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ONE PLANET DEVELOPMENTS LIMITED

PROPOSED SOLAR FARM AND BATTERY ENERGY STORAGE SYSTEM ON LAND ADJACENT TO THE A614, WORKSOP, S80 3PA

GLINT ASSESSMENT

MARCH 2024

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MARCH 2024

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EXECUTIVE SUMMARY

This report seeks to demonstrate the possible effects that reflected sunlight from a proposed solar farm would have on receptors in the vicinity. These receptors include residential properties, road, rail, air traffic and national trails. The methodology employs the use of:

- A Zone of Theoretical Visibility (ZTV) to identify whether local topography screens those receptors;
- A computer model to determine the times, dates and duration that glint may theoretically be visible; and
- A discussion of existing and proposed screening such that a realistic assessment of potential effects can be made.

The reflectivity of solar panels is considerably less than many other common materials seen in the built or natural environment. Water bodies such as reservoirs, lakes (and on a calm day the ocean) have very similar reflective properties to solar panels and represent much larger areas than that taken up by the solar panels at the Site. In any case, the overall potential for glint at receptors within the vicinity of the Site is low.

Most of the Observation Points (OPs) are too distant to have direct visibility of the panels, given the level of intervening vegetation and other screening. The OP that was progressed to further assessment (OP1) had 6,636 minutes of glint predicted, without taking screening into account. With screening, there is no visibility to glint causing panels.

None of the routes identified were predicted glint.

The roads that do not lie in the immediate vicinity of the Site are already screened by extensive vegetation and intervening topography. Glimpses of the solar farm, if any, from the perspective of a motorist using these roads, will pass very quickly, and in the unlikely event that there was any glint visible, it would be very weak and not have a material effect on the driver's ability to drive.

In all cases, any glint would be no worse than seeing a sunlight reflection off a window or still water, as solar panels have lower reflective properties than these materials and drivers are experienced in driving in conditions when the sun is low in the sky and far more intense than any glint effect.

Situated to the north of the Site, travelling through Worksop Station, the Northern Railway Line runs from Sheffield. Other railway lines include the London North Eastern Railway, which is situated to the east of the Site, running from Doncaster, through Retford, heading south

towards London. The Robin Hood Line from Nottingham runs northwards towards Worksop to the west of the Site, but it lies outside the study area of the Site. None of them lie within the ZTV and there is not expected to be any direct visibility to the Site. Glint will therefore not be an issue.

The nearest major aviation receptor is Retford (Gamston) Airport which is 2.8km to the northeast at its closest point. Other aviation receptors within 15km include Headon Farm which is 9.5km to the east, Darlton Airstrip which is 10km to the southeast, and the Three Counties Flying School which is located 13km to the northwest of the Site.

The flight paths at Retford (Gamston) were mostly predicted green glint. Additional consultation was undertaken with the airport and additional aviation receptors were assessed.

A decision was made to reorientate some of the panels (PV Array 7) from a bearing of 180^{o} to 205^{o} to minimise glint effects for aviation receptors. After this change, all aviation receptors at Retford (Gamston) Airport, were predicted to only receive green glint.

Only green glint was predicted on approach paths to the runways at Darlton Airstrip.

Only green glint was predicted on approach paths to the runways at Headon Farm airstrip.

Only green glint was predicted on approach paths to the runways at Three Counties Flying School.

1 INTRODUCTION

1.1 Study Area

1.1.1 This report undertaken by Wardell Armstrong examines the potential glint effects arising from a proposed solar farm on land adjacent to the A614, Worksop, S80 3PA.

1.1.2 This assessment studies the potential glint effects associated with the installation of solar photovoltaic arrays on land to the southeast of Worksop, Nottinghamshire, UK. The National Grid reference for the Site is 465422, 374895 (Easting, Northing).

1.1.3 This assessment considers the potential effects of glint caused by the proposed solar development on ground-based receptors and aircraft operations in the surrounding area. Figure 1.1 shows the Site boundary in red in the context of the surrounding land. The solar arrays will cover most of this area (see more detailed layout drawing in Appendix 6).

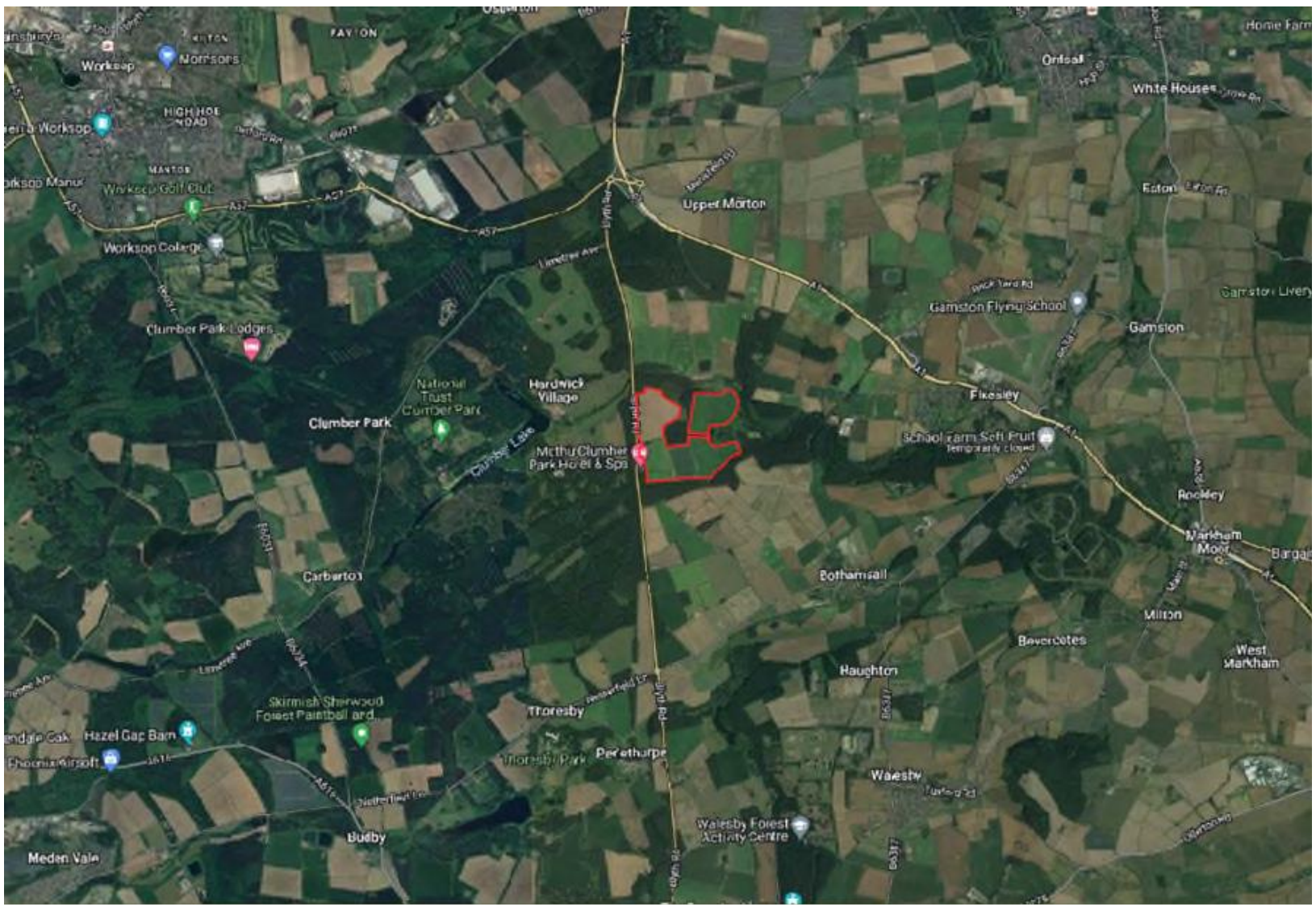


Figure 1.1: Satellite Photography of Site and Surroundings

(Google 2024; Image © Airbus; Image © Maxar Technologies; Image © 2024 Infoterra Ltd & Bluesky)

1.2 Panel Specifications

1.2.1 Only fixed-tilt panels are being considered for this installation, so only fixed will be modelled in this assessment.

1.2.2 The fixed-tilt panels will be set at an angle to the horizontal of 25 degrees and at a maximum height above ground level (agl) of 3.58m.

1.2.3 Following analysis undertaken as part of this glint assessment the panel layout has undergone a slight revision to avoid causing unnecessary impacts on flight circuits associated with Retford (Gamston) Airport. This layout change has subsequently been considered as embedded mitigation in this report and incorporated into all the modelling. The layout change involves the reorientation of an array of panels in the north-eastern corner of the Site which have been adjusted to face a bearing of 205degrees. These panels, which were previously causing unacceptable glint on some of the overhead circuits, now only produce glint at an intensity generally considered acceptable by aviation stakeholders.

1.2.4 Further variation in the angle or orientation of the proposed panels affects where and when any glint may occur.

1.2.5 Table 1.1 illustrates the specifications of the panels proposed for this Development with summarising the parameters used within the report.

Table 1.1: Panel Specifications	
Panel Type (fixed or trackers)	Fixed
Panel Orientation	Arrays 1-6 & 8: South (180deg bearing); Array 7: SSW (205deg bearing)
Panel Surface Type	Anti-reflective coating
Panel Height (m)	3.58m
Panel Angle (°)	25°

1.3 Defining Glint

1.3.1 Glint, glare and dazzle are often used interchangeably but are defined in this report as described in Table 1.2, below.

Table 1.2: Definitions of Glint, Glare and Dazzle	
Name	**Description**
Glint	Also known as a specular reflection is produced as a direct reflection of the sun on the surface of the solar panel. It occurs with the reflection of light from smooth surfaces such as glass, steel, and calm water.
Glare	A scattered reflection of light. Glare is significantly less intense than glint and is produced from rougher surfaces such as concrete, tarmac, and vegetation.
Dazzle	An effect caused by intense glint and glare, which can cause distraction, and if strong enough reduce the ability of the receptor (pilot or otherwise) to distinguish details and objects.

1.3.2 It is noted that different organisations and agencies apply slightly different definitions to these terms, and some refer to the terms glint and glare interchangeably.

1.3.3 Discussion on the guidance and legislation that currently exists relating to definitions and assessing glint effects from solar parks is included in Section 2 and in Appendix 1.

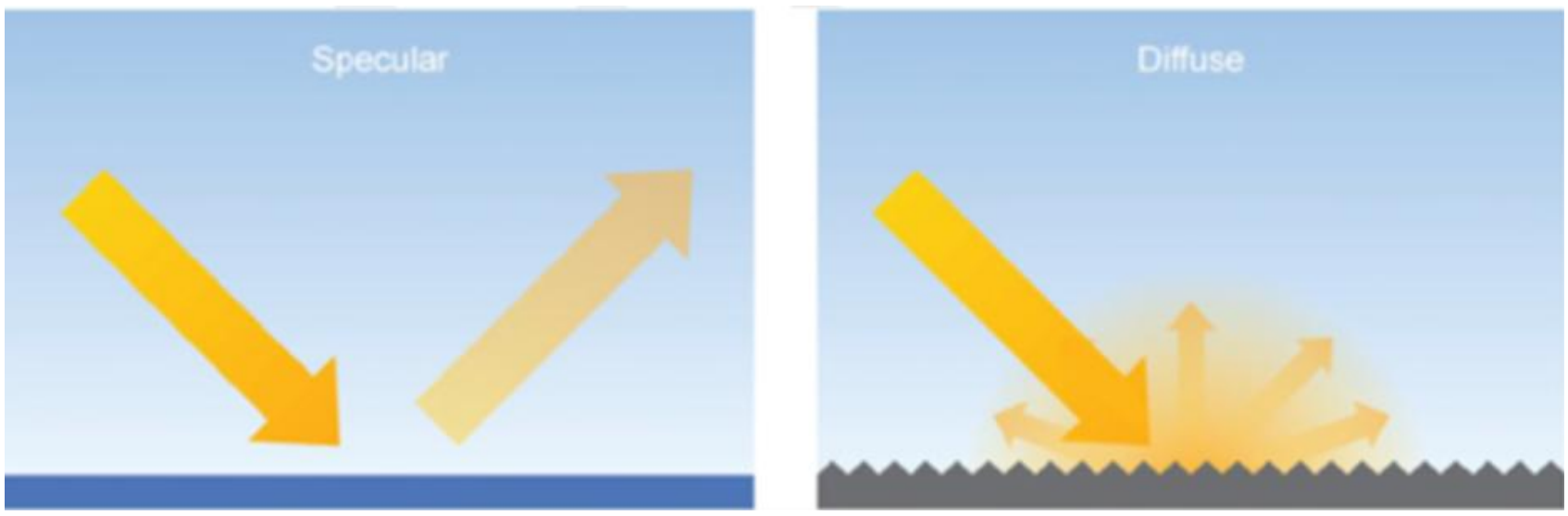


Figure 1.2: Types of Reflection, Specular or Glint (left), Diffused or Glare (right)

(Federal Aviation Administration 2010)

1.3.4 Figure 1.2: Types of Reflection, Specular or Glint (left), Diffused or Glare (right) illustrates the difference between glint, also known as specular reflection, produced as a direct reflection of the sun on the solar panel and glare which is a scattered or diffused reflection of light.

1.3.5 Due to the intensity of glint being much higher than glare, this report will focus on assessing glint effects alone. The perceived intensity of glint will vary depending on the ambient light level, direction and distance to the receptor.

1.4 The Reflectivity of Solar Panels

1.4.1 Solar PV panels are designed to absorb sunlight and convert it into electricity; they are not designed to reflect light, although there may still be a small unavoidable reflective component present. The glass which forms the surface layer of solar panels is specifically designed with a low iron content to aid the absorption of daylight and thus has a much lower level of reflectivity than the glass typically seen in conventional windows.

1.4.2 For example, with a 75deg angle of incidence, less than 9% of the total incident visible light is reflected, while normal glass reflects approximately 19% of light. If the panels have an anti-reflective coating applied reflectivity drops to about 5%. Thus, reflectance levels from a given solar site will be much lower than the reflectance generated by standard glass and other common reflective surfaces in the surrounding environment, although reflectance characteristics will also vary with the incidence angle, which changes as the sun moves across the sky.

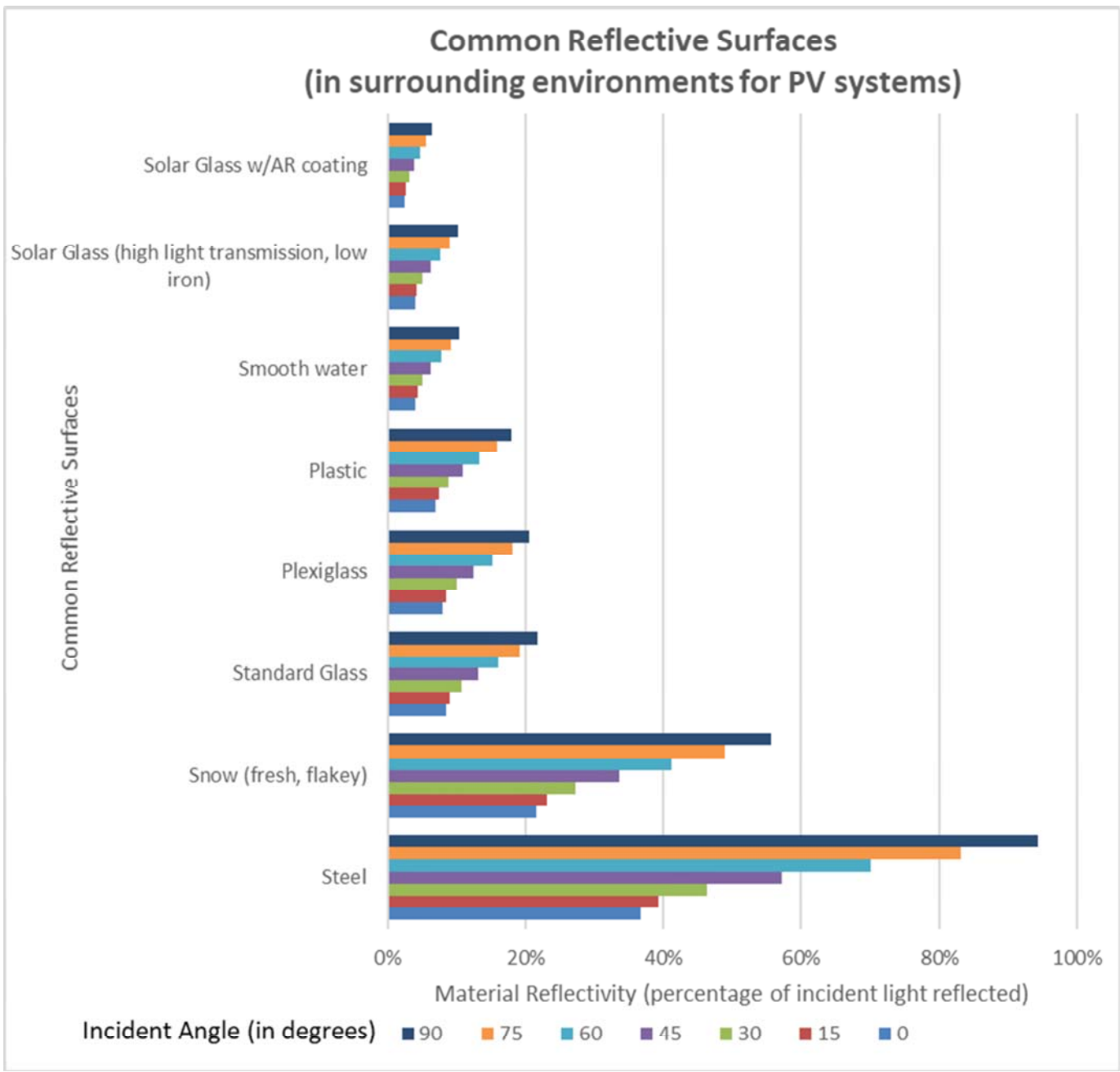


Figure 1.3: Reflectivity of Common Materials at Varying Angles of Incidence

(Based on data from Sunpower Corporation, 2009)

1.4.3 Solar panels have a comparable reflectivity to that of calm water and considerably lower than that of snow. Any glint that may occur would be less intense than that seen when flying over a reservoir on a calm day or a snow-covered landscape on a bright day. As can be seen from Figure 1.3 the reflectivity of light incident on solar glass is considerably less than light reflections from many other materials found in the built and natural environment, and it is approximately half that of standard glass.

1.4.4 Some commentators have suggested that solar panels may not be the only source of reflection from a solar farm. Although the steel mounts used to support the panels could reflect sunlight, following construction, the frames are usually well shaded by the solar panels above them and any exposed elements on the end of rows cover an extremely small area.

1.4.5 As distance from the glint source increases, the intensity of the event drops appreciably. This is due to a combination of factors including the diffraction of light after it reflects off the panel, atmospheric weather conditions such as the presence of particulates, haze, or low cloud, and the diminishing subtended viewing angle.

1.5 Occurrence of Glint

1.5.1 In the northern hemisphere, the sun appears to rise in the east and set in the west. For fixed, south-oriented solar panels, when the sun reaches a sufficient elevation in the morning sky to allow sunlight to strike the panels, ground glint can occur. When the sun's position in the sky attains a certain height, the reflected beam will be directed back into the sky towards the west. Put simply, with fixed panels on flat terrain, glint that has potential to affect ground receptors will normally only occur in the early morning or evening when the sun appears low in the sky.

1.5.2 In general, in the northern hemisphere, glint from south-facing solar arrays has potential to occur on land towards the west and southwest of the PV panels in the early morning and towards the east and southeast of the PV panels in the early evening. Glint will only usually occur in the morning or evening for fixed receptors but not both unless a receptor is to the immediate south of the solar array or positioned between multiple arrays.

1.5.3 Glint can only occur when direct sunlight can reach the solar panels. Diffused lighting, caused by weather conditions such as cloud, fog, and mist, cannot result in glint due to the low energy intensity of the light incident on the panels.

2 PLANNING POLICY, LEGISLATION & GUIDANCE

2.1.1 Specific policy, legislation and guidance relating to assessing glint effects from solar parks have been considered as part of this assessment and are summarised below. More details can be found in Appendix 1.

2.2 National Policy

2.2.1 UK National Policy Statements mentioning solar developments and/or glint include:

- *National Planning Policy Framework (NPPF) – December 2023*
- *National Planning Policy – Planning Practice Guidance – August 2023*
- *Overarching National Policy Statement for Energy (NPS EN-1) - November 2023*
- *National Policy Statement for Renewable Energy (NPS EN-3) – November 2023*

2.3 Local Policy

2.3.1 Local Policies specific to Normanton Larches Solar Farm, Nottinghamshire include:

- Policy DM10: Renewable & Low Carbon Energy. Bassetlaw District Council North Nottinghamshire. December 2011. Core Strategy & Development Management Plan[1]. It is noted that the Core Strategy & Development Management Plan will soon be replaced by the emerging Bassetlaw Local Plan. The relevant policy requirements are not significantly different between the two and both are considered to be equally addressed in the assessment below.

2.4 Guidance

2.4.1 In the UK, at the domestic level, the closest guidelines regarding glint are the BRE guidelines on 'Site layout planning for Daylight and Sunlight'. Other guidance also exists relating to aviation and equestrian receptors, the details of which are provided in **Appendix 1.**

2.4.2 The relevant guidance includes:

- *BRE guidelines: Site Layout Planning for Daylight and Sunlight: A guide to good practice*
- *Aviation Guidance from Civil Aviation Authority (CAA)*

[1] cs1adoptedcorestrategy.pdf (bassetlaw.gov.uk)

- *The Combined Aerodrome Safeguarding Team (CAST) – July 2023*
- *Federal Aviation Administration (FAA)*
- *The British Horse Society - Jan 2023*

3 METHODOLOGY

3.1 Glint Analysis

3.1.1 A geometric analysis is conducted to study where and when glint events may occur. This examines receptors present at ground level, such as dwellings, roads, national waymarked trails, and railway lines. Receptors are identified using available mapping, aerial photography, and street level imagery. Details of the mathematical calculations used, including limitations are provided in Appendix 3.

3.1.2 The glint analysis is completed in several stages using various methods, software models and tools to progressively assess the potential for glint effects, while building an understanding of the local environmental conditions either existing or proposed that impact the potential for glint in the local area. The stages and tools used in the assessment are discussed below.

3.2 Zone of Theoretical Visibility (ZTV)

3.2.1 The first stage in the glint assessment is to identify those receptors which have the potential to receive glint. The 'bare earth' Zone of Theoretical Visibility (ZTV) is a computer model which determines whether any part of the site is visible from land surrounding the site based on local topography only; it does not account for screening from surface obstacles such as trees, hedgerows, or buildings, it only considers the landform itself. Therefore it does not determine whether views of the site will exist, but rather whether they can theoretically exist if no surface features are present. It is calculated as described below and is an effective tool used to reduce the study area and eliminate multiple receptors that have no risk of experiencing glint.

3.2.2 A selection of sample points is identified on the site boundary and on land contained within the site. Sample points are chosen as it is unfeasible to perform this calculation on every panel on site. Terrain data in the form of a Digital Terrain Model (DTM) forms the basis for determining whether the site could be visible at local receptors. The DTM comprises a grid of cells where each cell has a given height value and the GIS allows this data to be displayed graphically.

3.2.3 Terrain data comes in various resolutions determined by the cell size, which dictates the overall accuracy and quality of the terrain data. The analysis uses OS Terrain 50 data which has a 50m resolution. The data used is considered to be sufficiently accurate for the purposes of modelling a ZTV.

3.2.4 The model predicts whether any of the sample points are visible out to 5km using a line-of-sight calculation between each cell and each sample point. The calculation assumes the sample points are the maximum panel height, 3.58m above ground level in this case, and an observer height of 1.8m representing the eyeline of a tall person standing up. The output is called a viewshed. For clarity, the output viewshed is converted to show binary results. Irrespective of whether a cell has visibility of one sample point or 100, they are both given a positive result, as opposed to no visibility which is ascribed a negative result.

3.3 Geometric Analysis

3.3.1 The detailed geometric analysis uses a software model to make a prediction on the dates, times and durations of glint effects at fixed positions over the course of a year. The software calculations are complex and completed in several stages. Descriptions of the main calculations are provided in Appendix 3. The software used is the GlareGauge tool that was originally developed in the United States by the Sandia National Laboratory and since improved upon and licensed to ForgeSolar. The times reported as to when glint may occur are reported in Coordinated Universal Time (UTC) and therefore any relevant daylight savings should be considered when observing the results.

3.3.2 The computer model predicts whether glint effects are possible at a 1-minute temporal resolution over the course of a full year. The model accounts for the maximum panel height, the area taken up by the panels and a fixed observer height.

3.3.3 Any glint that is predicted is classified as either 'green glint' or 'yellow glint'. Green glint is defined as '*low intensity glint with low potential for temporary after image*'. Yellow glint is '*medium intensity glint with some potential for temporary after image*'. Temporary after image is phenomenon whereby an image remains momentarily visible on the retina when looking away from a bright light source. Red glint is theoretically possible but even the looking directly towards the sun is still only classified within the yellow intensity band, so red glint would require sunlight to be actively focused at a particular point, such as may occur at a parabolic collector.

3.3.4 It is important to understand certain limitations within the model. The model calculates its results based on the geometric relationship between the observation point at a fixed height, the reflective plane (panels) at a fixed height, and the position of the sun at each time interval as it progresses across the sky. It therefore takes no

account of any screening features whatsoever. It does not account for surface features such as buildings or trees or intervening topography. The software also assumes it is sunny, at the maximum intensity possible, 365 days per year. The computer model suggests when glint 'can' happen not when it 'will' happen, which is why further interpretation by the assessor is essential.

3.3.5 The results are processed, and key information is provided, as reported by the model with its inherent limitations, in Appendix 4. It is important to interpret these results in the context of the wider assessment and the methods and limitations discussed. These results are further refined to account for local prevailing weather conditions such as cloud cover.

3.3.6 Despite the computer model not accounting for screening features directly, other tools are used in the assessment that do take this into consideration such as the ZTV, aerial photography, site visit photography, mapping and observations made by the design team.

3.4 Screening

3.4.1 Features such as intervening vegetation, buildings, and topography can partially or completely screen solar arrays from ground-based receptors. If a receptor has reduced visibility of the arrays, glint will also be reduced, or eliminated altogether if there is no line of sight.

3.4.2 To assess whether a receptor can receive glint in practice, any available reference sources including aerial photography, site visit photography, and online street imagery at potential receptors are inspected for screening. If the arrays are completely screened from a receptor, the results from the computer analysis do not apply.

3.5 Assessment of Effects

3.5.1 Raw results provided by computer simulation assume that sunshine hours comprise 100% of daylight hours. To provide a more realistic assessment of the anticipated effects, the raw results are adjusted for local weather conditions by multiplying them by the maximum ratio of sunshine hours to daylight hours based on historical local trends. This is examined along with screening for each receptor to determine the overall level of glint expected after accounting for local environmental conditions.

3.6 Cumulative Effects

3.6.1 The assessment considers the potential for cumulative glint effects caused by both the Proposed Development and other existing or consented PV developments in the vicinity. Effects on receptors from the other solar PV sites are assessed alongside the Proposed Development to determine the overall level of cumulative effect expected, using the methods described above. The cumulative assessment is provided in Section 5.7.7.

3.7 Software, Data and Methods

3.7.1 The assessment methodology has been developed over more than a decade, having been used to complete hundreds of glint assessments across the UK and elsewhere. Improvements and adjustments to the methodology are applied as and when better data, updated methods, software, and guidance become available, in addition to incorporating changes in best practise techniques, consultee engagement and regulatory or policy updates.

3.7.2 Regular improvements are made to the algorithm and implementation of the ForgeSolar model used in the geometric analysis. Recent changes have included adding some capability to model specific visual obstructions such as woodland blocks, and improvements to how reflected light is modelled in the software. The latter of these changes now account for scattering of reflected sunlight which spreads from the glint source (PV modules) as opposed to behaving like a laser beam. Once the scattering is incorporated into the calculations, different parts of the site can produce glint at the same receptor at the same time, in addition to increasing the theoretical time when glint is reported to occur. The calculations also make use of a random number generator in the results to significantly reduce the time taken for the calculations to be completed. This can cause small variations in the results between runs of the software but is an important improvement to ensure more practicable results can be calculated.

3.7.3 It should be noted that aviation regulators in the United States, where the model is produced and maintained, are aware of the ongoing improvements to the model. Details of the mathematical calculations and limitations are provided in Appendix 3.

4 BASELINE

4.1 Introduction

4.1.1 A baseline survey was conducted using desktop survey analysis. An understanding of the Site, the local weather conditions and key receptors needed to be established in order to identify when glint can theoretically occur and where glint can occur.

4.1.2 The baseline boundary was determined by the ZTV. The receptors identified below are situated in the ZTV as any receptors outside this area will have no visibility to the panels and will not be able to receive glint.

4.2 Site Description and Context

4.2.1 The Site comprises five fields of agricultural land currently used for arable agriculture and bordered by mature woodland. The site is mainly flat with one field sloping gently north down to the River Poulter. There are minimal existing properties and establishments in close proximity to the Site Boundary, except for a hotel and spa which is situated next to the western boundary of the Site. Surrounding almost all sides of the Site is thick woodland providing extensive coverage to the Site.

4.2.2 The surrounding landscape comprises farmland and woodlands with the nearest village (Bothamsall) 2km to the southeast.

4.3 Weather Patterns

4.3.1 Figure 4.1 shows the total number of daylight hours available each month (red) based on the regional variation for the site. Also shown is the average number of hours of sunshine each month (blue), taken from The Meteorological Office data recorded at Sheffield (this is the closest active weather station to the site for which the historic sunshine data is available). Sheffield is approximately 33km from the Site and is expected to be broadly representative of the weather conditions that the site will experience.

4.3.2 Figure 4.1 also shows the ratio of sunshine to daylight displayed as a percentage (green) for each month at the site. As can be seen, the sunniest month on average was June with 180 hours of sunshine. Even then, conditions suitable for glint events to occur are only expected to be present approximately 35.7% of the theoretical maximum. This is because the ratio of sunshine to daylight is approximately 35.7% at this time. During more sunny months, glint events may occur for 36% of the theoretical maximum because the ratio of sunshine to daylight is slightly more at this

time (in this case, in May). During less sunny months, glint events may occur for as little as 15.6% of the theoretical maximum because the ratio of sunshine to daylight is much less at these times. The average percentage of sunshine hours to daylight hours is 29%.

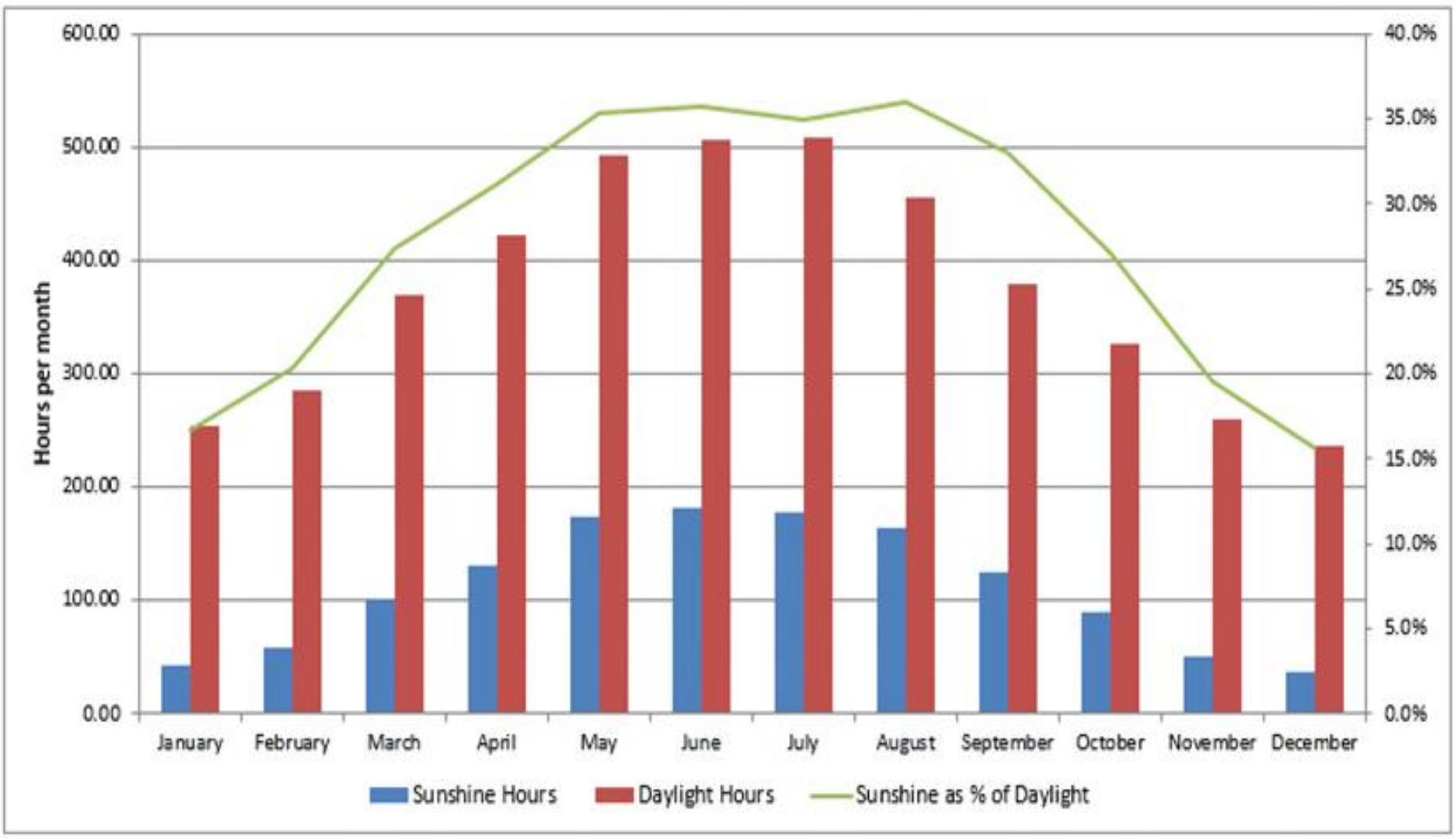


Figure 4.1: Number of Daylight and Sunshine Hours per Month in Sheffield

4.4 Roads

4.4.1 There are numerous roads and small country lanes within the 5km study area of the Site. Not all of these roads will need to be assessed as many are outside of the area within which effects could theoretically be received. Studies have therefore focused on road receptors lying within the ZTV. Where receptors such as roads cross areas within the ZTV, only those sections within the area predicted to have capacity to receive glint have been assessed. There are seven routes identified in the vicinity of the Site, but only three of these have any potential for visibility. These three (nominally Routes 1-3) have been considered in more detail in the assessment. The full list includes the following:

- Route 1 – Blythe Road
- Route 2 – Cross Lane

- Route 3 – West Drayton Avenue
- Redhill Lane
- A1
- B6387
- Single unnamed tracks

4.5 Public Rights of Way (PRoW)

4.5.1 The Robin Hood Way runs through the woodland immediately to the south of Site.

4.5.2 There are no other National Trails within the Study Area.

4.5.3 There are several PROWs that run to the north and the south of the Site but do not traverse the Site.

4.5.4 Due to the woodland blocks surrounding the solar farm, there is likely to be little visibility of the Site from paths outside the Site Boundary.

4.6 Railway

4.6.1 Situated c.3.2km to the north of the Site, travelling through Worksop Station, the Northern Railway Line runs from Sheffield. Other railway lines include the London North Eastern Railway, which is situated c.6.25km to the east of the Site, running from Doncaster, through Retford, heading south towards London. The Robin Hood Line from Nottingham runs northwards towards Worksop c.10km to the northwest of the Site at its closest point, but it lies outside the study area of the Site.

4.7 Aviation

4.7.1 Retford (Gamston) Airport is 2.8km to the northeast at its closest point. Other aviation receptors within 15km include:

- Headon Farm is 9.5km to the east;
- Darlton Airstrip is 10km to the southeast; and
- Three Counties Flying School is located 13km to the northwest of the Site.

4.8 Fixed Receptors

4.8.1 There are also a number of dwellings and commercial premises within the study area and within the ZTV. In some cases, the identified receptor is considered to be representative of several discrete receptors in close proximity. For the purposes of this report these receptors are called Observation Points (OP) and include:

- OP1 – Muthu Clumber Park Hotel and Spa
- OP2 – Plevin Elkesley Depot
- OP3 – Residential Properties on Coalpit Lane

4.9 Cumulative Effects

4.9.1 There is currently one operational solar farm in the immediate vicinity of the Proposed Development. This existing site, Wakers Wood Solar Park (14/00681/FUL)[2] is situated 3.5km to the north of the Normanton Larches Site.

4.9.2 There are several developments to the southwest of the Site, but these sit outside the 5km study area and are dismissed from further assessment.

4.9.3 There are a range of other common materials and surfaces likely to cause glint that are already present in the study area. These include, inter alia:

- glass in windows;
- conservatories or greenhouses;
- polythene used in agricultural practices;
- exposed metal surfaces;
- flashes caused by light reflecting off passing vehicles; and
- waterbodies.

4.9.4 In the wider area (beyond 5km) there are a number of other solar solar developments which form existing sources of potential glint, but the distance between these and the Site is such that the intensity of any effect would be low and there is very little likelihood of any intervisibility.

4.9.5 It is not possible to accurately quantify the full level of glint currently experienced by receptors in the vicinity of the Site, as there are a huge variety of sources, wide spread of receptors and some reflections could arise from mobile sources such as moving vehicles. For the purposes of this assessment, it is therefore presumed that no baseline glint currently occurs at these receptors.

[2] Renewable Energy Planning Database | BEIS & Barbour ABI (barbour-abi.com)

5 ASSESSMENT OF EFFECTS

5.1 Introduction

5.1.1 Figure 5.1 shows the approximate geographical extent of potential ground glint events. For a glint event to occur on the ground the receptor must be in the zone of theoretical visibility (ZTV). The ZTV is based on a worst-case scenario with 3.58m high panels, a receptor viewing height of 1.8 m and OS Terrain 50 data at a 50m resolution.

5.1.2 As described in the methodology section above, the ZTV shows the locations in the surrounding area from which any part of the solar farm has the potential to be visible. It uses a bare earth model and does not account for screening by surface obstacles but does account for screening from topography. So, while a point may lie within the ZTV, further inspection of the Site, the receptor, and the intervening land could reveal that it cannot receive glint, which will be discussed in detail where relevant.

5.1.3 Receptors would have to be able to see the panels to experience glint events and this may not be possible due to screening from intervening hedgerows, trees, buildings, or other surface features. When the sun is not shining directly onto the panels due to cloud cover, rain, mist or other weather (i.e. approximately two thirds of daylight hours during the year), it will also not be possible for glint to occur.

5.1.4 Inspection of aerial photography and ground level imagery may suggest that glint will not be visible in some locations due to screening. Figure 5.1 shows an overhead view of the Proposed Development area, shown in red outline, and the ZTV shaded purple, out to 5km from the Site (shown in orange dashed line). The ZTV and 5km study area are also shown more clearly in drawing BR10356_001 in Appendix 2.

5.1.5 The receptors identified in the Baseline Section are dismissed from detailed assessment if they are not predicted to receive glint by the computer model, or if they are found to have no visibility of the Site.

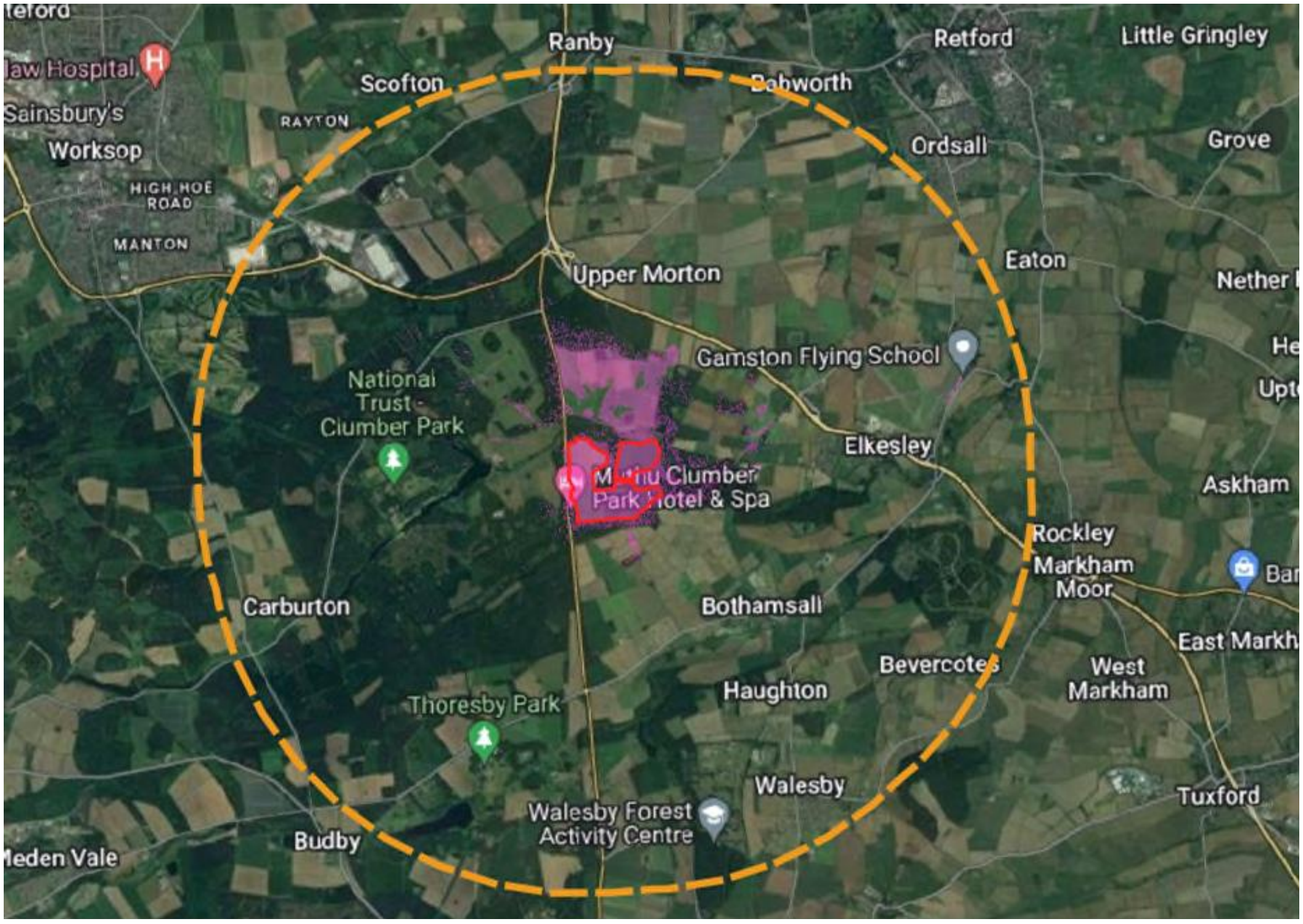


Figure 5.1: Development Boundary (red) and ZTV (purple) within 5km of Site

(Google © 2024 – Imagery © 2024, Data SIO, NOAA, U.S Navy, NGA, GEBCO)

5.2 ForgeSolar

5.2.1 The software used to predict the glint effects is ForgeSolar, with the calculations behind the modelling described further in Appendix 3.

5.2.2 In order to model the panels in the software accurately, the arrays have been separated into eight discrete areas to prevent the over prediction of glint effects. This helps to avoid a limitation in the software whereby convex shapes are assumed to contain panels. The modelled panel array area was therefore divided into the constituent parts, as denoted in Figure 5.2 below.

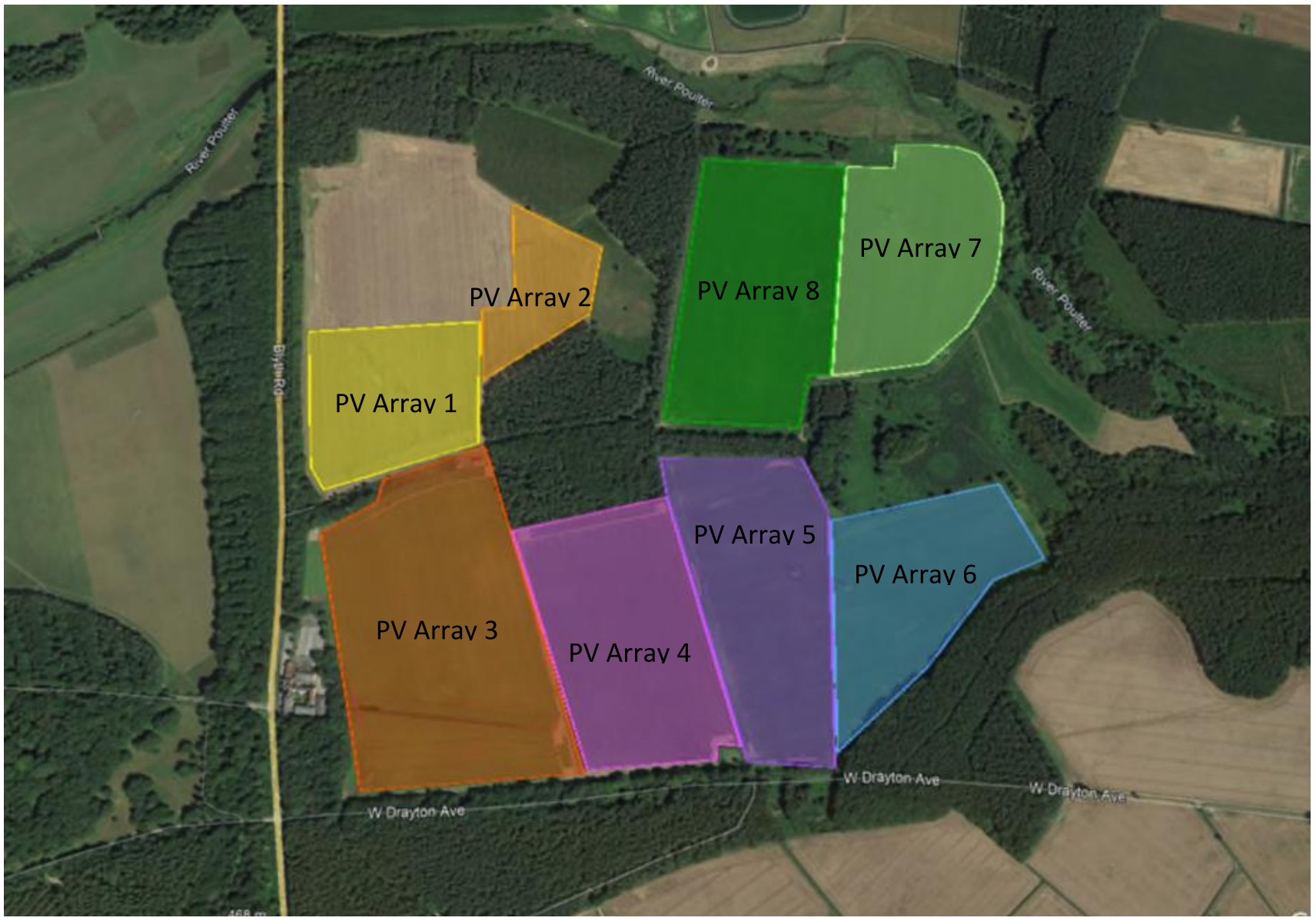


Figure 5.2: Panel Array Allocation in ForgeSolar
(Google © 2024 – Imagery © 2024, Airbus)

5.2.3 It should be noted that, while the direct output from ForgeSolar does not take into account potential duplication of glint at one receptor from multiple panel areas (as indicated in Appendix 4), the results discussed in this Chapter have been corrected to remove potential duplications of timings so represent total predicted annual glint duration.

5.3 Routes

5.3.1 There are a number of routes within the 5km study area comprising national, regional, and local roads. There are no motorways within the study area. Motorists are, as a matter of routine, used to driving towards the sun which provides a much more intense source of light than glint. Notwithstanding this, roads within the immediate vicinity of the Site have been assessed for glint effects.

5.3.2 Stretches of roads and routes that lie within the ZTV have been identified and selected for computer simulation. Although the dates and times when glint has the potential to be visible for specific stretches of the road may vary, the results reported are expected to be representative of the route in general. It should be noted that the glint results (dates and times) reported by the model do not account for screening which will limit or eliminate the potential for glint effects. The results reported should therefore be placed in context with the discussion of screening which is provided for each road. The durations reported are the extents of when glint effects could be geometrically possible, but glint would not occur continuously during that period.

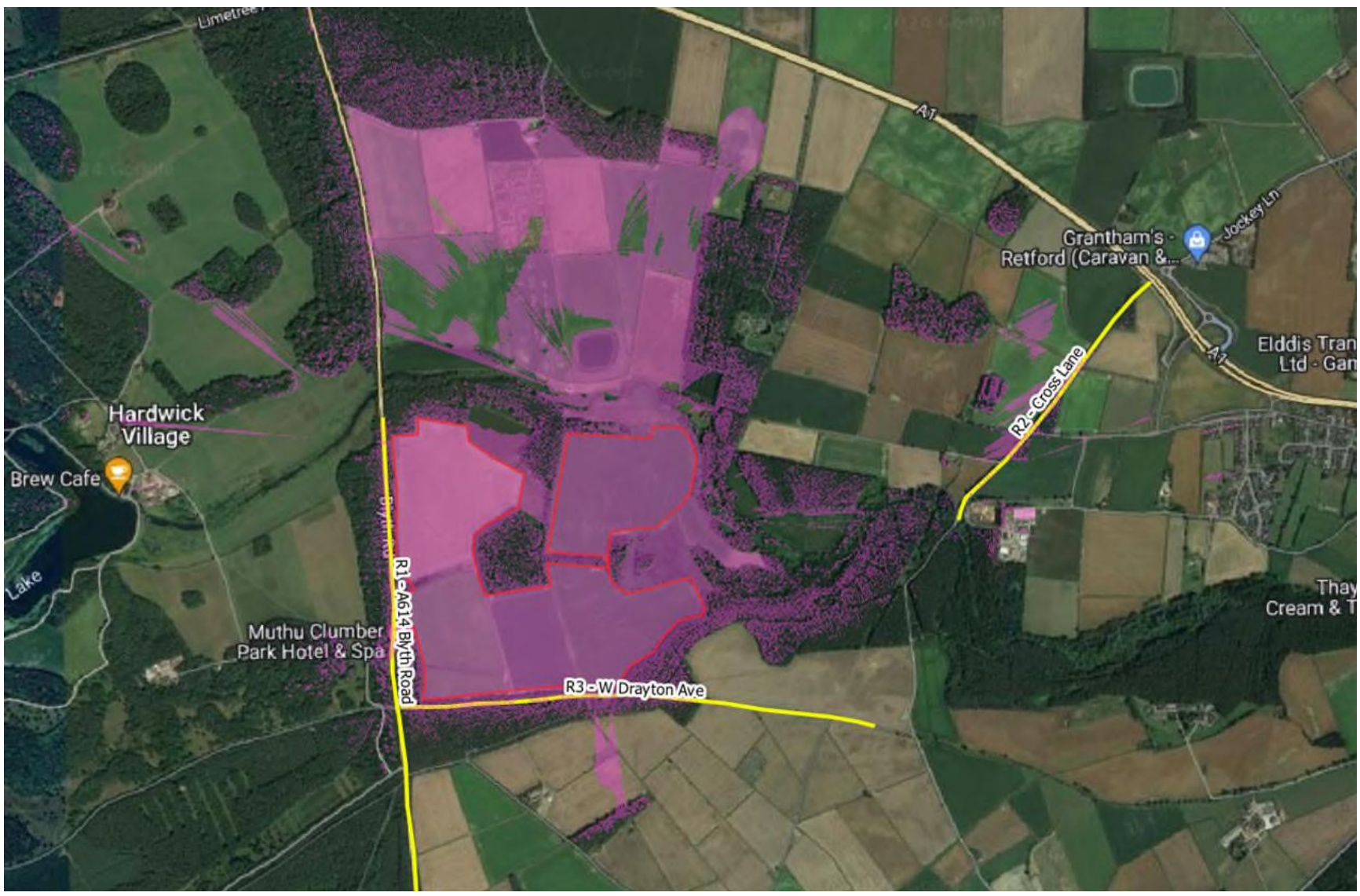
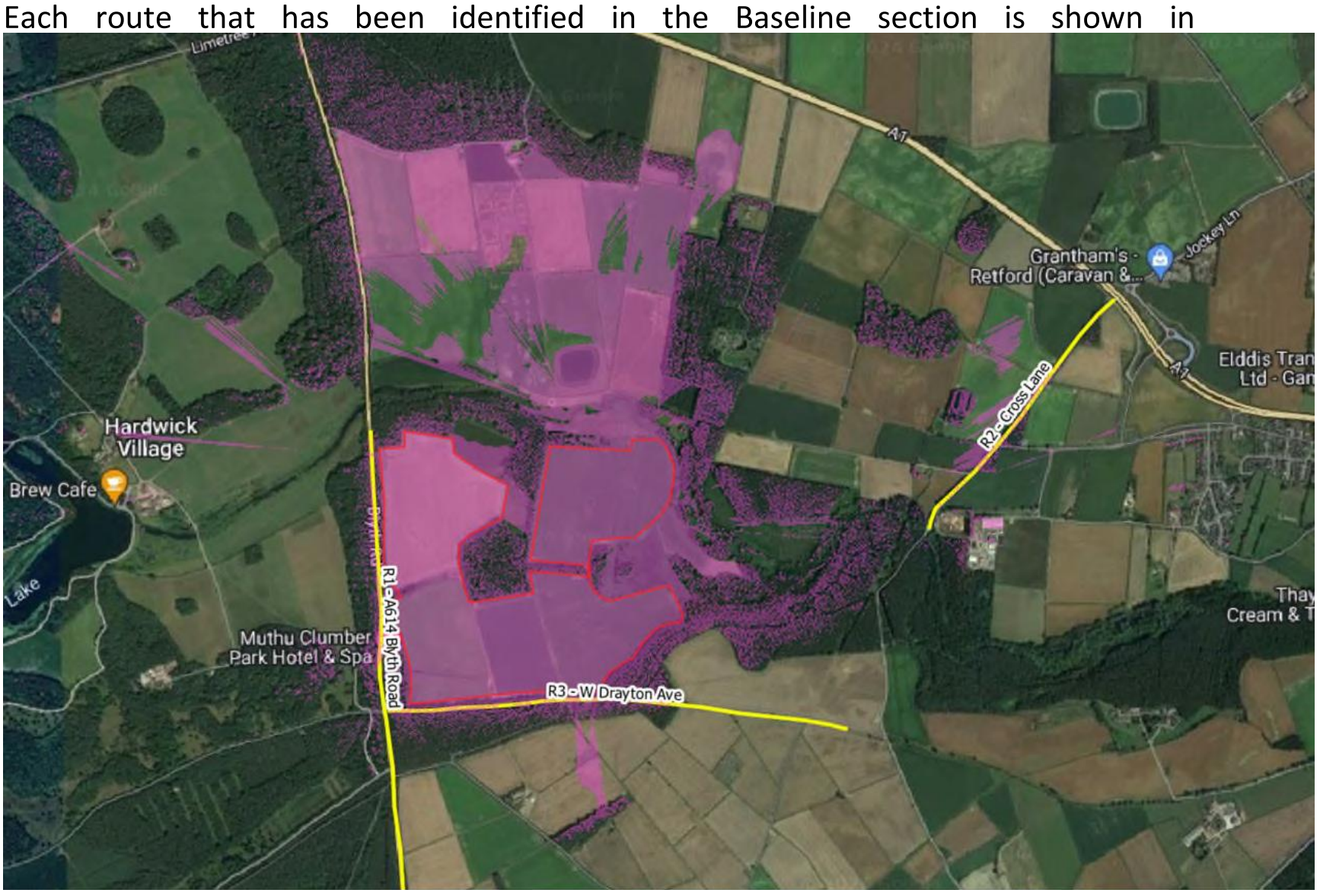


Figure 5.3: Routes (yellow) within ZTV (purple) with Site Boundary (red)
(Google Earth © Google Image © 2024 Bluesky, Landsat)

5.3.3 Each route that has been identified in the Baseline section is shown in



5.3.4 Figure **5.3** above. The routes that have been modelled are those closest to the Site and are more likely to receive glint. All the routes modelled are at least partially or completely within the ZTV and within 5km of the Site.

5.3.5 The routes identified in the Baseline section have undergone desk-based analysis for screening, visibility to the Site and whether they need further assessment. The results are displayed in Table 5.1.

Table 5.1 Elimination of Baseline Routes from Further Assessment

Route	Screening	Level of Visibility to the Site	Progressed to further assessment/Dismissed
Route 1 – A614 Blyth Road	Route 1 represents the A614 which is heavily screened by the presence of thick woodland which lines the road and the Site. The only break in the screening is at the hotel carpark entrance where there are gaps in the trees that line the edge of the carpark and the Site.	There is minimal to no visibility to the Site except from small gaps providing limited visibility along the hotel carpark.	Progressed to further assessment

Route 2 – Cross Lane	This route is the road that connects to the A1 and is to the northeast of the Site. The route is partially within the ZTV. The road is a single-track road and is well screened from the Site.	There is minimal to no visibility to the Site.	Dismissed
Route 3 – W. Drayton Ave	This section of the route is directly to the South of the Site. There is a thick line of woodland that acts as thick screening to the Site.	There is no visibility of the Site and so the route is dismissed from further assessment.	Dismissed

5.3.6 Of the routes analysed from the Baseline, only Route 1 (A614 Blyth Road) was found to have visibility of the Site such that glint could have a potential impact on receptors. This route was chosen to be modelled in the ForgeSolar software.

5.3.7 Table 5.2, below, illustrates the annual duration of glint at Route 1 prior to taking weather conditions and screening into account.

5.3.8 Between the road and Site is a 35m wide line of mature deciduous woodland and, as part of the Landscaping Plan, a new 15m wide scrub belt will be created to further enhance the screening of the Site from the road. From the perspective of a motorist using these roads, if there were any glimpses of glint it would be very low intensity and pass very quickly, having no material impact.

5.3.9 In reality, the model predicts that no glint will be visible along this route.

Table 5.2: Modelling Results for Public Roads

Road	Maximum Annual Duration (minutes)	Earliest Start Time	Latest End Time	Earliest Start Date	Latest Finish Date
Route 1 – A614 Blyth Road	0	-	-	-	-

5.4 PRoW

5.4.1 No PRoWs were identified traversing the Site. There are some bridleways and paths surrounding the Site, but they are screened by the thick forest that encompasses the Site.

5.4.2 Any remaining glimpses of the PV panels from the PRoW between the trees, especially for users of the Robin Hood Way to the south of the Site (see assessment of the West Drayton Avenue route above), have the potential to slightly change the outlook for walkers, but this would be confined to a short distance (relative to the total length of

the PRoW) and it would not equate to 'harm'. There is no risk posed to the health and safety of users of these footpaths and bridleways due to the presence of the solar farm.

5.5 Railway

5.5.1 Situated to the north of the Site, travelling through Worksop Station, the Northern Railway Line runs from Sheffield. Other railway lines include:

- London North Eastern Railway, which is situated to the east of the Site, running from Doncaster, through Retford, heading south towards London; and
- The Robin Hood Line from Nottingham runs northwards towards Worksop to the west of the Site, but it lies outside the study area of the Site.

5.5.2 The railway lines and any stations were dismissed from further assessment as none lie within the ZTV and/or 5km study area.

5.6 Aviation

5.6.1 Initial consideration has been given to the effect of the solar farm on nearby airports and on aircraft flying over or near to the Site.

5.6.2 The nearest major aviation receptor is Retford (Gamston) Airport which is 2.8km to the northeast at its closest point. Other aviation receptors within 15km include:

- Headon Farm - 9.5km to the east;
- Darlton Airstrip - 10km to the southeast; and
- Three Counties Flying School - located 13km to the northwest of the Site.

5.6.3 Glint effects were initially modelled for critical flight times (2-mile final approach paths) at each runway at Gamston Airport.

5.6.4 The computer model used, ForgeSolar, is of industry standard, approved and recommended by regulators in the United States and aviation authorities around the world. The model is regularly upgraded to account for technological progression and to improve accuracy. Details of the computer model can be found in Appendix 3.

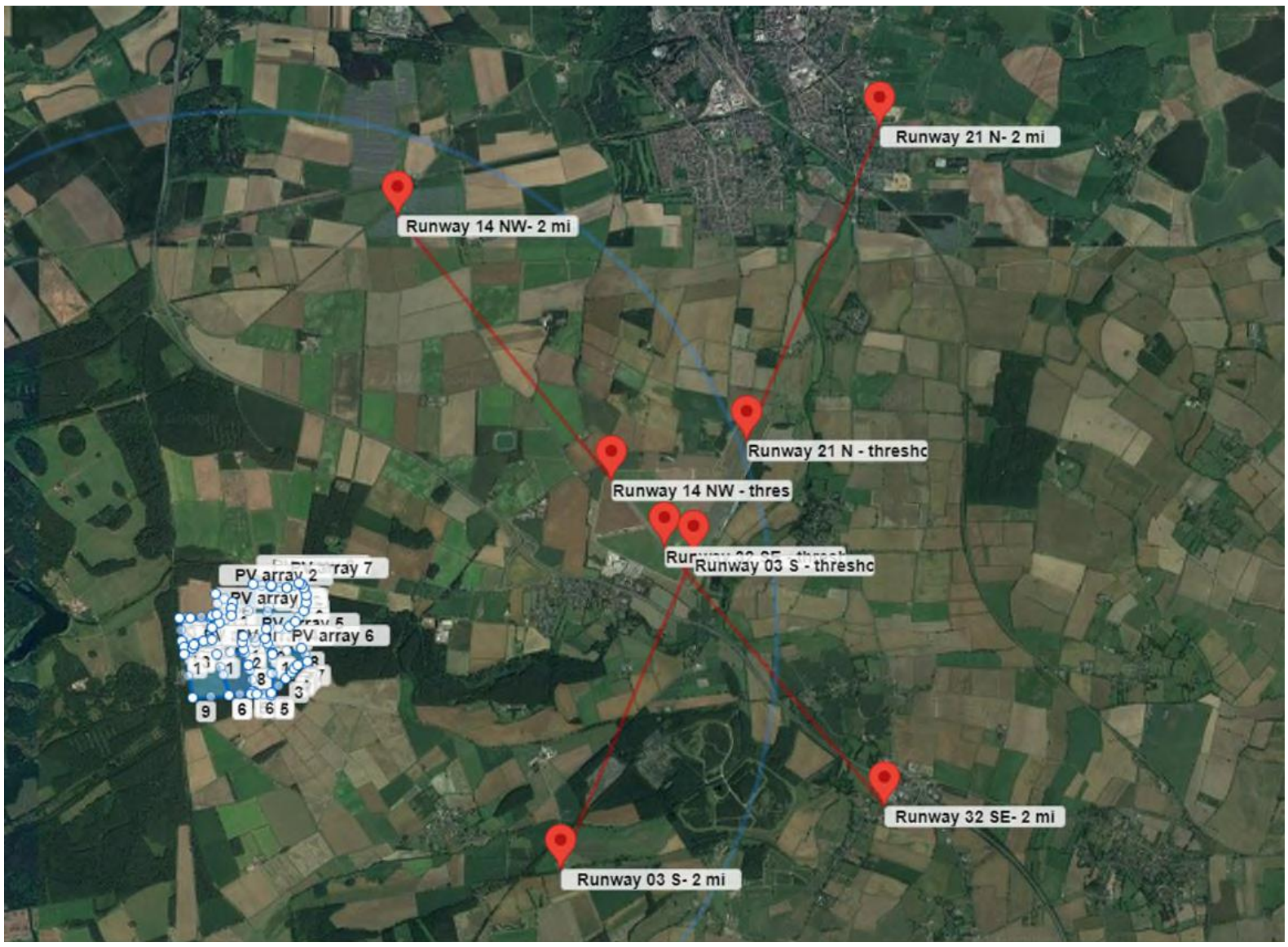


Figure 5.4: Flight Paths at Gamston Airport
(Google Earth © Google Image © 2024 Bluesky, Landsat)

5.6.5 Of the flight paths analysed, only Flight Path: Runway 32 SE was predicted to receive glint. This was the approach to the southeast of the Site to Runway 32. It extends two miles out, parallel to the runway, from a point 15.24m above ground level at the runway threshold. The angle of descent is assumed to be a three-degree glide angle.

5.6.6 Along the Flight Path: Runway 32 E, green glint is predicted from all the individual solar arrays with a source area coming from the whole Site.

5.6.7 On this Flight Path a combined 4,712 minutes of lower intensity ‘green’ glint (i.e. glint with low potential for temporary after image) was predicted to be possible between the hours of 17:10 and 18:50 GMT, during March and October, as shown in Appendix 4.

5.6.8 Green glint does not exceed the tolerable thresholds for pilots on final approach within the FAA's most recent guidance. Therefore, glint is not expected to have a material impact on aircraft landing at this airfield. Any effects would be comparable or less than reflections from large bodies of still water or cars in the airport carparks.

5.6.9 Given the proximity of the solar farm to the Retford (Gamston) Airport, it was considered prudent to open a dialogue with the airport operators. As result, the Airport has requested that a series of specific scenarios be further modelled to analyse effects that may occur when aircraft are carrying out designated manoeuvres near the aerodrome. These results have been compiled into a separate Aviation report which has been sent to the airport for its consideration.

5.6.10 Essentially, a series of discreet points have been modelled along the flight paths associated with the overhead circuits that would be performed by aircraft near coming into land at the airport. These points have been determined by the airport to provide them with the information that they require. The circuits are fixed at different altitudes for different types of aircraft. The aviation report concludes that, following the reorientation discussed, only 'green glint' is predicted at all of the points requested to be assessed. Green glint is low intensity glint with low potential for temporary after image and it is usually considered acceptable for all receptors other than air traffic control towers.

5.6.11 Dialogue remains open and it is anticipated that the layout changes that have been implemented as a result of this work (i.e. the reorientation of Array 7 to 205degs to face broadly towards the SSW) will enable the Airport to support the solar farm.

5.6.12 The detailed Aviation Report has been appended to this glint assessment to provide further context on the aviation assessment that has been undertaken. See Appendix 5 for further detail.

5.7 Fixed Ground Receptors

5.7.1 A total of three observation points (OPs) were identified within the 5km study area as having potential for glint. As the Proposed Development will exclusively use fixed-tilt panels, mostly orientated directly southwards, with just Array 7 facing 205degs, a number of other OPs were directly eliminated as they were positioned to the north of the Site and therefore there would be no glint potential for these receptors.

5.7.2 In one case, the receptor selected is intended to represent more than one property in the immediate vicinity of one another. Although the levels of screening differ slightly for the different individual dwellings, the general level of glint recorded will be about the same for all of that group of surrounding properties.



Figure 5.5: Fixed Ground Receptors identified in the Baseline that lie in the ZTV
(Google Earth © Google Image © 2024 Bluesky, Landsat)

5.7.3 It is important to understand the level of intervisibility between the receptor and the Proposed Development as this will determine whether any glint is able to arrive at the receptor. Figure 5.5, above, shows the extent of woodland in the vicinity of the Site.

5.7.4 For the solar panel layout, the glint effects will be visible to the east and west of the Site, when the sun is low in the sky, with a small amount visible to the south. It will not be possible for reflections to reach receptors located towards the north of the solar PV panels as the south facing pitches of the arrays will prevent this from happening.

5.7.5 The fixed ground receptors or Observation Points (OPs) identified in the Baseline section underwent desk analysis for screening, visibility to the Site and whether they need further assessment. The results are displayed in Table 5.3.

Table 5.3: Elimination of Baseline Ground Receptors from Further Assessment			
Observation Point (OP)	**Screening**	**Level of Visibility to the Site**	**Progressed to further assessment/ Dismissed**
OP1 – Muthu Clumber Park Hotel and Spa	This OP represents the hotel that is situated on Route 1 to the west of the southwestern boundary of the Site. There is some visibility through the gaps in the trees that line the carpark. Otherwise, the receptor is well screened.	There is some visibility to the Site at a small section of the OP.	Progressed to further assessment
OP2 – Plevin Elkesley Depot	This represents a depot to the east of the Site. It is well screened due to the presence of thick, extensive woodland that surrounds the Site.	There is no visibility to the Site	Dismissed from further assessment
OP3 – Residential Properties on Coalpit Lane	This OP represents a cluster of residential properties to the northeast of the Site on the edge of Elkesley. There are layers of screening provided by the surrounding woodlands to the Site.	There is no visibility to the Site	Dismissed from further assessment

5.7.6 Of the ground receptors analysed from the Baseline, only OP1 – Muthu Clumber Park Hotel and Spa to has visibility of the Site such that glint could have a potential impact on receptors. This one receptor was chosen to be modelled in the ForgeSolar software and assessed for glint.

Table 5.4: Modelling Results for Local Properties					
Observation Point (OP)	**Maximum Annual Duration (minutes)**	**Earliest Start Time**	**Latest End Time**	**Earliest Start Date**	**Latest Finish Date**
OP1 – Muthu Clumber Park Hotel and Spa	6,636	05:27	-06:27	15/03/2024	25/09/2024

5.7.7 Although the earliest and latest times and dates when glint is expected to occur is reported in Table 5.4, glint would not occur continuously between these periods throughout the year. These represent the limits of when glint effects are predicted to be capable of occurring.

5.7.8 Table 5.5 shows the modelled results whilst accounting for local weather conditions such as cloud, fog, haze or mist. This will reduce the durations of theoretical events modelled.

5.7.9 The results provided in Table 5.5, specifically for the modelled annual durations, provide a more realistic prediction on the durations of when glint is possible. However, it is necessary to understand that these results still do not account for screening features and are provided to demonstrate how the potential for glint is reduced beyond the initial geometric analysis, based on local weather conditions at the Site. Descriptive statistics show that the time periods for when glint is possible are short in the context of annual daylight hours.

Table 5.5: Modelling Results for Local Receptors Including Weather Conditions

Observation Point (OP)	Weather Adjusted Annual Duration (*mins*)	Glint Events Proportion of Daylight Hours	Number of Glint Days	Maximum Duration of Glint Event (*mins*)	Average Duration of Glint Event
OP1	1,964	0.73%	196	44	34

5.7.10 As can be seen in Table 5.4 and Table 5.5, OP1 has the highest exposure to potential glint effects. At OP1, glint is modelled to occur for approximately 0.73% of annual daylight hours. The times and dates when glint events have the possibility of occurring at the receptors is provided in Table 5.4.

5.7.11 The effects modelled will be further reduced by existing and proposed screening in the form of trees, hedgerows, buildings, and other obstacles which is discussed in detail below.

Observation Point 1 (OP1)

5.7.12 OP1 represents Muthu Clumber Park Hotel and Spa which is situated to the west of the southern section of the Site. Mainly, the hotel is well screened by tree cover on its eastern boundary but there are views from the northern section of the carpark.

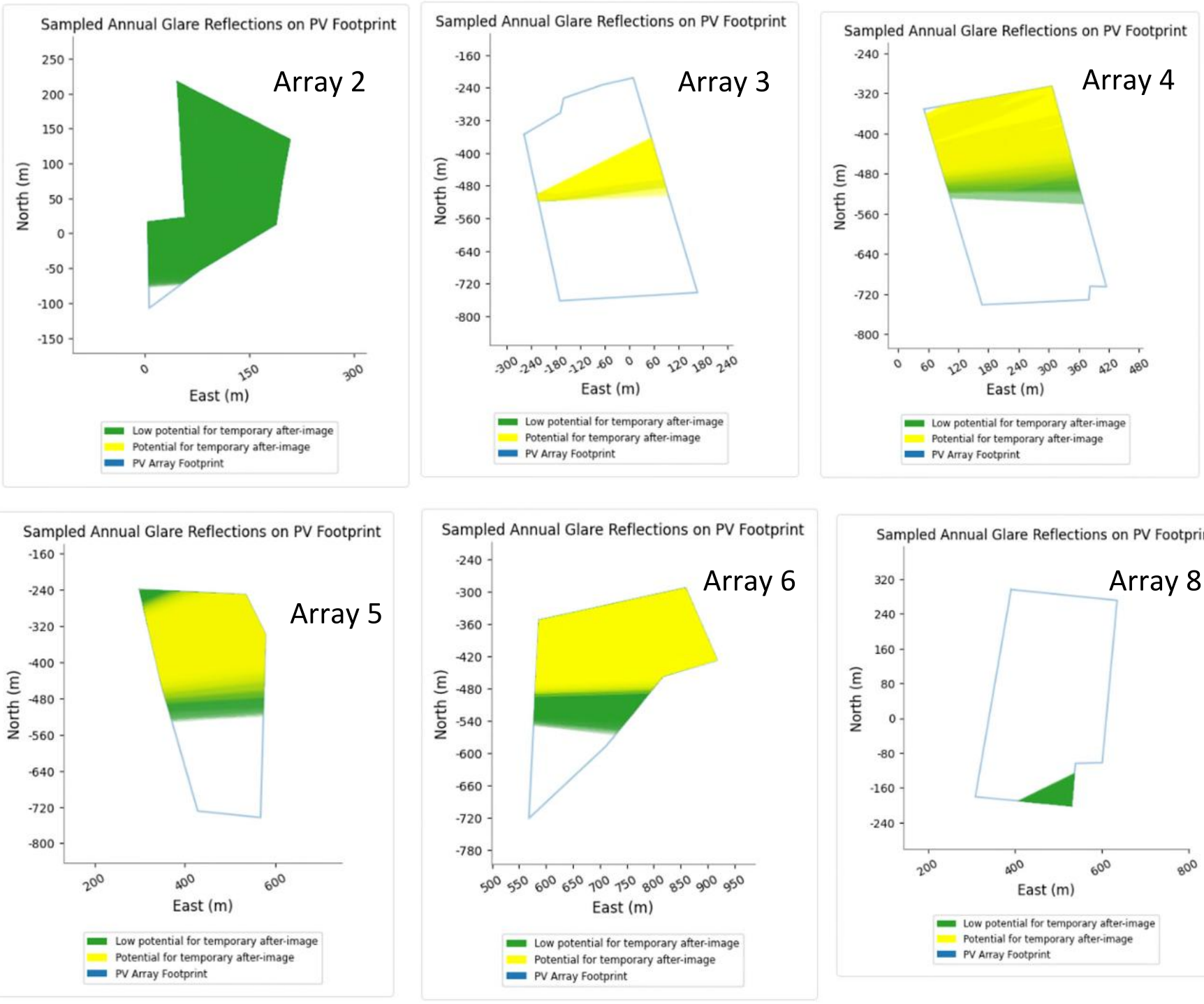


Figure 5.6: Arrays from which Glint Originates at OP1

(Extract from ForgeSolar 2024)

5.7.13 Figure 5.6 shows the parts of the Site from which glint has potential to originate. These include PV Arrays 2, 3, 4, 5, 6 and 8. No glint was predicted from PV Arrays 1 or 7. The glint predicted was a mixture of yellow and green glint so there is some potential for temporary after image.

5.7.14 Glint is only predicted at this OP in the early morning between 05:27 and 06:27 GMT, so observers are likely to not be affected as most will still be sleeping. Any visibility is not likely to be a material issue and there is no risk to health and safety.

5.7.15 These potential glint effects are largely contained within the carpark with some potential for upper stories of the hotel, but with the additional planting proposed in the Planting Plan (as shown in Appendix 6), any glint will be screened further.

5.7.16 As noted in Table 5.3, there is already some screening present in the form of hedgerows and trees but there is also a woodland area that makes up the borders of the Site and within the centre of the Site, acting as screening to the eastern and southern section of the arrays where Figure 5.6 shows that glint is predicted. This glint will be screened by the woodland areas.

5.8 Cumulative Effects

5.8.1 Figure 5.7 shows a chart for an illustrative Observation Point demonstrating the timings of cumulative effects. The geometric potential for glint associated with the proposed site, as described in Sections 5.3-5.7, is shown in orange. Cumulative effects include the glint associated with both the proposed site and existing sites (grey). Simultaneous cumulative effects have the potential to occur when the times and dates when glint is possible, overlap between the arrays, as shown in Figure 5.7 in yellow.

5.8.2 Cumulative glint can only occur where glint from the proposed site can occur. Therefore, cumulative glint can only occur at OP1. However, due the screening present, OP1 cannot experience glint and therefore cannot experience cumulative glint. No other receptors will be assessed for cumulative glint.

5.8.3 Simultaneous cumulative effects will be considered as this is when glint is more intense for a particular receptor.

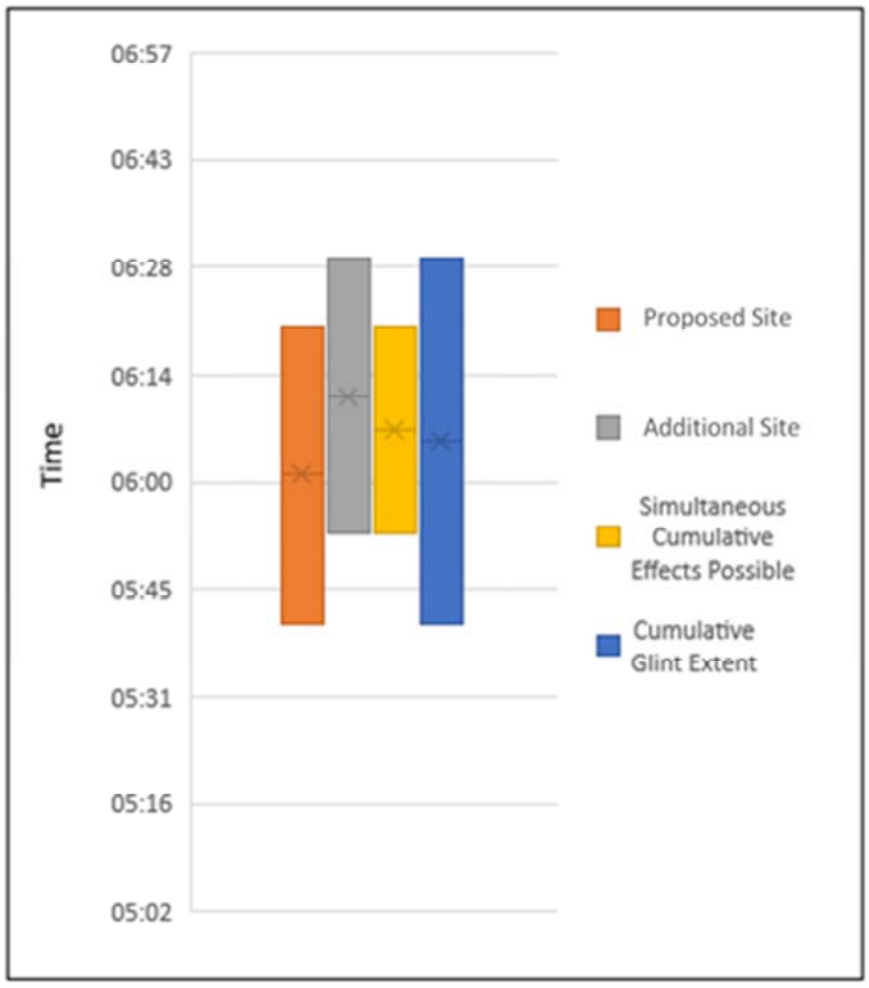


Figure 5.7: Example Chart Representation of Simultaneous Cumulative Effects

5.8.4 The operational solar farms in the immediate vicinity of the Proposed Development identified in the Baseline are discussed below.

5.8.5 There is currently one operational solar development in the immediate vicinity of the Proposed Development. This existing solar site, Wakers Wood Solar Park (14/00681/FUL)[3] is situated 3.5km to the north of the Site.

5.8.6 There are several developments to the southwest of the Site, but these sit outside the 5km study area and are dismissed from further assessment.

5.8.7 Due to the high levels of screening present around the Site and the levels of trees, hedgerows and vegetation in the wider landscape, there will not be any cumulative glint.

5.8.8 For those receptors identified in the sections above, there is no glint after screening is taken into account. Therefore, there cannot be cumulative glint from the other sites.

[3] Renewable Energy Planning Database | BEIS & Barbour ABI (barbour-abi.com)

6 CONCLUSIONS

6.1 Introduction

6.1.1 The purpose of this glint assessment is to consider the effects of glint arising from the proposed solar farm on receptors around the Site. Particular attention is paid to receptors considered to be more sensitive to glint, such as pilots on final approach to landing, motorists on main roads travelling at speed, and train drivers.

6.1.2 Other less sensitive receptors include residents of nearby properties and users of footpaths. Effects experienced at these receptors are not likely to cause any material issues and do not pose a risk to health and safety.

6.1.3 For glint to occur there must be viable weather conditions, the geometrical alignment for glint (i.e. reflected light must physically arrive at the receptor, given the relative position of the sun in the sky and the panels), and there must be visibility to the panels (i.e. no intervening landform, or surface features (buildings/trees/hedgerows etc).

6.2 Aviation

6.2.1 The nearest aviation receptor is Retford (Gamston) Airport which is 2.8km to the northeast at its closest point. Other aviation receptors within 15km include Headon Farm which is 9.5km to the east, Darlton Airstrip is 10km which is to the southeast and the Three Counties Flying School which is 13km northwest of the Site.

6.2.2 The straight-line final approach paths to the Runway at Retford (Gamston) Airport were predicted to only receive green glint. Additional consultation was undertaken with the Airport and additional aviation receptors were assessed at their request.

6.2.3 Following this modelling, some of the panels were reorientated (PV Array 7) from a bearing of 180° to 205° to minimise glint effects for aviation receptors. After this embedded mitigation was implemented into the design, no glint of greater intensity than green glint was predicted at any aviation receptor at Retford (Gamston) Airport.

6.3 Railway

6.3.1 There is no glint at any of the rail receptors.

6.4 Roads

6.4.1 The initial geometric analysis has shown there is potential for road users to see glint, although this does not account for surface features which will provide screening. Only Route 1 (A614) was identified to have the possibility to receive glint. However,

between the road and Site is a 35m wide line of mature deciduous woodland and as part of the Landscaping Plan a new 15m wide scrub belt will be created to further enhance the screening of the Site from the road. From the perspective of a motorist using these roads, any glimpses of glint would be very low intensity and pass very quickly, having no material impact. Modelling in the ForgeSolar software has confirmed that no glint will be visible on Route 1.

6.4.2 The roads that do not lie in the immediate vicinity of the Site are screened by vegetation and intervening topography.

6.5 PRoW

6.5.1 If any, only a brief glimpses of glint will be visible through the tree line along Robin Hood Way as it passes along West Drayton Avenue to the south of the Site. It will not cause any material issues for users and as part of the Landscaping Plan a new 15m wide scrub belt will be created to further enhance the screening of the Site. There is no predicted glint at any other PRoWs.

6.6 Fixed Receptors

6.6.1 For fixed panels, only OP1 can theoretically receive glint. It is predicted 1,964 minutes of glint after adjusting for weather but prior to taking screening into account. After considering the screening present, it is unlikely anything more than slight glimpses through the trees will remain visible.

6.7 Cumulative Effects

6.7.1 There are no cumulative effects as there will be no intervisibility between the Proposed Development and existing solar farms.

APPENDICES

Appendix 1

Policy, Legislation and Guidance

Appendix 2

Theoretical Zone of Visibility (ZTV) for Normanton Larches Solar

Appendix 3

Mathematical Calculations

Appendix 4

ForgeSolar Glint Report Normanton Larches Solar

Appendix 5

Retford (Gamston) Airport Aviation Report

Appendix 6

Panel Layout and Planting Plan

DRAWINGS

wardell-armstrong.com

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APPENDIX 3.1.1 POLICIES AND GUIDANCE

LEGISLATIVE FRAMEWORK

The applicable legislation includes:

- National Planning Policy Framework (December 2023)
- Planning Practise Guidance

National Planning Policy Framework (December 2023)[1]

The National Planning Policy Framework (NPPF) is intended for applications submitted under the Town and Country Planning Regulations and provides a strategic framework for considering planning applications.

Specific guidance on solar PV is limited, and there is no direct mention of glint, but Paragraph 163 states:

"When determining planning applications for renewable and low carbon development, local planning authorities should:

a) *not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions;*
b) *approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas, and*
c) *in the case of applications for the repowering and life-extension of existing renewable sites, give significant weight to the benefits of utilising an established site, and approve the proposal if its impacts are or can be made acceptable.*

National Planning Practice Guidance (NPPG)

The National Planning Practice Guidance (NPPG) planning practice guidance sets out guidance for large ground mount solar farms under the section entitled 'Renewable and Low Carbon Energy'.

[1] Department for Levelling Up, Housing and Communities (December 2023) 'National Planning Policy Framework'. Available at: National Planning Policy Framework (publishing.service.gov.uk)

Paragraph 013 states:

"What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?"

"The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

"Particular factors a local planning authority will need to consider include [inter alia]:

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on neighbouring uses and aircraft safety;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun;*
- *the potential to mitigate landscape and visual impacts through, for example, screening with native hedges;*

"The approach to assessing cumulative landscape and visual impact of large scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero."

Due to the scale of this application, the Proposed Development will be determined by the Local Planning Authority under the Town and Country Planning Regulations rather than as a Nationally Significant Infrastructure Project, which would instead be considered by the Secretary of State through the Development Consent Order process. Nevertheless, it is relevant to consider guidance for larger renewable energy projects contained in the National Policy Statements, which still carry weight as material guidance.

Planning Policy

'Overarching National Policy Statement for Energy' (NPS EN-1) – November 2023[2]

EN-1 recognises that there is significant need to increase the penetration of renewables in the UK generation mix. Paragraph 3.3.1 states:

"Electricity meets a significant proportion of our overall energy needs and our reliance on it will increase as we transition our energy system to deliver our net zero target. We need to ensure that there is sufficient electricity to always meet demand; with a margin to accommodate unexpectedly high demand and to mitigate risks such as unexpected plant closures and extreme weather events."

It continues in paragraph 3.3.13, under the heading 'Delivering affordable decarbonisation':

"The Net Zero Strategy sets out the government's ambition for increasing the deployment of low carbon energy infrastructure consistent with delivering our carbon budgets and the 2050 net zero target. This made clear the commitment that the cost of the transition to net zero should be fair and affordable."

In Paragraph 3.3.20 it says:

"Wind and solar are the lowest cost ways of generating electricity, helping reduce costs and providing a clean and secure source of electricity supply (as they are not reliant on fuel for generation). Our analysis shows that a secure, reliable, affordable, net zero consistent system in 2050 is likely to be composed predominantly of wind and solar."

Paragraph 3.3.59, under the heading 'The need for electricity generating capacity' states:

"All the generating technologies mentioned above are urgently needed to meet the government's energy objectives by:

- *providing security of supply (by reducing reliance on imported oil and gas, avoiding concentration risk and not relying on one fuel or generation type)*
- *providing an affordable, reliable system (through the deployment of technologies with complementary characteristics)*

[2] Department for Energy Security & Net Zero (November 2023), 'Overarching National Policy Statement for Energy (EN-1)'. Available at: EN-1 Overarching National Policy Statement for Energy (publishing.service.gov.uk)

- *ensuring the system is net zero consistent (by remaining in line with our carbon budgets and maintaining the options required to deliver for a wide range of demand, decarbonisation and technology scenarios, including where there are difficulties with delivering any technology)"*

Under the heading 'Bringing forward new electricity infrastructure projects', Paragraphs 3.3.82 - 3.3.83 go on to say:

"Government has committed to reduce GHG emissions by 78 per cent by 2035 under carbon budget 6. According to the Net Zero Strategy this means that by 2035, all our electricity will need to come from low carbon sources, subject to security of supply, whilst meeting a 40-60 per cent increase in demand.

"Given the urgent need for new electricity infrastructure and the time it takes for electricity NSIPs to move from design conception to operation, there is an urgent need for new (and particularly low carbon) electricity NSIPs to be brought forward as soon as possible, given the crucial role of electricity as the UK decarbonises its economy."

In respect of civil and military aerodromes, EN-1 comments in Section 5.5.5:

"UK airspace is important for both civilian and military aviation interests. It is essential that new energy infrastructure is developed collaboratively alongside aerodromes, aircraft, air systems and airspace so that safety, operations and capabilities are not adversely affected by new energy infrastructure.

"...The approaches and flight patterns to aerodromes can be irregular owing to a variety of factors including the performance characteristics of the aircraft concerned and the prevailing meteorological conditions. It may be possible to adapt flight patterns to work alongside new energy infrastructure without impacting on aviation safety."

The subsection 'Safeguarding' continues from Paragraph 5.5.8:

"Certain civil aerodromes, and aviation technical sites, selected on the basis of their importance to the national air transport system, are officially safeguarded in order to ensure that their safety and operation are not compromised by new development.

"A similar official safeguarding system applies to all military aerodromes, defence surveillance sites, and other defence assets.

"Areas of airspace around aerodromes used by aircraft, including taking off or on approach and landing are described as "obstacle limitation surfaces" (OLS). All civil aerodromes licensed by the Civil Aviation Authority (CAA) and all military aerodromes must comply with the OLS. These are defined according to criteria set out in relevant CAA guidance for licensed civil aerodromes and according to MOD criteria, as set by the Military Aviation Authority, which is part of the Defence Safety Authority (DSA), for military aerodromes.

"Aerodromes that are officially safeguarded will have officially produced plans that show the OLS. Care must be taken to ensure that new developments do not infringe these protected OLS, as these encompass the critical airspace within which key air traffic associated with the aerodrome operates.

"The CAA's CAP 738 sets out that all licensed aerodromes are required to ensure they have a system in place to safeguard their aerodrome against the growth of obstacles or activities that may present a hazard to aircraft operations.

"It is considered best practice for the LPA to include the safeguarded area and explanatory notes on its planning 'constraints' plan so that potential applicants can be aware of the presence of the aerodrome and the extent and nature of the safeguarding relevant to a particular aerodrome. DfT/ODPM Circular 01/2003 provides advice to planning authorities on the official safeguarding of aerodromes and includes a list of the civil aerodromes which are officially safeguarded.

"The DfT/ODPM Circular 01/2003 and CAA guidance also recommends that the operators of aerodromes which are not officially safeguarded should take steps to protect their aerodrome from the possible effects of development by establishing an agreed consultation procedure between themselves and the LPAs.

"The certified Safeguarding maps for all aerodromes (both licensed and unlicensed) depicting the OLS and other criteria (for example to minimise "birdstrike" hazards) are deposited with the relevant LPAs.

"The CAA makes clear that the responsibility for the safeguarding of General Aviation aerodromes lies with the aerodrome operator."

Whilst not specifically glint related, in talking about 'artificial light', Section 5.7.1 mentions:

"During the construction, operation and decommissioning of energy infrastructure there is potential for the release of a range of emissions such as odour, dust, steam, smoke, artificial

light and infestation of insects. All have the potential to have a detrimental impact on amenity or cause a common law nuisance or statutory nuisance under Part III, Environmental Protection Act 1990. However, they are not regulated by the environmental permitting regime, so mitigation of these impacts will need to be included in the Development Consent Order.

"Because of the potential effects of these emissions and infestation, and in view of the availability of the defence of statutory authority against nuisance claims described in Section 4.15, it is important that the potential for these impacts is considered by the applicant and Secretary of State."

"The applicant should assess the potential for insect infestation and emissions of odour, dust, steam, smoke, and artificial light to have a detrimental impact on amenity, as part of the ES."

"The applicant is advised to consult the relevant local planning authority and, where appropriate, the EA about the scope and methodology of the assessment."

Section 5.9 deals with Landscape and Visual Effects, and paragraph 5.10.21 mentions:

"The assessment should include the visibility and conspicuousness of the project during construction and of the presence and operation of the project and potential impacts on views and visual amenity. This should include light pollution effects, including on local amenity, and nature conservation."

"The assessment should also demonstrate how noise and light pollution, and other emissions (see Section 5.2 and Section 5.7), from construction and operational activities on residential amenity and on sensitive locations, receptors and views, will be minimised."

Paragraph 5.10.26 continues:

"Reducing the scale of a project can help to mitigate the visual and landscape effects of a proposed project. However, reducing the scale or otherwise amending the design of a proposed energy infrastructure project may result in a significant operational constraint and reduction in function - for example, the electricity generation output. There may, however, be exceptional circumstances, where mitigation could have a very significant benefit and warrant a small reduction in function. In these circumstances, the Secretary of State may decide that the benefits of the mitigation to reduce the landscape and/or visual effects outweigh the marginal loss of function."

Paragraph 5.10.28 goes on to say:

"Depending on the topography of the surrounding terrain and areas of population it may be appropriate to undertake landscaping off site. For example, filling in gaps in existing tree and hedge lines would mitigate the impact when viewed from a more distant vista."

In Section 5.14 EN-1 discusses transport impacts:

"If a project is likely to have significant transport implications, the applicant's ES (see Section 4.3) should include a transport appraisal. The DfT's Transport Analysis Guidance (TAG) and Welsh Governments WelTAG provides guidance on modelling and assessing the impacts of transport schemes.

"Applicants should consult National Highways and Highways Authorities as appropriate on the assessment and mitigation to inform the application to be submitted."

National Policy Statement for Renewable Energy (NPS EN-3) – November 2023[3] (in force 17th January 2024)

Section 2.10 is entitled 'Solar Photovoltaic Generation'. Paragraph 2.10.9 states:

"The government has committed to sustained growth in solar capacity to ensure that we are on a pathway that allows us to meet net zero emissions. As such solar is a key part of the government's strategy for low-cost decarbonisation of the energy sector.

"Solar also has an important role in delivering the government's goals for greater energy independence and the British Energy Security Strategy states that government expects a five-fold increase in solar deployment by 2035 (up to 70GW). It sets out that government is supportive of solar that is co-located with other functions (for example, agriculture, onshore wind generation, or storage) to maximise the efficiency of land use."

Under the heading 'Proximity of a site to dwellings', Paragraph 2.10.27 states:

"Utility-scale solar farms are large sites that may have a significant zone of visual influence. The two main impact issues that determine distances to sensitive receptors are therefore likely to be visual amenity and glint and glare..."

Paragraphs 2.10.94 and 2.10.95 relate to landscape, visual and residential amenity, and continue:

"...Solar farms are likely to be in low lying areas of good exposure and as such may have a wider zone of visual influence than other types of onshore energy infrastructure.

[3] Department for Energy Security & Net Zero (November 2023), 'National Policy Statement for Renewable Energy Infrastructure (EN-3)'. Available at: National Policy Statement for Renewable Energy Infrastructure (EN-3) (publishing.service.gov.uk)

"However, whilst it may be the case that the development covers a significant surface area, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography, the area of a zone of visual influence could be appropriately minimised."

Under the subsection 'Glint and Glare', specific guidance is given from Paragraph 2.10.102:

"Solar panels are specifically designed to absorb, not reflect, irradiation[4]. However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

"Applicants should map receptors to qualitatively identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.

"When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.

"The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.

"When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels."

In relation to mitigation, Paragraphs 2.10.134-2.10.136 state:

"Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.

"Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.

"Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence. In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy."

Concerning the Impacts of Solar PV, Paragraphs 2.10.158-2.10.159 continue:

[4] Most commercially available solar panels are designed with anti-reflective glass or are produced with anti-reflective coating and have a reflective capacity that is generally equal to or less hazardous than other objects typically found in the outdoor environment, such as bodies of water or glass buildings.

"Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths).

Whilst there is some evidence that glint and glare from solar farms can be experienced by pilots and air traffic controllers in certain conditions, there is no evidence that glint and glare from solar farms results in significant impairment on aircraft safety. Therefore, unless a significant impairment can be demonstrated, the Secretary of State is unlikely to give any more than limited weight to claims of aviation interference because of glint and glare from solar farms."

GUIDANCE

BRE: Site Layout Planning for Daylight and Sunlight: A guide to good practice

In the UK at the domestic level the closest guidelines regarding glint are the BRE guidelines on 'Site layout planning for Daylight and Sunlight'[5]

With regard to solar dazzle these state that:

"Glare or dazzle can occur when sunlight is reflected from a glazed façade or an area of metal cladding. This can affect road users outside and the occupants of adjoining buildings. The problem can occur where there are large areas of reflective glass or cladding on the façade, or where there are areas of glass or cladding slope back so that high altitude sunlight can be reflected along the ground. Thus solar dazzle is only a long-term problem for some heavily glazed (or mirror clad) buildings. Photovoltaic panels tend to cause less dazzle because they are designed to absorb light.

If it is likely that a building may cause solar dazzle the exact scale of the problem should be evaluated. This is done by identifying key locations such as road junctions and windows of nearby buildings, and working out the numbers of hours of the year that sunlight can be reflected to these points. BRE information paper IP 3/87 gives details.

Glare to motorists approaching the building can be an issue. The worst problems occur when drivers are travelling directly towards the building and sunlight can reflect off surfaces in the drivers direct line of sight (usually this will be off the lower parts of the building)."

After setting out a methodology for calculating solar reflections from sloping glazed facades, BRE information paper IP 3/872 summarises effects as follows:

"Initial experience suggests that, in Europe and the USA at least, the greatest problems occur with facades facing within 90o of due south, sloping back at angles between 5o and 30o to the vertical. Where the façade slopes at more than 40o to the vertical (less than 50o to the horizontal) solar reflections are likely to be less of a problem, unless nearby buildings are very high; and facades which slope forward, so that the top of the building forms an effective overhang, should also cause few problems in this respect. In the northern hemisphere, north

[5] Site Layout Planning for Daylight and Sunlight: A guide to good practice. (2nd Edition) Paul Littlefair, BRE Trust, First published 2011.

facing facades should only cause reflected solar glare on a few occasions during the year, if at all."

In the domestic setting the guidelines therefore suggest that glare and dazzle are only likely to be issues if the facade (or panel in this case) is within 40 degrees of the vertical or 50 degrees of the horizontal. Beyond this angle, incident light will be reflected primarily skywards. This is because the angle of reflection of light from a point source will always be the same as the angle of incidence.

Aviation Guidance (CAA)

The UK Civil Aviation Authority (CAA) issued interim guidance in relation to solar farms in December 2010[6]. The formal policy was cancelled in September 2012, however in the absence of formal policy, the guidance is still relevant. It refers to solar farms as Solar Photovoltaic Systems (SPV).

CAA Interim Guidance

This interim guidance makes the following recommendations (p.2-3):

"8. It is recommended that, as part of a planning application, the SPV developer provide safety assurance documentation (including risk assessment) regarding the full potential impact of the SPV installation on aviation interests.

9. Guidance on safeguarding procedures at CAA licensed aerodromes is published within CAP 738 Safeguarding of Aerodromes and advice for unlicensed aerodromes is contained within CAP 793 Safe Operating Practices at Unlicensed Aerodromes.

10. Where proposed developments in the vicinity of aerodromes require an application for planning permission the relevant LPA normally consults aerodrome operators or NATS when aeronautical interests might be affected. This consultation procedure is a statutory obligation in the case of certain major airports, and may include military establishments and certain air traffic surveillance technical sites. These arrangements are explained in Department for Transport Circular 1/2003 and for Scotland, Scottish Government Circular 2/2003.

11. In the event of SPV developments proposed under the Electricity Act, the relevant government department should routinely consult with the CAA. There is therefore no

[6] Civil Aviation Authority, 2010. "*Interim CAA Guidance - Solar Photovoltaic Systems*"

requirement for the CAA to be separately consulted for such proposed SPV installations or developments.

12. If an installation of SPV systems is planned on-aerodrome (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH10, as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.

13. During the installation and associated construction of SPV systems there may also be a need to liaise with nearby aerodromes if cranes are to be used; CAA notification and permission is not required.

14. The CAA aims to replace this informal guidance with formal policy in due course and reserves the right to cancel, amend or alter the guidance provided in this document at its discretion upon receipt of new information.

15. Further guidance may be obtained from CAA's Aerodrome Standards Department via aerodromes@caa.co.uk."

The CAA Civil Aviation Publication (CAP) 738 document[7] notes:

"In 2010 the CAA published interim guidance on Solar Photovoltaic Cells (SPCs). At that time, it was agreed that we would review our policy based on research carried out by the Federal Aviation Authorities (FAA) in the United States, in addition to reviewing guidance issued by other National Aviation Authorities. New information and field experience, particularly with respect to compatibility and glare, has resulted in the FAA reviewing its original document 'Technical Guidance for Evaluating Selected Solar Technologies on Airports', which is likely to be subject to change, see link;

https://www.federalregister.gov/documents/2013/10/23/2013-24729/interimpolicy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

[7] Civil Aviation Authority - Safety and Airspace Regulation Group, 2020, CAP 738, "*Safeguarding of Aerodromes*".

In the United Kingdom there has been a further increase in SPV cells, including some located close to aerodrome boundaries; to date the CAA has not received any detrimental comments or issues of glare at these established sites. Whilst this early indication is encouraging, those responsible for safeguarding should remain vigilant to the possibility."

Renewable energy developments: solar photovoltaic developments CAST Aerodrome Safeguarding Guidance Note[8].

As of July 2023, Industry body, The Combined Aerodrome Safeguarding Team (CAST), has released its guidance document titled 'Renewable energy developments: solar photovoltaic developments CAST Aerodrome Safeguarding Guidance Note'.

With regard to glint, it suggests that the developer should supply:

"... a glint and glare survey when a development is within a distance specified by the aerodrome from an Aerodrome Reference Point (ARP) (5km in most cases)".

The document also states that:

"For many aerodromes, 5km is the distance of choice but it could be considered out to 10km. In exceptional circumstances, assessments may be required beyond 10km."

The document provides some considerations on safety and states:

"Safety considerations must be assessed for the design of the planned solar photovoltaic development for Air Traffic Services (ATS) personnel, pilots and for CNS equipment:

- *ATS personnel – The control tower (if applicable) is the most important location for visual surveillance across an aerodrome for monitoring operations on the ground as well as in the air. It is therefore of critical importance that the development of solar photovoltaic developments does not significantly hinder the view from a control tower's visual control room (VCR). This may be from redesigning the layout and design of the proposed solar development to avoid glare from the solar panels or by avoiding the physical blocking of key viewpoints.*
- *Pilot – A pilot's ability to safely navigate the airspace around an aerodrome is paramount. A pilot is required to look for other aircraft and obstructions on the ground, as well as navigate towards a runway or reference points. This applies to both pilots of*

[8] Combined Aerodrome Safeguarding Team (CAST), 2023, "Renewable energy developments: solar photovoltaic developments CAST Aerodrome Safeguarding Guidance Note" Available at: cast-renewable-energy-developments-solar-july-2023.pdf (caa.co.uk)

fixed wing aircraft and helicopters in the air, and sometimes on the ground. The standard operations that should be considered are:

- *pilots on approach*
- *pilots in a visual circuit*
- *pilots on the ground (departing and taxiing aircraft).”*

The document also makes note of other available guidance:

“The UK CAA and US FAA have produced guidance with respect to glint and glare however neither of them mandates a specific methodology for assessing the effects of glint and glare. The effects of glare may mean that some solar PV developments are unacceptable, however layout modifications (such as changes to panel tilt and elevation angle) can often alleviate these concerns and overcome objections. The benefit of early consultation with the aerodrome authority cannot be understated.”

The document comments on the Aerodrome Operator’s Safety Assurance stating:

“The aerodrome operator in conjunction with any ATS personnel should, as part of the change management process in their safety management system, consider all the potential hazards posed by solar photovoltaic developments… The developer should provide the aerodrome with a safety survey which should include:

- *a glint and glare survey when a development is within a distance specified by the aerodrome from an Aerodrome Reference Point (ARP) (5km in most cases)*

The aerodrome operator should also ensure both impact and safety assessments are undertaken to provide assurance that any on- or off-aerodrome planned development does not introduce unacceptable hazards to aircrew, ATS personnel, RFFS and aerodrome vehicle operators undertaking their tasks.

As part of the aerodrome and or ATS change management process, safety assurances should take into account any potential adverse effect to critical ATS infrastructure and equipment.

The assessment must also consider any impacts to aircraft utilising instrument flight procedures and aircraft in the visual circuit.

Developers should apply the same principals for safety assurance for unlicensed aerodromes and airfields as required by this policy that are not officially safeguarded.

The developer in conjunction with the aerodrome operator, ATS personnel, RFFS and aerodrome operations should develop adequate mitigation to mitigate any risks identified.

Should risk mitigation or agreement not be possible, the aerodrome operator should follow Local Planning Authority procedures and lodge an objection regarding the development under their statutory obligations."

Aviation Guidance (FAA)

The most comprehensive guidance setting out a methodology for assessing solar farm developments near aerodromes was produced November 2010 by the US Federal Aviation Administration (FAA) in a document entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'. This was updated in Oct 2013 in the '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*'. In April 2018 the FAA released a new version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*', and in May 2021 it provided a further set of guidance entitled '*14CRF Part 77 - FAA Policy: Review of Solar Energy System Projects on Federally Obligated Airports*'.

In this last review the FAA concluded, contrary to its initial beliefs, that:

"...in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass façade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs. Therefore, FAA has determined the scope of agency policy should be focused on the impact of on airport solar energy systems to federally obligated towered airports, specifically the airport's ATCT cab."

Operational Examples

There are a considerable number of large-scale solar installations that are already operating and located near to airports overseas. These include Newquay Airport in Cornwall, UK and Dunsfold Aerodrome in Surrey, also in the UK. Figure 1 shows a large-scale solar farm similar to the proposed scheme constructed at Dusseldorf Airport, glint from the solar farm has not affected flight operations.



Figure 1: Solar Farm Adjacent to the Runway at Dusseldorf Airport (Aviation Pros, 2013[9])

A ground-mounted array of panels has also been installed at London Gatwick on land adjacent to the runway and taxiway (see Figure 2). Consultation was undertaken between the developer and the Gatwick aerodrome safeguarding team, National Air Traffic Services (NATS), and NATS (En Route) Plc (NERL) (Crawley Borough Council, Planning Ref: CR/2011/0602/CON). These consultees did not object to the proposal on any grounds including glint.

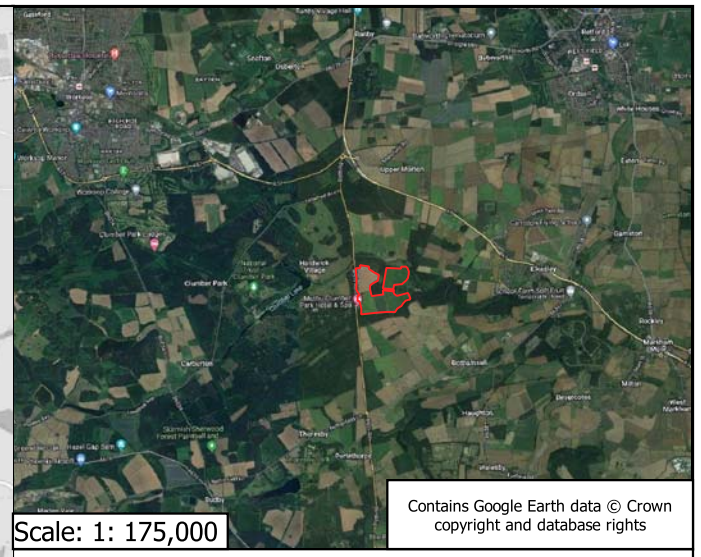
[9] Aviation Pros, 2013. 'Düsseldorf International Airport Goes Solar' [Online] Available at: http://www.aviationpros.com/news/10599152/dsseldorf-international-airport-goes-solar [Accessed 23 July 2022]



Figure 2: Solar Array next to Gatwick Runway (Business Green, 2013[10])

It is not expected that the potential for glint generated by the proposed solar farm could cause any serious operational effects to aircraft but since the position of the sun in the sky and the angle of the panels will be known, it is possible to predict exactly when there would be any chance of affecting a particular flight path and hence it would be possible to forewarn any pilots.

[10] Business Green, 2013. 'Gatwick solar system hailed a runway success'. [Online] Available at: http://www.businessgreen.com/bg/news/2156392/gatwick-solar-cleared [Accessed 23 July 2022]



Scale: 1: 175,000

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NOTES

This figure shows the geographical extent of potential glint events out to 5km. For a glint event to occur on the ground the receptor must be in the ZTV. The ZTV is based on 3.58 m high panels, a receptor height of 1.8 m and a Digital Surface Model.
Receptors would have to be able to see the panels to experience glint events and this may not be possible due to screening from hedgerows, trees, buildings and other obstacles positioned between the panel and the receptor. When clouds obscure the sun from the site it would not be possible for glint to occur.

Legend

- ZTV
- 5KMBuffer
- SiteBoundary

0 1 2 km

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CLIENT	ONE PLANET DEVELOPMENTS LIMITED
PROJECT	BR10356 - NORMANTON LARCHES SOLAR FARM
DRAWING TITLE	Zone of Theoretical Visibility (ZTV), 5km Buffer

DRG No. 001		REV: 1
DRG SIZE: A3	SCALE: 1:50,000	DATE: March 2024
DRAWN: AS	CHECKED BY: SA	APPROVED BY: SA

wardell armstrong

Solar Position

Firstly the sun position is calculated. The sun position algorithm calculates the sun position in two forms: first as a unit vector extending from the Cartesian origin toward the sun, and second as azimuthal and altitudinal angles. The algorithm relies on the latitude, longitude and time zone offset from UTC in order to determine the position of the sun at every time step throughout the year.

The equations used are:

$$t_{solar} = 4(L_{st} - L_{loc}) + E + t_{standard}$$

Where:

$$L_{st} = tz_{offset} * 15$$

$$E = 229.2(0.000075 + 0.001868 * \cos B - 0.0320077 * \sin B - 0.014615 * \cos 2B - 0.04089 * \sin 2B)$$

L_{st} is the local standard meridian, L_{loc} is the given longitude and E is the equation of time, in minutes.

The solar time can then be used to calculate the Hour angle, ω:

$$\omega = \Delta t_{noon} * 15$$

Where $\Delta t_{noon}$is the difference between solar time and solar noon.

Once the declination,δ is known, the solar zenith and azimuthal angle of the sun can be found:

$$\delta = 23.45 * \sin\left(360 * \frac{284 + n}{365}\right)$$

$$\theta_z = \cos^{-1}(\cos\varphi * \cos\delta * \cos\omega + \sin\varphi * \sin\delta)$$

$$\gamma_s = sign(\omega)\left|\cos^{-1}\left(\frac{\cos\theta_z \sin\phi - \sin\delta}{\sin\theta_z \cos\phi}\right)\right|$$

Where:

- n is the day of the year (1 to 365)
- θ_z is the sun zenith angle (subtract from 90 to get the altitude angle, θ_a)
- φ is the given latitude
- γ_s is the sun azimuthal angle

The sun altitude and azimuth can be converted to unit vector components as follows:

$$\overrightarrow{s_i} = \cos\theta_a * \sin\gamma_s$$

$$\overrightarrow{s_j} = \cos\theta_a * \cos\gamma_s$$

$$\overrightarrow{s_k} = \sin\theta_a$$

Reflected Sun Vector

$$x_1' - x_0 = v - 2(v \cdot \hat{n})\,\hat{n}$$

Figure 1 illustrates this vector reflection graphically.

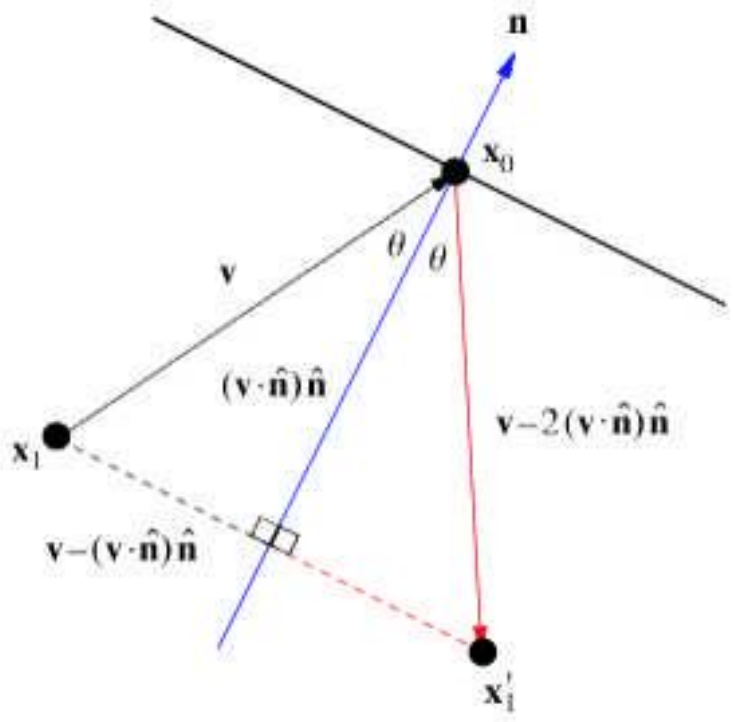


Figure 1 - Vector reflection over normal vector of plane. Source: mathworld.wolfram.com/Reflection.html

Scattering and Subtended Beam Angle

The reflected sun vector calculated above defines the axis of a conical beam which represents an actual beam of sunlight. This sun beam is translated to extend from the observation point (OP) toward the PV array (note this is the whole array not an individual panel). The aperture of this sun beam is equivalent to the subtended beam angle. This is formed of the sum of the sun shape and an additional scattering caused by slope error. This additional scattering takes into account errors in the panel angle across the array and slightly widens the subtended beam angle. The calculation is as follows:

$$\beta = 2 * \left(\frac{\theta_{sun\ angle}}{2} + 2 * 3 * \theta_{slope\ error}\right)$$

Beam Projection onto the PV Array Plane

This calculation takes the sun beam angle defined above and uses the result to calculate a cone from the eye back out to the array in order to define how much of the array is potentially visible and the intensity of any reflections.

The calculation is carried out in several steps. Firstly points lying on the edge of the beam in a conical section orthogonal to the axis (the subtended beam angle) are calculated. This conical section is arbitrarily defined to be 1 meter from the cone apex (the OP).

These 30 points are calculated by randomly generating two coordinates and solving for the third using the following equation:

$$v_{axis} \cdot v_{radius} = 0$$

This equation states that the cone axis is orthogonal to the radius vectors of the conical section upon which the 30 conical points lie. Next, conical edge vectors are defined by subtracting the cone apex (the OP) from the cone points. This collection of vectors extends from the OP toward the PV array plane.

These vectors define the conical sun beam. At their centre, or the axis of the cone, is the reflected sun vector calculated above. These conical vectors are then intersected with the PV array plane. This cone-plane intersection will be an elliptical conical section defined by 30 co-planar points. These intersection points are calculated using line-plane intersection equations:

$$d = \frac{(\boldsymbol{p_0} - \boldsymbol{I_0}) \cdot \vec{\boldsymbol{n}}}{\boldsymbol{I} \cdot \vec{\boldsymbol{n}}}$$

$$(x, y, z) = d\mathbf{I} + \boldsymbol{I_0}$$

Where:

- $\vec{\boldsymbol{n}}$ is the PV array panel normal vector
- $\mathbf{I}$ is one of the vectors extending from the OP to the PV array plane, which define the conical sun beam.
- $\mathbf{I_0}$ is a point on the vector (the OP)
- $\mathbf{p_0}$ is a point on the PV array plane
- d is the distance from the OP to the intersection point, and
- (x, y, z) define the intersection point for this vector.

The n intersection points found using the above equations define the elliptical conical section of the sun beam cone as it intersects the PV array plane. Glint is present when any of the OP vertices lie within this co-planar elipse.

In more simple terms we have calculated a cone defining the glint from the array (sections 2 and 3). When an observation point (OP) falls within this cone the subtended angle (the axis)

is used to define a cone from the viewer's eye back to the array. Where this cone intersects then glint will be received by the viewer. The amount of intersection is then used in the intensity calculation and also defines the subtended angle. Both of these are then used to calculate the potential for after-image.

Direct Normal Irradience (DNI), Reflectance and Subtended Beam Angle

The software modifies the peak DNI for a clear day irradiance profile. This lowers the DNI in the morning and evenings around the noon value which is calculated based upon the results of section 1 above. The calculation is as followed:

$$DNI = \cos(1 - t_s)$$

Here t_s represents the normalized time relative to solar noon. Normalization is based on the amount of time between sunrise or sunset and solar noon. Sandia determined the DNI scaling profile by fitting empirical DNI data to the cosine function, as illustrated in Figure 4. Note that DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

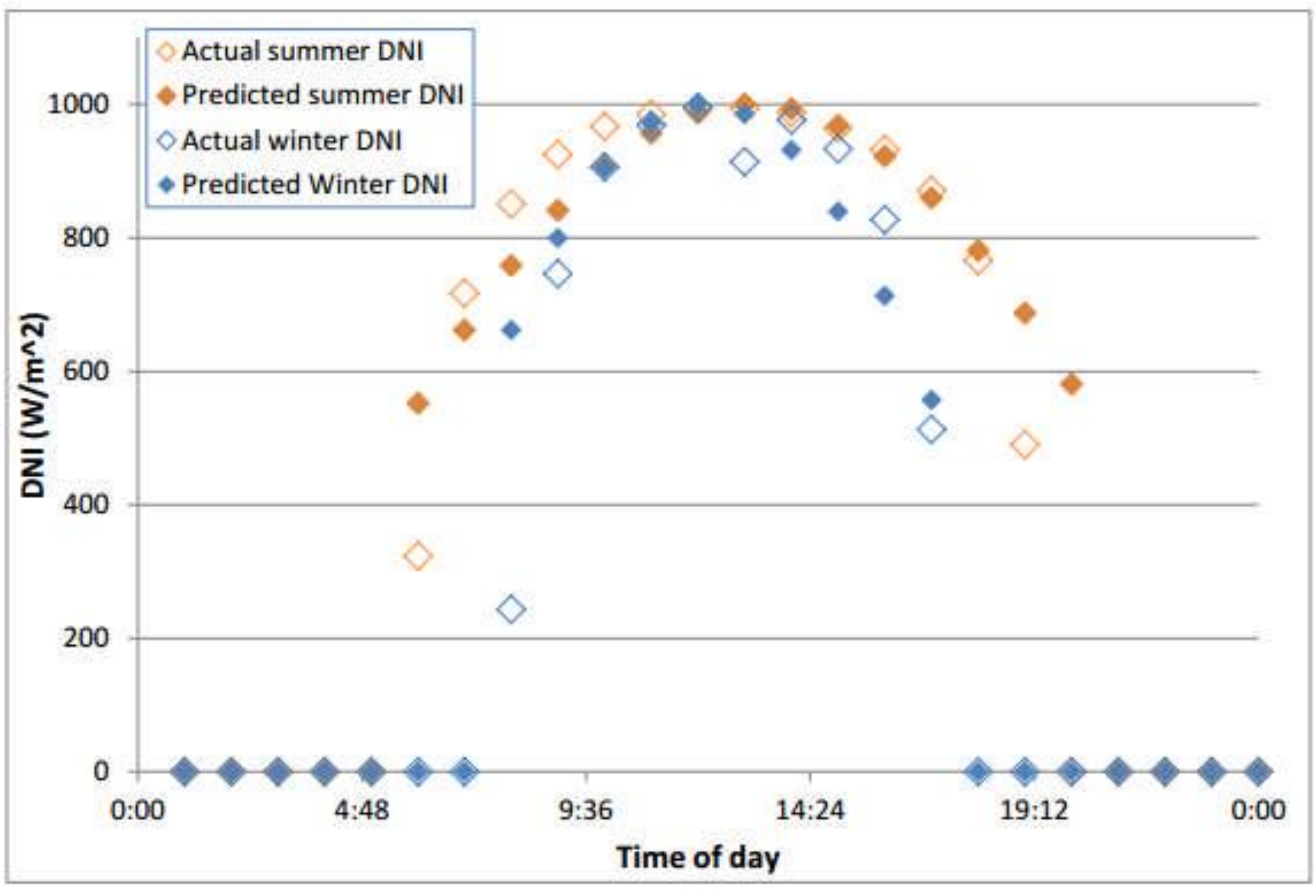


Figure 4 - Fit functions modeling normalized DNI vs. hour. Cosine was chosen to profile empirical data.

The DNI is further modified by Panel reflectivity which can be varied for each time step to account for the position of the sun relative to the array.

Smooth glass and light textured glass with and without Anti-Reflection coating, along with deeply textured glass were analysed to derive accurate functions for computing reflectivity based on sun incidence angle.

Table 1 contains the fit functions for different panel reflectivities.

Table 1 - Reflectance fit functions for PV cover types.

PV Glass Cover Type	Fit Function Defined over $0° \leq \theta \leq 60°$	Fit Function Defined over $60° < \theta < 90°$
Smooth Glass without Anti-Reflection Coating	$y = 1.1977E\text{-}5\,x^2 - 9.5728E\text{-}4\,x + 4.410E\text{-}2$	$y = 6.2952E\text{-}5\,e^{0.1018x}$
Smooth Glass with Anti-Reflection Coating	$y = 1.473E\text{-}5\,x^2 - 9.6416E\text{-}4\,x + 3.2395E\text{-}2$	$y = 4.7464E\text{-}5\,e^{0.1051x}$
Light Textured Glass without Anti-Reflection Coating	$y = 1.5272E\text{-}5\,x^2 - 1.1304E\text{-}3\,x + 4.305E\text{-}2$	$y = 7.3804E\text{-}5\,e^{0.0994x}$
Light Textured Glass with Anti-Reflection Coating	$y = 1.4188E\text{-}5\,x^2 - 1.0326E\text{-}3\,x + 3.9016E\text{-}2$	$y = 7.0179E\text{-}5\,e^{0.0994x}$
Deeply Textured Glass	$y = 6.8750E\text{-}6\,x^2 - 6.5250E\text{-}4\,x + 2.10E\text{-}2$	$y = 4.1793E\text{-}5\,e^{0.0834x}$

The glare analysis must account for the actual visible area of the PV array when viewed from the observation point. For example, less viewable area will be apparent when viewing an array with panel tilt of 0 degrees on a flat surface from the side than when viewing it from above in an aircraft.

To account for this, the analysis replaces the solar beam angle with an array-limiting beam angle if the latter is a smaller value. This represents the physical situation where the sun beam “overflows” the PV array from the viewer’s perspective, and thus less glare is possible.

The calculation is as follows:

$$\theta = \frac{1}{d}\sqrt{\frac{4 * A * \left|\cos\theta_{ref-pva}\right|}{\pi}}$$

where:

- A is area of PV array
- d is distance between observer and array
- $\theta_{ref\text{-}pva}$ is angle between reflected sun vector and PV array normal

Methodology Limitations

There are some identified limitations with the methodology used that should be noted and accounted for when considering the content of the subsequent analysis.

ZTV & GGZ Limitations

The ZTV is based upon NASA SRTM V3 data which represents bare earth topography. Although the ZTV does take into account screening from an intervening land form, it does not take into account any potential screening from obstacles such as trees, hedgerows or buildings.

Furthermore, the ZTV is a binary classification based upon visibility of any section of the solar farm. For example, there is no distinction between being able to see 1 solar panel or the entire array. This is crucial when considering the GGZ. For example, a receptor may be in the northern extent of the GGZ and may be within the ZTV as a result of the southerly panels in the array being visible. In this instance the analysis may indicate that glint is visible when in fact glint would not be visible as receptors in the northern extents of the GGZ may not receive glint from the southerly panels in the array.

The ZTV is based on a number of representative observation points along and within the site boundary. It is possible that a receptor may not be included within the ZTV as a consequence of a part of the site being visible that isn't included as an observation point. This is however considered highly unlikely.

Computer Simulation

The GlareGuage software tool is used primarily for assessing the potential impacts of glint on aviation receptors - both aircraft and control towers. As such it does provide something of a worst case scenario, modelling a situation where any glint could potentially occur rather than where glint might be most expected to cause an issue in reality.

Additionally, it is important to consider some of the other limitations of the modelling software that has been used.

One such limitation is that the model does not account for any screening from other panels within the solar farm. It assumes that glint is possible from every point within the array boundary and does not account for the panel in front screening glint from the panel behind. Again this does provide a worst case scenario and, particularly in the case of an aircraft flying overhead, is a perfectly reasonable approach but in the case of a ground receptor it does represent quite a large potential for over estimation within the model.

Another limitation is that the Sandia tool does not account for screening by a landform. The shape of the GGZ is characterised by the times during the day when glint effects can occur.

There is potential for glint in the zone extending to the west when the sun is low in the sky and rising in the east, and conversely there is potential glint in the zone to the east when the sun is low in the sky as it is setting in the west. If a landform would prohibit sunlight from reaching the panel when it is at a low altitude the model would not necessarily account for this and suggest glint is visible when it is not

In summary although there are some limitations to the techniques used in this methodology, as the limitations are known they can be accounted for during the analysis. The techniques chosen in this report will still enable a robust and accurate assessment of potential glint effects.

FORGESOLAR GLARE ANALYSIS

Project: **BR10356 Normanton Larches Solar**
Site configuration: **BR10356 Normanton Larches Solar**

Created 22 Feb, 2024
Updated 25 Mar, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 112720.19448

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	5,054	84.2	0	0.0	-	162,112
PV array 2	25.0	180.0	5,891	98.2	0	0.0	-	80,687
PV array 3	25.0	180.0	7,239	120.7	10,787	179.8	-	1,672,925
PV array 4	25.0	180.0	8,705	145.1	7,943	132.4	-	1,363,436
PV array 5	25.0	180.0	7,592	126.5	10,995	183.2	-	2,010,517
PV array 6	25.0	180.0	14,131	235.5	6,070	101.2	-	840,949
PV array 7	25.0	205.0	982	16.4	0	0.0	-	10,267
PV array 8	25.0	180.0	10,244	170.7	0	0.0	-	250,599

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
Route 2	1,264	21.1	0	0.0
Route 3	21,164	352.7	28,510	475.2
Darlton 1	8,563	142.7	0	0.0
Darlton 2	0	0.0	0	0.0
Headon 23	0	0.0	0	0.0
Headon 32	4,528	75.5	0	0.0
Headon R14	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Runway 03 S	0	0.0	0	0.0
Runway 14 NW	0	0.0	0	0.0
Runway 21 N	0	0.0	0	0.0
Runway 32 SE	14,772	246.2	0	0.0
Three Counties R06	570	9.5	0	0.0
Three Counties R19	0	0.0	0	0.0
Three Counties R24	0	0.0	0	0.0
Three Counties R36	0	0.0	0	0.0
OP 1	5,704	95.1	7,285	121.4
OP 2	2,961	49.4	0	0.0
OP 3	312	5.2	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270453	-1.023592	44.16	3.58	47.74
2	53.270382	-1.026510	38.69	3.58	42.27
3	53.270337	-1.028001	42.19	3.58	45.77
4	53.268374	-1.027819	47.55	3.58	51.13
5	53.267835	-1.027411	47.97	3.58	51.55
6	53.268194	-1.025823	42.76	3.58	46.34
7	53.268605	-1.023538	48.05	3.58	51.63

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272403	-1.022893	44.98	3.58	48.56
2	53.271659	-1.020468	49.10	3.58	52.68
3	53.271146	-1.020629	49.06	3.58	52.64
4	53.270568	-1.020768	49.76	3.58	53.34
5	53.269978	-1.022399	48.94	3.58	52.52
6	53.269490	-1.023494	46.53	3.58	50.11
7	53.270600	-1.023526	44.05	3.58	47.63
8	53.270658	-1.022721	44.52	3.58	48.10

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267270	-1.027453	49.52	3.58	53.10
2	53.267742	-1.026122	44.46	3.58	48.04
3	53.267742	-1.026122	44.46	3.58	48.04
4	53.268066	-1.026004	43.25	3.58	46.83
5	53.268066	-1.026004	43.25	3.58	46.83
6	53.268361	-1.024577	44.74	3.58	48.32
7	53.268515	-1.023451	48.43	3.58	52.01
8	53.263789	-1.021096	44.95	3.58	48.53
9	53.263606	-1.026144	50.81	3.58	54.39

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267296	-1.022818	47.72	3.58	51.30
2	53.267707	-1.018998	49.22	3.58	52.80
3	53.264120	-1.017373	43.17	3.58	46.75
4	53.264126	-1.017861	43.81	3.58	47.39
5	53.263885	-1.017893	45.60	3.58	49.18
6	53.263795	-1.021085	44.91	3.58	48.49

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.268300	-1.019106	51.65	3.58	55.23
2	53.268197	-1.015587	47.94	3.58	51.52
3	53.267411	-1.014932	45.87	3.58	49.45
4	53.267411	-1.014932	45.87	3.58	49.45
5	53.263776	-1.015093	42.99	3.58	46.57
6	53.263904	-1.017175	44.48	3.58	48.06
7	53.266359	-1.018355	43.98	3.58	47.56
8	53.266359	-1.018355	43.98	3.58	47.56

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267286	-1.014793	45.26	3.58	48.84
2	53.263975	-1.015072	41.69	3.58	45.27
3	53.265181	-1.012926	37.52	3.58	41.10
4	53.265759	-1.012132	35.68	3.58	39.26
5	53.266067	-1.011724	35.43	3.58	39.01
6	53.266349	-1.011338	34.83	3.58	38.41
7	53.266619	-1.009836	34.68	3.58	38.26
8	53.267825	-1.010716	42.25	3.58	45.83

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 205.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272892	-1.014039	31.26	3.58	34.84
2	53.269530	-1.014554	43.06	3.58	46.64
3	53.269645	-1.012452	41.27	3.58	44.85
4	53.270081	-1.011636	34.85	3.58	38.43
5	53.270916	-1.010456	29.19	3.58	32.77
6	53.271634	-1.010070	28.02	3.58	31.60
7	53.272289	-1.010027	28.11	3.58	31.69
8	53.272956	-1.010370	28.00	3.58	31.58
9	53.273052	-1.010638	28.00	3.58	31.58
10	53.273155	-1.011164	28.00	3.58	31.58
11	53.273213	-1.012548	28.90	3.58	32.48
12	53.272847	-1.012698	29.64	3.58	33.22

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273110	-1.017719	40.37	3.58	43.95
2	53.268830	-1.018953	51.49	3.58	55.07
3	53.268638	-1.015627	47.64	3.58	51.22
4	53.269518	-1.015499	43.86	3.58	47.44
4	53.269518	-1.015499	43.86	3.58	47.44
4	53.269518	-1.015499	43.86	0.00	43.86
5	53.269533	-1.014576	43.07	3.58	46.65
5	53.269533	-1.014576	43.07	0.00	43.07
5	53.269533	-1.014576	43.07	3.58	46.65
6	53.272885	-1.014061	31.29	3.58	34.87

Route Receptors

Name: Route 1
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273121	-1.028896	37.19	1.00	38.19
2	53.270349	-1.028703	43.89	1.00	44.89
3	53.268424	-1.028510	50.14	1.00	51.14
4	53.267320	-1.028381	52.22	1.00	53.22
5	53.266127	-1.028446	54.15	1.00	55.15
6	53.265318	-1.028446	55.33	1.00	56.33
7	53.264818	-1.028488	56.74	1.00	57.74
8	53.264356	-1.028424	57.75	1.00	58.75
9	53.262880	-1.028167	54.07	1.00	55.07
10	53.260454	-1.027716	47.37	1.00	48.37
11	53.257386	-1.027351	49.05	1.00	50.05

Name: Route 2
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270634	-0.993466	28.31	1.00	29.31
2	53.272572	-0.990312	40.32	1.00	41.32
3	53.273021	-0.989518	41.87	1.00	42.87
4	53.274343	-0.987801	45.73	1.00	46.73
5	53.275459	-0.986514	48.44	1.00	49.44
6	53.275574	-0.986063	47.29	1.00	48.29
7	53.276229	-0.985484	46.69	1.00	47.69
8	53.277756	-0.983359	45.12	1.00	46.12
9	53.278333	-0.982394	40.90	1.00	41.90

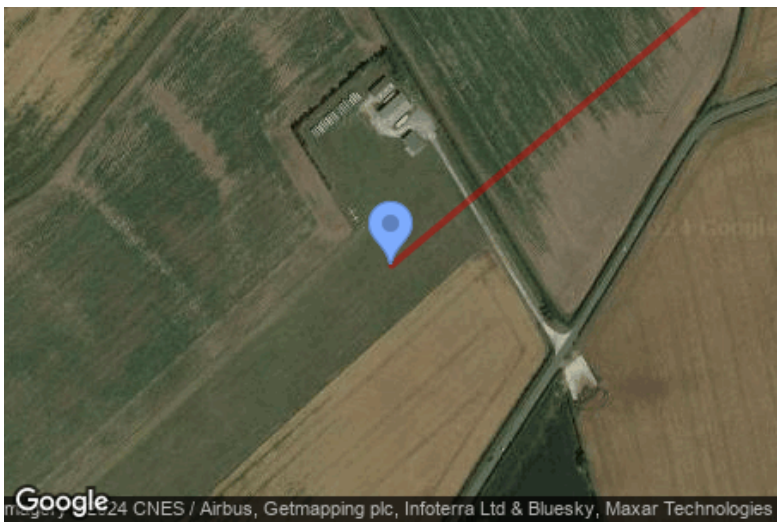
Name: Route 3
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.263345	-1.028120	55.39	1.00	56.39
2	53.263319	-1.025760	51.29	1.00	52.29
3	53.263345	-1.023185	48.03	1.00	49.03
4	53.263396	-1.021511	47.21	1.00	48.21
5	53.263499	-1.019709	47.62	1.00	48.62
6	53.263627	-1.018400	47.53	1.00	48.53
7	53.263627	-1.014237	44.36	1.00	45.36
8	53.263422	-1.010439	47.04	1.00	48.04
9	53.262729	-1.001749	33.37	1.00	34.37
10	53.262074	-0.997221	31.11	1.00	32.11

Flight Path Receptors

Name: Darlton 1
Description:
Threshold height: 15 m
Direction: 230.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



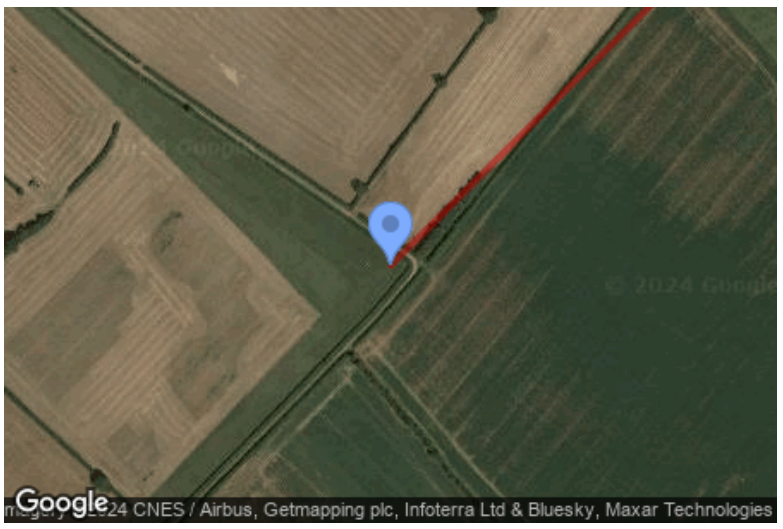
Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.248409	-0.853711	38.08	15.24	53.32
Two-mile	53.266994	-0.816652	13.00	209.00	222.00

Name: Darlton 2
Description:
Threshold height: 15 m
Direction: 50.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.242234	-0.864967	45.65	15.24	60.89
Two-mile	53.223665	-0.902042	46.04	183.54	229.58

Name: Headon 23
Description:
Threshold height: 15 m
Direction: 225.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.281077	-0.868031	42.04	15.24	57.28
Two-mile	53.301521	-0.833797	33.34	192.62	225.96

Name: Headon 32
Description:
Threshold height: 15 m
Direction: 315.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.281056	-0.868280	41.64	15.24	56.88
Two-mile	53.260612	-0.834046	16.39	209.18	225.57

Name: Headon R14
Description:
Threshold height: 15 m
Direction: 135.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.283658	-0.873694	43.93	15.24	59.17
Two-mile	53.304102	-0.907930	50.26	177.59	227.85

Name: Runway 03 S
Description:
Threshold height: 15 m
Direction: 23.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.275749	-0.955114	26.00	15.24	41.24
Two-mile	53.249135	-0.974028	29.98	179.95	209.92

Name: Runway 14 NW
Description:
Threshold height: 15 m
Direction: 141.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.282130	-0.966797	23.54	15.24	38.78
Two-mile	53.304628	-0.997207	32.14	175.32	207.47

Name: Runway 21 N
Description:
Threshold height: 15 m
Direction: 203.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.285576	-0.947531	24.73	15.24	39.97
Two-mile	53.312190	-0.928612	21.88	186.78	208.66

Name: Runway 32 SE
Description:
Threshold height: 15 m
Direction: 320.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.276535	-0.959200	24.68	15.24	39.92
Two-mile	53.254387	-0.928083	25.39	183.21	208.60

Name: Three Counties R06
Description:
Threshold height: 15 m
Direction: 54.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.315949	-1.198597	77.60	15.24	92.84
Two-mile	53.299209	-1.238102	131.46	130.06	261.52

Name: Three Counties R19
Description:
Threshold height: 15 m
Direction: 178.5°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.318401	-1.195787	70.68	15.24	85.92
Two-mile	53.347304	-1.197047	104.03	150.57	254.60

Name: Three Counties R24
Description:
Threshold height: 15 m
Direction: 236.5°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.317671	-1.194436	69.76	15.24	85.00
Two-mile	53.333637	-1.154039	61.87	191.81	253.68

Name: Three Counties R36
Description:
Threshold height: 15 m
Direction: 356.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.315754	-1.195385	73.18	15.24	88.42
Two-mile	53.286892	-1.192537	84.36	172.74	257.10

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.265711	-1.027789	52.70	1.80
OP 2	2	53.269454	-0.991192	38.22	1.80
OP 3	3	53.272586	-0.978795	33.87	1.80

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m²
PV array 1	25.0	180.0	5,054	84.2	0	0.0	-	162,112
PV array 2	25.0	180.0	5,891	98.2	0	0.0	-	80,687
PV array 3	25.0	180.0	7,239	120.7	10,787	179.8	-	1,672,925
PV array 4	25.0	180.0	8,705	145.1	7,943	132.4	-	1,363,436
PV array 5	25.0	180.0	7,592	126.5	10,995	183.2	-	2,010,517
PV array 6	25.0	180.0	14,131	235.5	6,070	101.2	-	840,949
PV array 7	25.0	205.0	982	16.4	0	0.0	-	10,267
PV array 8	25.0	180.0	10,244	170.7	0	0.0	-	250,599

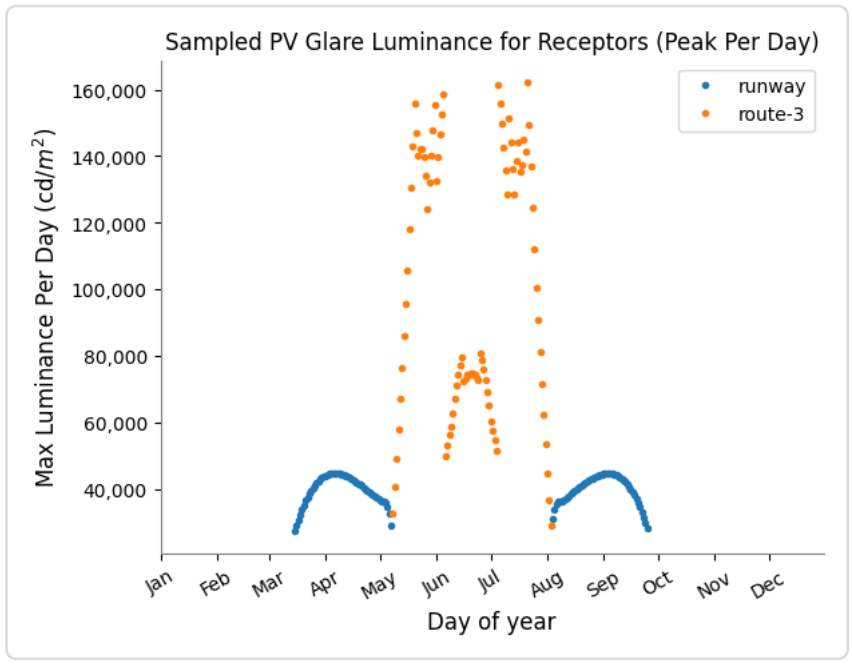
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
Route 2	1,264	21.1	0	0.0
Route 3	21,164	352.7	28,510	475.2
Darlton 1	8,563	142.7	0	0.0
Darlton 2	0	0.0	0	0.0
Headon 23	0	0.0	0	0.0
Headon 32	4,528	75.5	0	0.0
Headon R14	0	0.0	0	0.0
Runway 03 S	0	0.0	0	0.0
Runway 14 NW	0	0.0	0	0.0
Runway 21 N	0	0.0	0	0.0
Runway 32 SE	14,772	246.2	0	0.0
Three Counties R06	570	9.5	0	0.0
Three Counties R19	0	0.0	0	0.0
Three Counties R24	0	0.0	0	0.0
Three Counties R36	0	0.0	0	0.0
OP 1	5,704	95.1	7,285	121.4
OP 2	2,961	49.4	0	0.0
OP 3	312	5.2	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

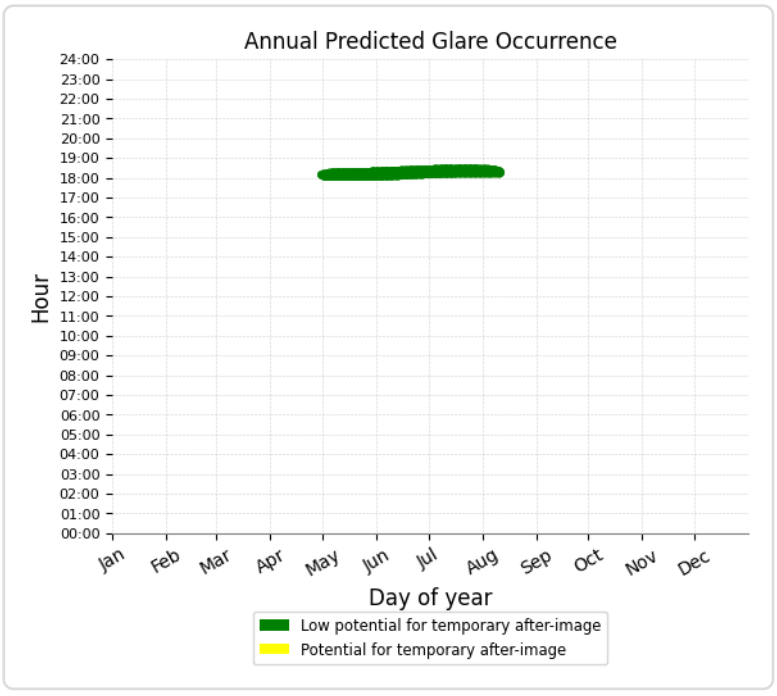
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	2,353	39.2	0	0.0	162,112
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Darlton 1	851	14.2	0	0.0	12,056
Headon 32	551	9.2	0	0.0	9,034
Runway 32 SE	1,274	21.2	0	0.0	44,711
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 2	25	0.4	0	0.0	29,084
OP 1	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

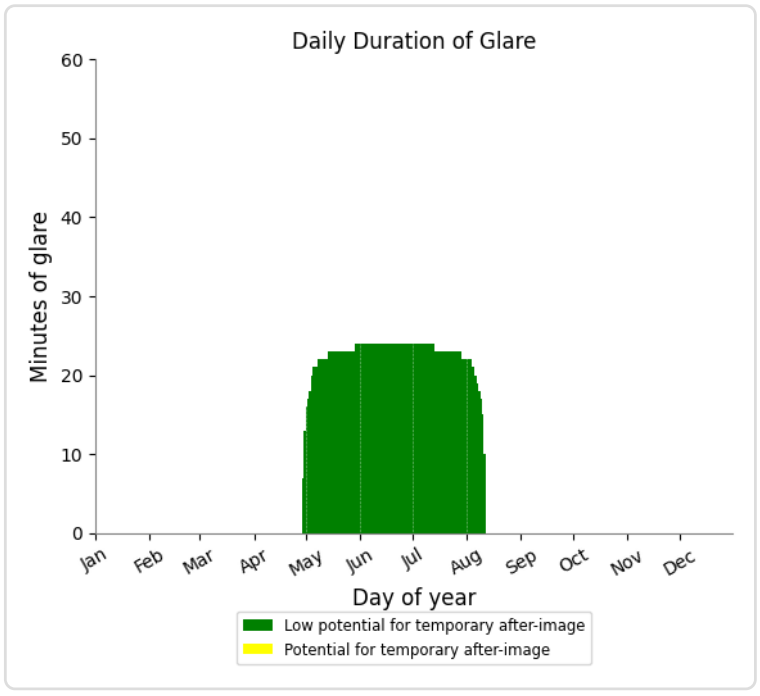


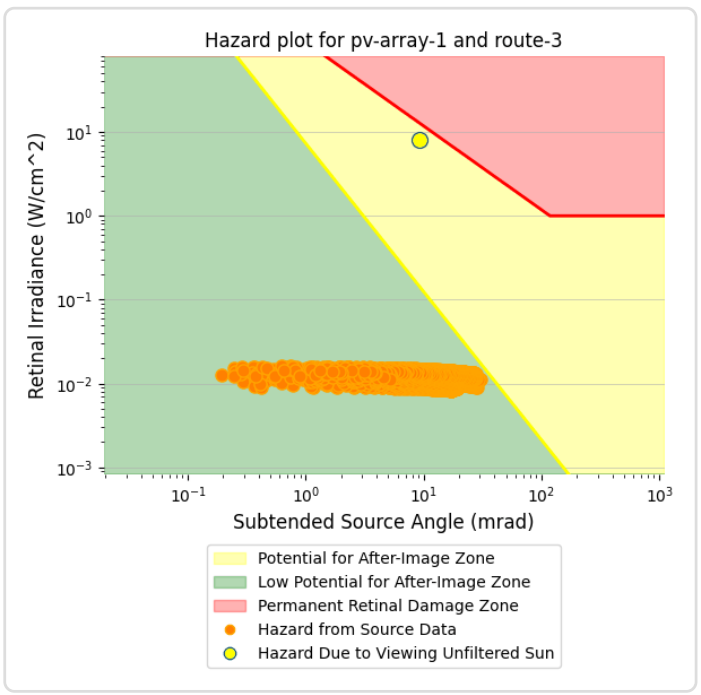
PV array 1 and Route: Route 3

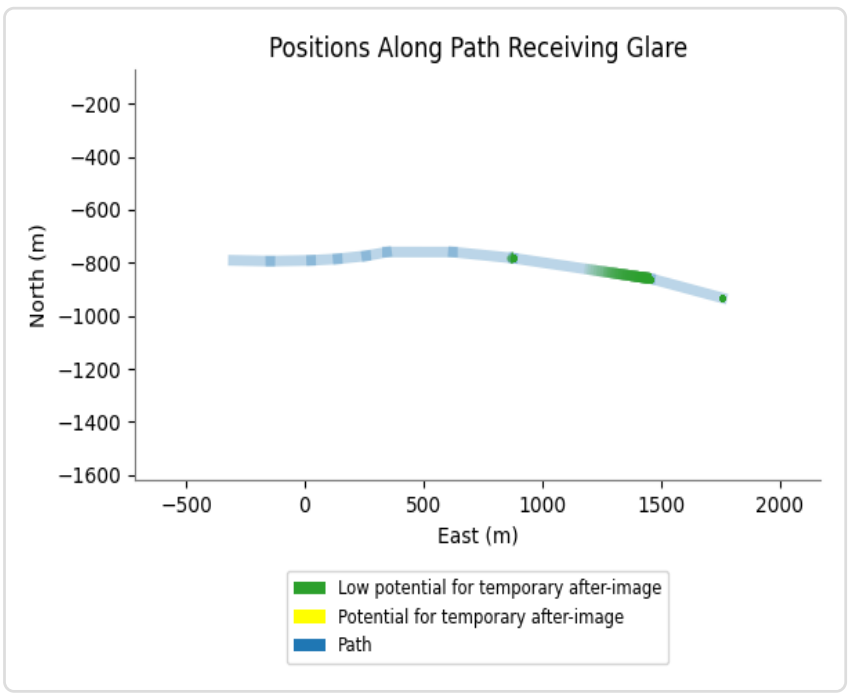
Yellow glare: none

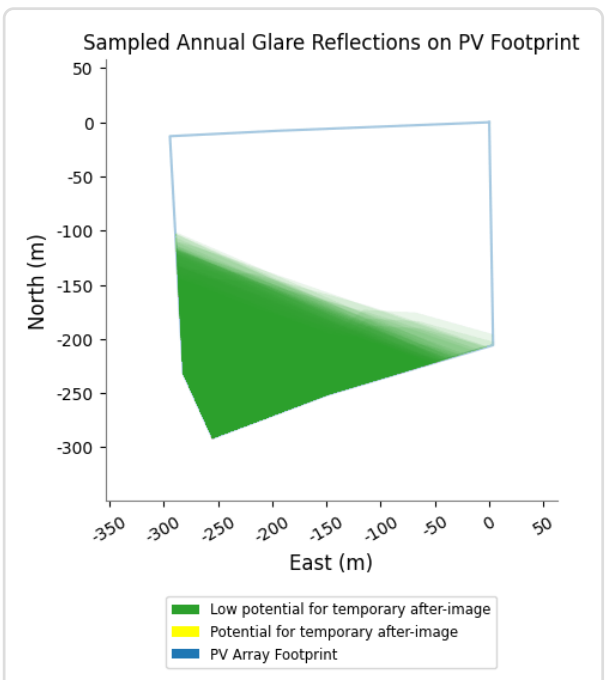
Green glare: 2,353 min.

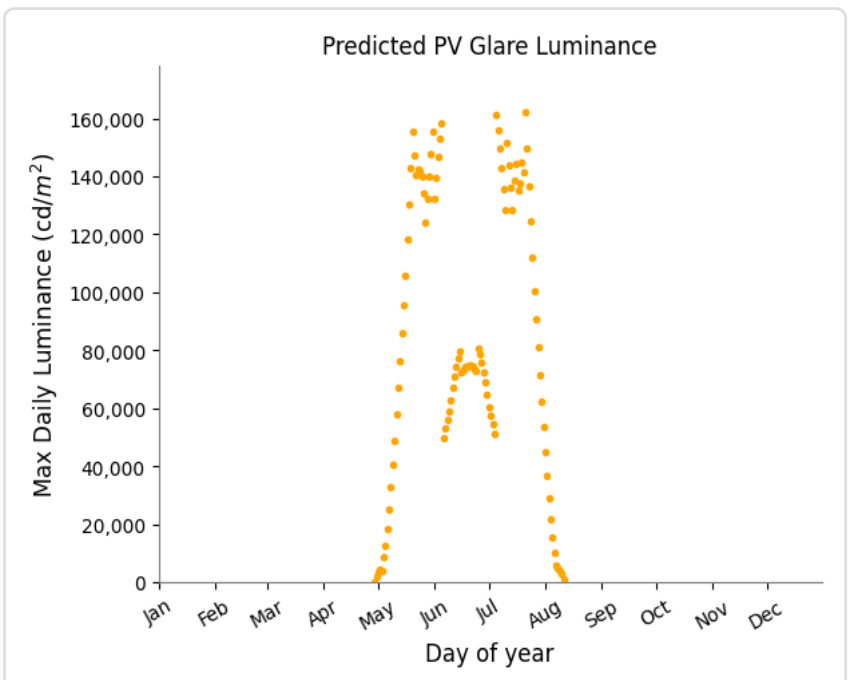












PV array 1 and Route: Route 1

No glare found

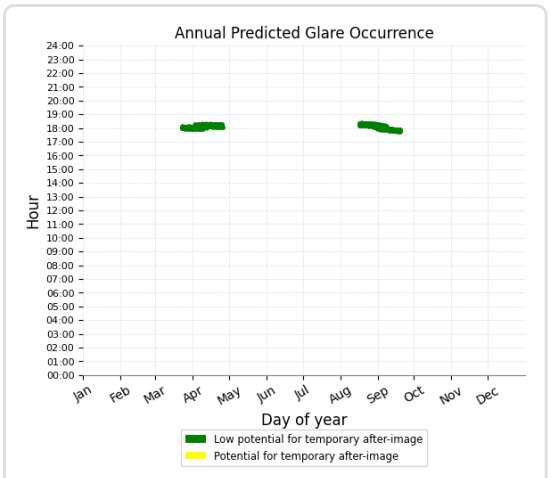
PV array 1 and Route: Route 2

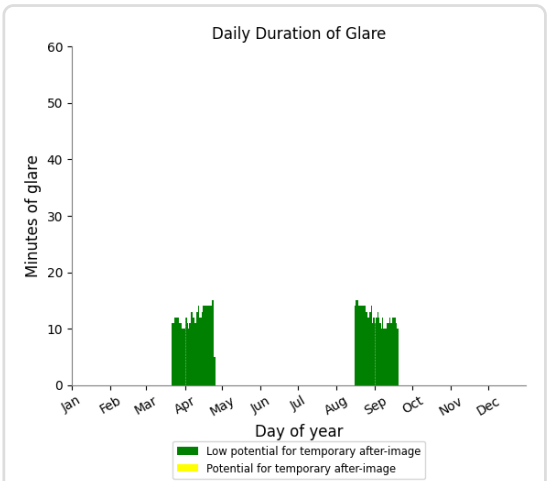
No glare found

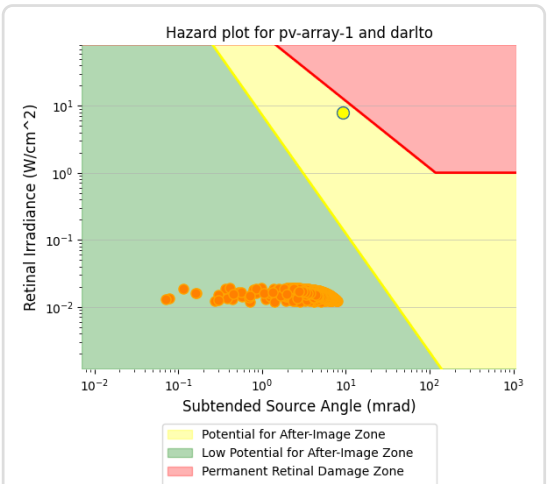
PV array 1 and FP: Darlton 1

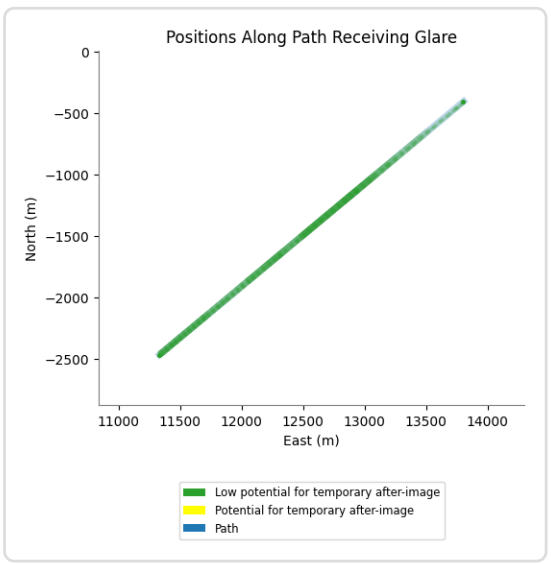
Yellow glare: none

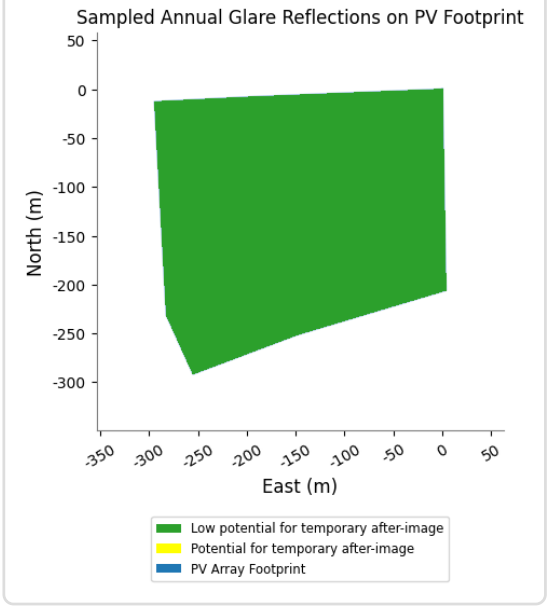
Green glare: 851 min.

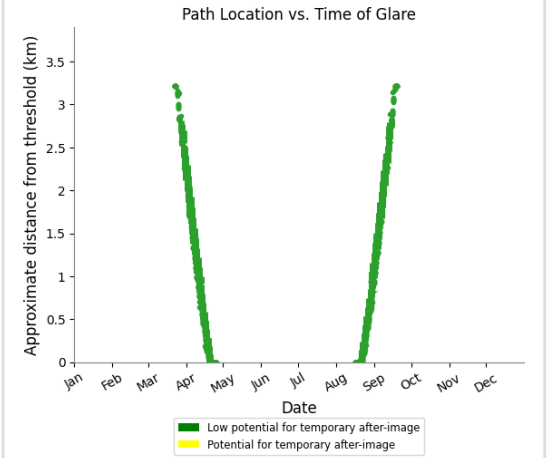


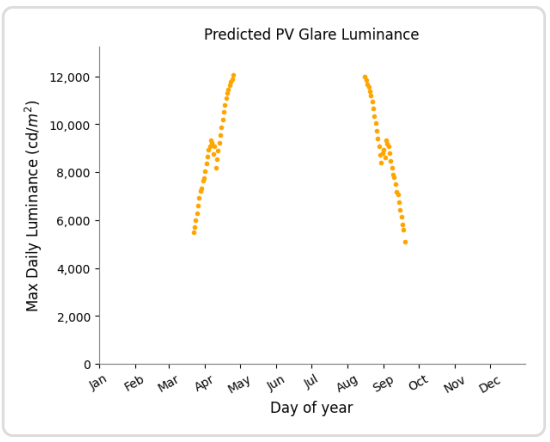








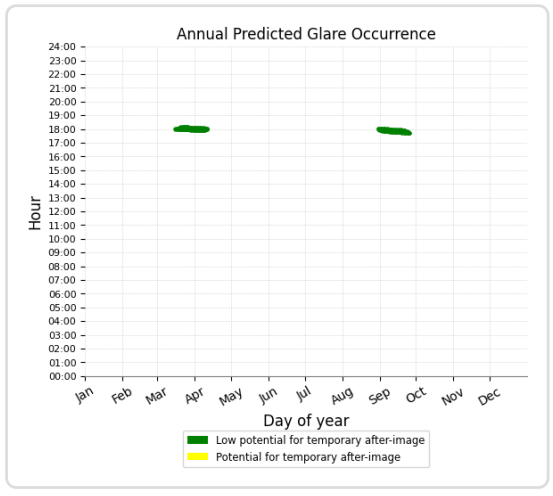


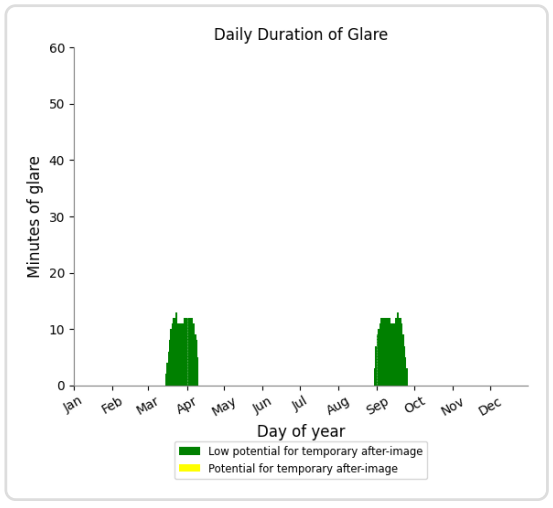


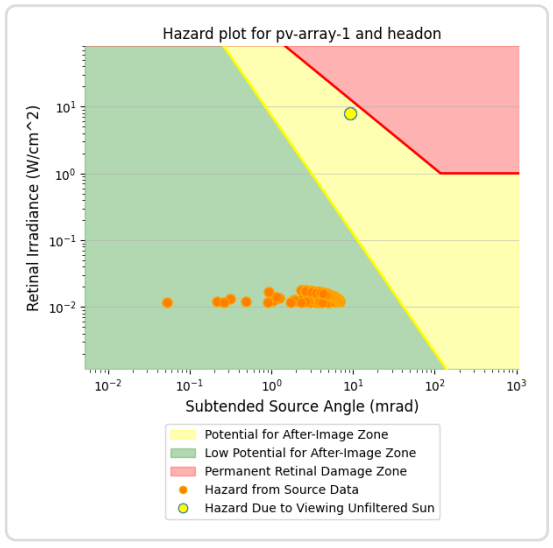
PV array 1 and FP: Headon 32

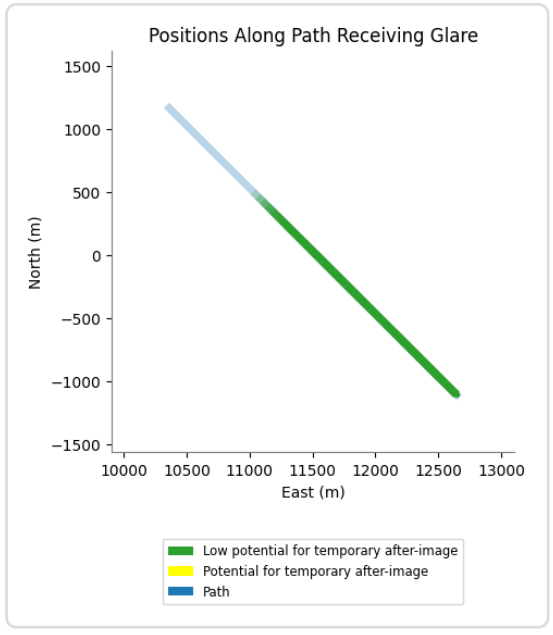
Yellow glare: none

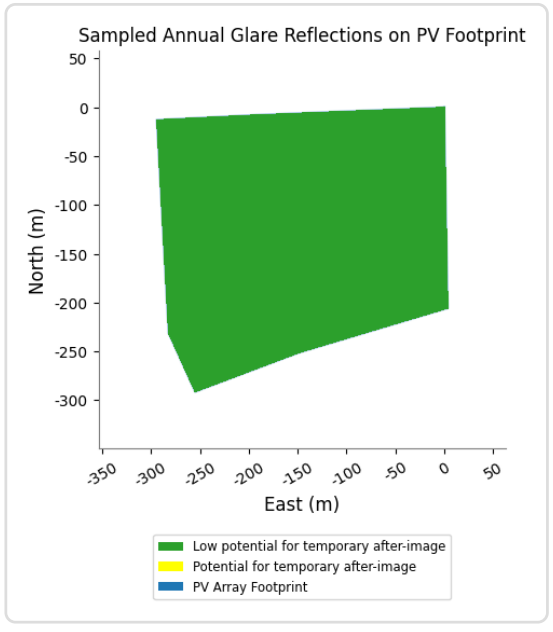
Green glare: 551 min.

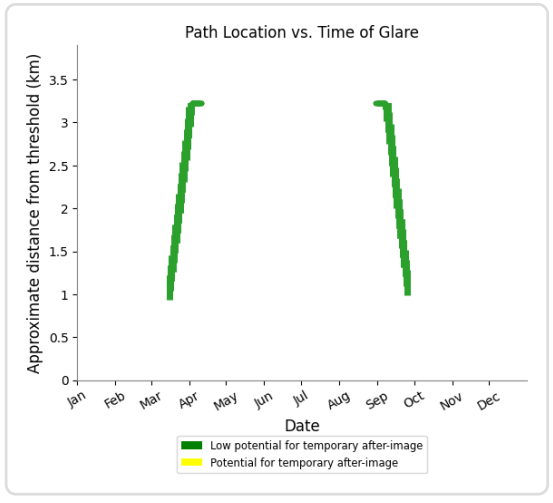


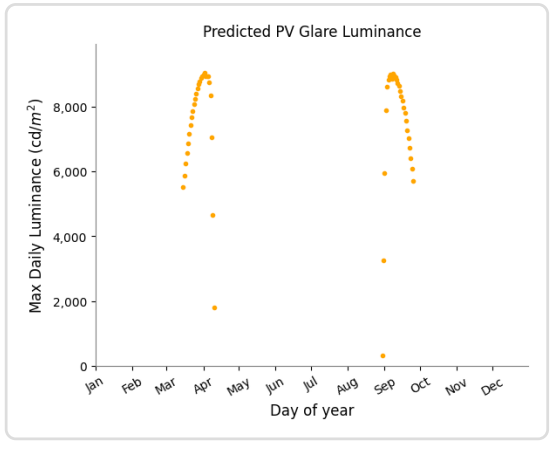








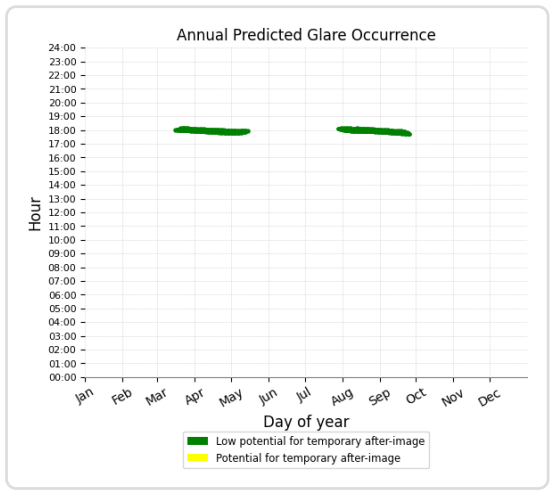


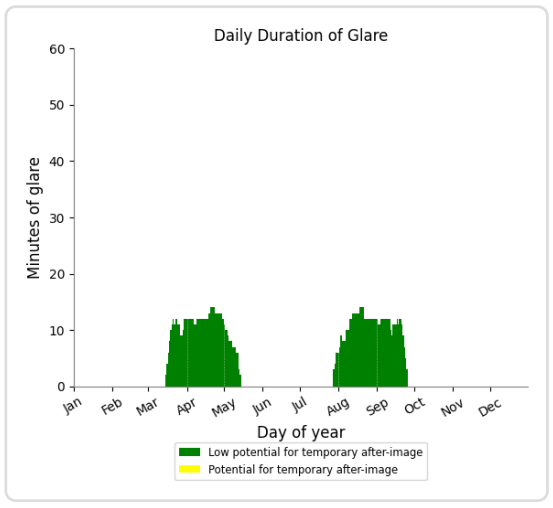


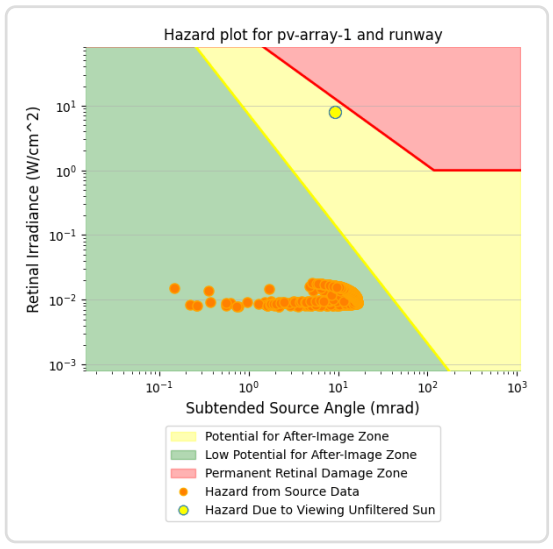
PV array 1 and FP: Runway 32 SE

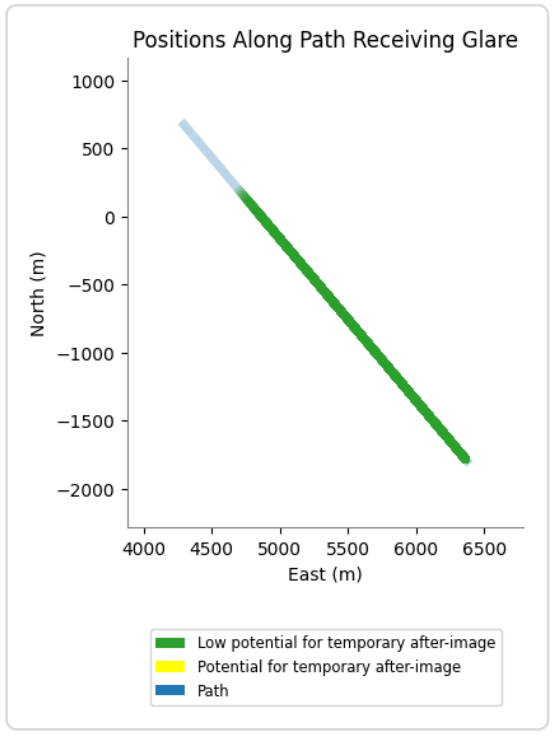
Yellow glare: none

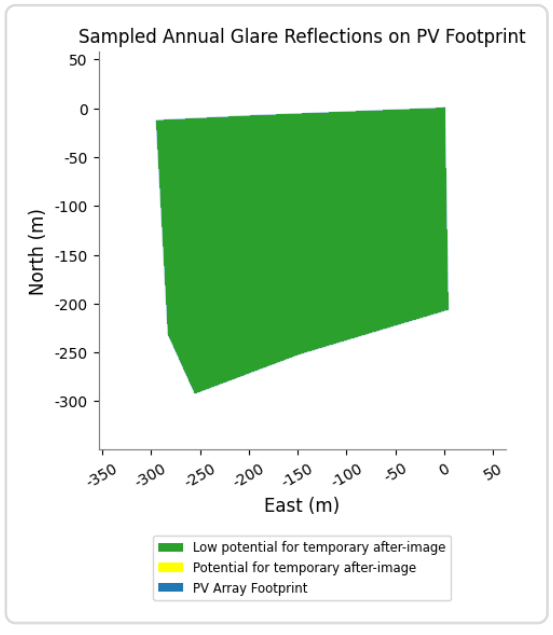
Green glare: 1,274 min.

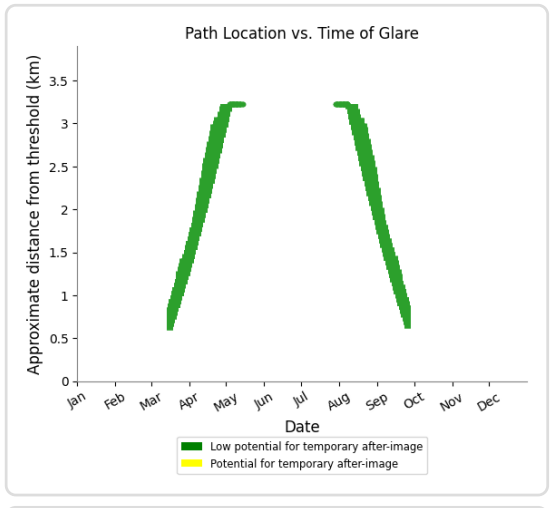


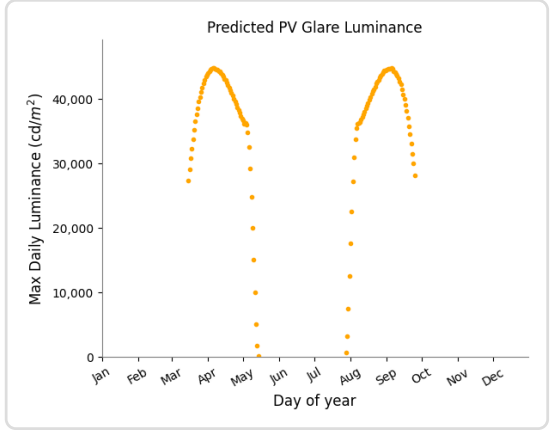












PV array 1 and FP: Darlton 2

No glare found

PV array 1 and FP: Headon 23

No glare found

PV array 1 and FP: Headon R14

No glare found

PV array 1 and FP: Runway 03 S

No glare found

PV array 1 and FP: Runway 14 NW

No glare found

PV array 1 and FP: Runway 21 N

No glare found

PV array 1 and FP: Three Counties R06

No glare found

PV array 1 and FP: Three Counties R19

No glare found

PV array 1 and FP: Three Counties R24

No glare found

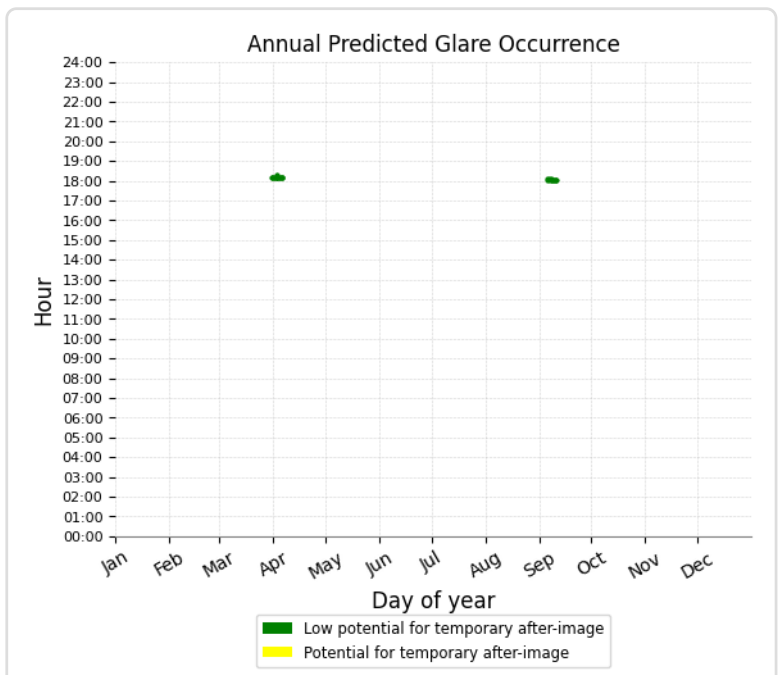
PV array 1 and FP: Three Counties R36

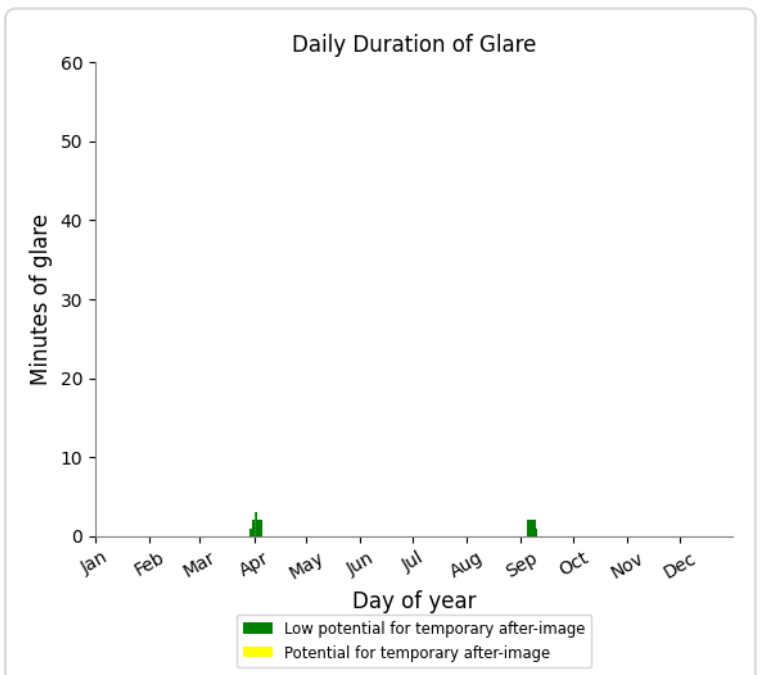
No glare found

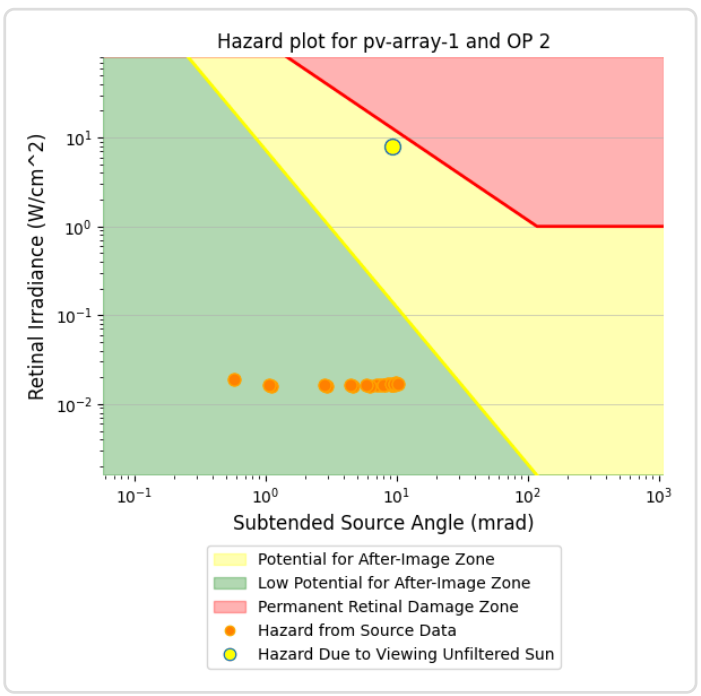
PV array 1 and OP 2

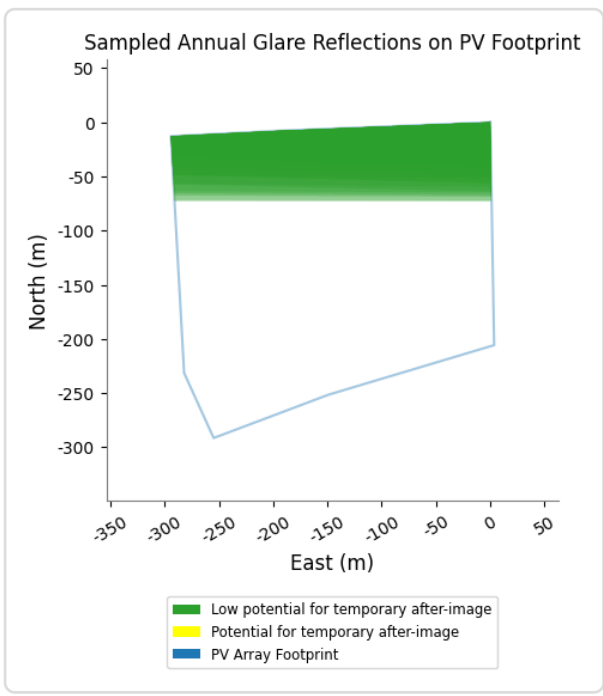
Yellow glare: none

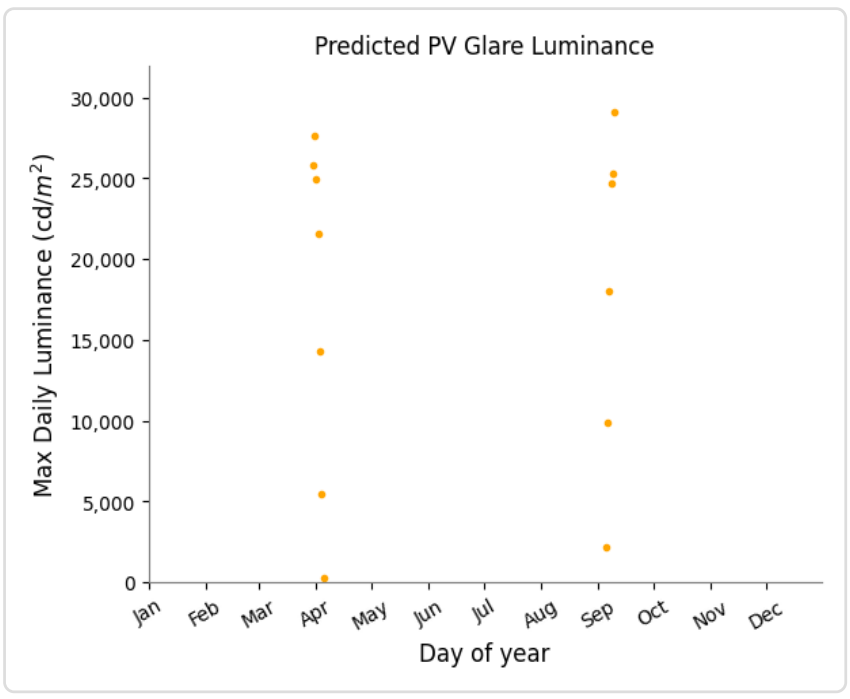
Green glare: 25 min.











PV array 1 and OP 1

No glare found

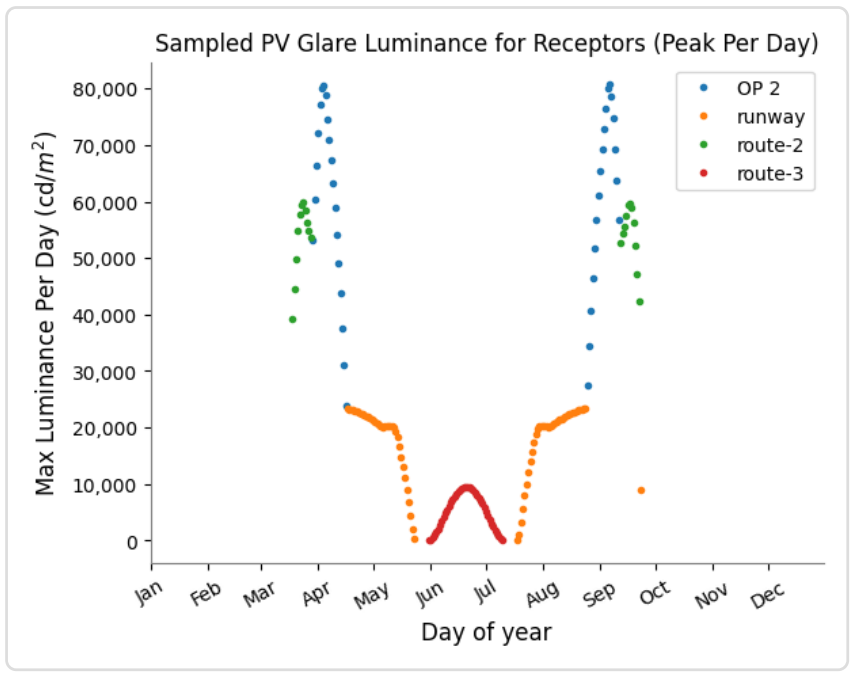
PV array 1 and OP 3

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

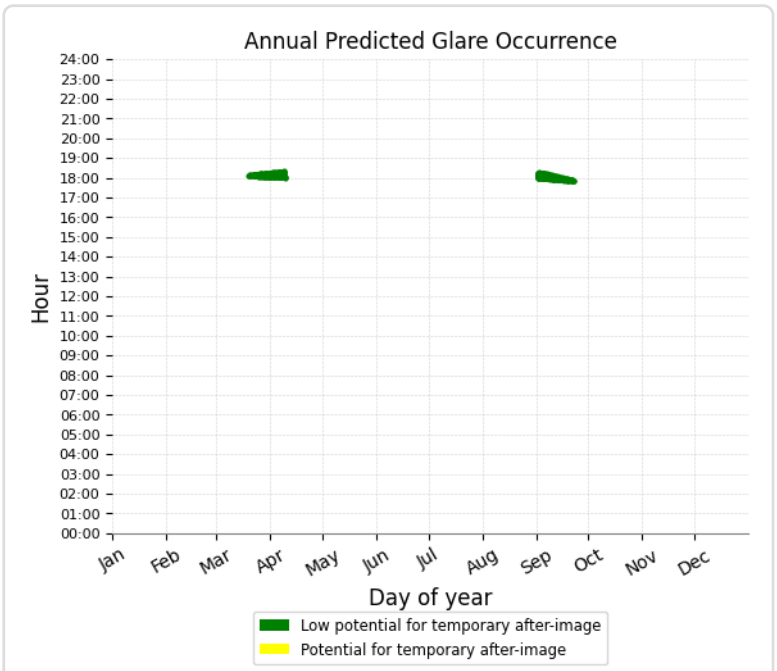
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 2	503	8.4	0	0.0	59,811
Route 3	764	12.7	0	0.0	9,480
Route 1	0	0.0	0	0.0	0
Darlton 1	1,145	19.1	0	0.0	6,464
Headon 32	605	10.1	0	0.0	4,464
Runway 32 SE	1,905	31.8	0	0.0	23,330
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 2	969	16.1	0	0.0	80,687
OP 1	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

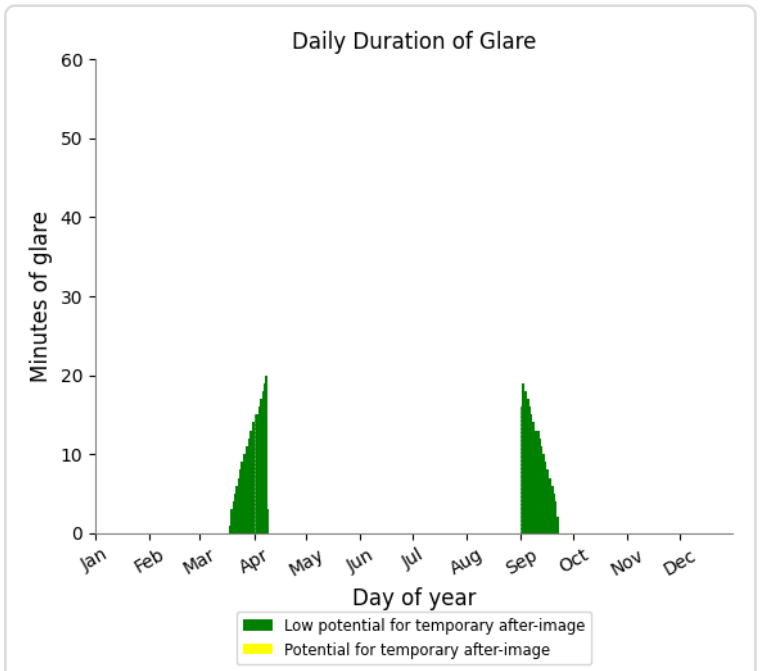


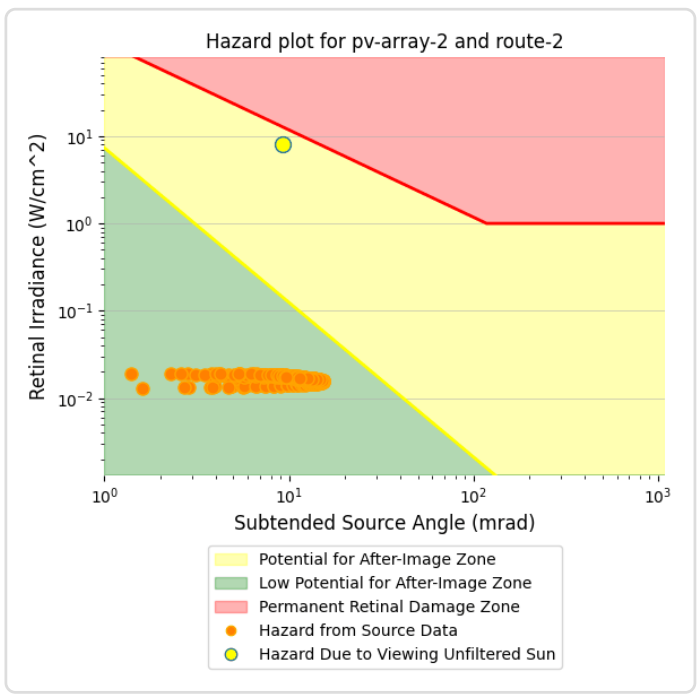
PV array 2 and Route: Route 2

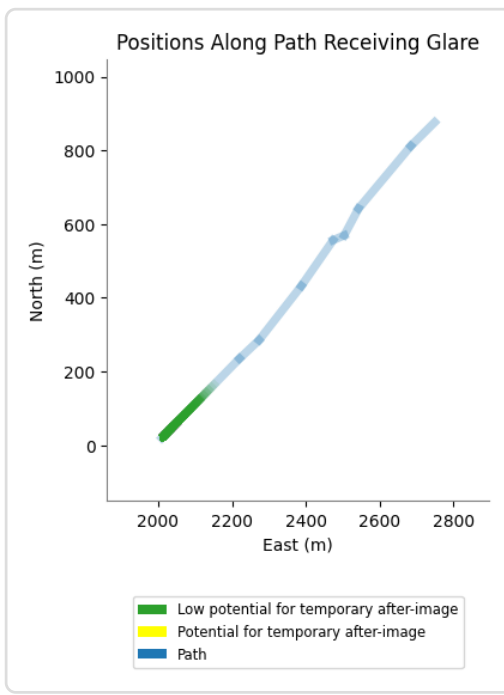
Yellow glare: none

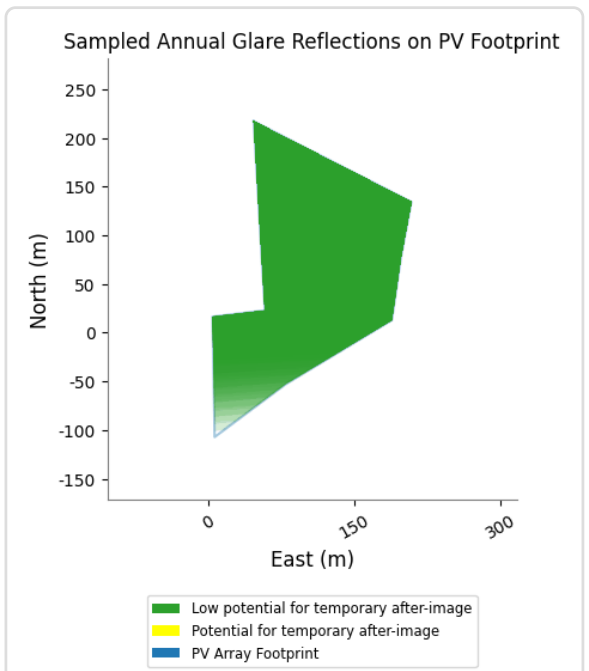
Green glare: 503 min.

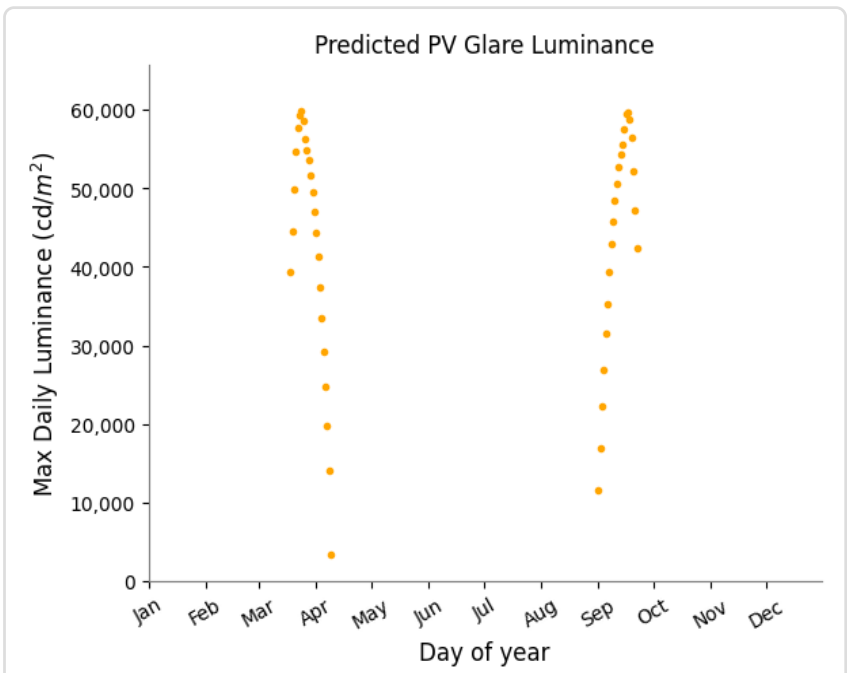








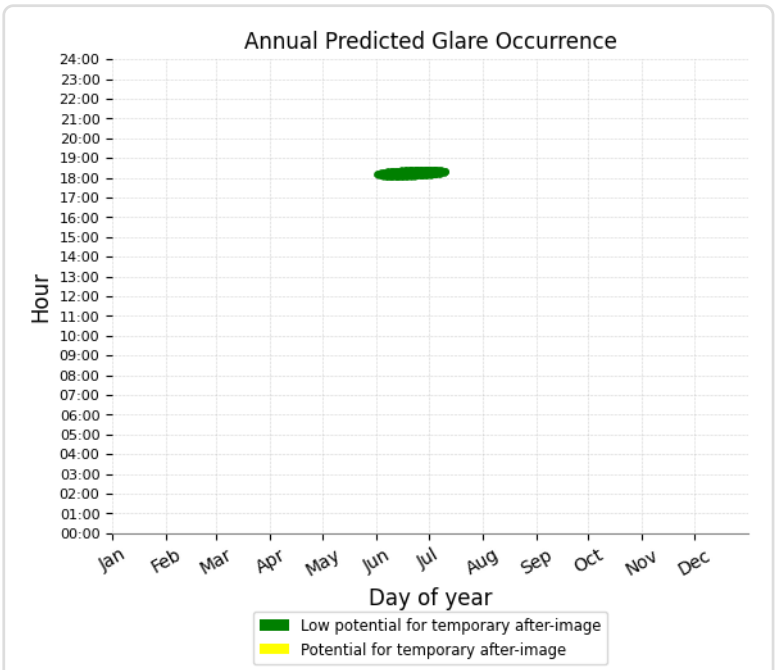


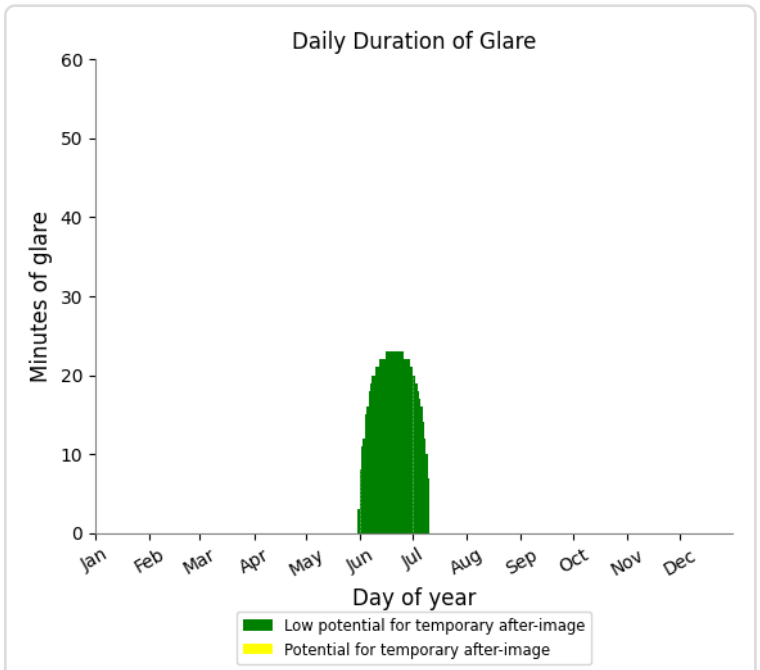


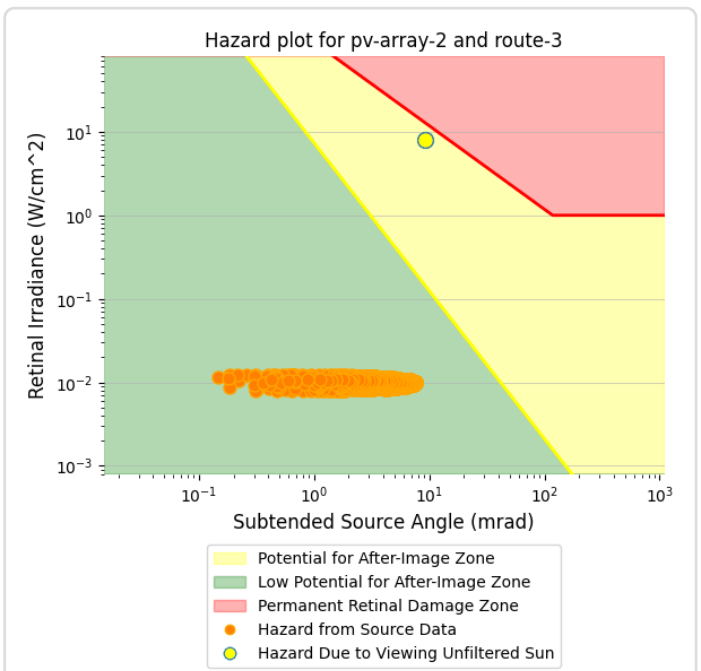
PV array 2 and Route: Route 3

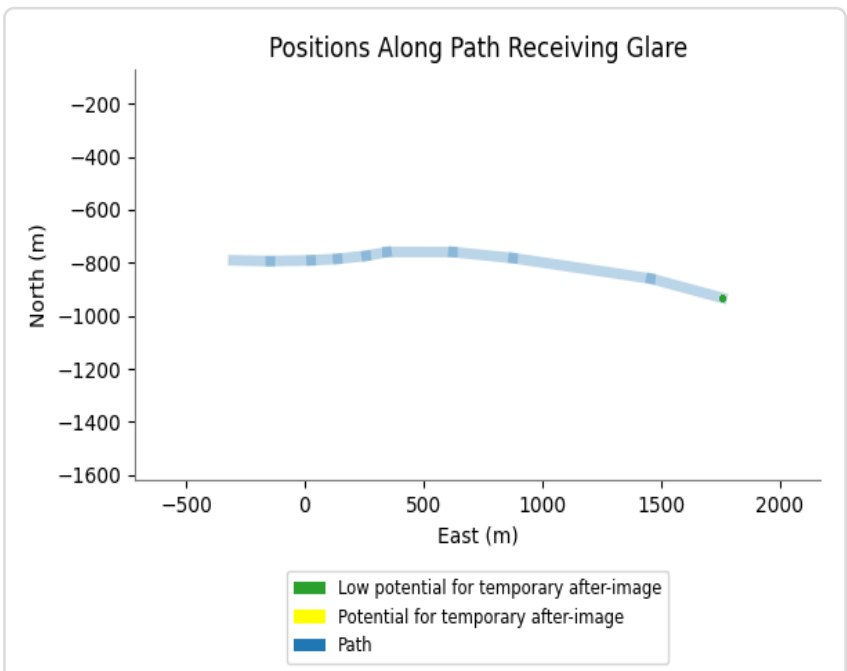
Yellow glare: none

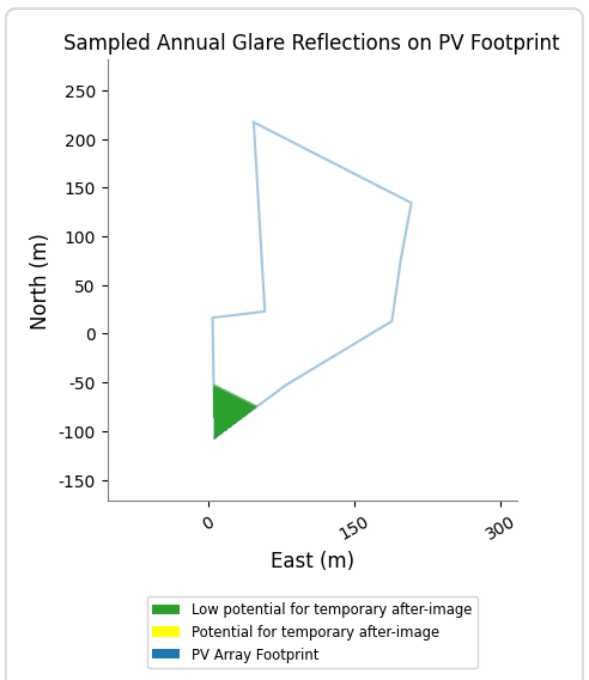
Green glare: 764 min.

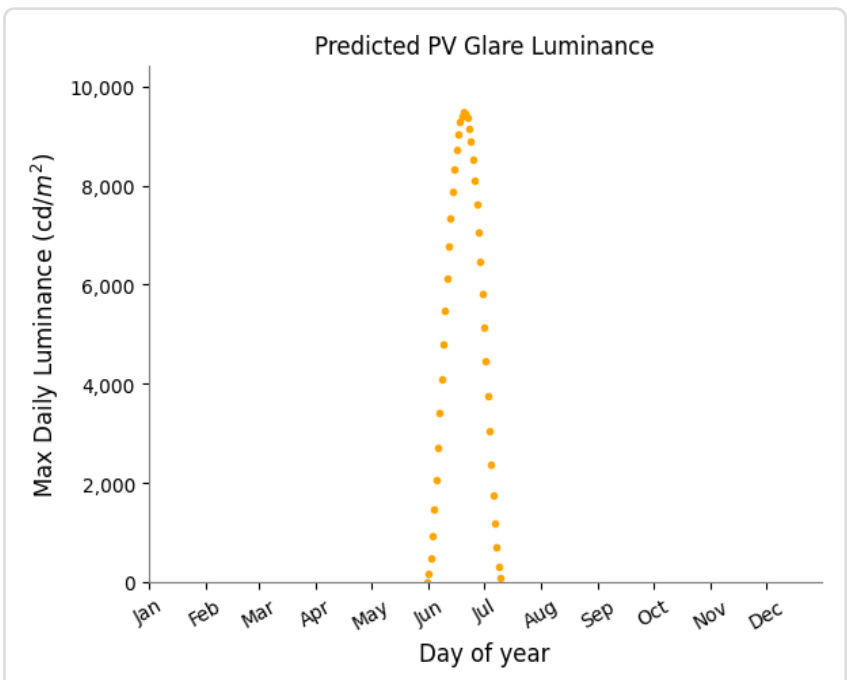












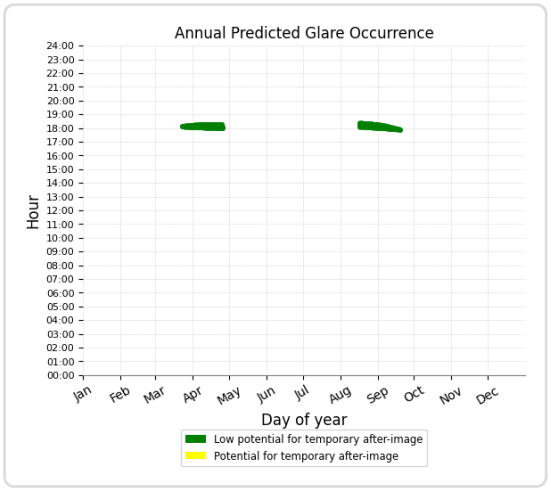
PV array 2 and Route: Route 1

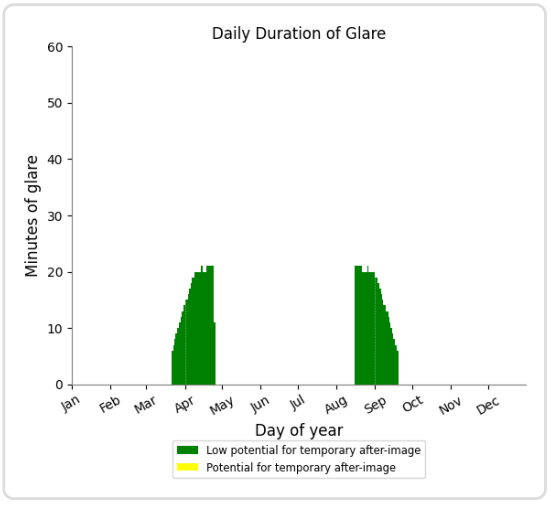
No glare found

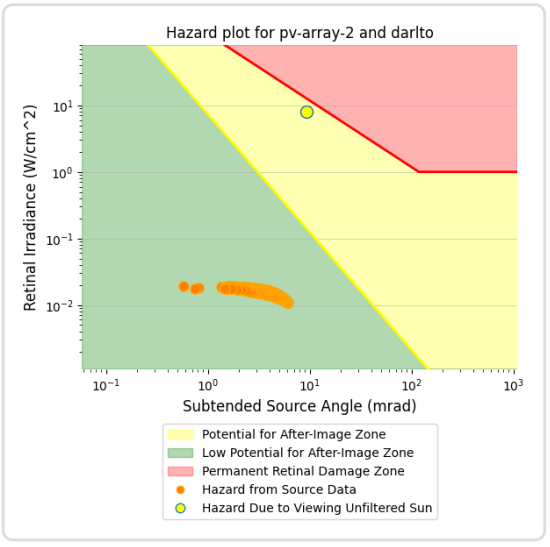
PV array 2 and FP: Darlton 1

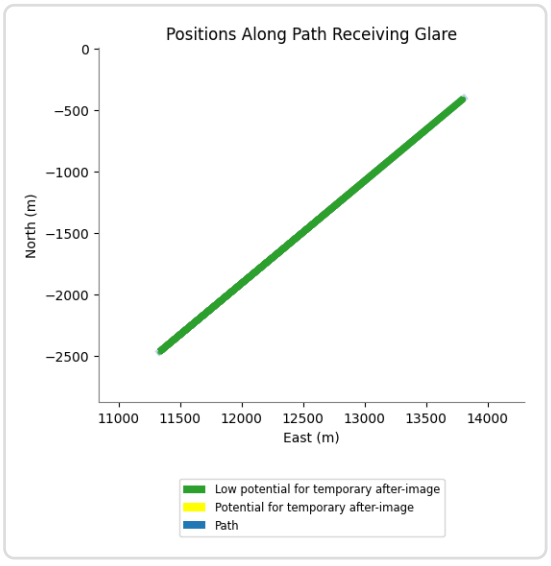
Yellow glare: none

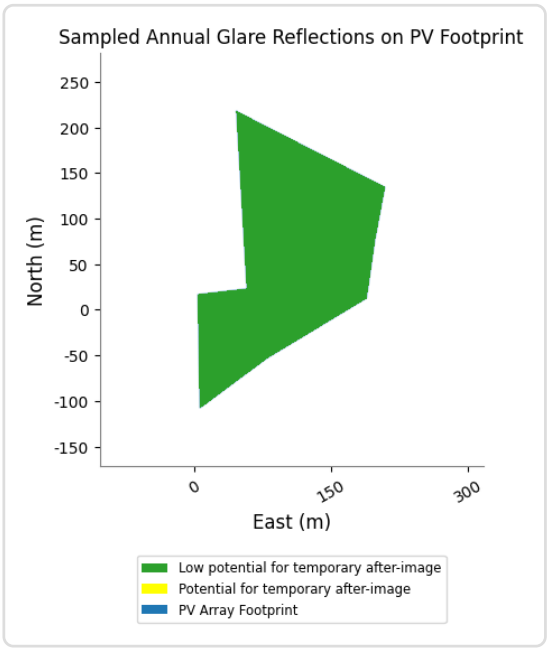
Green glare: 1,145 min.

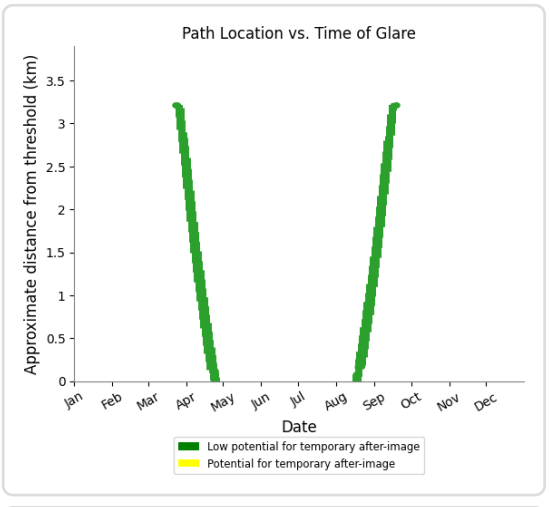


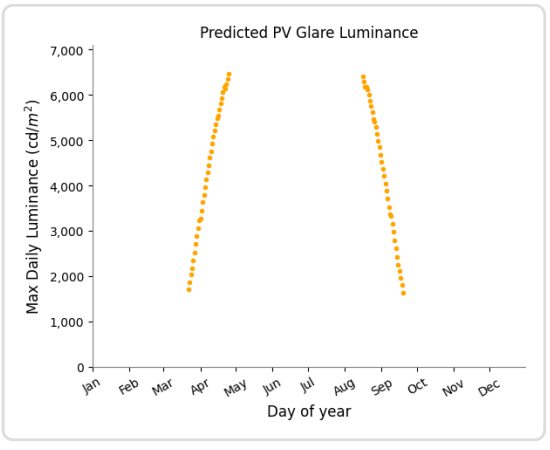








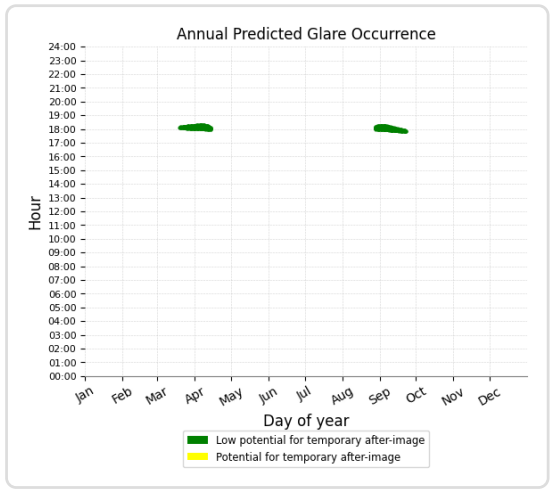


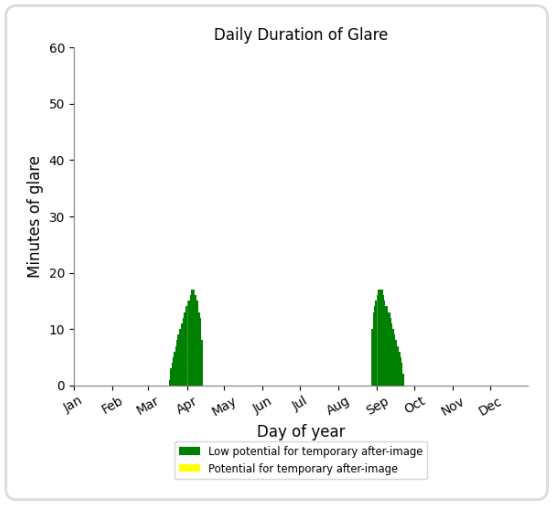


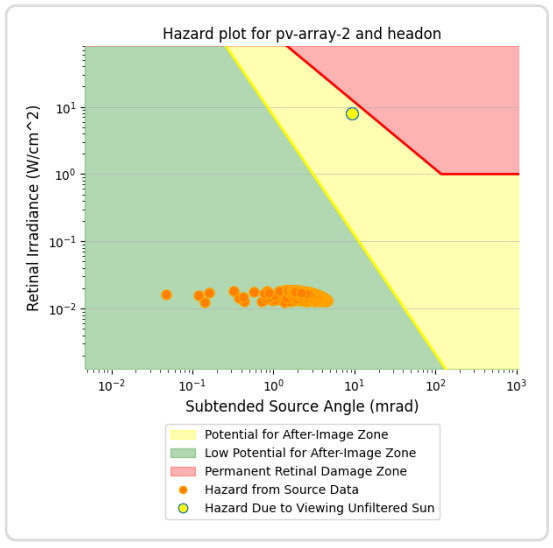
PV array 2 and FP: Headon 32

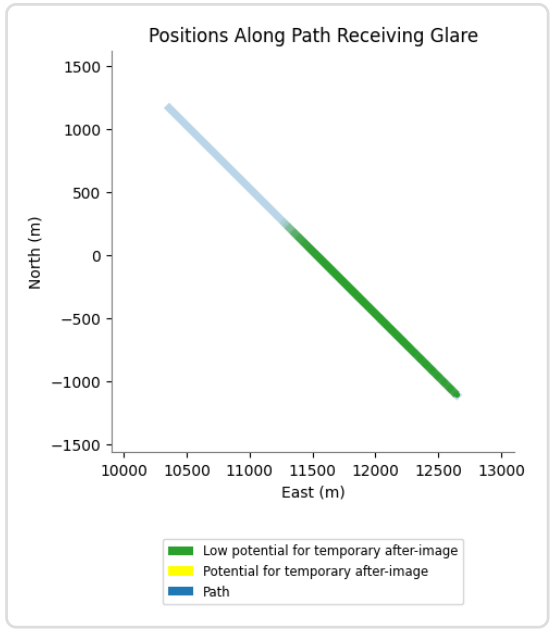
Yellow glare: none

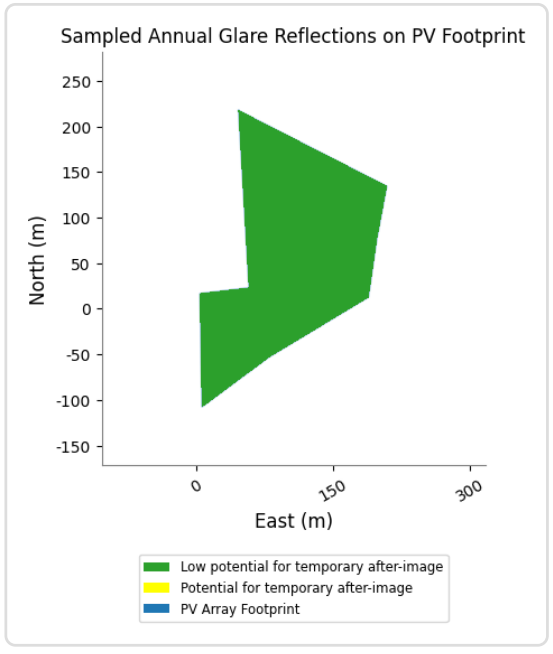
Green glare: 605 min.

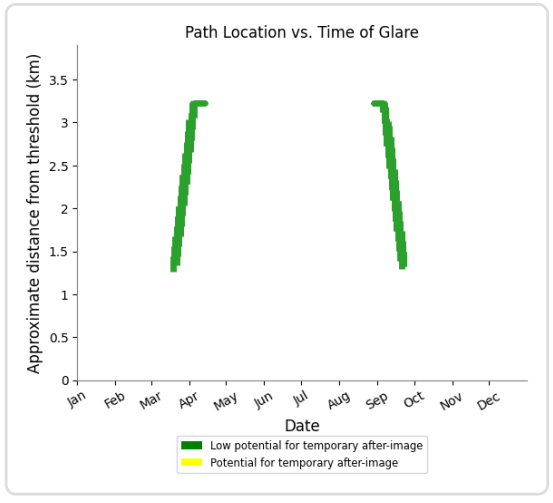


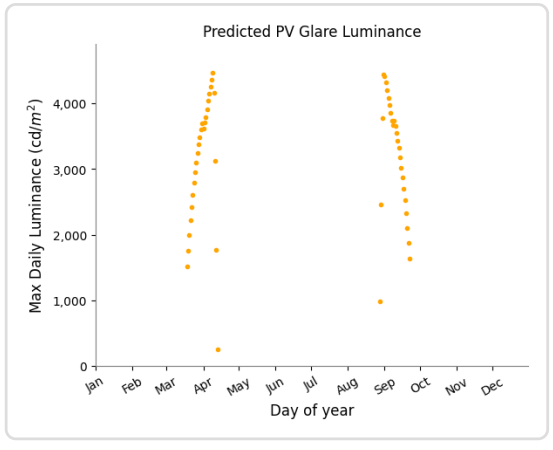








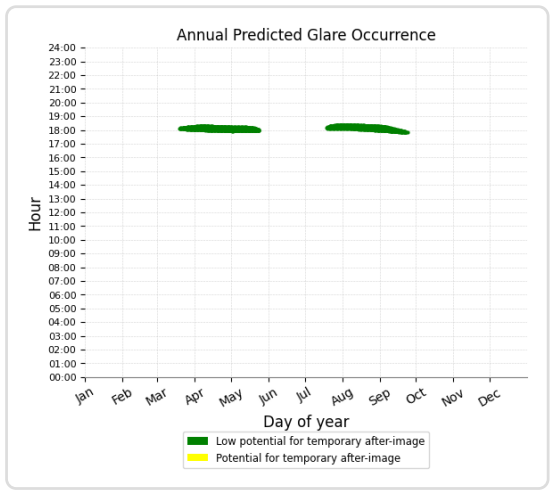


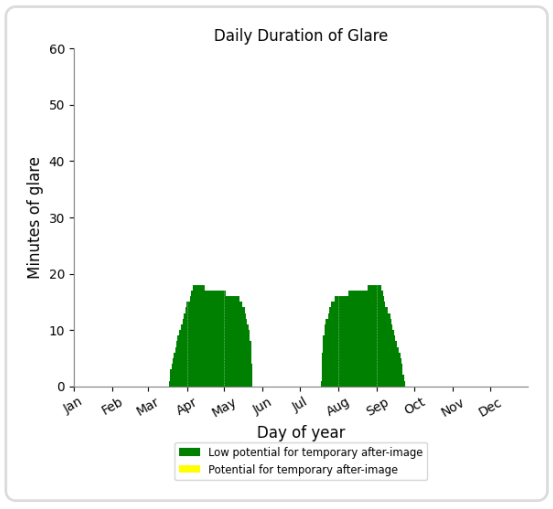


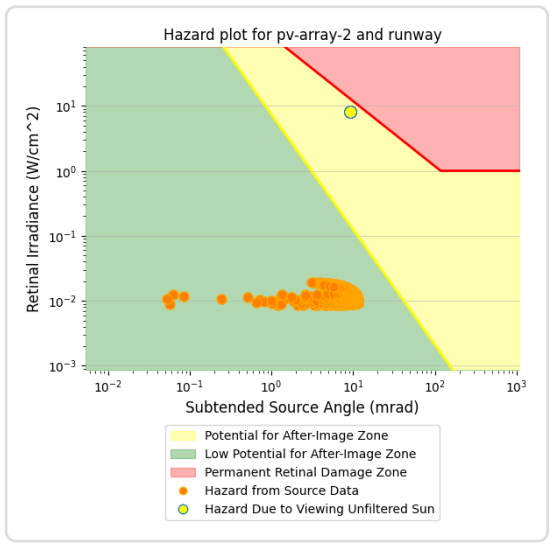
PV array 2 and FP: Runway 32 SE

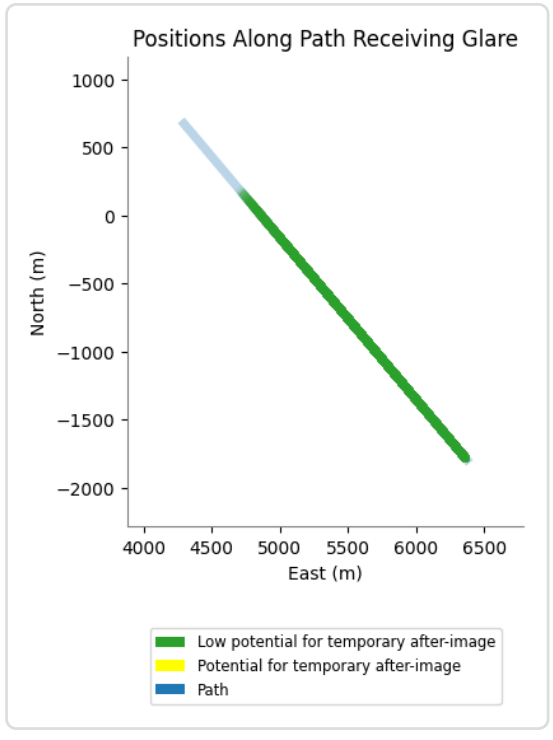
Yellow glare: none

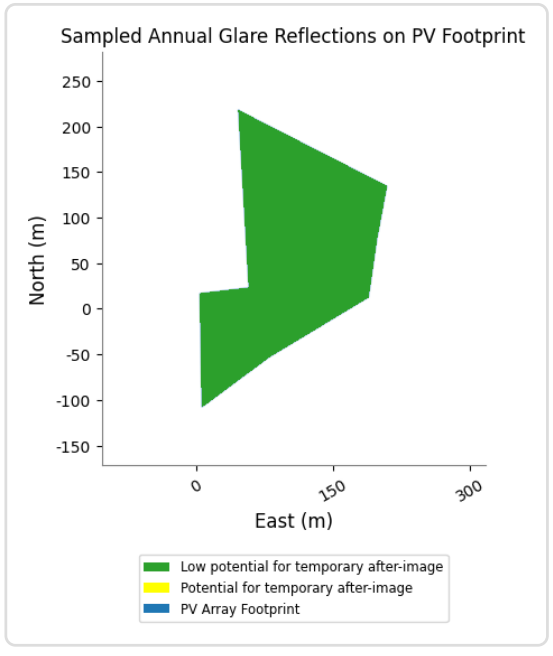
Green glare: 1,905 min.

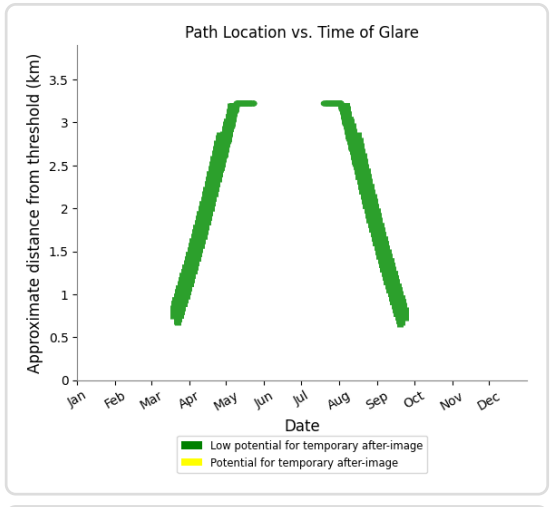


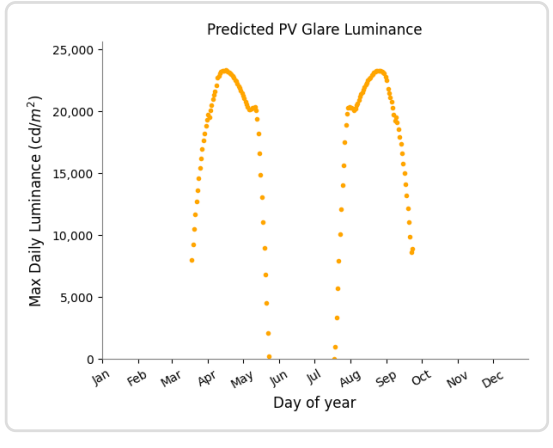












PV array 2 and FP: Darlton 2

No glare found

PV array 2 and FP: Headon 23

No glare found

PV array 2 and FP: Headon R14

No glare found

PV array 2 and FP: Runway 03 S

No glare found

PV array 2 and FP: Runway 14 NW

No glare found

PV array 2 and FP: Runway 21 N

No glare found

PV array 2 and FP: Three Counties R06

No glare found

PV array 2 and FP: Three Counties R19

No glare found

PV array 2 and FP: Three Counties R24

No glare found

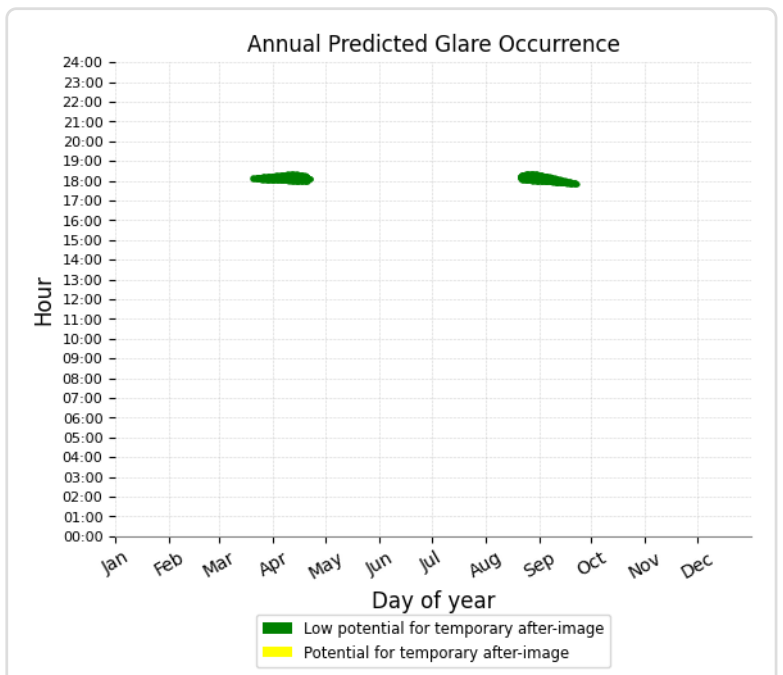
PV array 2 and FP: Three Counties R36

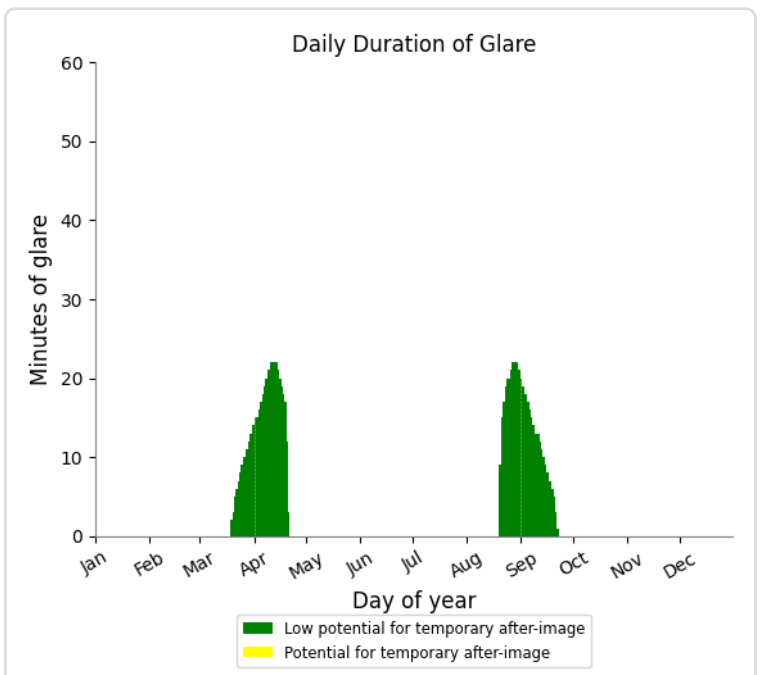
No glare found

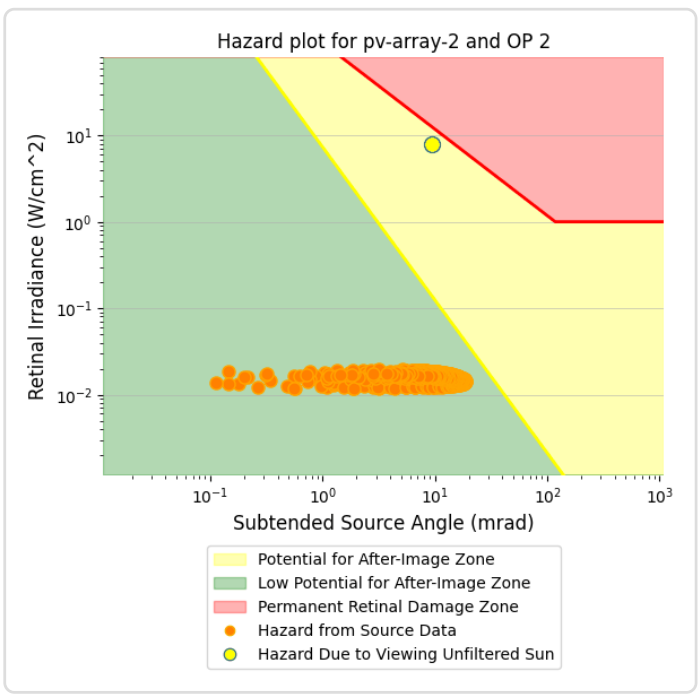
PV array 2 and OP 2

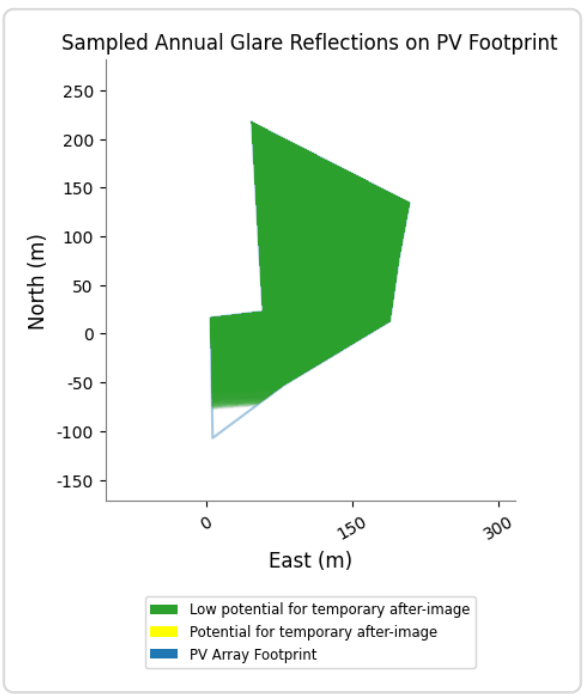
Yellow glare: none

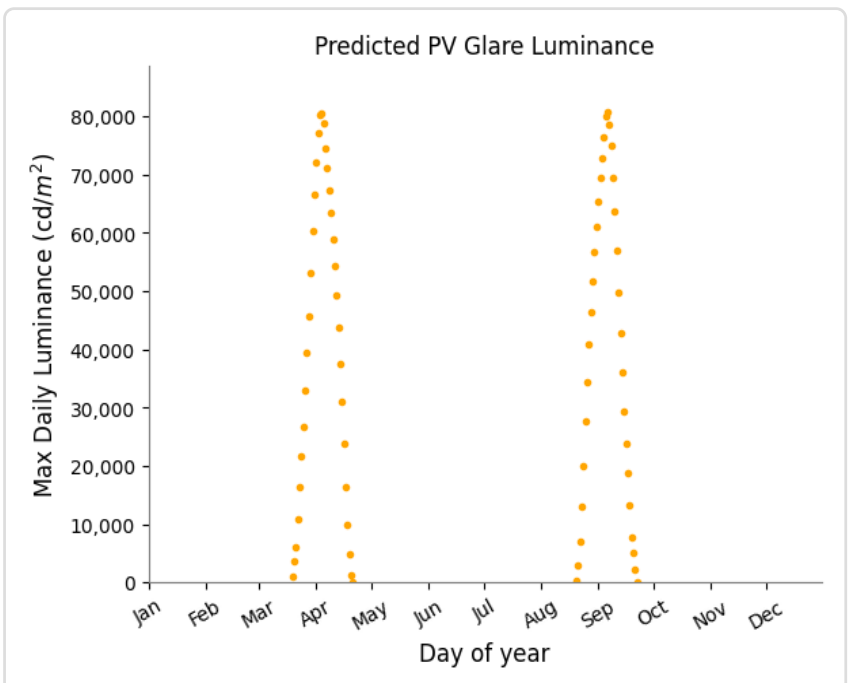
Green glare: 969 min.











PV array 2 and OP 1

No glare found

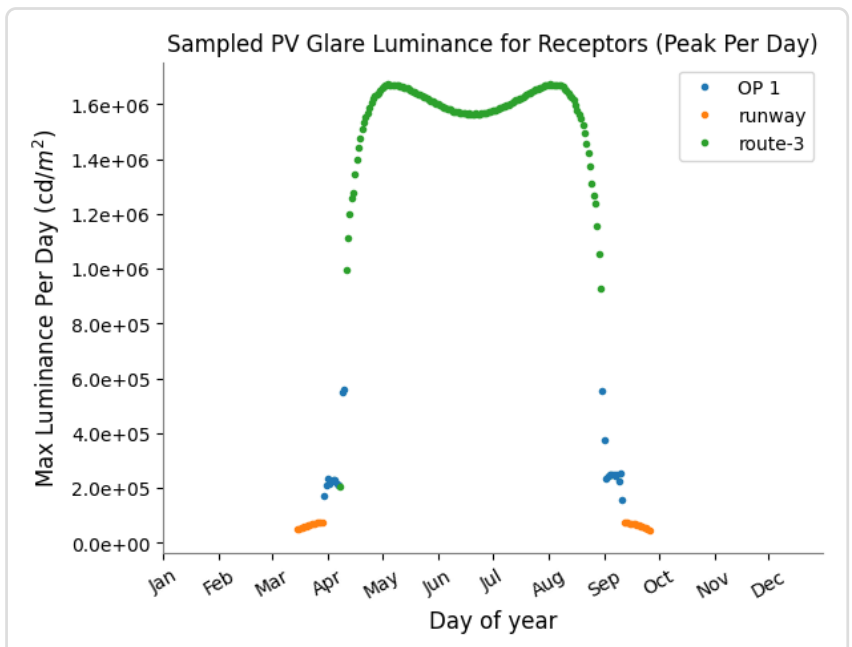
PV array 2 and OP 3

No glare found

PV: PV array 3 potential temporary after-image

Receptor results ordered by category of glare

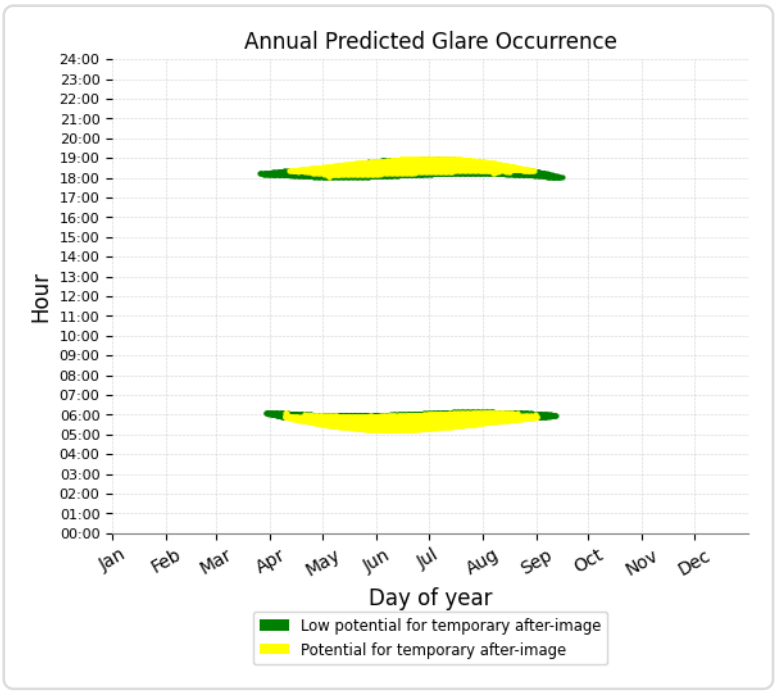
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	3,322	55.4	7,293	121.5	1,672,925
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Darlton 1	1,077	17.9	0	0.0	22,555
Headon 32	519	8.7	0	0.0	17,353
Runway 32 SE	1,504	25.1	0	0.0	78,618
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	817	13.6	3,494	58.2	681,255
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

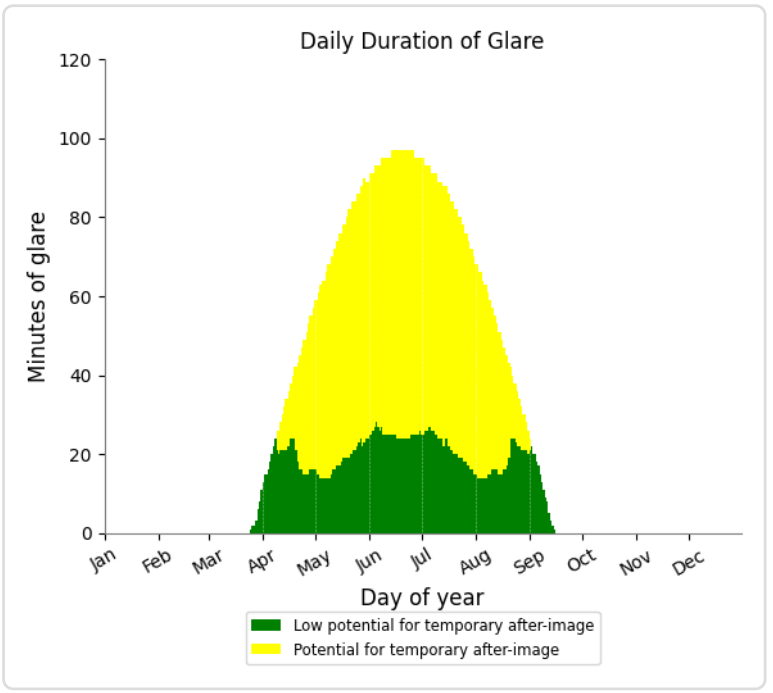


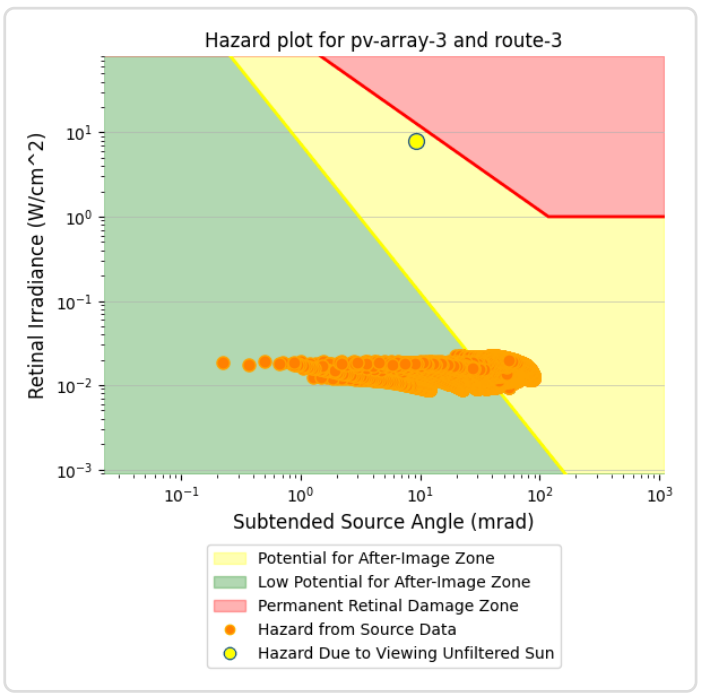
PV array 3 and Route: Route 3

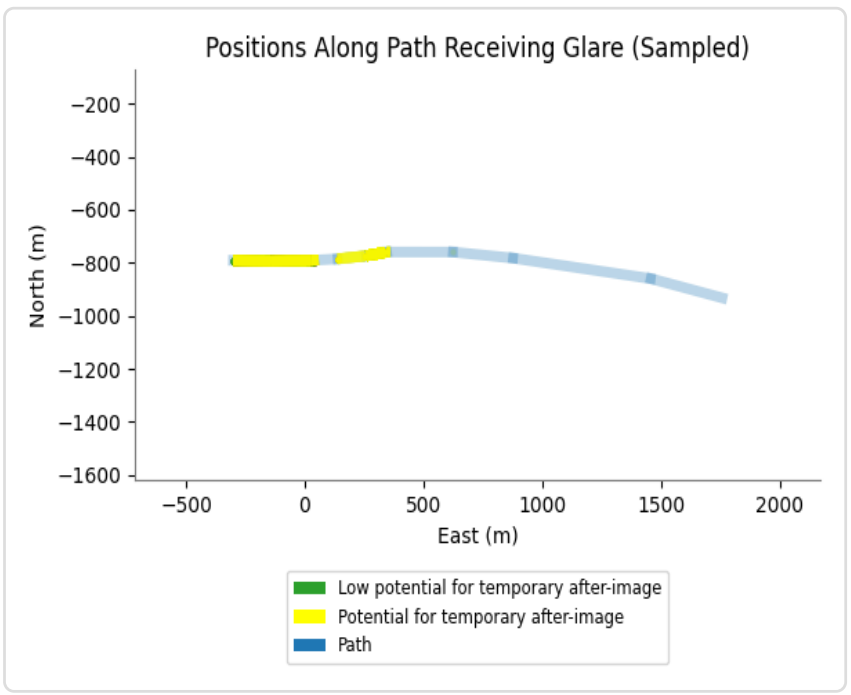
Yellow glare: 7,293 min.

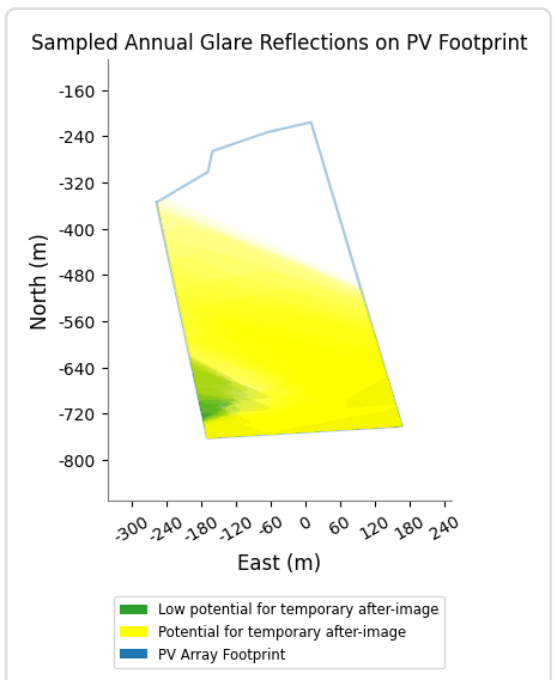
Green glare: 3,322 min.

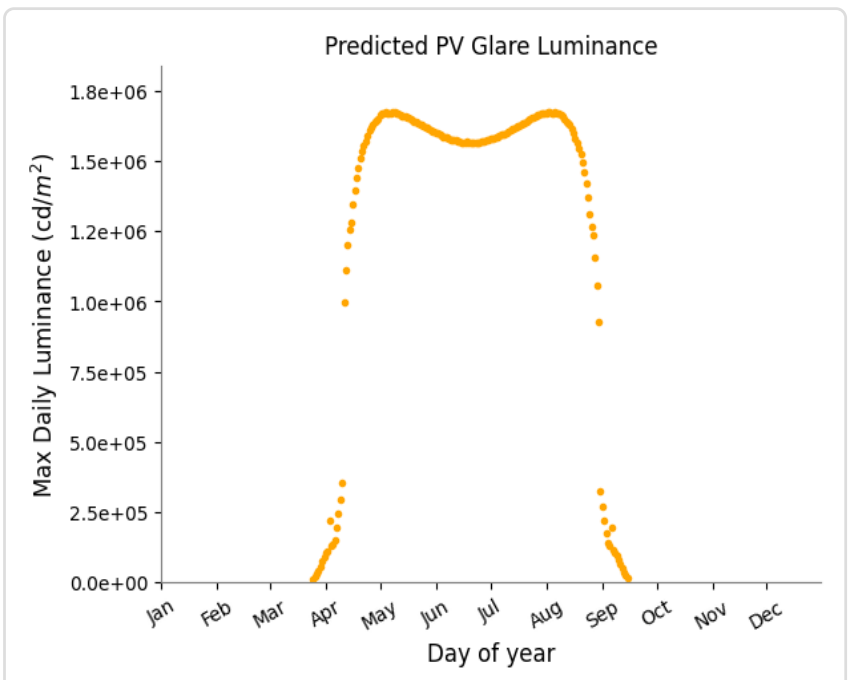












PV array 3 and Route: Route 1

No glare found

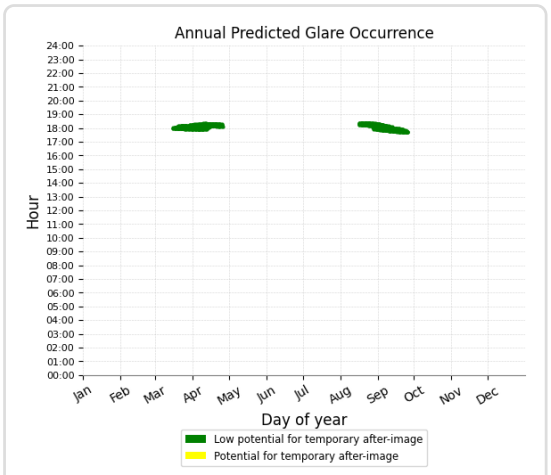
PV array 3 and Route: Route 2

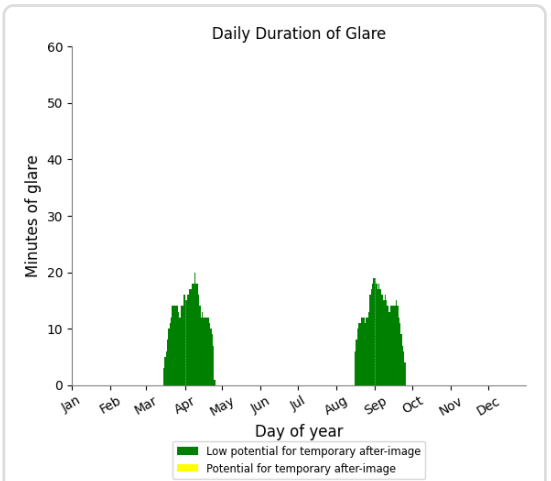
No glare found

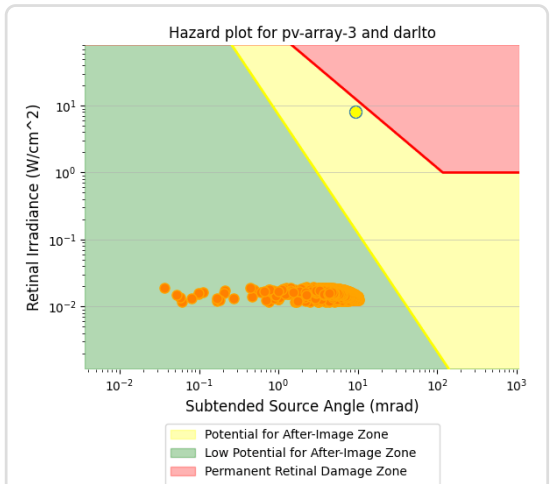
PV array 3 and FP: Darlton 1

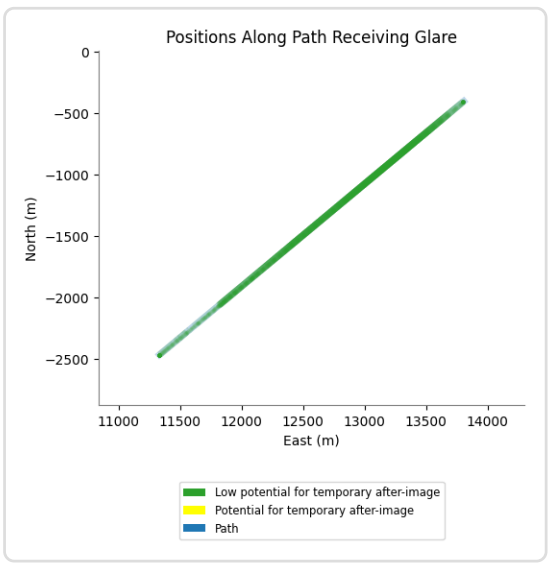
Yellow glare: none

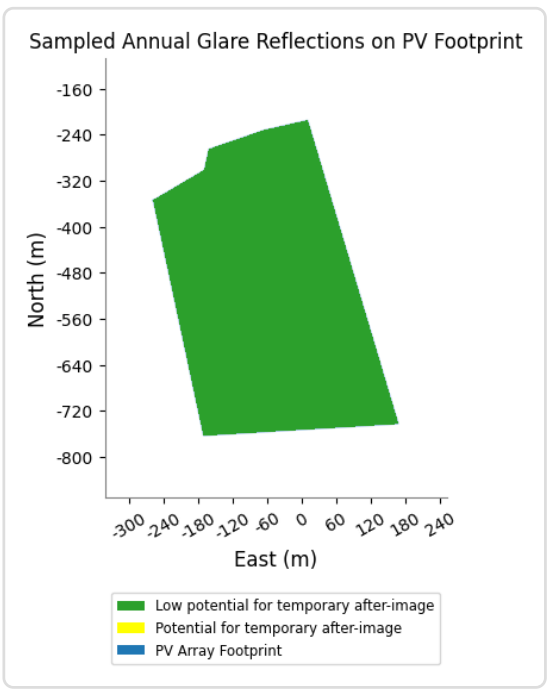
Green glare: 1,077 min.

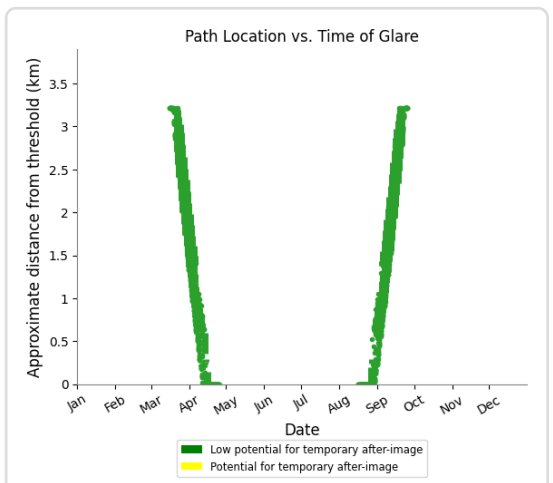


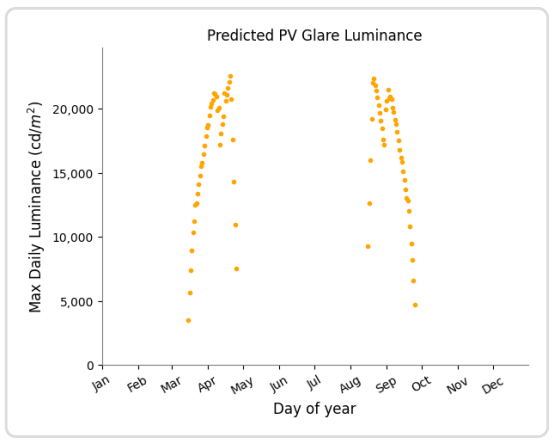








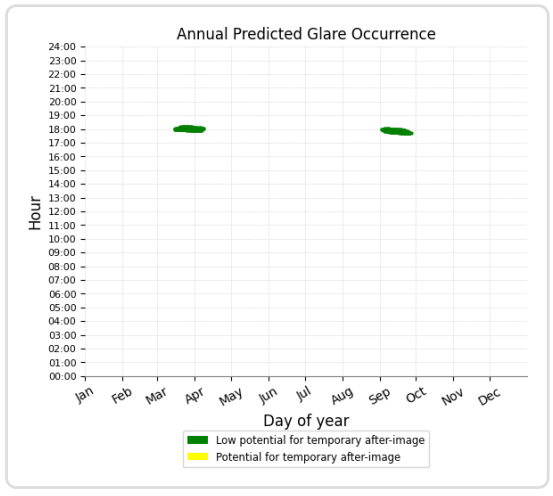


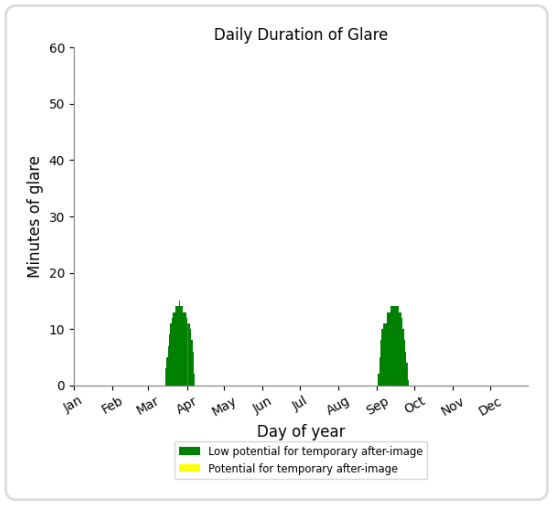


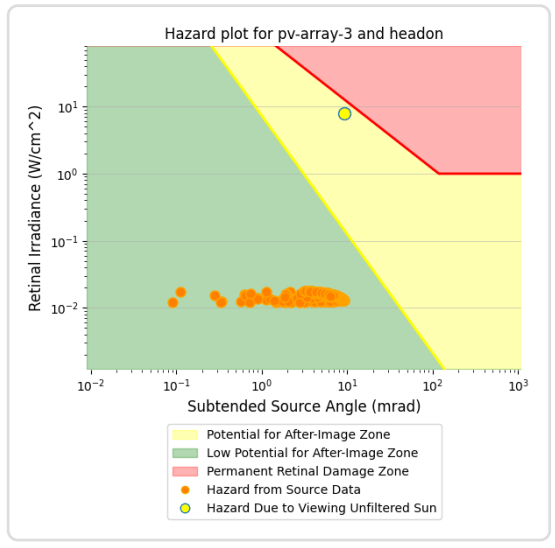
PV array 3 and FP: Headon 32

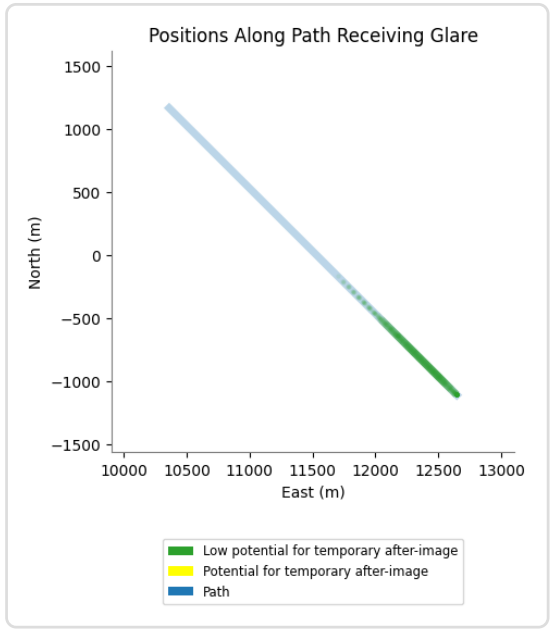
Yellow glare: none

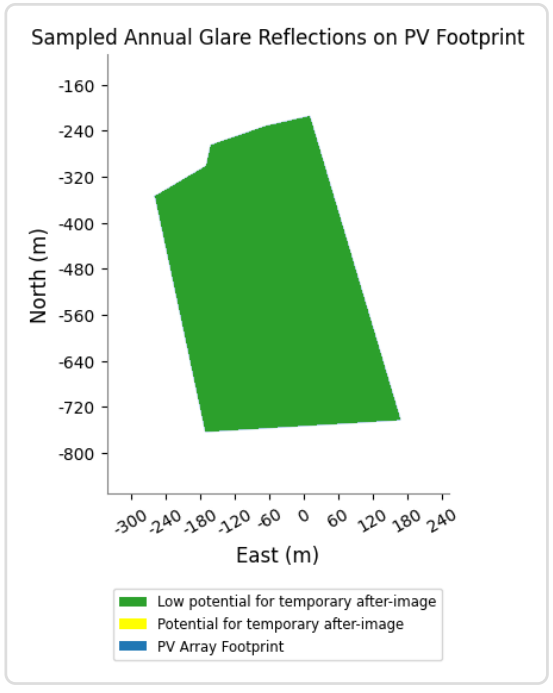
Green glare: 519 min.

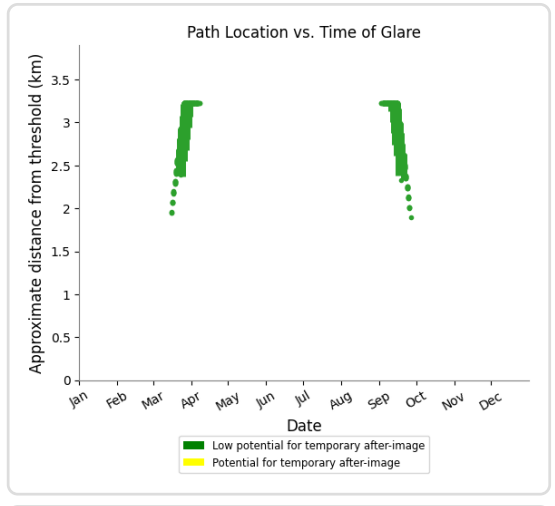


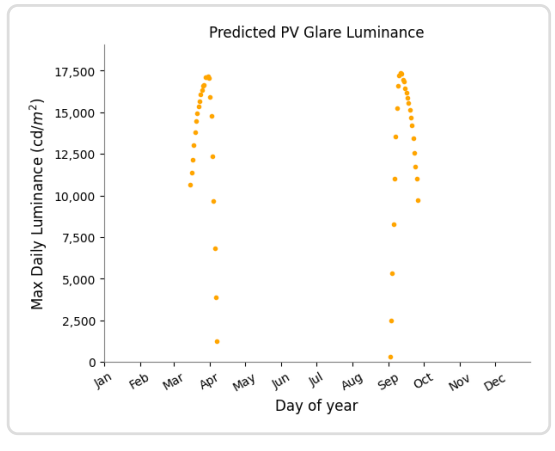








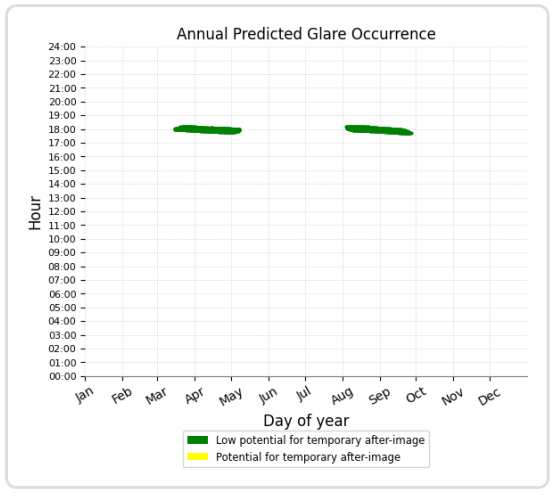


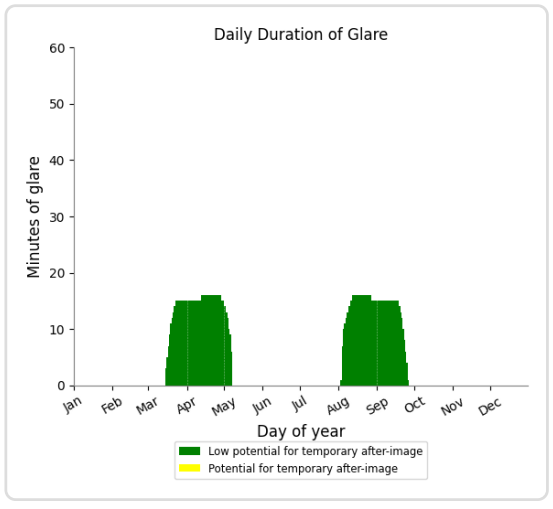


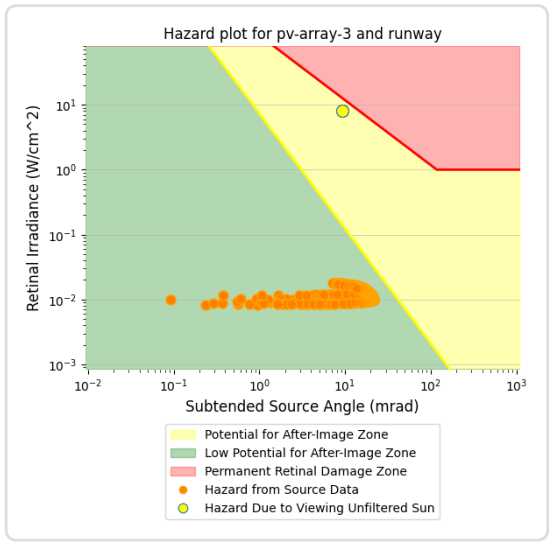
PV array 3 and FP: Runway 32 SE

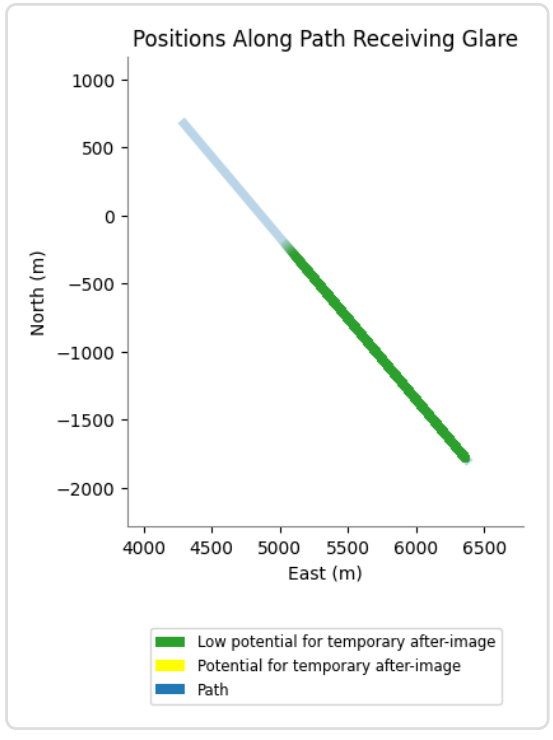
Yellow glare: none

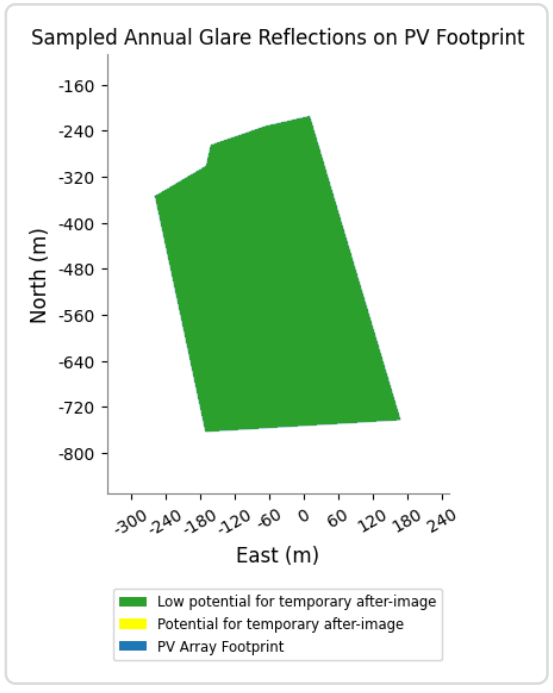
Green glare: 1,504 min.

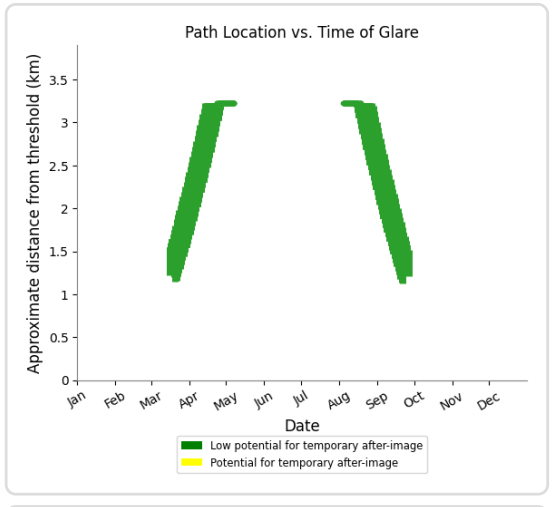


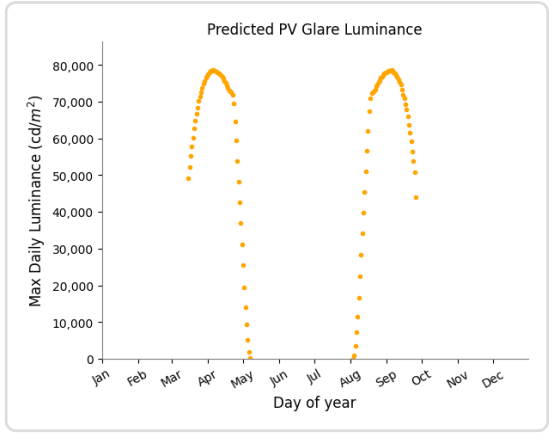












PV array 3 and FP: Darlton 2

No glare found

PV array 3 and FP: Headon 23

No glare found

PV array 3 and FP: Headon R14

No glare found

PV array 3 and FP: Runway 03 S

No glare found

PV array 3 and FP: Runway 14 NW

No glare found

PV array 3 and FP: Runway 21 N

No glare found

PV array 3 and FP: Three Counties R06

No glare found

PV array 3 and FP: Three Counties R19

No glare found

PV array 3 and FP: Three Counties R24

No glare found

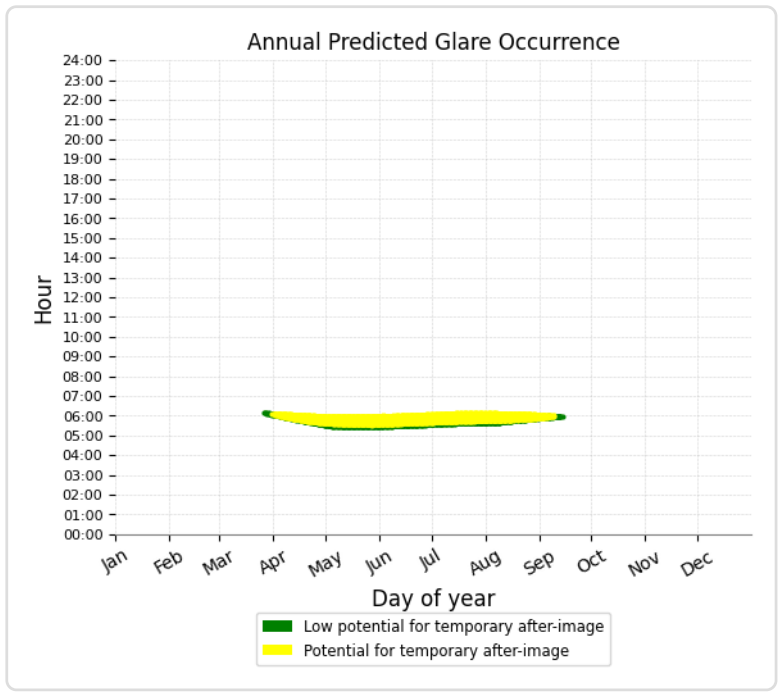
PV array 3 and FP: Three Counties R36

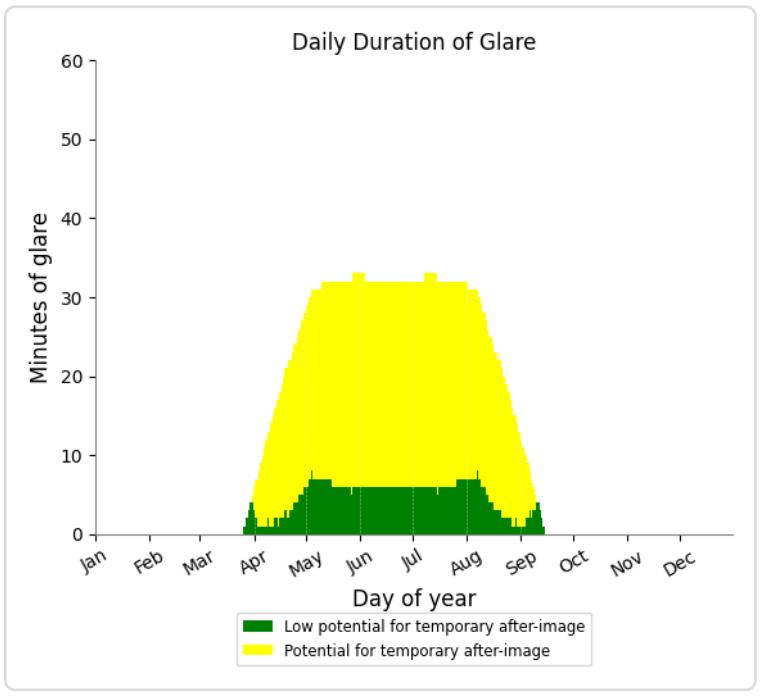
No glare found

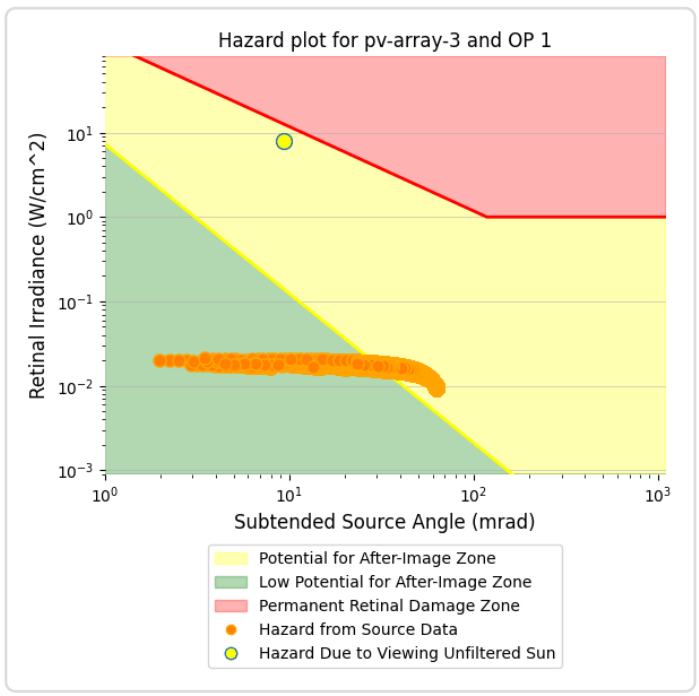
PV array 3 and OP 1

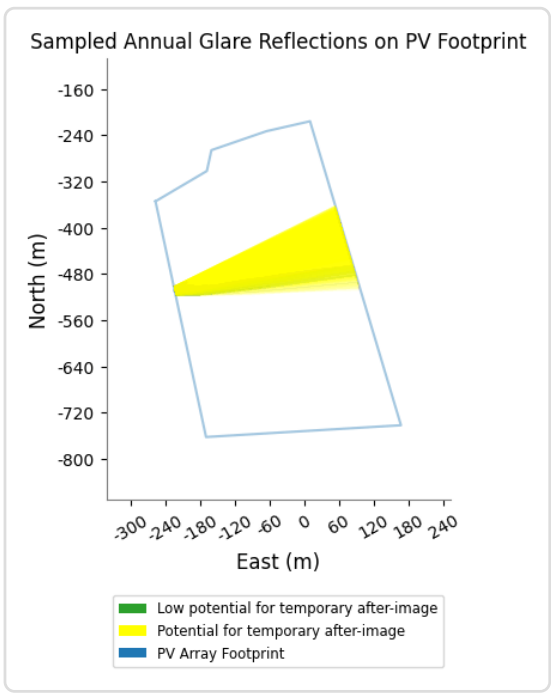
Yellow glare: 3,494 min.

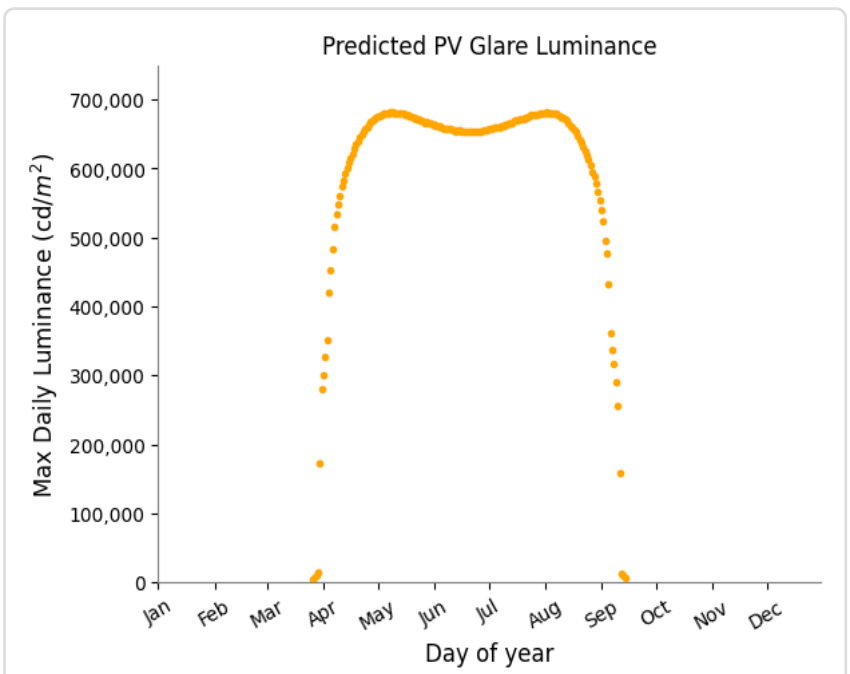
Green glare: 817 min.











PV array 3 and OP 2

No glare found

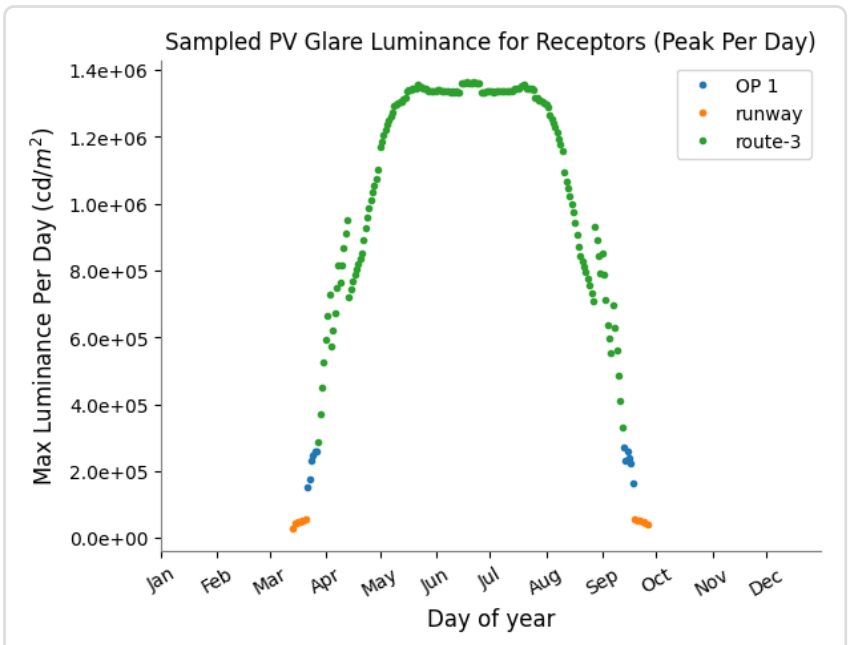
PV array 3 and OP 3

No glare found

PV: PV array 4 potential temporary after-image

Receptor results ordered by category of glare

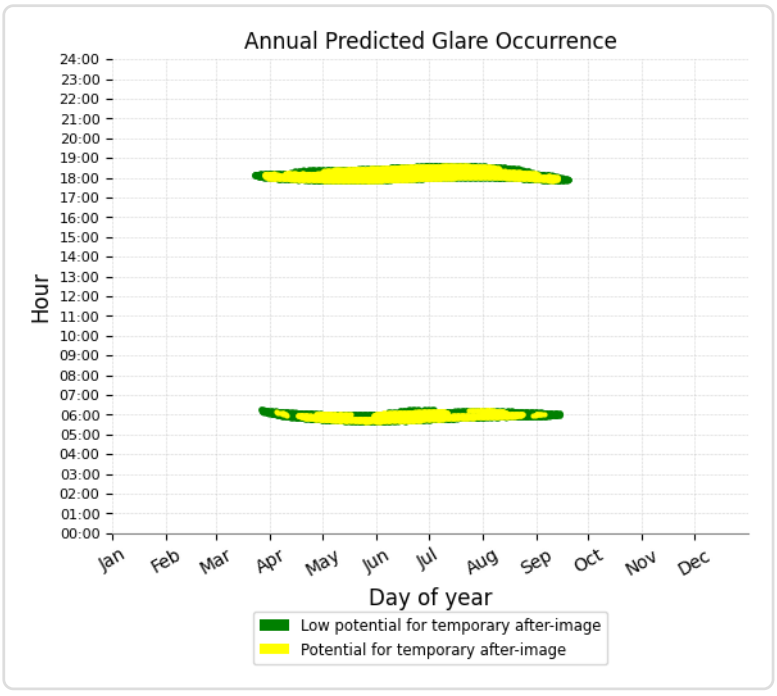
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	3,716	61.9	5,679	94.7	1,363,436
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Darlton 1	1,400	23.3	0	0.0	19,272
Headon 32	725	12.1	0	0.0	12,841
Runway 32 SE	2,159	36.0	0	0.0	65,227
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	705	11.8	2,264	37.7	459,146
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

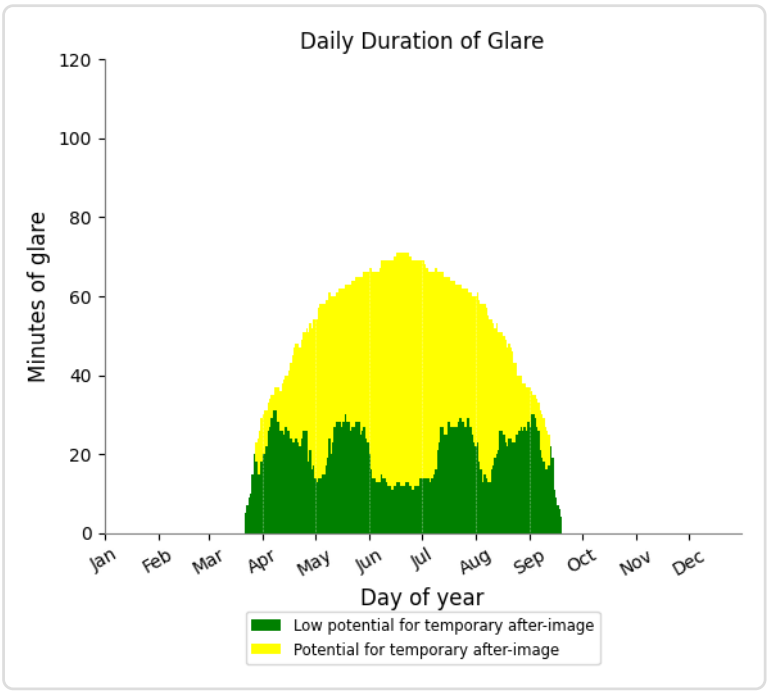


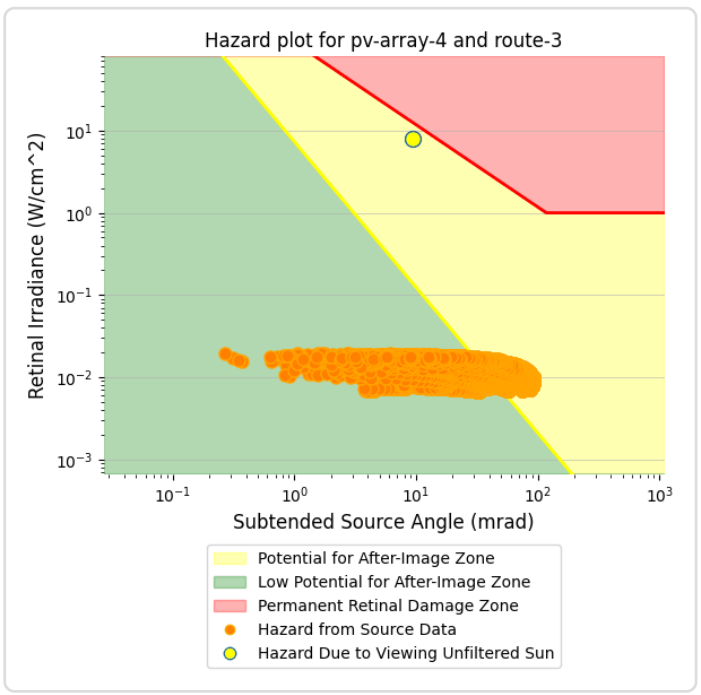
PV array 4 and Route: Route 3

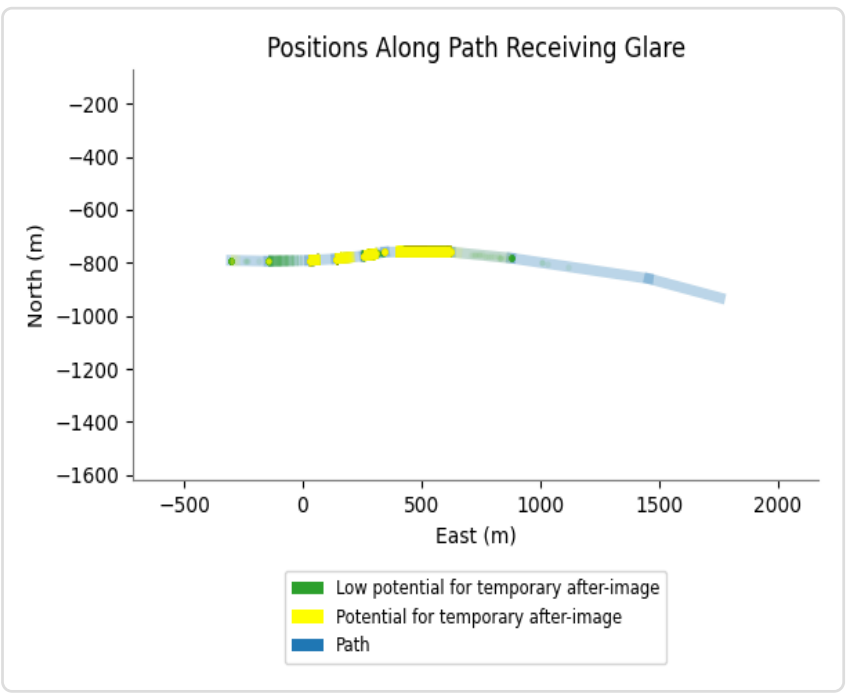
Yellow glare: 5,679 min.

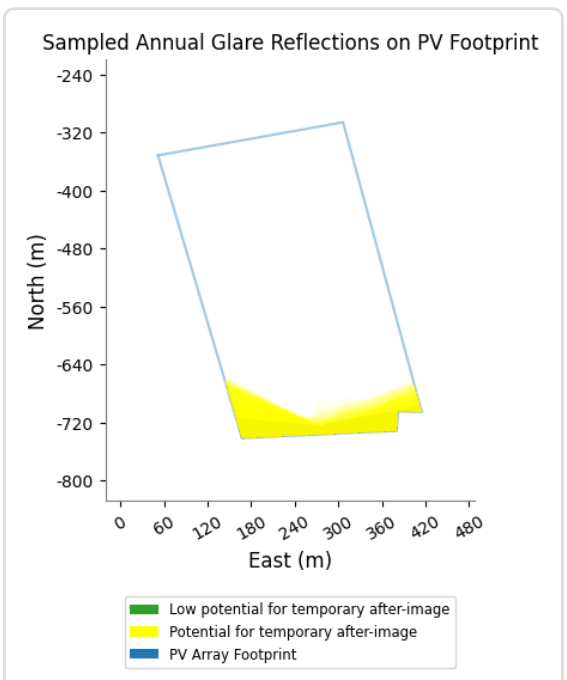
Green glare: 3,716 min.

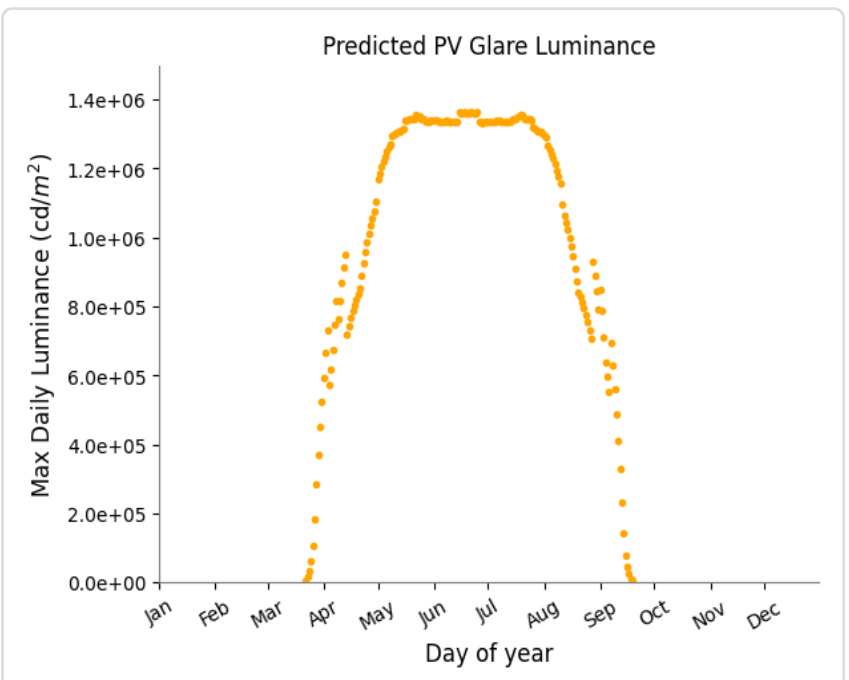












PV array 4 and Route: Route 1

No glare found

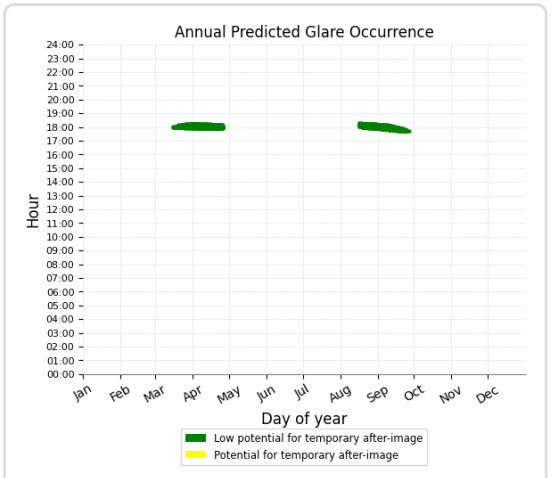
PV array 4 and Route: Route 2

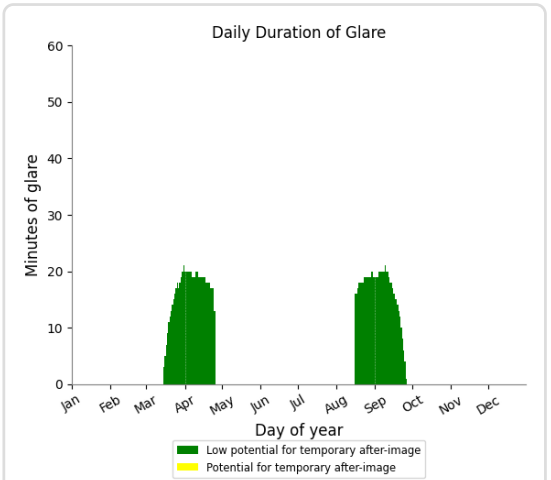
No glare found

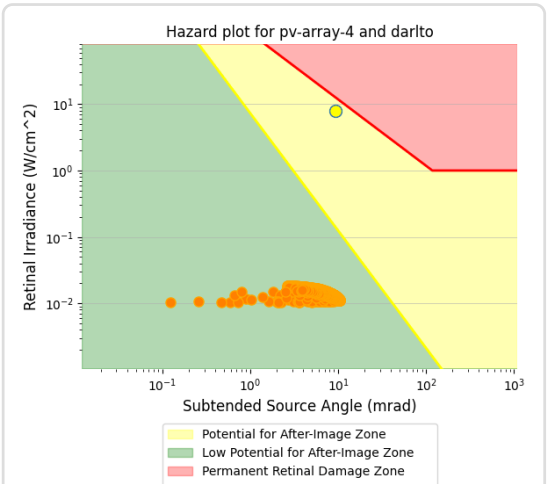
PV array 4 and FP: Darlton 1

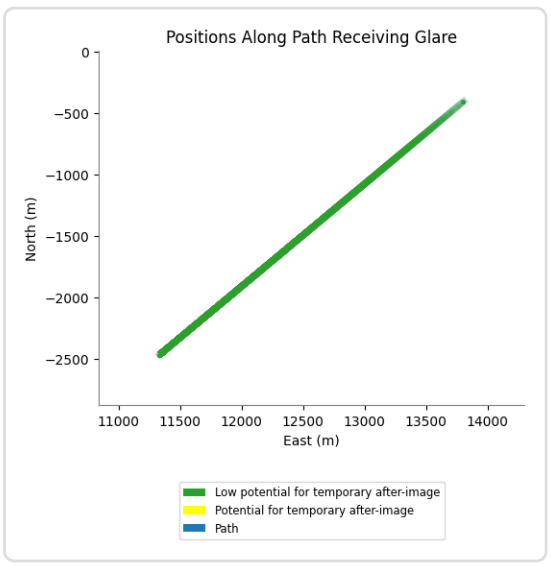
Yellow glare: none

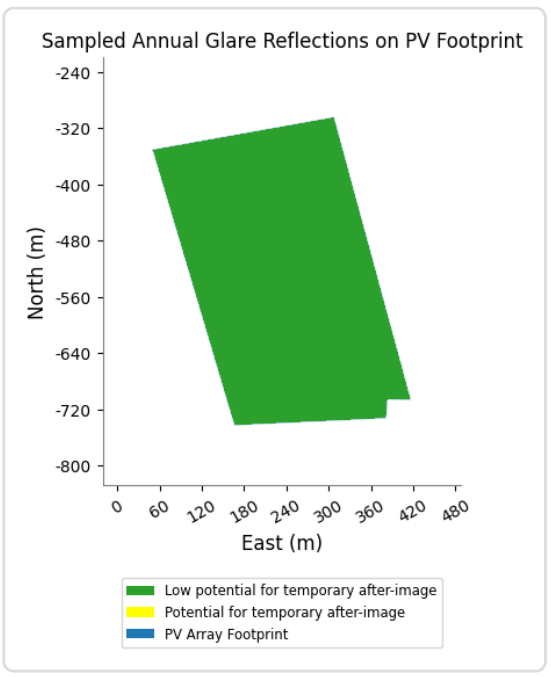
Green glare: 1,400 min.

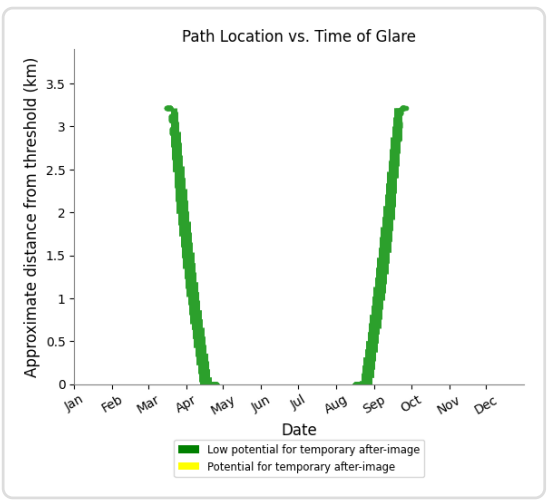


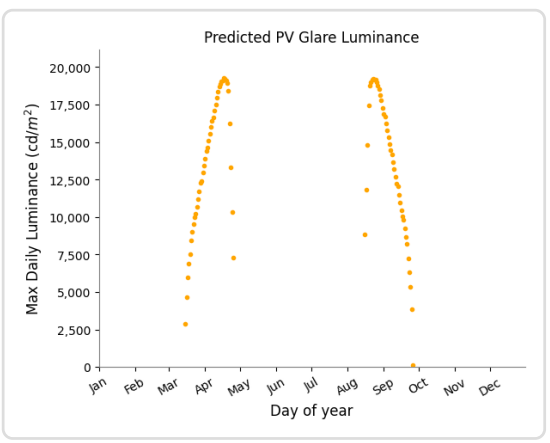








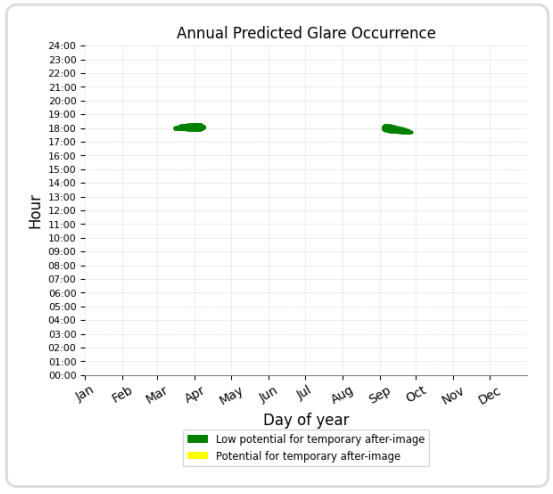


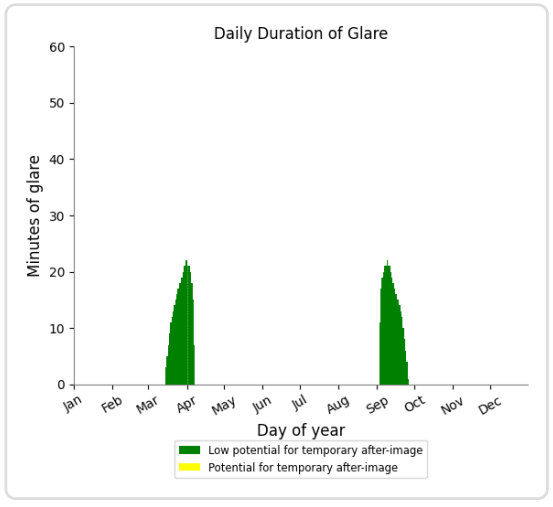


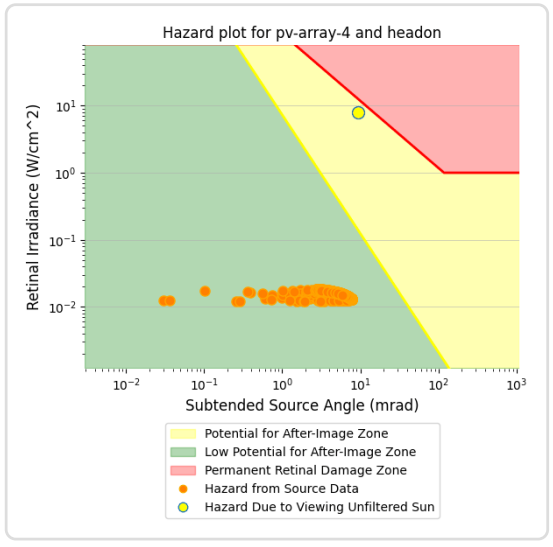
PV array 4 and FP: Headon 32

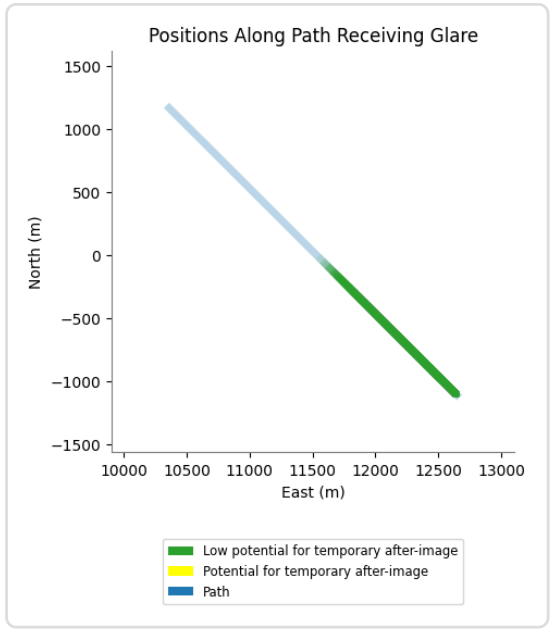
Yellow glare: none

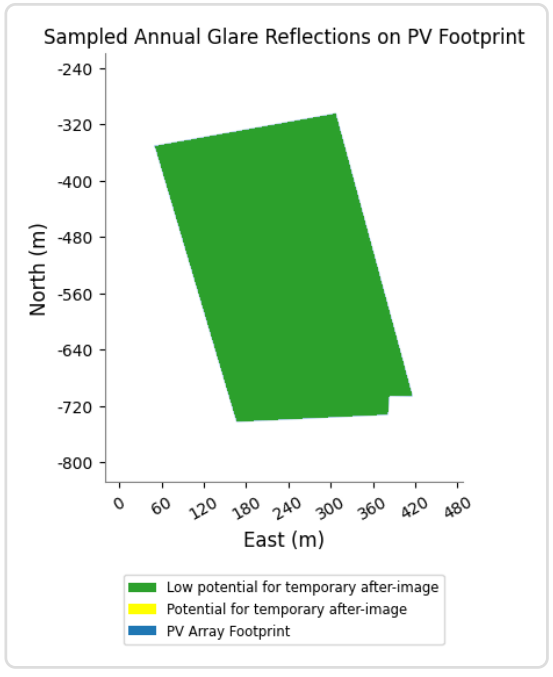
Green glare: 725 min.

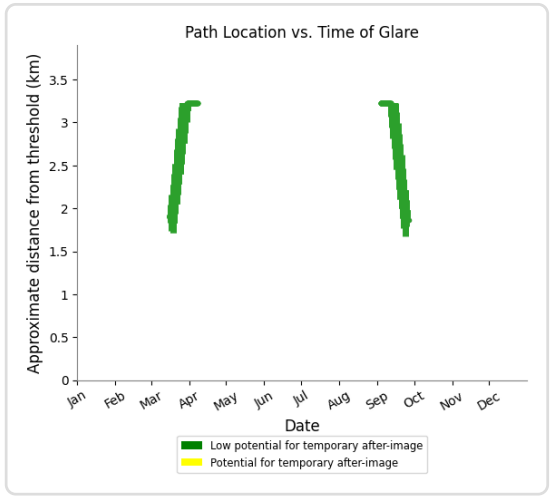


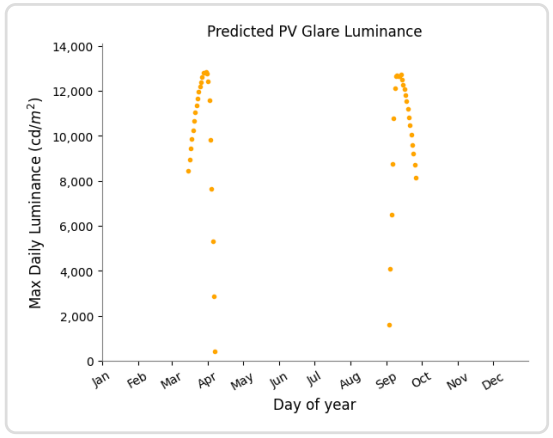








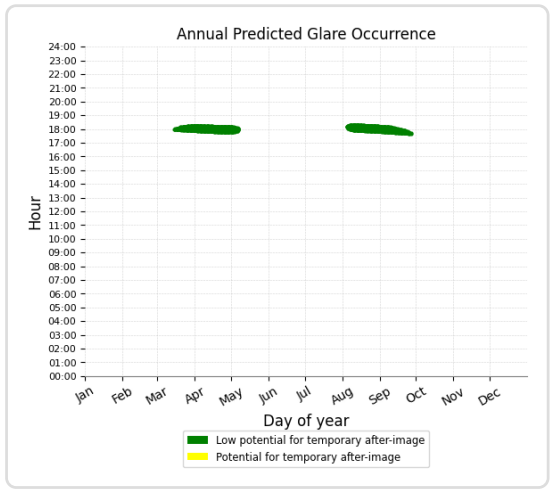


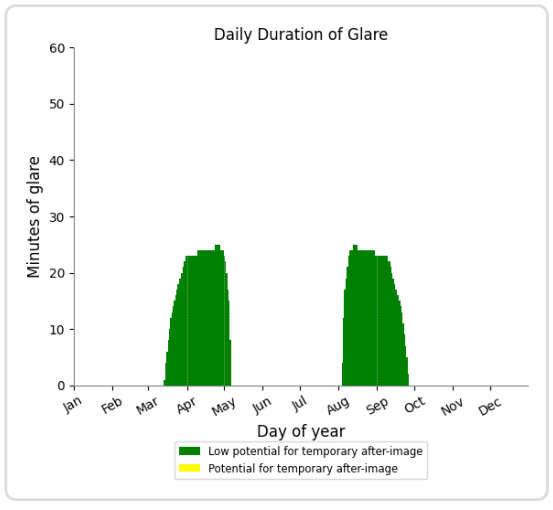


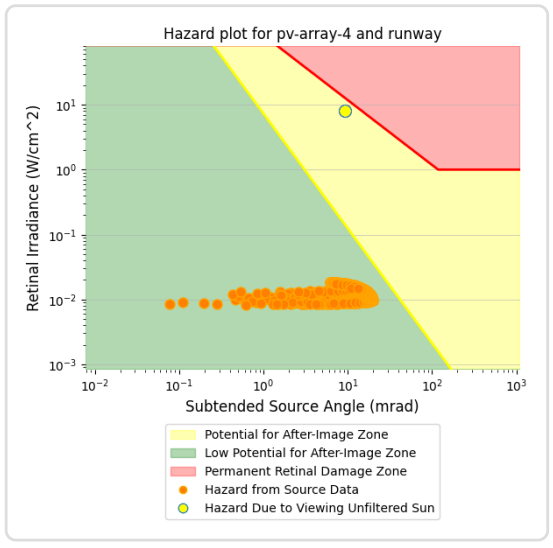
PV array 4 and FP: Runway 32 SE

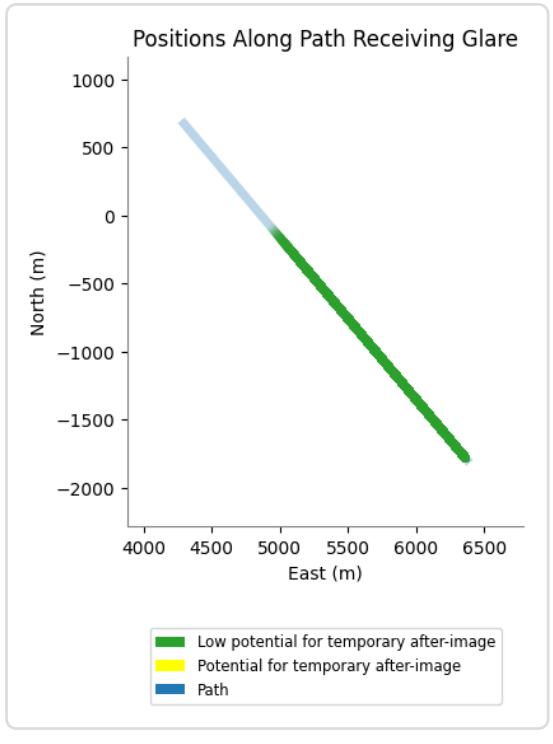
Yellow glare: none

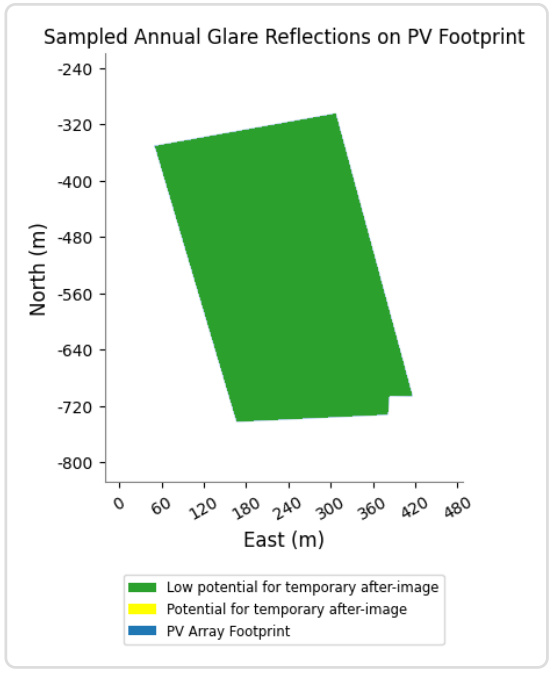
Green glare: 2,159 min.

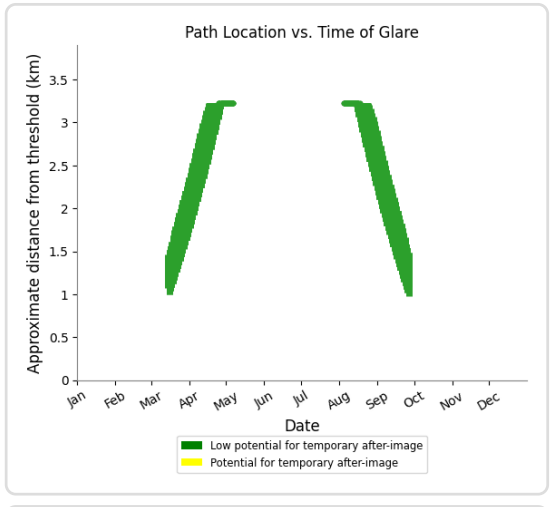


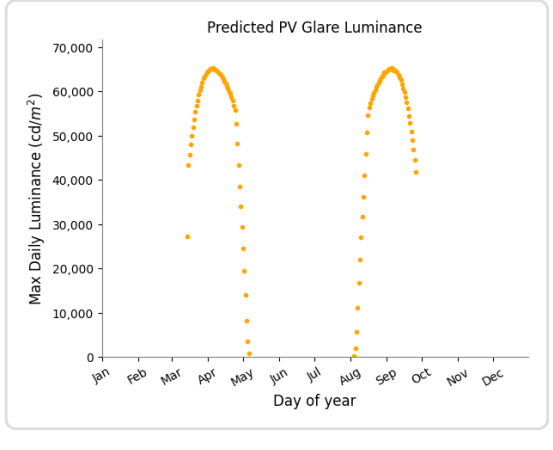












PV array 4 and FP: Darlton 2

No glare found

PV array 4 and FP: Headon 23

No glare found

PV array 4 and FP: Headon R14

No glare found

PV array 4 and FP: Runway 03 S

No glare found

PV array 4 and FP: Runway 14 NW

No glare found

PV array 4 and FP: Runway 21 N

No glare found

PV array 4 and FP: Three Counties R06

No glare found

PV array 4 and FP: Three Counties R19

No glare found

PV array 4 and FP: Three Counties R24

No glare found

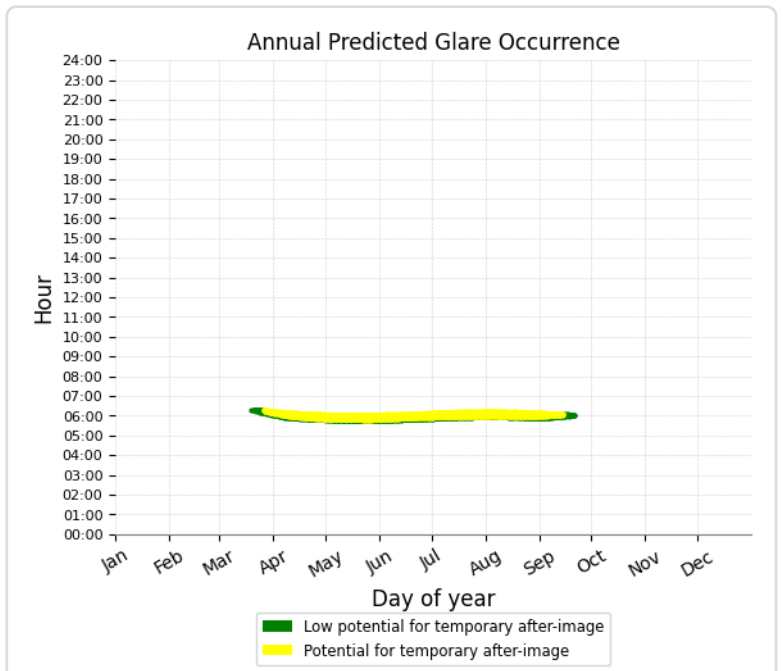
PV array 4 and FP: Three Counties R36

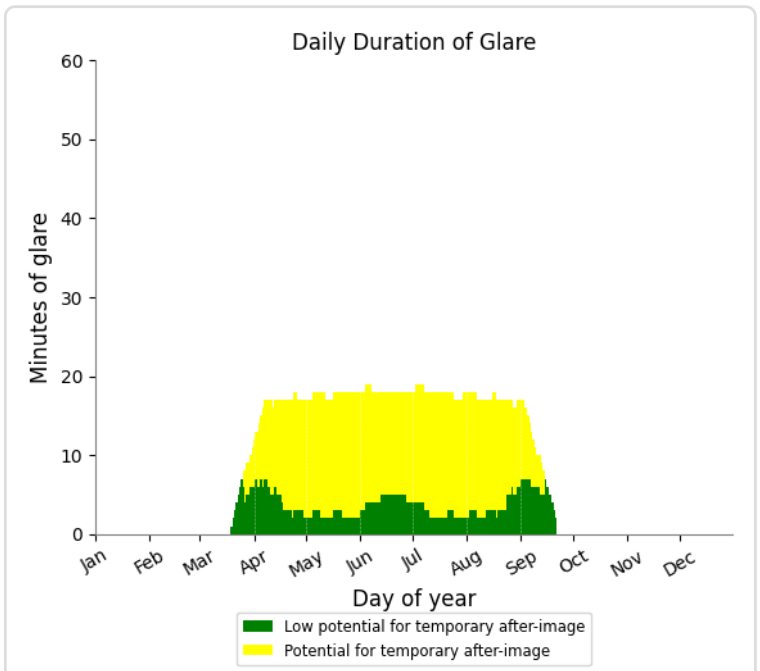
No glare found

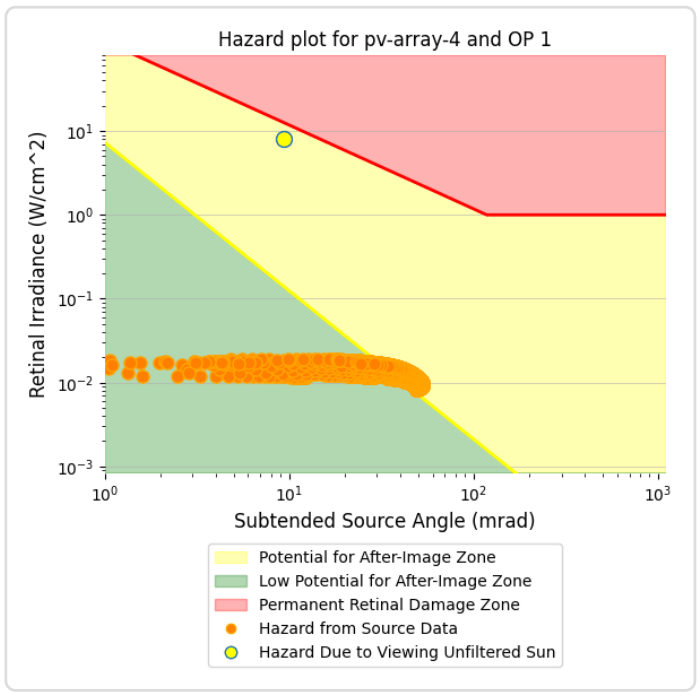
PV array 4 and OP 1

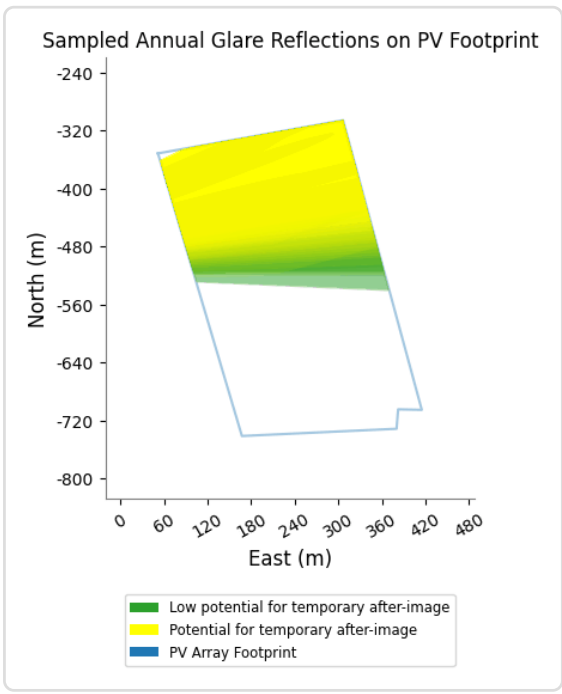
Yellow glare: 2,264 min.

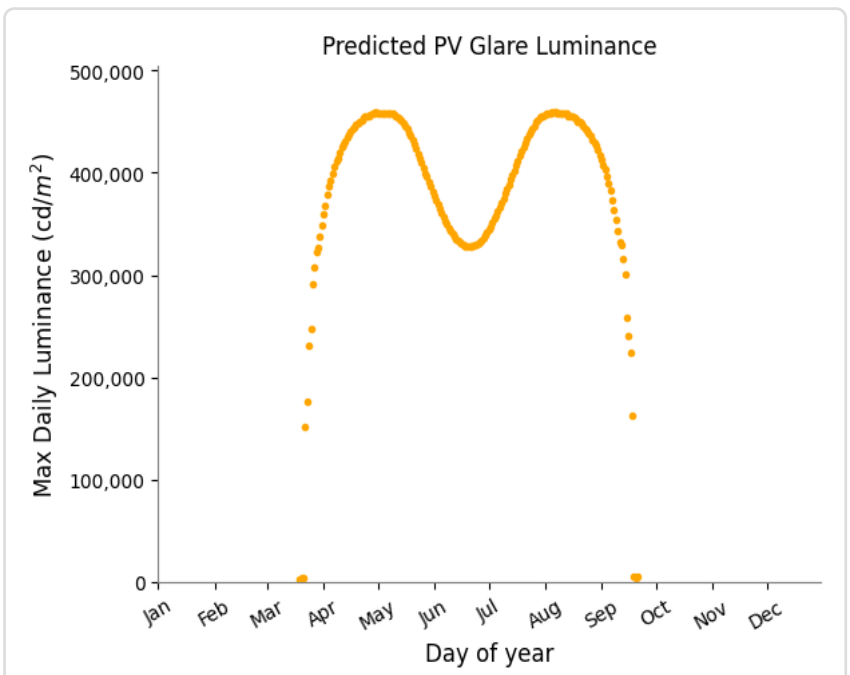
Green glare: 705 min.











PV array 4 and OP 2

No glare found

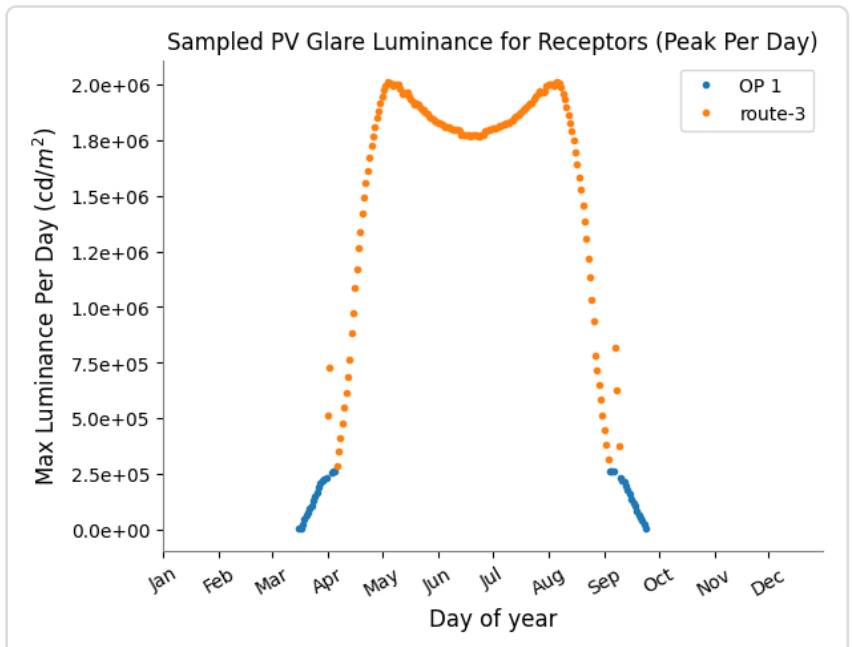
PV array 4 and OP 3

No glare found

PV: PV array 5 potential temporary after-image

Receptor results ordered by category of glare

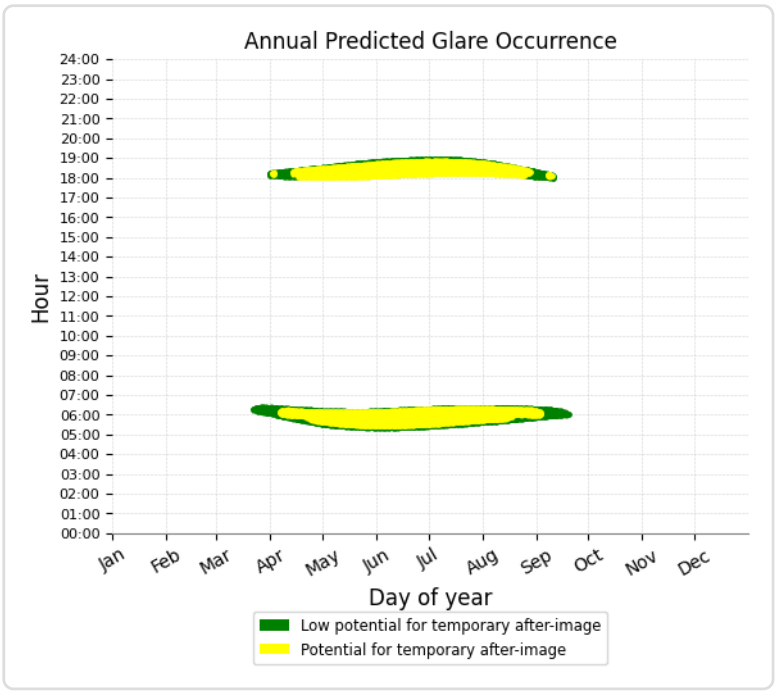
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	3,042	50.7	9,729	162.2	2,010,517
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Darlton 1	856	14.3	0	0.0	17,491
Headon 32	220	3.7	0	0.0	8,720
Runway 32 SE	1,247	20.8	0	0.0	59,475
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	2,227	37.1	1,266	21.1	354,104
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

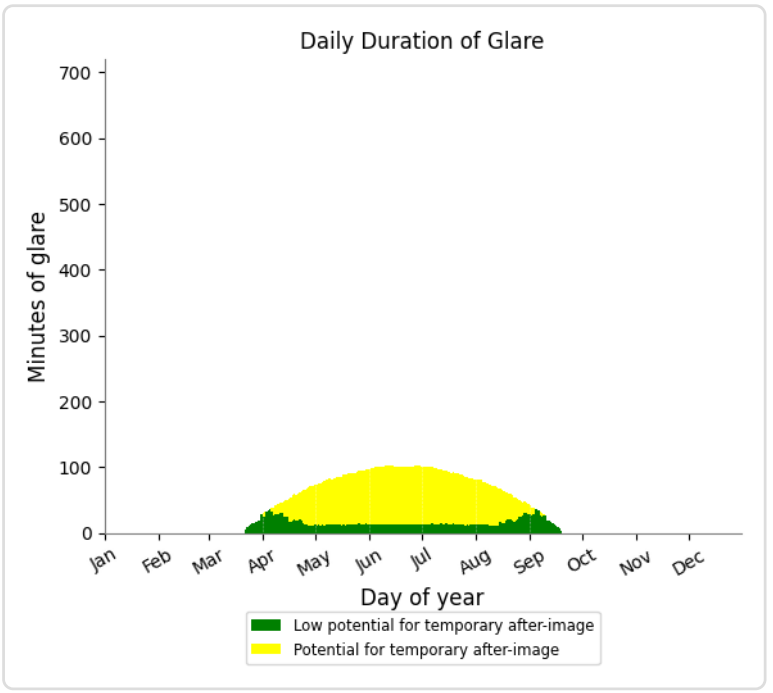


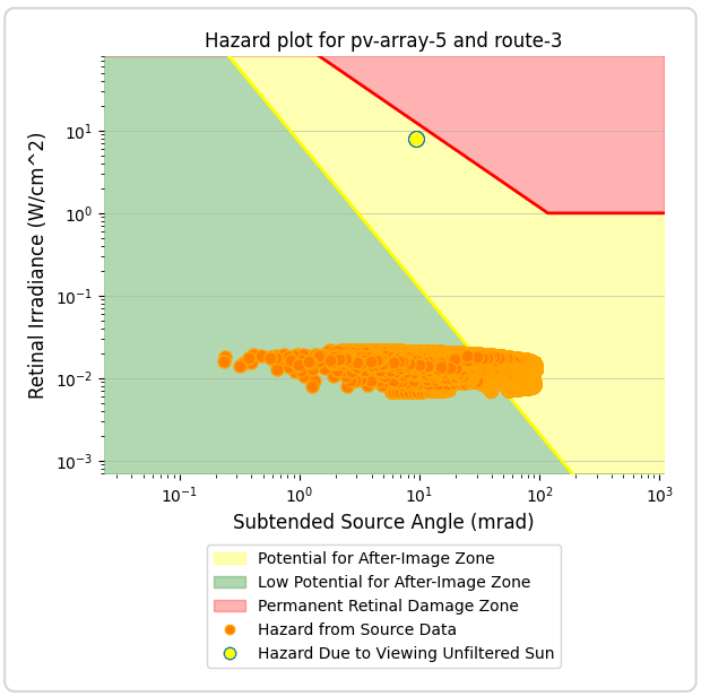
PV array 5 and Route: Route 3

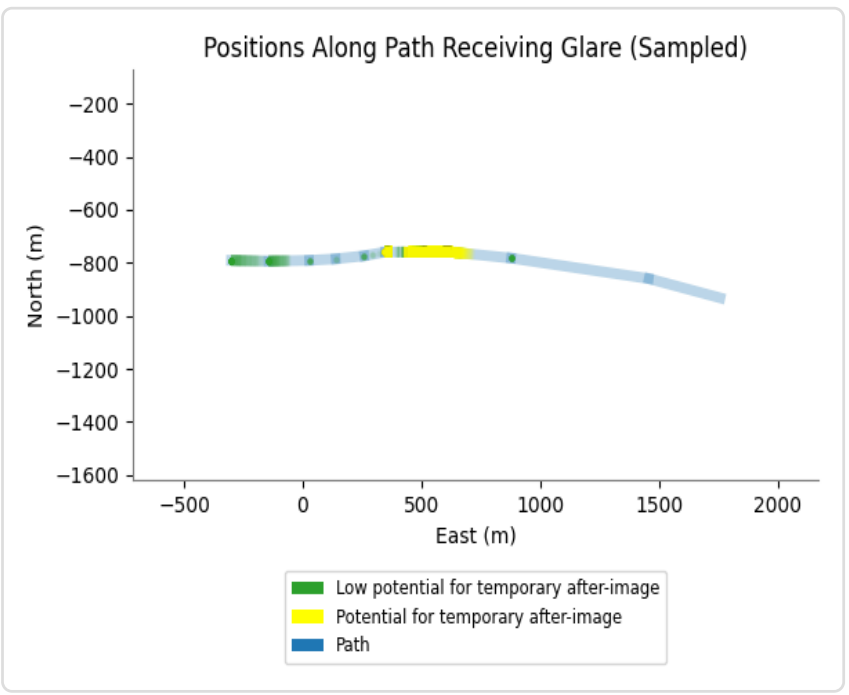
Yellow glare: 9,729 min.

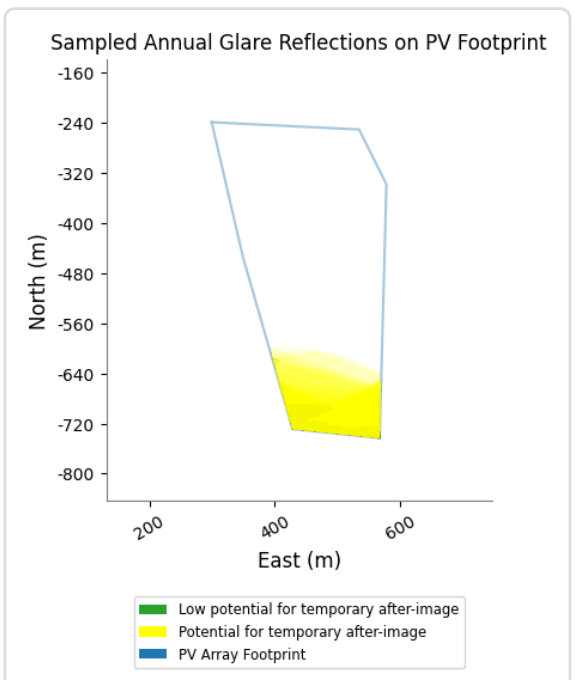
Green glare: 3,042 min.

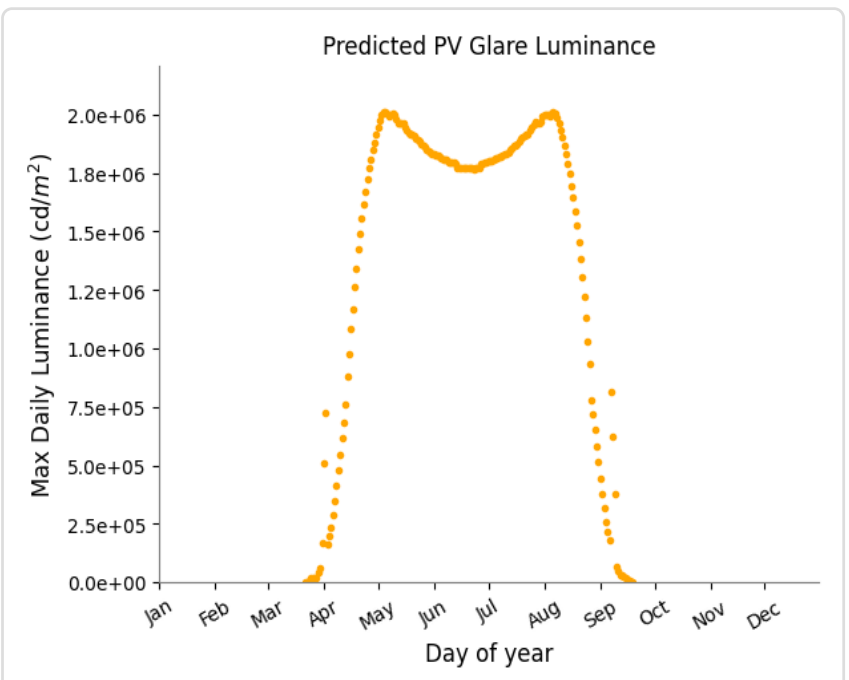












PV array 5 and Route: Route 1

No glare found

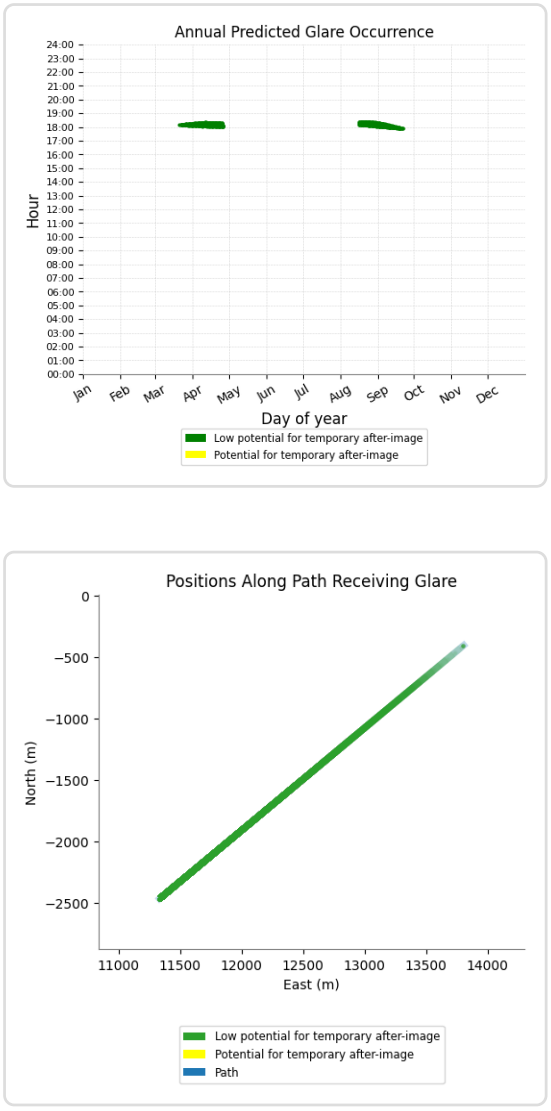
PV array 5 and Route: Route 2

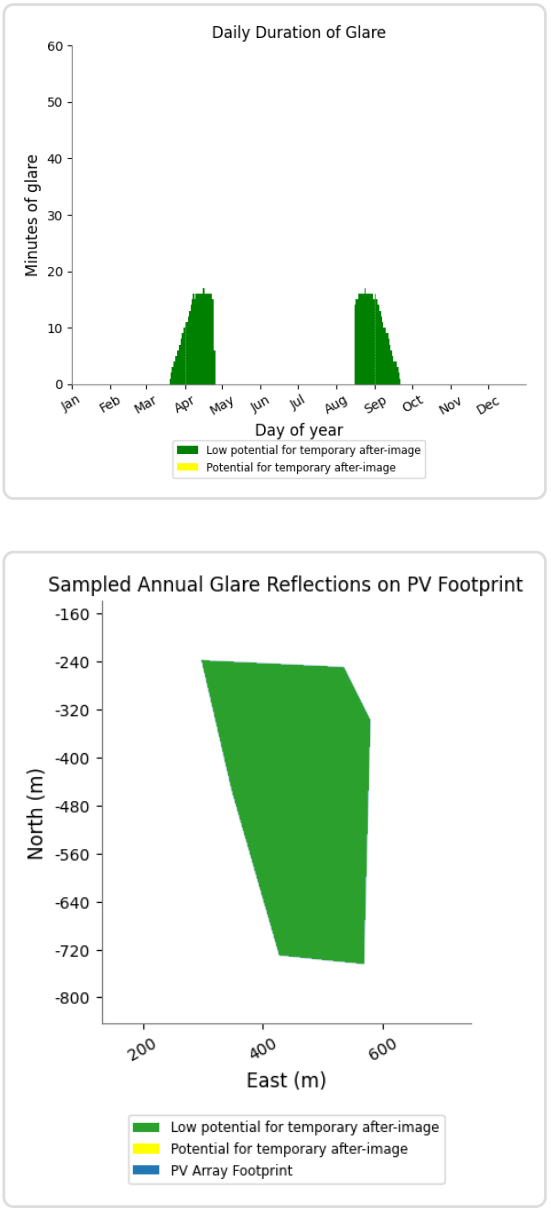
No glare found

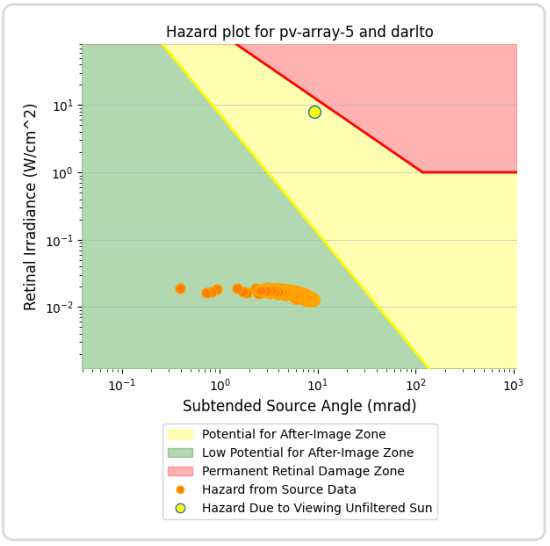
PV array 5 and FP: Darlton 1

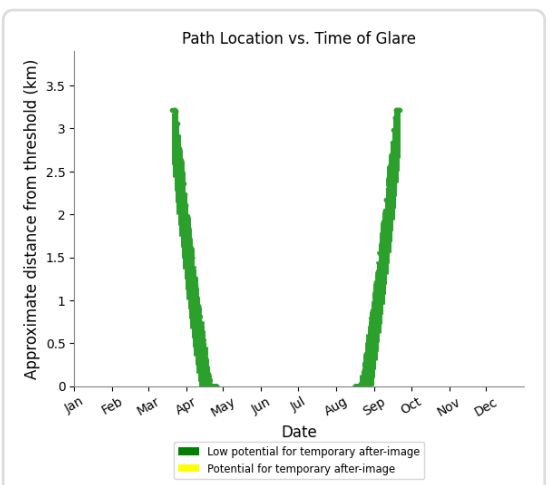
Yellow glare: none

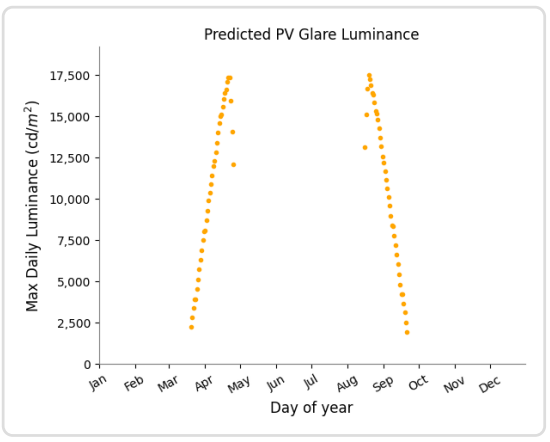
Green glare: 856 min.







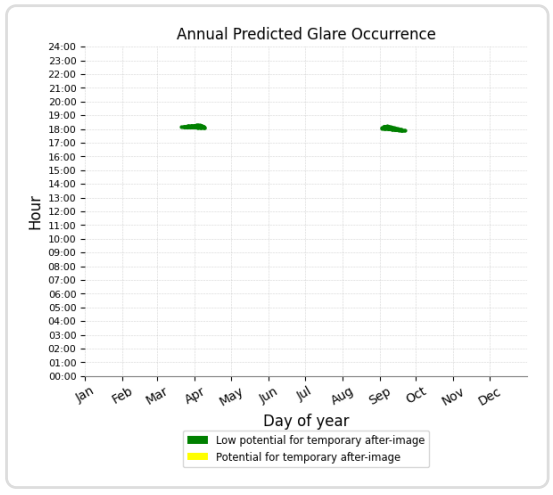


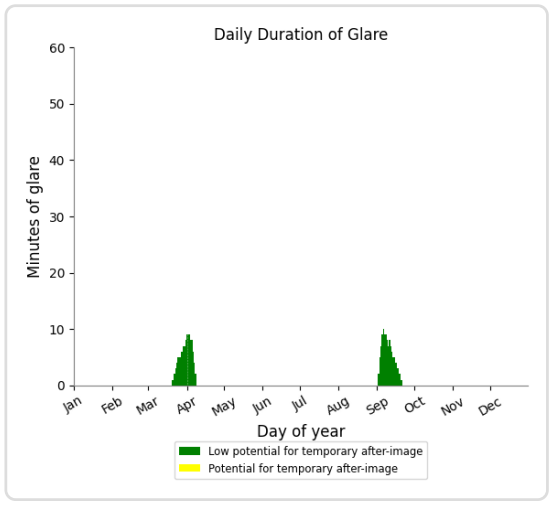


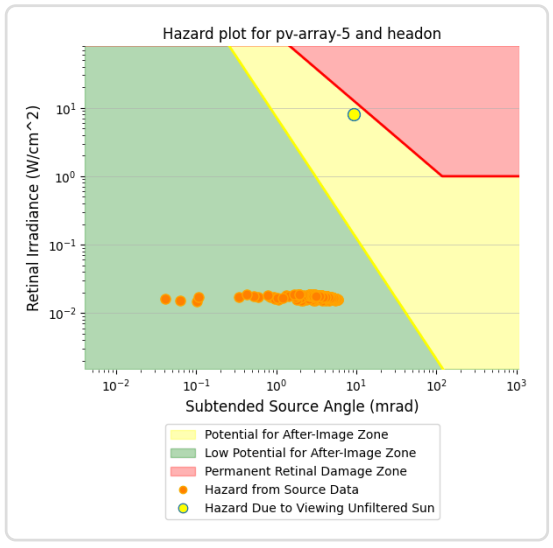
PV array 5 and FP: Headon 32

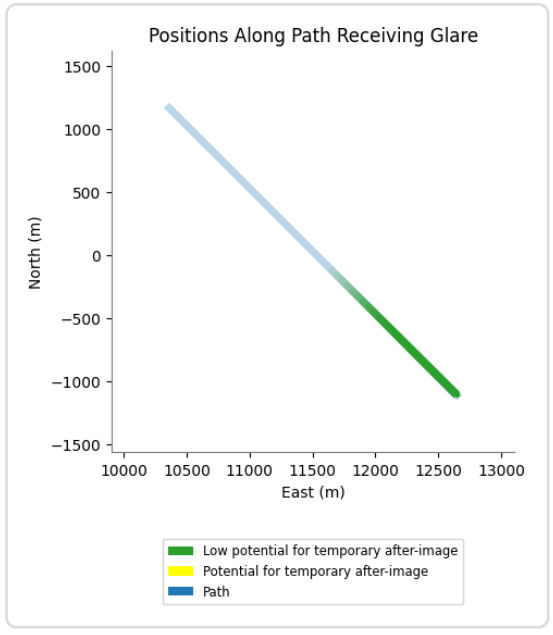
Yellow glare: none

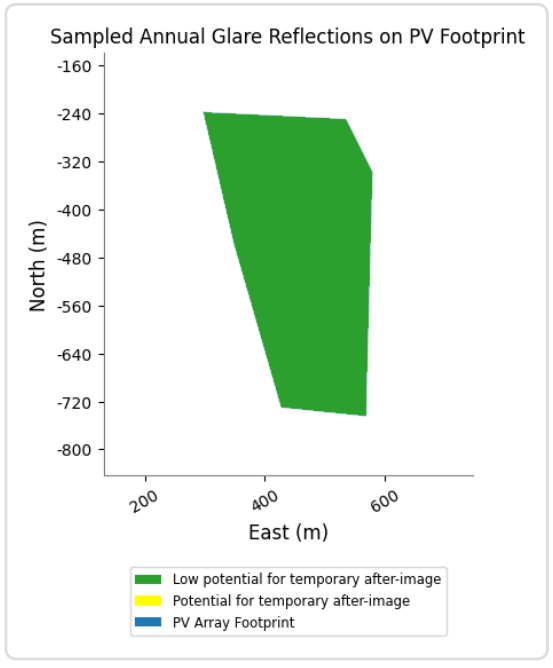
Green glare: 220 min.

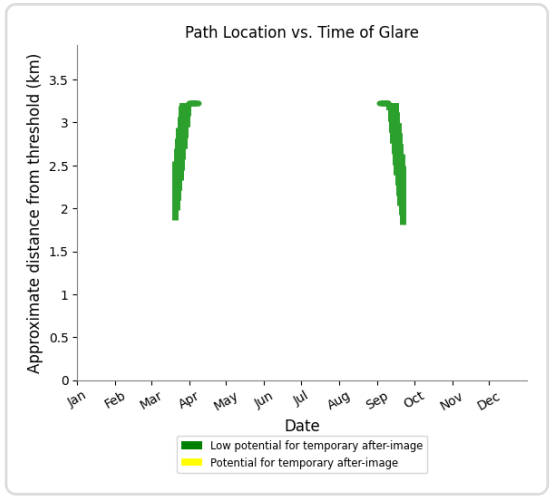


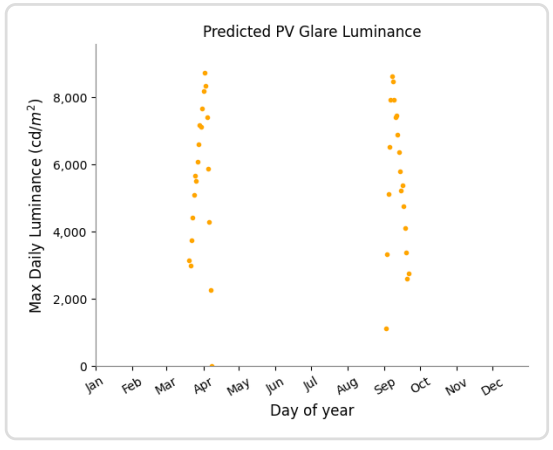








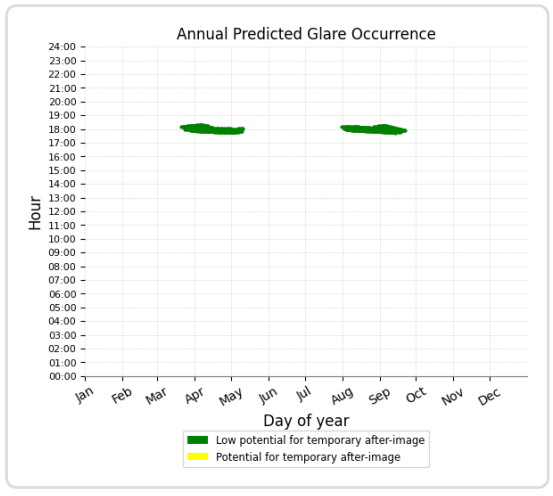


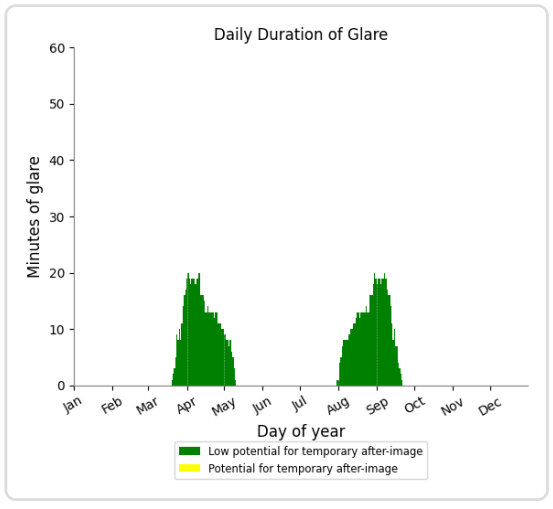


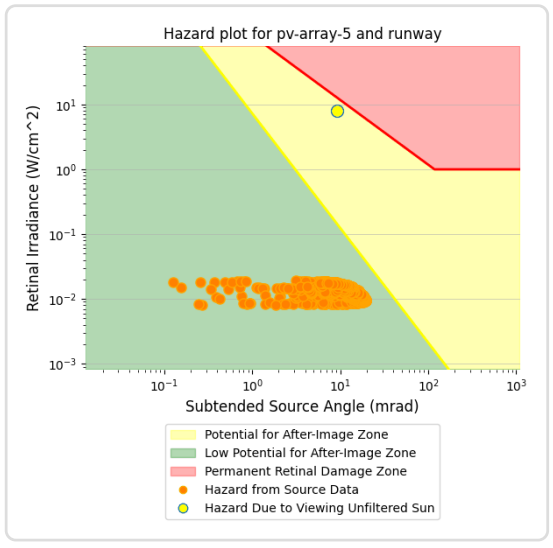
PV array 5 and FP: Runway 32 SE

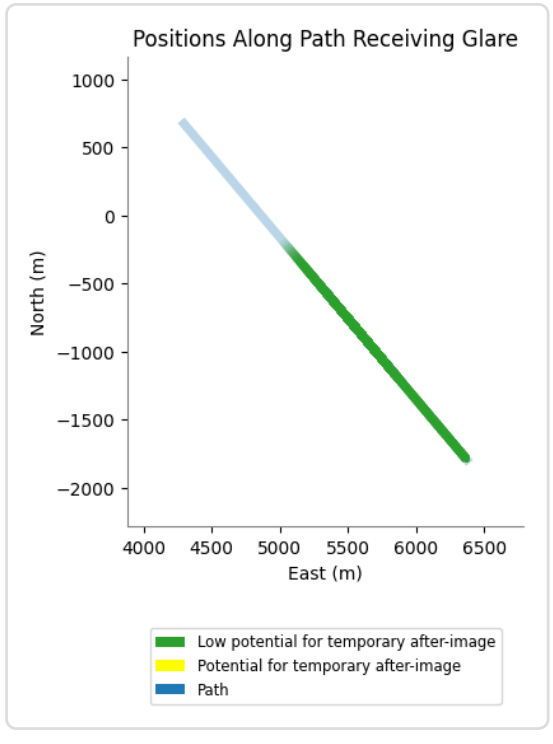
Yellow glare: none

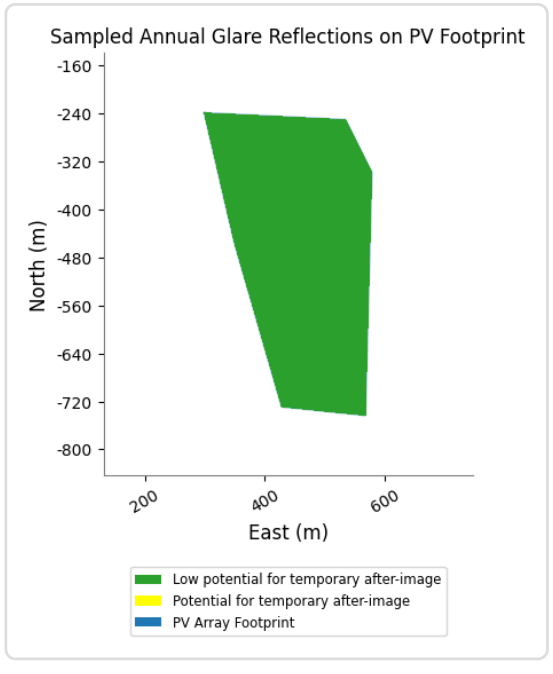
Green glare: 1,247 min.

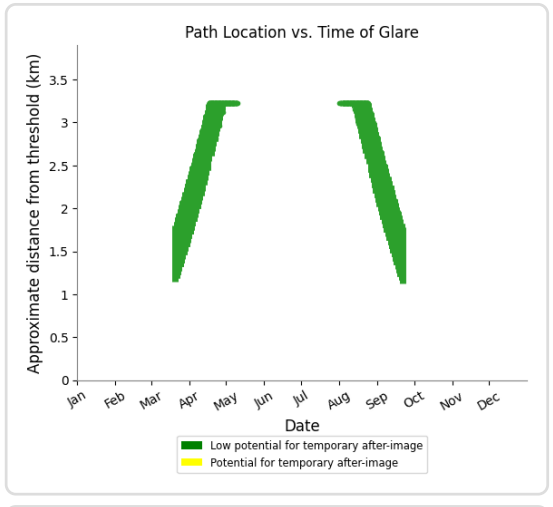


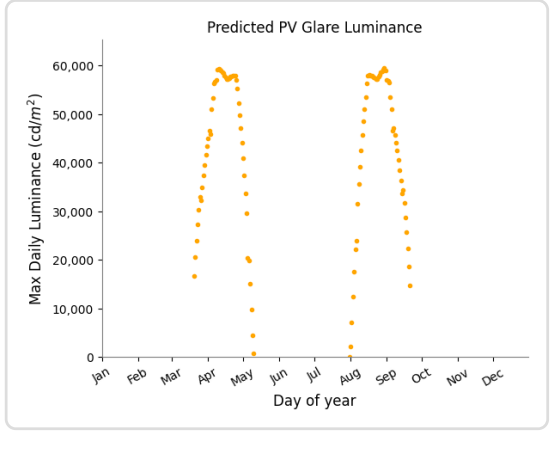












PV array 5 and FP: Darlton 2

No glare found

PV array 5 and FP: Headon 23

No glare found

PV array 5 and FP: Headon R14

No glare found

PV array 5 and FP: Runway 03 S

No glare found

PV array 5 and FP: Runway 14 NW

No glare found

PV array 5 and FP: Runway 21 N

No glare found

PV array 5 and FP: Three Counties R06

No glare found

PV array 5 and FP: Three Counties R19

No glare found

PV array 5 and FP: Three Counties R24

No glare found

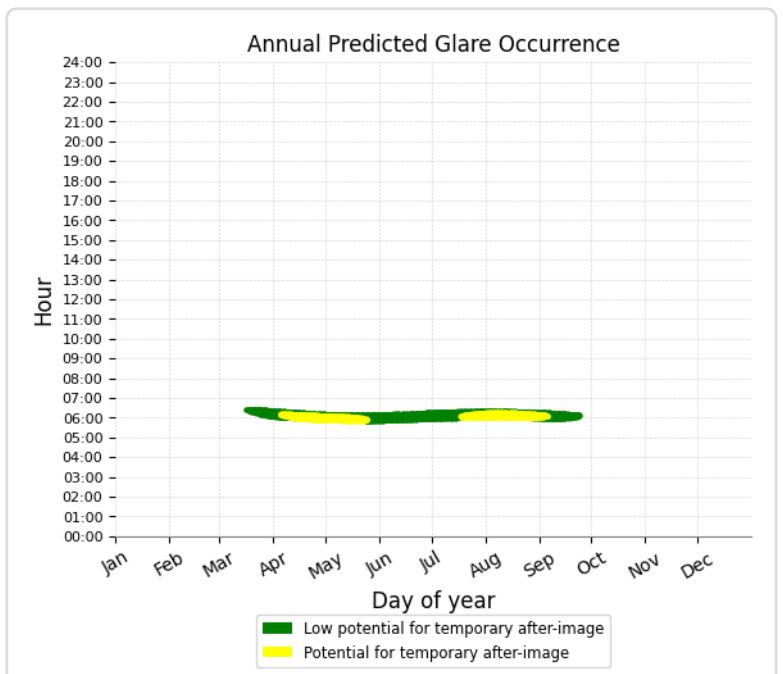
PV array 5 and FP: Three Counties R36

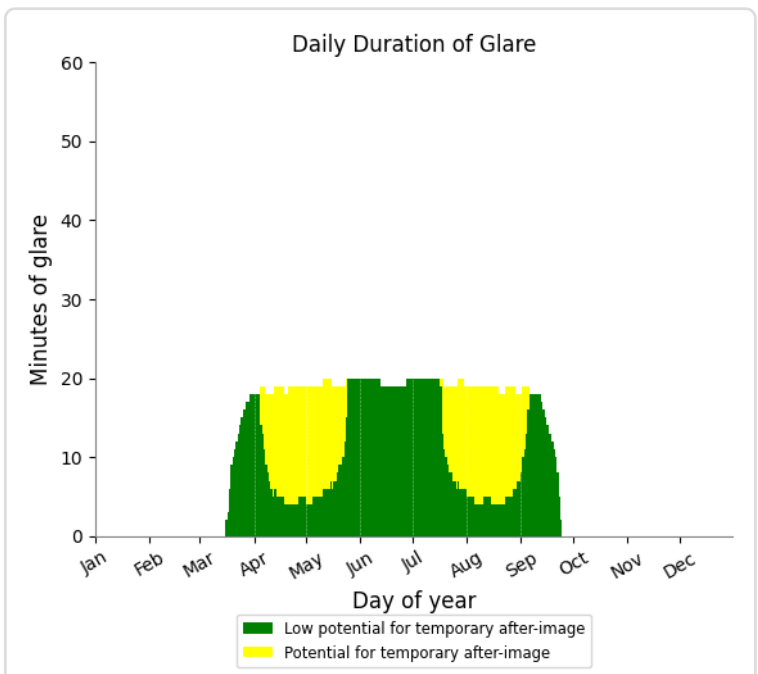
No glare found

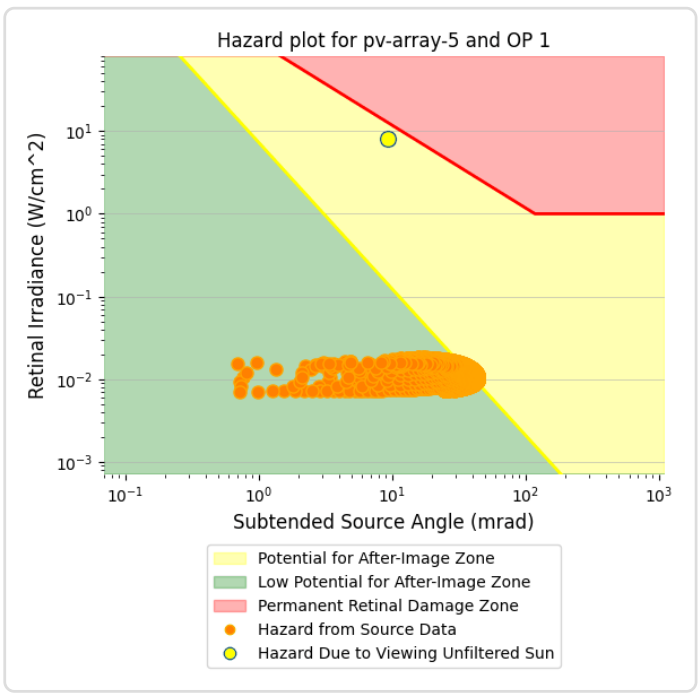
PV array 5 and OP 1

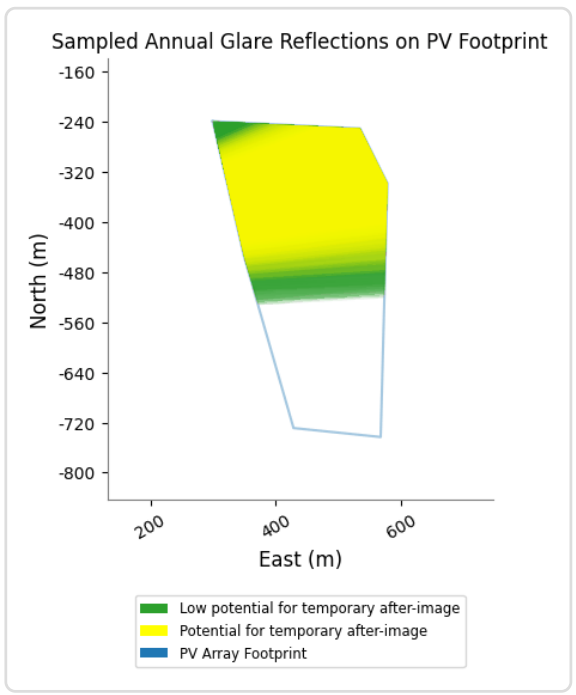
Yellow glare: 1,266 min.

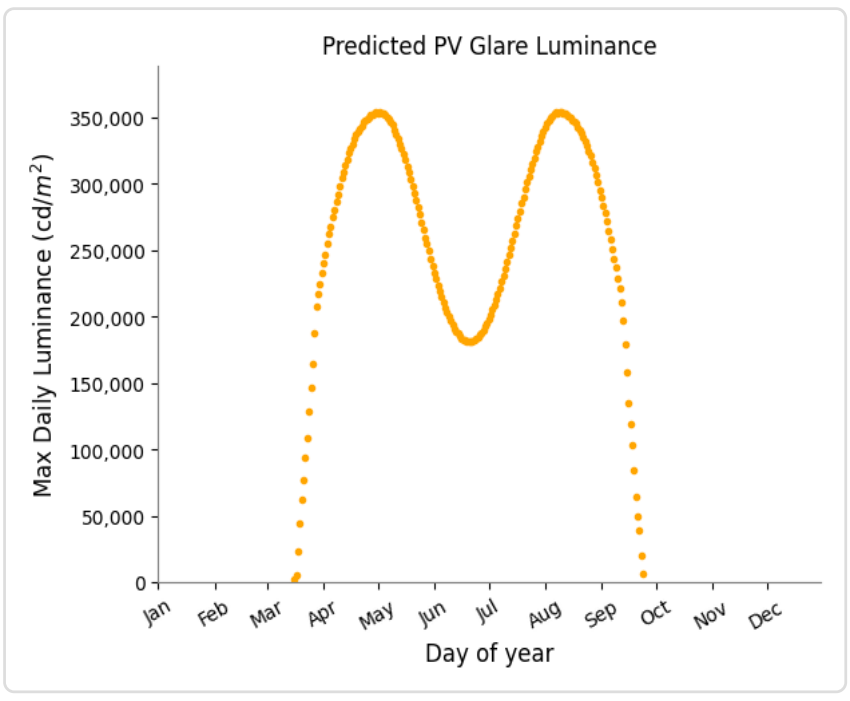
Green glare: 2,227 min.











PV array 5 and OP 2

No glare found

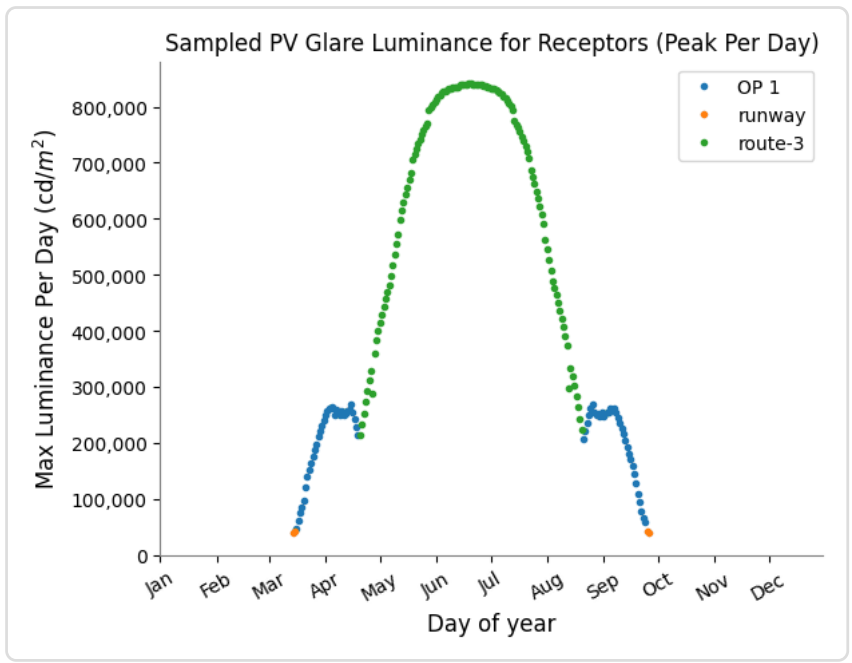
PV array 5 and OP 3

No glare found

PV: PV array 6 potential temporary after-image

Receptor results ordered by category of glare

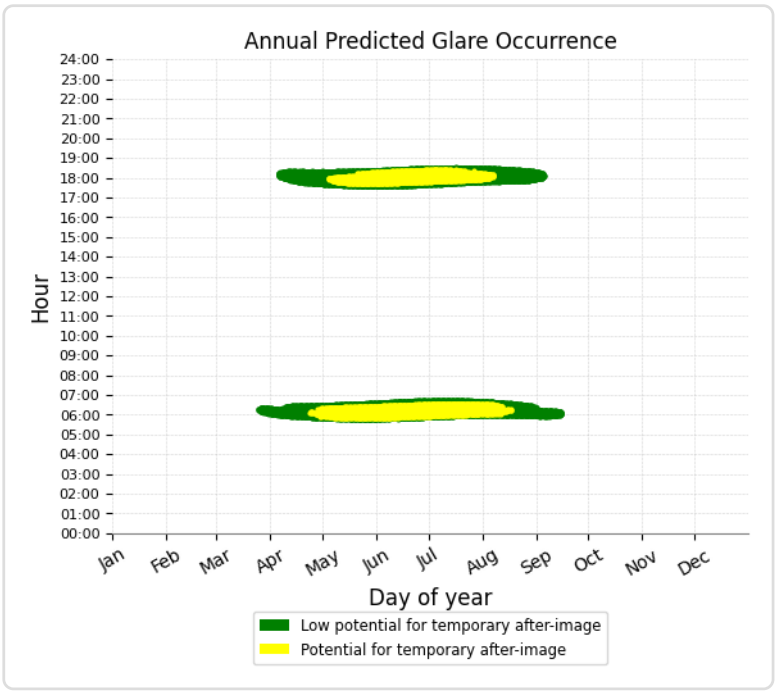
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	7,629	127.2	5,809	96.8	840,949
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Darlton 1	1,732	28.9	0	0.0	15,239
Headon 32	801	13.3	0	0.0	10,271
Runway 32 SE	2,662	44.4	0	0.0	60,149
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	1,307	21.8	261	4.3	305,260
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

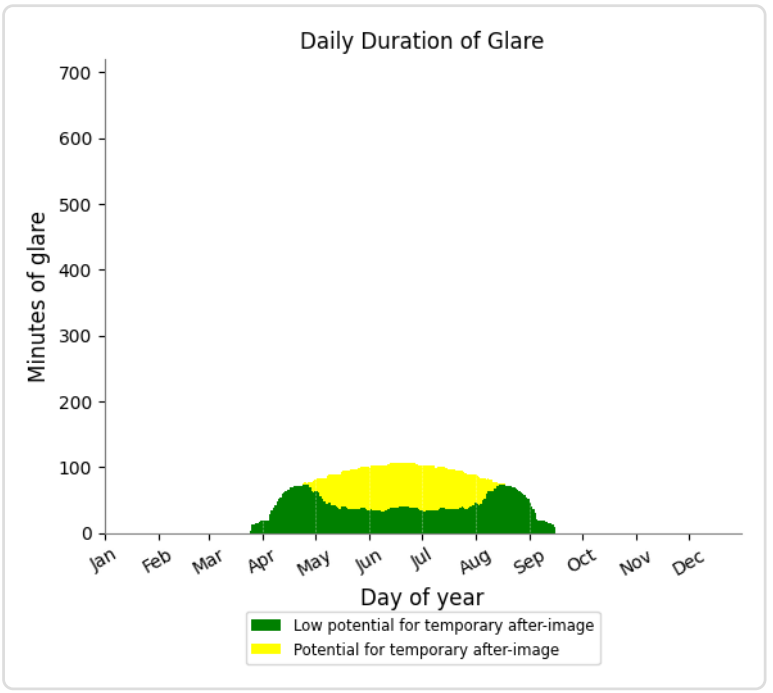


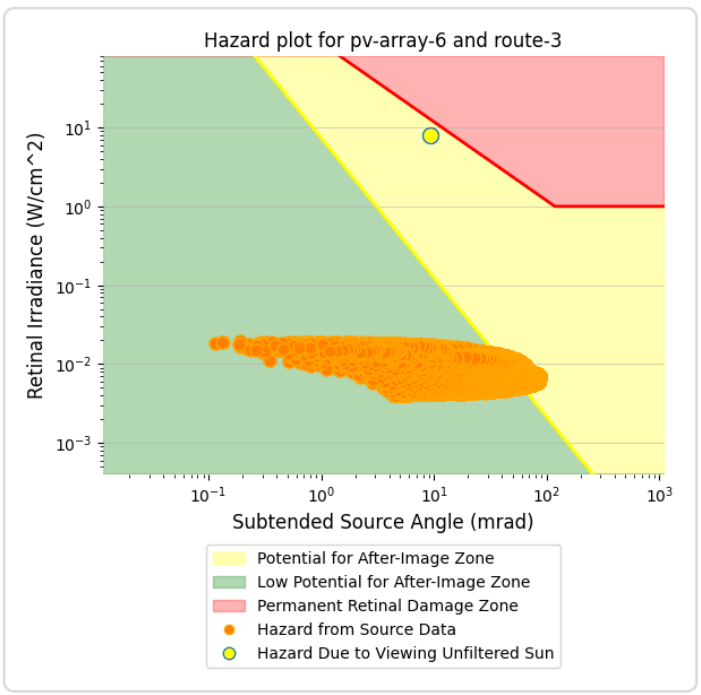
PV array 6 and Route: Route 3

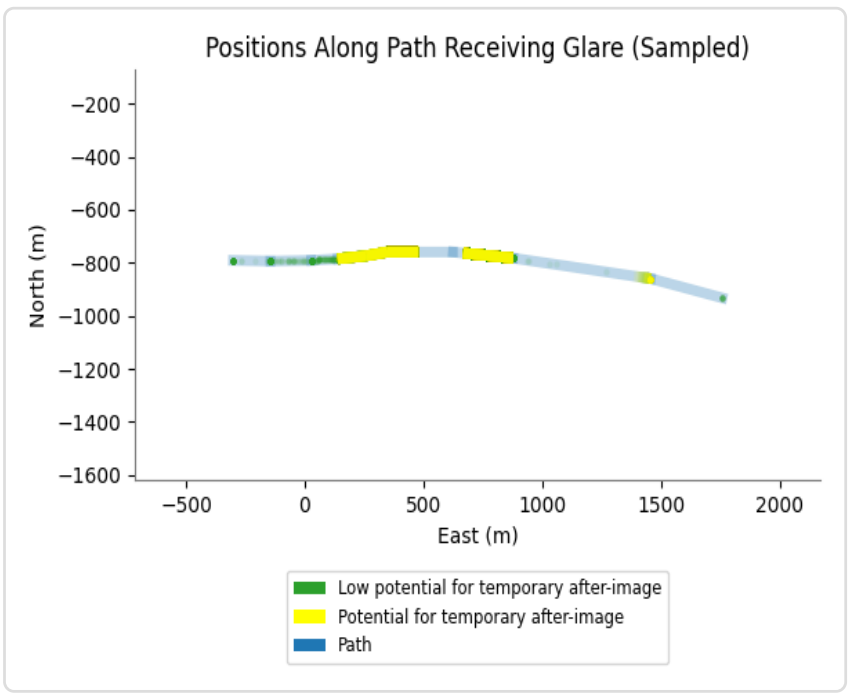
Yellow glare: 5,809 min.

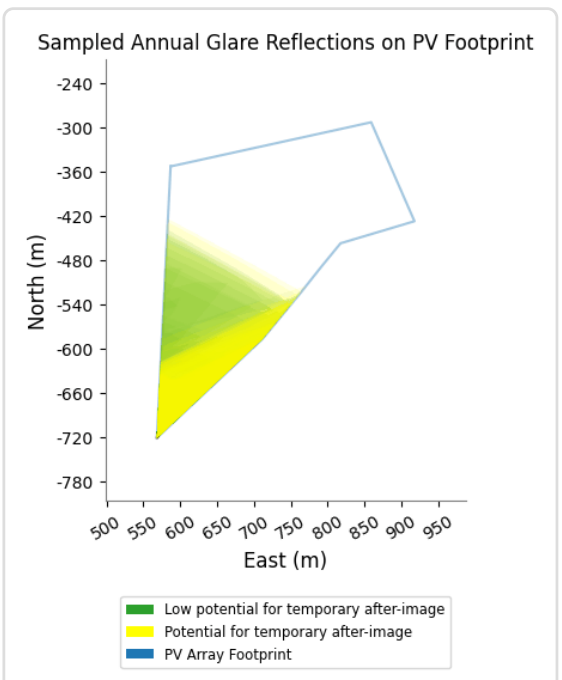
Green glare: 7,629 min.

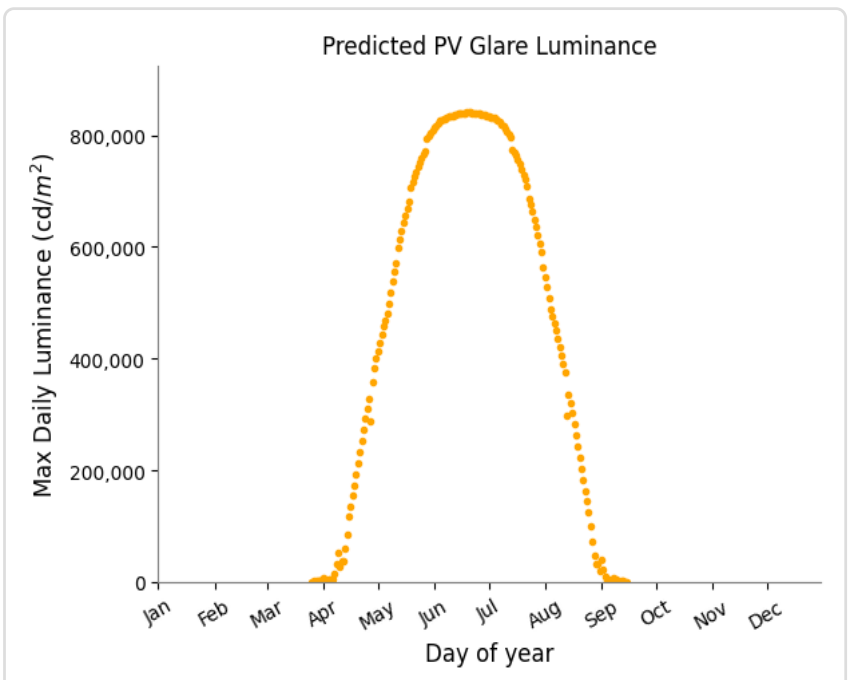












PV array 6 and Route: Route 1

No glare found

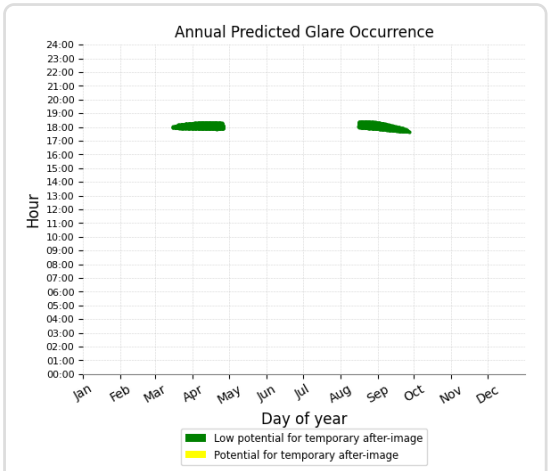
PV array 6 and Route: Route 2

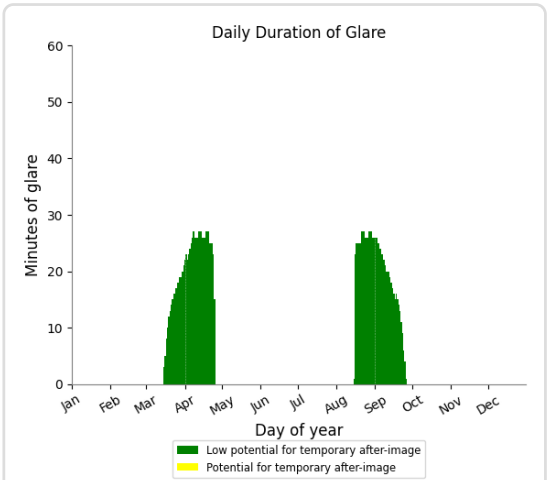
No glare found

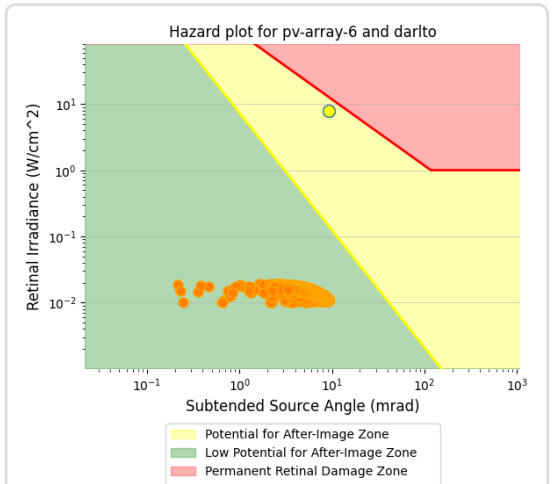
PV array 6 and FP: Darlton 1

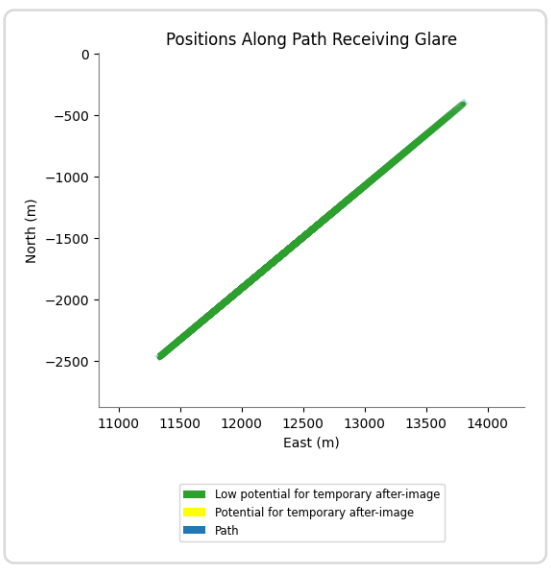
Yellow glare: none

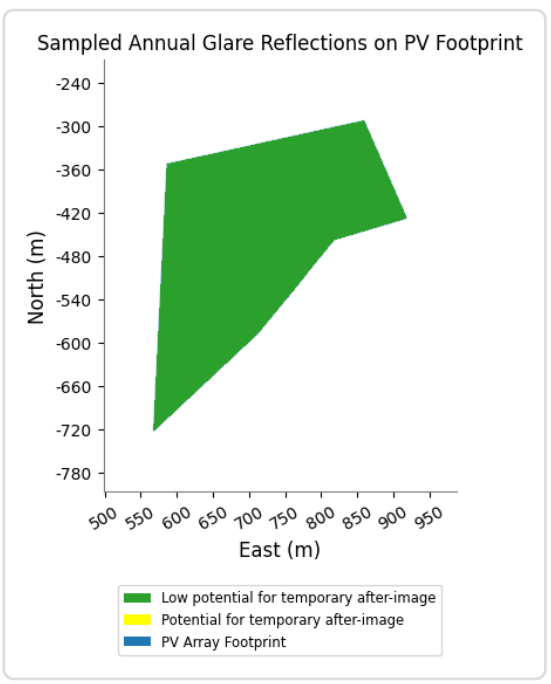
Green glare: 1,732 min.

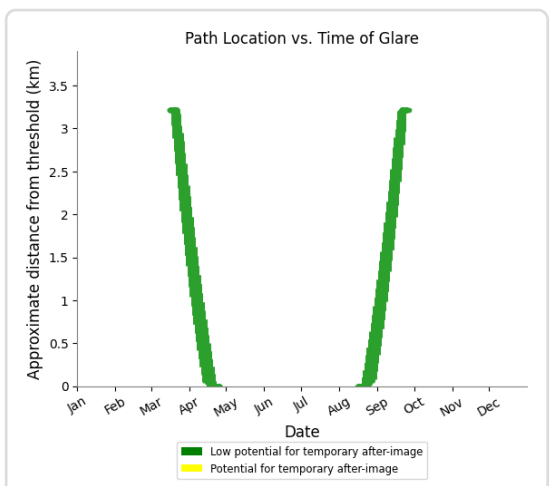


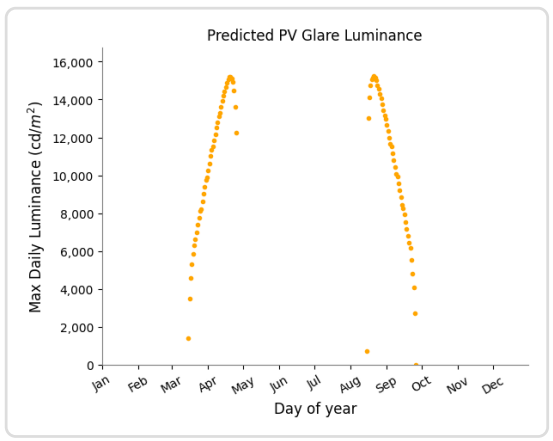








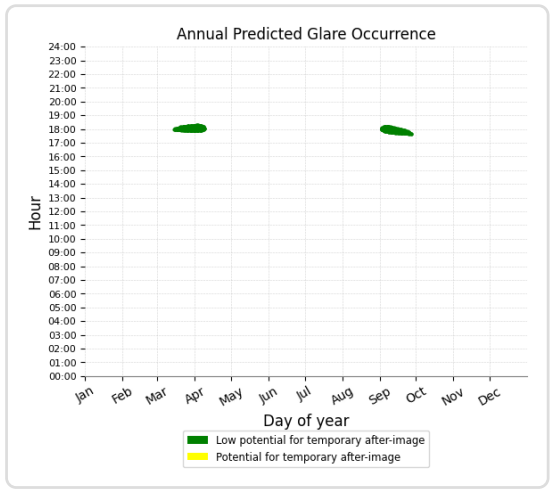


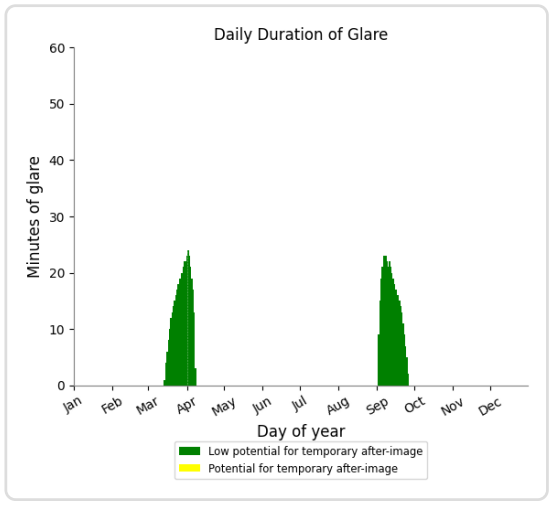


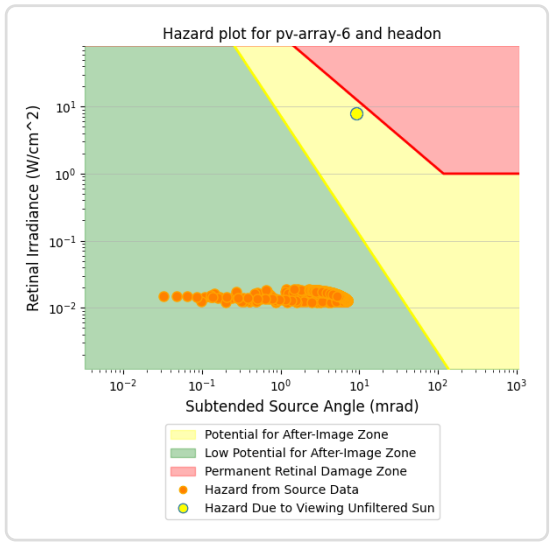
PV array 6 and FP: Headon 32

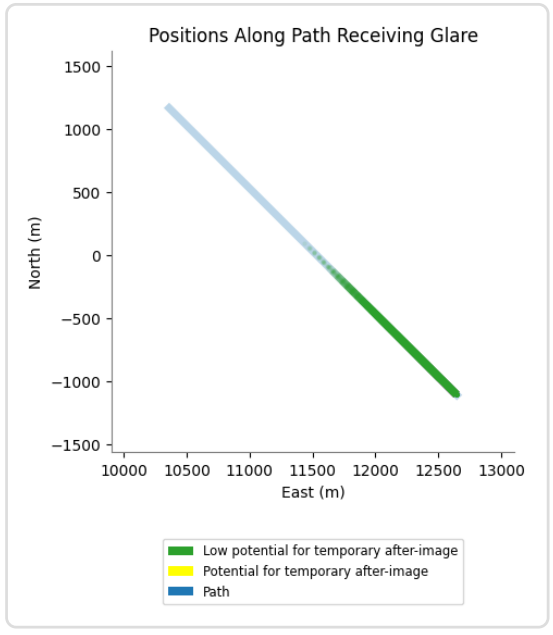
Yellow glare: none

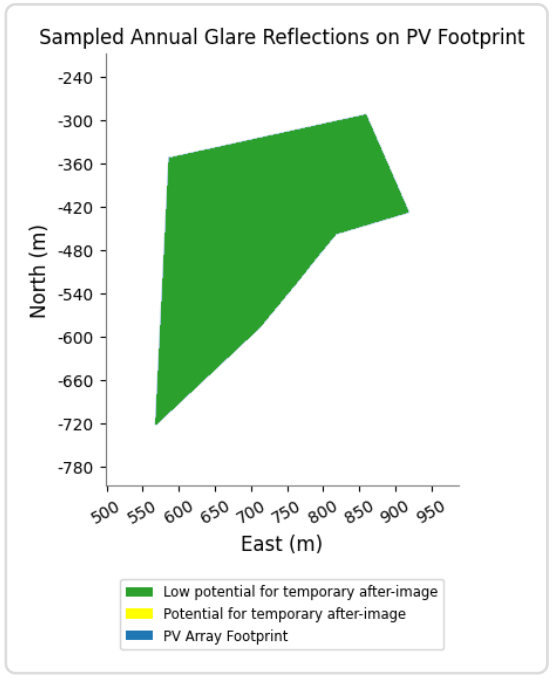
Green glare: 801 min.



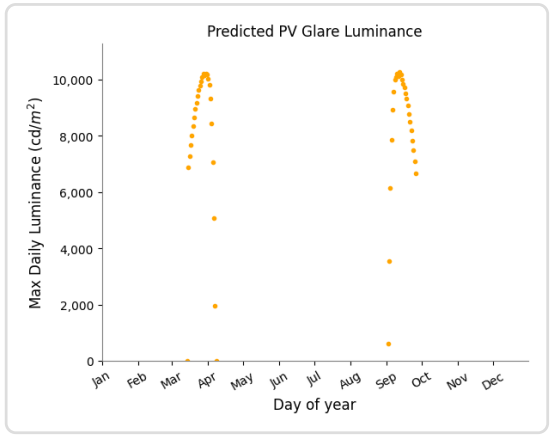








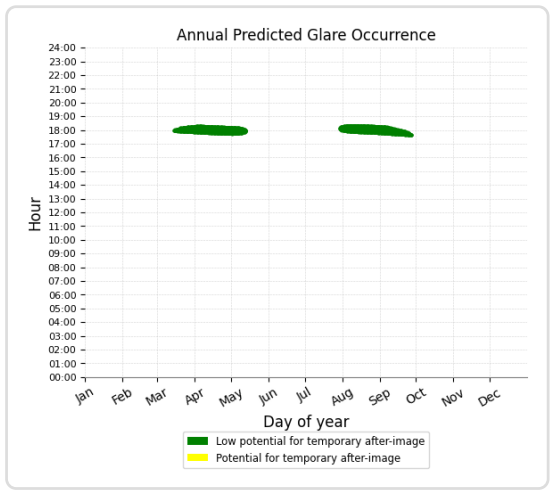


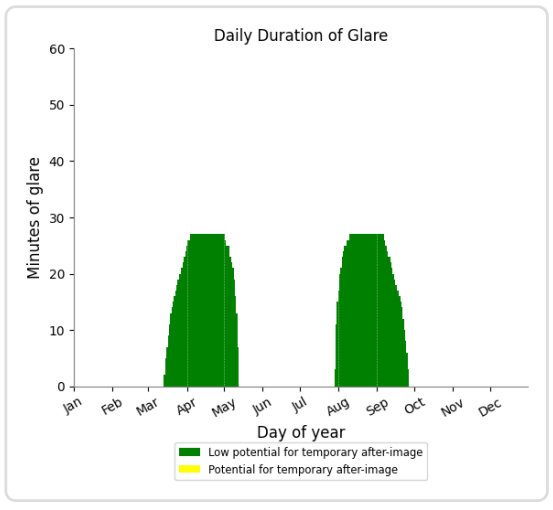


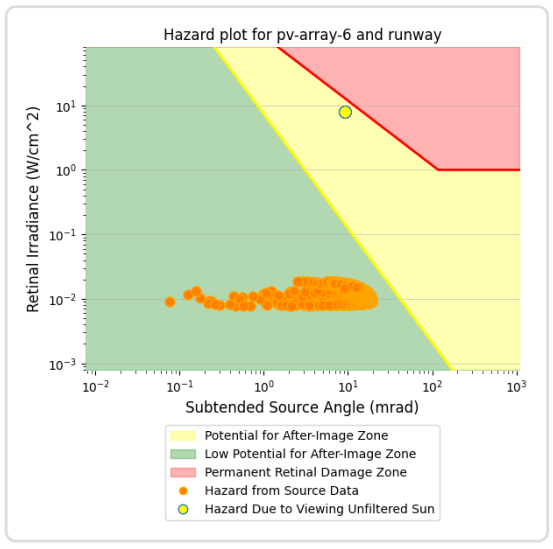
PV array 6 and FP: Runway 32 SE

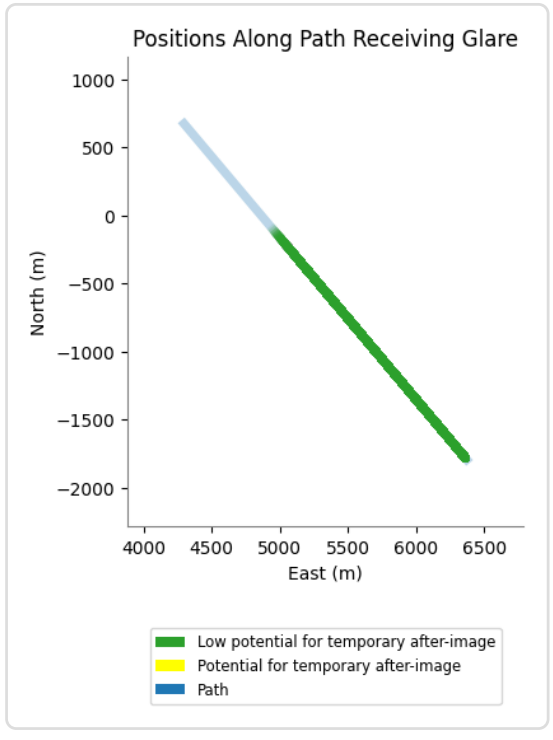
Yellow glare: none

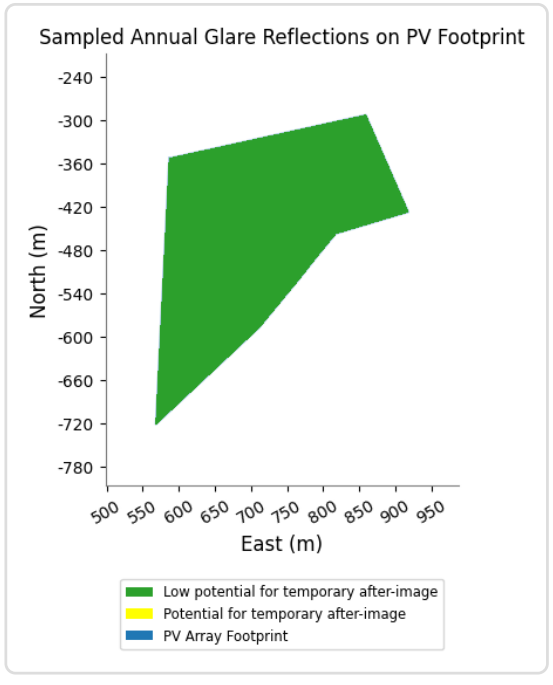
Green glare: 2,662 min.

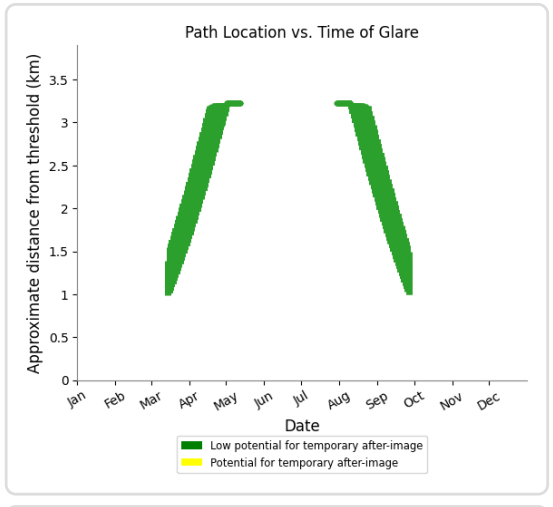


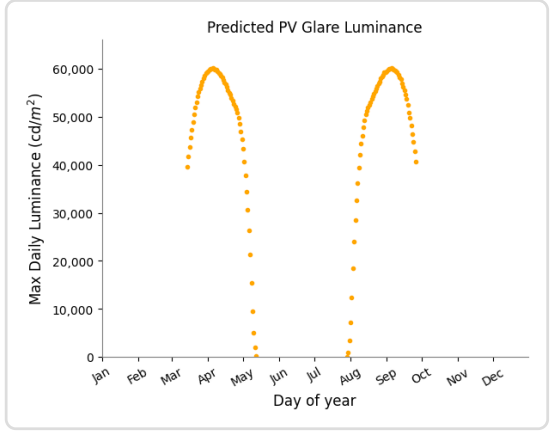












PV array 6 and FP: Darlton 2

No glare found

PV array 6 and FP: Headon 23

No glare found

PV array 6 and FP: Headon R14

No glare found

PV array 6 and FP: Runway 03 S

No glare found

PV array 6 and FP: Runway 14 NW

No glare found

PV array 6 and FP: Runway 21 N

No glare found

PV array 6 and FP: Three Counties R06

No glare found

PV array 6 and FP: Three Counties R19

No glare found

PV array 6 and FP: Three Counties R24

No glare found

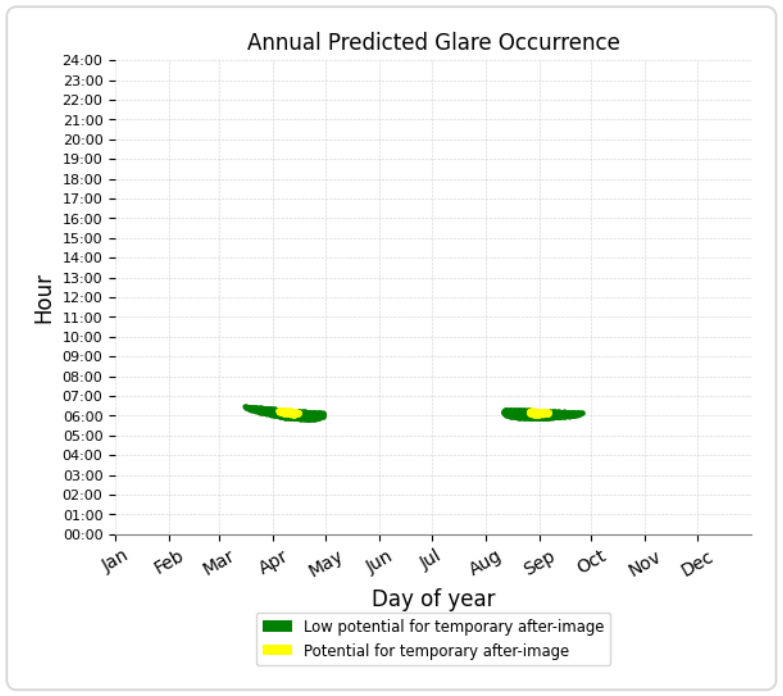
PV array 6 and FP: Three Counties R36

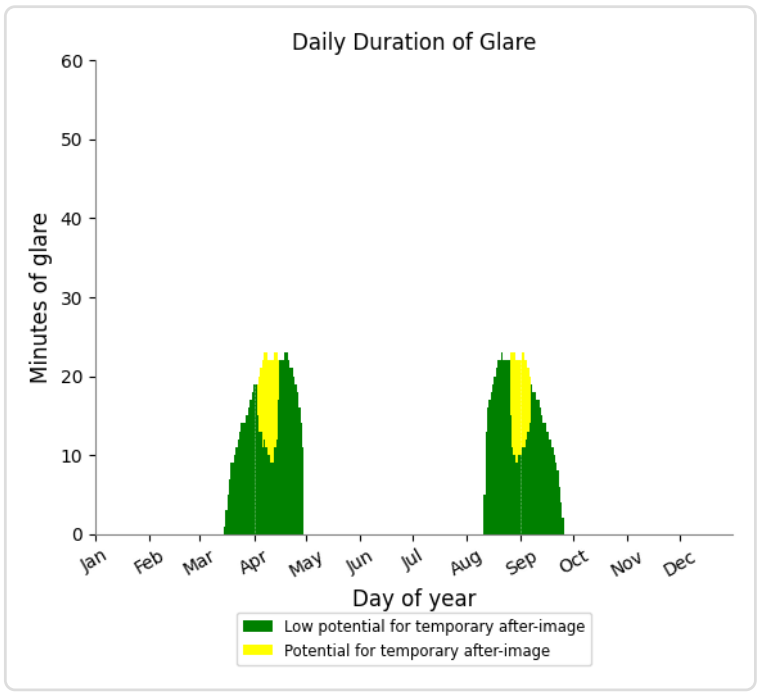
No glare found

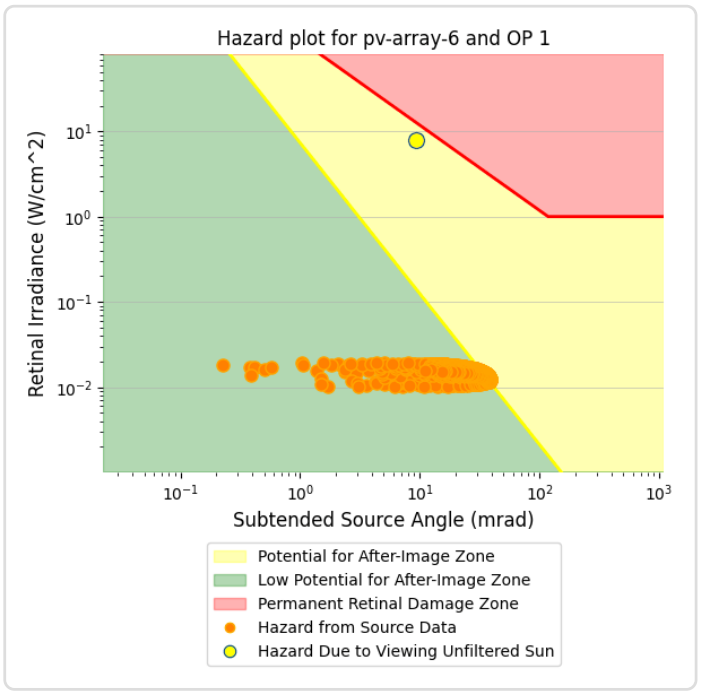
PV array 6 and OP 1

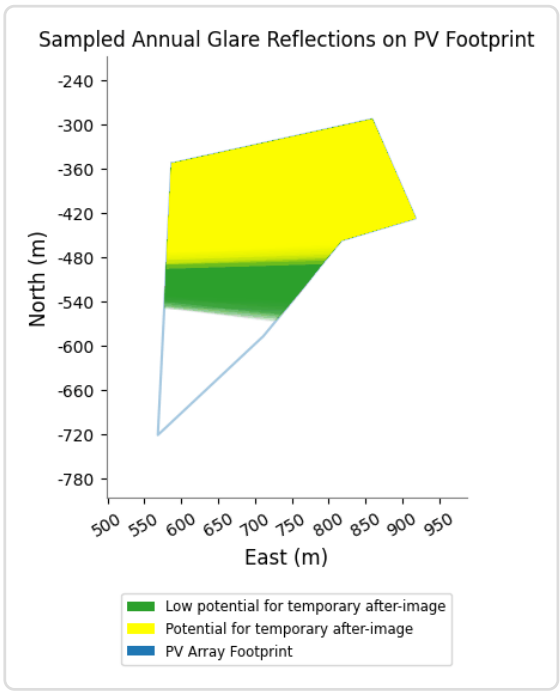
Yellow glare: 261 min.

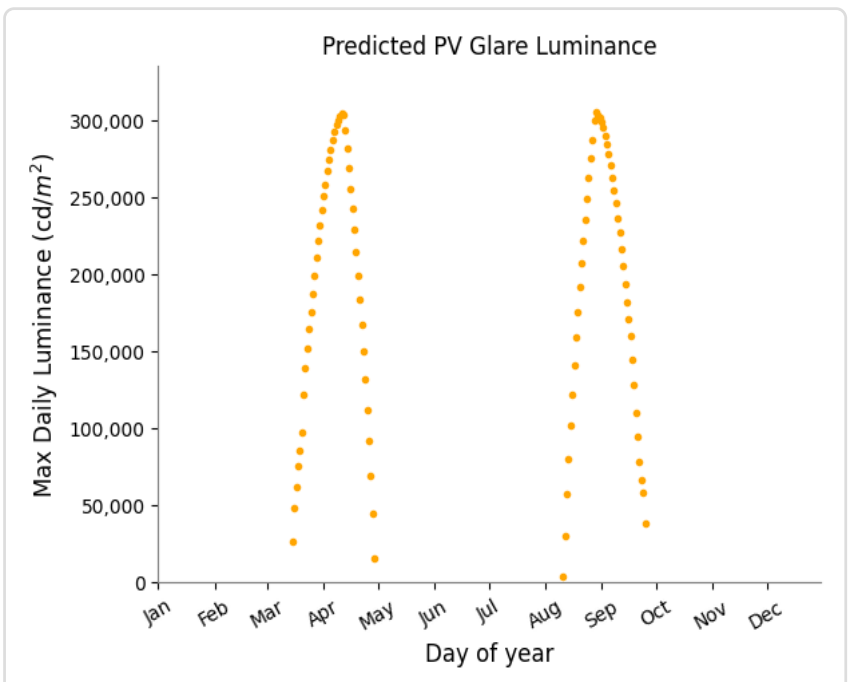
Green glare: 1,307 min.











PV array 6 and OP 2

No glare found

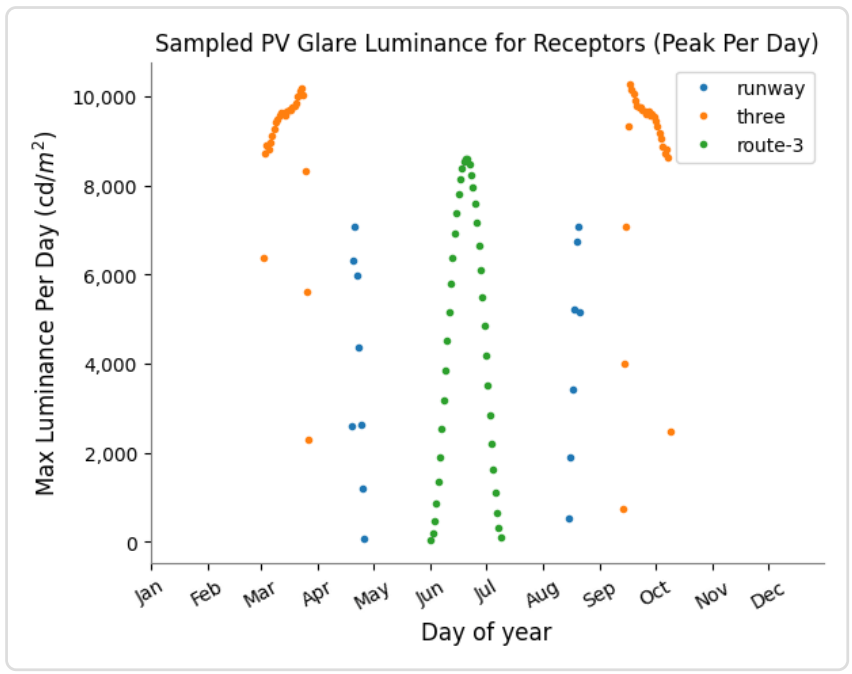
PV array 6 and OP 3

No glare found

PV: PV array 7 low potential for temporary after-image

Receptor results ordered by category of glare

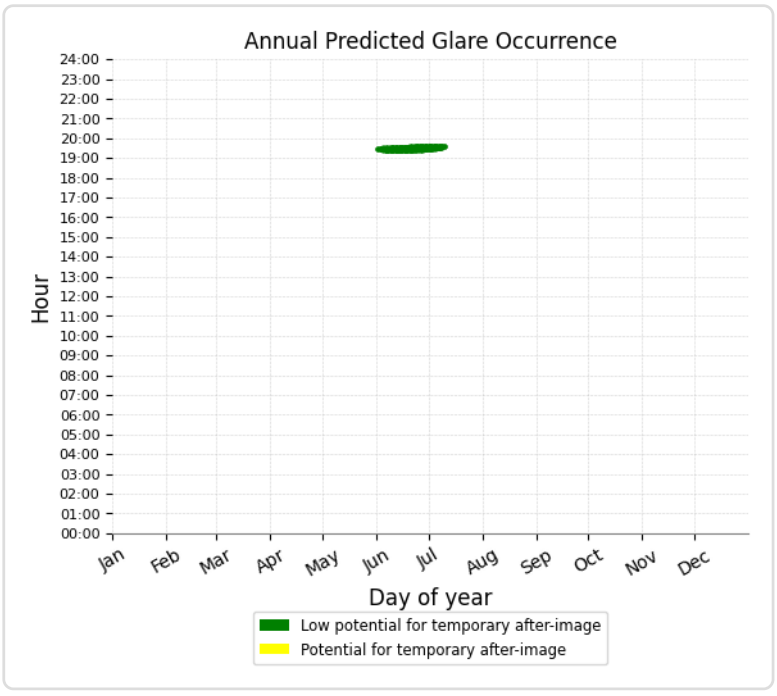
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 3	338	5.6	0	0.0	8,610
Route 1	0	0.0	0	0.0	0
Route 2	0	0.0	0	0.0	0
Runway 32 SE	74	1.2	0	0.0	7,085
Three Counties R06	570	9.5	0	0.0	10,267
Darlton 1	0	0.0	0	0.0	0
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon 32	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0

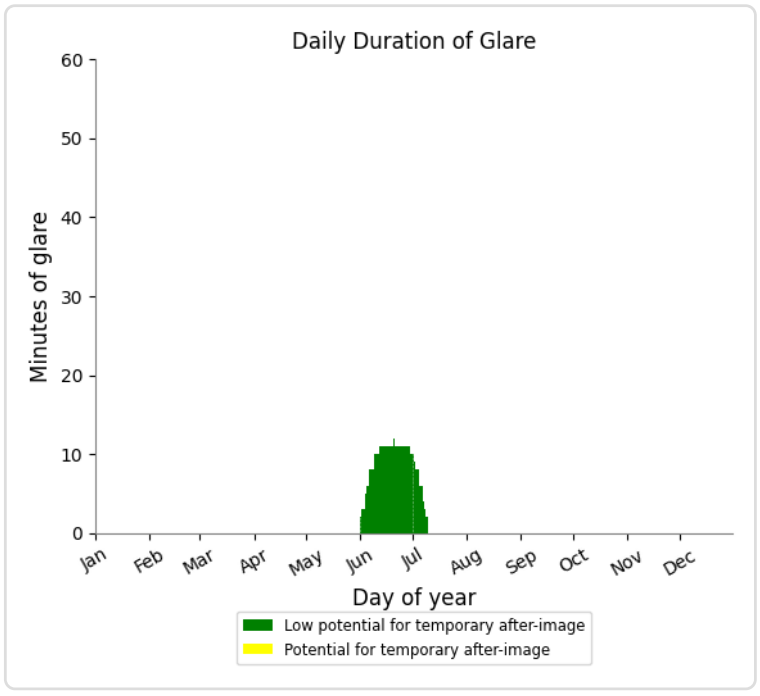


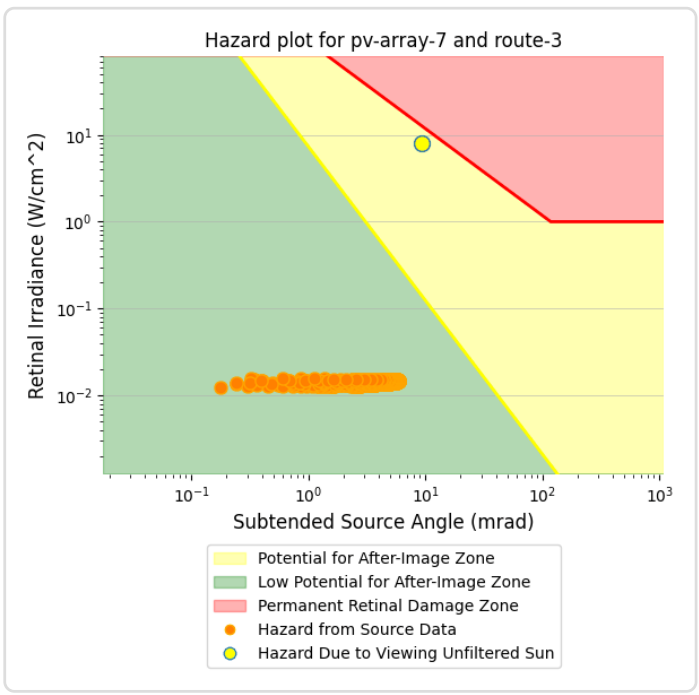
PV array 7 and Route: Route 3

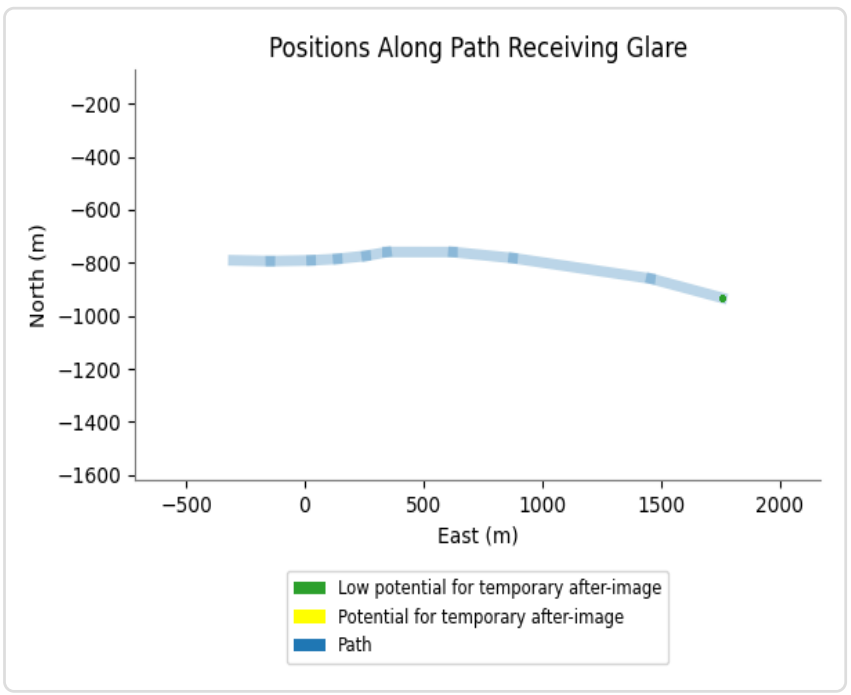
Yellow glare: none

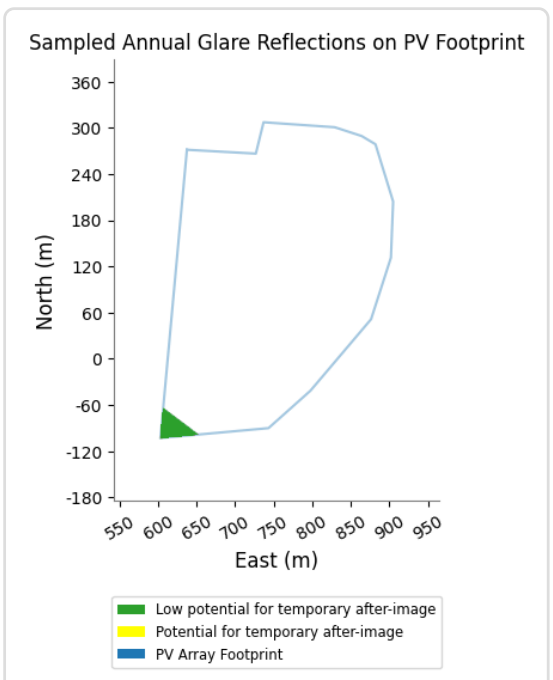
Green glare: 338 min.

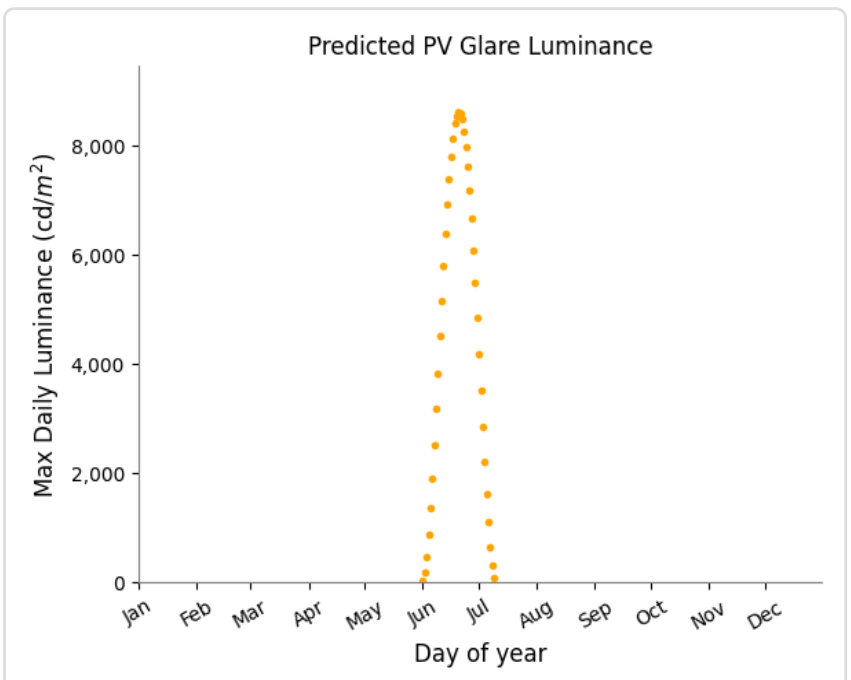












PV array 7 and Route: Route 1

No glare found

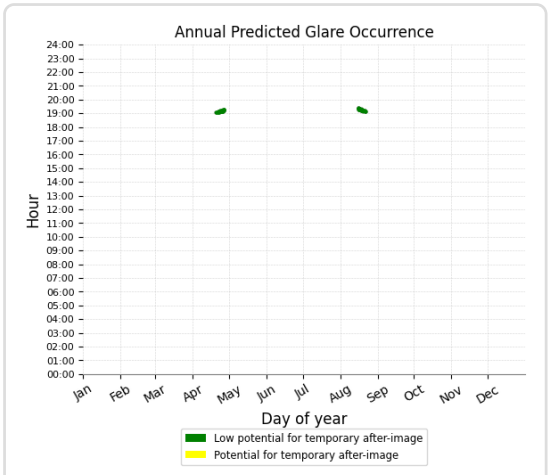
PV array 7 and Route: Route 2

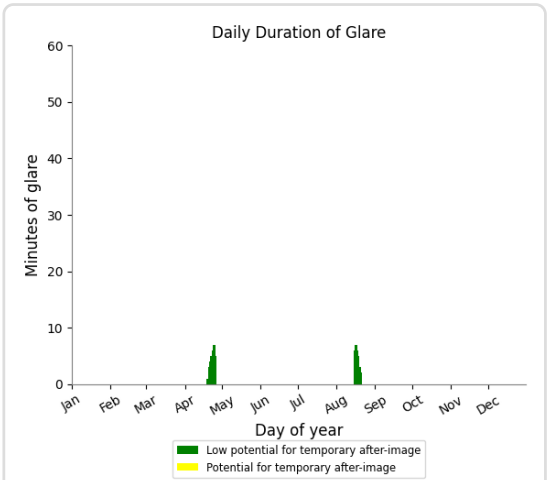
No glare found

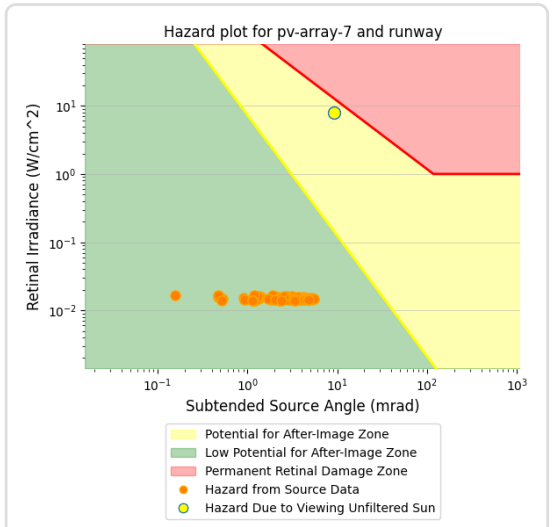
PV array 7 and FP: Runway 32 SE

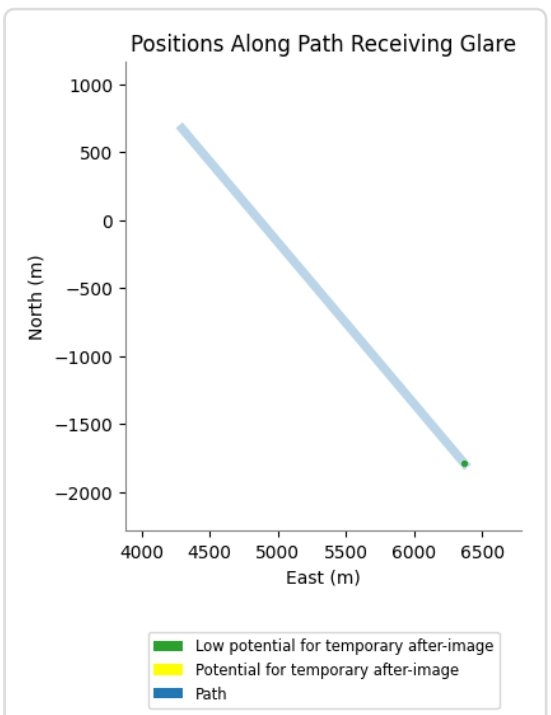
Yellow glare: none

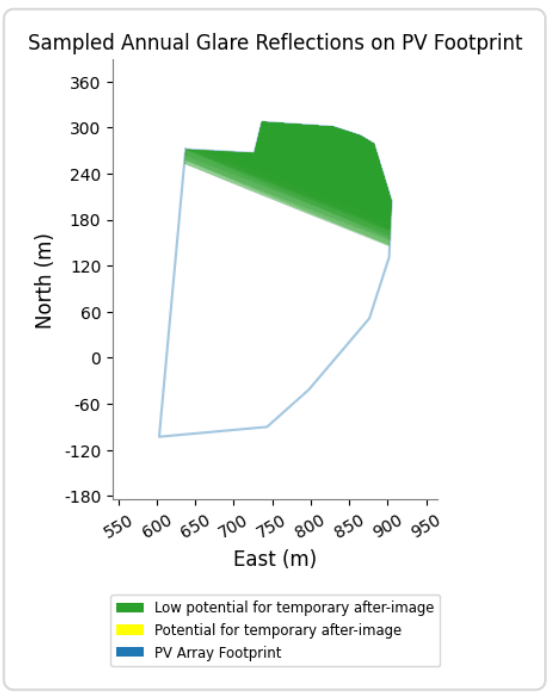
Green glare: 74 min.

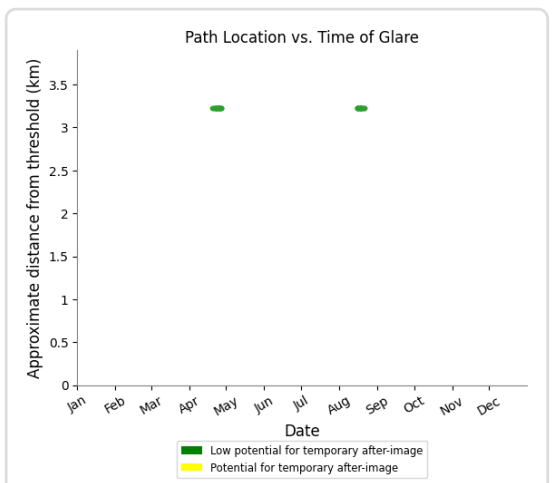


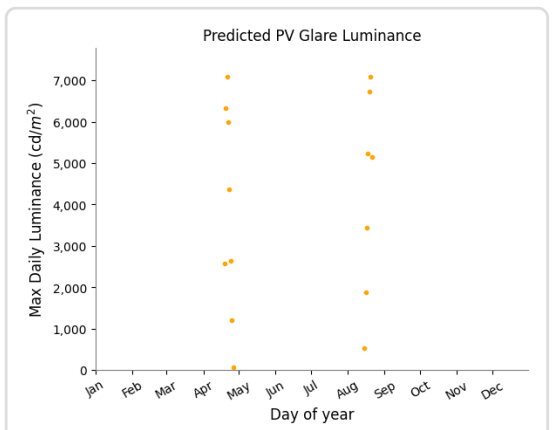








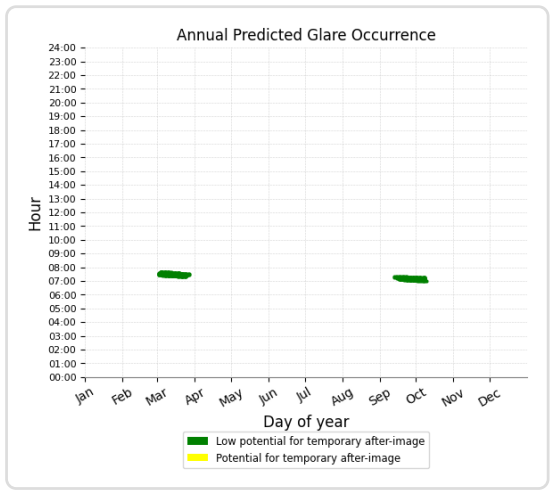


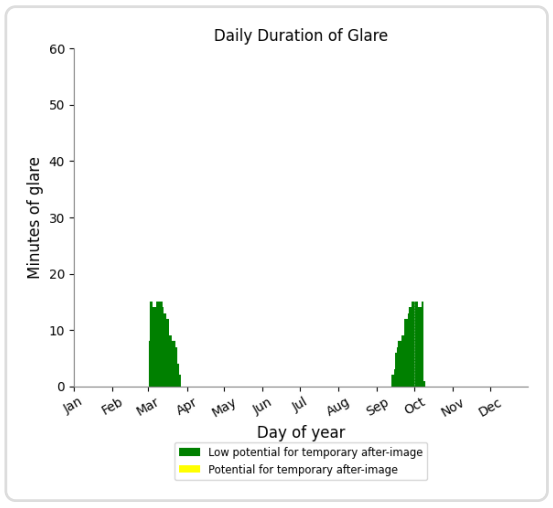


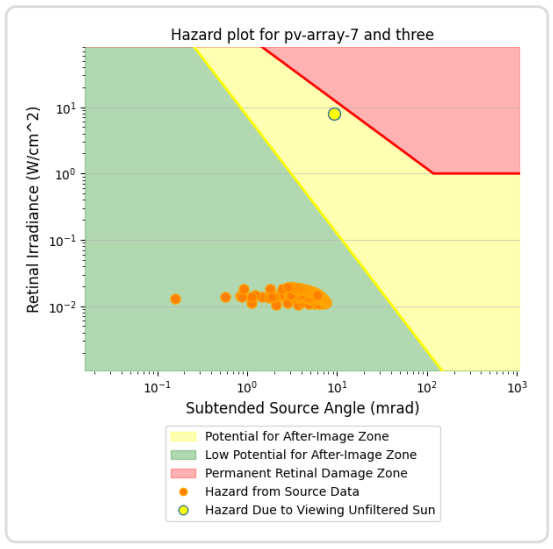
PV array 7 and FP: Three Counties R06

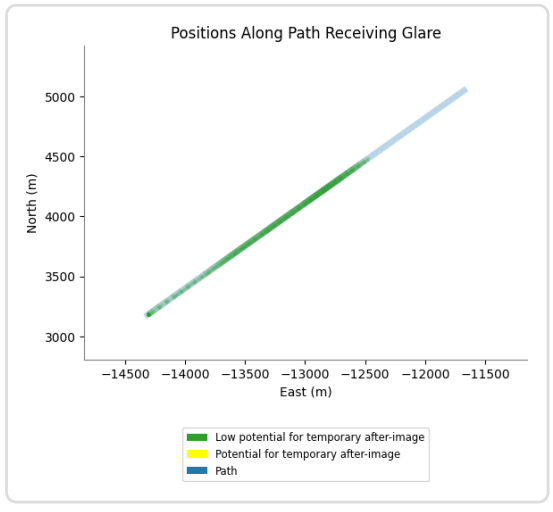
Yellow glare: none

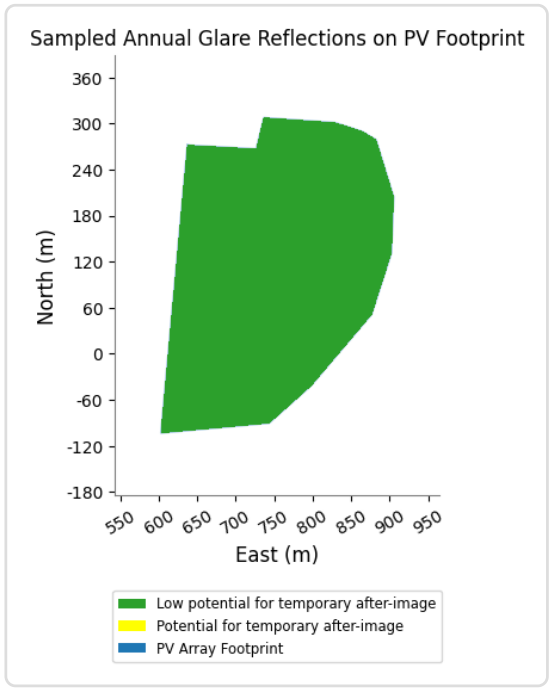
Green glare: 570 min.

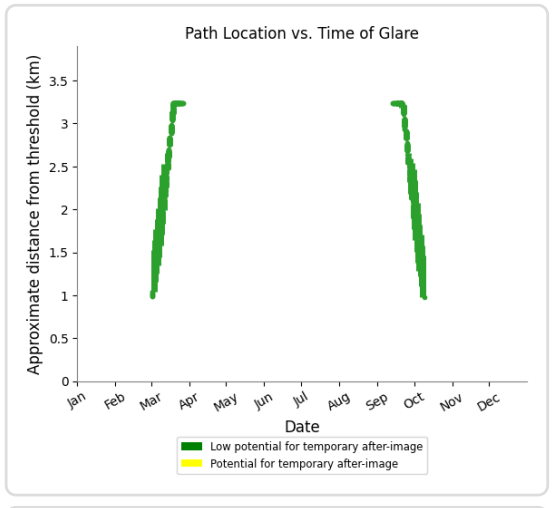


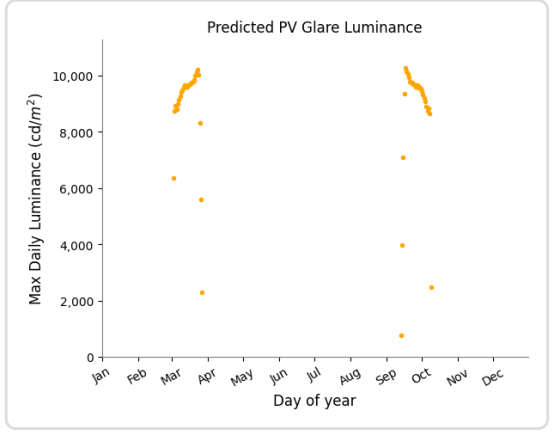












PV array 7 and FP: Darlton 1

No glare found

PV array 7 and FP: Darlton 2

No glare found

PV array 7 and FP: Headon 23

No glare found

PV array 7 and FP: Headon 32

No glare found

PV array 7 and FP: Headon R14

No glare found

PV array 7 and FP: Runway 03 S

No glare found

PV array 7 and FP: Runway 14 NW

No glare found

PV array 7 and FP: Runway 21 N

No glare found

PV array 7 and FP: Three Counties R19

No glare found

PV array 7 and FP: Three Counties R24

No glare found

PV array 7 and FP: Three Counties R36

No glare found

PV array 7 and OP 1

No glare found

PV array 7 and OP 2

No glare found

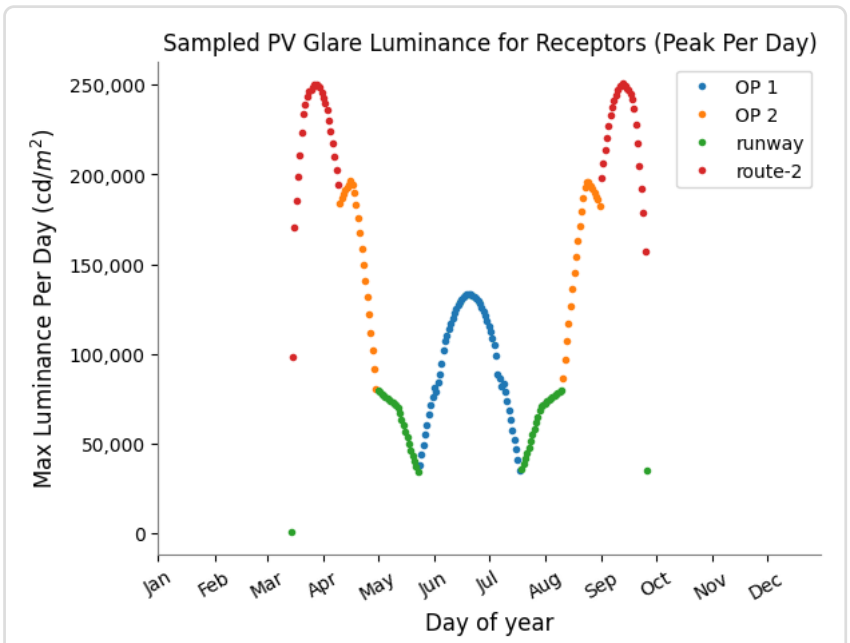
PV array 7 and OP 3

No glare found

PV: PV array 8 low potential for temporary after-image

Receptor results ordered by category of glare

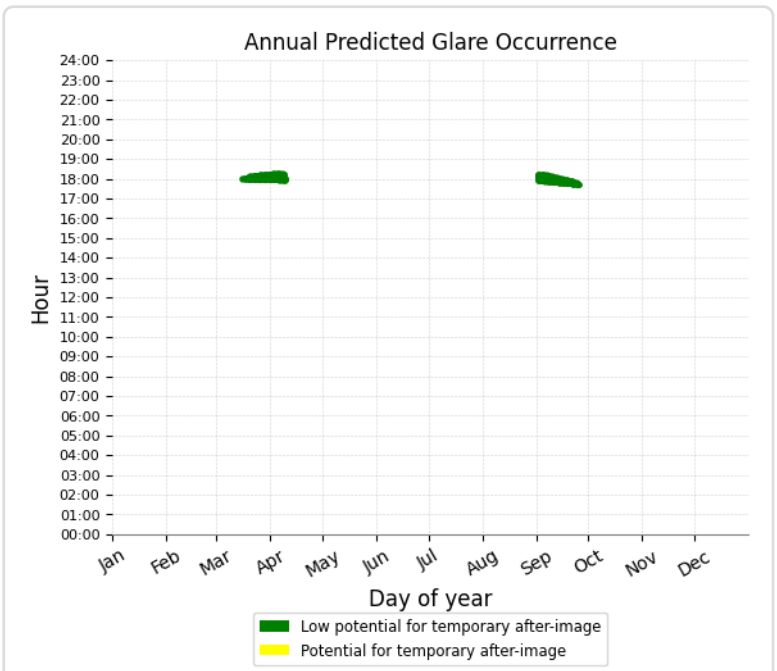
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
Route 2	761	12.7	0	0.0	250,599
Route 1	0	0.0	0	0.0	0
Route 3	0	0.0	0	0.0	0
Darlton 1	1,502	25.0	0	0.0	23,168
Headon 32	1,107	18.4	0	0.0	17,567
Runway 32 SE	3,947	65.8	0	0.0	97,342
Darlton 2	0	0.0	0	0.0	0
Headon 23	0	0.0	0	0.0	0
Headon R14	0	0.0	0	0.0	0
Runway 03 S	0	0.0	0	0.0	0
Runway 14 NW	0	0.0	0	0.0	0
Runway 21 N	0	0.0	0	0.0	0
Three Counties R06	0	0.0	0	0.0	0
Three Counties R19	0	0.0	0	0.0	0
Three Counties R24	0	0.0	0	0.0	0
Three Counties R36	0	0.0	0	0.0	0
OP 1	648	10.8	0	0.0	133,326
OP 2	1,967	32.8	0	0.0	196,295
OP 3	312	5.2	0	0.0	17,046

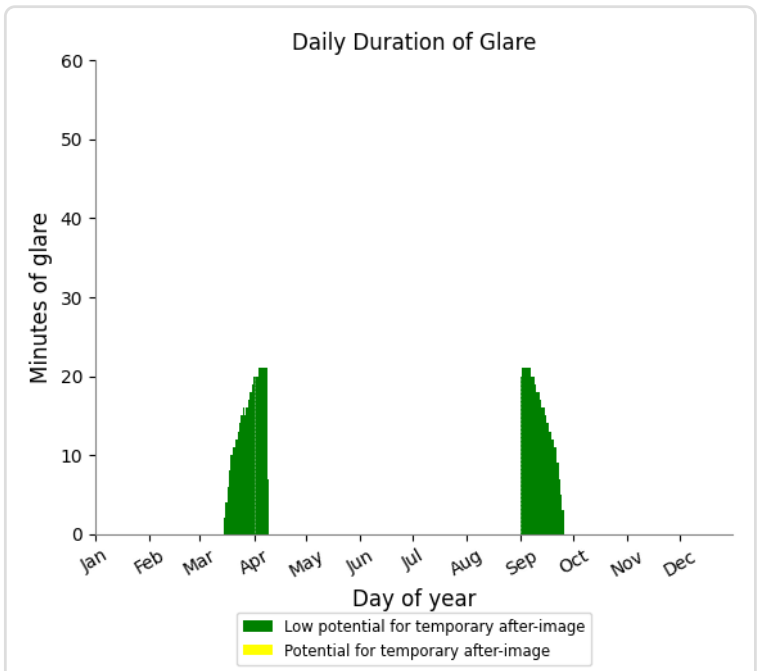


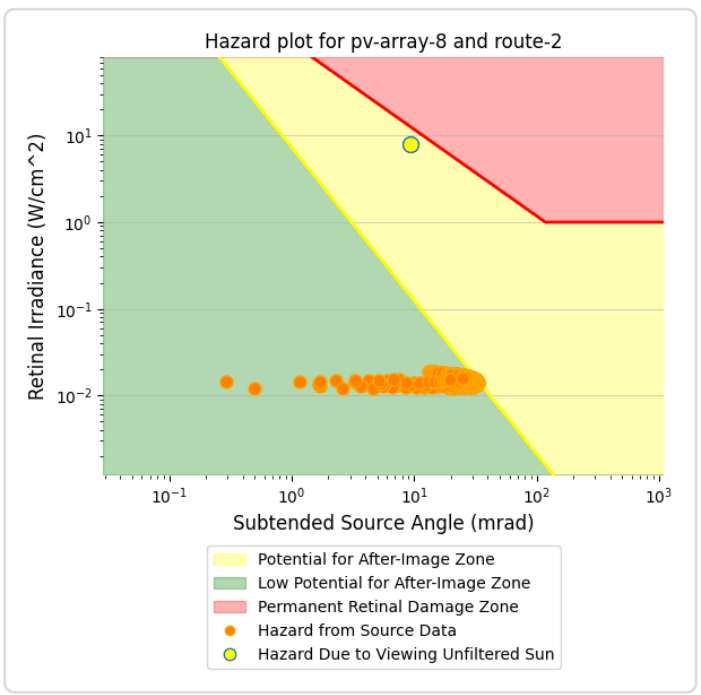
PV array 8 and Route: Route 2

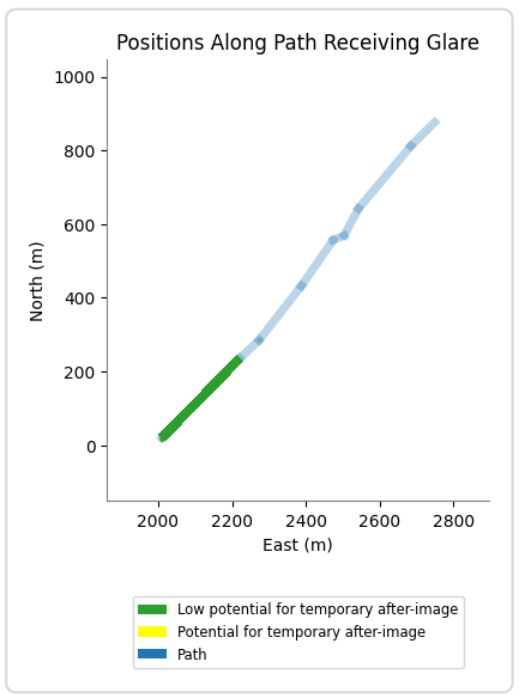
Yellow glare: none

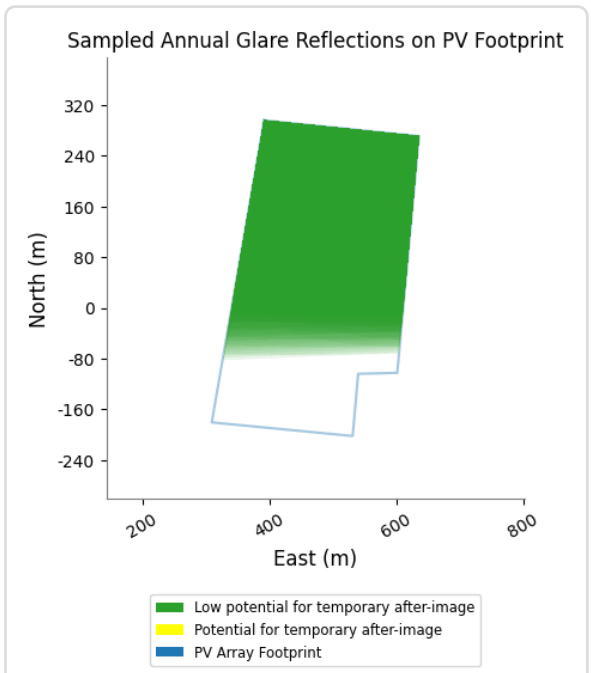
Green glare: 761 min.

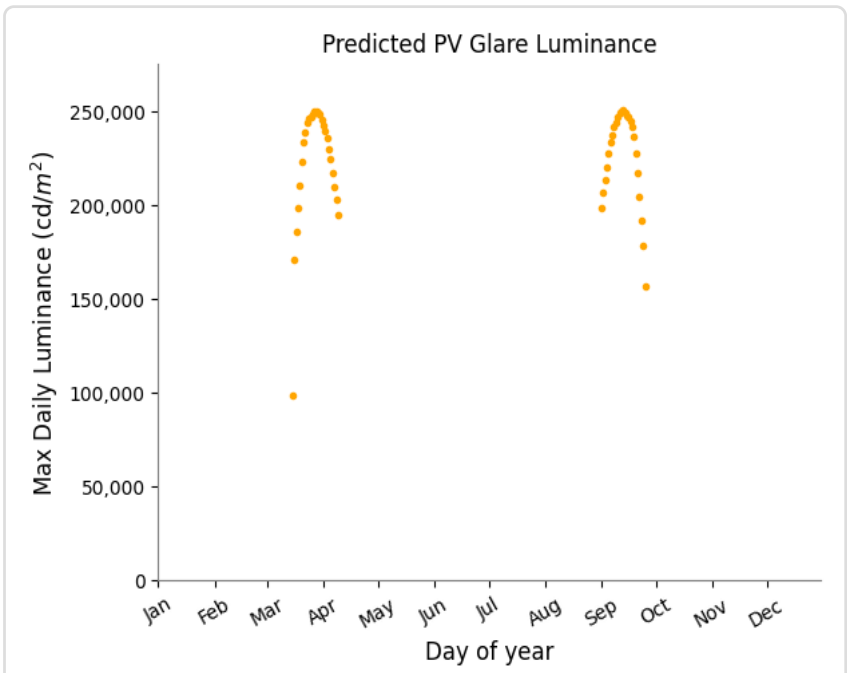












PV array 8 and Route: Route 1

No glare found

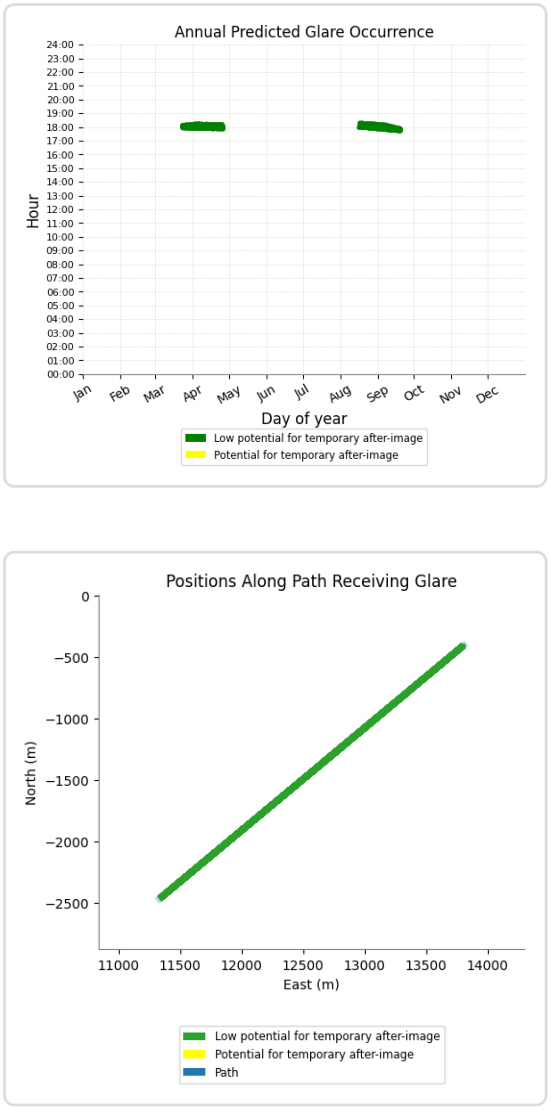
PV array 8 and Route: Route 3

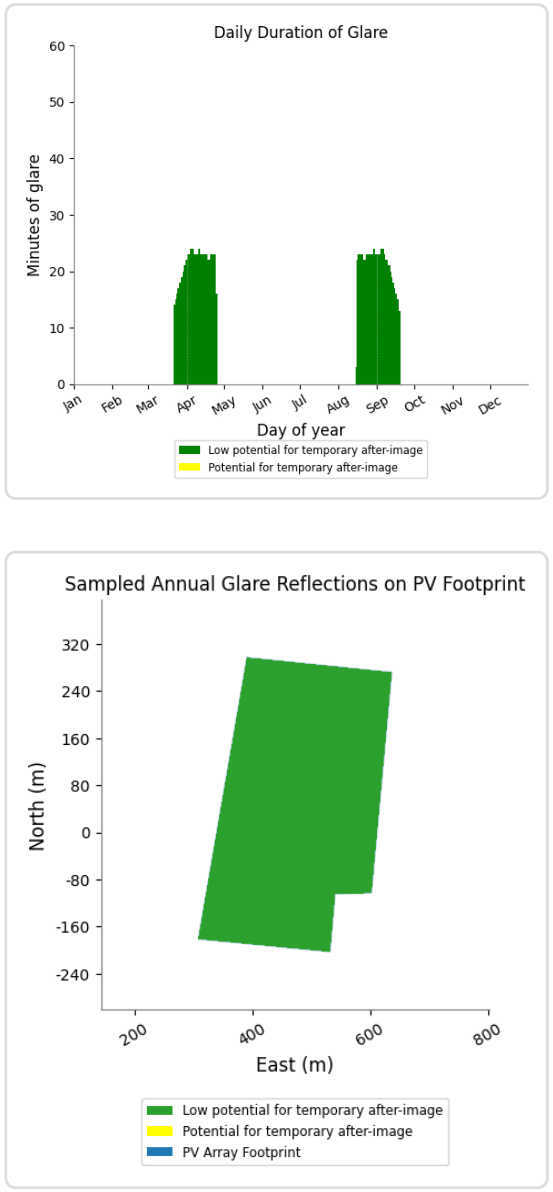
No glare found

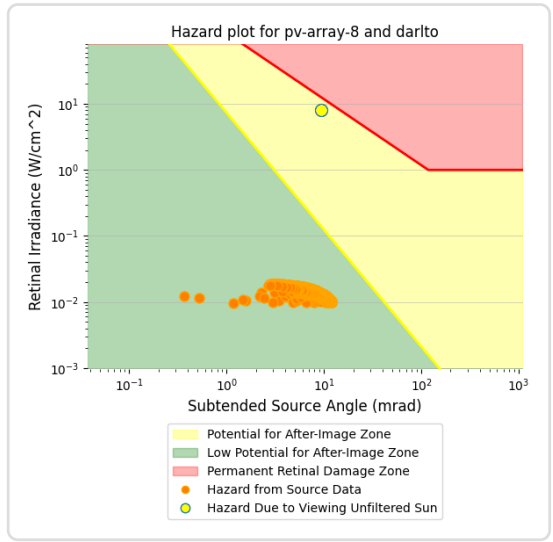
PV array 8 and FP: Darlton 1

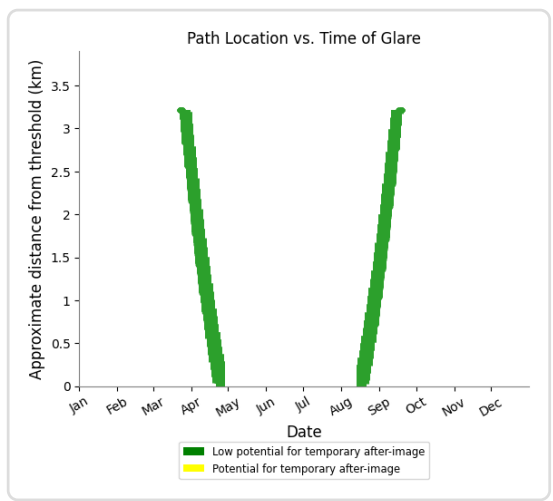
Yellow glare: none

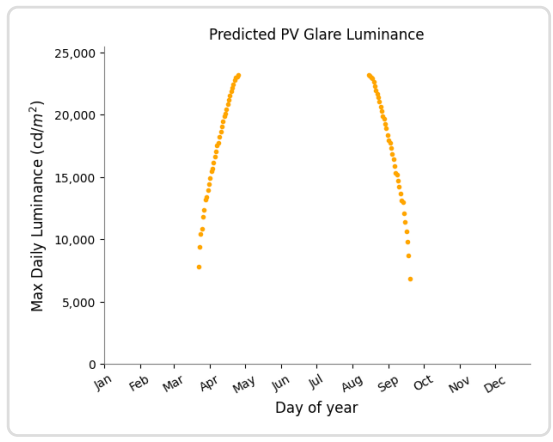
Green glare: 1,502 min.







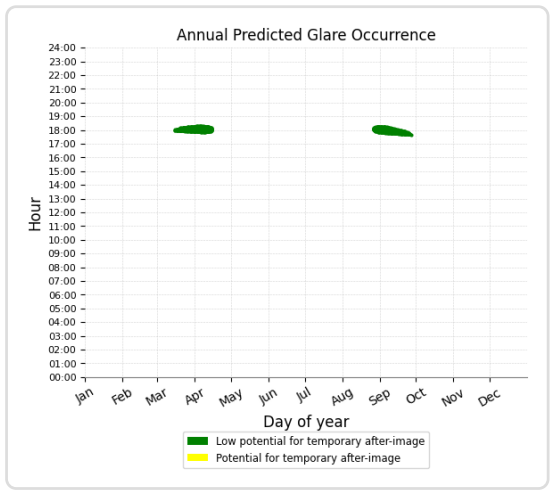


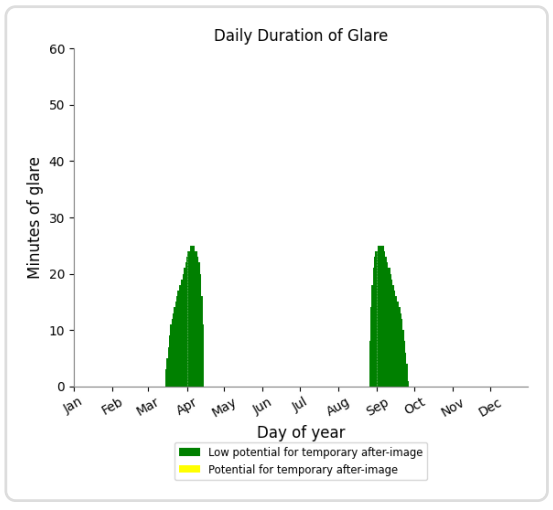


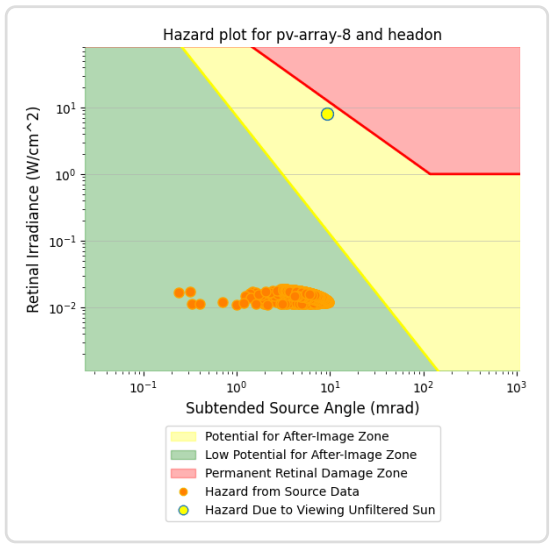
PV array 8 and FP: Headon 32

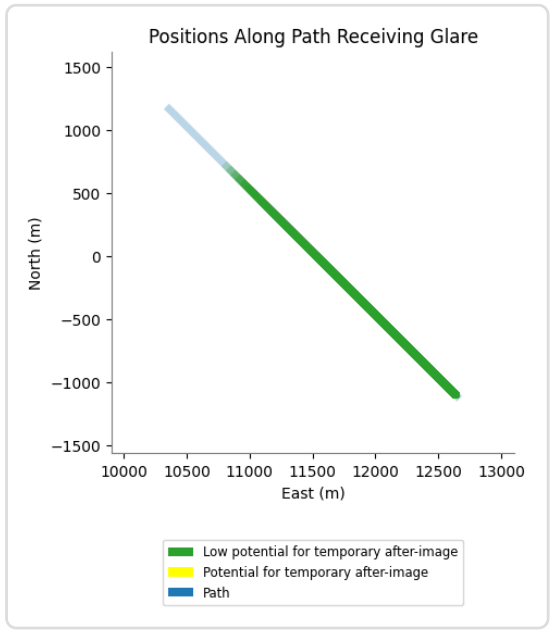
Yellow glare: none

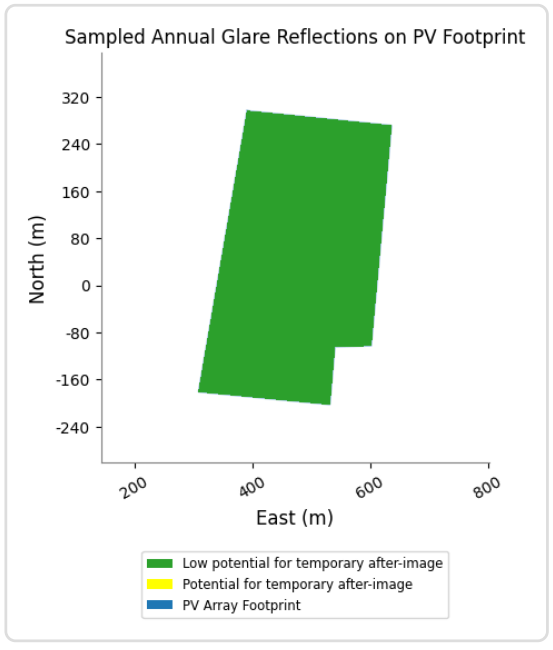
Green glare: 1,107 min.



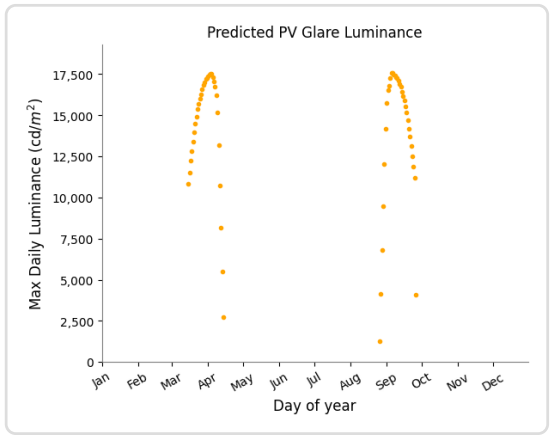








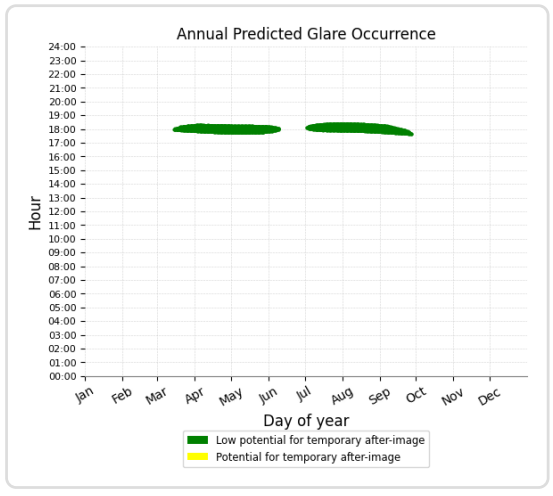


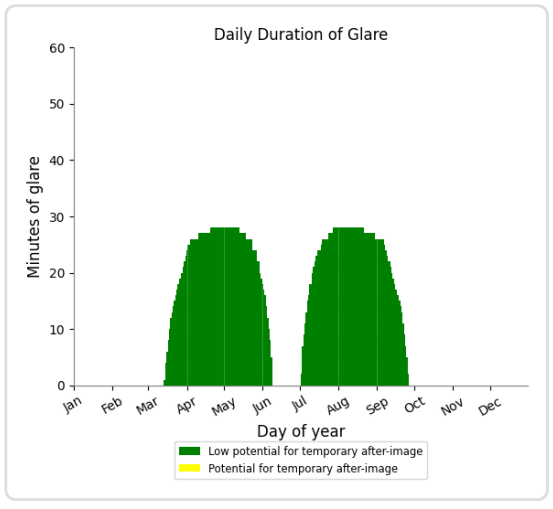


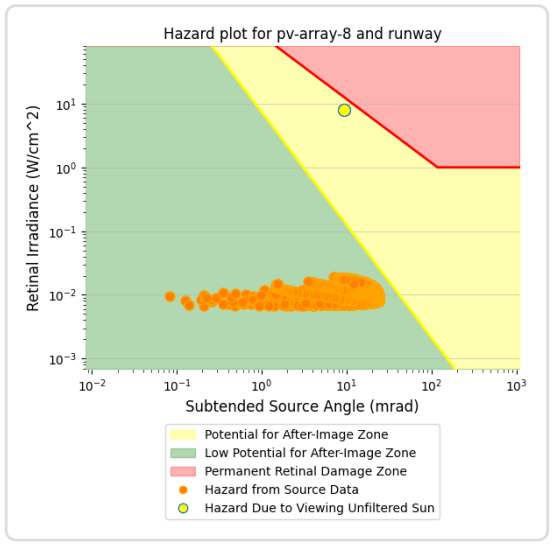
PV array 8 and FP: Runway 32 SE

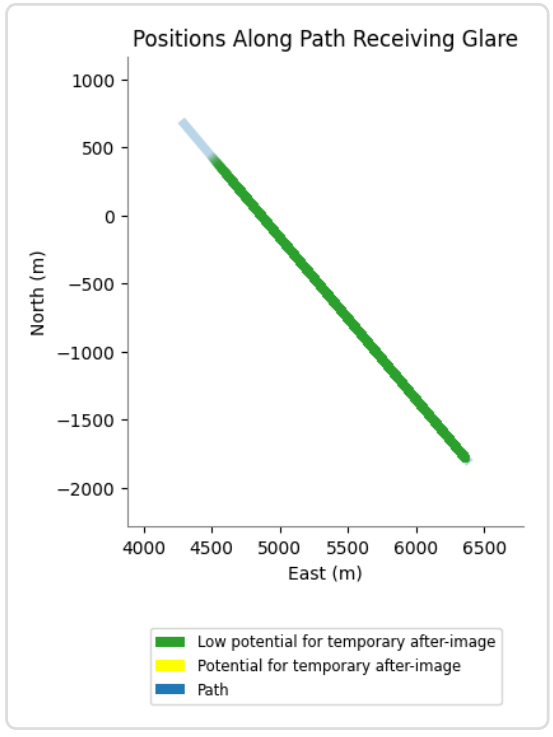
Yellow glare: none

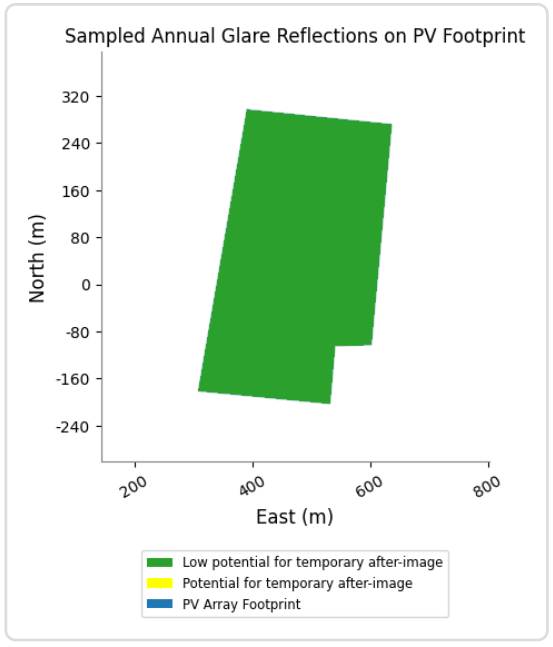
Green glare: 3,947 min.

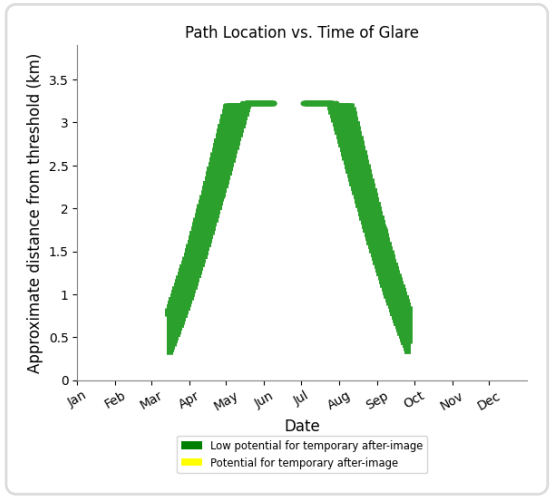


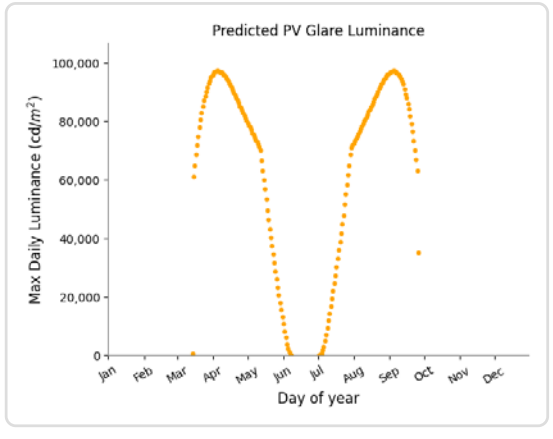












PV array 8 and FP: Darlton 2

No glare found

PV array 8 and FP: Headon 23

No glare found

PV array 8 and FP: Headon R14

No glare found

PV array 8 and FP: Runway 03 S

No glare found

PV array 8 and FP: Runway 14 NW

No glare found

PV array 8 and FP: Runway 21 N

No glare found

PV array 8 and FP: Three Counties R06

No glare found

PV array 8 and FP: Three Counties R19

No glare found

PV array 8 and FP: Three Counties R24

No glare found

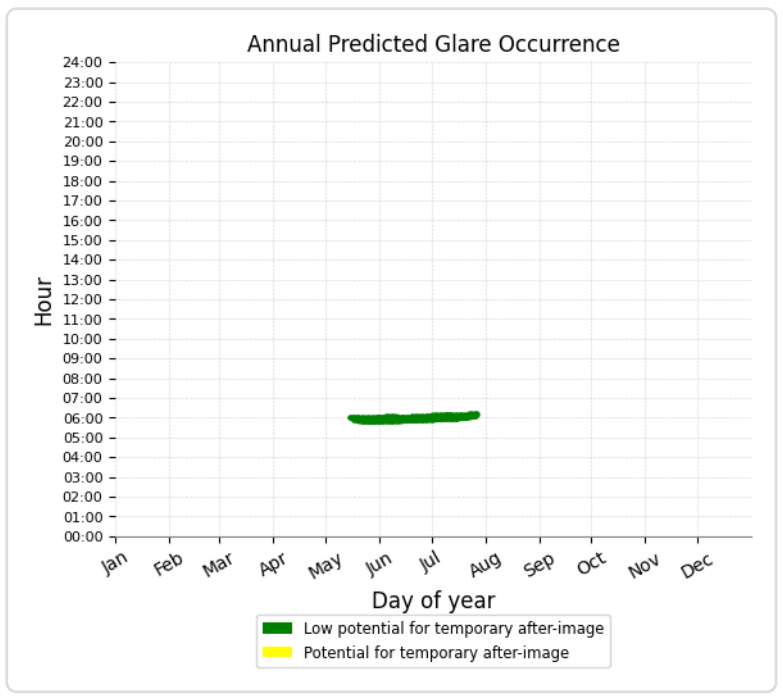
PV array 8 and FP: Three Counties R36

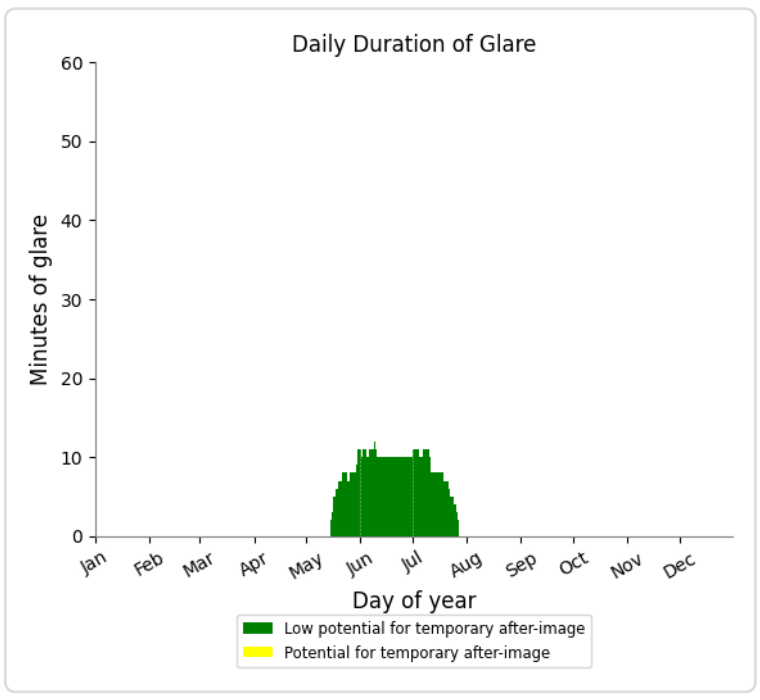
No glare found

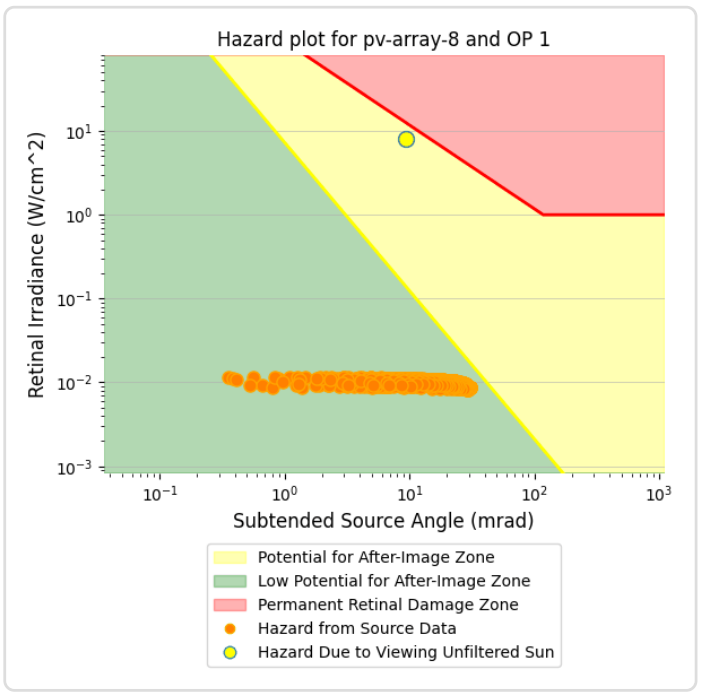
PV array 8 and OP 1

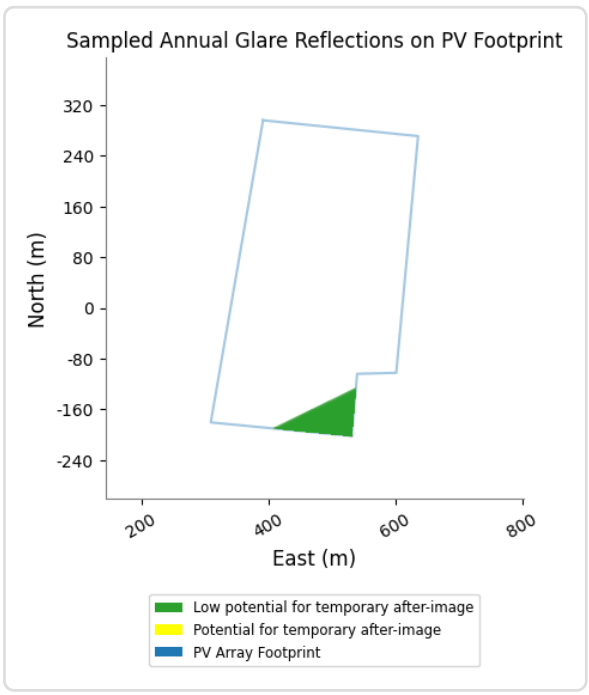
Yellow glare: none

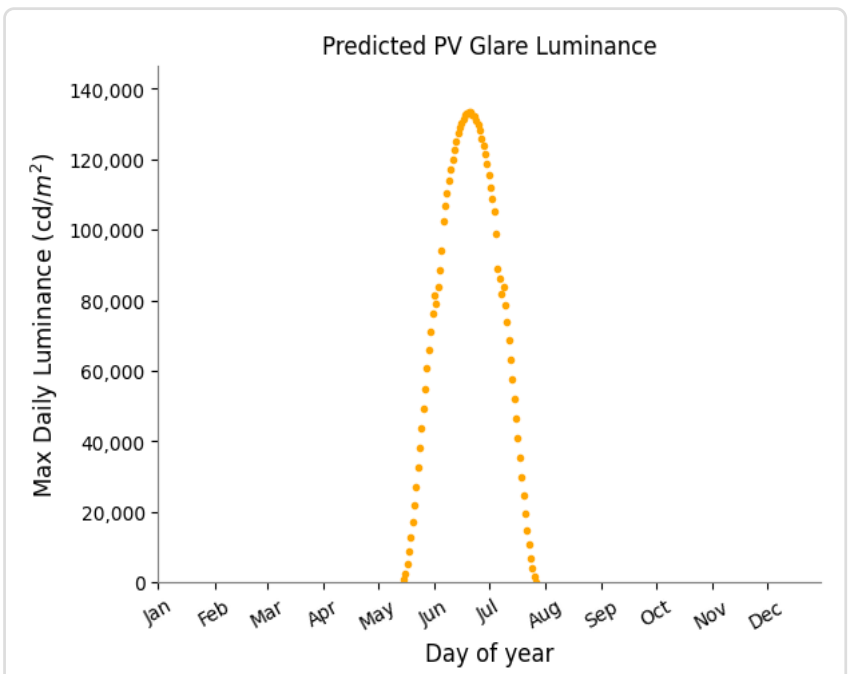
Green glare: 648 min.







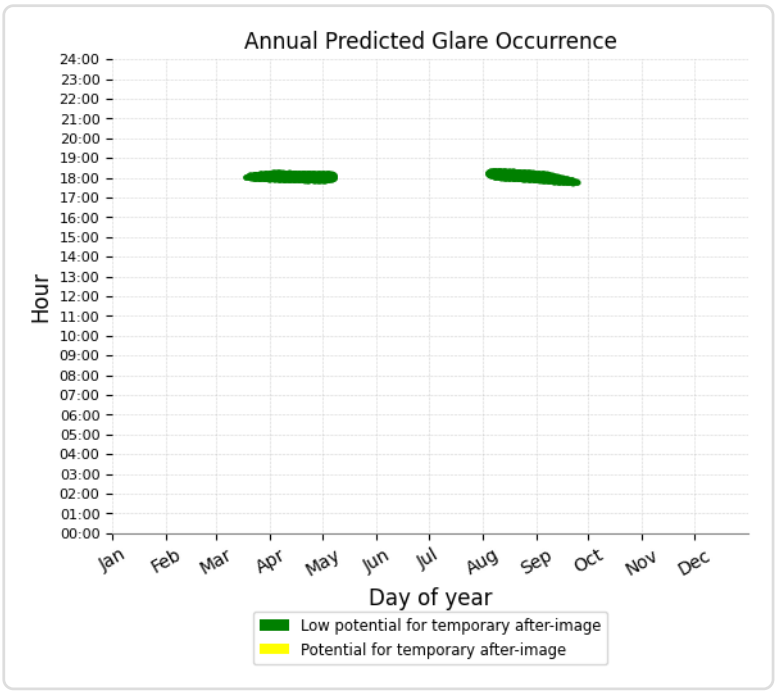


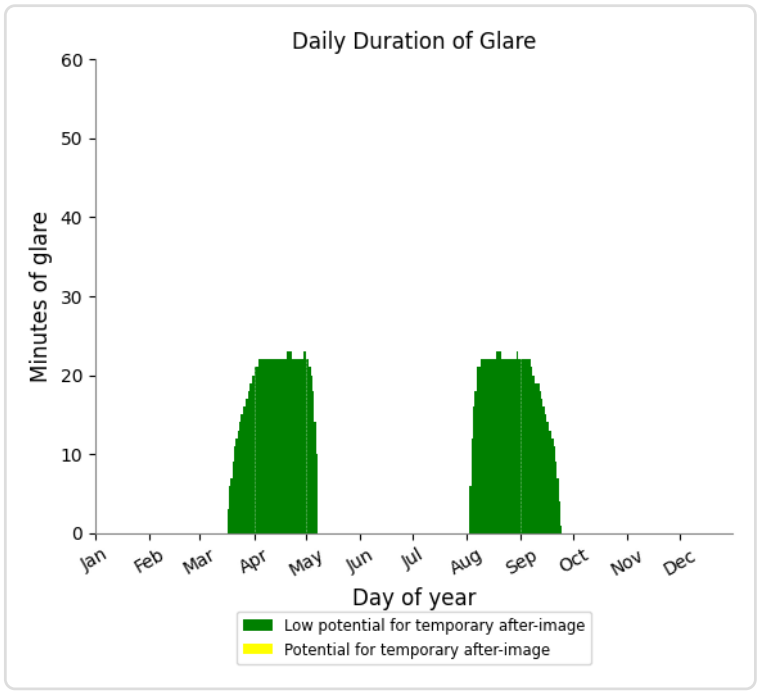


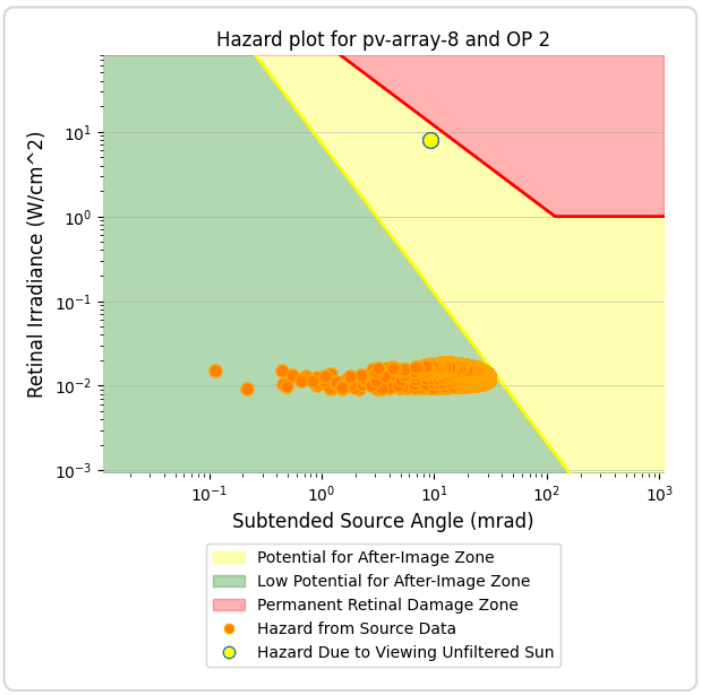
PV array 8 and OP 2

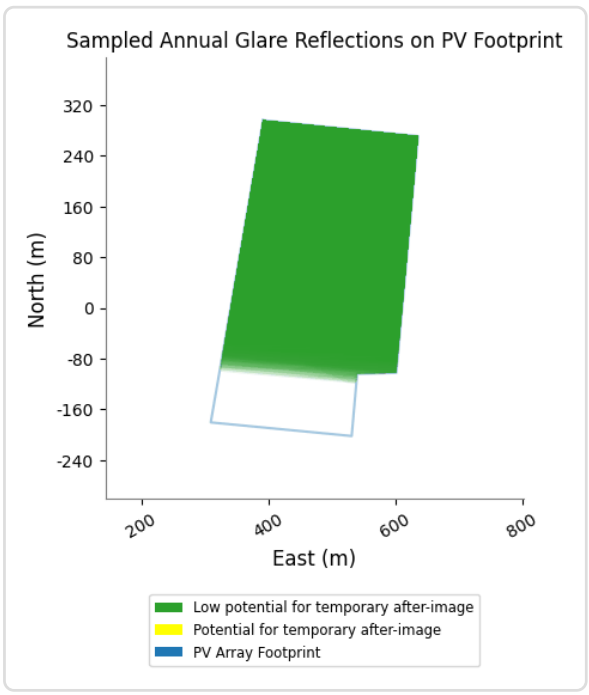
Yellow glare: none

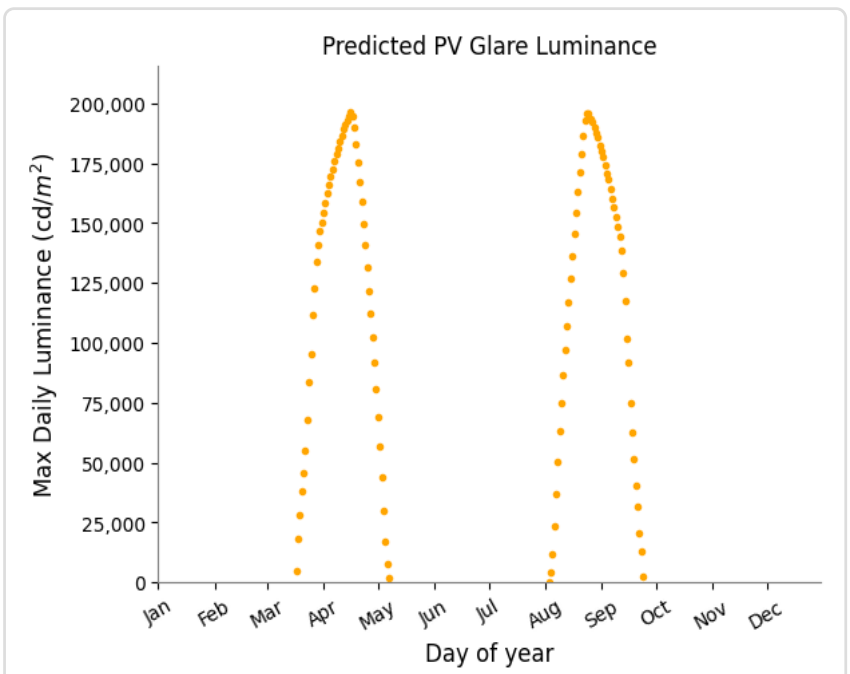
Green glare: 1,967 min.







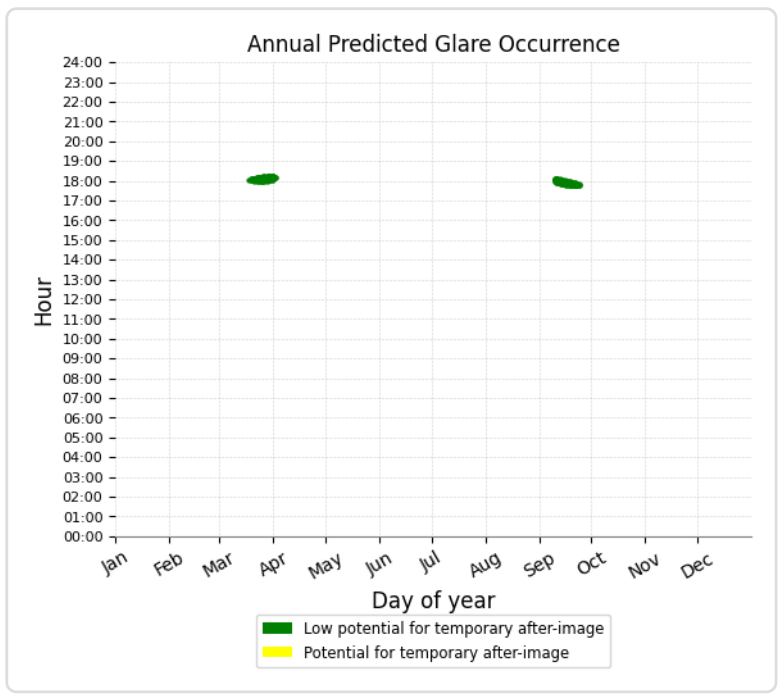


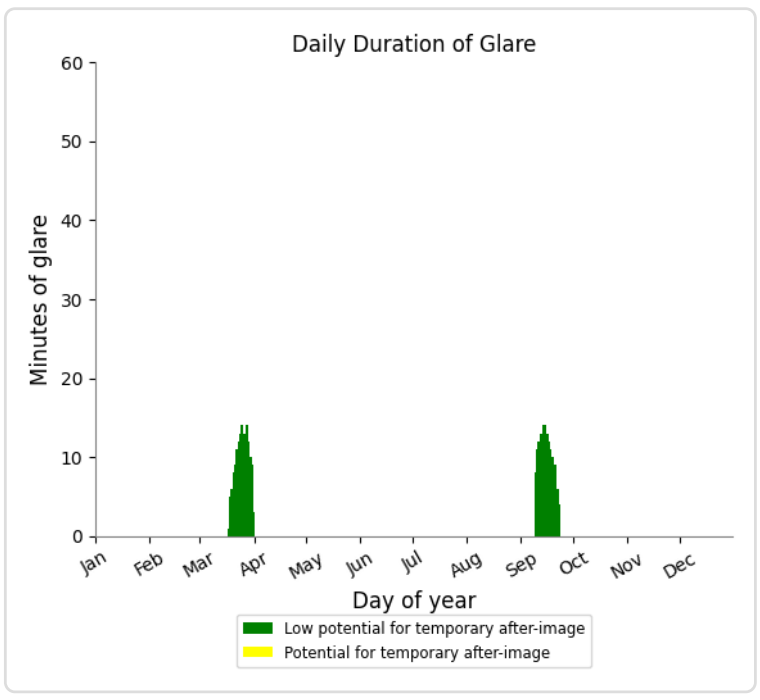


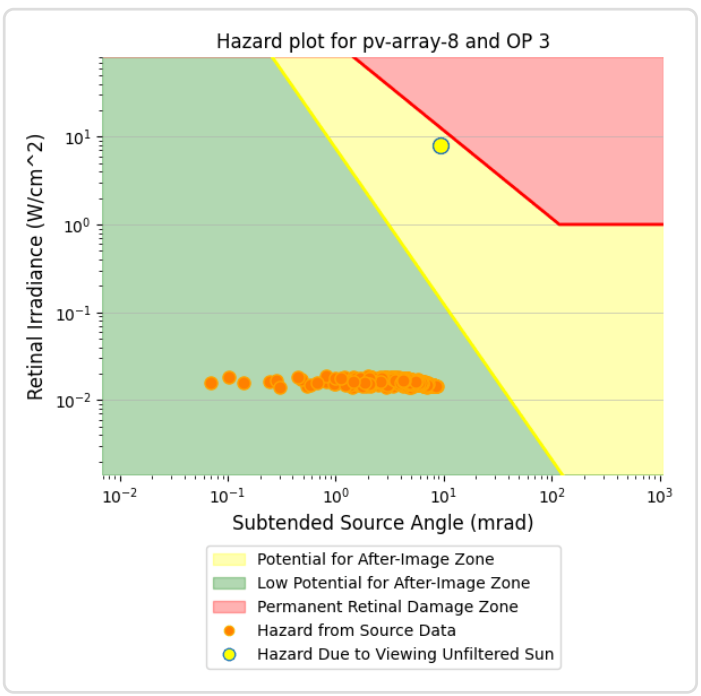
PV array 8 and OP 3

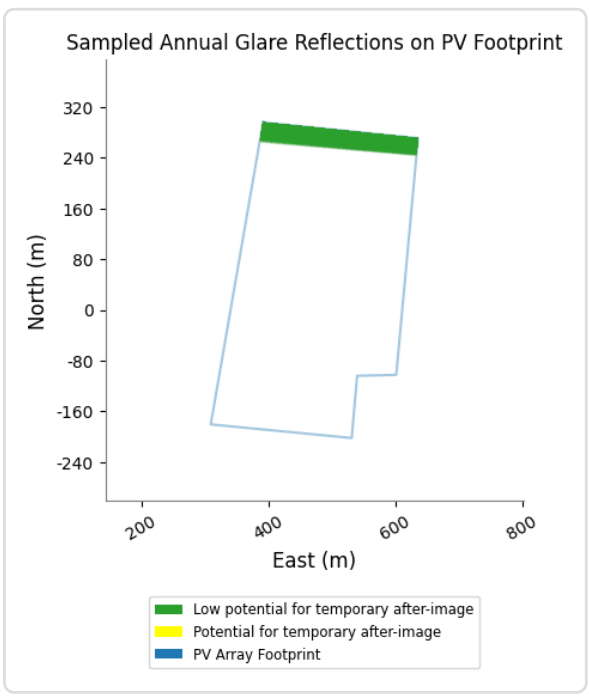
Yellow glare: none

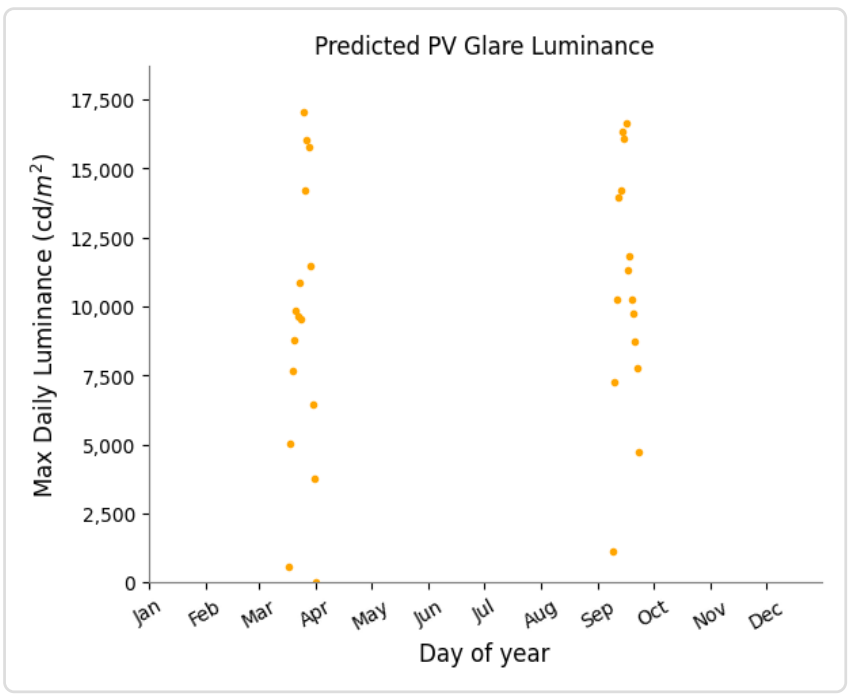
Green glare: 312 min.











Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **BR10356 Normanton Larches Solar**
Site configuration: **Aviation 1000ft 180 and 205 OPs 1-20**

Created 08 Mar, 2024
Updated 21 Mar, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 113978.19448

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	7,988	133.1	0	0.0	-	195,337
PV array 2	25.0	180.0	10,142	169.0	0	0.0	-	126,276
PV array 3	25.0	180.0	7,582	126.4	0	0.0	-	183,924
PV array 4	25.0	180.0	7,132	118.9	0	0.0	-	185,561
PV array 5	25.0	180.0	8,673	144.6	0	0.0	-	205,269
PV array 6	25.0	180.0	9,953	165.9	0	0.0	-	226,980
PV array 7	25.0	205.0	10,536	175.6	0	0.0	-	207,785
PV array 8	25.0	180.0	19,467	324.4	0	0.0	-	189,760

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	810	13.5	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	2,877	48.0	0	0.0
OP 8	10,161	169.3	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	24,333	405.6	0	0.0
OP 15	21,499	358.3	0	0.0
OP 16	17,384	289.7	0	0.0
OP 17	3,849	64.2	0	0.0
OP 18	560	9.3	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270453	-1.023592	44.16	3.58	47.74
2	53.270382	-1.026510	38.69	3.58	42.27
3	53.270337	-1.028001	42.19	3.58	45.77
4	53.268374	-1.027819	47.55	3.58	51.13
5	53.267835	-1.027411	47.97	3.58	51.55
6	53.268194	-1.025823	42.76	3.58	46.34
7	53.268605	-1.023538	48.05	3.58	51.63

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272403	-1.022893	44.98	3.58	48.56
2	53.271659	-1.020468	49.10	3.58	52.68
3	53.271146	-1.020629	49.06	3.58	52.64
4	53.270568	-1.020768	49.76	3.58	53.34
5	53.269978	-1.022399	48.94	3.58	52.52
6	53.269490	-1.023494	46.53	3.58	50.11
7	53.270600	-1.023526	44.05	3.58	47.63
8	53.270658	-1.022721	44.52	3.58	48.10

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267270	-1.027453	49.52	3.58	53.10
2	53.267742	-1.026122	44.46	3.58	48.04
3	53.268066	-1.026004	43.25	3.58	46.83
4	53.268361	-1.024577	44.74	3.58	48.32
5	53.268515	-1.023451	48.43	3.58	52.01
6	53.263789	-1.021096	44.95	3.58	48.53
7	53.263606	-1.026144	50.81	3.58	54.39

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267296	-1.022818	47.72	3.58	51.30
2	53.267707	-1.018998	49.22	3.58	52.80
3	53.264120	-1.017373	43.17	3.58	46.75
4	53.264126	-1.017861	43.81	3.58	47.39
5	53.263885	-1.017893	45.60	3.58	49.18
6	53.263795	-1.021085	44.91	3.58	48.49

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.268300	-1.019106	51.65	3.58	55.23
2	53.268197	-1.015587	47.94	3.58	51.52
3	53.267411	-1.014932	45.87	3.58	49.45
4	53.263776	-1.015093	42.99	3.58	46.57
5	53.263904	-1.017175	44.48	3.58	48.06
6	53.266359	-1.018355	43.98	3.58	47.56

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267286	-1.014793	45.26	3.58	48.84
2	53.263975	-1.015072	41.69	3.58	45.27
3	53.265181	-1.012926	37.52	3.58	41.10
4	53.265759	-1.012132	35.68	3.58	39.26
5	53.266067	-1.011724	35.43	3.58	39.01
6	53.266349	-1.011338	34.83	3.58	38.41
7	53.266619	-1.009836	34.68	3.58	38.26
8	53.267825	-1.010716	42.25	3.58	45.83

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 205.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272933	-1.013997	31.09	3.58	34.67
2	53.269546	-1.014764	42.94	3.58	46.52
3	53.269645	-1.012452	41.27	3.58	44.85
4	53.270081	-1.011636	34.85	3.58	38.43
5	53.270733	-1.010606	29.68	3.58	33.26
6	53.271246	-1.010247	28.40	3.58	31.98
7	53.271987	-1.010064	28.01	3.58	31.59
8	53.272488	-1.010134	28.03	3.58	31.61
9	53.273142	-1.010767	28.00	3.58	31.58
10	53.273261	-1.012672	29.00	3.58	32.58
11	53.272872	-1.012827	29.79	3.58	33.37

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273116	-1.017655	40.05	3.58	43.63
2	53.268882	-1.018996	51.65	3.58	55.23
3	53.268631	-1.015611	47.72	3.58	51.30
4	53.269518	-1.015426	43.79	3.58	47.37
4	53.269518	-1.015426	43.79	3.58	47.37
5	53.269551	-1.014776	42.95	3.58	46.53
5	53.269551	-1.014776	42.95	3.58	46.53
6	53.272933	-1.014007	31.10	3.58	34.68

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.274658	-0.956085	26.85	304.80
OP 2	2	53.280560	-0.951536	27.44	304.80
OP 3	3	53.287000	-0.946429	23.00	304.80
OP 4	4	53.298511	-0.952811	33.00	304.80
OP 5	5	53.299640	-0.964398	28.38	304.80
OP 6	6	53.287225	-0.974011	23.92	304.80
OP 7	7	53.272753	-0.986371	37.57	304.80
OP 8	8	53.265874	-0.967488	33.88	304.80
OP 9	9	53.299127	-0.939421	18.00	304.80
OP 10	10	53.306154	-0.950150	29.17	304.80
OP 11	11	53.308462	-0.963540	37.62	304.80
OP 12	12	53.296511	-0.979762	23.67	304.80
OP 13	13	53.283581	-0.992722	40.63	304.80
OP 14	14	53.268595	-0.997529	38.41	304.80
OP 15	15	53.264437	-0.984998	29.15	304.80
OP 16	16	53.260330	-0.969119	37.98	304.80
OP 17	17	53.269570	-0.934272	22.21	304.80
OP 18	18	53.275422	-0.930581	24.95	304.80
OP 19	19	53.281734	-0.928263	23.00	304.80
OP 20	20	53.283581	-0.968861	22.00	304.80

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	7,988	133.1	0	0.0	-	195,337
PV array 2	25.0	180.0	10,142	169.0	0	0.0	-	126,276
PV array 3	25.0	180.0	7,582	126.4	0	0.0	-	183,924
PV array 4	25.0	180.0	7,132	118.9	0	0.0	-	185,561
PV array 5	25.0	180.0	8,673	144.6	0	0.0	-	205,269
PV array 6	25.0	180.0	9,953	165.9	0	0.0	-	226,980
PV array 7	25.0	205.0	10,536	175.6	0	0.0	-	207,785
PV array 8	25.0	180.0	19,467	324.4	0	0.0	-	189,760

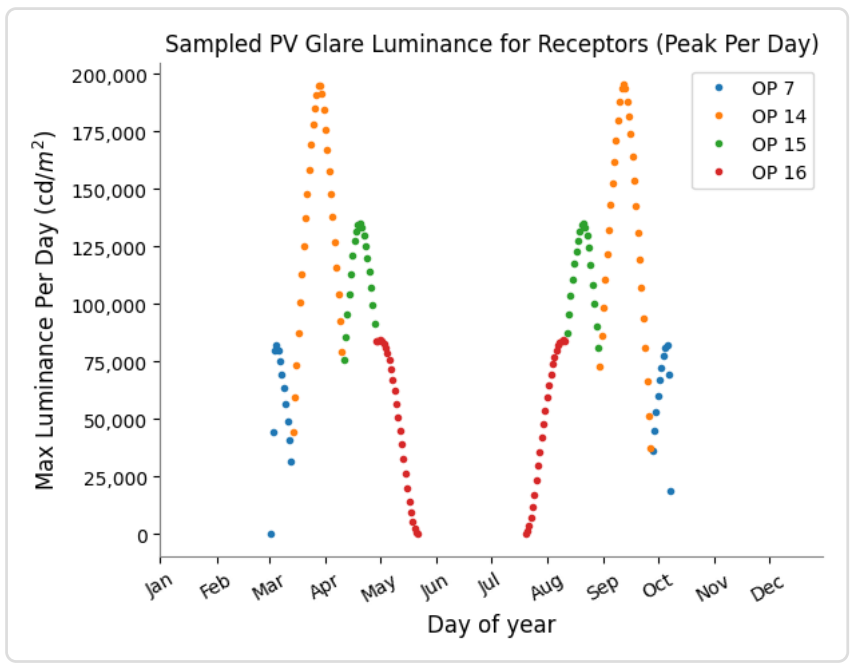
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	810	13.5	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	2,877	48.0	0	0.0
OP 8	10,161	169.3	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	24,333	405.6	0	0.0
OP 15	21,499	358.3	0	0.0
OP 16	17,384	289.7	0	0.0
OP 17	3,849	64.2	0	0.0
OP 18	560	9.3	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

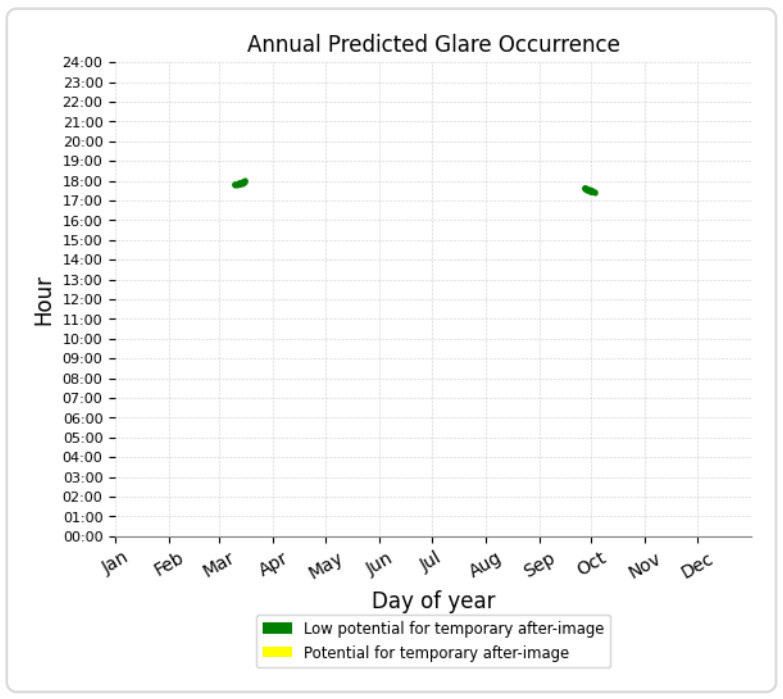
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	63	1.1	0	0.0	15,681
OP 7	349	5.8	0	0.0	82,069
OP 8	1,266	21.1	0	0.0	79,020
OP 14	2,032	33.9	0	0.0	195,337
OP 15	1,836	30.6	0	0.0	135,079
OP 16	1,756	29.3	0	0.0	84,332
OP 17	636	10.6	0	0.0	30,313
OP 18	50	0.8	0	0.0	2,538
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

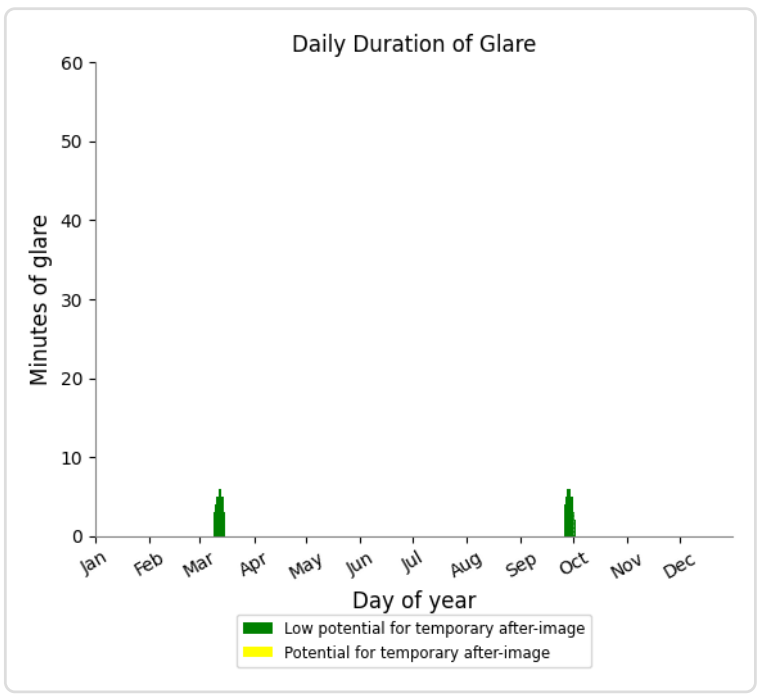


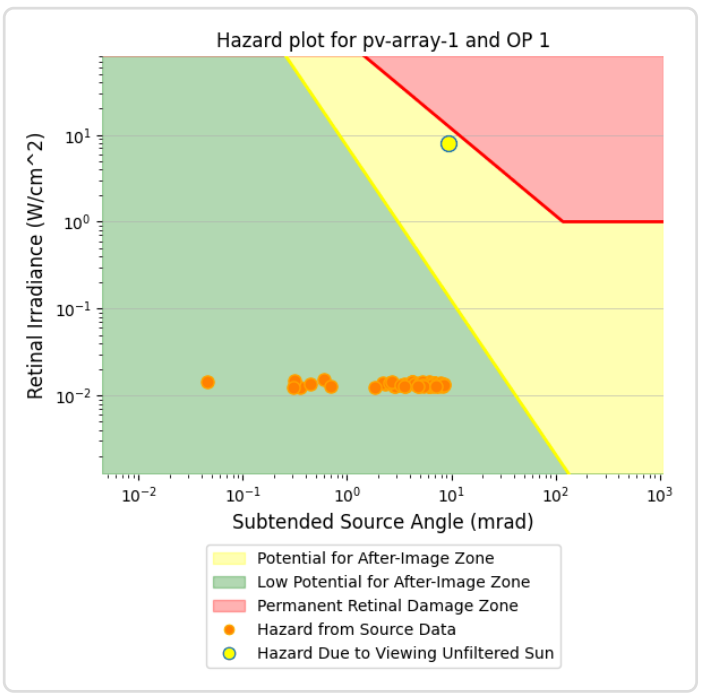
PV array 1 and OP 1

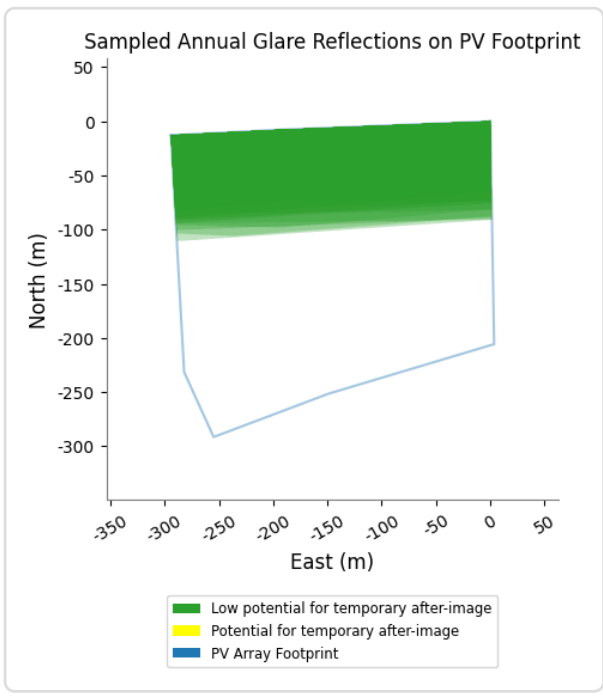
Yellow glare: none

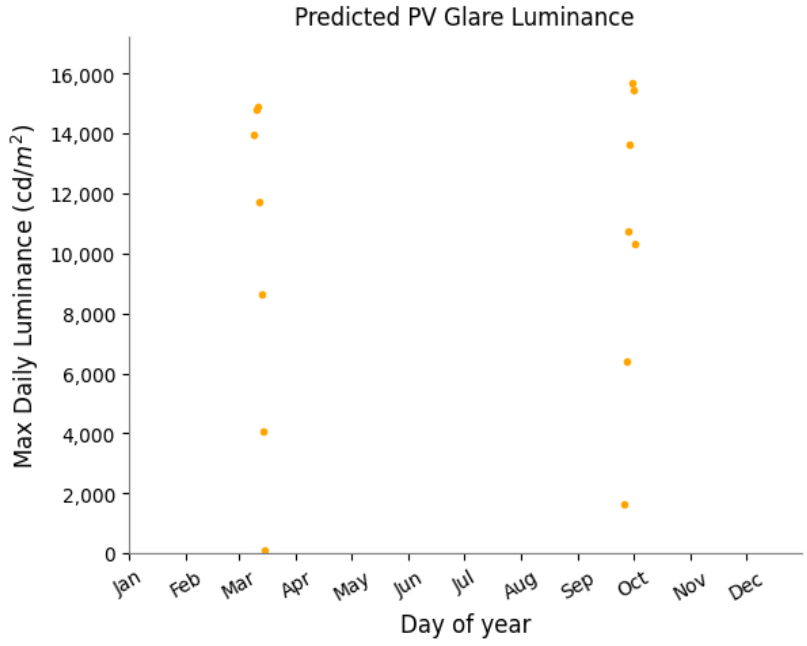
Green glare: 63 min.







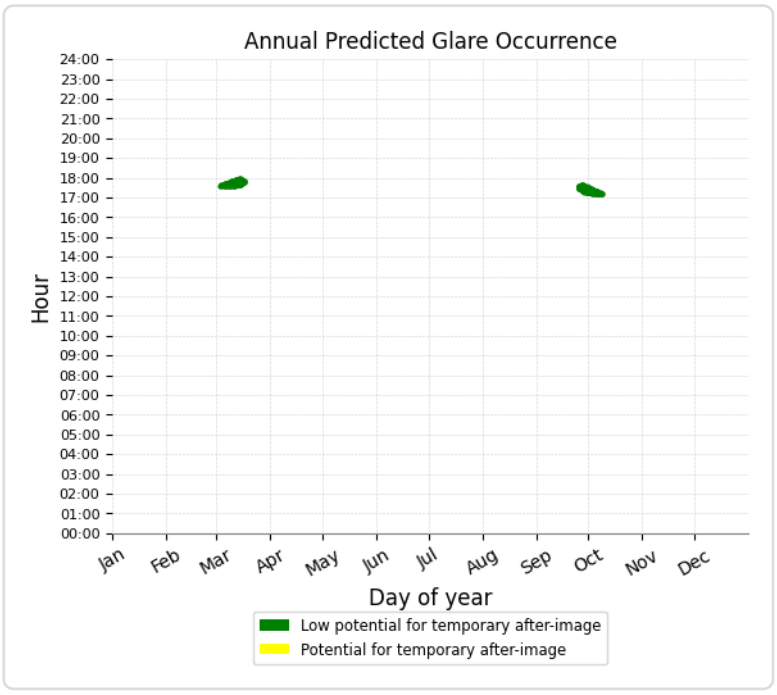


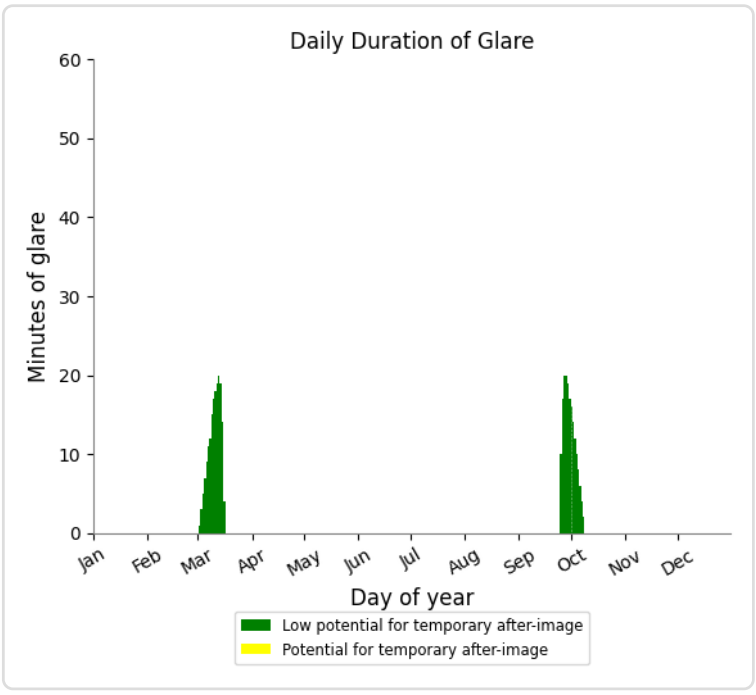


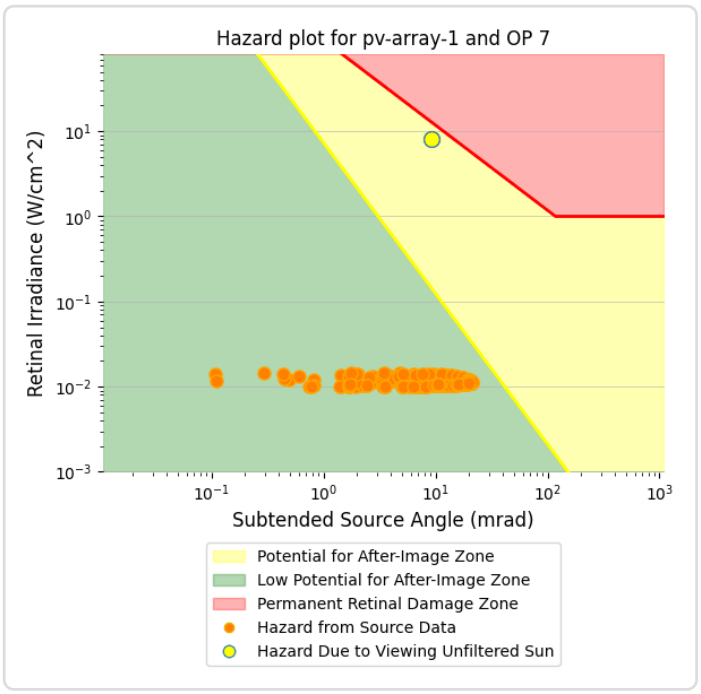
PV array 1 and OP 7

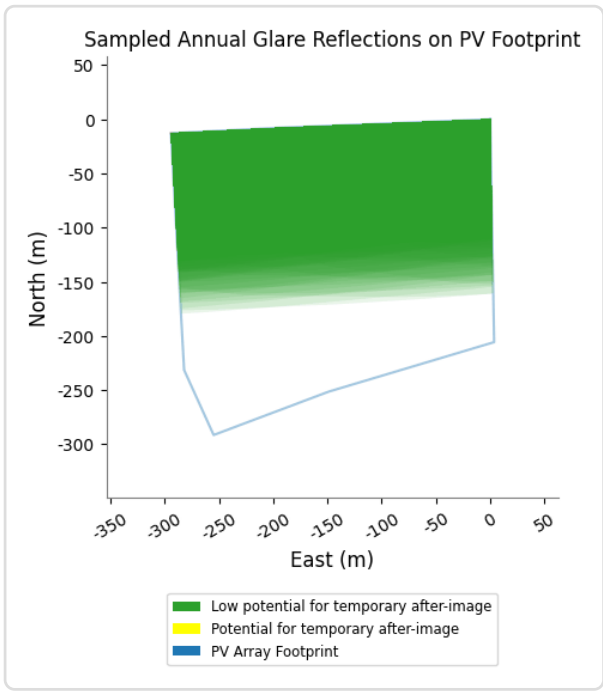
Yellow glare: none

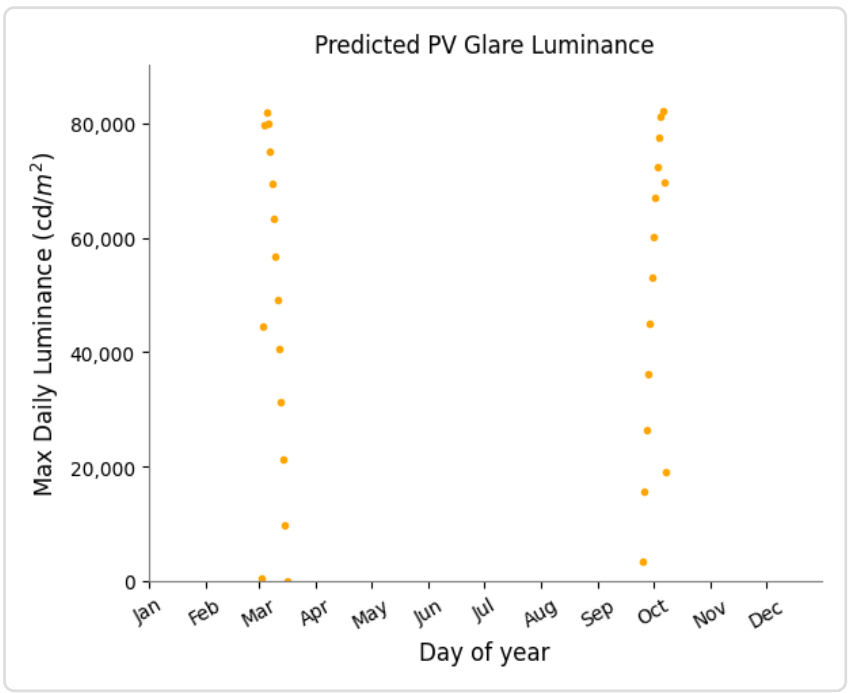
Green glare: 349 min.







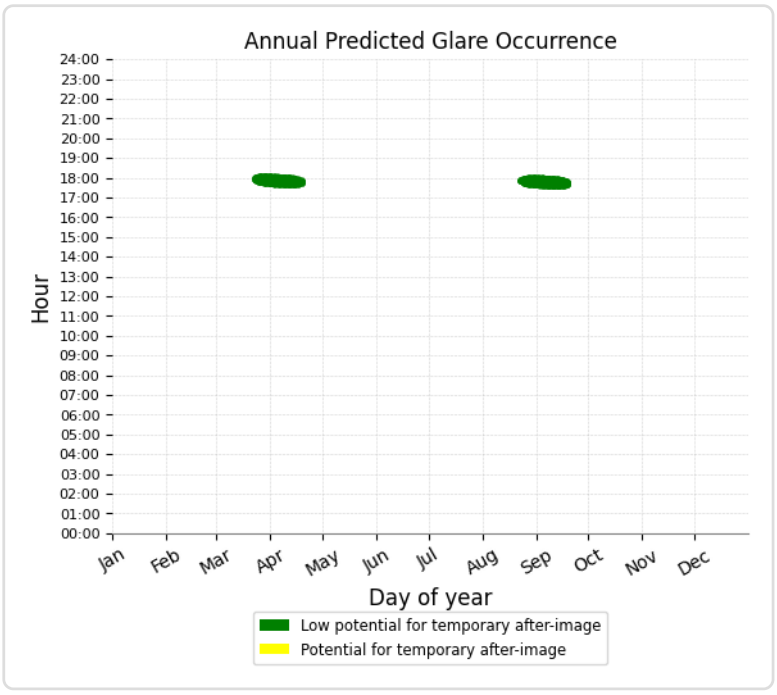


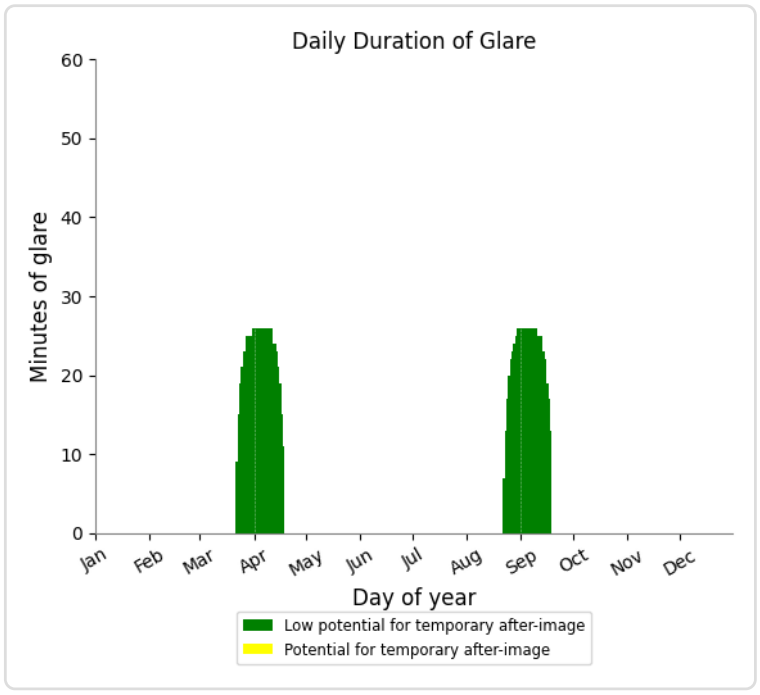


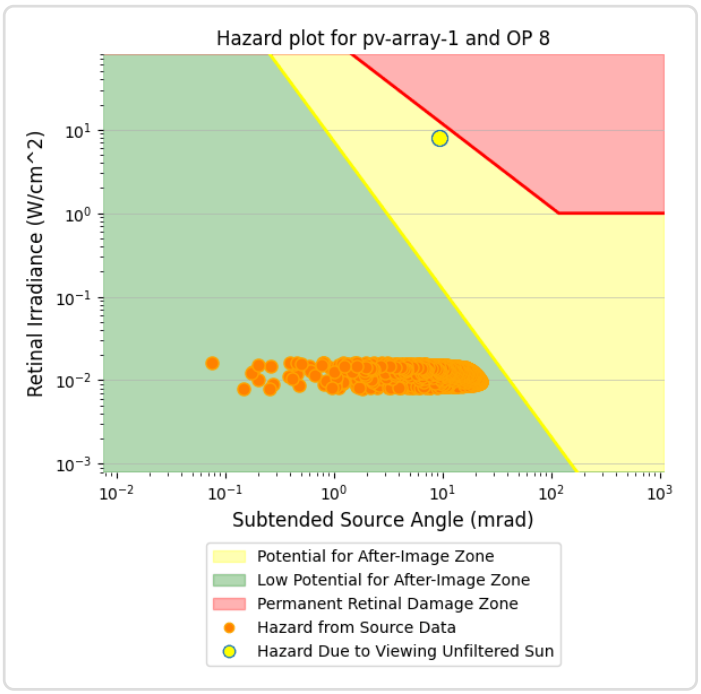
PV array 1 and OP 8

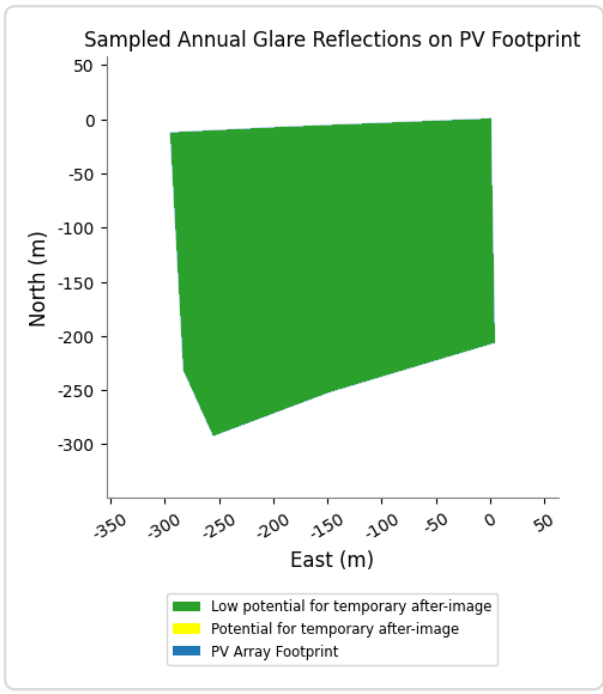
Yellow glare: none

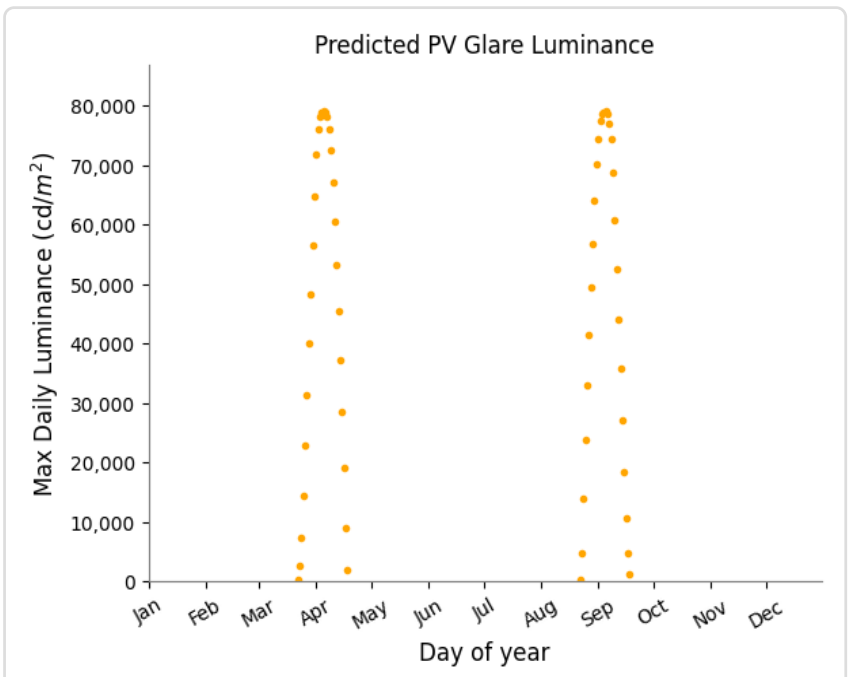
Green glare: 1,266 min.







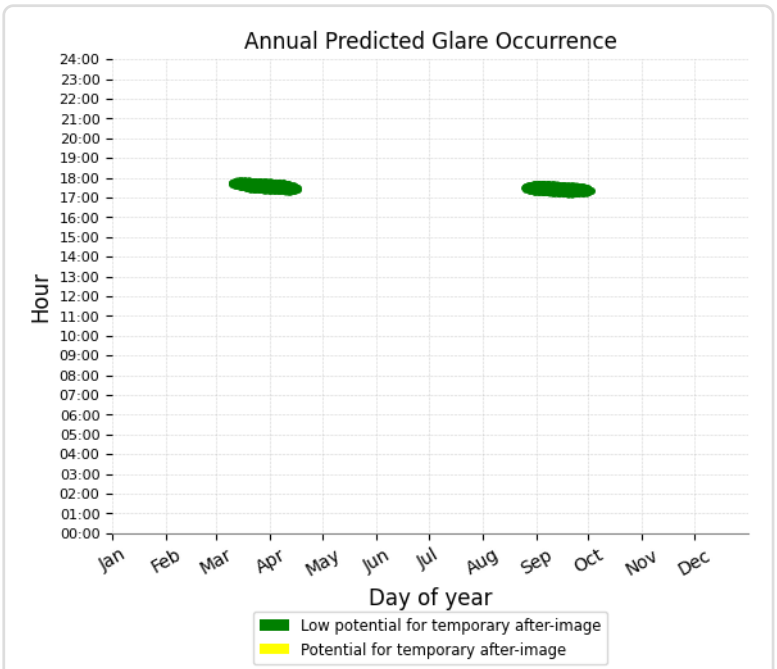


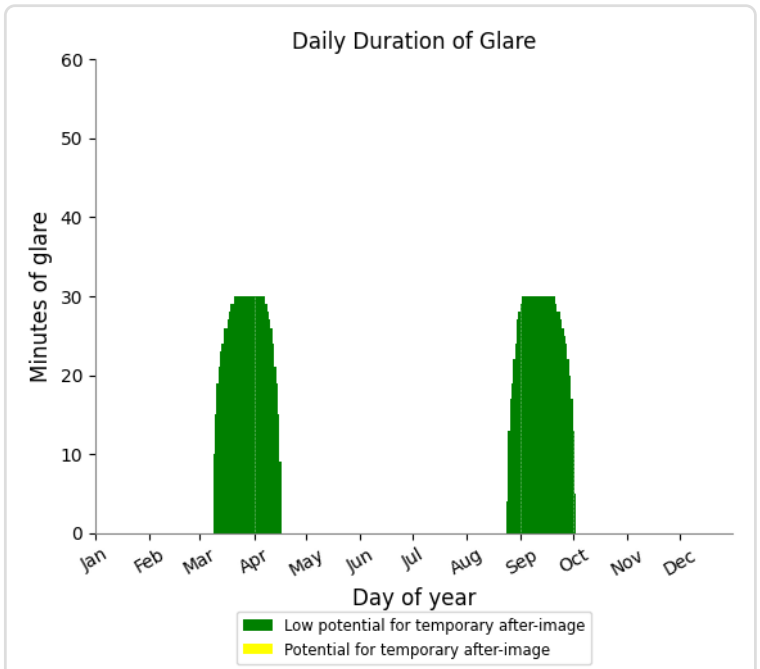


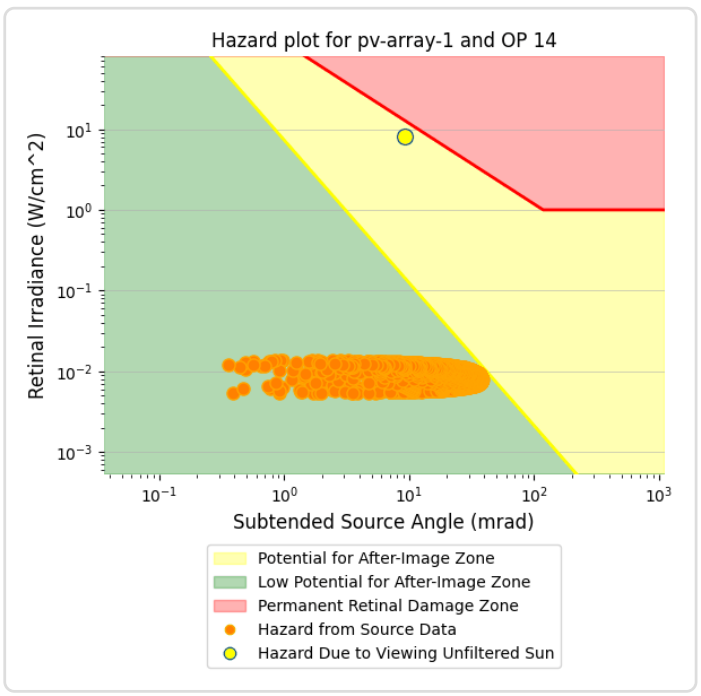
PV array 1 and OP 14

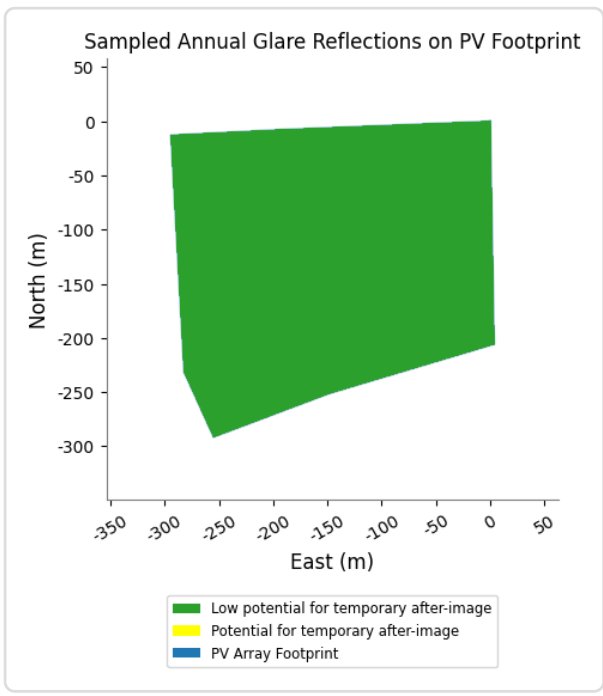
Yellow glare: none

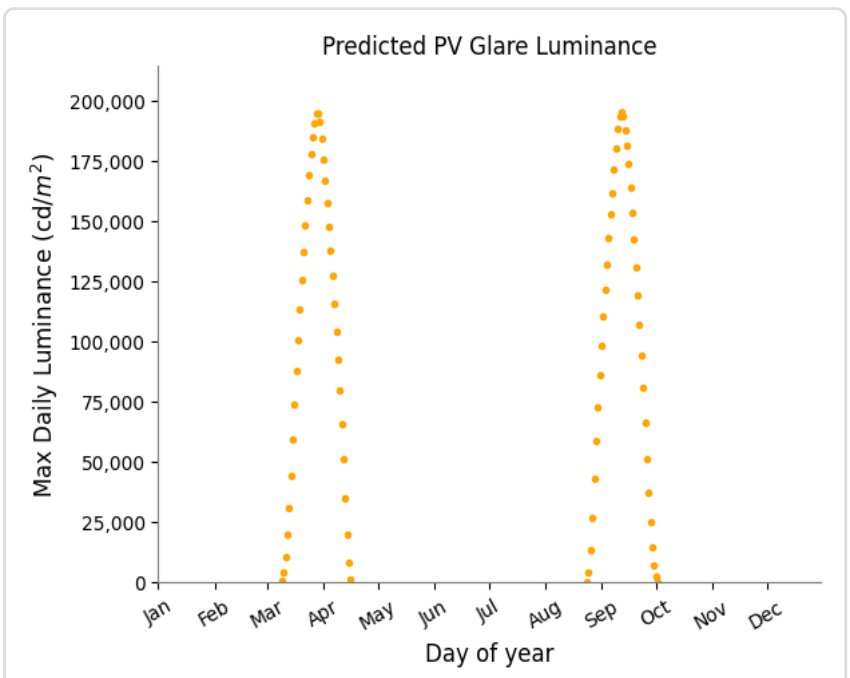
Green glare: 2,032 min.







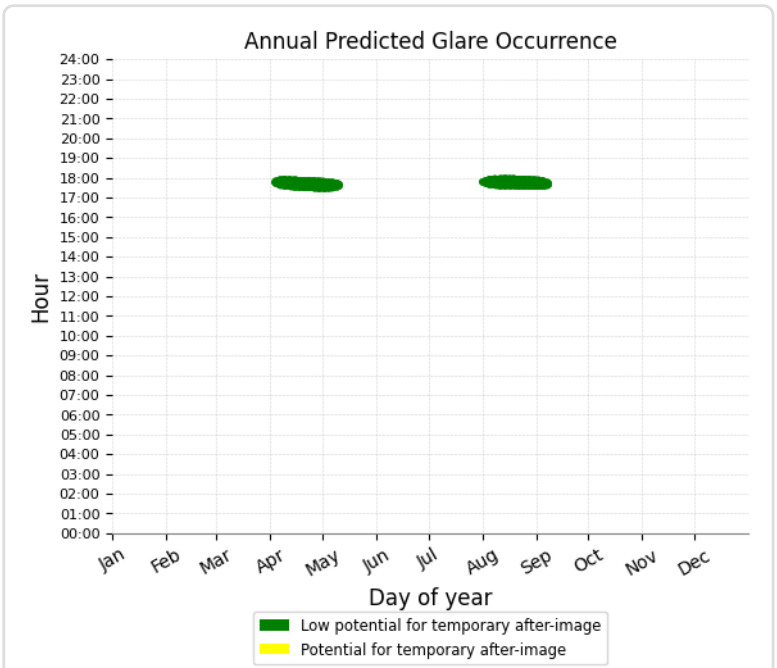


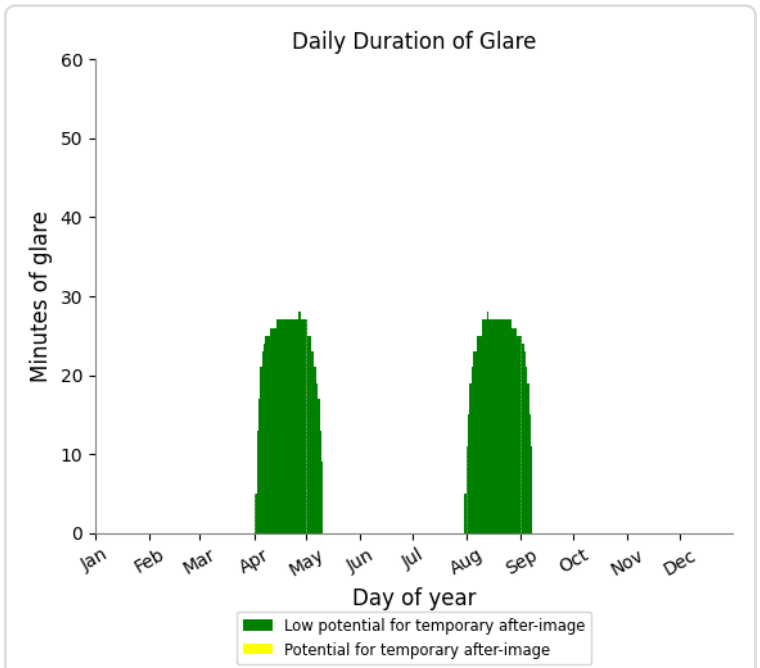


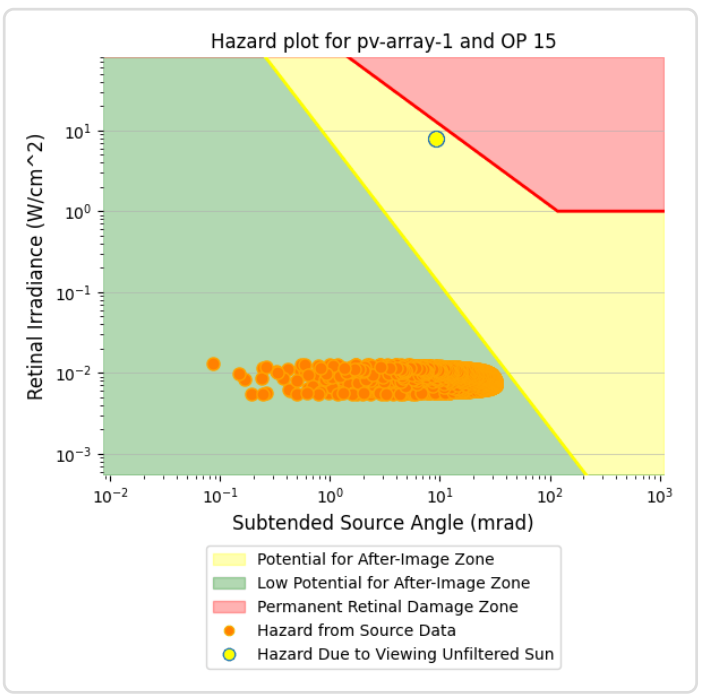
PV array 1 and OP 15

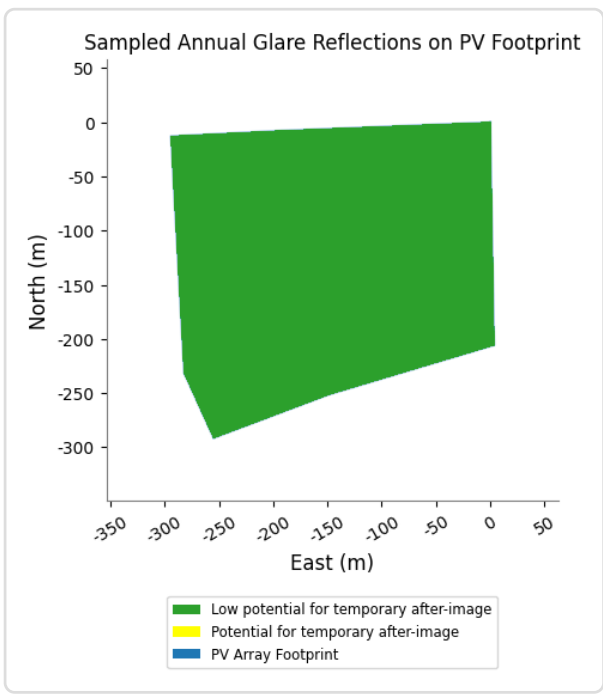
Yellow glare: none

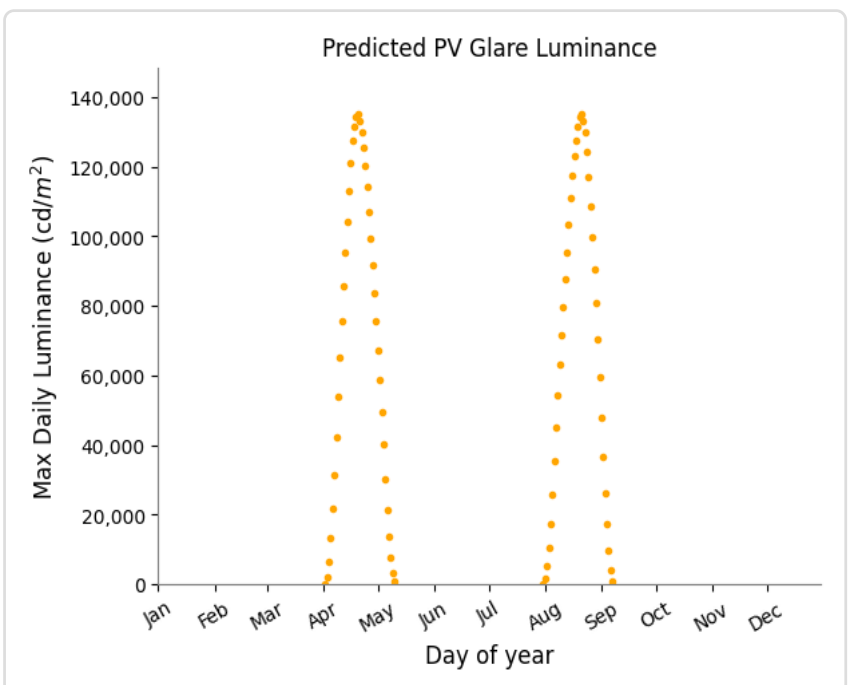
Green glare: 1,836 min.







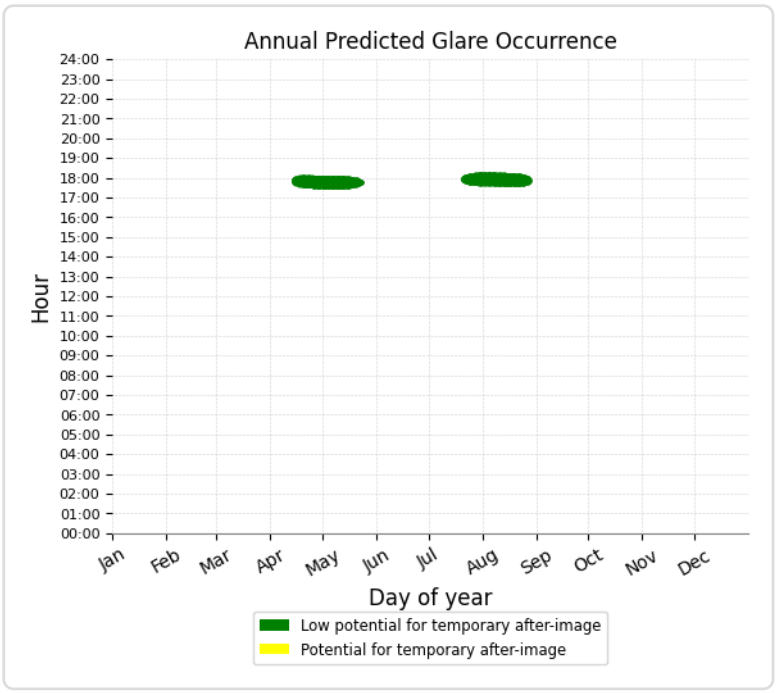


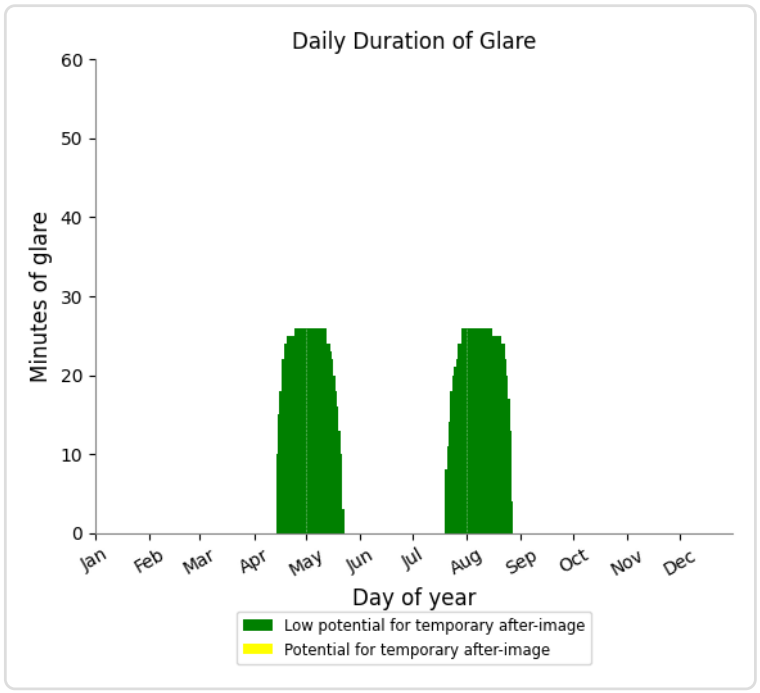


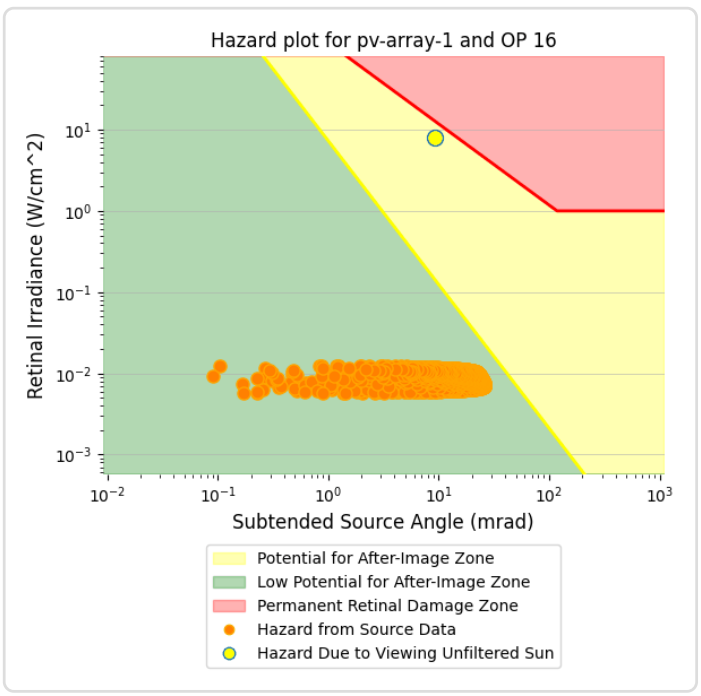
PV array 1 and OP 16

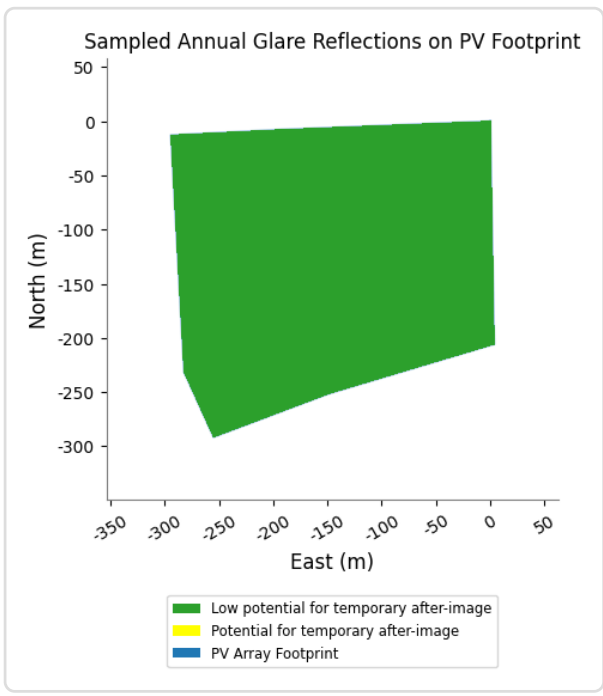
Yellow glare: none

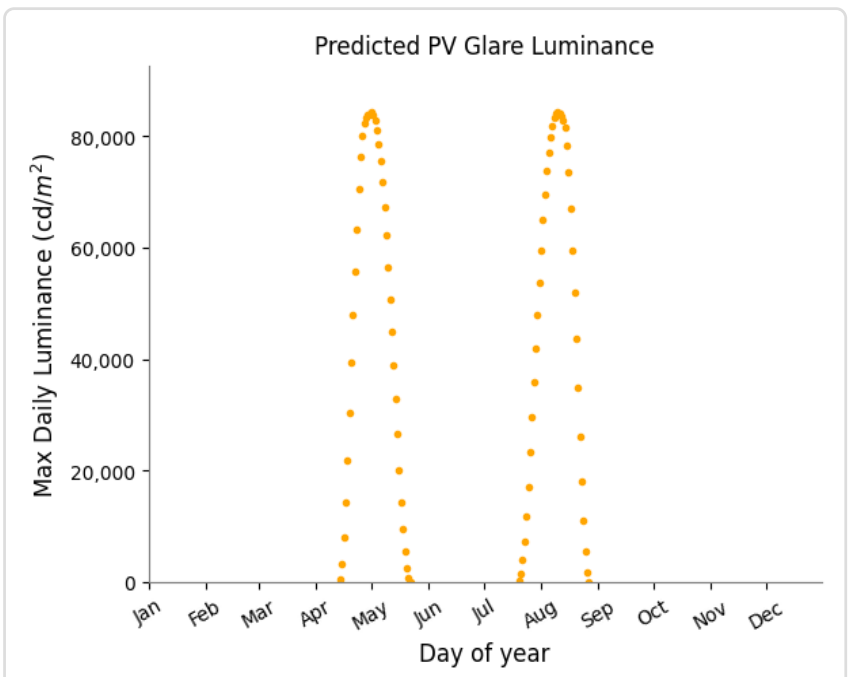
Green glare: 1,756 min.







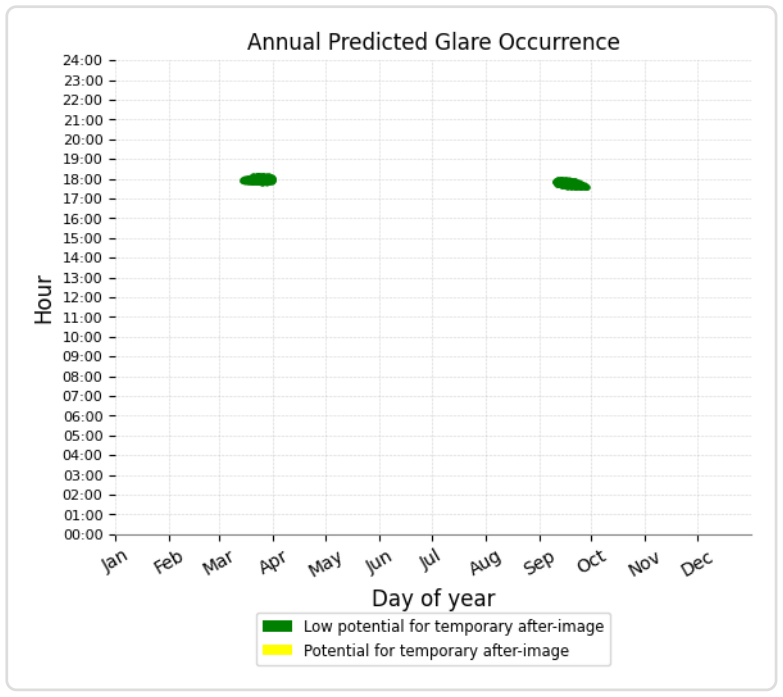


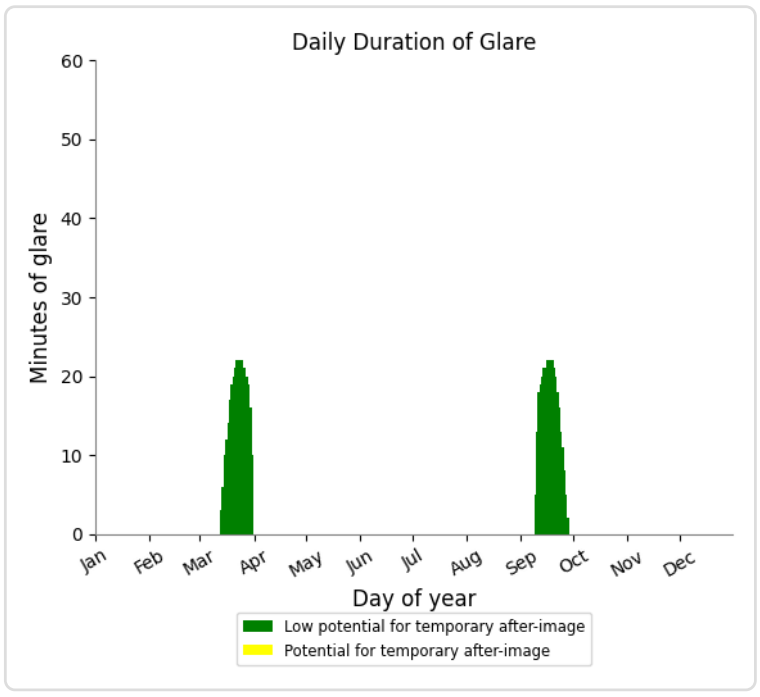


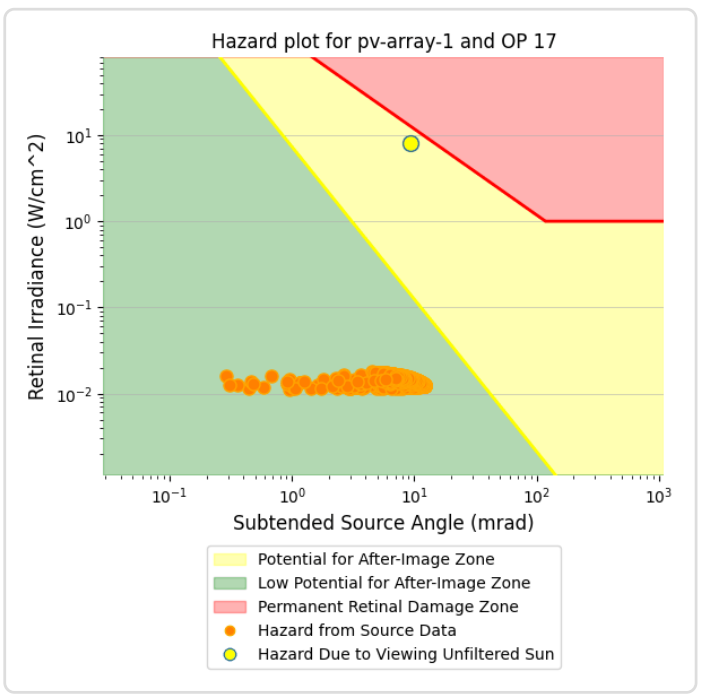
PV array 1 and OP 17

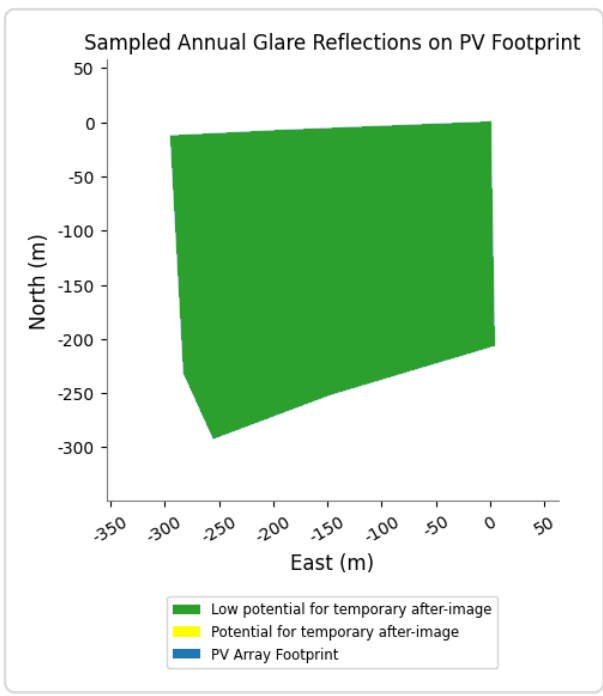
Yellow glare: none

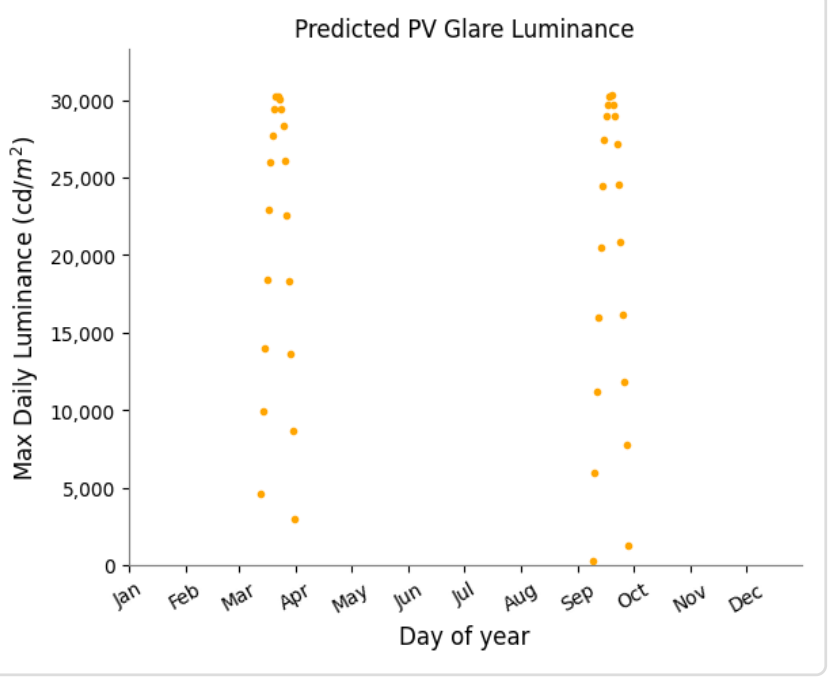
Green glare: 636 min.







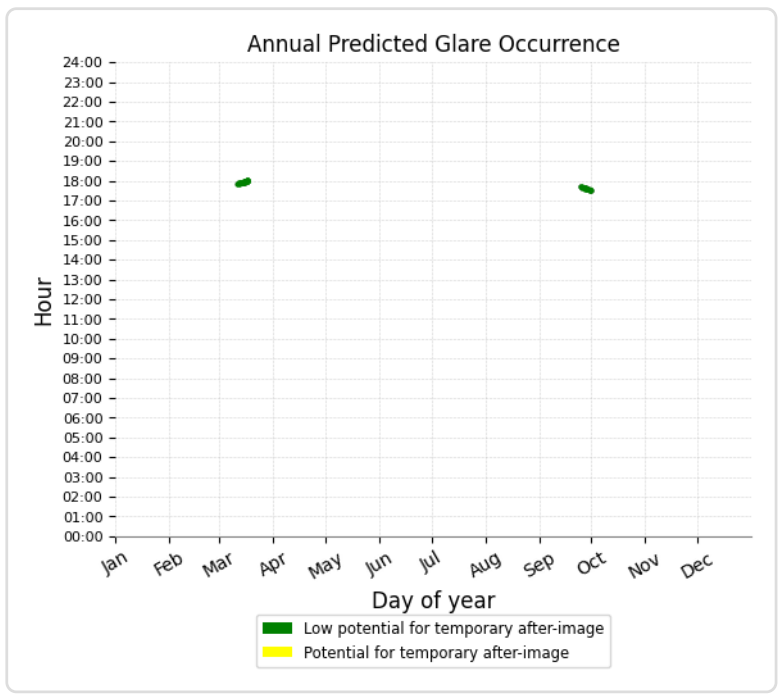


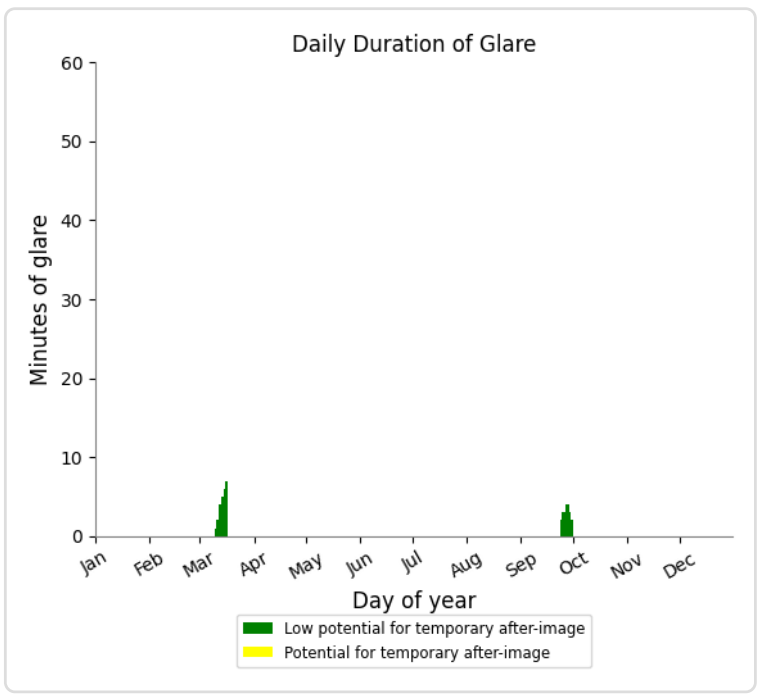


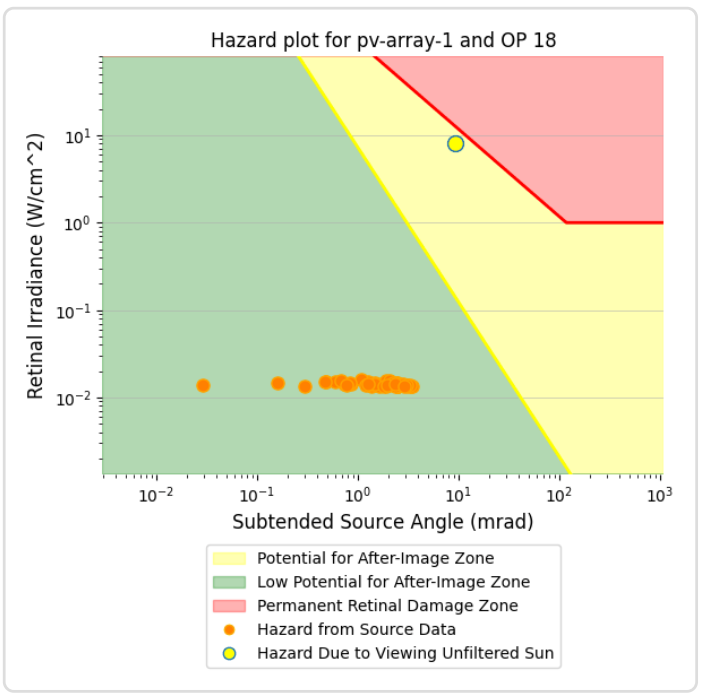
PV array 1 and OP 18

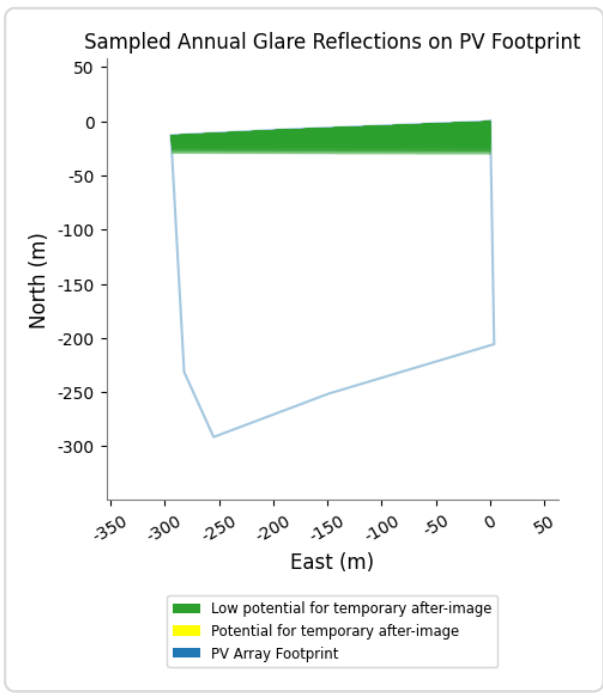
Yellow glare: none

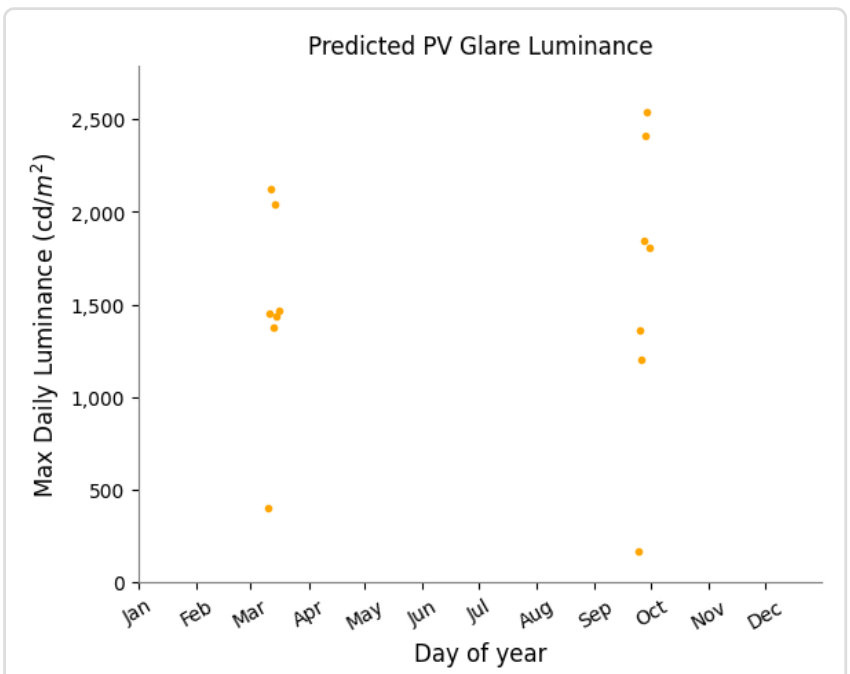
Green glare: 50 min.











PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 19

No glare found

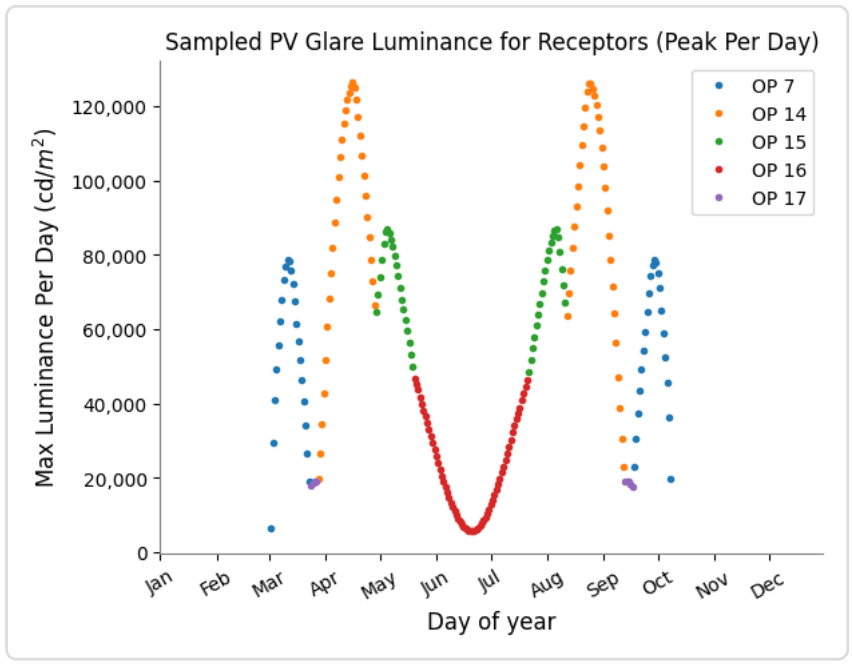
PV array 1 and OP 20

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

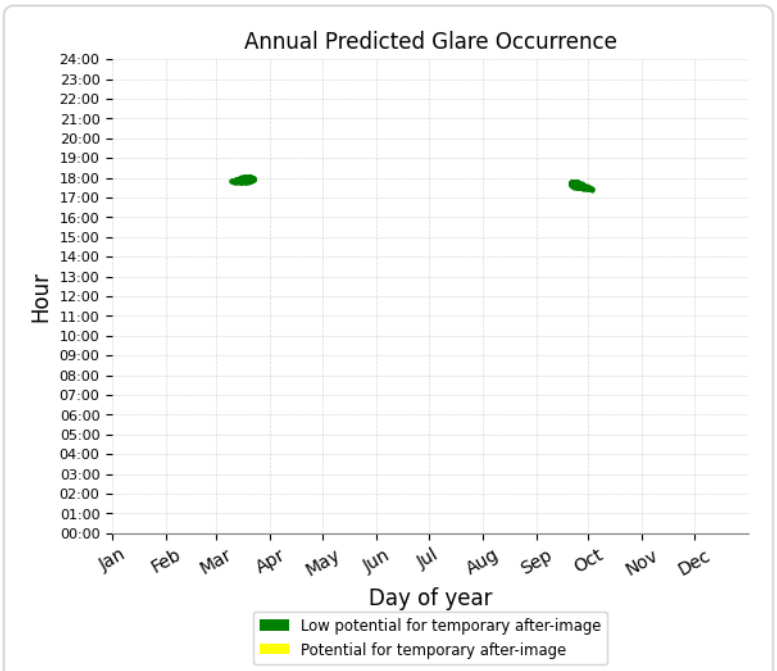
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	283	4.7	0	0.0	22,424
OP 7	954	15.9	0	0.0	78,795
OP 8	1,164	19.4	0	0.0	50,534
OP 14	2,363	39.4	0	0.0	126,276
OP 15	2,443	40.7	0	0.0	87,055
OP 16	2,245	37.4	0	0.0	52,185
OP 17	504	8.4	0	0.0	19,105
OP 18	186	3.1	0	0.0	10,654
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

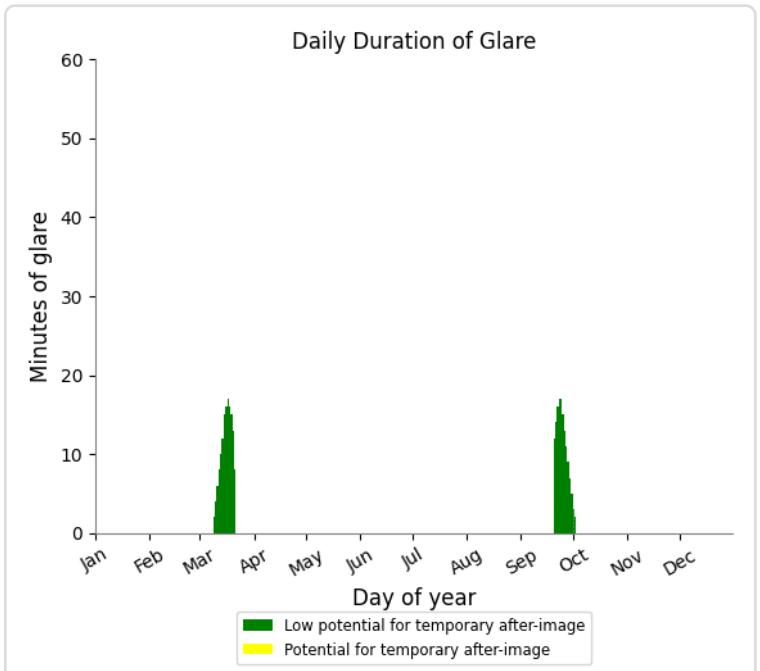


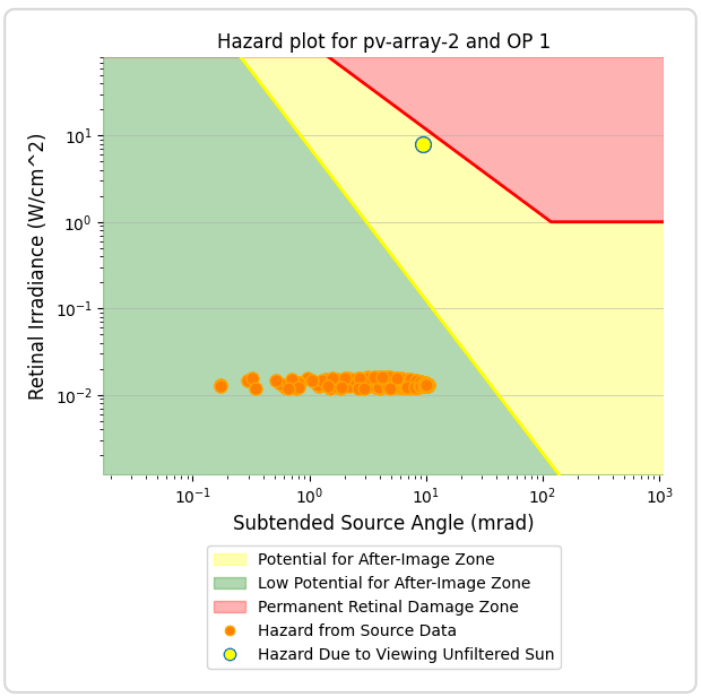
PV array 2 and OP 1

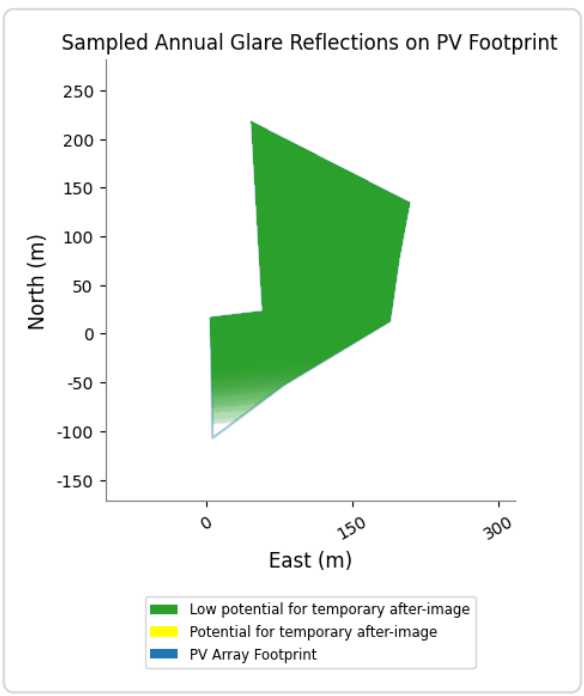
Yellow glare: none

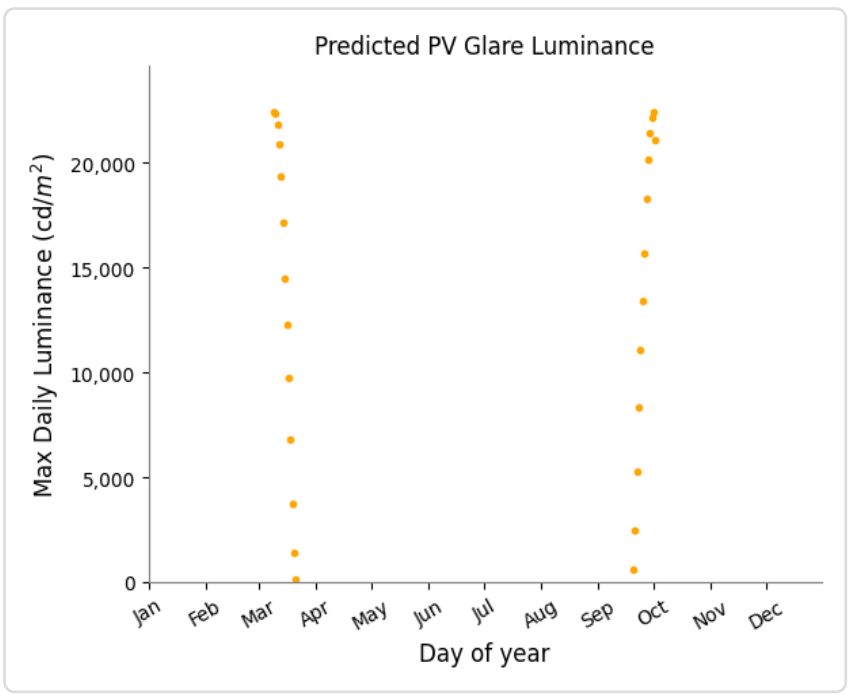
Green glare: 283 min.







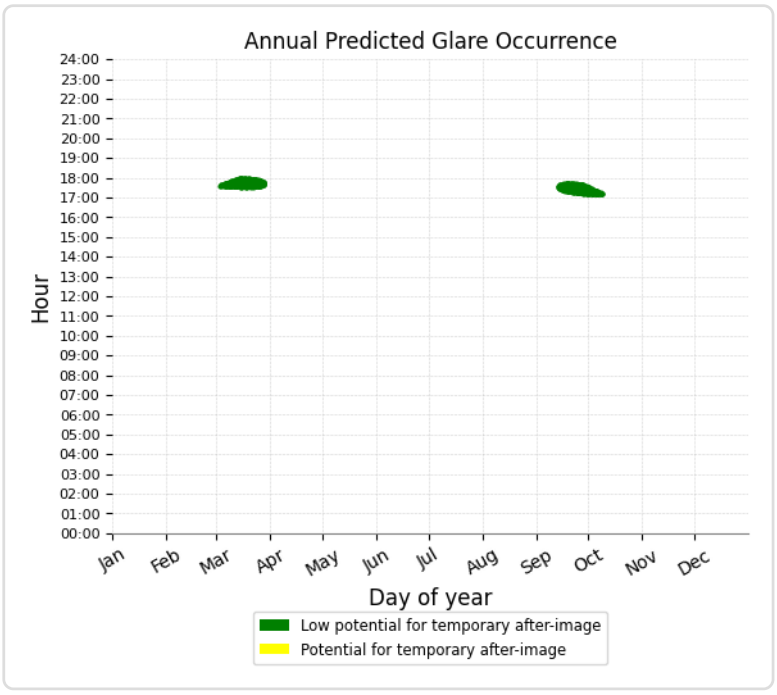


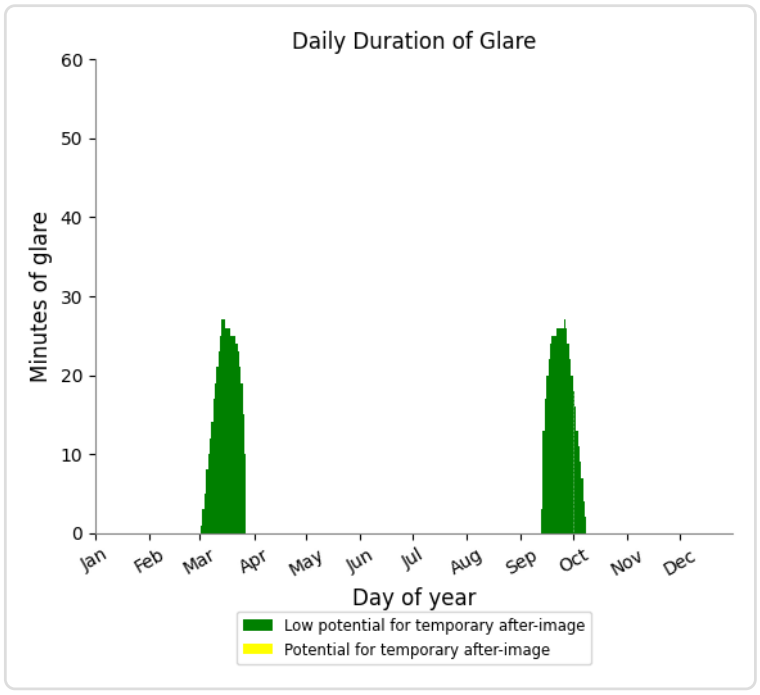


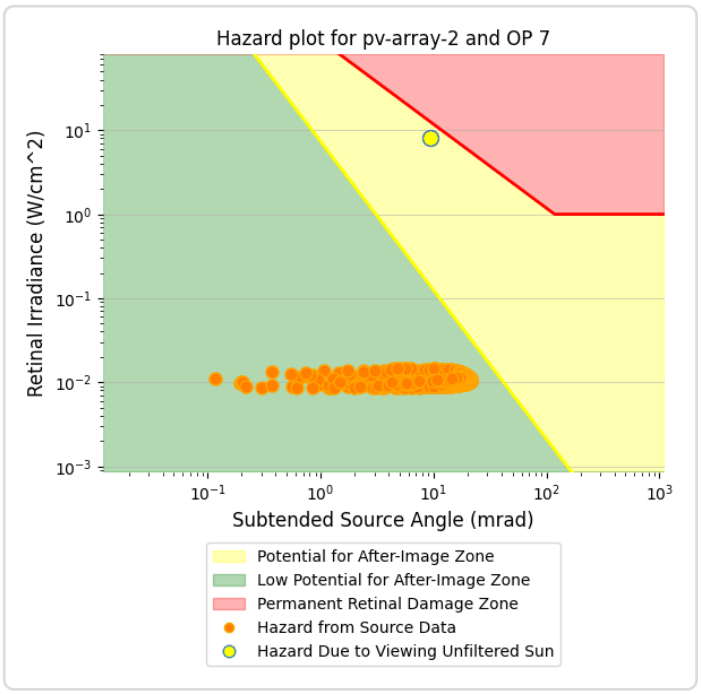
PV array 2 and OP 7

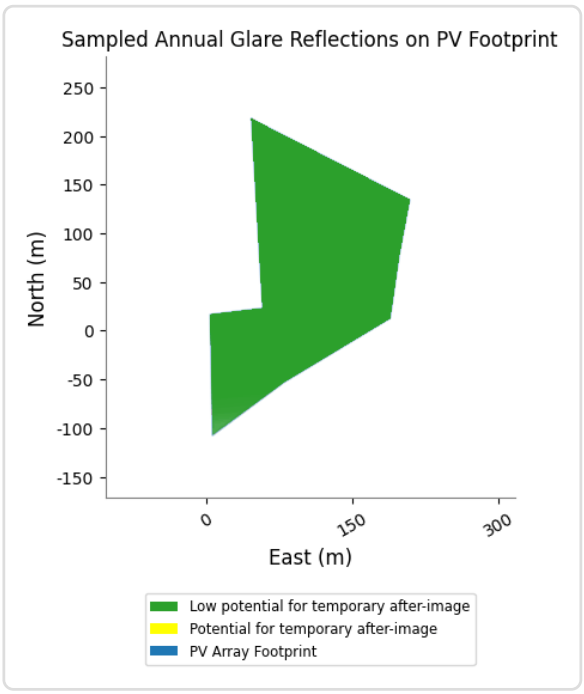
Yellow glare: none

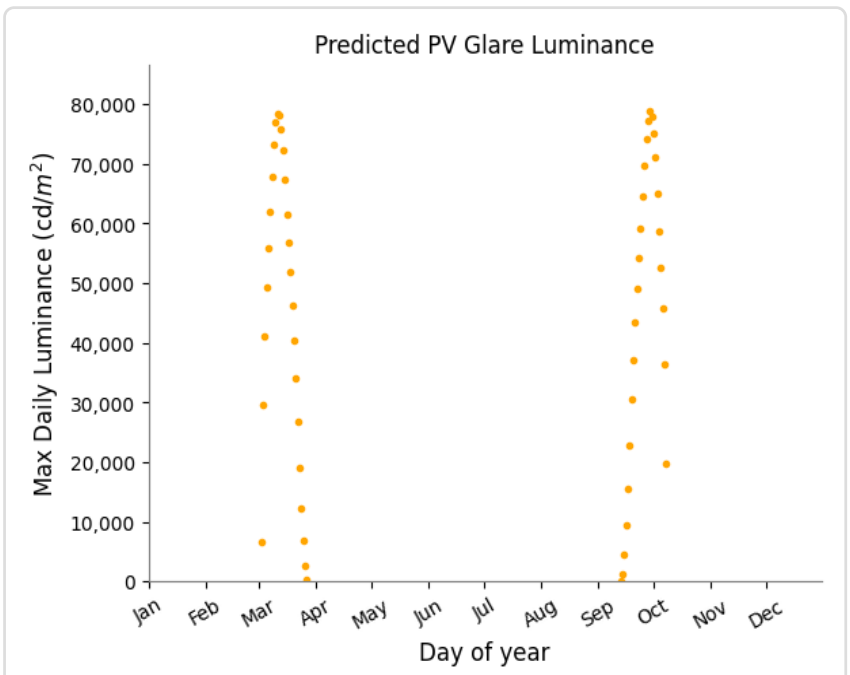
Green glare: 954 min.







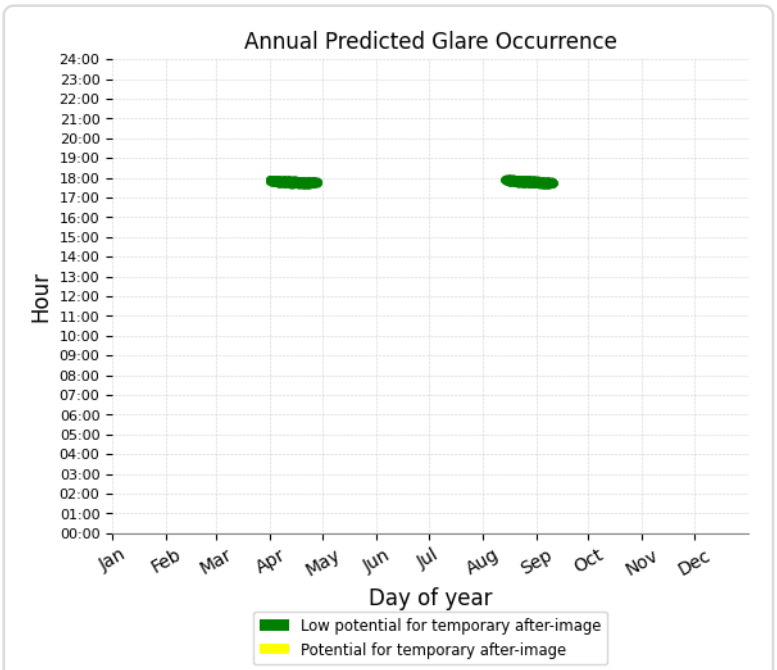


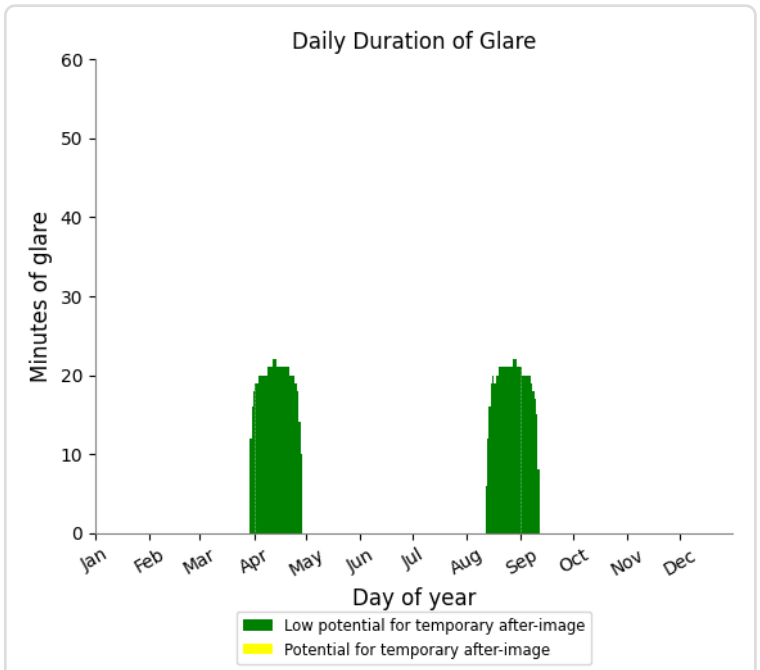


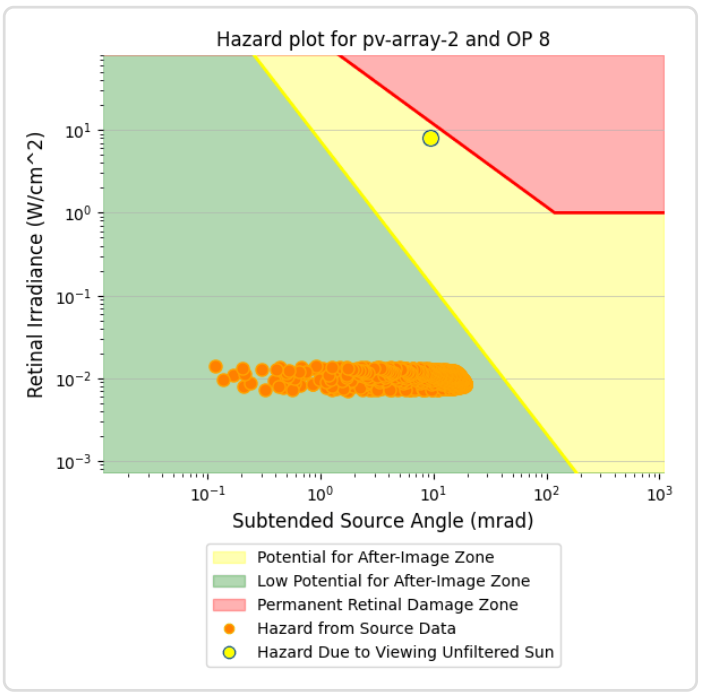
PV array 2 and OP 8

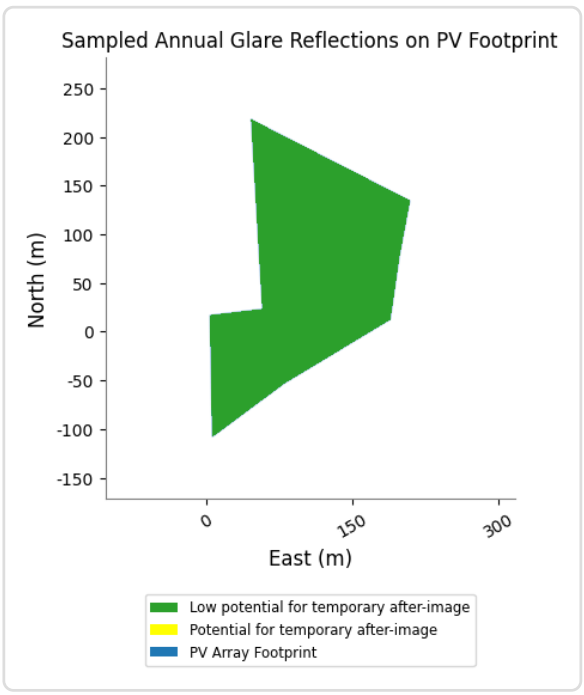
Yellow glare: none

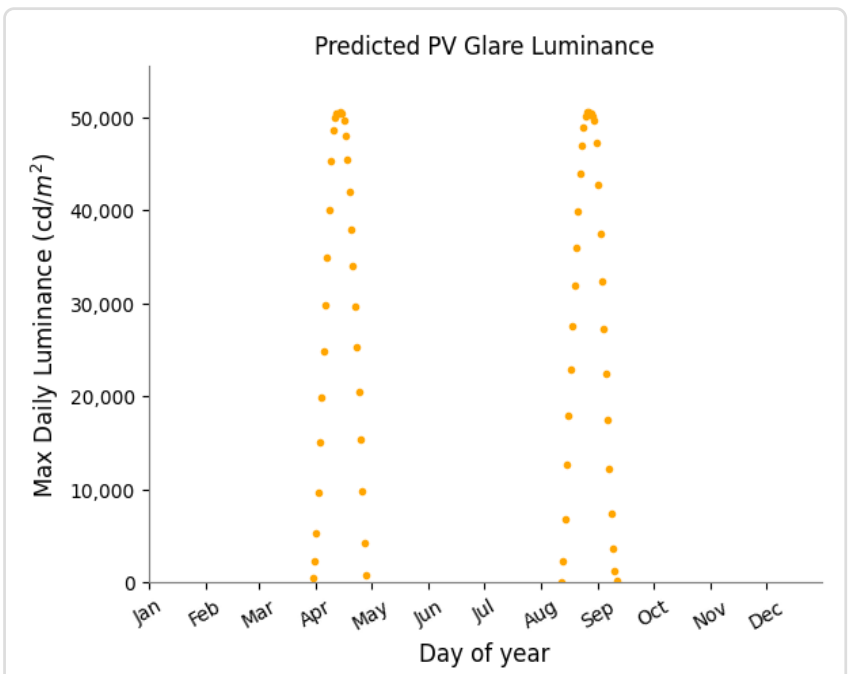
Green glare: 1,164 min.







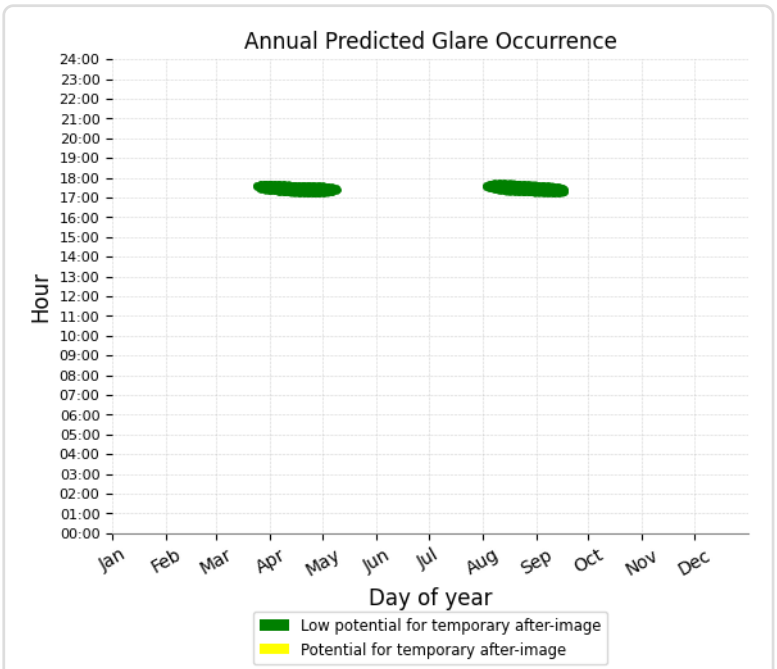


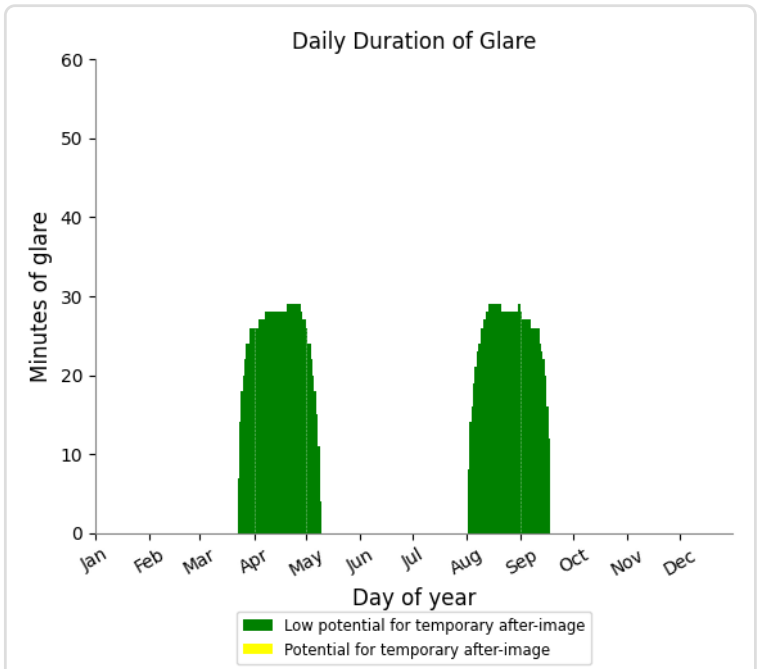


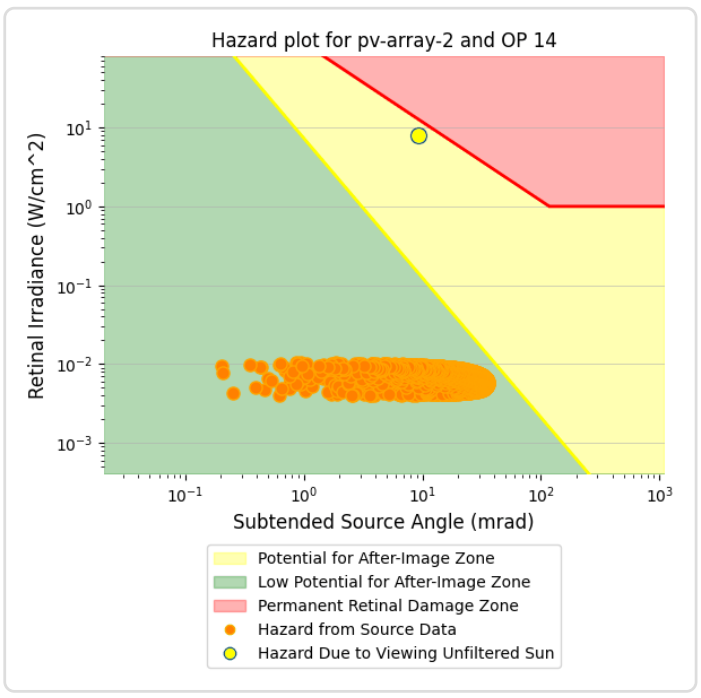
PV array 2 and OP 14

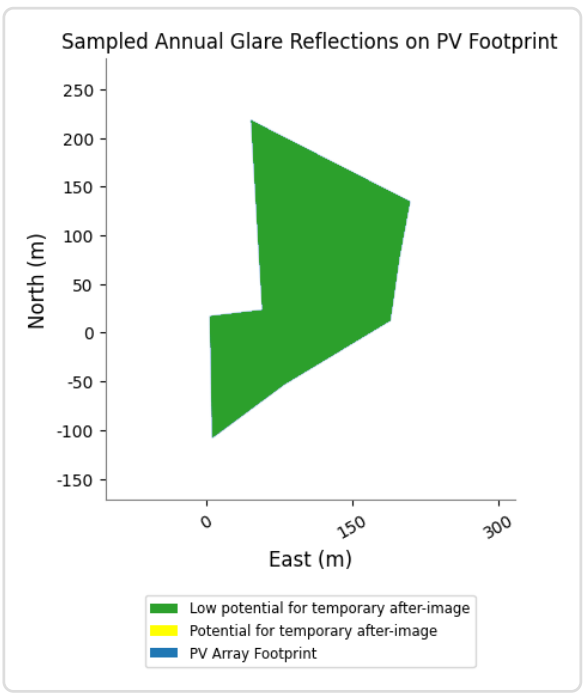
Yellow glare: none

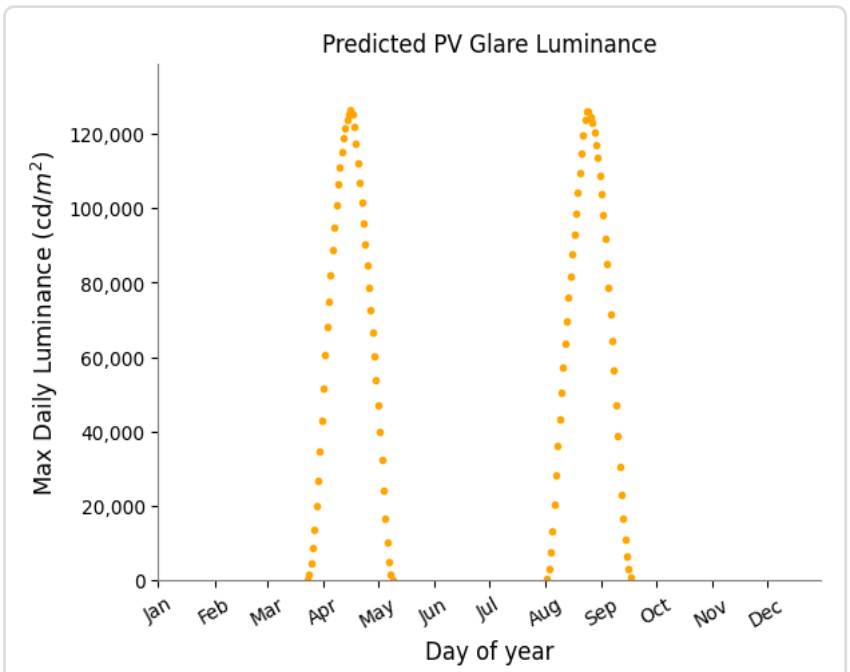
Green glare: 2,363 min.







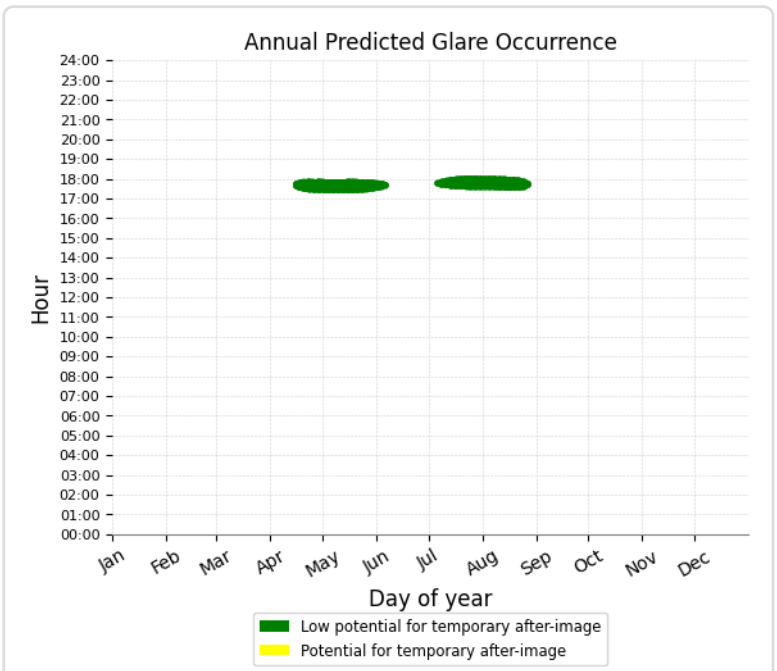


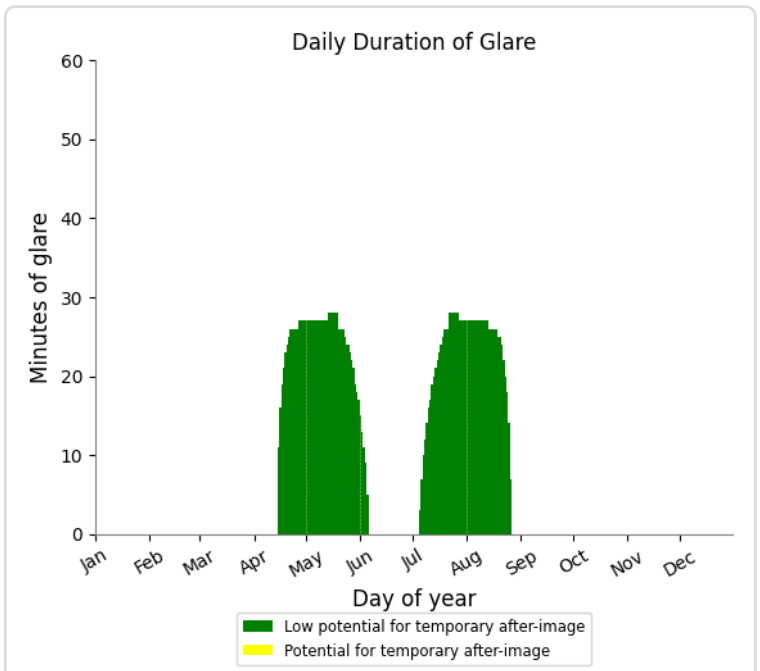


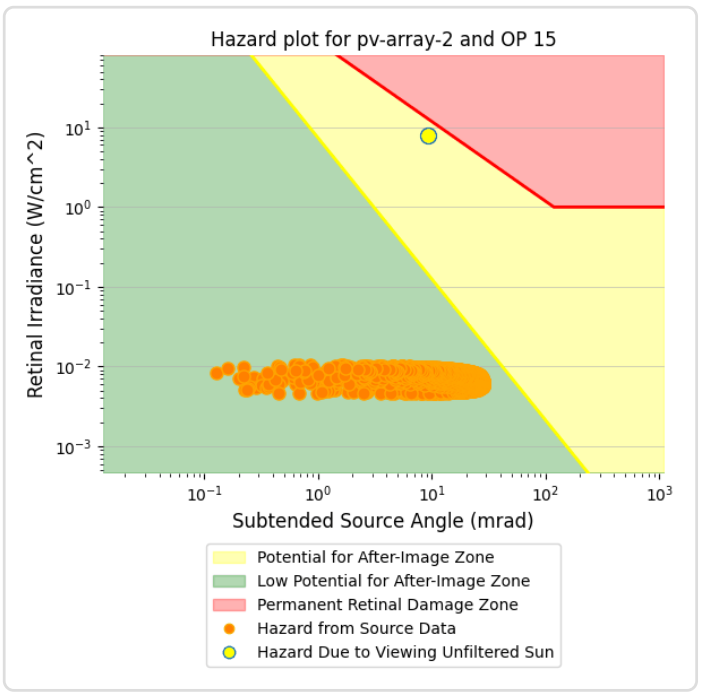
PV array 2 and OP 15

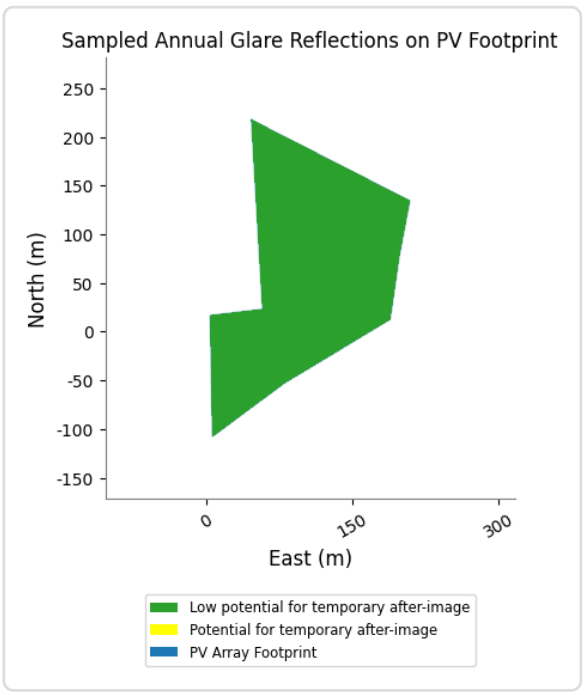
Yellow glare: none

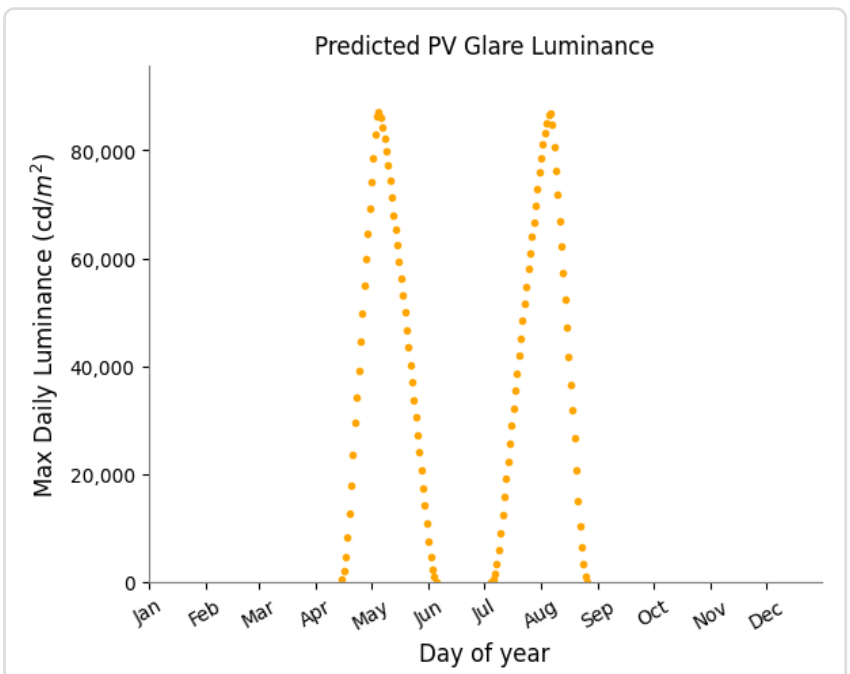
Green glare: 2,443 min.







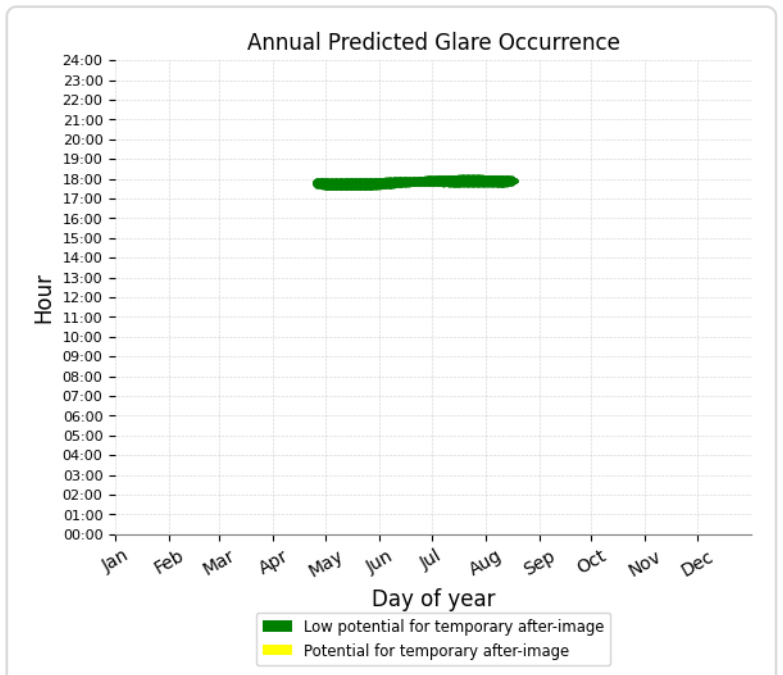


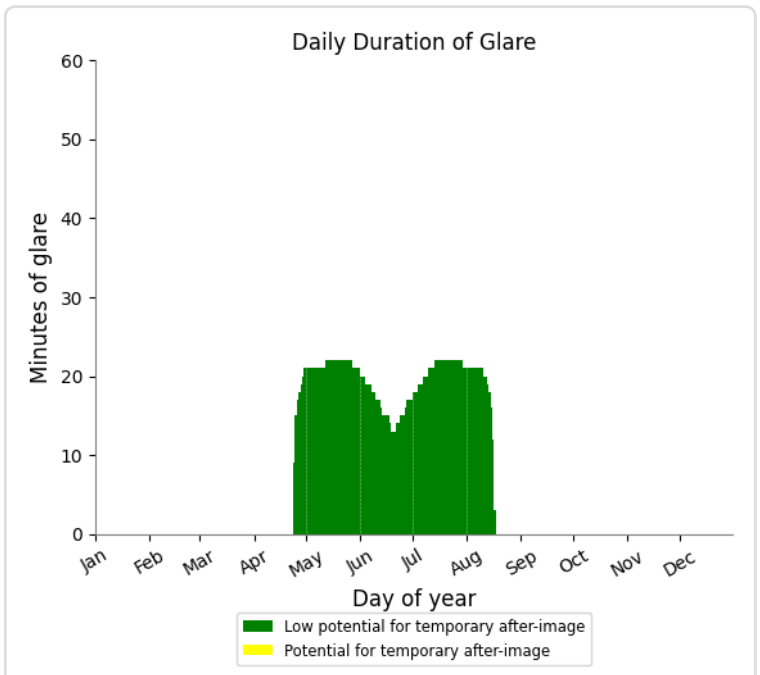


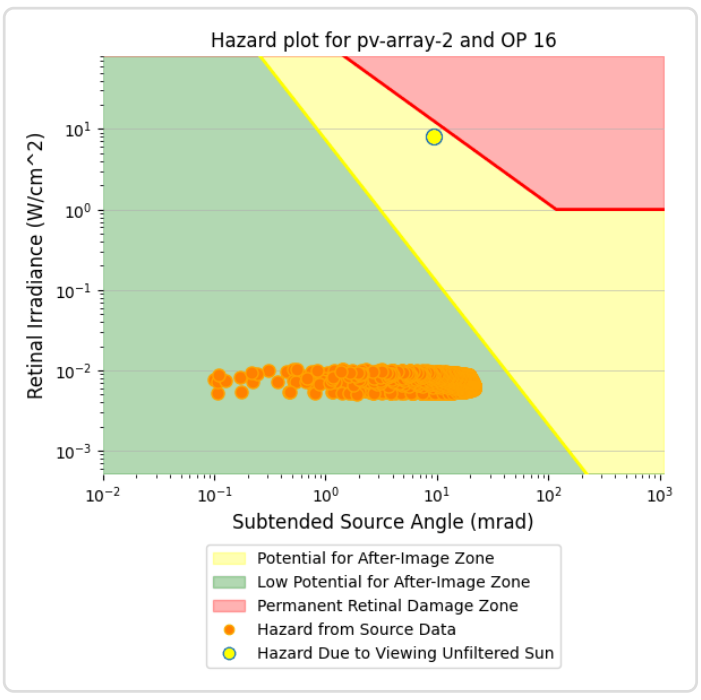
PV array 2 and OP 16

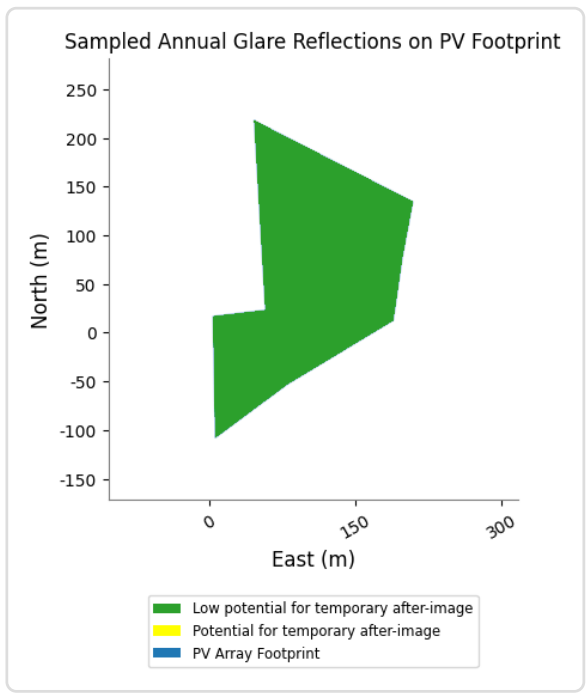
Yellow glare: none

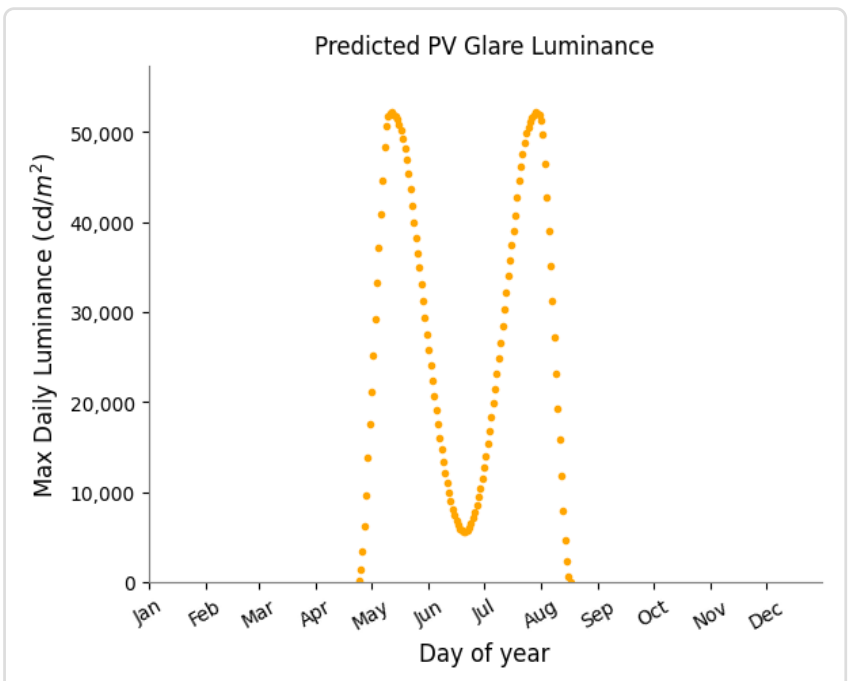
Green glare: 2,245 min.







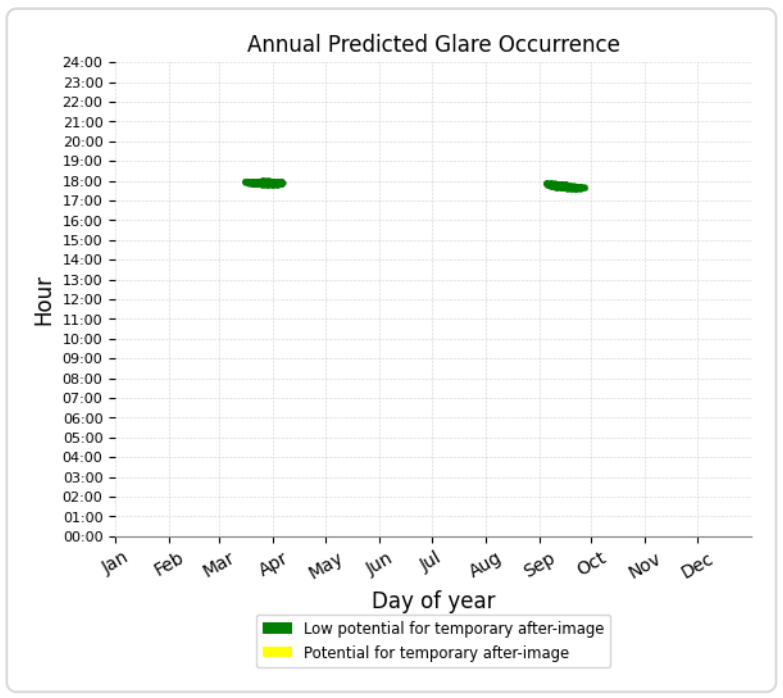


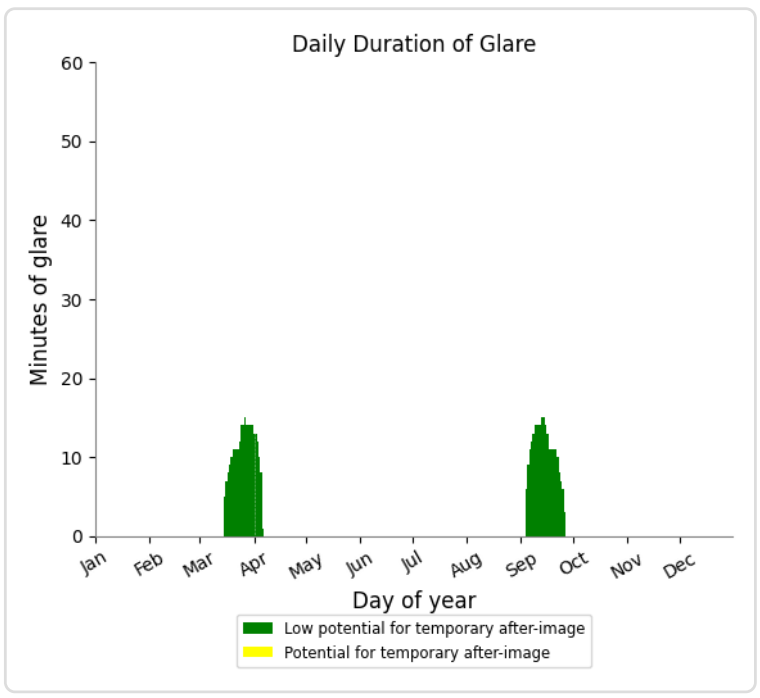


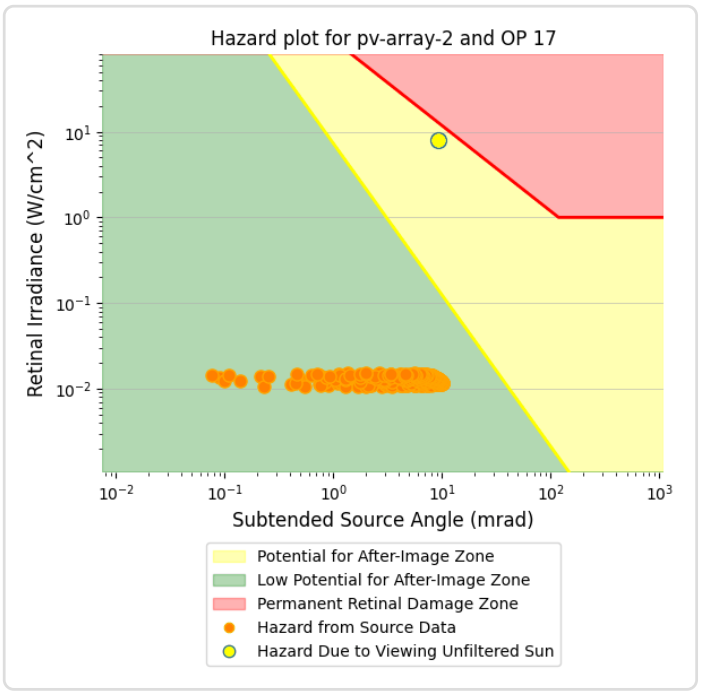
PV array 2 and OP 17

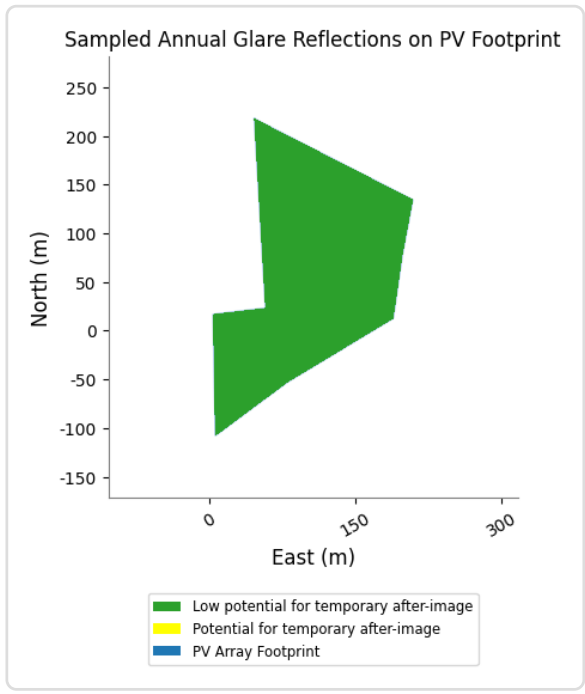
Yellow glare: none

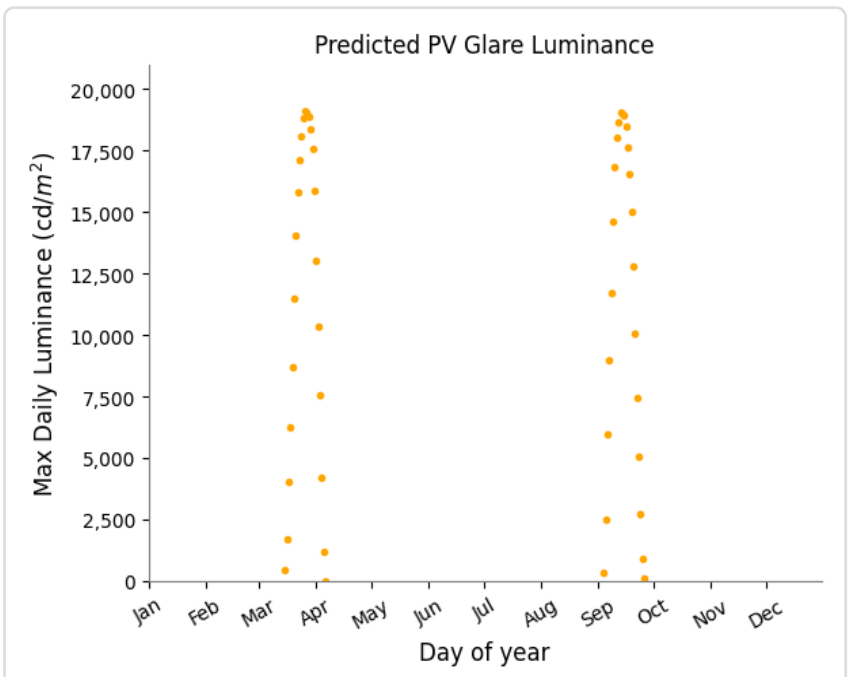
Green glare: 504 min.







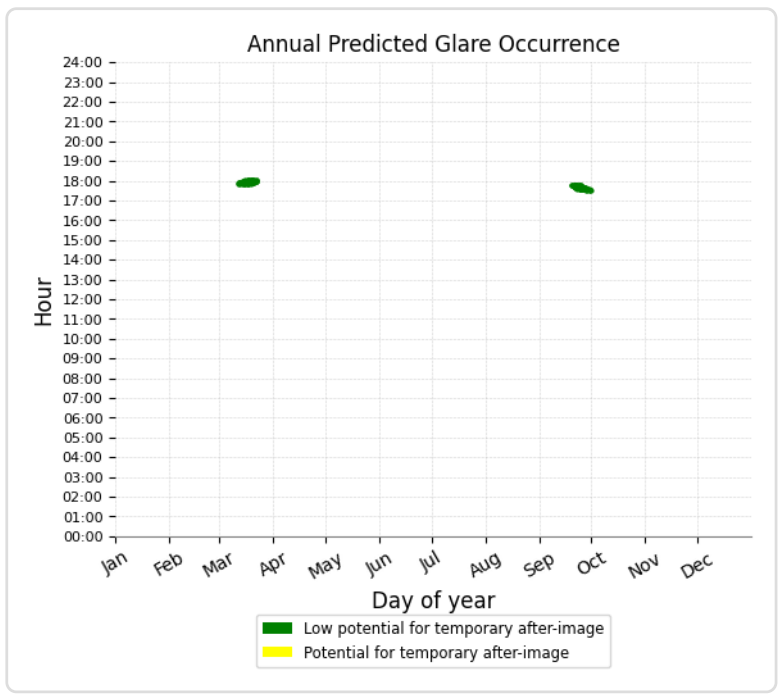


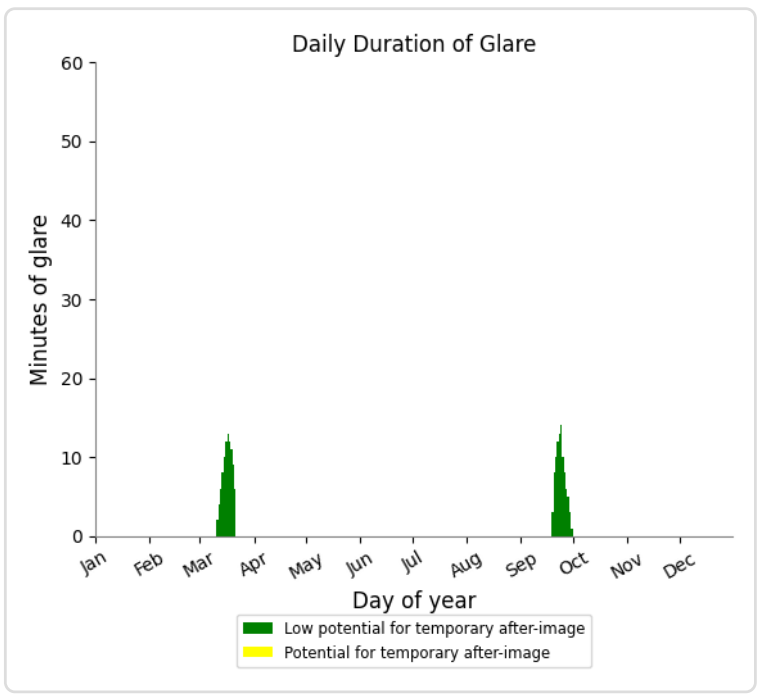


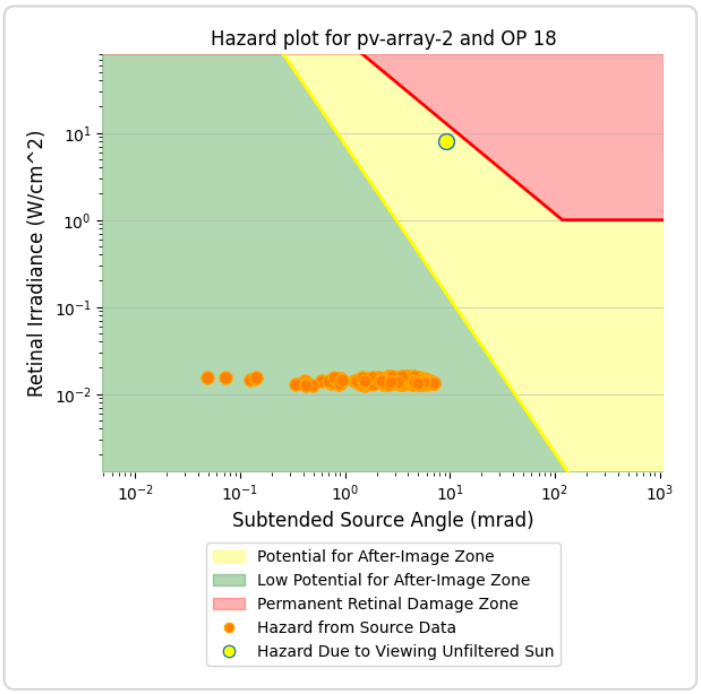
PV array 2 and OP 18

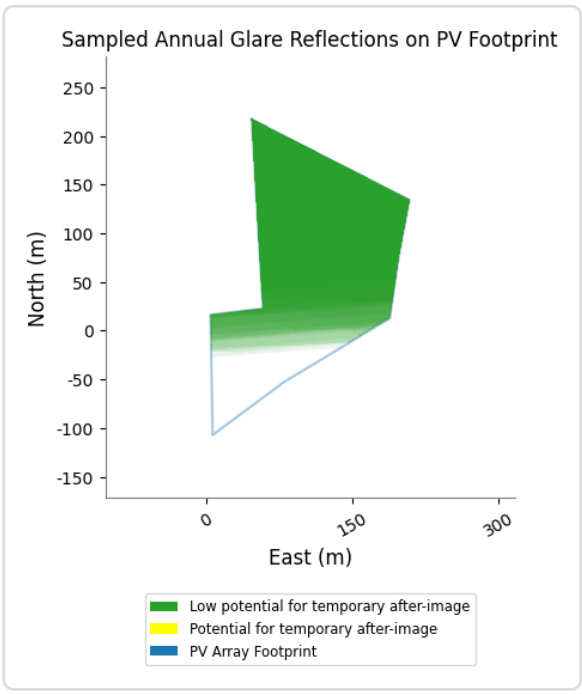
Yellow glare: none

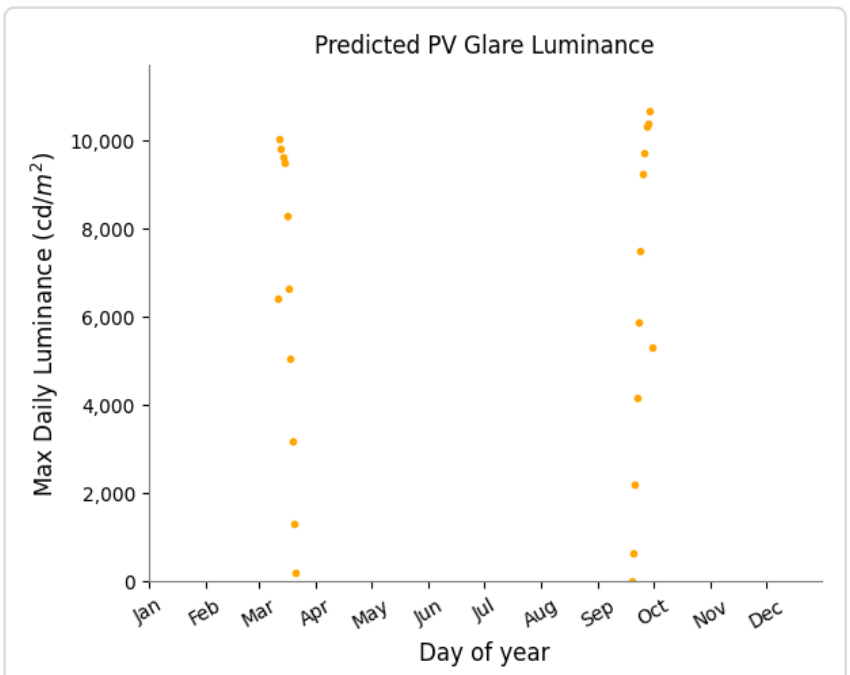
Green glare: 186 min.











PV array 2 and OP 2

No glare found

PV array 2 and OP 3

No glare found

PV array 2 and OP 4

No glare found

PV array 2 and OP 5

No glare found

PV array 2 and OP 6

No glare found

PV array 2 and OP 9

No glare found

PV array 2 and OP 10

No glare found

PV array 2 and OP 11

No glare found

PV array 2 and OP 12

No glare found

PV array 2 and OP 13

No glare found

PV array 2 and OP 19

No glare found

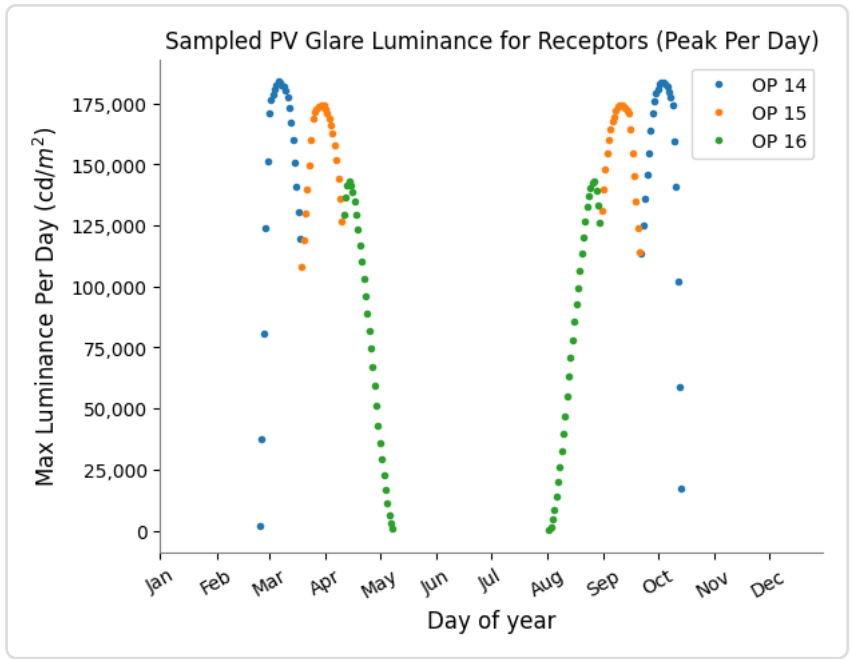
PV array 2 and OP 20

No glare found

PV: PV array 3 low potential for temporary after-image

Receptor results ordered by category of glare

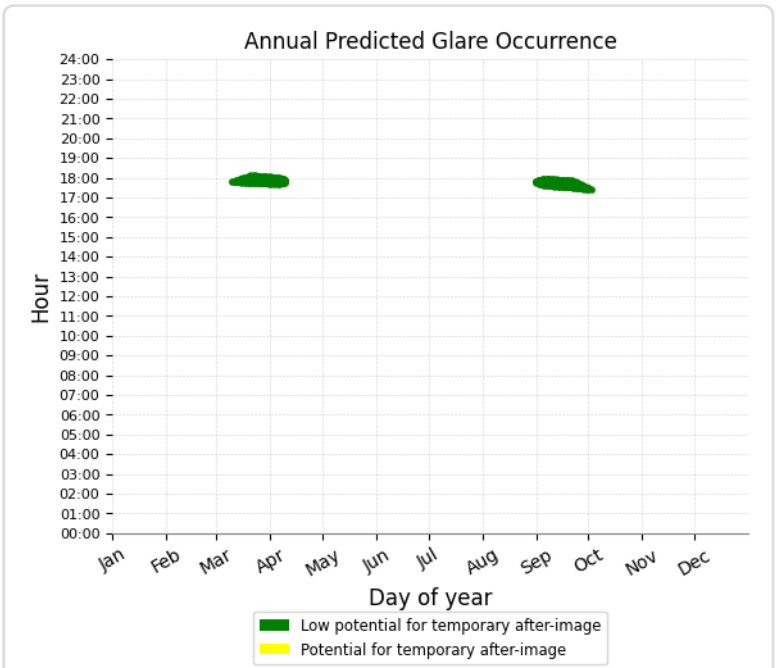
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,349	22.5	0	0.0	110,890
OP 14	1,414	23.6	0	0.0	183,924
OP 15	2,332	38.9	0	0.0	174,520
OP 16	2,042	34.0	0	0.0	143,140
OP 17	445	7.4	0	0.0	37,708
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

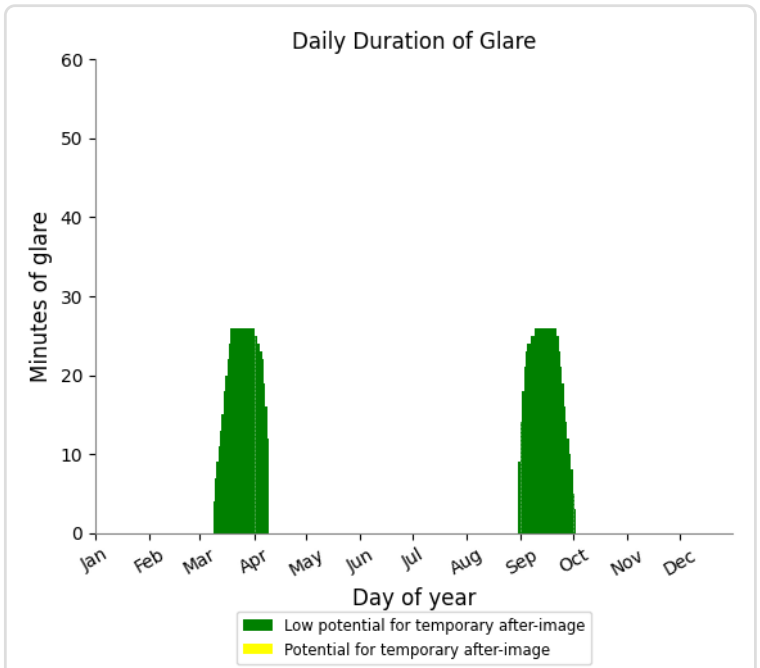


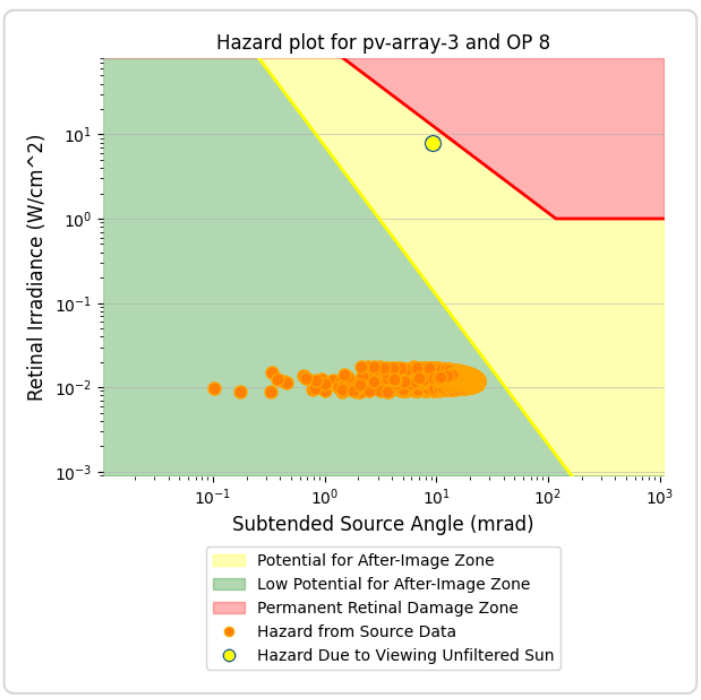
PV array 3 and OP 8

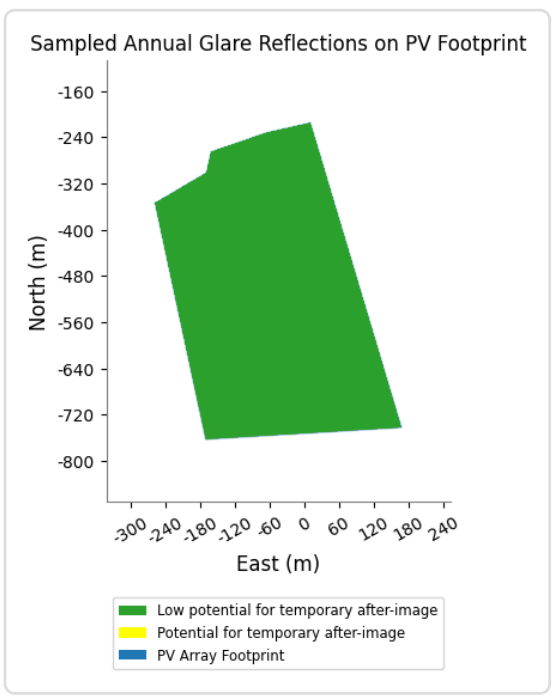
Yellow glare: none

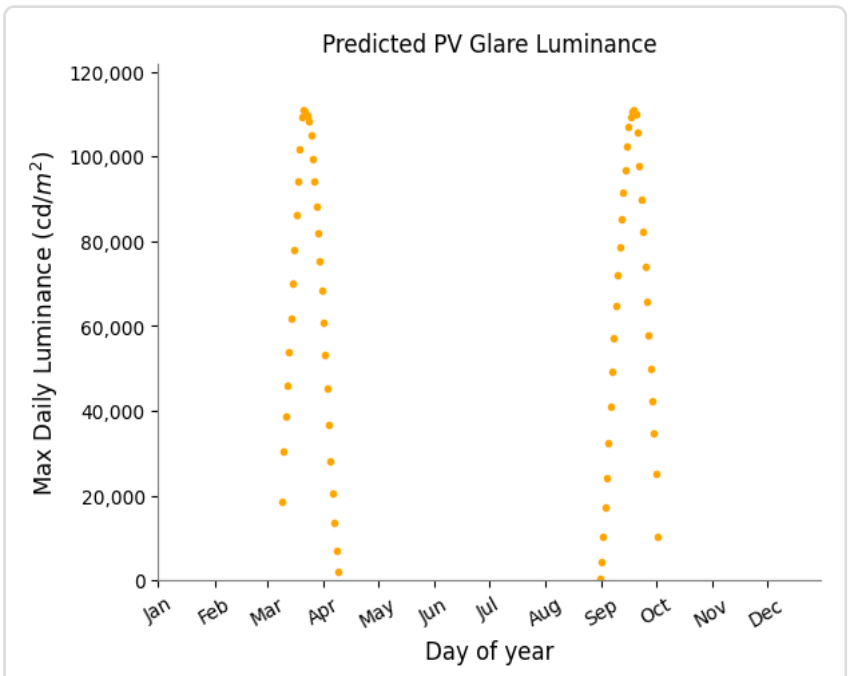
Green glare: 1,349 min.







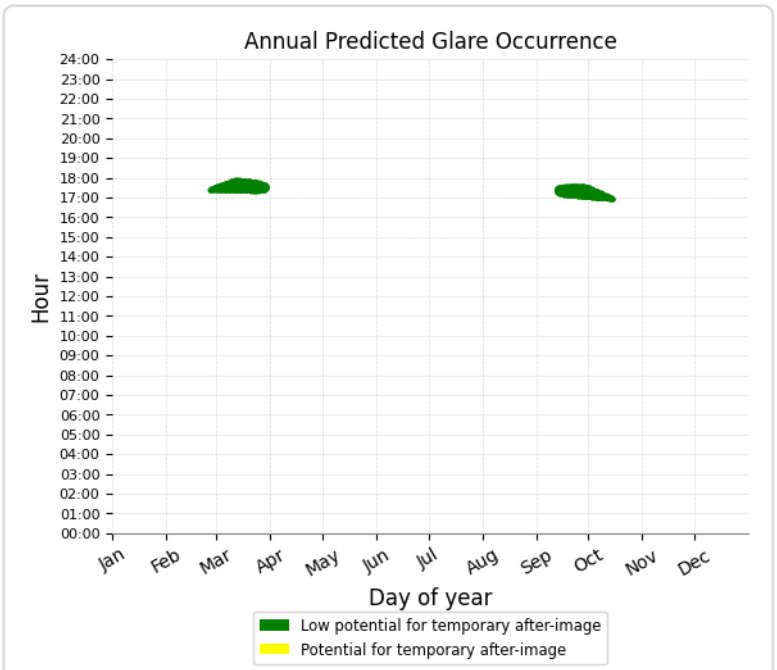


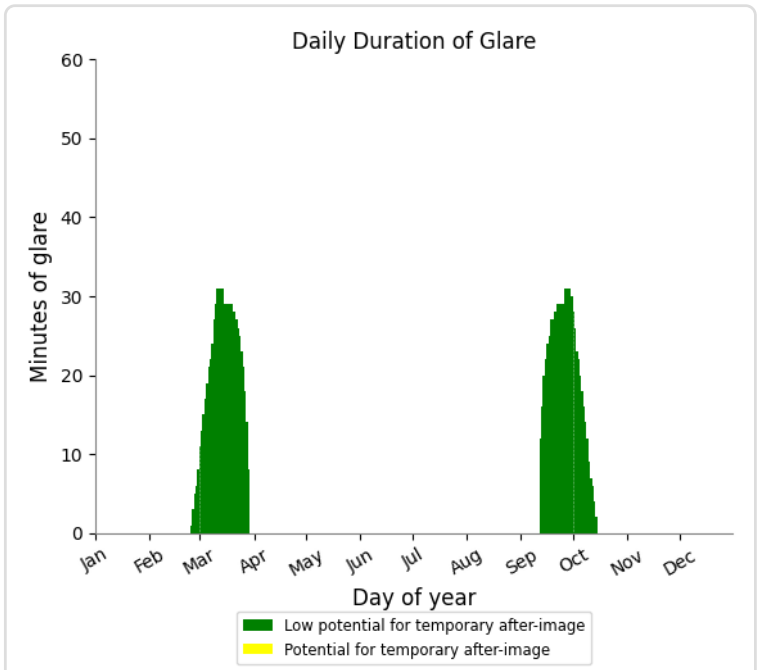


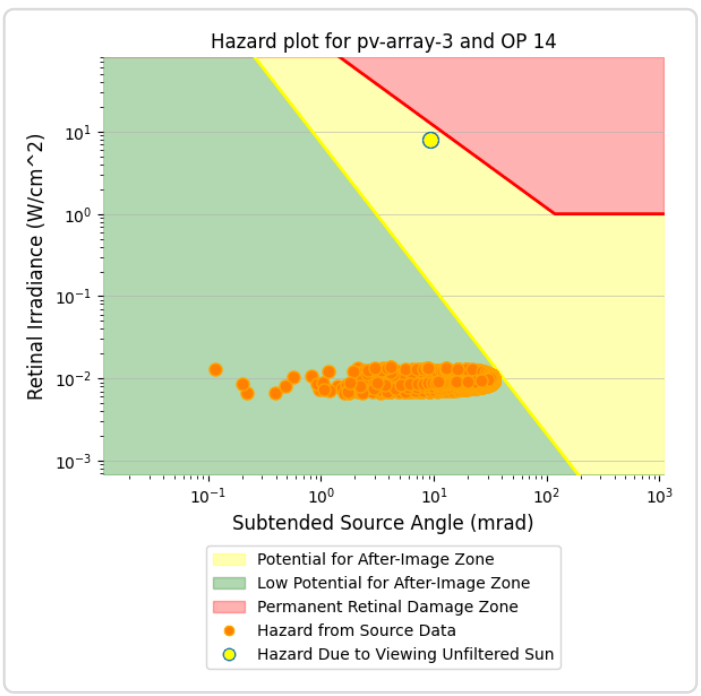
PV array 3 and OP 14

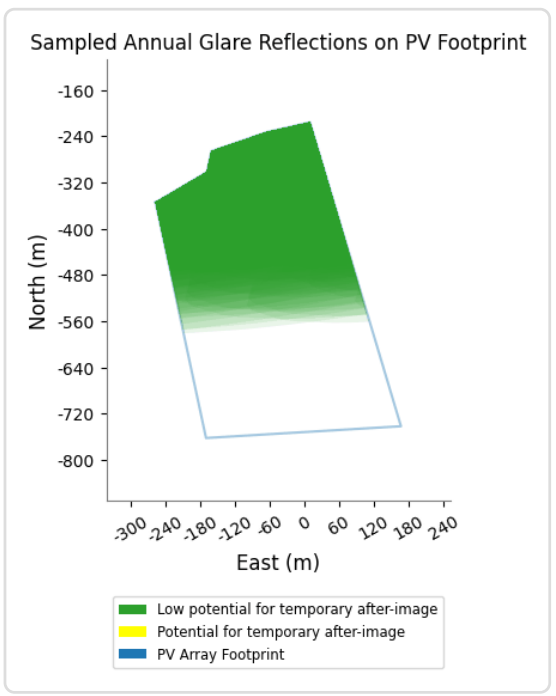
Yellow glare: none

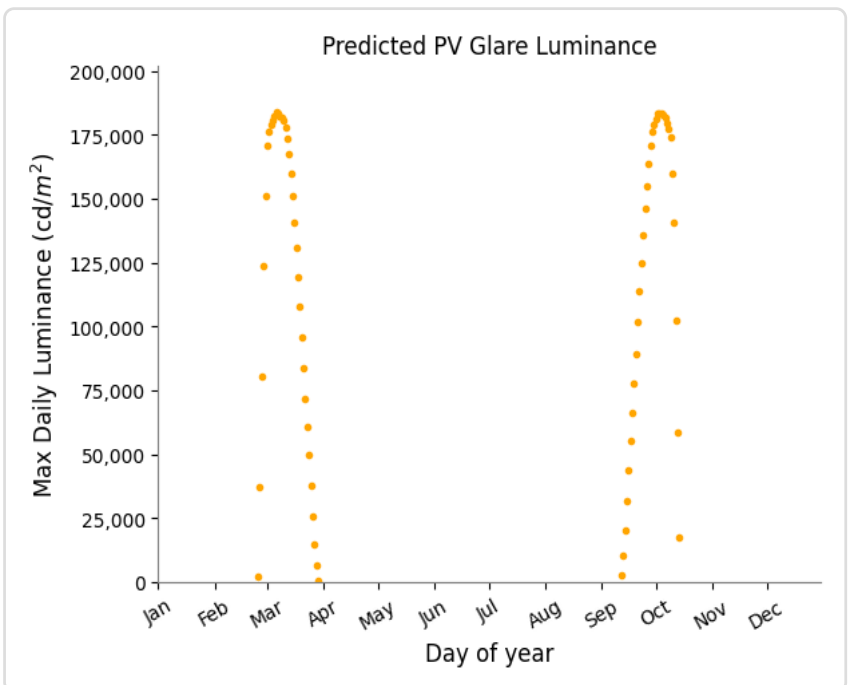
Green glare: 1,414 min.







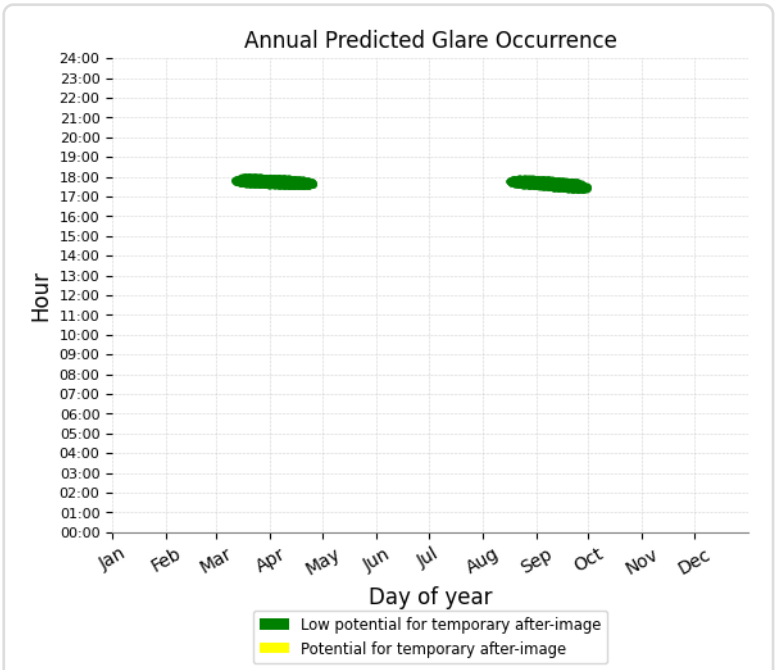


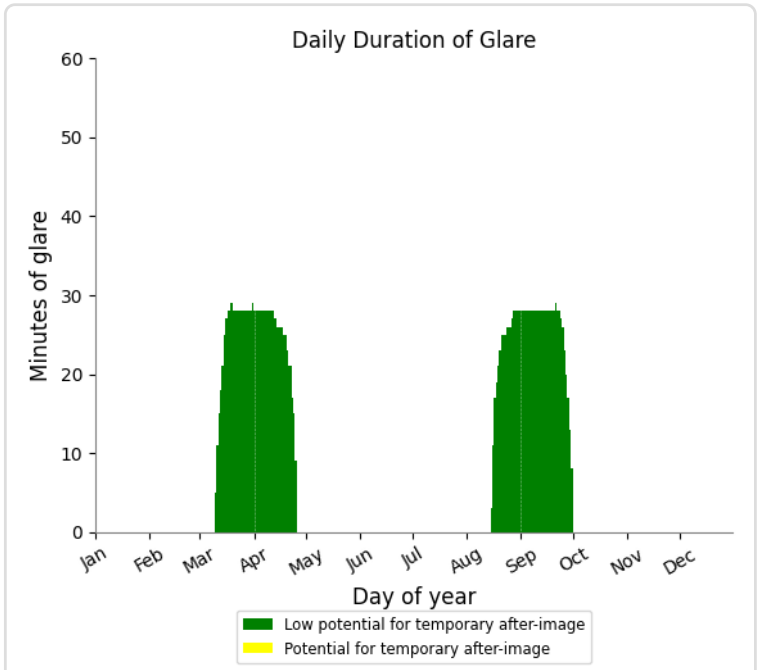


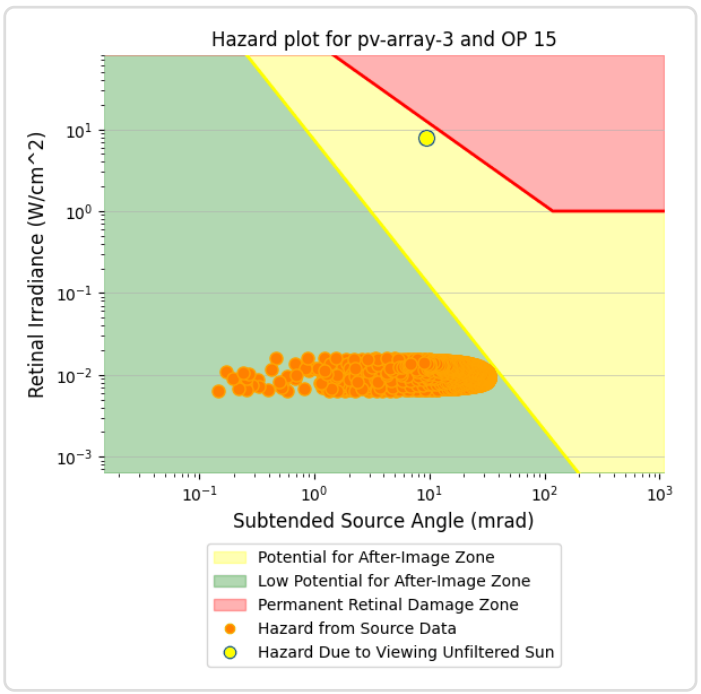
PV array 3 and OP 15

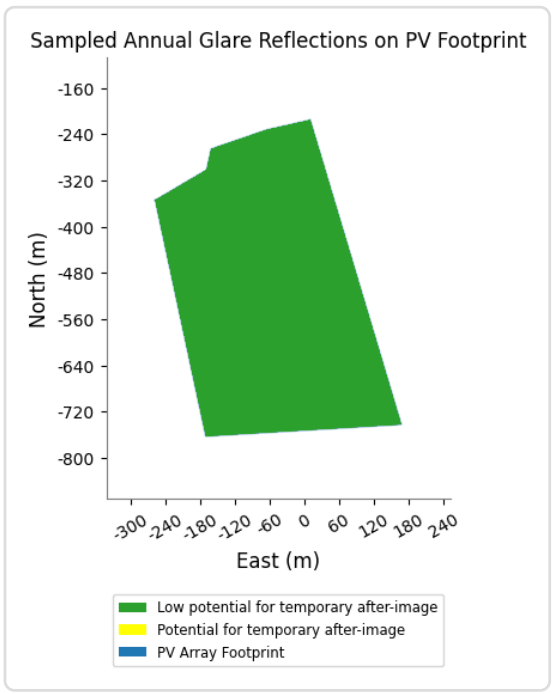
Yellow glare: none

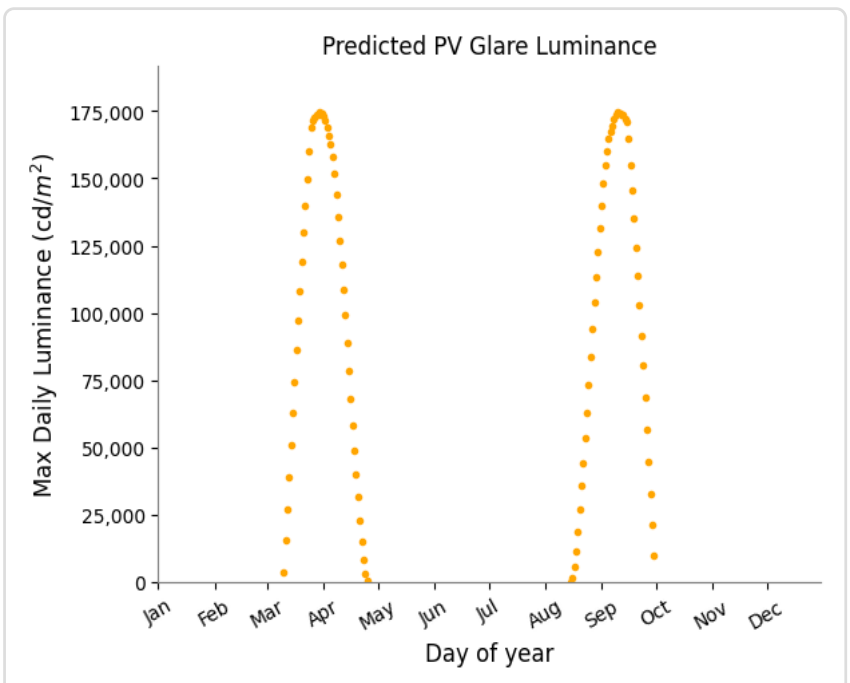
Green glare: 2,332 min.







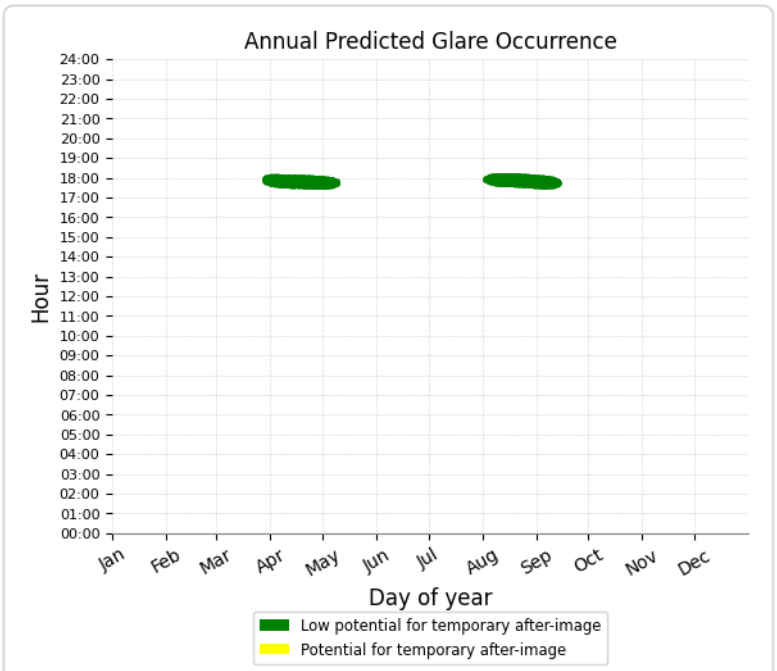


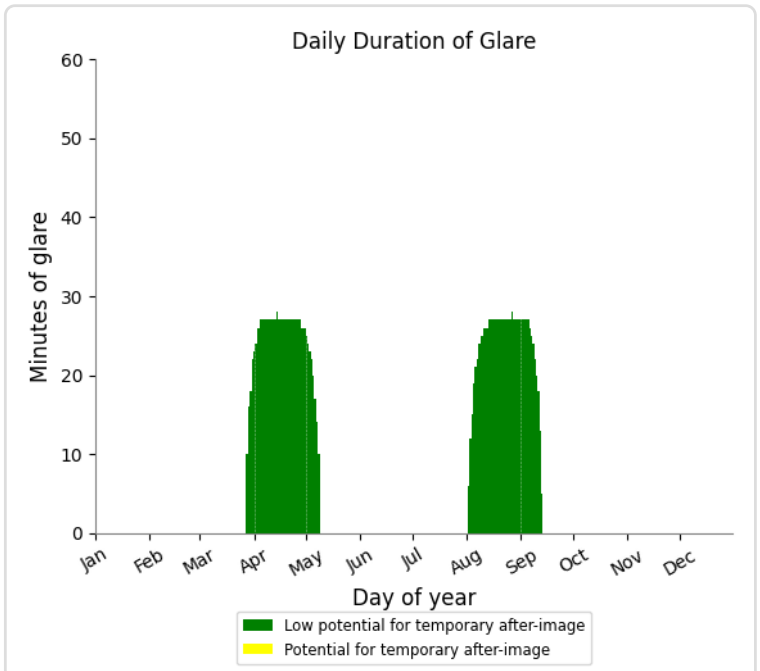


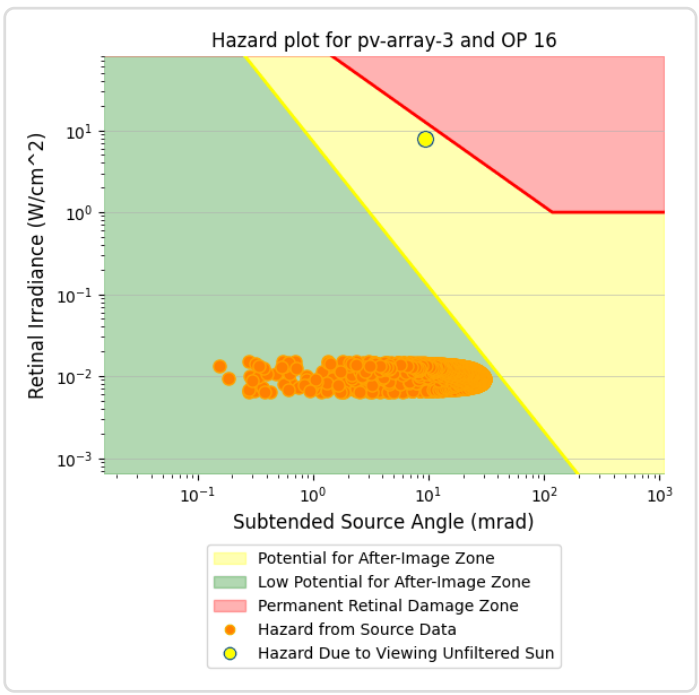
PV array 3 and OP 16

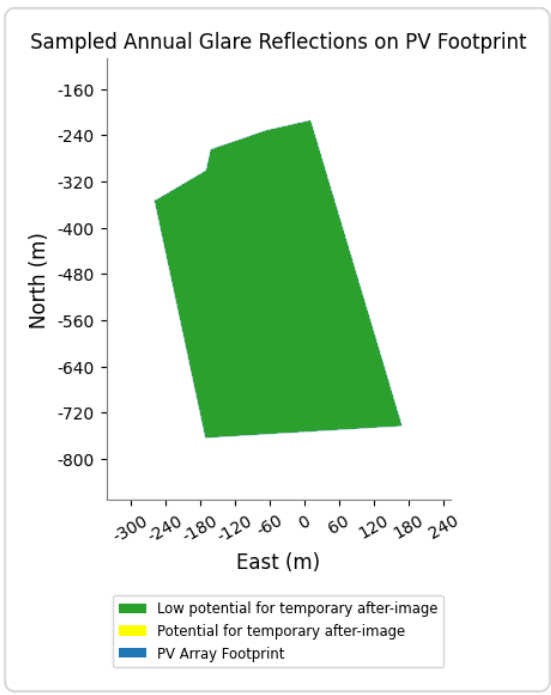
Yellow glare: none

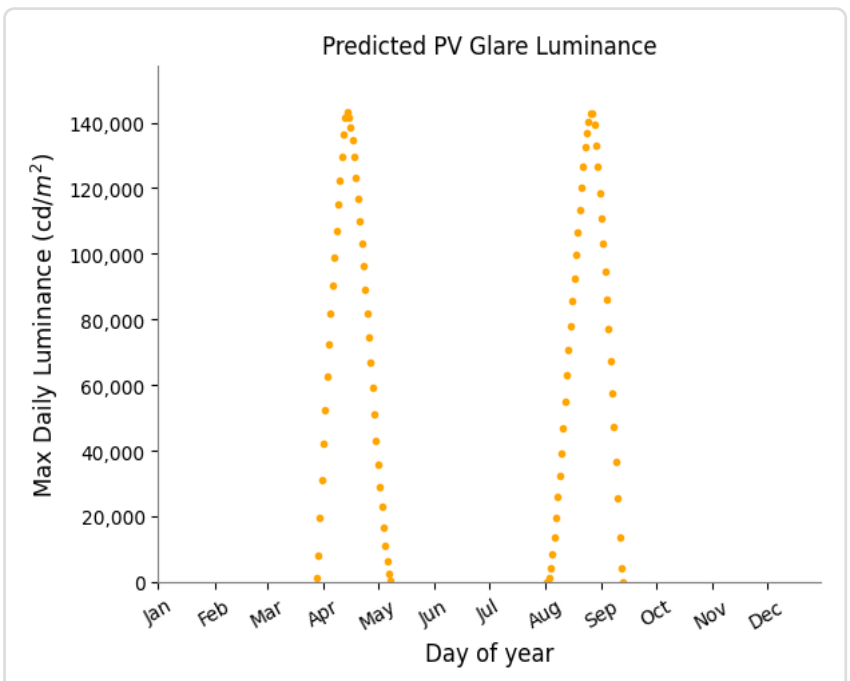
Green glare: 2,042 min.







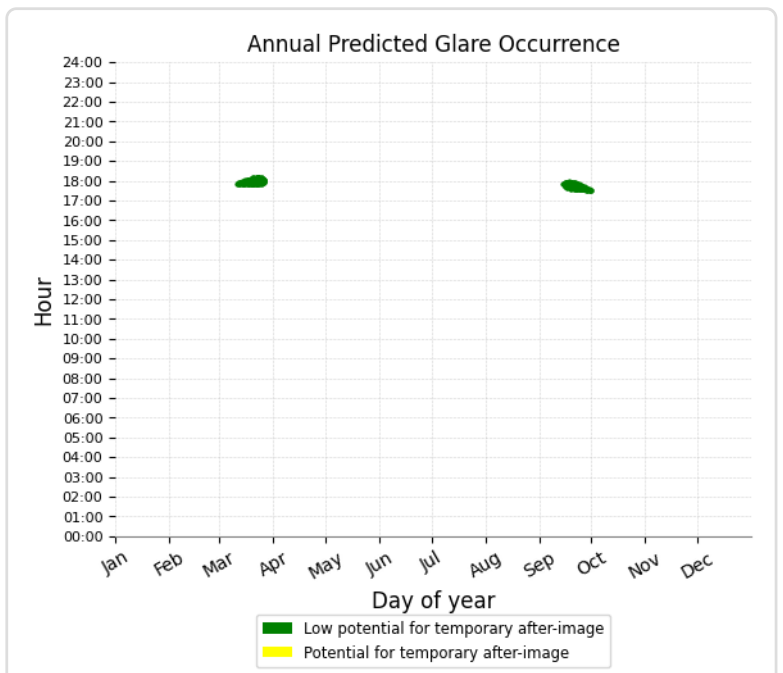


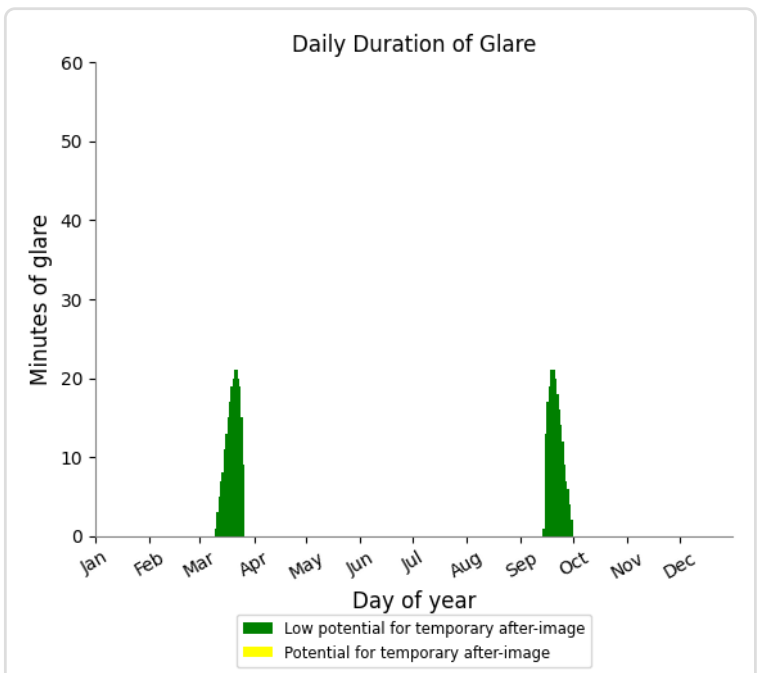


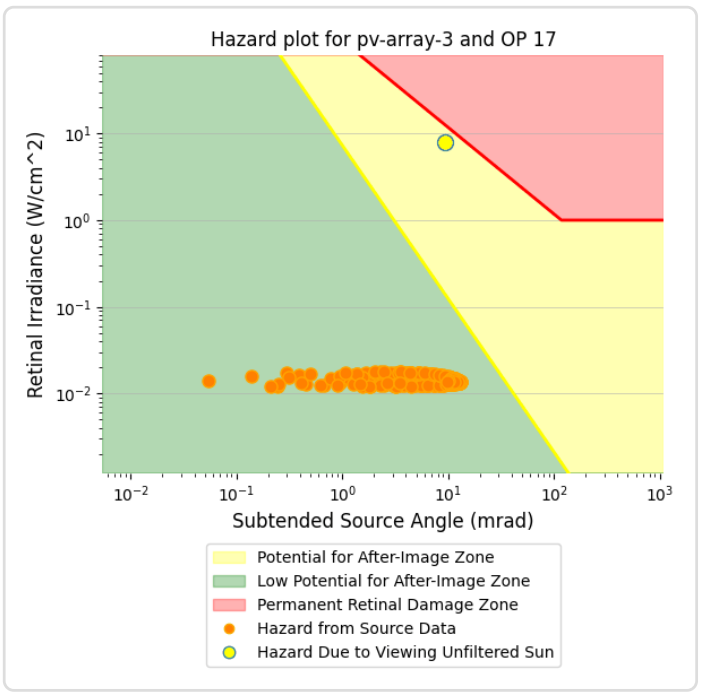
PV array 3 and OP 17

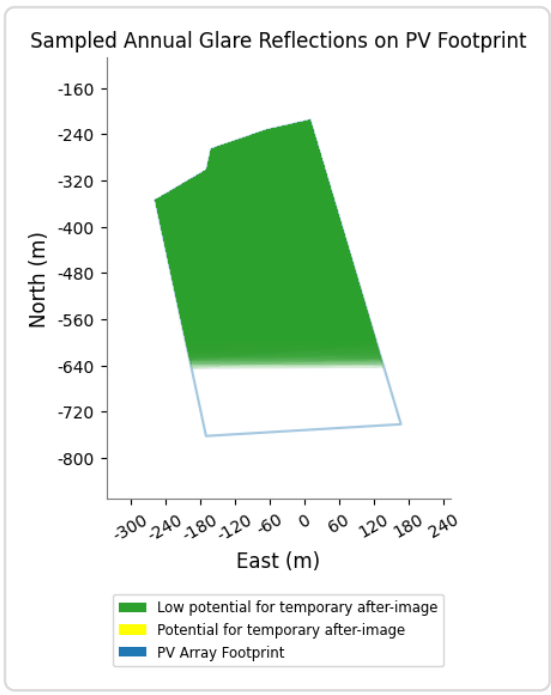
Yellow glare: none

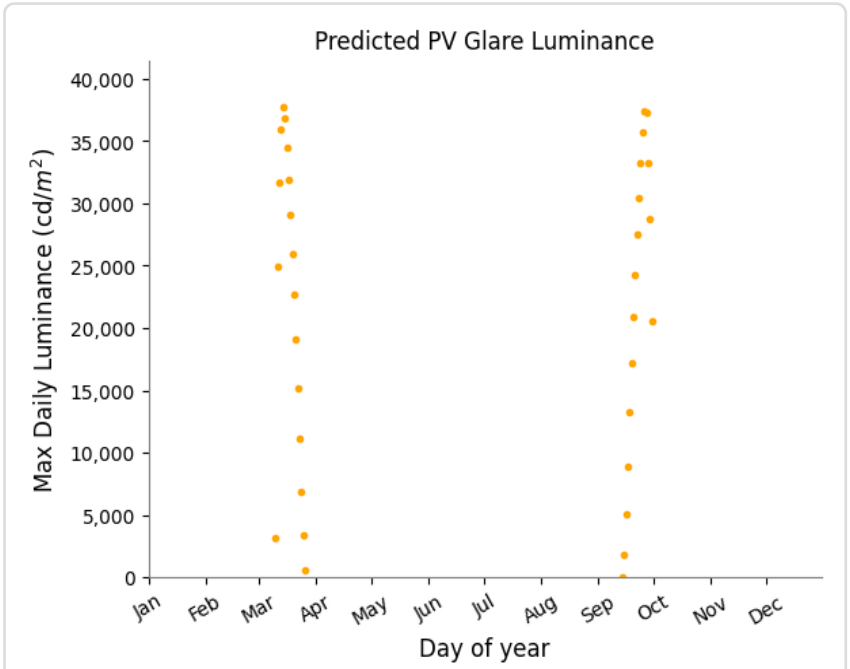
Green glare: 445 min.











PV array 3 and OP 1

No glare found

PV array 3 and OP 2

No glare found

PV array 3 and OP 3

No glare found

PV array 3 and OP 4

No glare found

PV array 3 and OP 5

No glare found

PV array 3 and OP 6

No glare found

PV array 3 and OP 7

No glare found

PV array 3 and OP 9

No glare found

PV array 3 and OP 10

No glare found

PV array 3 and OP 11

No glare found

PV array 3 and OP 12

No glare found

PV array 3 and OP 13

No glare found

PV array 3 and OP 18

No glare found

PV array 3 and OP 19

No glare found

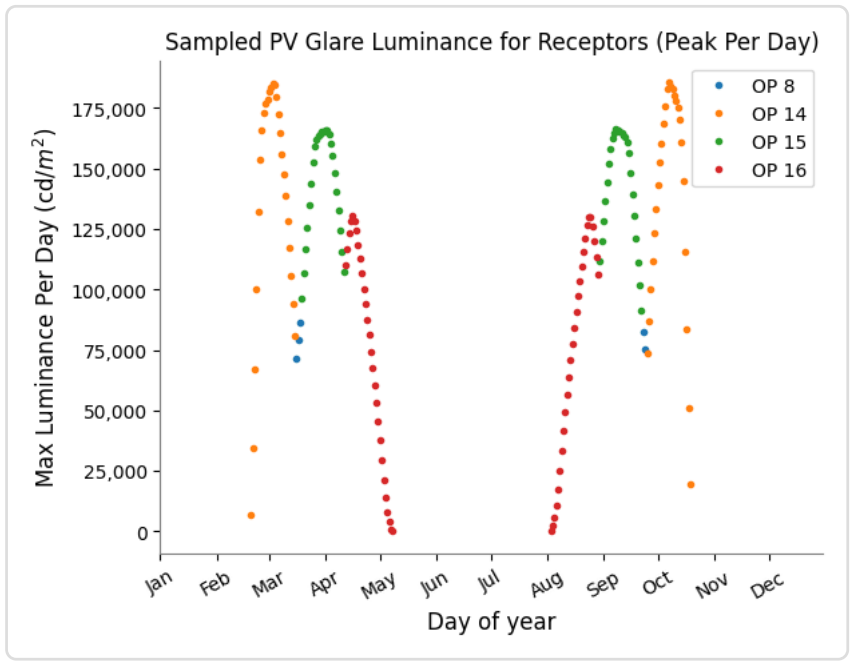
PV array 3 and OP 20

No glare found

PV: PV array 4 low potential for temporary after-image

Receptor results ordered by category of glare

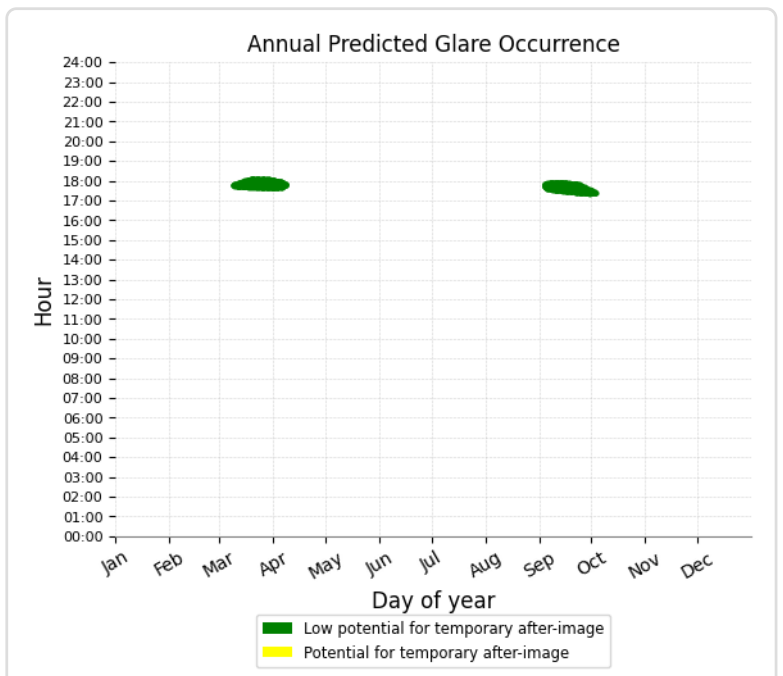
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,301	21.7	0	0.0	104,389
OP 14	1,285	21.4	0	0.0	185,561
OP 15	2,286	38.1	0	0.0	166,297
OP 16	1,894	31.6	0	0.0	130,668
OP 17	366	6.1	0	0.0	33,027
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

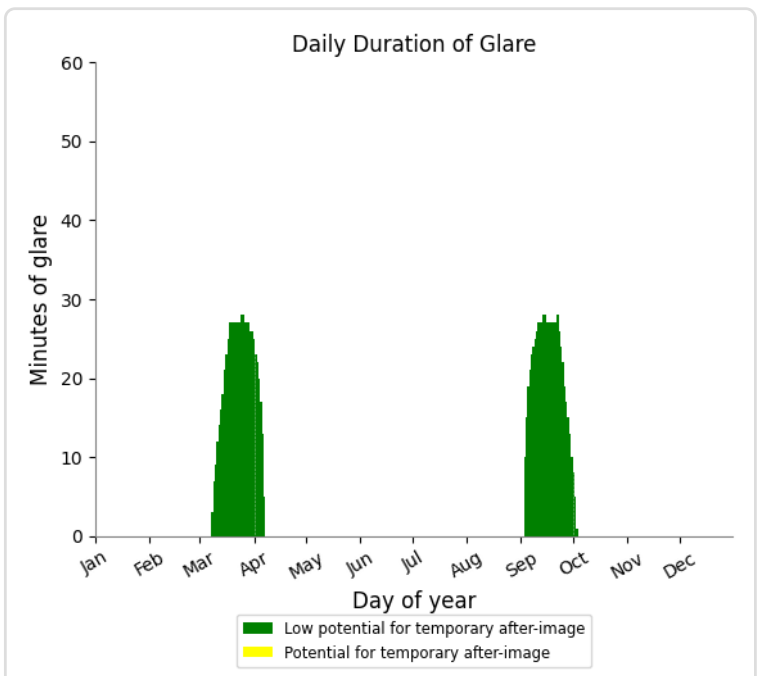


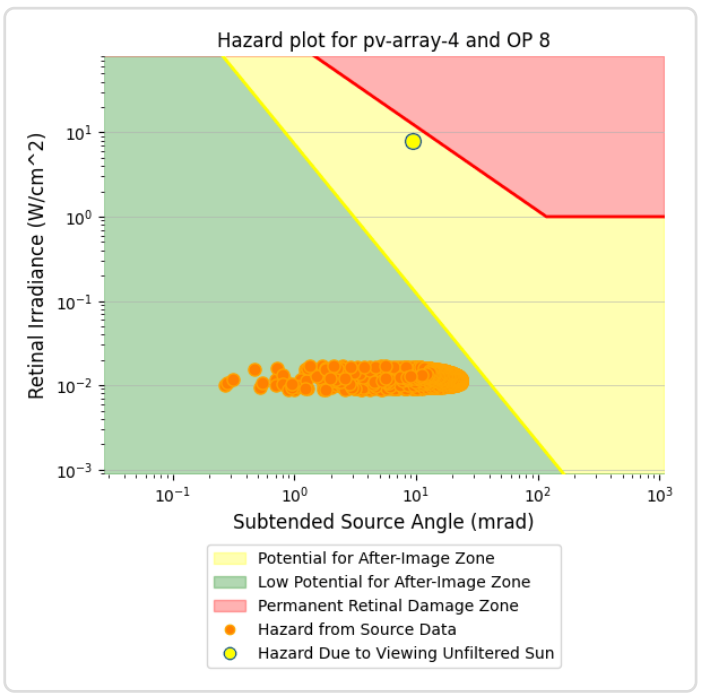
PV array 4 and OP 8

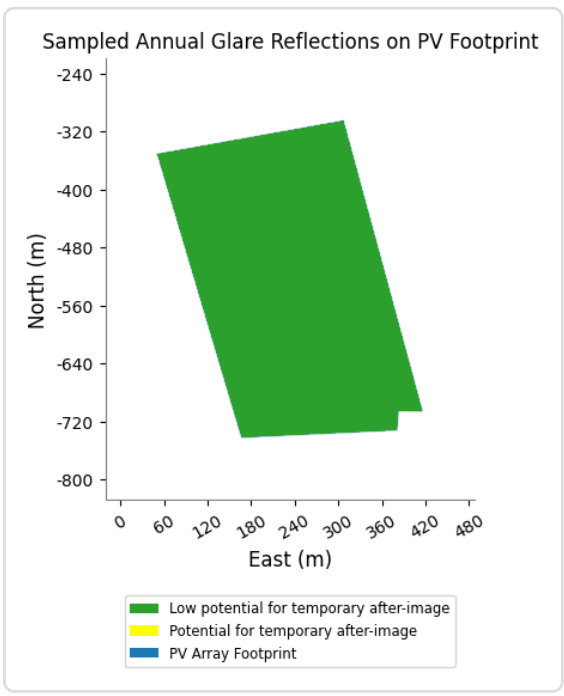
Yellow glare: none

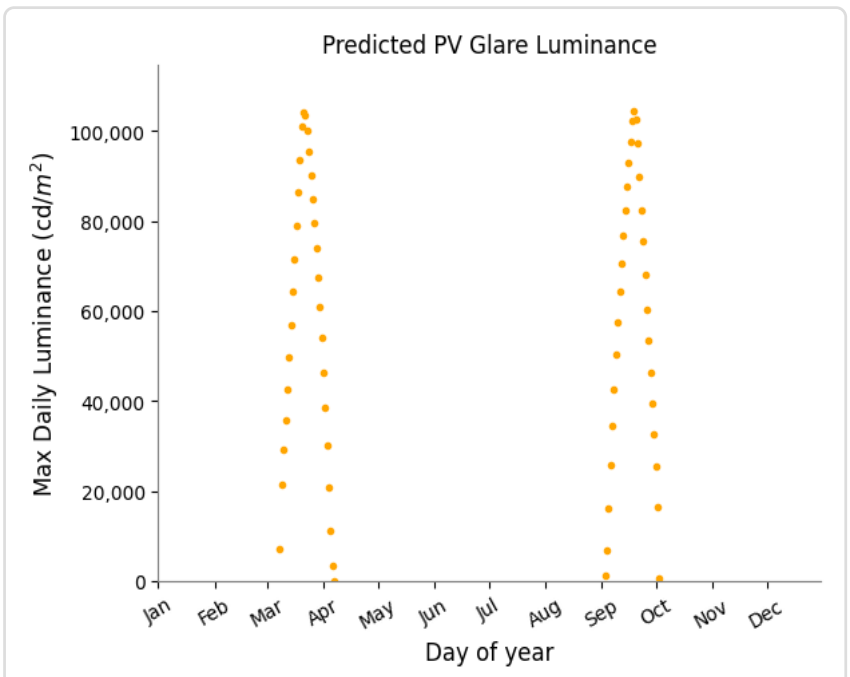
Green glare: 1,301 min.







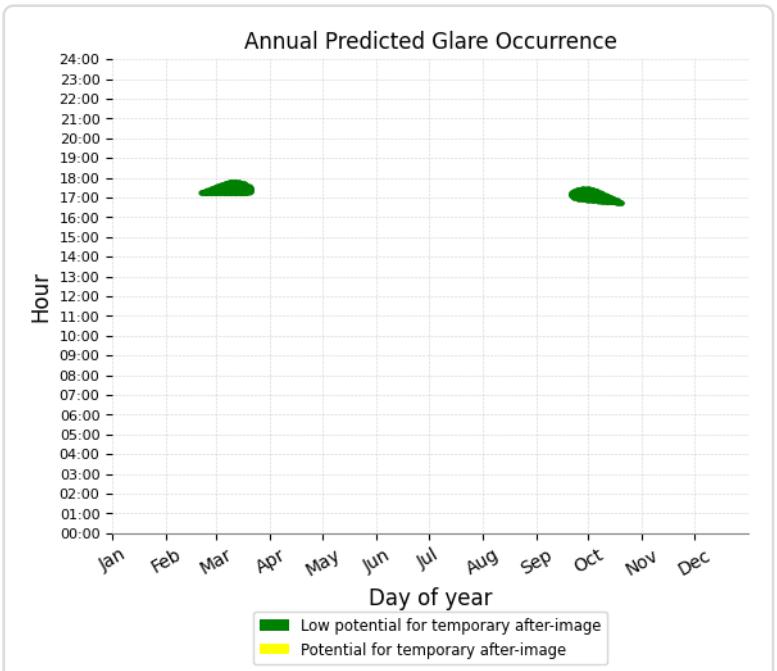


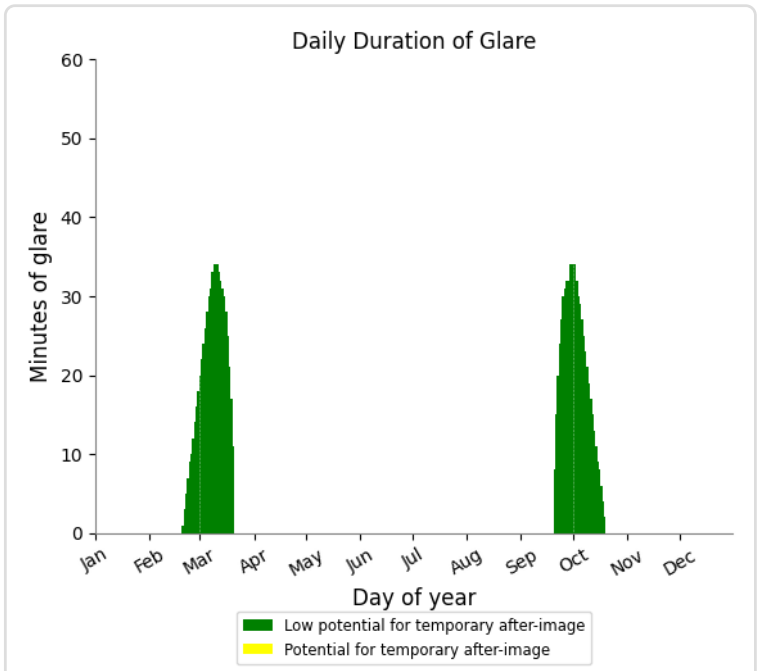


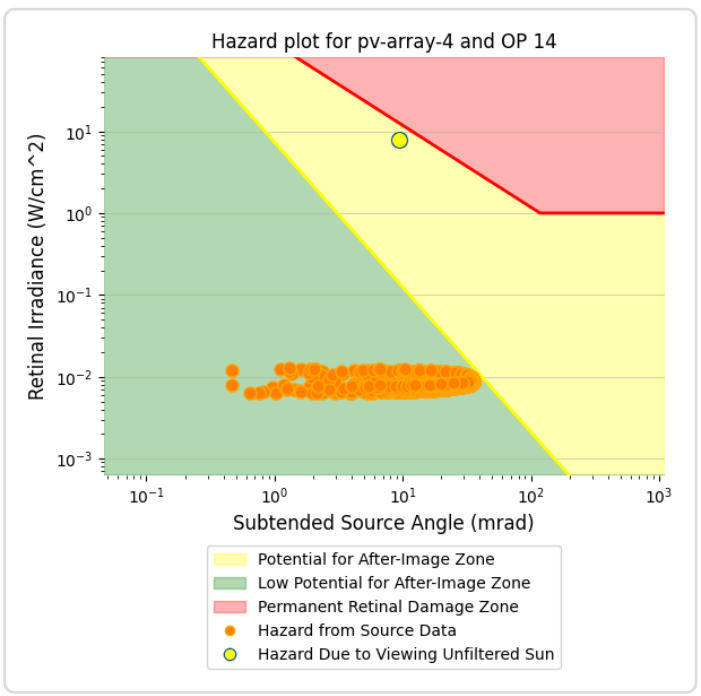
PV array 4 and OP 14

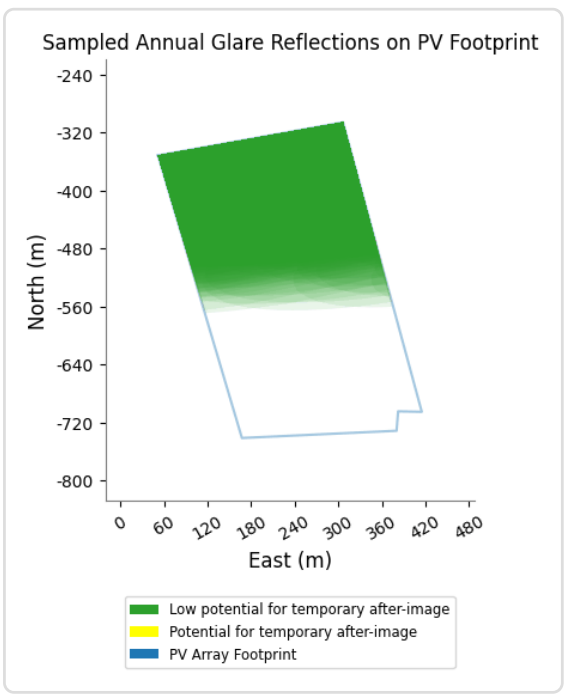
Yellow glare: none

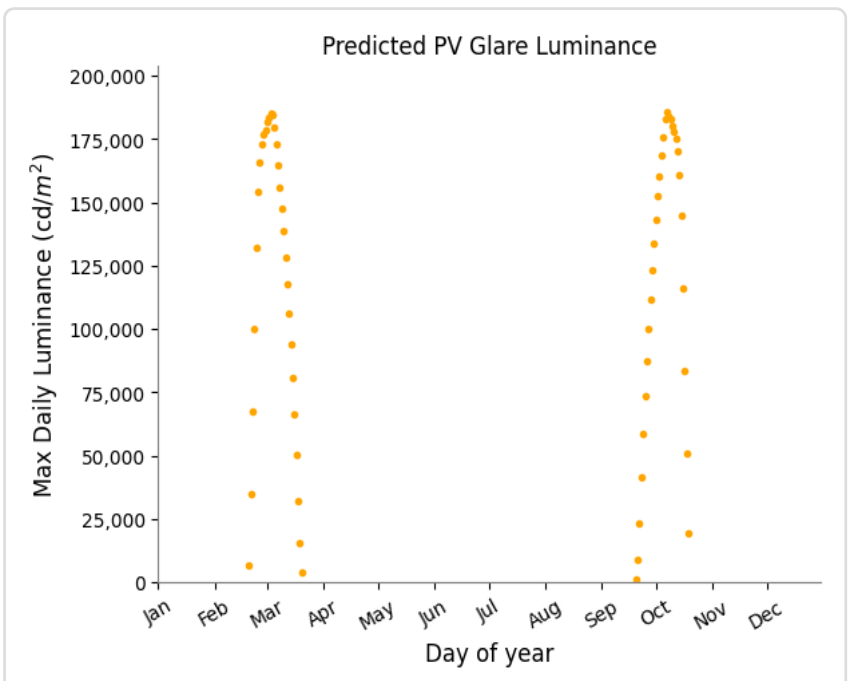
Green glare: 1,285 min.







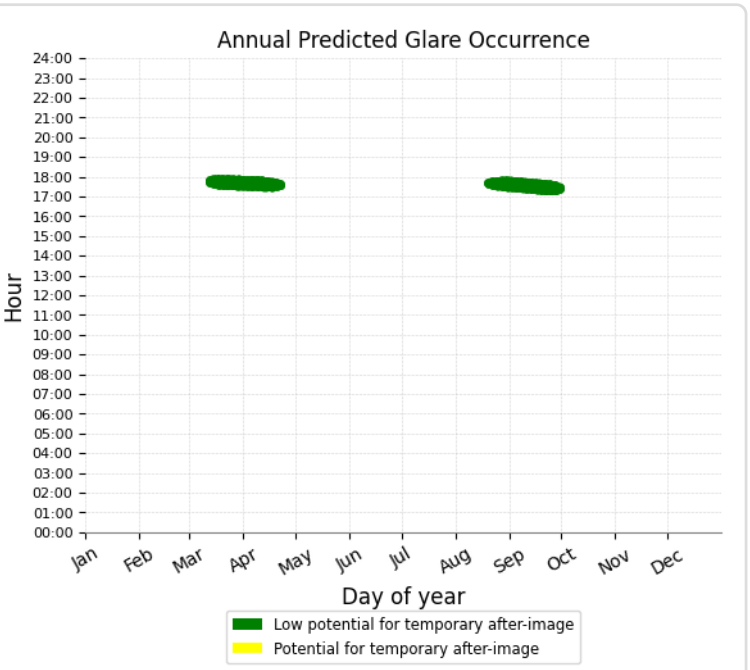


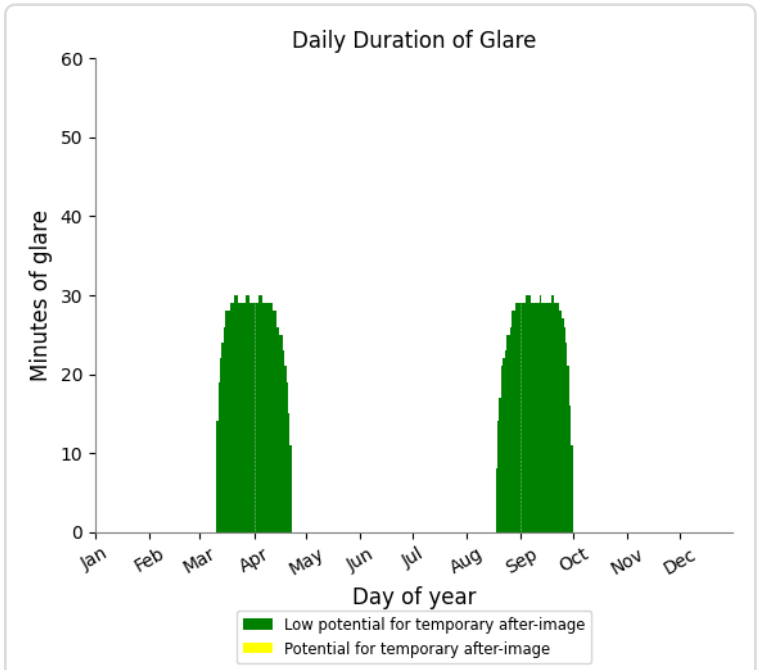


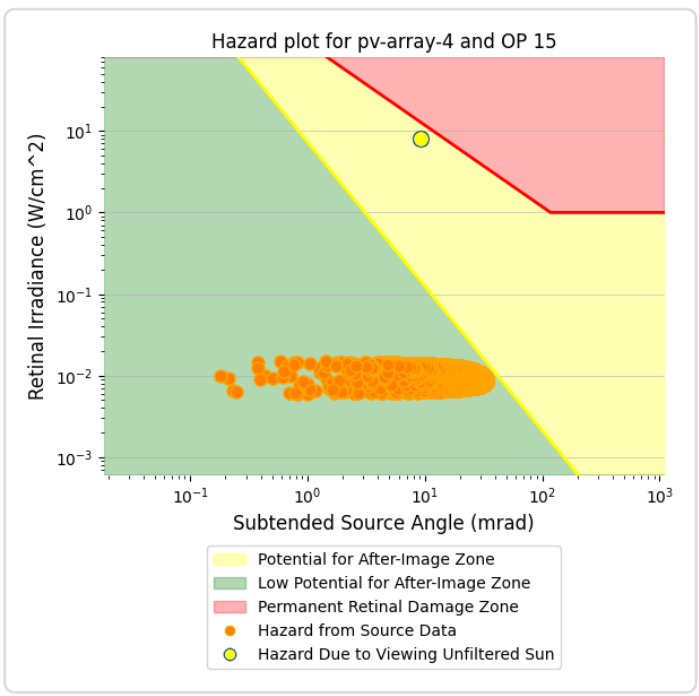
PV array 4 and OP 15

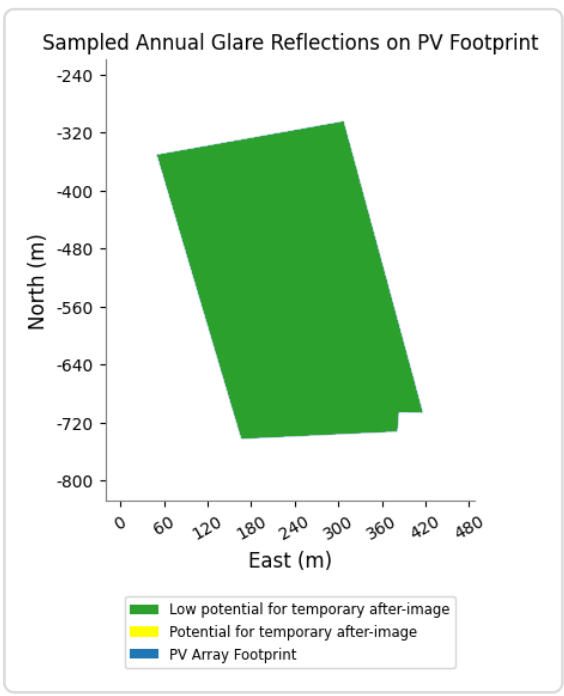
Yellow glare: none

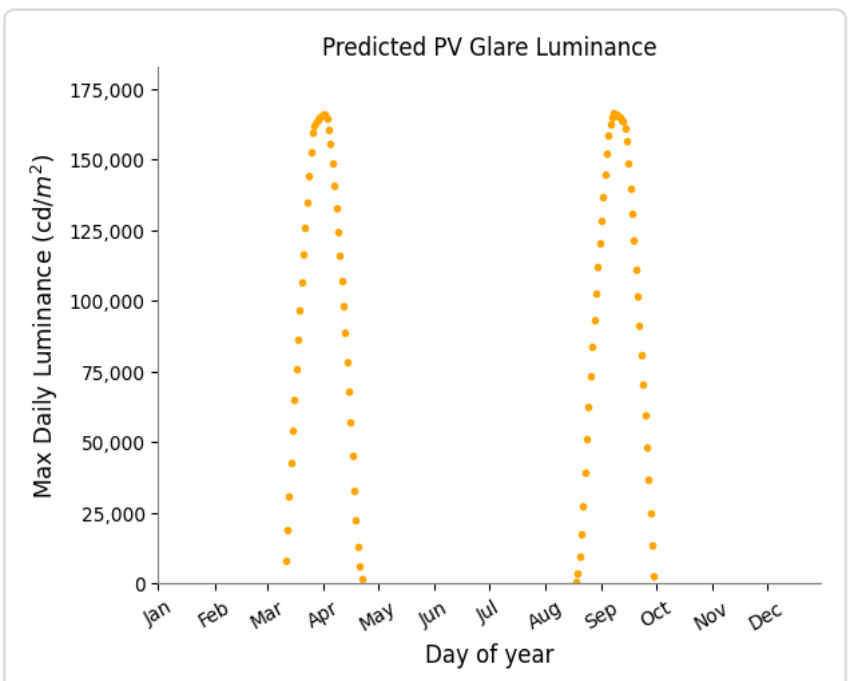
Green glare: 2,286 min.







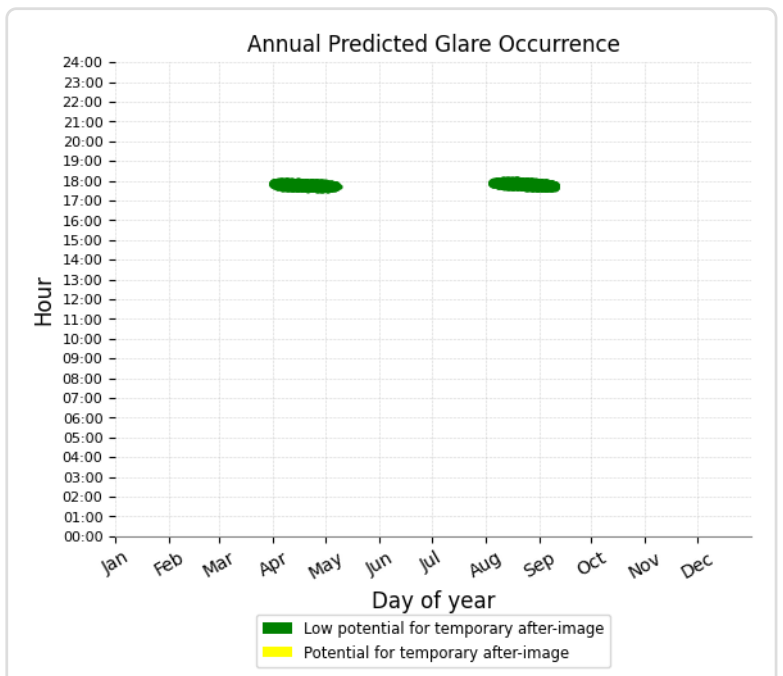


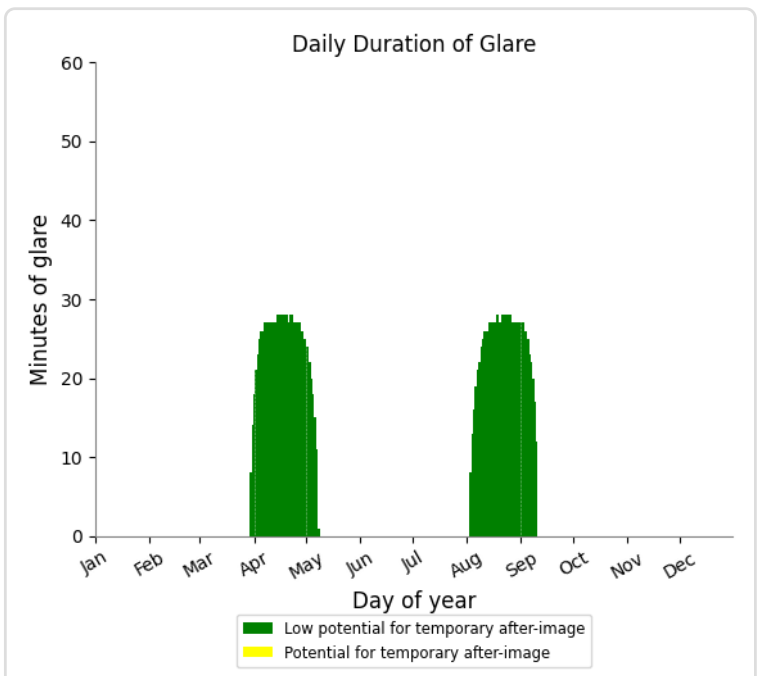


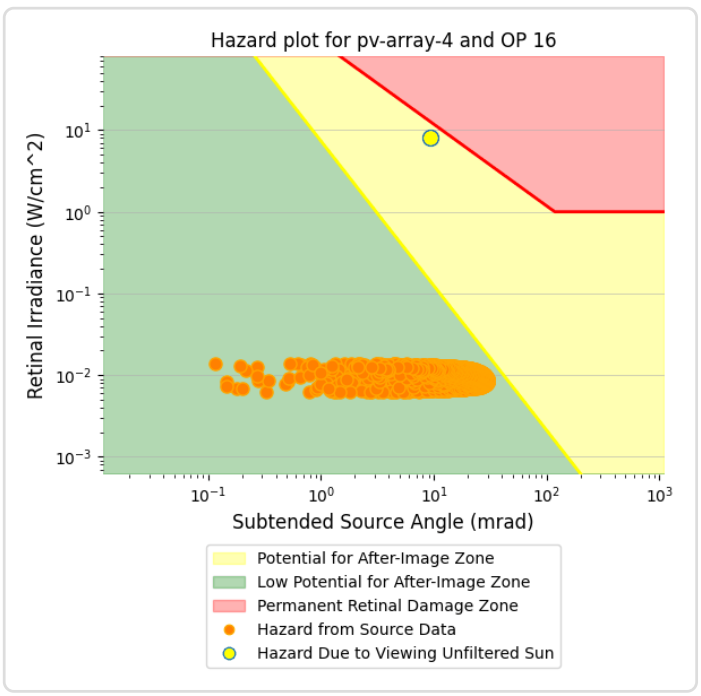
PV array 4 and OP 16

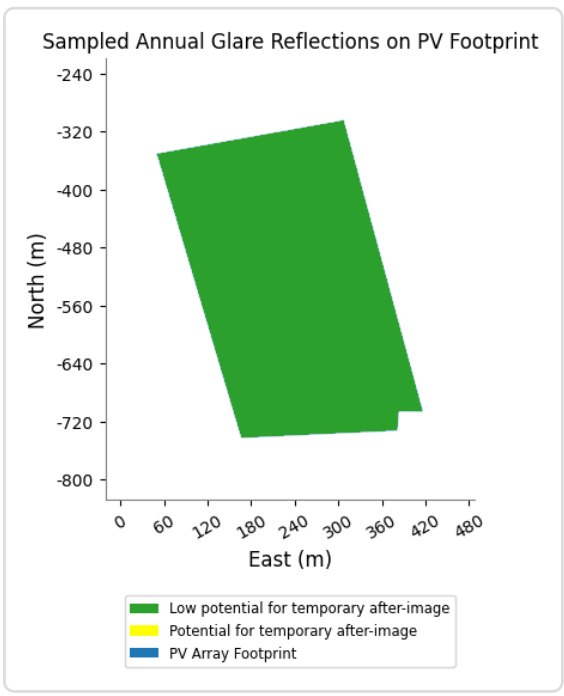
Yellow glare: none

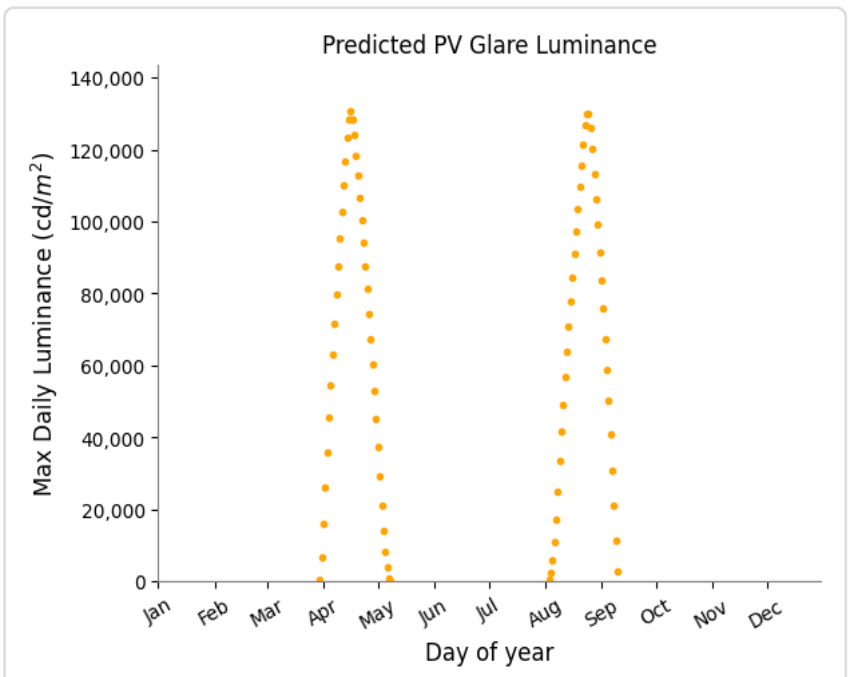
Green glare: 1,894 min.







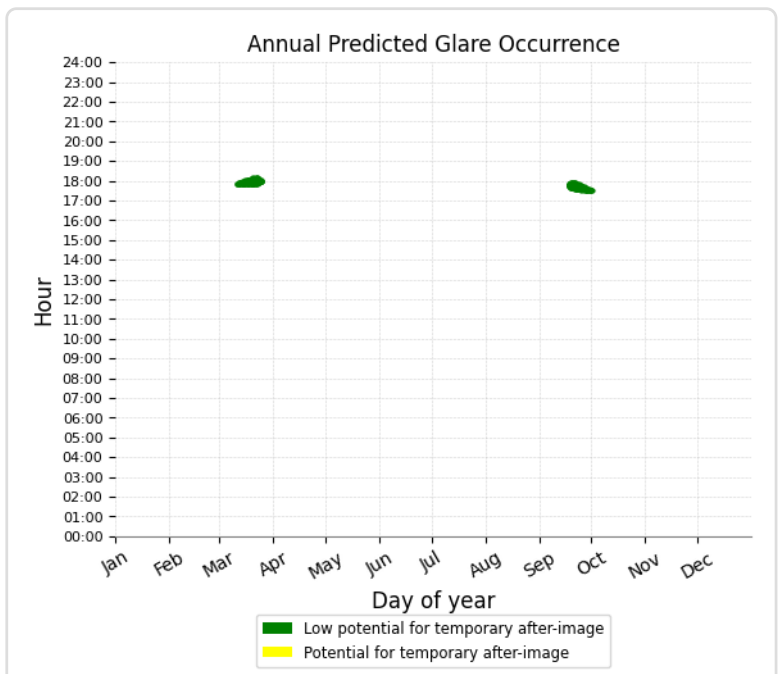


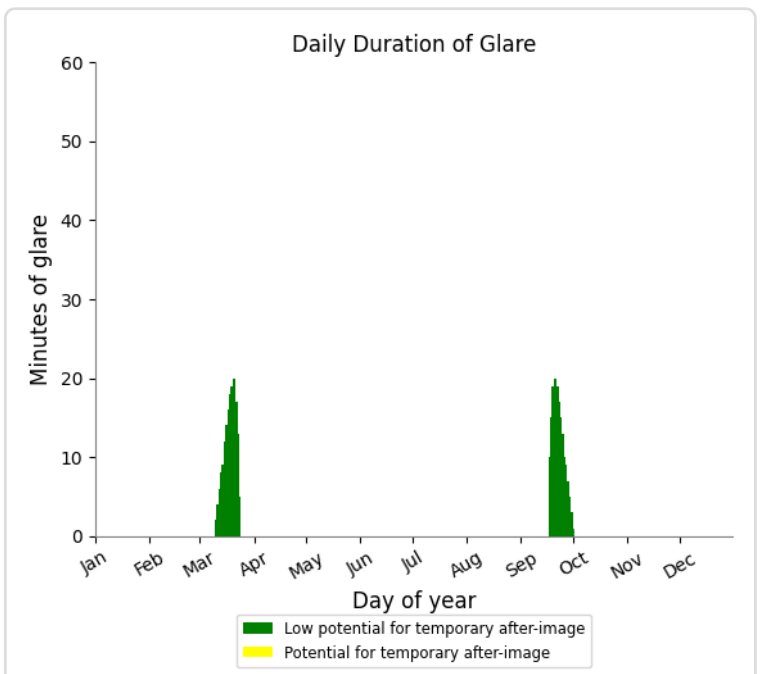


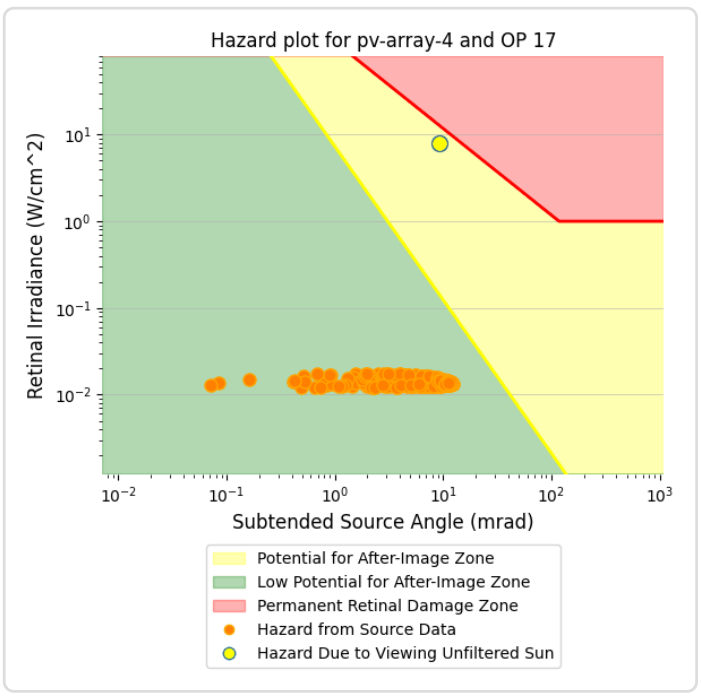
PV array 4 and OP 17

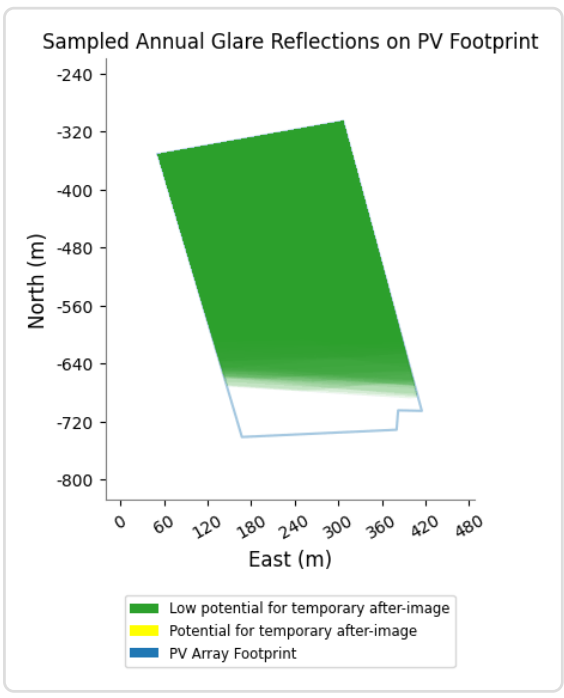
Yellow glare: none

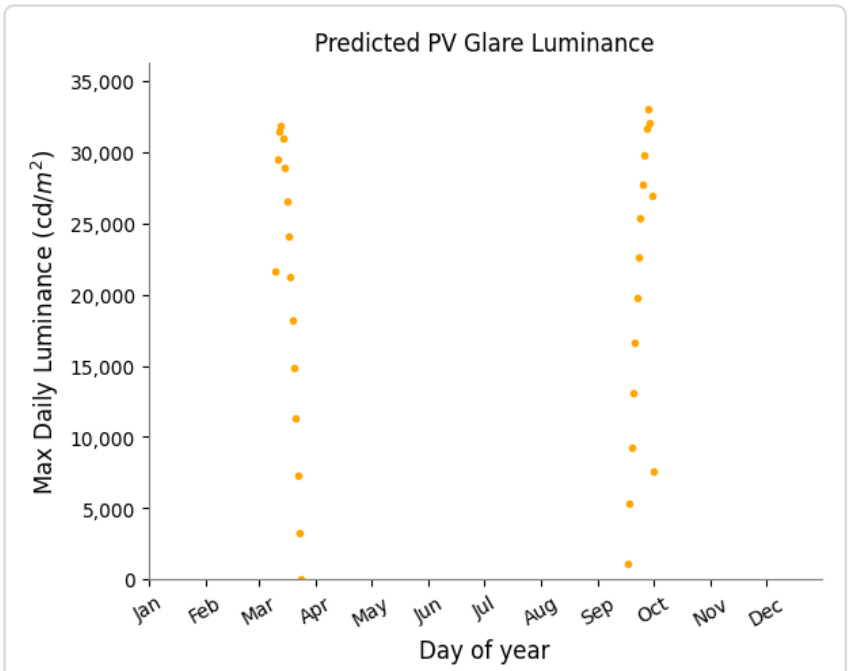
Green glare: 366 min.











PV array 4 and OP 1

No glare found

PV array 4 and OP 2

No glare found

PV array 4 and OP 3

No glare found

PV array 4 and OP 4

No glare found

PV array 4 and OP 5

No glare found

PV array 4 and OP 6

No glare found

PV array 4 and OP 7

No glare found

PV array 4 and OP 9

No glare found

PV array 4 and OP 10

No glare found

PV array 4 and OP 11

No glare found

PV array 4 and OP 12

No glare found

PV array 4 and OP 13

No glare found

PV array 4 and OP 18

No glare found

PV array 4 and OP 19

No glare found

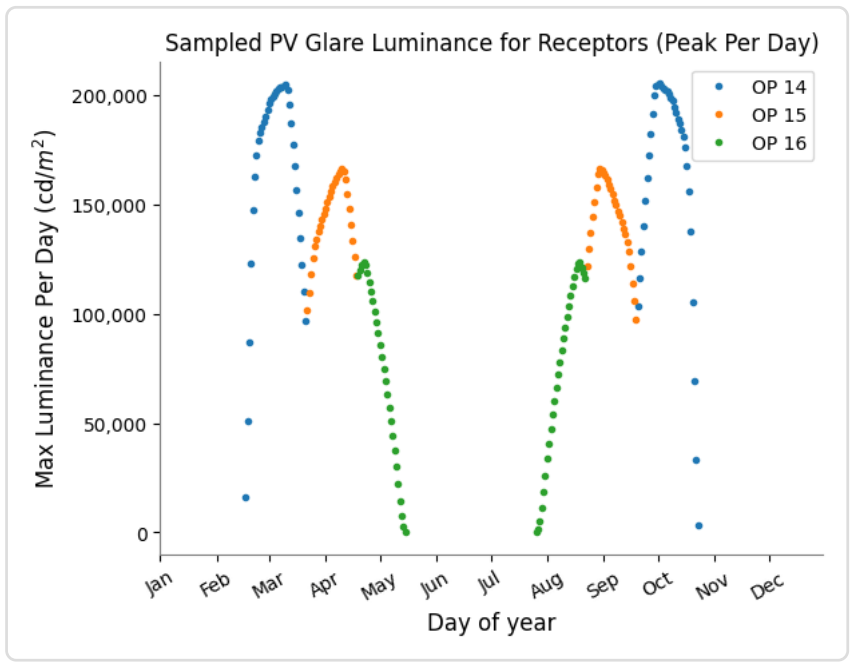
PV array 4 and OP 20

No glare found

PV: PV array 5 low potential for temporary after-image

Receptor results ordered by category of glare

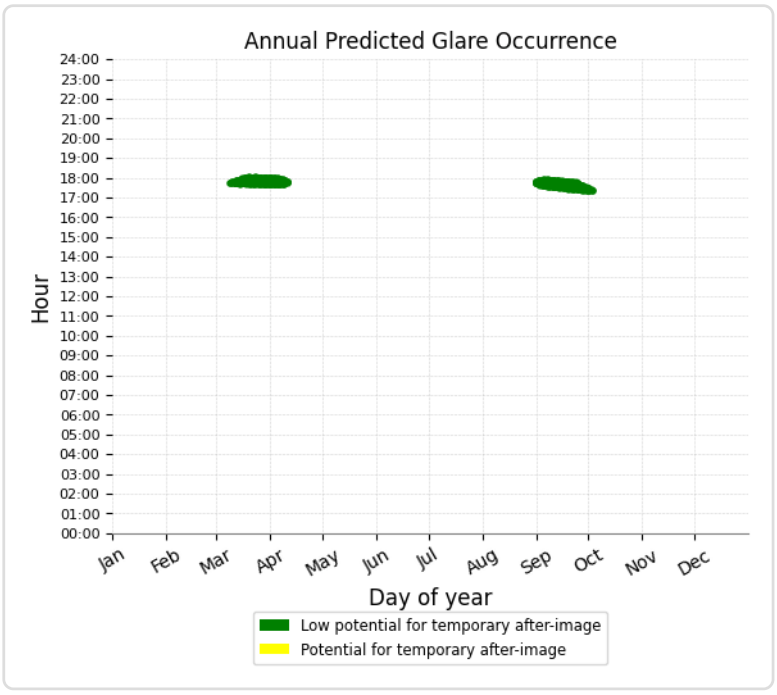
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,475	24.6	0	0.0	105,001
OP 14	1,966	32.8	0	0.0	205,269
OP 15	2,661	44.4	0	0.0	166,687
OP 16	2,172	36.2	0	0.0	123,648
OP 17	399	6.7	0	0.0	34,955
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

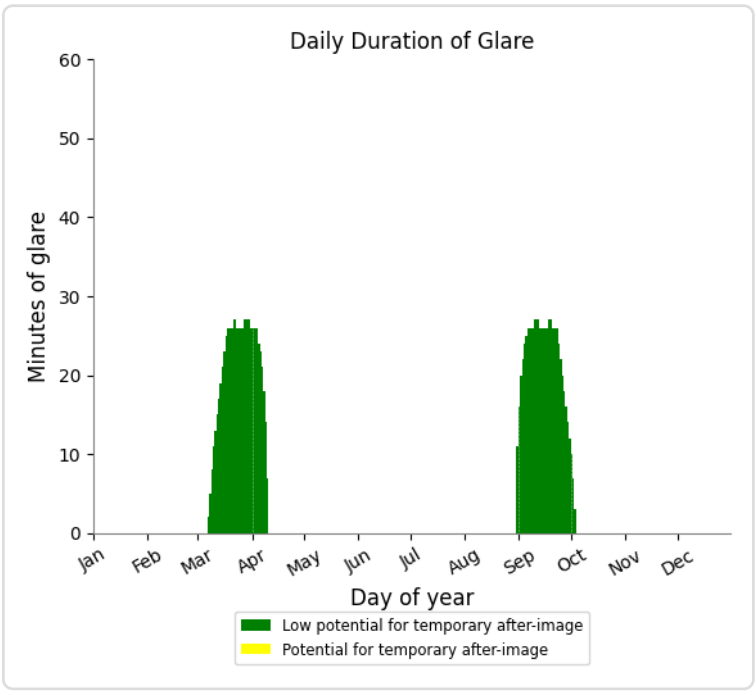


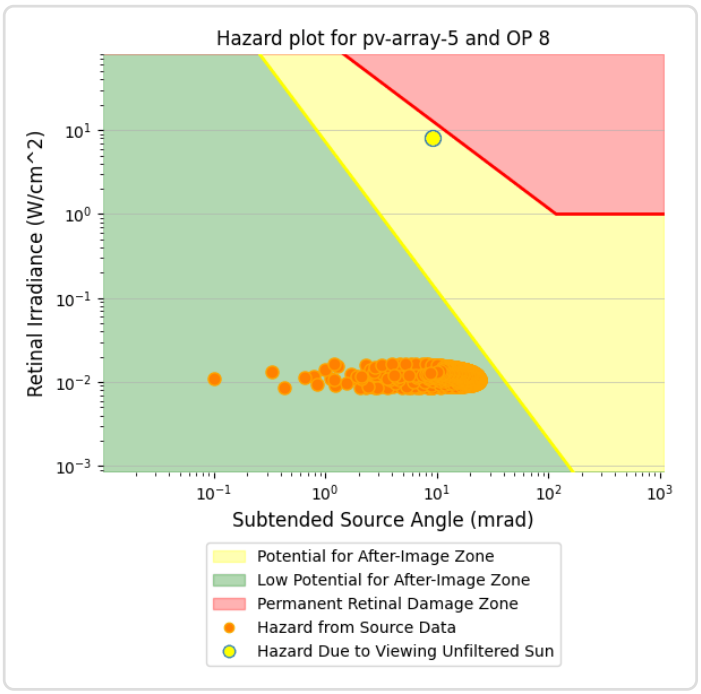
PV array 5 and OP 8

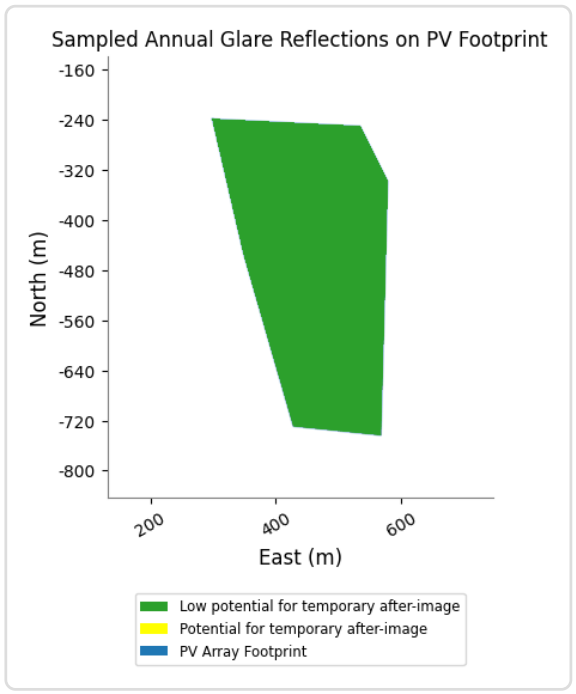
Yellow glare: none

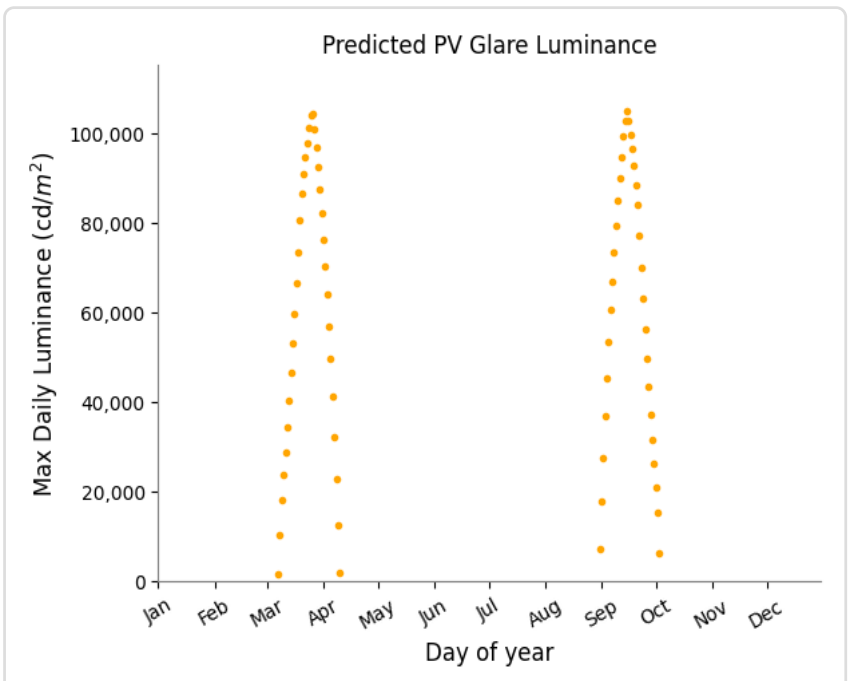
Green glare: 1,475 min.







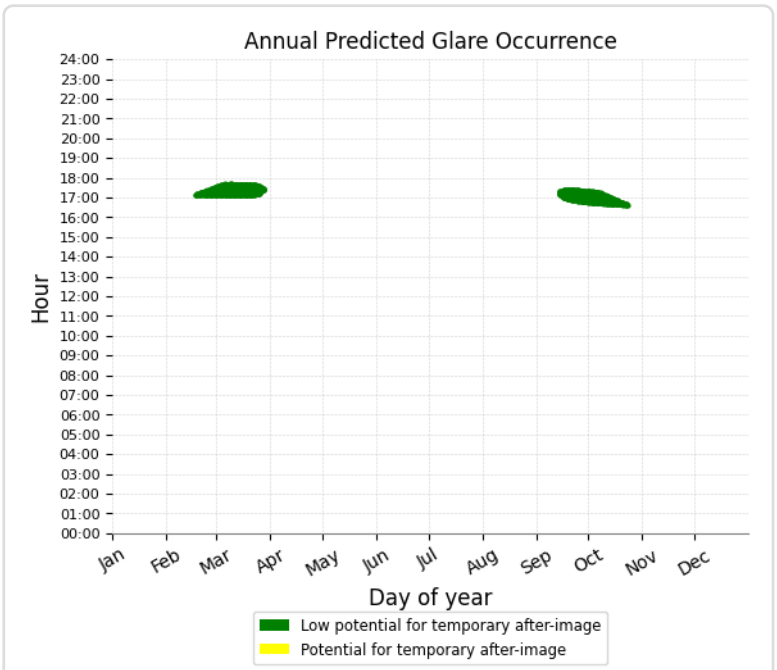


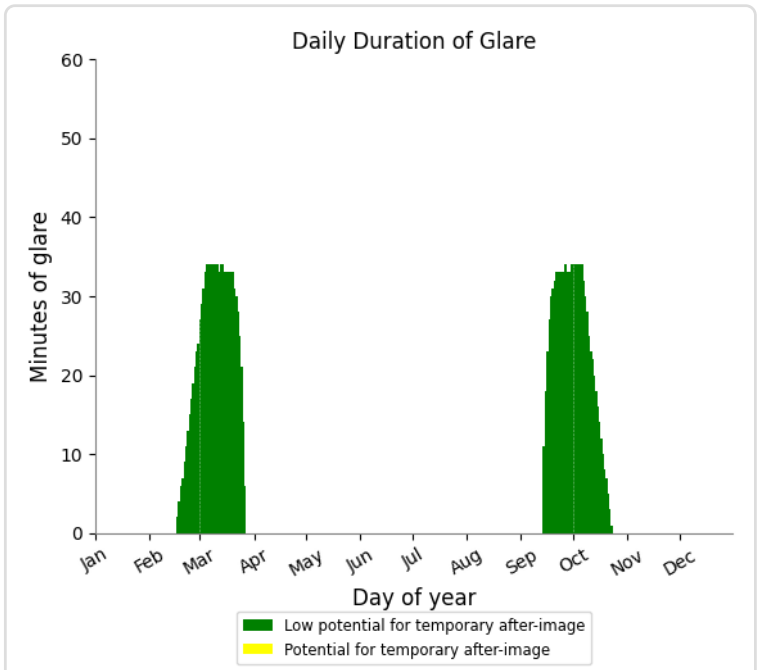


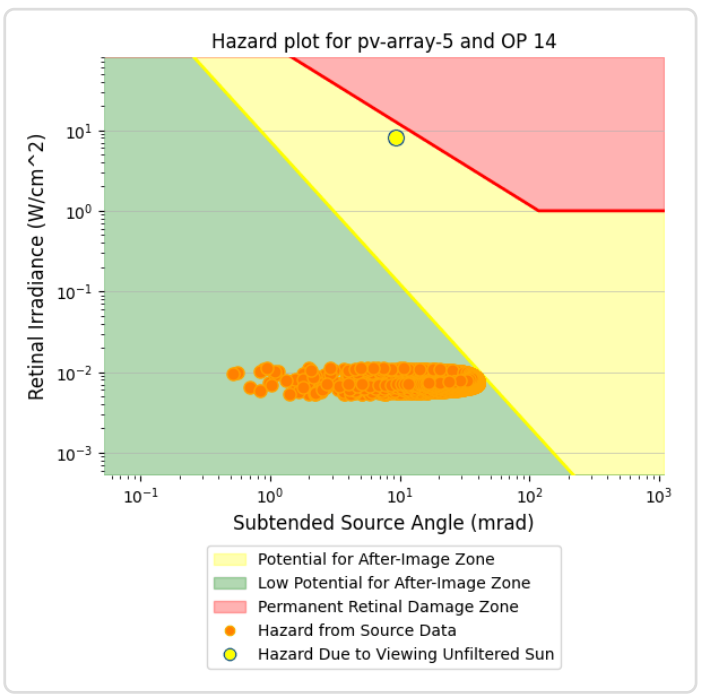
PV array 5 and OP 14

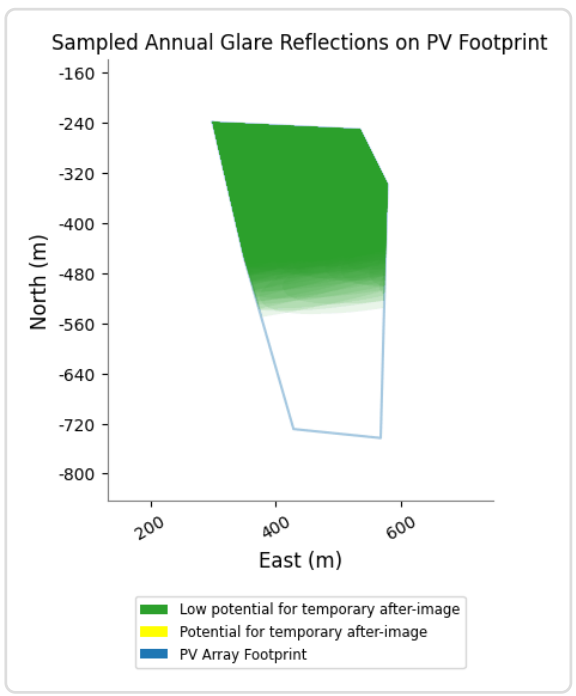
Yellow glare: none

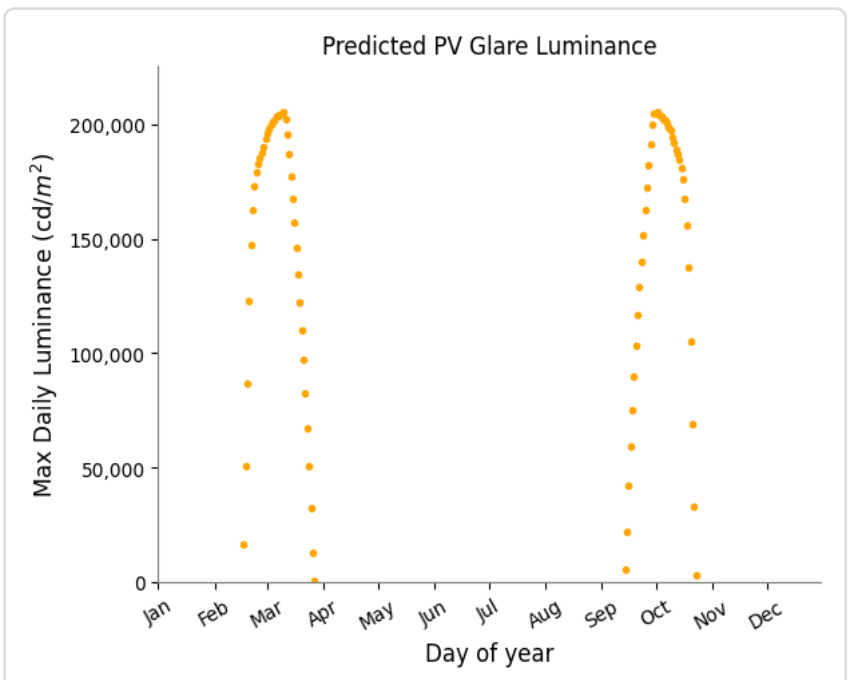
Green glare: 1,966 min.







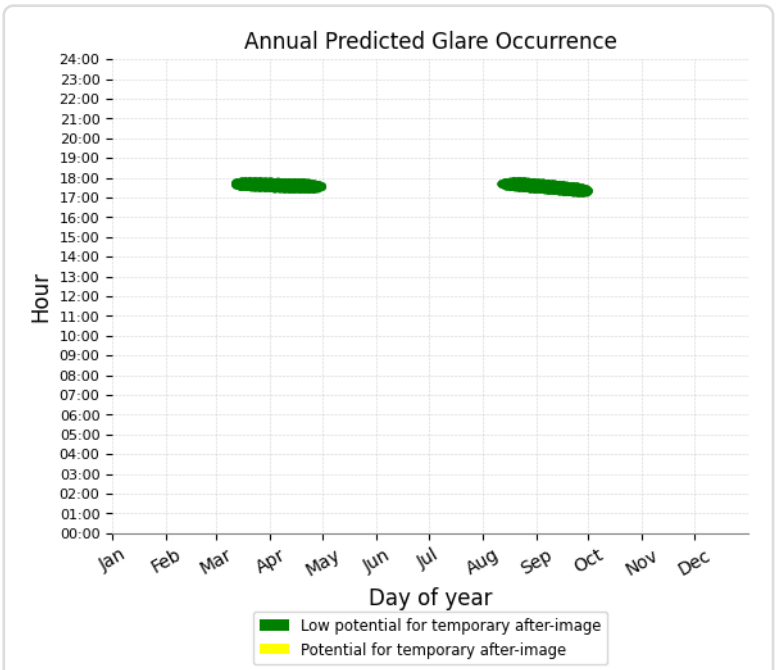


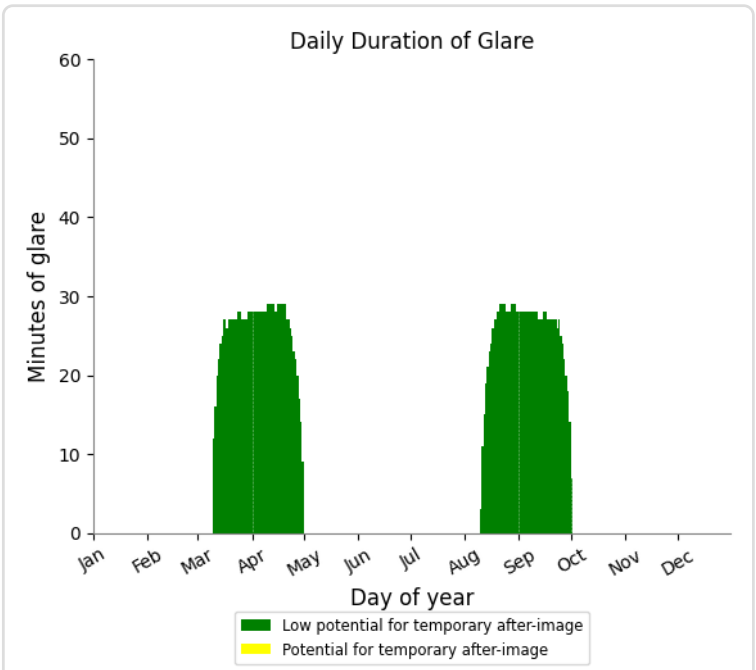


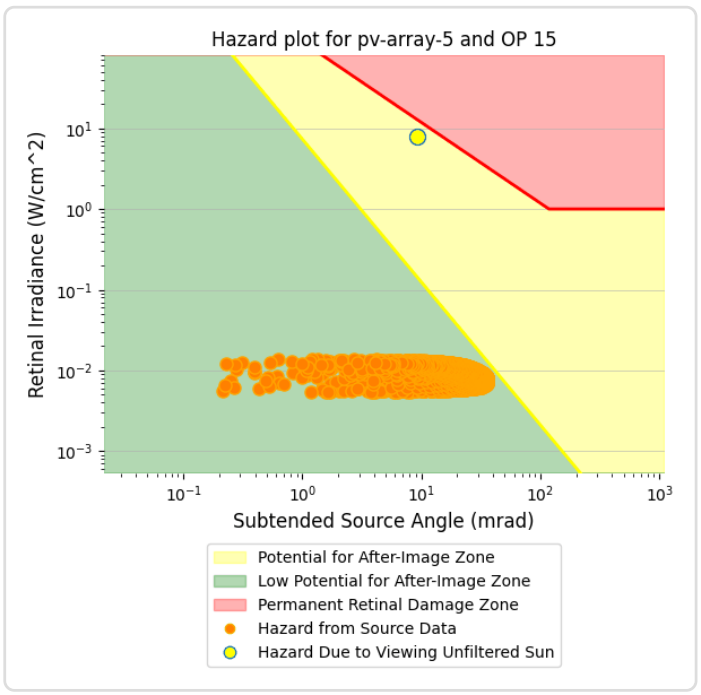
PV array 5 and OP 15

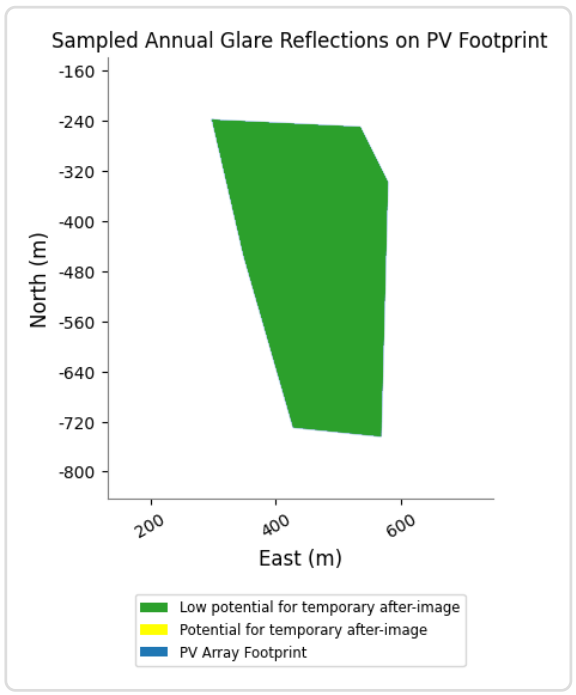
Yellow glare: none

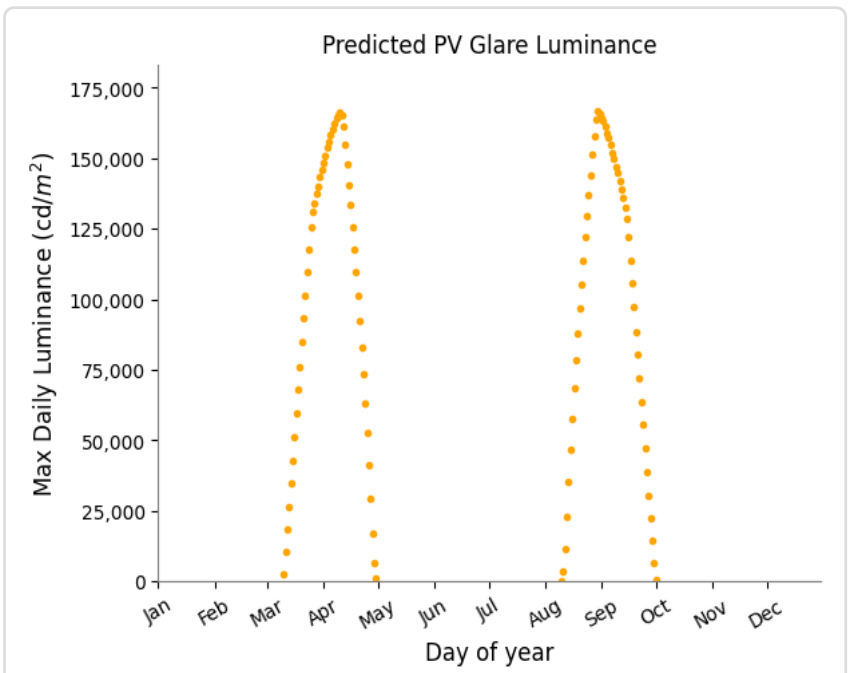
Green glare: 2,661 min.







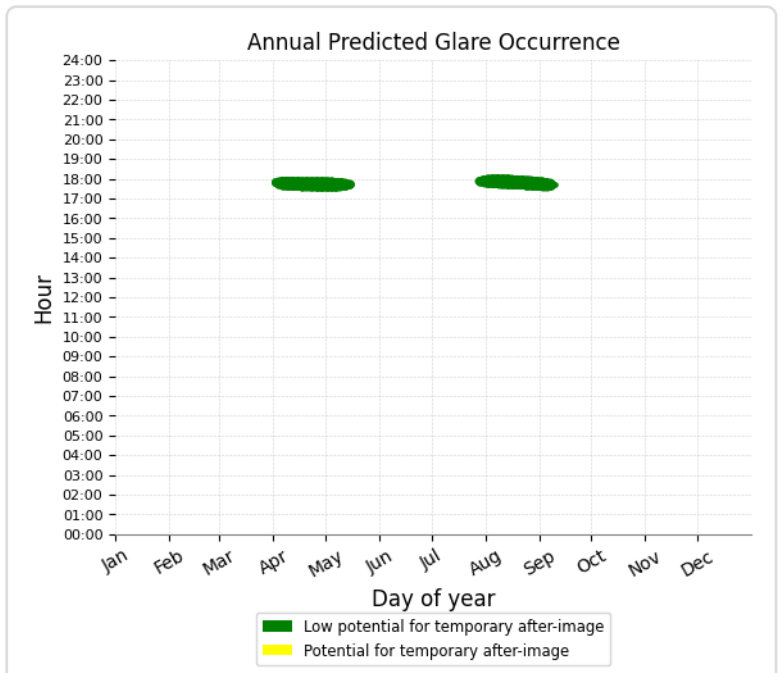


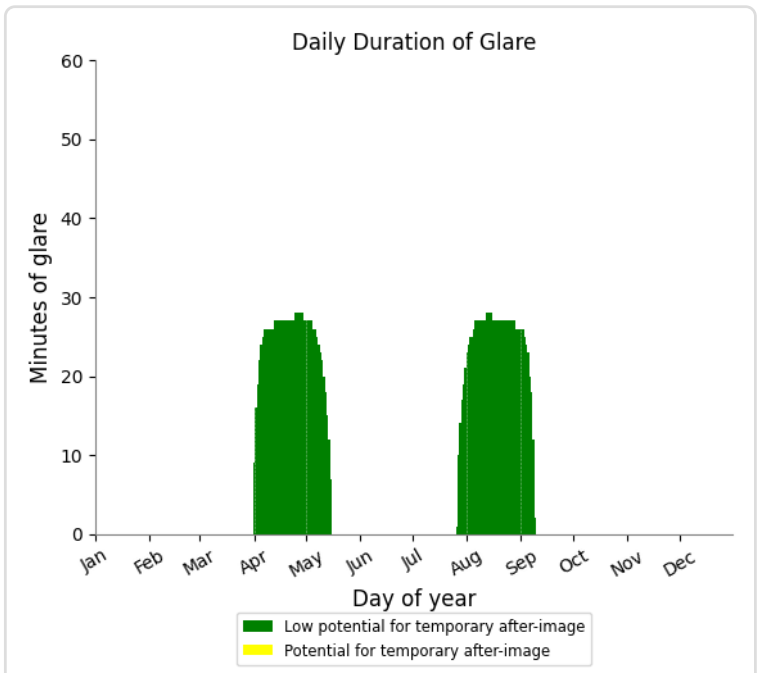


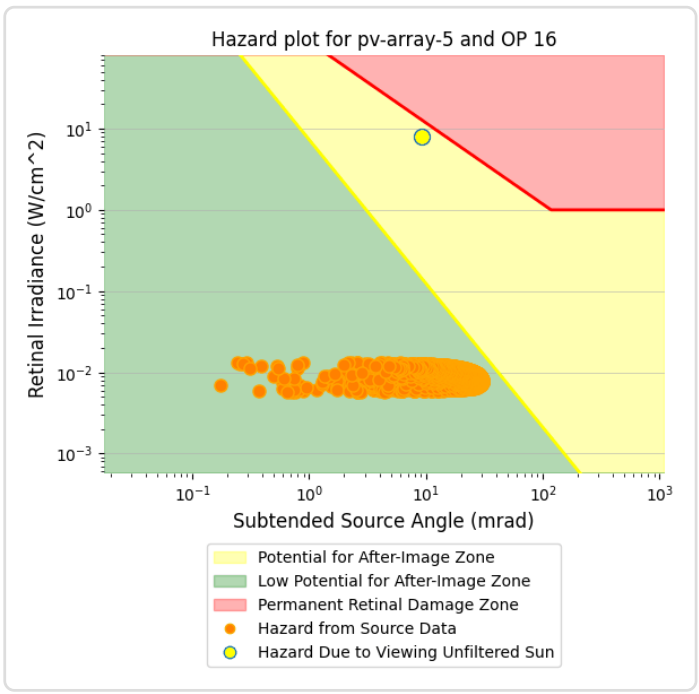
PV array 5 and OP 16

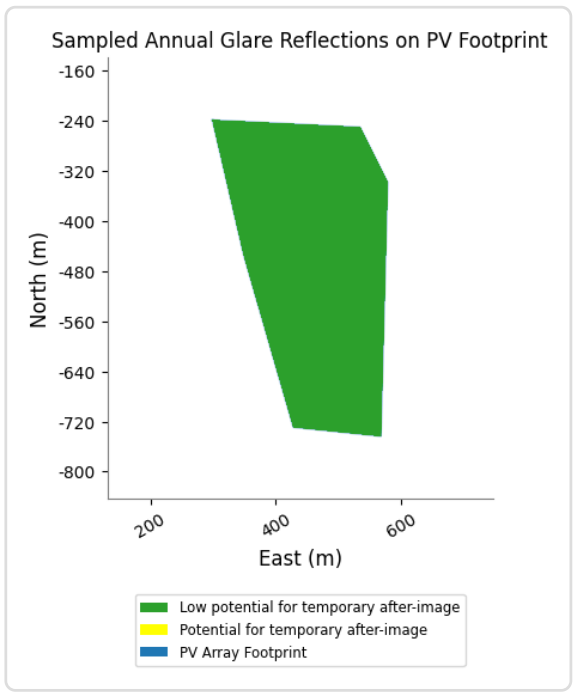
Yellow glare: none

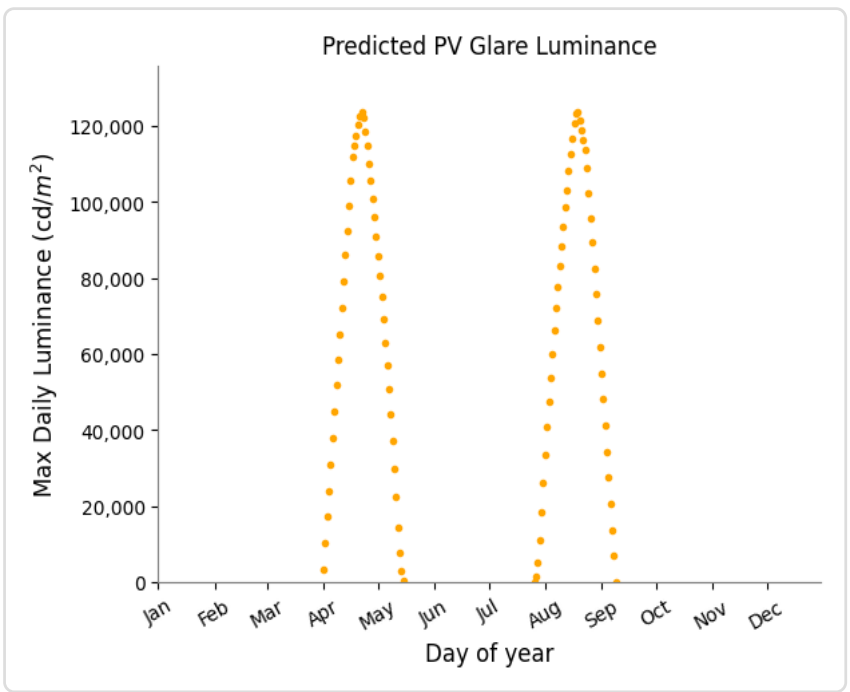
Green glare: 2,172 min.







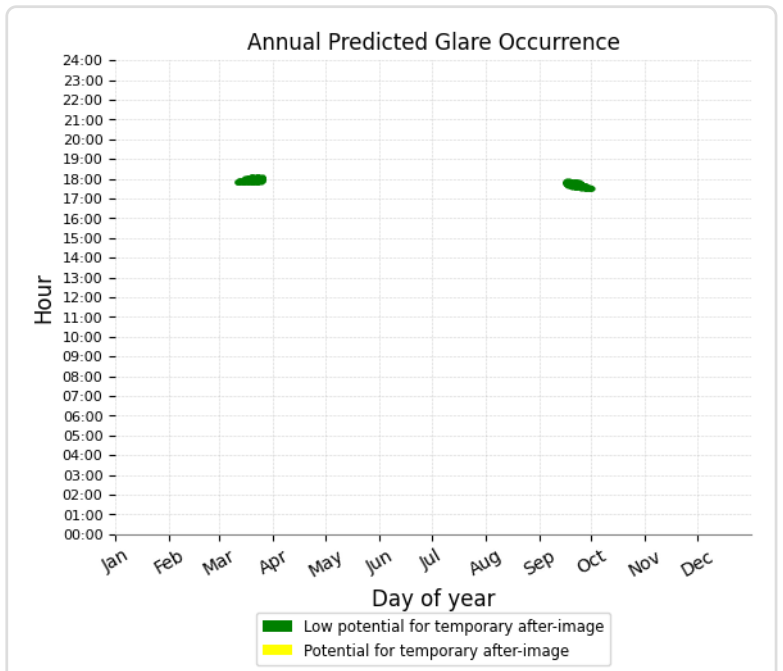


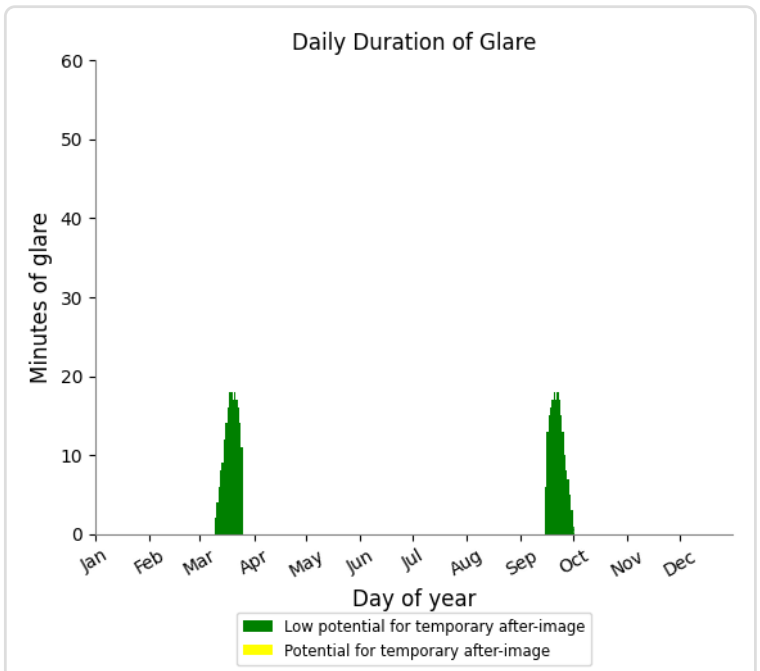


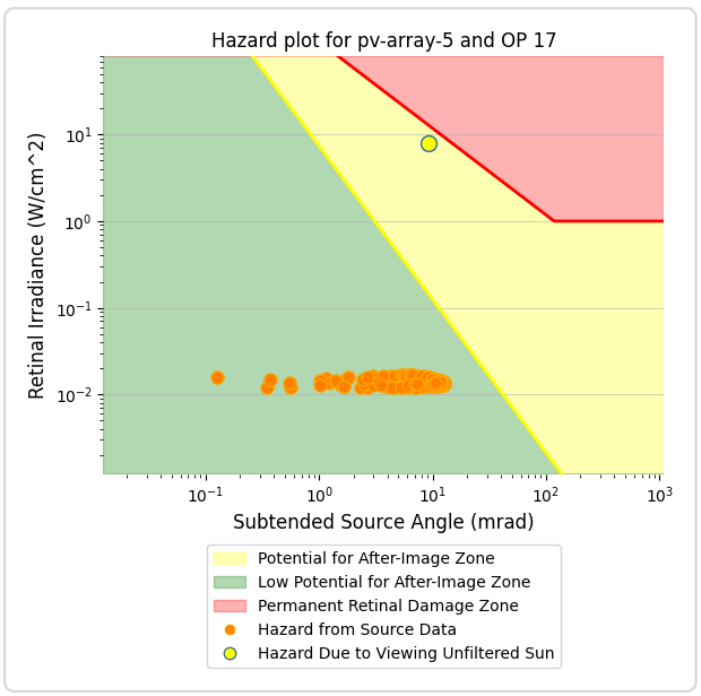
PV array 5 and OP 17

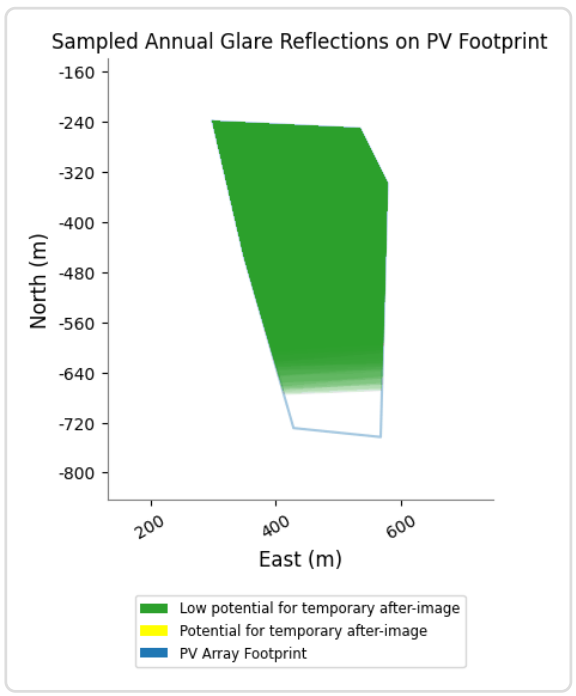
Yellow glare: none

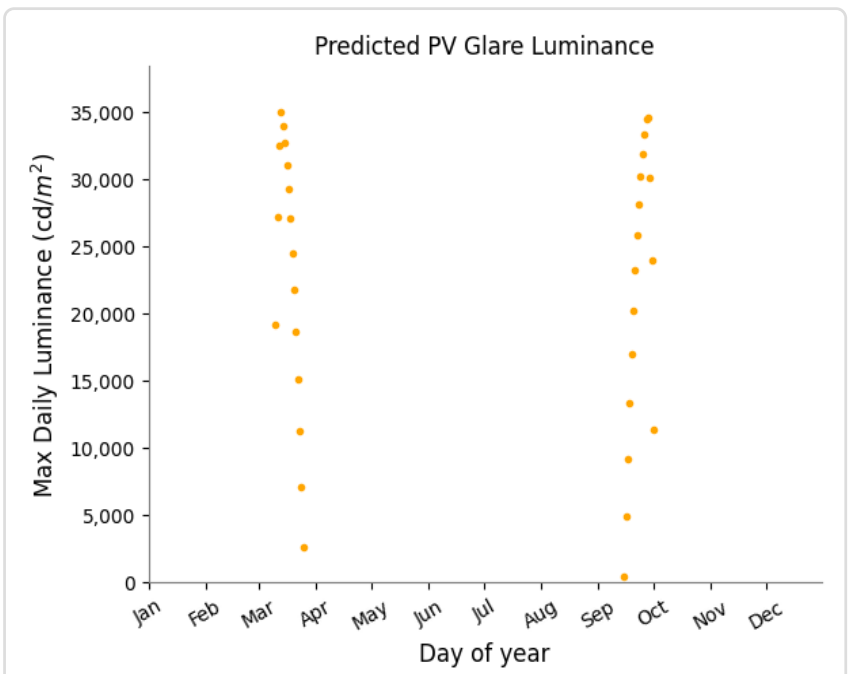
Green glare: 399 min.











PV array 5 and OP 1

No glare found

PV array 5 and OP 2

No glare found

PV array 5 and OP 3

No glare found

PV array 5 and OP 4

No glare found

PV array 5 and OP 5

No glare found

PV array 5 and OP 6

No glare found

PV array 5 and OP 7

No glare found

PV array 5 and OP 9

No glare found

PV array 5 and OP 10

No glare found

PV array 5 and OP 11

No glare found

PV array 5 and OP 12

No glare found

PV array 5 and OP 13

No glare found

PV array 5 and OP 18

No glare found

PV array 5 and OP 19

No glare found

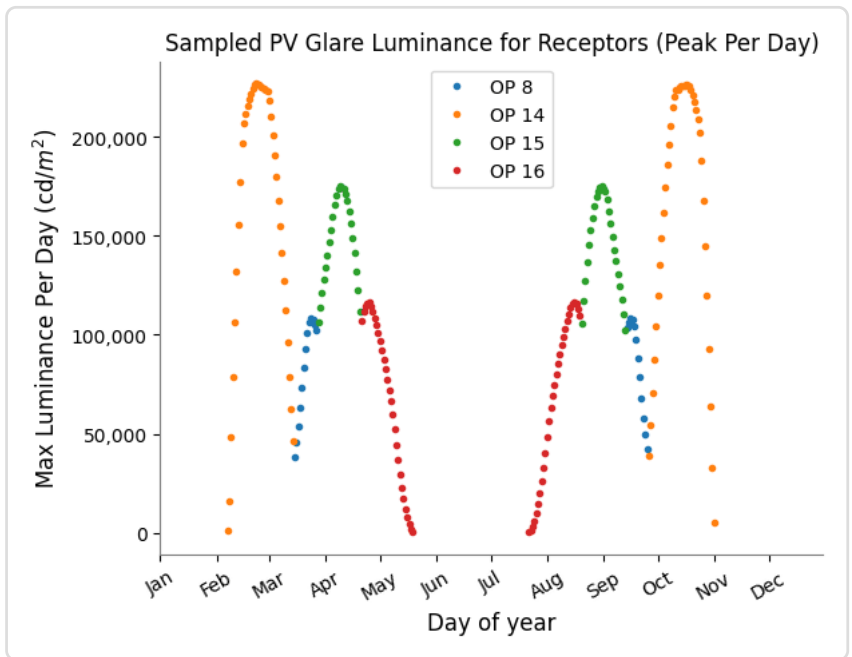
PV array 5 and OP 20

No glare found

PV: PV array 6 low potential for temporary after-image

Receptor results ordered by category of glare

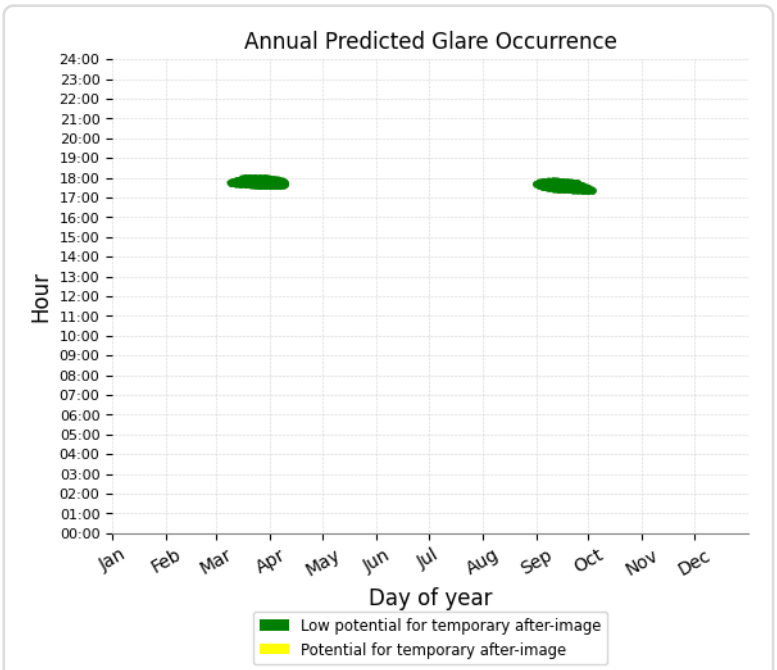
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,519	25.3	0	0.0	108,635
OP 14	2,765	46.1	0	0.0	226,980
OP 15	2,882	48.0	0	0.0	175,008
OP 16	2,392	39.9	0	0.0	116,307
OP 17	395	6.6	0	0.0	32,962
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

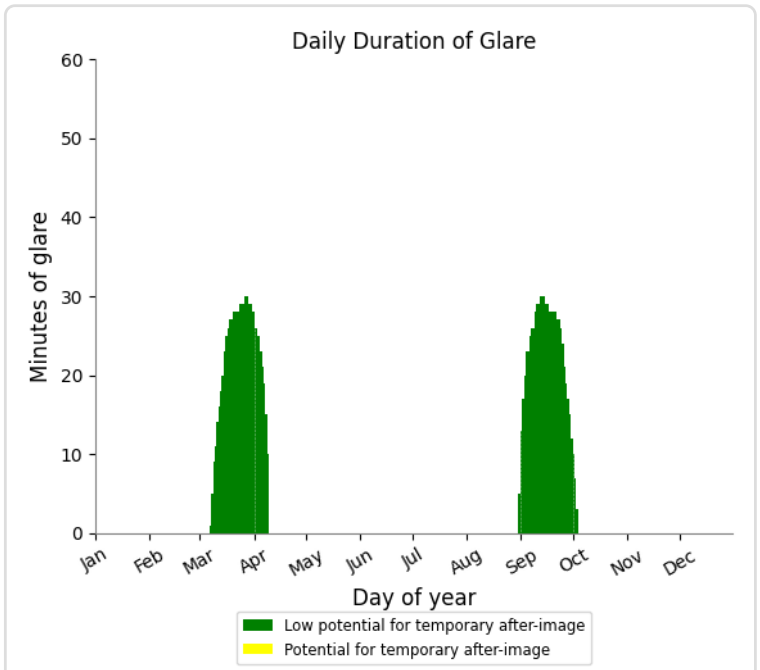


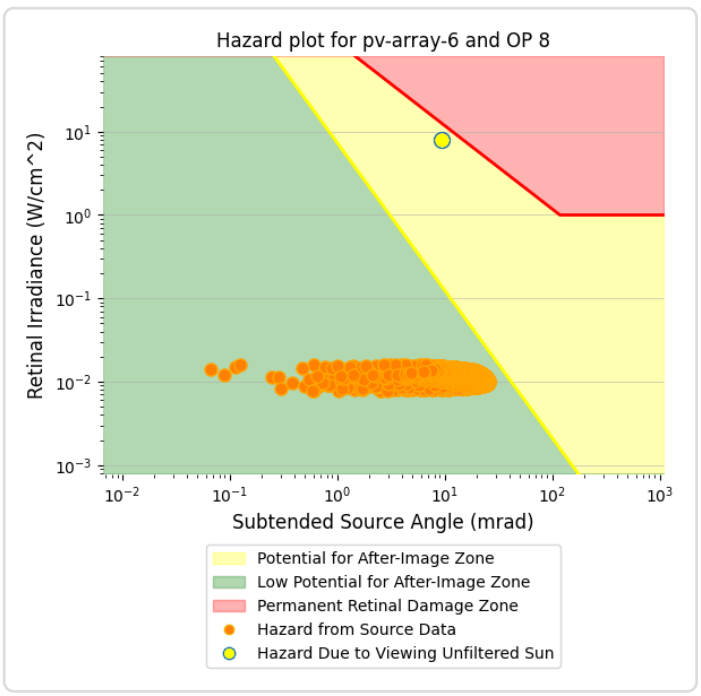
PV array 6 and OP 8

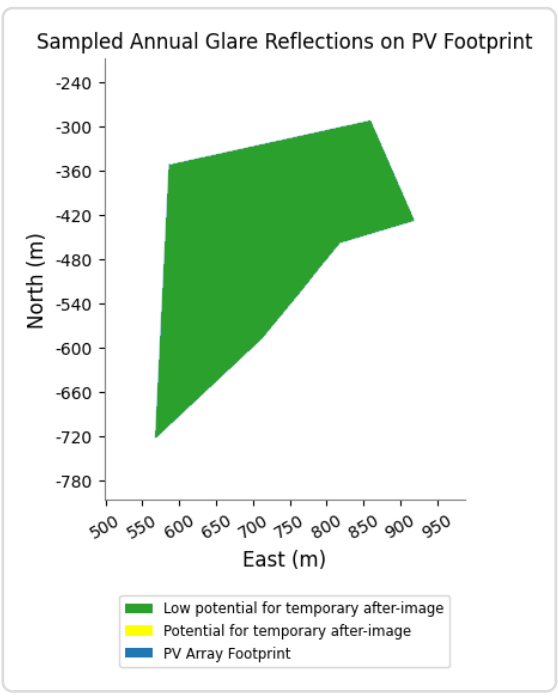
Yellow glare: none

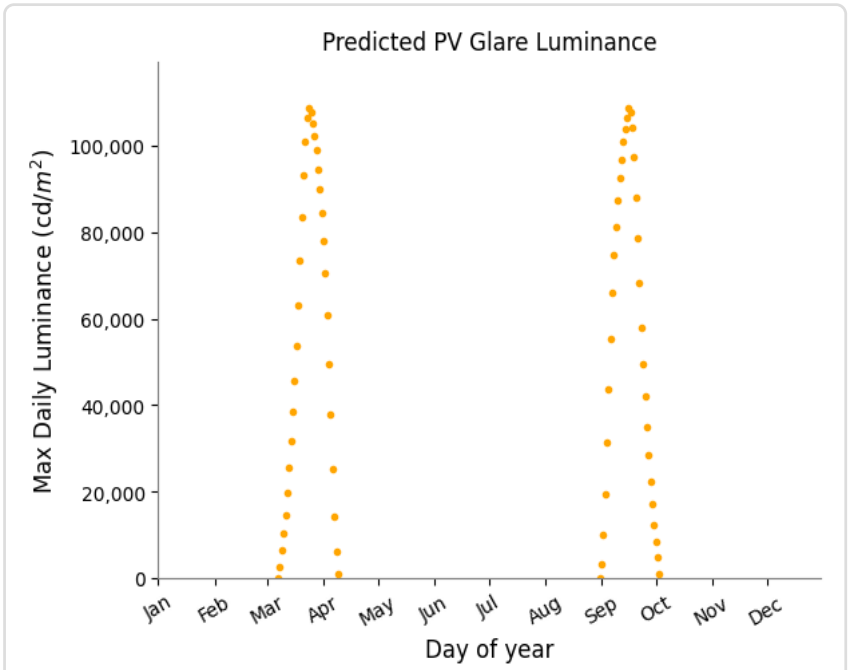
Green glare: 1,519 min.







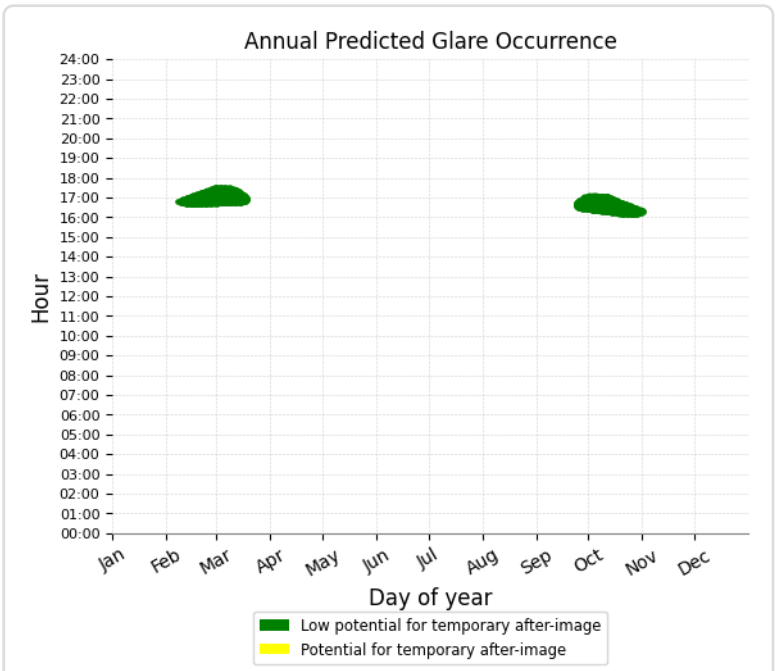


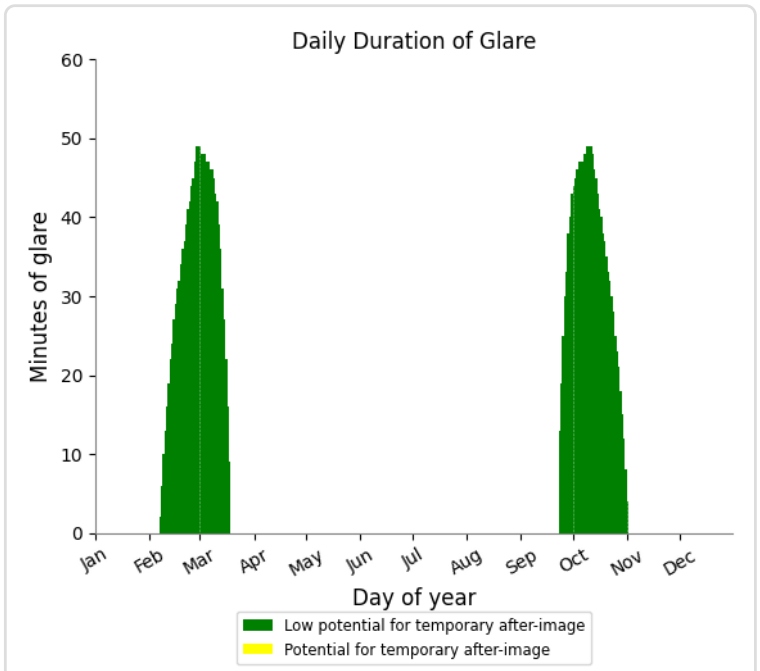


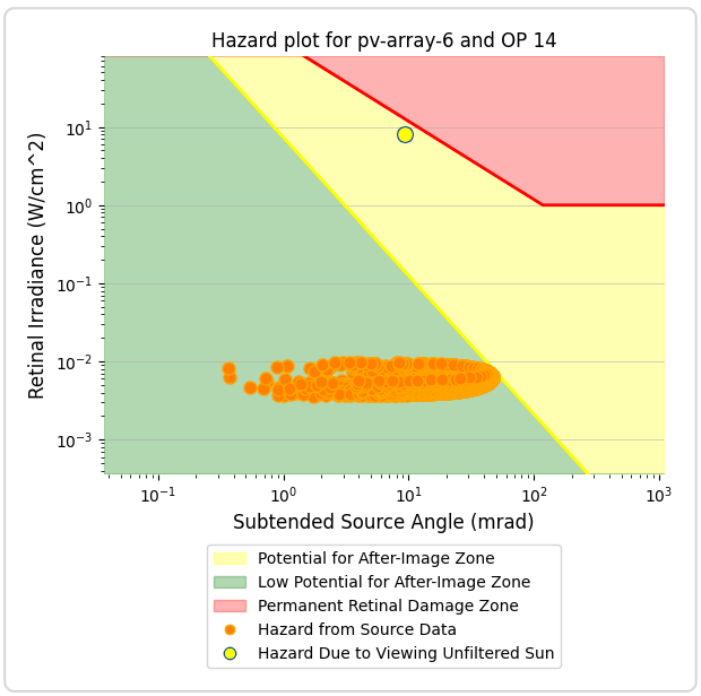
PV array 6 and OP 14

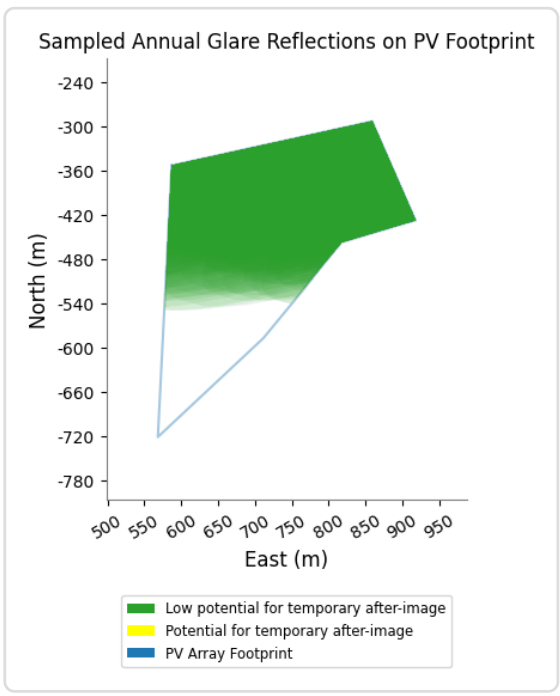
Yellow glare: none

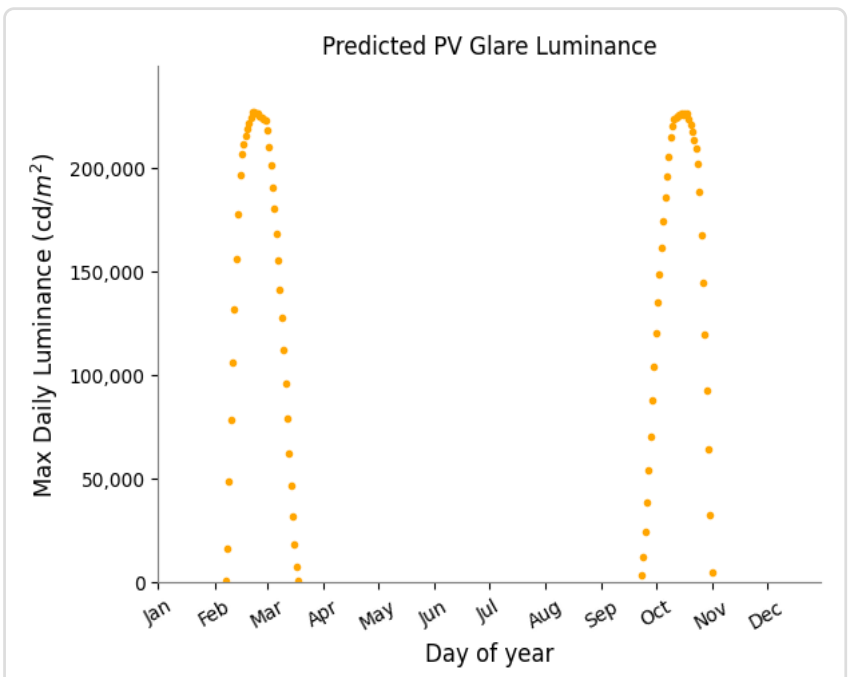
Green glare: 2,765 min.







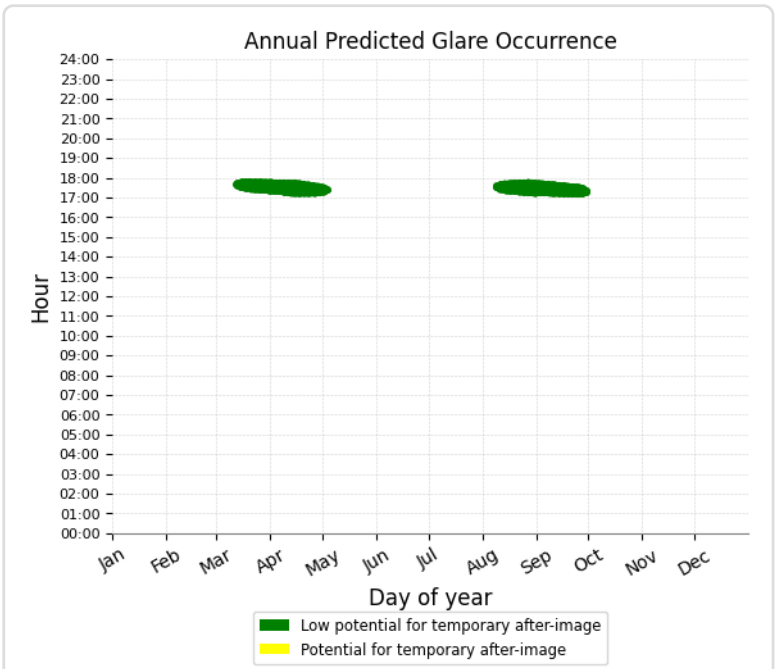


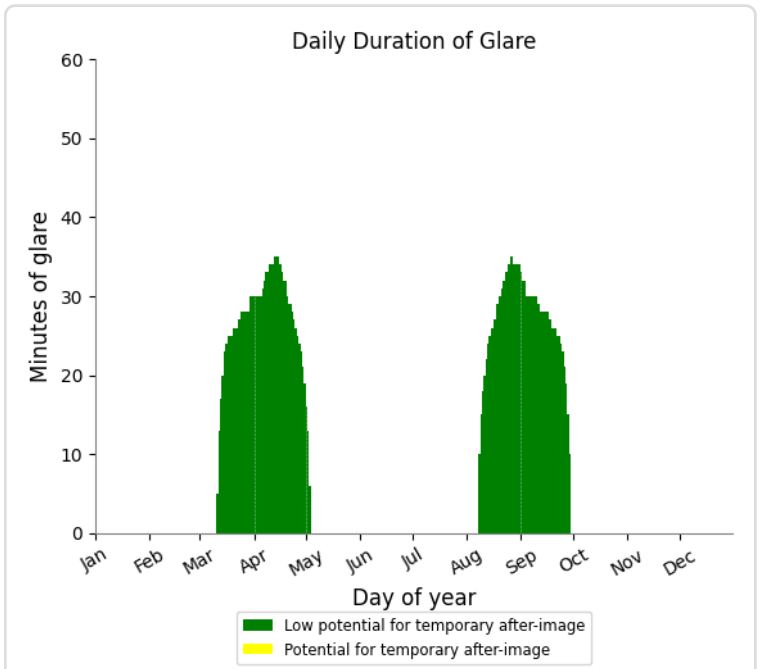


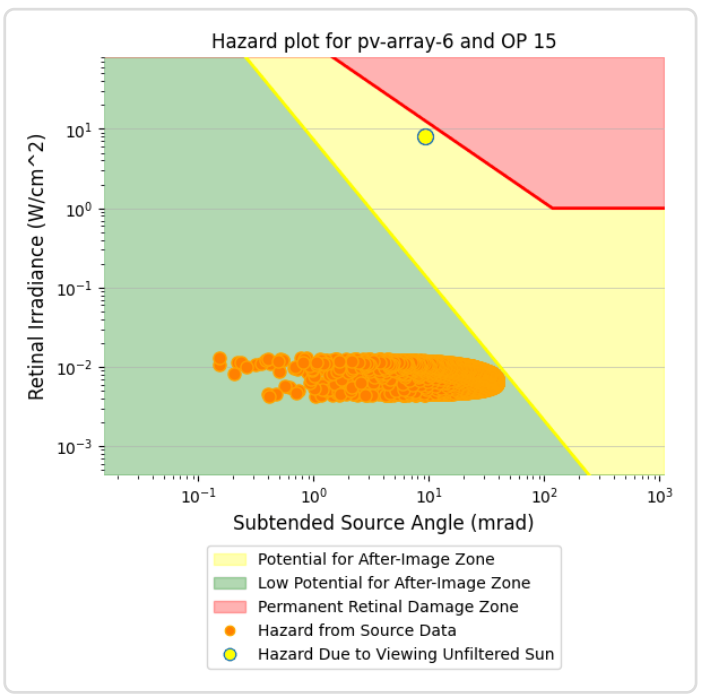
PV array 6 and OP 15

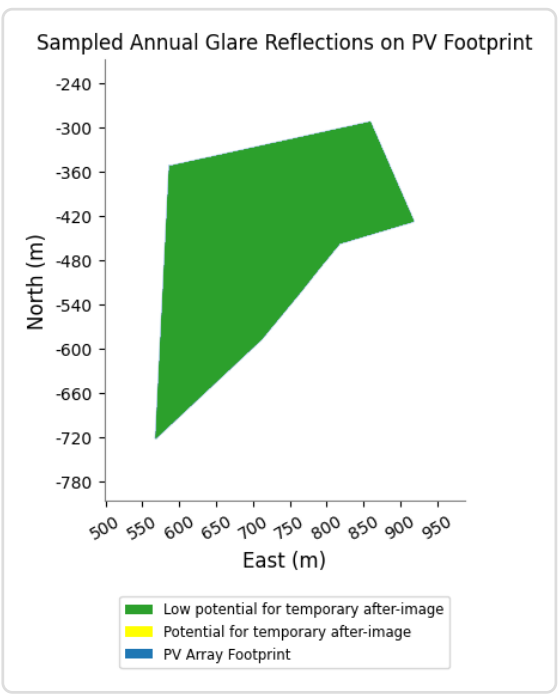
Yellow glare: none

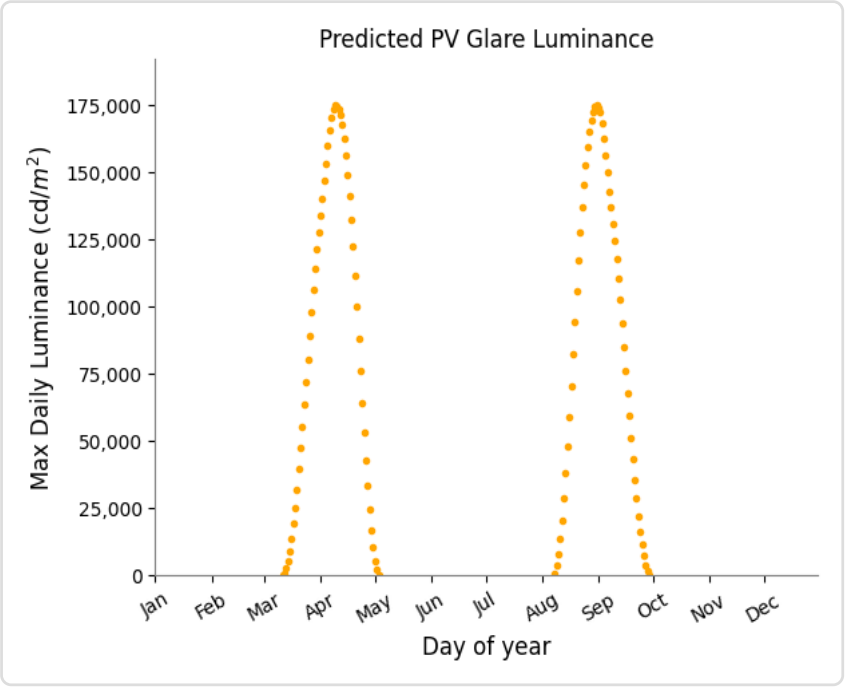
Green glare: 2,882 min.







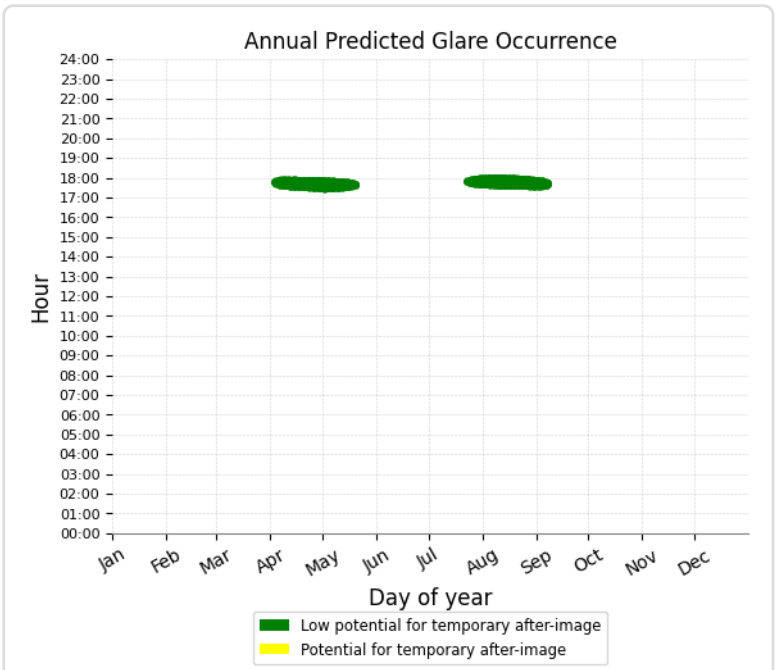


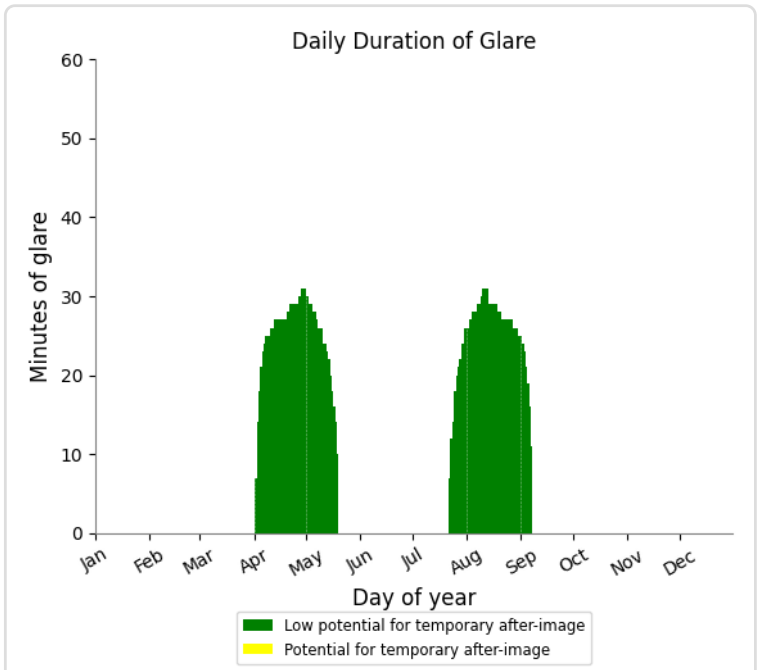


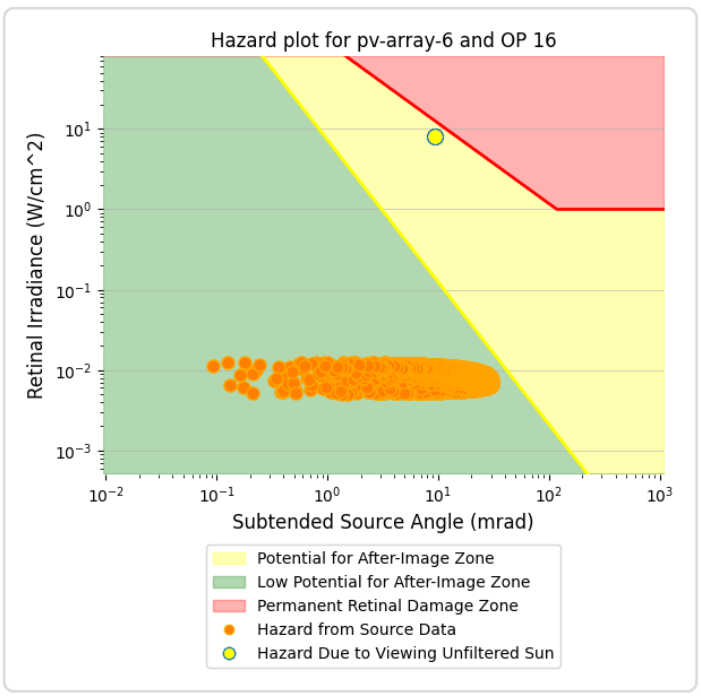
PV array 6 and OP 16

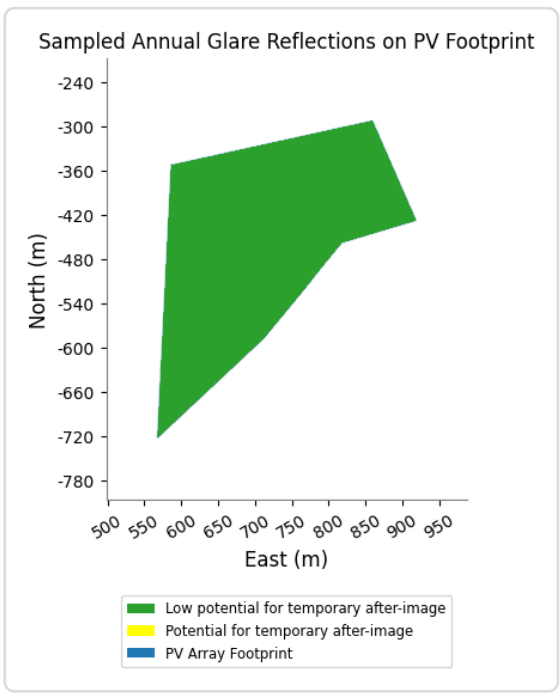
Yellow glare: none

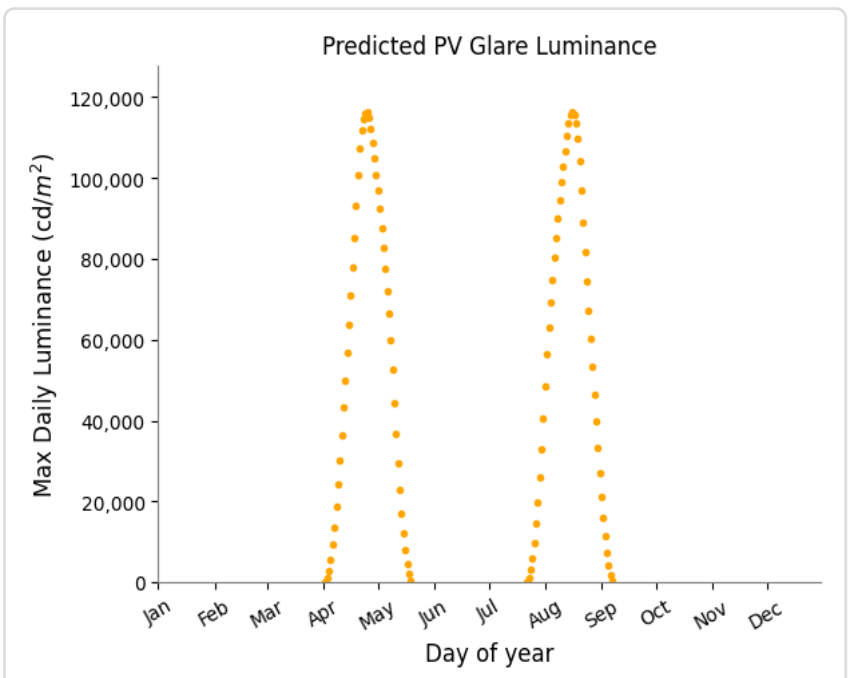
Green glare: 2,392 min.







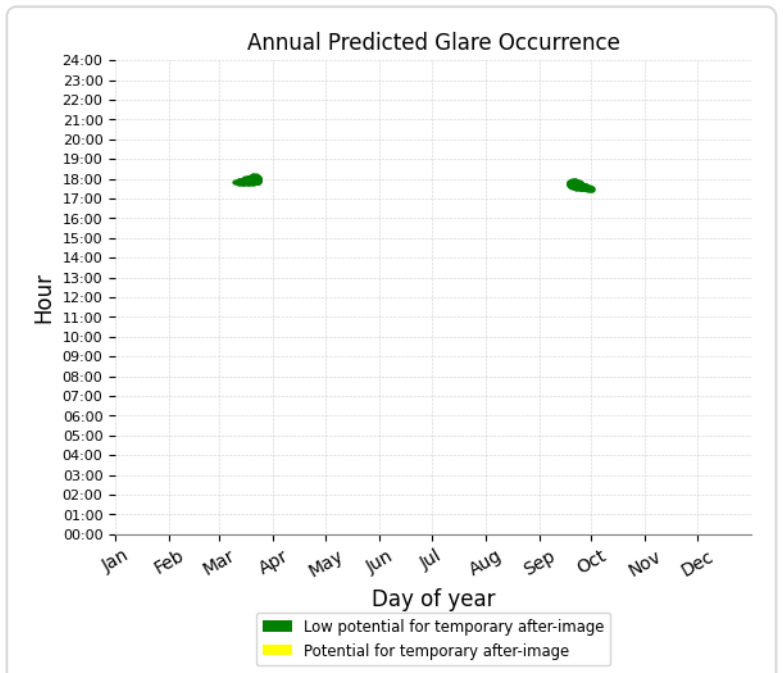


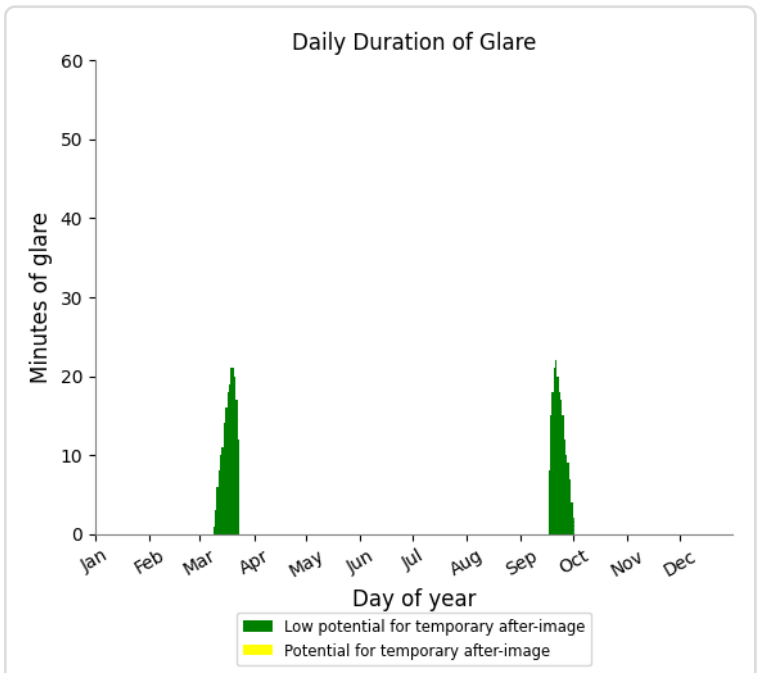


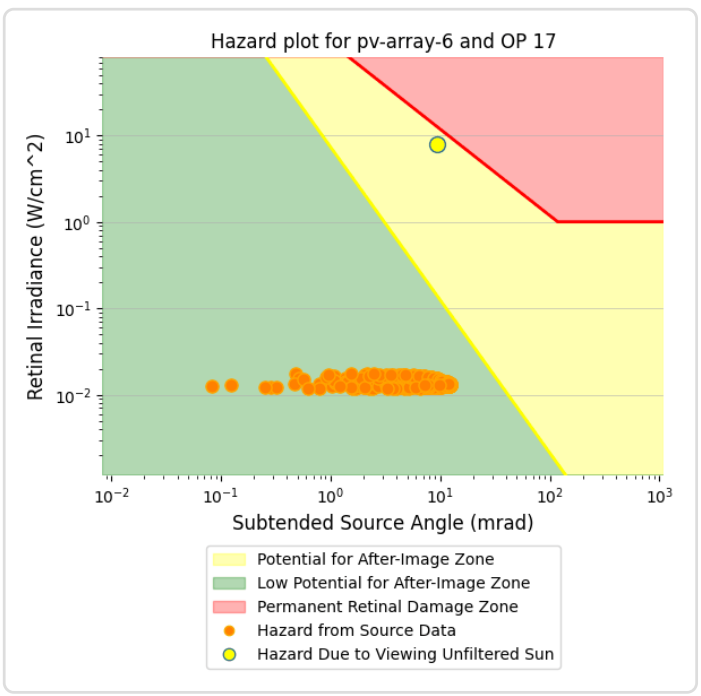
PV array 6 and OP 17

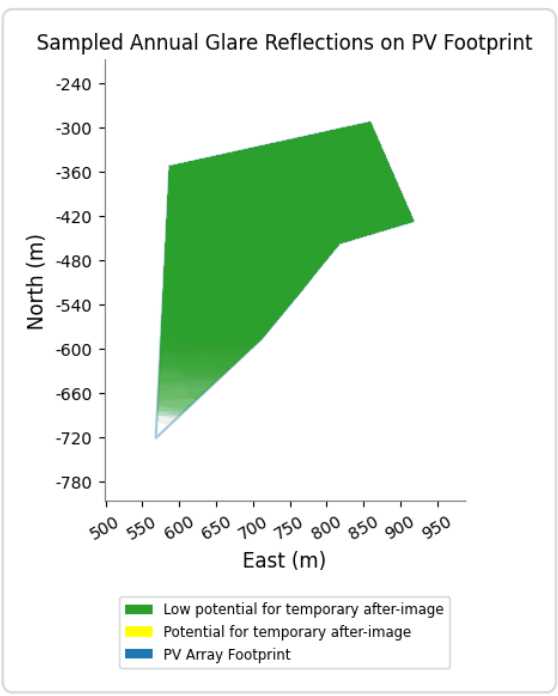
Yellow glare: none

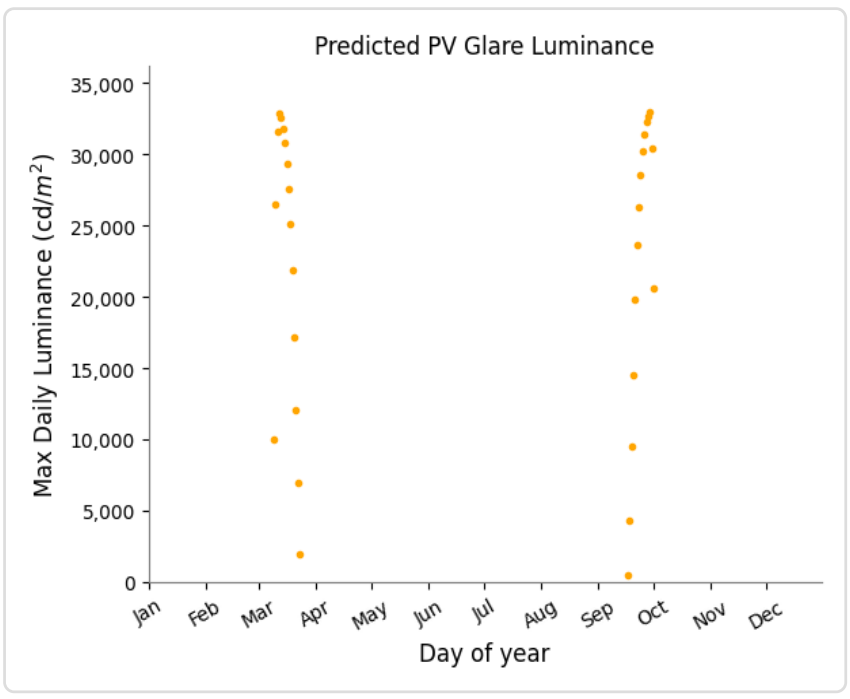
Green glare: 395 min.











PV array 6 and OP 1

No glare found

PV array 6 and OP 2

No glare found

PV array 6 and OP 3

No glare found

PV array 6 and OP 4

No glare found

PV array 6 and OP 5

No glare found

PV array 6 and OP 6

No glare found

PV array 6 and OP 7

No glare found

PV array 6 and OP 9

No glare found

PV array 6 and OP 10

No glare found

PV array 6 and OP 11

No glare found

PV array 6 and OP 12

No glare found

PV array 6 and OP 13

No glare found

PV array 6 and OP 18

No glare found

PV array 6 and OP 19

No glare found

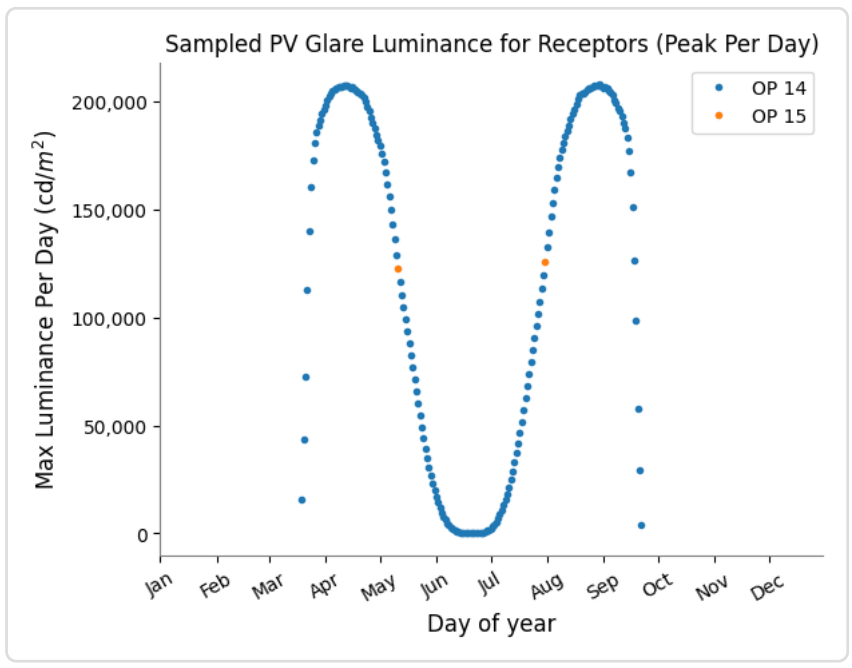
PV array 6 and OP 20

No glare found

PV: PV array 7 low potential for temporary after-image

Receptor results ordered by category of glare

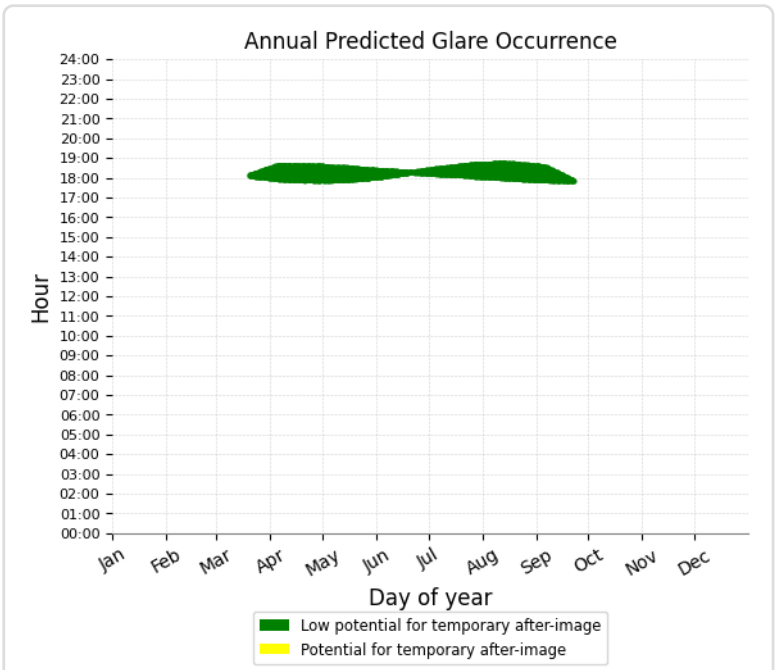
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 14	5,718	95.3	0	0.0	207,785
OP 15	3,074	51.2	0	0.0	173,748
OP 16	1,744	29.1	0	0.0	107,143
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

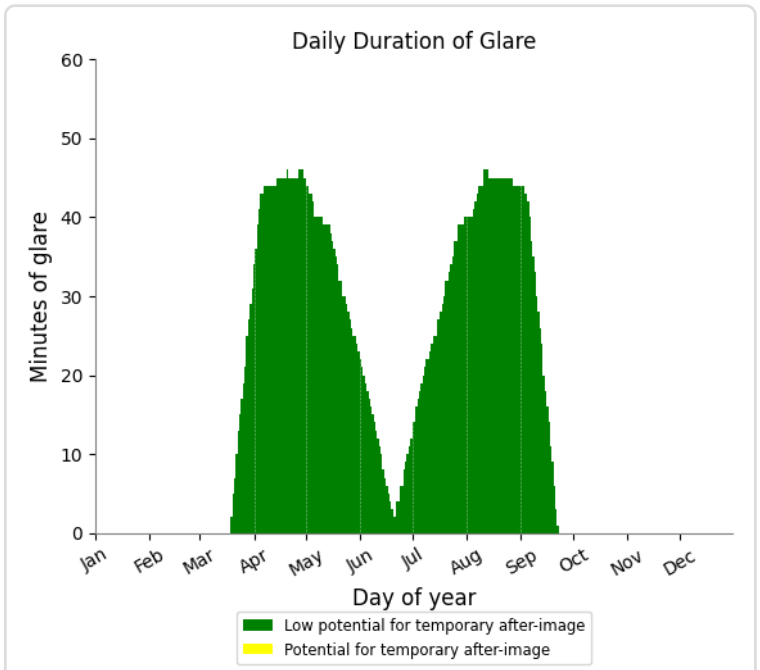


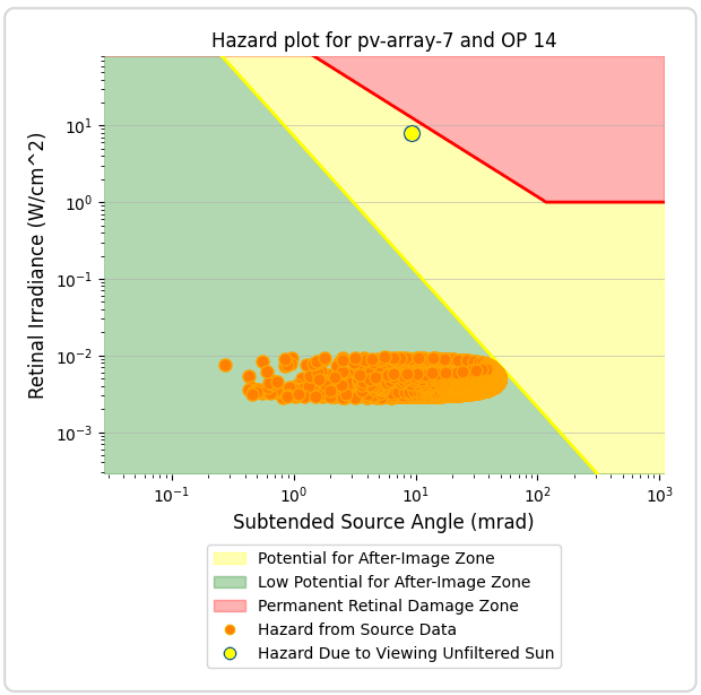
PV array 7 and OP 14

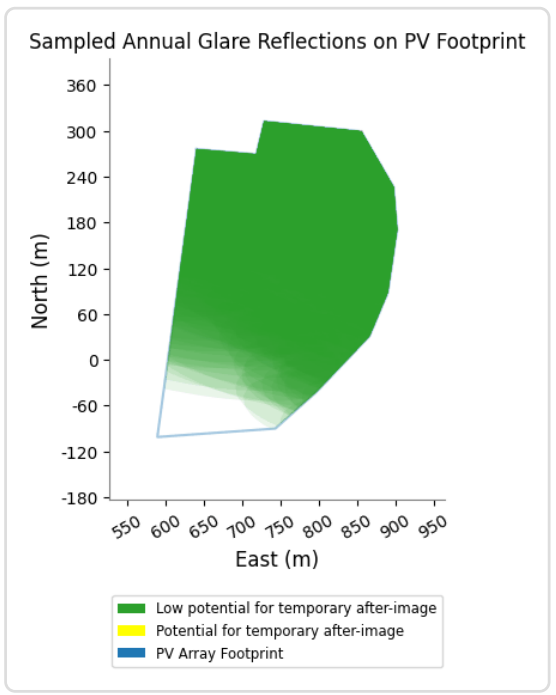
Yellow glare: none

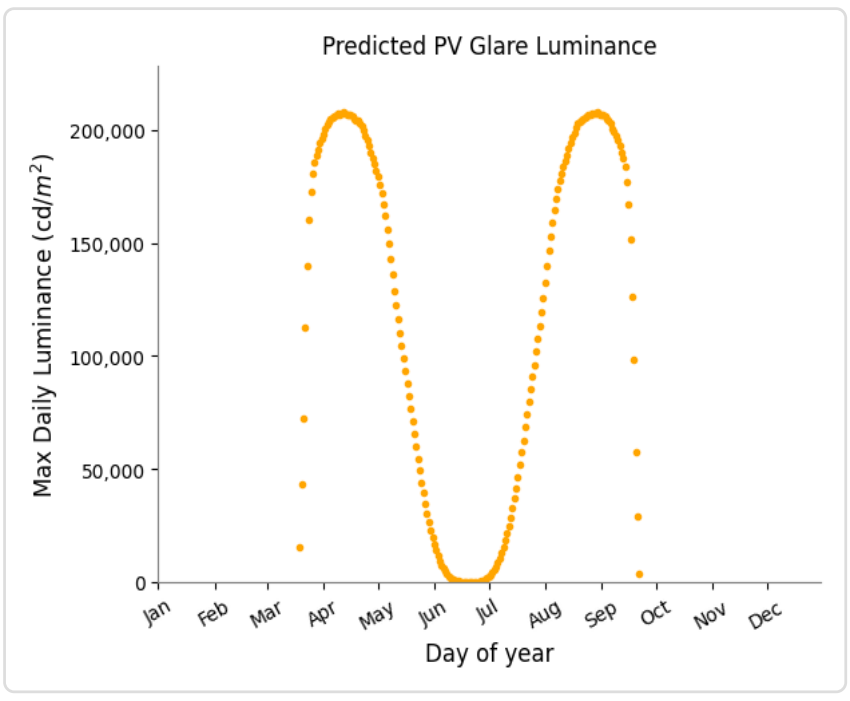
Green glare: 5,718 min.







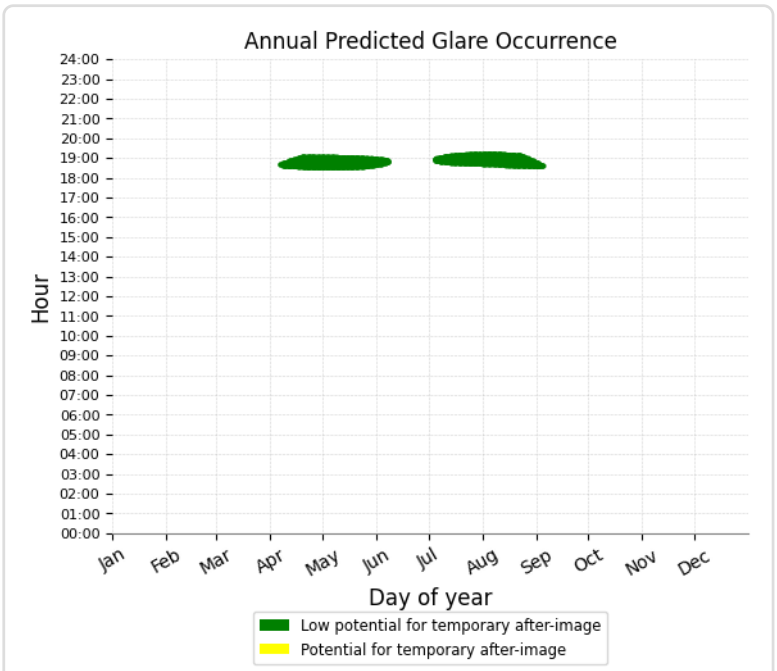


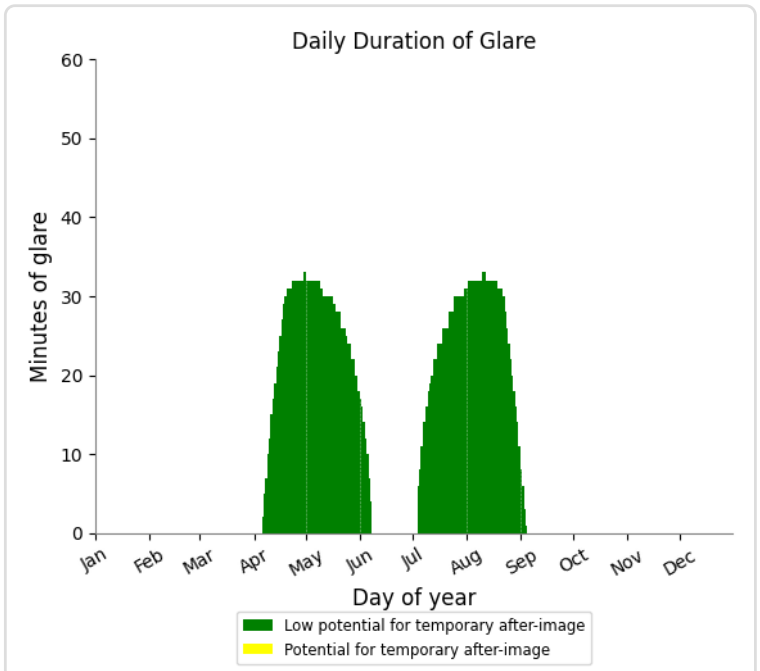


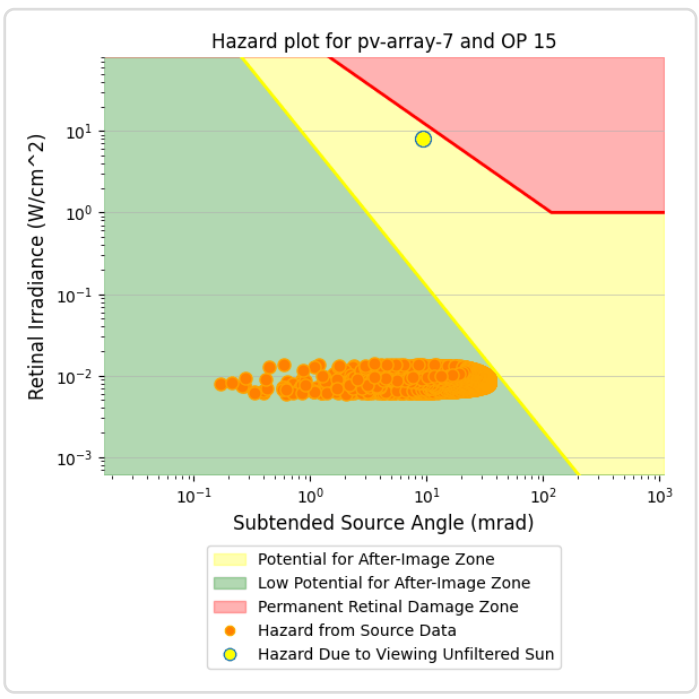
PV array 7 and OP 15

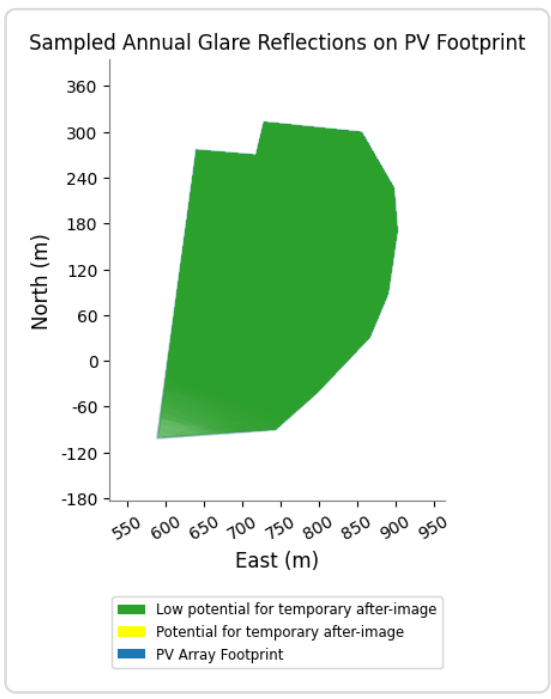
Yellow glare: none

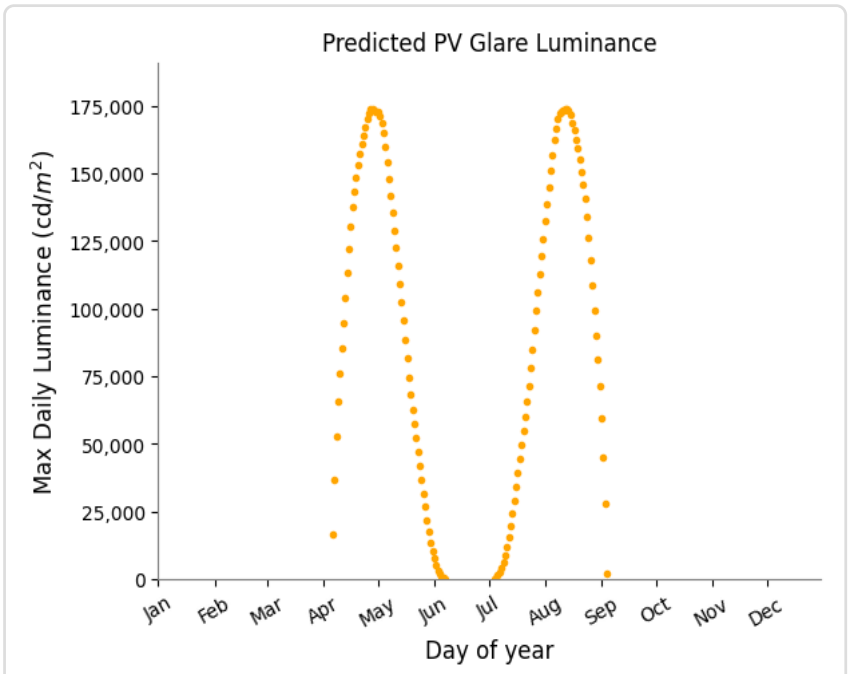
Green glare: 3,074 min.







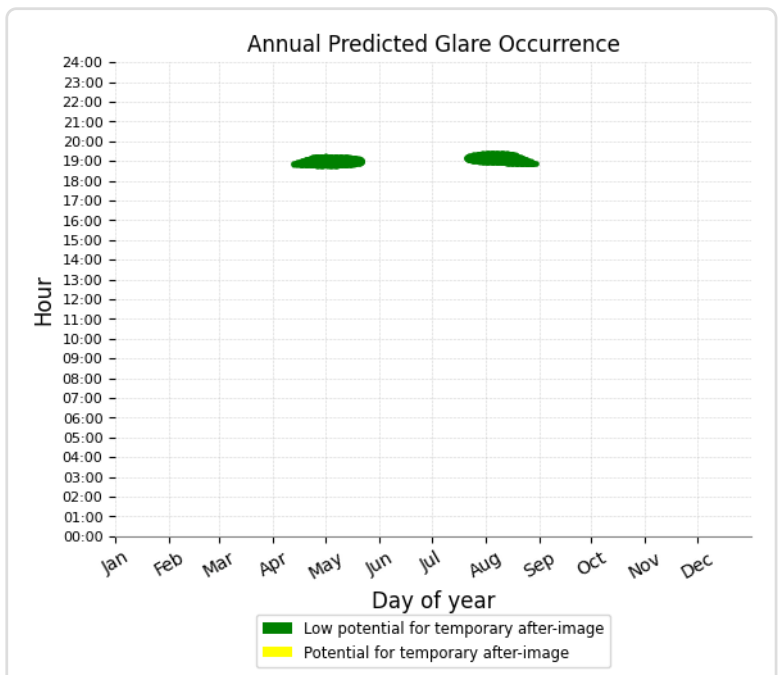


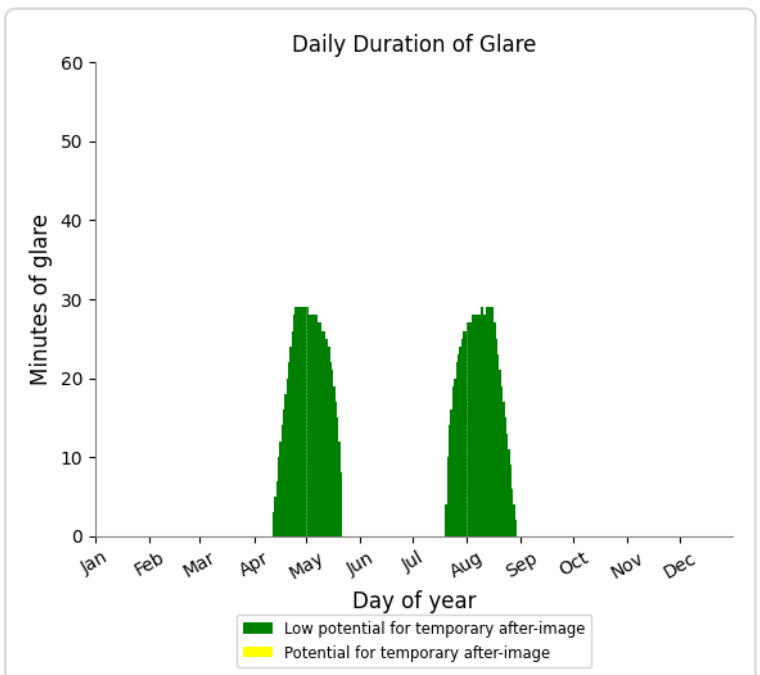


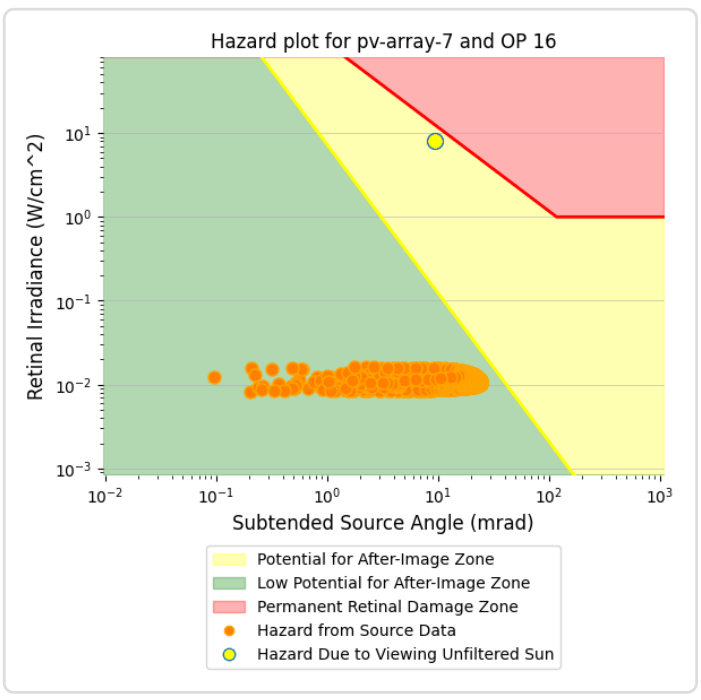
PV array 7 and OP 16

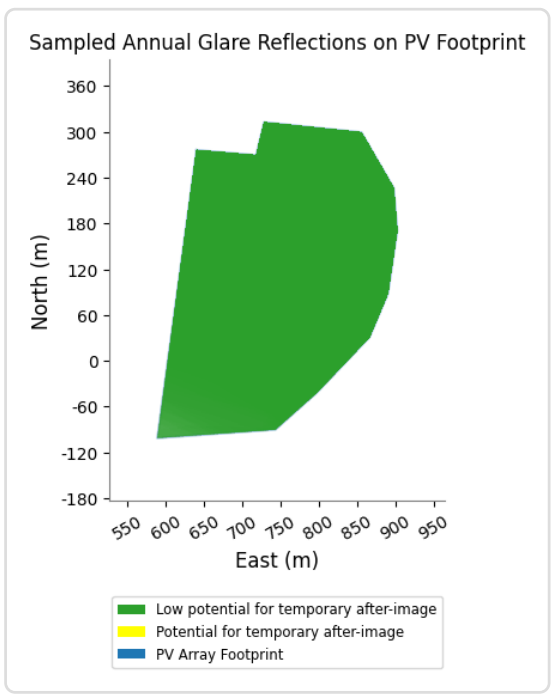
Yellow glare: none

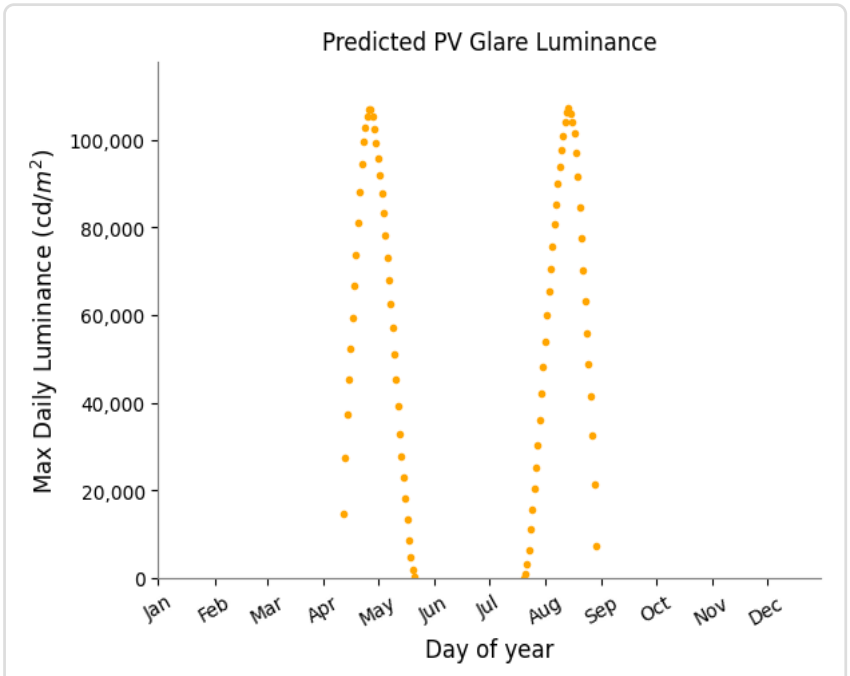
Green glare: 1,744 min.











PV array 7 and OP 1

No glare found

PV array 7 and OP 2

No glare found

PV array 7 and OP 3

No glare found

PV array 7 and OP 4

No glare found

PV array 7 and OP 5

No glare found

PV array 7 and OP 6

No glare found

PV array 7 and OP 7

No glare found

PV array 7 and OP 8

No glare found

PV array 7 and OP 9

No glare found

PV array 7 and OP 10

No glare found

PV array 7 and OP 11

No glare found

PV array 7 and OP 12

No glare found

PV array 7 and OP 13

No glare found

PV array 7 and OP 17

No glare found

PV array 7 and OP 18

No glare found

PV array 7 and OP 19

No glare found

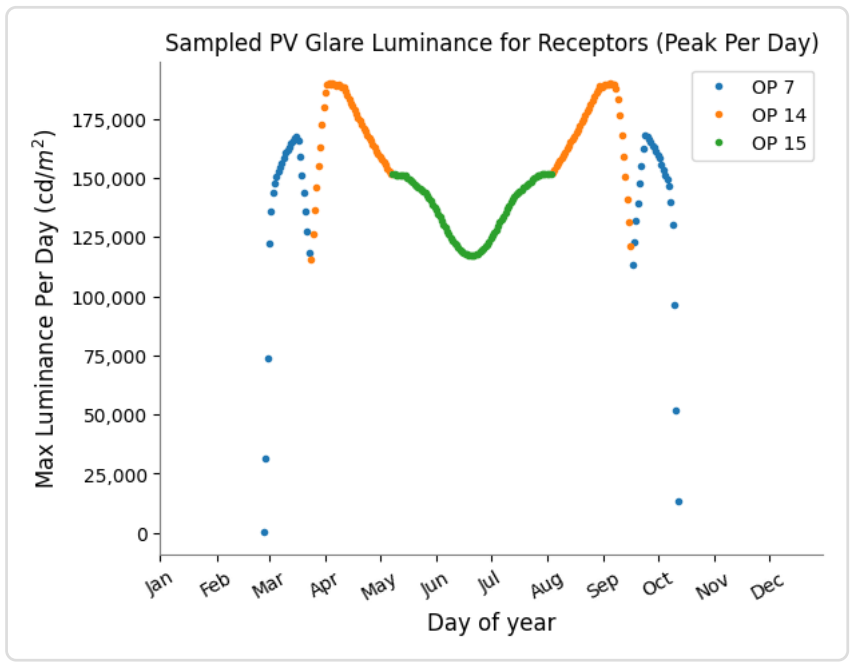
PV array 7 and OP 20

No glare found

PV: PV array 8 low potential for temporary after-image

Receptor results ordered by category of glare

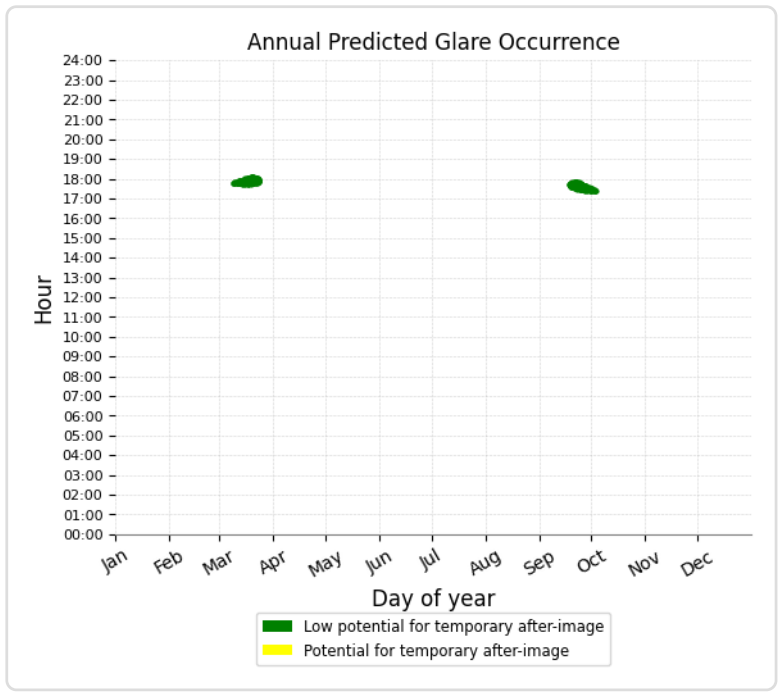
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	464	7.7	0	0.0	59,616
OP 7	1,574	26.2	0	0.0	167,831
OP 8	2,087	34.8	0	0.0	130,059
OP 14	6,790	113.2	0	0.0	189,760
OP 15	3,985	66.4	0	0.0	151,720
OP 16	3,139	52.3	0	0.0	121,743
OP 17	1,104	18.4	0	0.0	60,561
OP 18	324	5.4	0	0.0	29,154
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

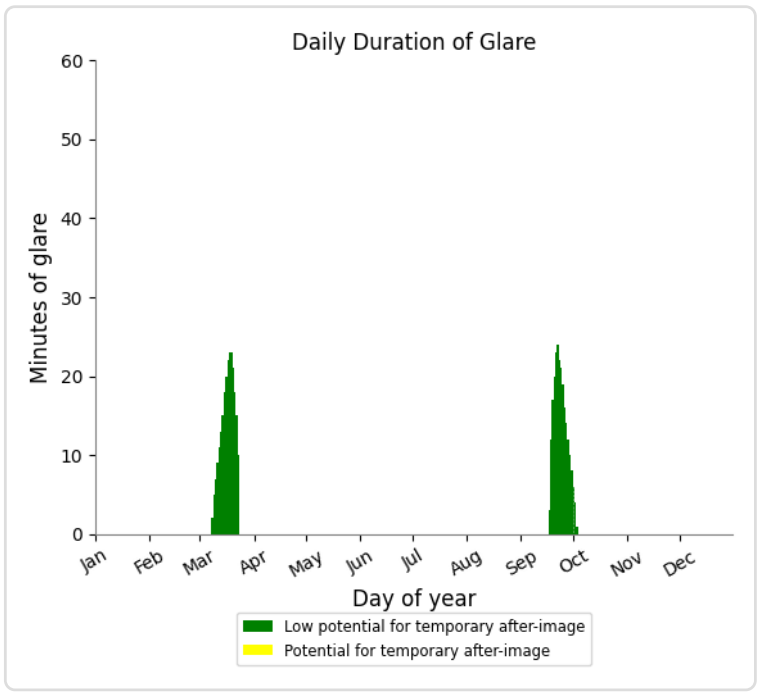


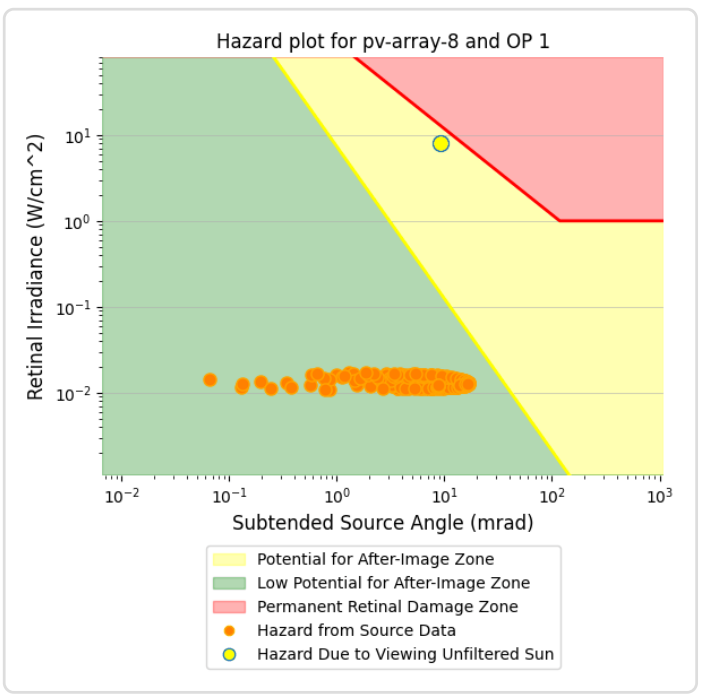
PV array 8 and OP 1

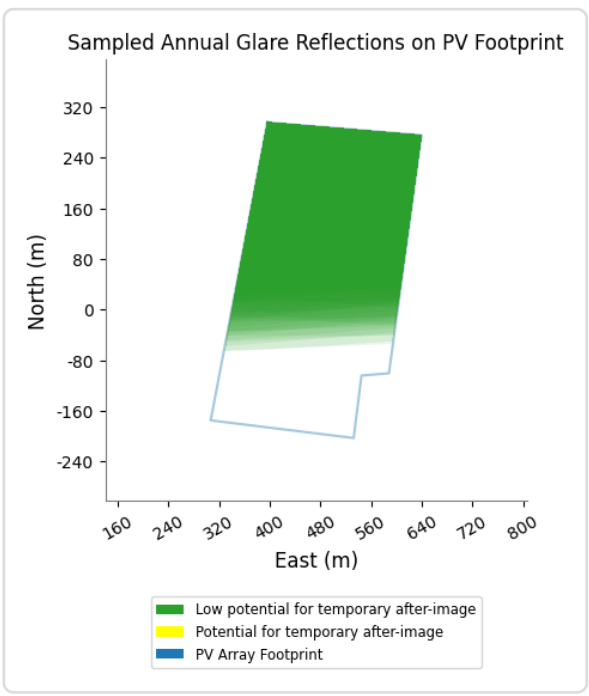
Yellow glare: none

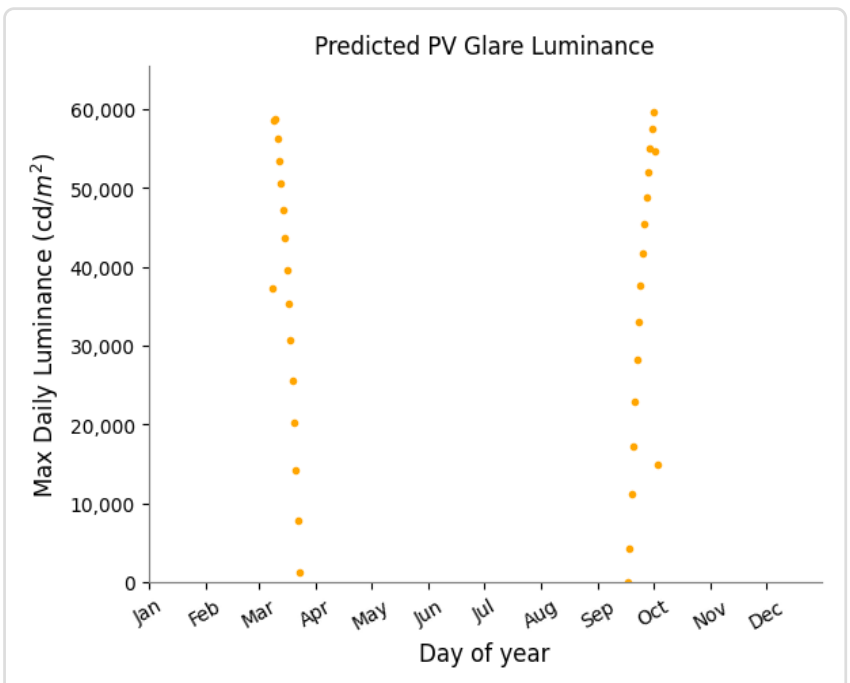
Green glare: 464 min.







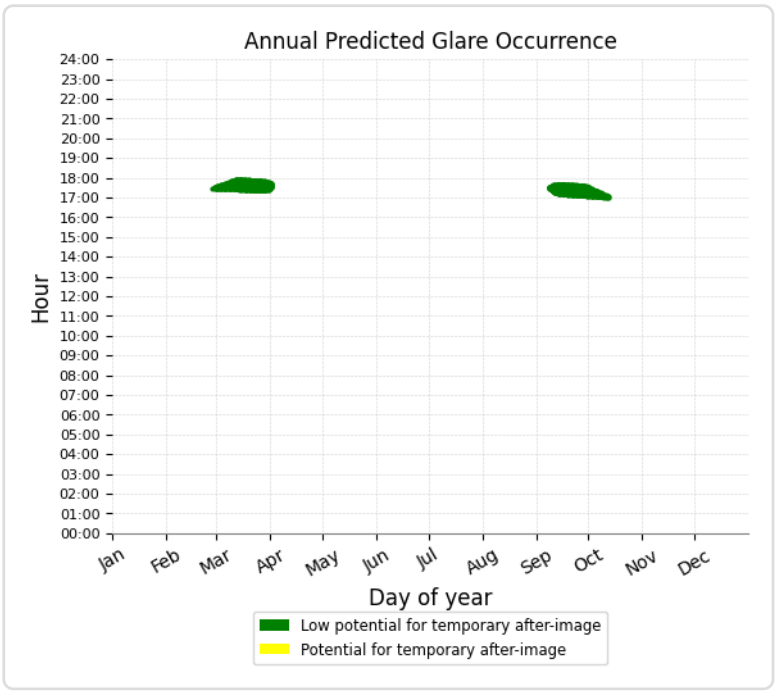


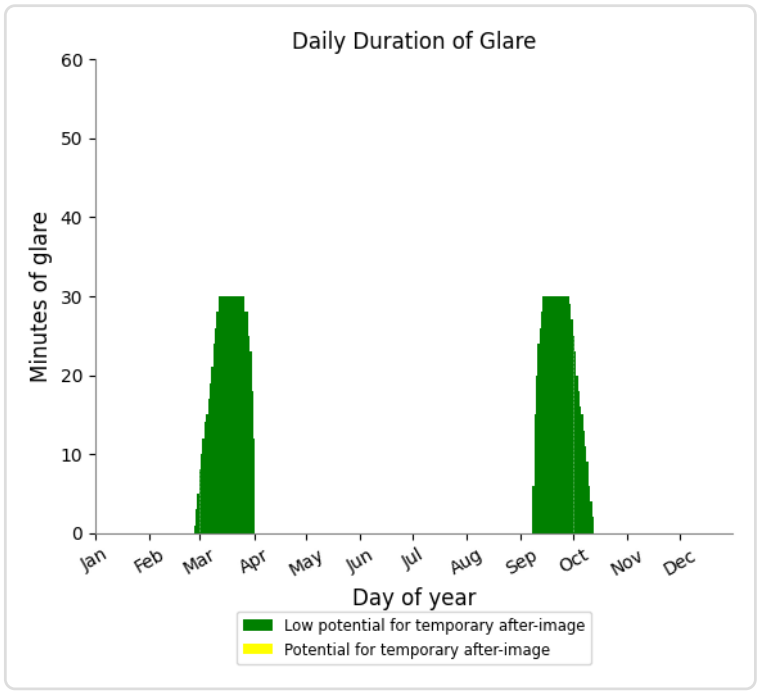


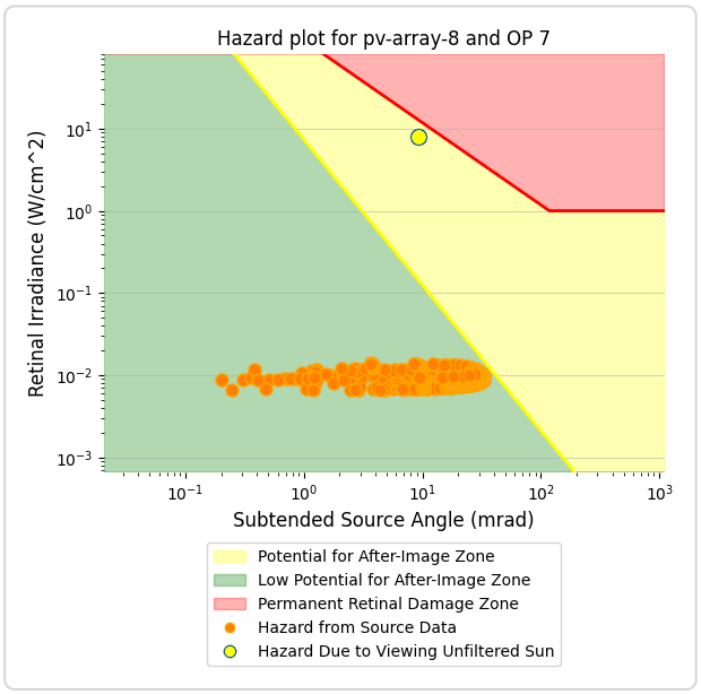
PV array 8 and OP 7

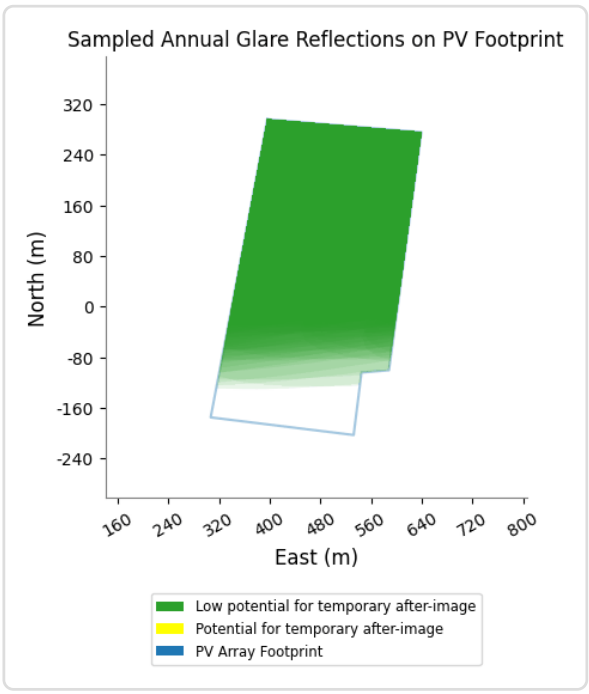
Yellow glare: none

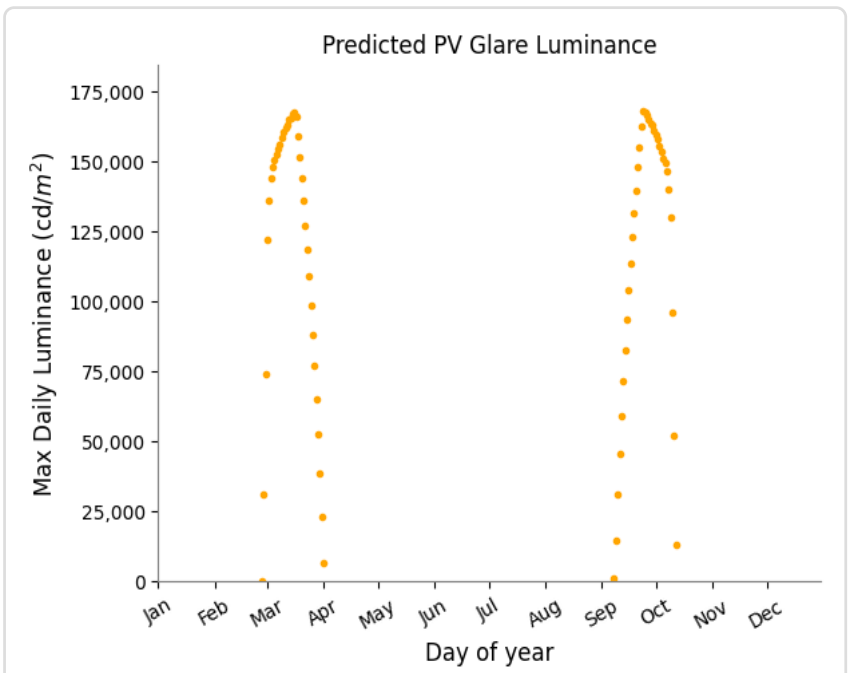
Green glare: 1,574 min.







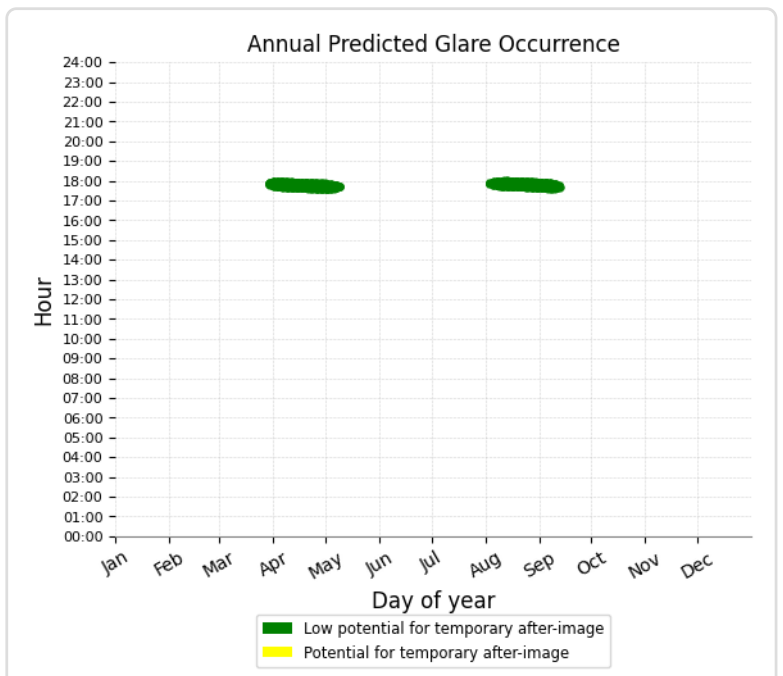


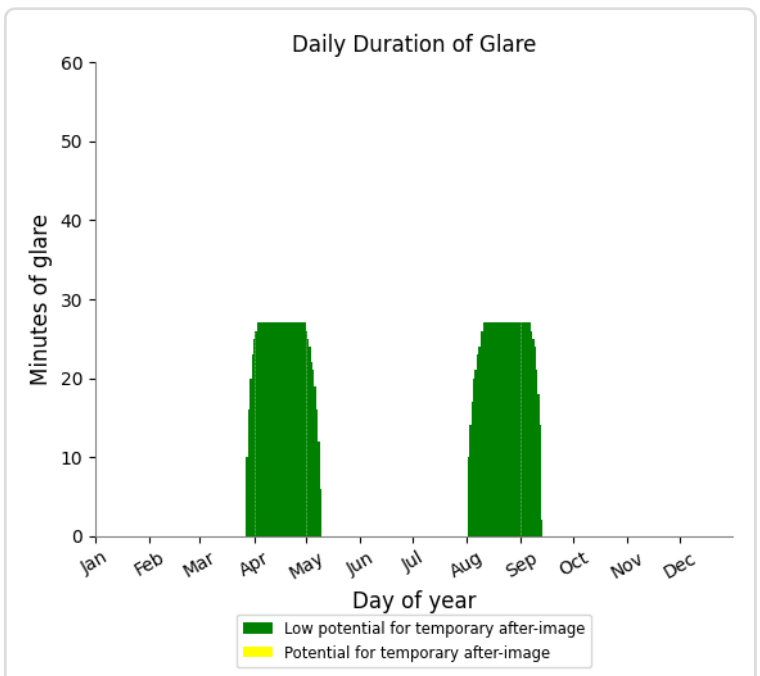


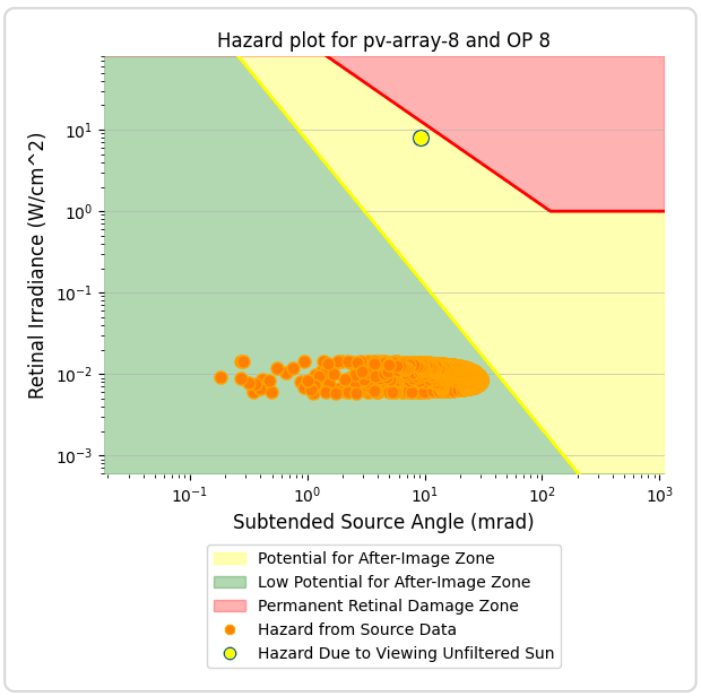
PV array 8 and OP 8

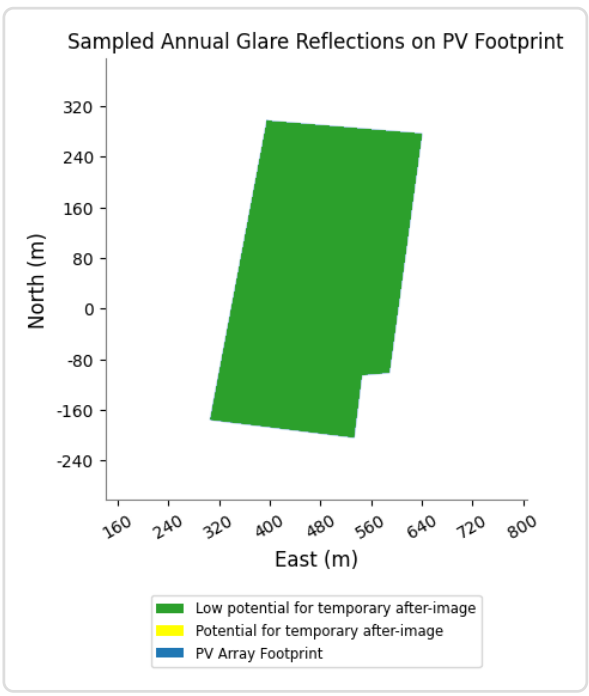
Yellow glare: none

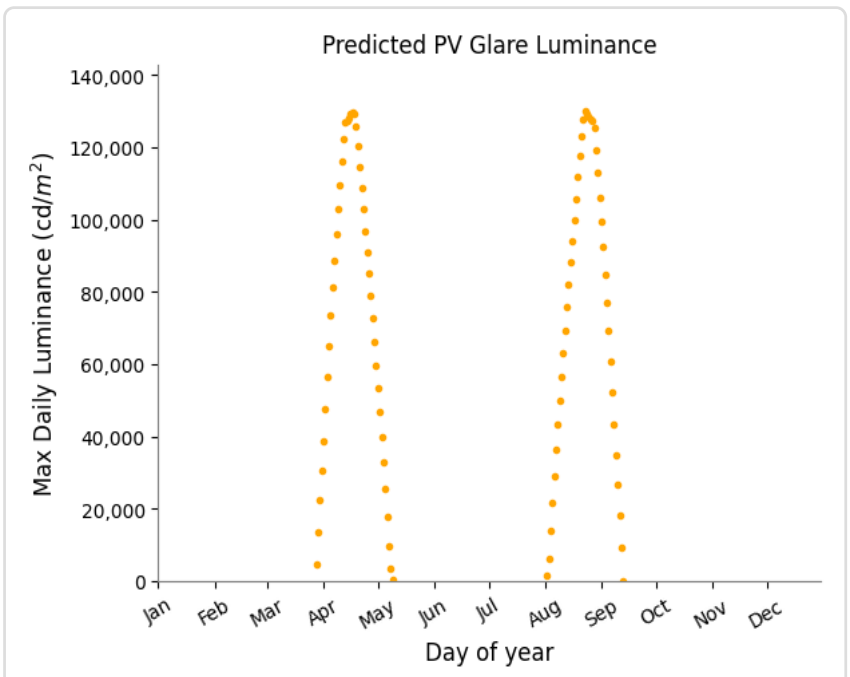
Green glare: 2,087 min.







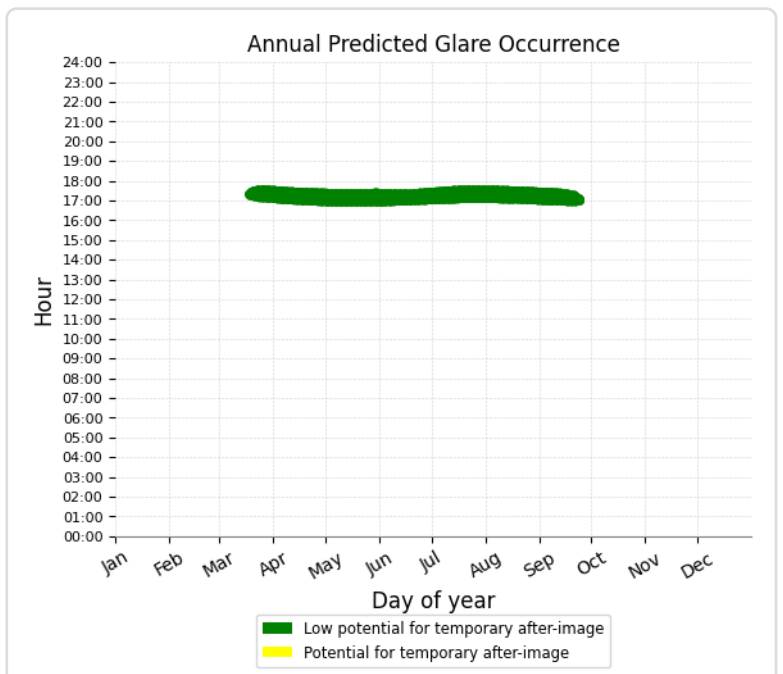


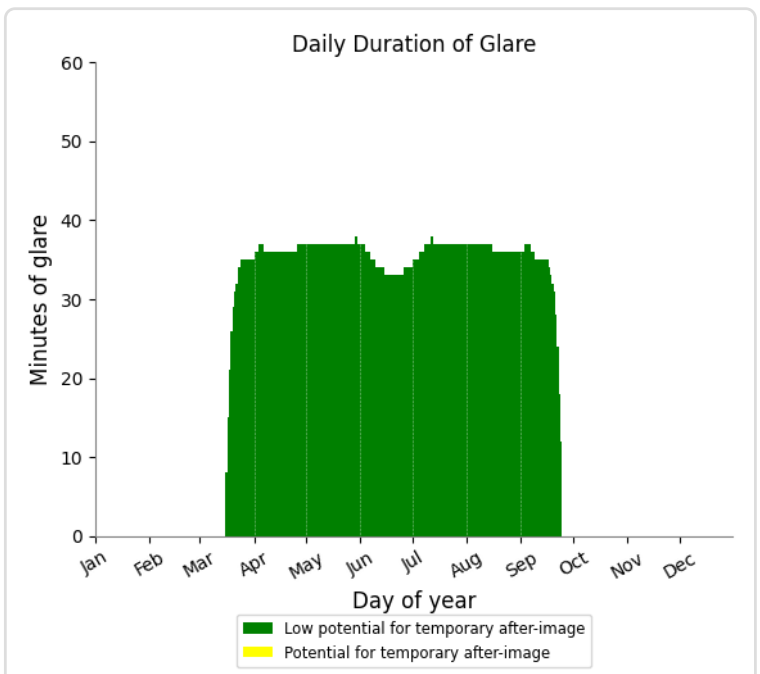


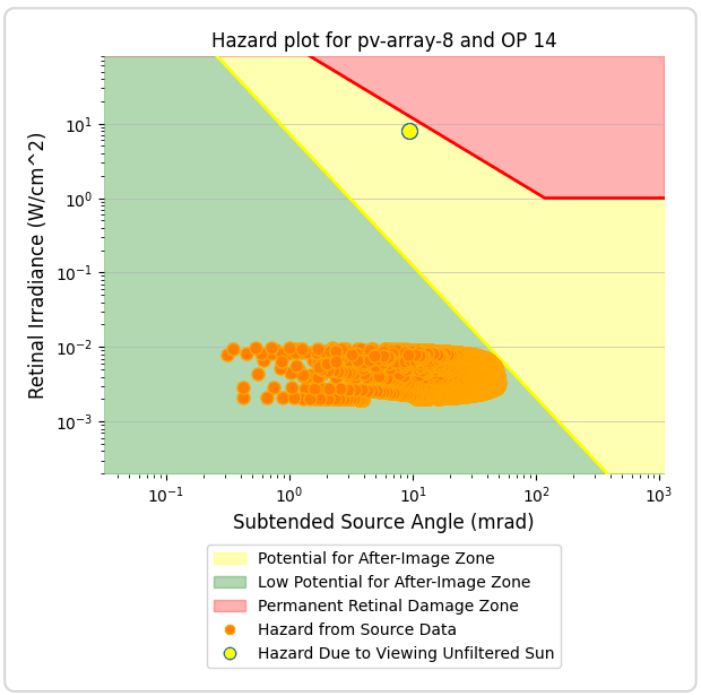
PV array 8 and OP 14

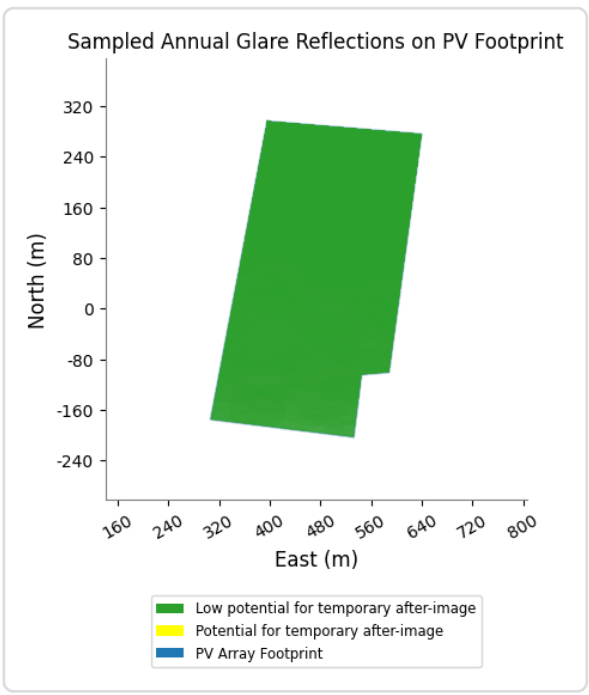
Yellow glare: none

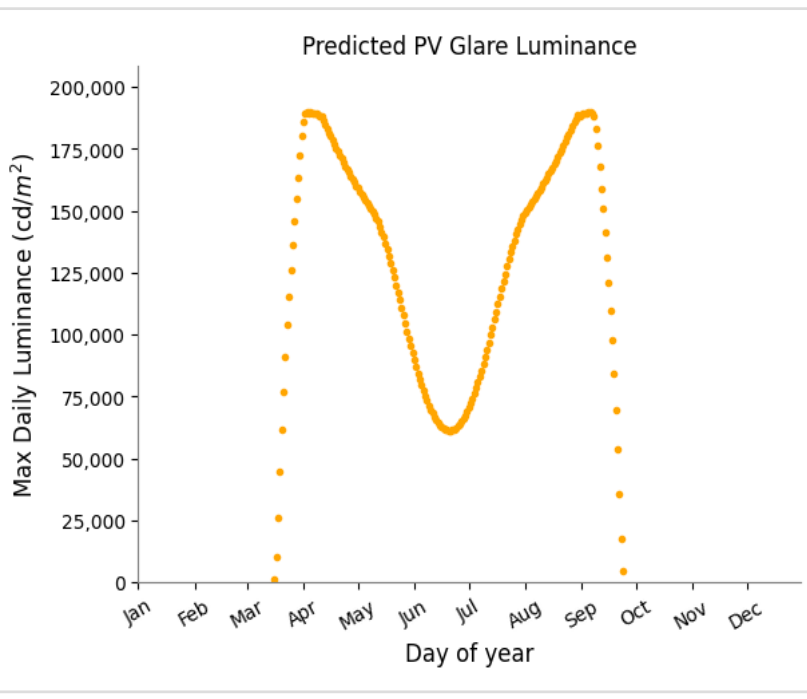
Green glare: 6,790 min.







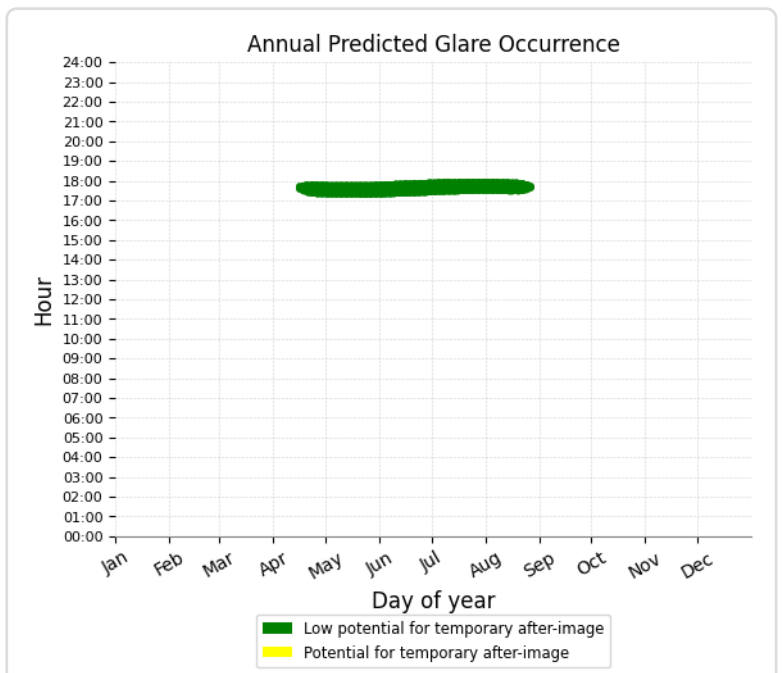


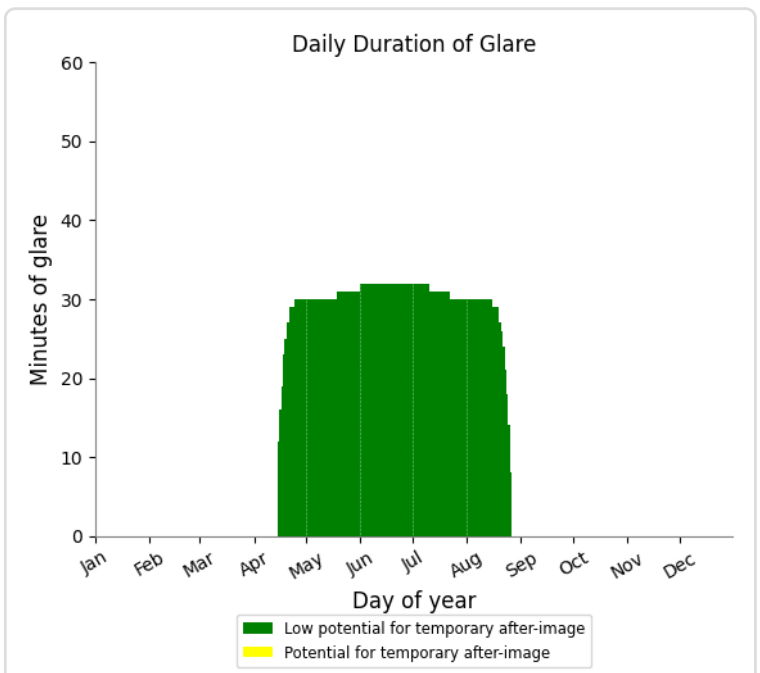


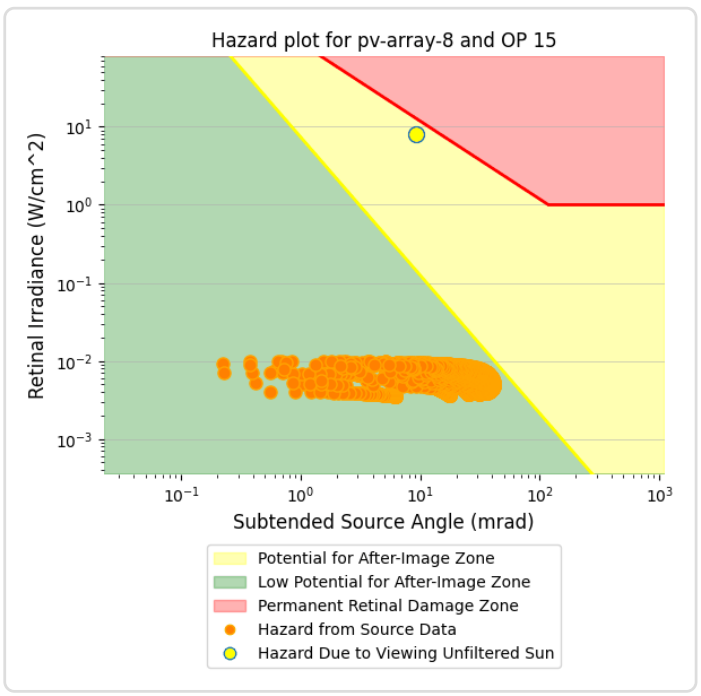
PV array 8 and OP 15

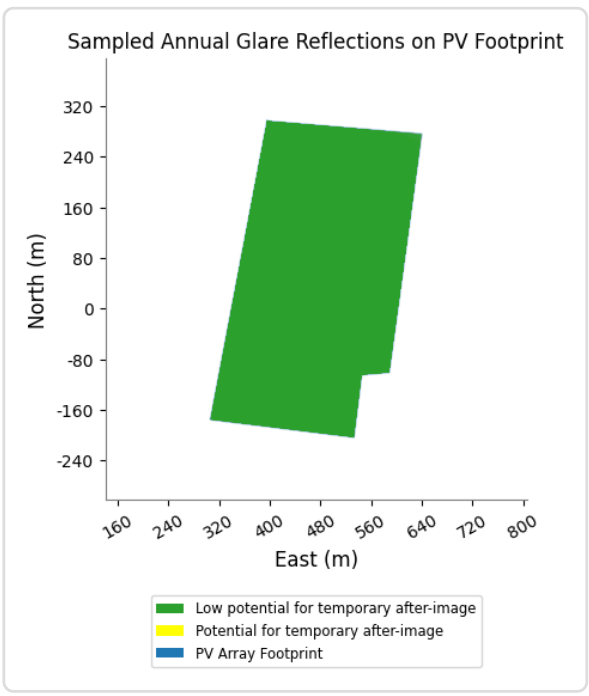
Yellow glare: none

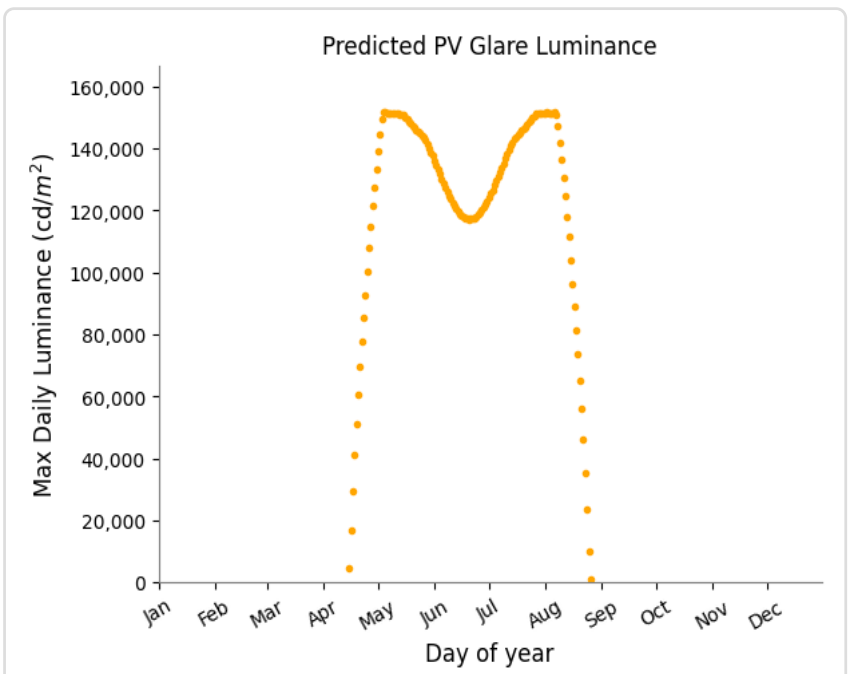
Green glare: 3,985 min.







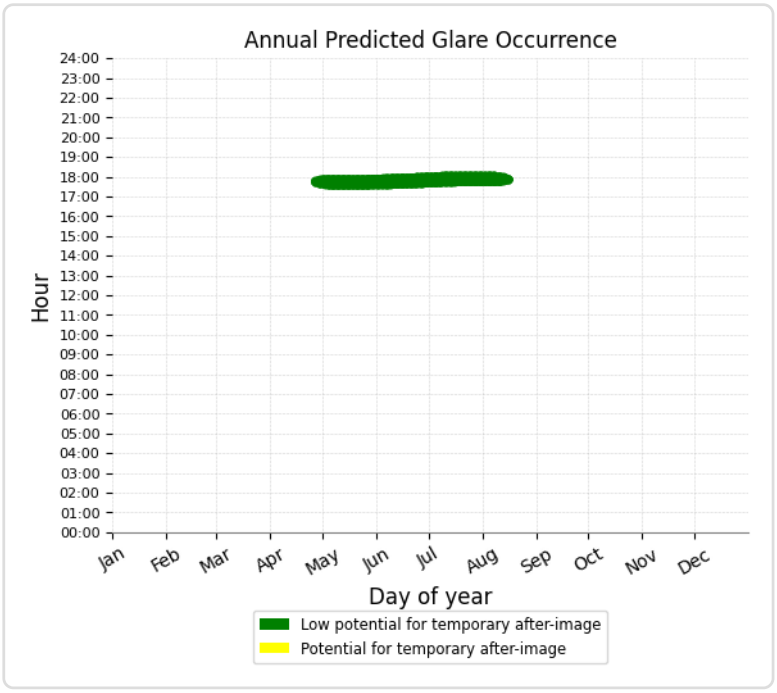


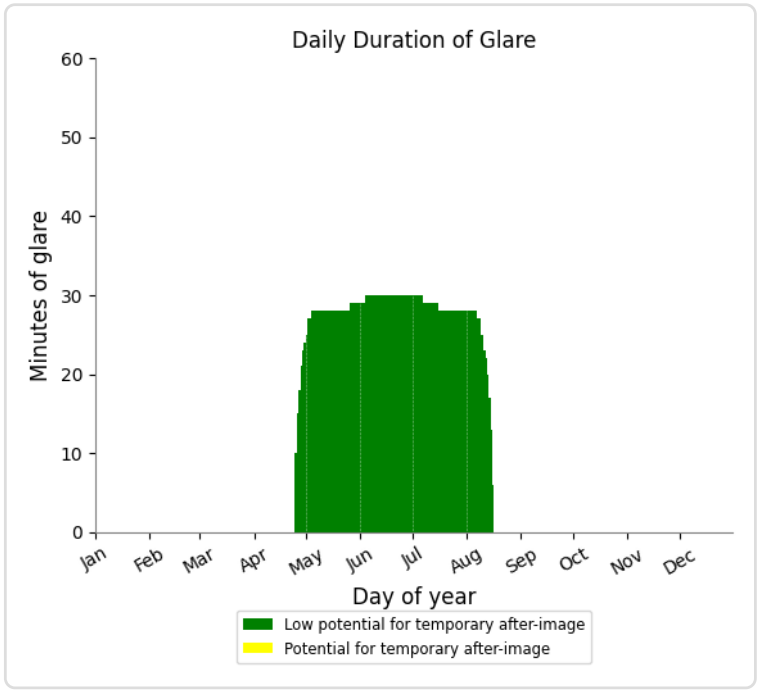


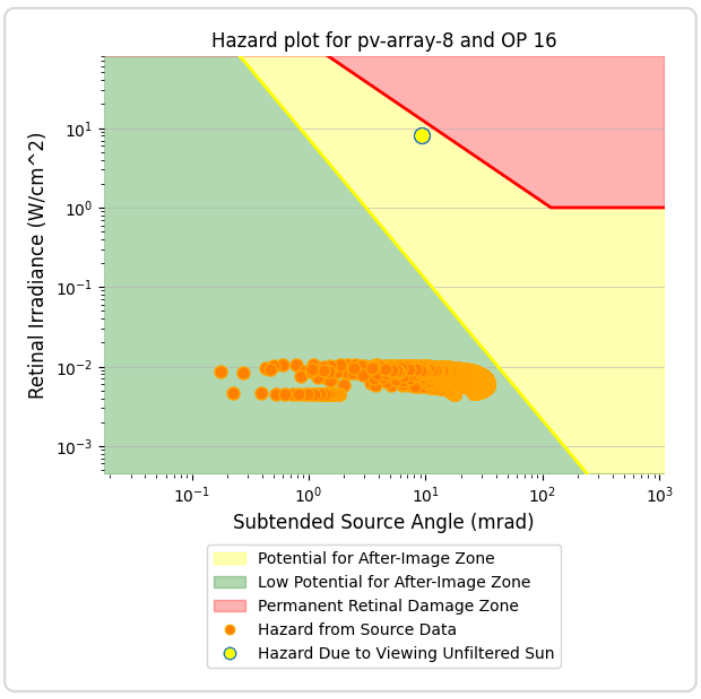
PV array 8 and OP 16

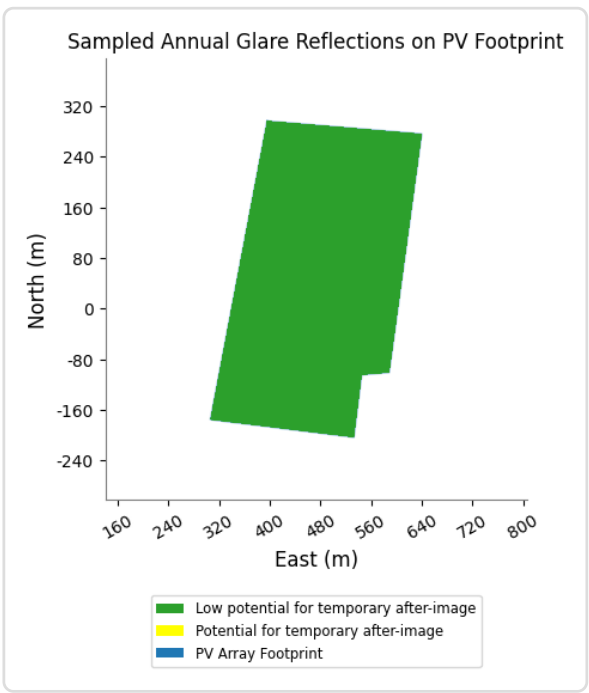
Yellow glare: none

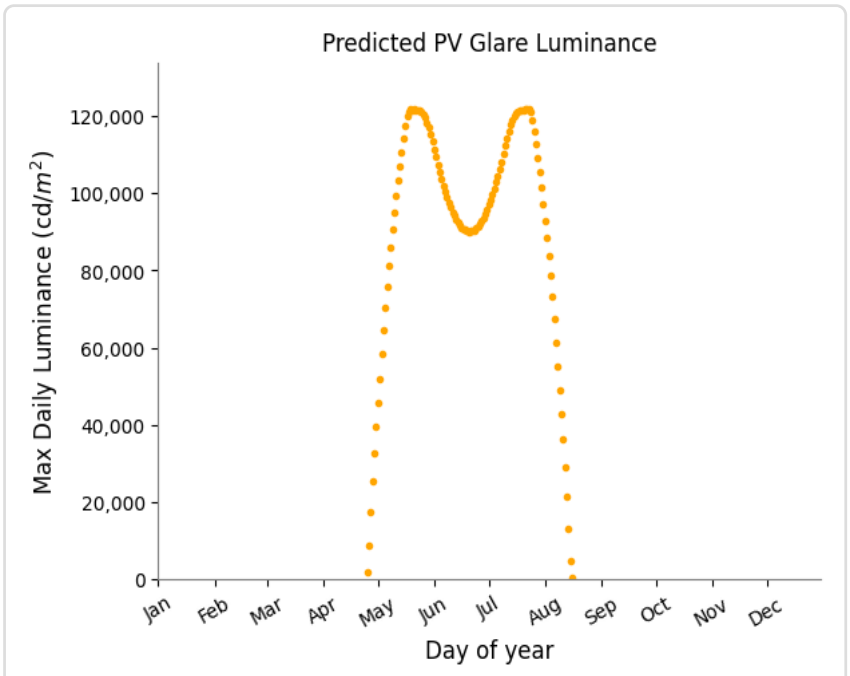
Green glare: 3,139 min.







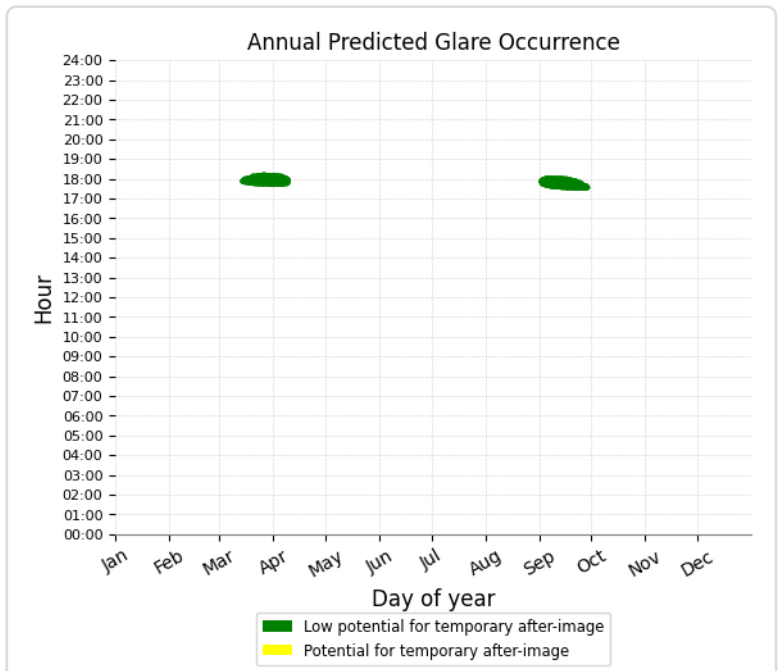


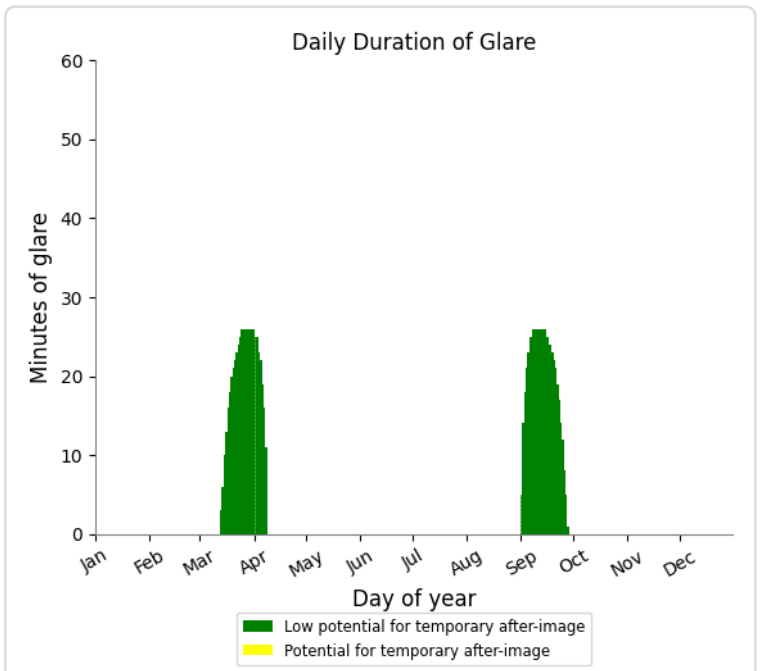


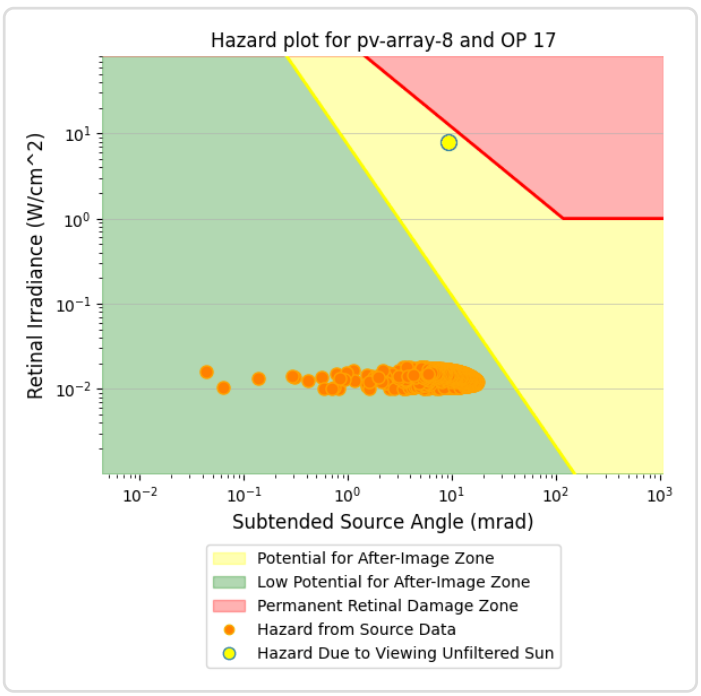
PV array 8 and OP 17

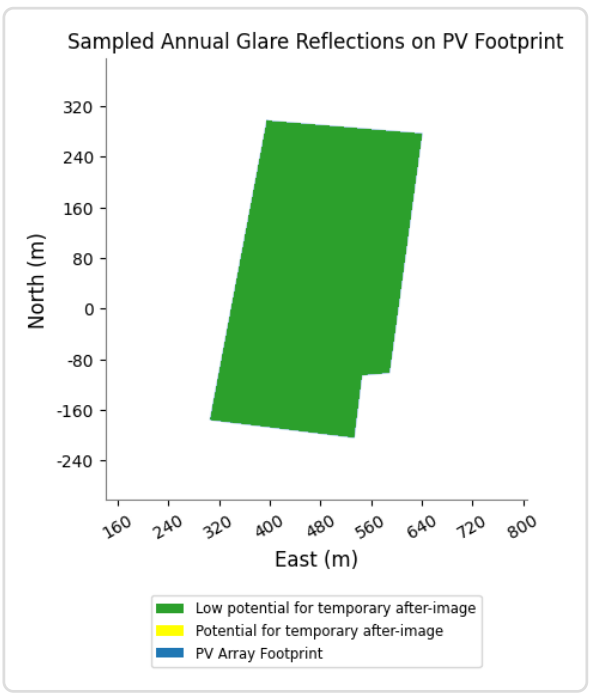
Yellow glare: none

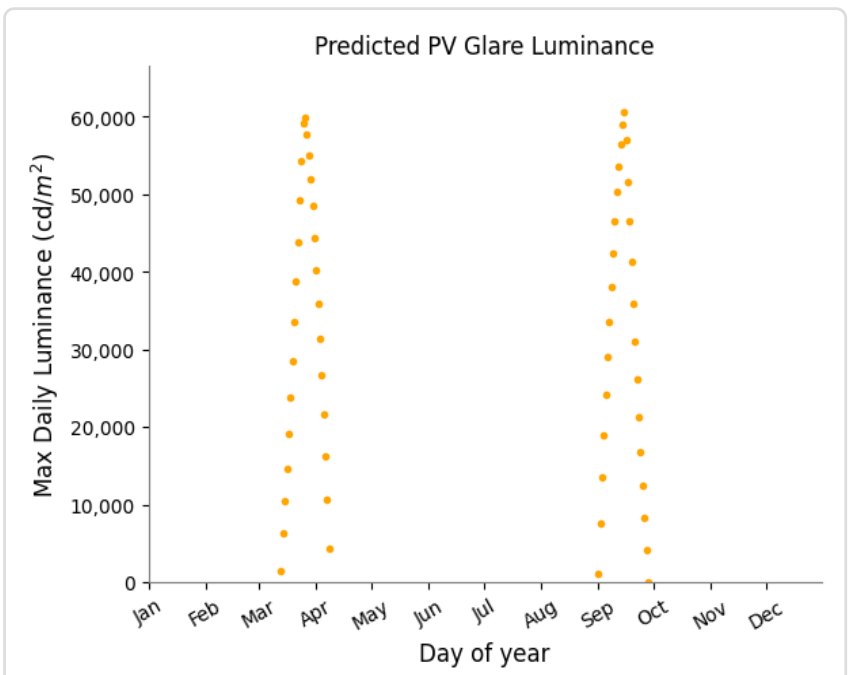
Green glare: 1,104 min.







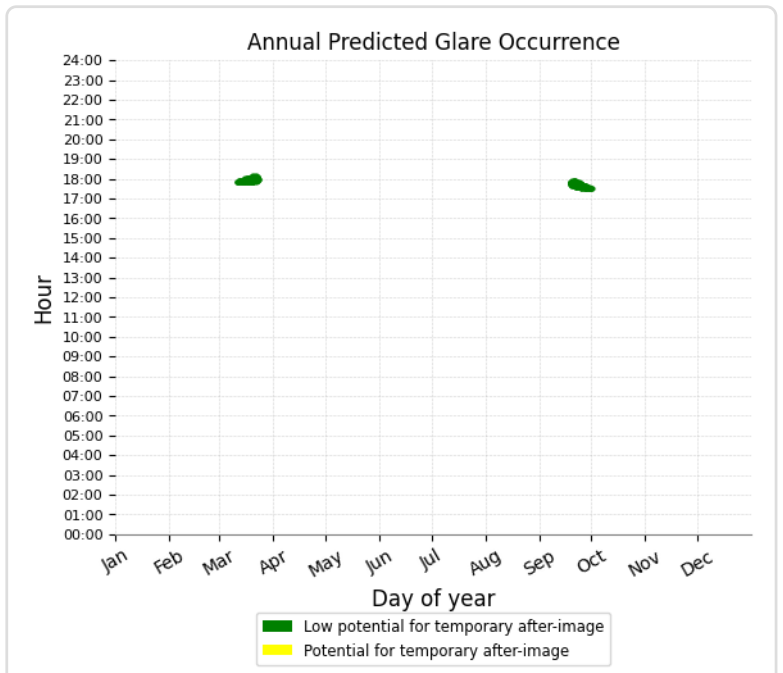


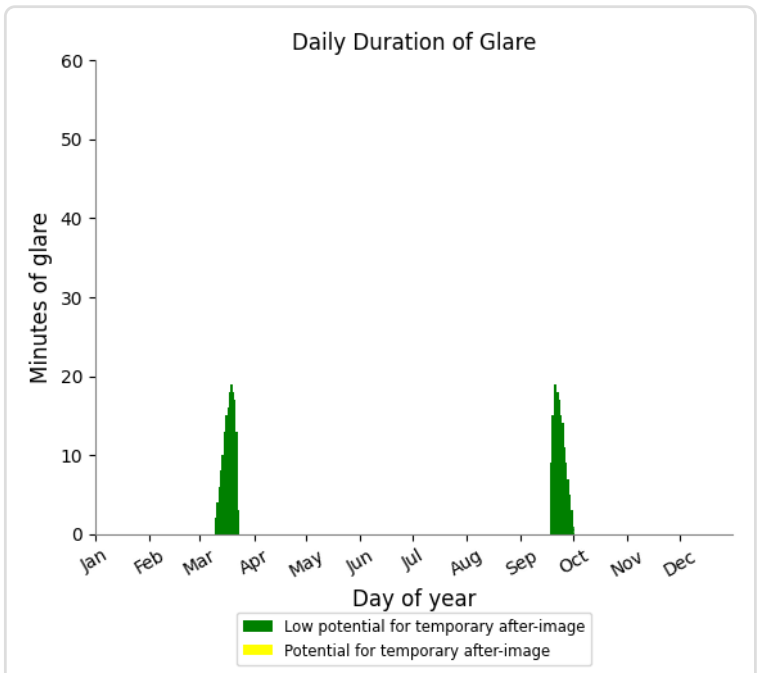


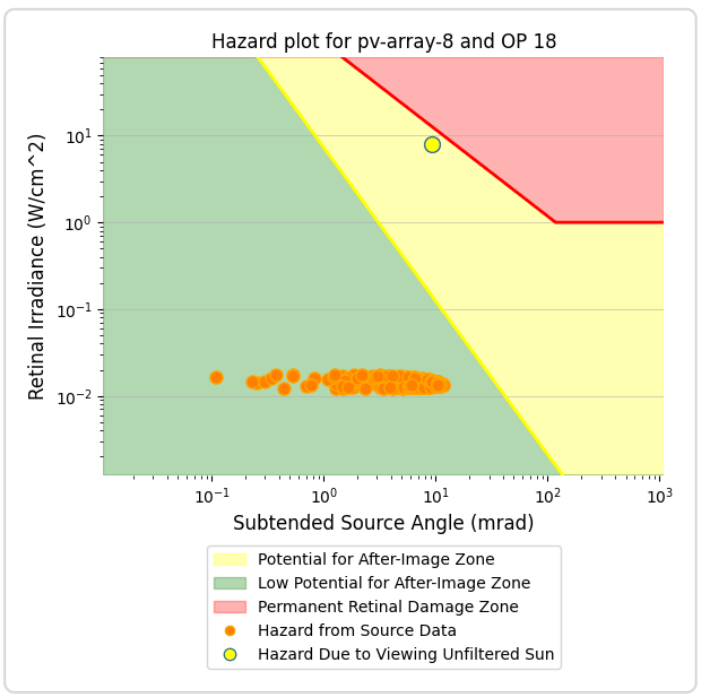
PV array 8 and OP 18

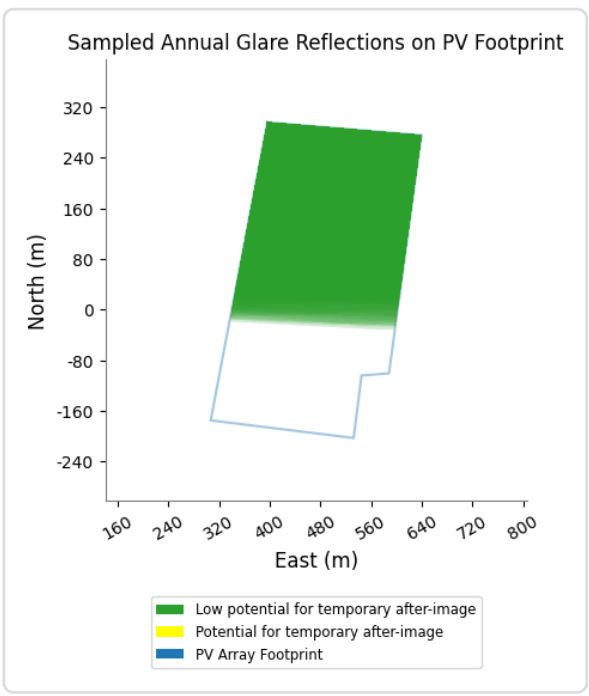
Yellow glare: none

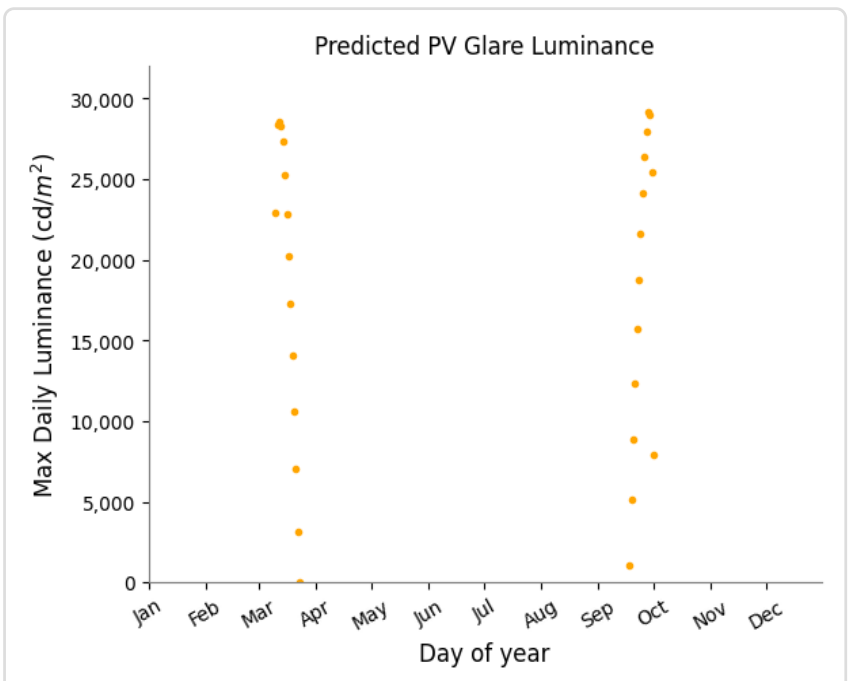
Green glare: 324 min.











PV array 8 and OP 2

No glare found

PV array 8 and OP 3

No glare found

PV array 8 and OP 4

No glare found

PV array 8 and OP 5

No glare found

PV array 8 and OP 6

No glare found

PV array 8 and OP 9

No glare found

PV array 8 and OP 10

No glare found

PV array 8 and OP 11

No glare found

PV array 8 and OP 12

No glare found

PV array 8 and OP 13

No glare found

PV array 8 and OP 19

No glare found

PV array 8 and OP 20

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **BR10356 Normanton Larches Solar**
Site configuration: **Aviation 1000ft 180 and 205 OPs 21-41**

Created 08 Mar, 2024
Updated 21 Mar, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 113991.19448

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	9,230	153.8	0	0.0	-	164,450
PV array 2	25.0	180.0	7,777	129.6	0	0.0	-	120,928
PV array 3	25.0	180.0	9,235	153.9	0	0.0	-	170,547
PV array 4	25.0	180.0	8,668	144.5	0	0.0	-	154,677
PV array 5	25.0	180.0	9,761	162.7	0	0.0	-	141,244
PV array 6	25.0	180.0	9,954	165.9	0	0.0	-	130,339
PV array 7	25.0	205.0	7,351	122.5	0	0.0	-	151,369
PV array 8	25.0	180.0	12,938	215.6	0	0.0	-	204,795

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	0	0.0	0	0.0
OP 2	674	11.2	0	0.0
OP 3	7,178	119.6	0	0.0
OP 4	13,077	217.9	0	0.0
OP 5	15,350	255.8	0	0.0
OP 6	23,917	398.6	0	0.0
OP 7	8,571	142.8	0	0.0
OP 8	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	4,983	83.0	0	0.0
OP 15	1,164	19.4	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270453	-1.023592	44.16	3.58	47.74
2	53.270382	-1.026510	38.69	3.58	42.27
3	53.270337	-1.028001	42.19	3.58	45.77
4	53.268374	-1.027819	47.55	3.58	51.13
5	53.267835	-1.027411	47.97	3.58	51.55
6	53.268194	-1.025823	42.76	3.58	46.34
7	53.268605	-1.023538	48.05	3.58	51.63

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272403	-1.022893	44.98	3.58	48.56
2	53.271659	-1.020468	49.10	3.58	52.68
3	53.271146	-1.020629	49.06	3.58	52.64
4	53.270568	-1.020768	49.76	3.58	53.34
5	53.269978	-1.022399	48.94	3.58	52.52
6	53.269490	-1.023494	46.53	3.58	50.11
7	53.270600	-1.023526	44.05	3.58	47.63
8	53.270658	-1.022721	44.52	3.58	48.10

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267270	-1.027453	49.52	3.58	53.10
2	53.267742	-1.026122	44.46	3.58	48.04
3	53.268066	-1.026004	43.25	3.58	46.83
4	53.268361	-1.024577	44.74	3.58	48.32
5	53.268515	-1.023451	48.43	3.58	52.01
6	53.263789	-1.021096	44.95	3.58	48.53
7	53.263606	-1.026144	50.81	3.58	54.39

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267296	-1.022818	47.72	3.58	51.30
2	53.267707	-1.018998	49.22	3.58	52.80
3	53.264120	-1.017373	43.17	3.58	46.75
4	53.264126	-1.017861	43.81	3.58	47.39
5	53.263885	-1.017893	45.60	3.58	49.18
6	53.263795	-1.021085	44.91	3.58	48.49

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.268300	-1.019106	51.65	3.58	55.23
2	53.268197	-1.015587	47.94	3.58	51.52
3	53.267411	-1.014932	45.87	3.58	49.45
4	53.263776	-1.015093	42.99	3.58	46.57
5	53.263904	-1.017175	44.48	3.58	48.06
6	53.266359	-1.018355	43.98	3.58	47.56

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267286	-1.014793	45.26	3.58	48.84
2	53.263975	-1.015072	41.69	3.58	45.27
3	53.265181	-1.012926	37.52	3.58	41.10
4	53.265759	-1.012132	35.68	3.58	39.26
5	53.266067	-1.011724	35.43	3.58	39.01
6	53.266349	-1.011338	34.83	3.58	38.41
7	53.266619	-1.009836	34.68	3.58	38.26
8	53.267825	-1.010716	42.25	3.58	45.83

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 205.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272901	-1.014007	31.19	3.58	34.77
2	53.269555	-1.014726	42.85	3.58	46.43
3	53.269645	-1.012452	41.27	3.58	44.85
4	53.270081	-1.011636	34.85	3.58	38.43
5	53.270563	-1.010853	30.44	3.58	34.02
6	53.271018	-1.010359	28.90	3.58	32.48
7	53.271801	-1.010118	28.09	3.58	31.67
8	53.272436	-1.010113	28.03	3.58	31.61
9	53.273132	-1.010794	28.00	3.58	31.58
10	53.273251	-1.012709	29.07	3.58	32.65
11	53.272847	-1.012870	29.87	3.58	33.45

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273052	-1.017644	40.16	3.58	43.74
2	53.268875	-1.018991	51.61	3.58	55.19
3	53.268647	-1.015601	47.64	3.58	51.22
4	53.269510	-1.015448	43.86	3.58	47.44
4	53.269510	-1.015448	43.86	3.58	47.44
5	53.269557	-1.014760	42.86	3.58	46.44
5	53.269557	-1.014760	42.86	3.58	46.44
6	53.272905	-1.014029	31.22	3.58	34.80

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.279168	-0.962682	22.00	304.80
OP 2	2	53.275011	-0.957188	26.00	304.80
OP 3	3	53.265823	-0.946545	20.99	304.80
OP 4	4	53.258892	-0.954442	41.64	304.80
OP 5	5	53.253860	-0.968518	33.27	304.80
OP 6	6	53.259816	-0.979075	30.66	304.80
OP 7	7	53.270494	-0.993838	27.91	304.80
OP 8	8	53.282145	-1.005425	52.69	304.80
OP 9	9	53.287327	-0.996241	34.00	304.80
OP 10	10	53.291175	-0.981221	26.10	304.80
OP 11	11	53.286506	-0.974955	25.68	304.80
OP 12	12	53.281991	-0.989976	45.11	304.80
OP 13	13	53.277526	-0.995040	54.66	304.80
OP 14	14	53.268852	-0.946545	21.82	304.80
OP 15	15	53.273523	-0.934529	23.38	304.80
OP 16	16	53.279168	-0.926461	24.89	304.80
OP 17	17	53.284095	-0.934872	29.10	304.80
OP 18	18	53.291278	-0.946460	23.41	304.80
OP 19	19	53.296049	-0.954528	37.14	304.80
OP 20	20	53.293535	-0.965342	36.12	304.80
OP 21	21	53.288918	-0.971350	22.98	304.80

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	9,230	153.8	0	0.0	-	164,450
PV array 2	25.0	180.0	7,777	129.6	0	0.0	-	120,928
PV array 3	25.0	180.0	9,235	153.9	0	0.0	-	170,547
PV array 4	25.0	180.0	8,668	144.5	0	0.0	-	154,677
PV array 5	25.0	180.0	9,761	162.7	0	0.0	-	141,244
PV array 6	25.0	180.0	9,954	165.9	0	0.0	-	130,339
PV array 7	25.0	205.0	7,351	122.5	0	0.0	-	151,369
PV array 8	25.0	180.0	12,938	215.6	0	0.0	-	204,795

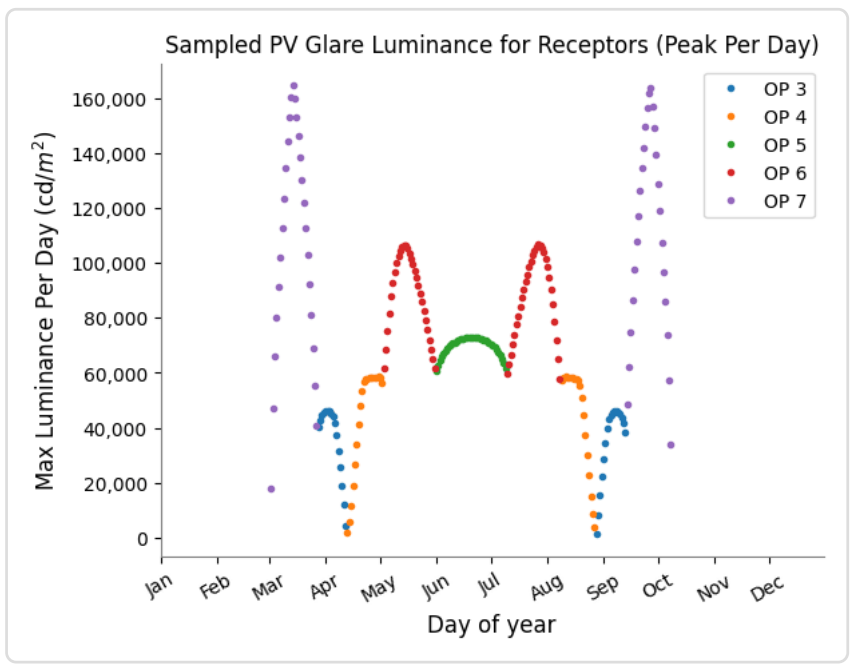
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	0	0.0	0	0.0
OP 2	674	11.2	0	0.0
OP 3	7,178	119.6	0	0.0
OP 4	13,077	217.9	0	0.0
OP 5	15,350	255.8	0	0.0
OP 6	23,917	398.6	0	0.0
OP 7	8,571	142.8	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	4,983	83.0	0	0.0
OP 15	1,164	19.4	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

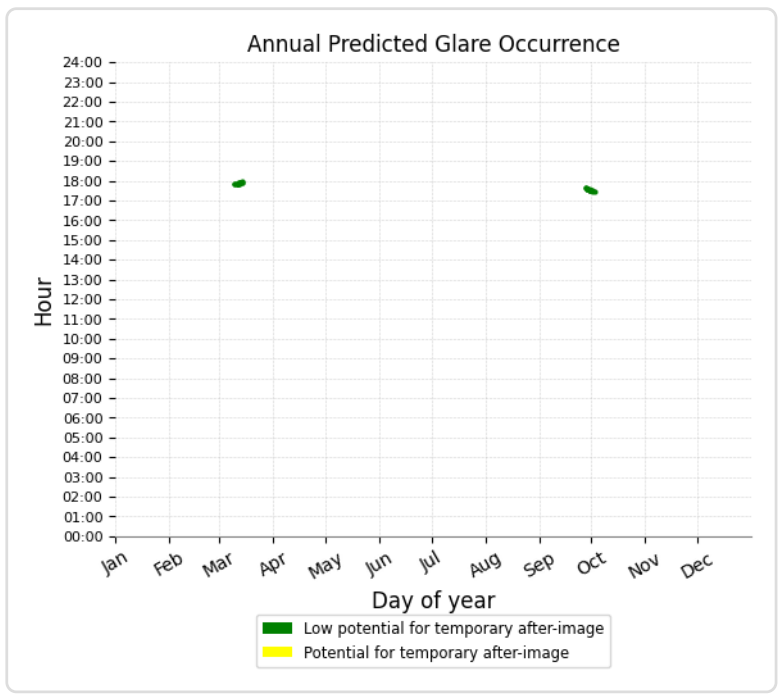
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	32	0.5	0	0.0	9,516
OP 3	956	15.9	0	0.0	46,081
OP 4	1,321	22.0	0	0.0	58,533
OP 5	1,658	27.6	0	0.0	72,930
OP 6	3,013	50.2	0	0.0	106,715
OP 7	1,236	20.6	0	0.0	164,450
OP 14	786	13.1	0	0.0	41,254
OP 15	228	3.8	0	0.0	20,533
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

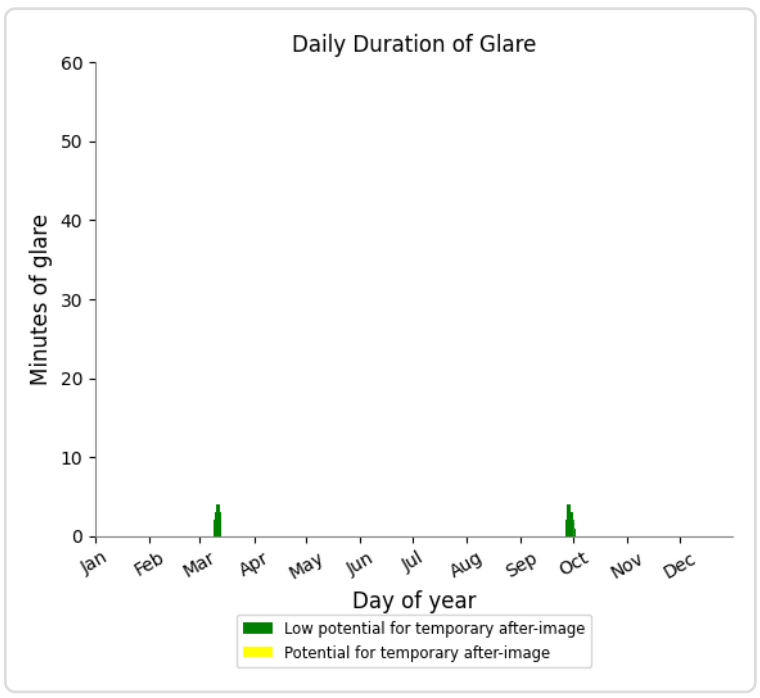


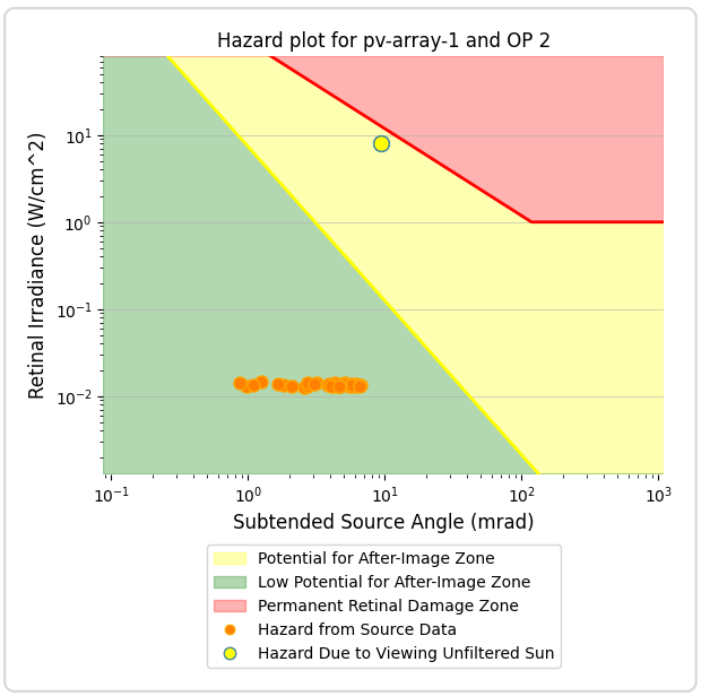
PV array 1 and OP 2

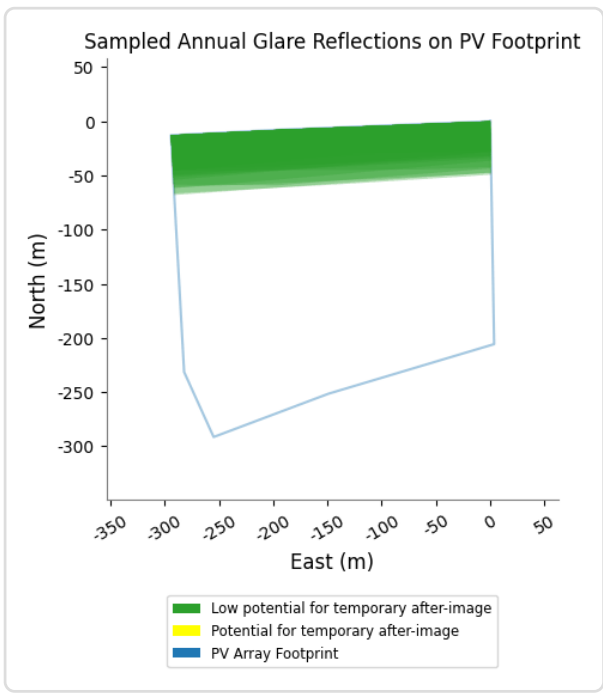
Yellow glare: none

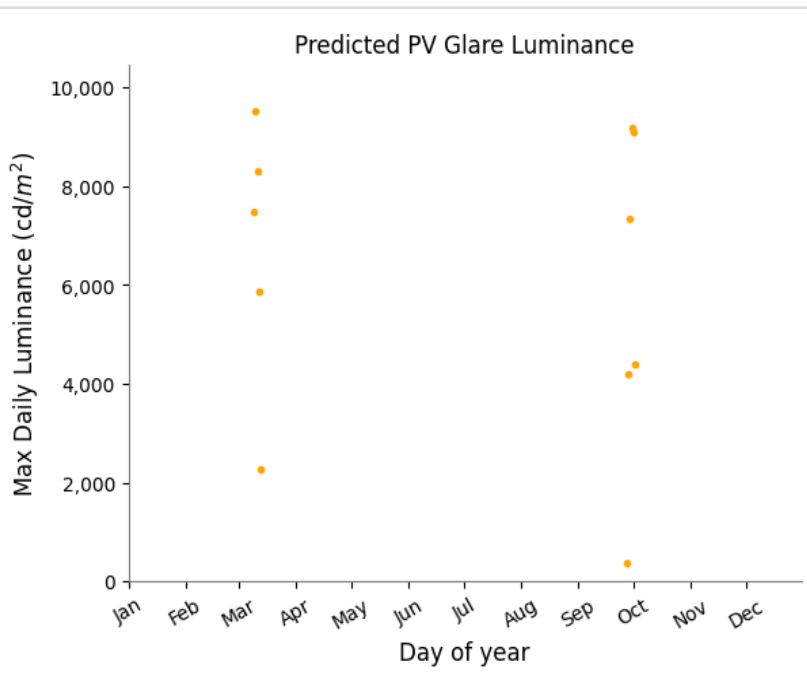
Green glare: 32 min.







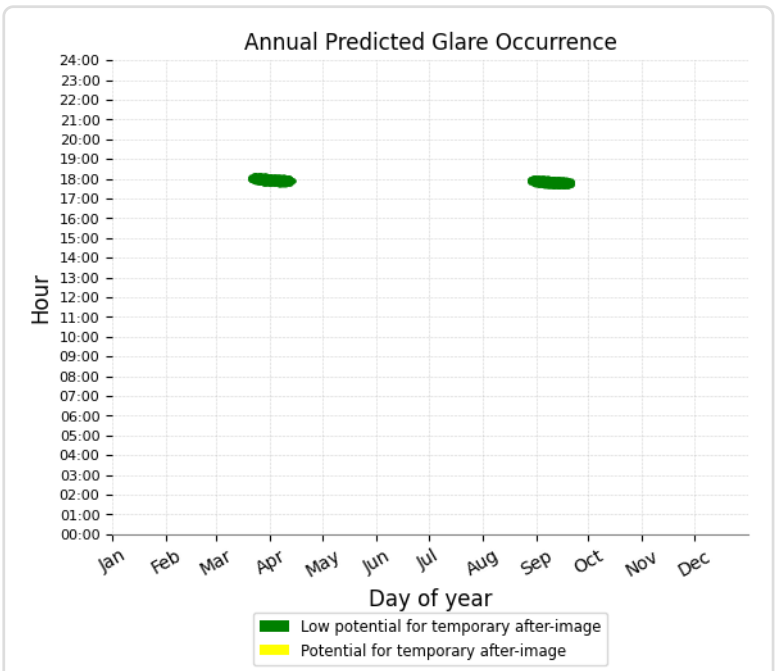


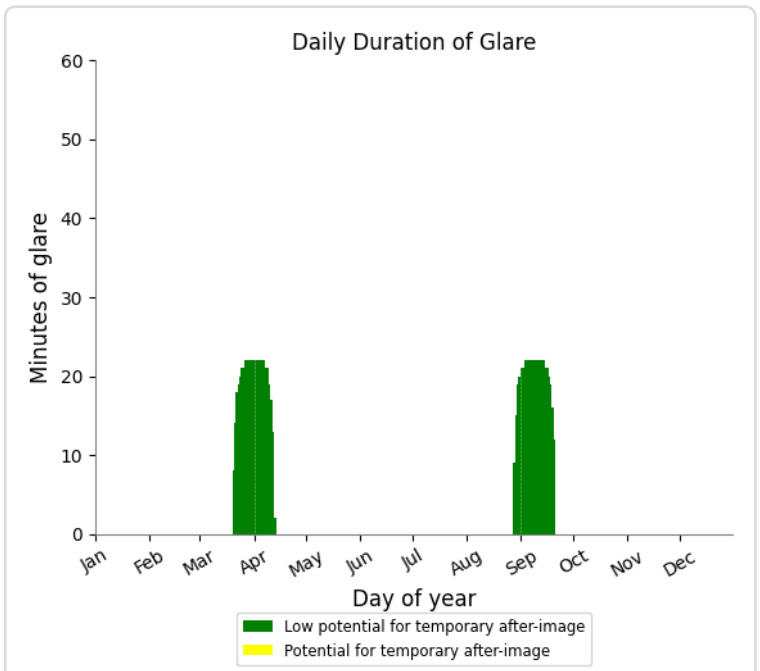


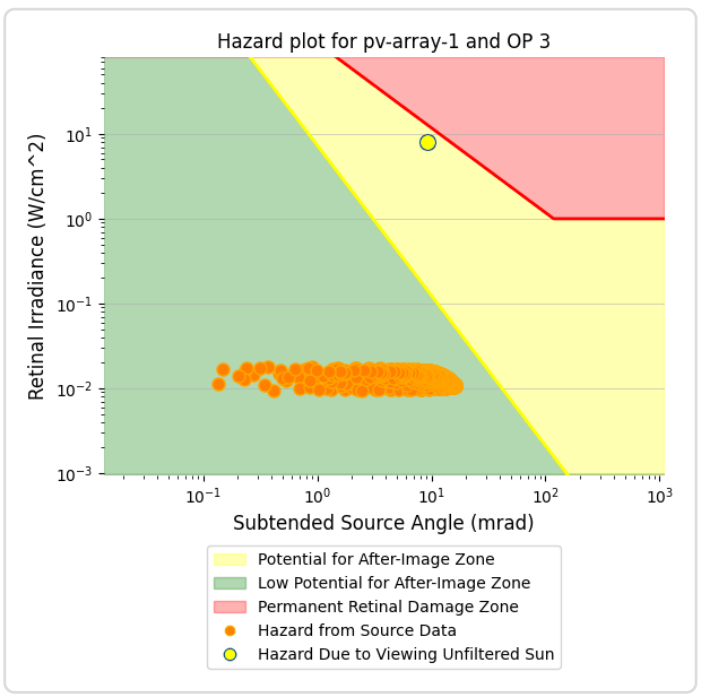
PV array 1 and OP 3

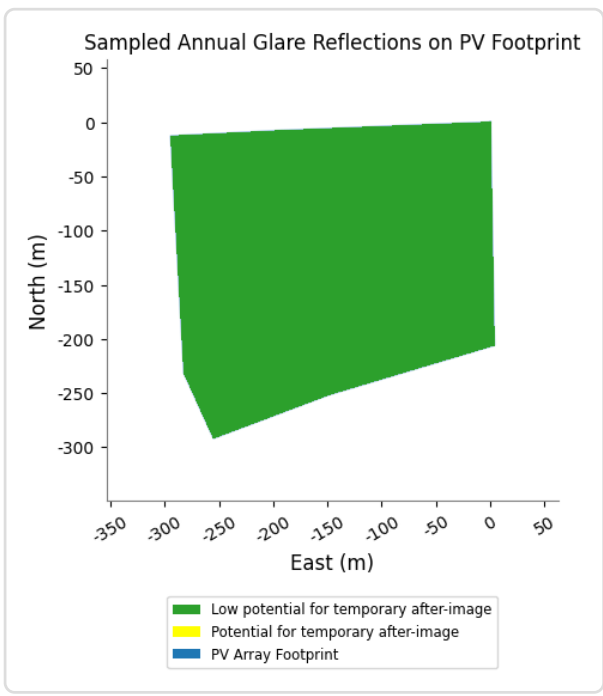
Yellow glare: none

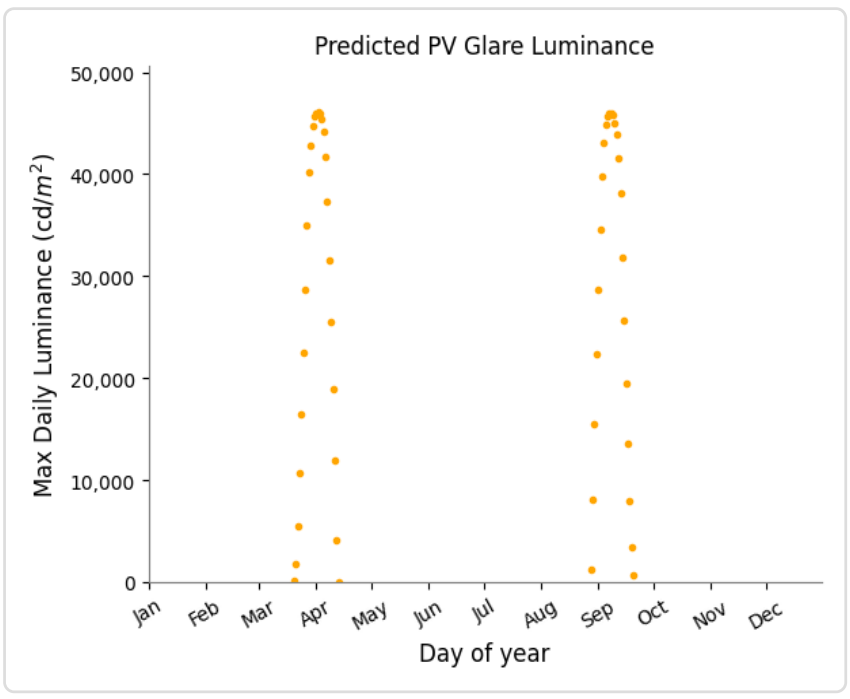
Green glare: 956 min.







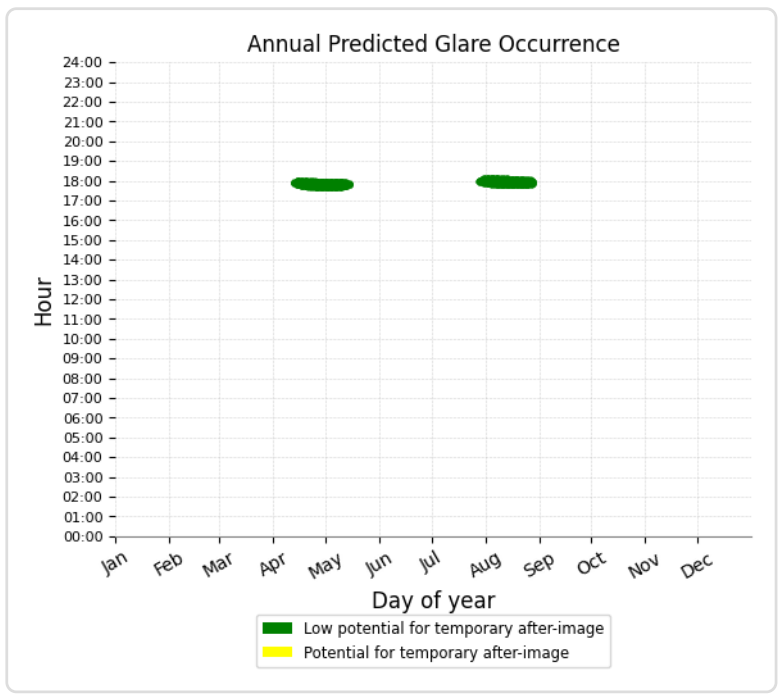


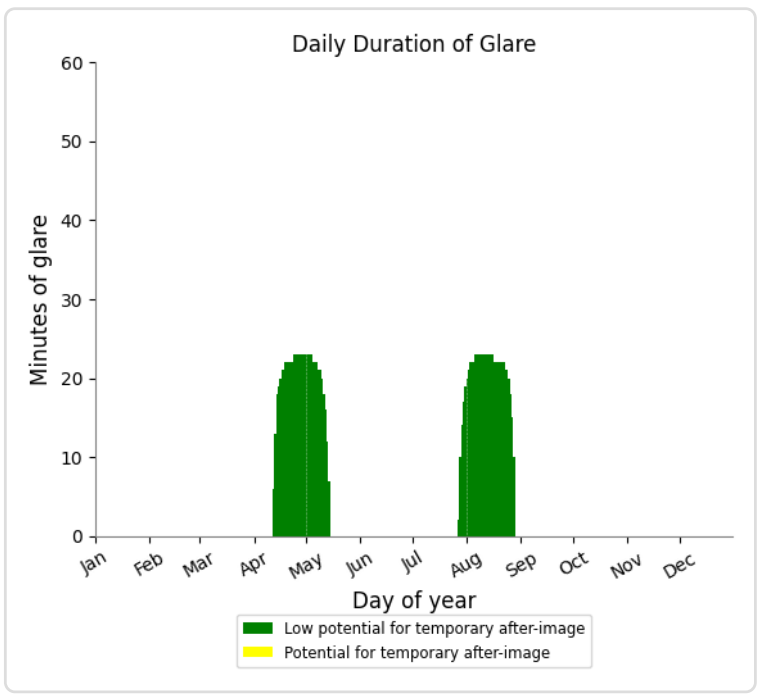


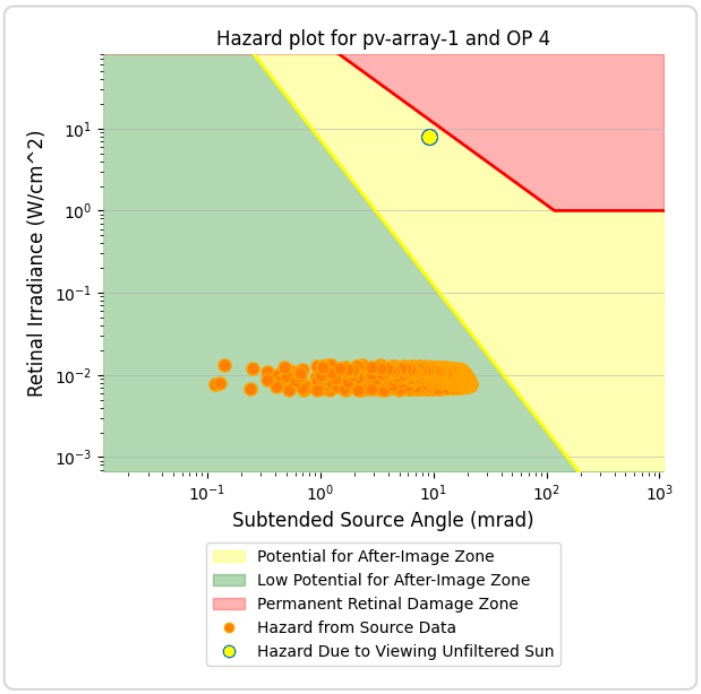
PV array 1 and OP 4

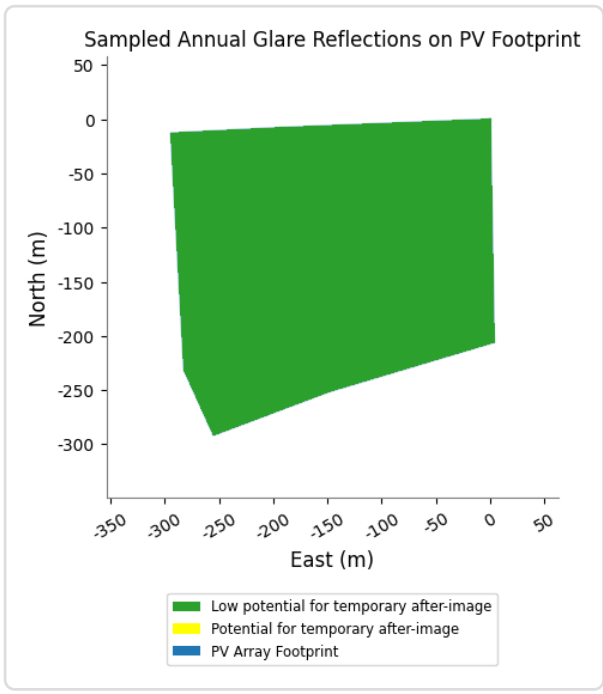
Yellow glare: none

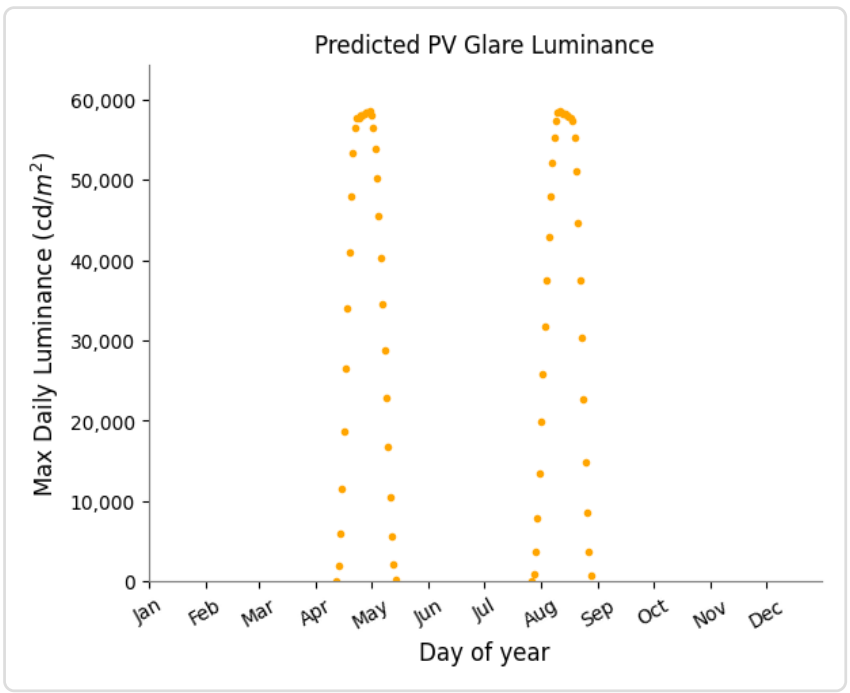
Green glare: 1,321 min.







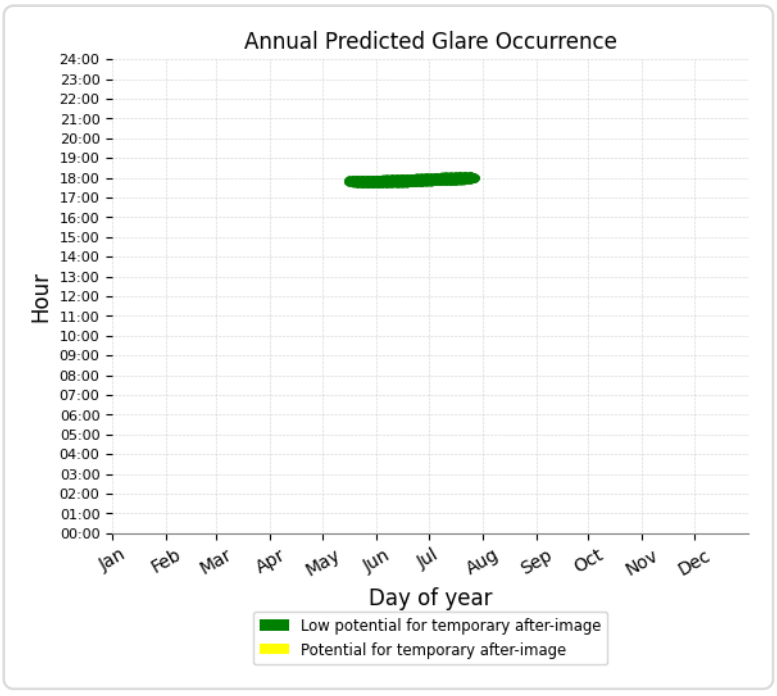


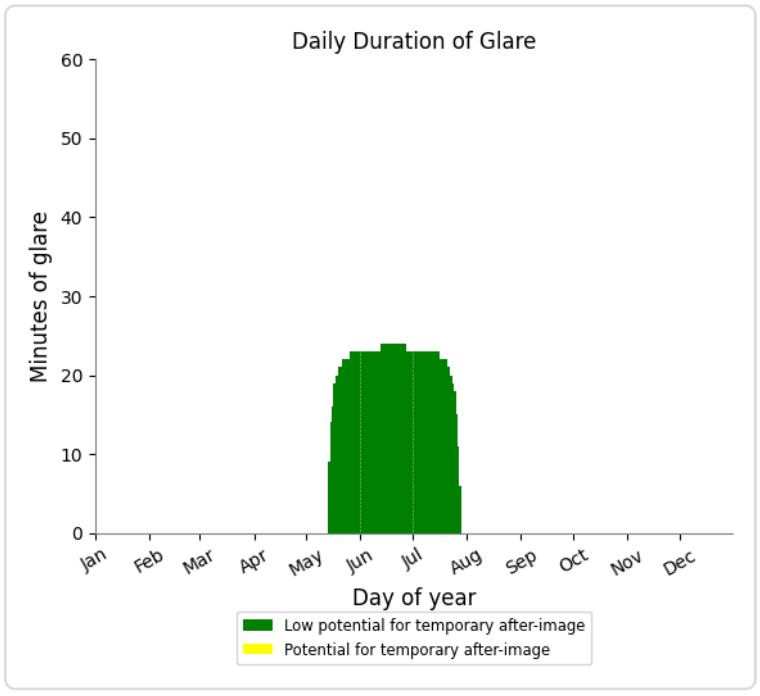


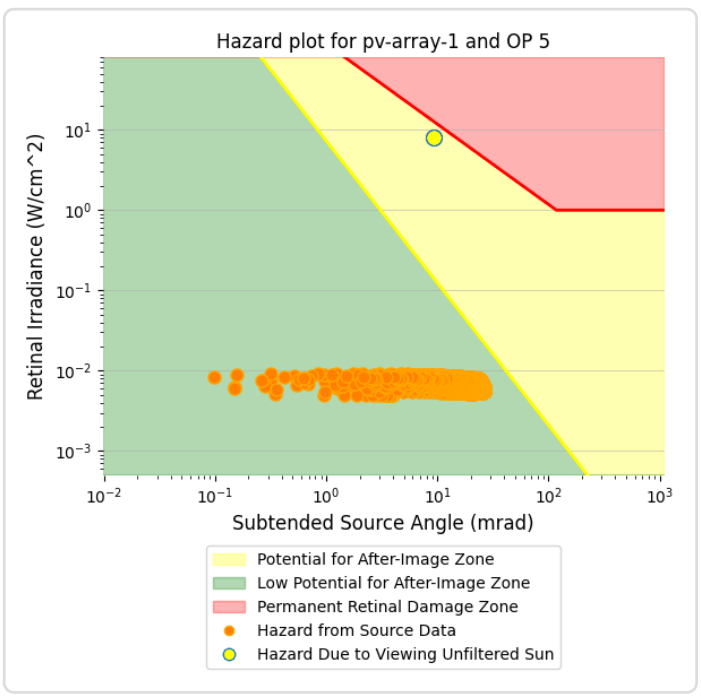
PV array 1 and OP 5

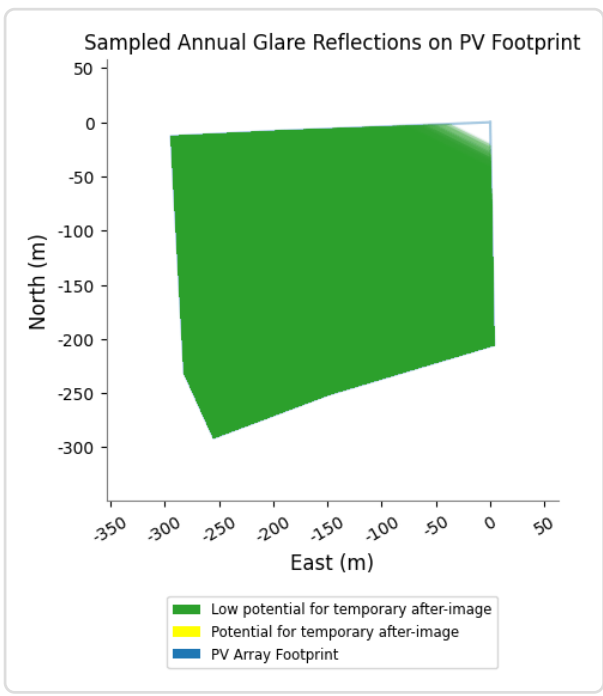
Yellow glare: none

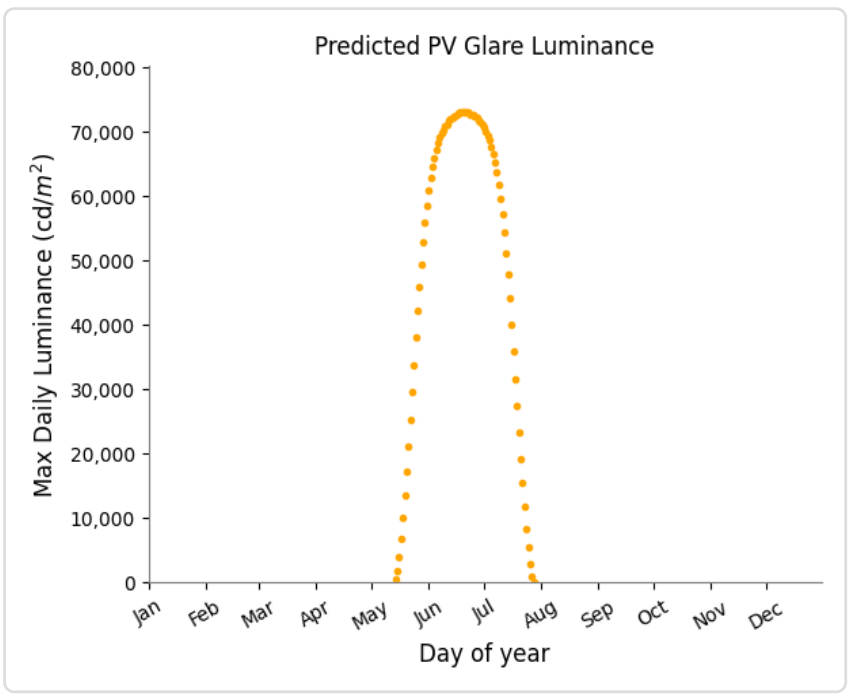
Green glare: 1,658 min.







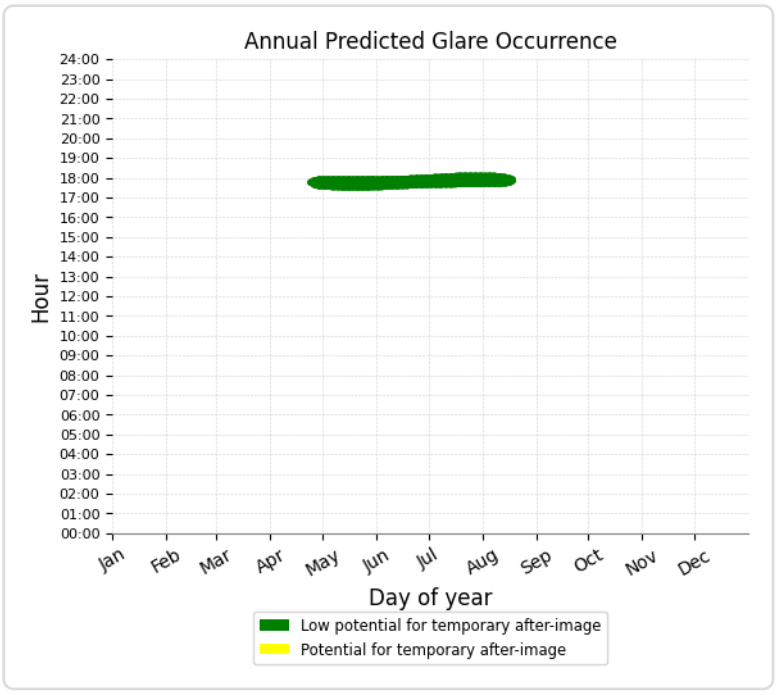


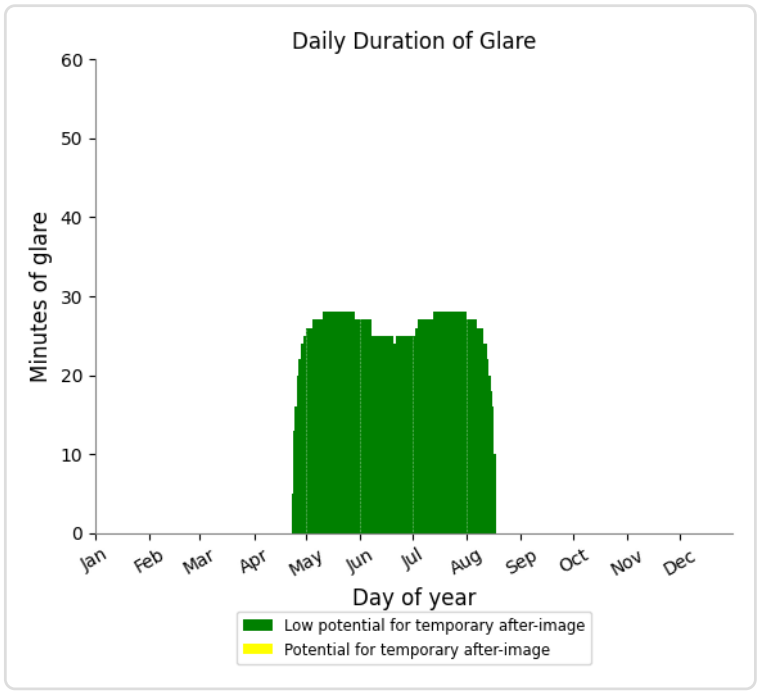


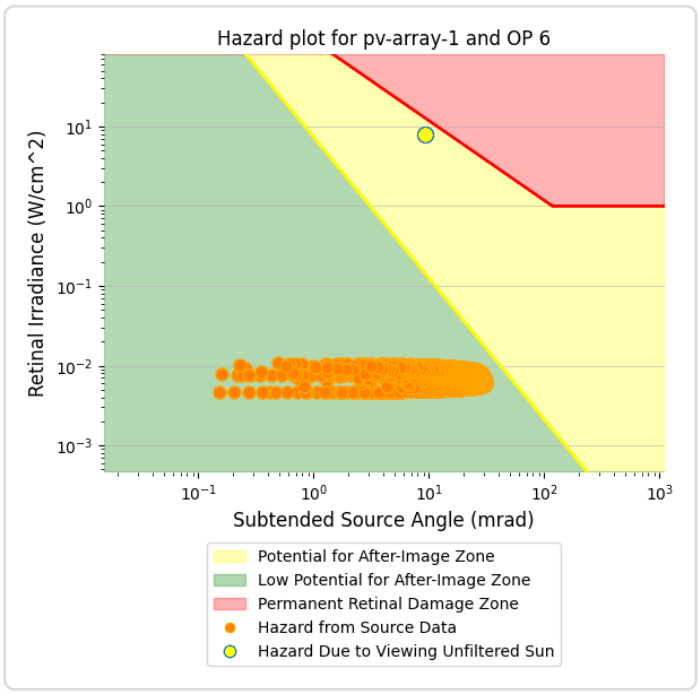
PV array 1 and OP 6

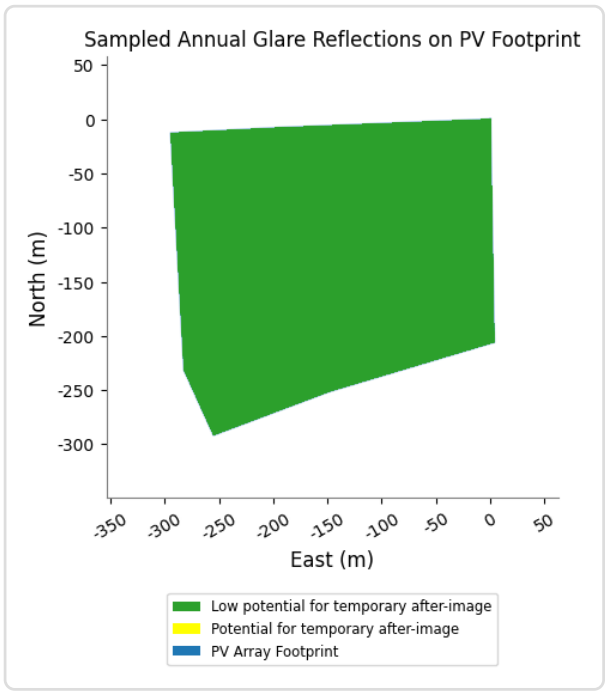
Yellow glare: none

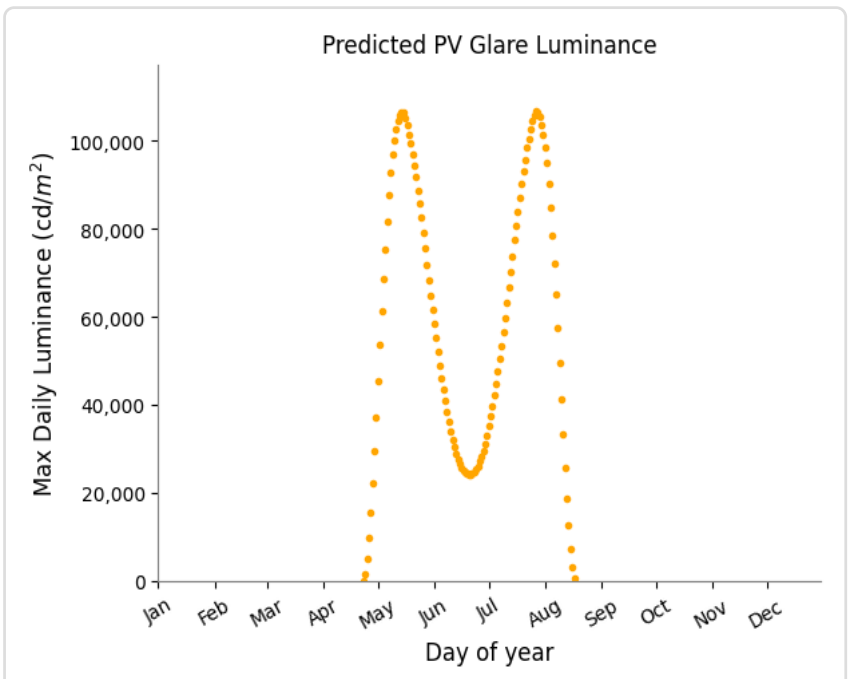
Green glare: 3,013 min.







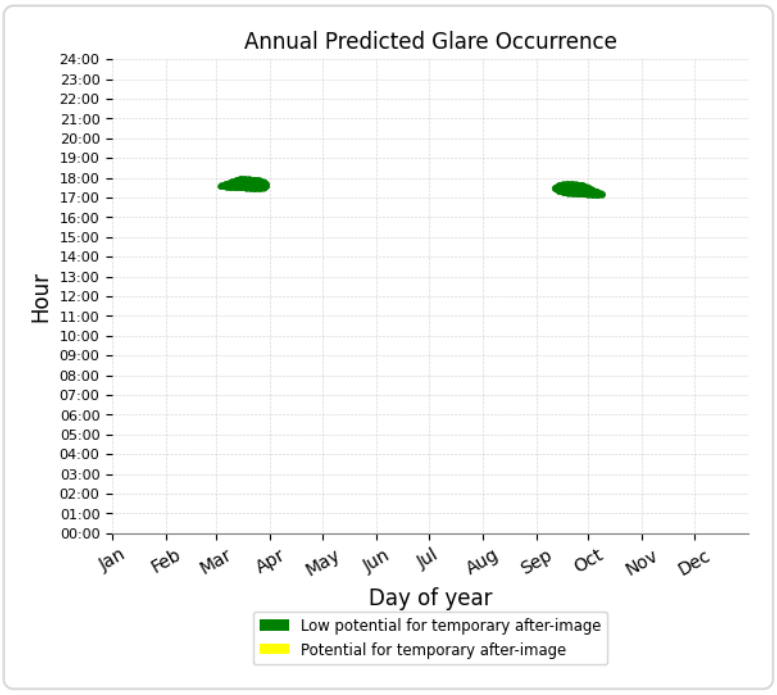


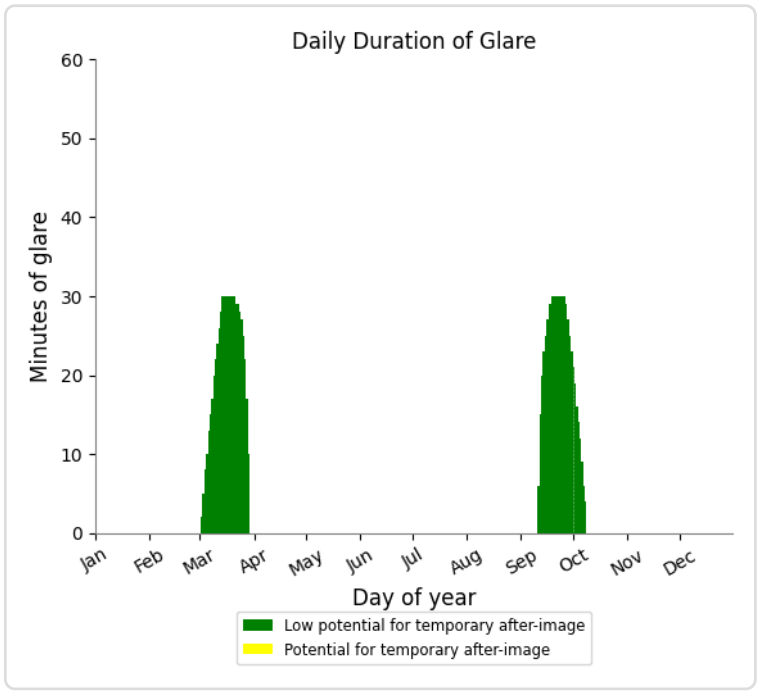


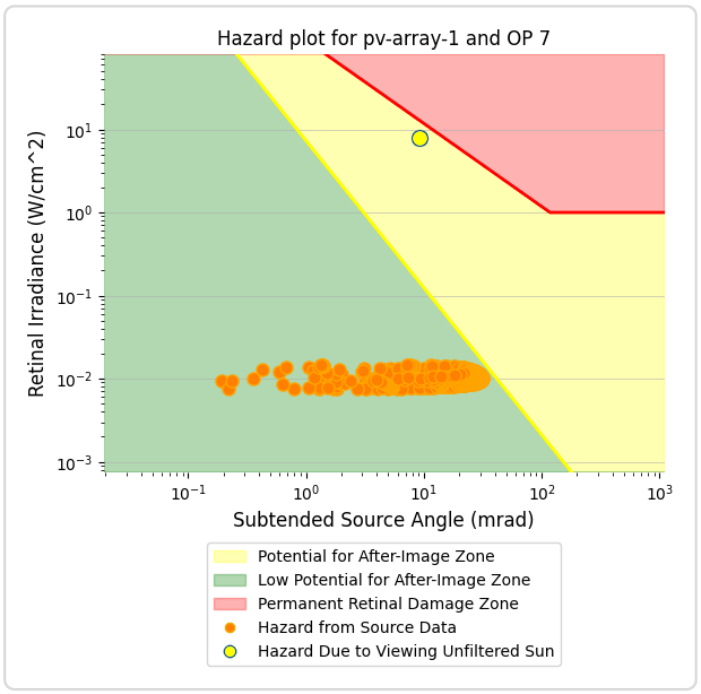
PV array 1 and OP 7

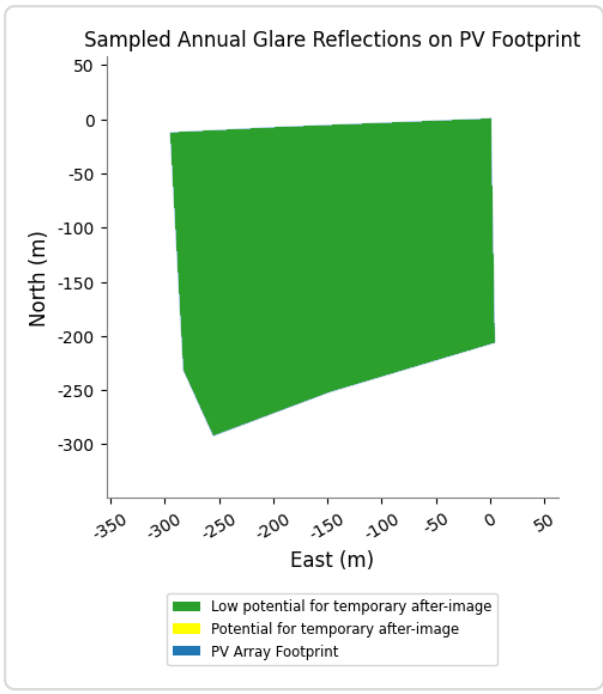
Yellow glare: none

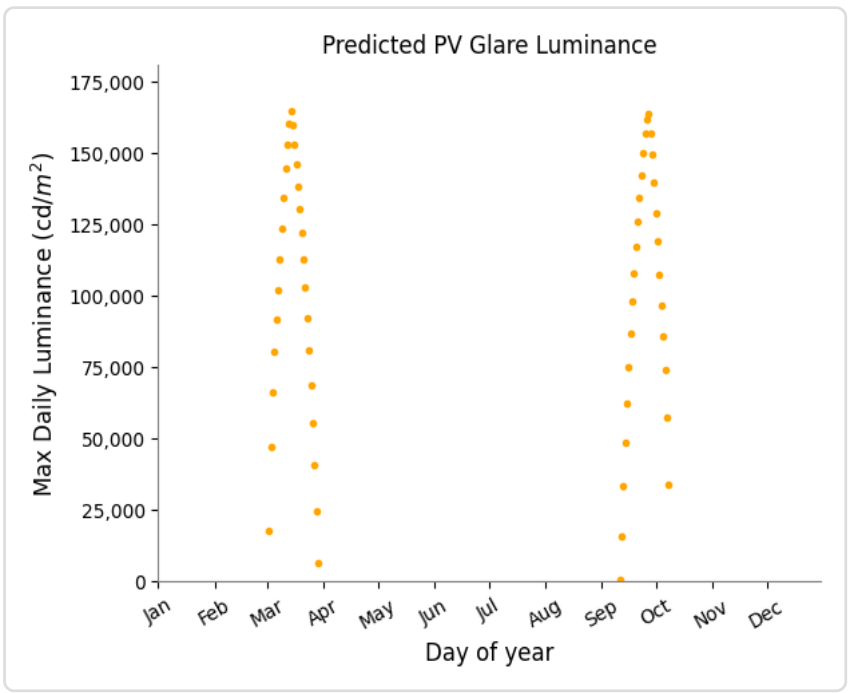
Green glare: 1,236 min.







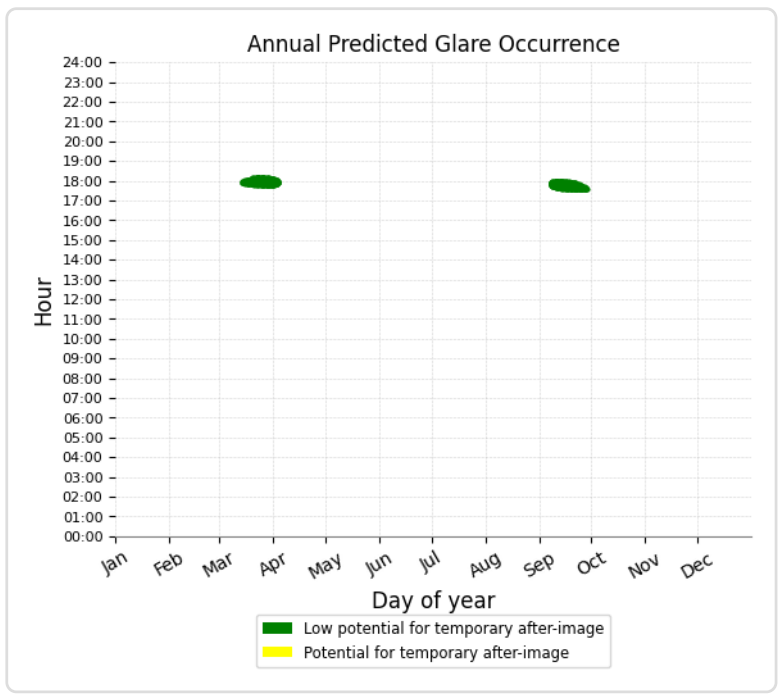


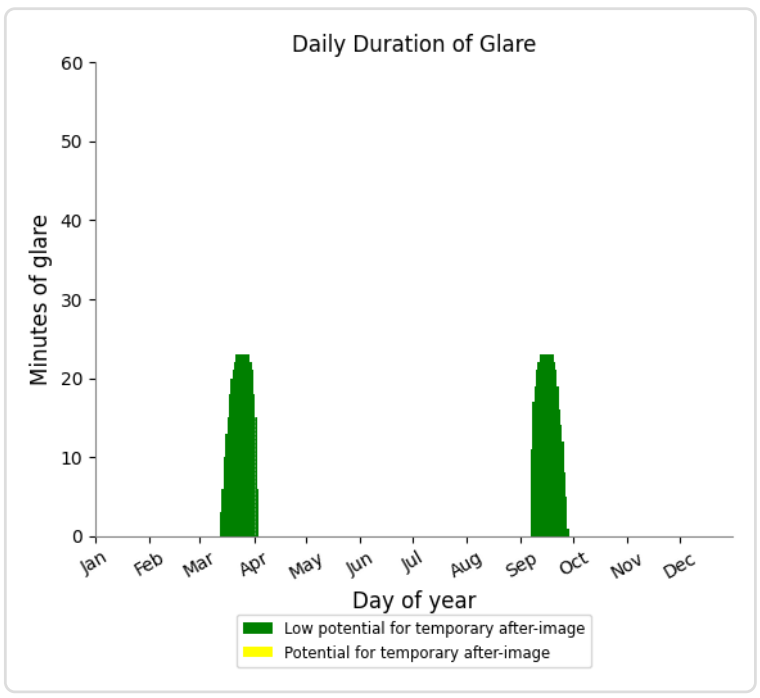


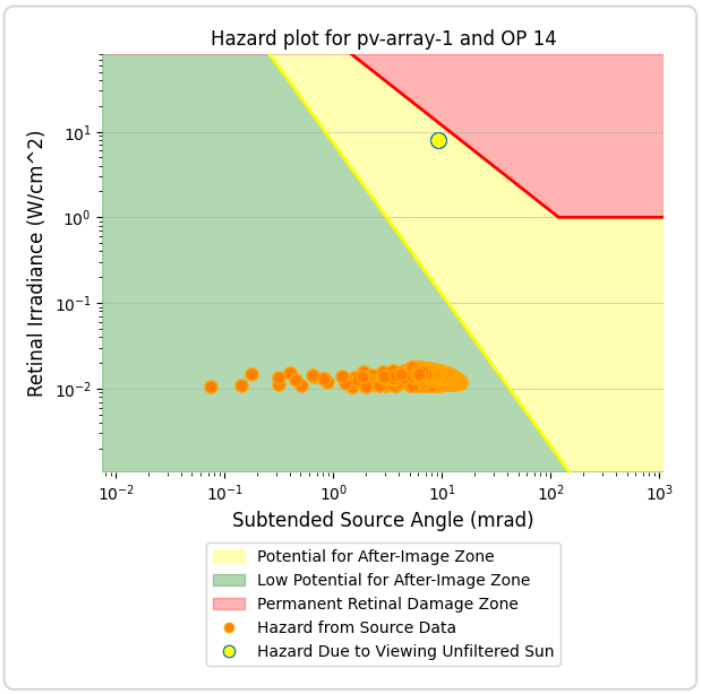
PV array 1 and OP 14

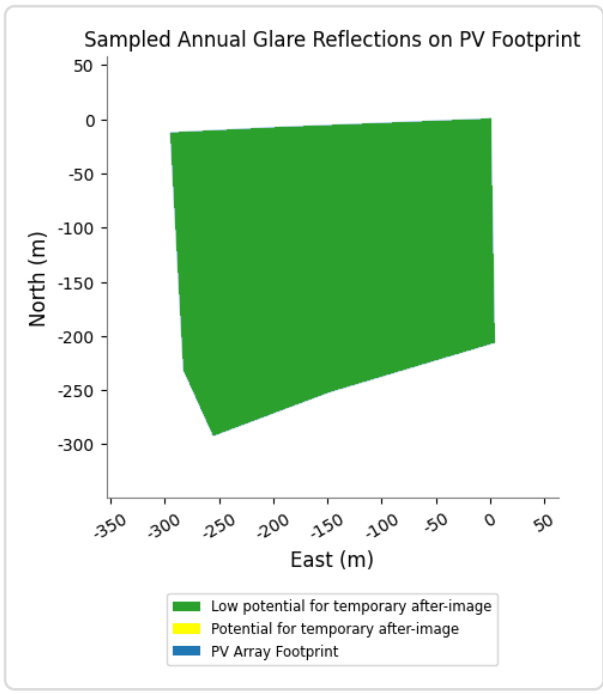
Yellow glare: none

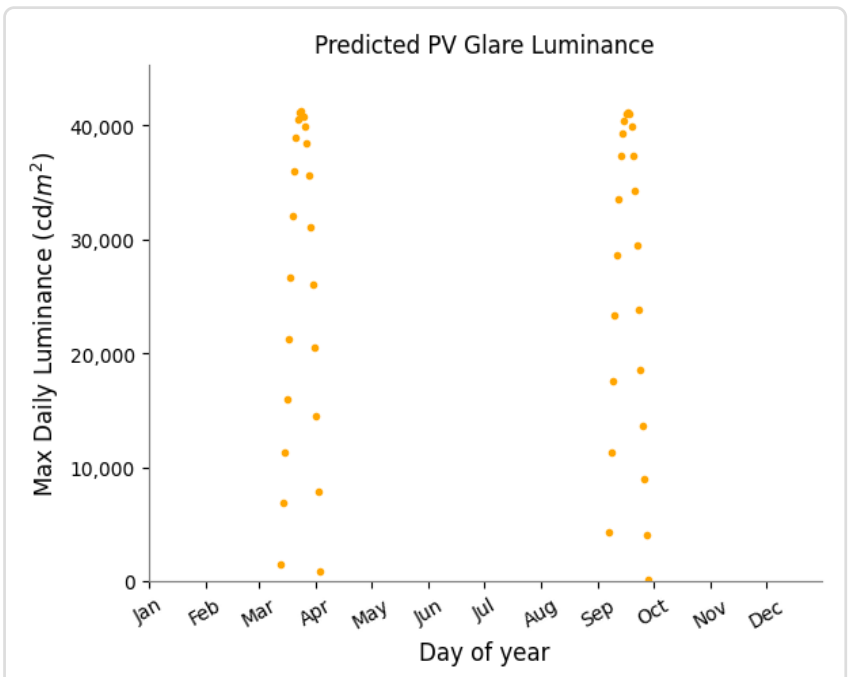
Green glare: 786 min.







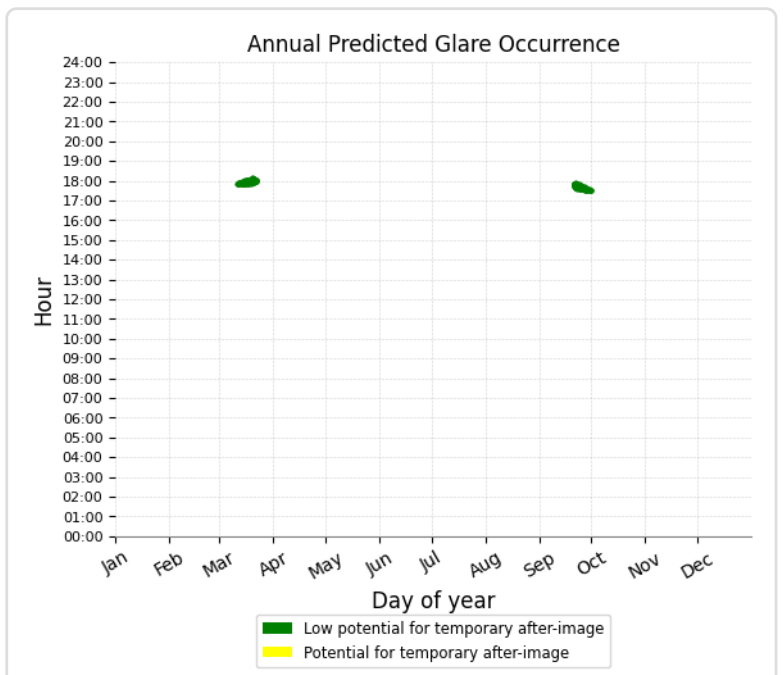


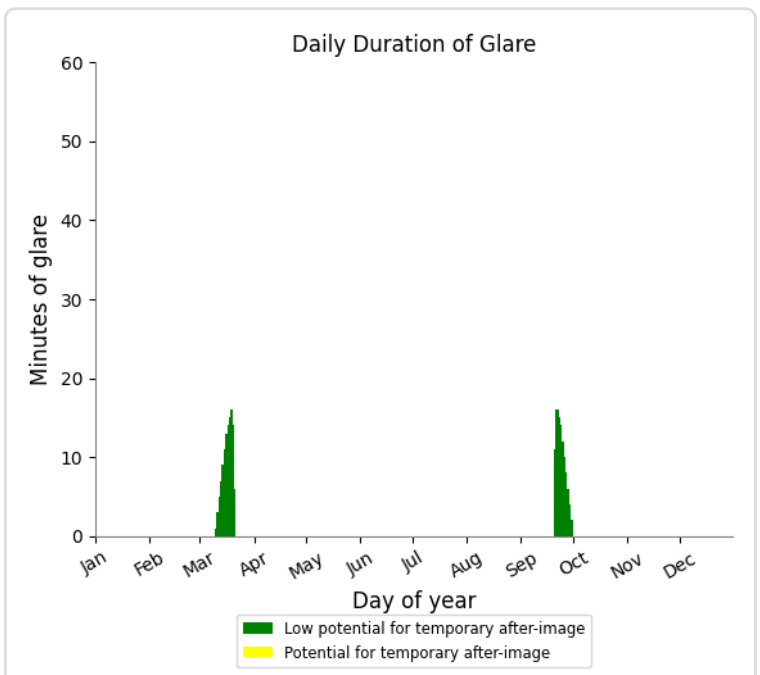


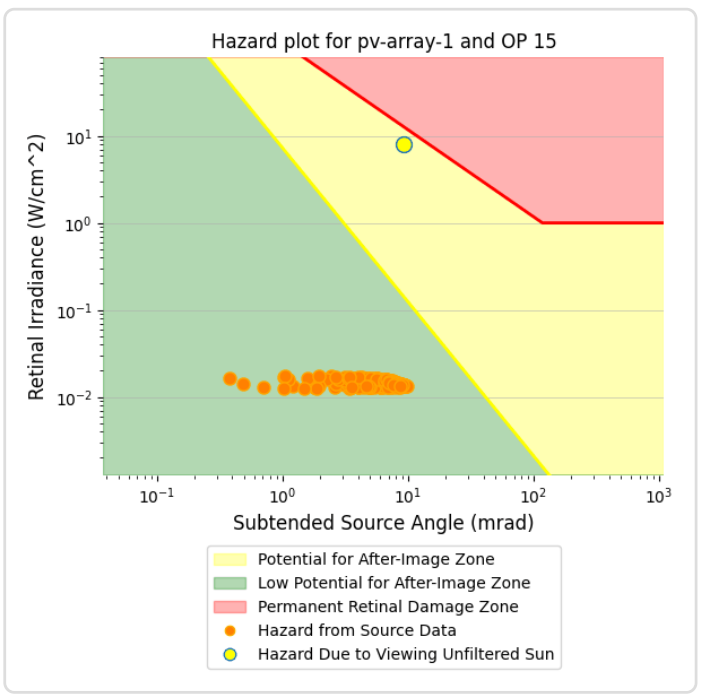
PV array 1 and OP 15

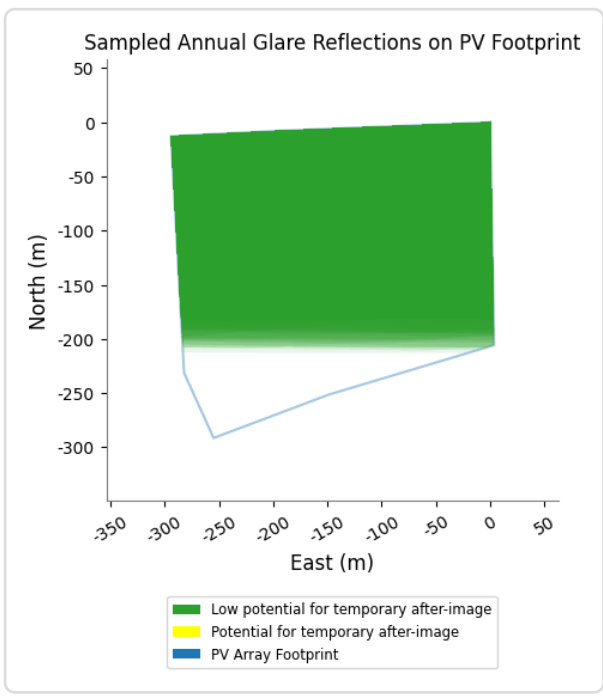
Yellow glare: none

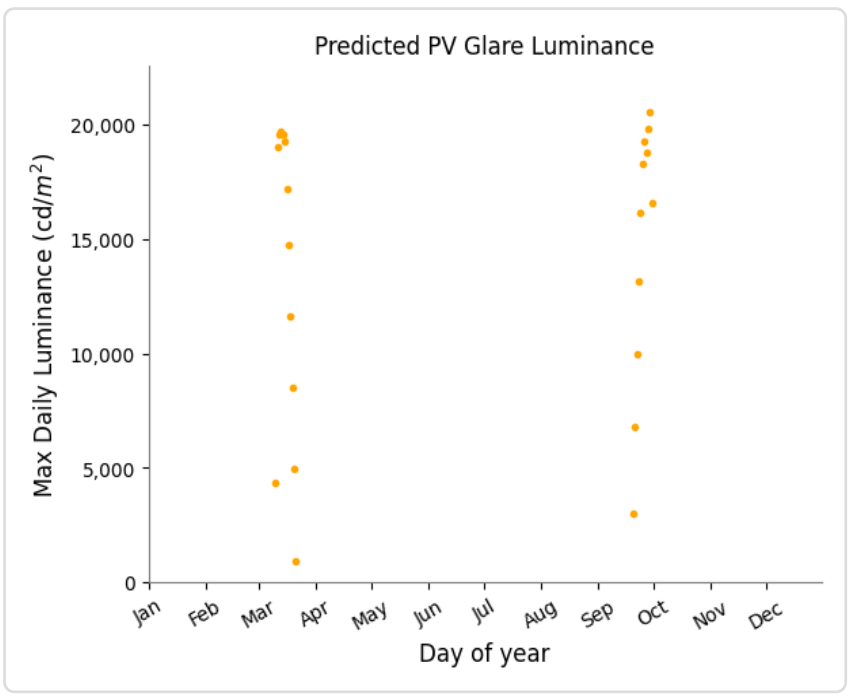
Green glare: 228 min.











PV array 1 and OP 1

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 16

No glare found

PV array 1 and OP 17

No glare found

PV array 1 and OP 18

No glare found

PV array 1 and OP 19

No glare found

PV array 1 and OP 20

No glare found

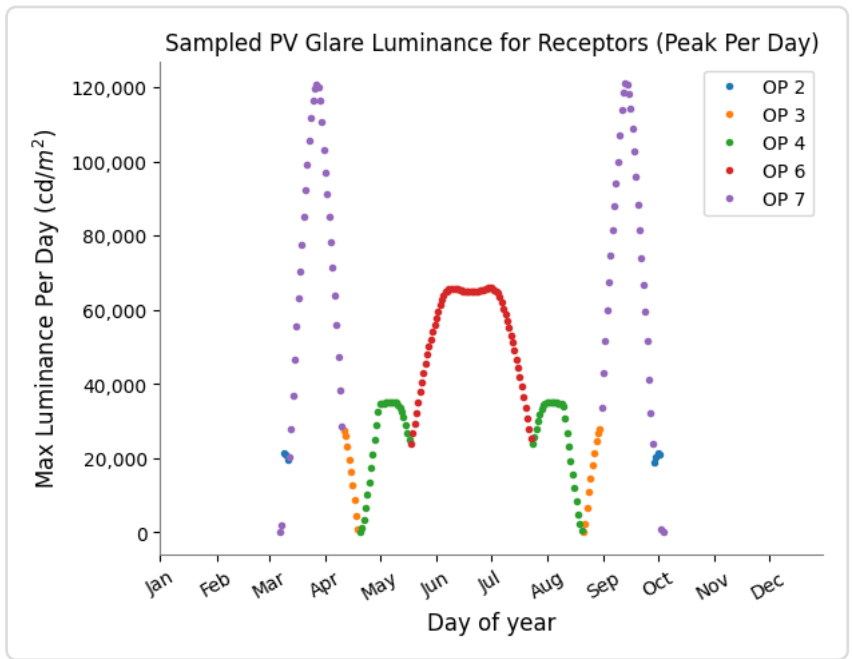
PV array 1 and OP 21

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

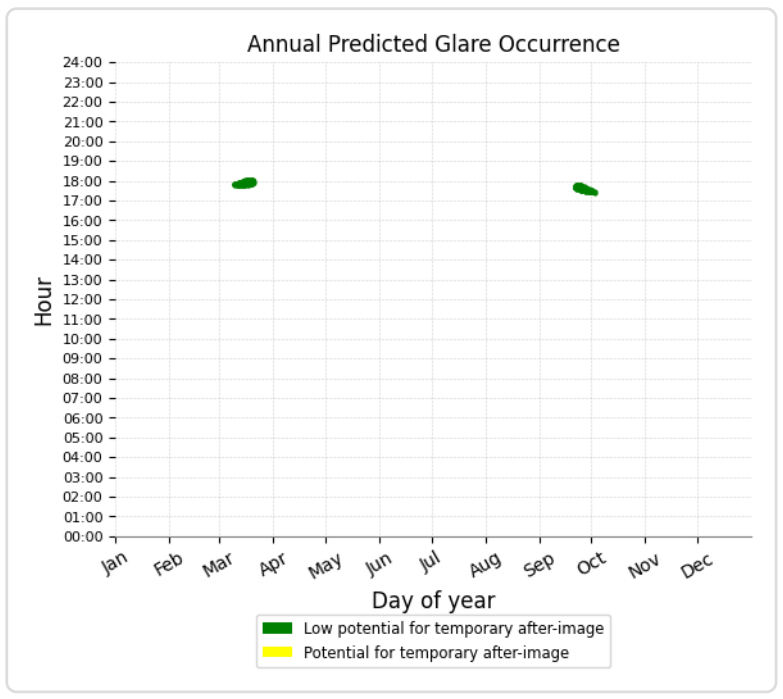
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	249	4.2	0	0.0	21,328
OP 3	713	11.9	0	0.0	28,465
OP 4	1,231	20.5	0	0.0	35,133
OP 5	512	8.5	0	0.0	4,908
OP 6	2,129	35.5	0	0.0	65,861
OP 7	1,903	31.7	0	0.0	120,928
OP 14	698	11.6	0	0.0	26,429
OP 15	342	5.7	0	0.0	15,111
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

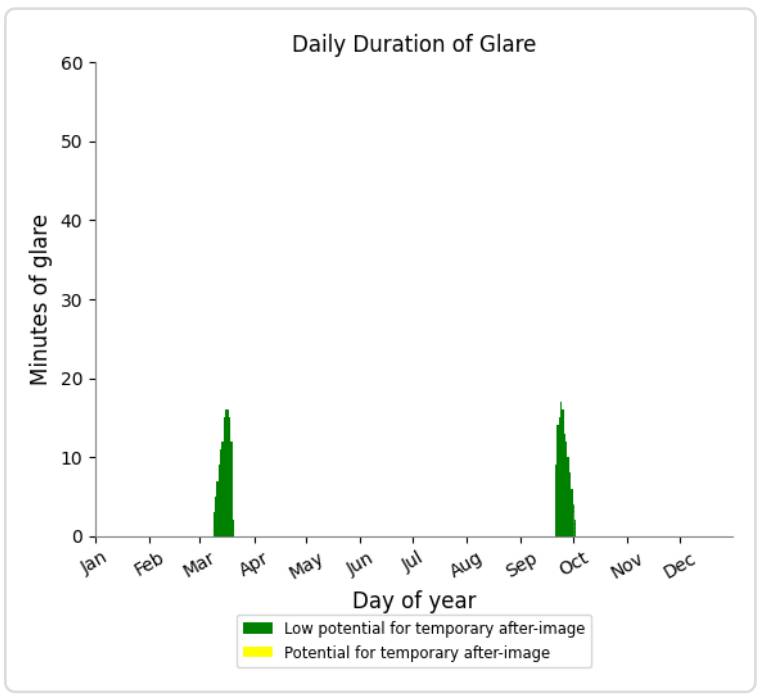


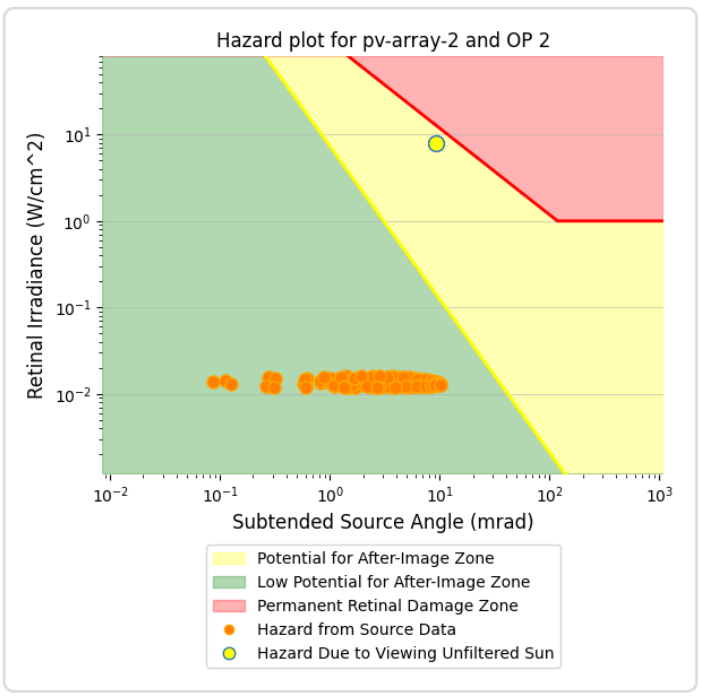
PV array 2 and OP 2

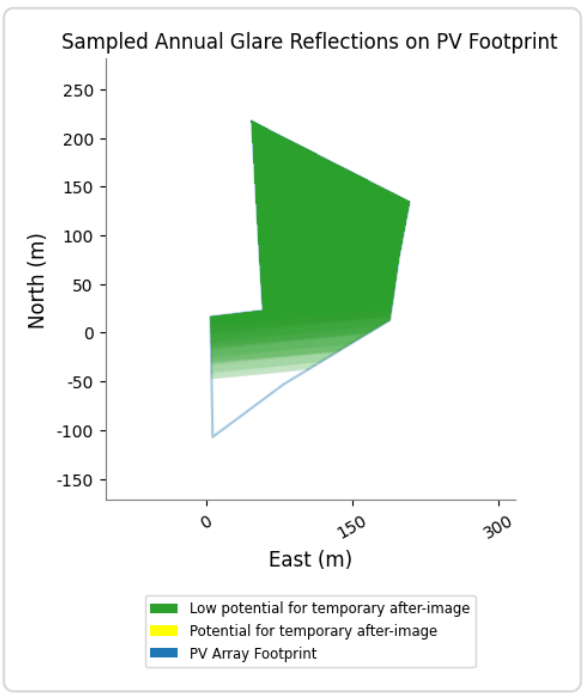
Yellow glare: none

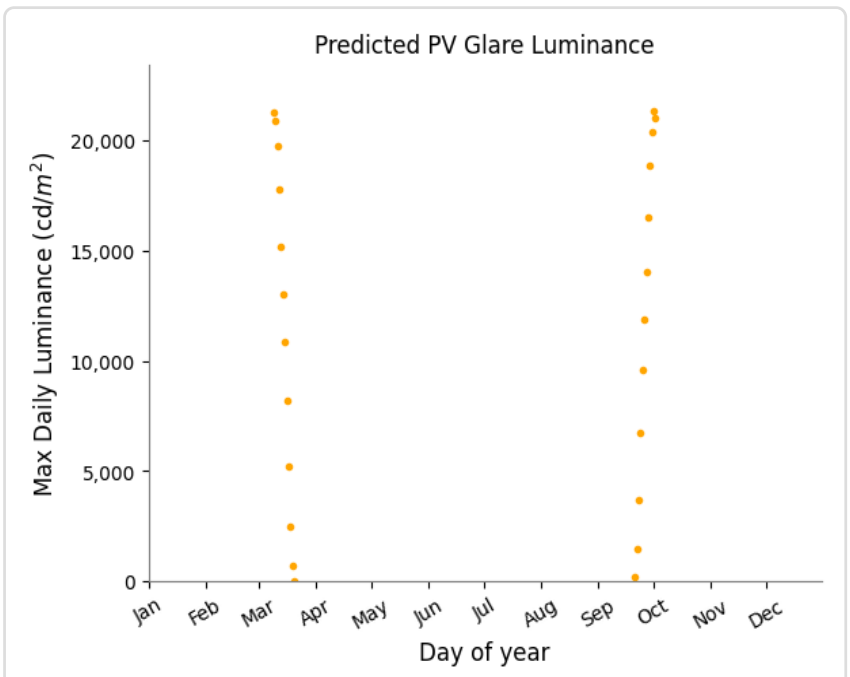
Green glare: 249 min.







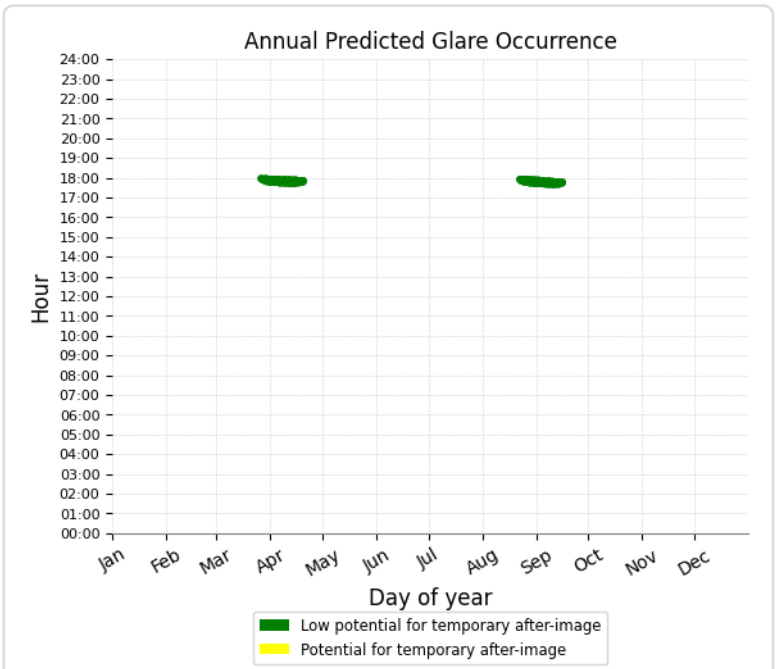


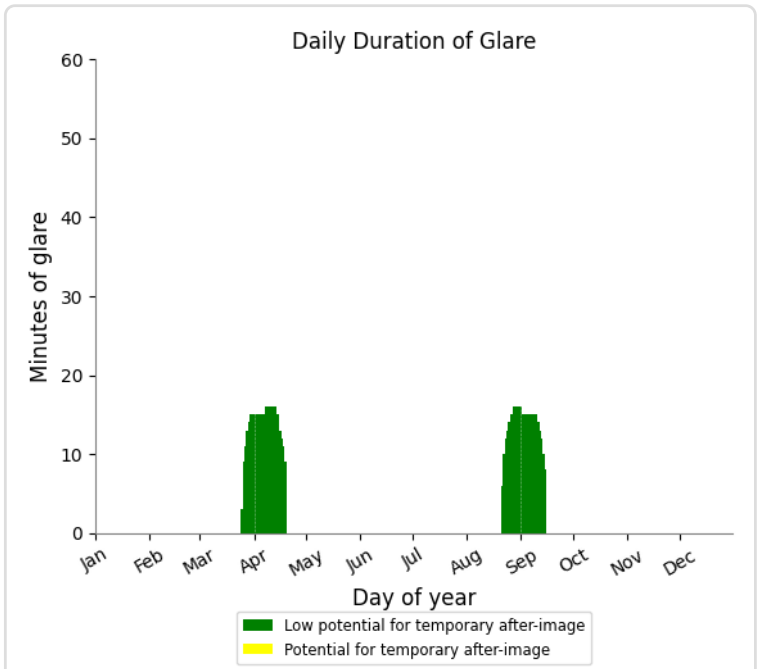


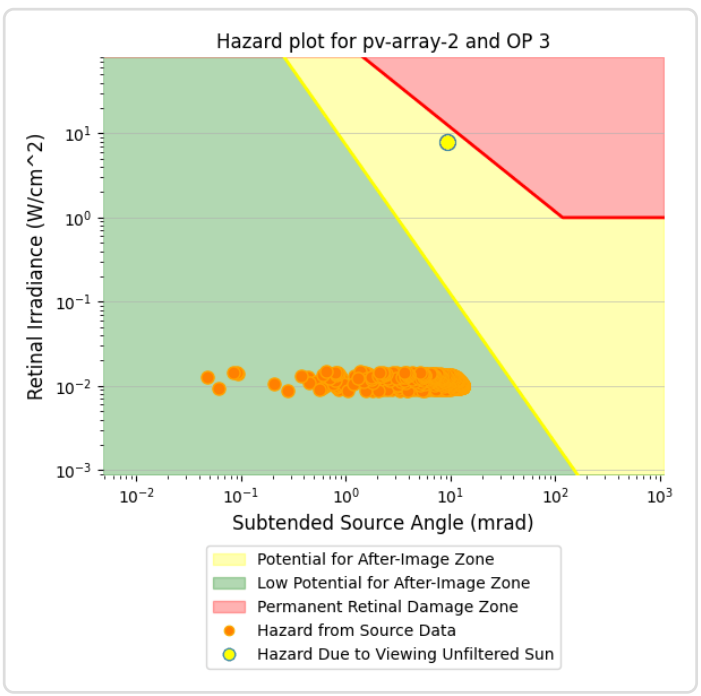
PV array 2 and OP 3

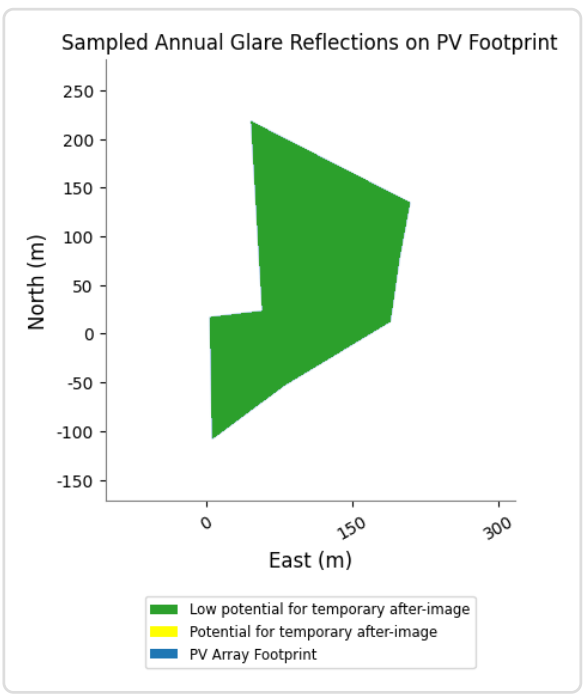
Yellow glare: none

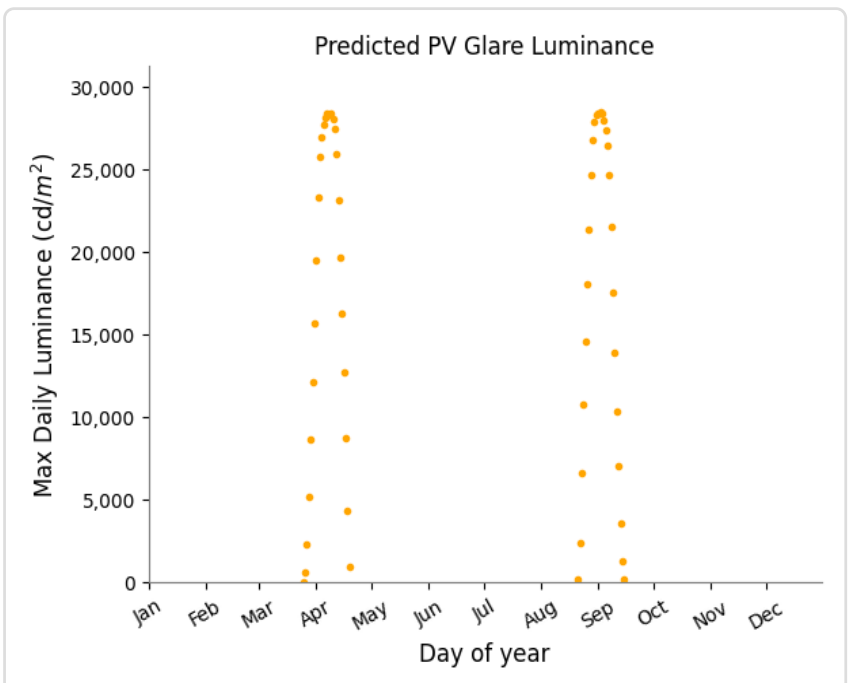
Green glare: 713 min.







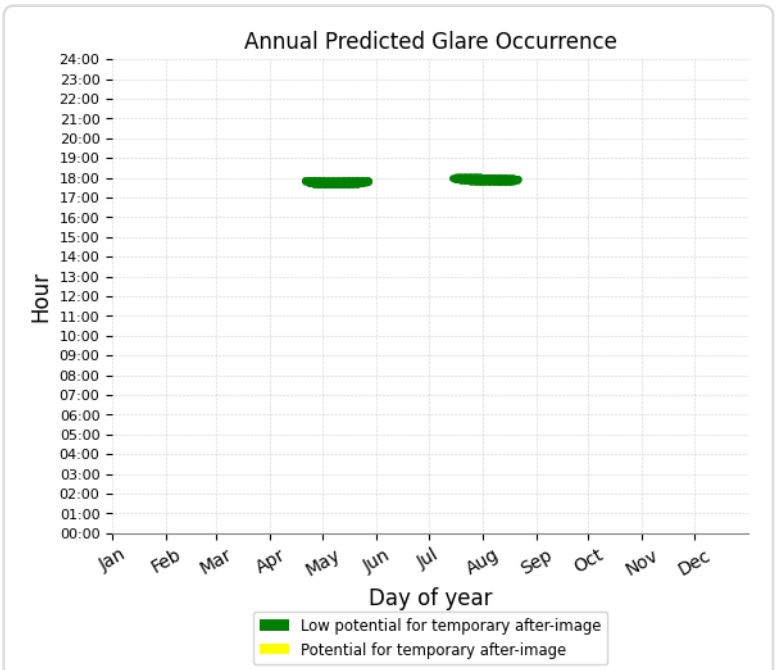


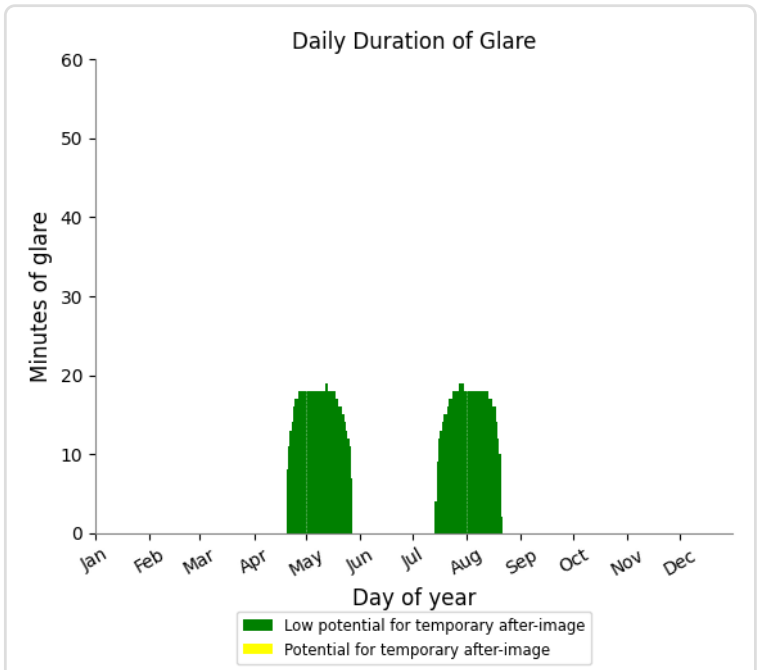


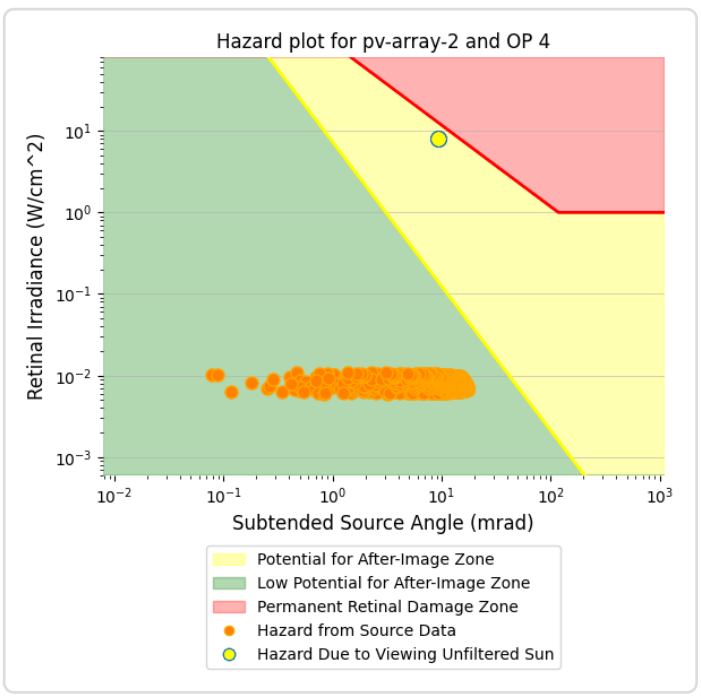
PV array 2 and OP 4

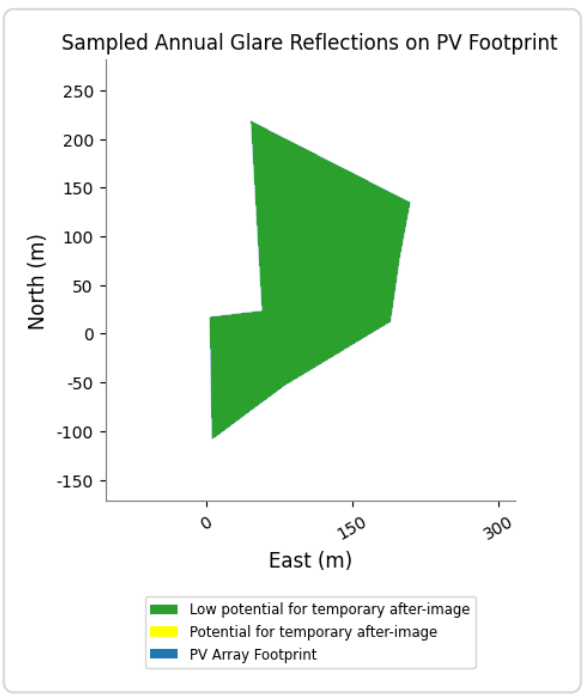
Yellow glare: none

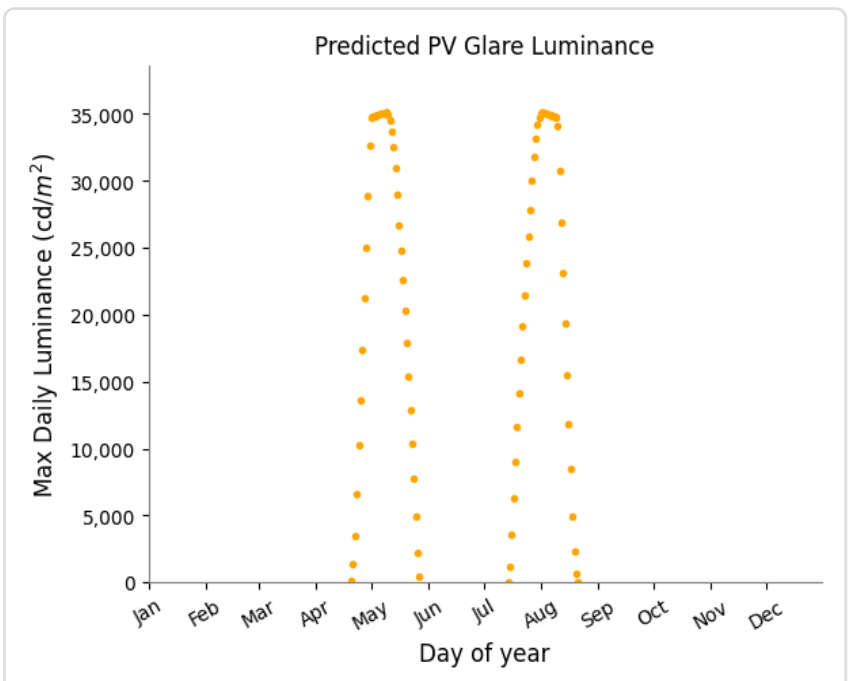
Green glare: 1,231 min.







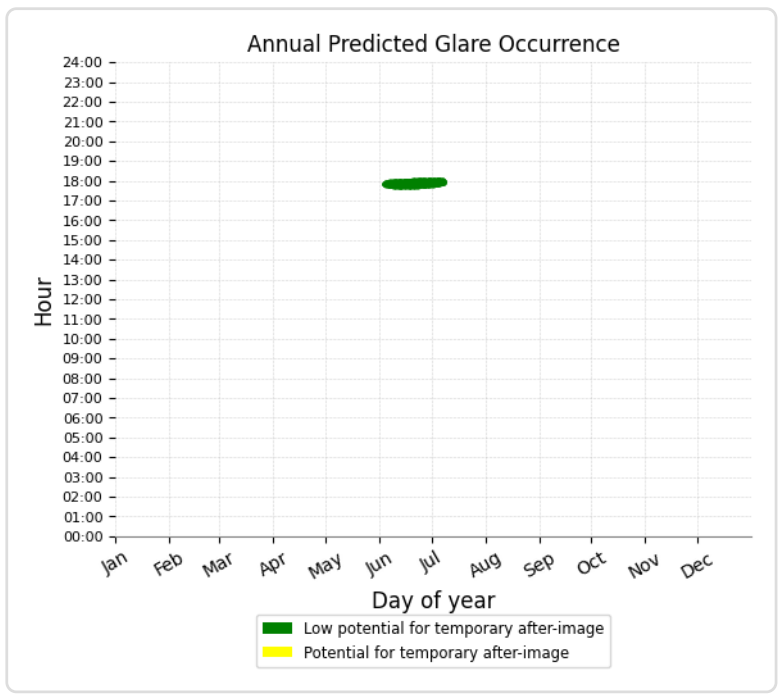


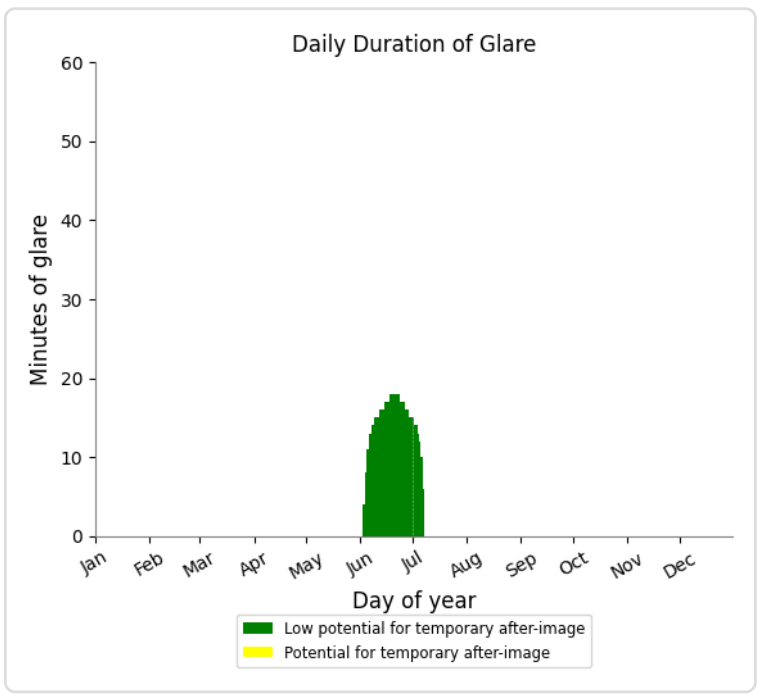


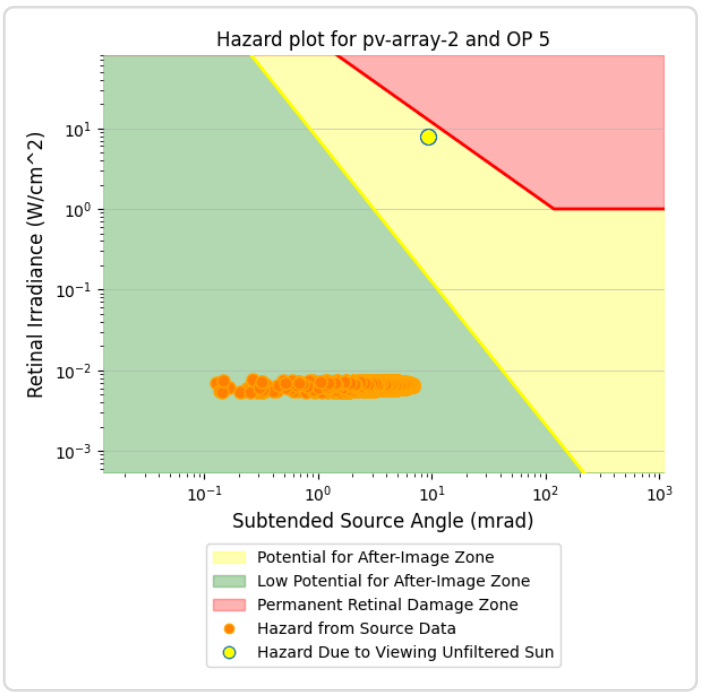
PV array 2 and OP 5

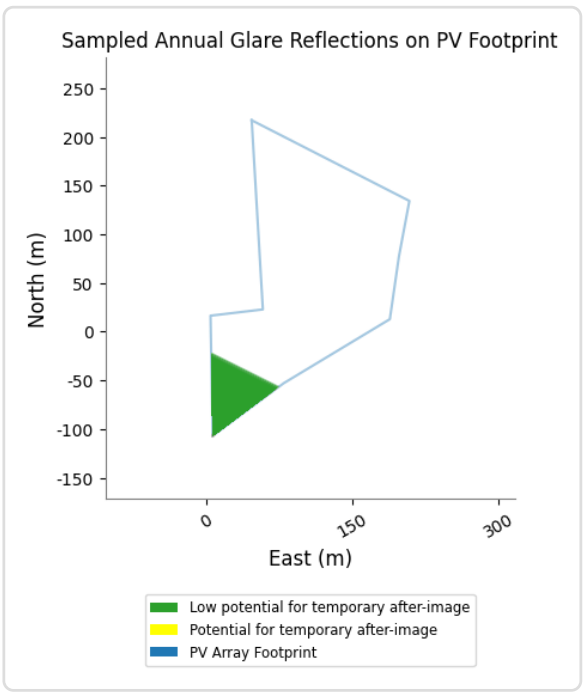
Yellow glare: none

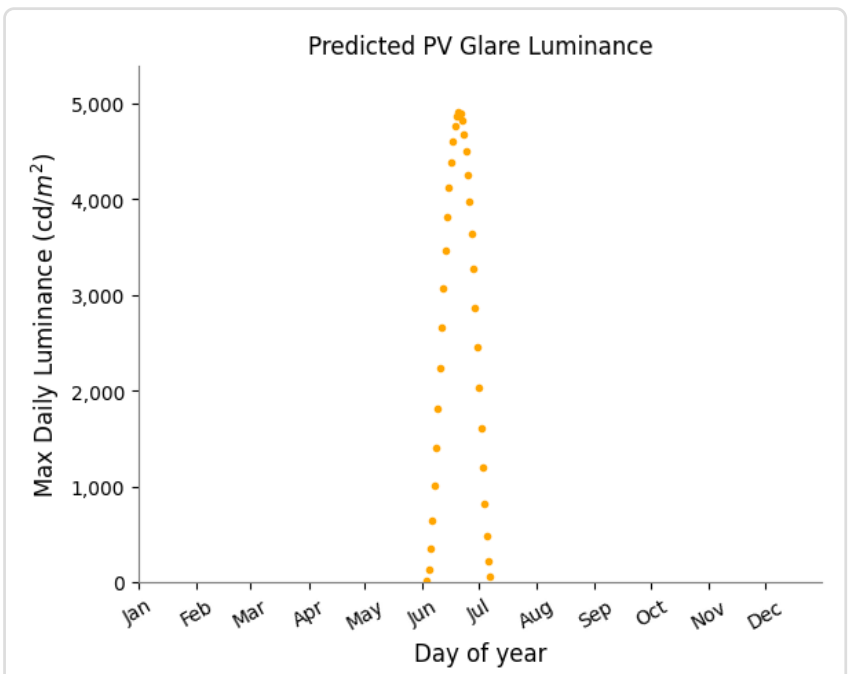
Green glare: 512 min.







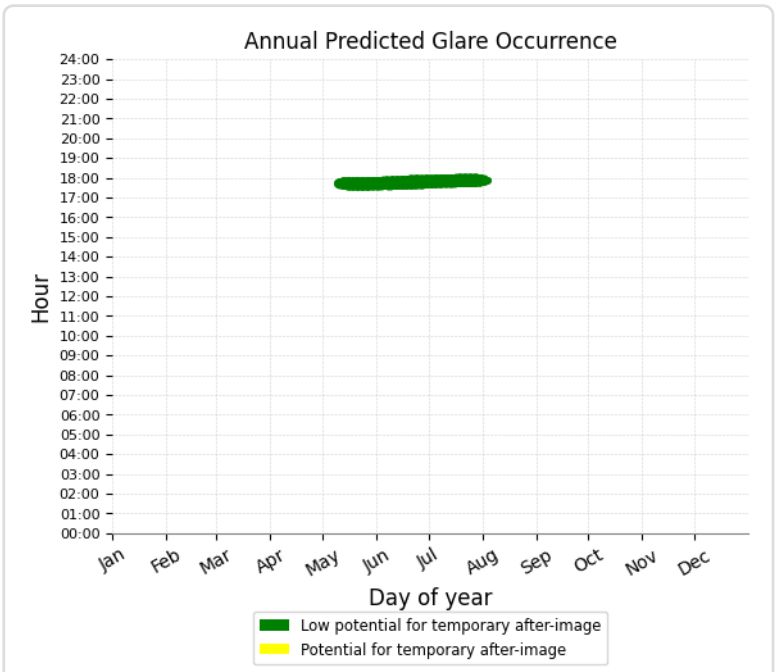


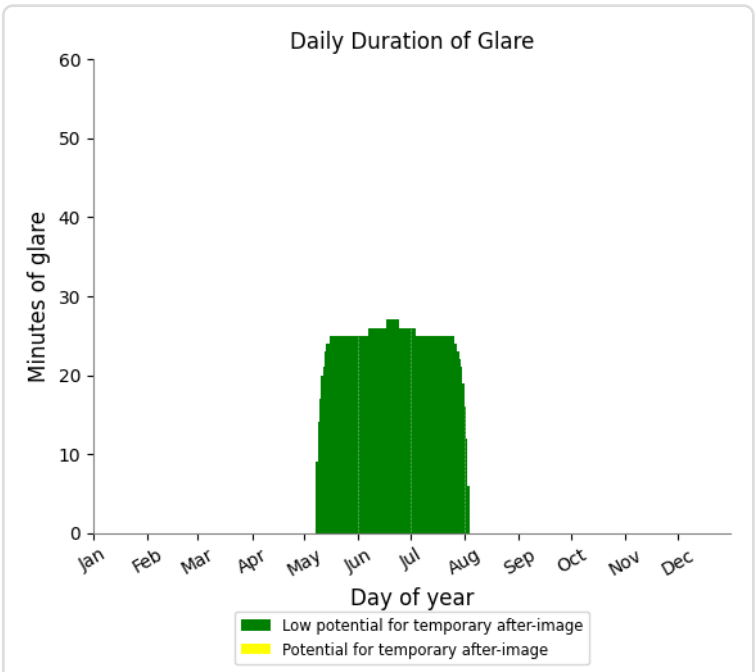


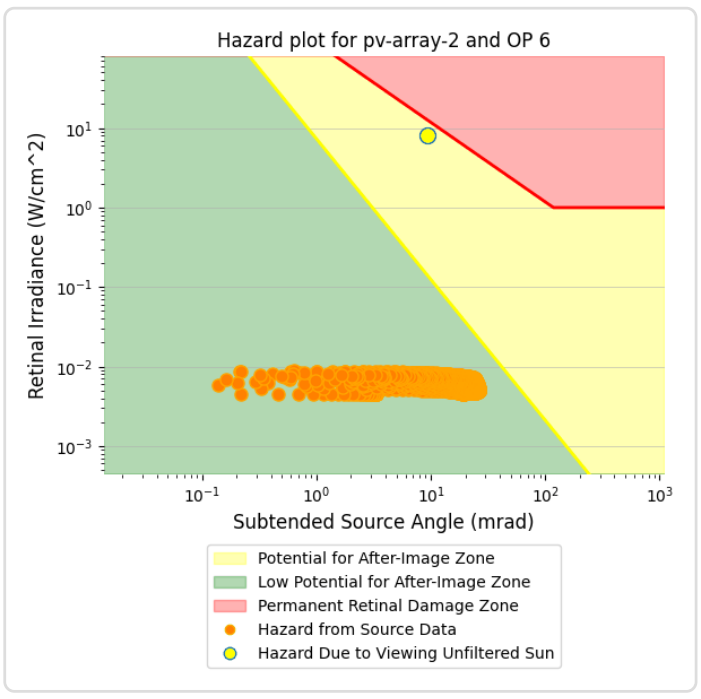
PV array 2 and OP 6

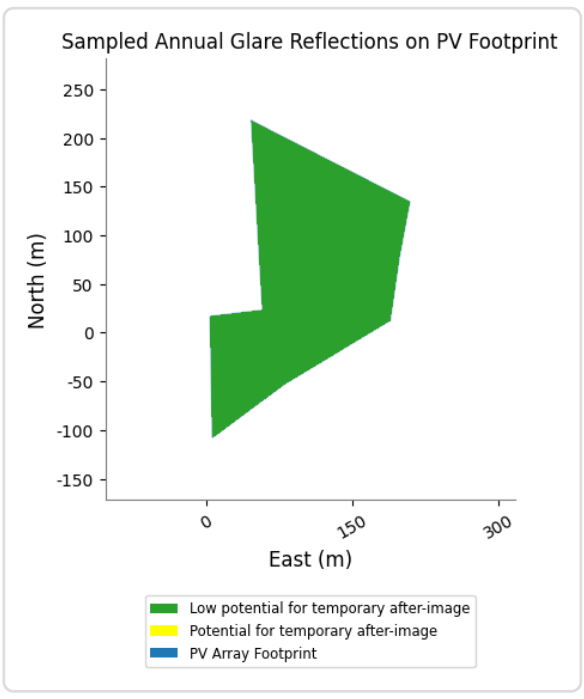
Yellow glare: none

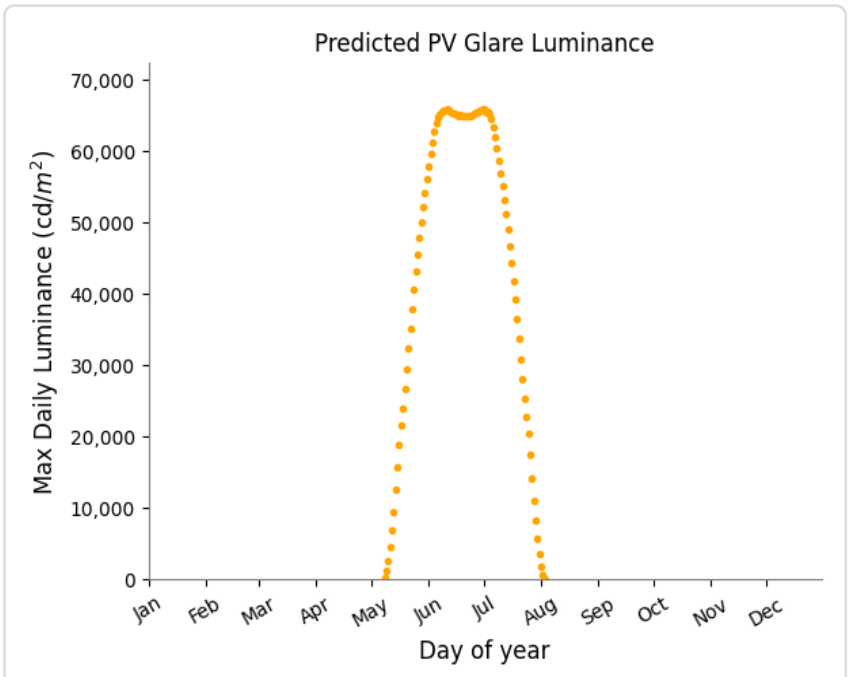
Green glare: 2,129 min.







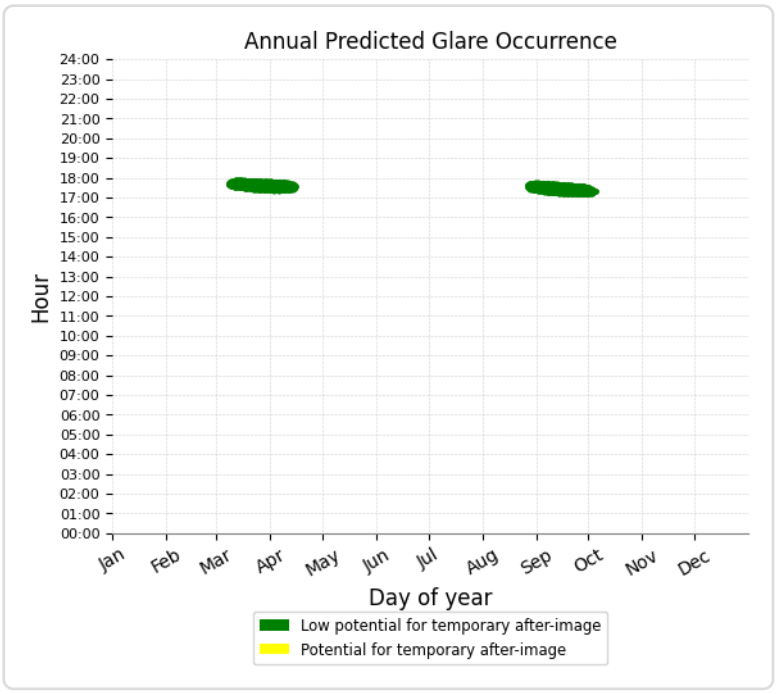


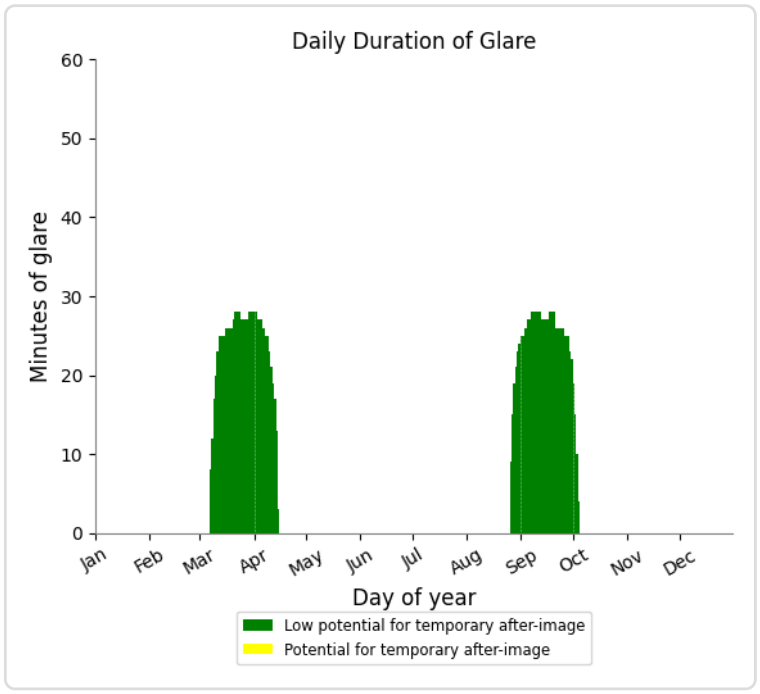


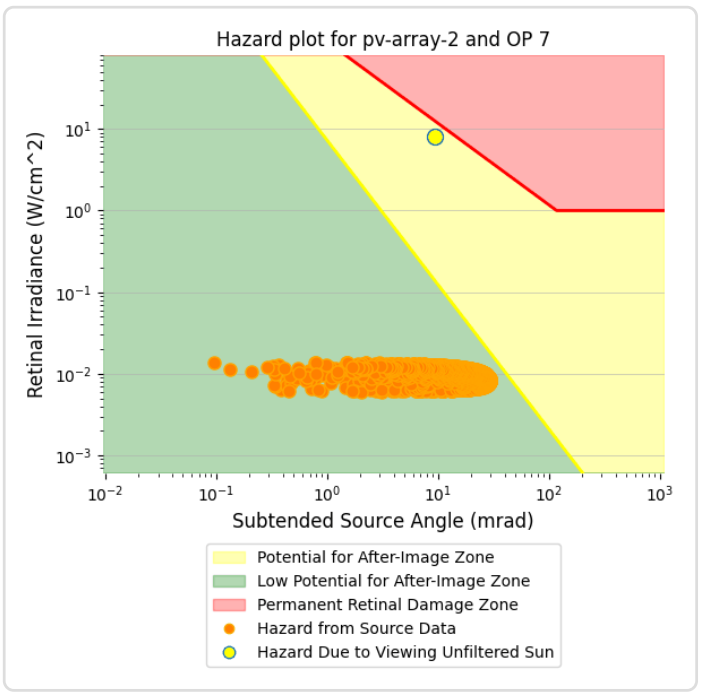
PV array 2 and OP 7

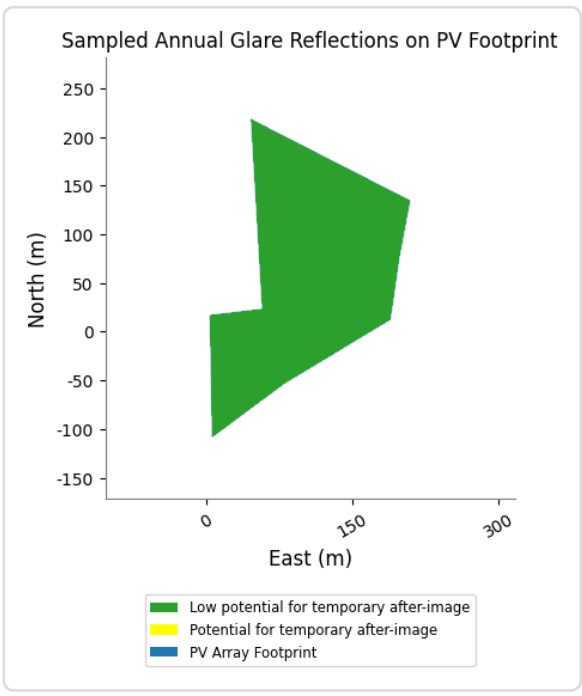
Yellow glare: none

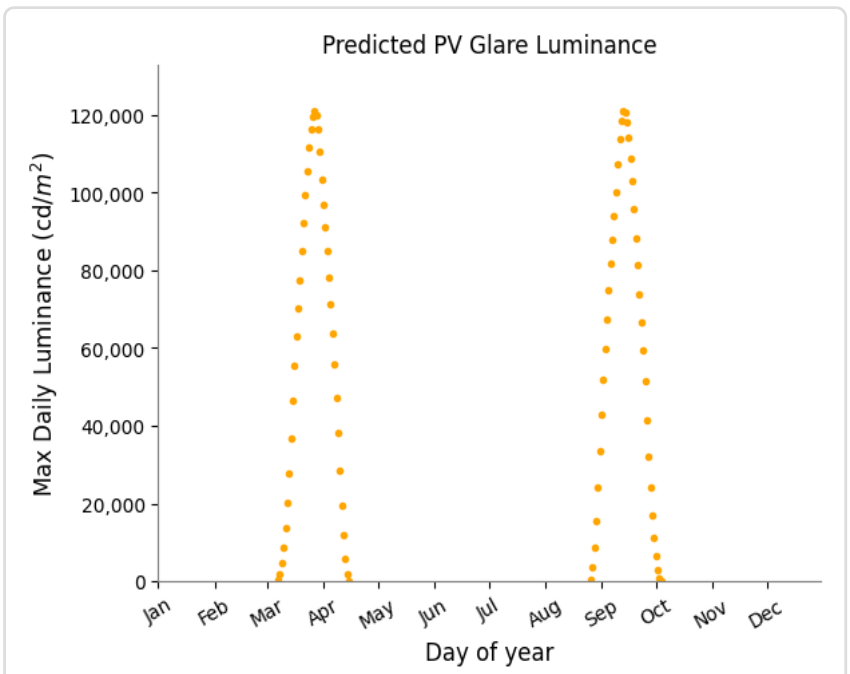
Green glare: 1,903 min.







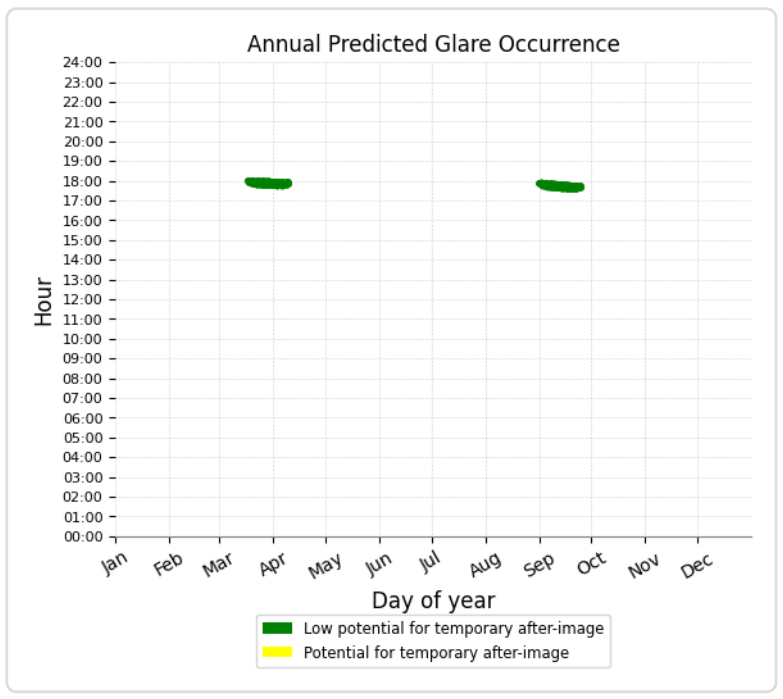


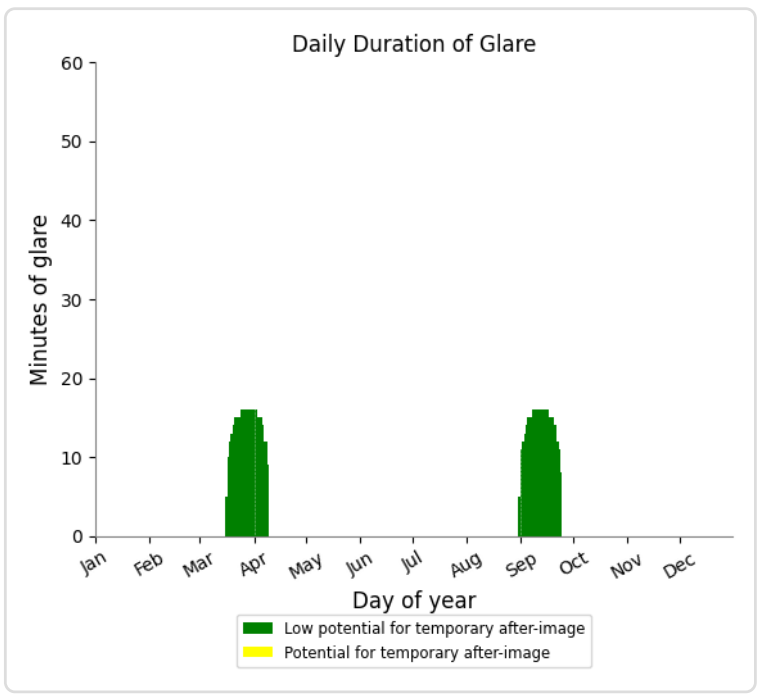


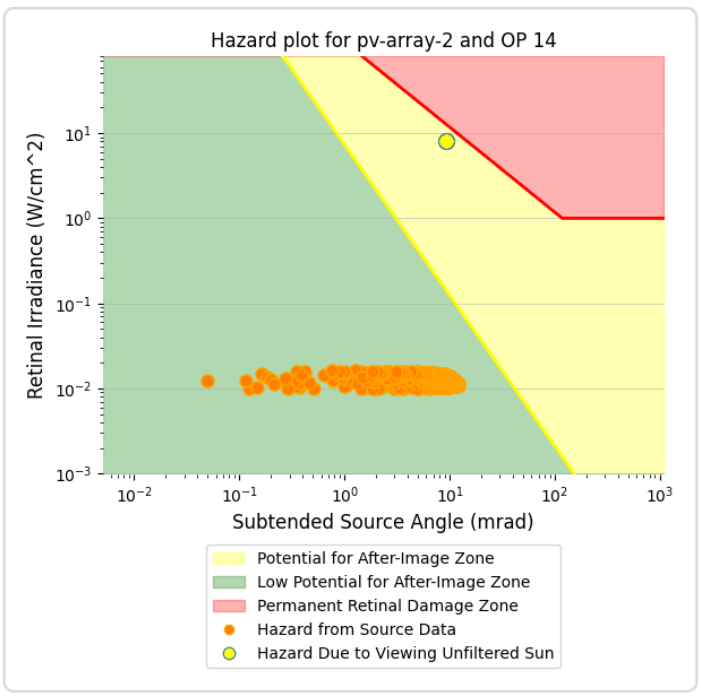
PV array 2 and OP 14

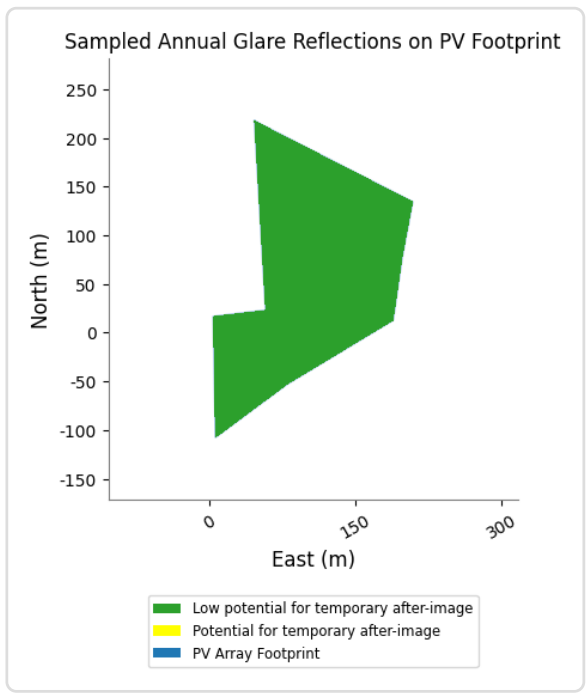
Yellow glare: none

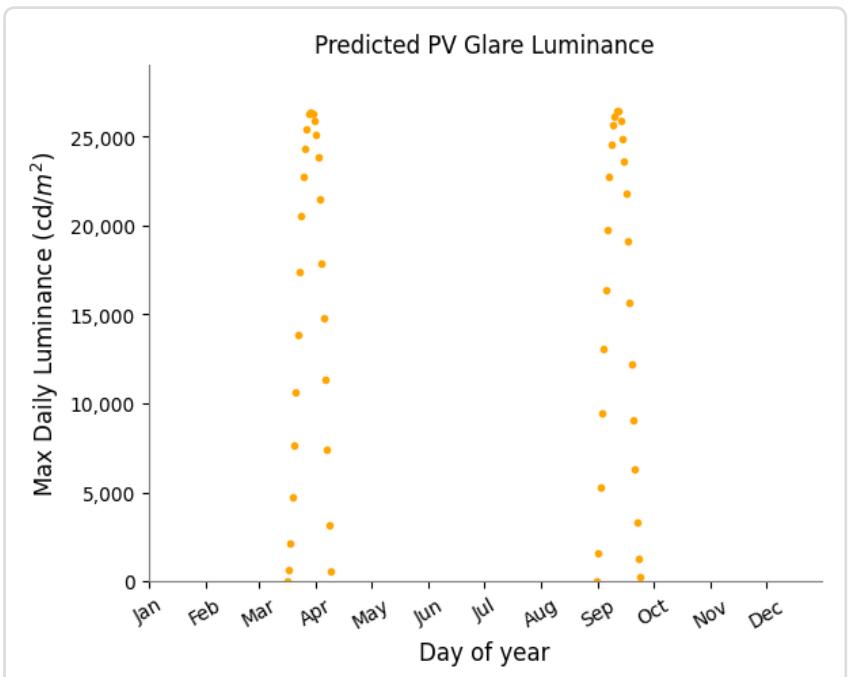
Green glare: 698 min.







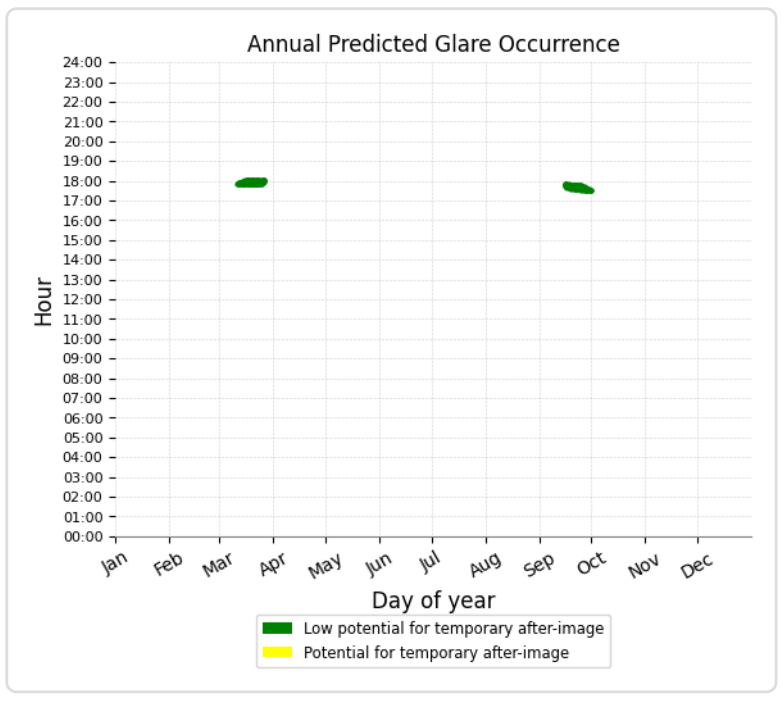


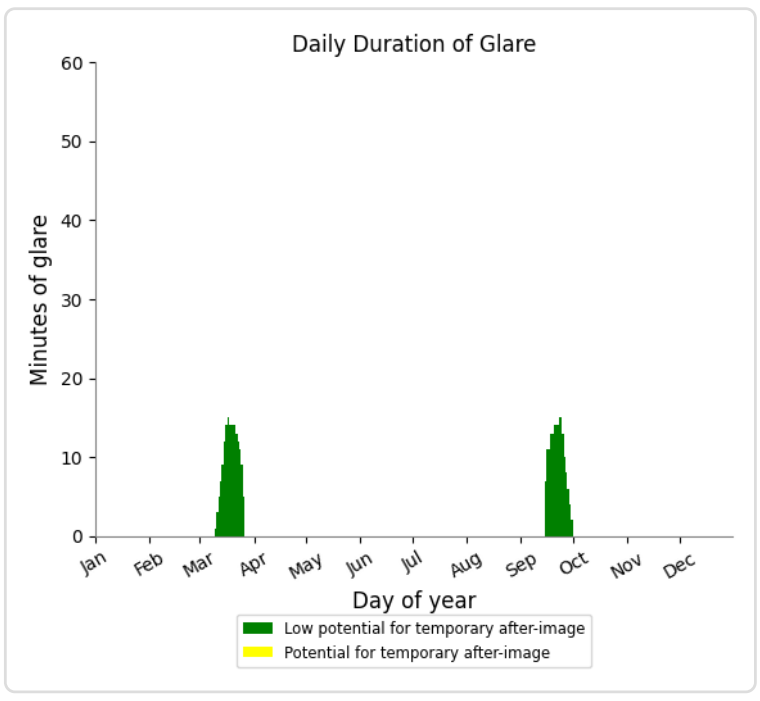


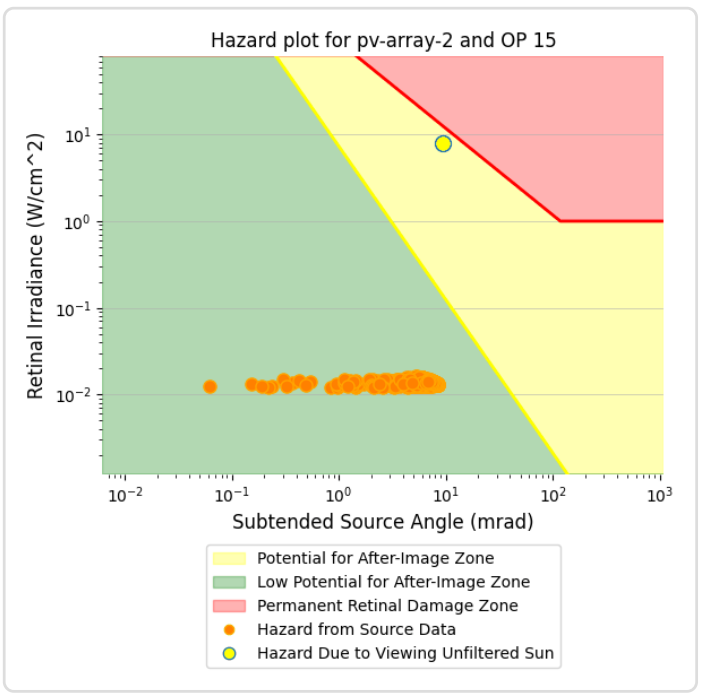
PV array 2 and OP 15

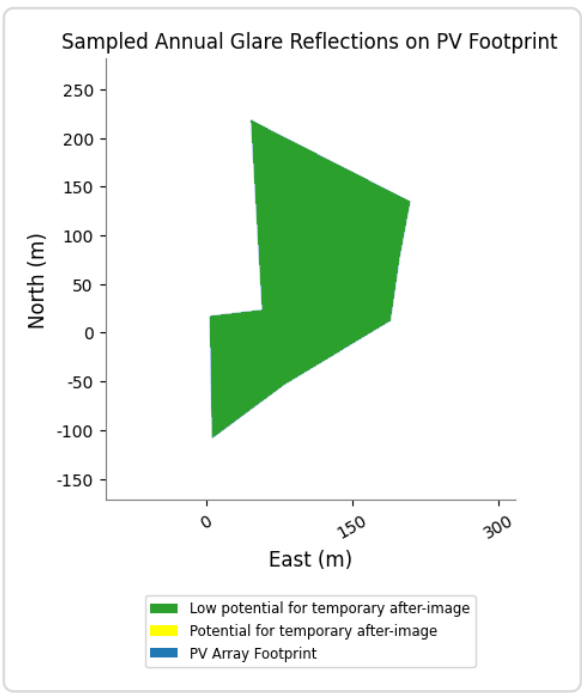
Yellow glare: none

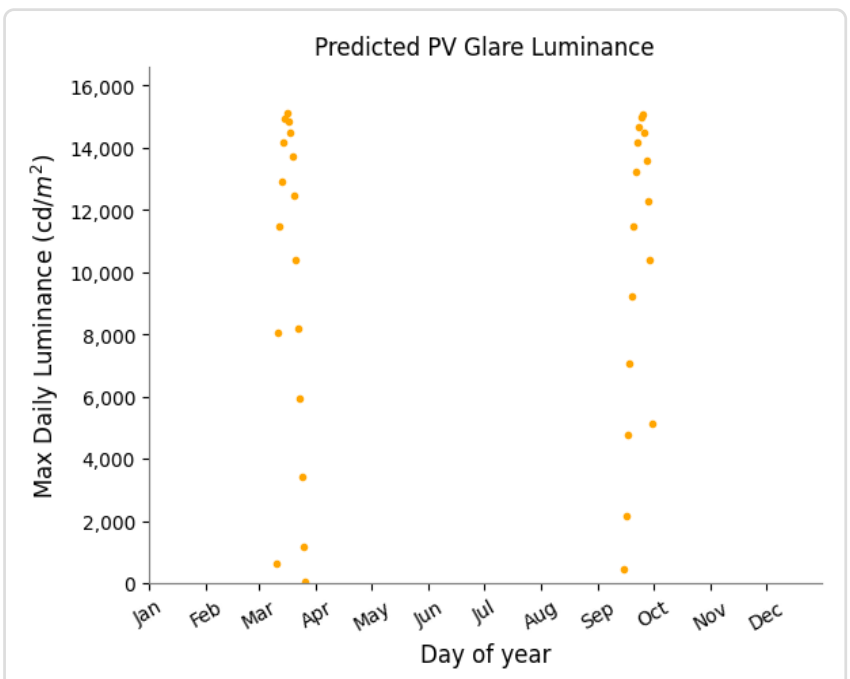
Green glare: 342 min.











PV array 2 and OP 1

No glare found

PV array 2 and OP 8

No glare found

PV array 2 and OP 9

No glare found

PV array 2 and OP 10

No glare found

PV array 2 and OP 11

No glare found

PV array 2 and OP 12

No glare found

PV array 2 and OP 13

No glare found

PV array 2 and OP 16

No glare found

PV array 2 and OP 17

No glare found

PV array 2 and OP 18

No glare found

PV array 2 and OP 19

No glare found

PV array 2 and OP 20

No glare found

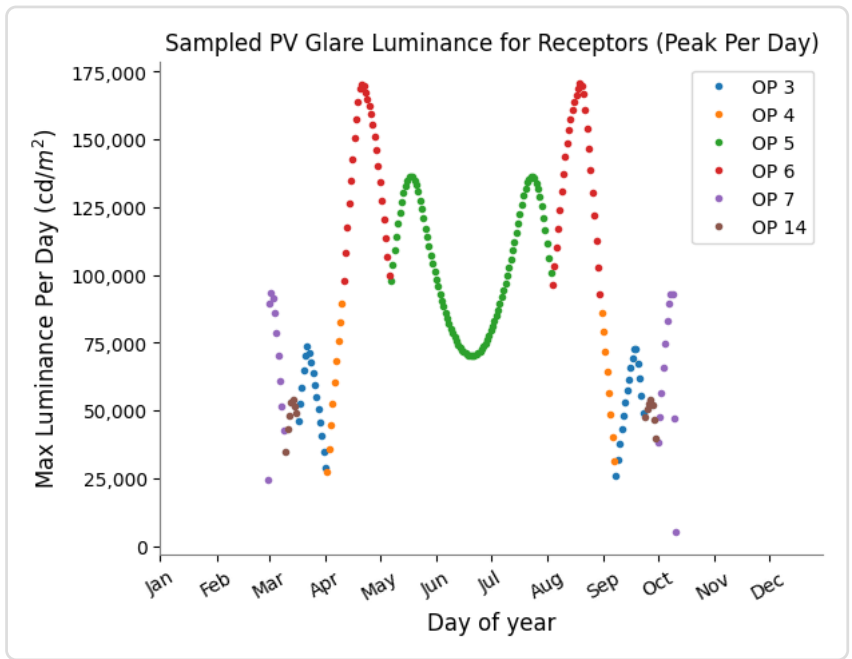
PV array 2 and OP 21

No glare found

PV: PV array 3 low potential for temporary after-image

Receptor results ordered by category of glare

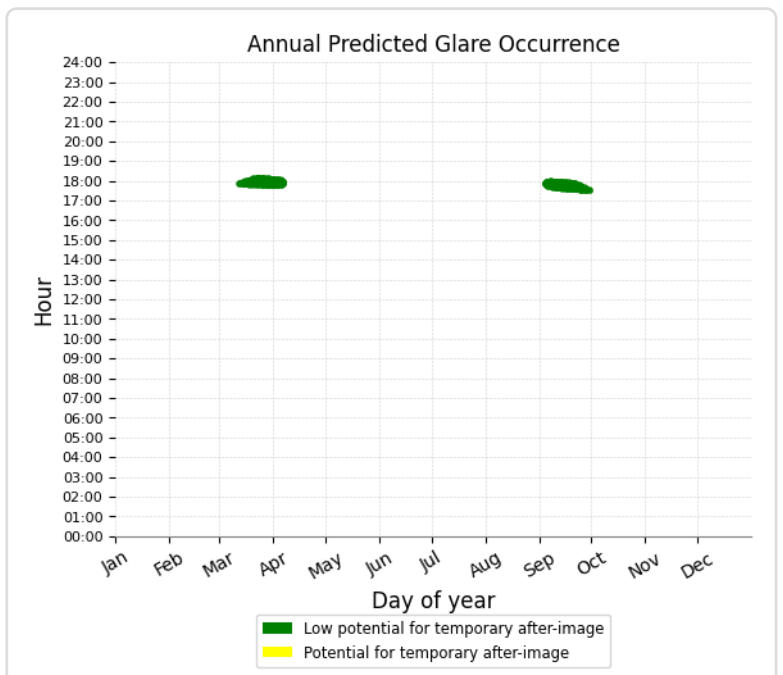
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	982	16.4	0	0.0	73,503
OP 4	1,616	26.9	0	0.0	110,784
OP 5	2,953	49.2	0	0.0	136,486
OP 6	2,683	44.7	0	0.0	170,547
OP 7	395	6.6	0	0.0	93,564
OP 14	576	9.6	0	0.0	53,923
OP 15	30	0.5	0	0.0	452
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

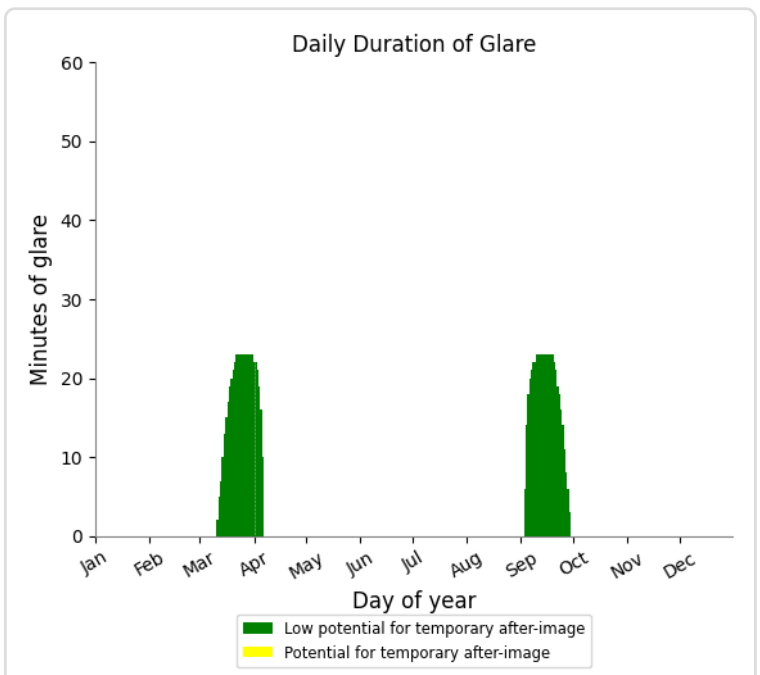


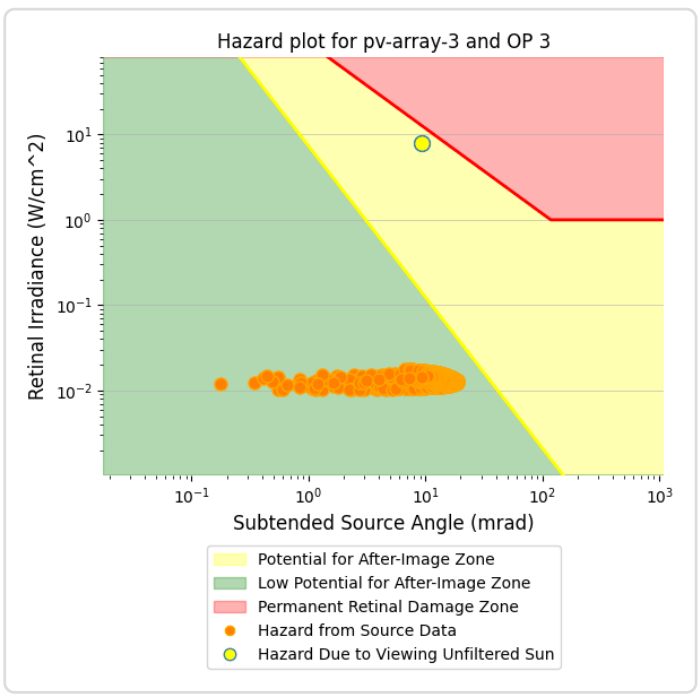
PV array 3 and OP 3

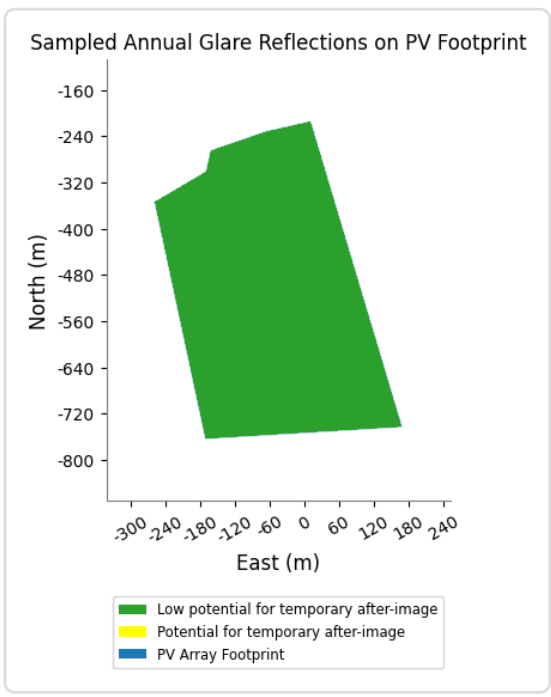
Yellow glare: none

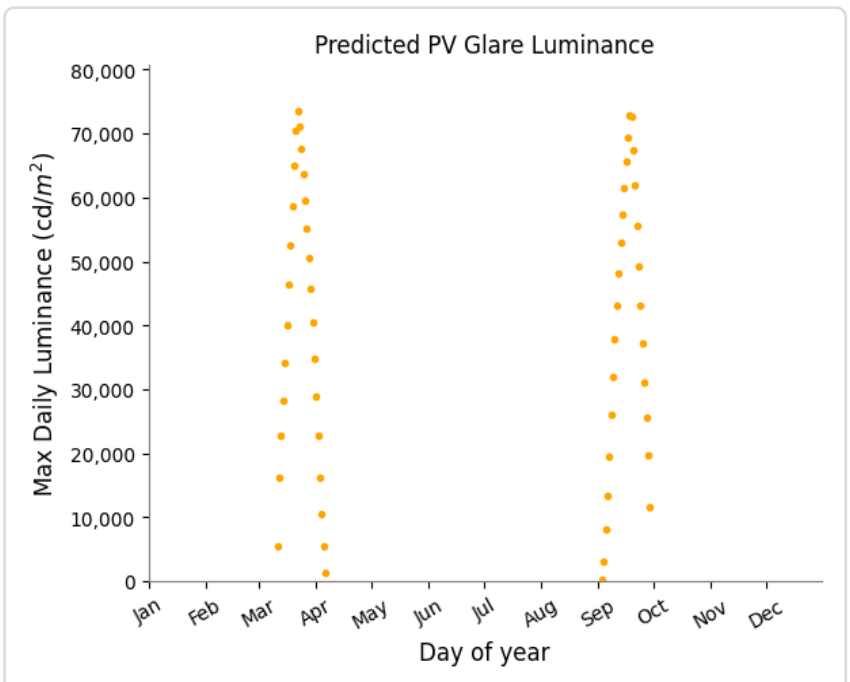
Green glare: 982 min.







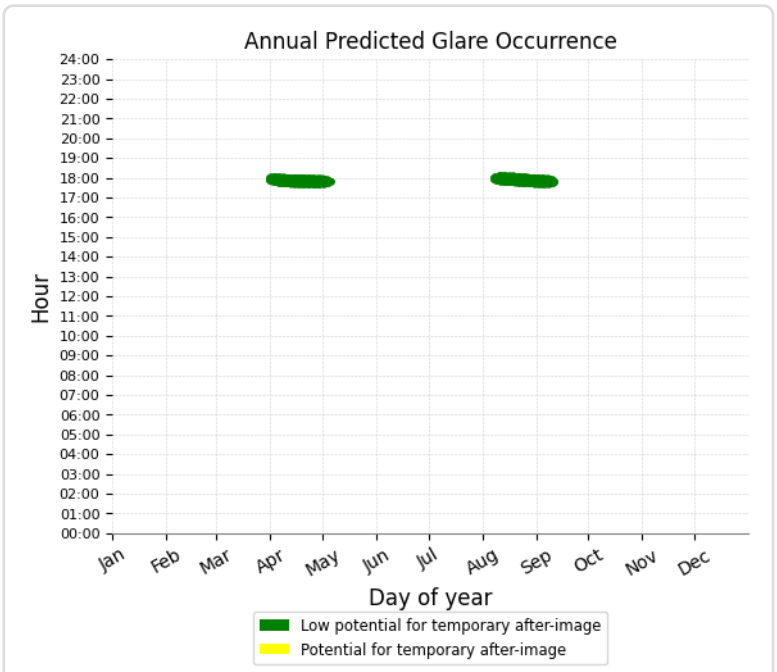


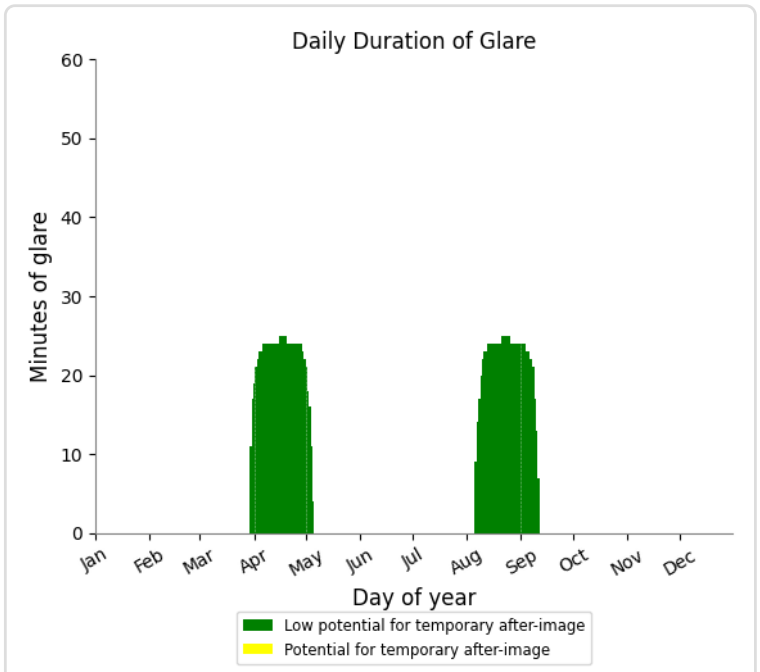


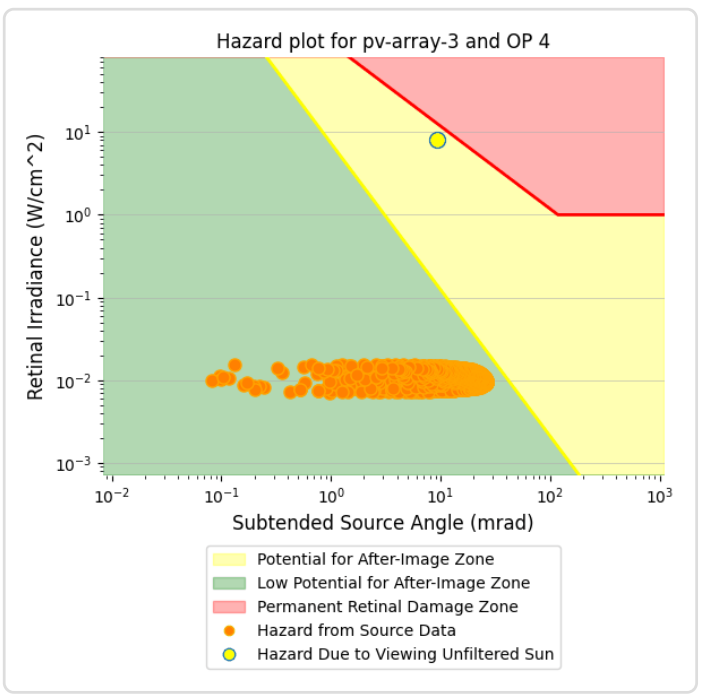
PV array 3 and OP 4

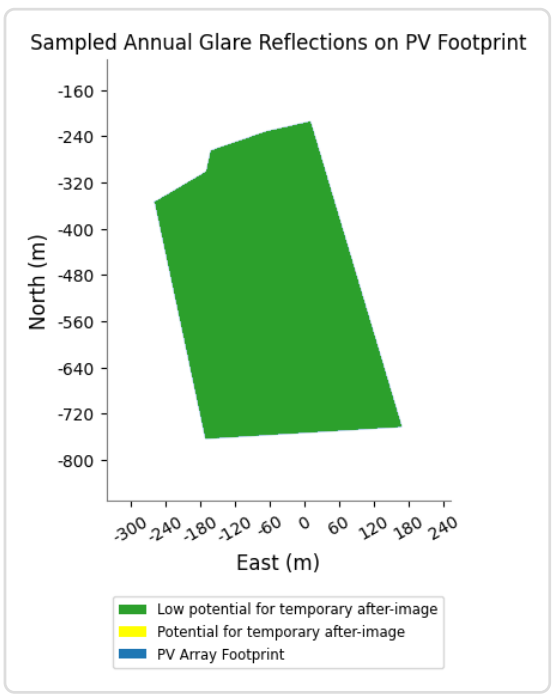
Yellow glare: none

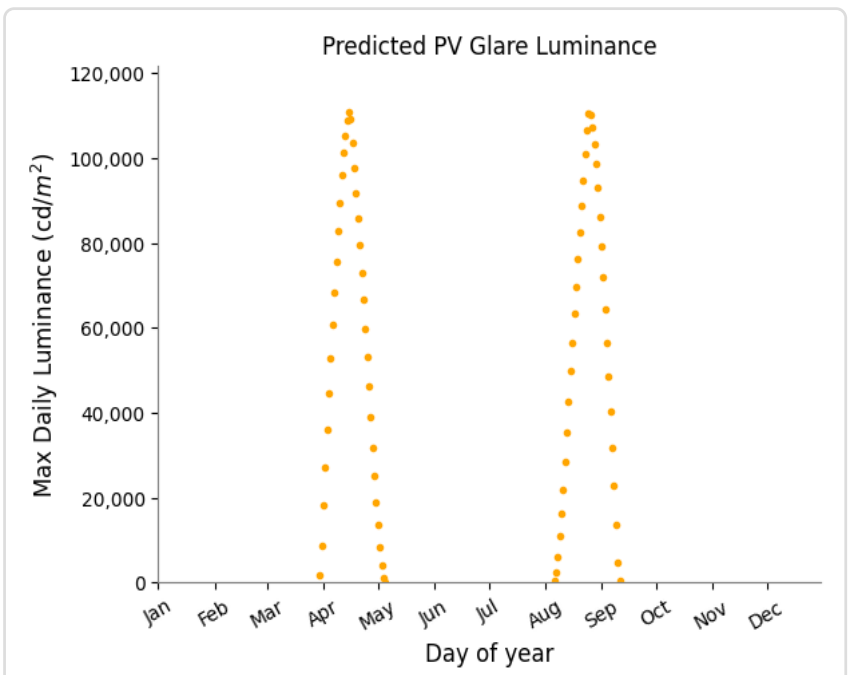
Green glare: 1,616 min.







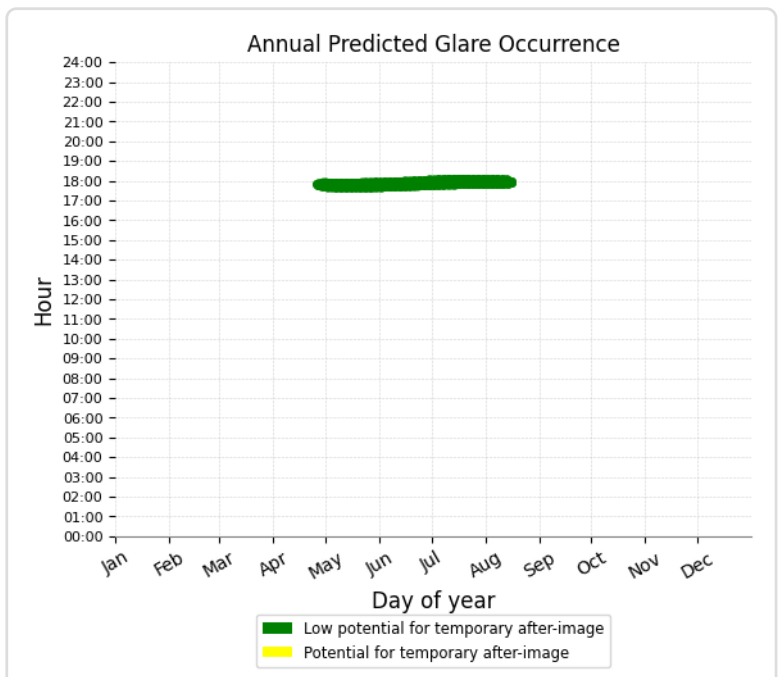


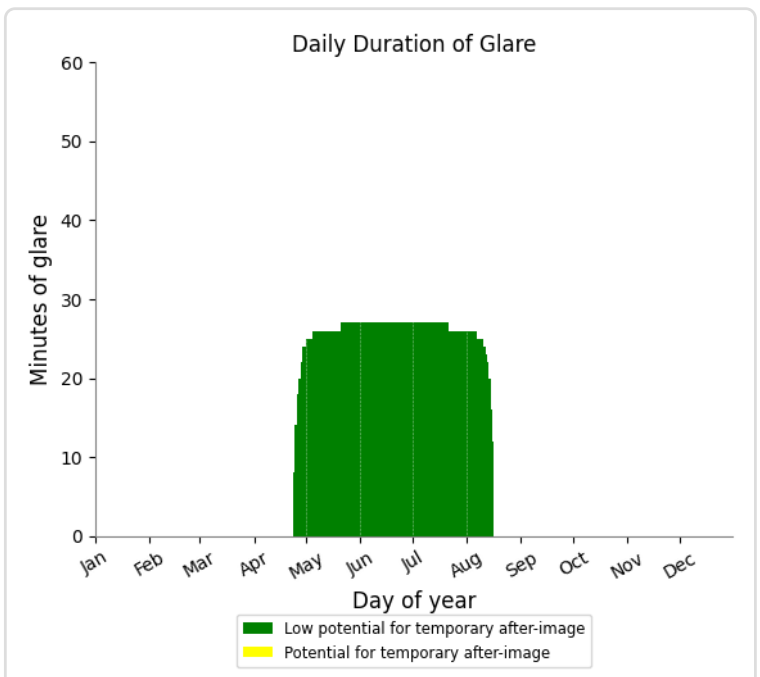


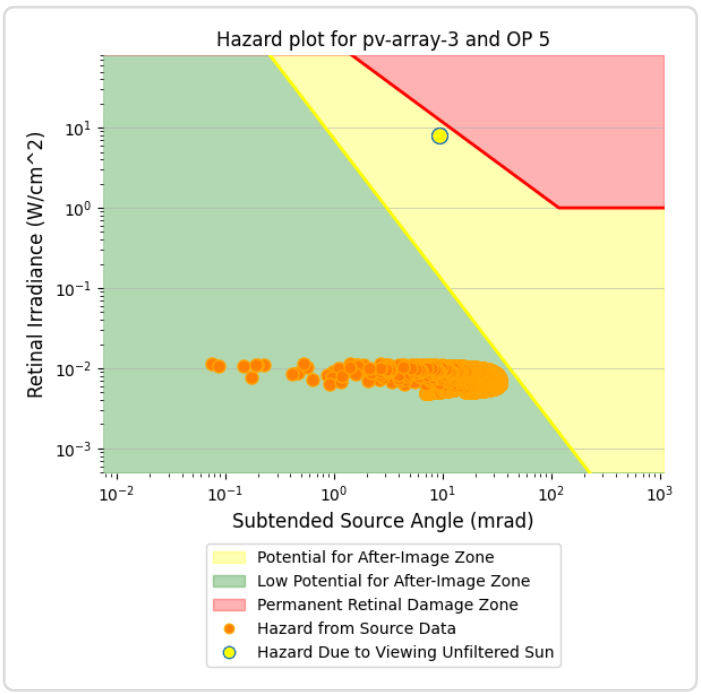
PV array 3 and OP 5

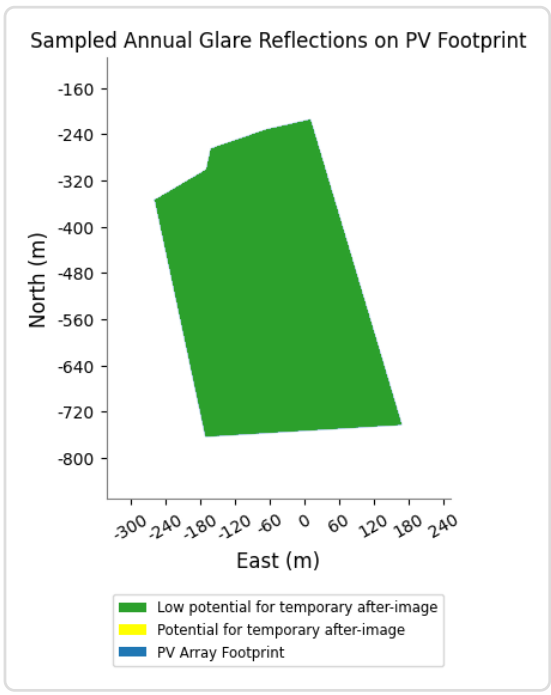
Yellow glare: none

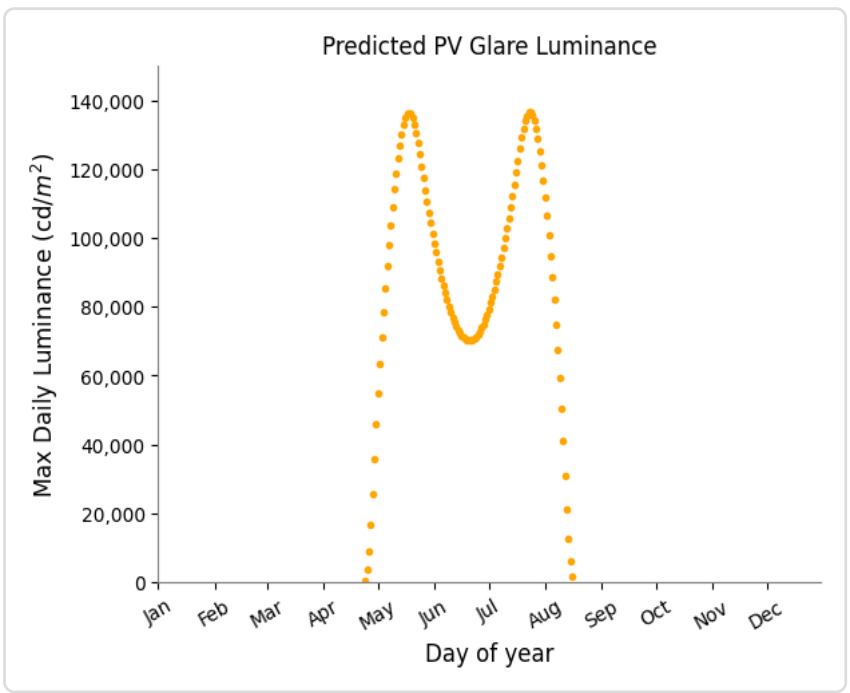
Green glare: 2,953 min.







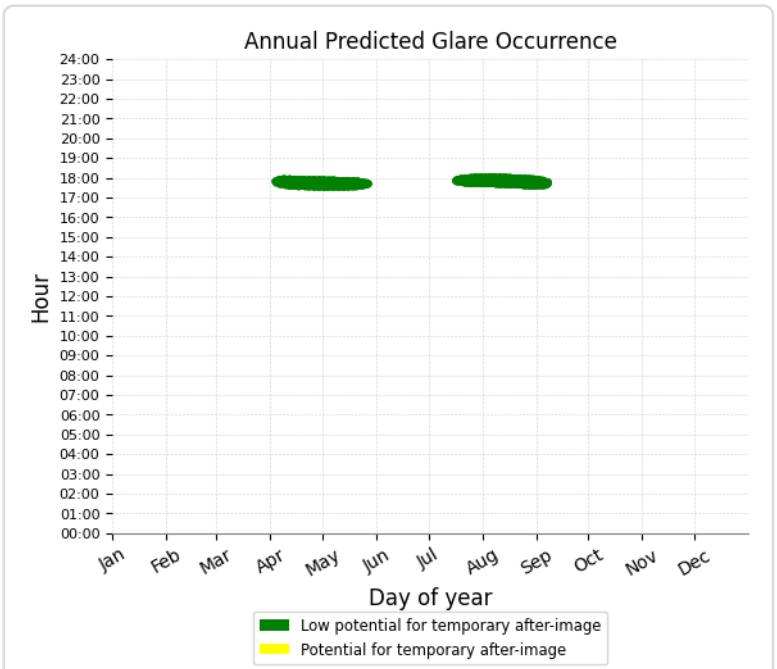


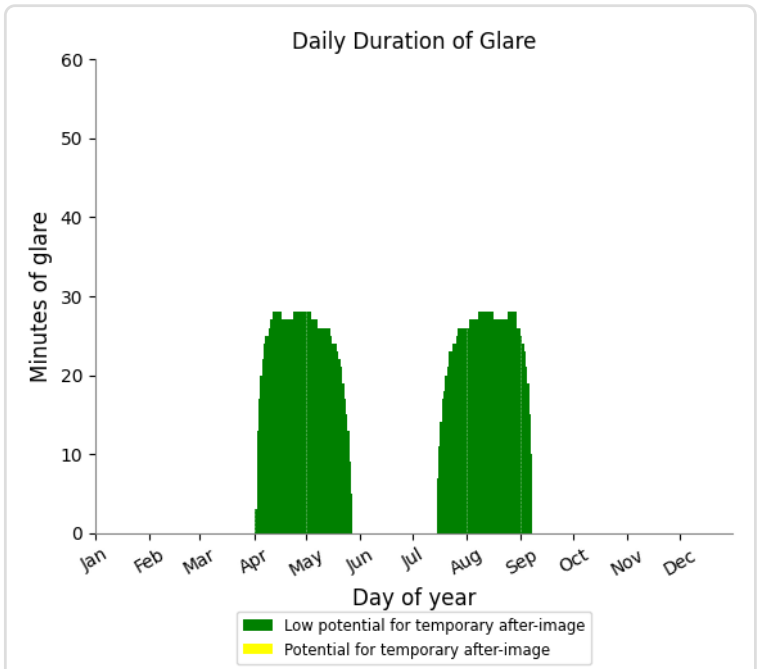


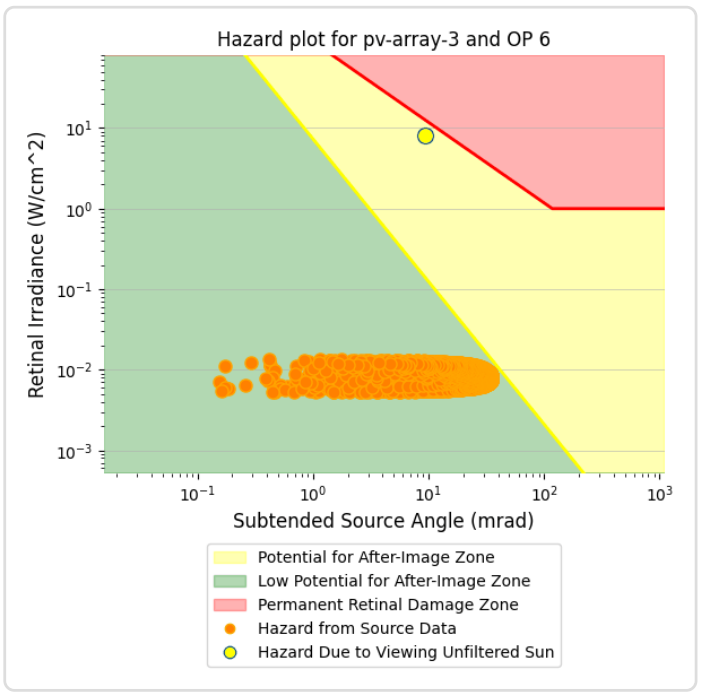
PV array 3 and OP 6

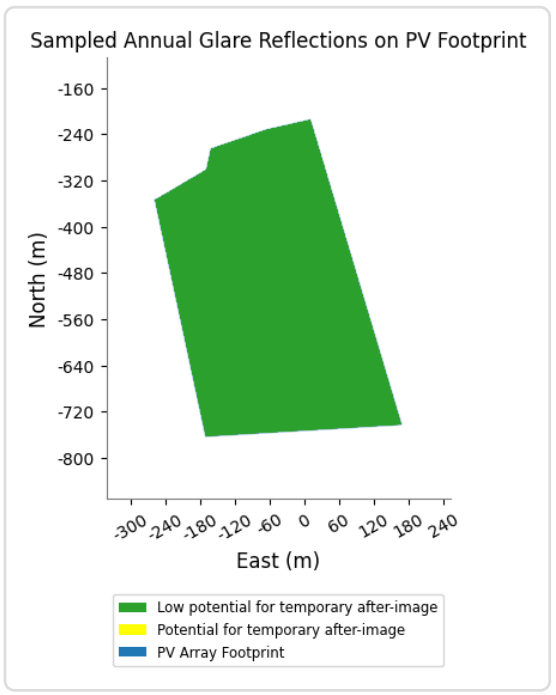
Yellow glare: none

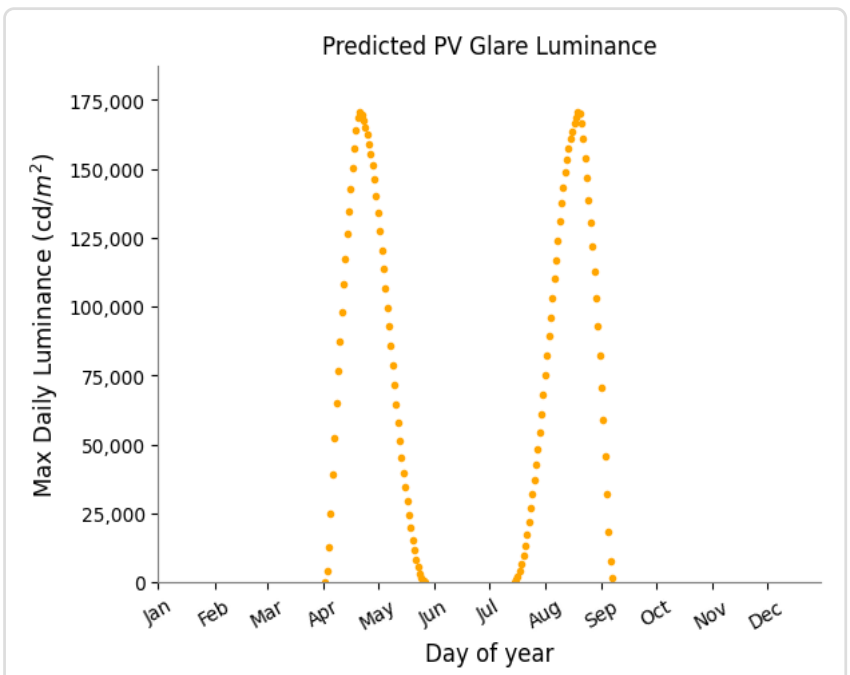
Green glare: 2,683 min.







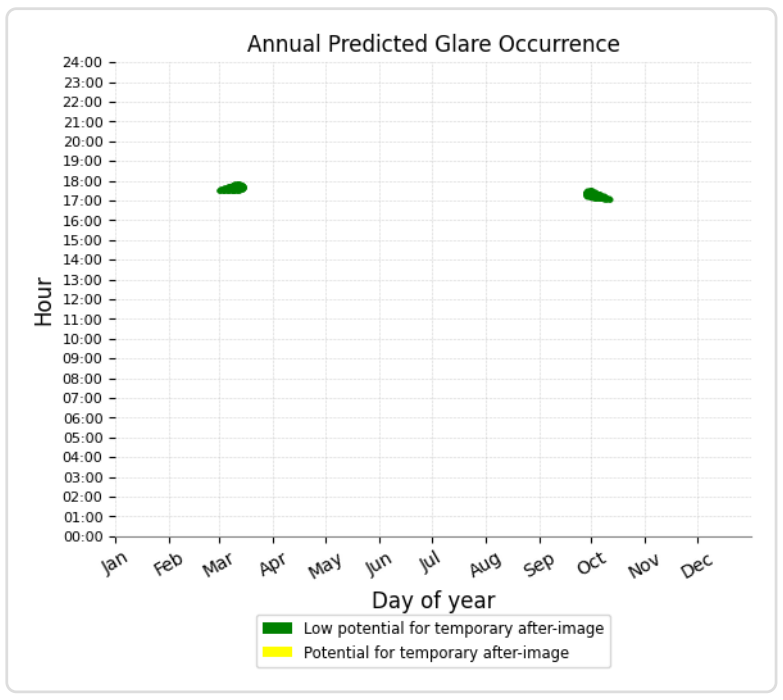


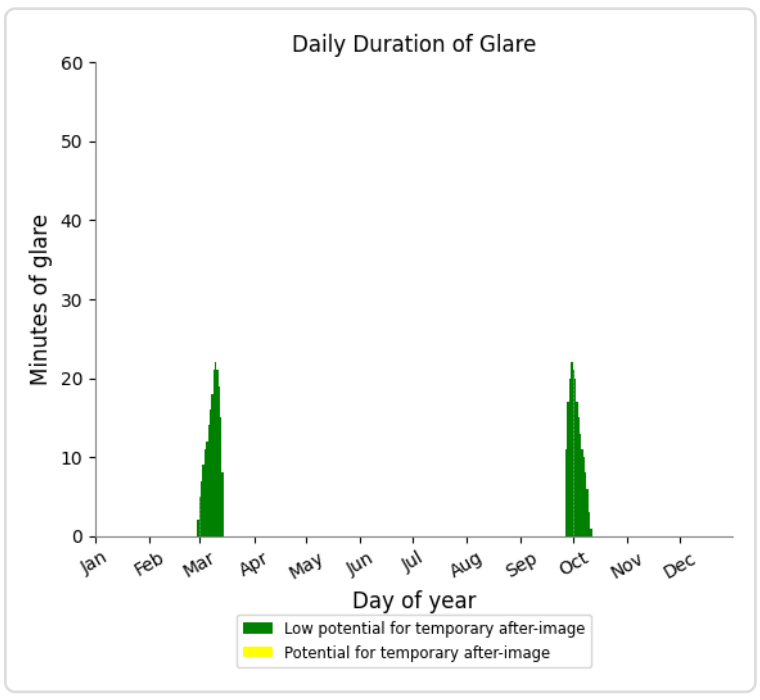


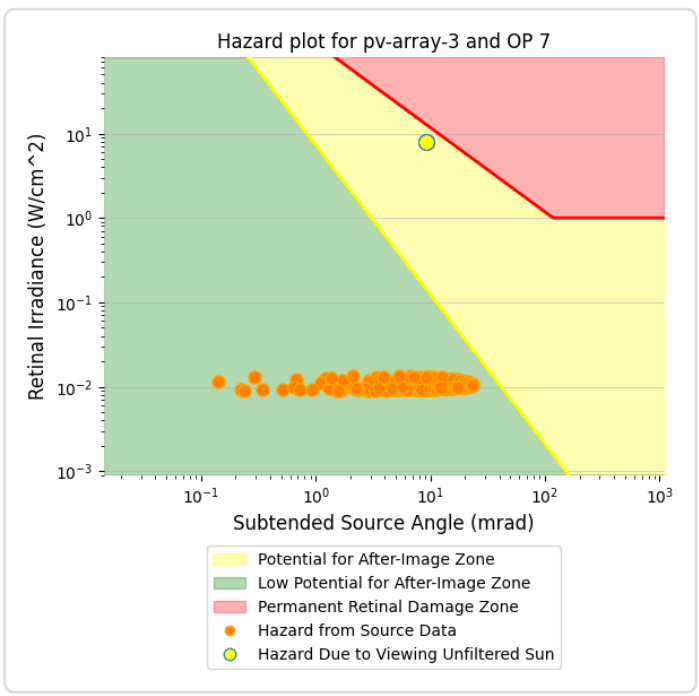
PV array 3 and OP 7

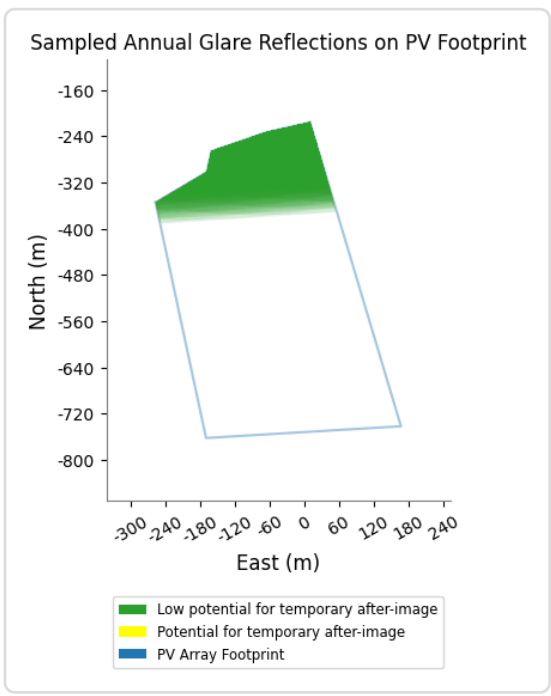
Yellow glare: none

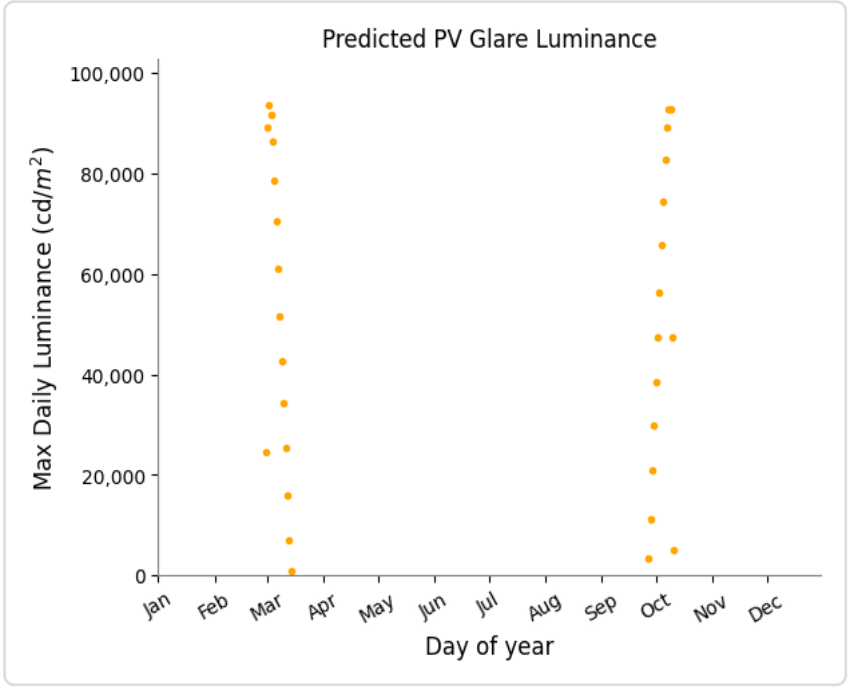
Green glare: 395 min.







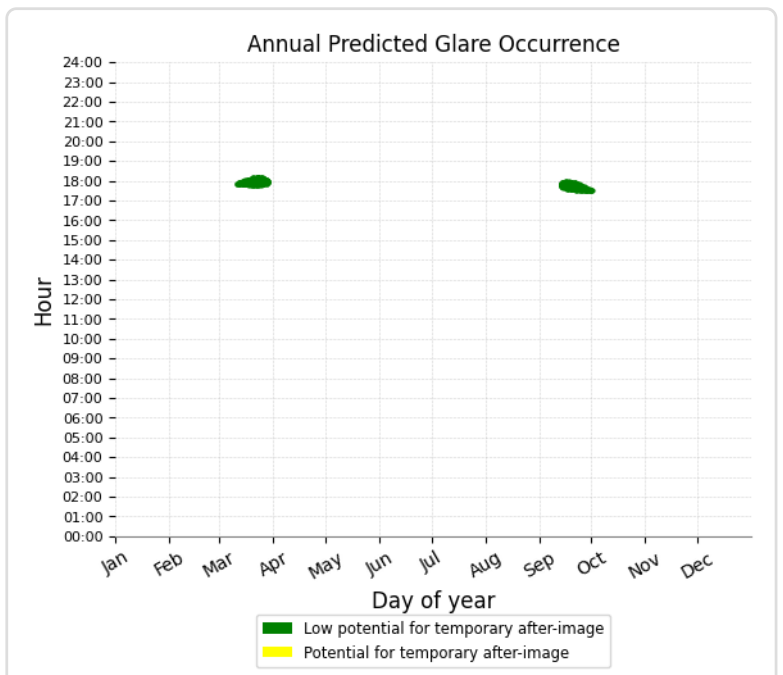


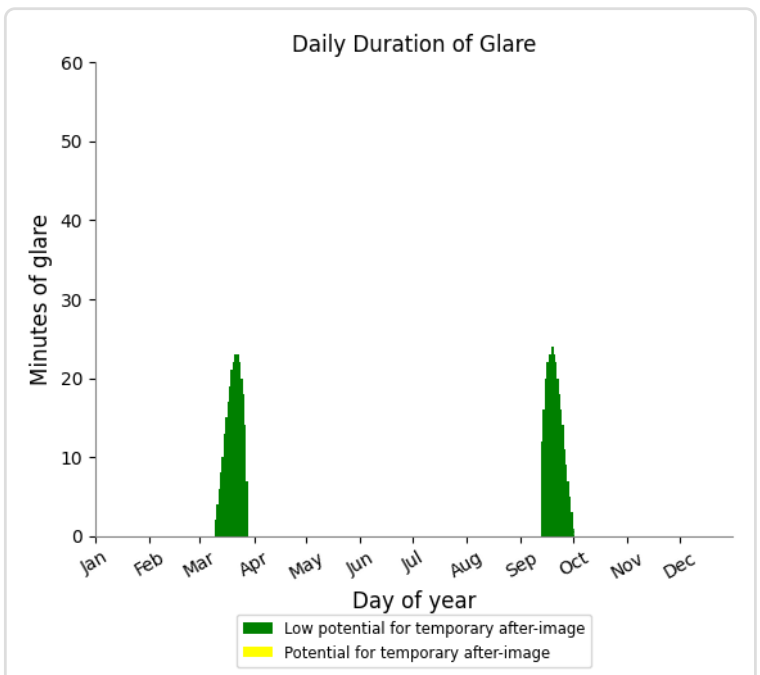


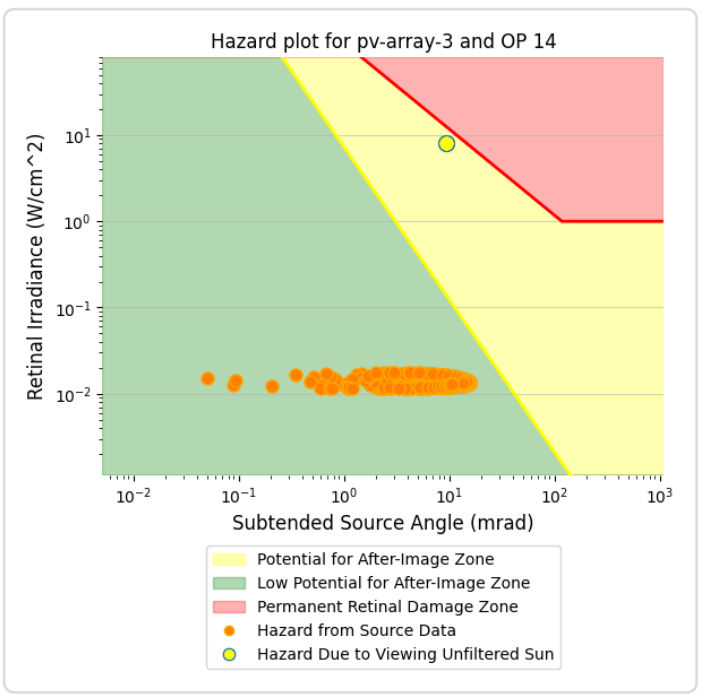
PV array 3 and OP 14

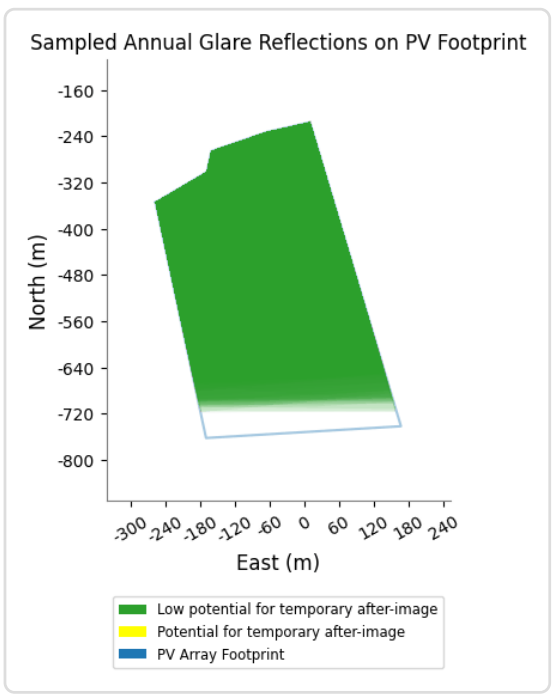
Yellow glare: none

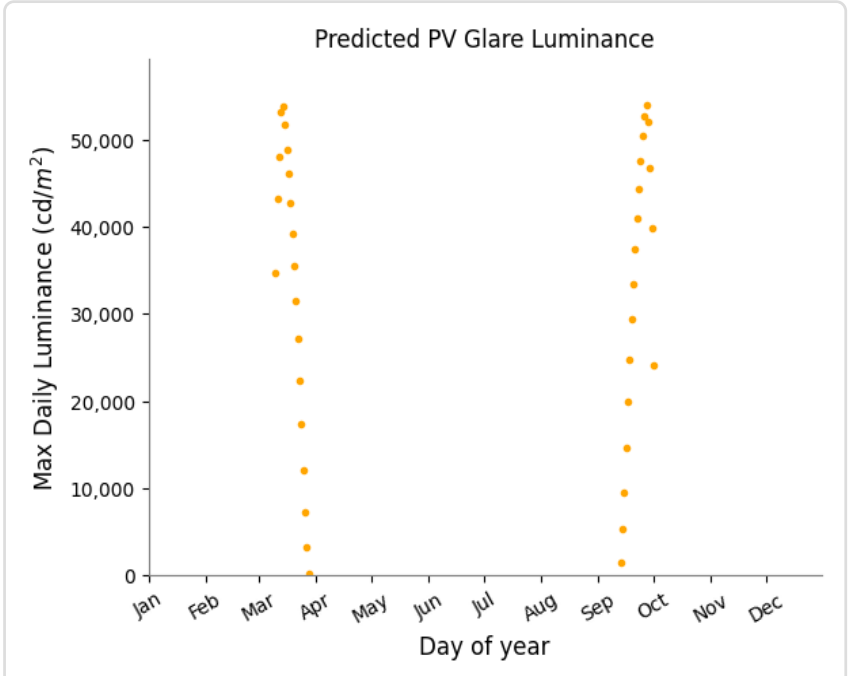
Green glare: 576 min.







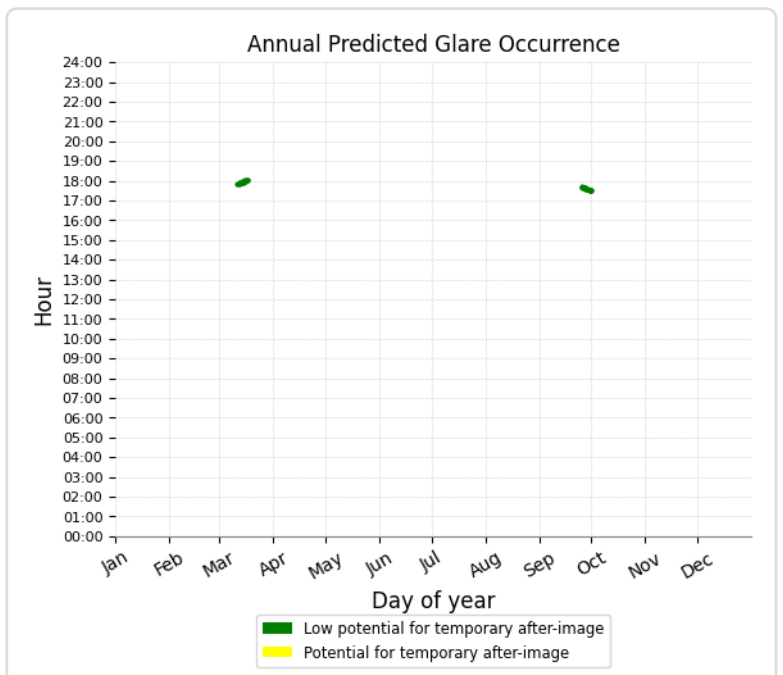


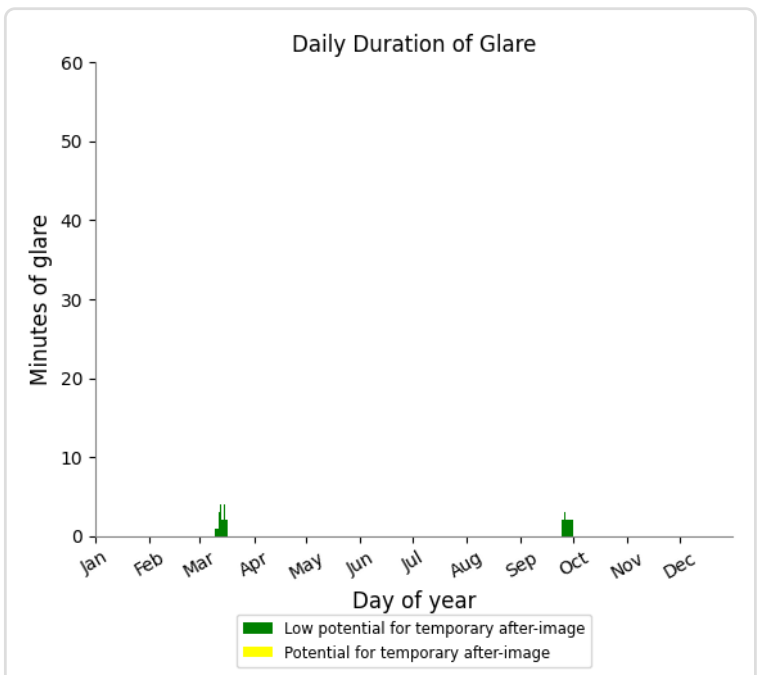


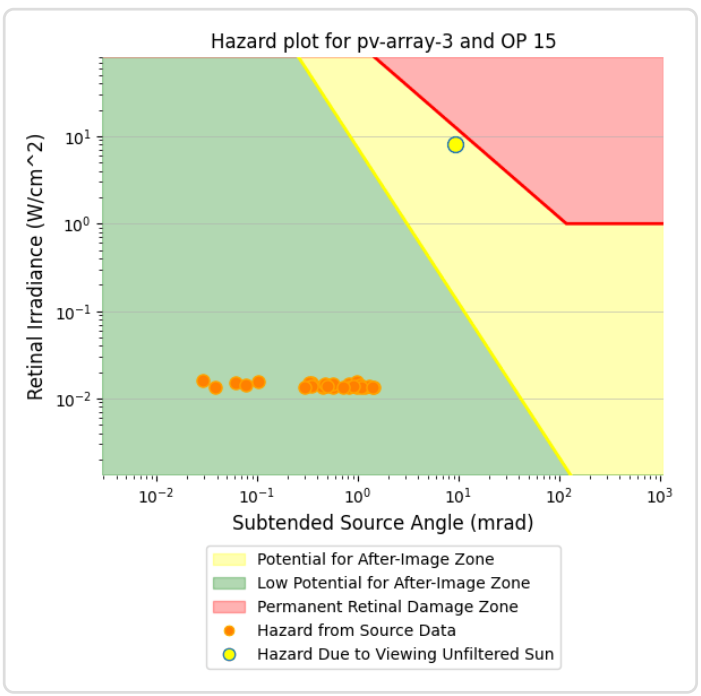
PV array 3 and OP 15

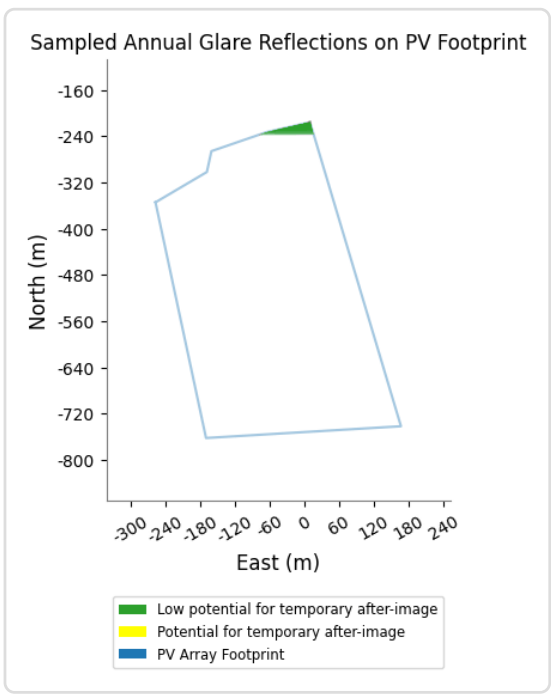
Yellow glare: none

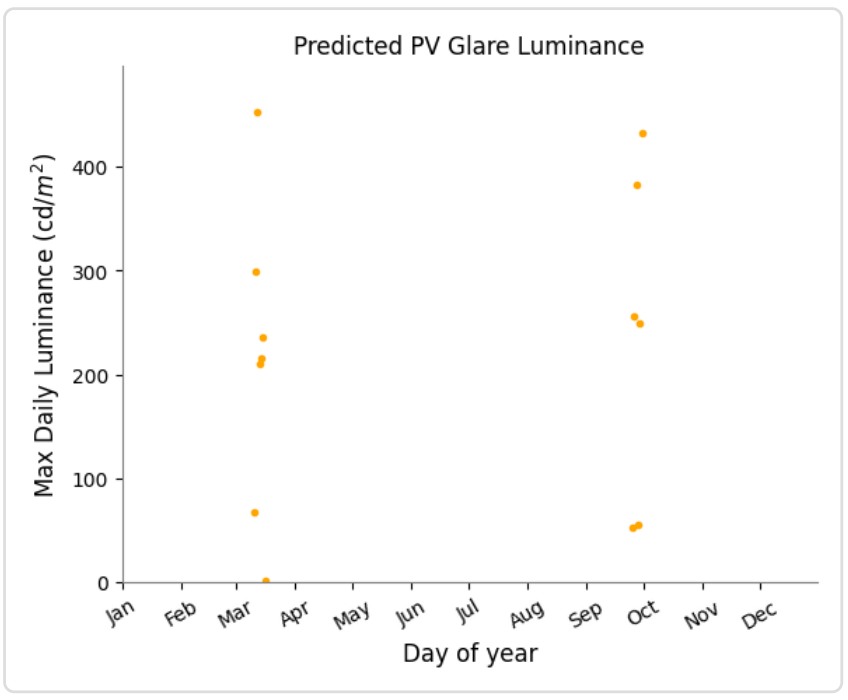
Green glare: 30 min.











PV array 3 and OP 1

No glare found

PV array 3 and OP 2

No glare found

PV array 3 and OP 8

No glare found

PV array 3 and OP 9

No glare found

PV array 3 and OP 10

No glare found

PV array 3 and OP 11

No glare found

PV array 3 and OP 12

No glare found

PV array 3 and OP 13

No glare found

PV array 3 and OP 16

No glare found

PV array 3 and OP 17

No glare found

PV array 3 and OP 18

No glare found

PV array 3 and OP 19

No glare found

PV array 3 and OP 20

No glare found

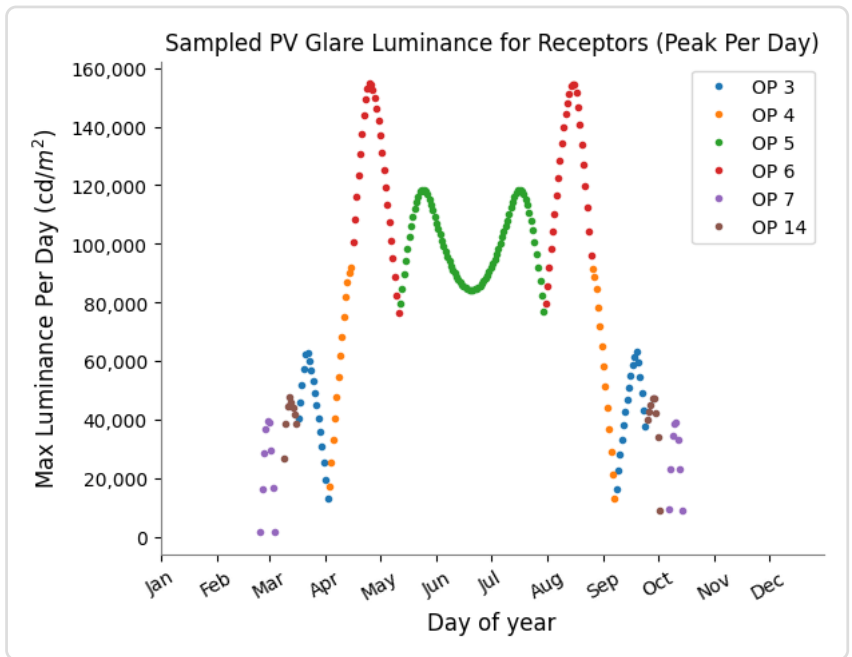
PV array 3 and OP 21

No glare found

PV: PV array 4 low potential for temporary after-image

Receptor results ordered by category of glare

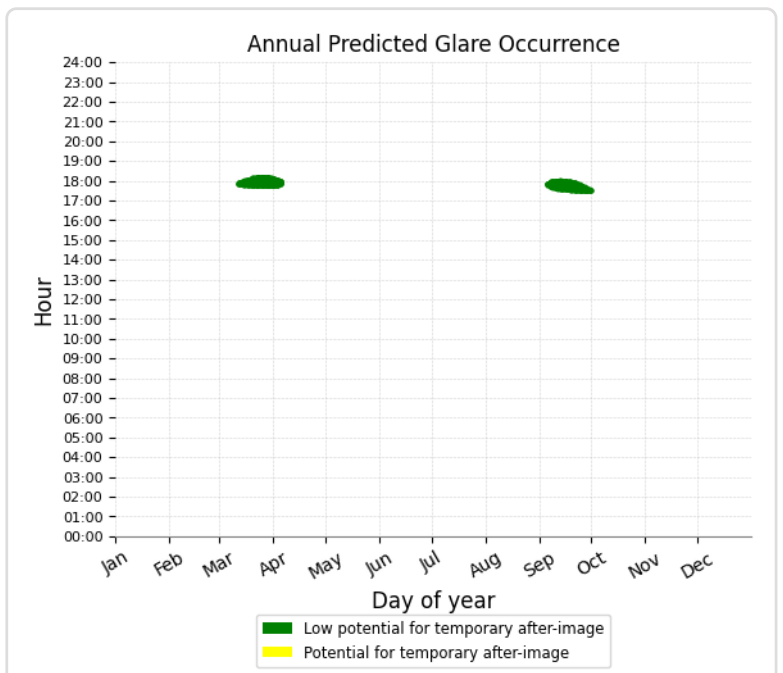
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	972	16.2	0	0.0	63,491
OP 4	1,595	26.6	0	0.0	92,707
OP 5	2,864	47.7	0	0.0	118,576
OP 6	2,641	44.0	0	0.0	154,677
OP 7	113	1.9	0	0.0	39,696
OP 14	483	8.1	0	0.0	47,838
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

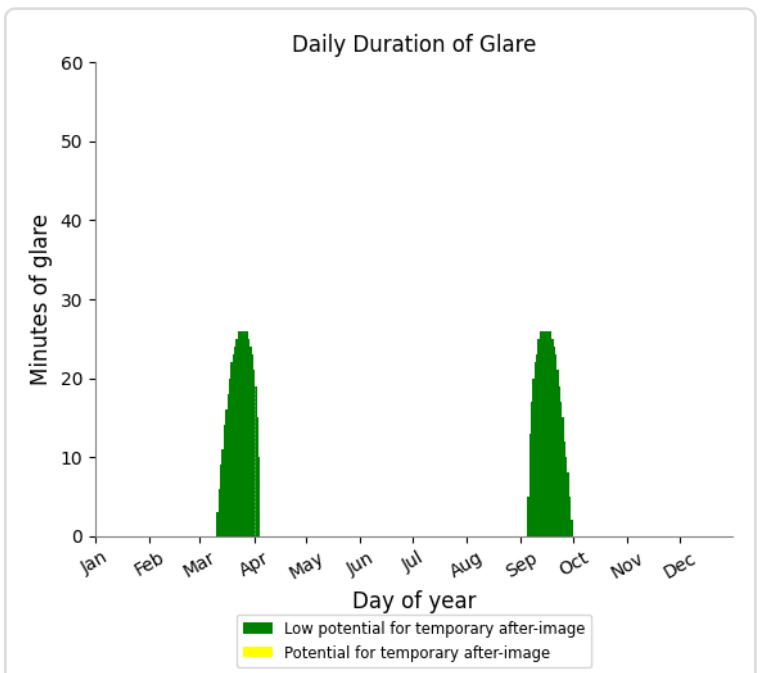


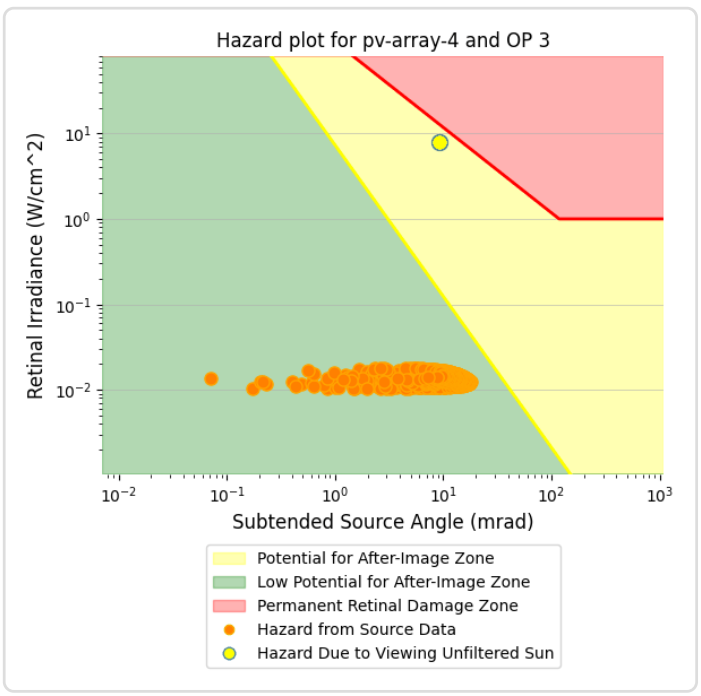
PV array 4 and OP 3

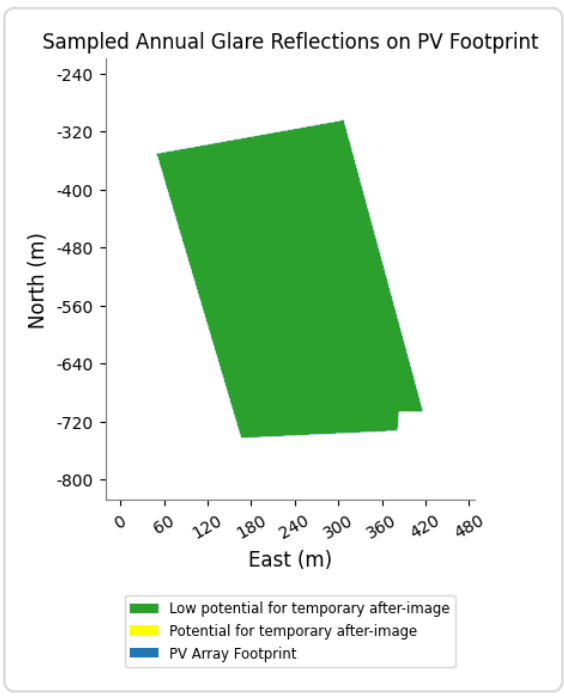
Yellow glare: none

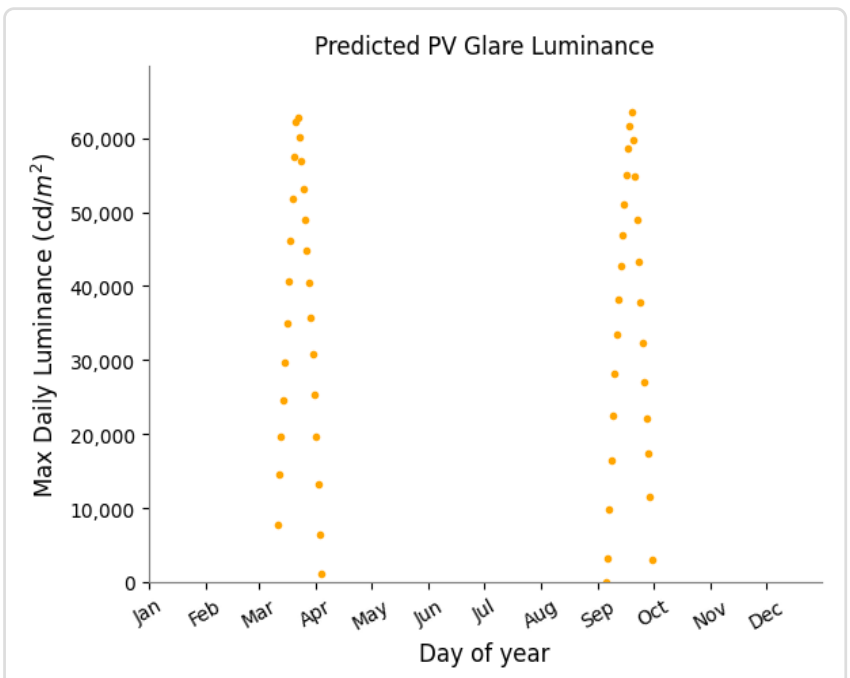
Green glare: 972 min.







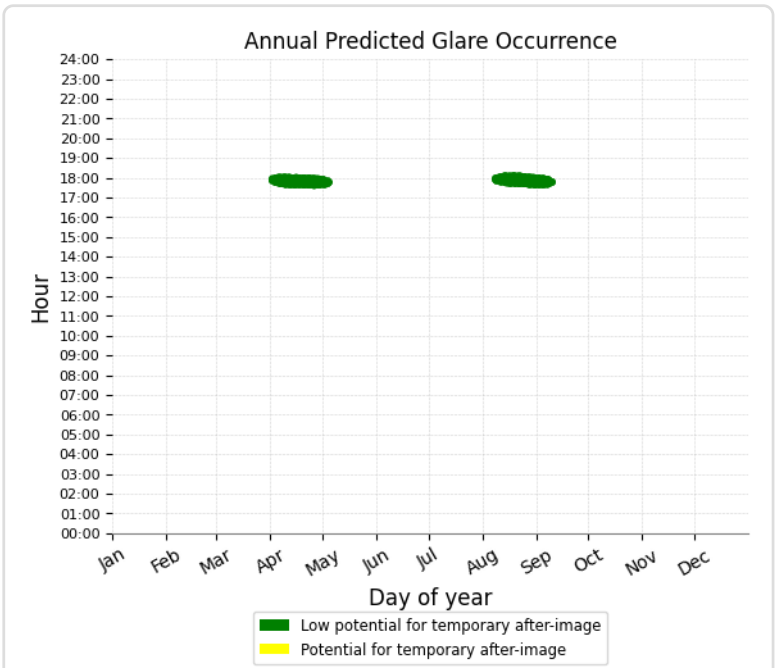


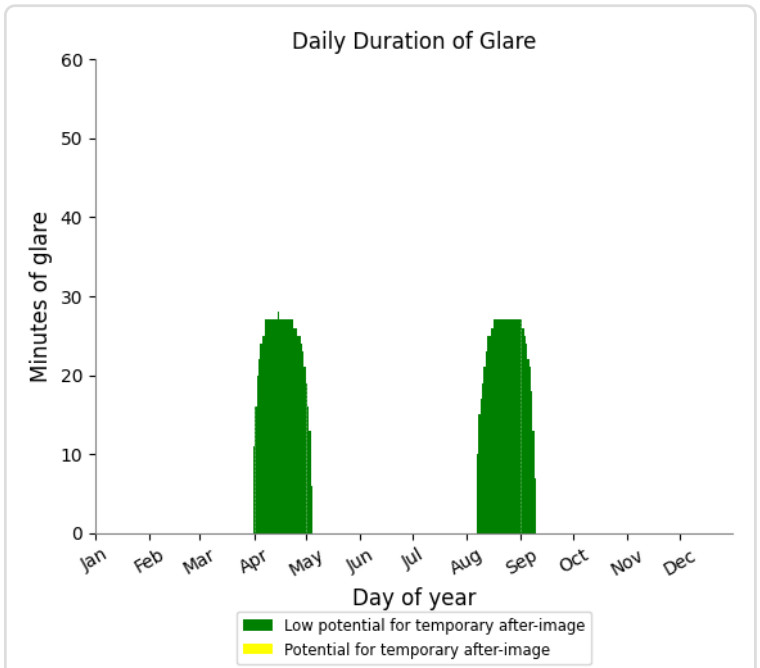


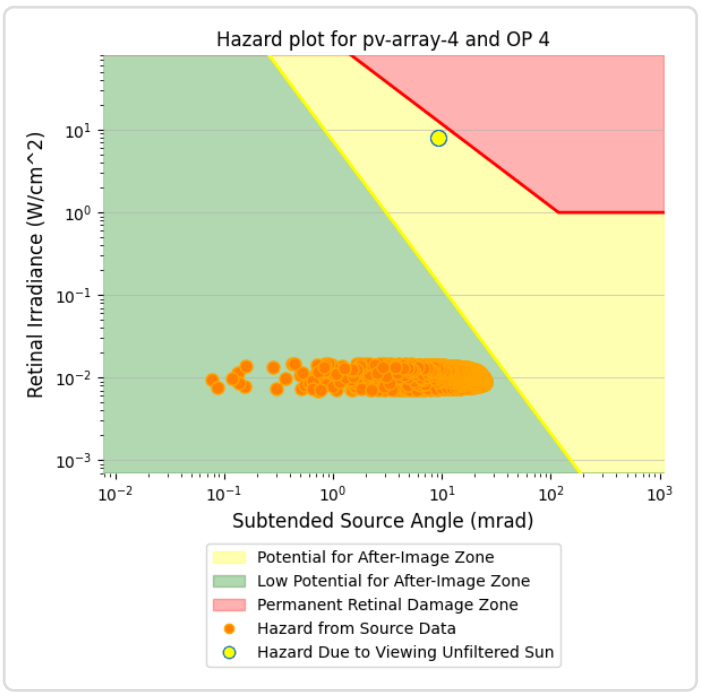
PV array 4 and OP 4

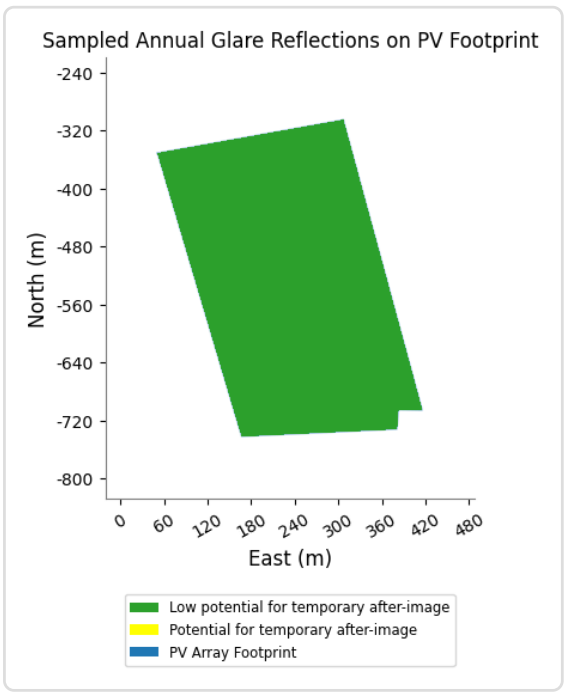
Yellow glare: none

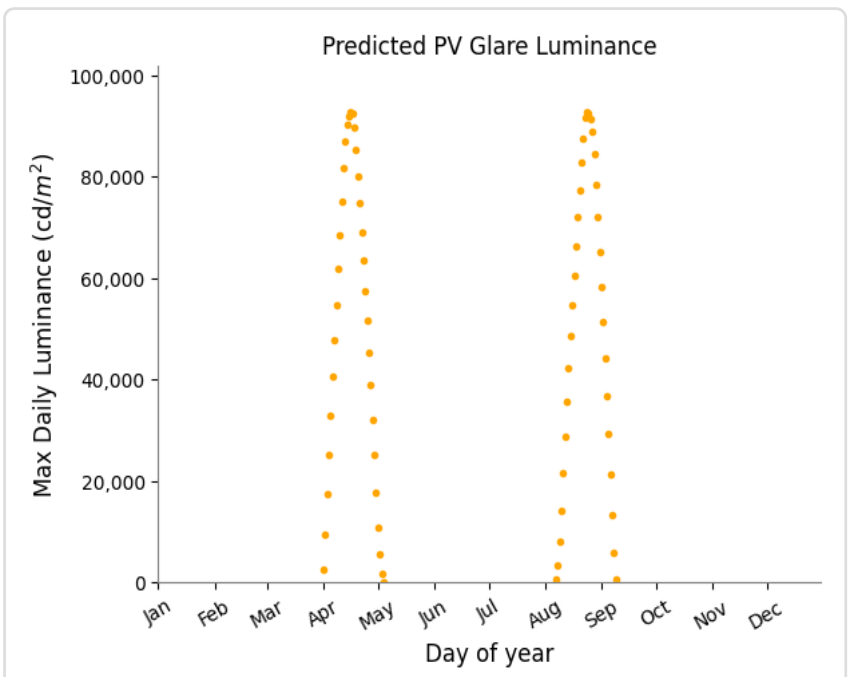
Green glare: 1,595 min.







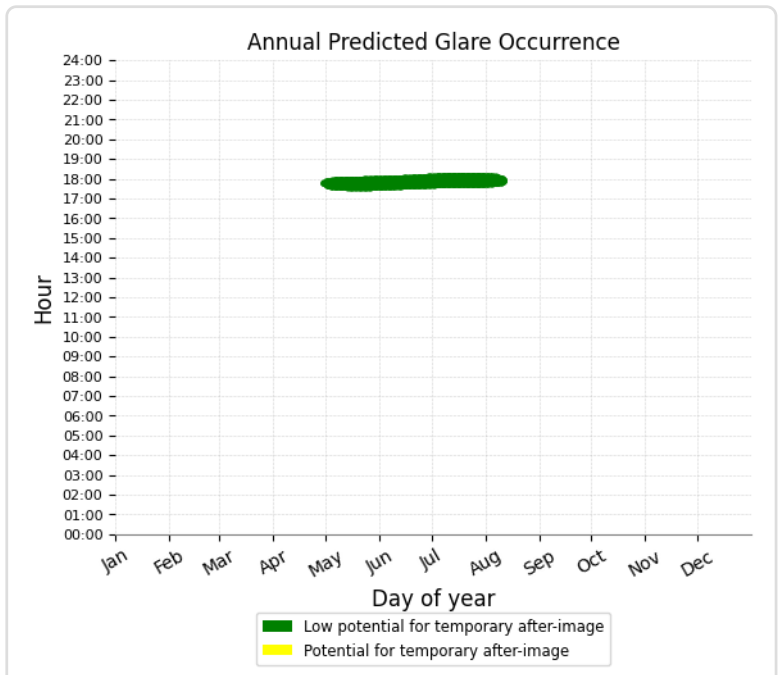


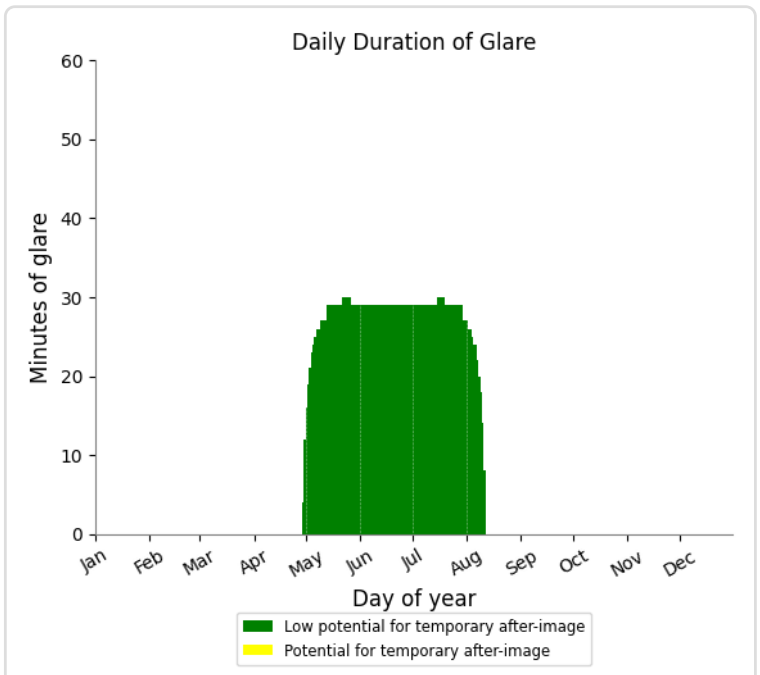


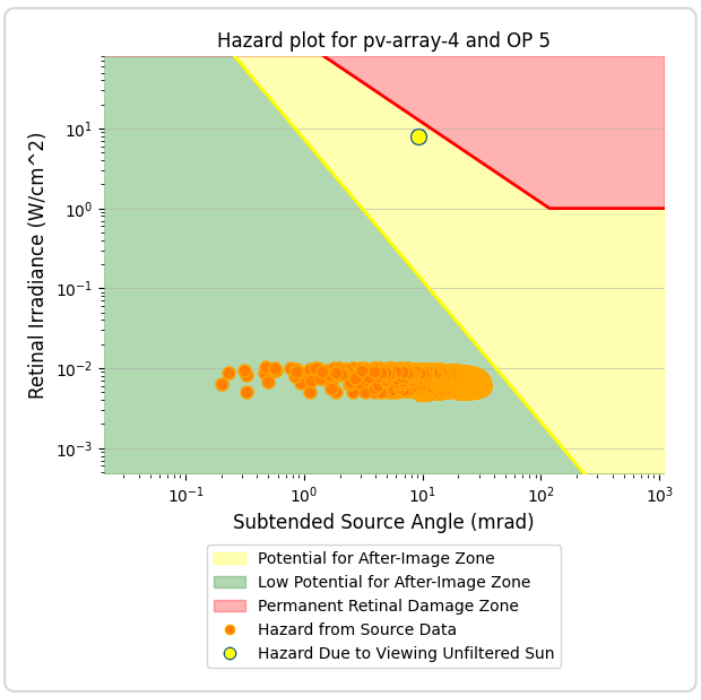
PV array 4 and OP 5

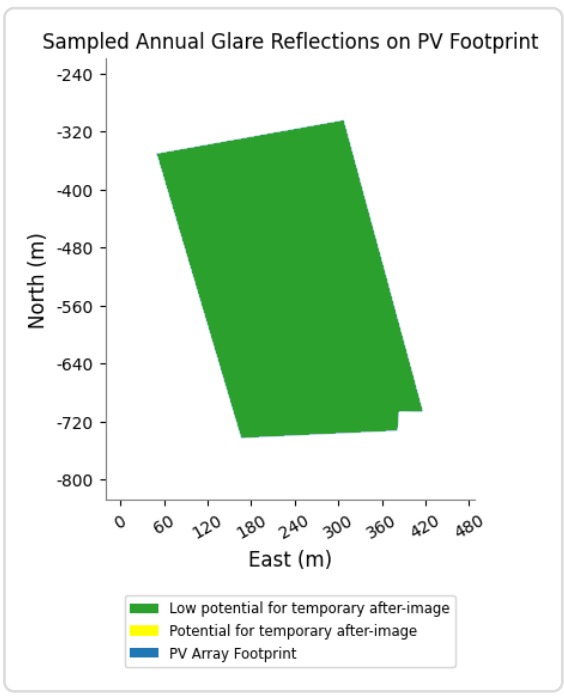
Yellow glare: none

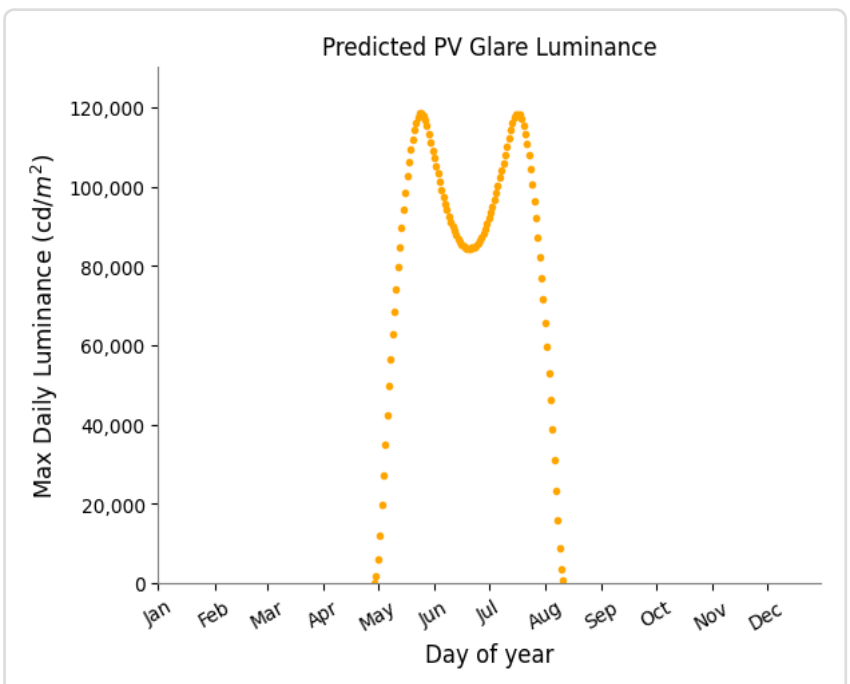
Green glare: 2,864 min.







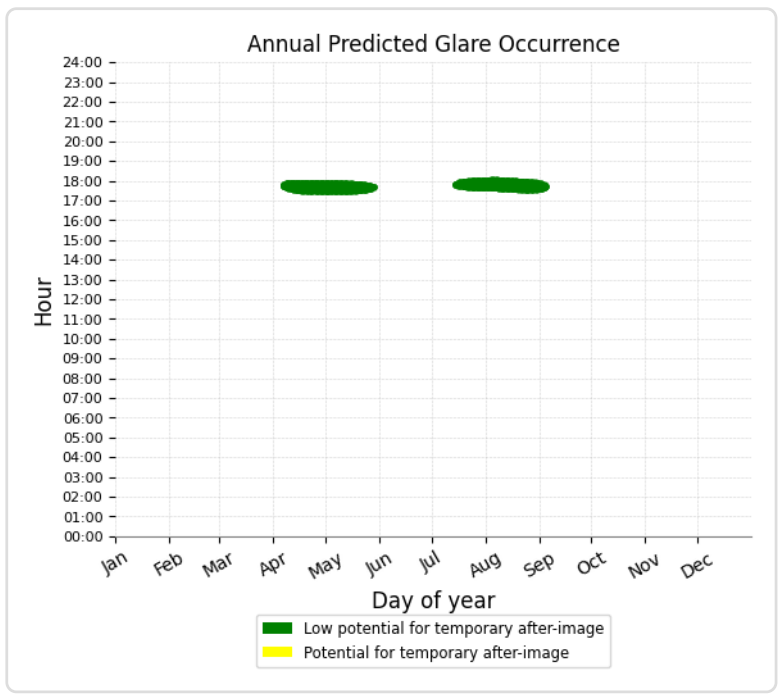


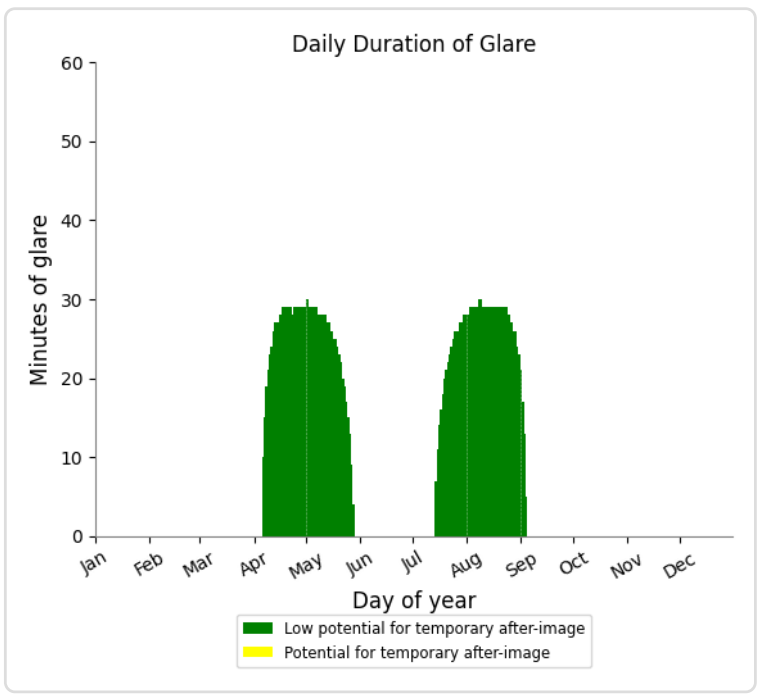


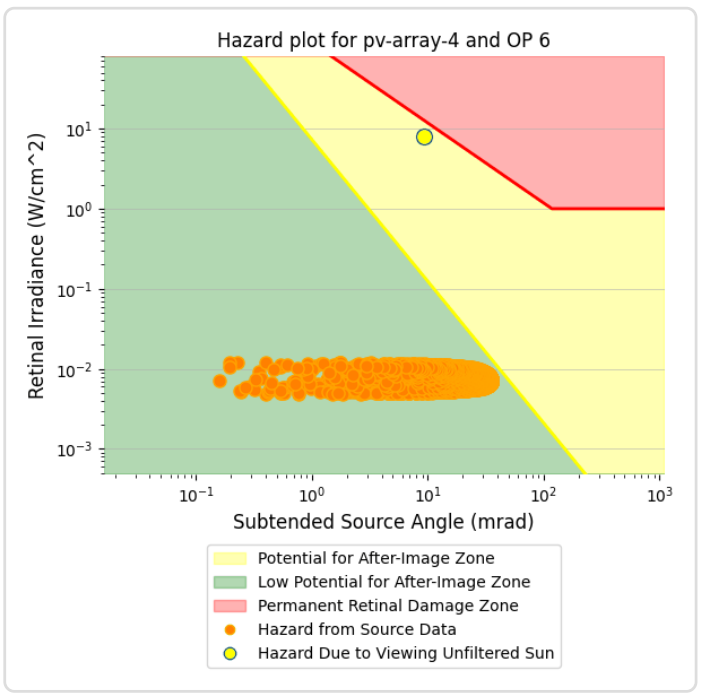
PV array 4 and OP 6

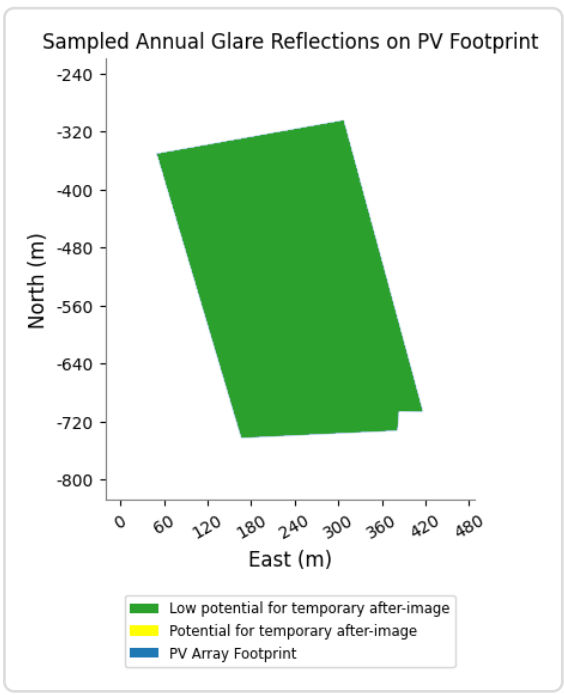
Yellow glare: none

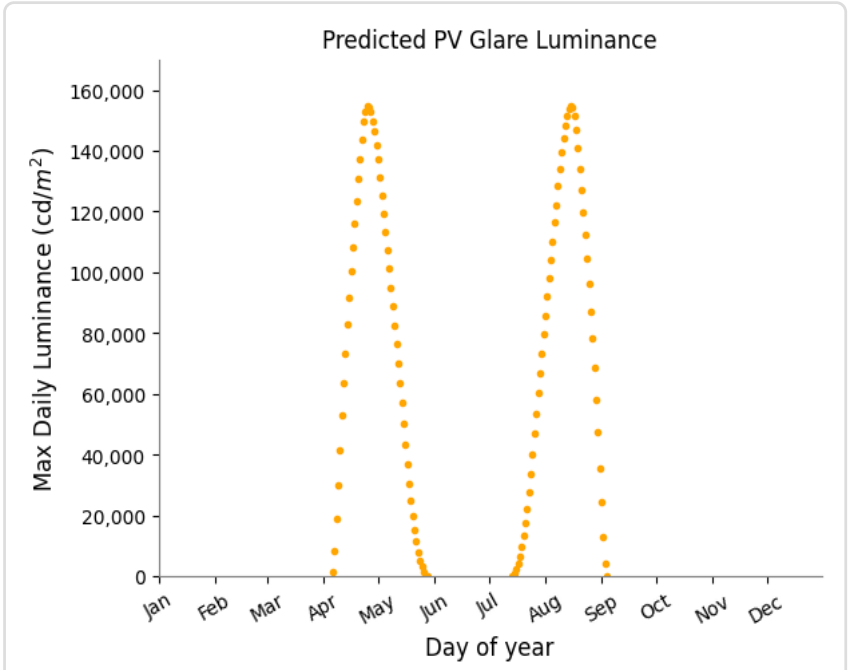
Green glare: 2,641 min.







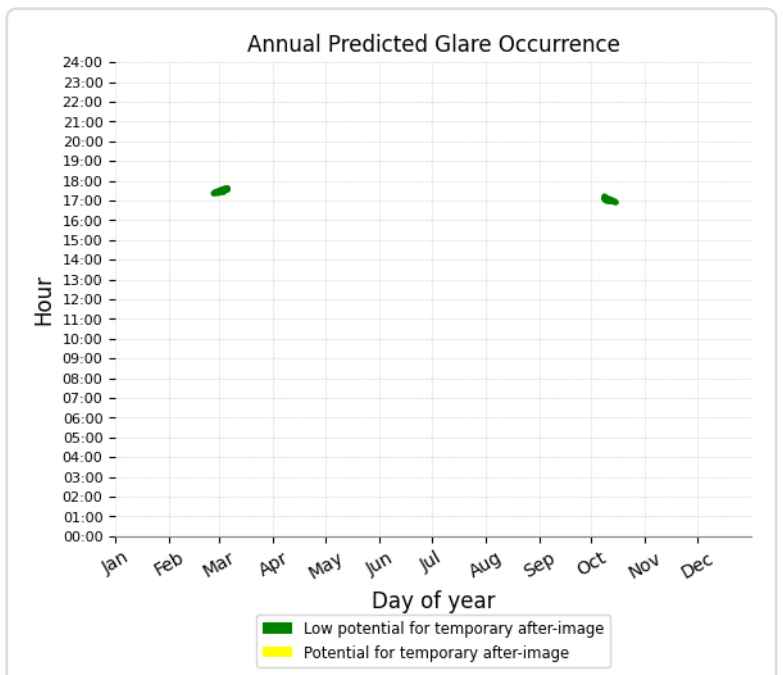


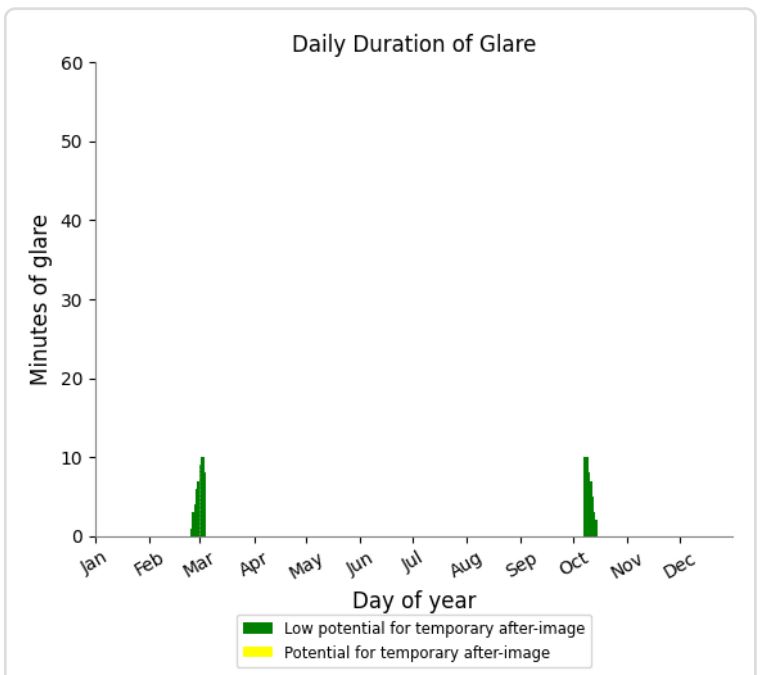


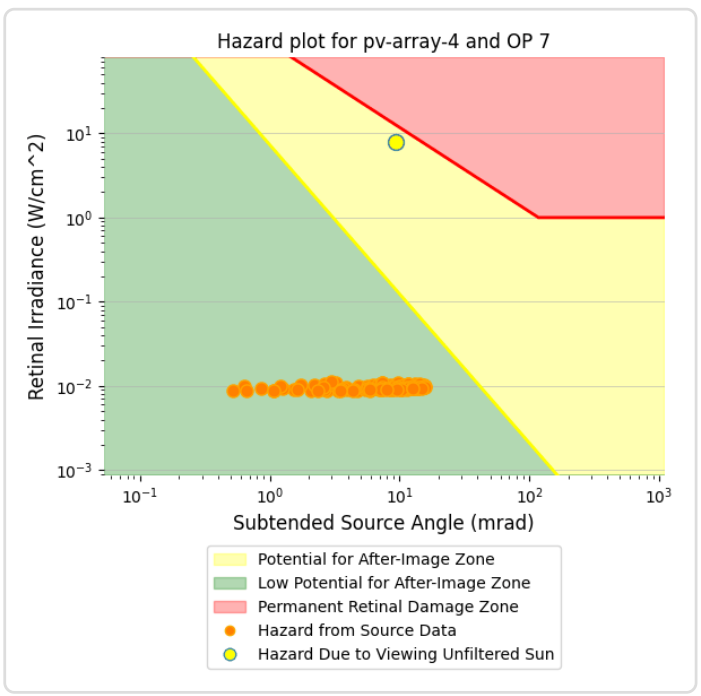
PV array 4 and OP 7

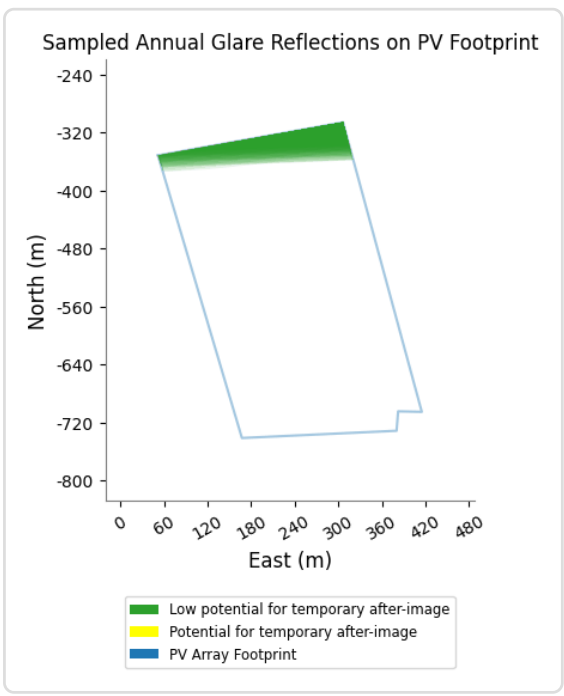
Yellow glare: none

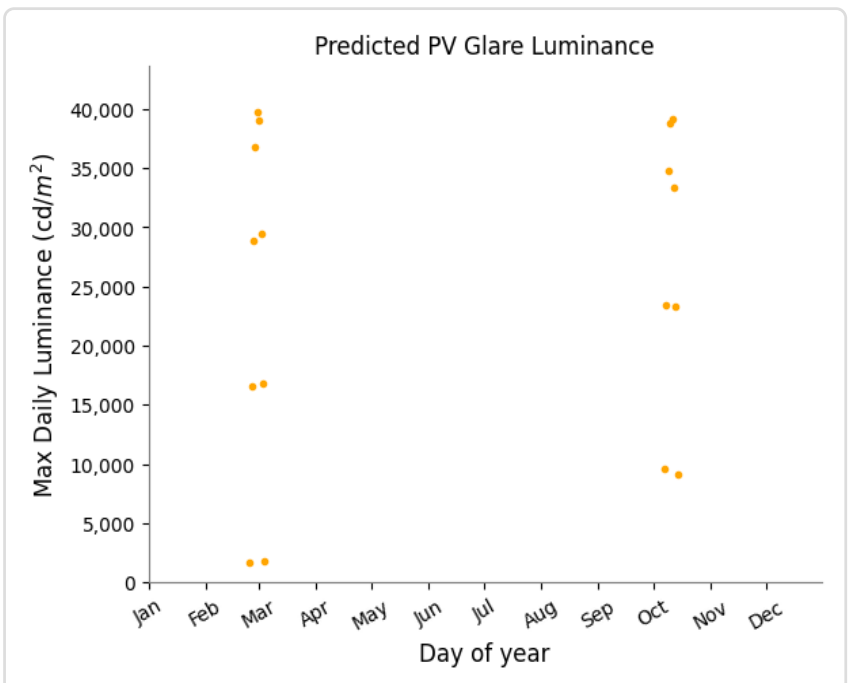
Green glare: 113 min.







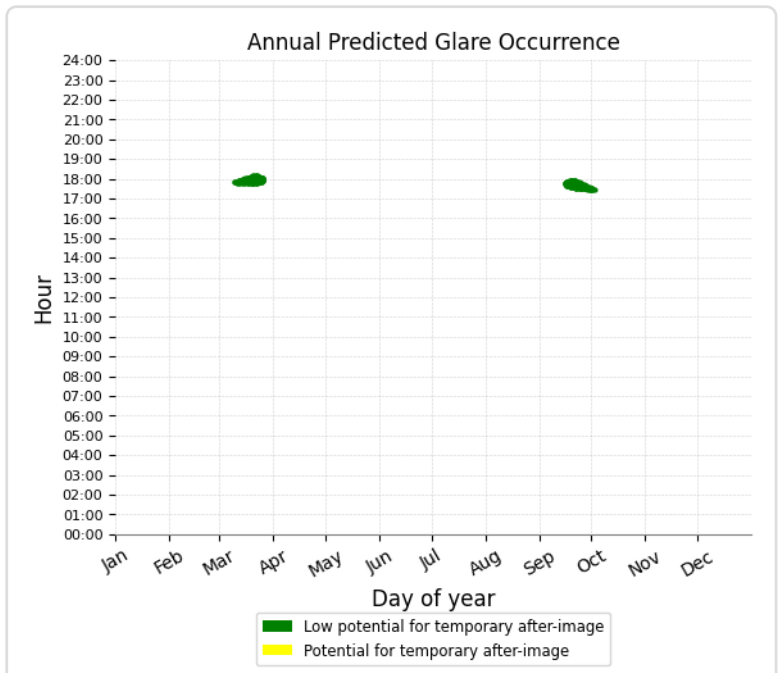


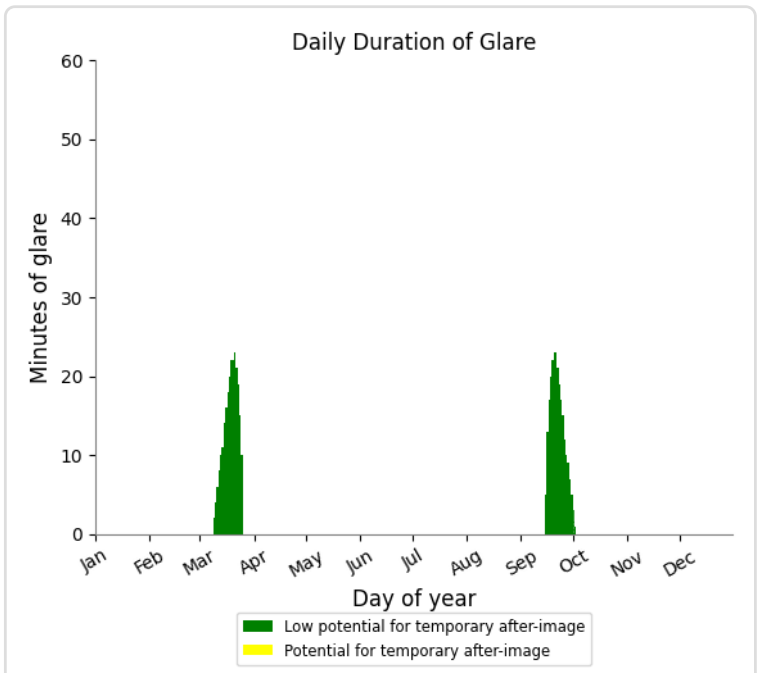


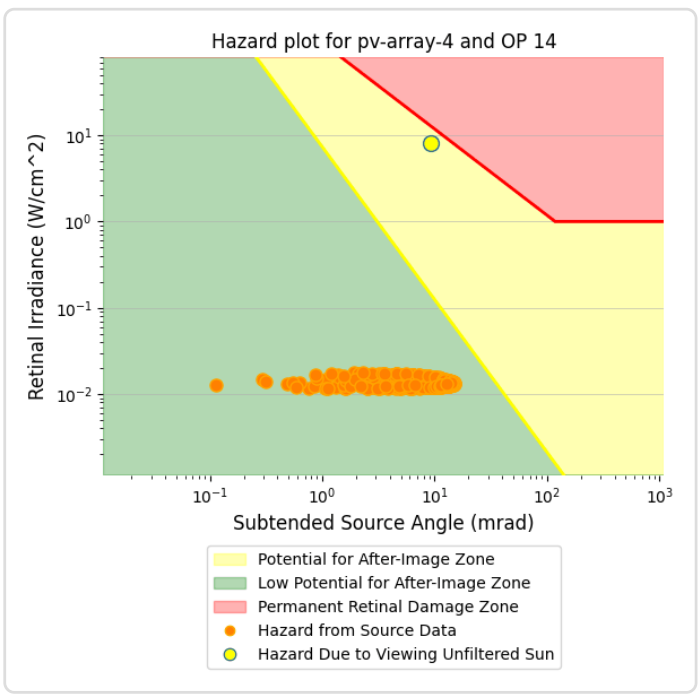
PV array 4 and OP 14

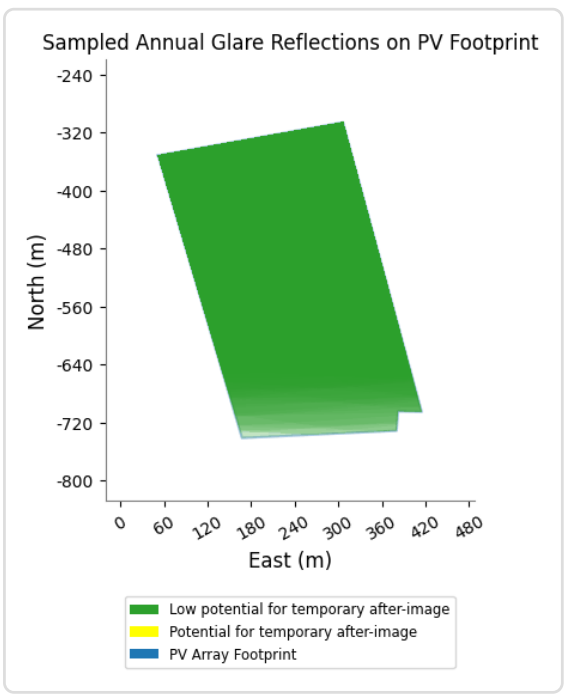
Yellow glare: none

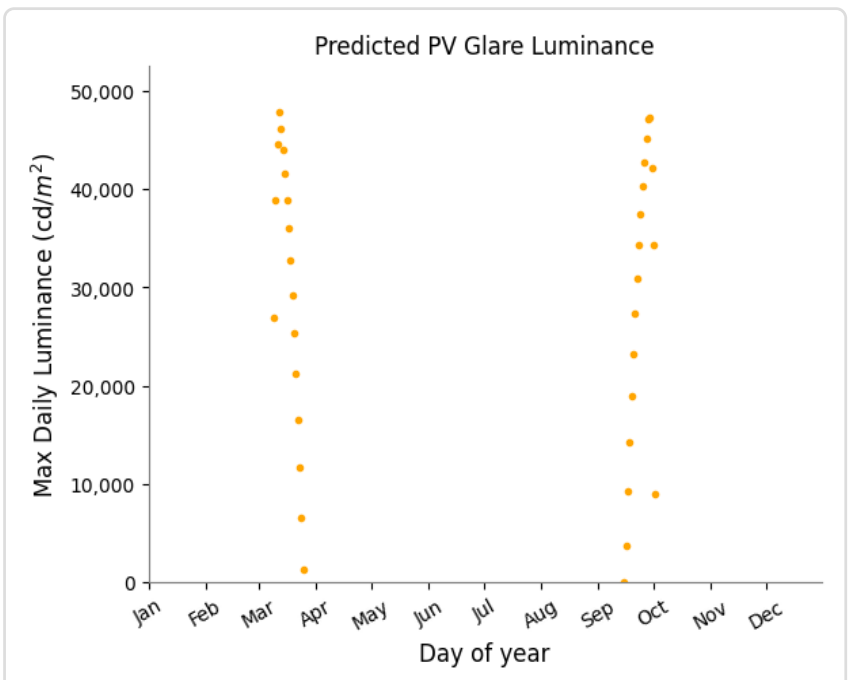
Green glare: 483 min.











PV array 4 and OP 1

No glare found

PV array 4 and OP 2

No glare found

PV array 4 and OP 8

No glare found

PV array 4 and OP 9

No glare found

PV array 4 and OP 10

No glare found

PV array 4 and OP 11

No glare found

PV array 4 and OP 12

No glare found

PV array 4 and OP 13

No glare found

PV array 4 and OP 15

No glare found

PV array 4 and OP 16

No glare found

PV array 4 and OP 17

No glare found

PV array 4 and OP 18

No glare found

PV array 4 and OP 19

No glare found

PV array 4 and OP 20

No glare found

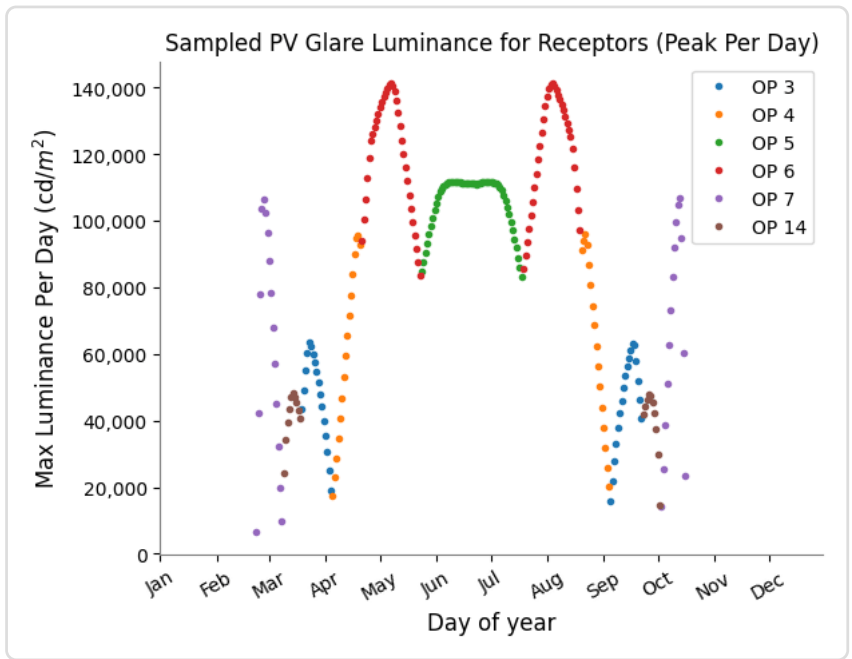
PV array 4 and OP 21

No glare found

PV: PV array 5 low potential for temporary after-image

Receptor results ordered by category of glare

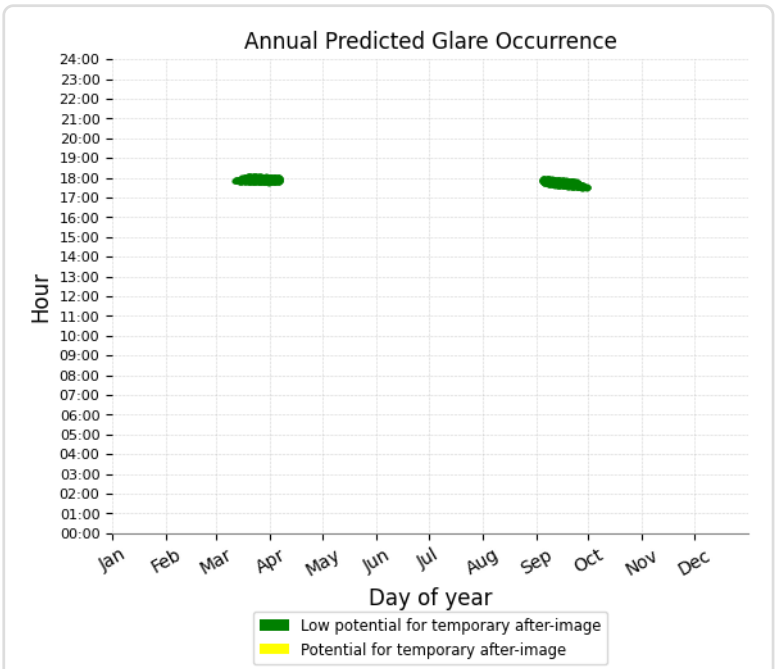
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	934	15.6	0	0.0	63,373
OP 4	1,664	27.7	0	0.0	96,116
OP 5	2,530	42.2	0	0.0	111,868
OP 6	3,717	62.0	0	0.0	141,244
OP 7	381	6.3	0	0.0	107,016
OP 14	535	8.9	0	0.0	48,192
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

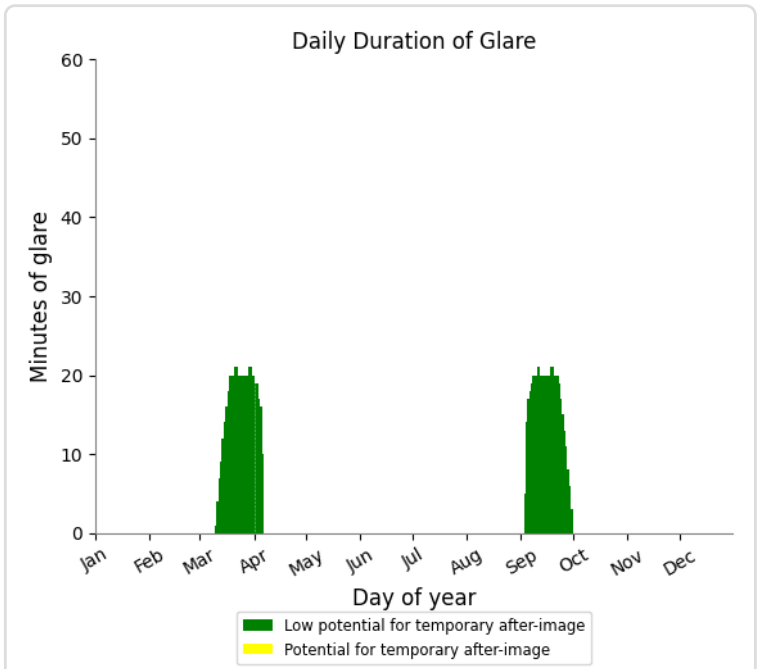


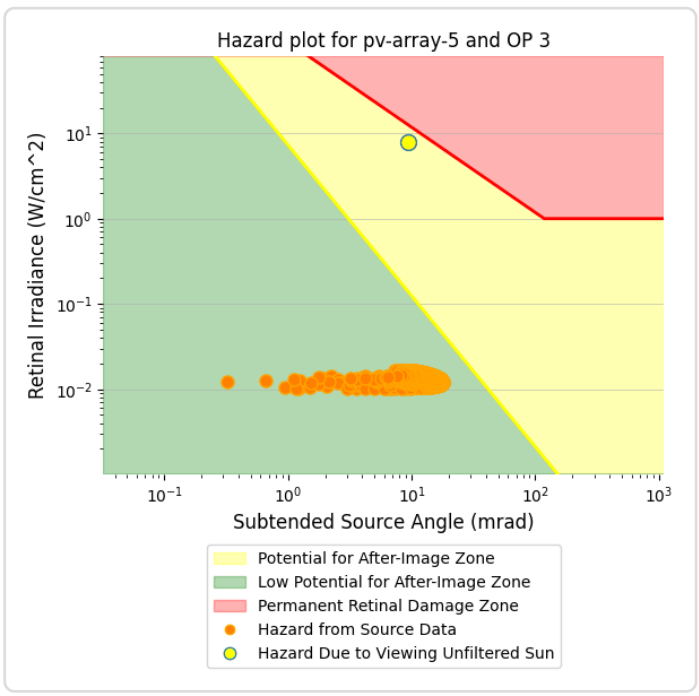
PV array 5 and OP 3

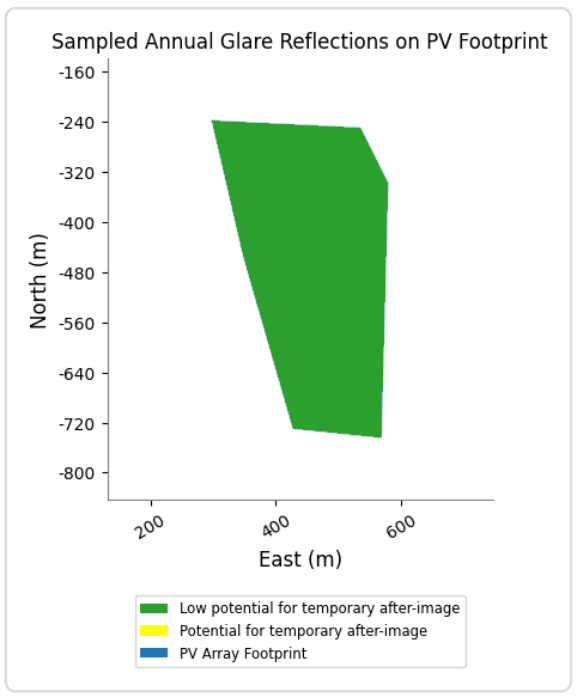
Yellow glare: none

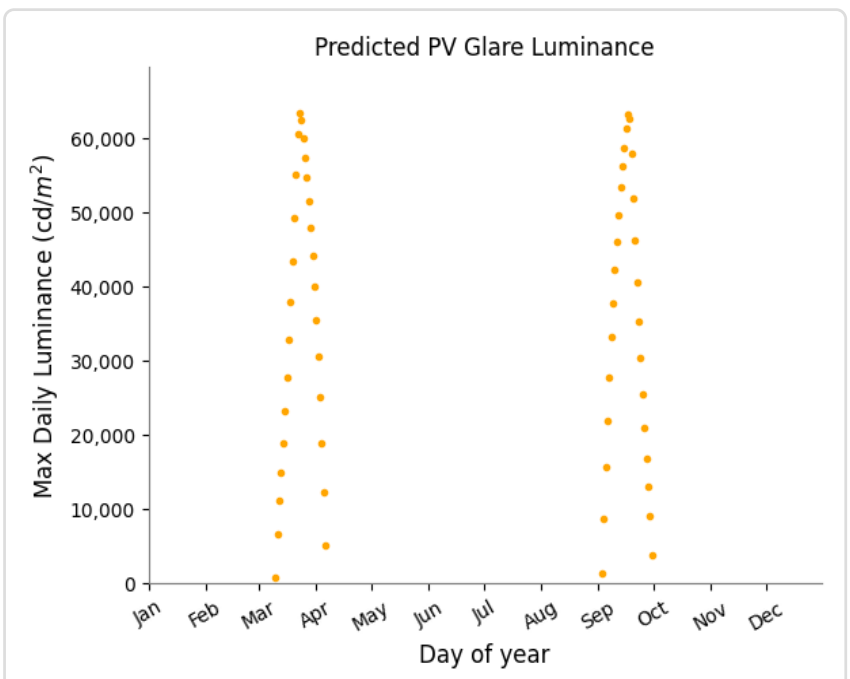
Green glare: 934 min.







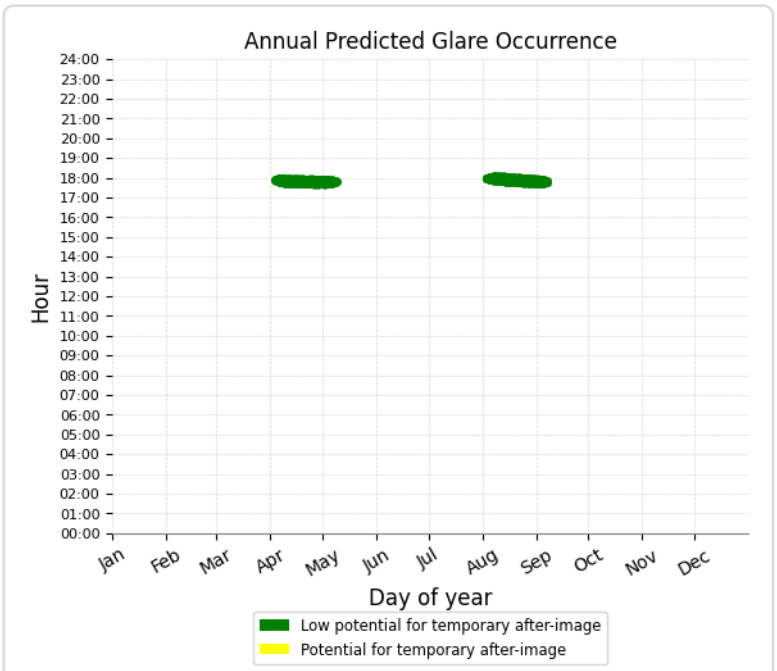


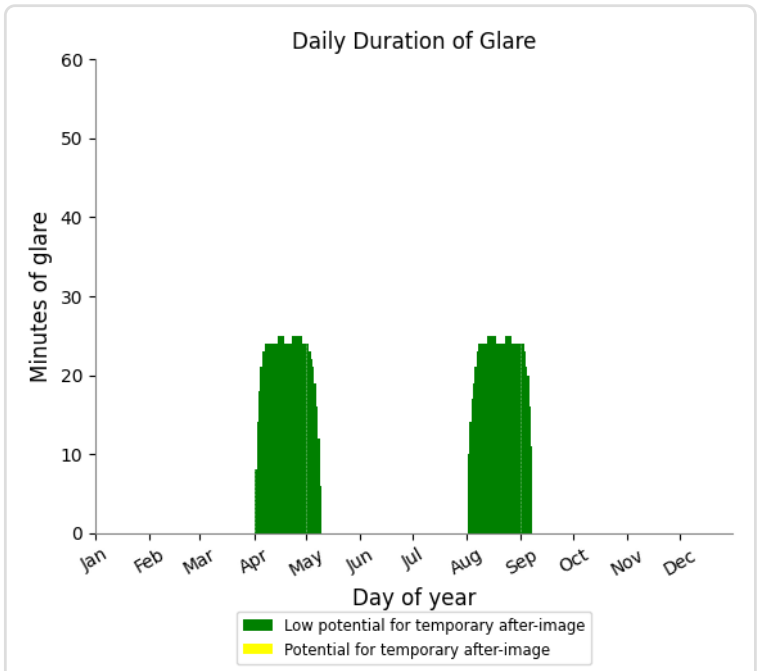


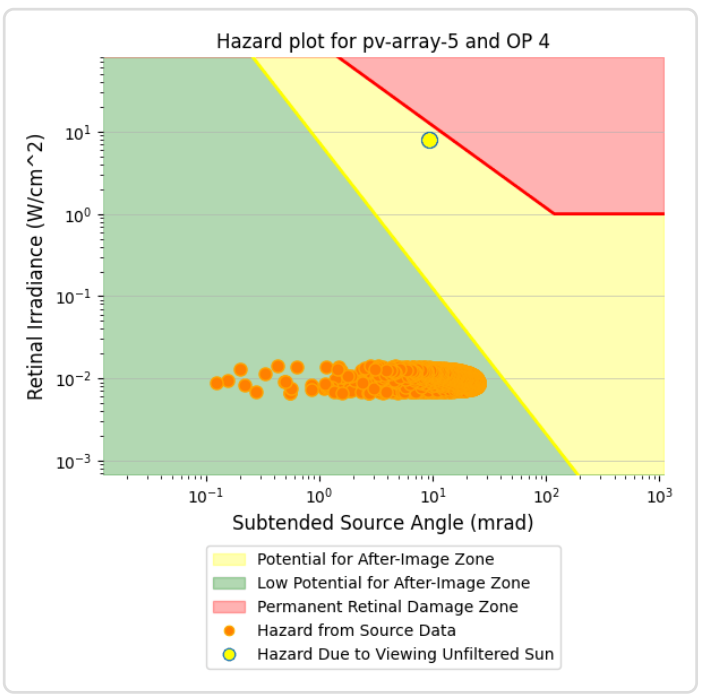
PV array 5 and OP 4

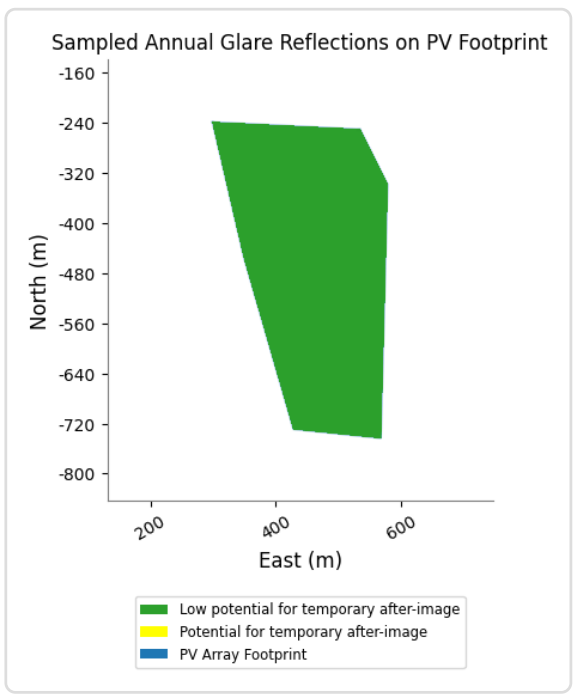
Yellow glare: none

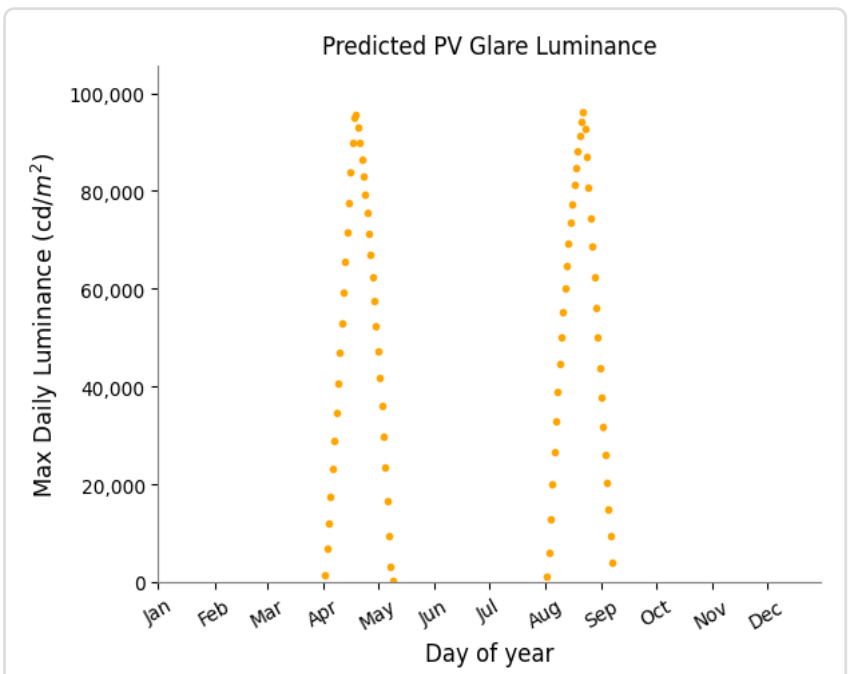
Green glare: 1,664 min.







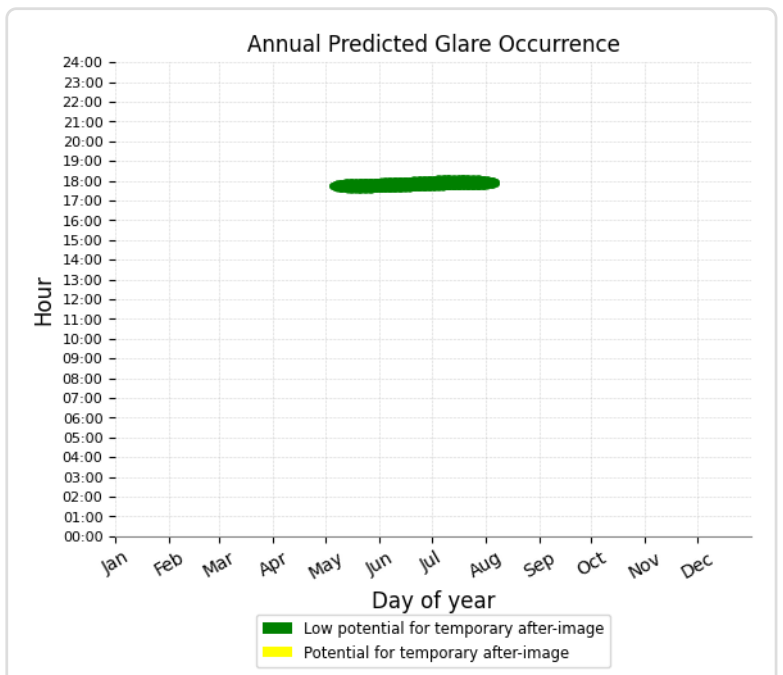


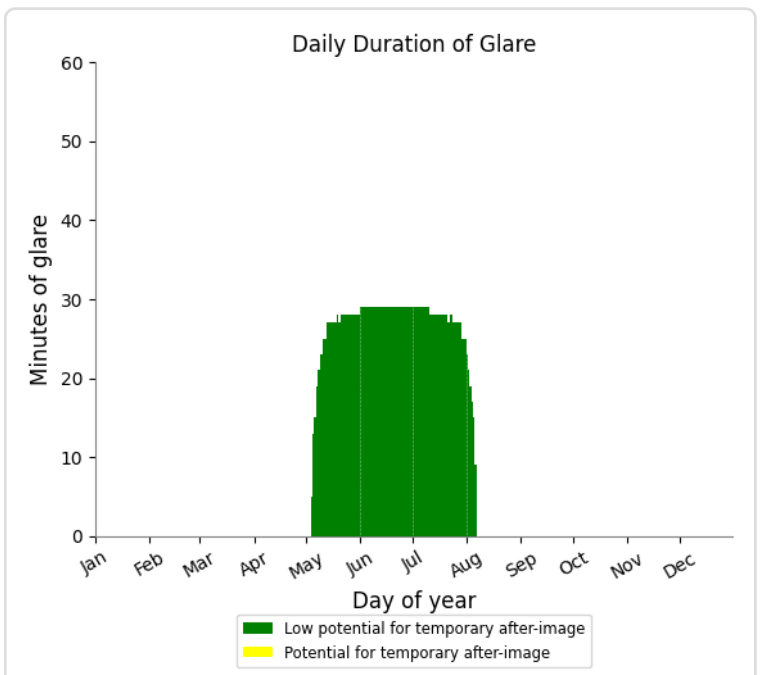


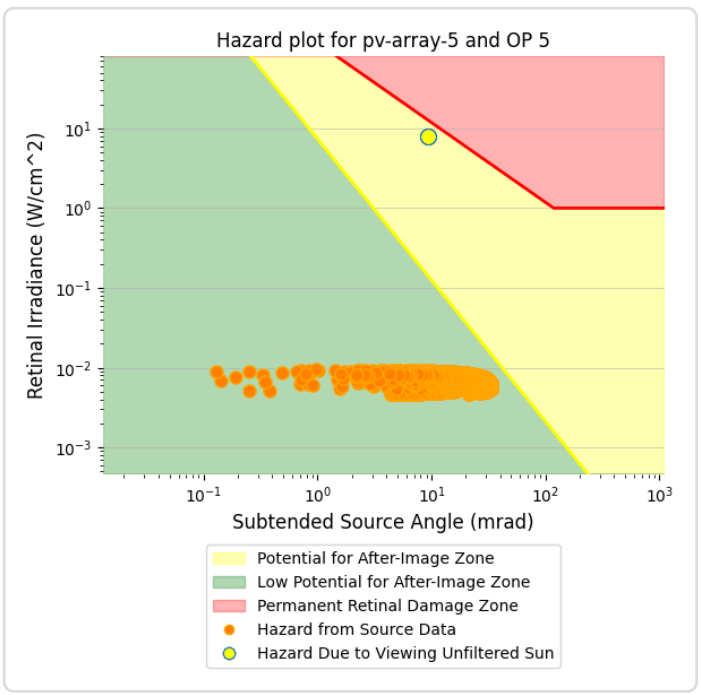
PV array 5 and OP 5

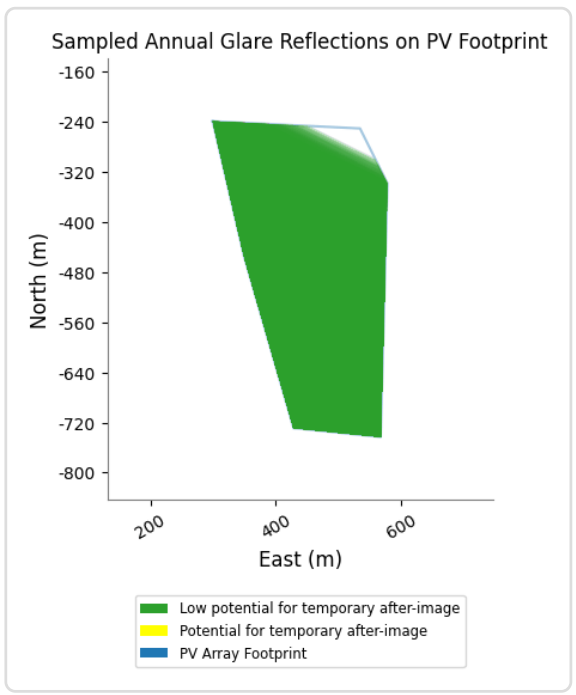
Yellow glare: none

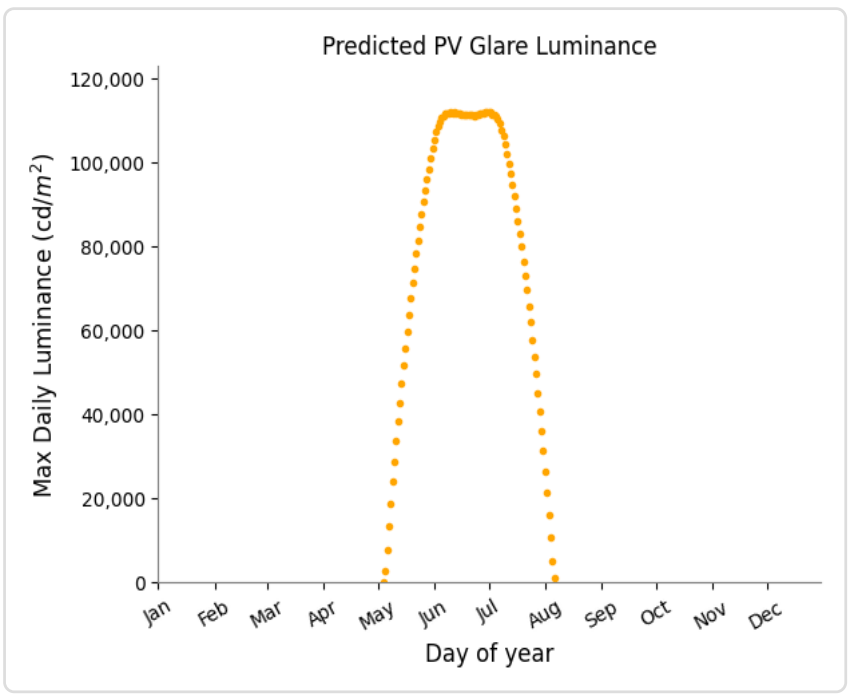
Green glare: 2,530 min.







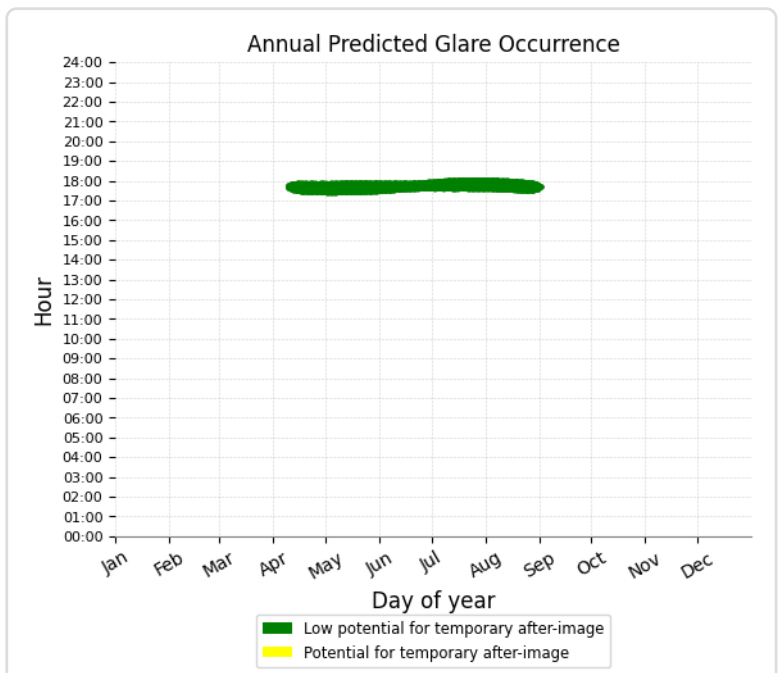


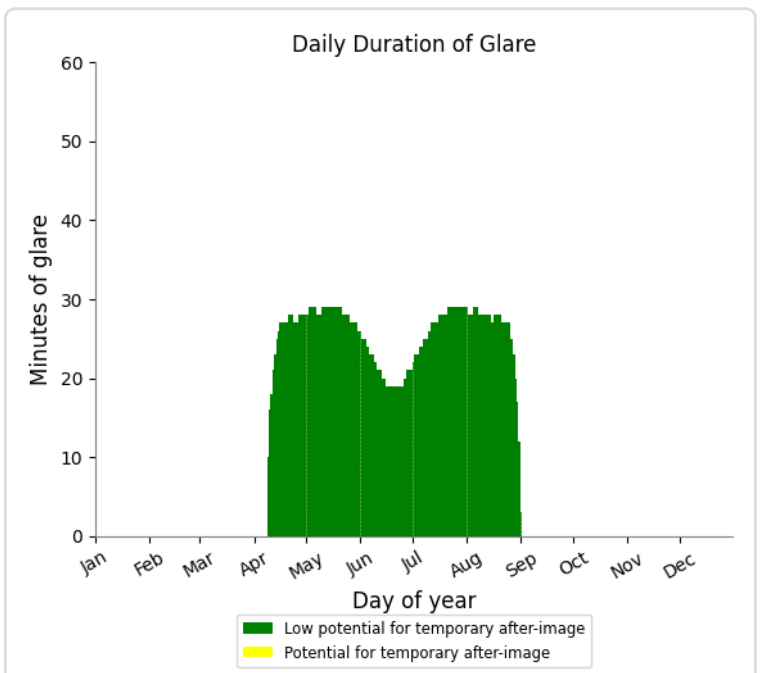


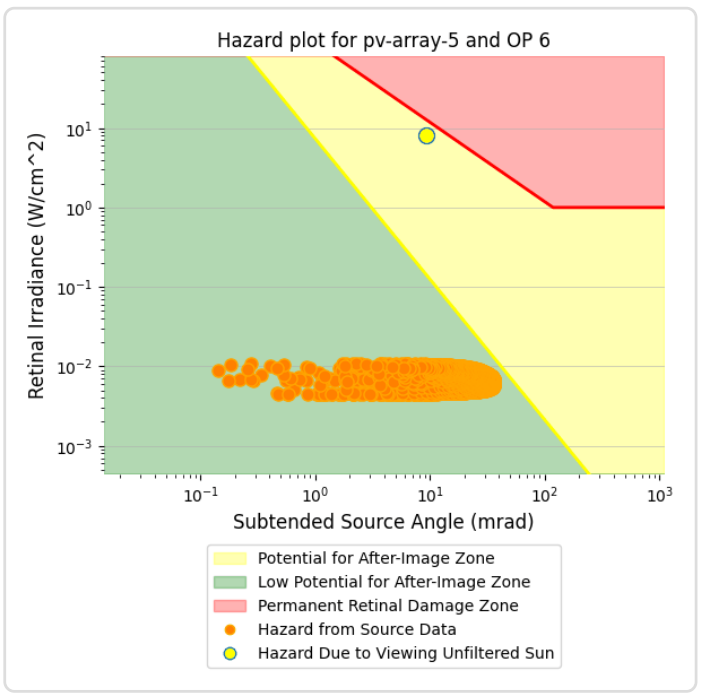
PV array 5 and OP 6

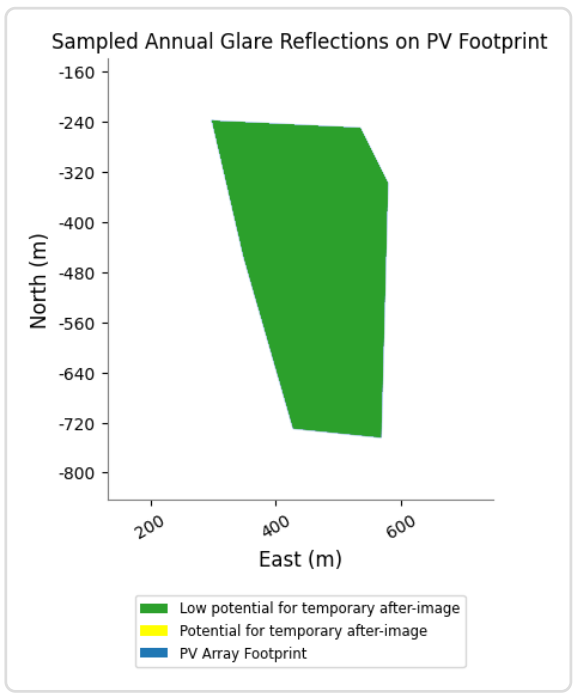
Yellow glare: none

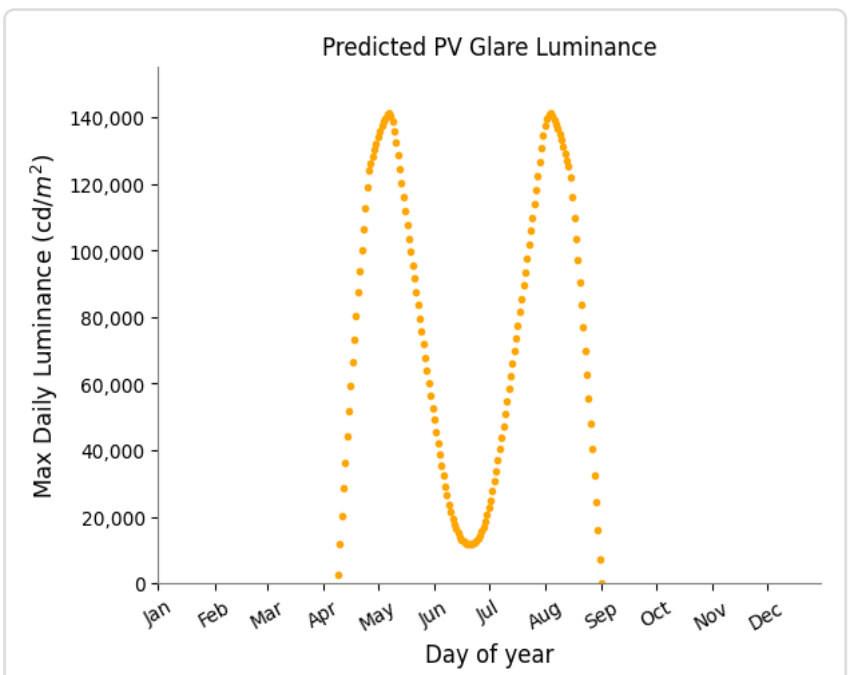
Green glare: 3,717 min.







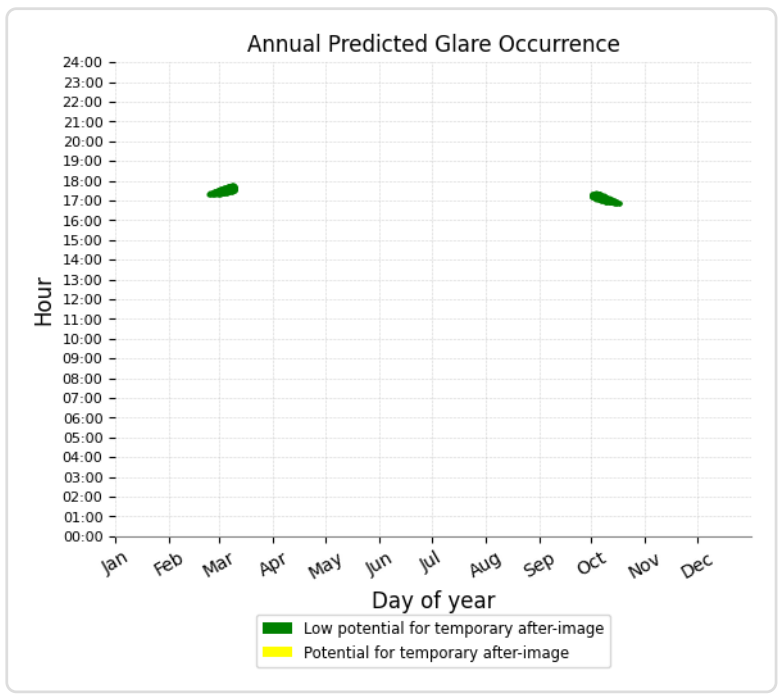


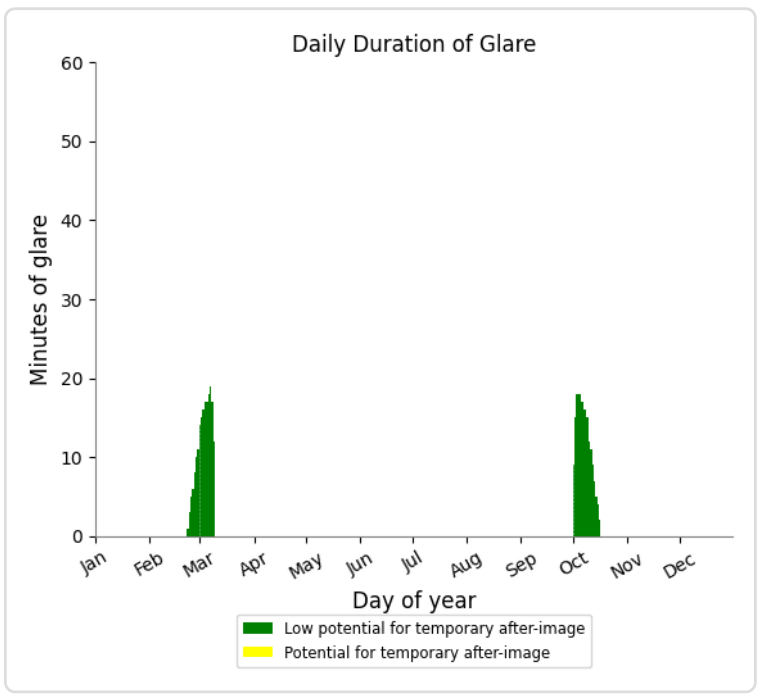


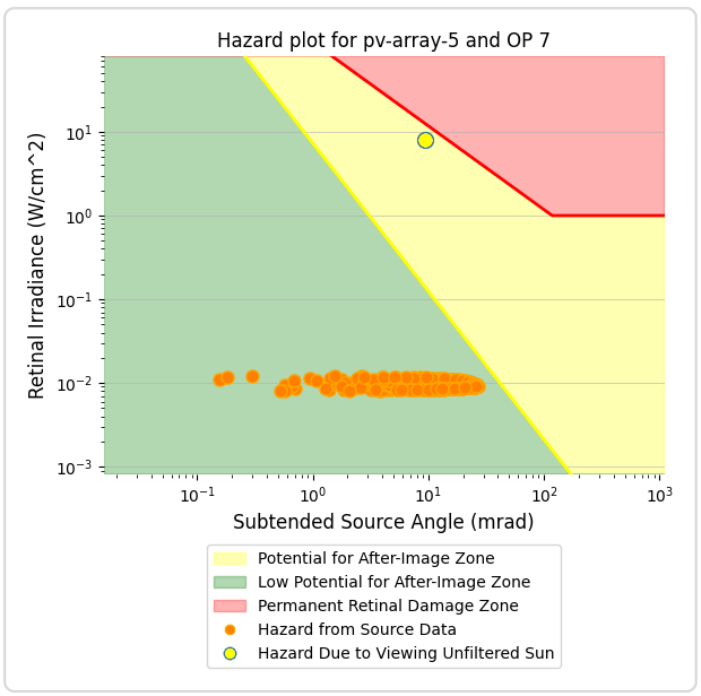
PV array 5 and OP 7

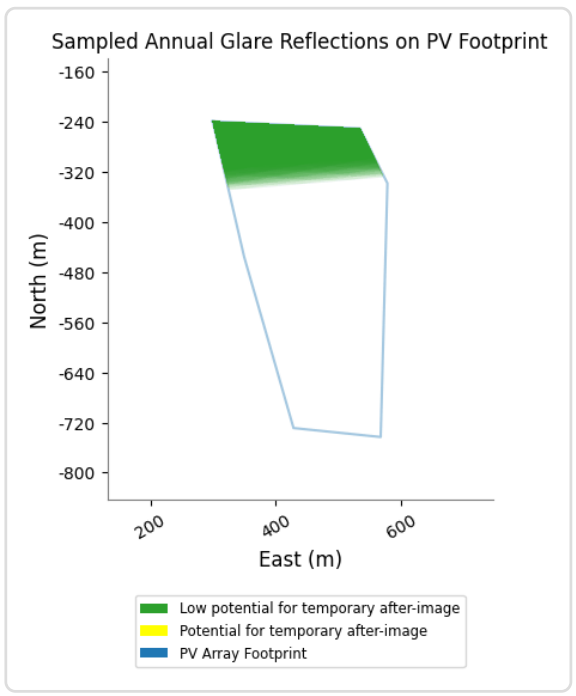
Yellow glare: none

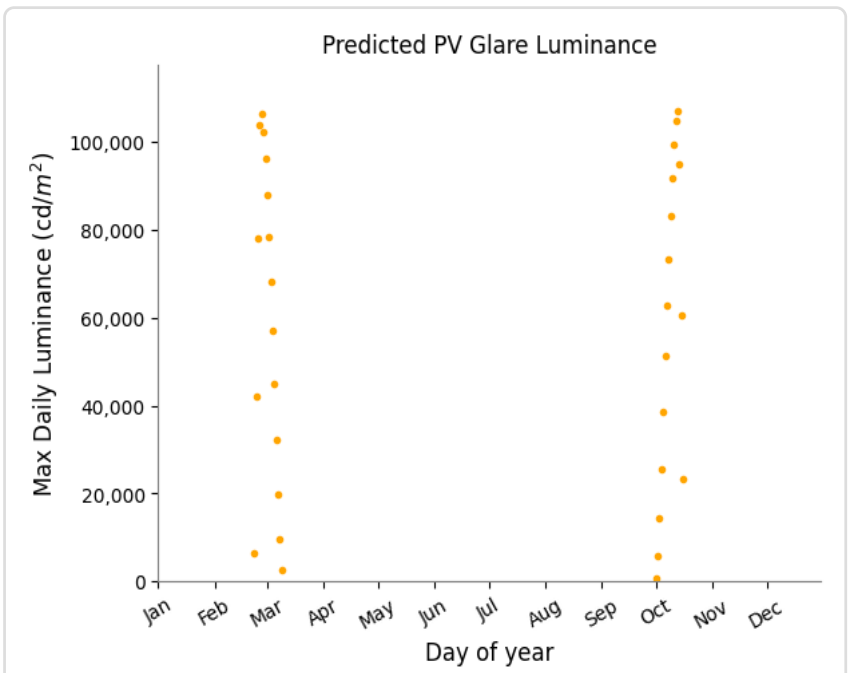
Green glare: 381 min.







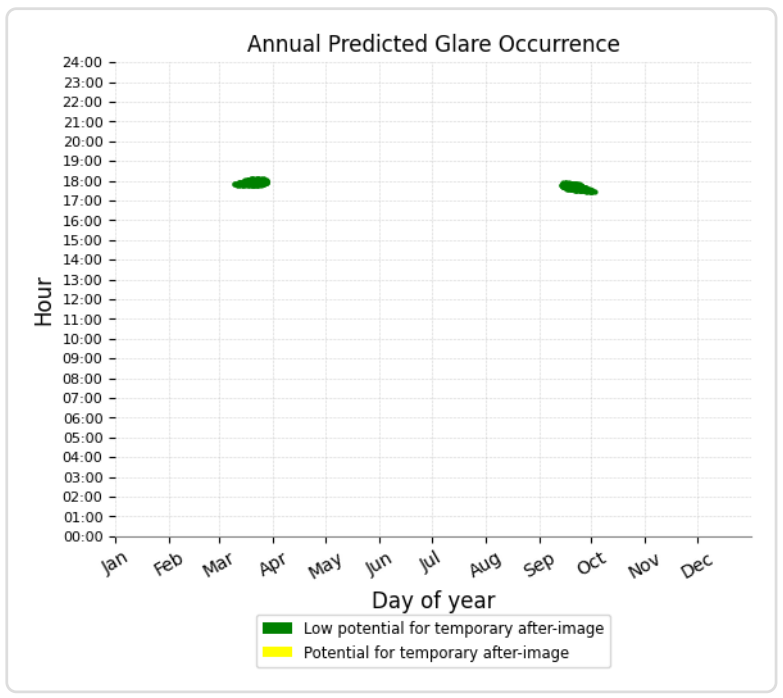


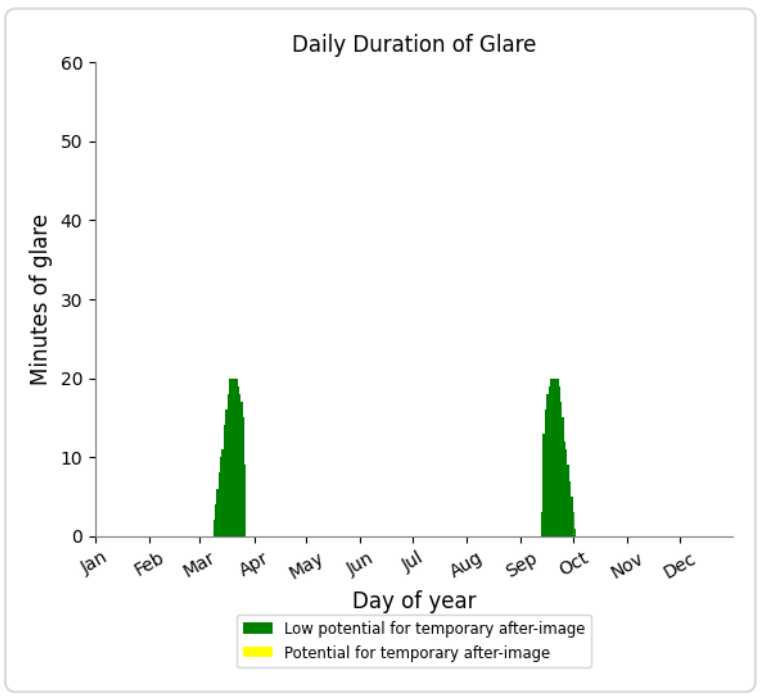


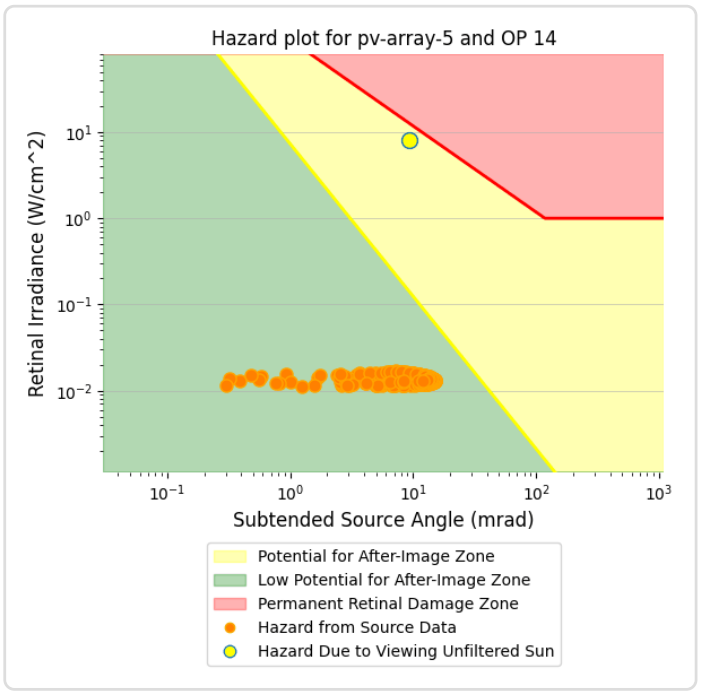
PV array 5 and OP 14

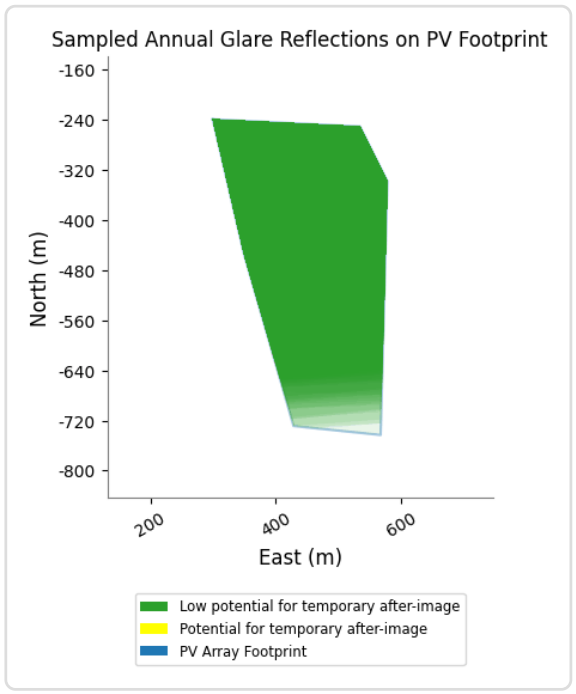
Yellow glare: none

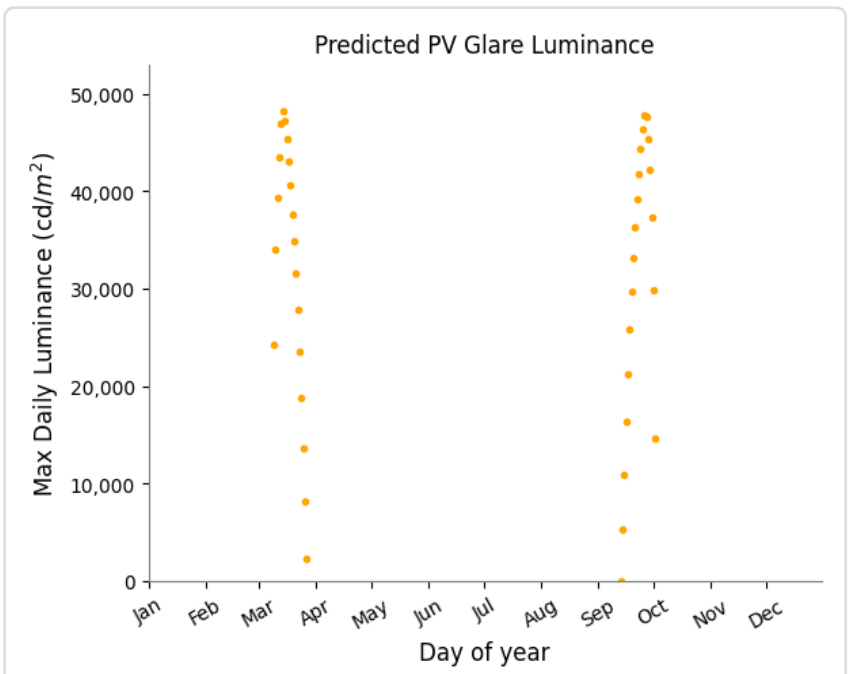
Green glare: 535 min.











PV array 5 and OP 1

No glare found

PV array 5 and OP 2

No glare found

PV array 5 and OP 8

No glare found

PV array 5 and OP 9

No glare found

PV array 5 and OP 10

No glare found

PV array 5 and OP 11

No glare found

PV array 5 and OP 12

No glare found

PV array 5 and OP 13

No glare found

PV array 5 and OP 15

No glare found

PV array 5 and OP 16

No glare found

PV array 5 and OP 17

No glare found

PV array 5 and OP 18

No glare found

PV array 5 and OP 19

No glare found

PV array 5 and OP 20

No glare found

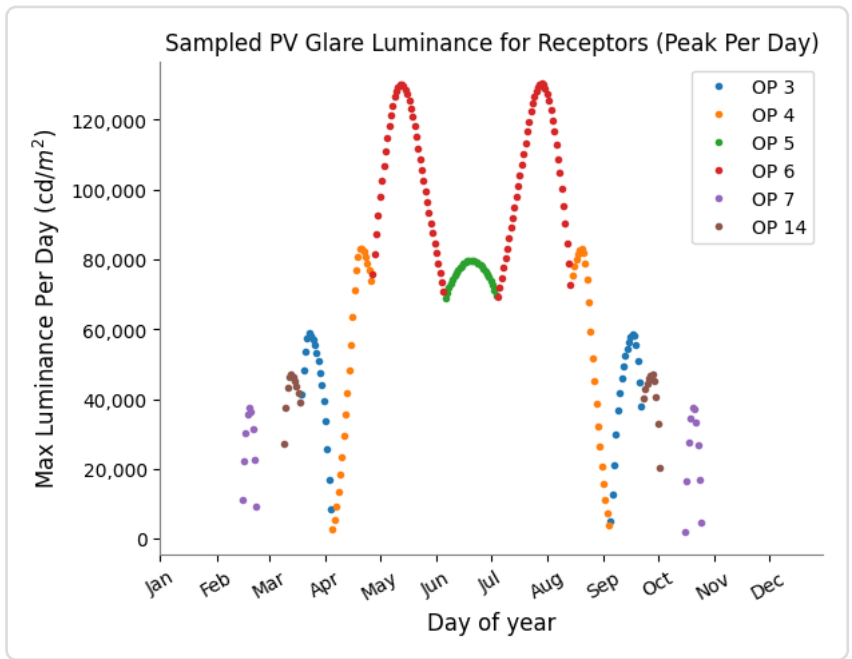
PV array 5 and OP 21

No glare found

PV: PV array 6 low potential for temporary after-image

Receptor results ordered by category of glare

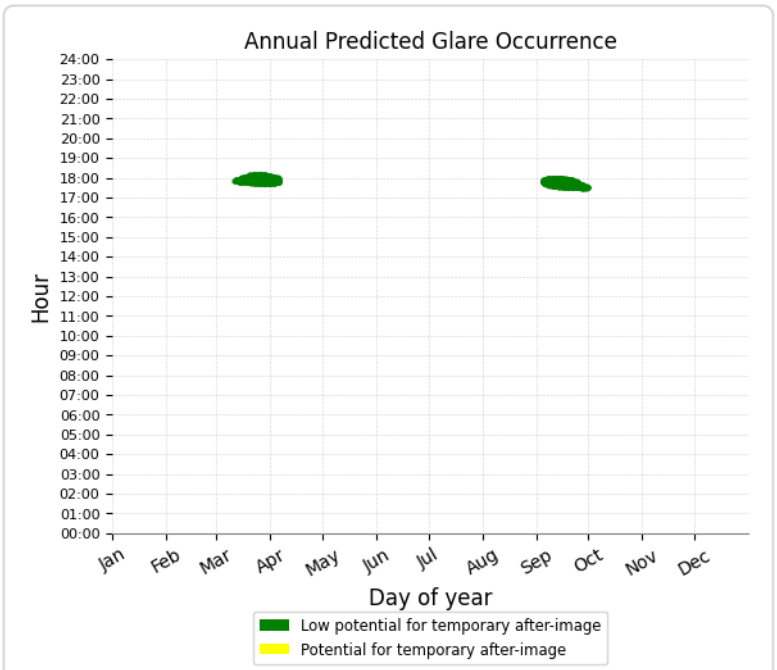
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	1,093	18.2	0	0.0	58,819
OP 4	1,853	30.9	0	0.0	83,226
OP 5	2,332	38.9	0	0.0	79,607
OP 6	4,005	66.8	0	0.0	130,339
OP 7	135	2.2	0	0.0	37,607
OP 14	536	8.9	0	0.0	47,005
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

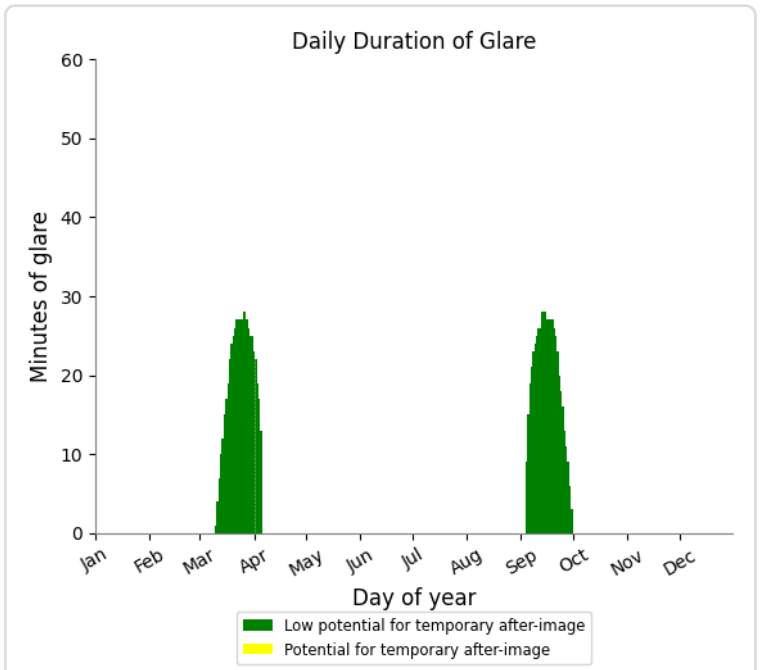


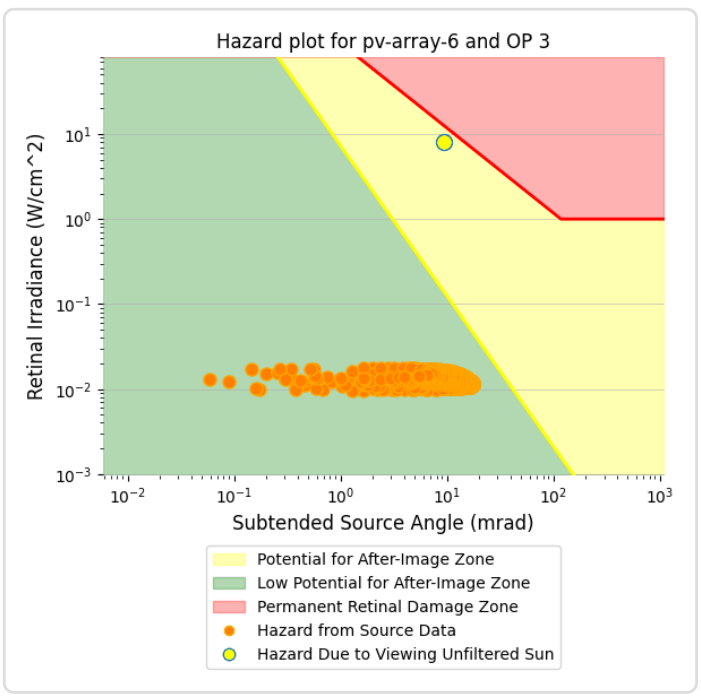
PV array 6 and OP 3

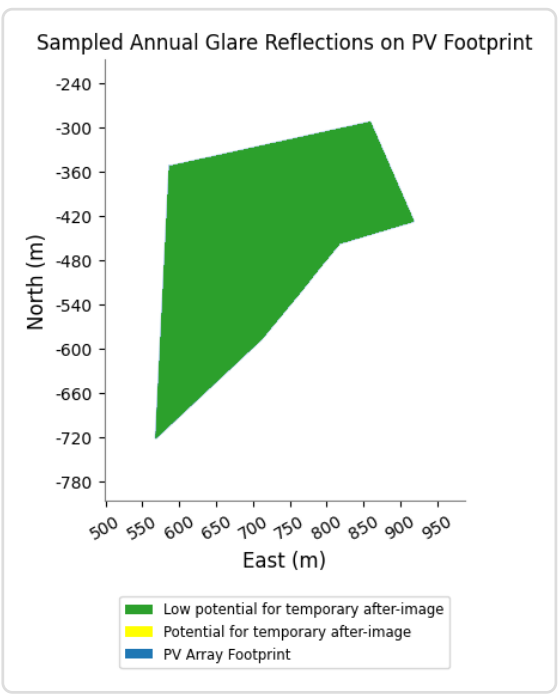
Yellow glare: none

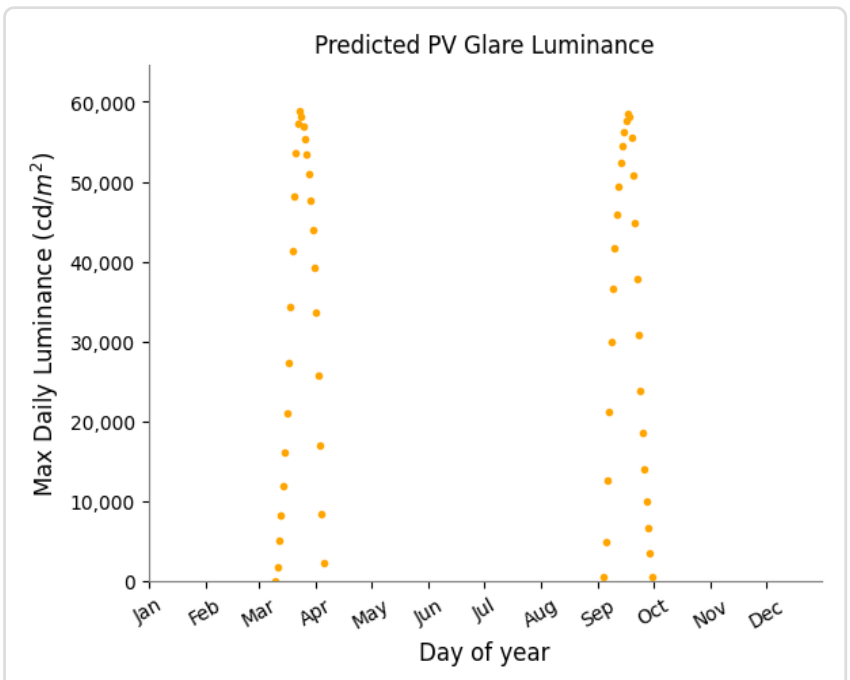
Green glare: 1,093 min.







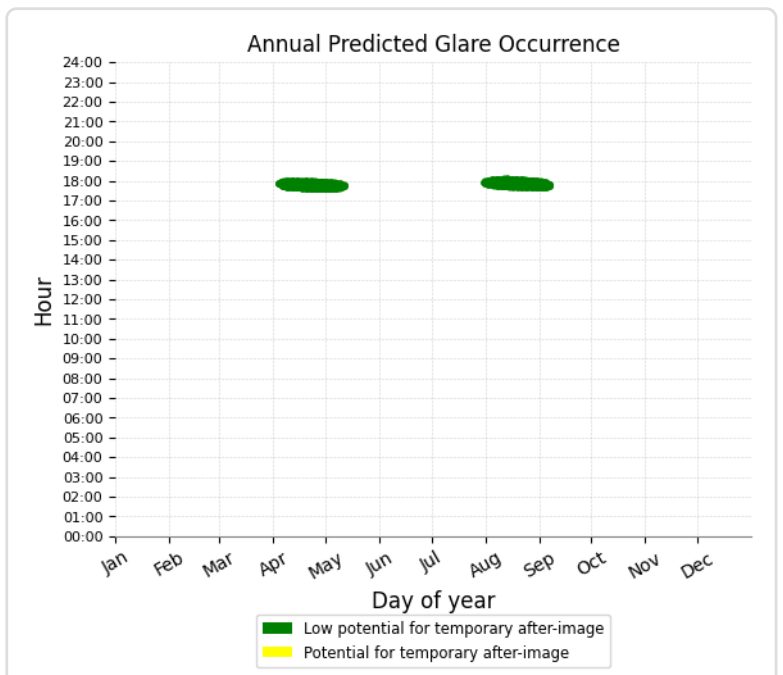


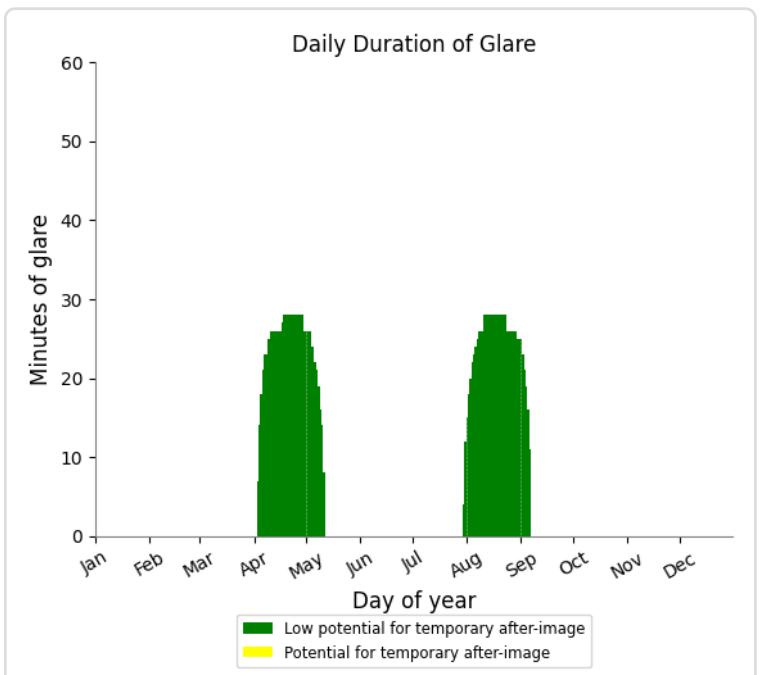


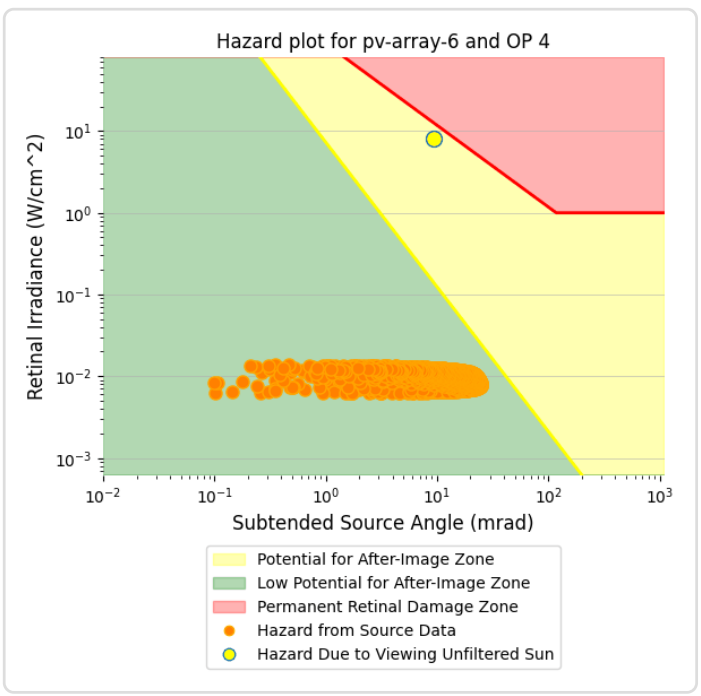
PV array 6 and OP 4

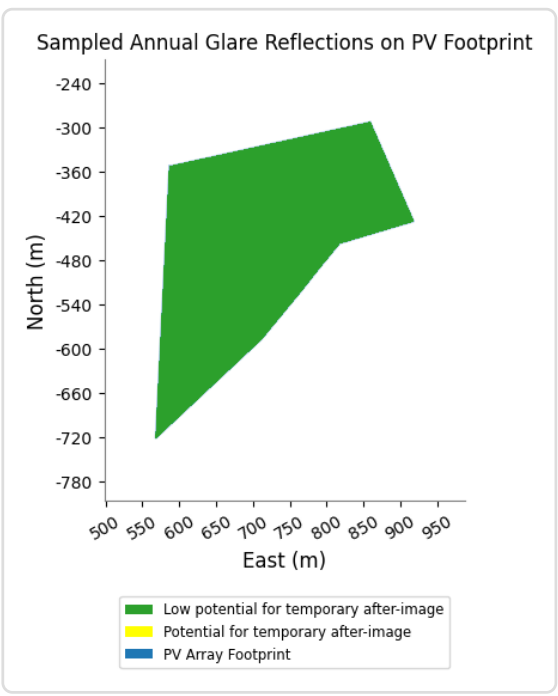
Yellow glare: none

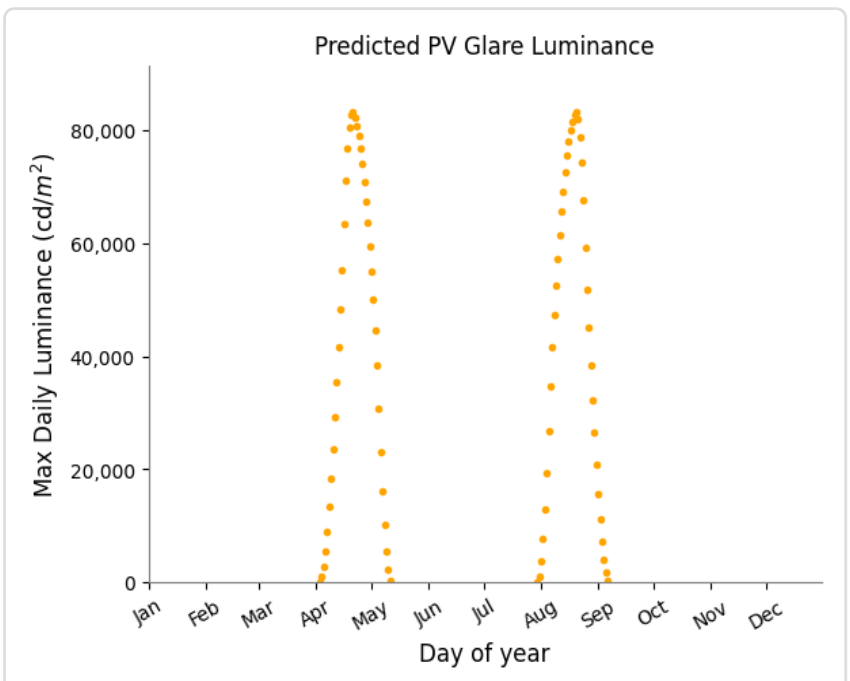
Green glare: 1,853 min.







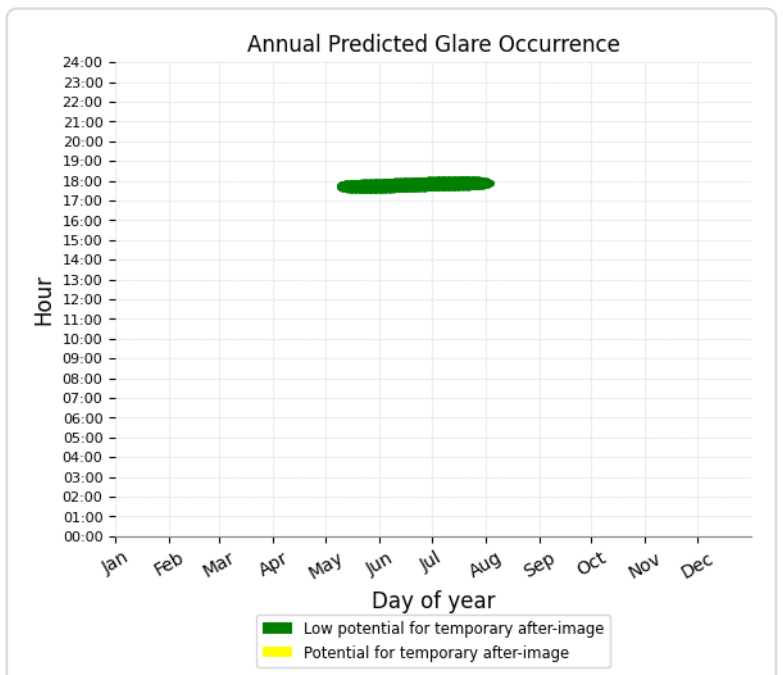


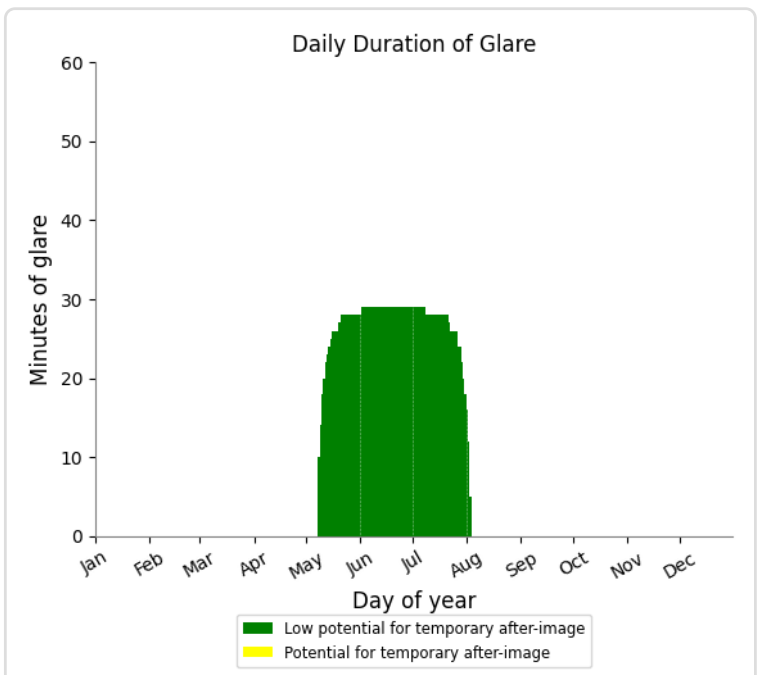


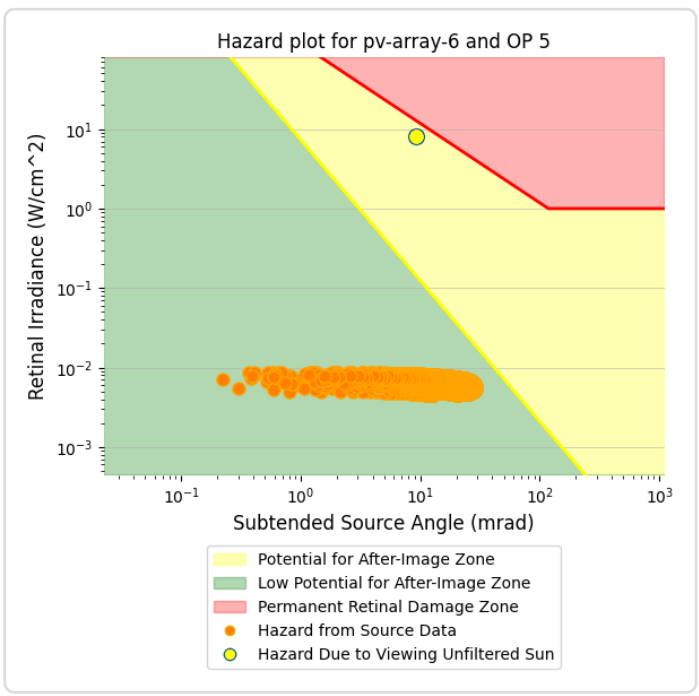
PV array 6 and OP 5

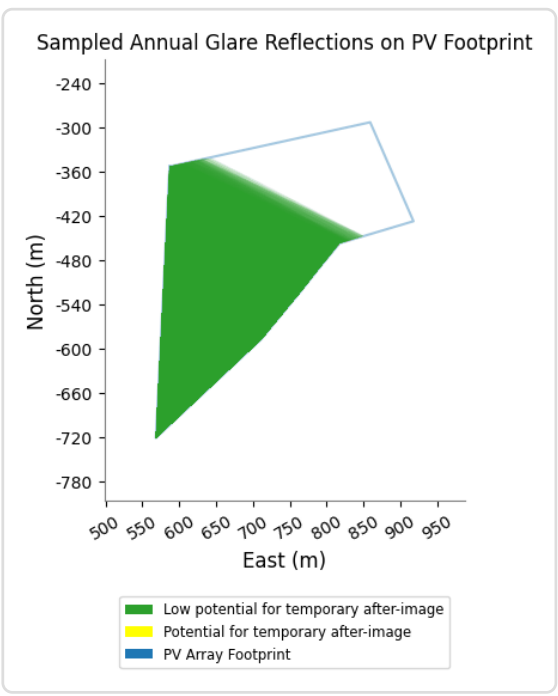
Yellow glare: none

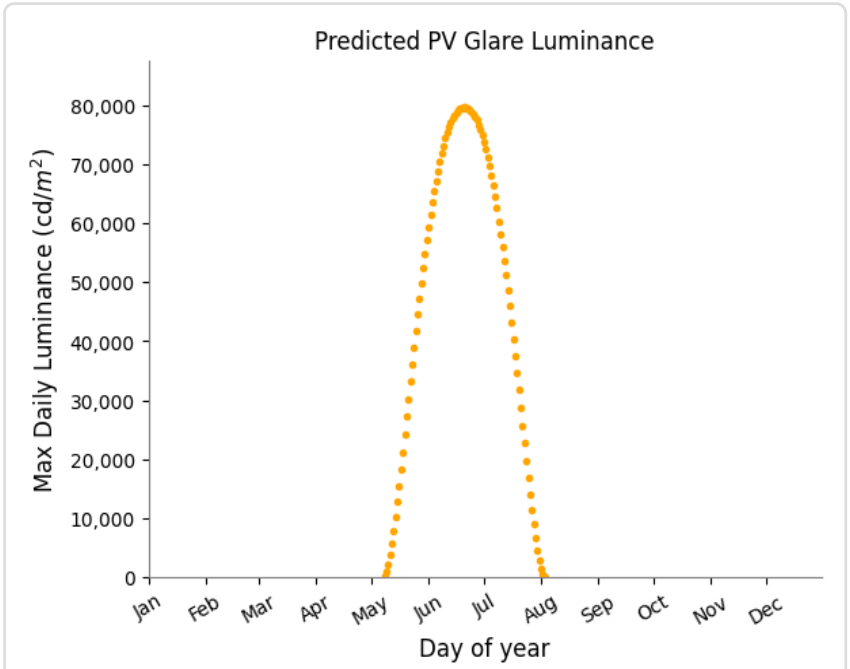
Green glare: 2,332 min.







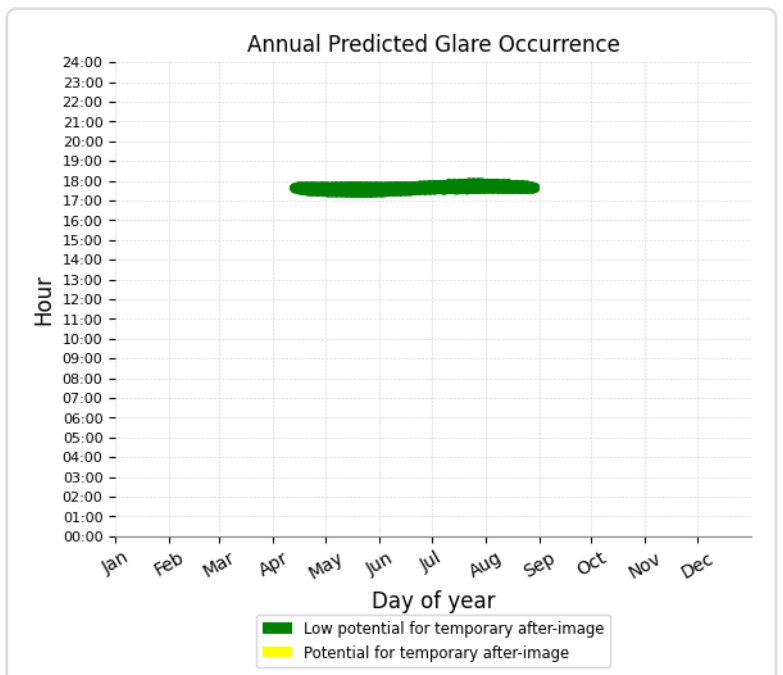


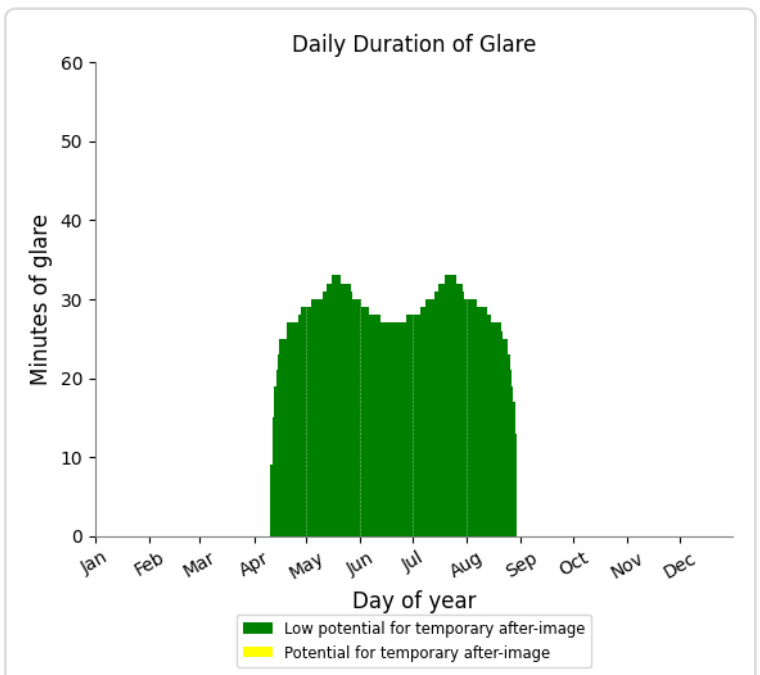


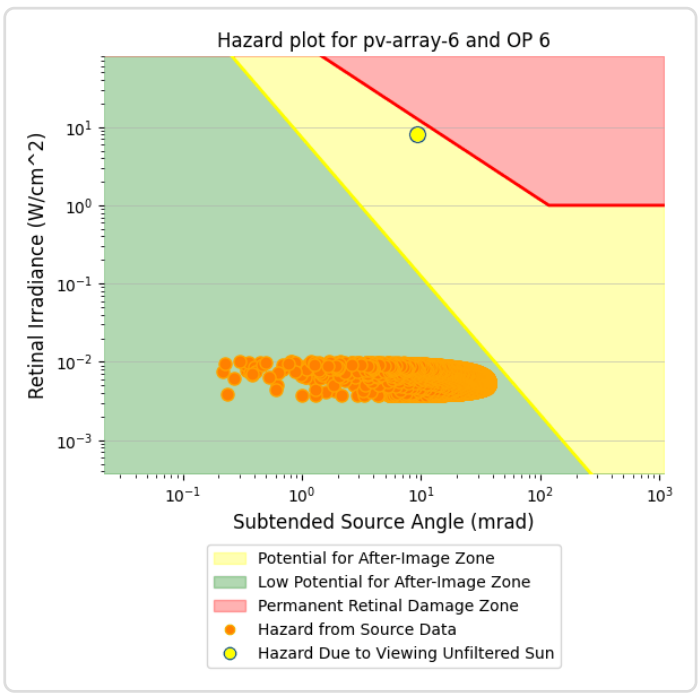
PV array 6 and OP 6

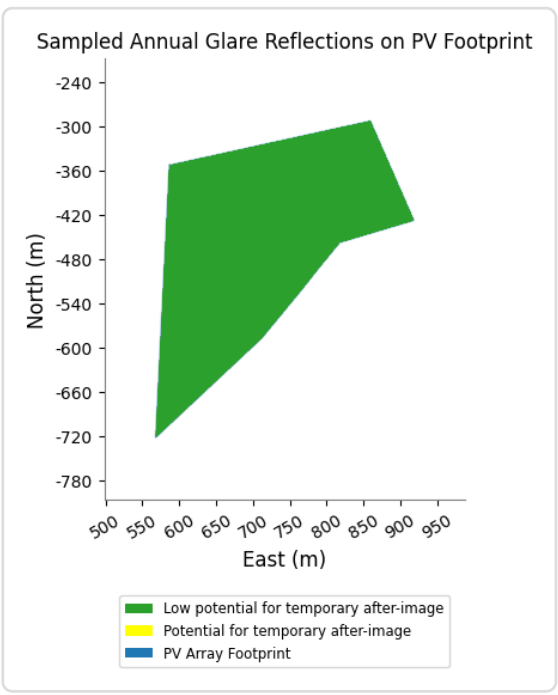
Yellow glare: none

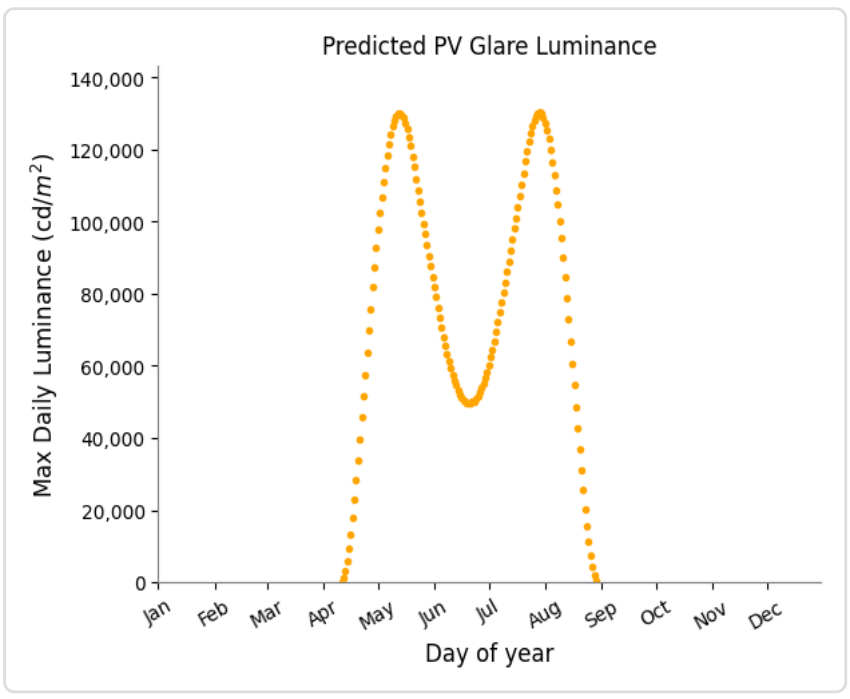
Green glare: 4,005 min.







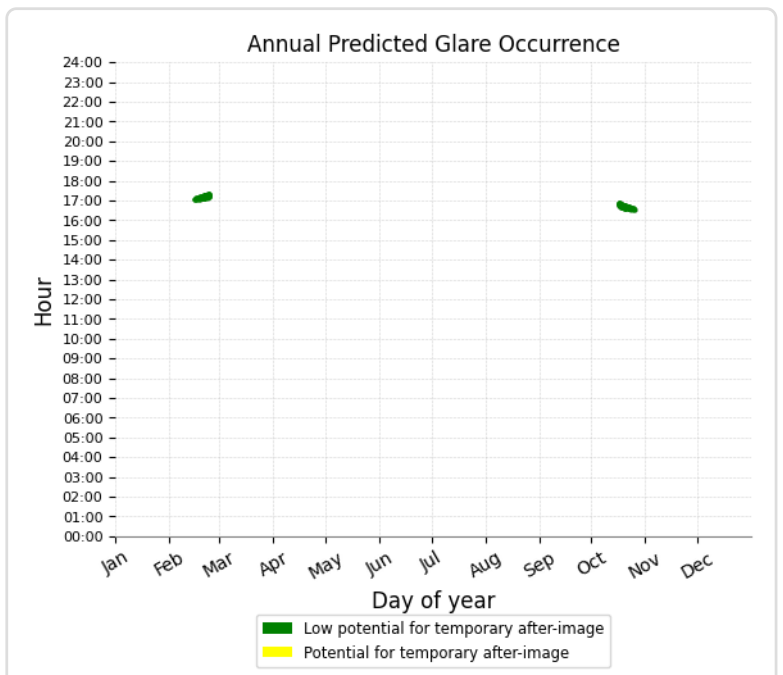


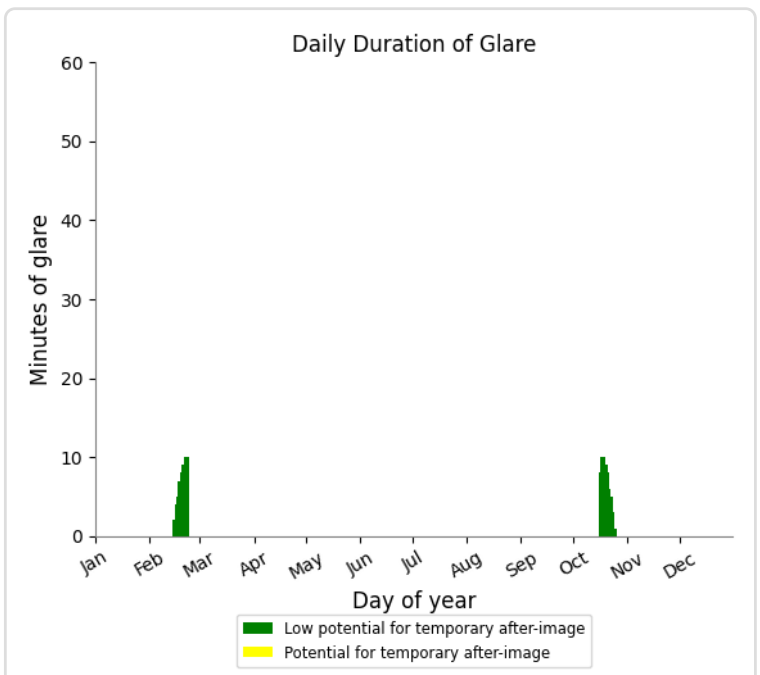


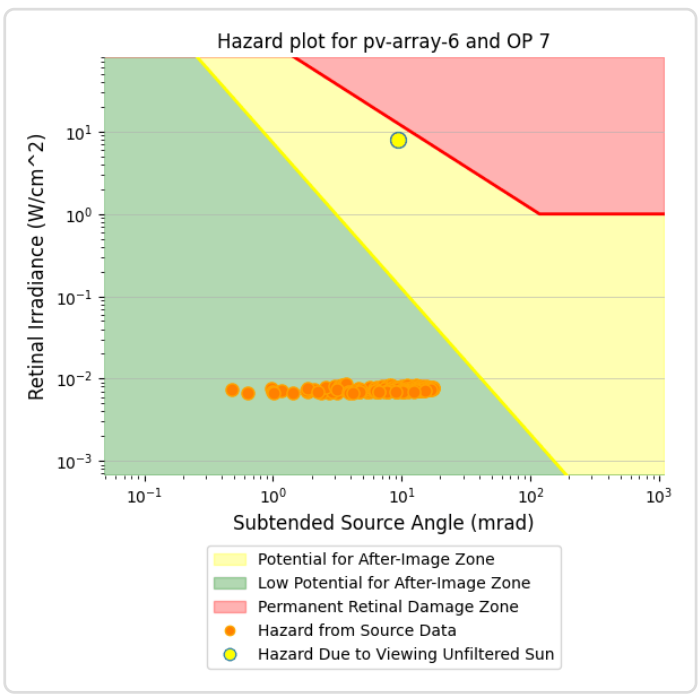
PV array 6 and OP 7

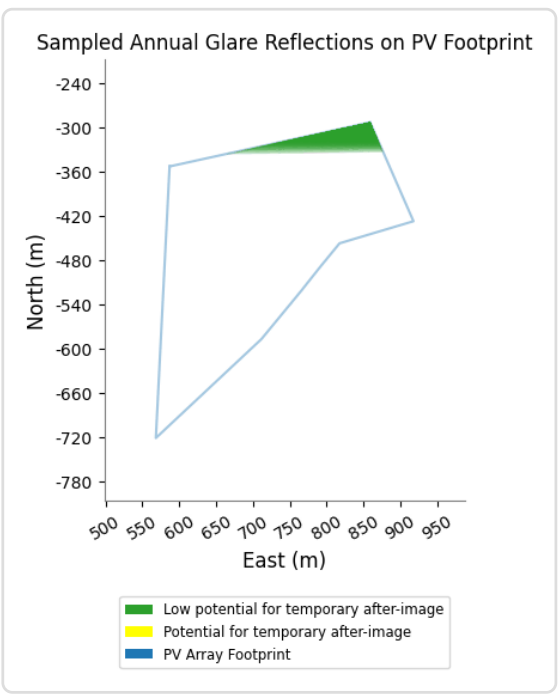
Yellow glare: none

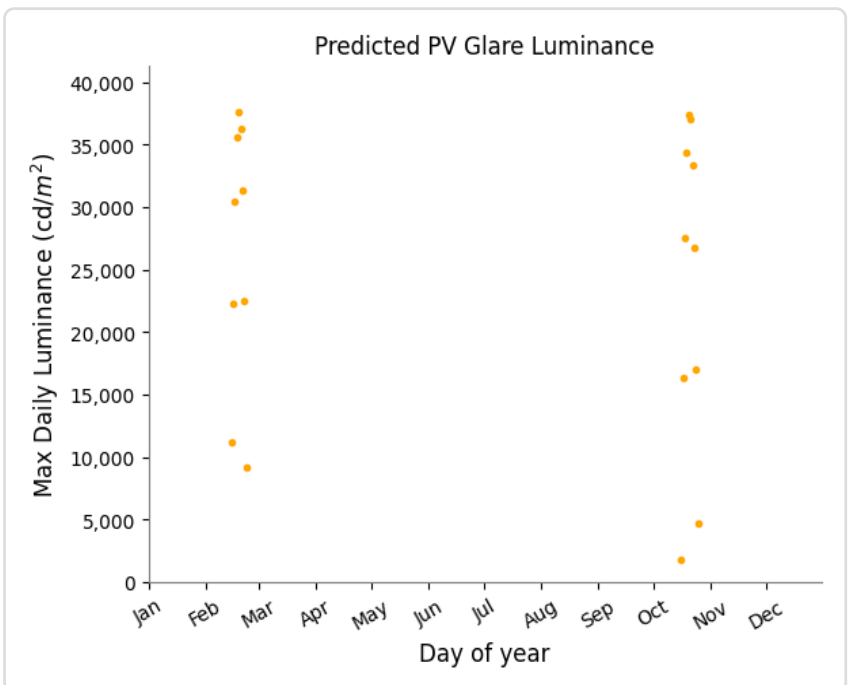
Green glare: 135 min.







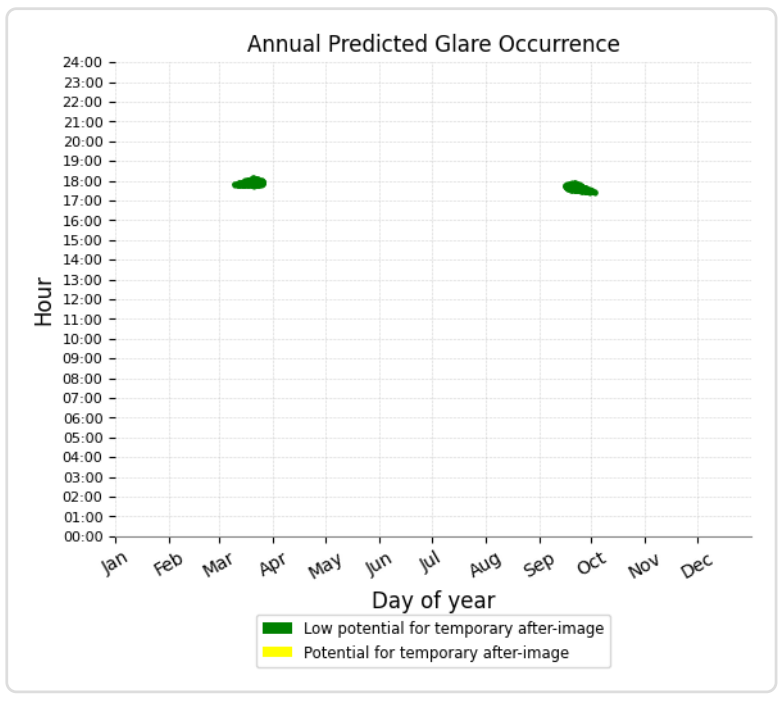


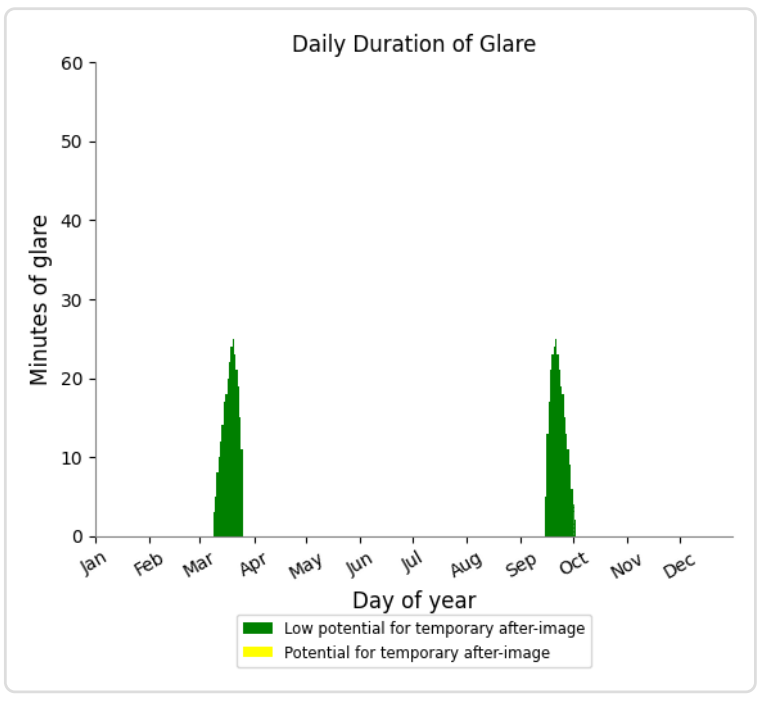


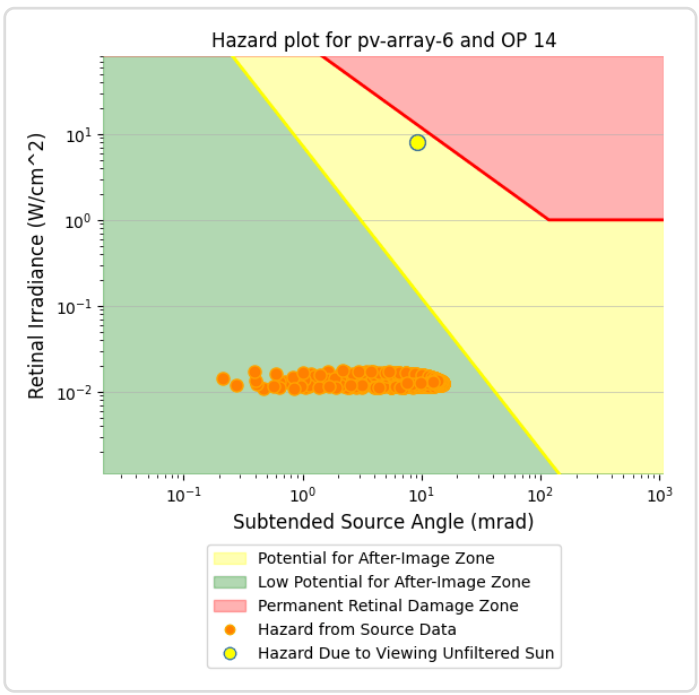
PV array 6 and OP 14

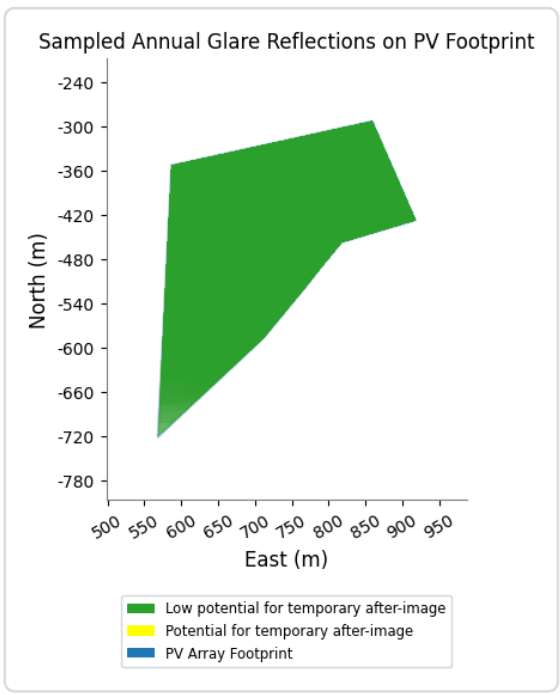
Yellow glare: none

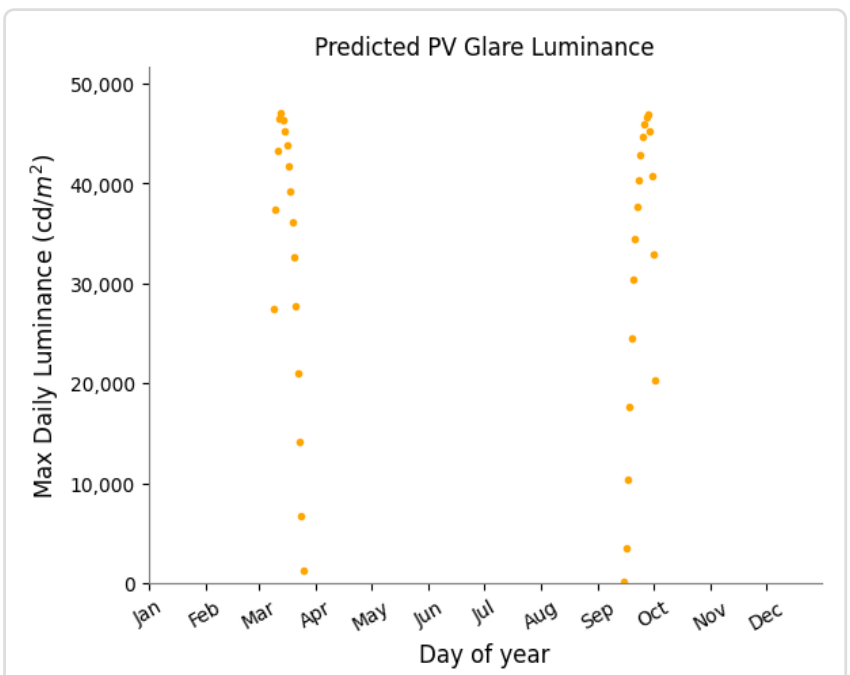
Green glare: 536 min.











PV array 6 and OP 1

No glare found

PV array 6 and OP 2

No glare found

PV array 6 and OP 8

No glare found

PV array 6 and OP 9

No glare found

PV array 6 and OP 10

No glare found

PV array 6 and OP 11

No glare found

PV array 6 and OP 12

No glare found

PV array 6 and OP 13

No glare found

PV array 6 and OP 15

No glare found

PV array 6 and OP 16

No glare found

PV array 6 and OP 17

No glare found

PV array 6 and OP 18

No glare found

PV array 6 and OP 19

No glare found

PV array 6 and OP 20

No glare found

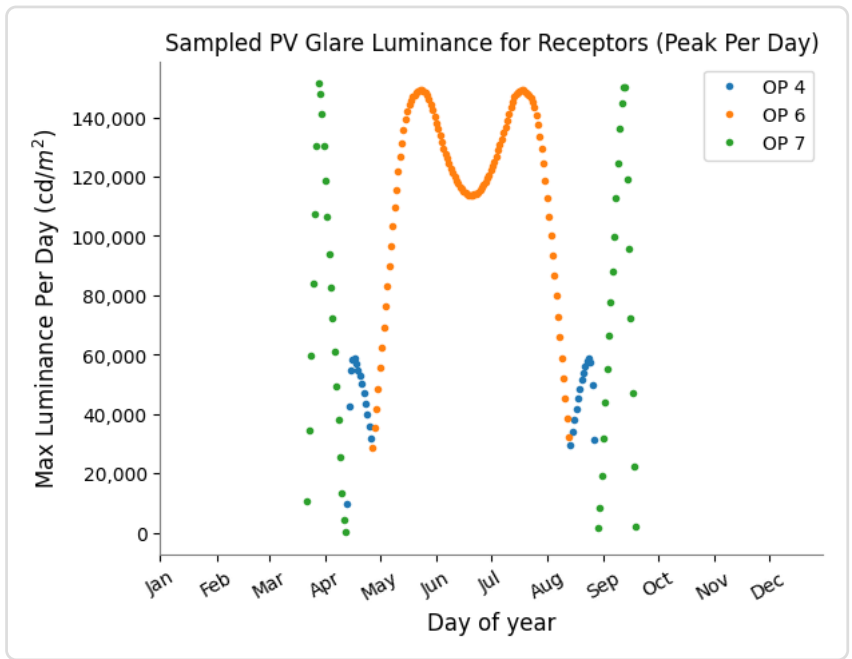
PV array 6 and OP 21

No glare found

PV: PV array 7 low potential for temporary after-image

Receptor results ordered by category of glare

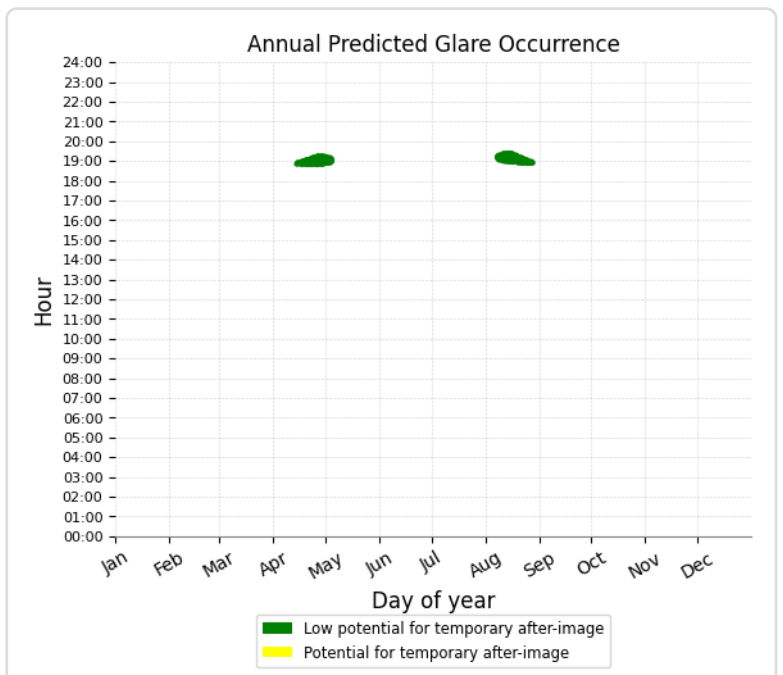
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 4	655	10.9	0	0.0	58,678
OP 5	2,476	41.3	0	0.0	113,612
OP 6	3,516	58.6	0	0.0	149,350
OP 7	704	11.7	0	0.0	151,369
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

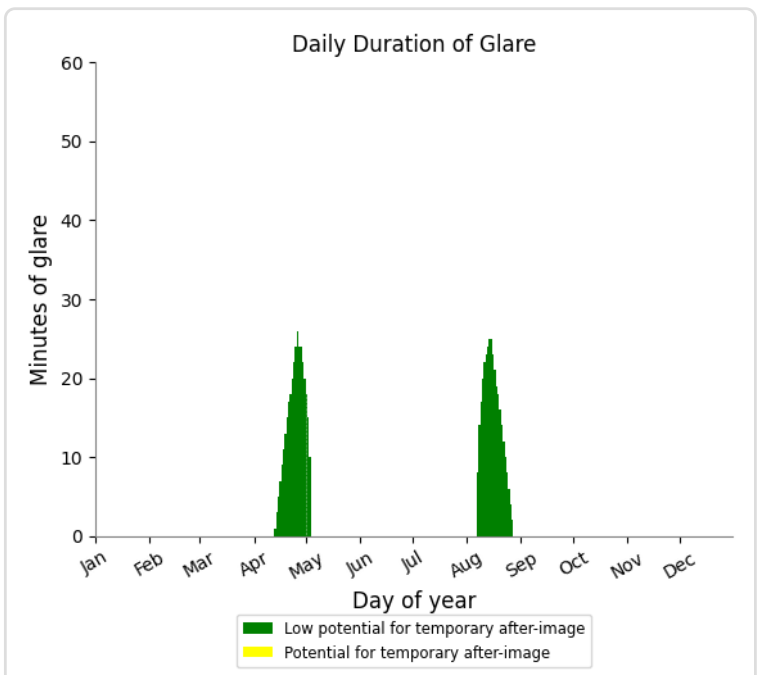


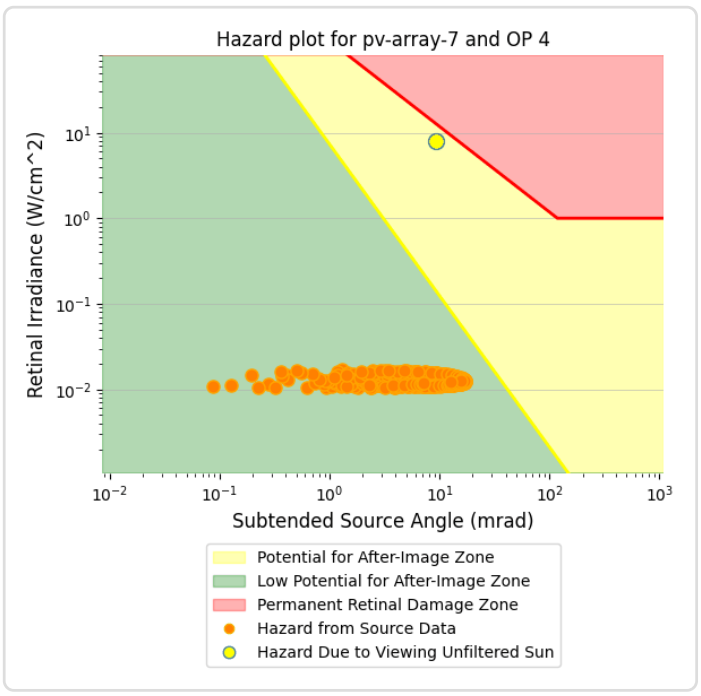
PV array 7 and OP 4

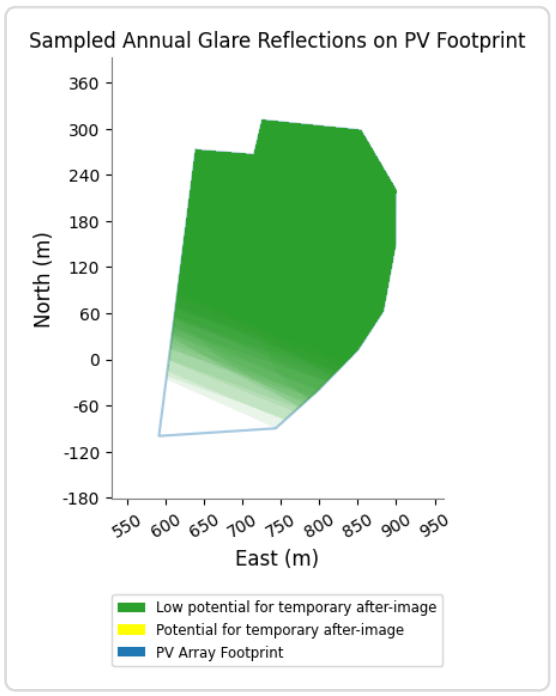
Yellow glare: none

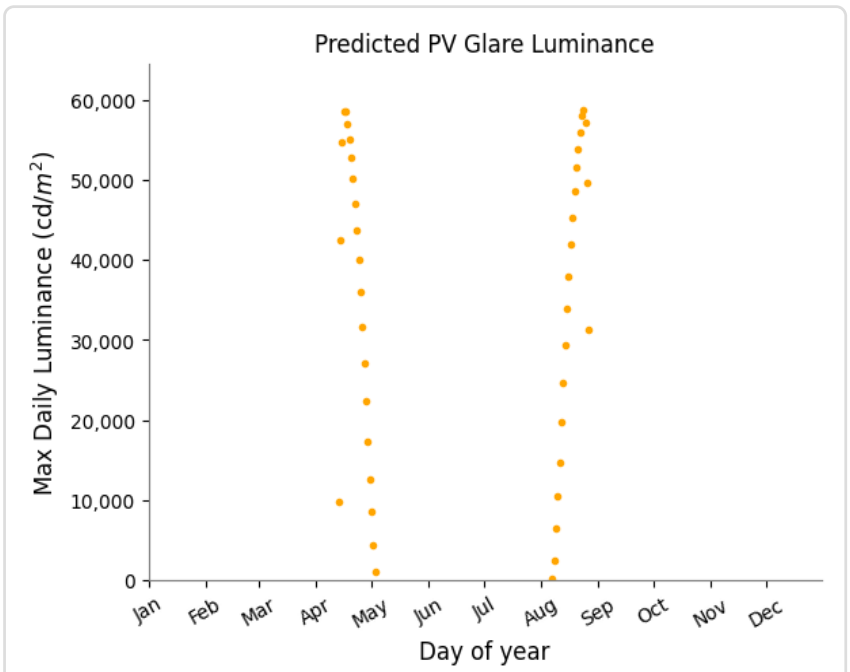
Green glare: 655 min.







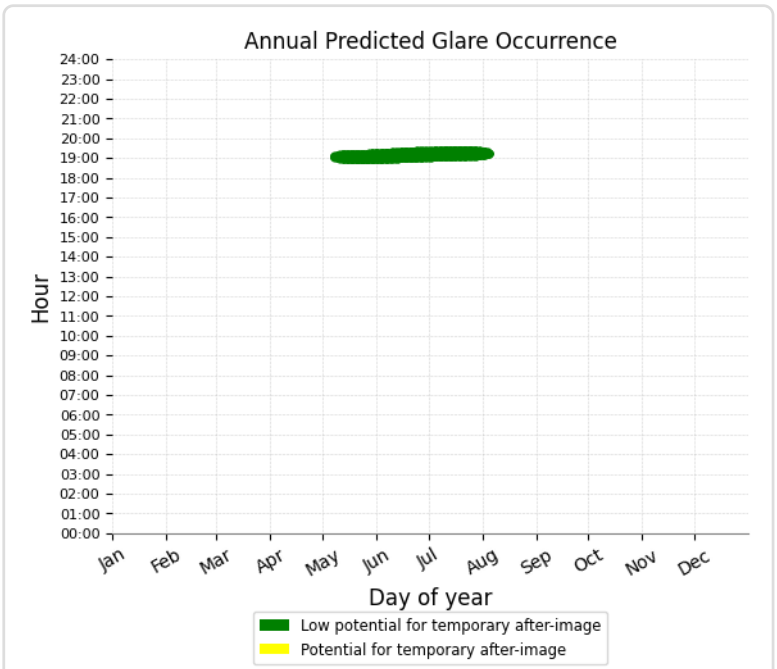


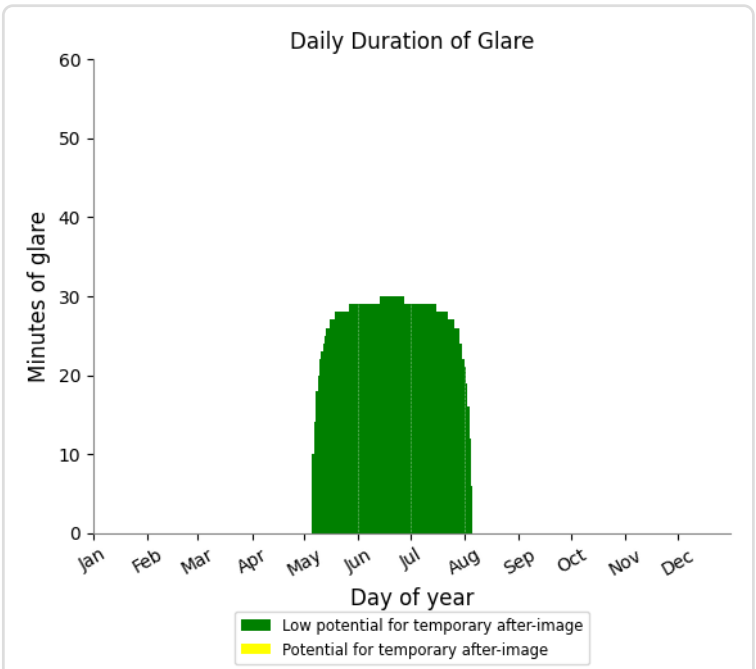


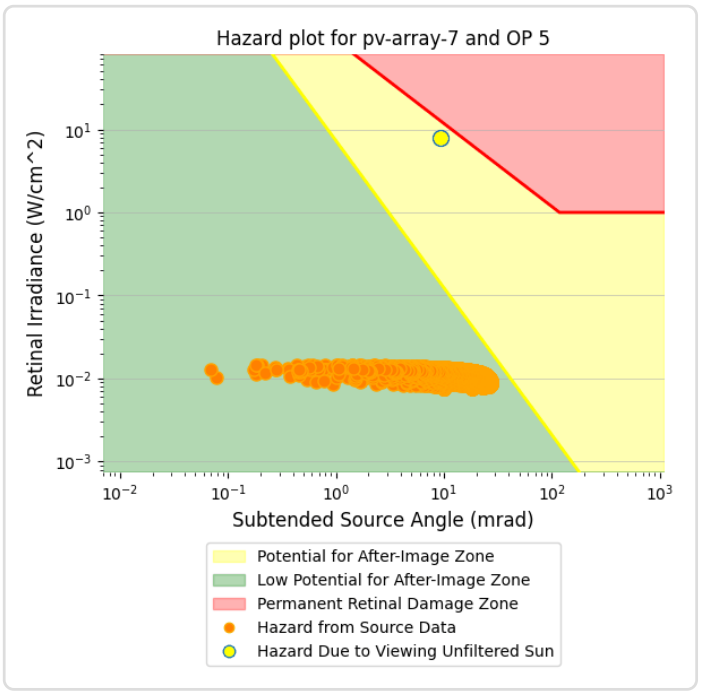
PV array 7 and OP 5

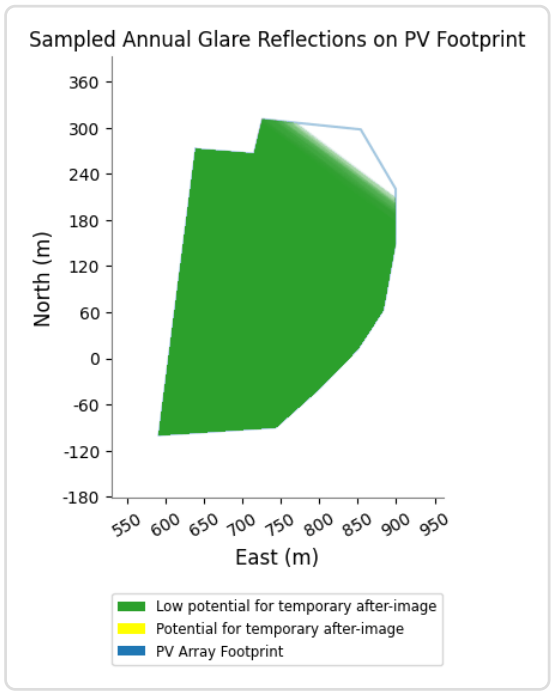
Yellow glare: none

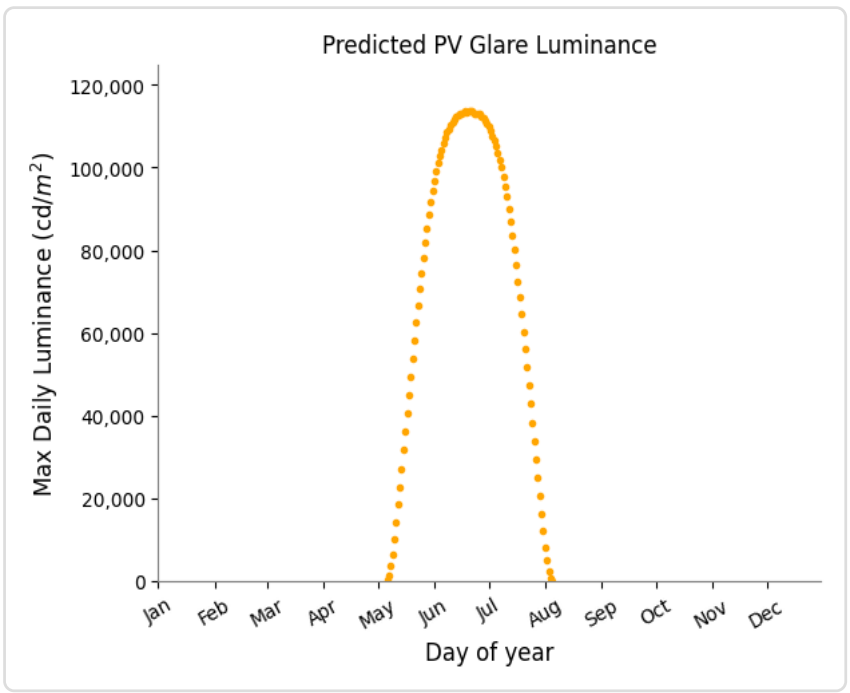
Green glare: 2,476 min.







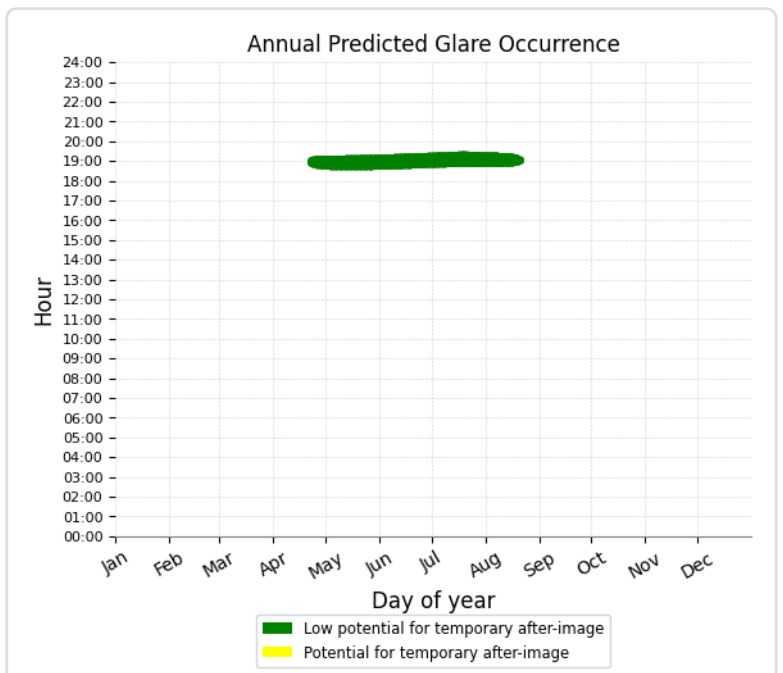


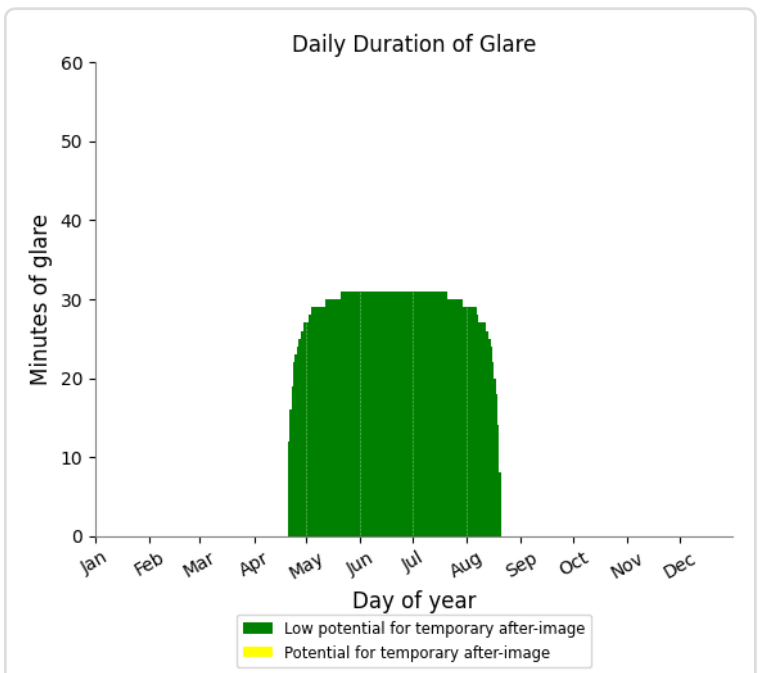


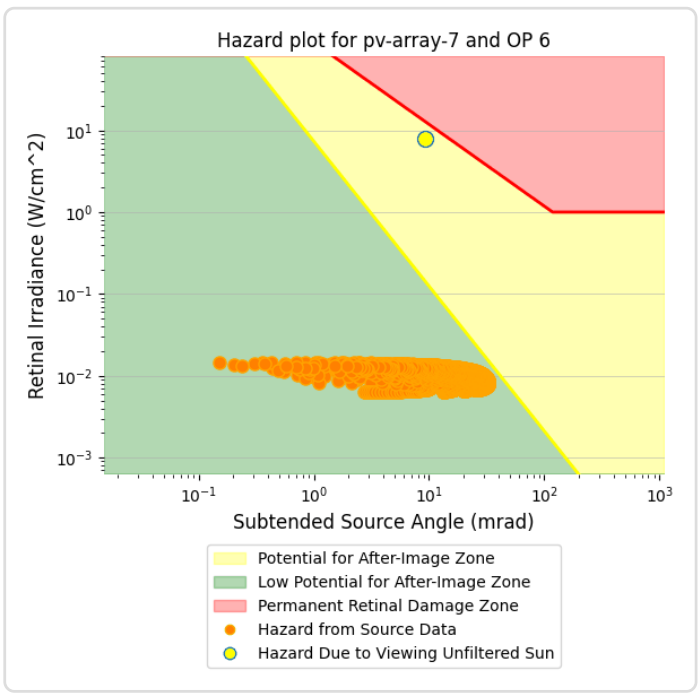
PV array 7 and OP 6

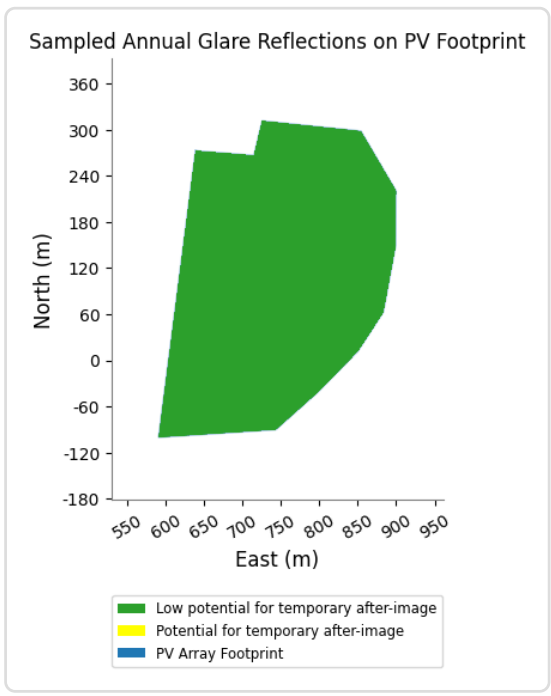
Yellow glare: none

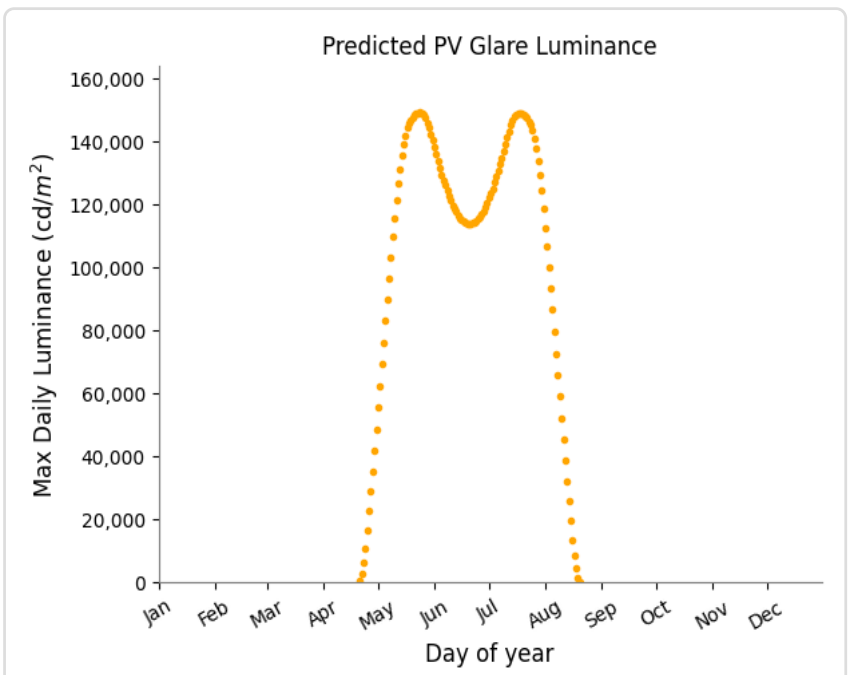
Green glare: 3,516 min.







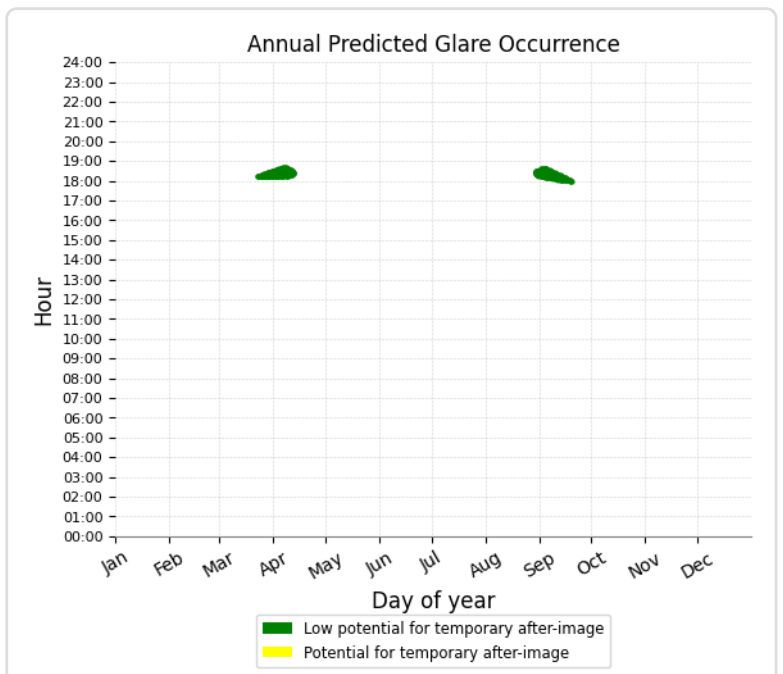


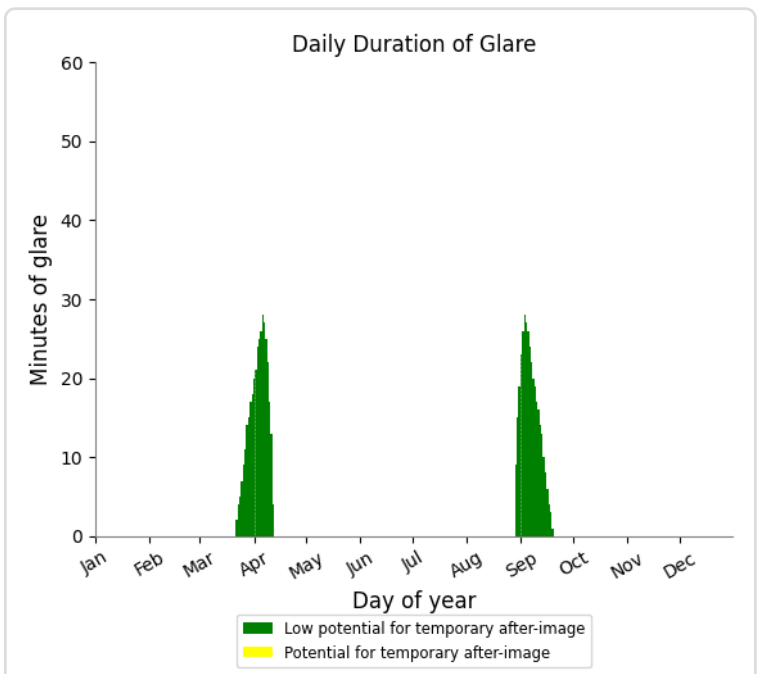


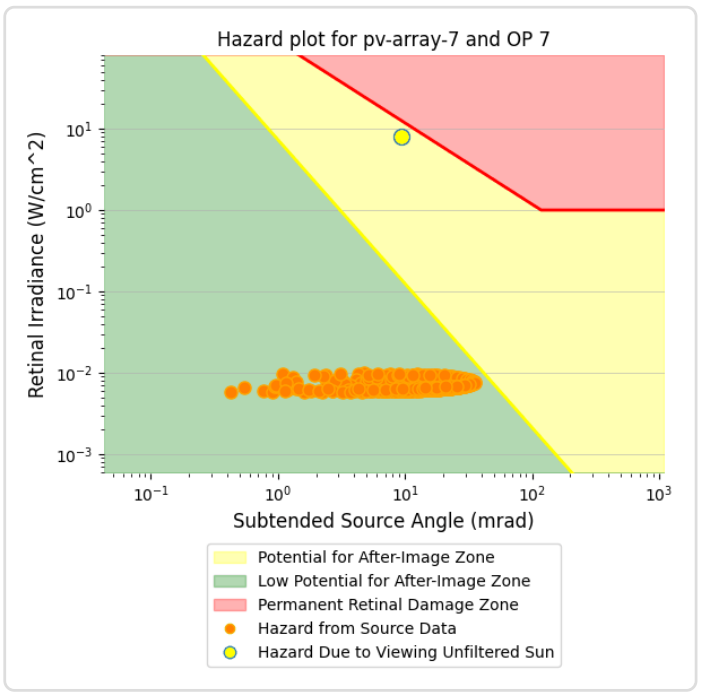
PV array 7 and OP 7

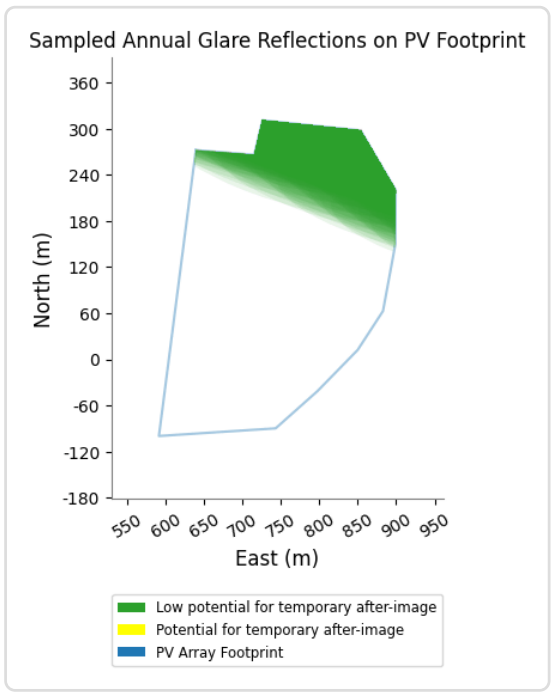
Yellow glare: none

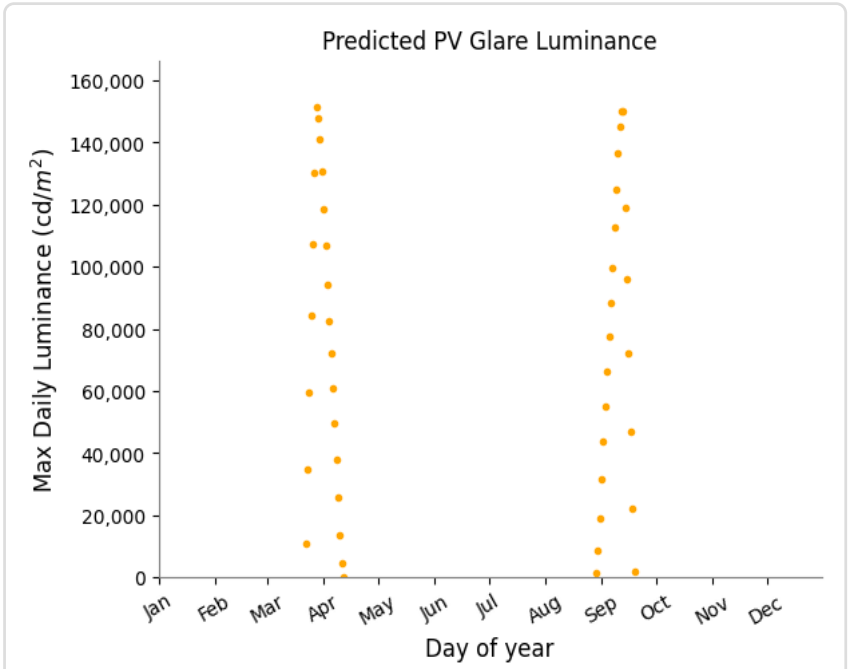
Green glare: 704 min.











PV array 7 and OP 1

No glare found

PV array 7 and OP 2

No glare found

PV array 7 and OP 3

No glare found

PV array 7 and OP 8

No glare found

PV array 7 and OP 9

No glare found

PV array 7 and OP 10

No glare found

PV array 7 and OP 11

No glare found

PV array 7 and OP 12

No glare found

PV array 7 and OP 13

No glare found

PV array 7 and OP 14

No glare found

PV array 7 and OP 15

No glare found

PV array 7 and OP 16

No glare found

PV array 7 and OP 17

No glare found

PV array 7 and OP 18

No glare found

PV array 7 and OP 19

No glare found

PV array 7 and OP 20

No glare found

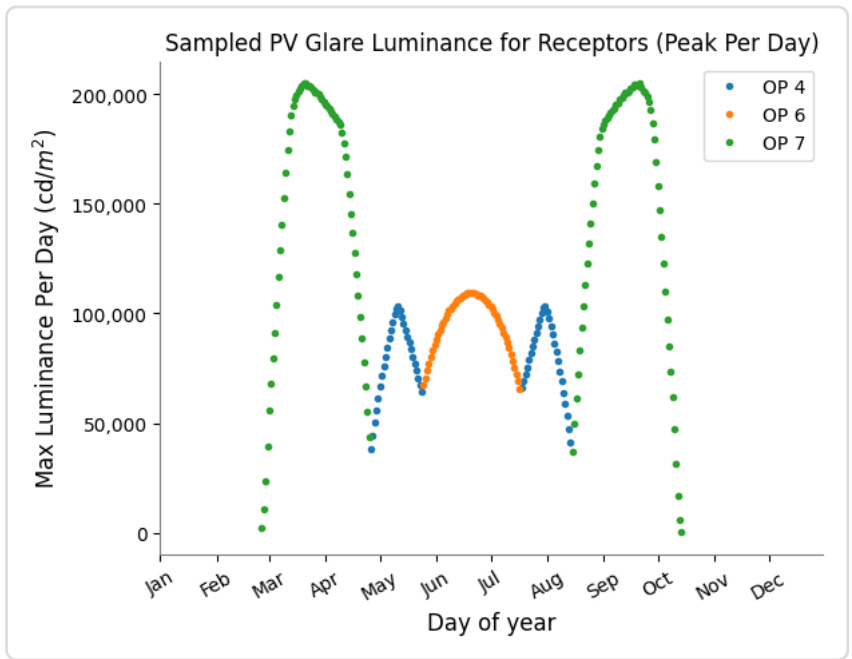
PV array 7 and OP 21

No glare found

PV: PV array 8 low potential for temporary after-image

Receptor results ordered by category of glare

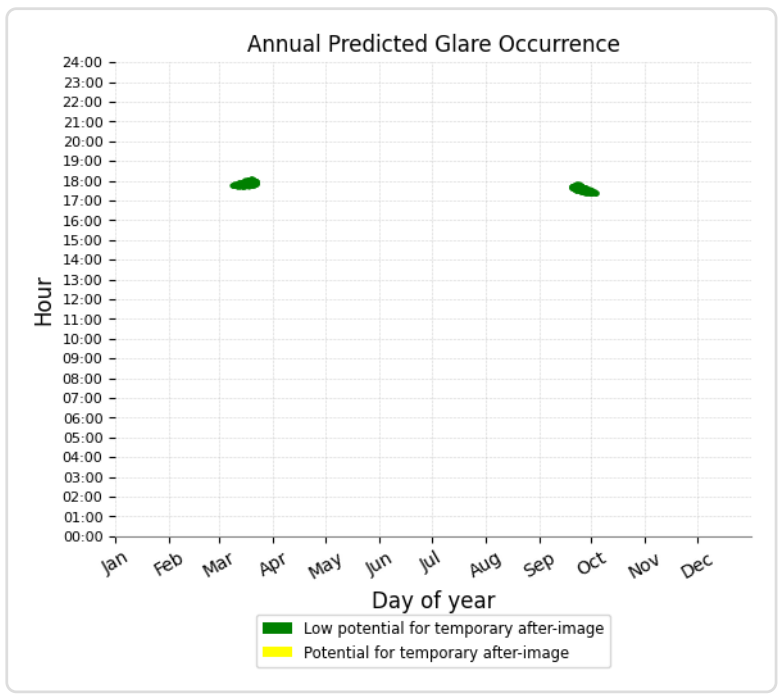
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	393	6.5	0	0.0	55,037
OP 3	1,528	25.5	0	0.0	88,787
OP 4	3,142	52.4	0	0.0	103,021
OP 5	25	0.4	0	0.0	39
OP 6	2,213	36.9	0	0.0	109,285
OP 7	3,704	61.7	0	0.0	204,795
OP 14	1,369	22.8	0	0.0	81,017
OP 15	564	9.4	0	0.0	44,774
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

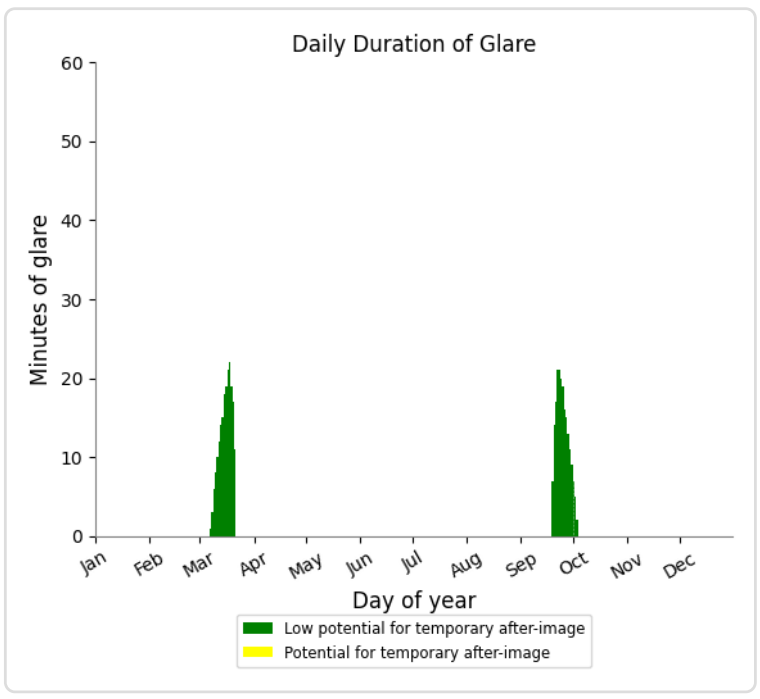


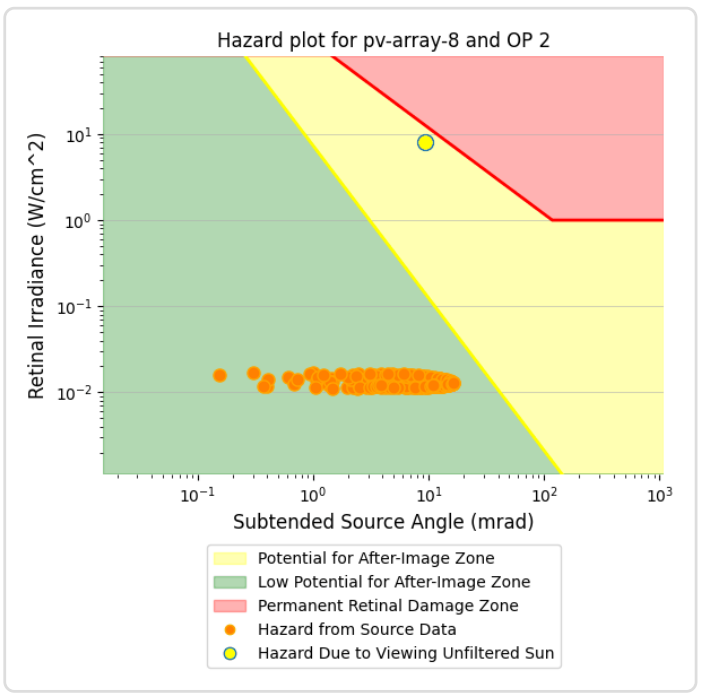
PV array 8 and OP 2

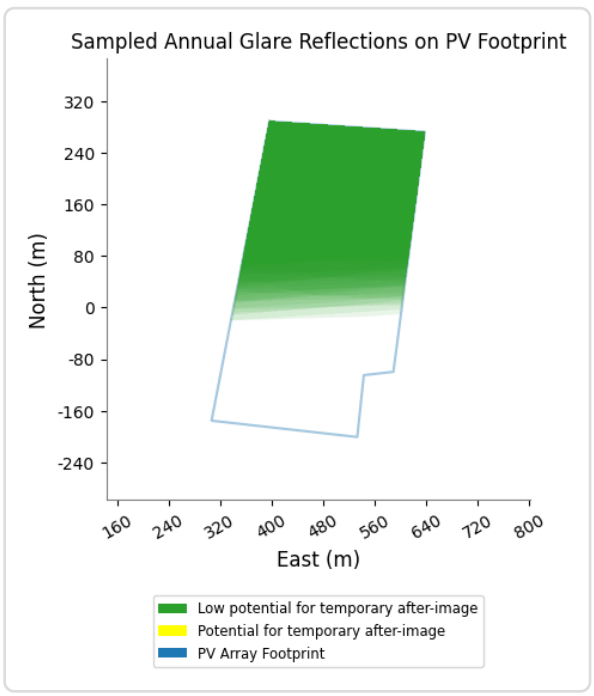
Yellow glare: none

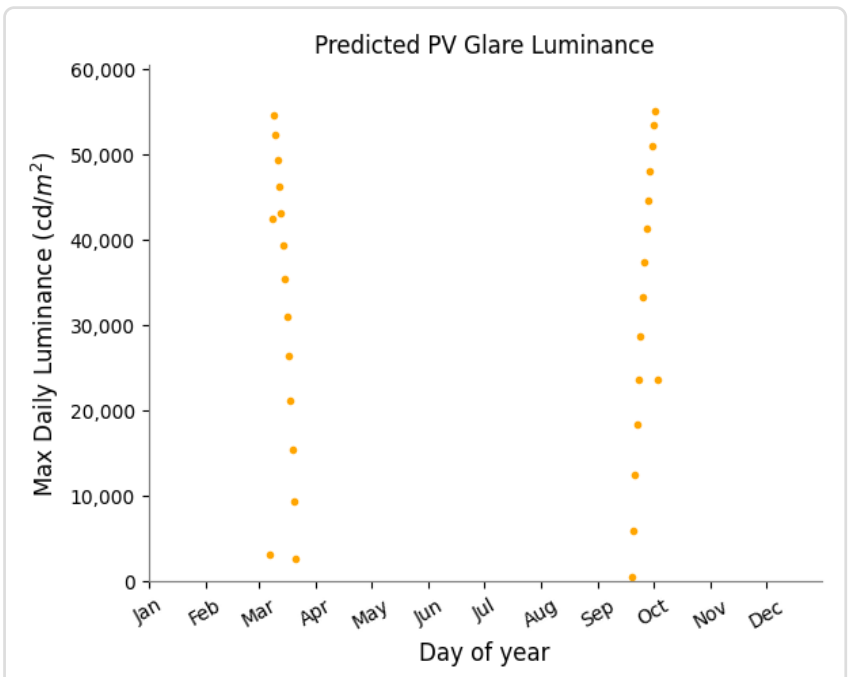
Green glare: 393 min.







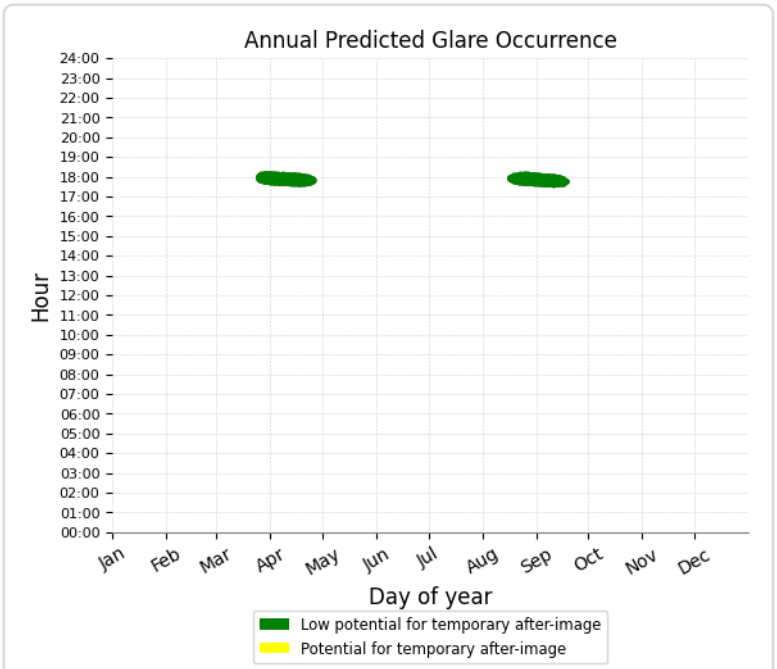


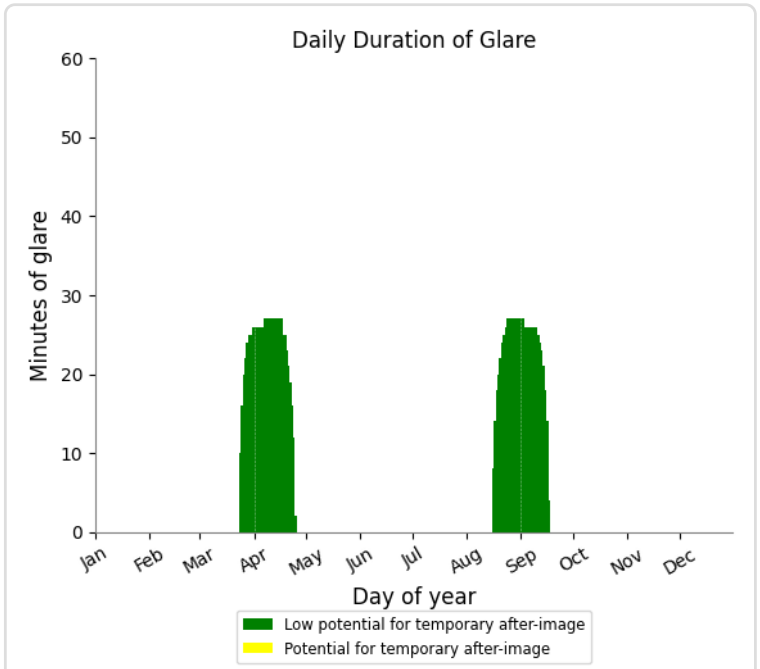


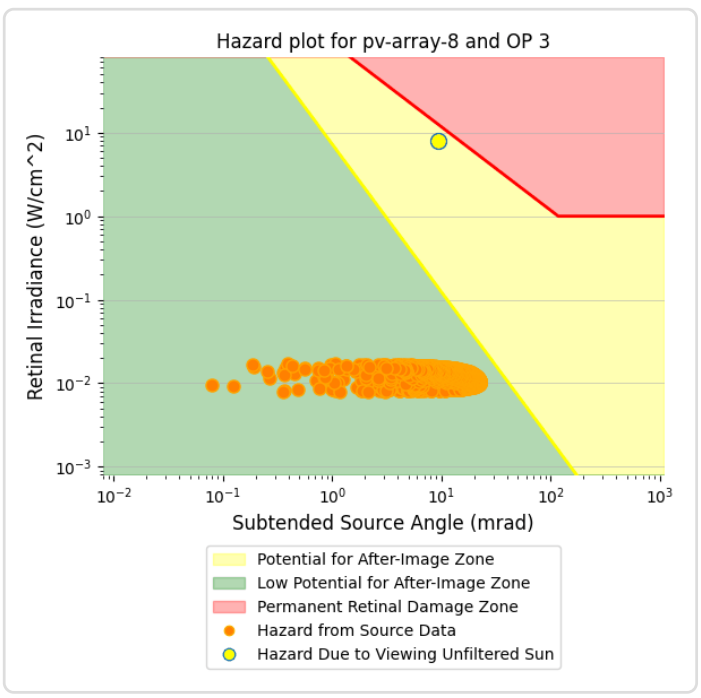
PV array 8 and OP 3

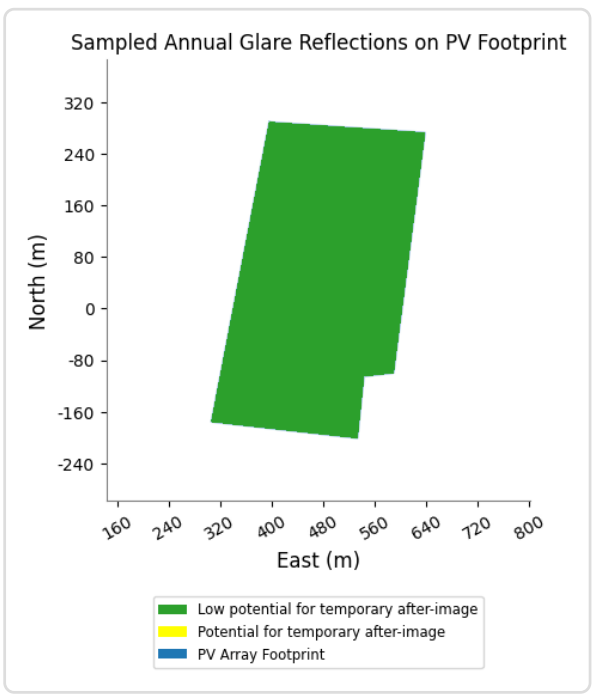
Yellow glare: none

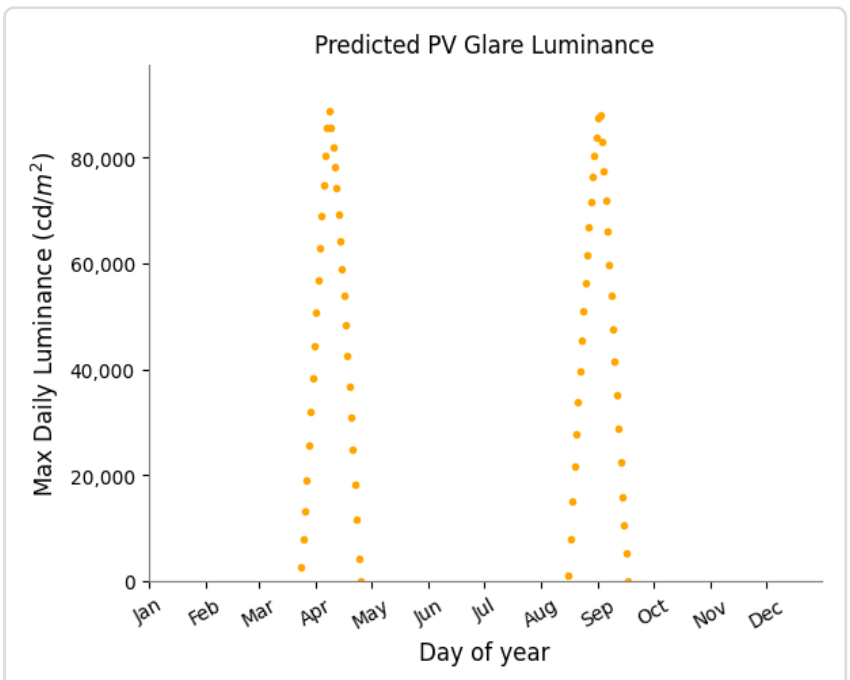
Green glare: 1,528 min.







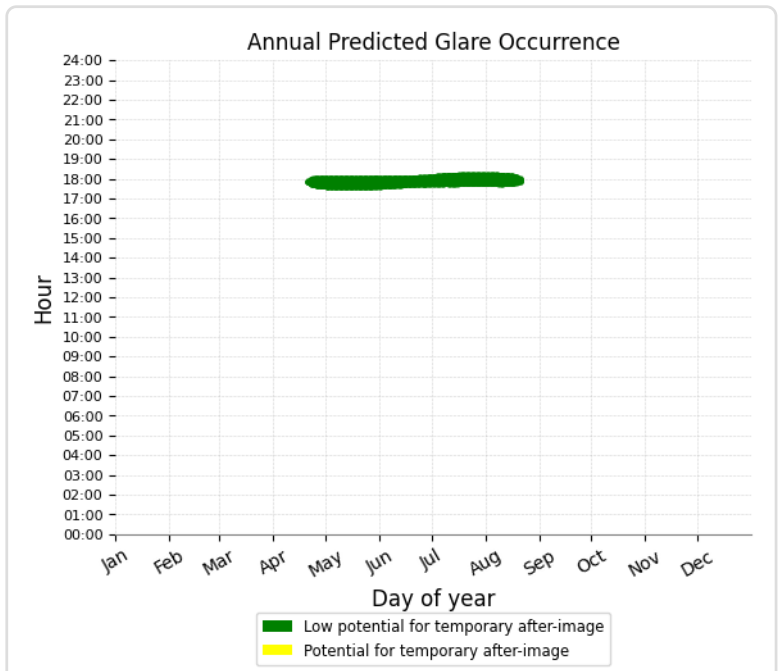


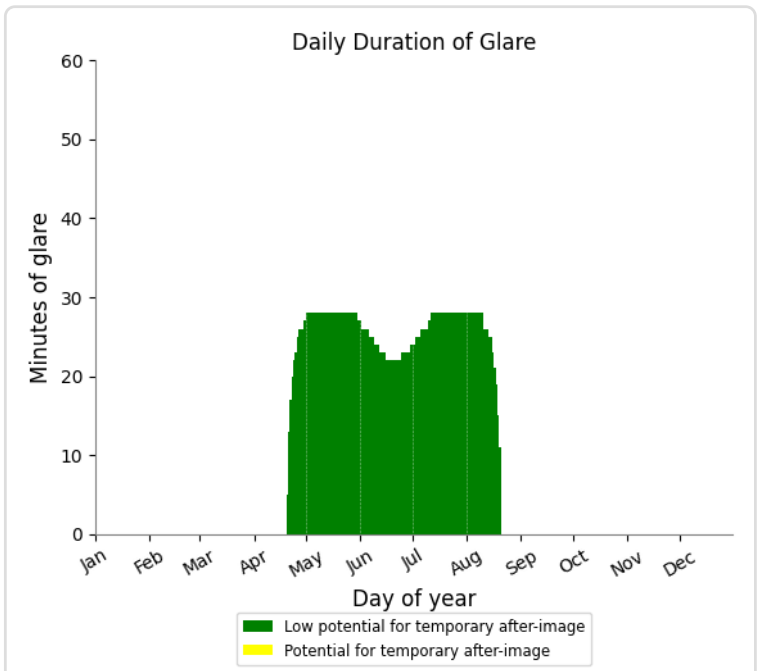


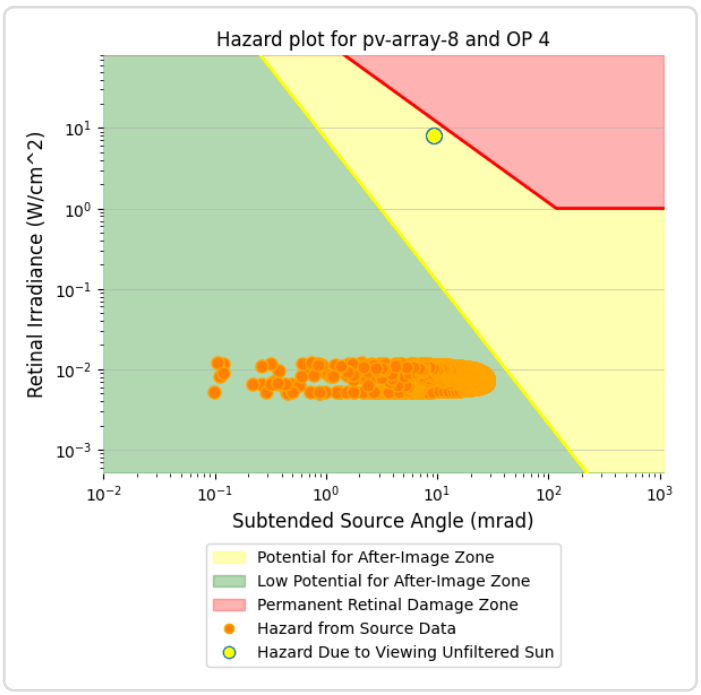
PV array 8 and OP 4

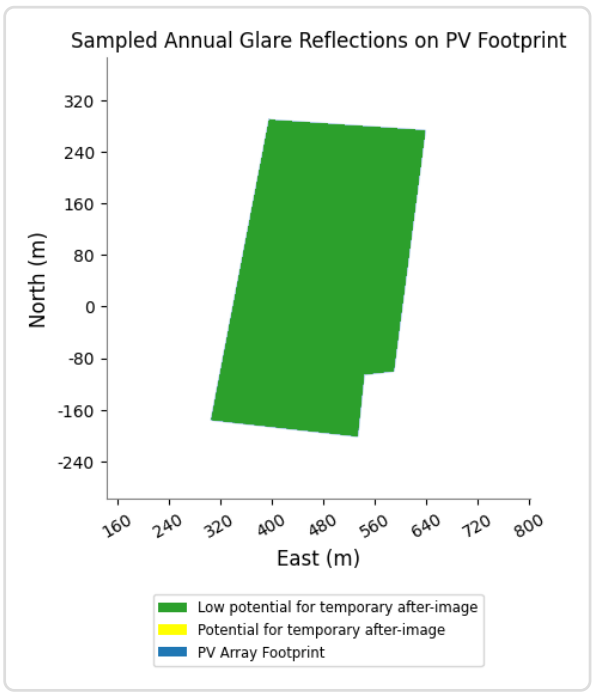
Yellow glare: none

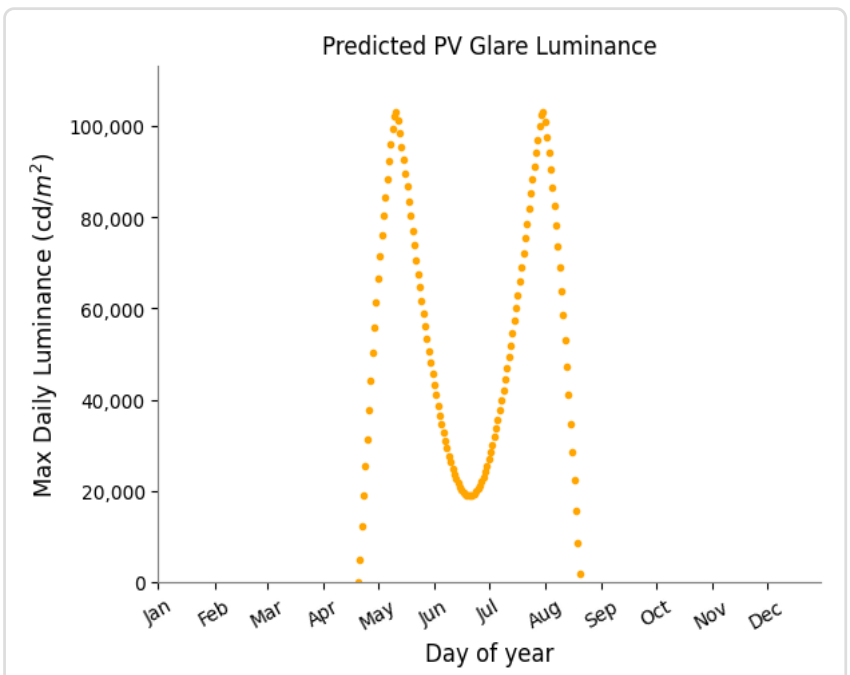
Green glare: 3,142 min.







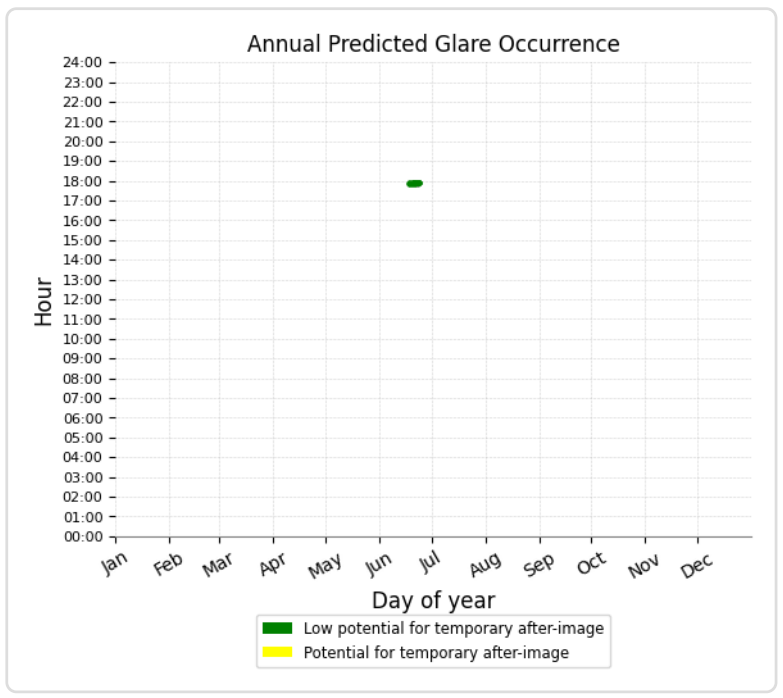


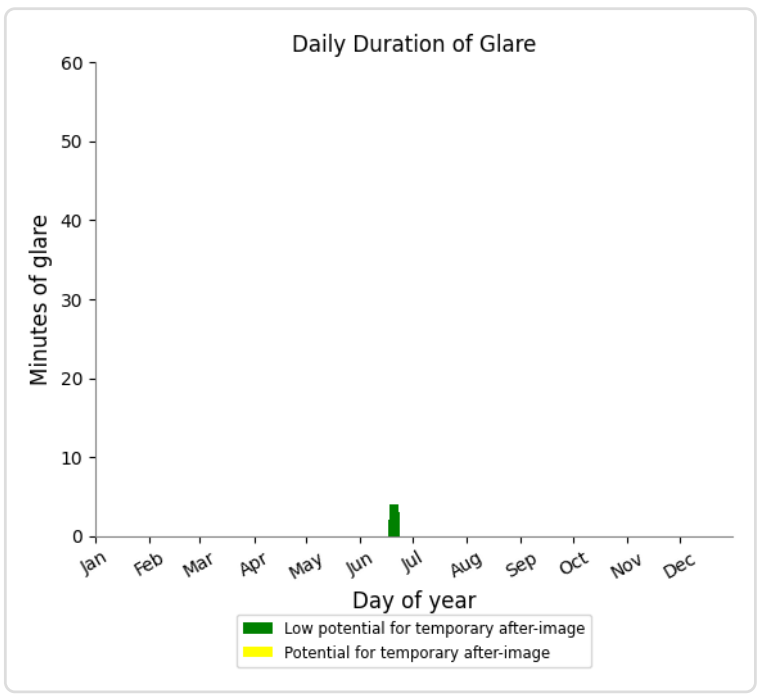


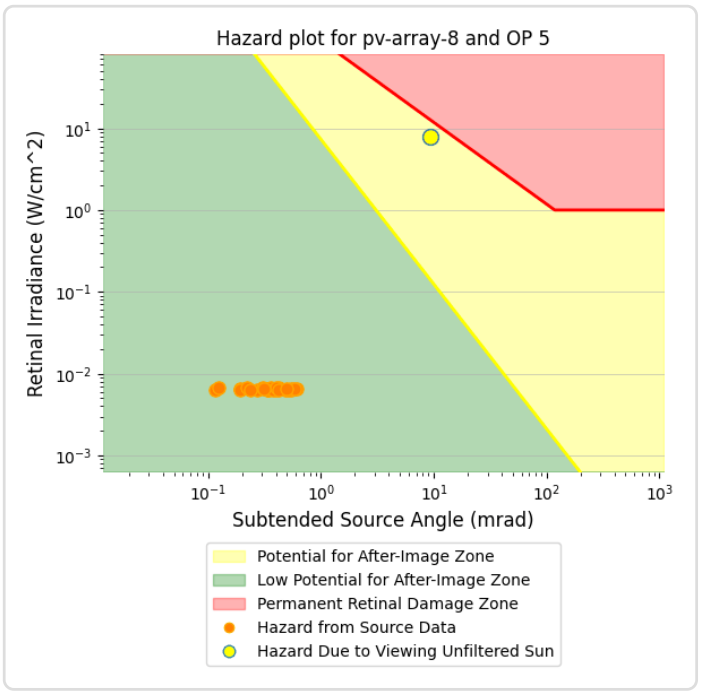
PV array 8 and OP 5

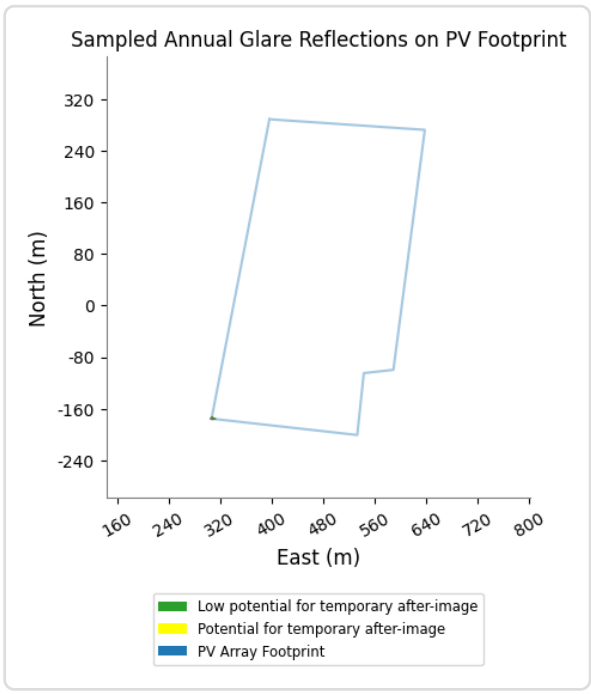
Yellow glare: none

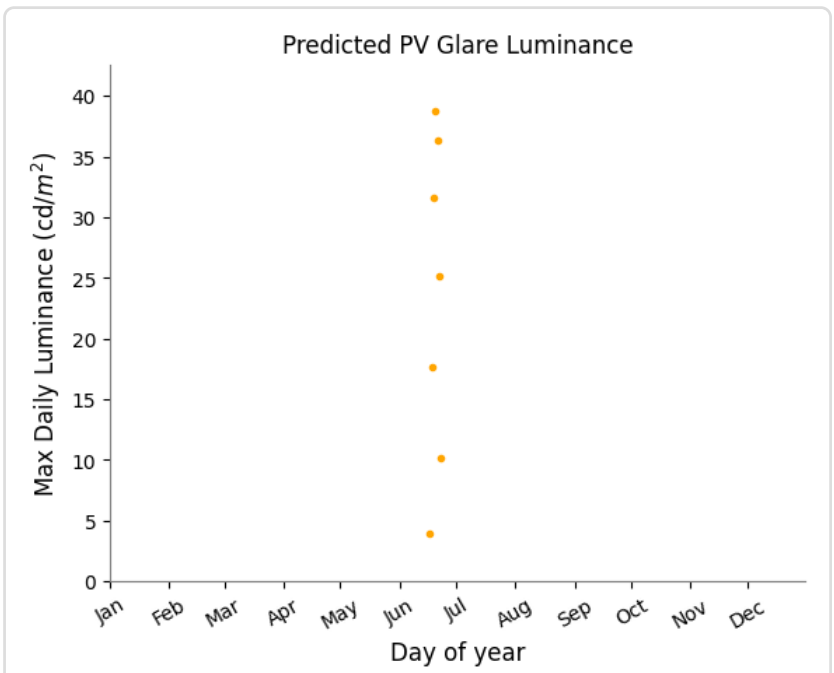
Green glare: 25 min.







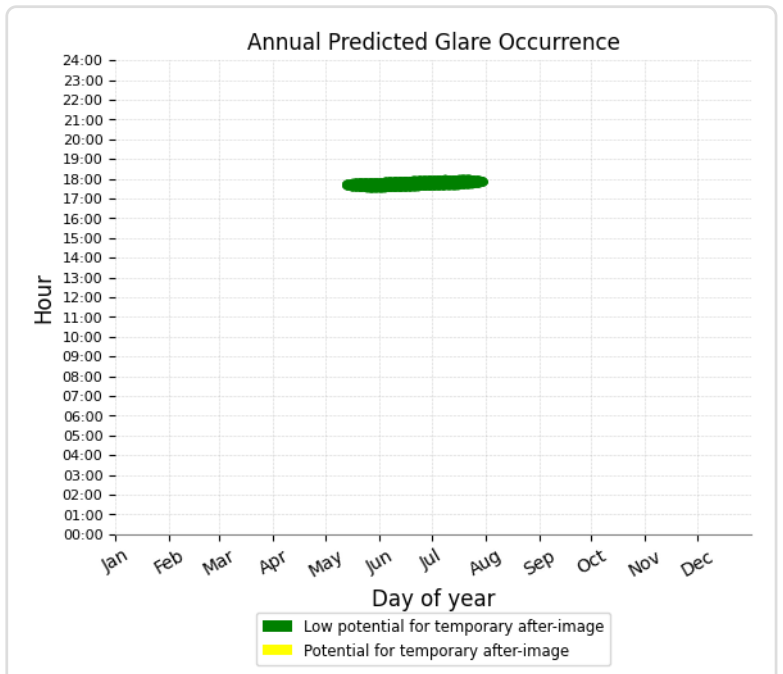


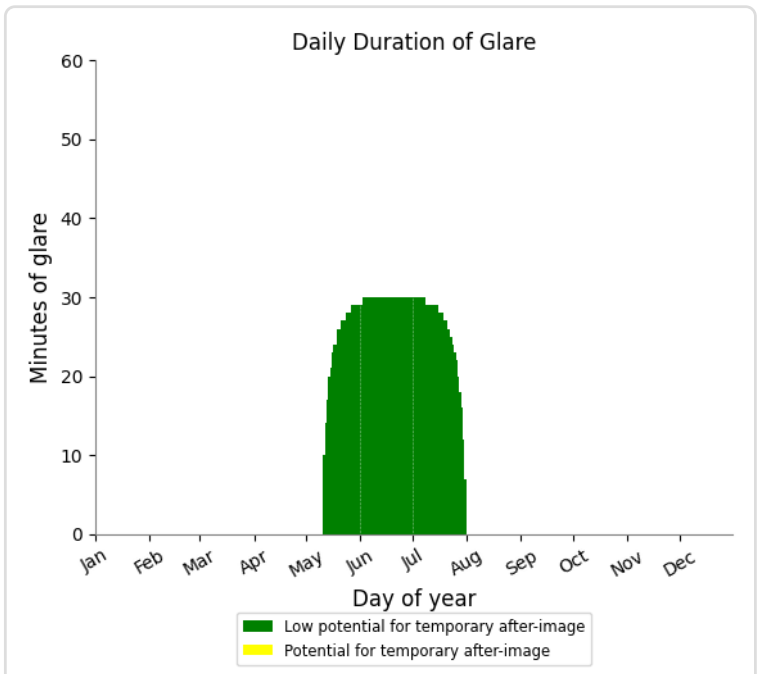


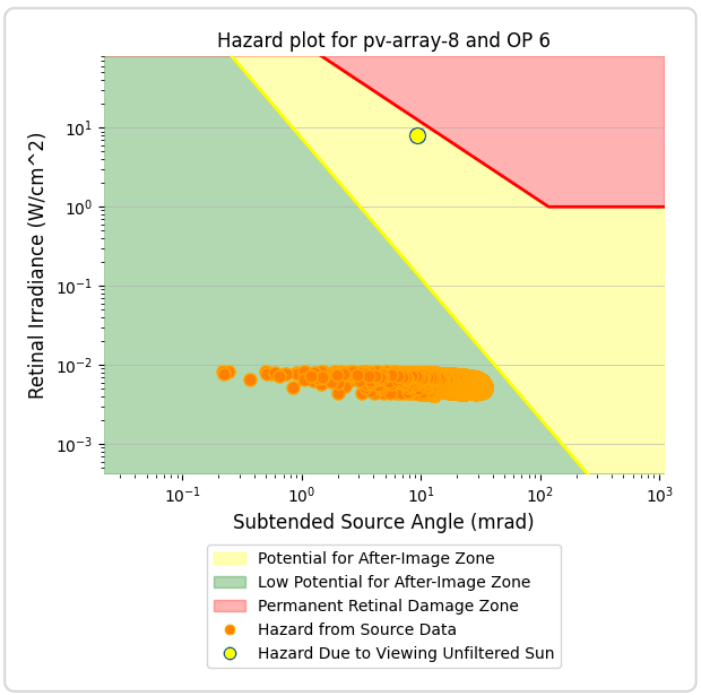
PV array 8 and OP 6

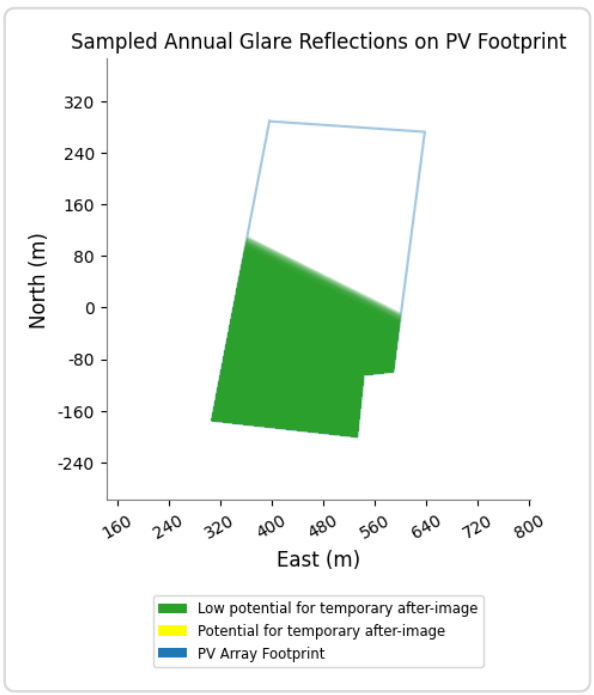
Yellow glare: none

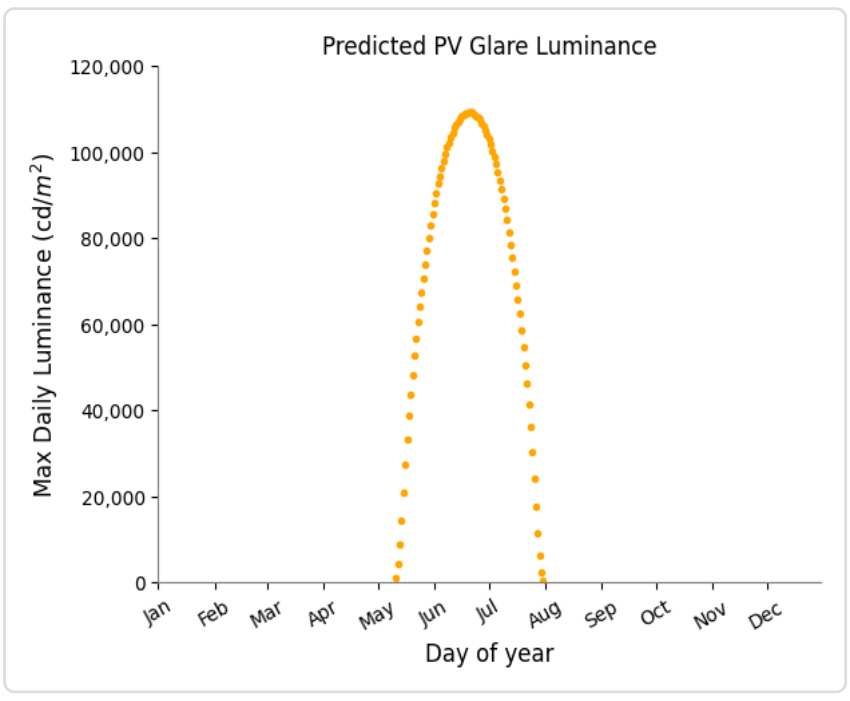
Green glare: 2,213 min.







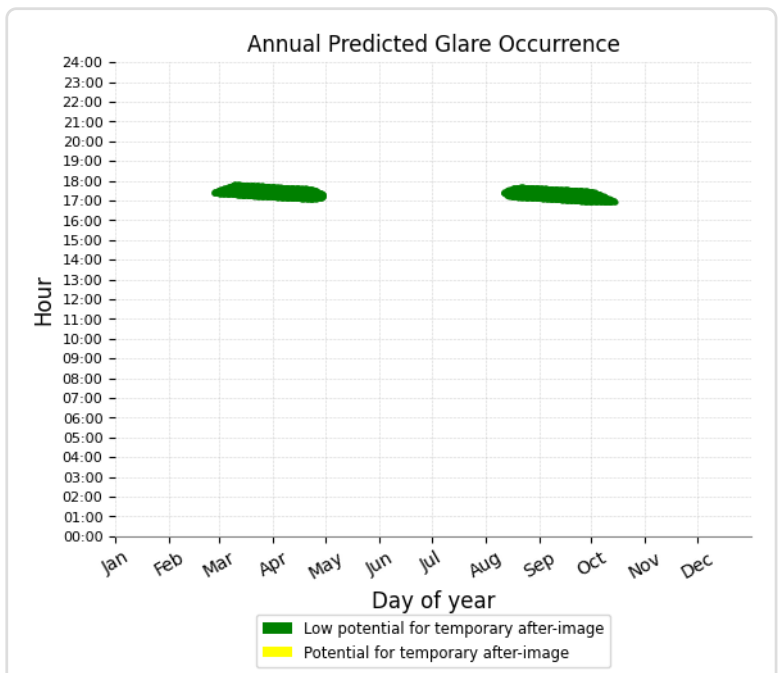


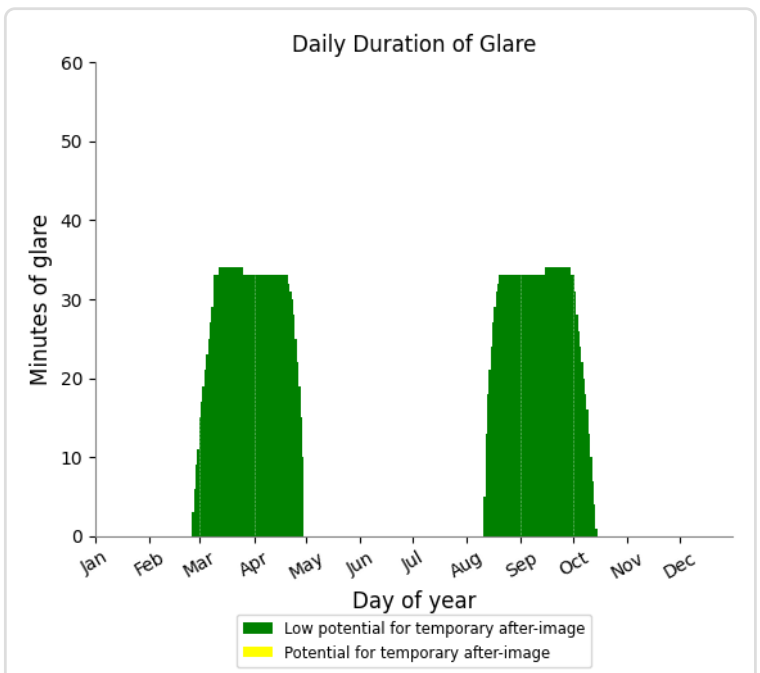


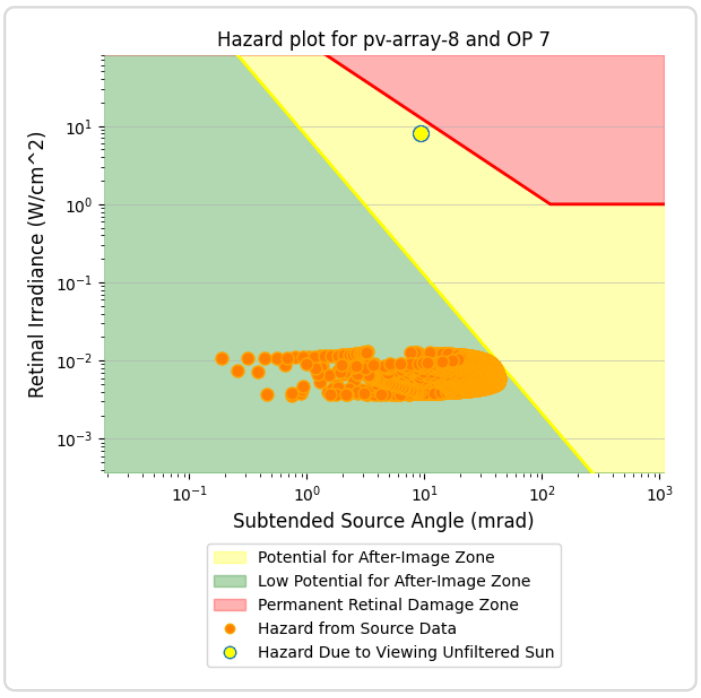
PV array 8 and OP 7

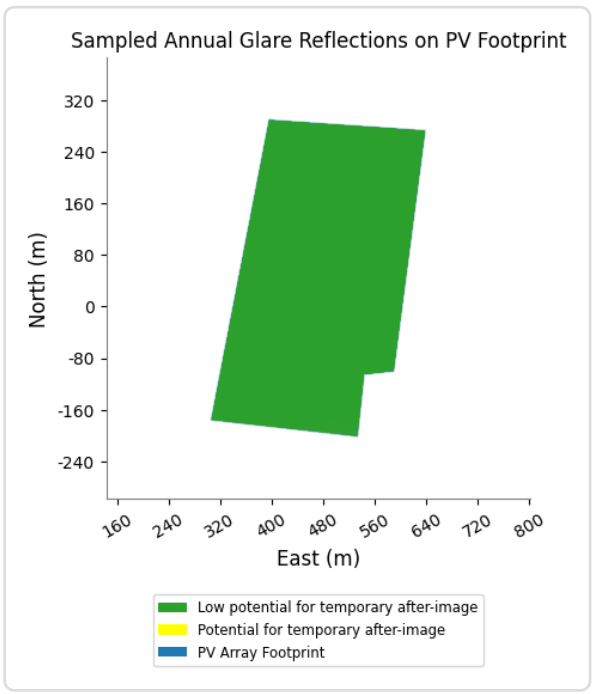
Yellow glare: none

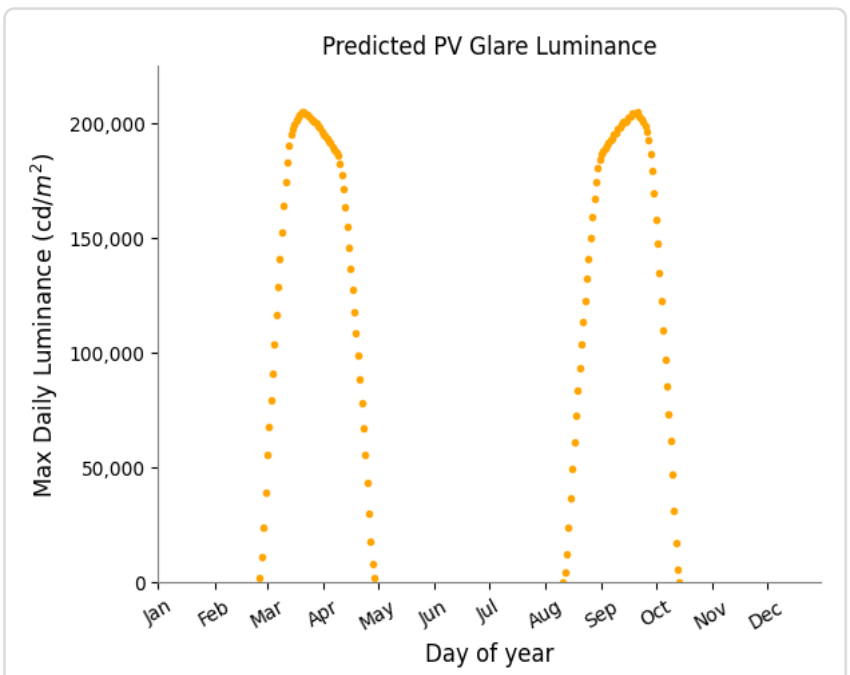
Green glare: 3,704 min.







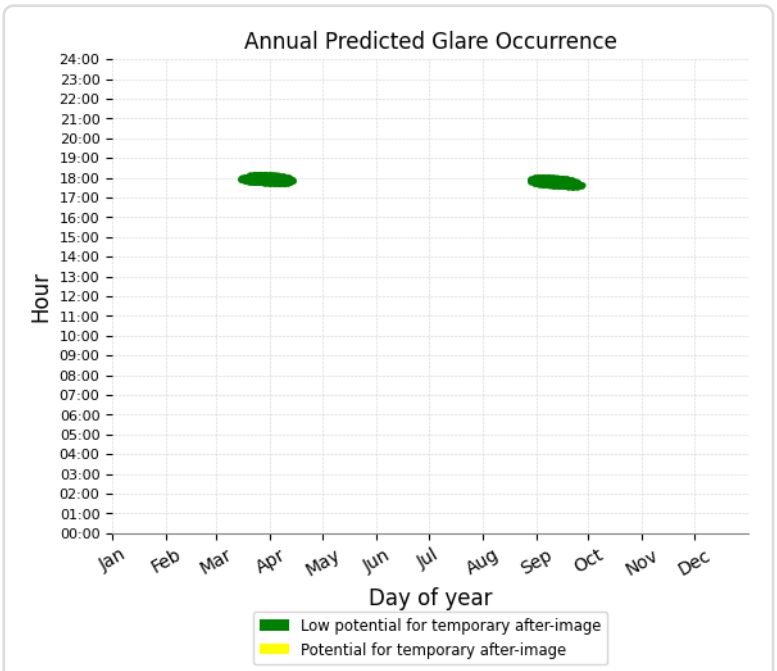


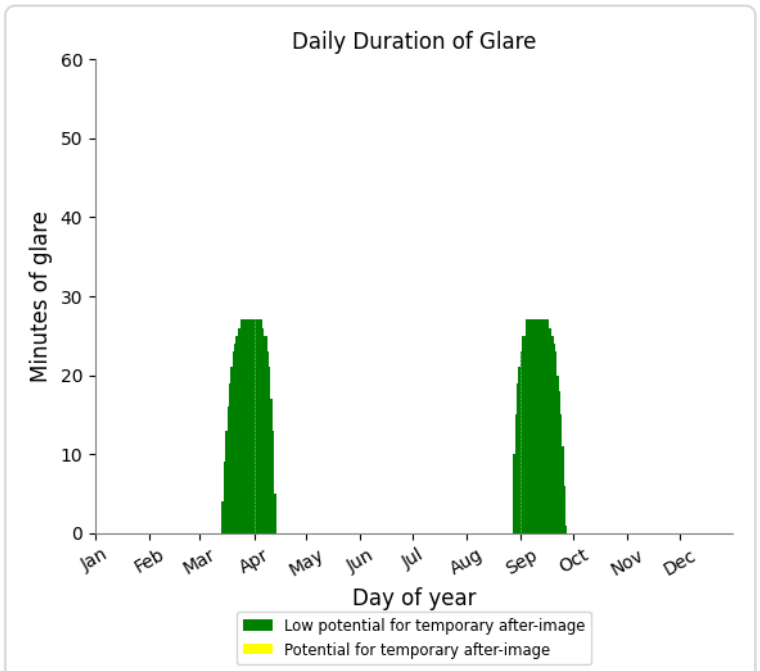


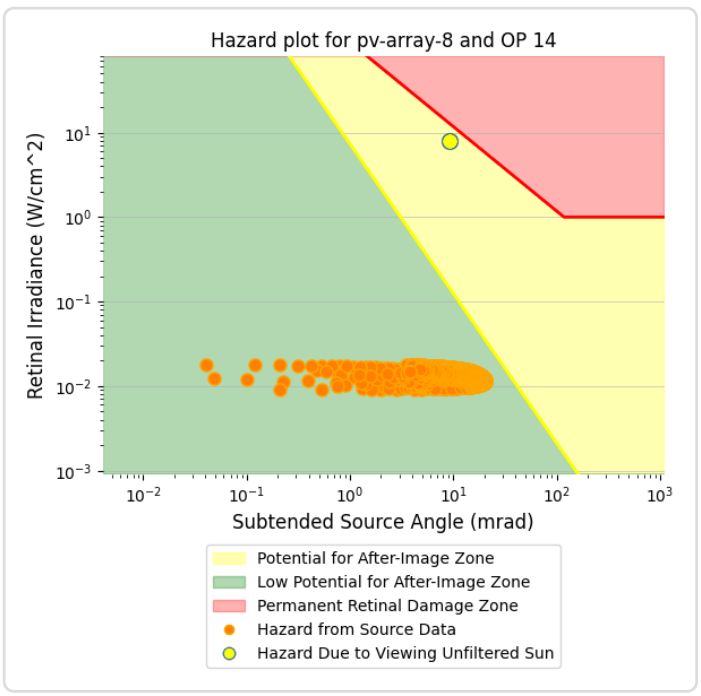
PV array 8 and OP 14

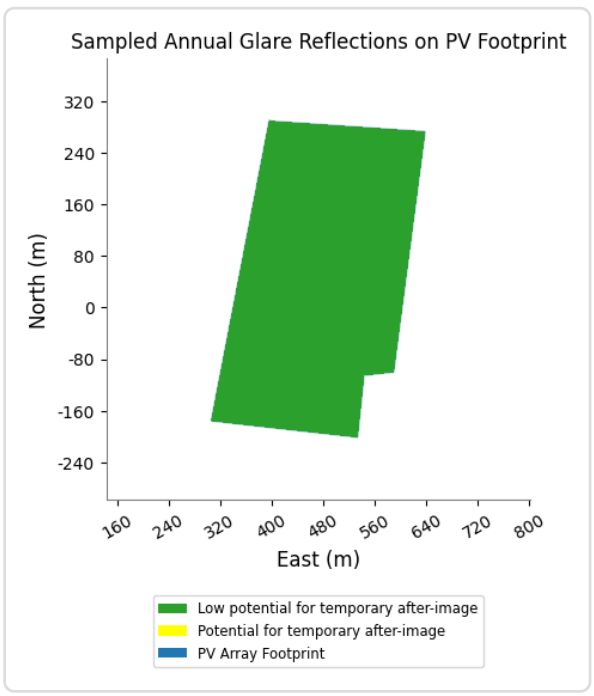
Yellow glare: none

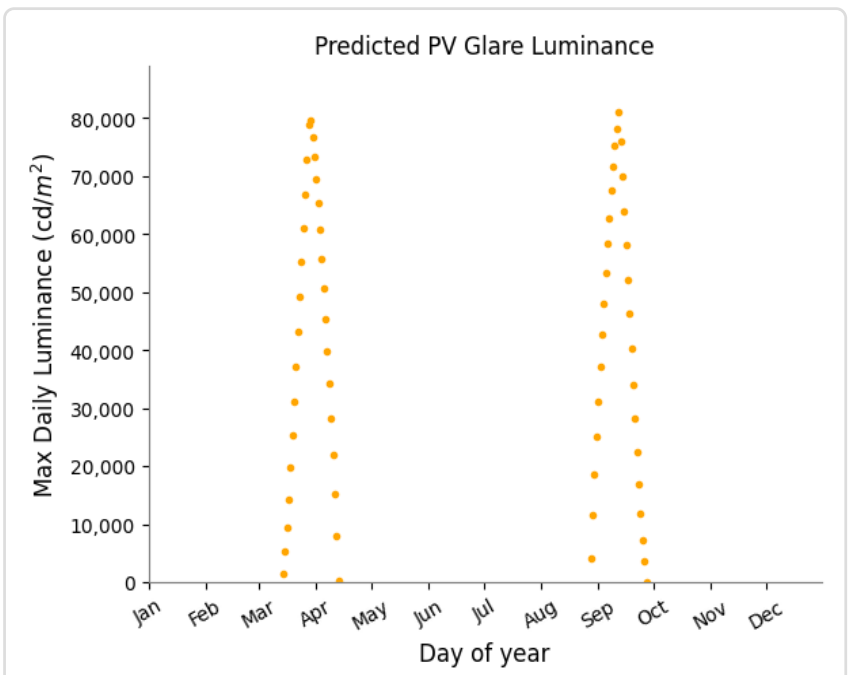
Green glare: 1,369 min.







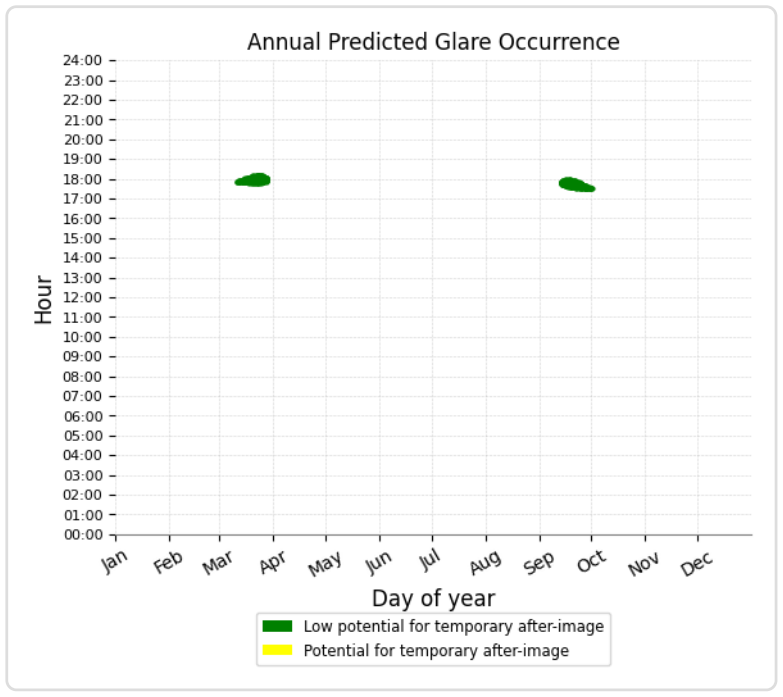


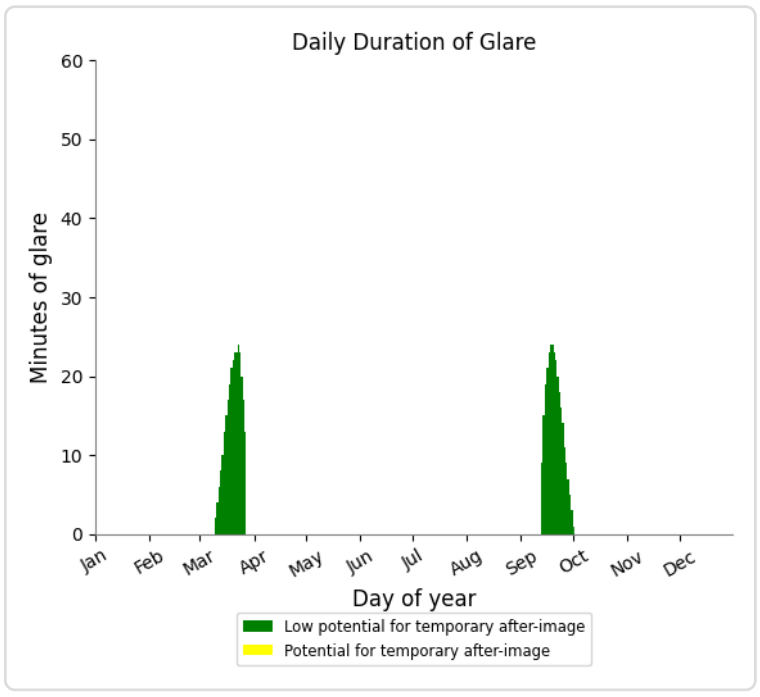


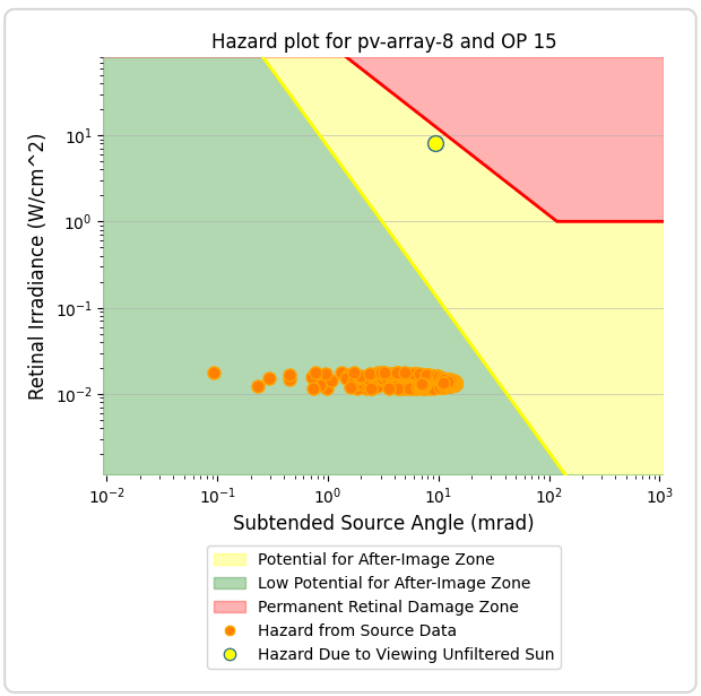
PV array 8 and OP 15

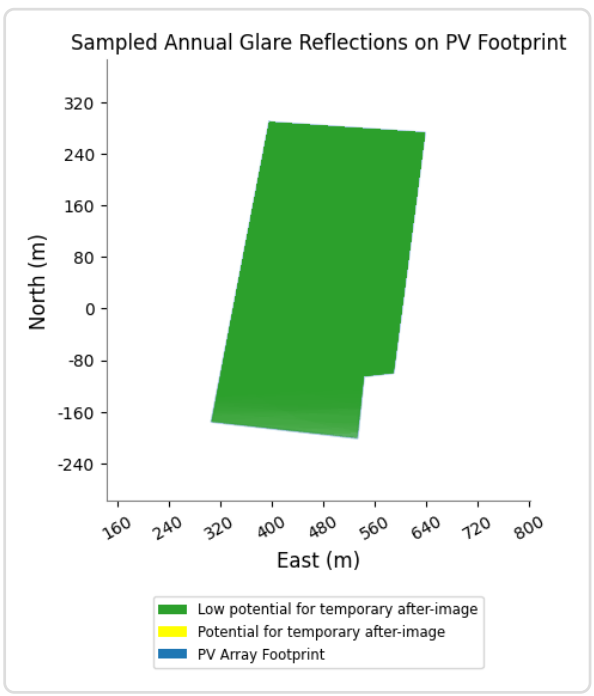
Yellow glare: none

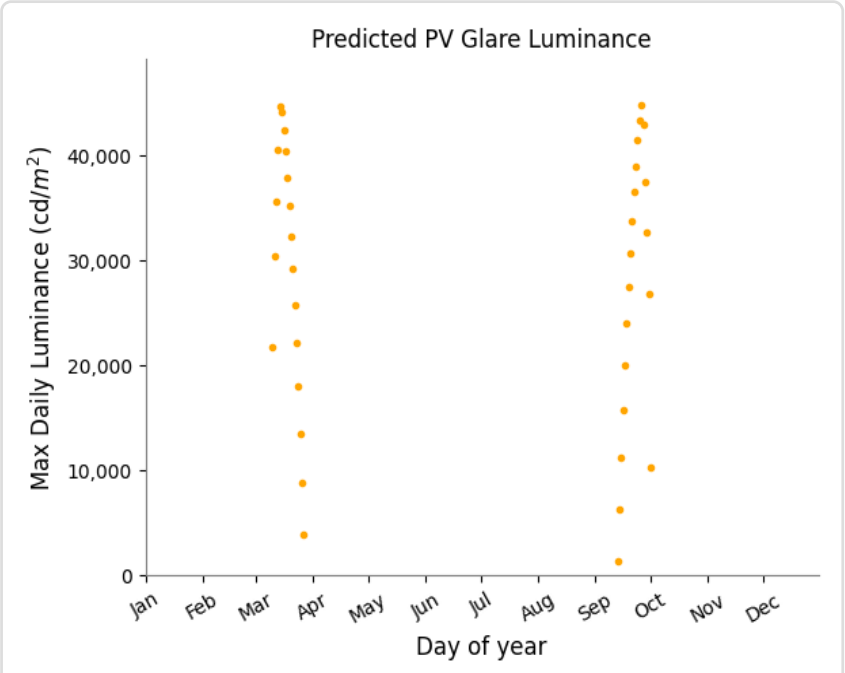
Green glare: 564 min.











PV array 8 and OP 1

No glare found

PV array 8 and OP 8

No glare found

PV array 8 and OP 9

No glare found

PV array 8 and OP 10

No glare found

PV array 8 and OP 11

No glare found

PV array 8 and OP 12

No glare found

PV array 8 and OP 13

No glare found

PV array 8 and OP 16

No glare found

PV array 8 and OP 17

No glare found

PV array 8 and OP 18

No glare found

PV array 8 and OP 19

No glare found

PV array 8 and OP 20

No glare found

PV array 8 and OP 21

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **BR10356 Normanton Larches Solar**
Site configuration: **Aviation 1500ft 180 and 205 OPs 1-20**

Created 08 Mar, 2024
Updated 21 Mar, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 113983.19448

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	9,098	151.6	0	0.0	-	170,300
PV array 2	25.0	180.0	11,993	199.9	0	0.0	-	99,286
PV array 3	25.0	180.0	9,129	152.2	0	0.0	-	187,209
PV array 4	25.0	180.0	8,770	146.2	0	0.0	-	173,524
PV array 5	25.0	180.0	10,686	178.1	0	0.0	-	168,050
PV array 6	25.0	180.0	12,221	203.7	0	0.0	-	156,017
PV array 7	25.0	205.0	13,488	224.8	0	0.0	-	161,574
PV array 8	25.0	180.0	21,512	358.5	0	0.0	-	164,006

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	1,402	23.4	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	4,415	73.6	0	0.0
OP 8	11,600	193.3	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	31,785	529.8	0	0.0
OP 15	23,059	384.3	0	0.0
OP 16	18,476	307.9	0	0.0
OP 17	5,172	86.2	0	0.0
OP 18	988	16.5	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270453	-1.023592	44.16	3.58	47.74
2	53.270382	-1.026510	38.69	3.58	42.27
3	53.270337	-1.028001	42.19	3.58	45.77
4	53.268374	-1.027819	47.55	3.58	51.13
5	53.267835	-1.027411	47.97	3.58	51.55
6	53.268194	-1.025823	42.76	3.58	46.34
7	53.268605	-1.023538	48.05	3.58	51.63

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272403	-1.022893	44.98	3.58	48.56
2	53.271659	-1.020468	49.10	3.58	52.68
3	53.271146	-1.020629	49.06	3.58	52.64
4	53.270568	-1.020768	49.76	3.58	53.34
5	53.269978	-1.022399	48.94	3.58	52.52
6	53.269490	-1.023494	46.53	3.58	50.11
7	53.270600	-1.023526	44.05	3.58	47.63
8	53.270658	-1.022721	44.52	3.58	48.10

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267270	-1.027453	49.52	3.58	53.10
2	53.267742	-1.026122	44.46	3.58	48.04
3	53.268066	-1.026004	43.25	3.58	46.83
4	53.268361	-1.024577	44.74	3.58	48.32
5	53.268515	-1.023451	48.43	3.58	52.01
6	53.263789	-1.021096	44.95	3.58	48.53
7	53.263606	-1.026144	50.81	3.58	54.39

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267296	-1.022818	47.72	3.58	51.30
2	53.267707	-1.018998	49.22	3.58	52.80
3	53.264120	-1.017373	43.17	3.58	46.75
4	53.264126	-1.017861	43.81	3.58	47.39
5	53.263885	-1.017893	45.60	3.58	49.18
6	53.263795	-1.021085	44.91	3.58	48.49

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.268300	-1.019106	51.65	3.58	55.23
2	53.268197	-1.015587	47.94	3.58	51.52
3	53.267411	-1.014932	45.87	3.58	49.45
4	53.263776	-1.015093	42.99	3.58	46.57
5	53.263904	-1.017175	44.48	3.58	48.06
6	53.266359	-1.018355	43.98	3.58	47.56

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267286	-1.014793	45.26	3.58	48.84
2	53.263975	-1.015072	41.69	3.58	45.27
3	53.265181	-1.012926	37.52	3.58	41.10
4	53.265759	-1.012132	35.68	3.58	39.26
5	53.266067	-1.011724	35.43	3.58	39.01
6	53.266349	-1.011338	34.83	3.58	38.41
7	53.266619	-1.009836	34.68	3.58	38.26
8	53.267825	-1.010716	42.25	3.58	45.83

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 205.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272921	-1.014029	31.16	3.58	34.74
2	53.269562	-1.014705	42.84	3.58	46.42
3	53.269645	-1.012452	41.27	3.58	44.85
4	53.270081	-1.011636	34.85	3.58	38.43
5	53.270916	-1.010456	29.19	3.58	32.77
6	53.271634	-1.010070	28.02	3.58	31.60
7	53.272289	-1.010027	28.11	3.58	31.69
8	53.272956	-1.010370	28.00	3.58	31.58
9	53.273187	-1.010671	28.00	3.58	31.58
10	53.273245	-1.012674	29.03	3.58	32.61
11	53.272881	-1.012808	29.75	3.58	33.33

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273046	-1.017687	40.41	3.58	43.99
2	53.268914	-1.018953	51.37	3.58	54.95
3	53.268651	-1.015563	47.70	3.58	51.28
4	53.269498	-1.015477	43.94	3.58	47.52
4	53.269498	-1.015477	43.94	3.58	47.52
4	53.269498	-1.015477	43.94	3.58	47.52
5	53.269549	-1.014726	42.93	3.58	46.51
5	53.269549	-1.014726	42.93	3.58	46.51
5	53.269549	-1.014726	42.93	3.58	46.51
6	53.272919	-1.014031	31.16	3.58	34.74

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.274658	-0.956085	26.85	457.20
OP 2	2	53.280560	-0.951536	27.44	457.20
OP 3	3	53.287000	-0.946429	23.00	457.20
OP 4	4	53.298511	-0.952811	33.00	457.20
OP 5	5	53.299640	-0.964398	28.38	457.20
OP 6	6	53.287225	-0.974011	23.92	457.20
OP 7	7	53.272753	-0.986371	37.57	457.20
OP 8	8	53.265874	-0.967488	33.88	457.20
OP 9	9	53.299127	-0.939421	18.00	457.20
OP 10	10	53.306154	-0.950150	29.17	457.20
OP 11	11	53.308462	-0.963540	37.62	457.20
OP 12	12	53.296511	-0.979762	23.67	457.20
OP 13	13	53.283581	-0.992722	40.63	457.20
OP 14	14	53.268595	-0.997529	38.41	457.20
OP 15	15	53.264437	-0.984998	29.15	457.20
OP 16	16	53.260330	-0.969119	37.98	457.20
OP 17	17	53.269570	-0.934272	22.21	457.20
OP 18	18	53.275422	-0.930581	24.95	457.20
OP 19	19	53.281734	-0.928263	23.00	457.20
OP 20	20	53.283581	-0.968861	22.00	457.20

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	9,098	151.6	0	0.0	-	170,300
PV array 2	25.0	180.0	11,993	199.9	0	0.0	-	99,286
PV array 3	25.0	180.0	9,129	152.2	0	0.0	-	187,209
PV array 4	25.0	180.0	8,770	146.2	0	0.0	-	173,524
PV array 5	25.0	180.0	10,686	178.1	0	0.0	-	168,050
PV array 6	25.0	180.0	12,221	203.7	0	0.0	-	156,017
PV array 7	25.0	205.0	13,488	224.8	0	0.0	-	161,574
PV array 8	25.0	180.0	21,512	358.5	0	0.0	-	164,006

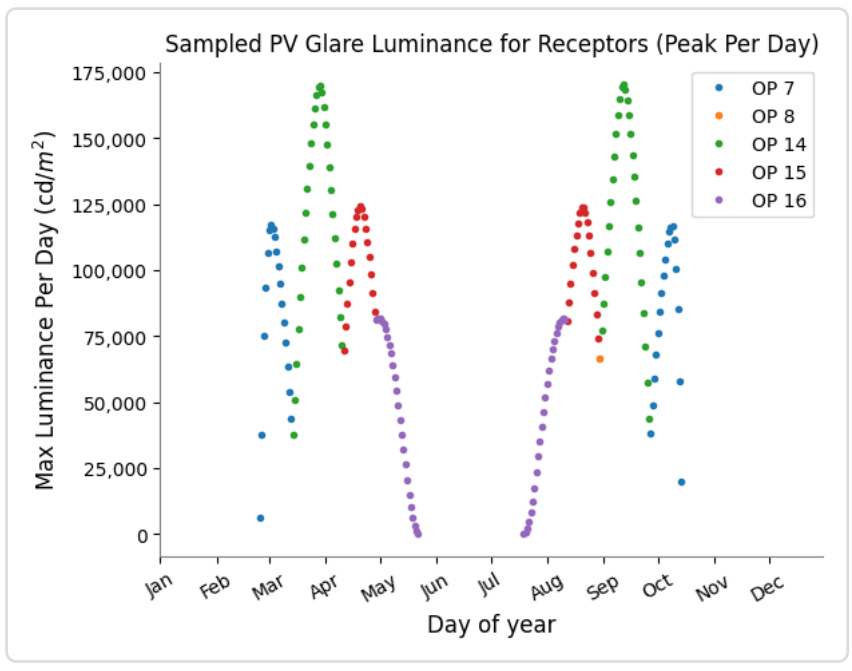
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	1,402	23.4	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	4,415	73.6	0	0.0
OP 8	11,600	193.3	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	31,785	529.8	0	0.0
OP 15	23,059	384.3	0	0.0
OP 16	18,476	307.9	0	0.0
OP 17	5,172	86.2	0	0.0
OP 18	988	16.5	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

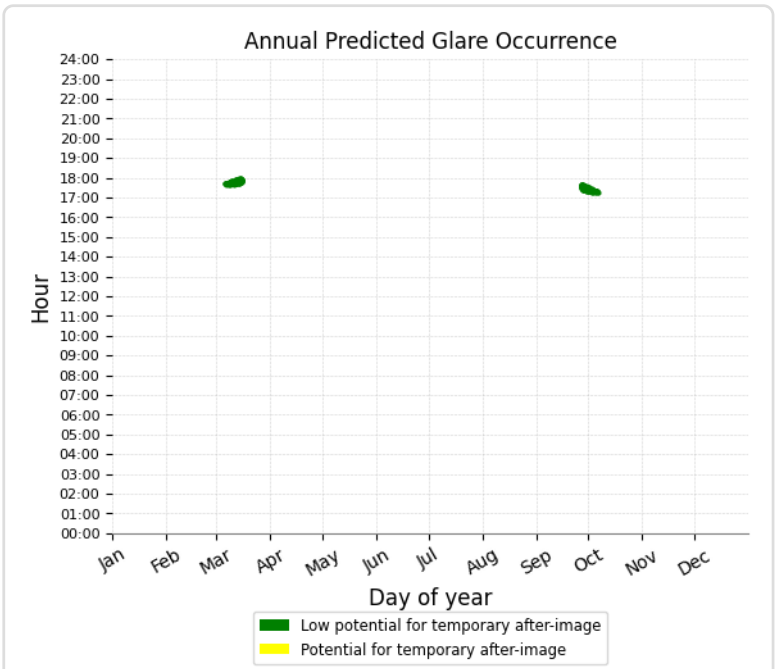
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	212	3.5	0	0.0	37,062
OP 7	732	12.2	0	0.0	117,199
OP 8	1,299	21.6	0	0.0	79,166
OP 14	2,175	36.2	0	0.0	170,300
OP 15	1,902	31.7	0	0.0	124,354
OP 16	1,821	30.4	0	0.0	81,912
OP 17	795	13.2	0	0.0	33,441
OP 18	162	2.7	0	0.0	21,714
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

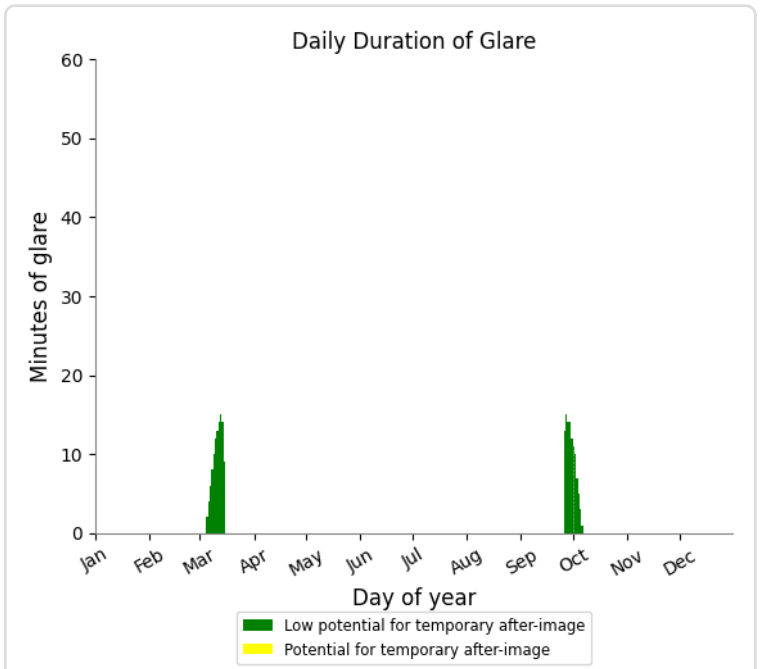


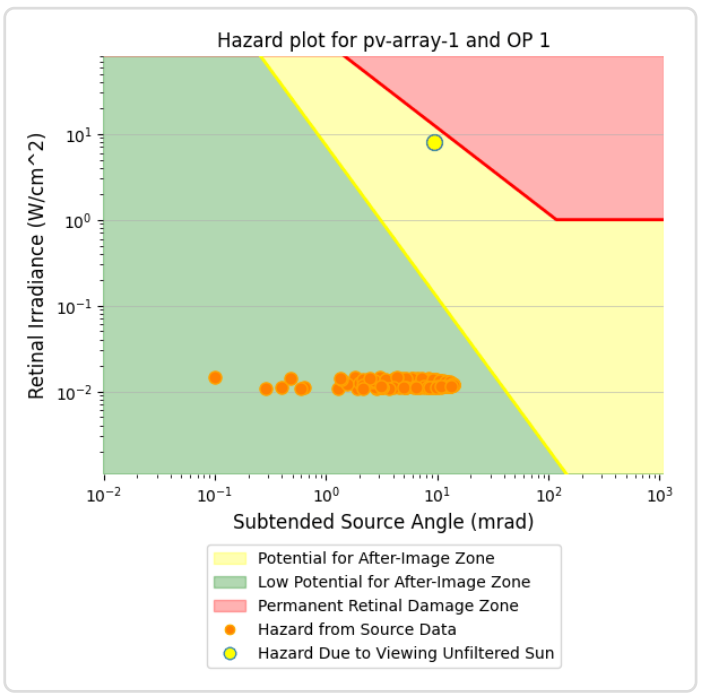
PV array 1 and OP 1

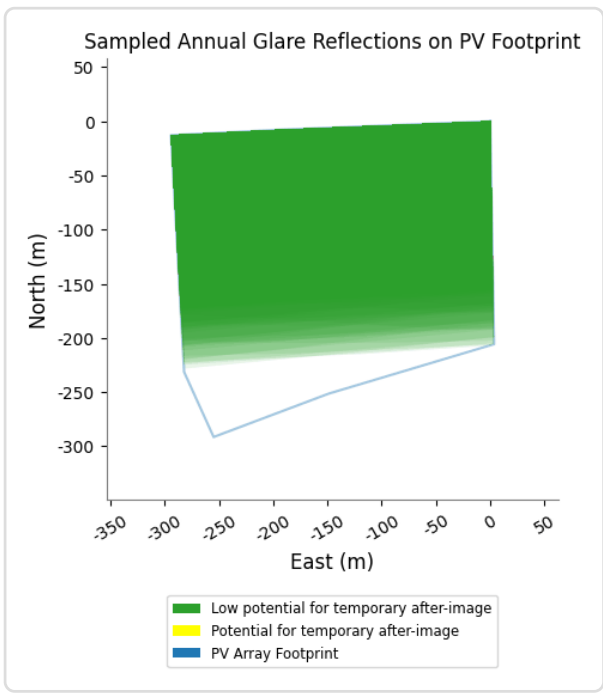
Yellow glare: none

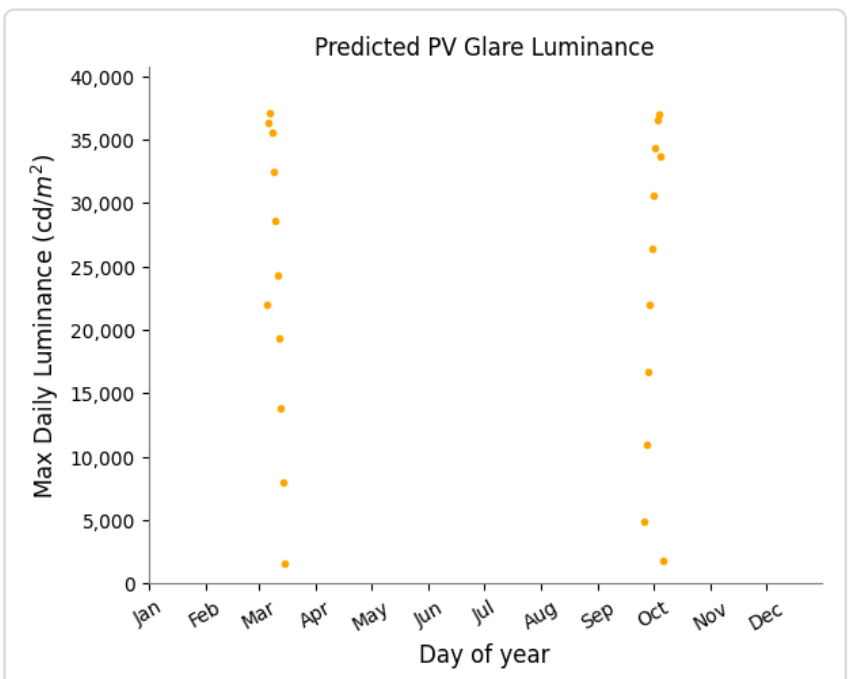
Green glare: 212 min.







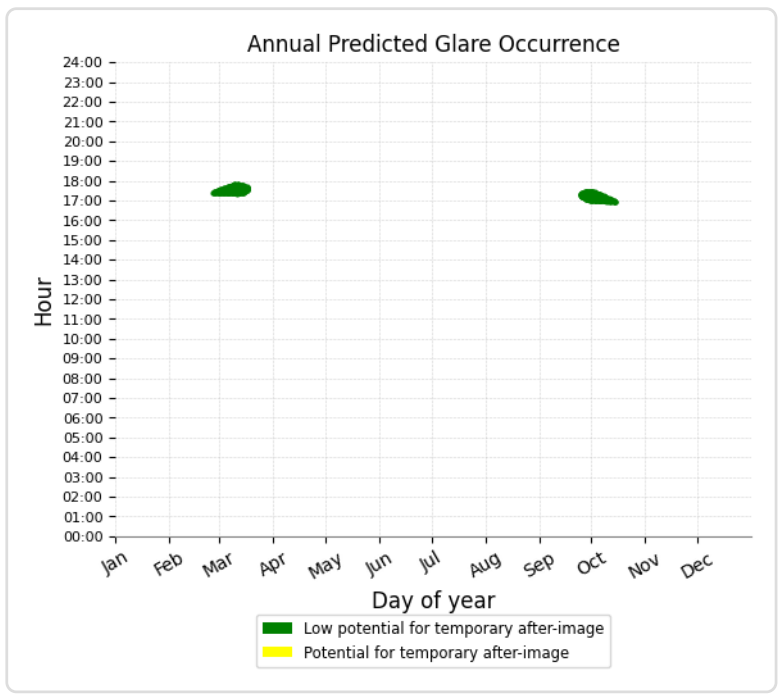


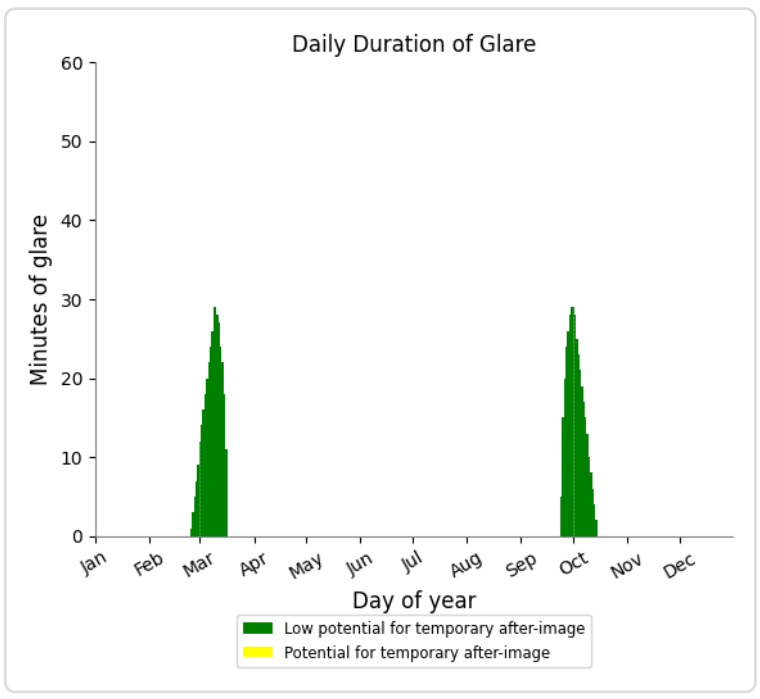


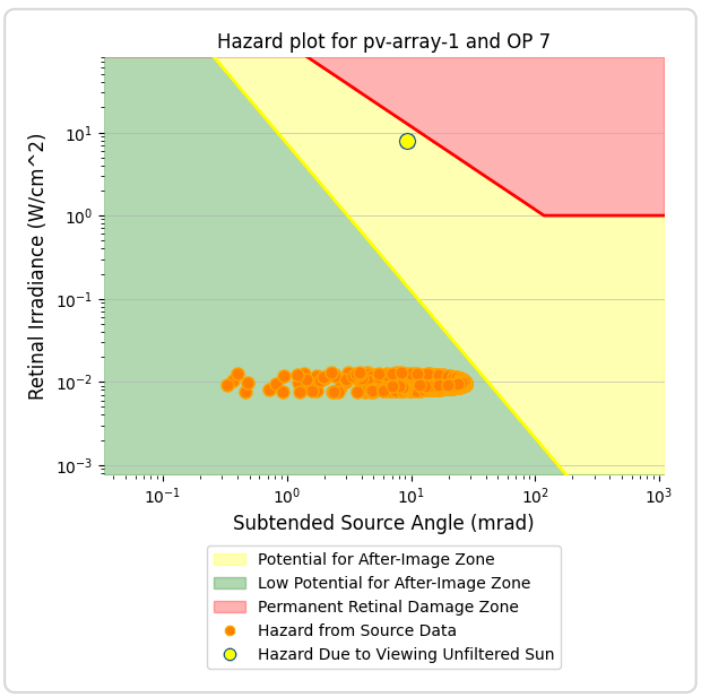
PV array 1 and OP 7

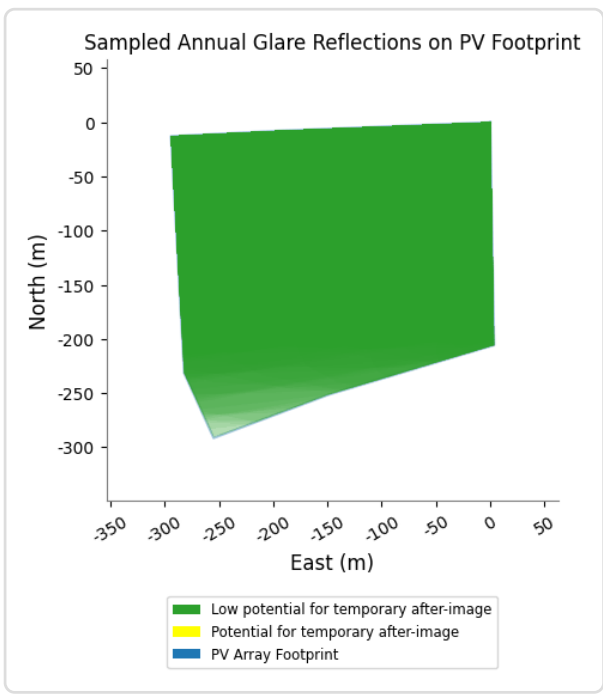
Yellow glare: none

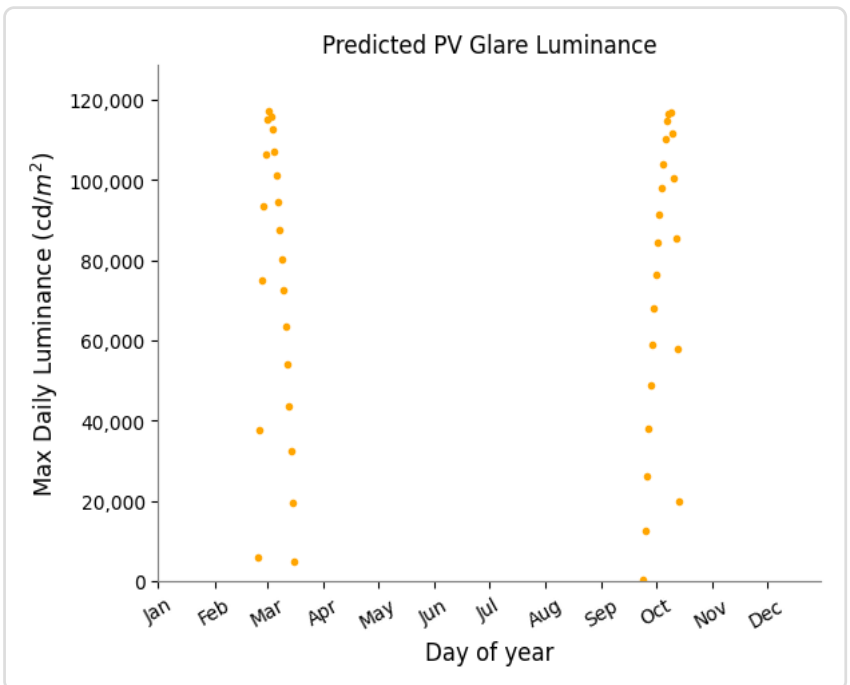
Green glare: 732 min.







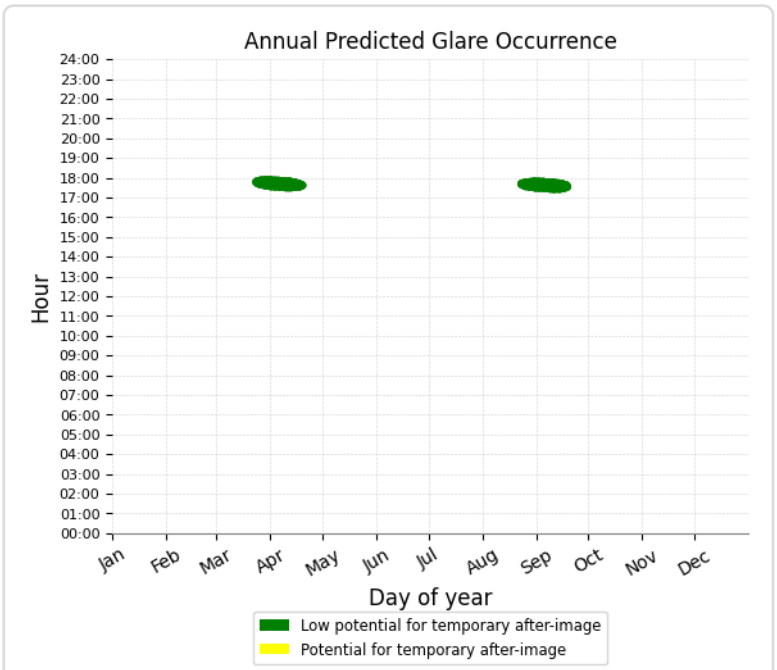


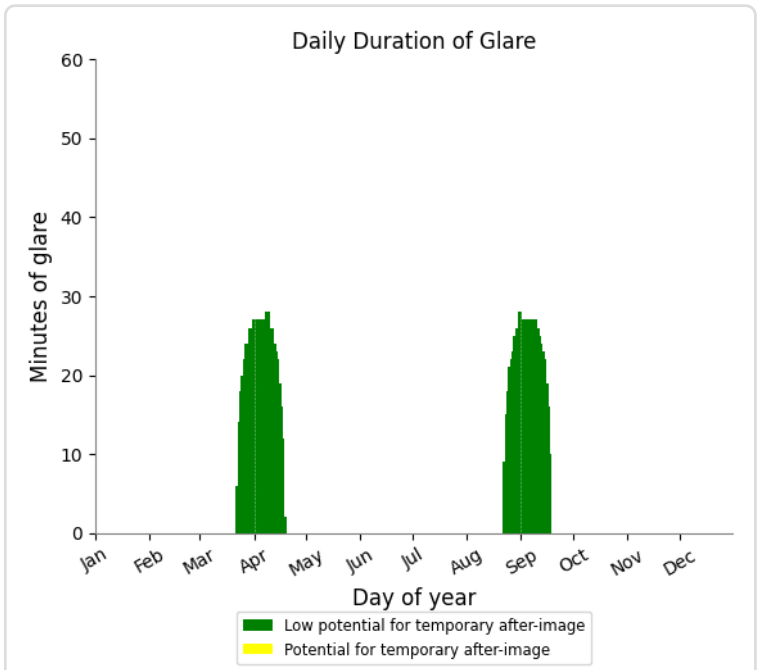


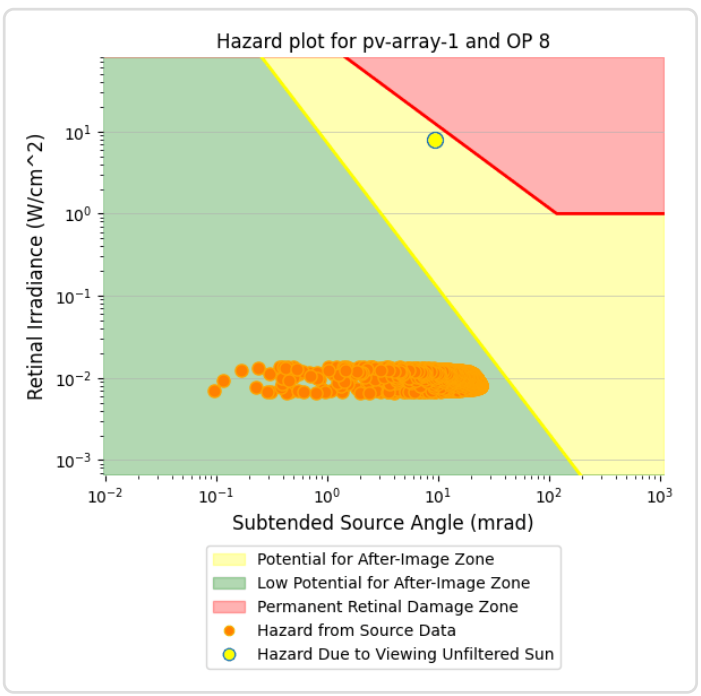
PV array 1 and OP 8

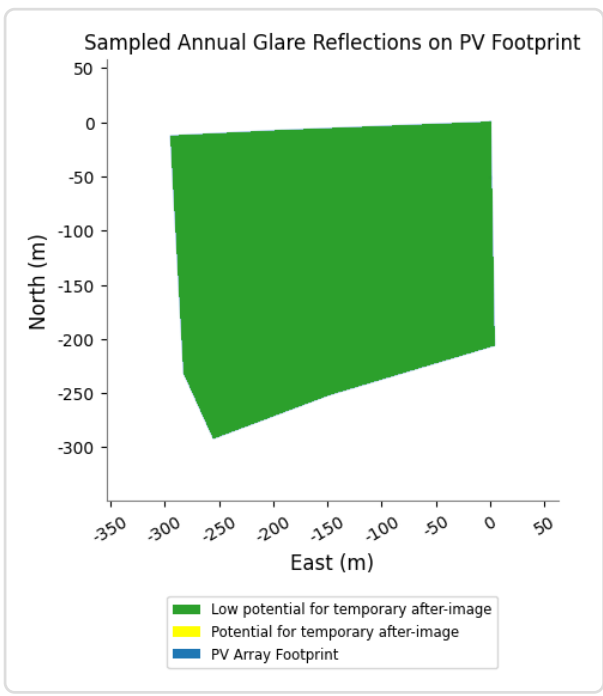
Yellow glare: none

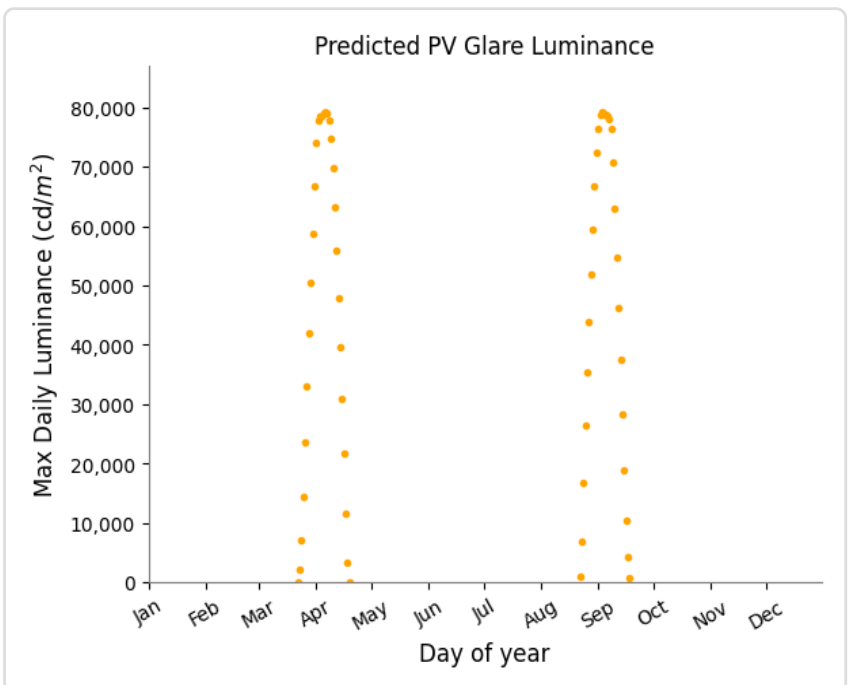
Green glare: 1,299 min.







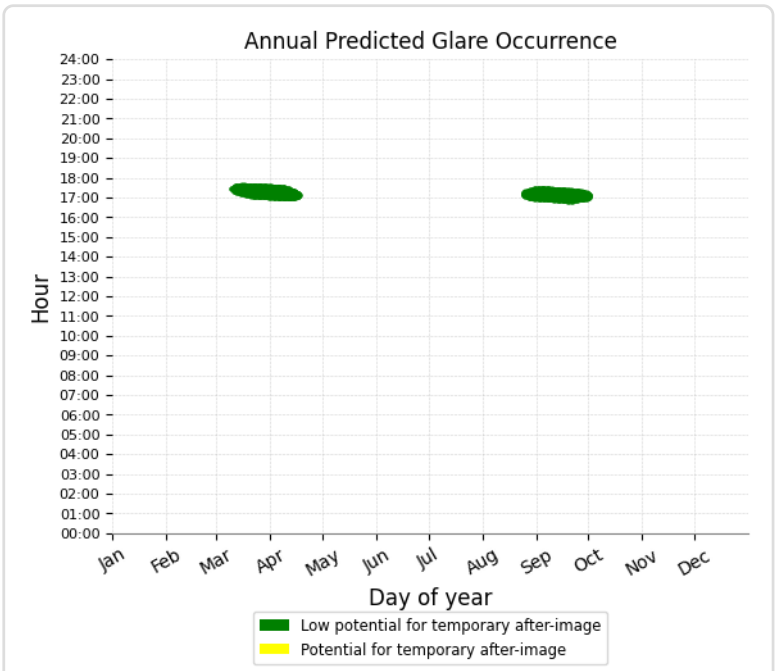


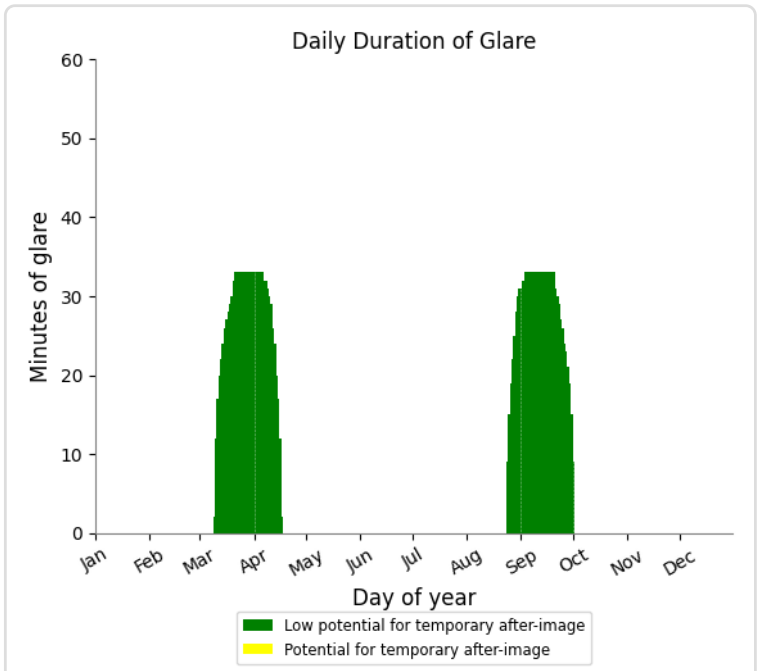


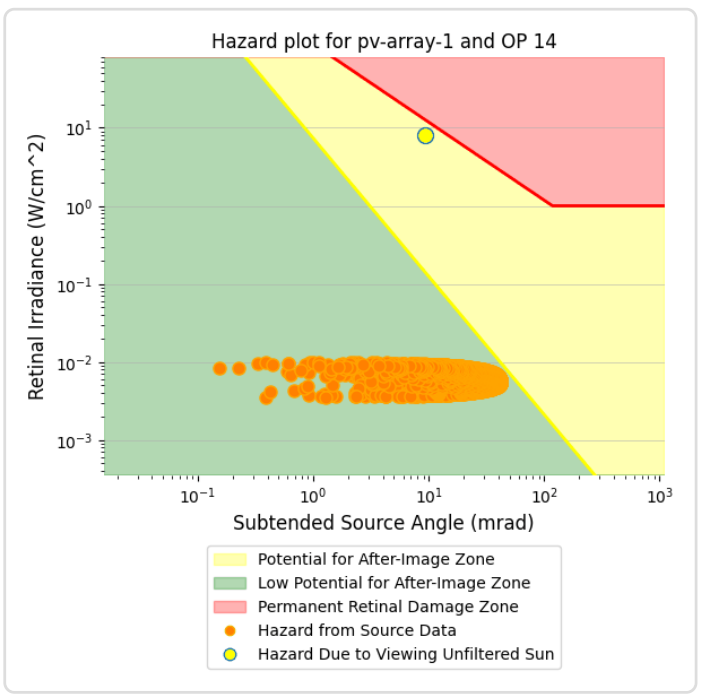
PV array 1 and OP 14

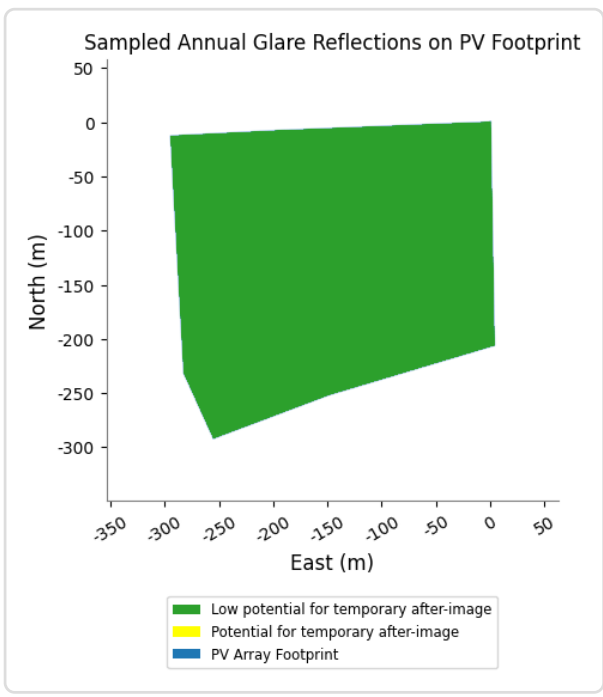
Yellow glare: none

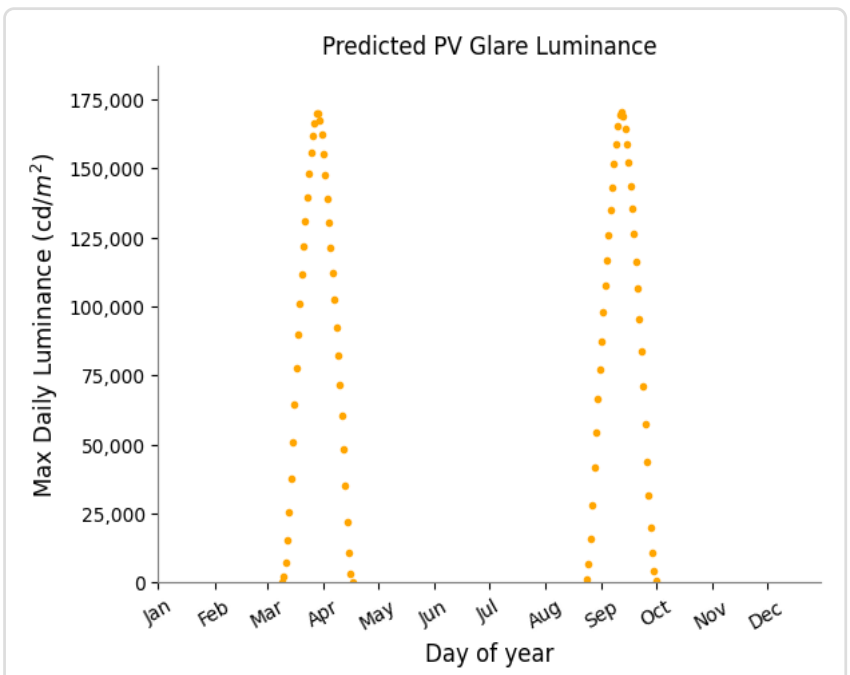
Green glare: 2,175 min.







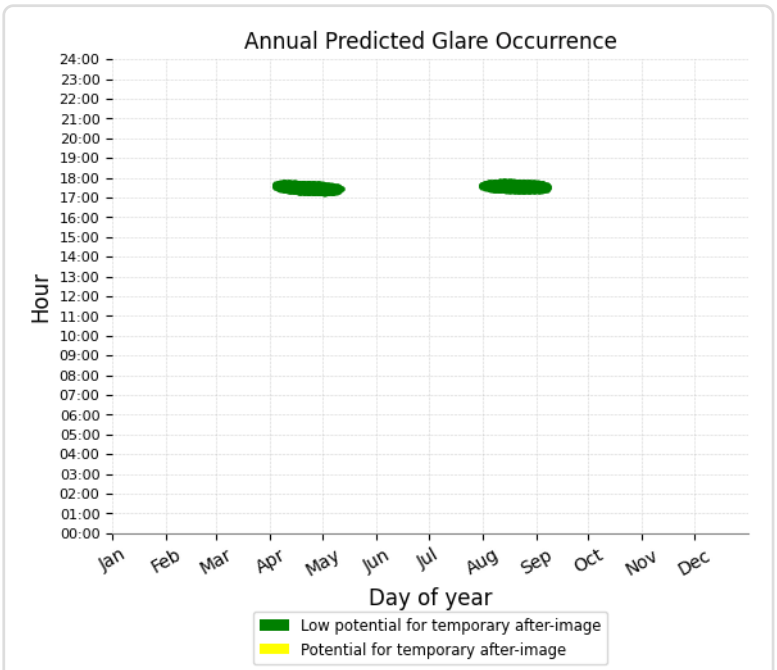


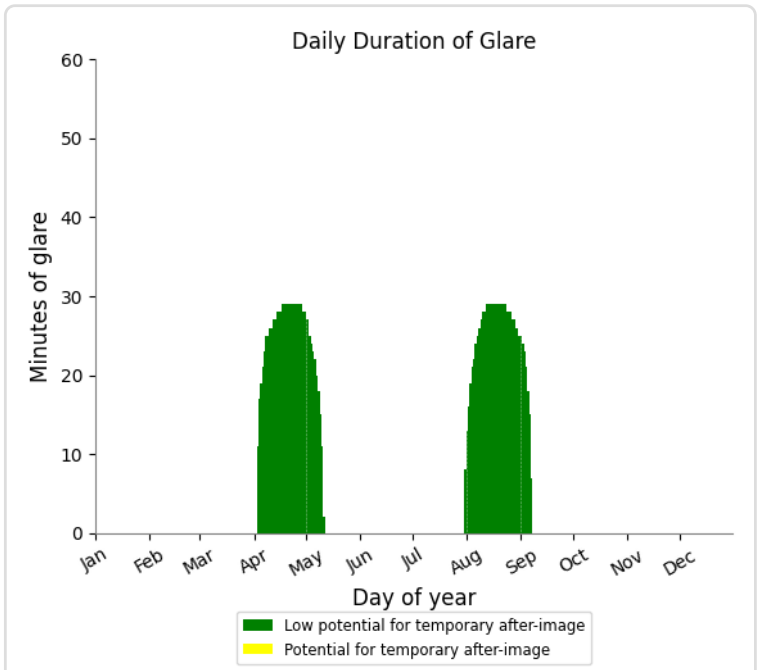


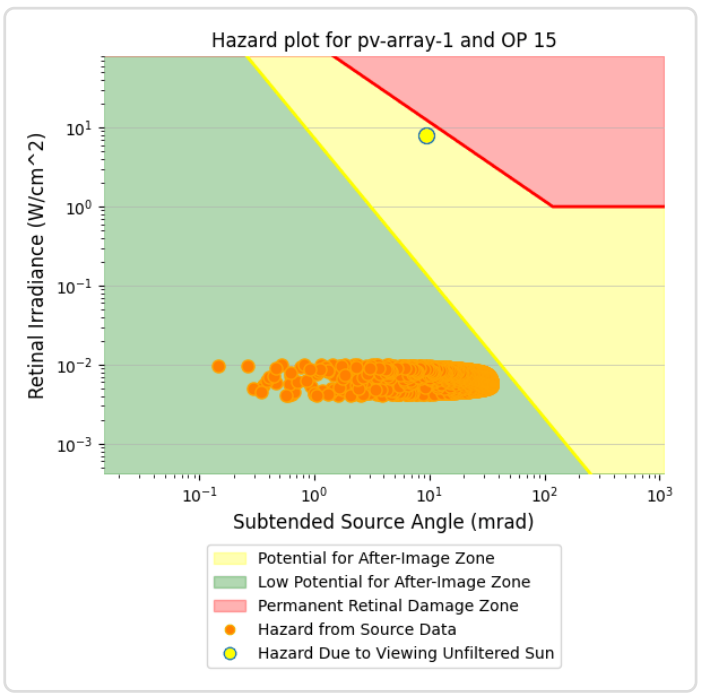
PV array 1 and OP 15

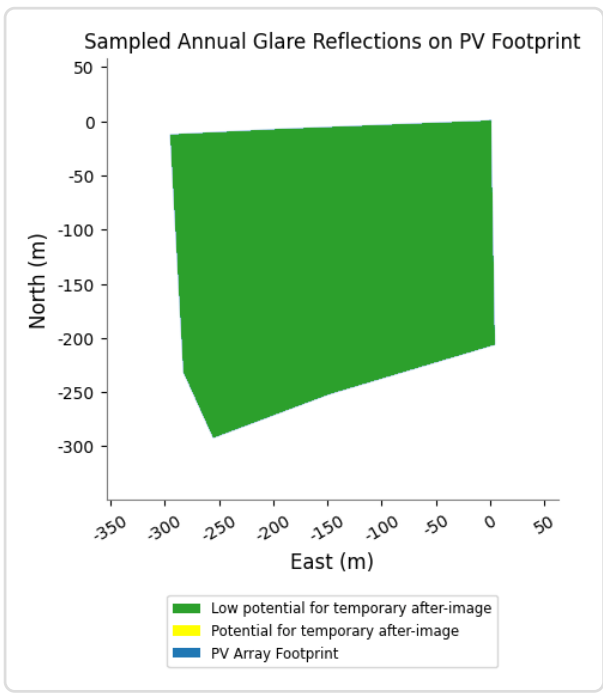
Yellow glare: none

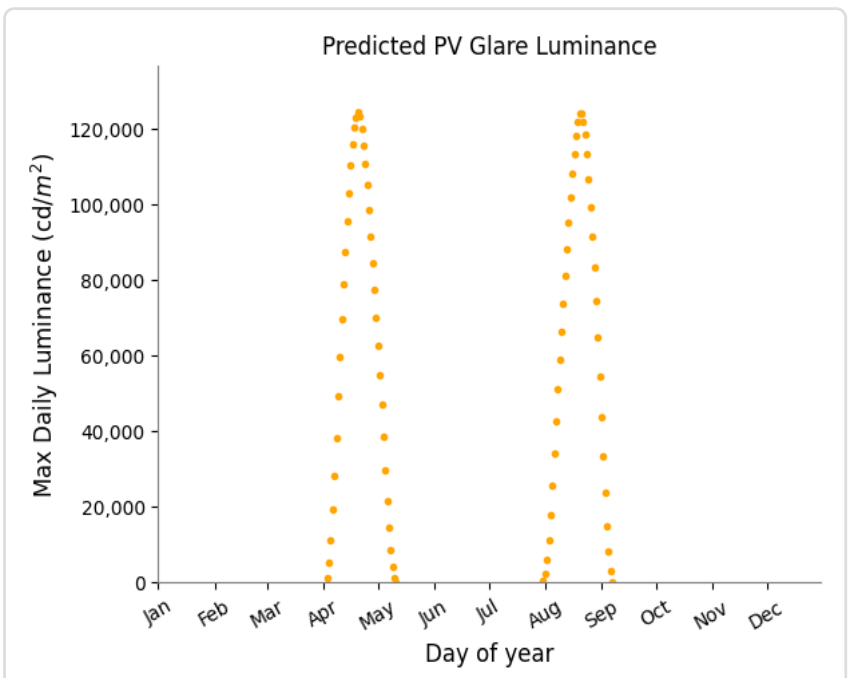
Green glare: 1,902 min.







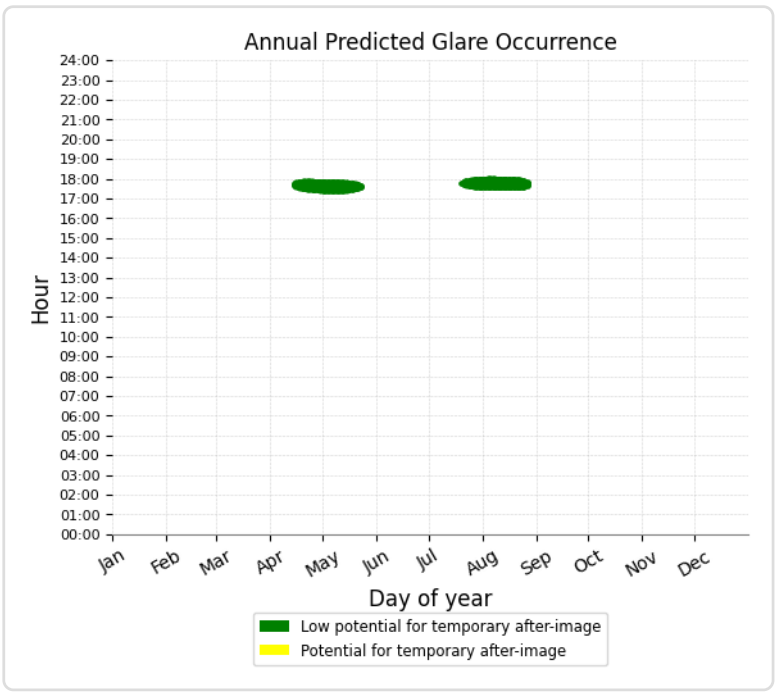


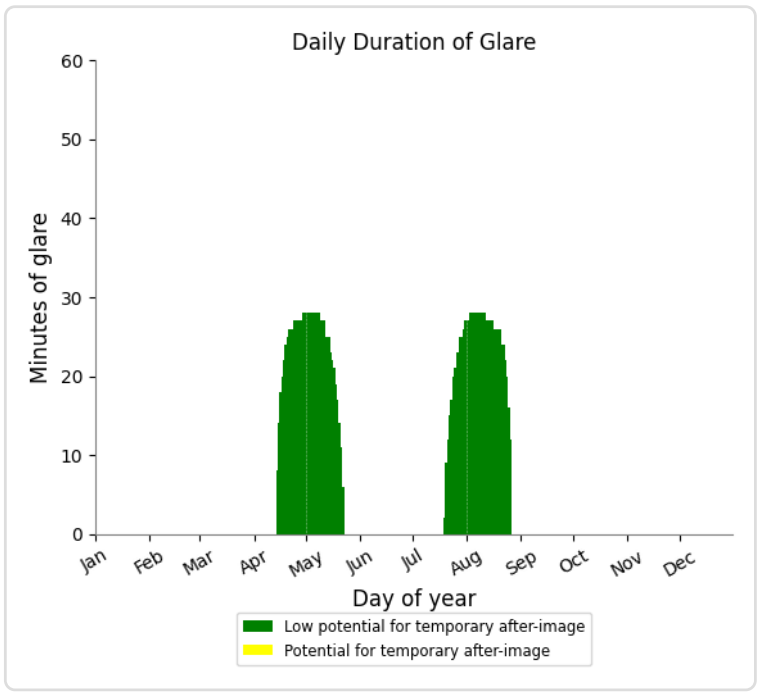


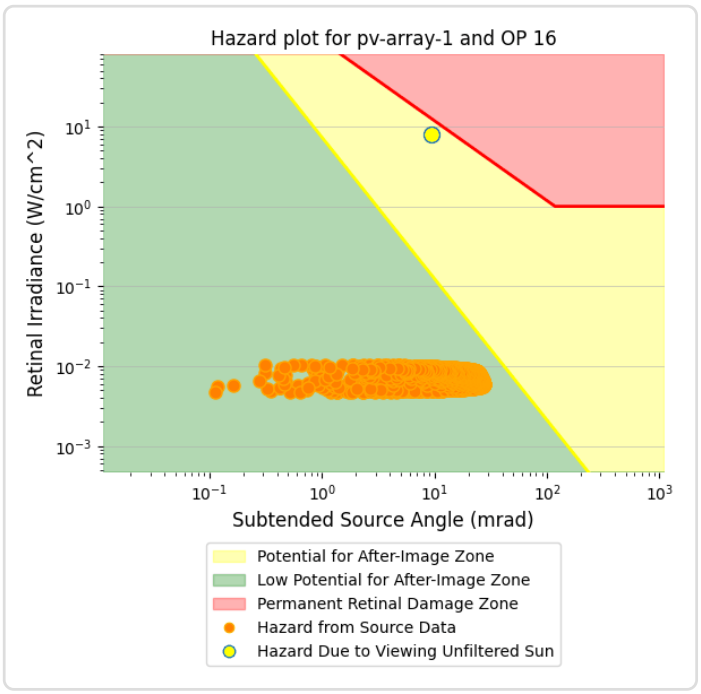
PV array 1 and OP 16

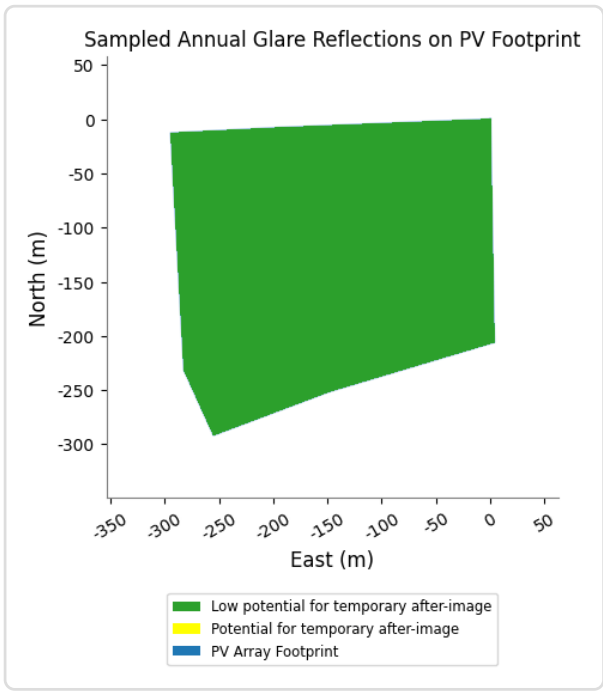
Yellow glare: none

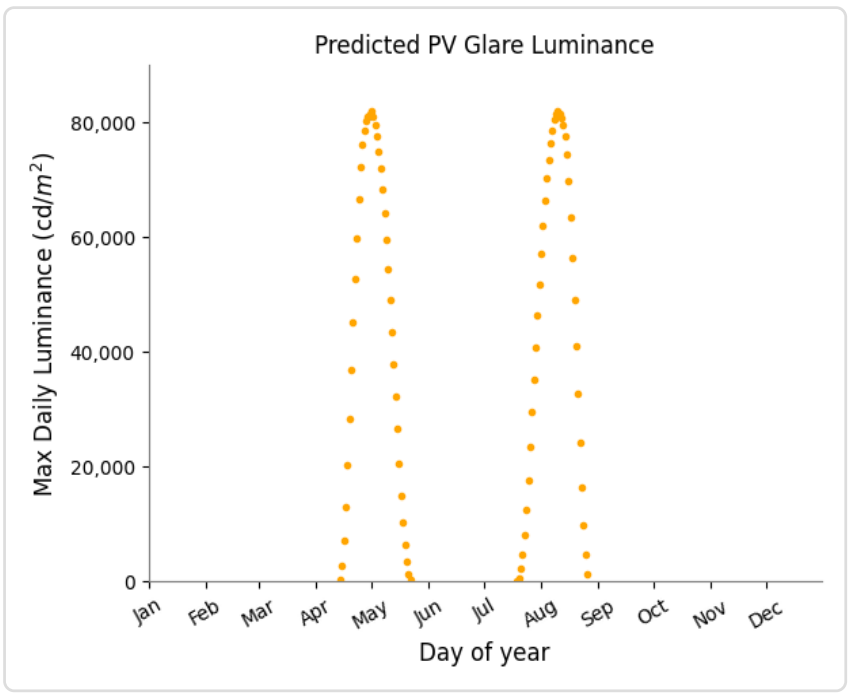
Green glare: 1,821 min.







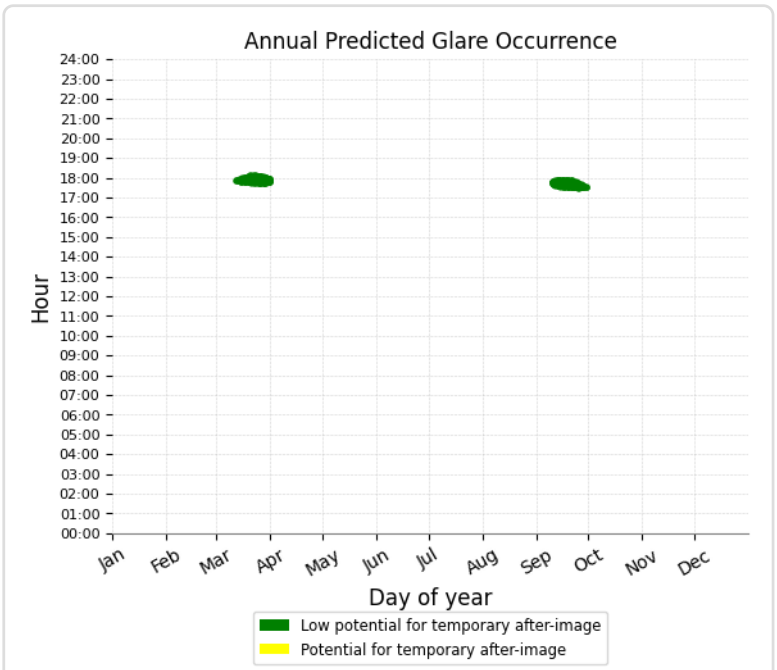


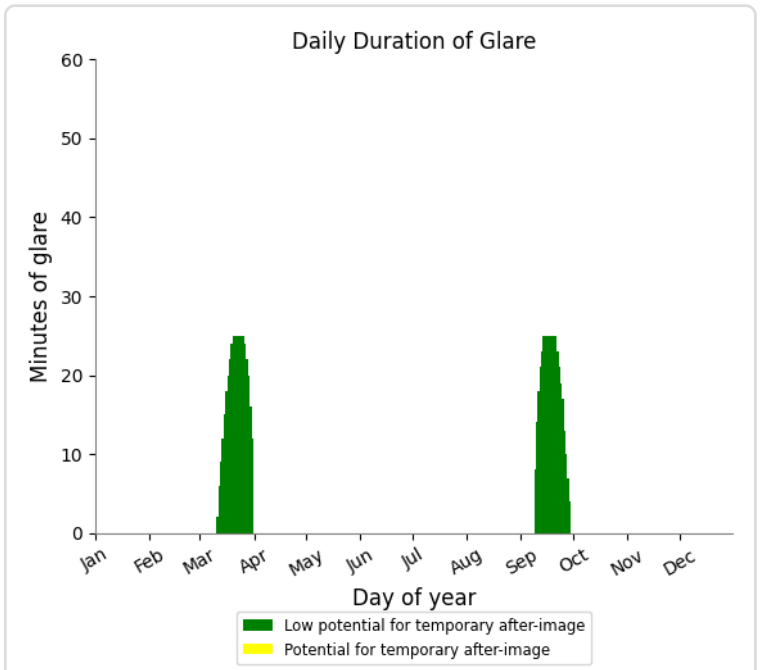


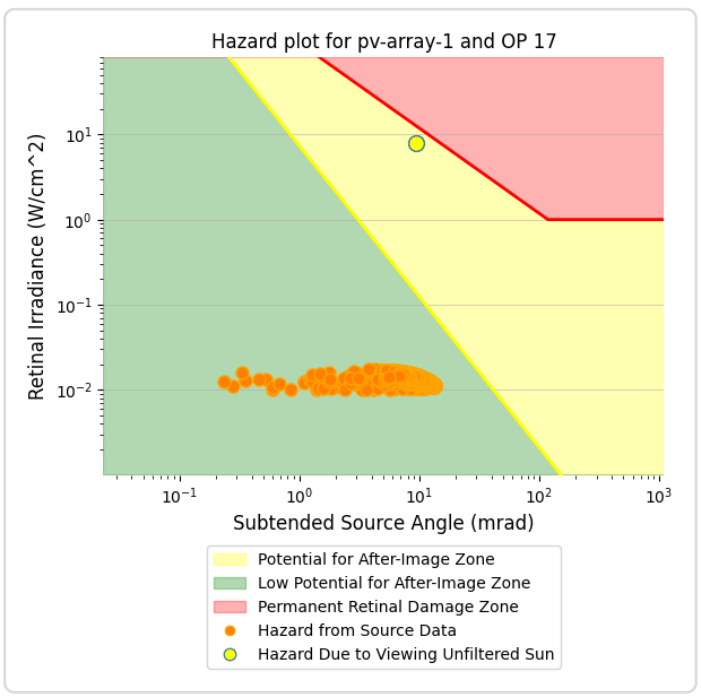
PV array 1 and OP 17

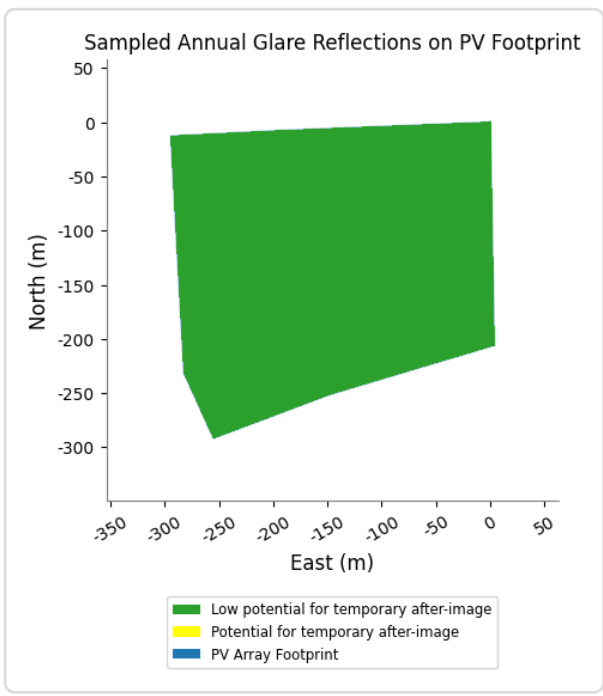
Yellow glare: none

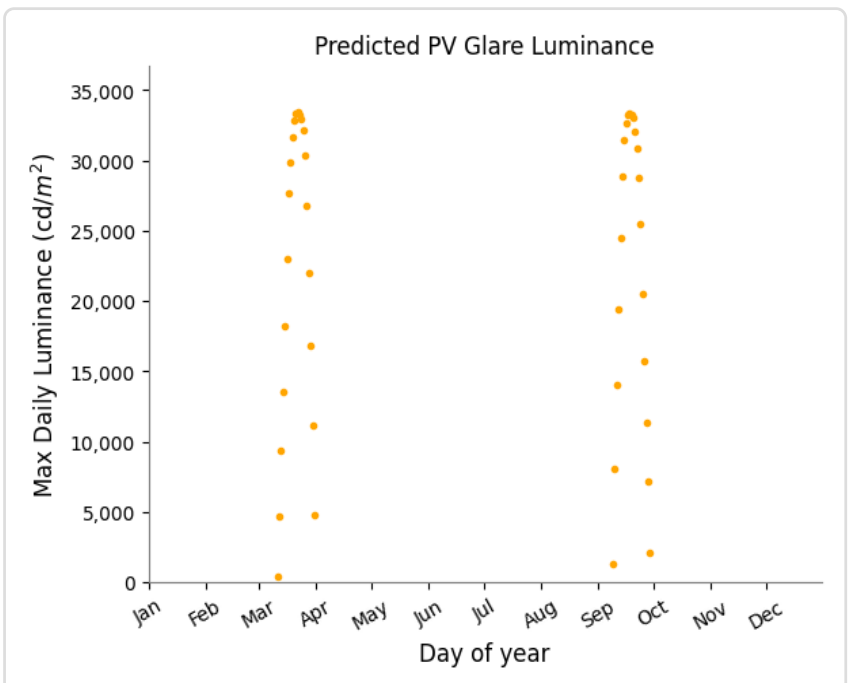
Green glare: 795 min.







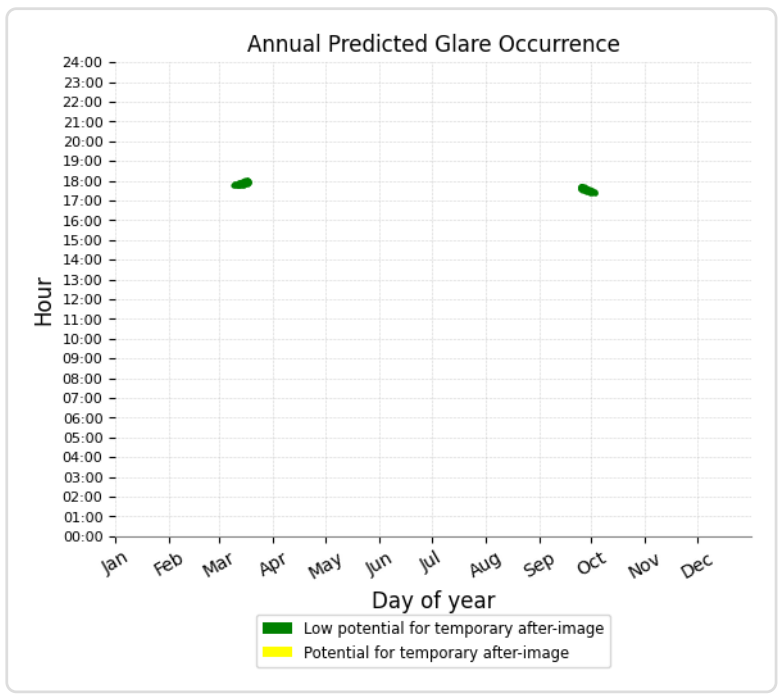


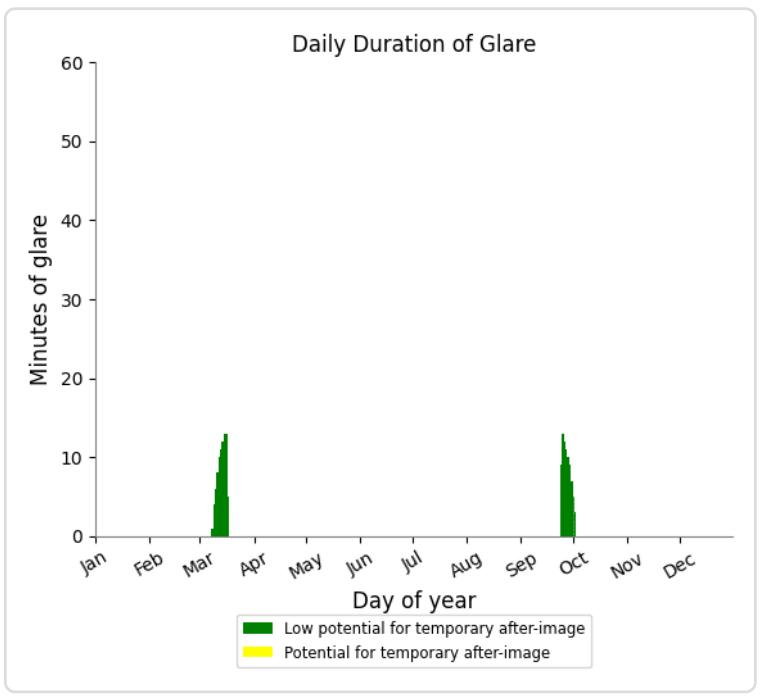


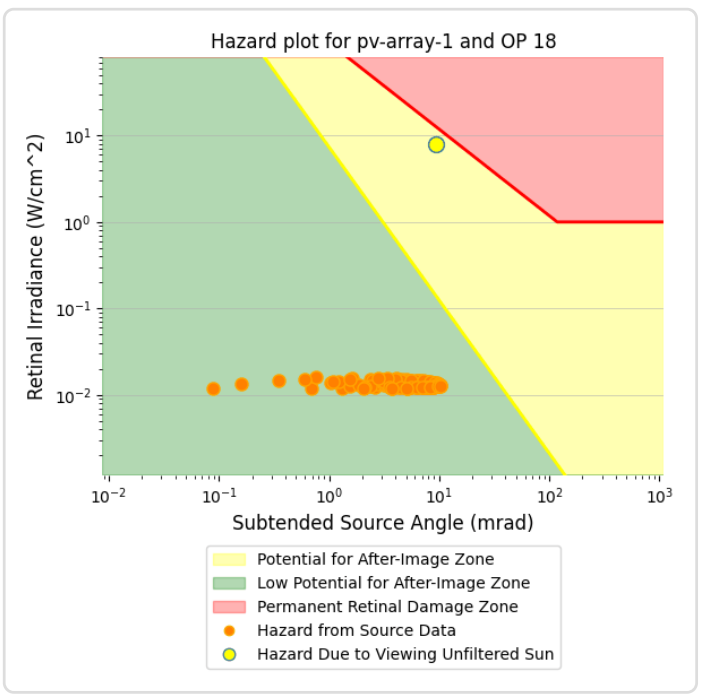
PV array 1 and OP 18

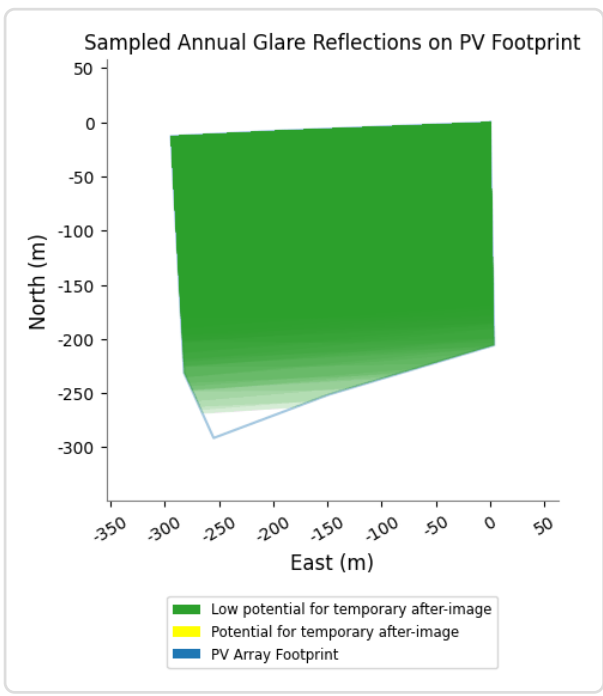
Yellow glare: none

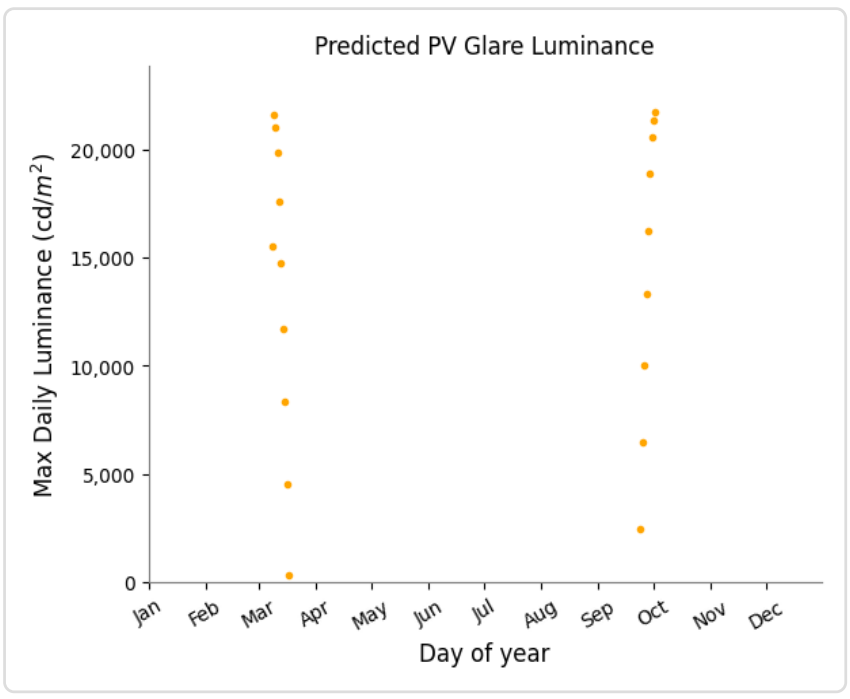
Green glare: 162 min.











PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 19

No glare found

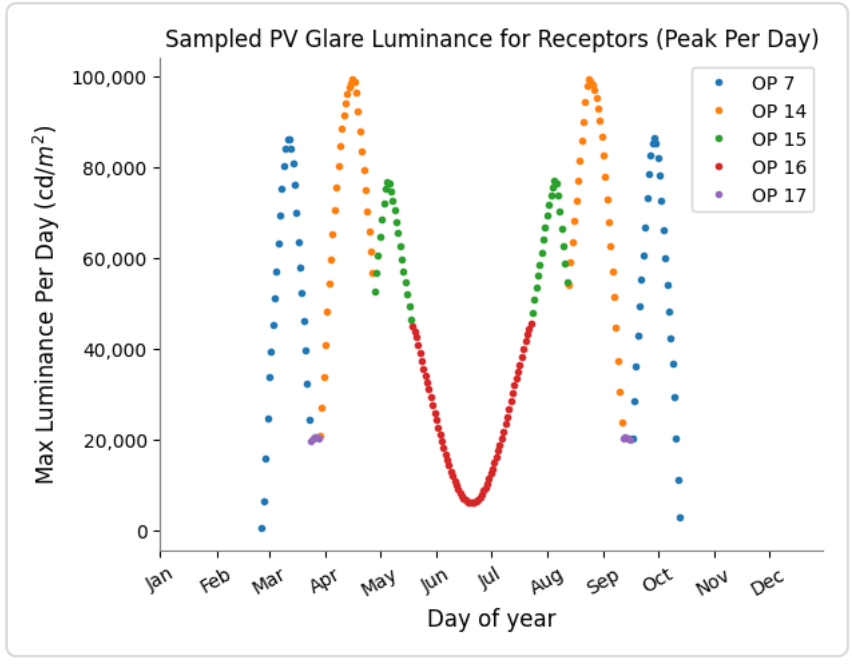
PV array 1 and OP 20

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

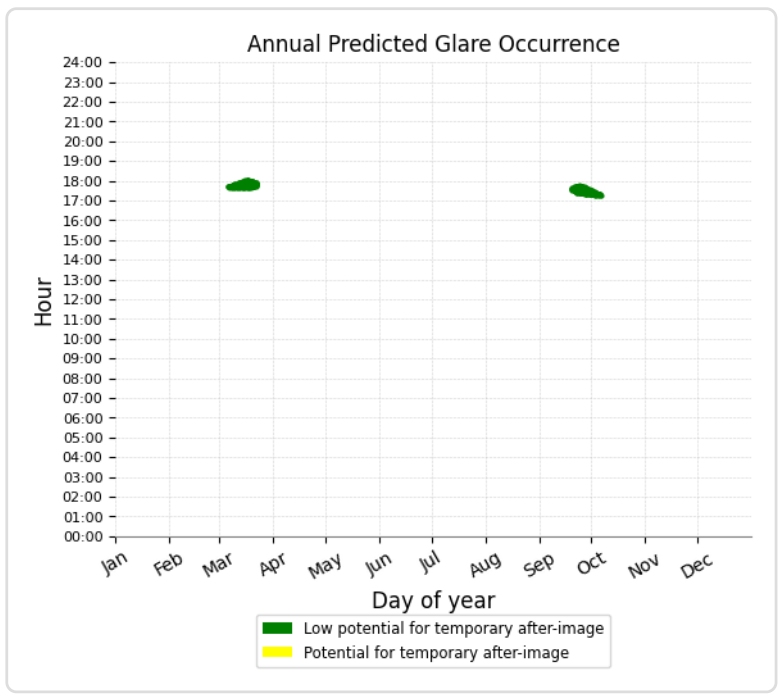
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	496	8.3	0	0.0	27,994
OP 7	1,328	22.1	0	0.0	86,481
OP 8	1,390	23.2	0	0.0	50,188
OP 14	2,447	40.8	0	0.0	99,286
OP 15	2,502	41.7	0	0.0	76,919
OP 16	2,650	44.2	0	0.0	49,786
OP 17	835	13.9	0	0.0	20,579
OP 18	345	5.8	0	0.0	14,343
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

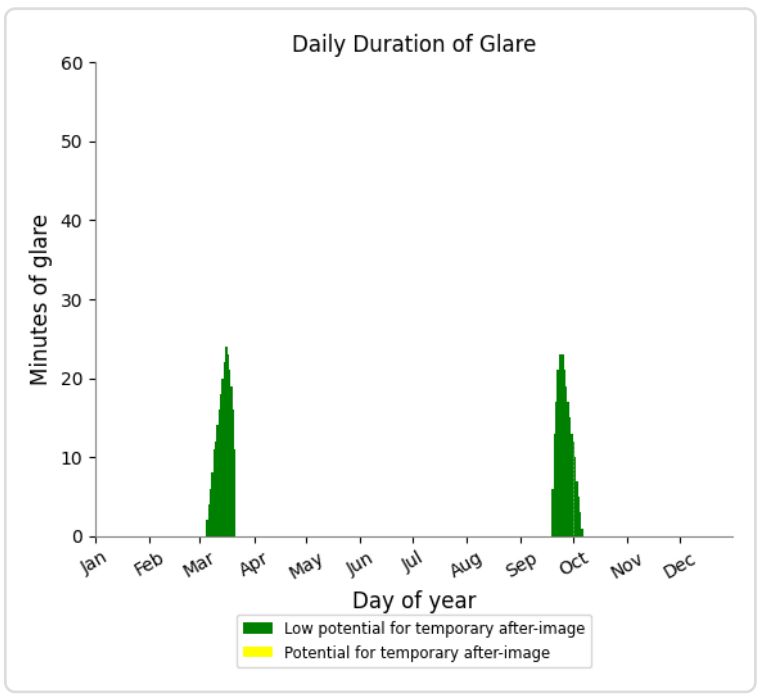


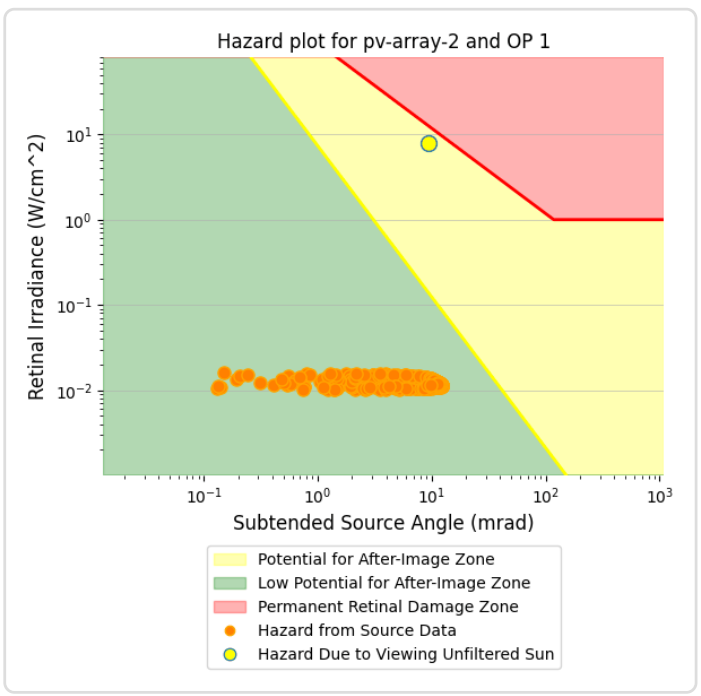
PV array 2 and OP 1

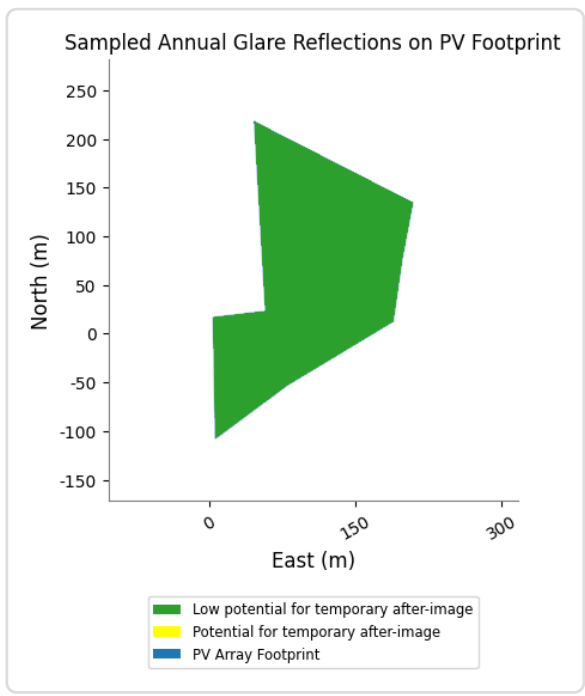
Yellow glare: none

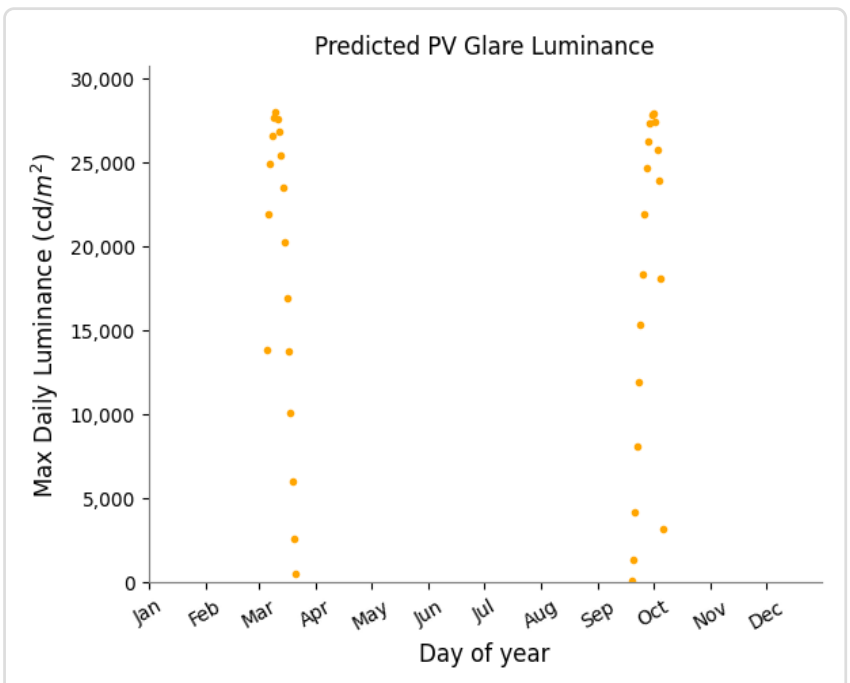
Green glare: 496 min.







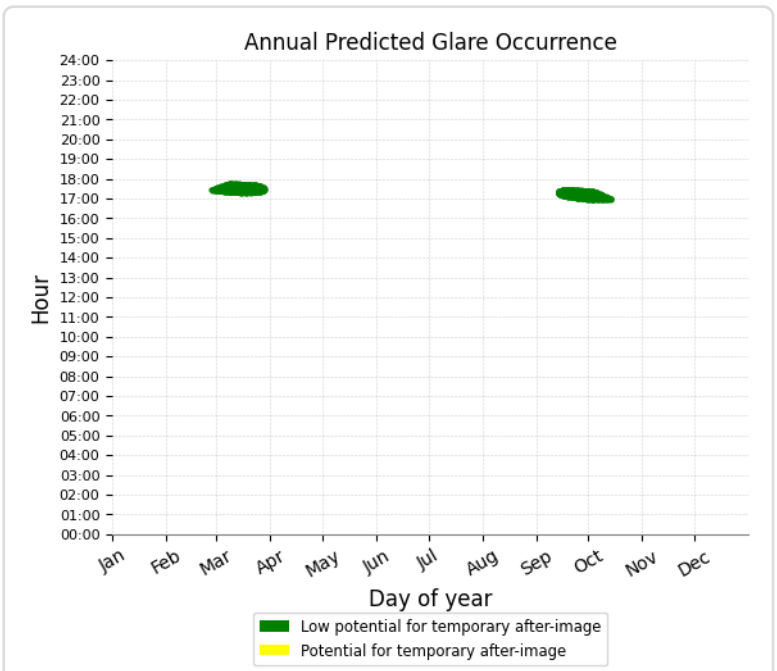


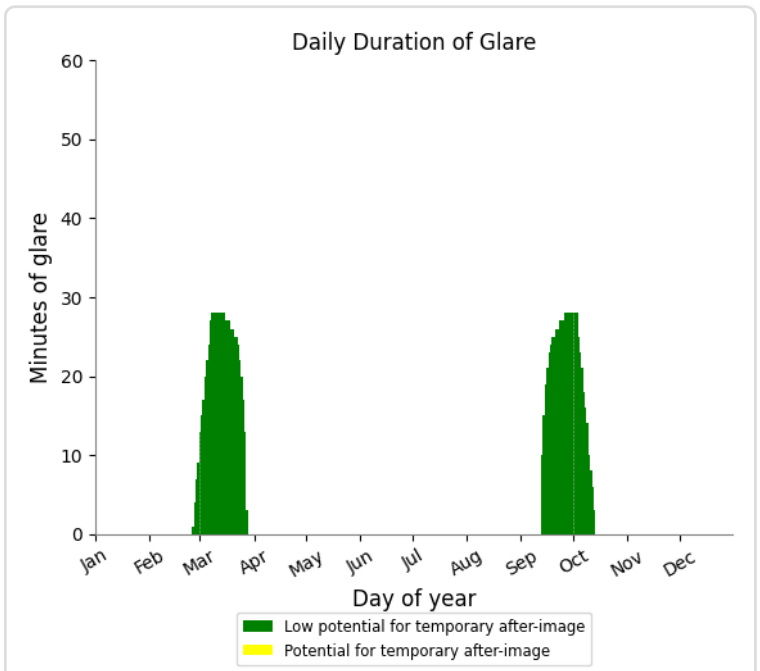


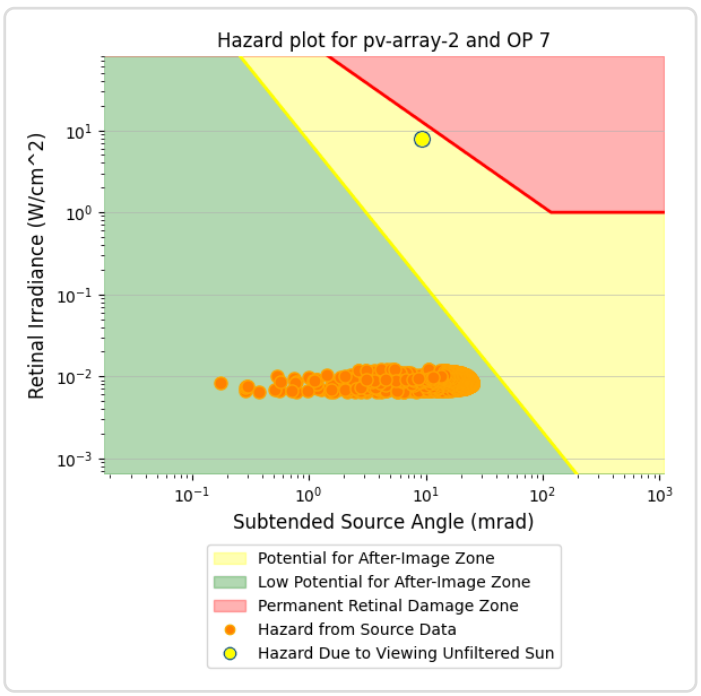
PV array 2 and OP 7

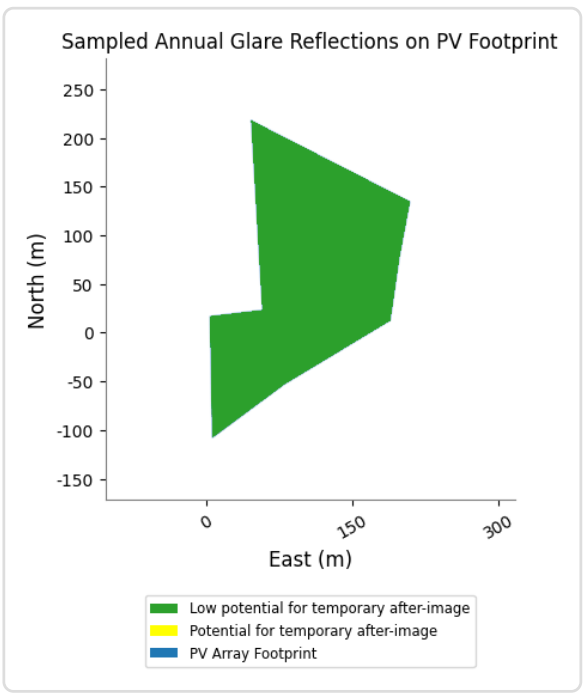
Yellow glare: none

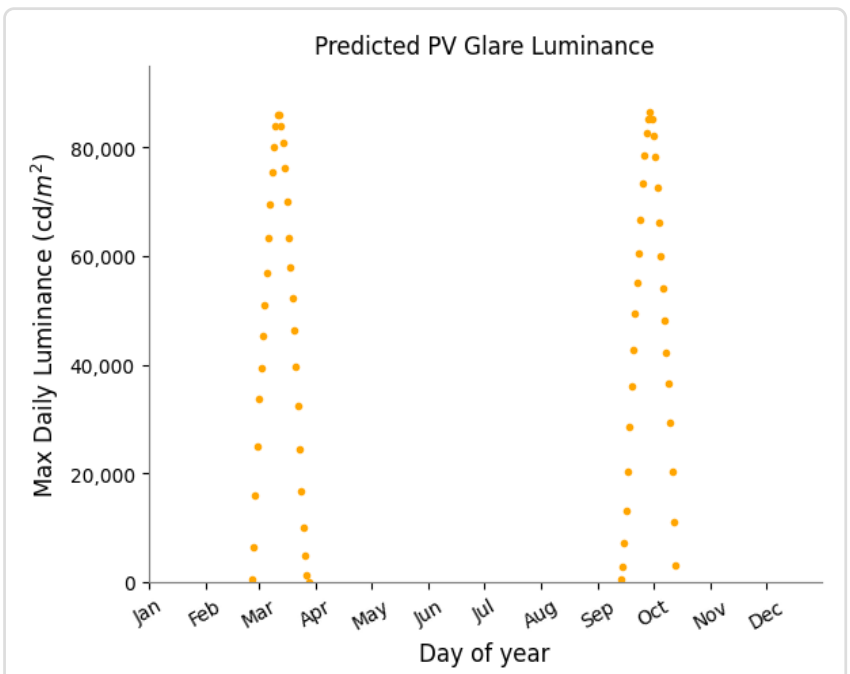
Green glare: 1,328 min.







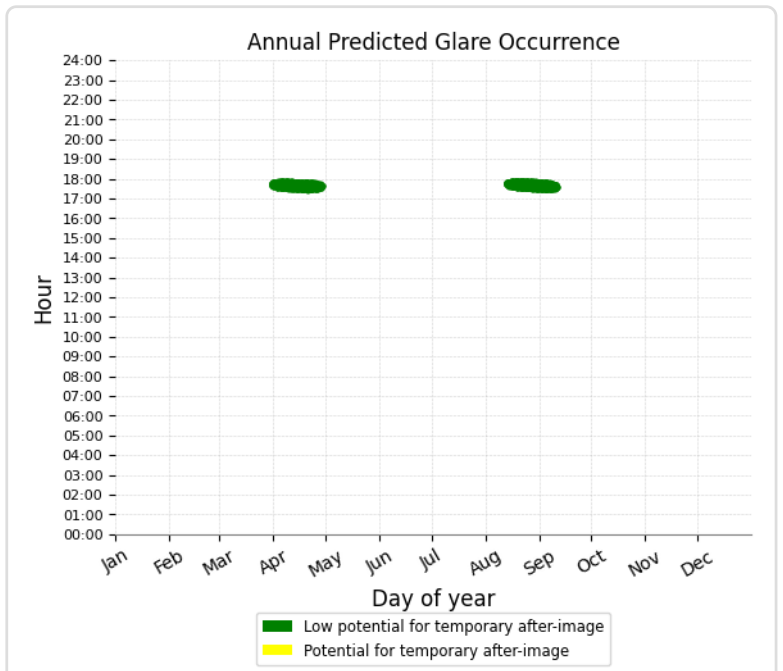


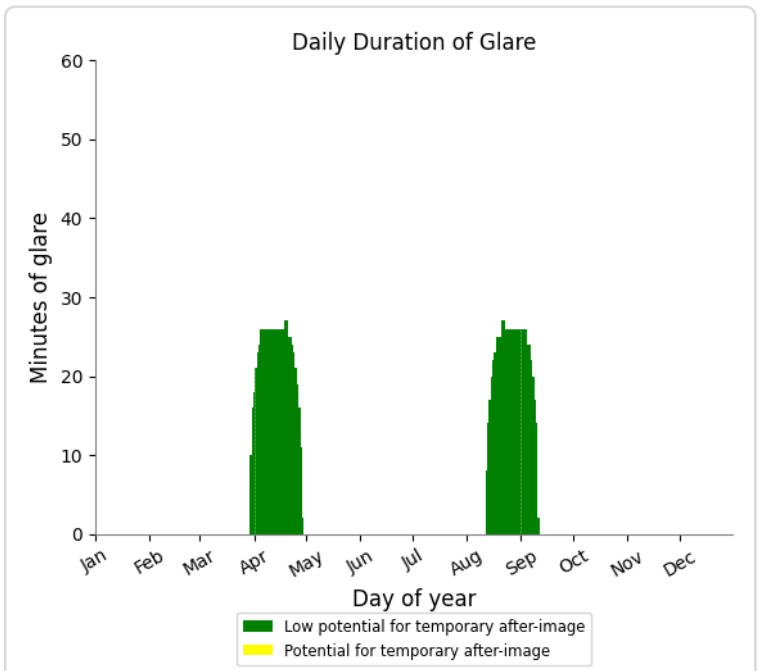


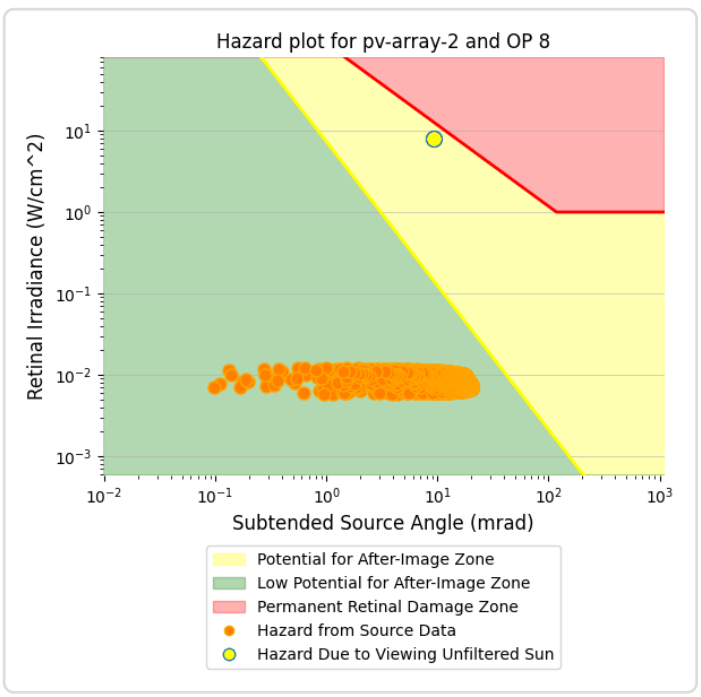
PV array 2 and OP 8

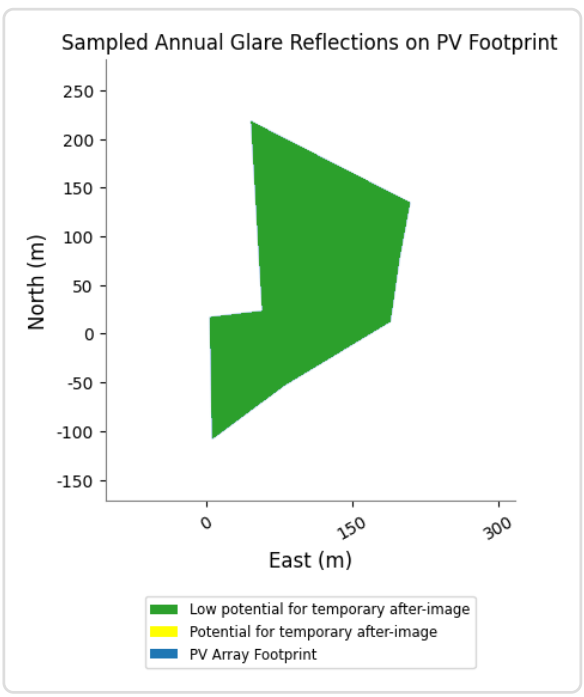
Yellow glare: none

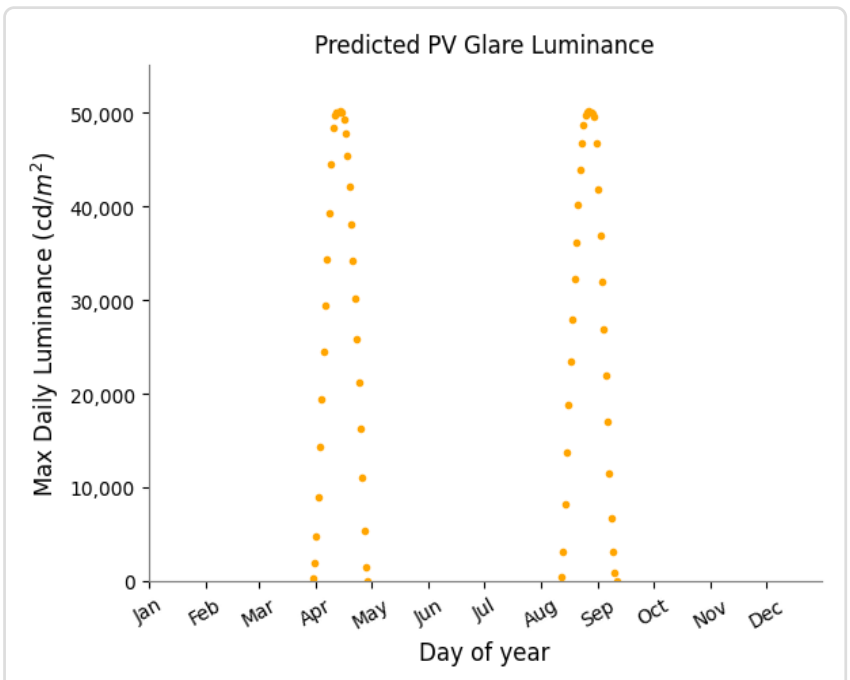
Green glare: 1,390 min.







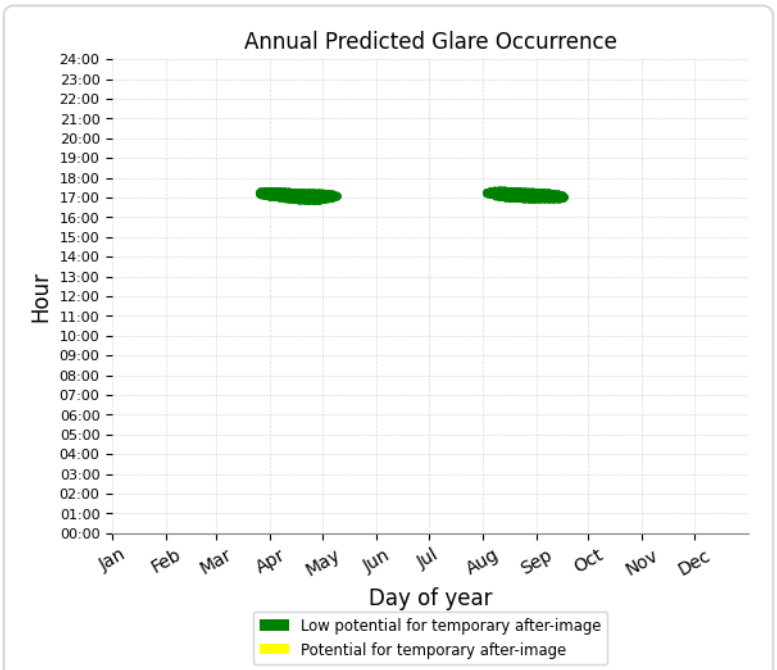


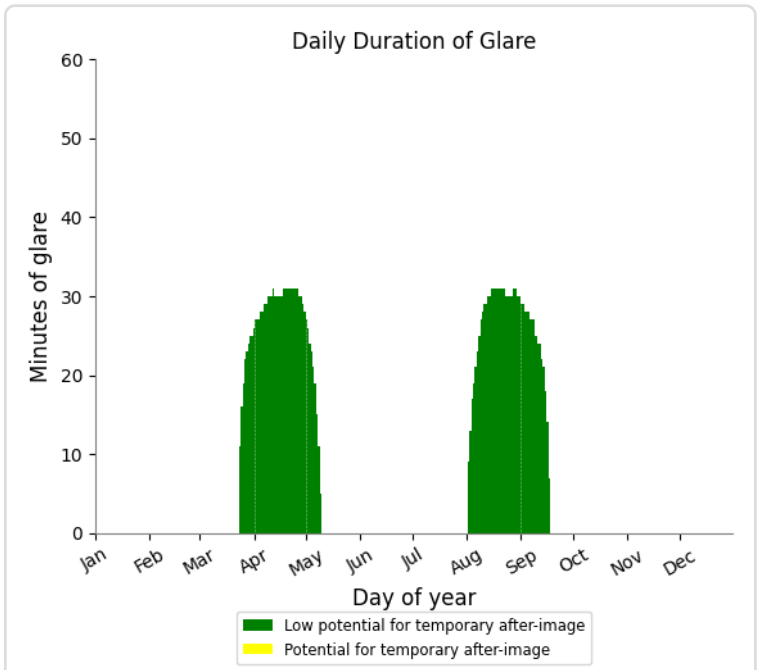


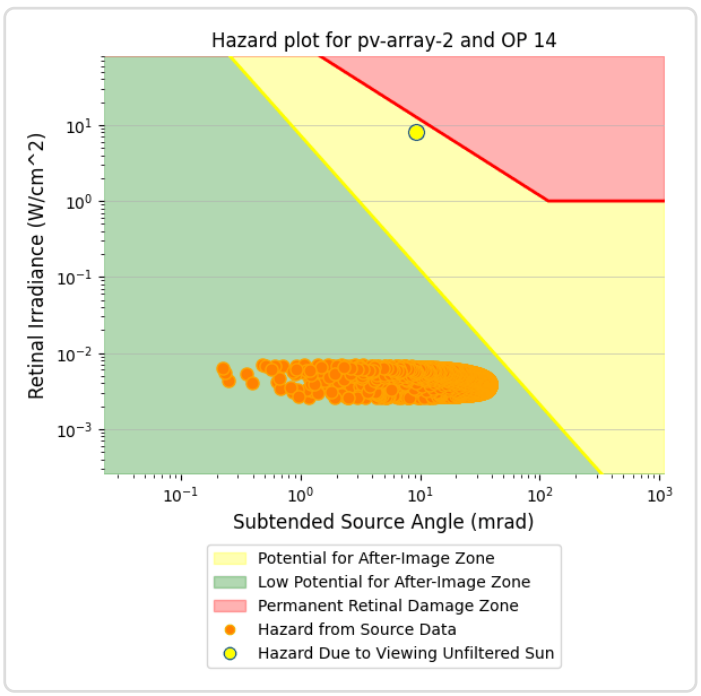
PV array 2 and OP 14

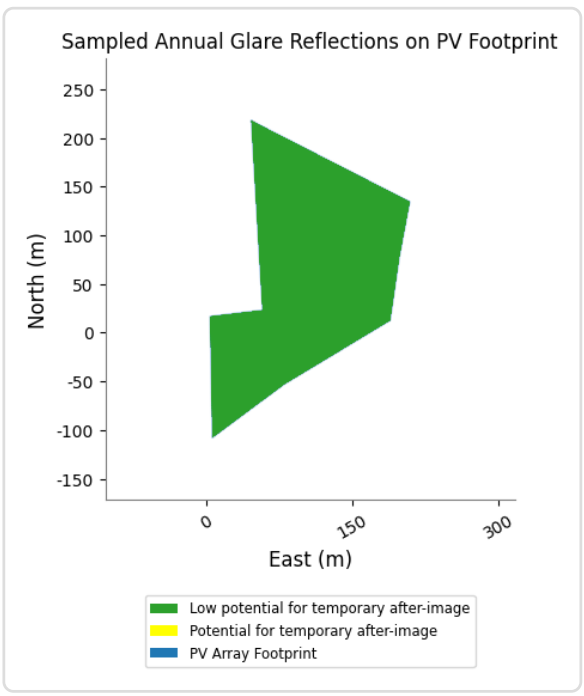
Yellow glare: none

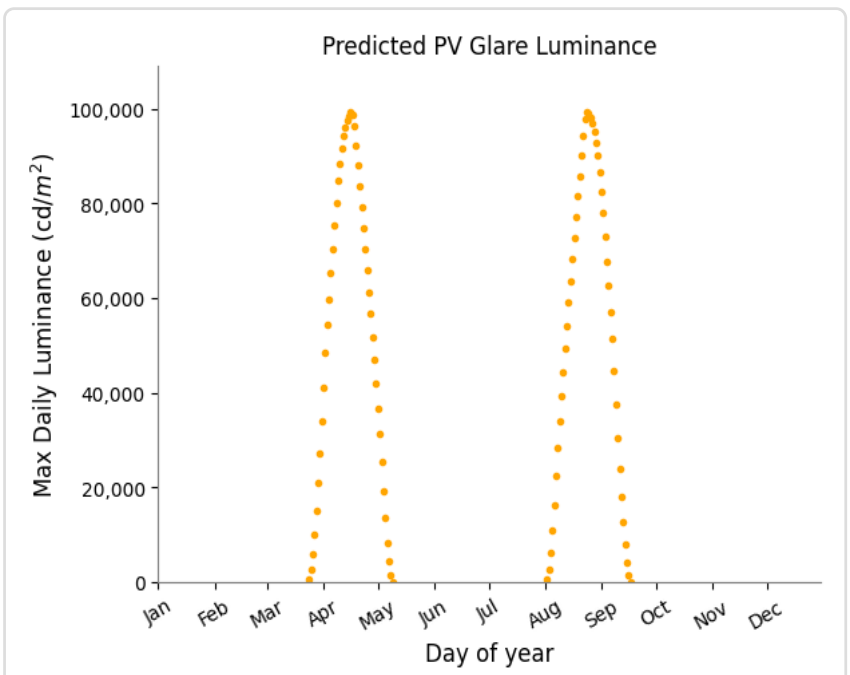
Green glare: 2,447 min.







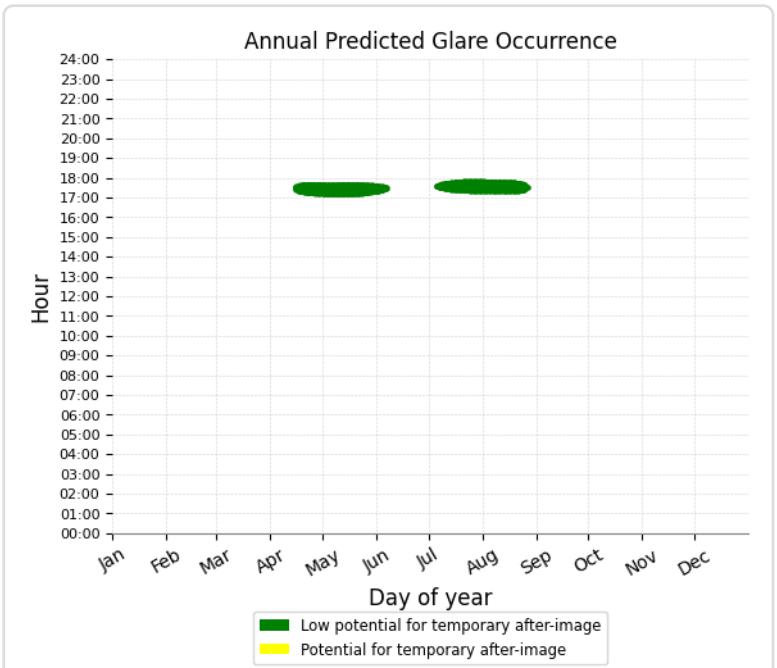


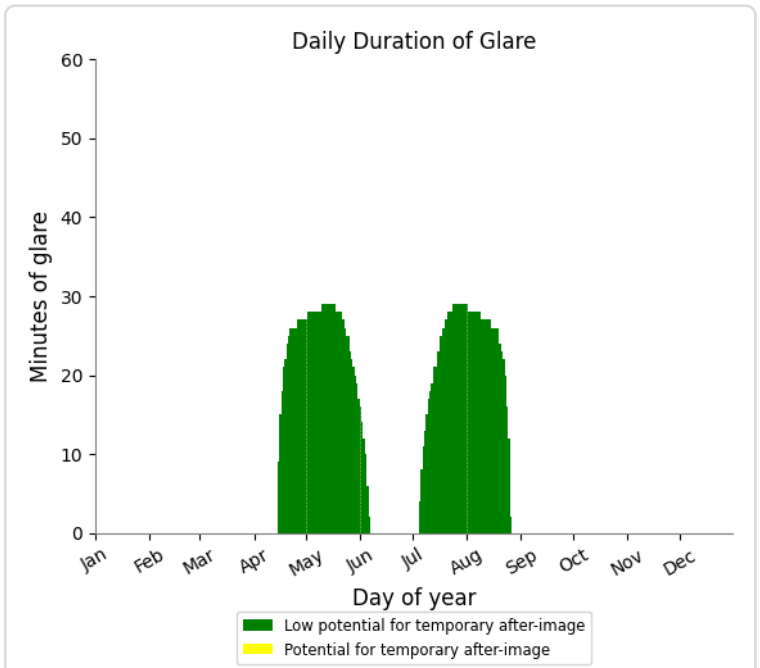


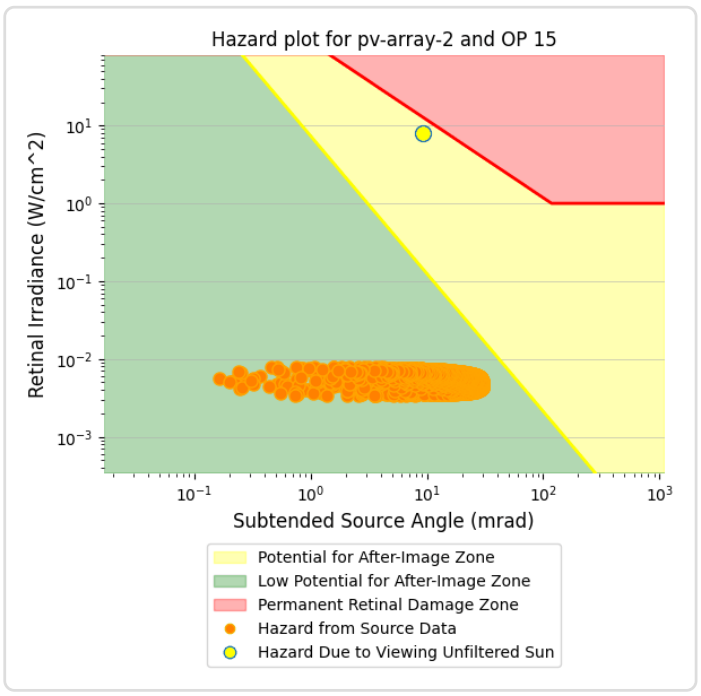
PV array 2 and OP 15

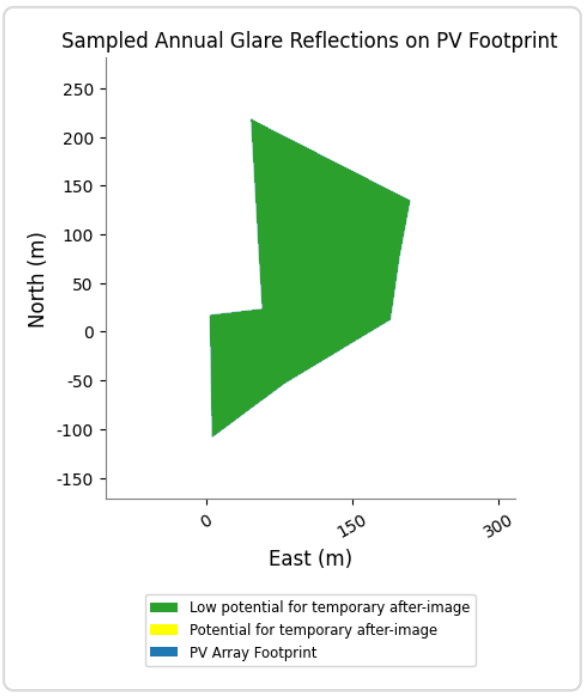
Yellow glare: none

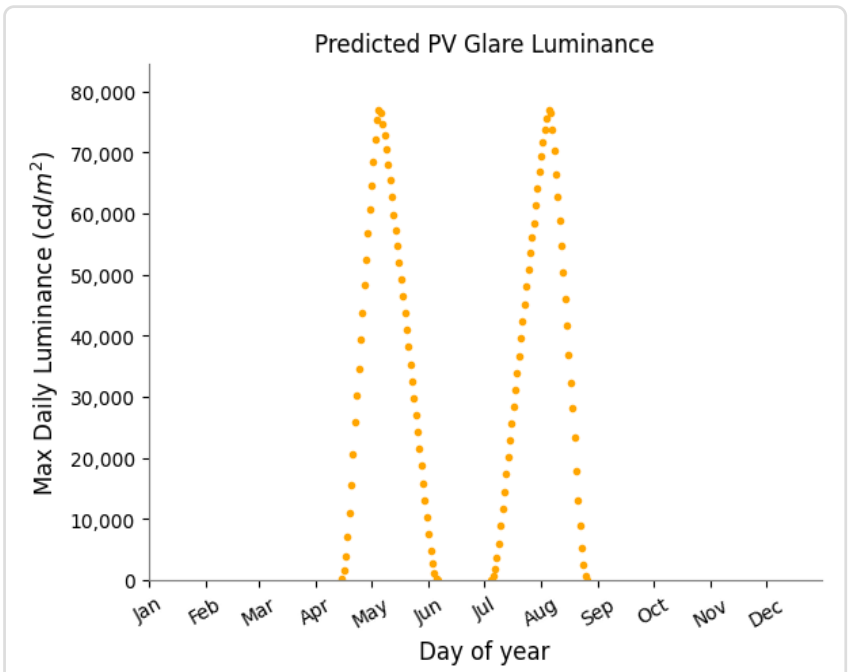
Green glare: 2,502 min.







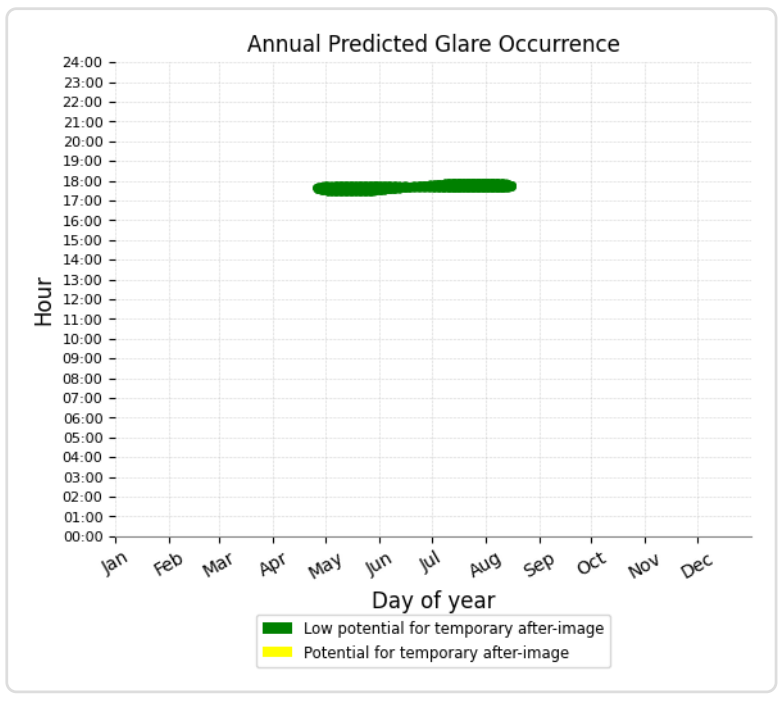


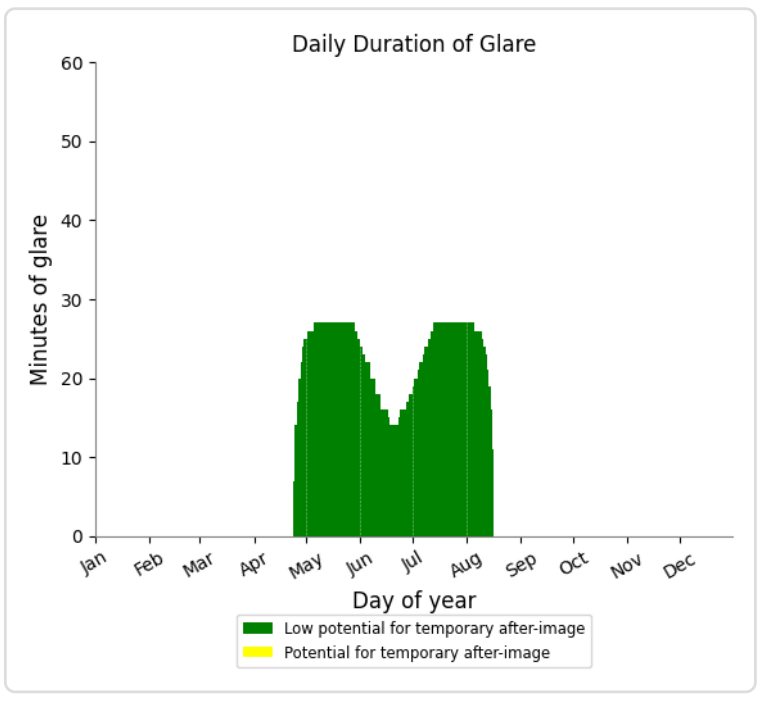


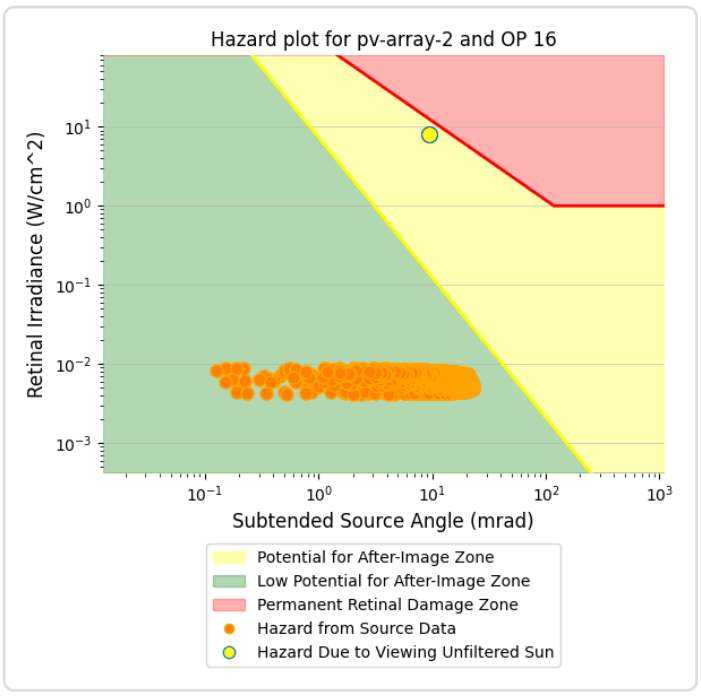
PV array 2 and OP 16

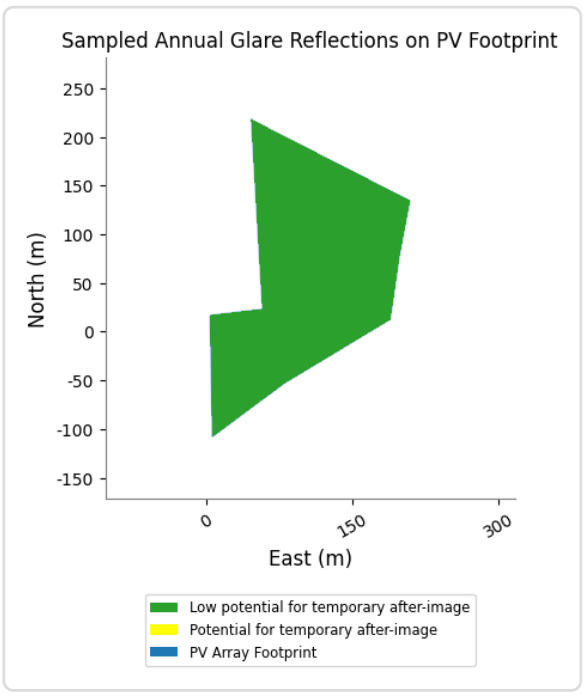
Yellow glare: none

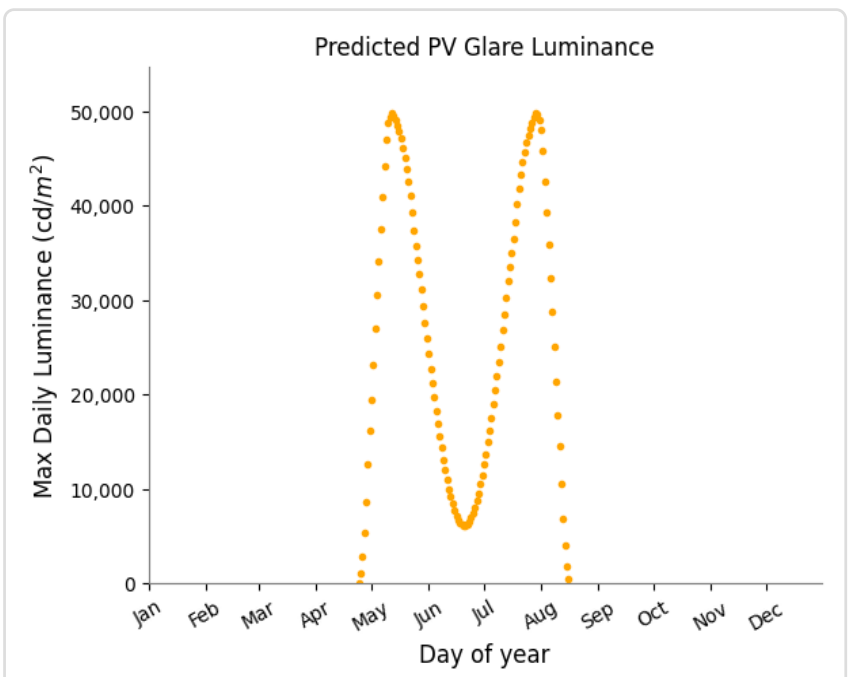
Green glare: 2,650 min.







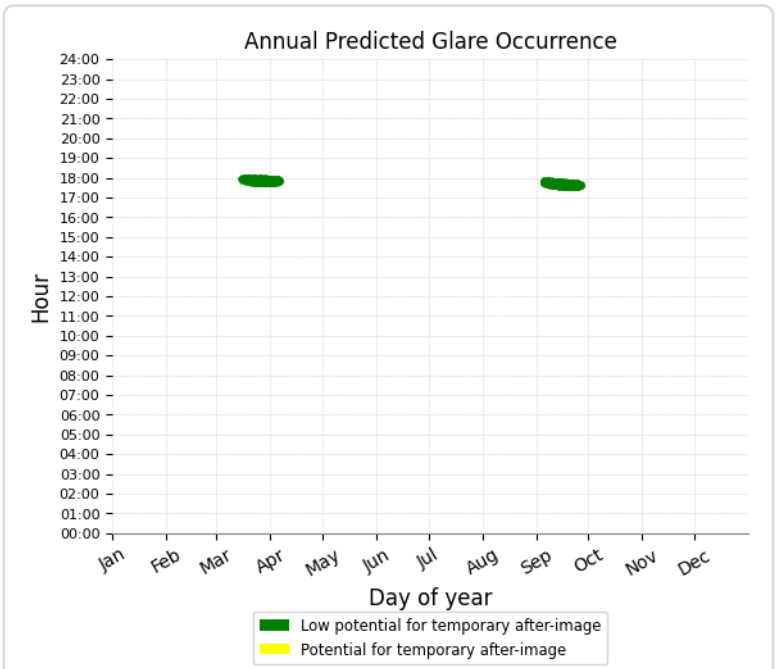


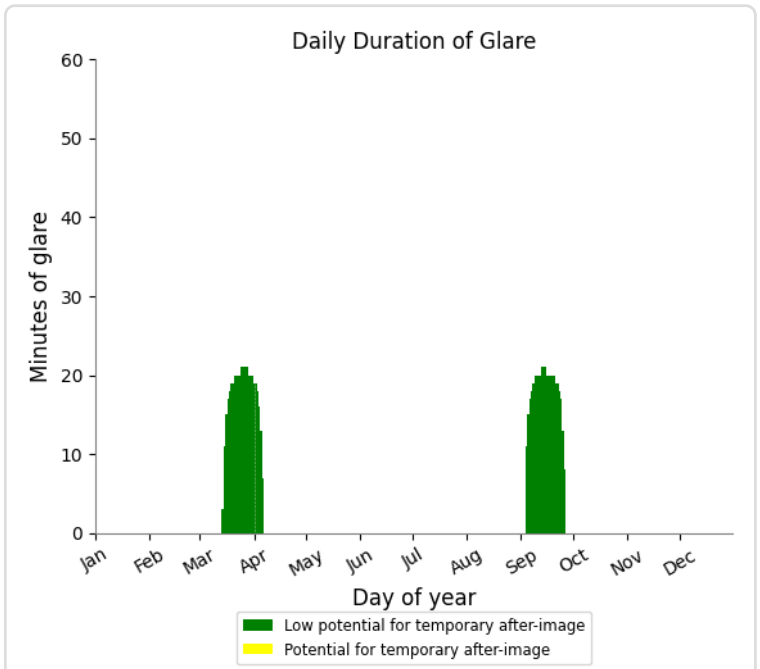


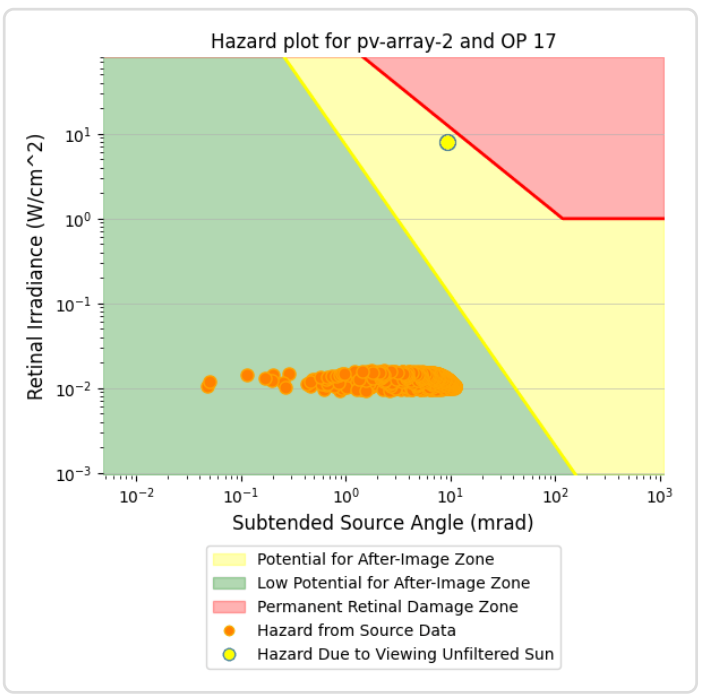
PV array 2 and OP 17

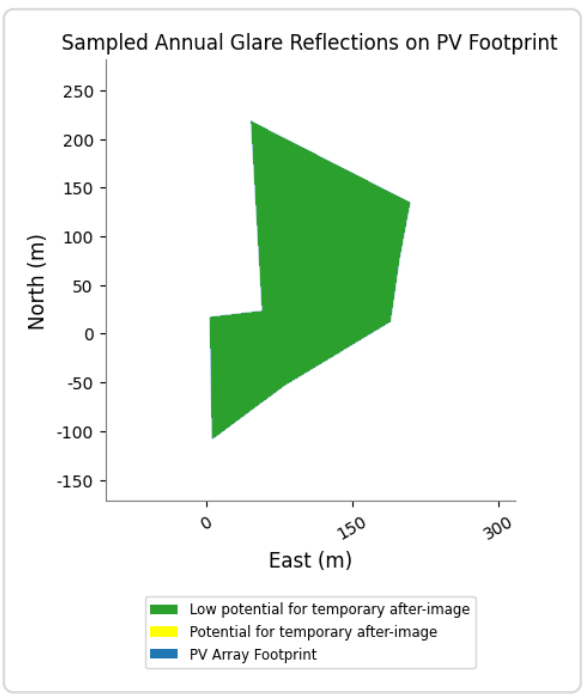
Yellow glare: none

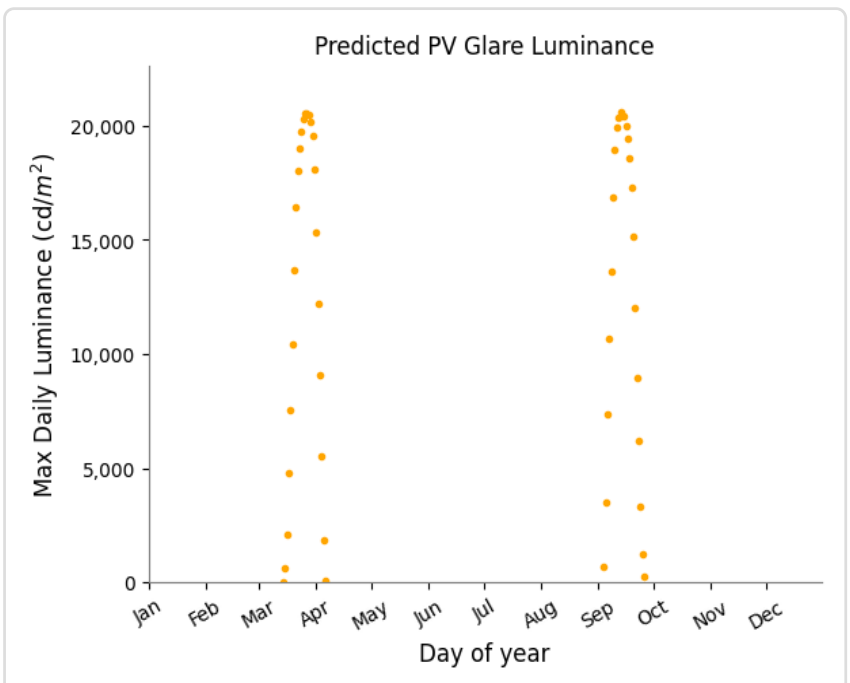
Green glare: 835 min.







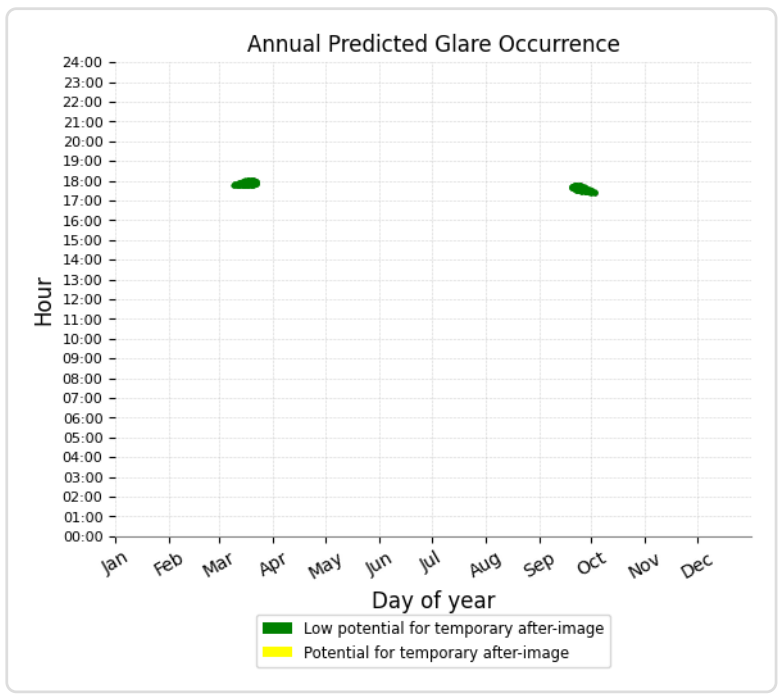


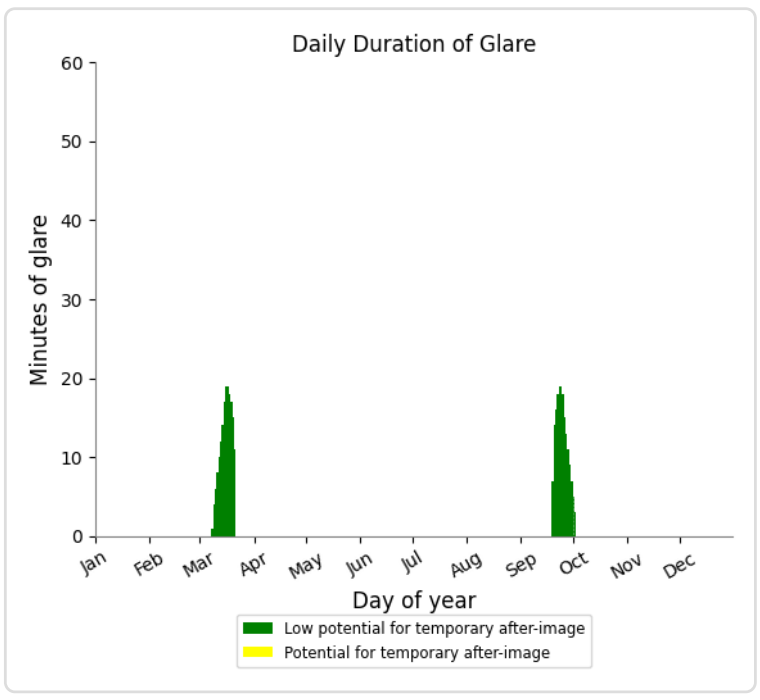


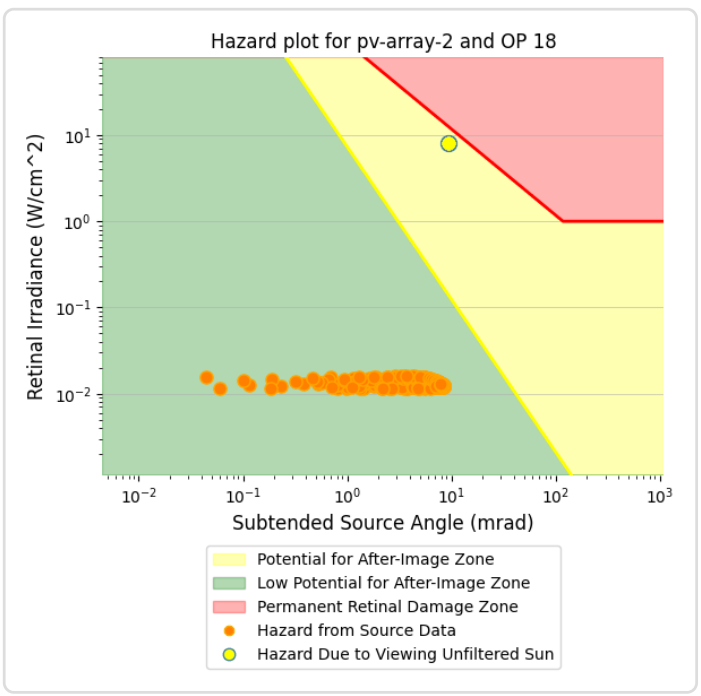
PV array 2 and OP 18

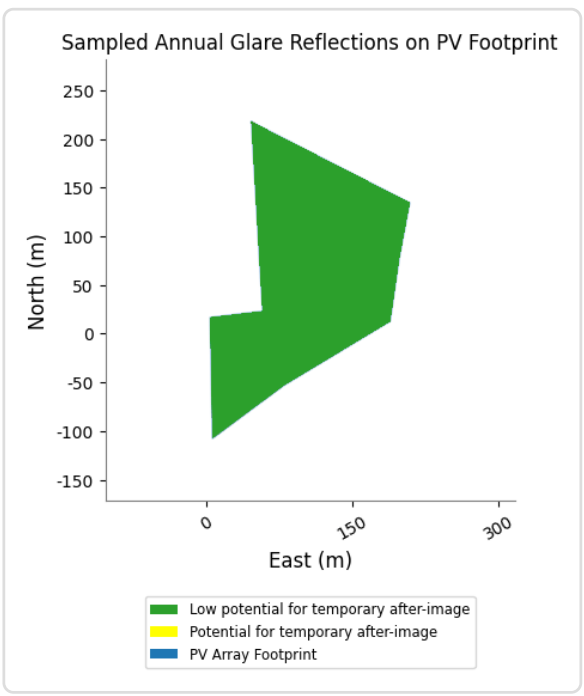
Yellow glare: none

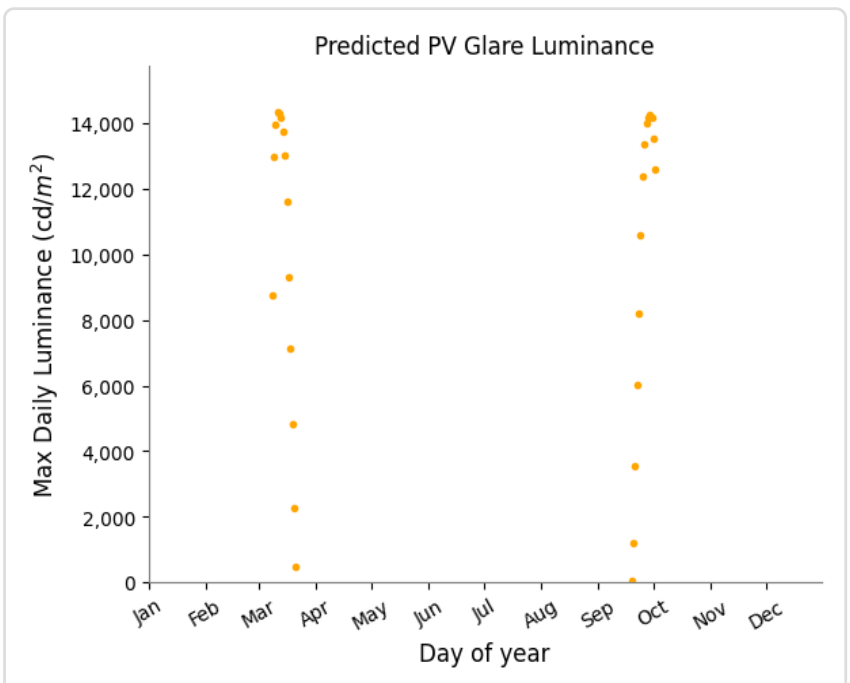
Green glare: 345 min.











PV array 2 and OP 2

No glare found

PV array 2 and OP 3

No glare found

PV array 2 and OP 4

No glare found

PV array 2 and OP 5

No glare found

PV array 2 and OP 6

No glare found

PV array 2 and OP 9

No glare found

PV array 2 and OP 10

No glare found

PV array 2 and OP 11

No glare found

PV array 2 and OP 12

No glare found

PV array 2 and OP 13

No glare found

PV array 2 and OP 19

No glare found

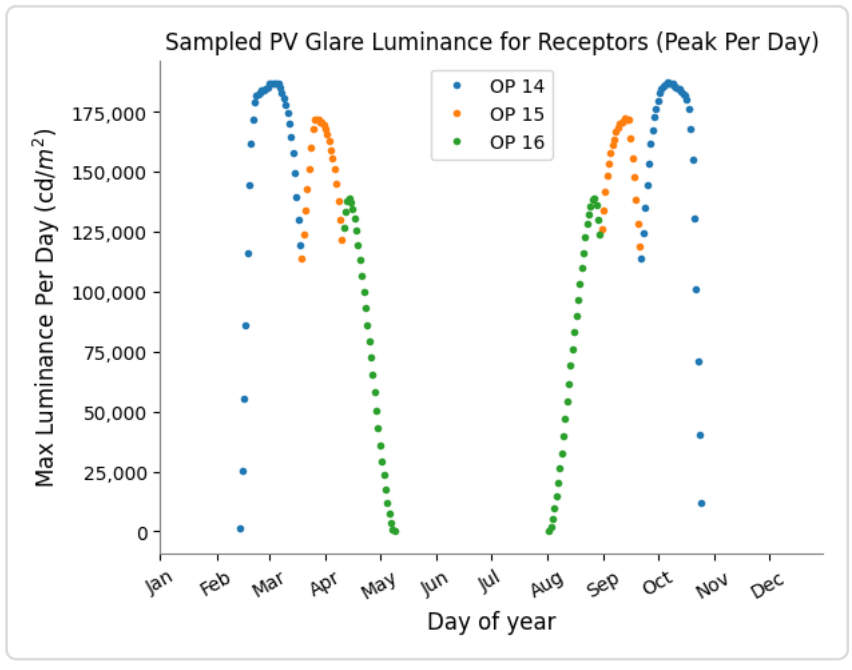
PV array 2 and OP 20

No glare found

PV: PV array 3 low potential for temporary after-image

Receptor results ordered by category of glare

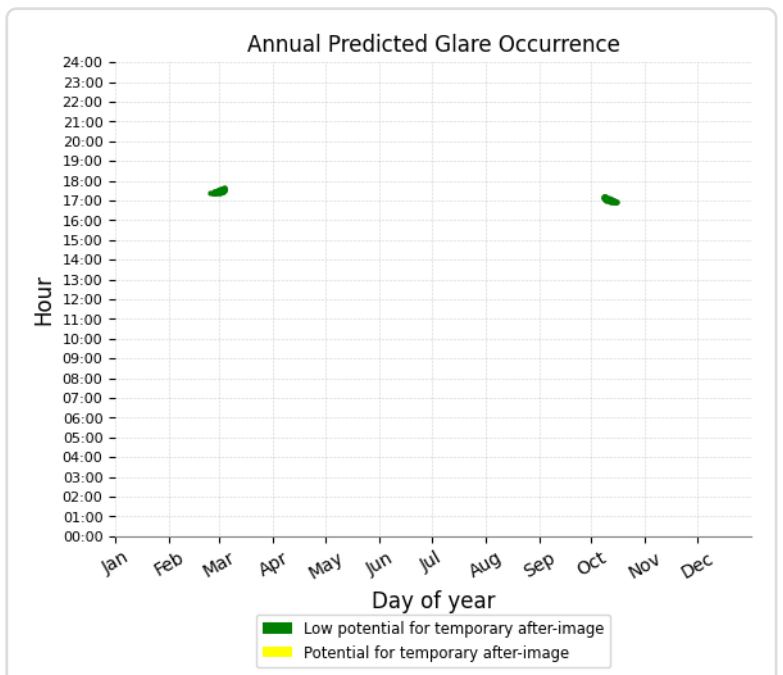
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 7	117	1.9	0	0.0	27,722
OP 8	1,588	26.5	0	0.0	124,529
OP 14	2,219	37.0	0	0.0	187,209
OP 15	2,499	41.6	0	0.0	172,134
OP 16	2,080	34.7	0	0.0	139,132
OP 17	610	10.2	0	0.0	53,087
OP 18	16	0.3	0	0.0	1,941
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

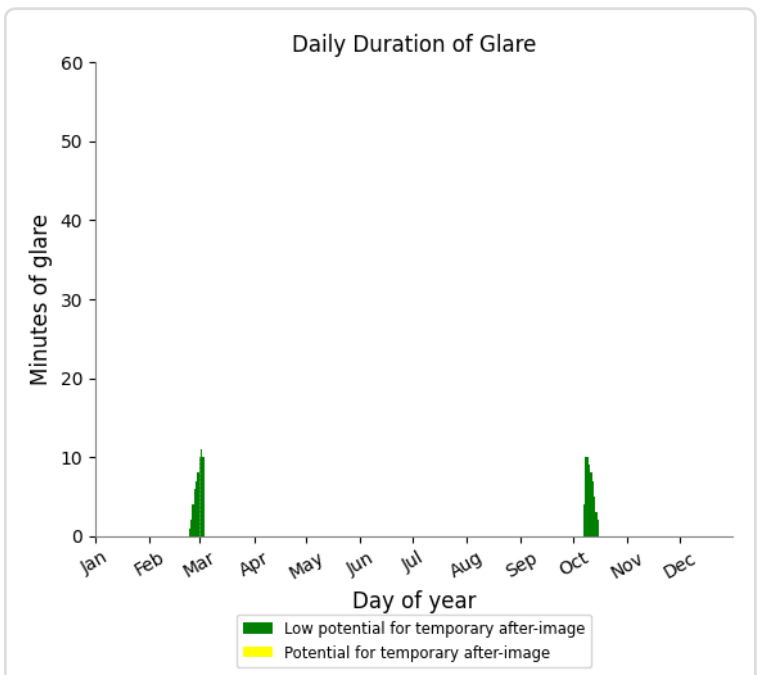


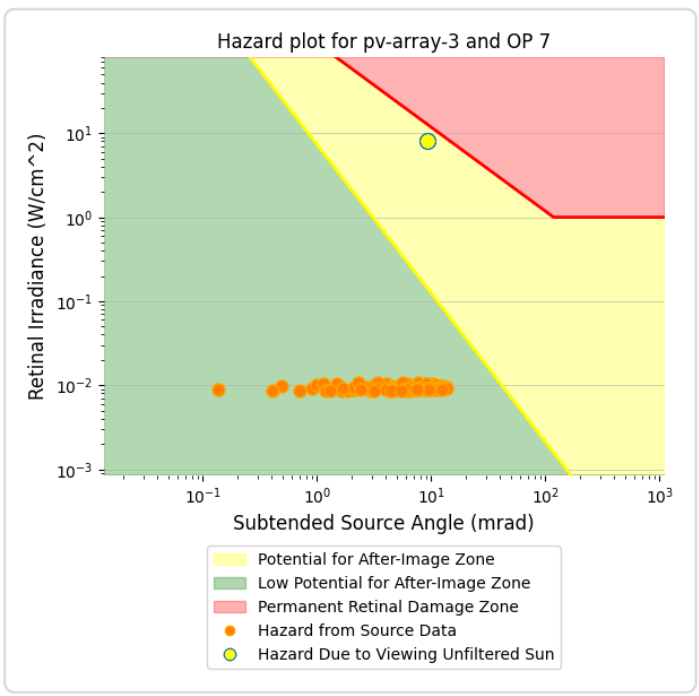
PV array 3 and OP 7

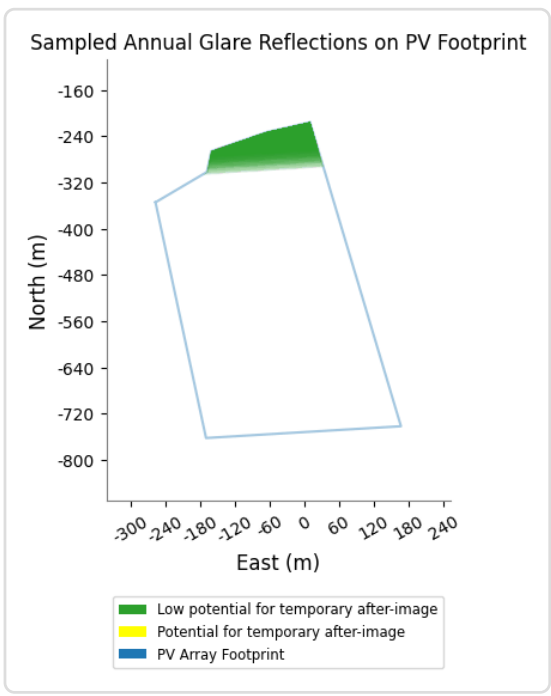
Yellow glare: none

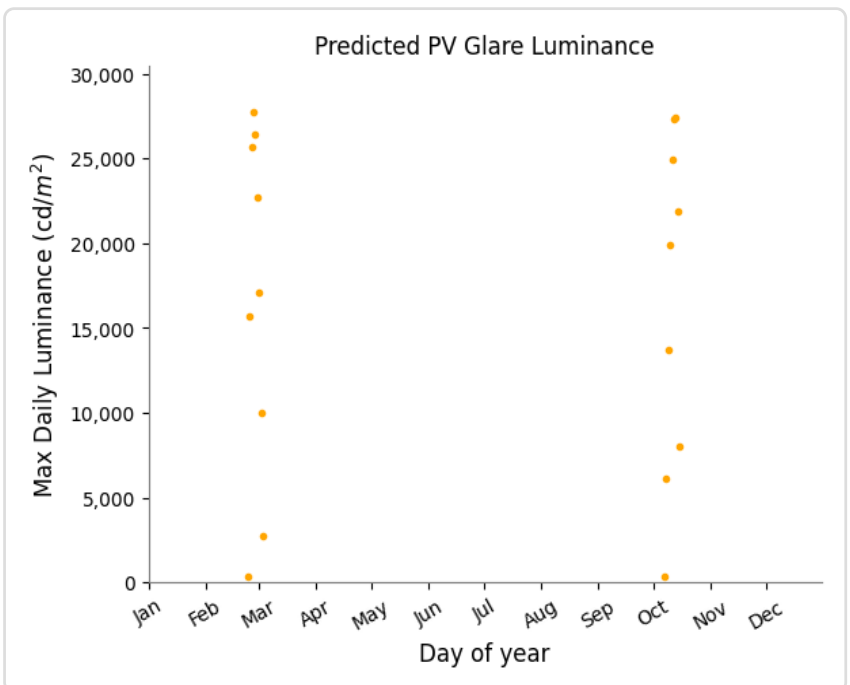
Green glare: 117 min.







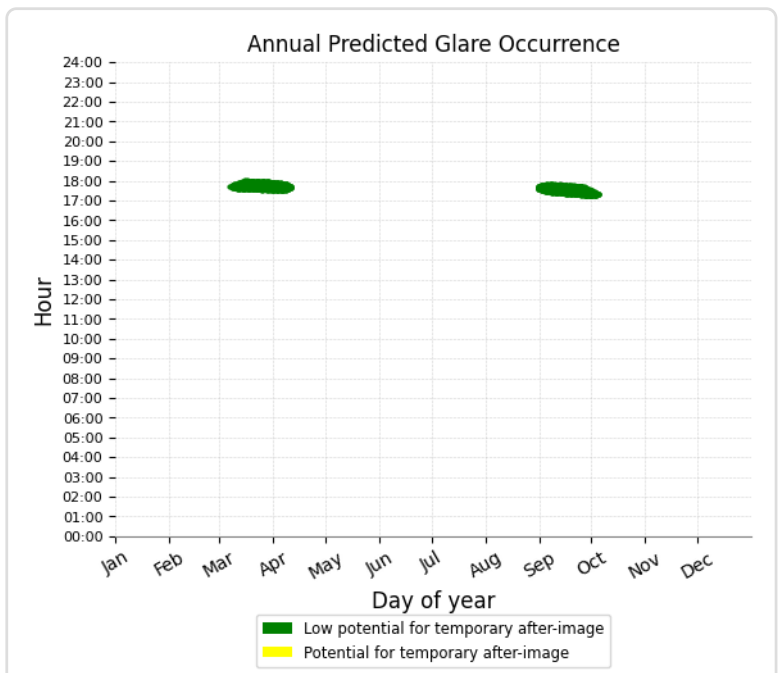


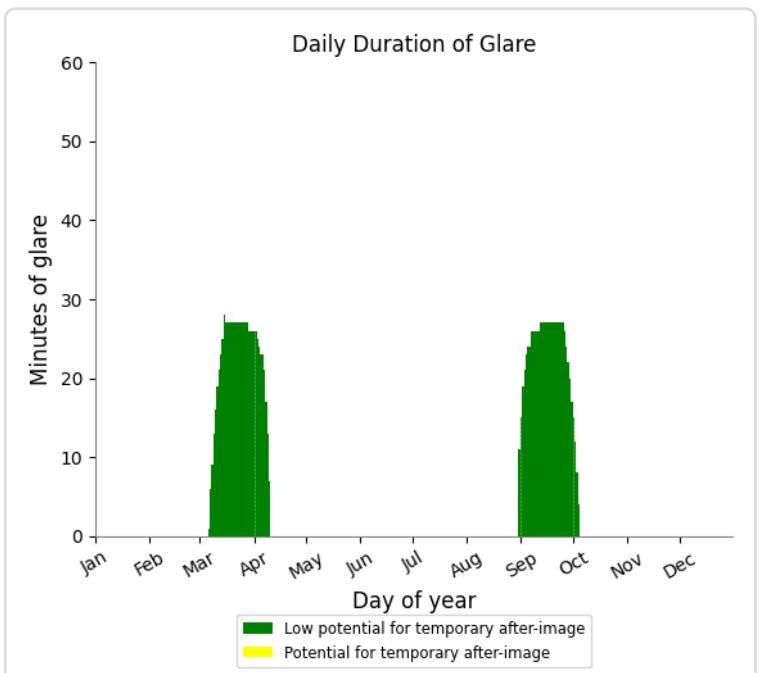


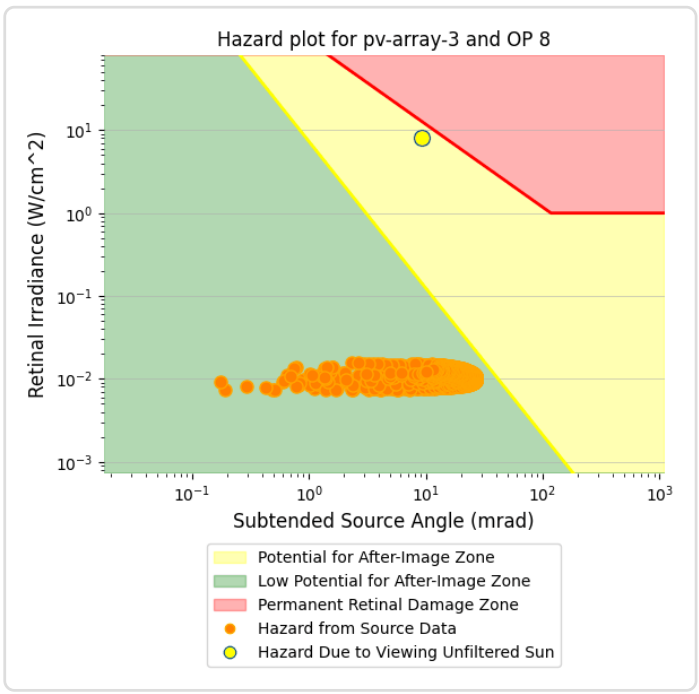
PV array 3 and OP 8

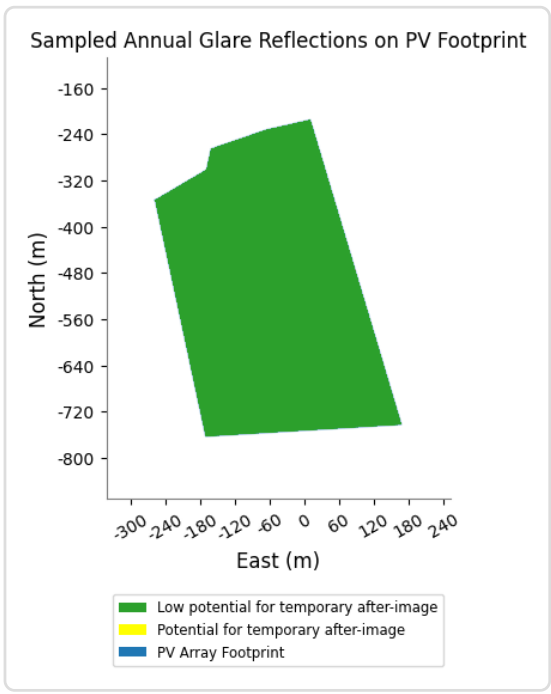
Yellow glare: none

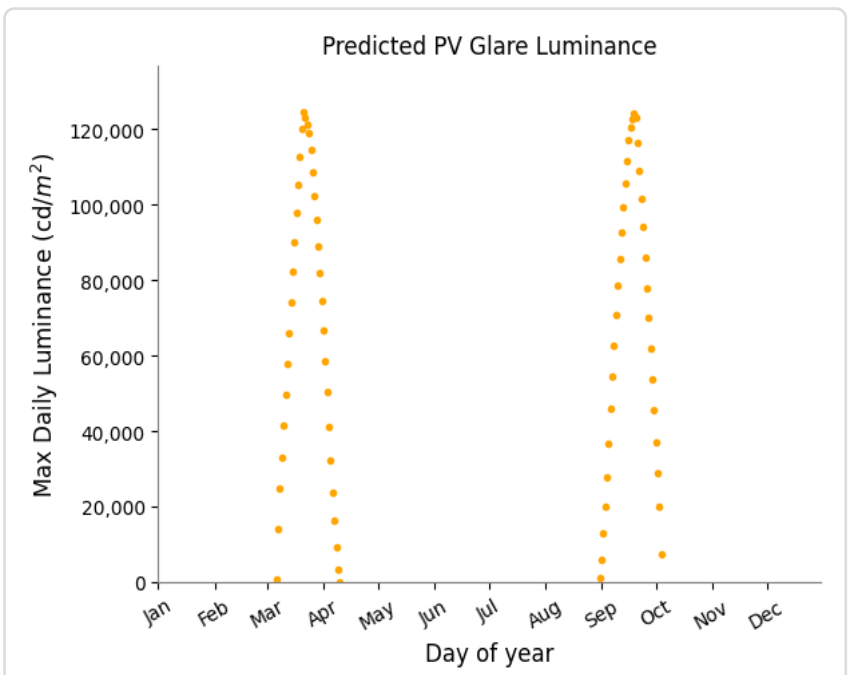
Green glare: 1,588 min.







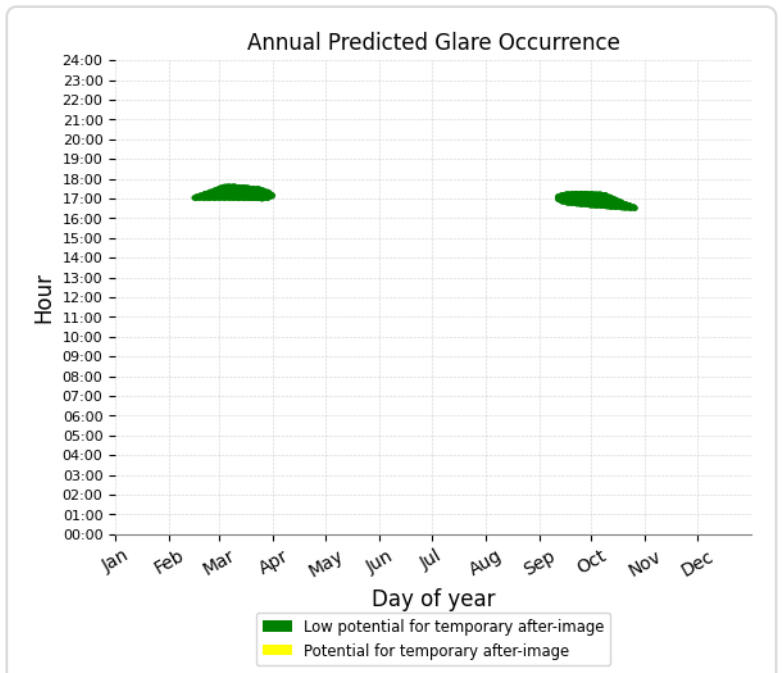


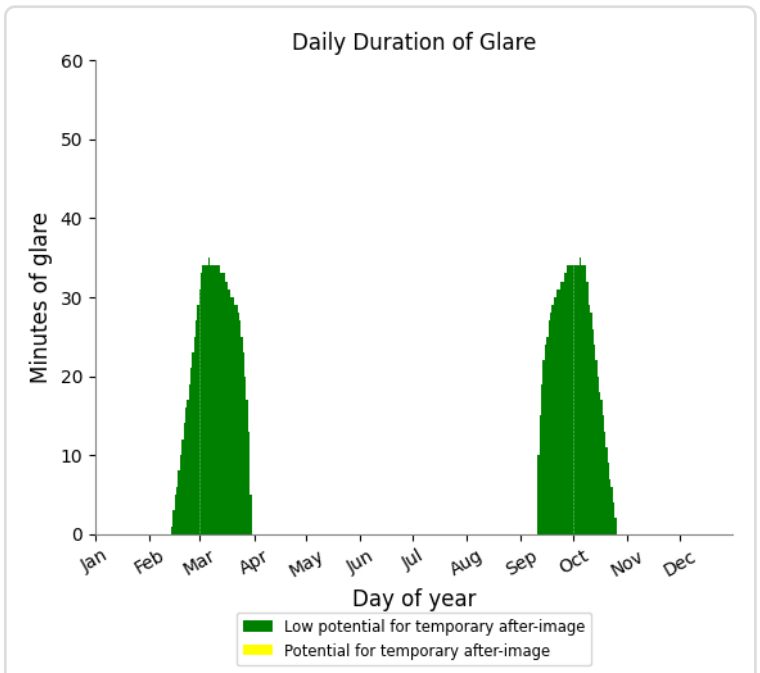


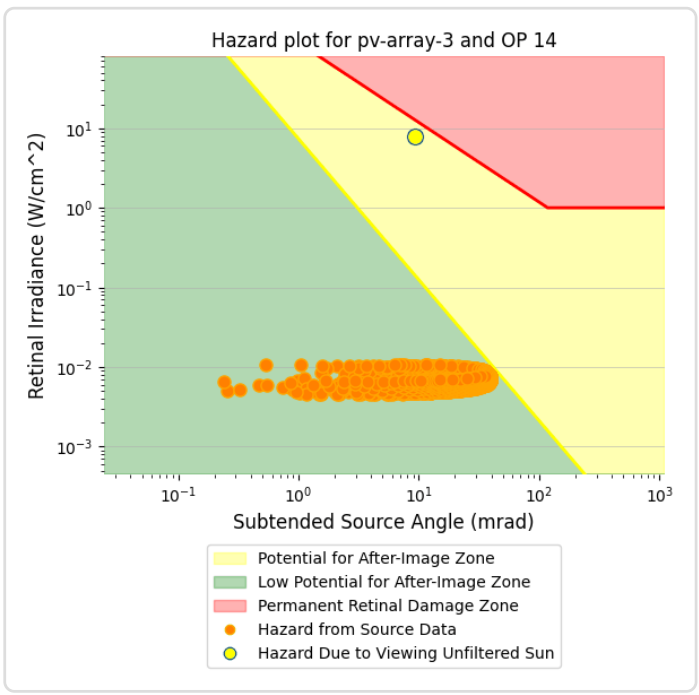
PV array 3 and OP 14

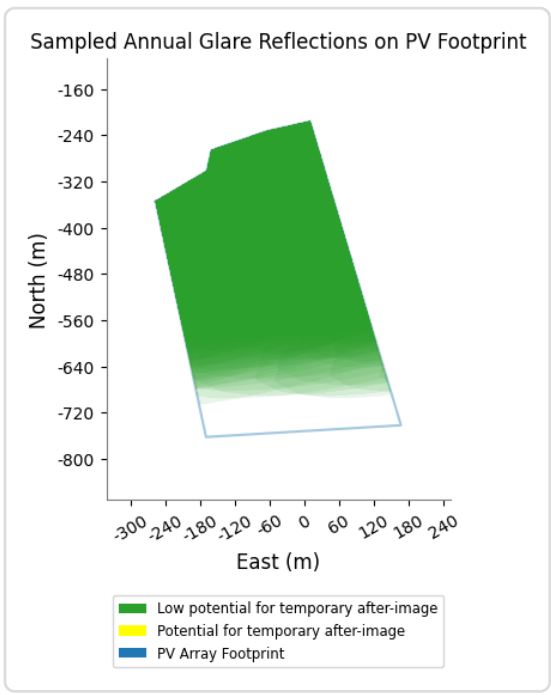
Yellow glare: none

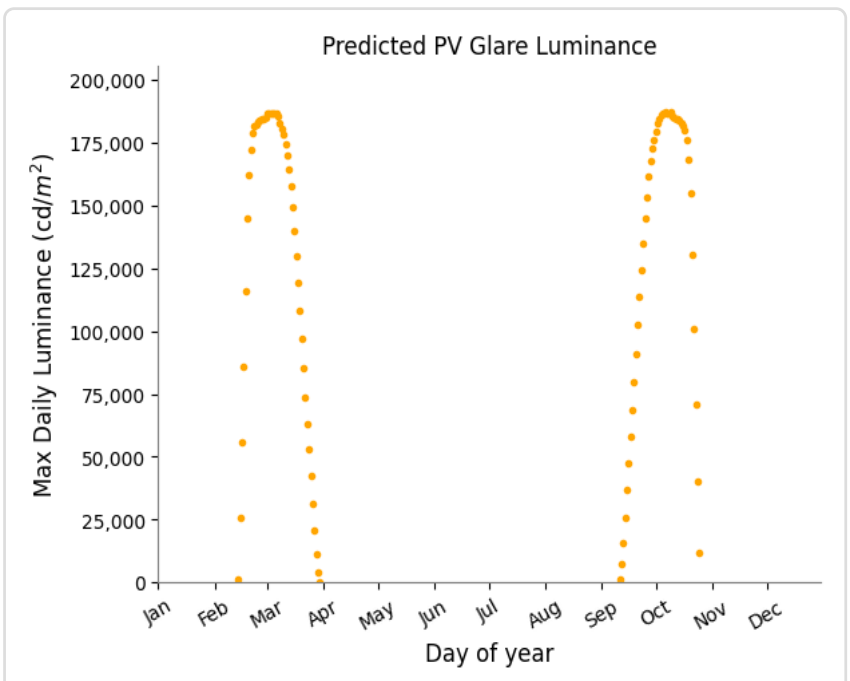
Green glare: 2,219 min.







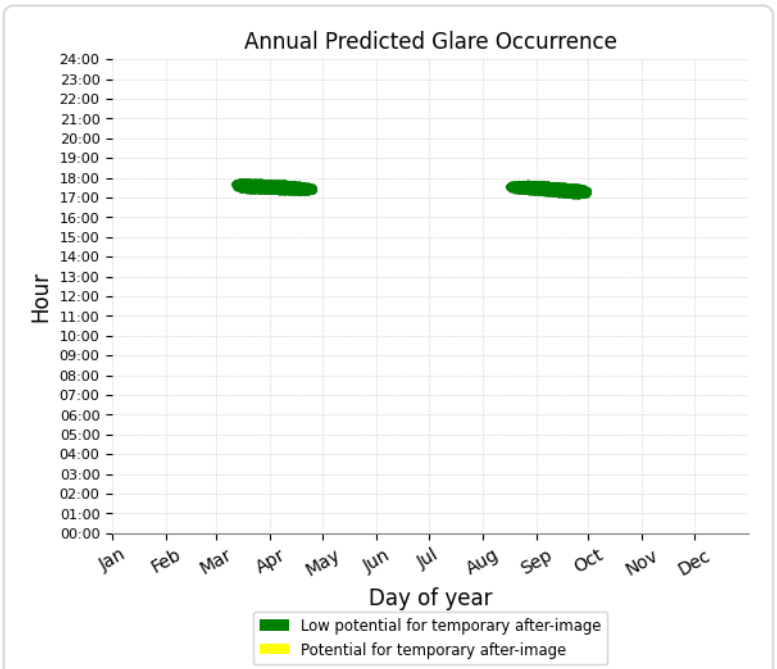


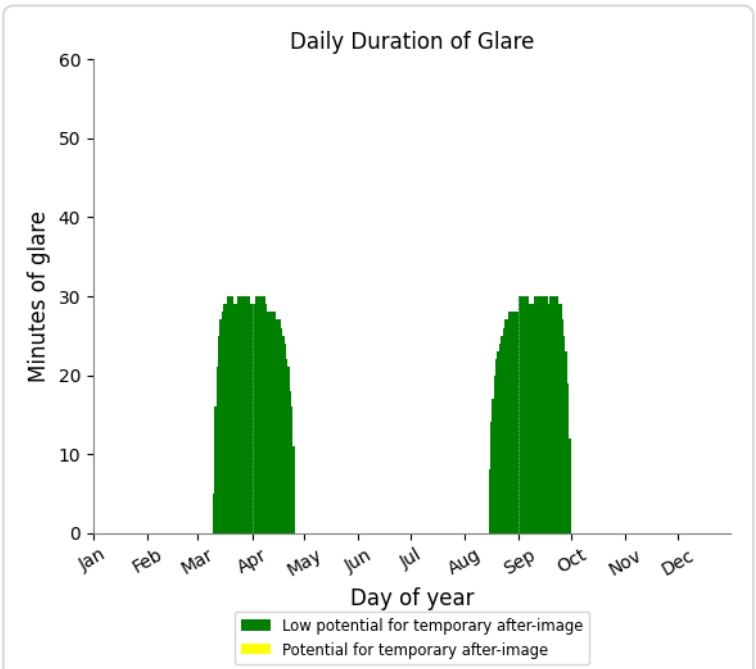


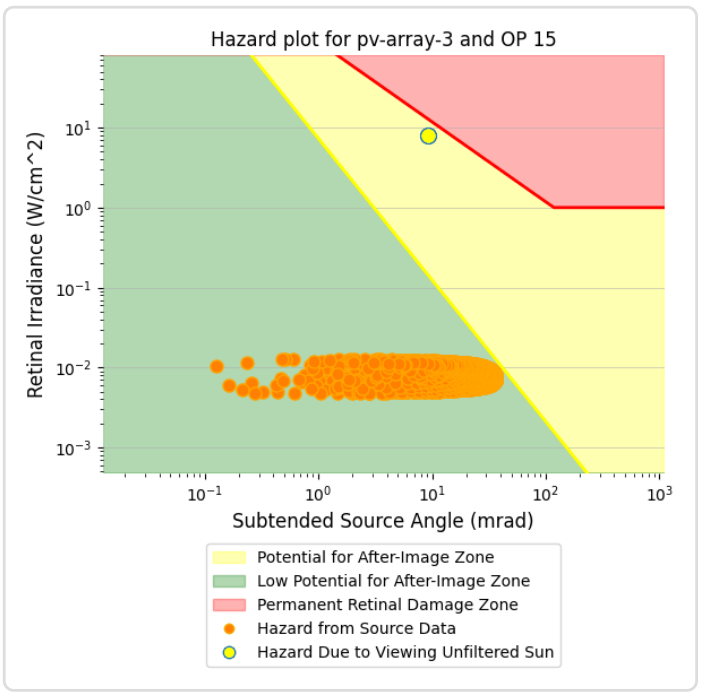
PV array 3 and OP 15

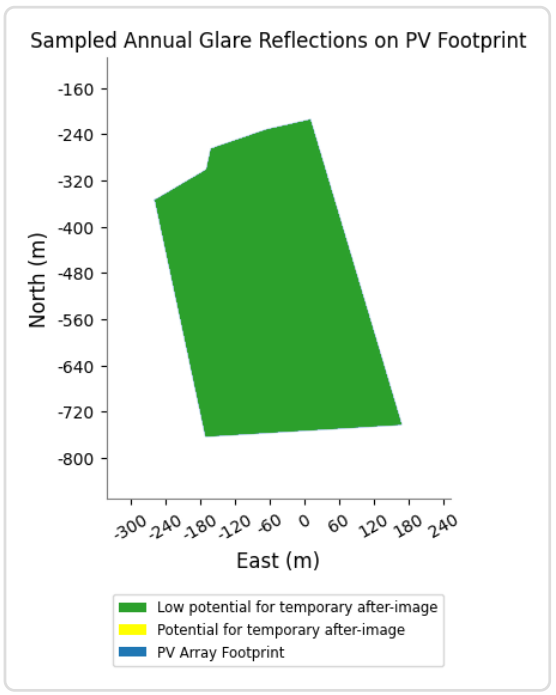
Yellow glare: none

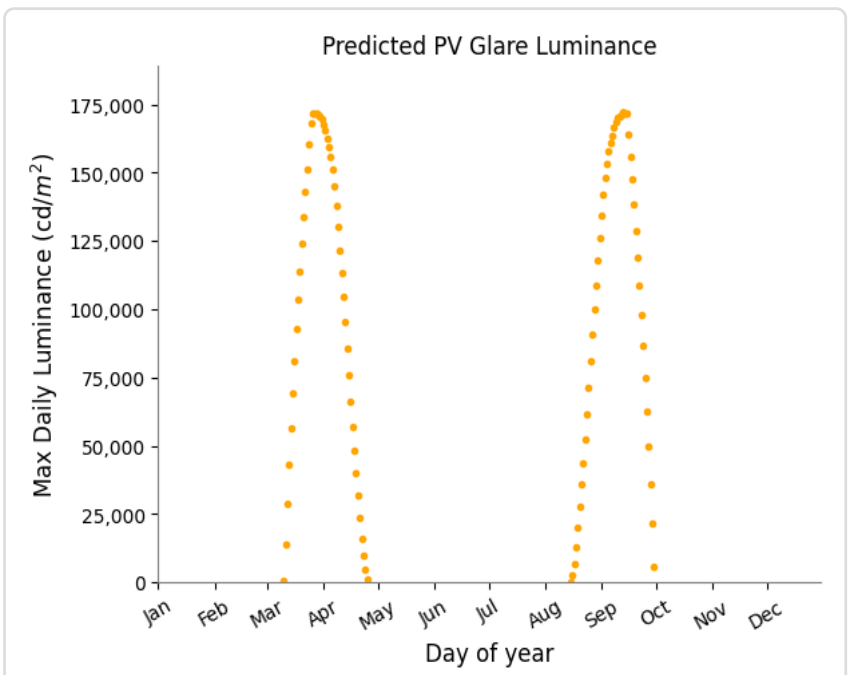
Green glare: 2,499 min.







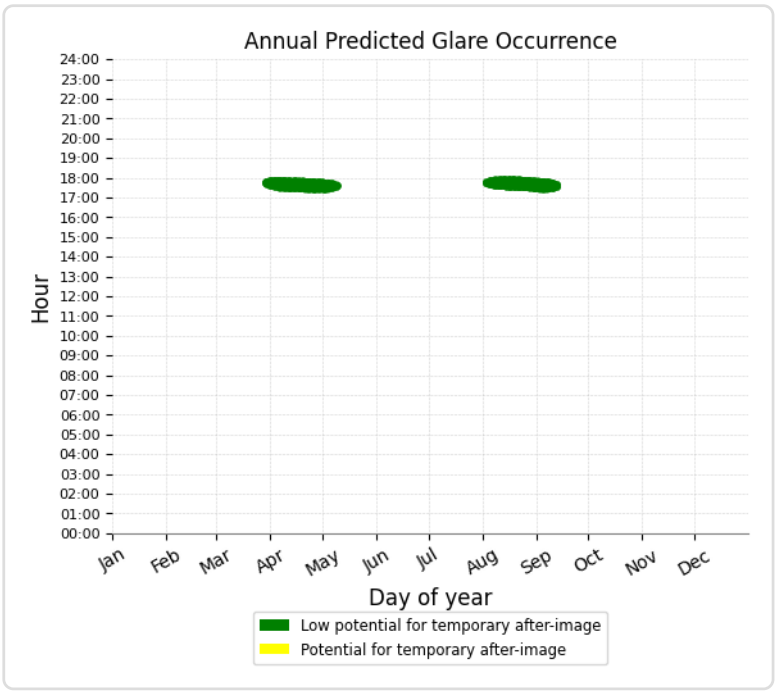


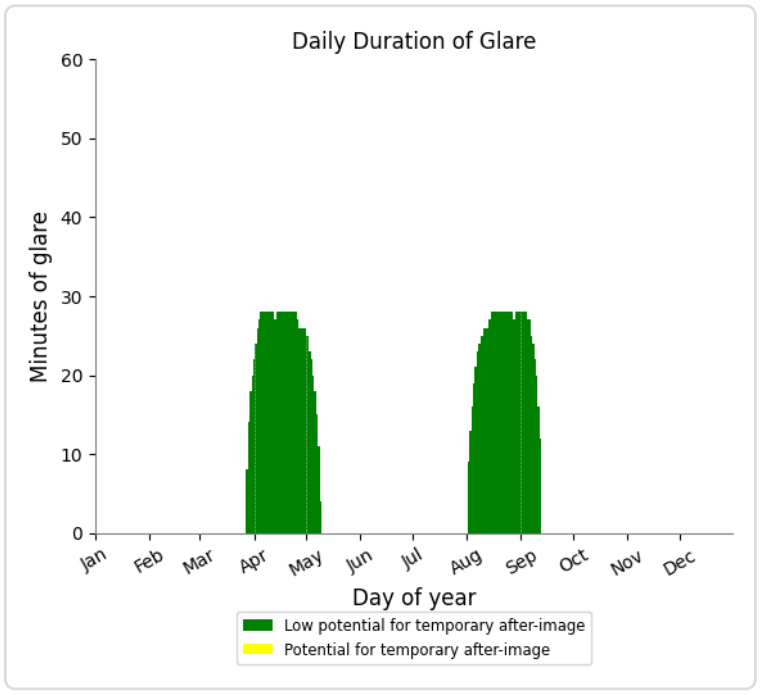


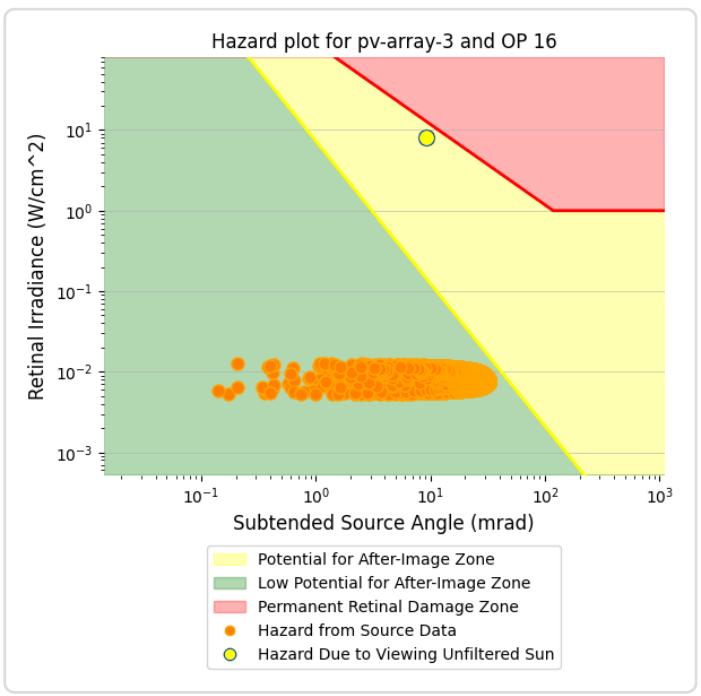
PV array 3 and OP 16

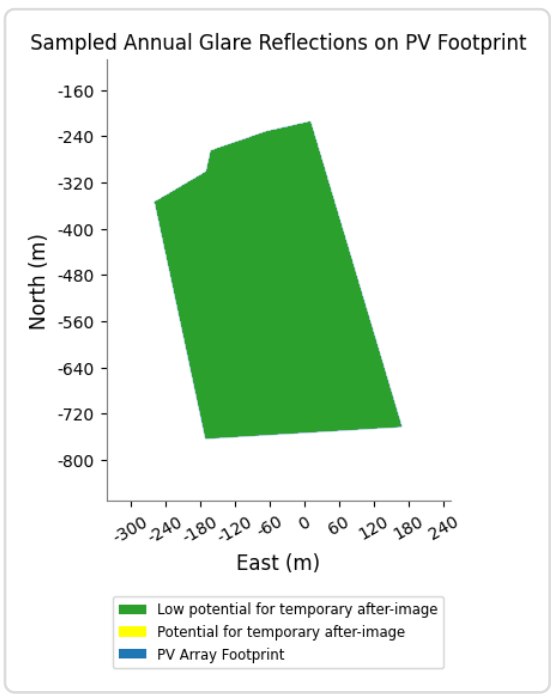
Yellow glare: none

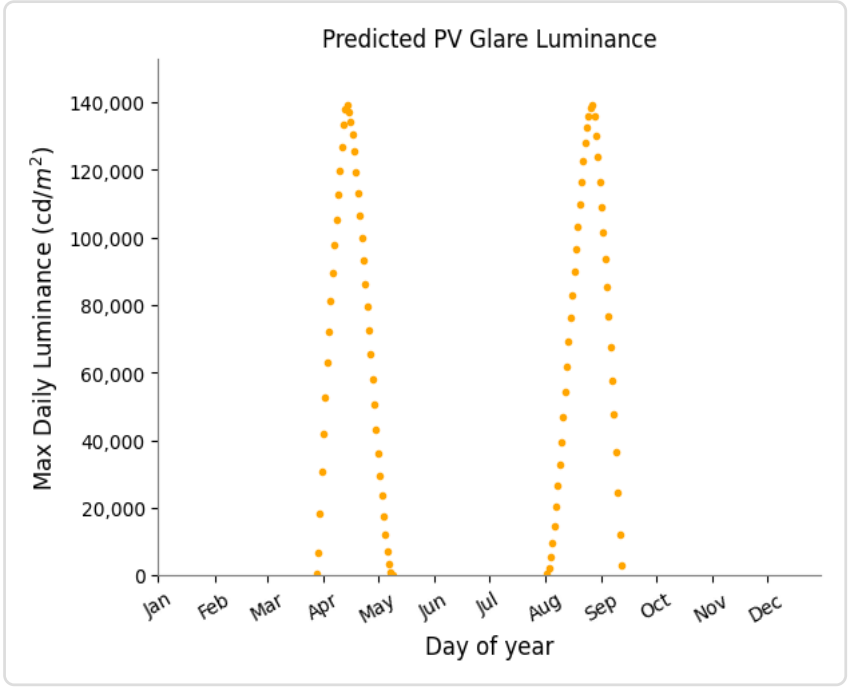
Green glare: 2,080 min.







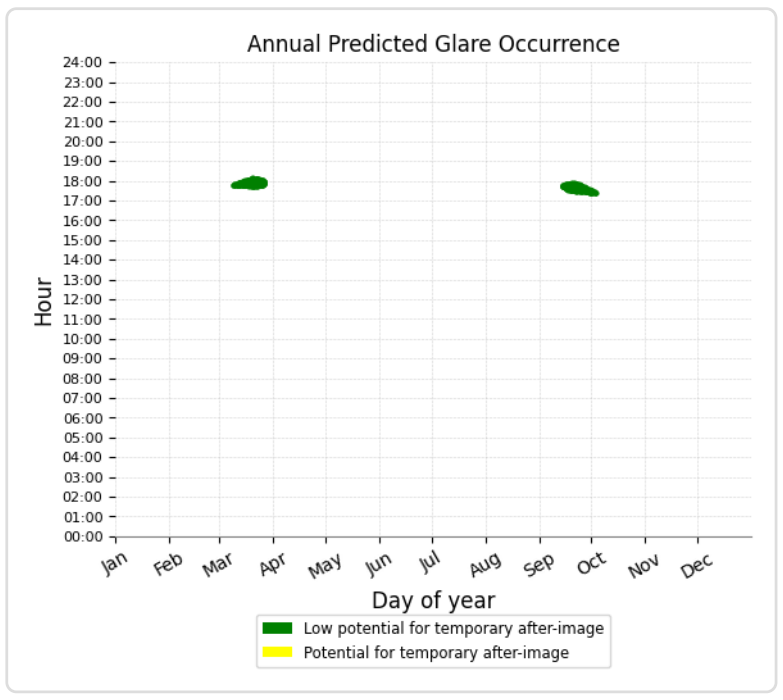


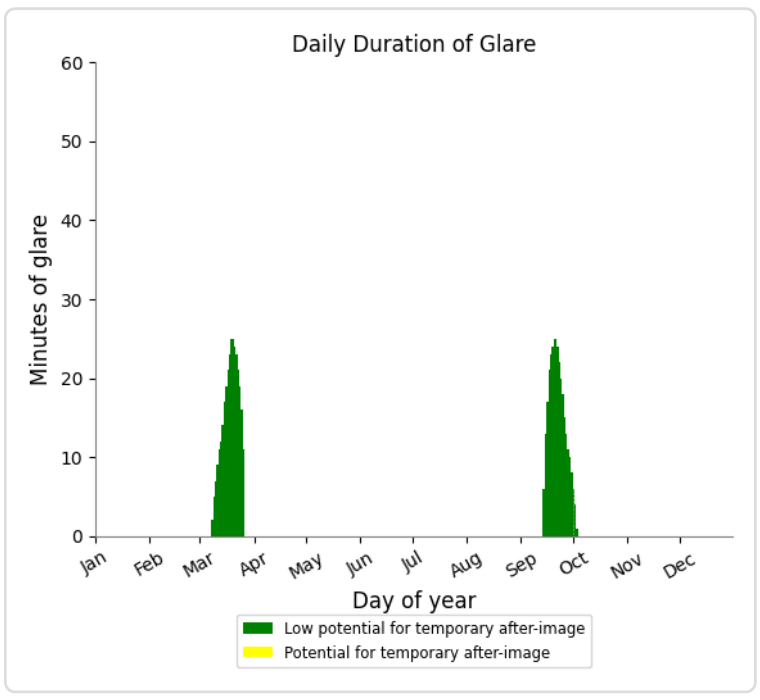


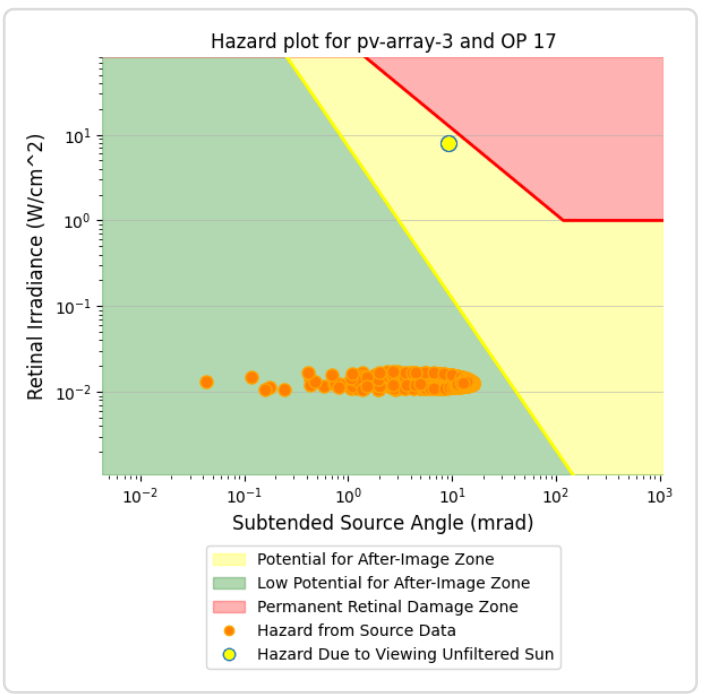
PV array 3 and OP 17

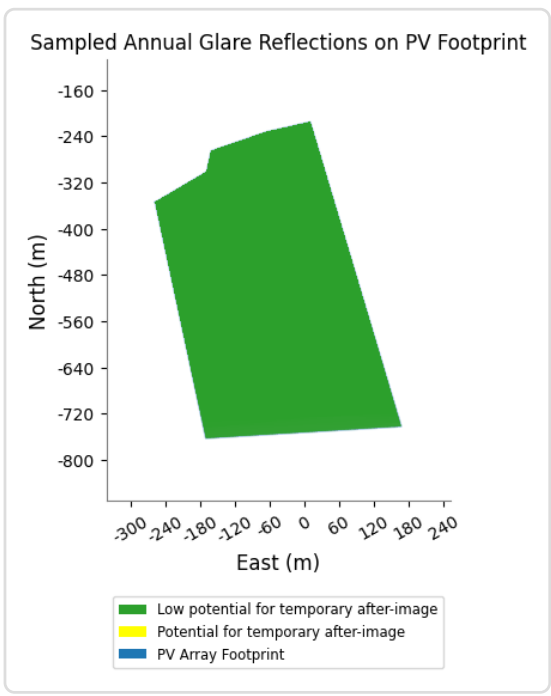
Yellow glare: none

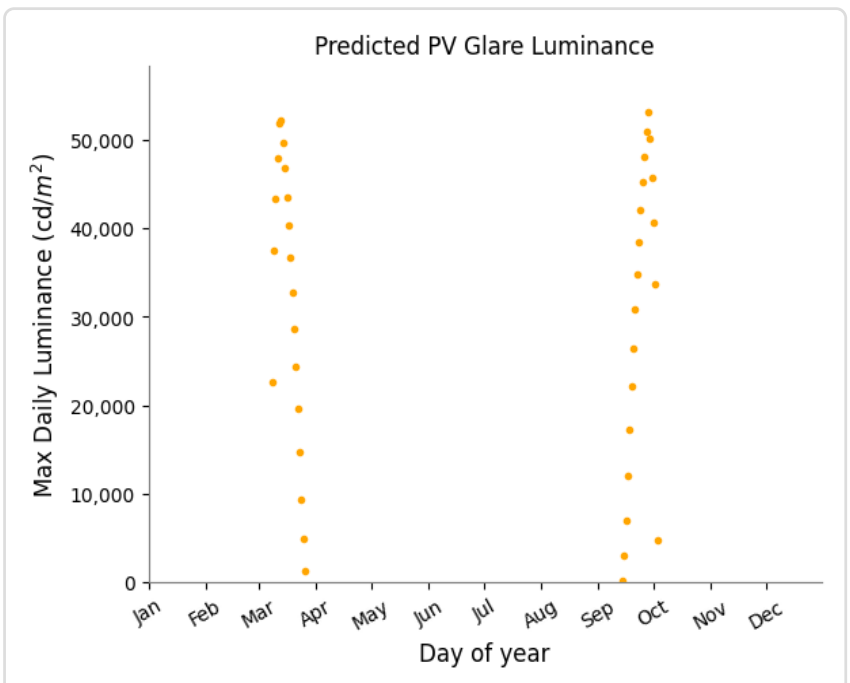
Green glare: 610 min.







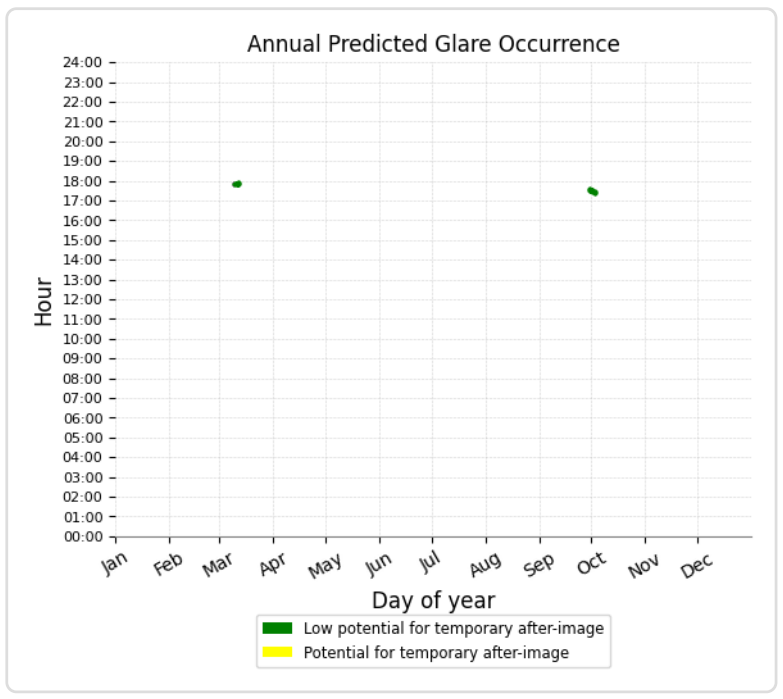


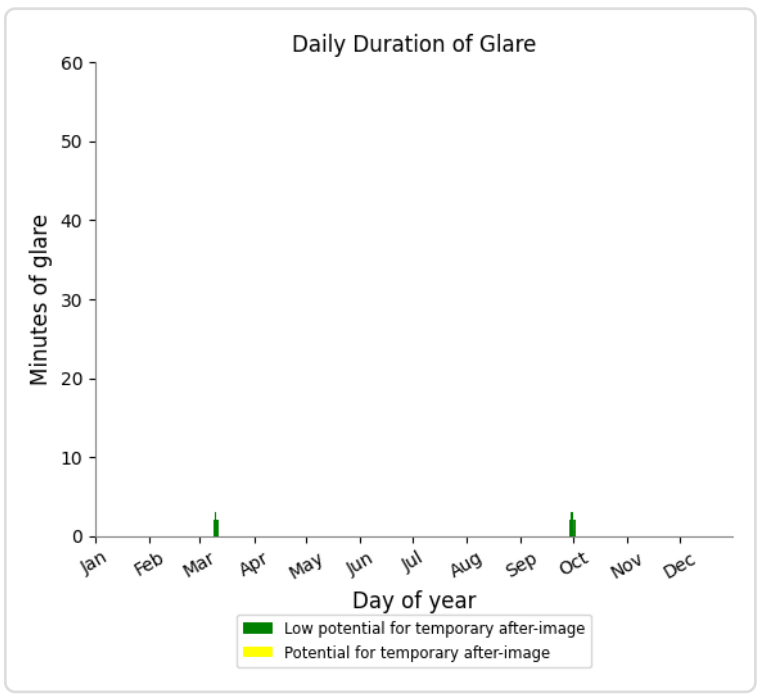


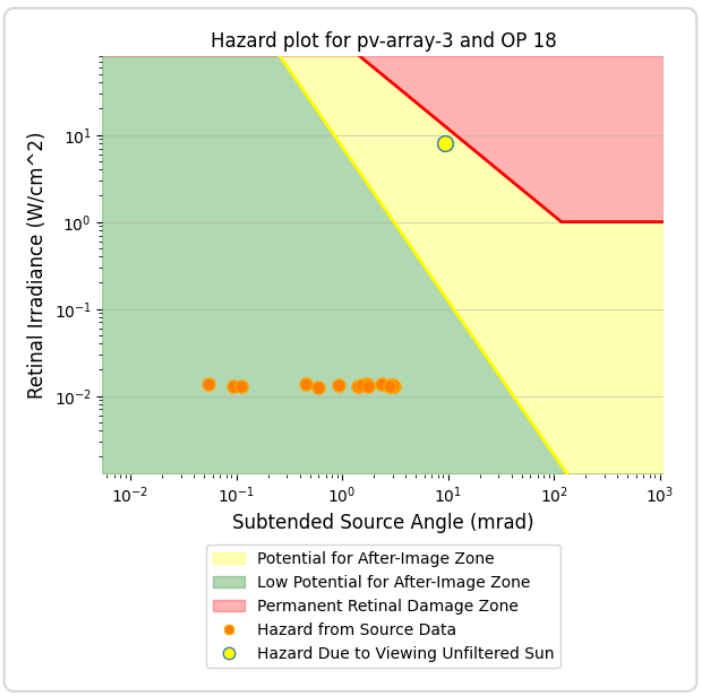
PV array 3 and OP 18

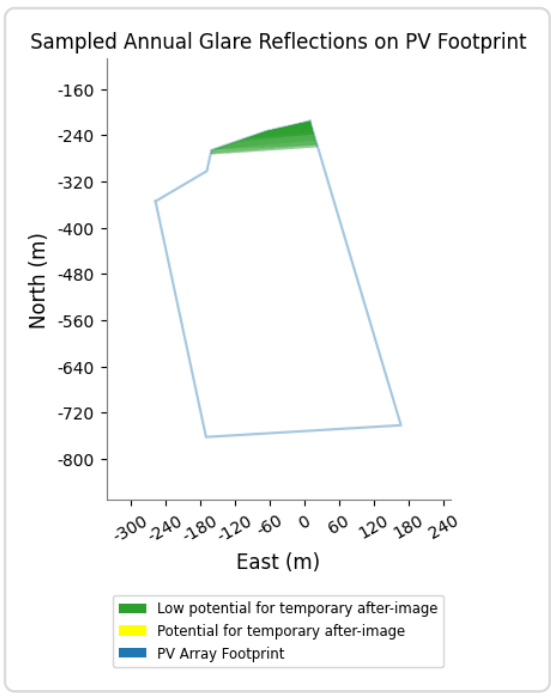
Yellow glare: none

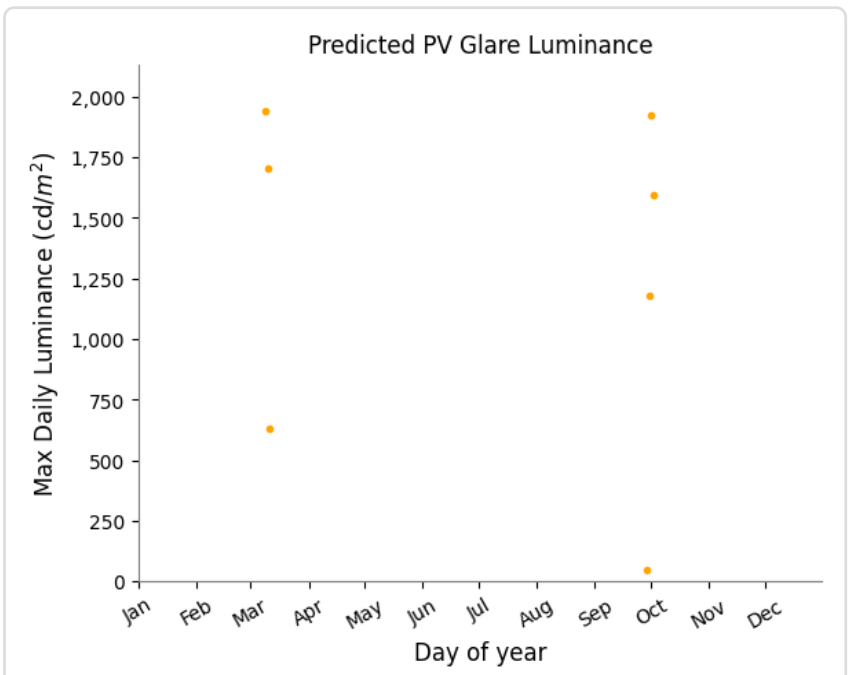
Green glare: 16 min.











PV array 3 and OP 1

No glare found

PV array 3 and OP 2

No glare found

PV array 3 and OP 3

No glare found

PV array 3 and OP 4

No glare found

PV array 3 and OP 5

No glare found

PV array 3 and OP 6

No glare found

PV array 3 and OP 9

No glare found

PV array 3 and OP 10

No glare found

PV array 3 and OP 11

No glare found

PV array 3 and OP 12

No glare found

PV array 3 and OP 13

No glare found

PV array 3 and OP 19

No glare found

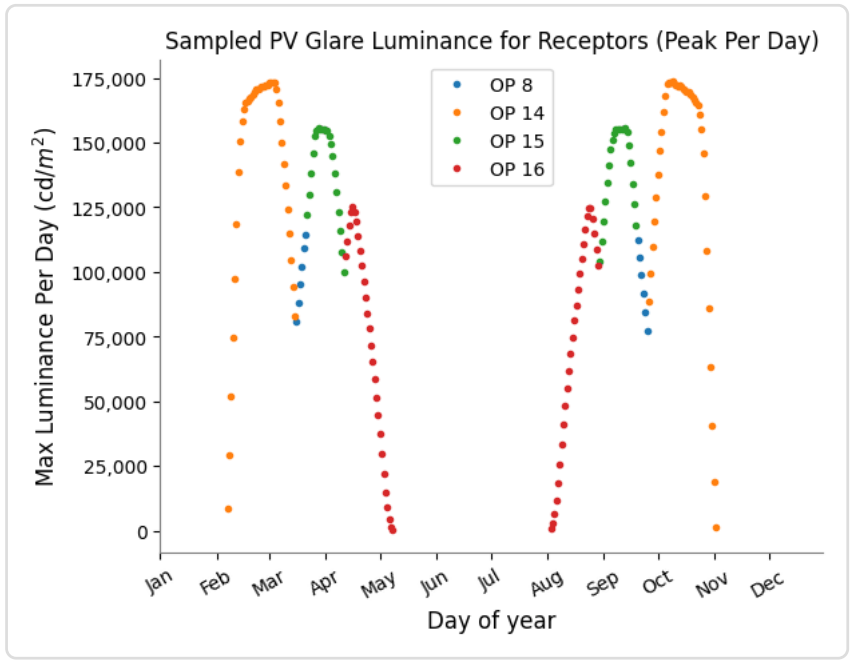
PV array 3 and OP 20

No glare found

PV: PV array 4 low potential for temporary after-image

Receptor results ordered by category of glare

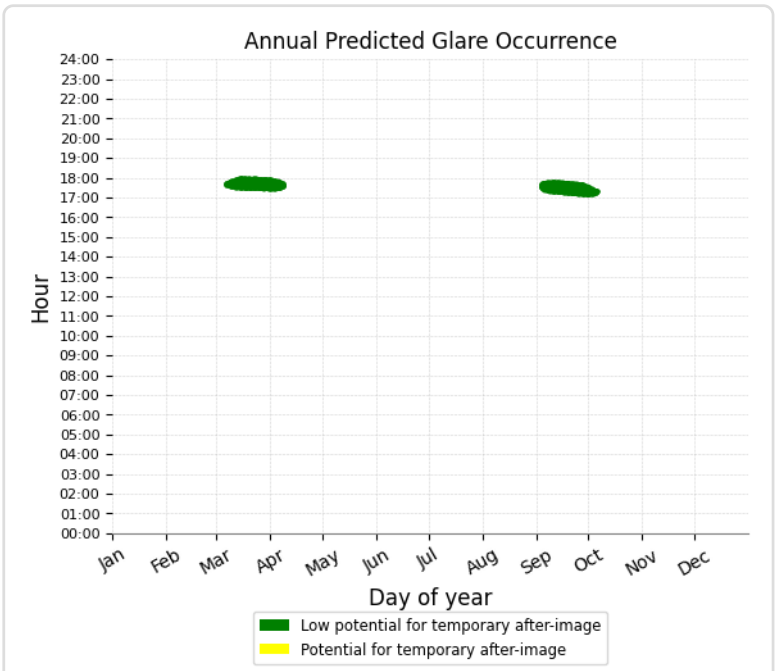
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,537	25.6	0	0.0	114,363
OP 14	2,375	39.6	0	0.0	173,524
OP 15	2,390	39.8	0	0.0	155,547
OP 16	1,942	32.4	0	0.0	125,201
OP 17	526	8.8	0	0.0	43,888
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

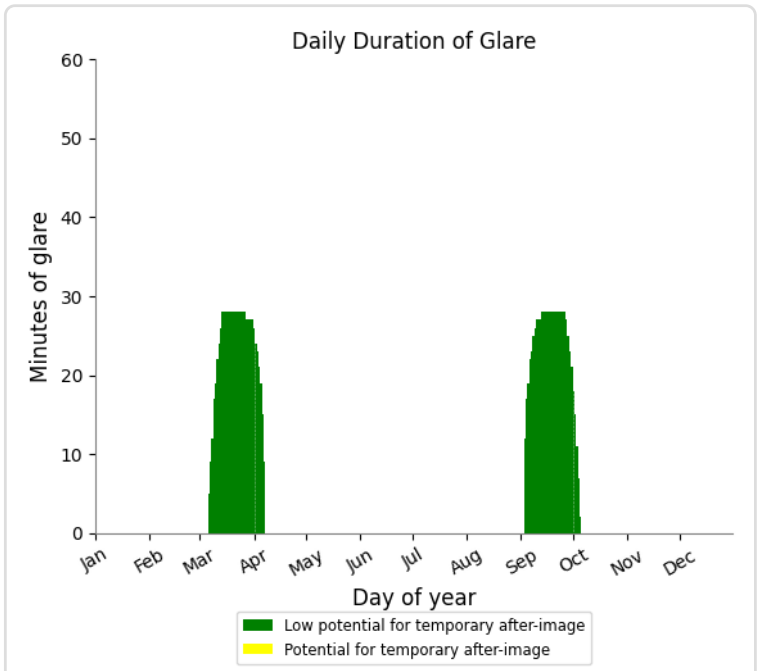


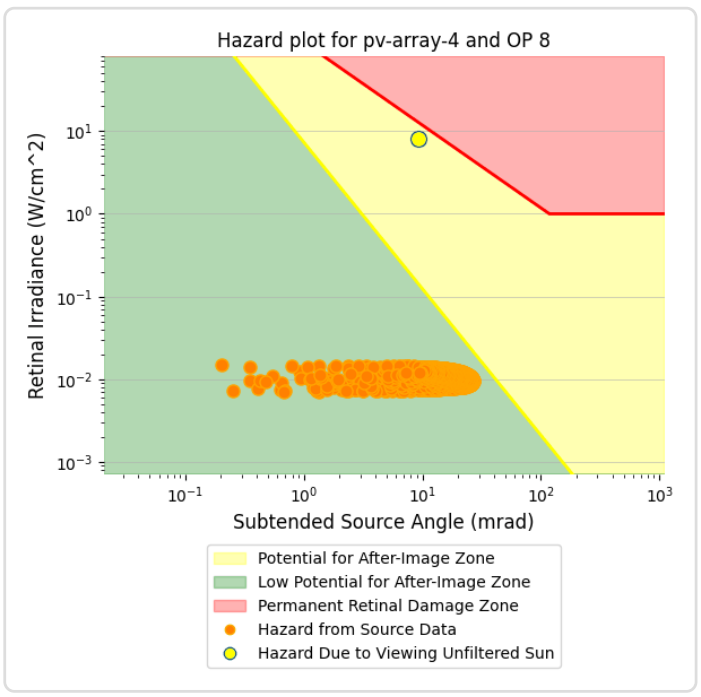
PV array 4 and OP 8

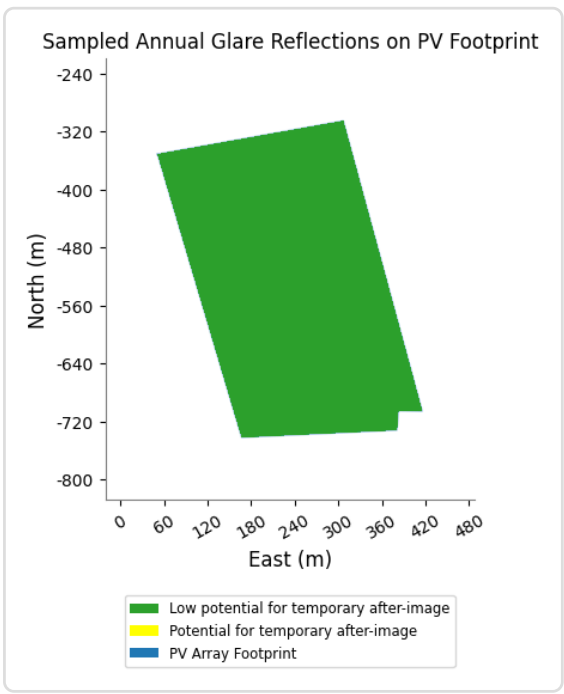
Yellow glare: none

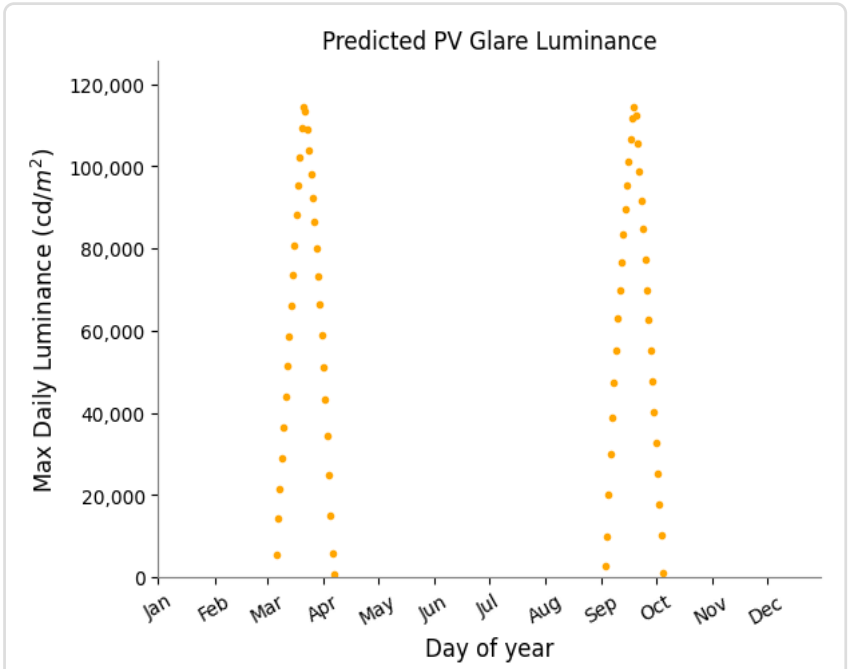
Green glare: 1,537 min.







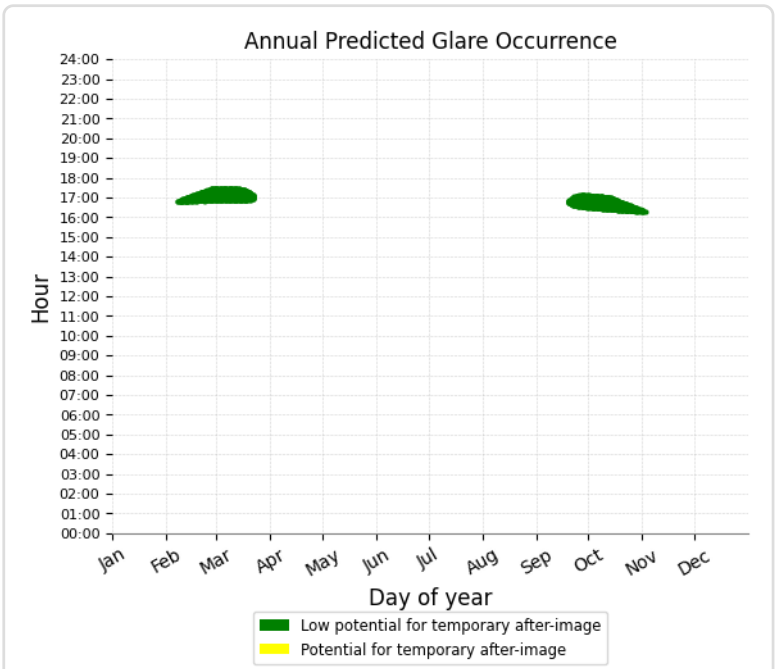


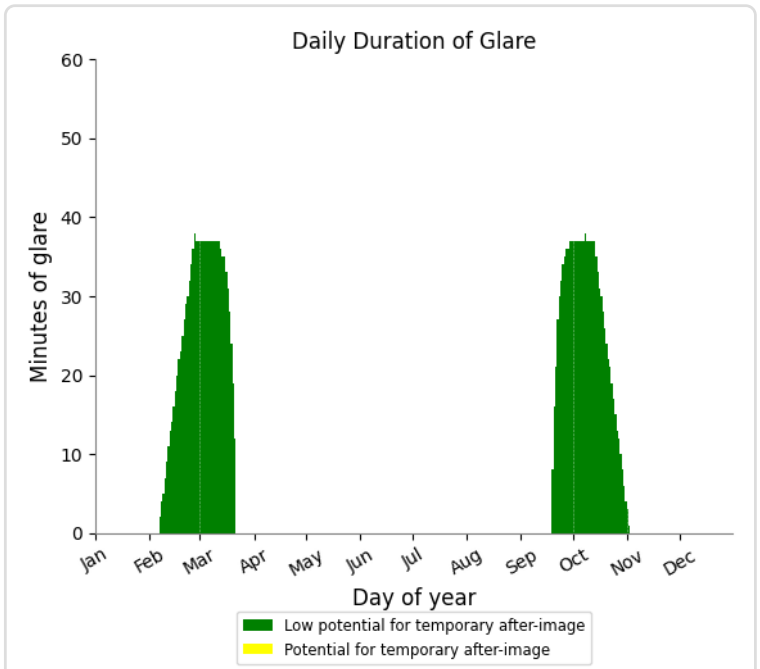


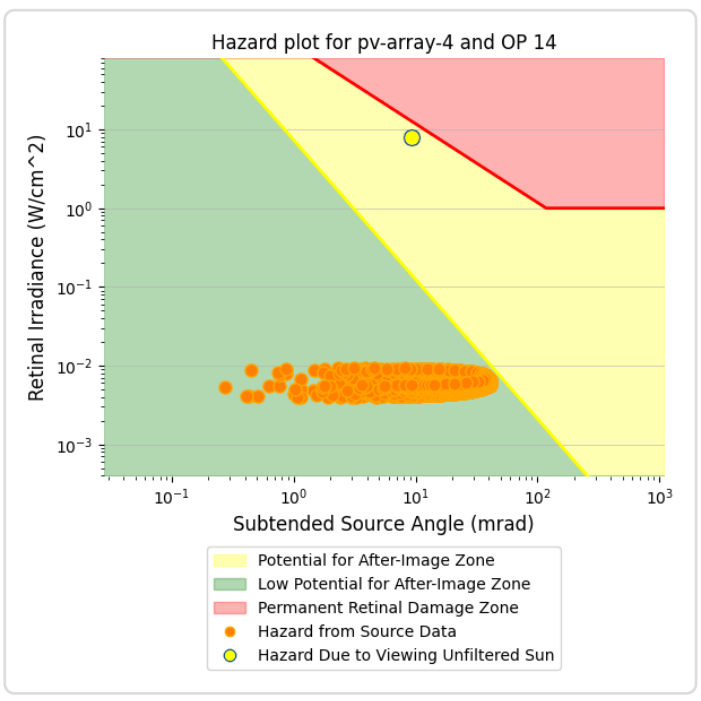
PV array 4 and OP 14

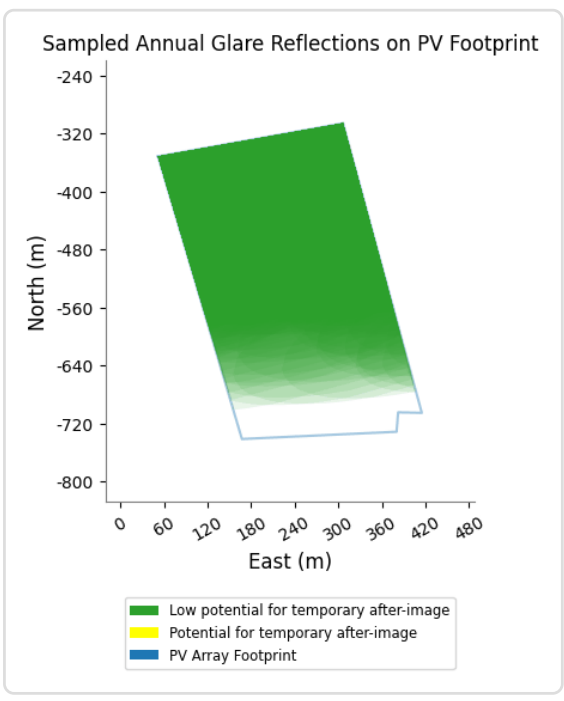
Yellow glare: none

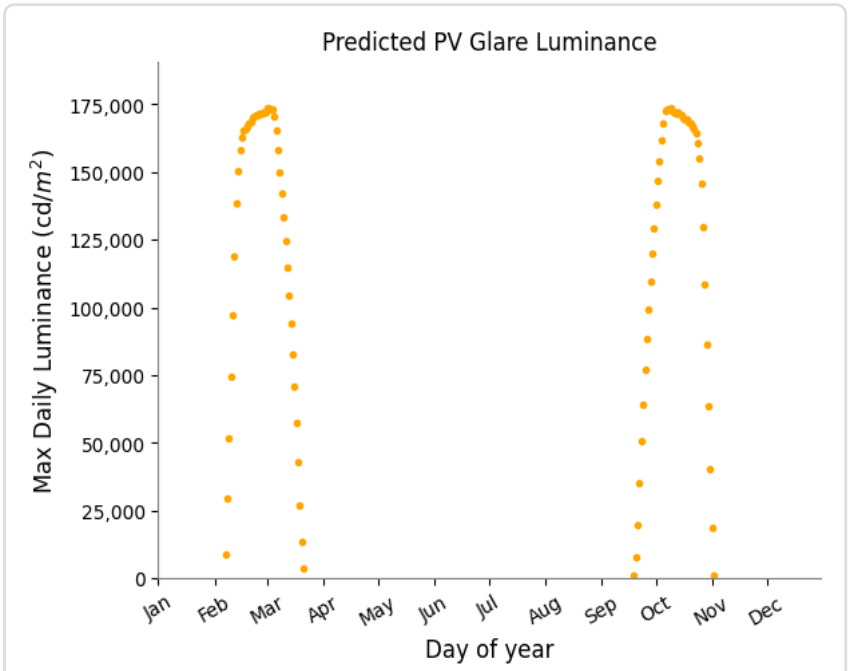
Green glare: 2,375 min.







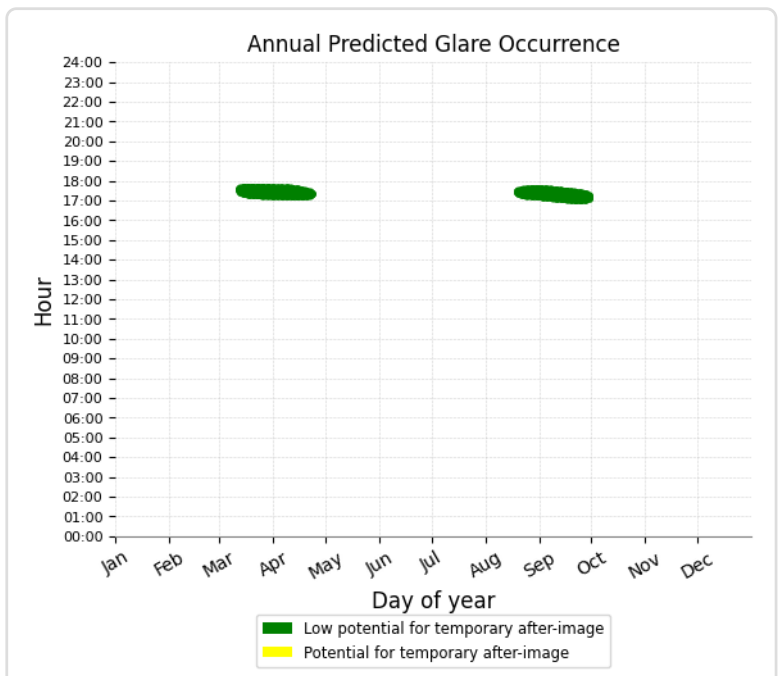


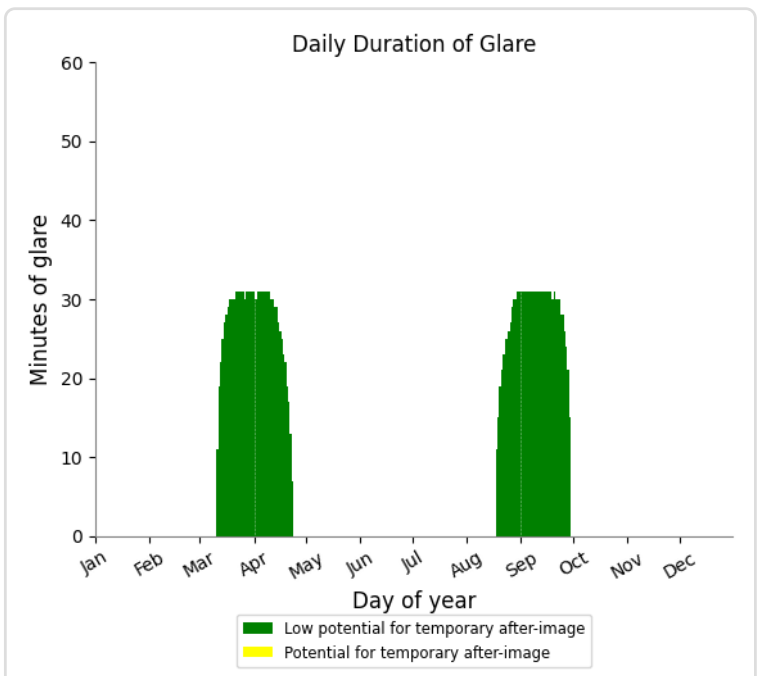


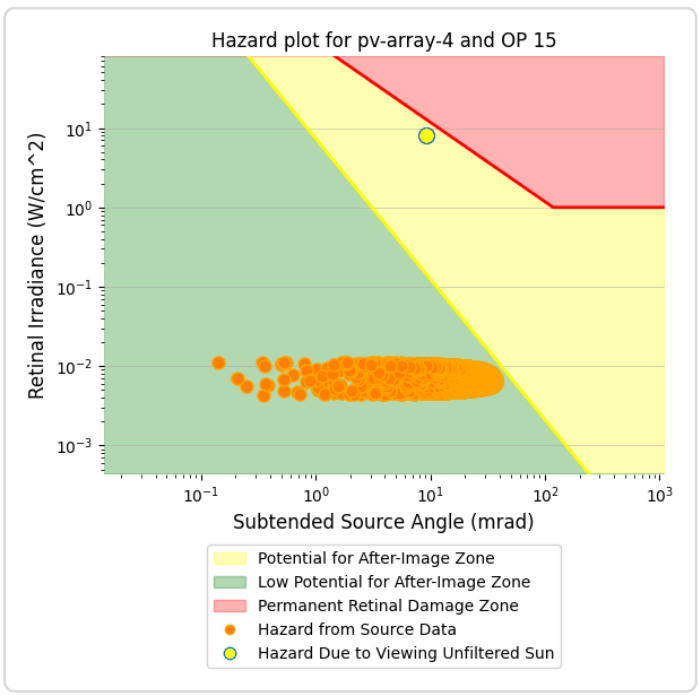
PV array 4 and OP 15

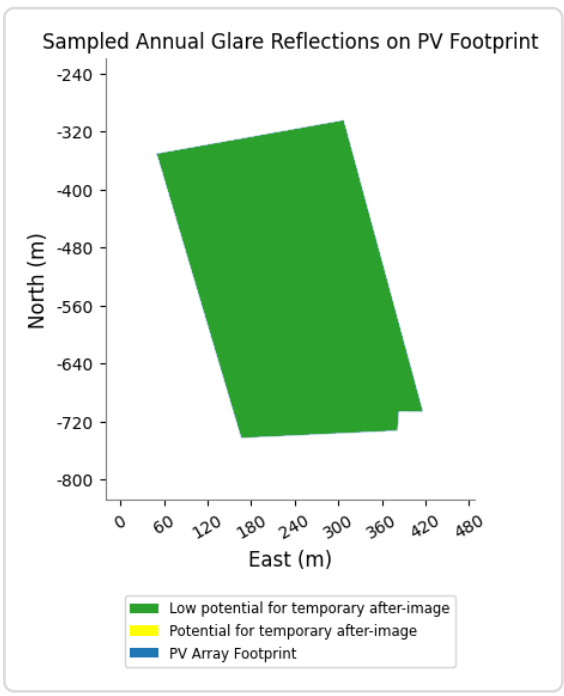
Yellow glare: none

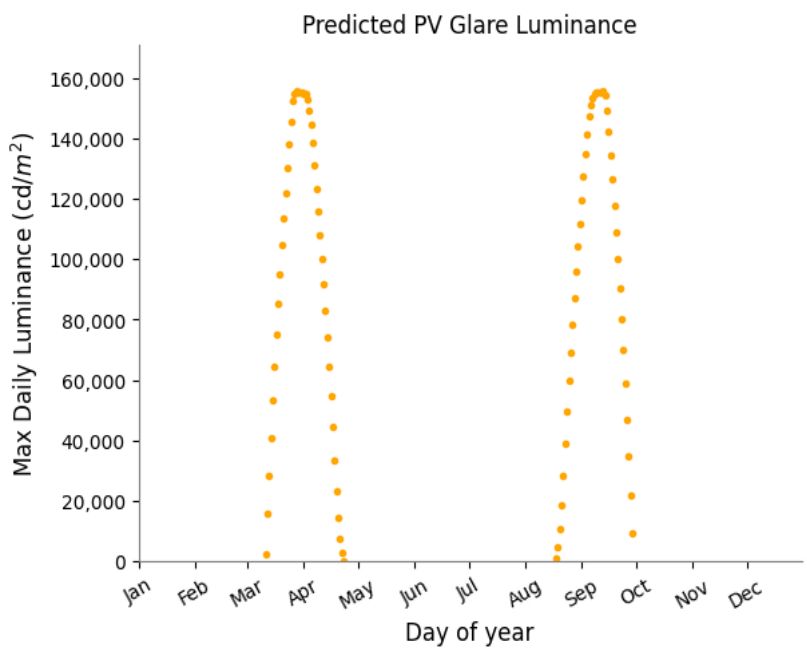
Green glare: 2,390 min.







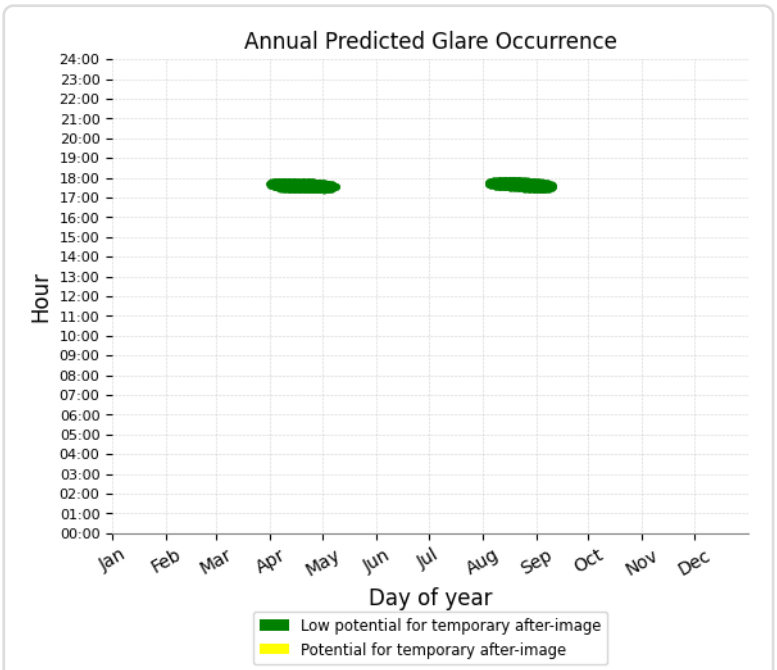


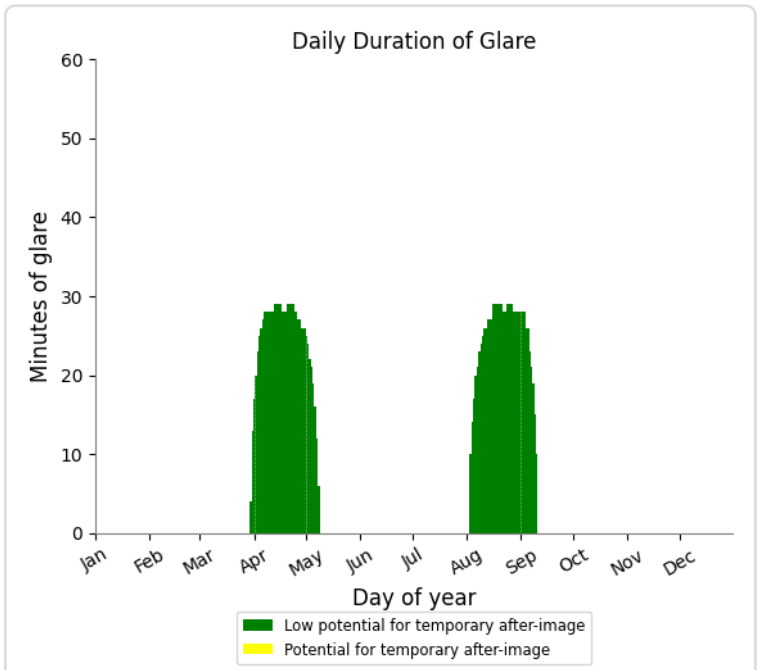


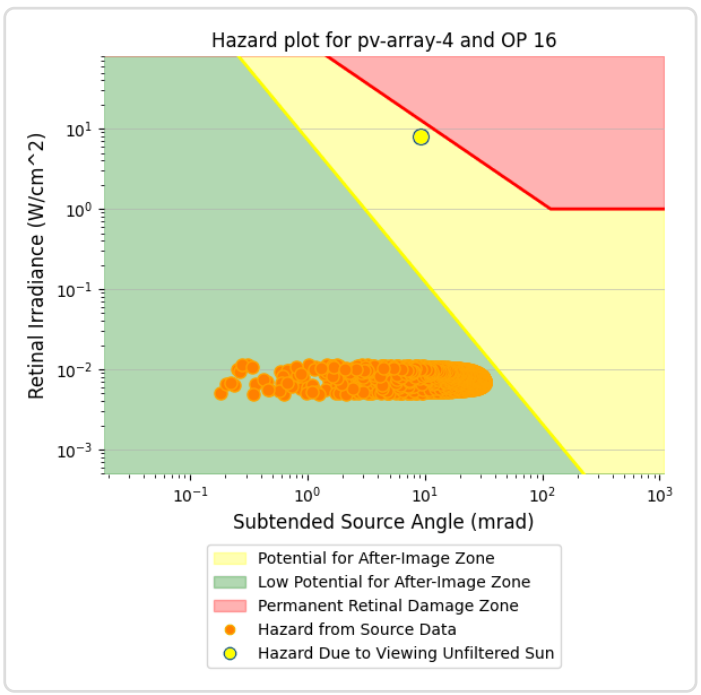
PV array 4 and OP 16

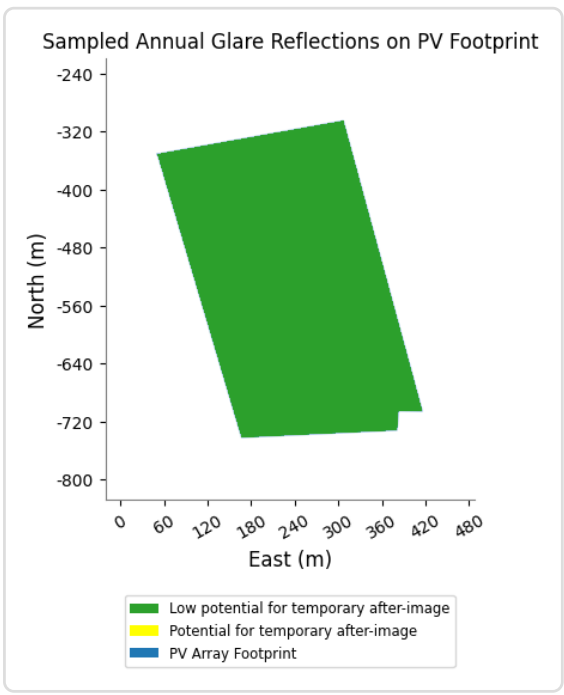
Yellow glare: none

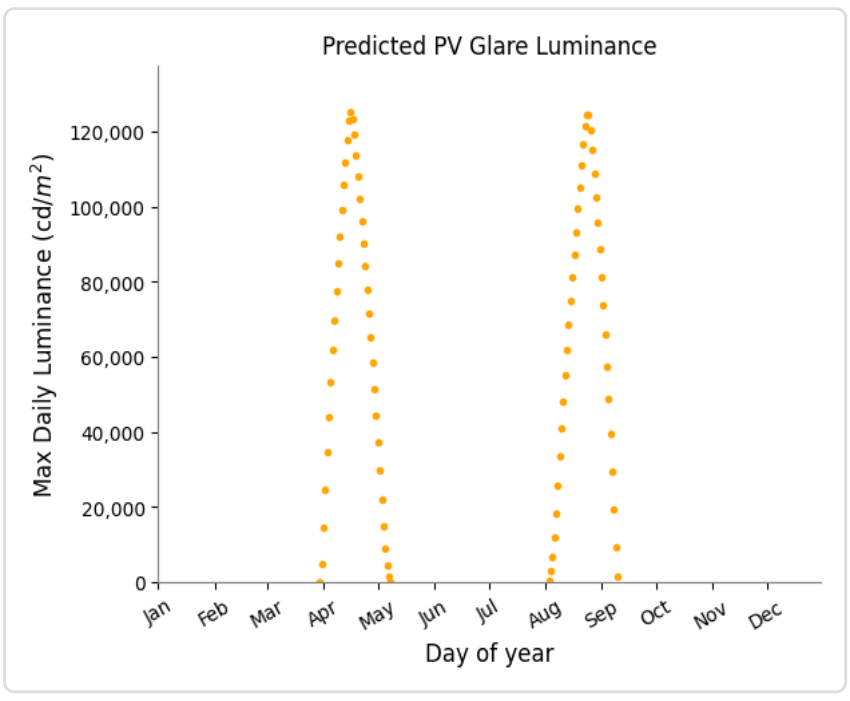
Green glare: 1,942 min.







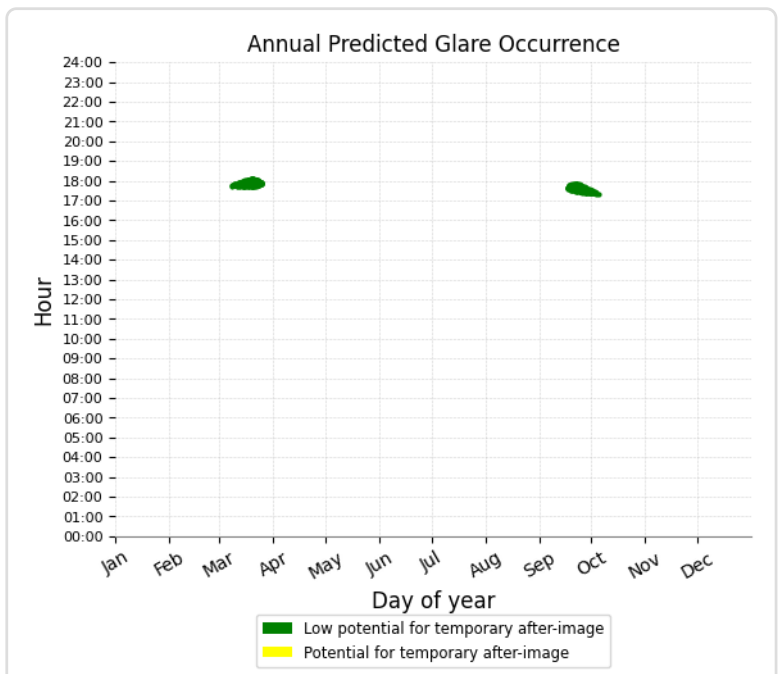


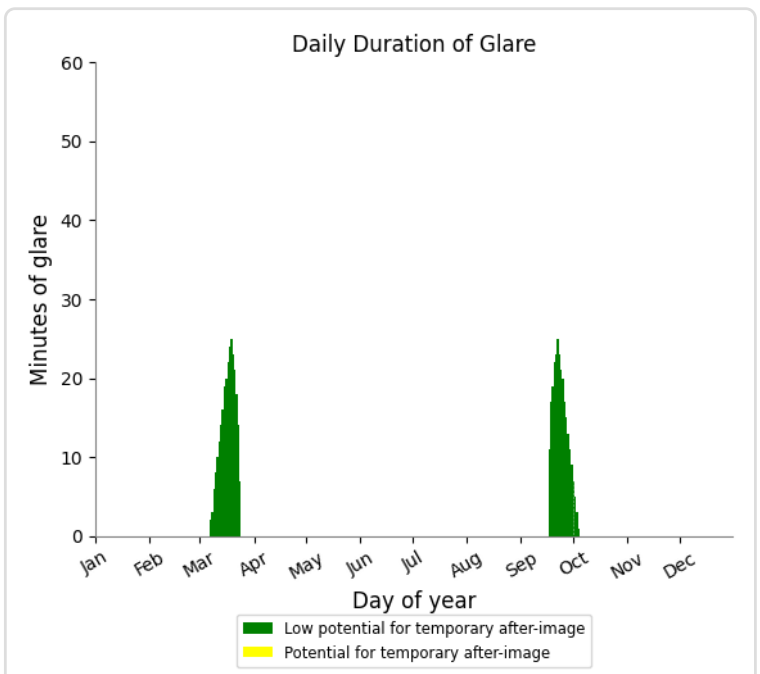


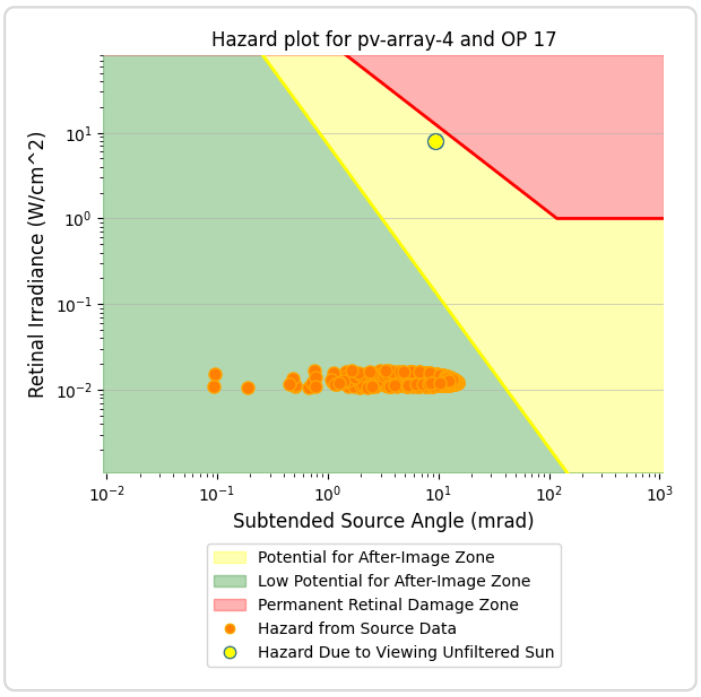
PV array 4 and OP 17

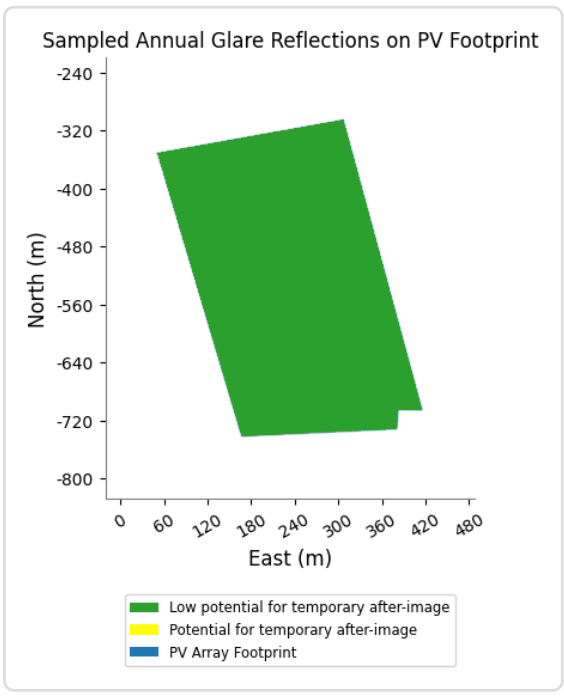
Yellow glare: none

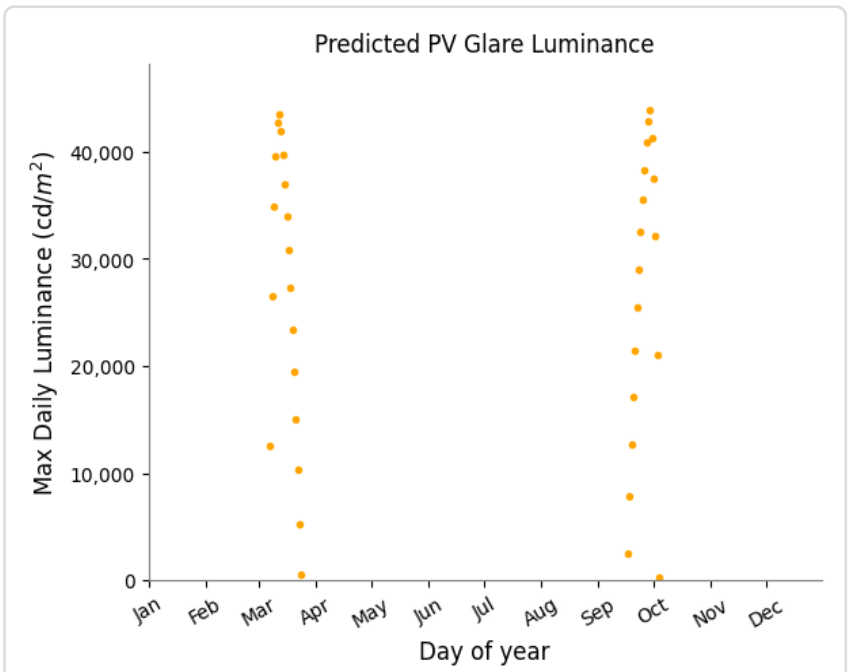
Green glare: 526 min.











PV array 4 and OP 1

No glare found

PV array 4 and OP 2

No glare found

PV array 4 and OP 3

No glare found

PV array 4 and OP 4

No glare found

PV array 4 and OP 5

No glare found

PV array 4 and OP 6

No glare found

PV array 4 and OP 7

No glare found

PV array 4 and OP 9

No glare found

PV array 4 and OP 10

No glare found

PV array 4 and OP 11

No glare found

PV array 4 and OP 12

No glare found

PV array 4 and OP 13

No glare found

PV array 4 and OP 18

No glare found

PV array 4 and OP 19

No glare found

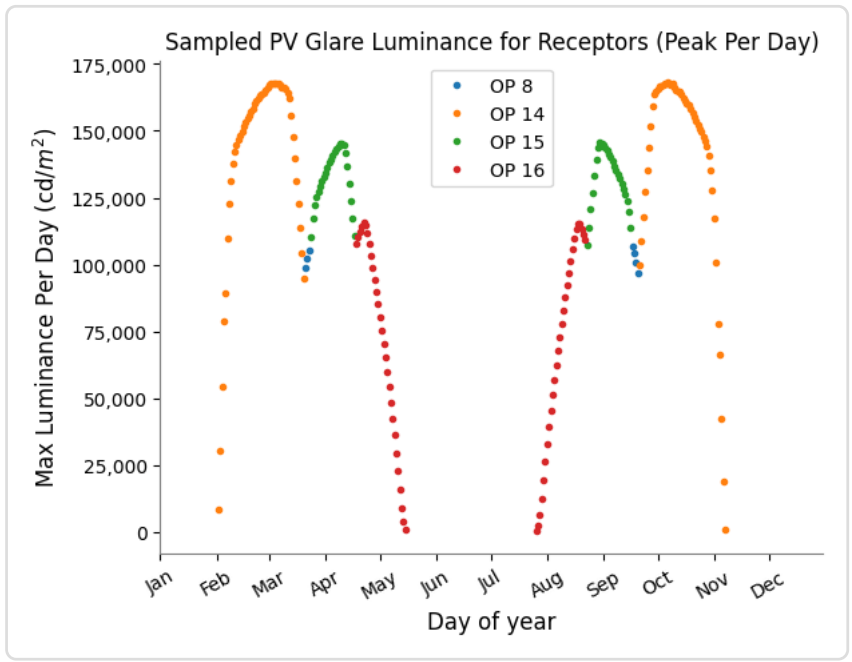
PV array 4 and OP 20

No glare found

PV: PV array 5 low potential for temporary after-image

Receptor results ordered by category of glare

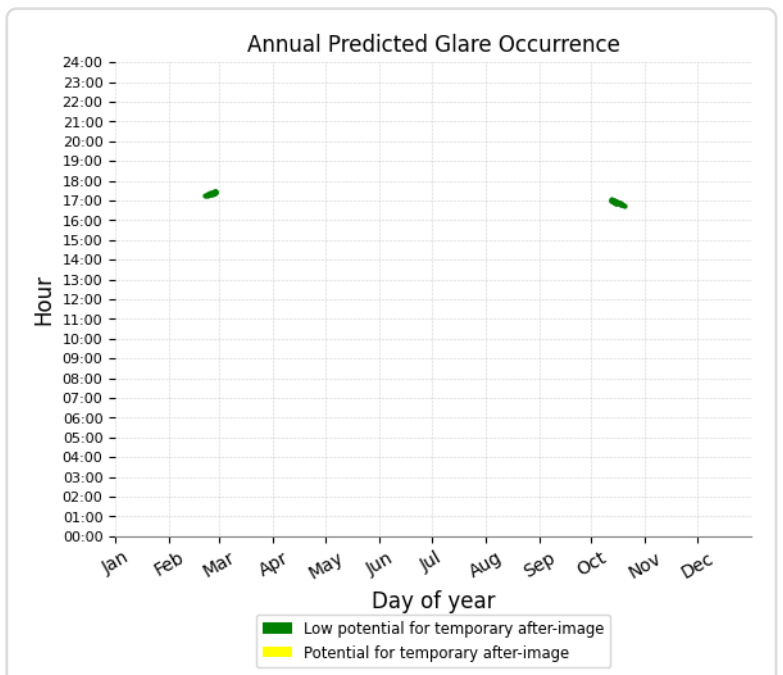
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 7	48	0.8	0	0.0	16,085
OP 8	1,738	29.0	0	0.0	111,331
OP 14	3,285	54.8	0	0.0	168,050
OP 15	2,784	46.4	0	0.0	145,865
OP 16	2,226	37.1	0	0.0	115,556
OP 17	605	10.1	0	0.0	43,940
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

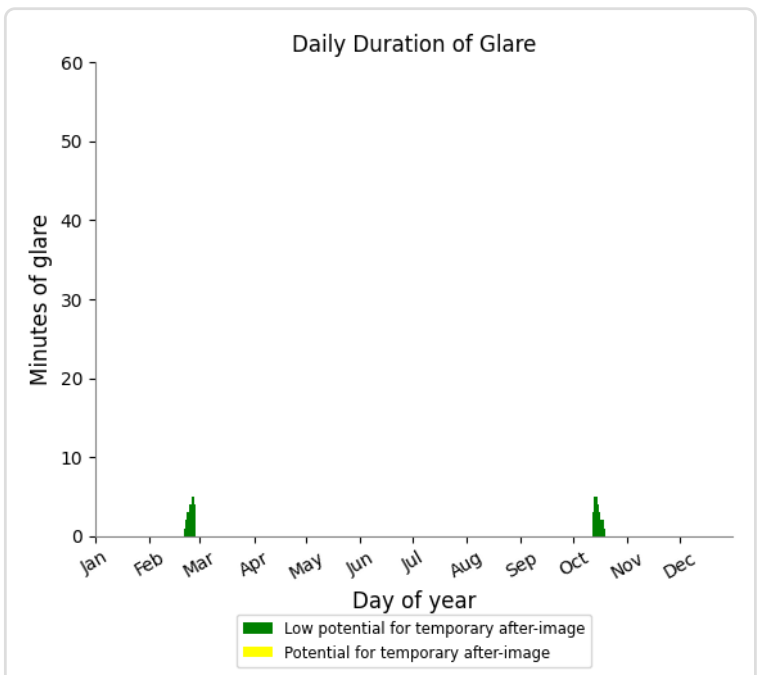


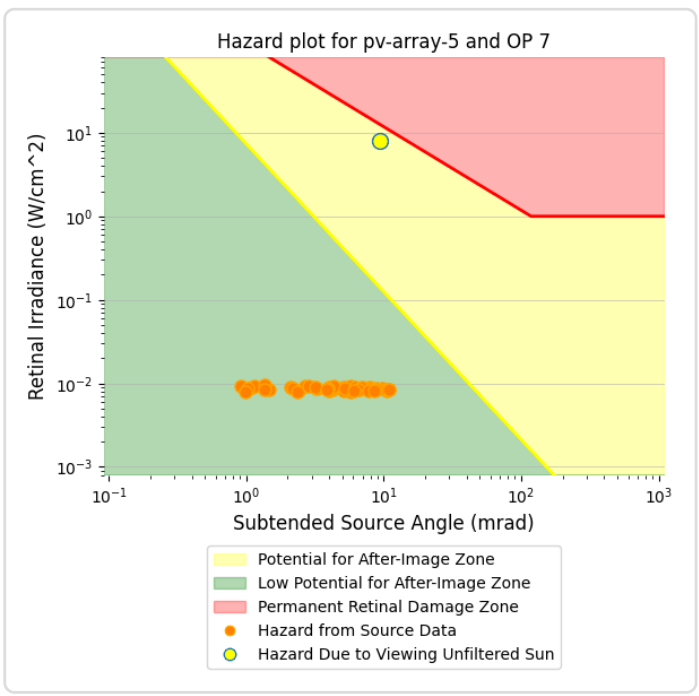
PV array 5 and OP 7

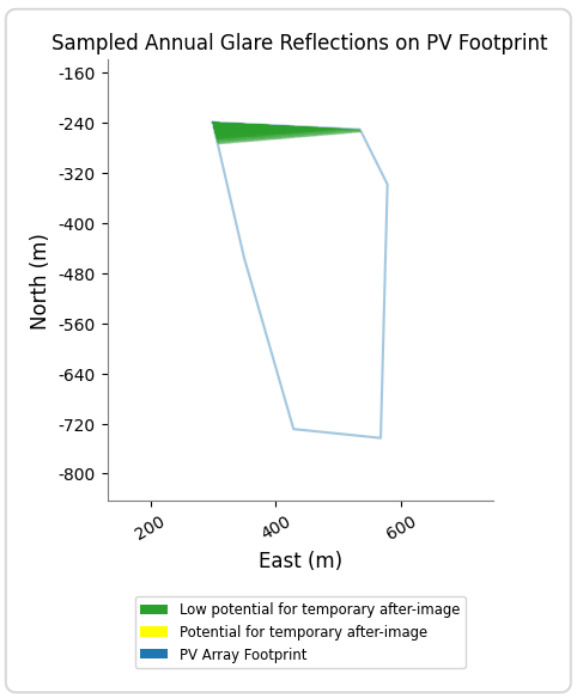
Yellow glare: none

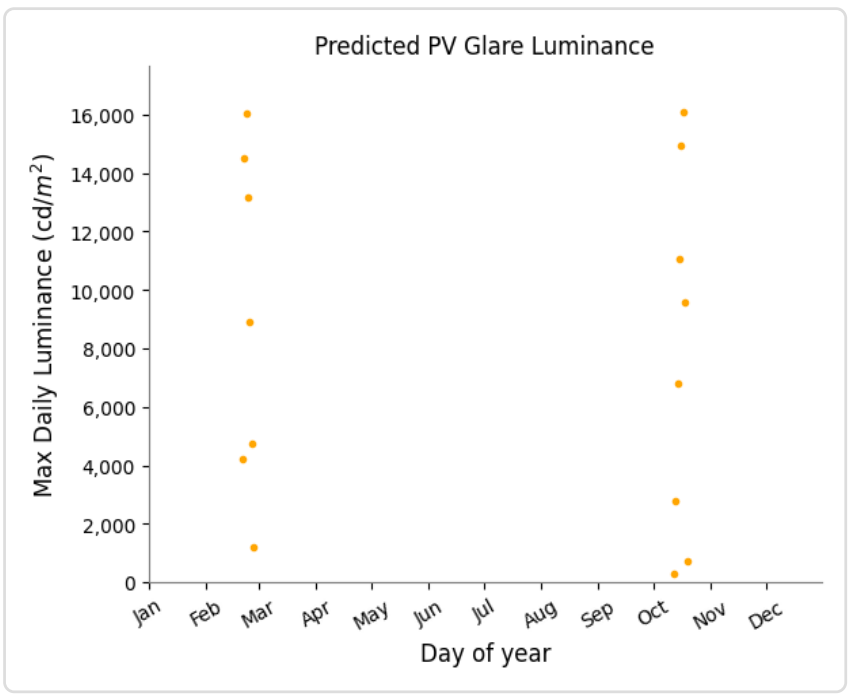
Green glare: 48 min.







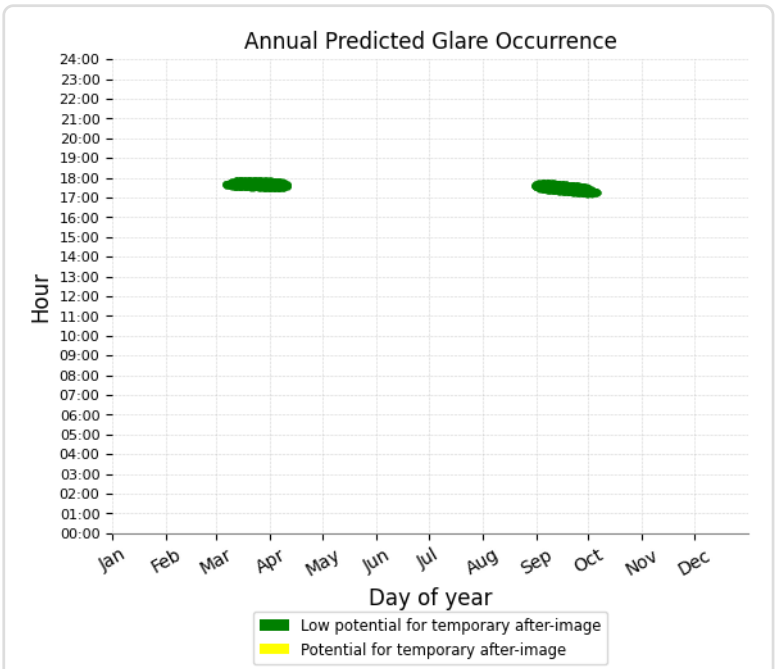


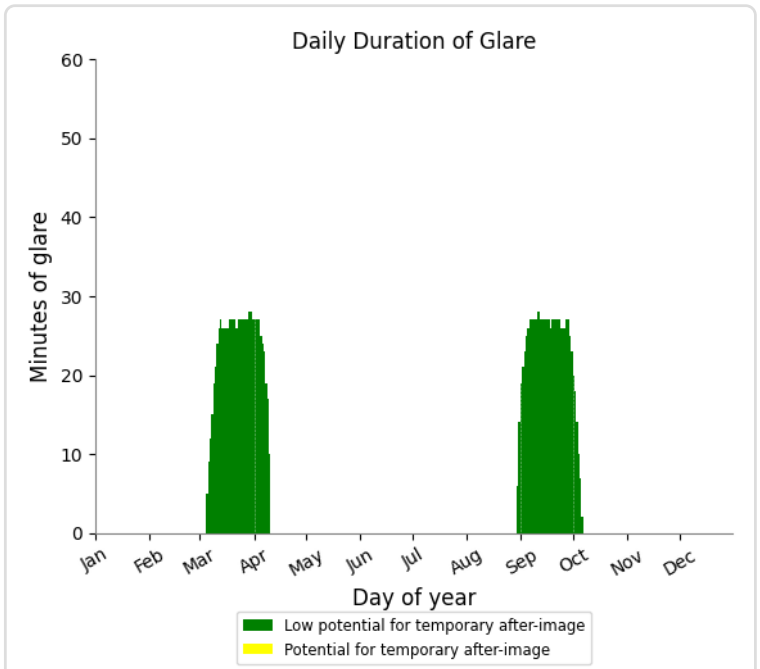


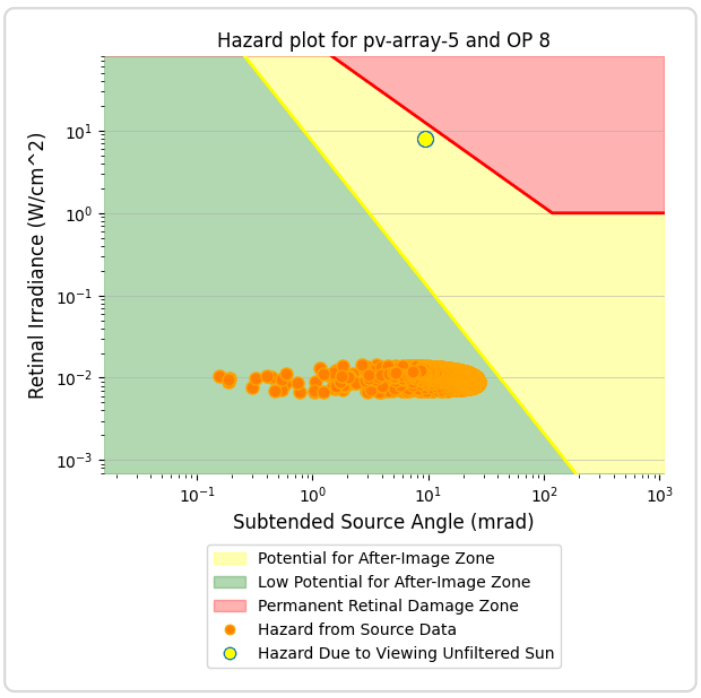
PV array 5 and OP 8

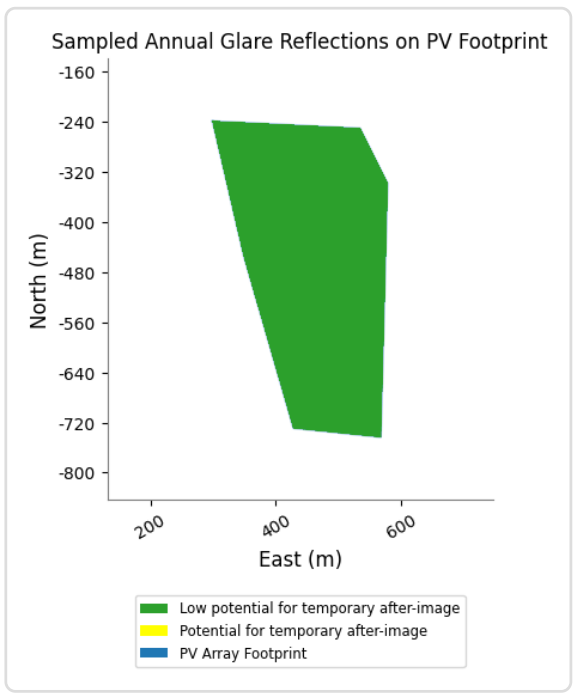
Yellow glare: none

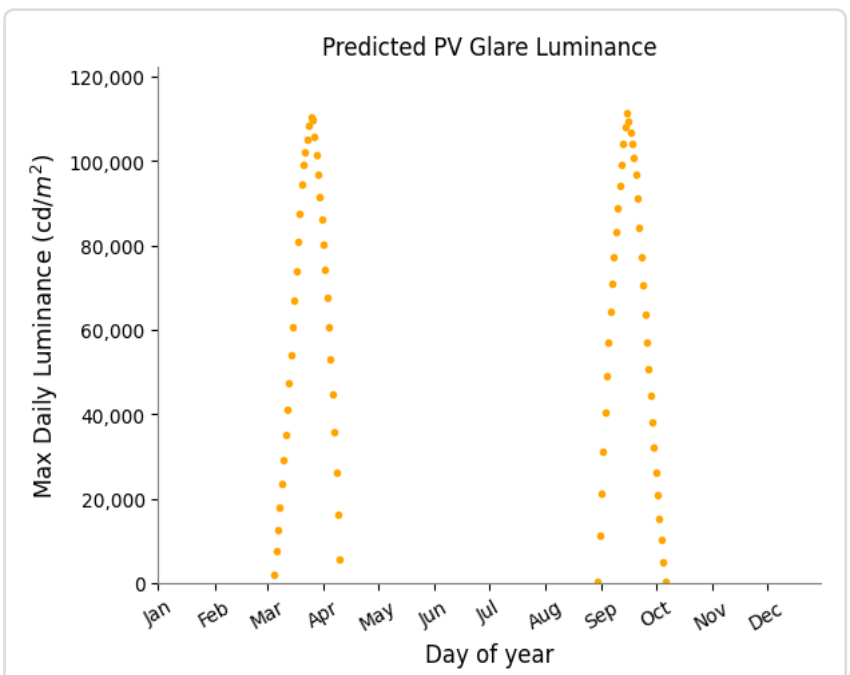
Green glare: 1,738 min.







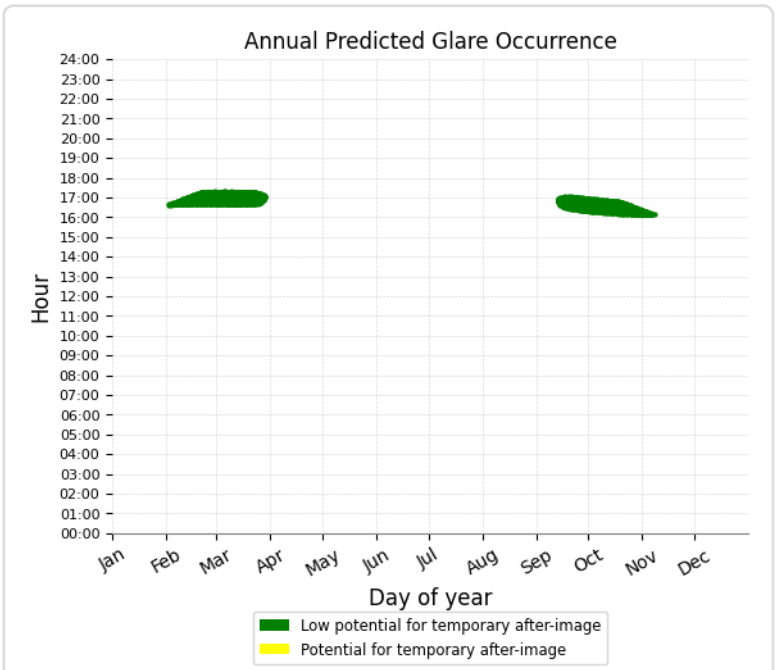


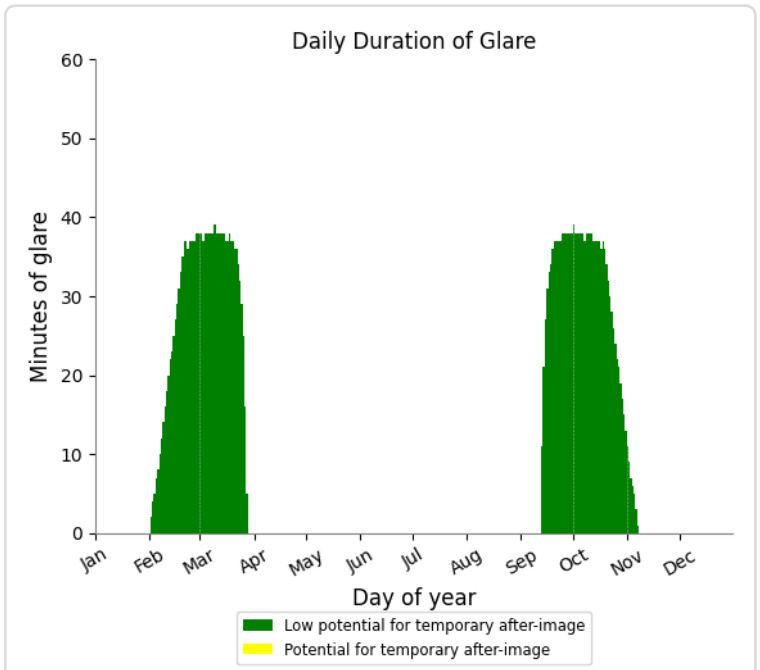


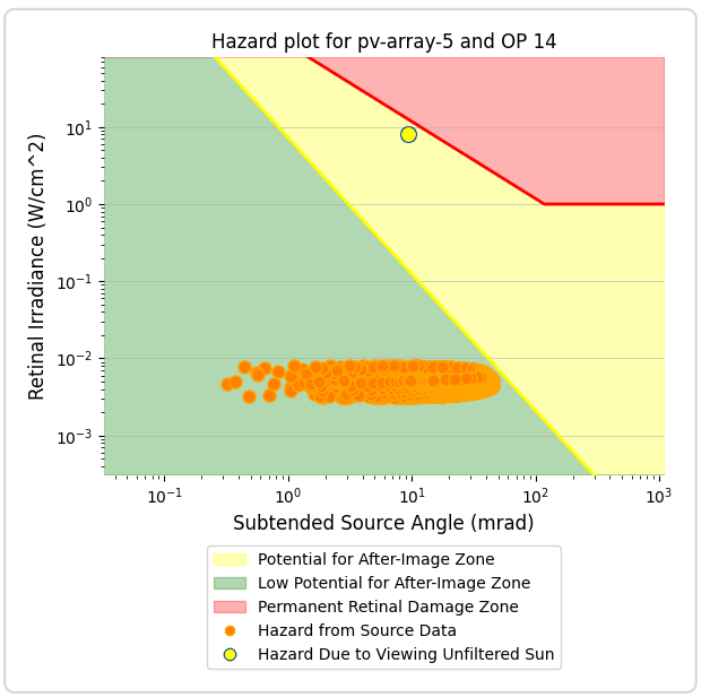
PV array 5 and OP 14

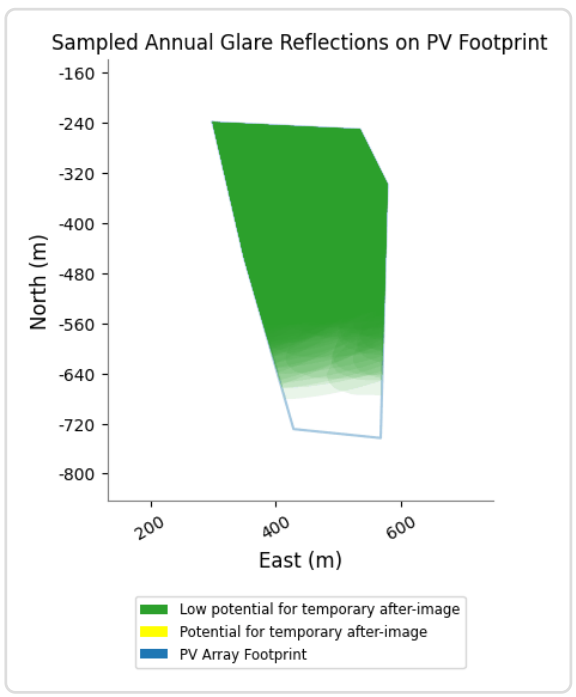
Yellow glare: none

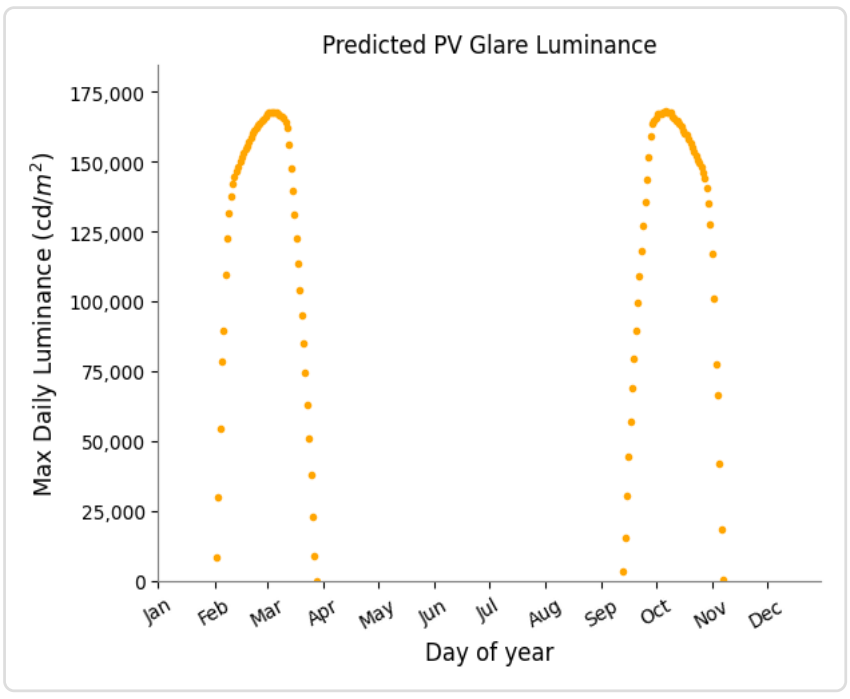
Green glare: 3,285 min.







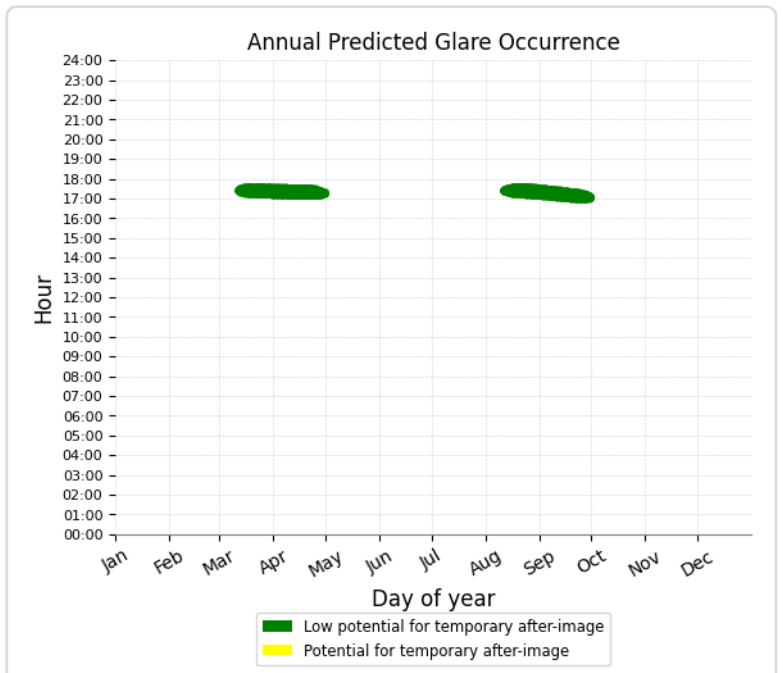


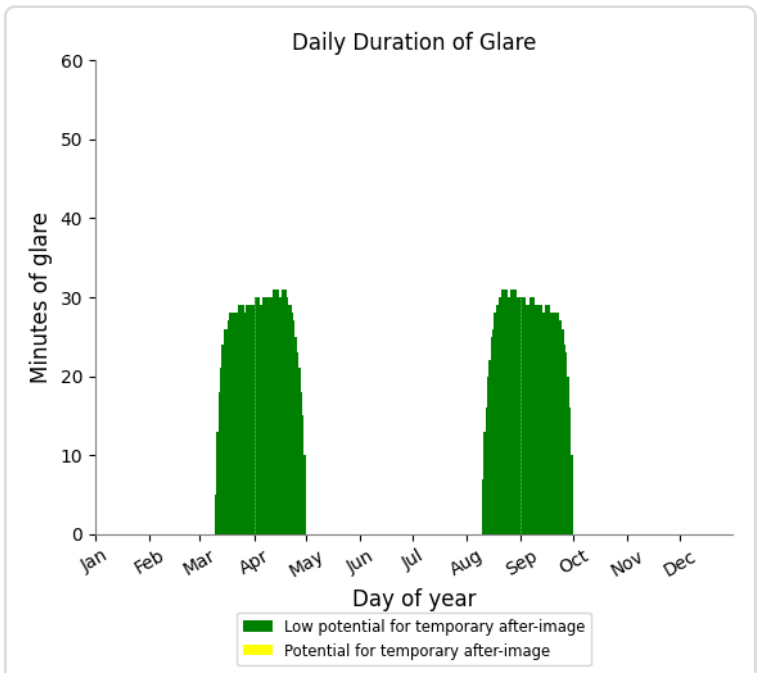


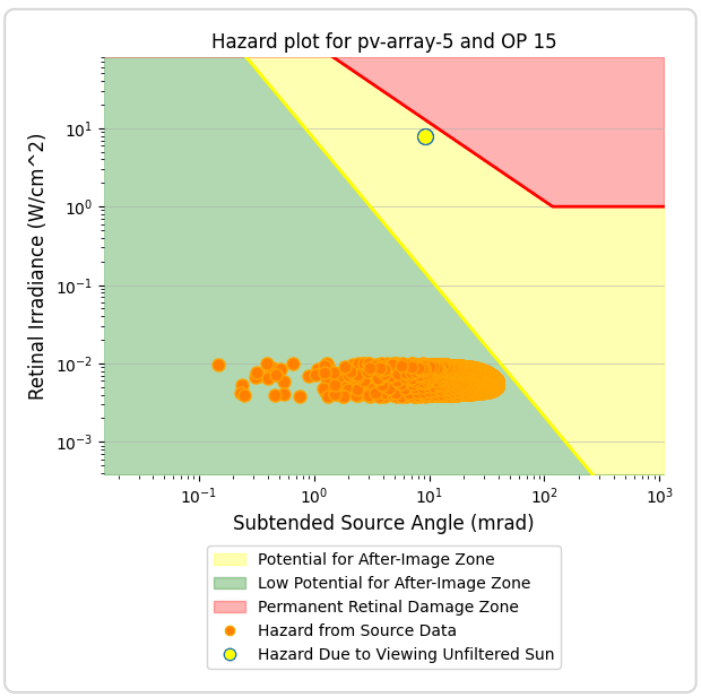
PV array 5 and OP 15

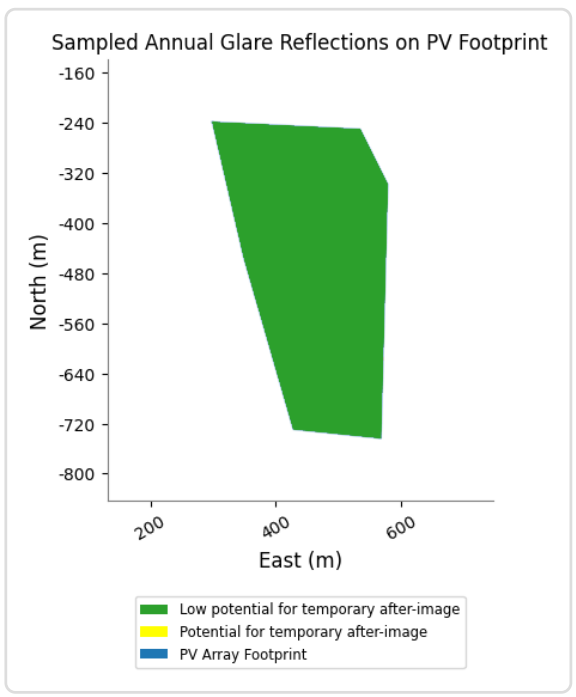
Yellow glare: none

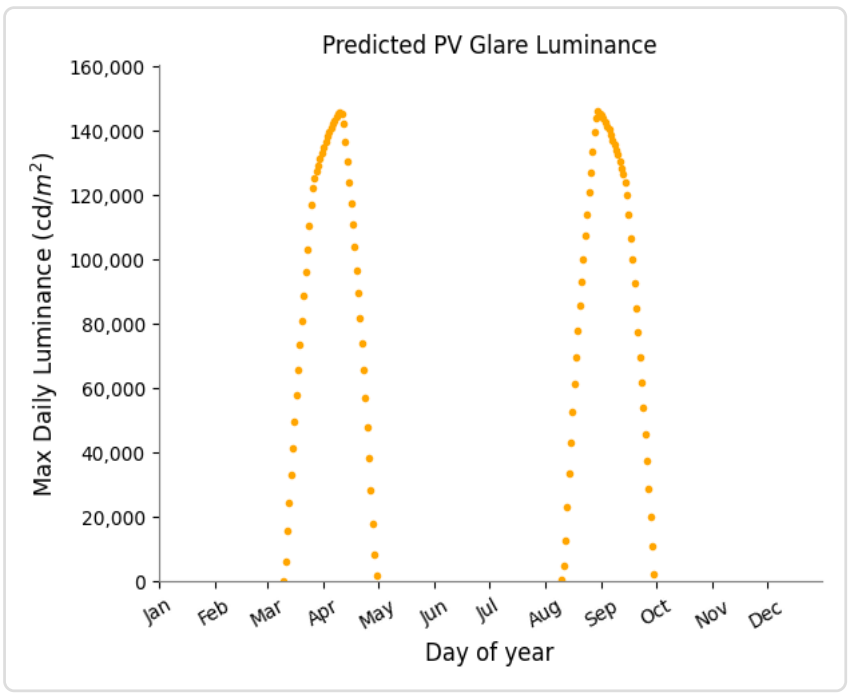
Green glare: 2,784 min.







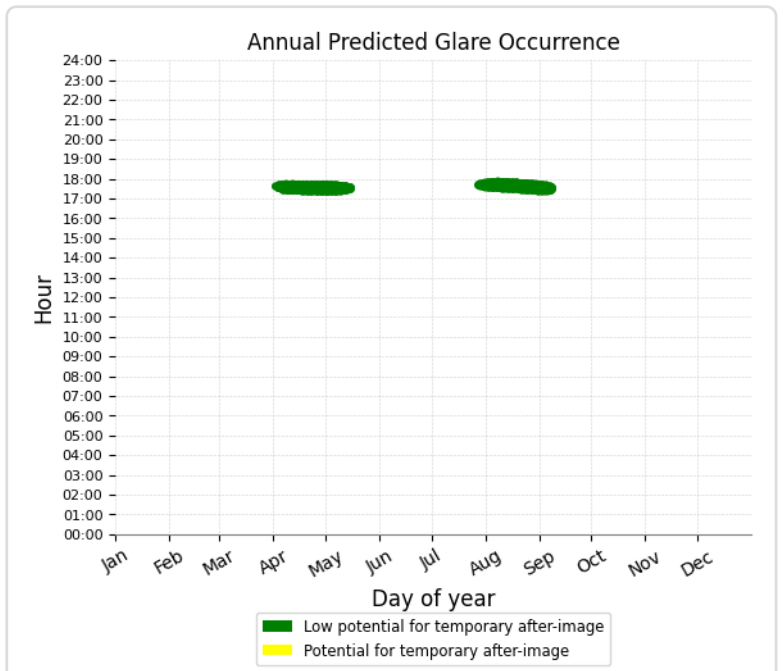


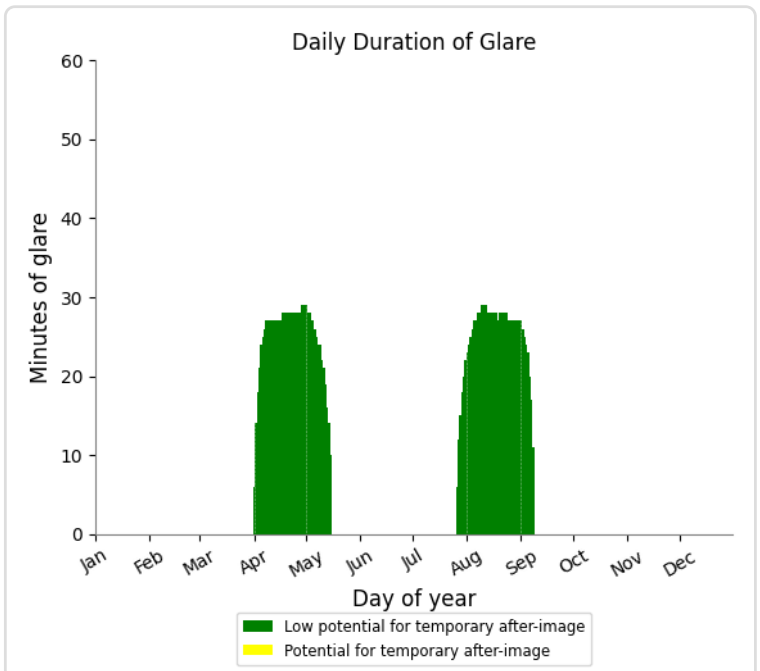


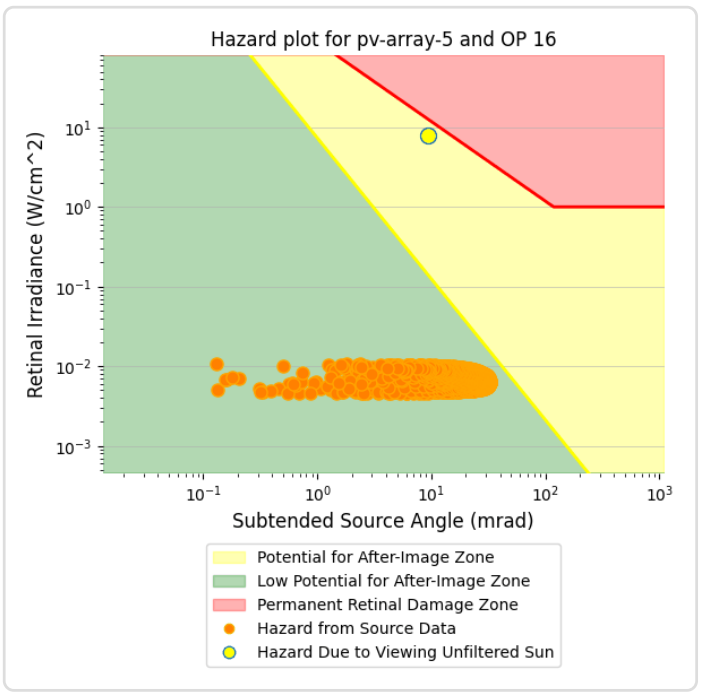
PV array 5 and OP 16

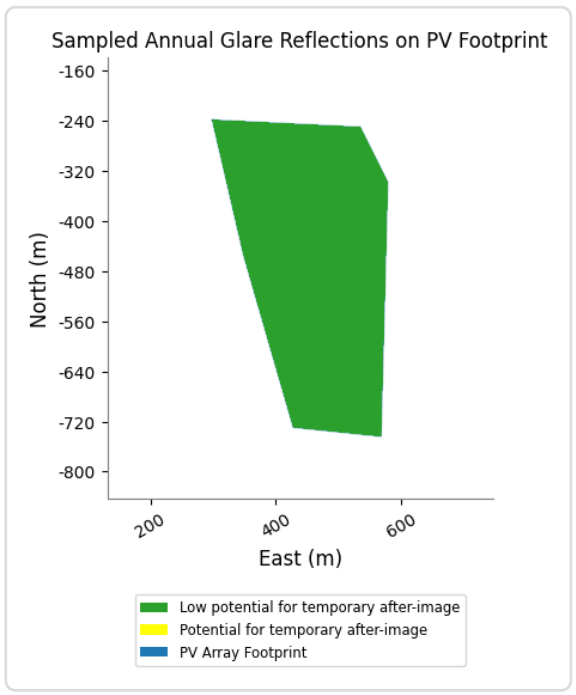
Yellow glare: none

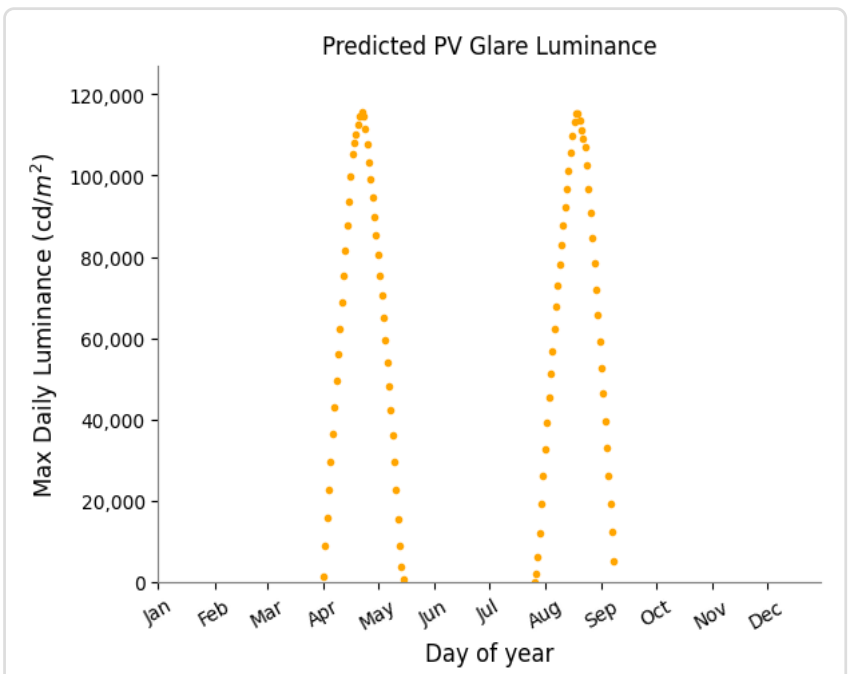
Green glare: 2,226 min.







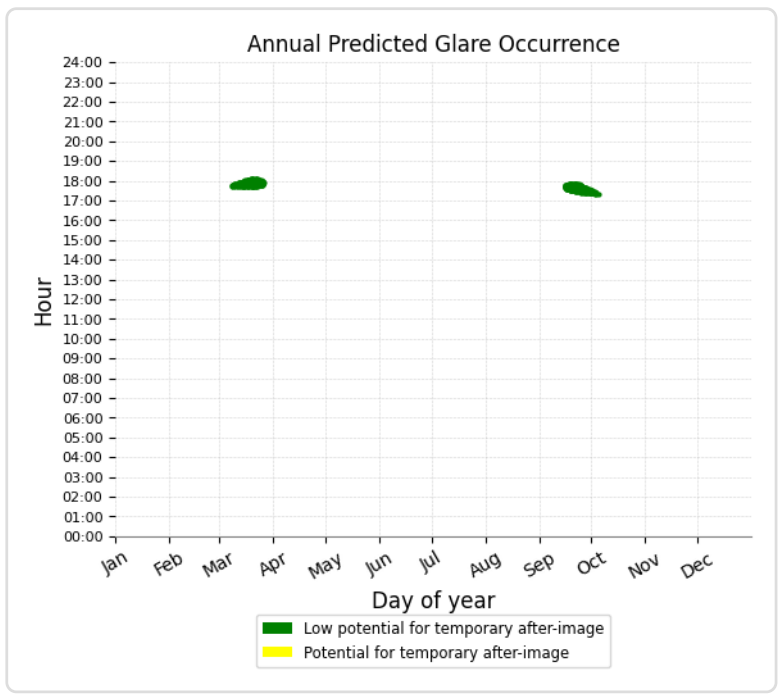


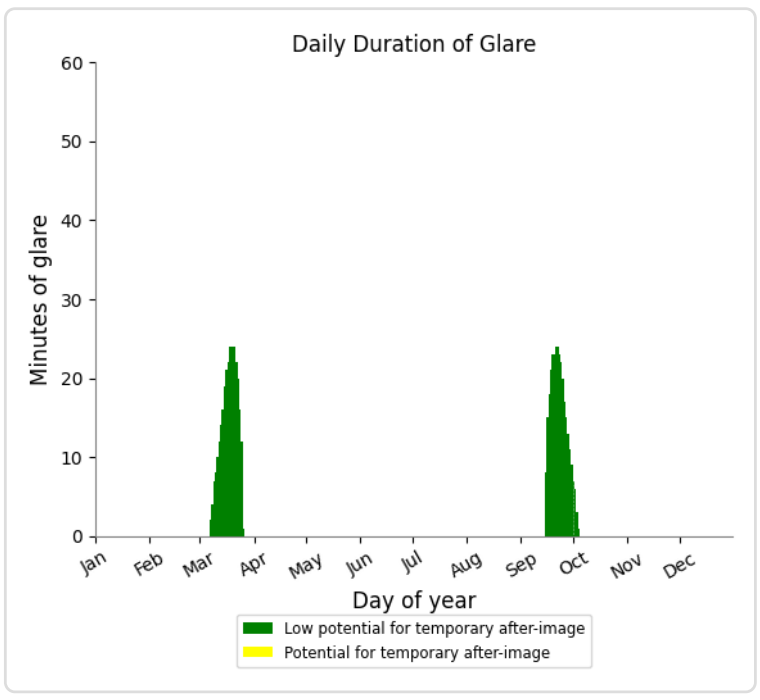


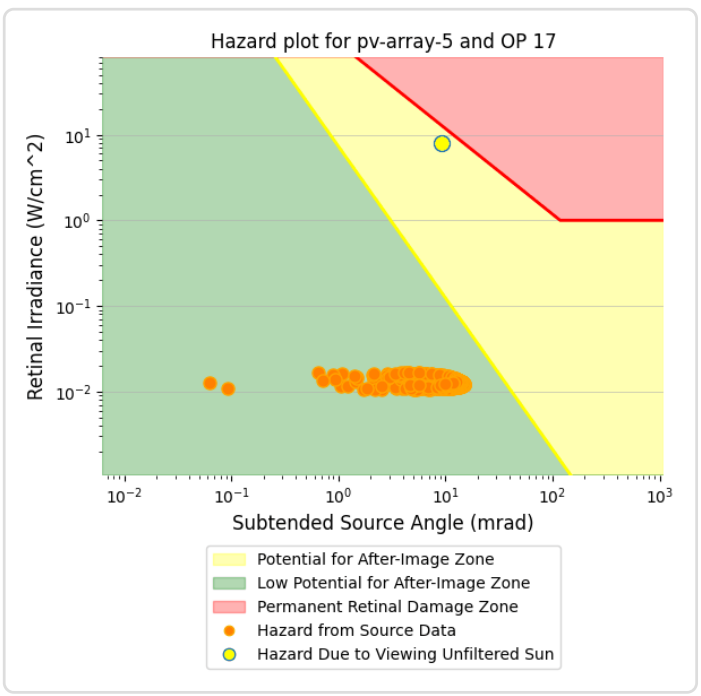
PV array 5 and OP 17

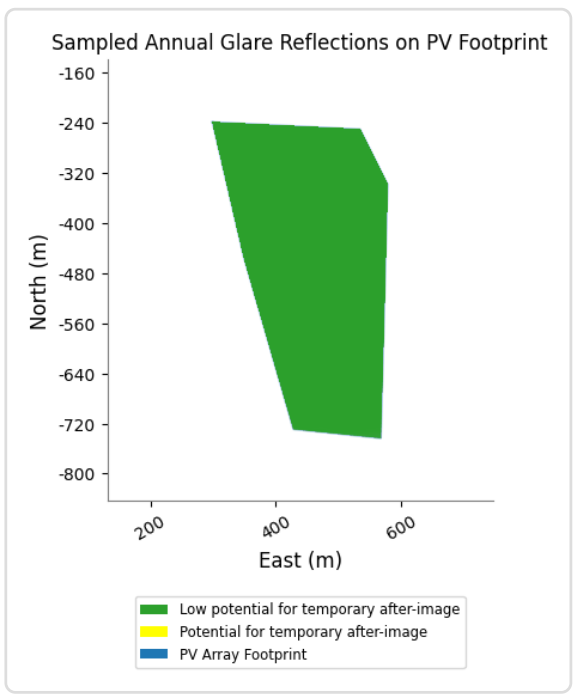
Yellow glare: none

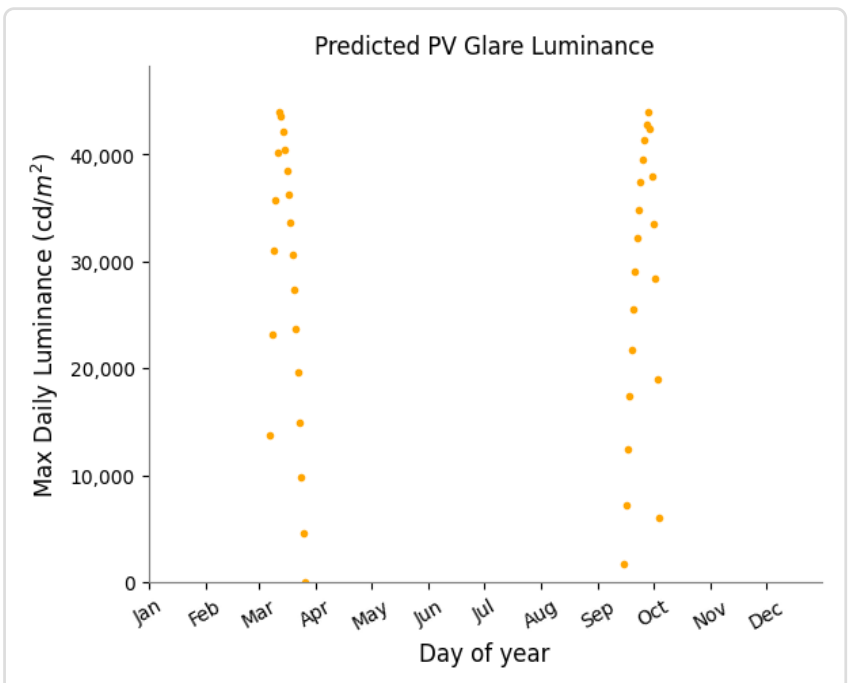
Green glare: 605 min.











PV array 5 and OP 1

No glare found

PV array 5 and OP 2

No glare found

PV array 5 and OP 3

No glare found

PV array 5 and OP 4

No glare found

PV array 5 and OP 5

No glare found

PV array 5 and OP 6

No glare found

PV array 5 and OP 9

No glare found

PV array 5 and OP 10

No glare found

PV array 5 and OP 11

No glare found

PV array 5 and OP 12

No glare found

PV array 5 and OP 13

No glare found

PV array 5 and OP 18

No glare found

PV array 5 and OP 19

No glare found

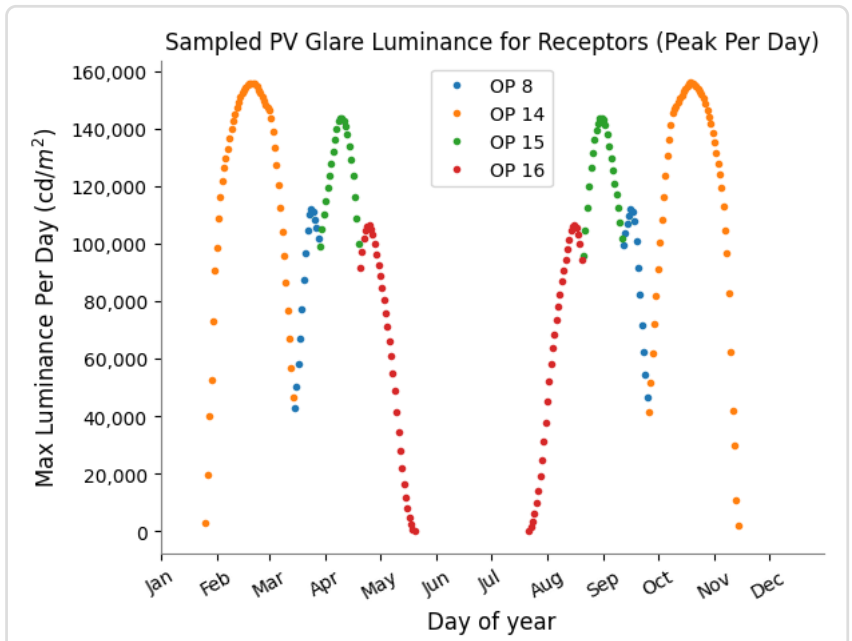
PV array 5 and OP 20

No glare found

PV: PV array 6 low potential for temporary after-image

Receptor results ordered by category of glare

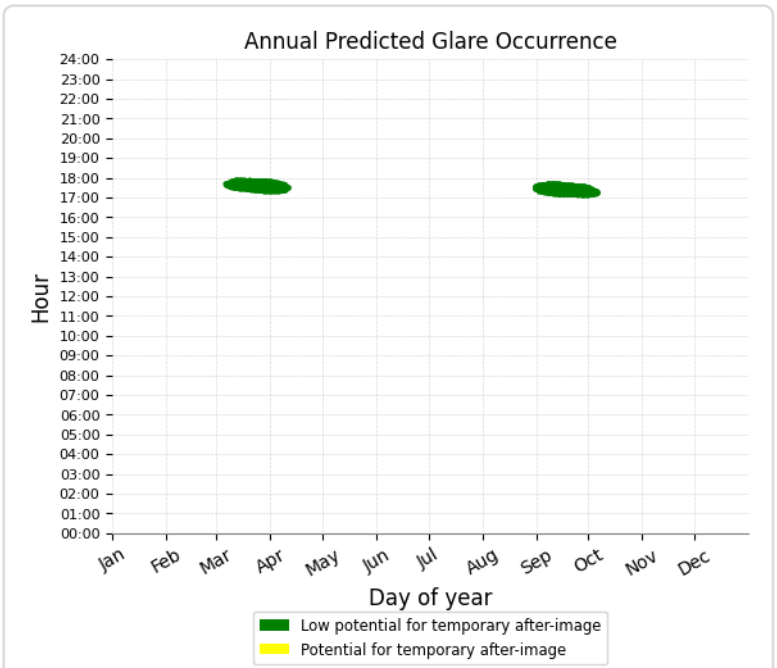
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	1,740	29.0	0	0.0	112,125
OP 14	4,491	74.8	0	0.0	156,017
OP 15	2,994	49.9	0	0.0	143,787
OP 16	2,428	40.5	0	0.0	106,331
OP 17	568	9.5	0	0.0	39,585
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

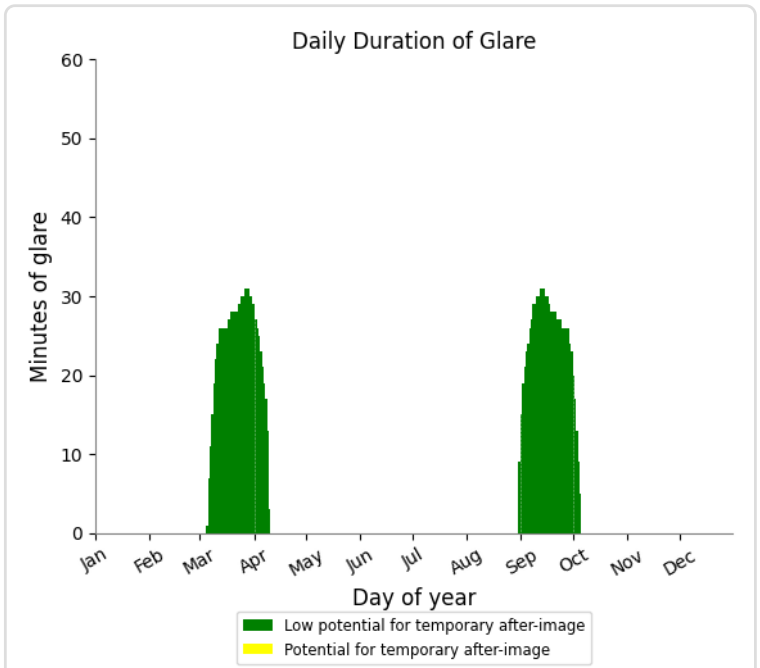


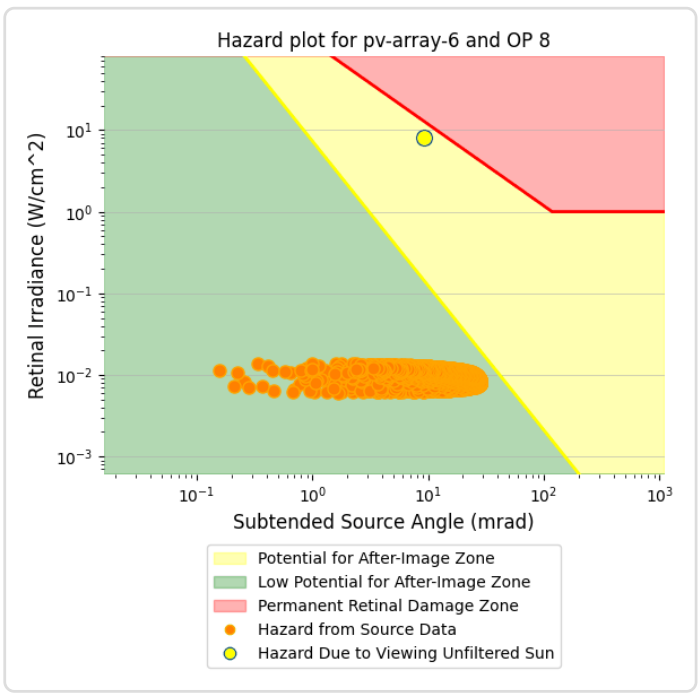
PV array 6 and OP 8

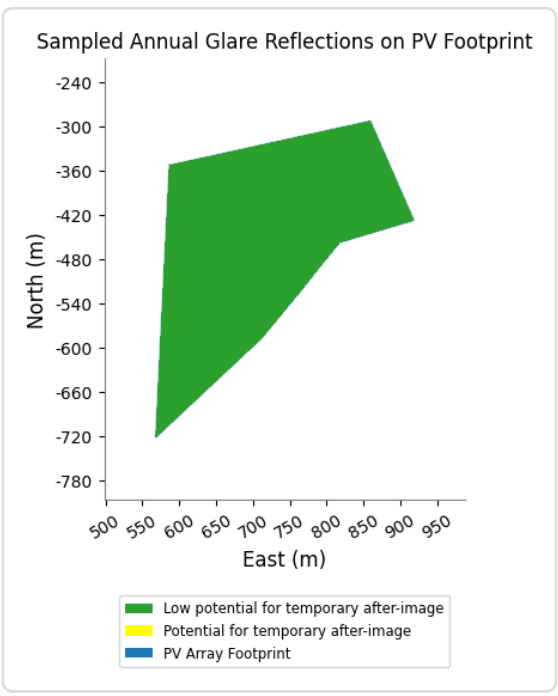
Yellow glare: none

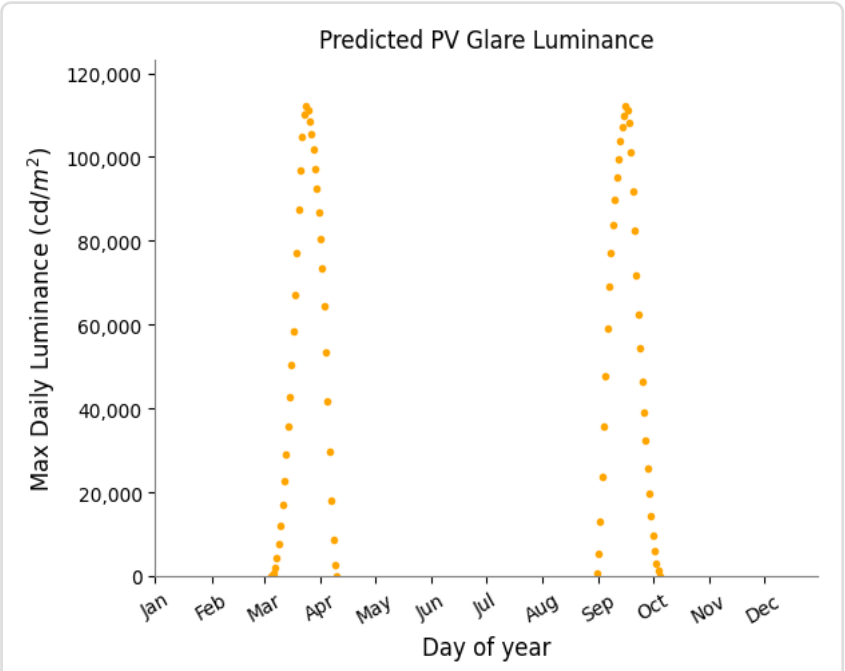
Green glare: 1,740 min.







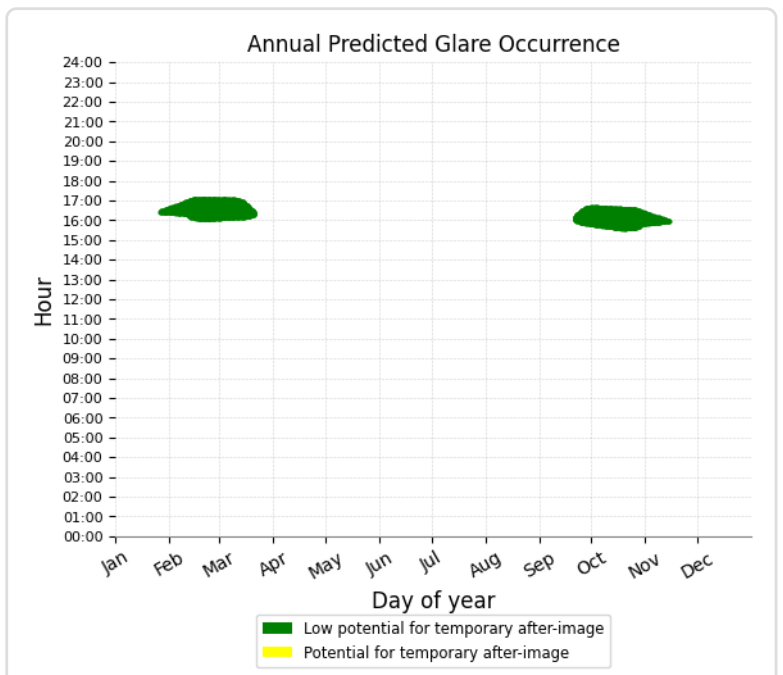


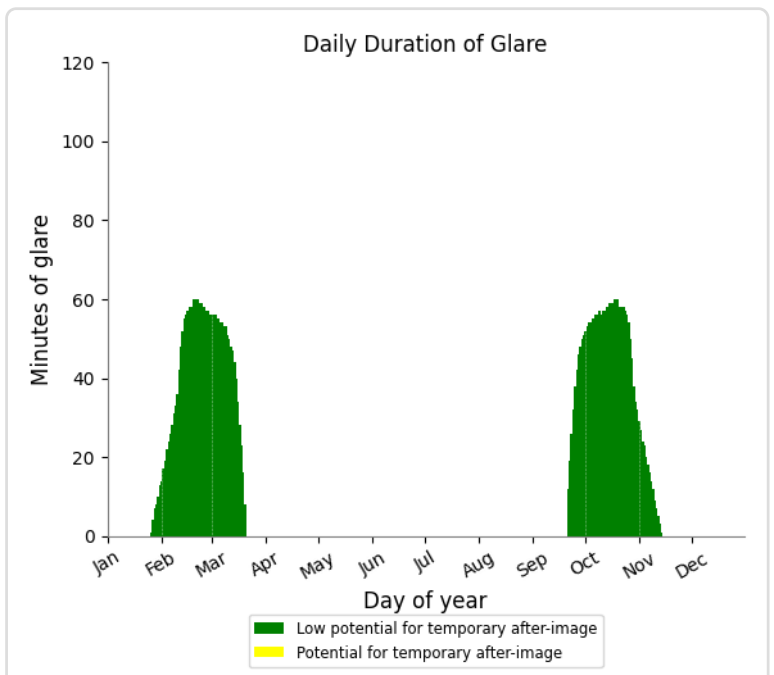


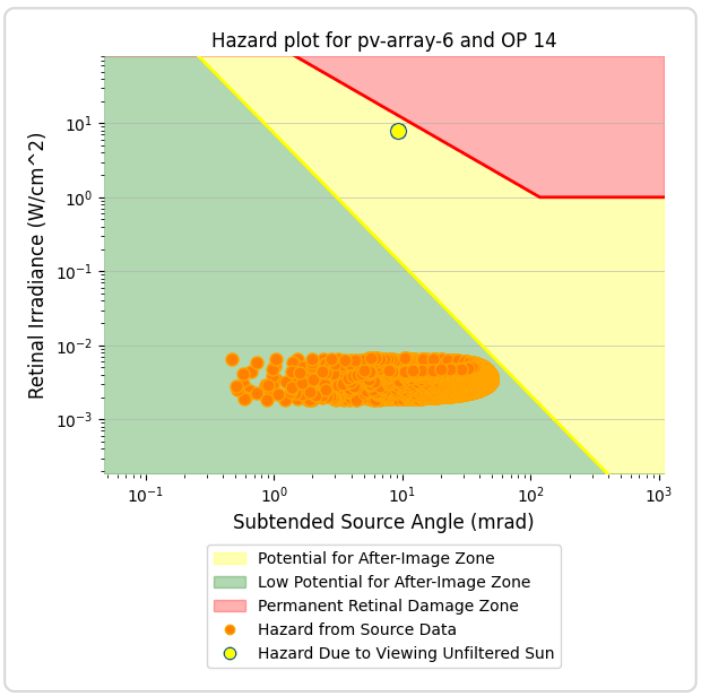
PV array 6 and OP 14

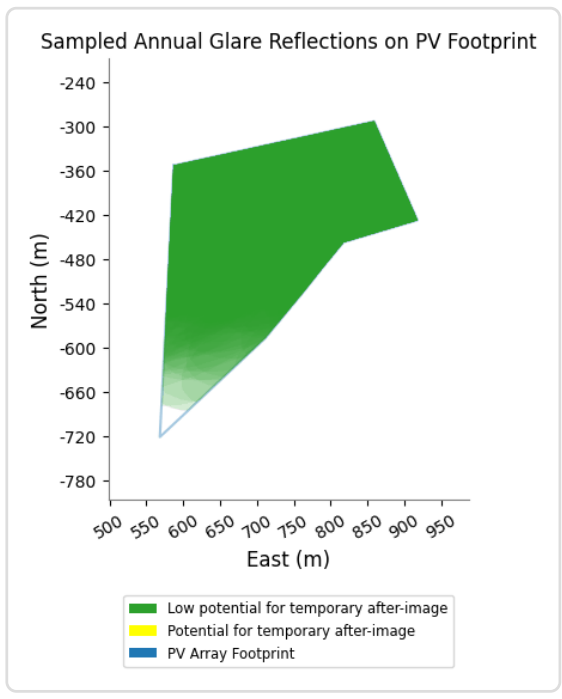
Yellow glare: none

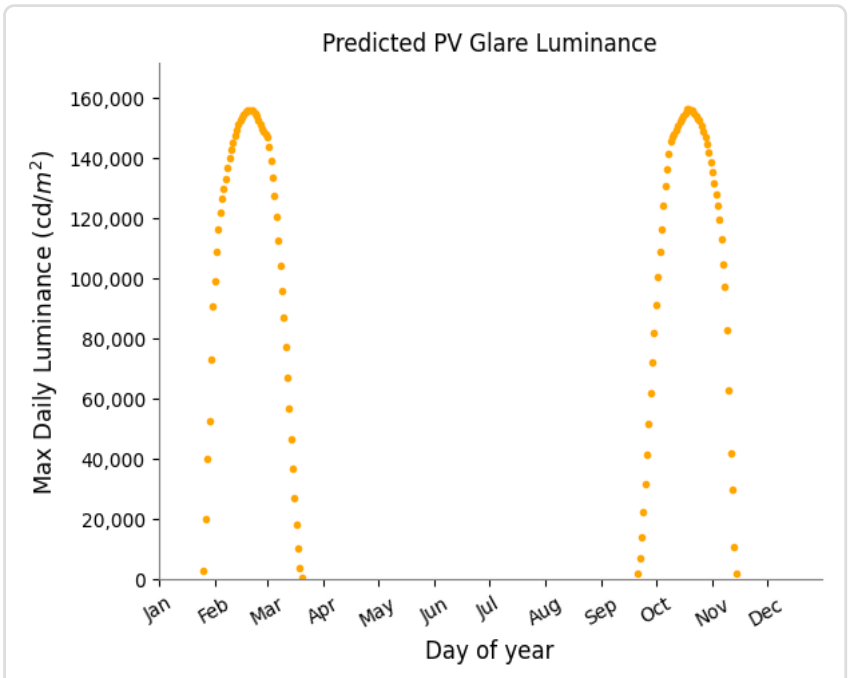
Green glare: 4,491 min.







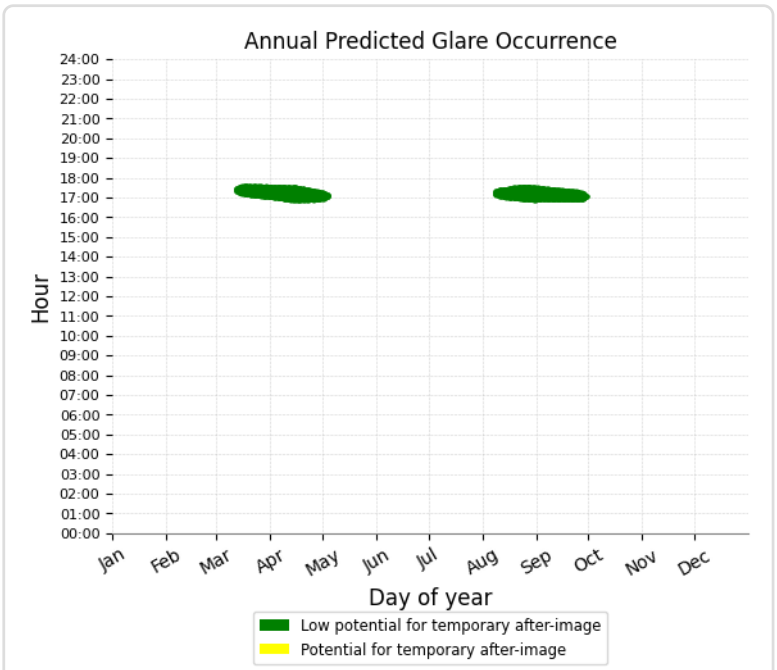


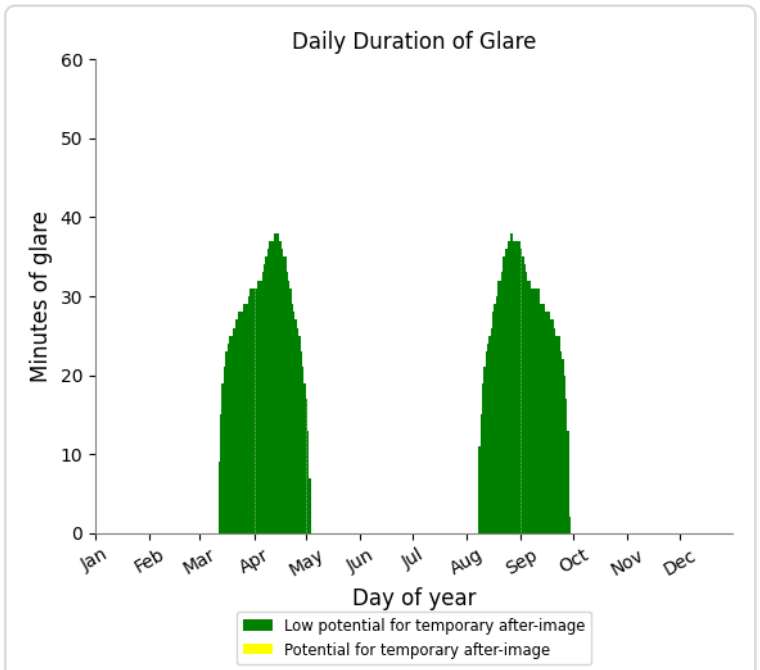


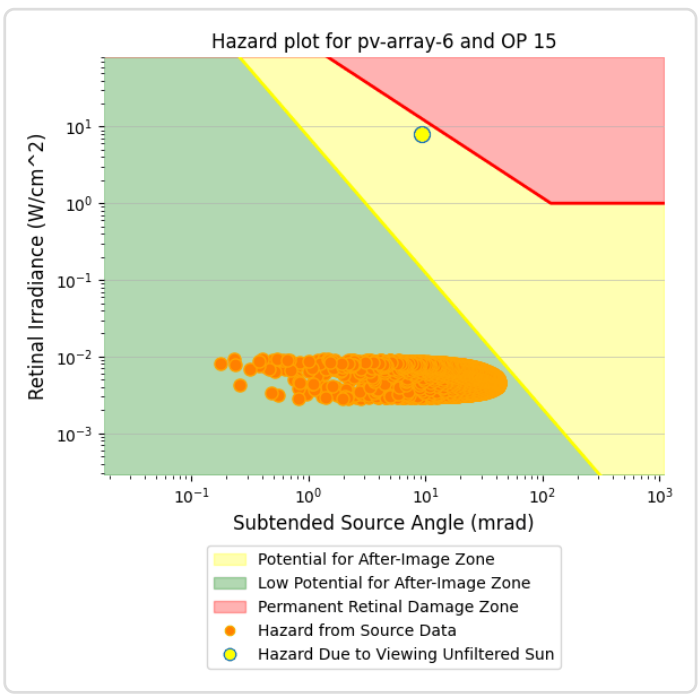
PV array 6 and OP 15

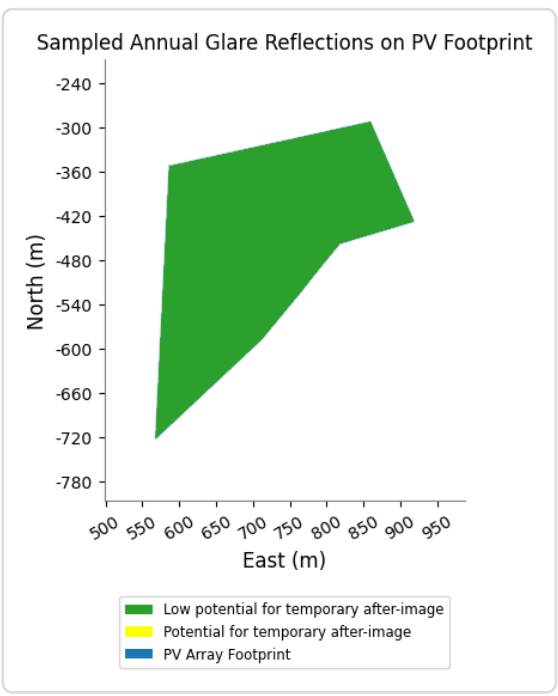
Yellow glare: none

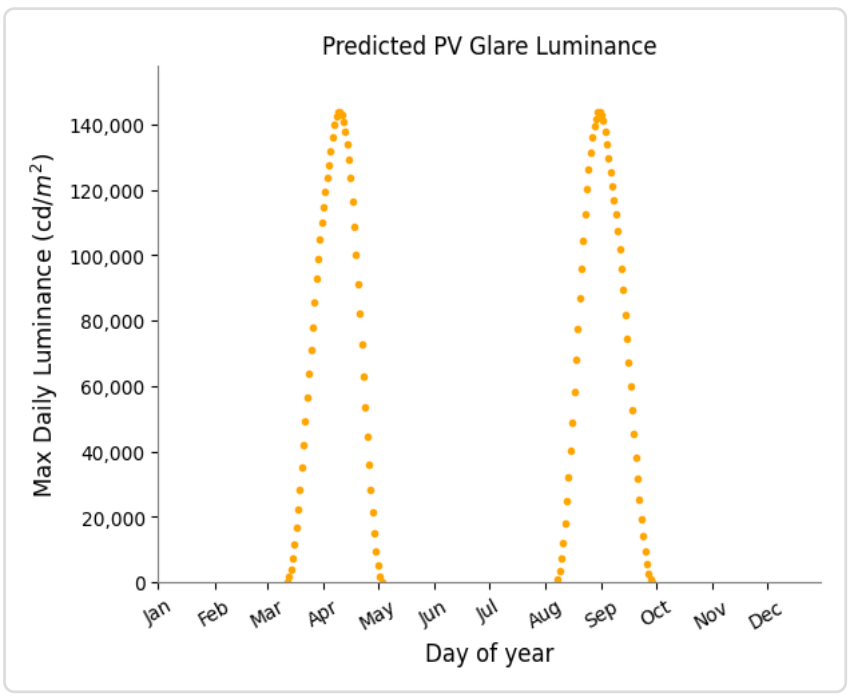
Green glare: 2,994 min.







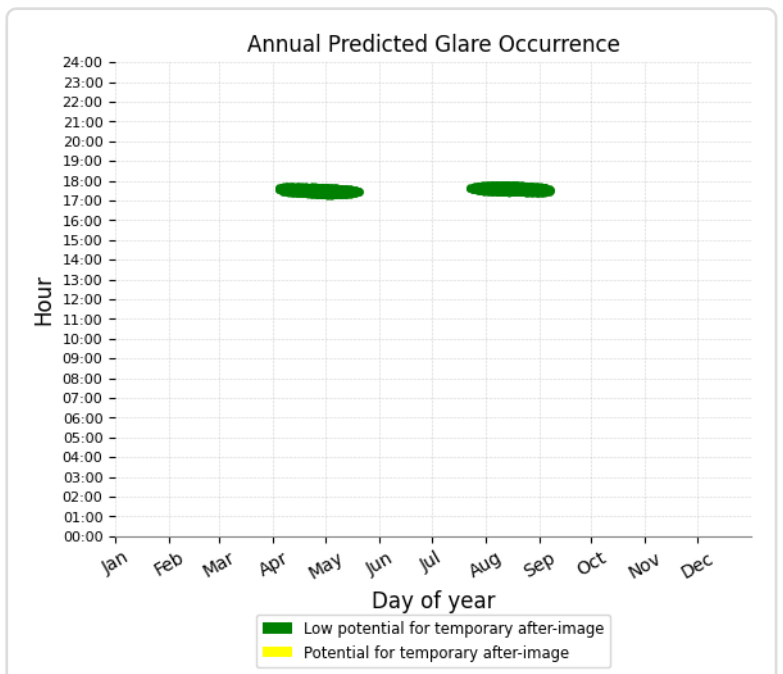


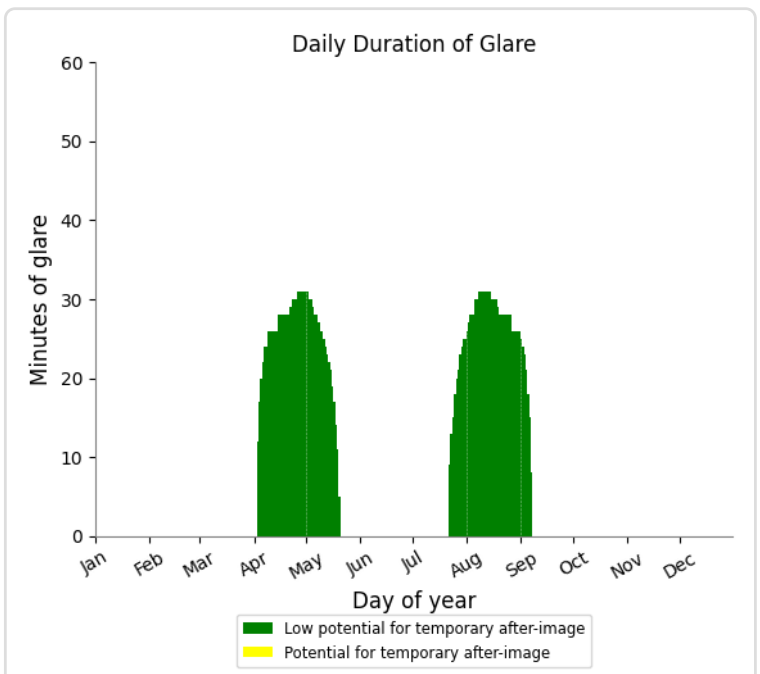


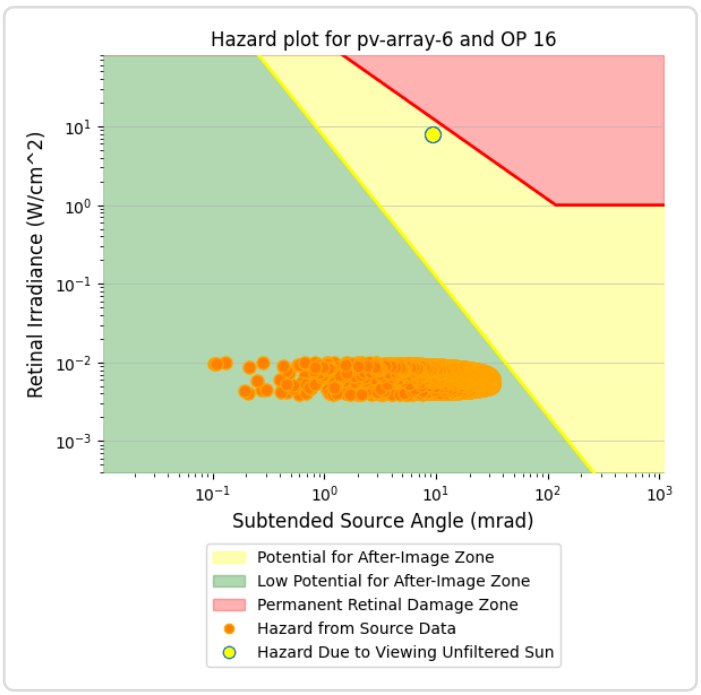
PV array 6 and OP 16

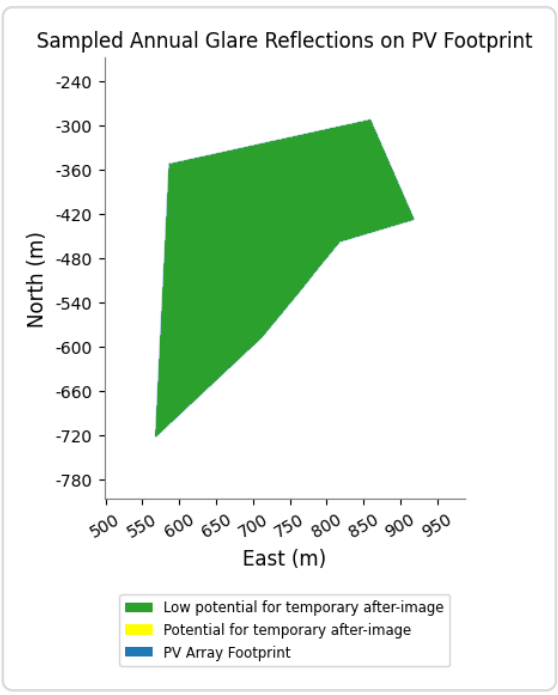
Yellow glare: none

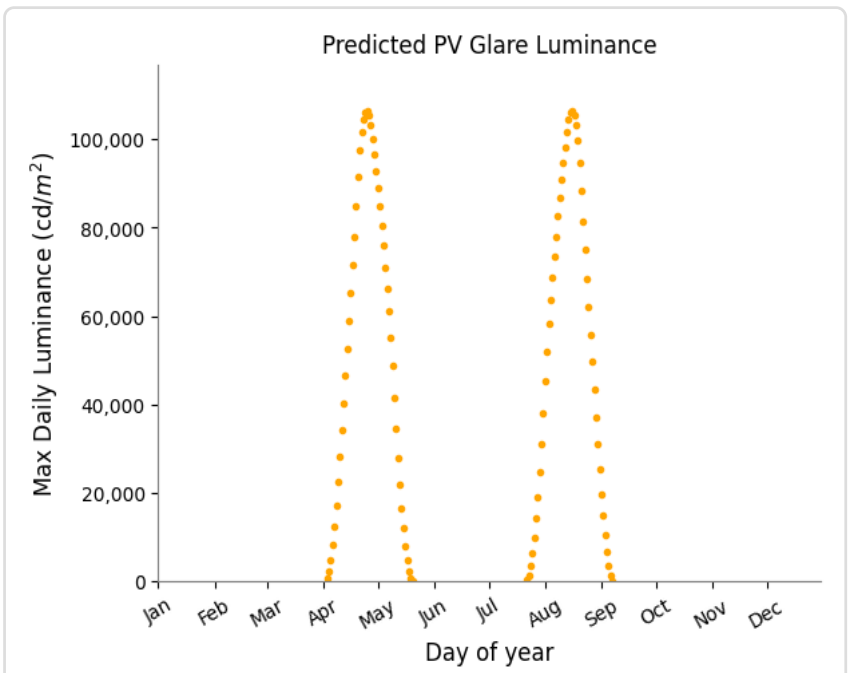
Green glare: 2,428 min.







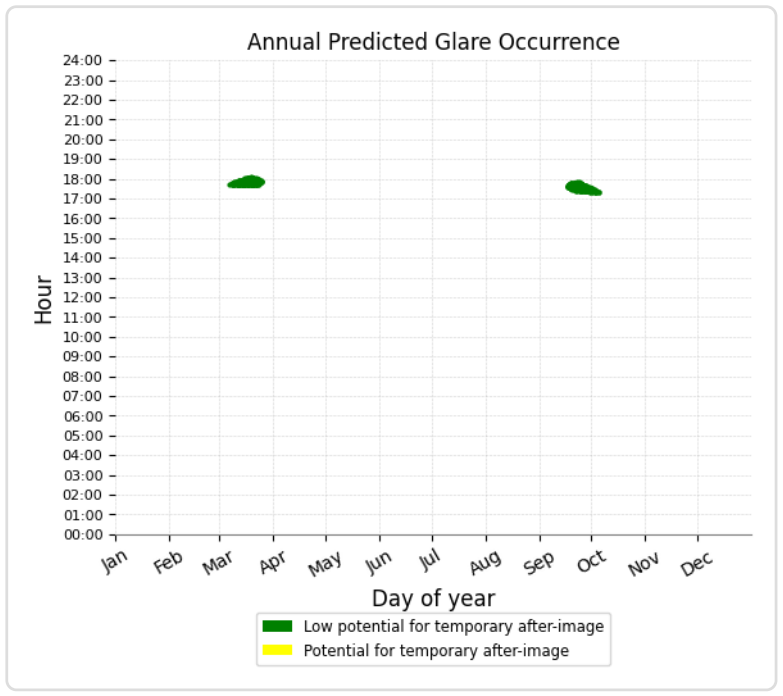


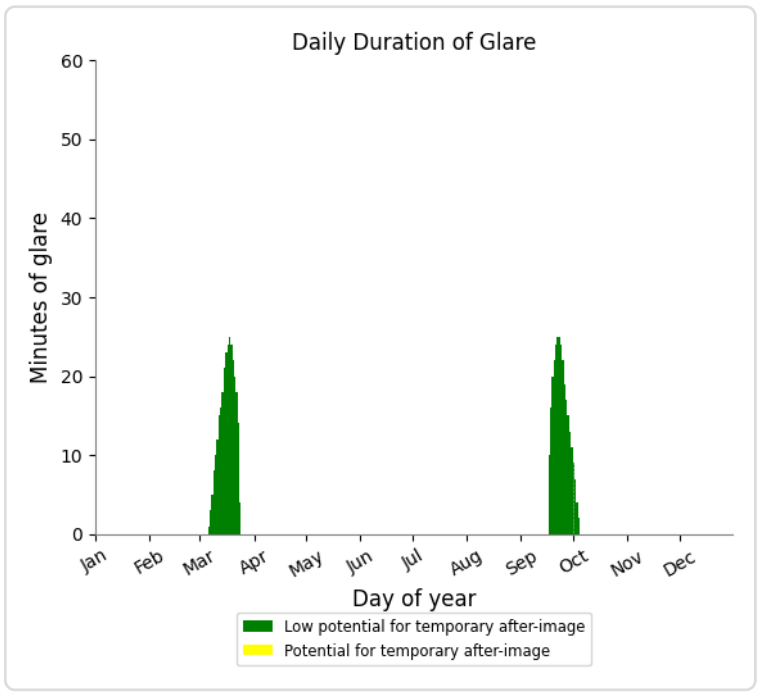


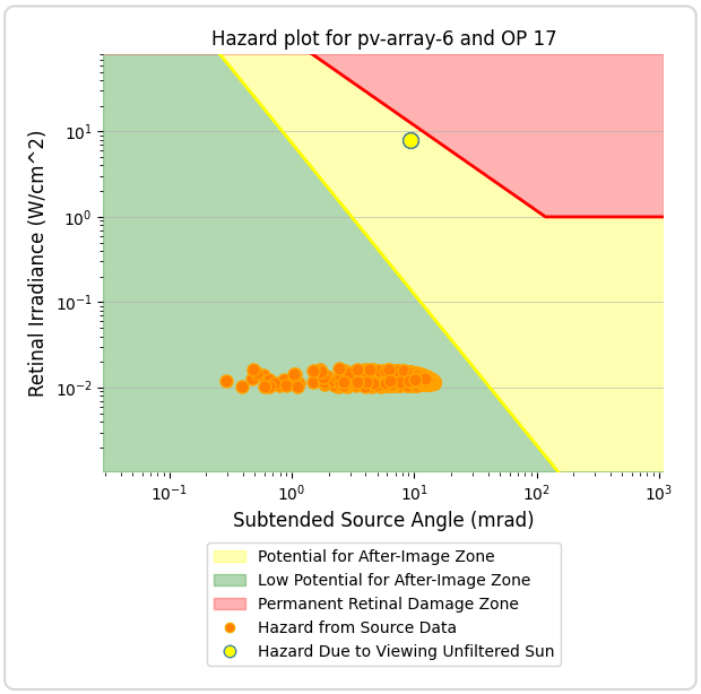
PV array 6 and OP 17

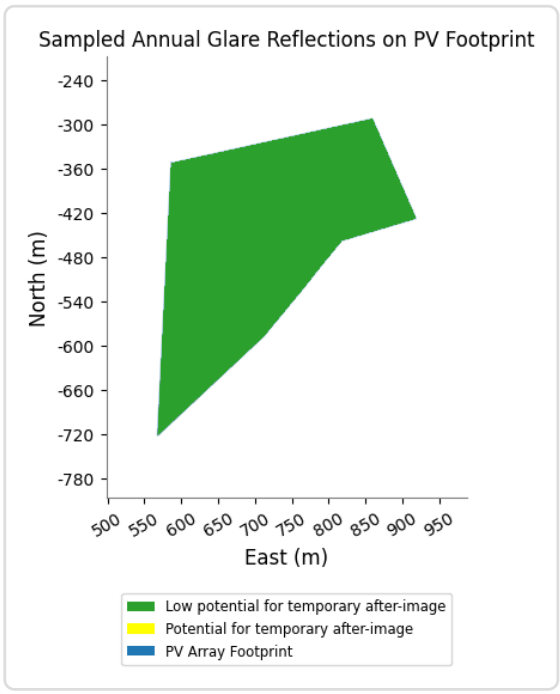
Yellow glare: none

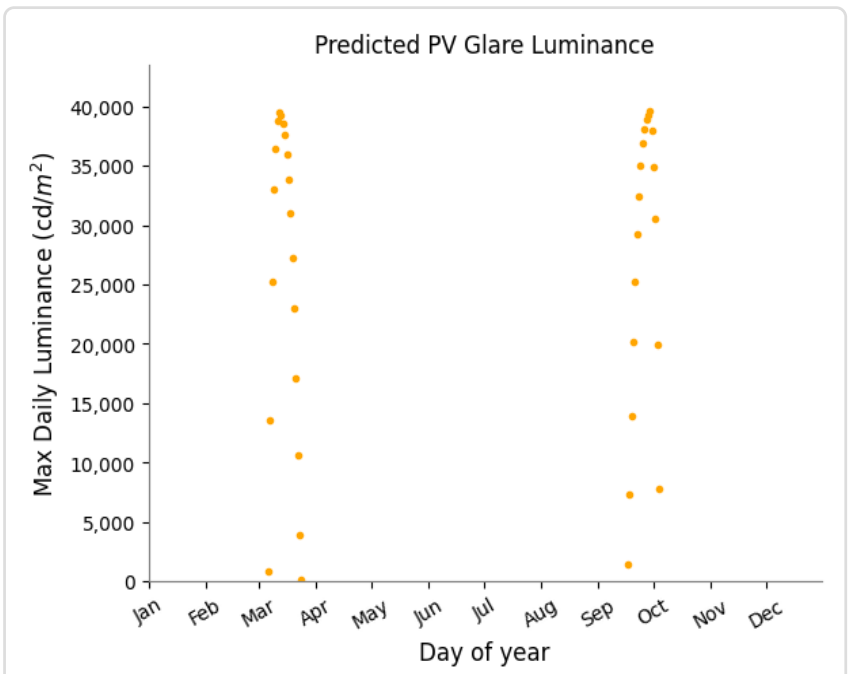
Green glare: 568 min.











PV array 6 and OP 1

No glare found

PV array 6 and OP 2

No glare found

PV array 6 and OP 3

No glare found

PV array 6 and OP 4

No glare found

PV array 6 and OP 5

No glare found

PV array 6 and OP 6

No glare found

PV array 6 and OP 7

No glare found

PV array 6 and OP 9

No glare found

PV array 6 and OP 10

No glare found

PV array 6 and OP 11

No glare found

PV array 6 and OP 12

No glare found

PV array 6 and OP 13

No glare found

PV array 6 and OP 18

No glare found

PV array 6 and OP 19

No glare found

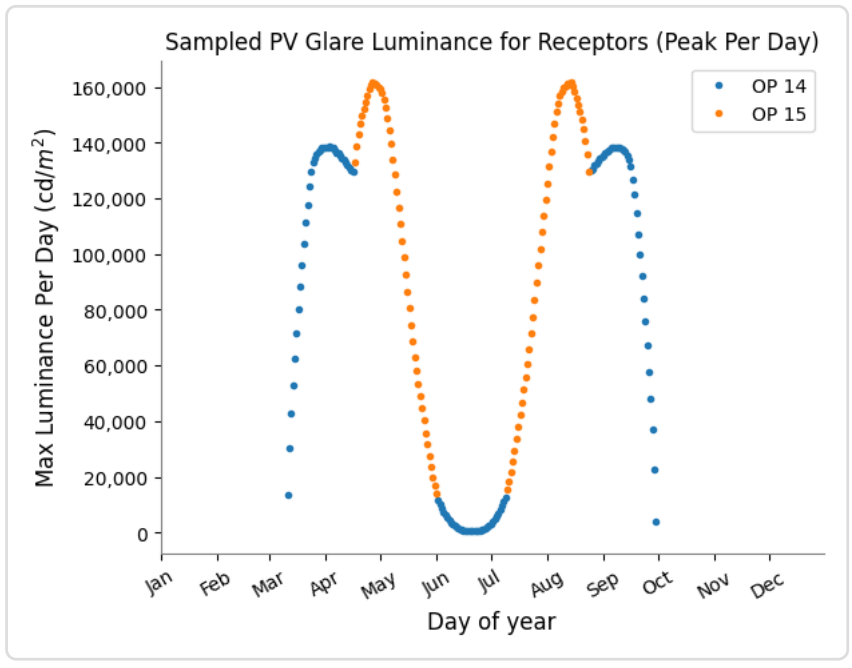
PV array 6 and OP 20

No glare found

PV: PV array 7 low potential for temporary after-image

Receptor results ordered by category of glare

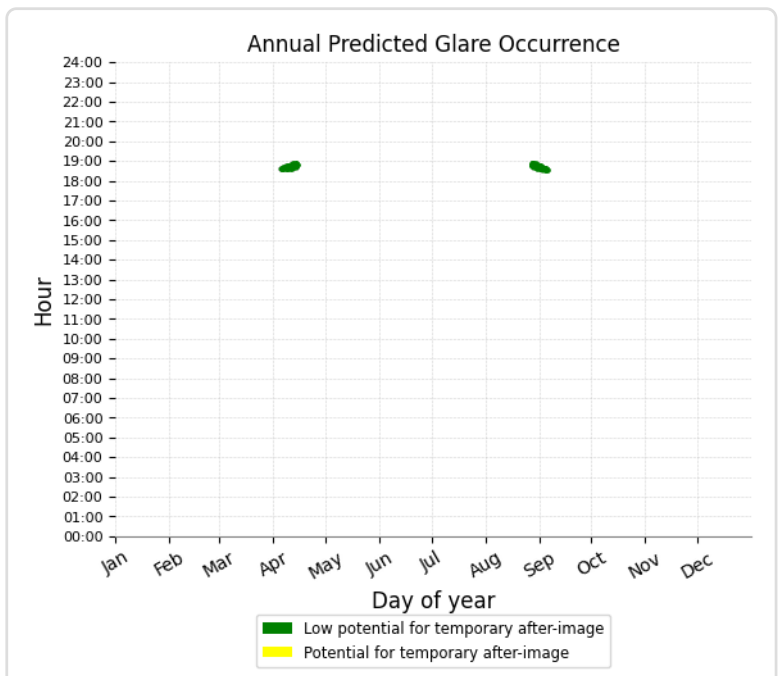
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 8	170	2.8	0	0.0	34,960
OP 14	7,386	123.1	0	0.0	138,562
OP 15	3,811	63.5	0	0.0	161,574
OP 16	2,121	35.4	0	0.0	115,807
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 7	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

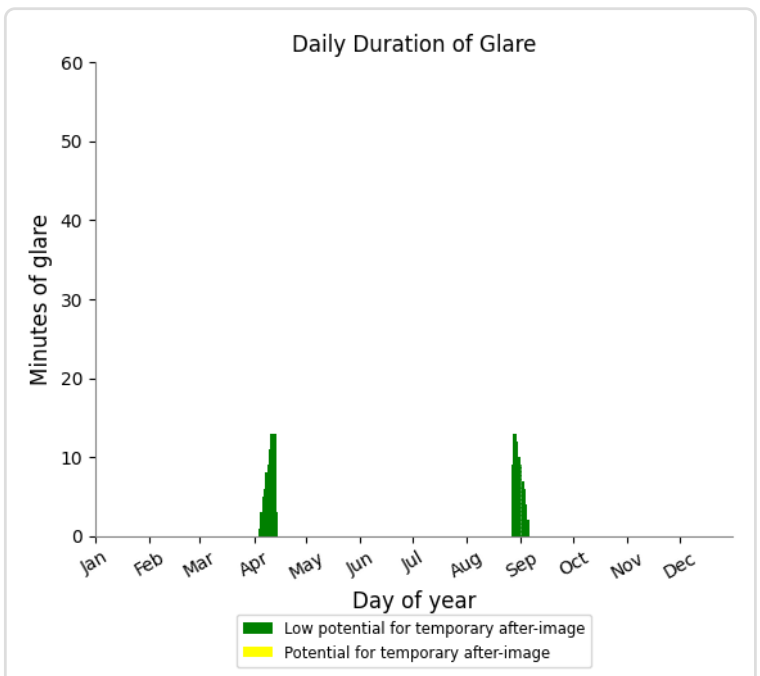


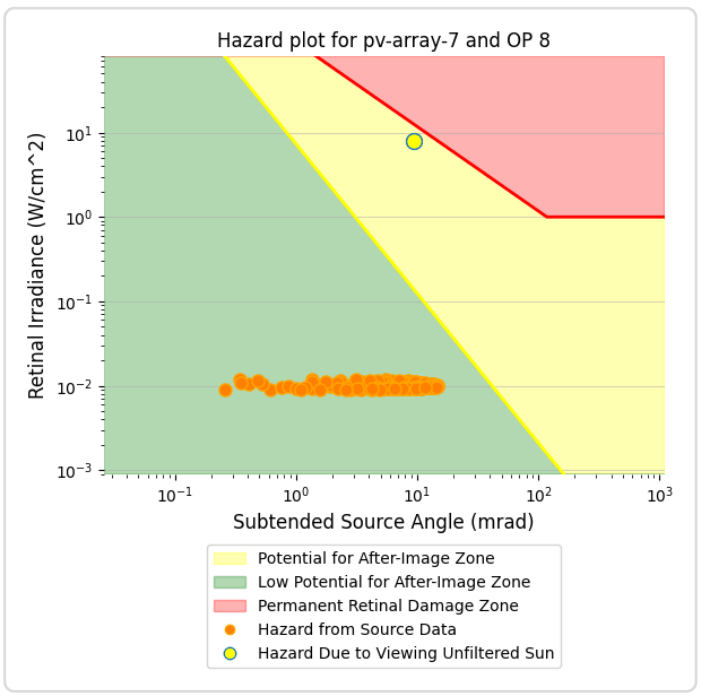
PV array 7 and OP 8

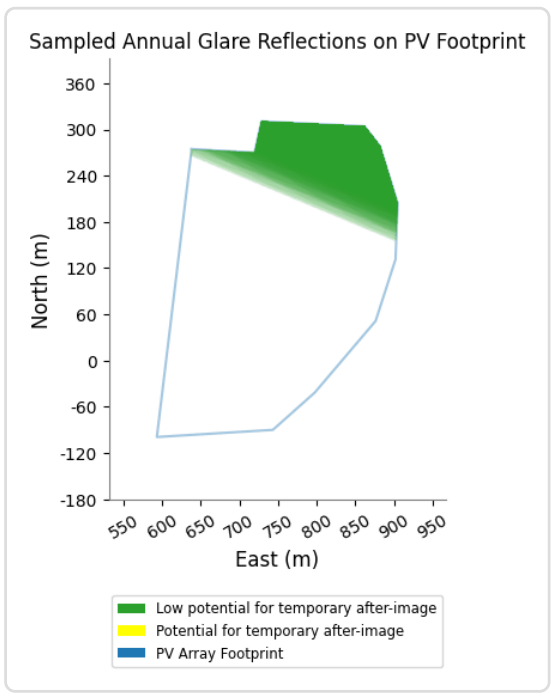
Yellow glare: none

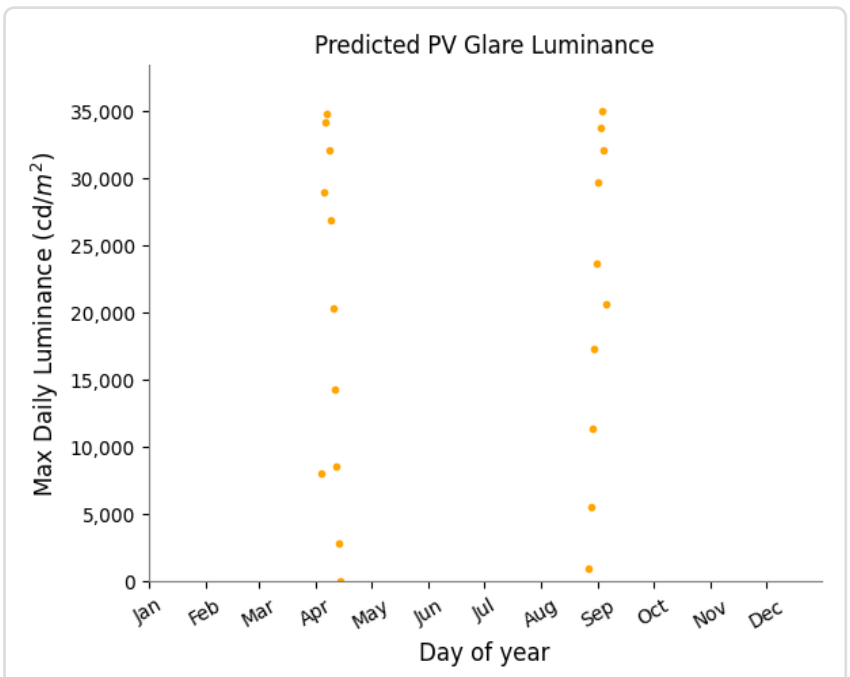
Green glare: 170 min.







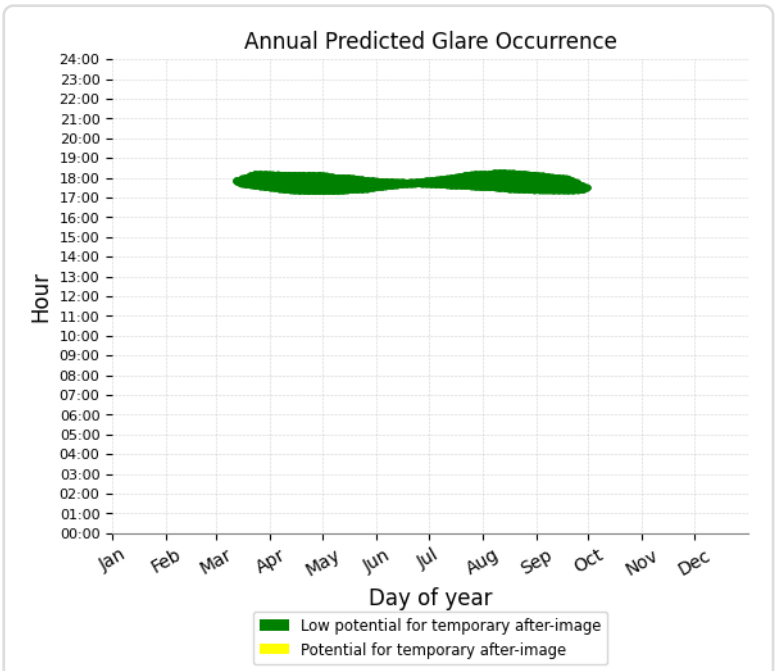


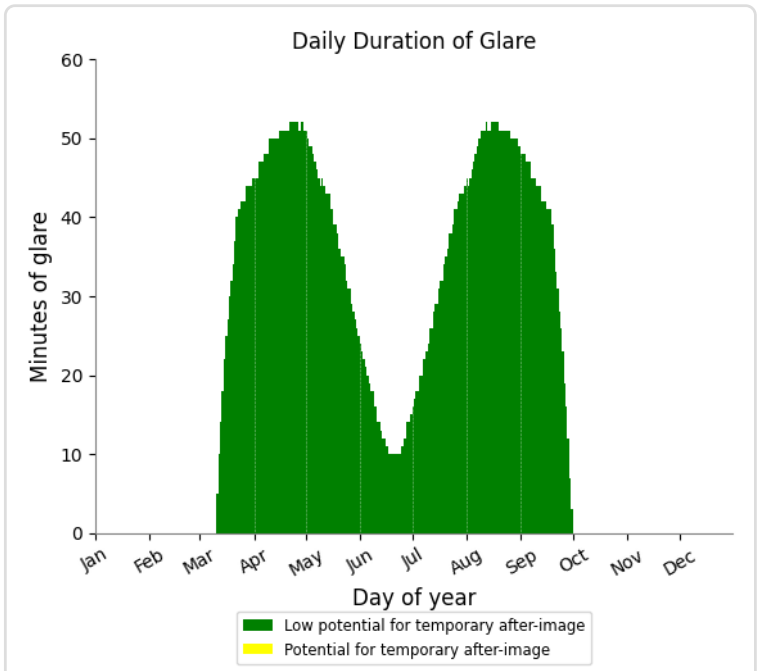


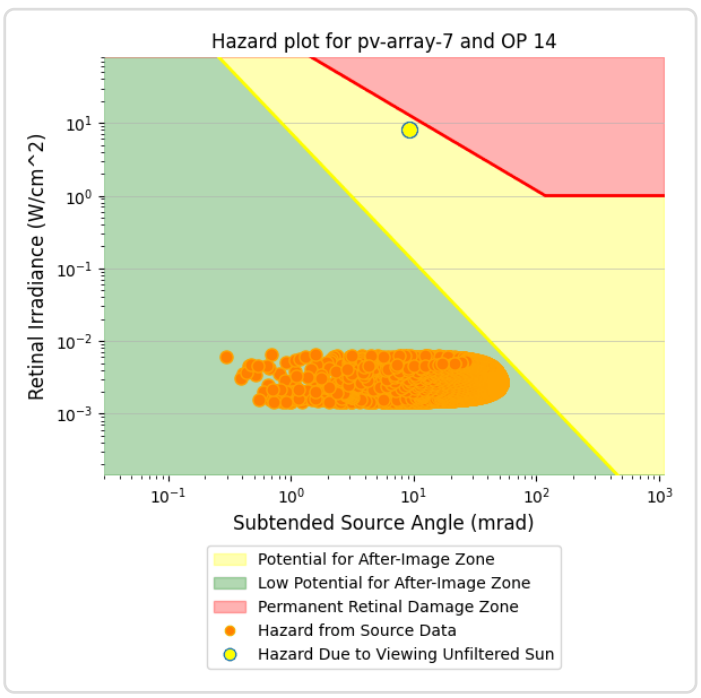
PV array 7 and OP 14

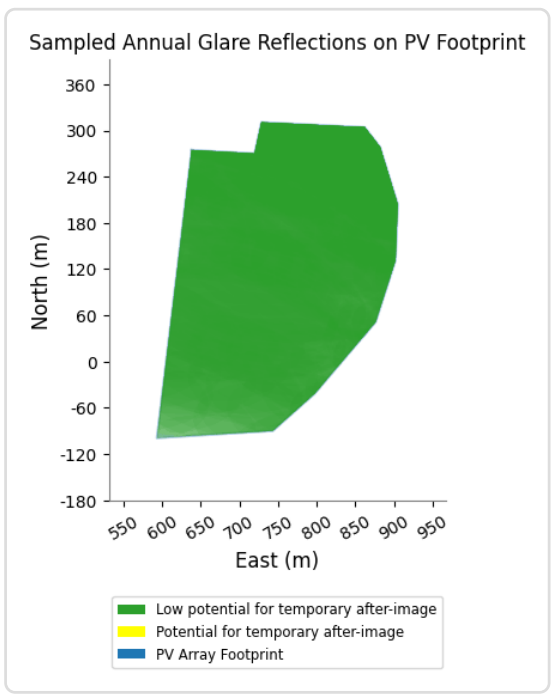
Yellow glare: none

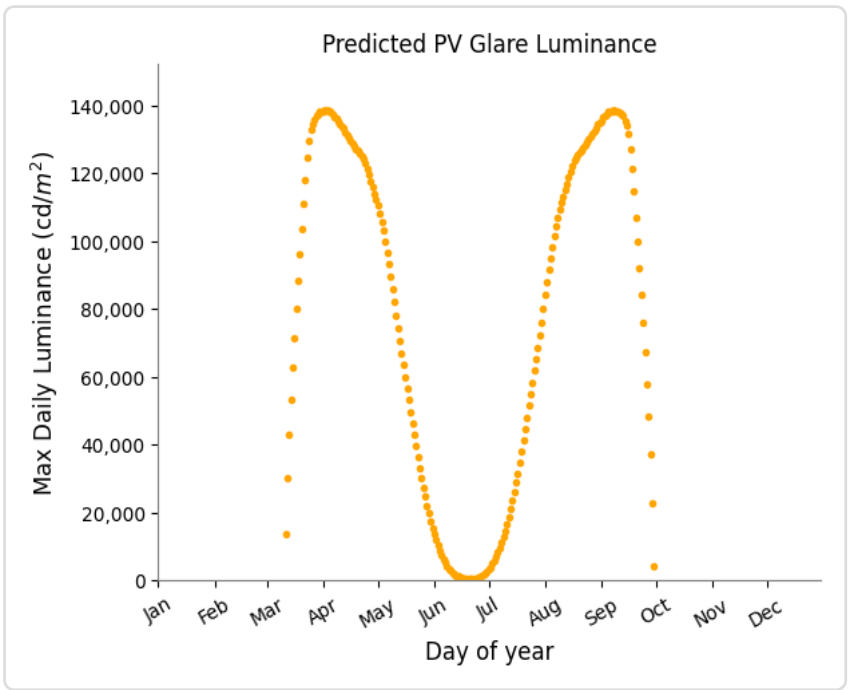
Green glare: 7,386 min.







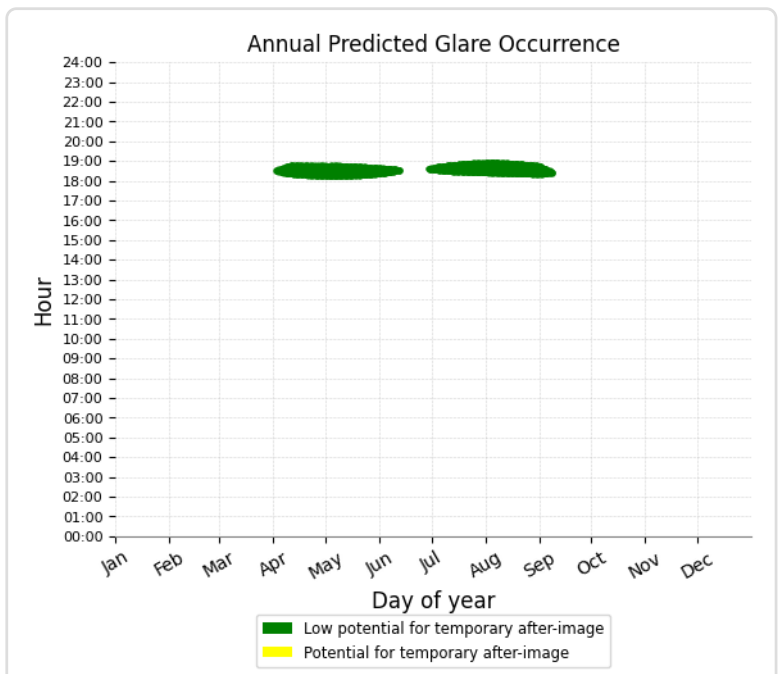


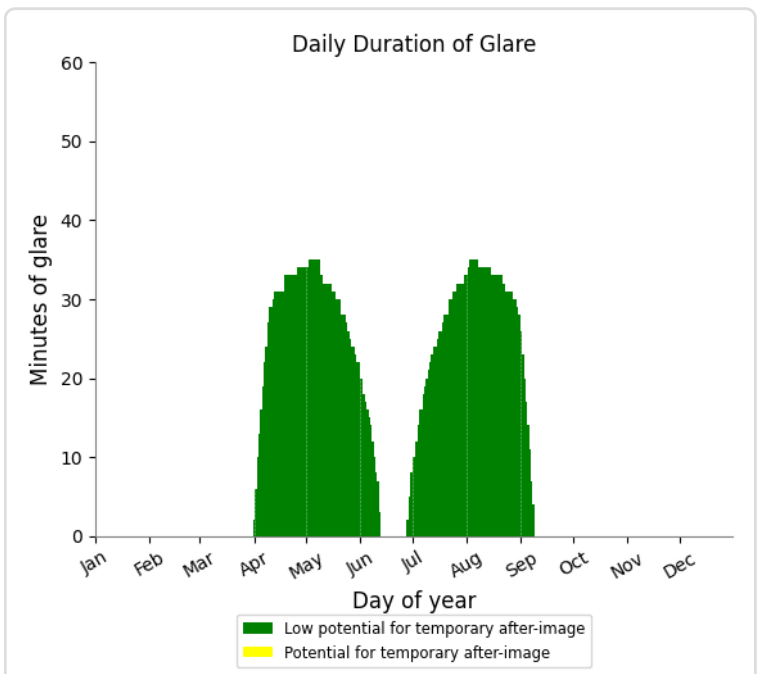


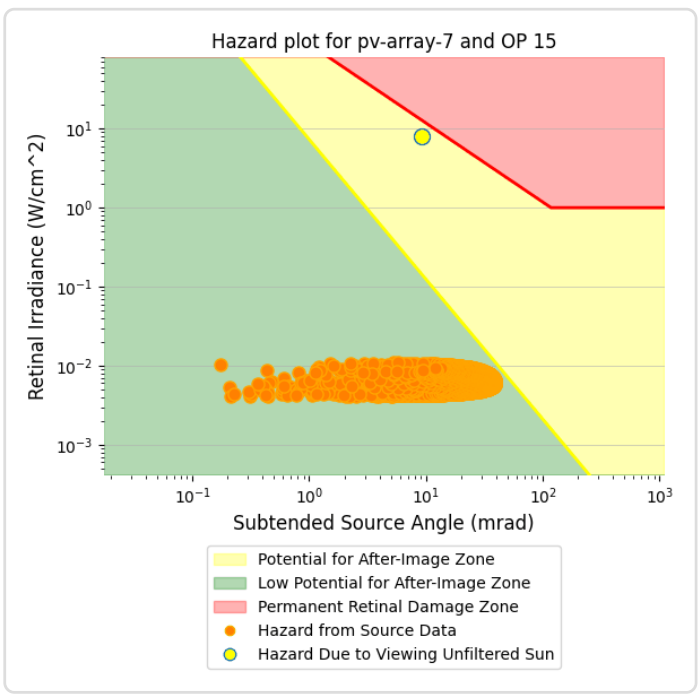
PV array 7 and OP 15

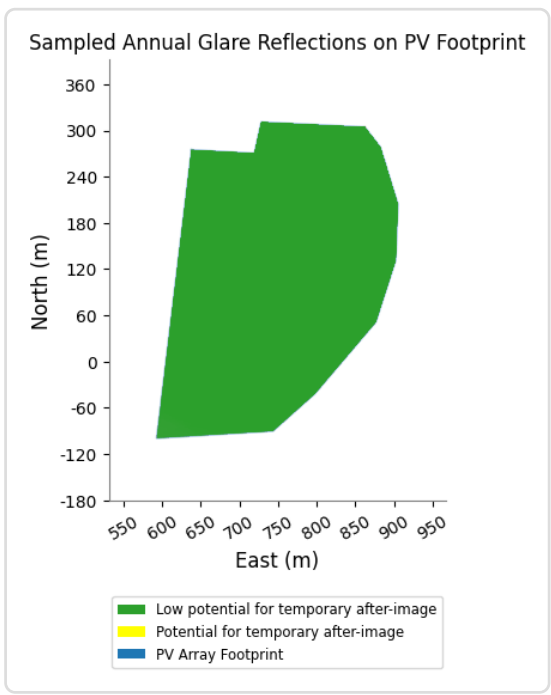
Yellow glare: none

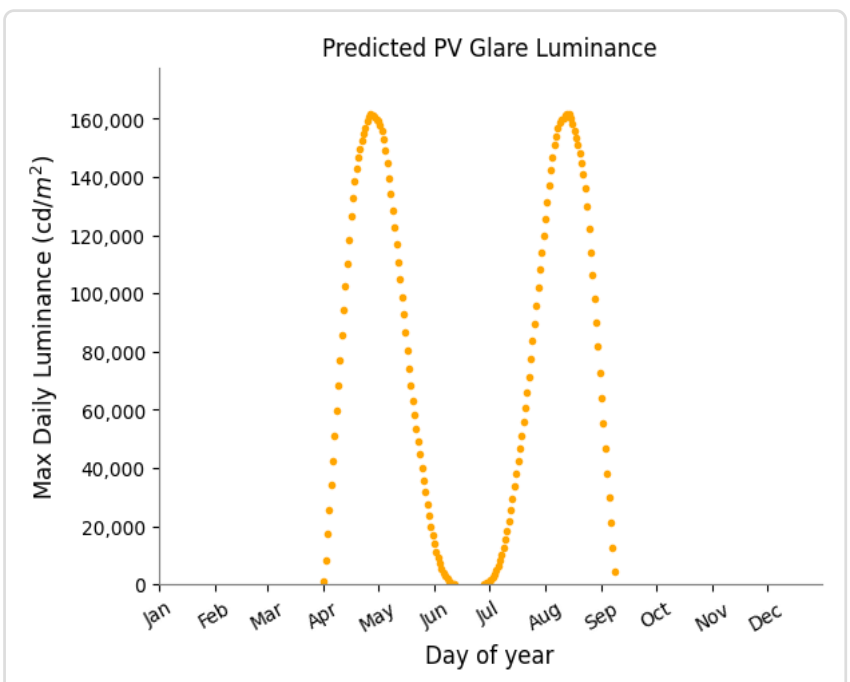
Green glare: 3,811 min.







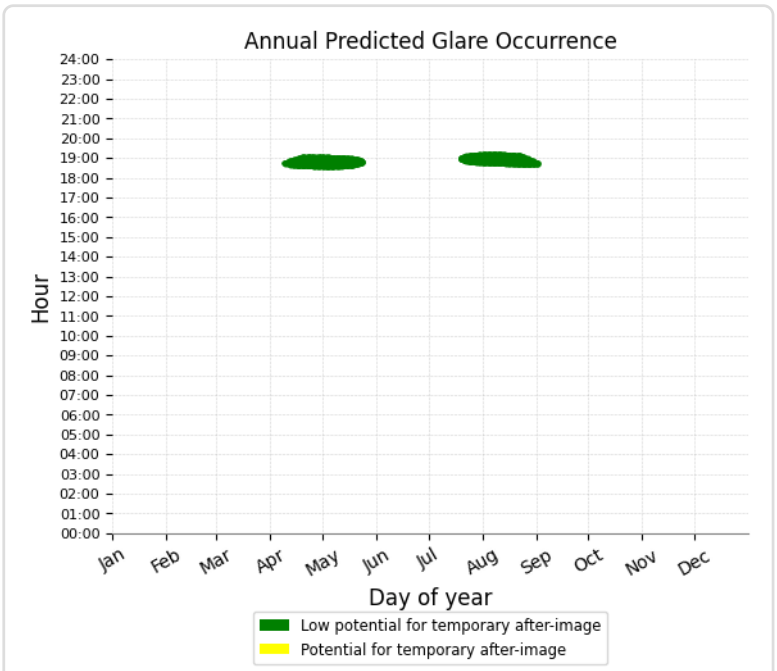


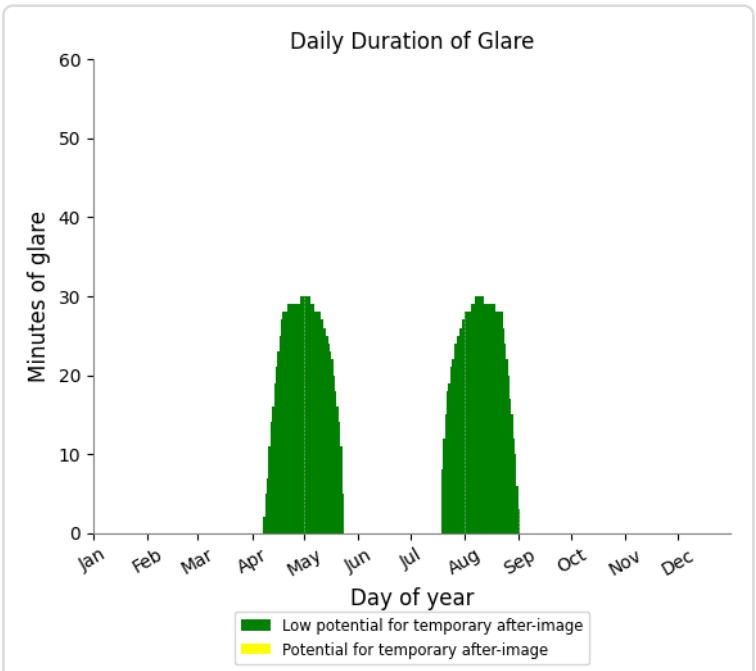


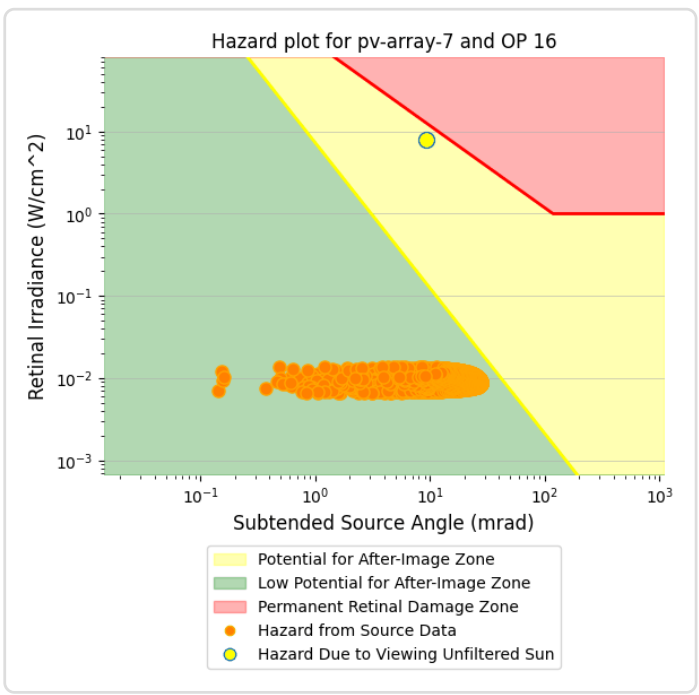
PV array 7 and OP 16

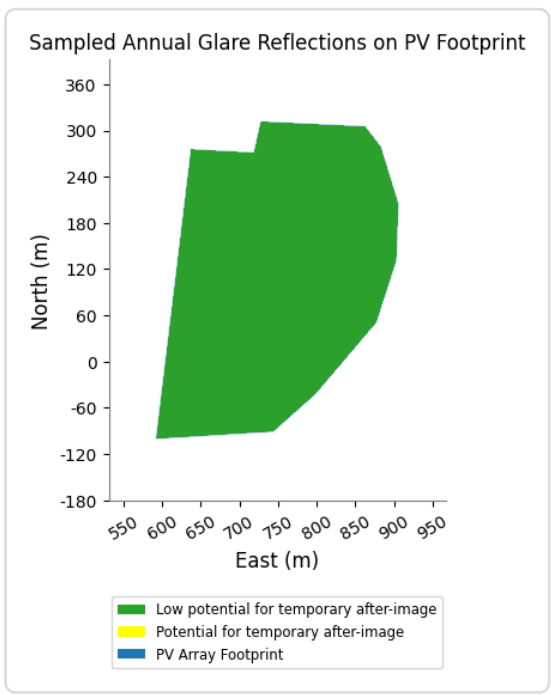
Yellow glare: none

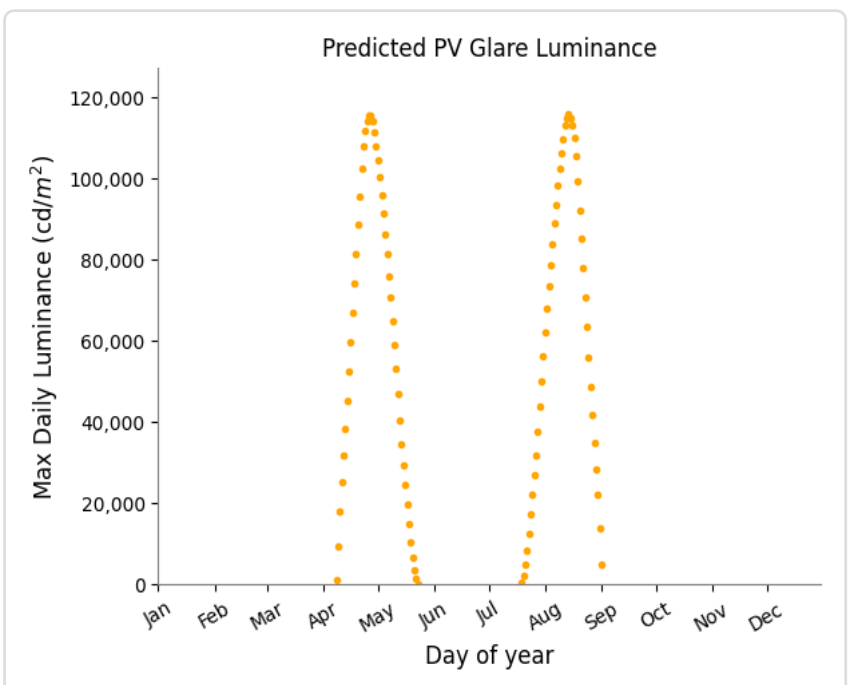
Green glare: 2,121 min.











PV array 7 and OP 1

No glare found

PV array 7 and OP 2

No glare found

PV array 7 and OP 3

No glare found

PV array 7 and OP 4

No glare found

PV array 7 and OP 5

No glare found

PV array 7 and OP 6

No glare found

PV array 7 and OP 7

No glare found

PV array 7 and OP 9

No glare found

PV array 7 and OP 10

No glare found

PV array 7 and OP 11

No glare found

PV array 7 and OP 12

No glare found

PV array 7 and OP 13

No glare found

PV array 7 and OP 17

No glare found

PV array 7 and OP 18

No glare found

PV array 7 and OP 19

No glare found

PV array 7 and OP 20

No glare found

PV: PV array 8 low potential for temporary after-image

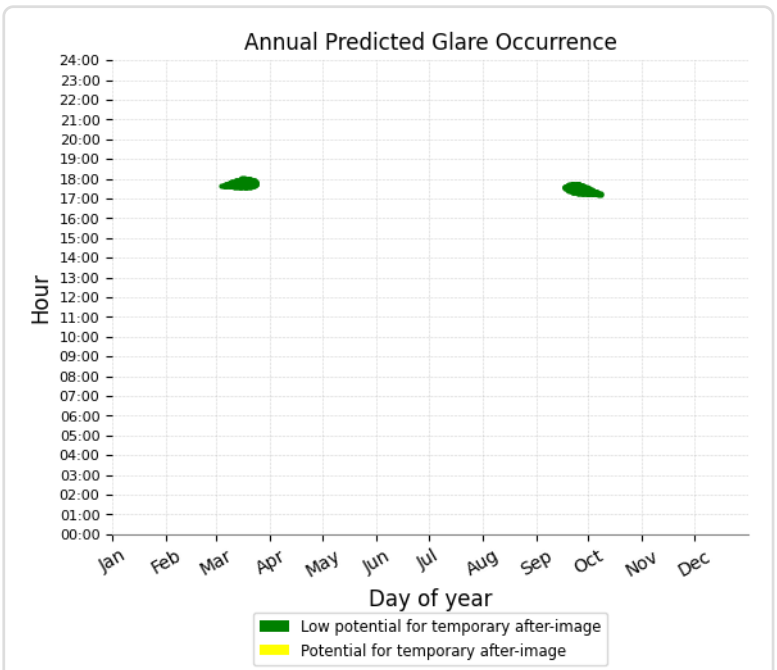
Receptor results ordered by category of glare

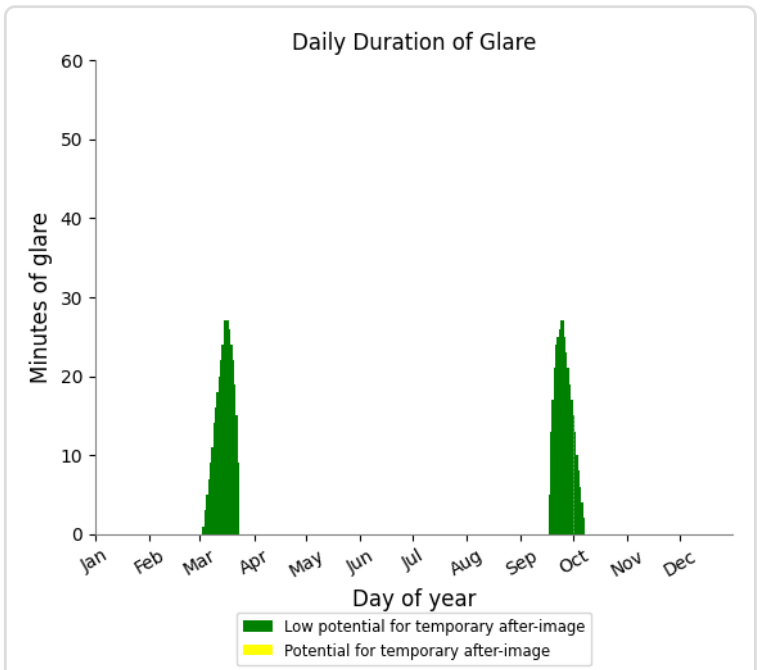
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 1	694	11.6	0	0.0	78,653
OP 7	2,190	36.5	0	0.0	164,006
OP 8	2,138	35.6	0	0.0	123,419
OP 14	7,407	123.5	0	0.0	132,879
OP 15	4,177	69.6	0	0.0	125,501
OP 16	3,208	53.5	0	0.0	109,257
OP 17	1,233	20.6	0	0.0	64,669
OP 18	465	7.8	0	0.0	43,984
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 4	0	0.0	0	0.0	0
OP 5	0	0.0	0	0.0	0
OP 6	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0

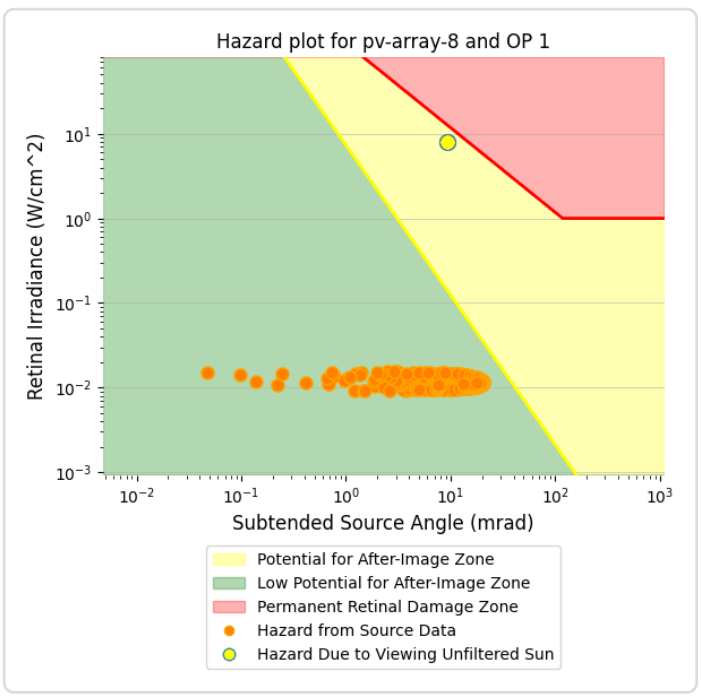
PV array 8 and OP 1

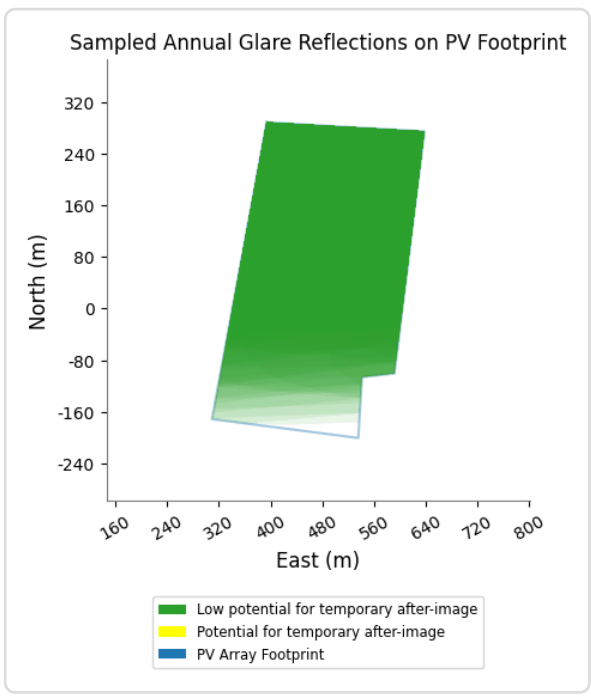
Yellow glare: none

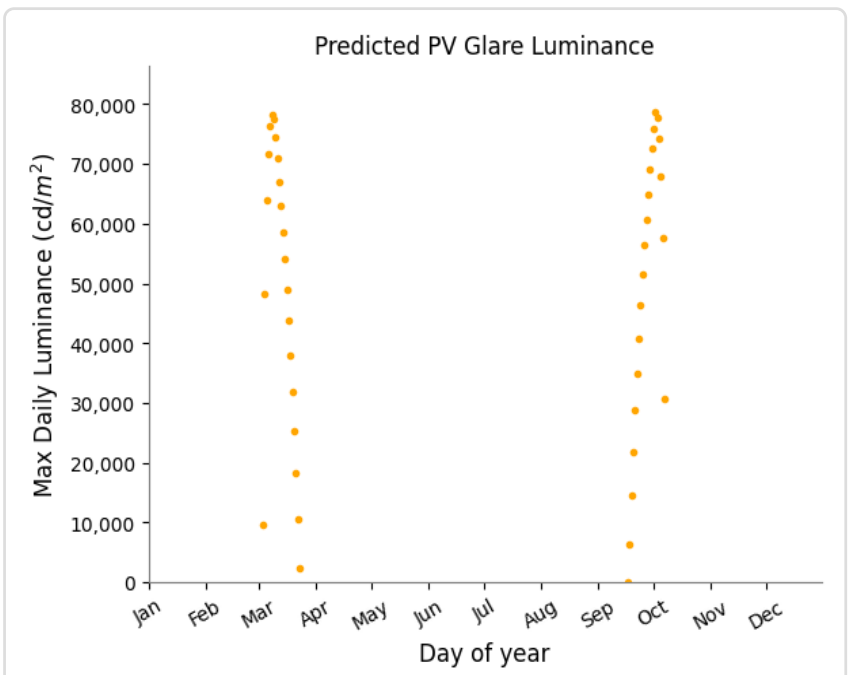
Green glare: 694 min.







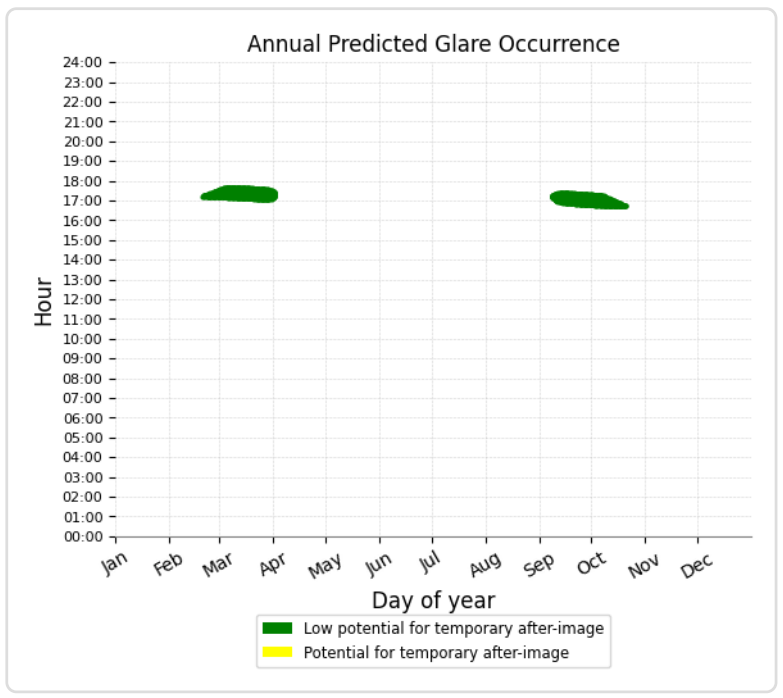


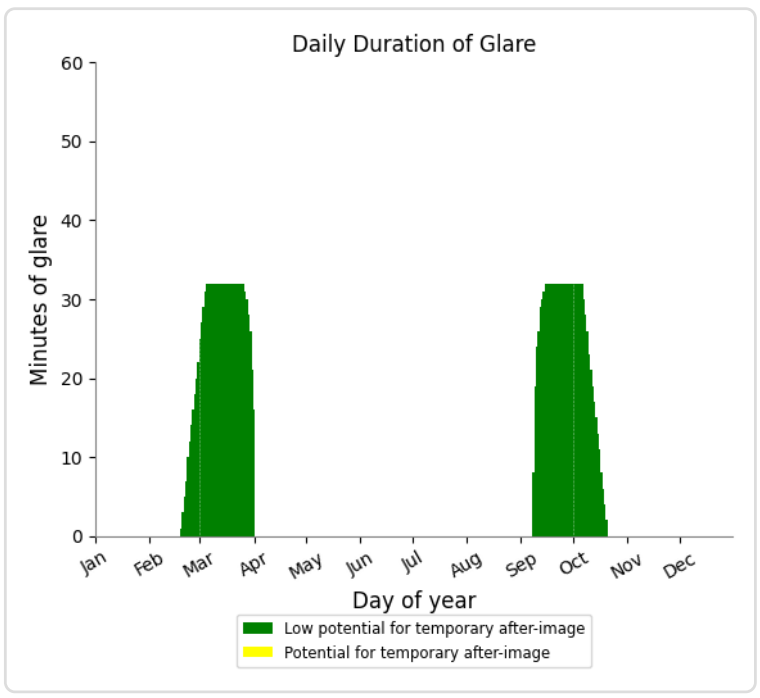


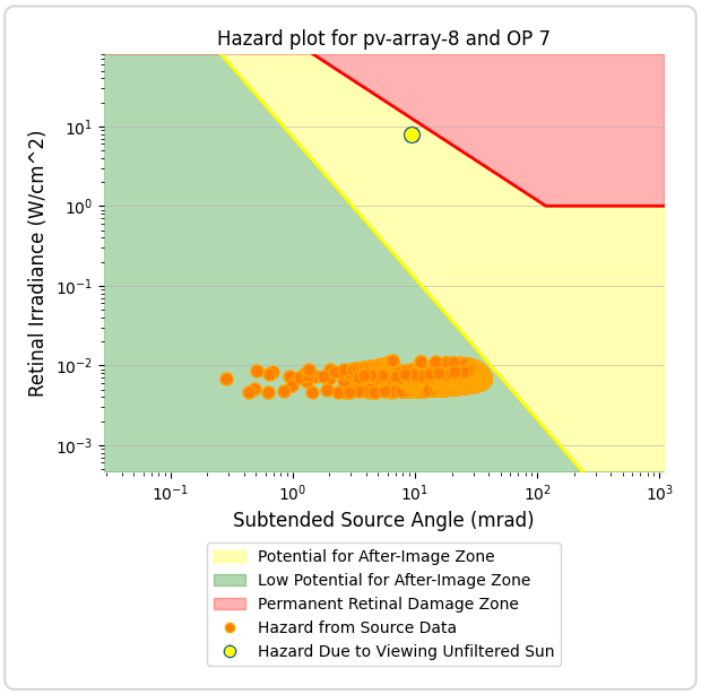
PV array 8 and OP 7

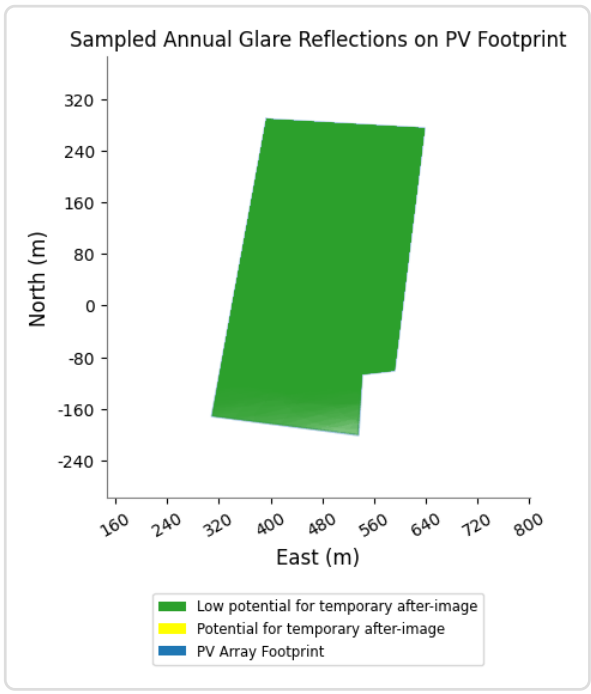
Yellow glare: none

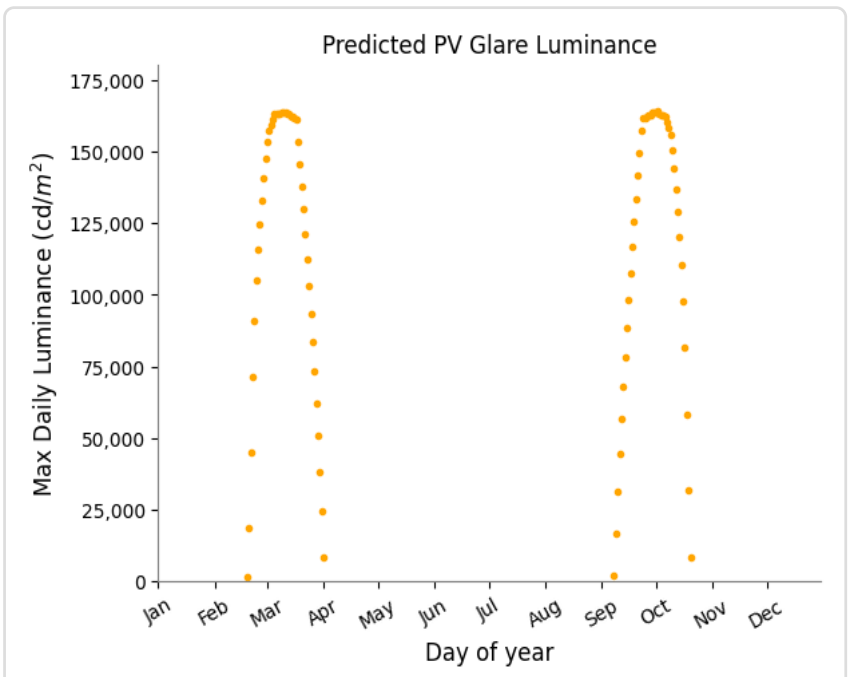
Green glare: 2,190 min.







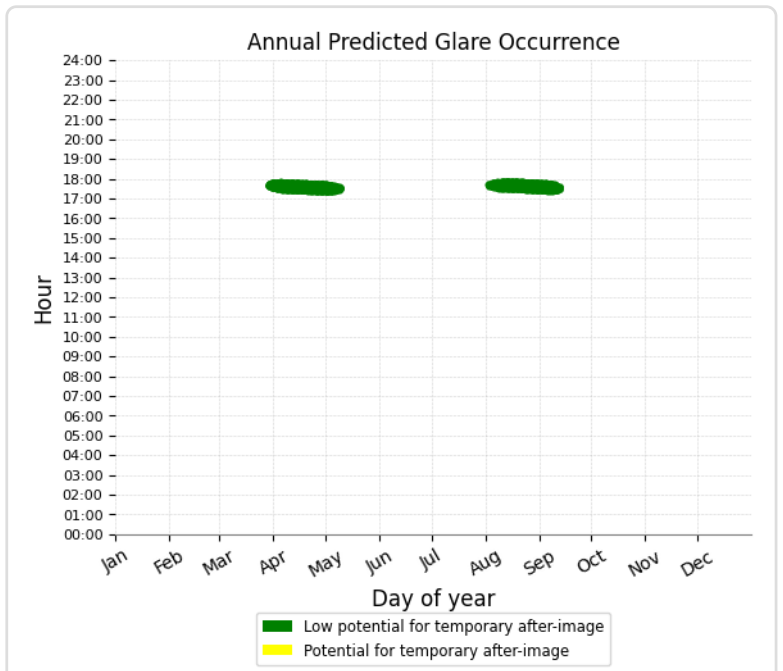


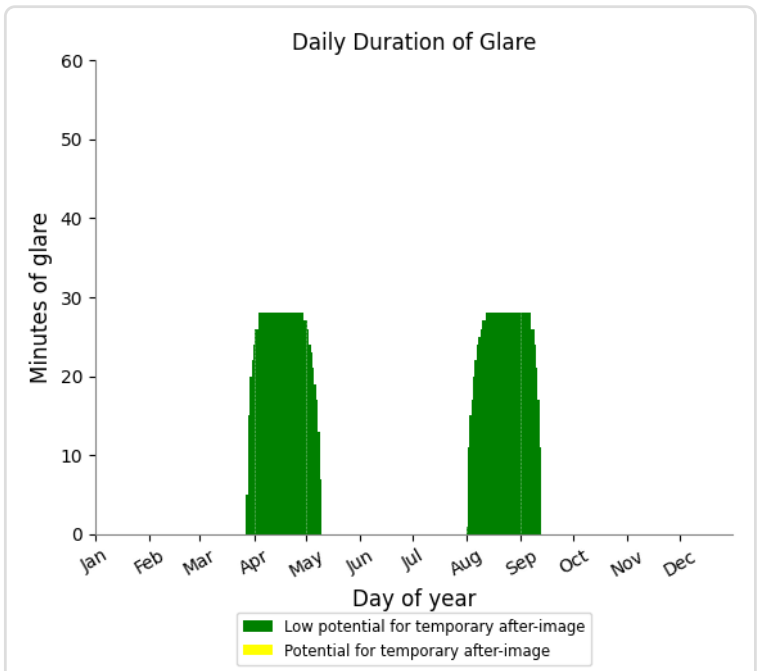


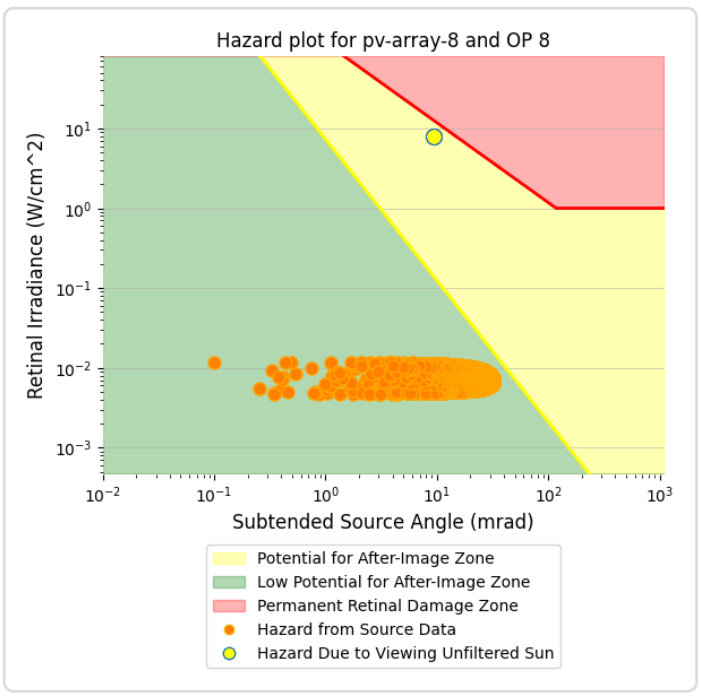
PV array 8 and OP 8

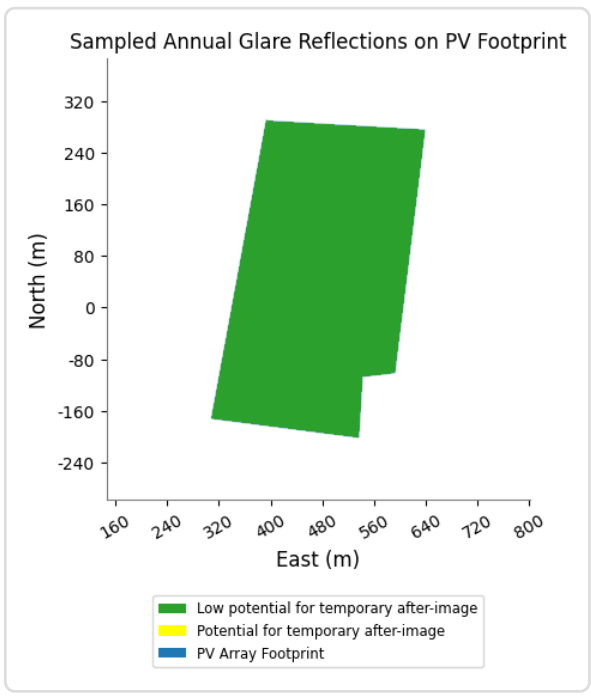
Yellow glare: none

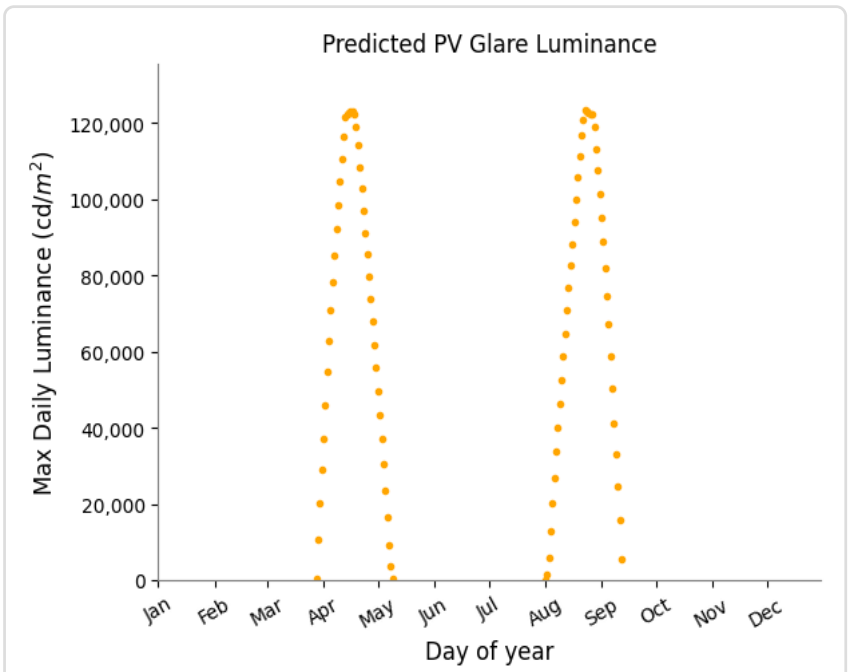
Green glare: 2,138 min.







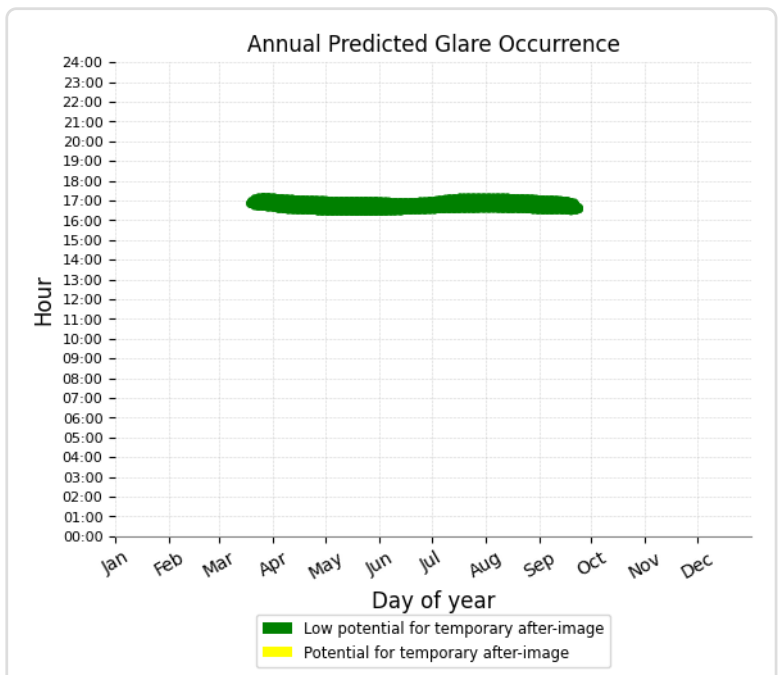


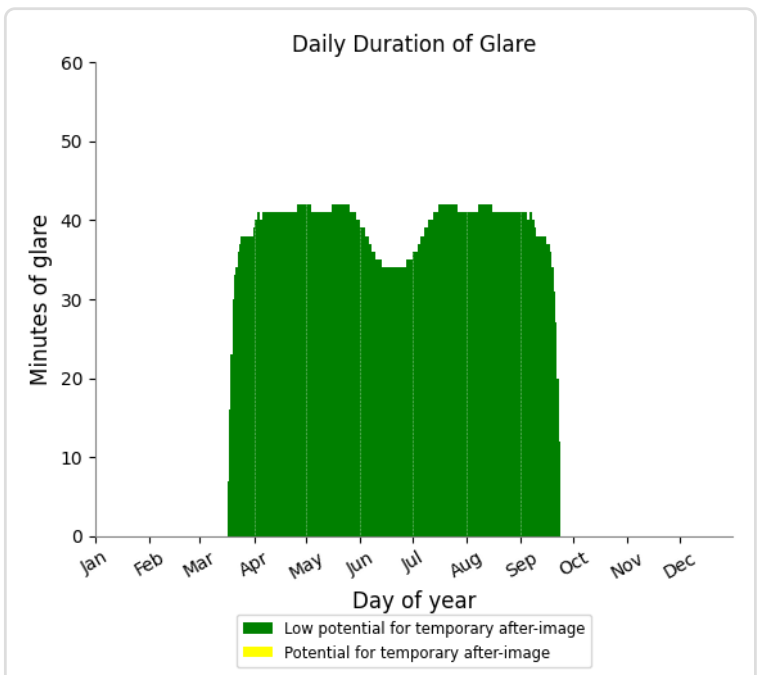


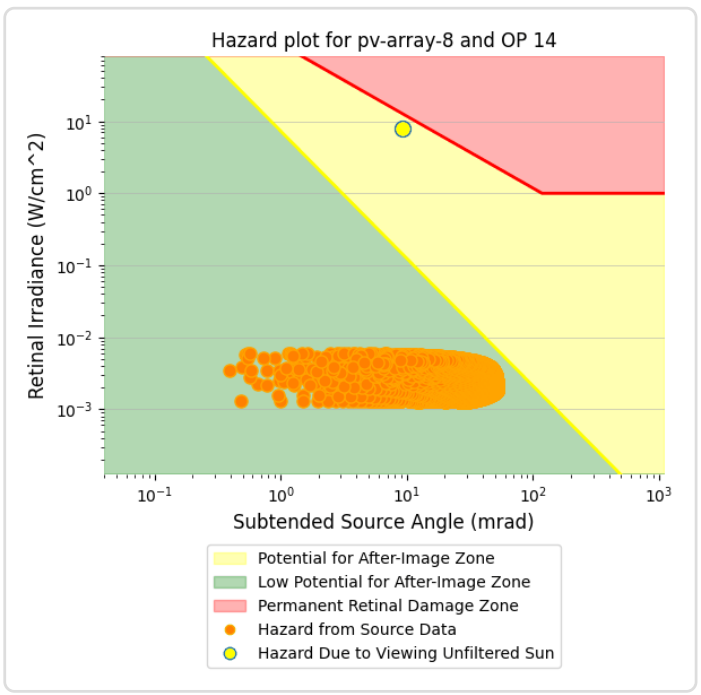
PV array 8 and OP 14

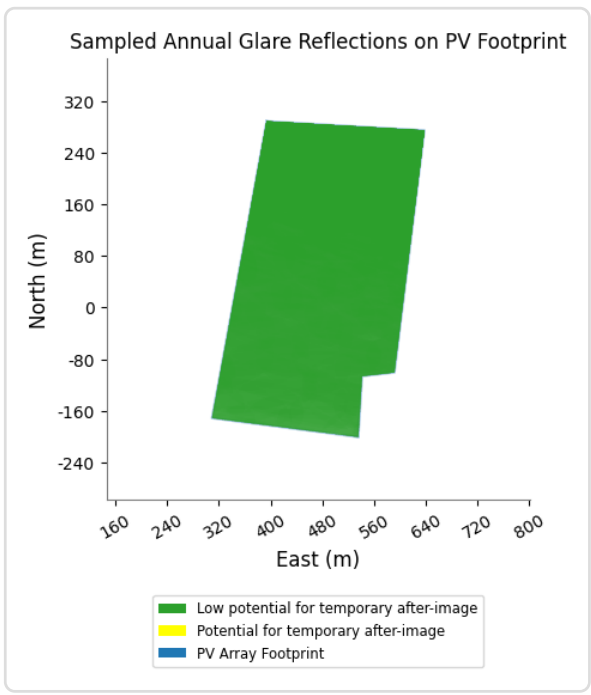
Yellow glare: none

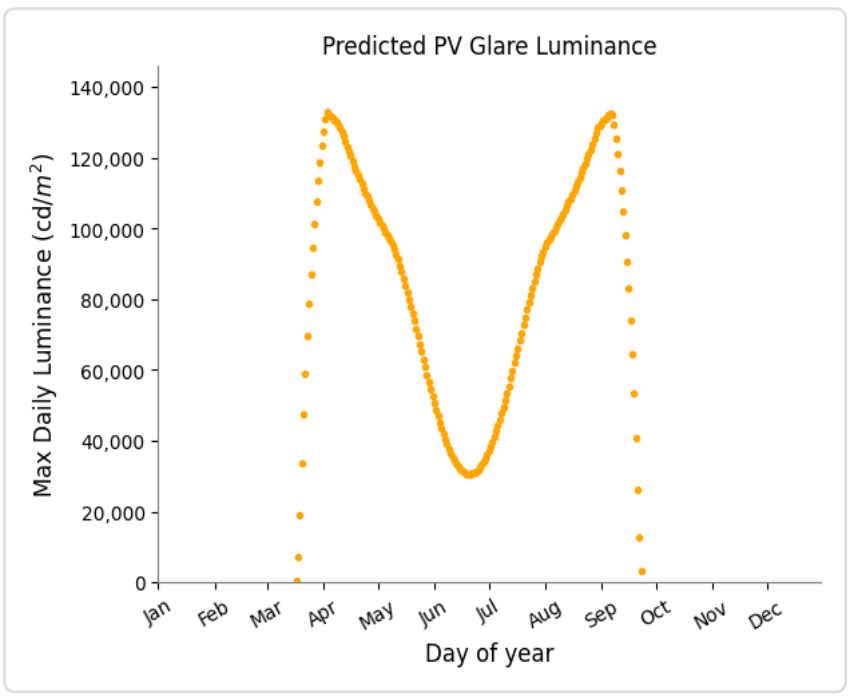
Green glare: 7,407 min.







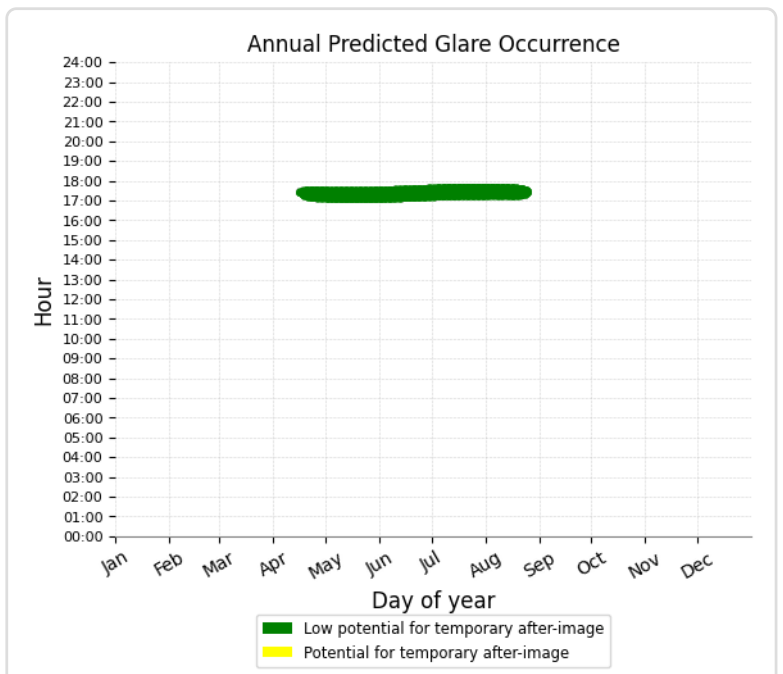


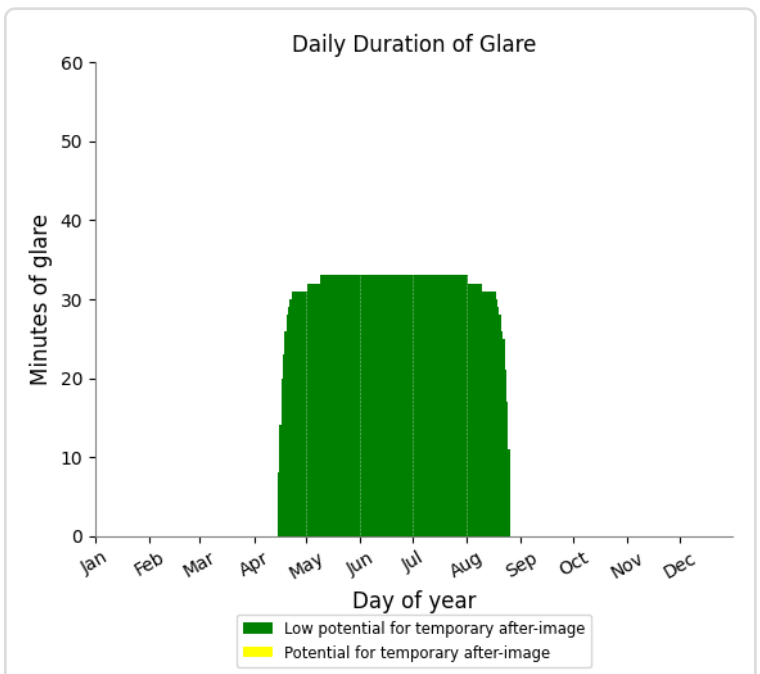


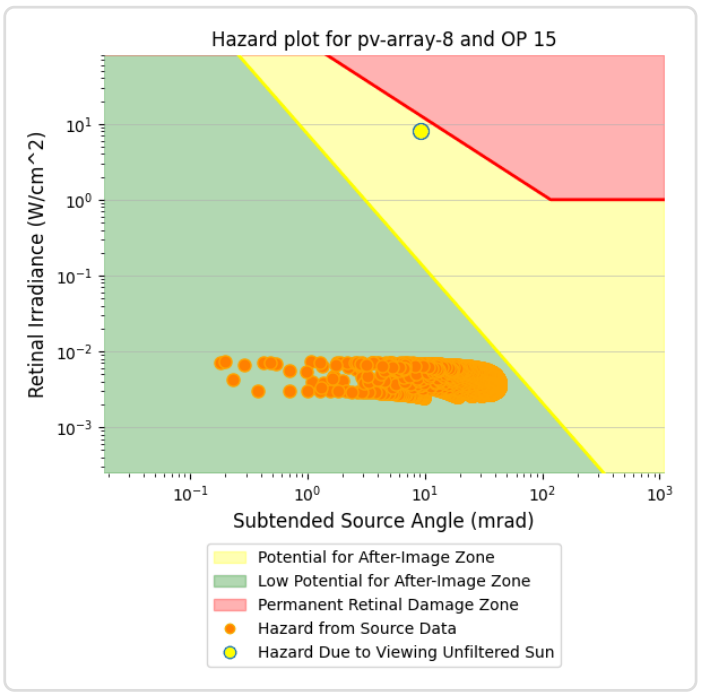
PV array 8 and OP 15

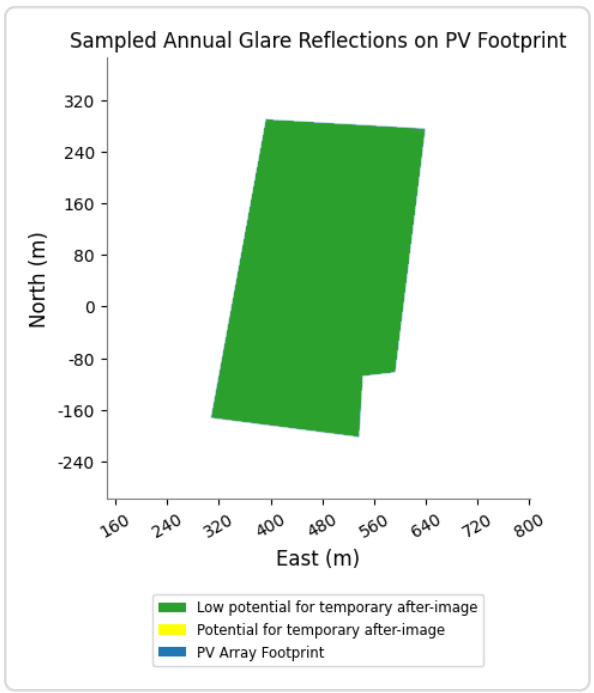
Yellow glare: none

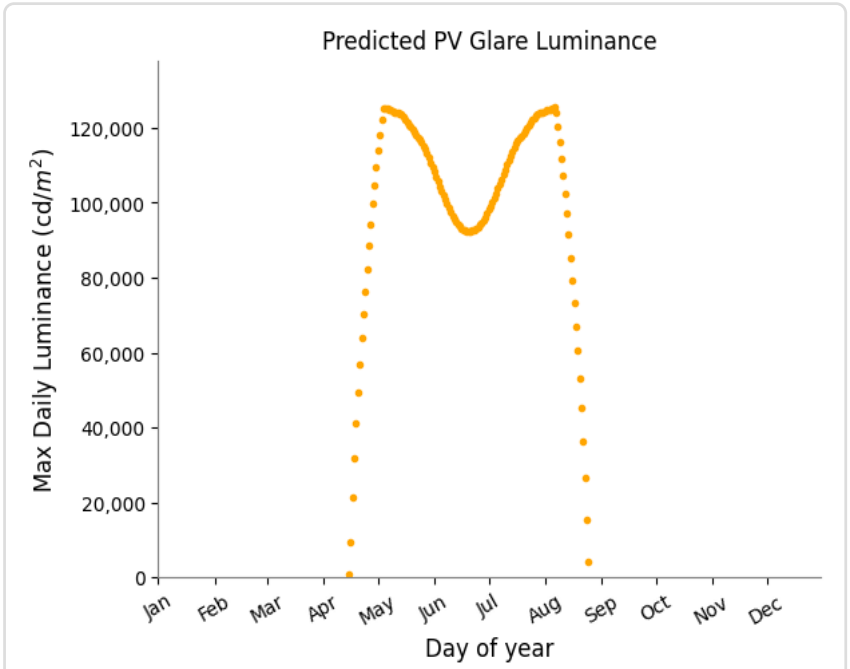
Green glare: 4,177 min.







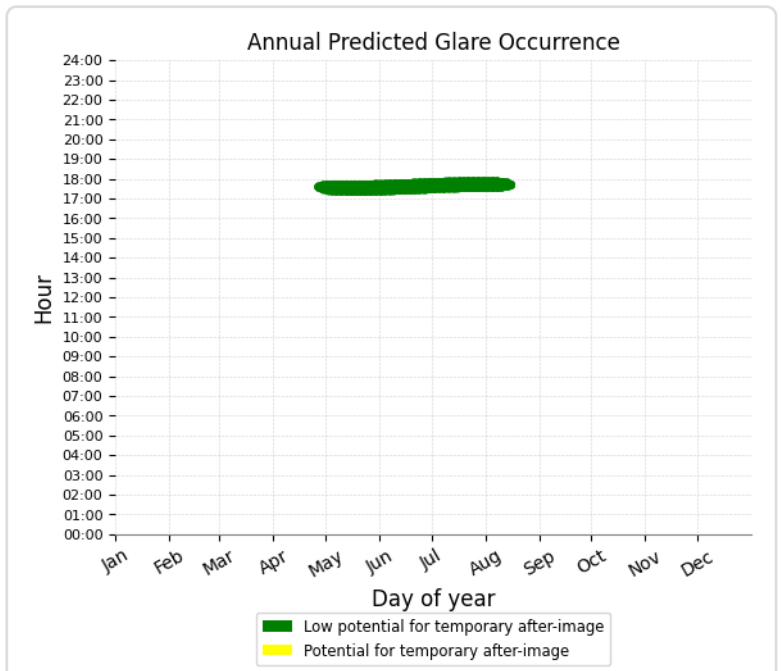


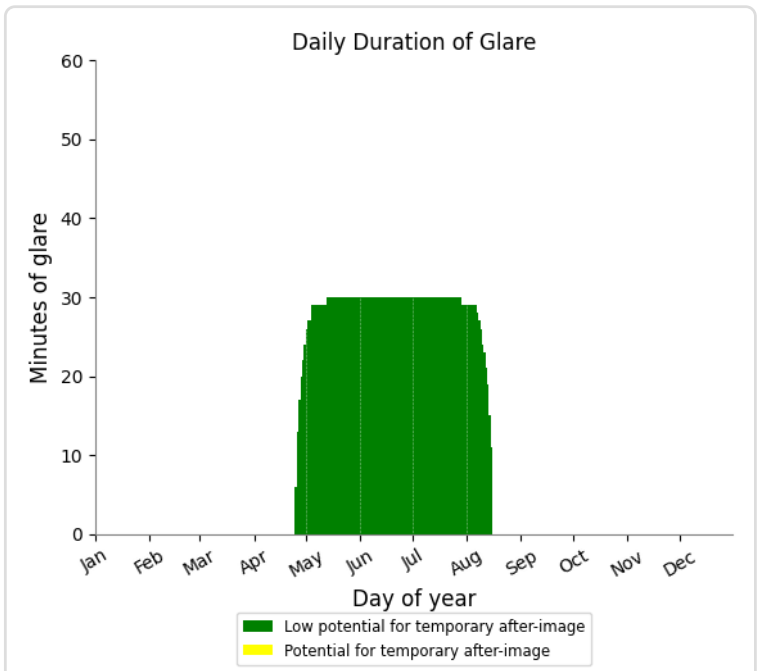


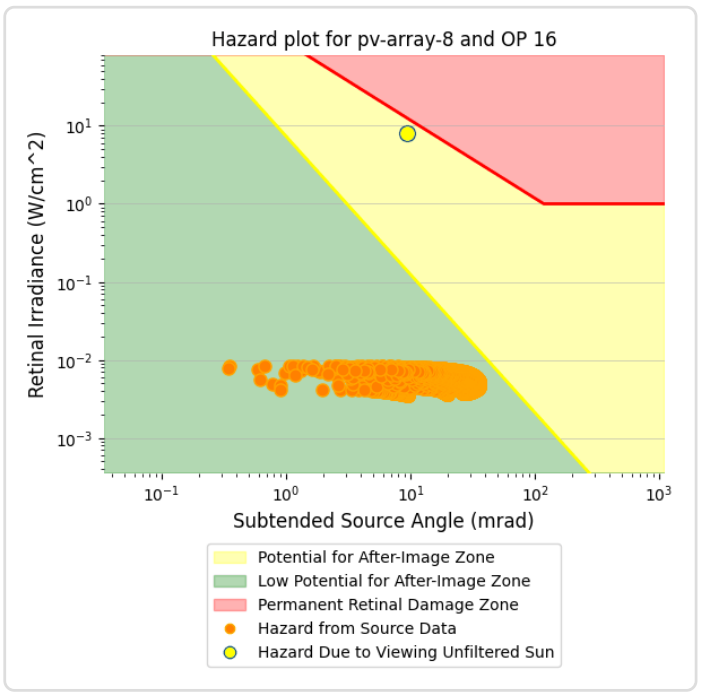
PV array 8 and OP 16

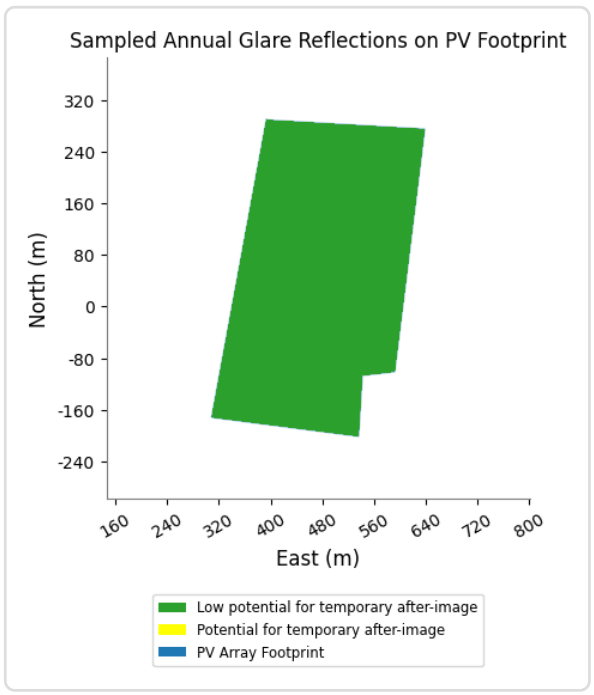
Yellow glare: none

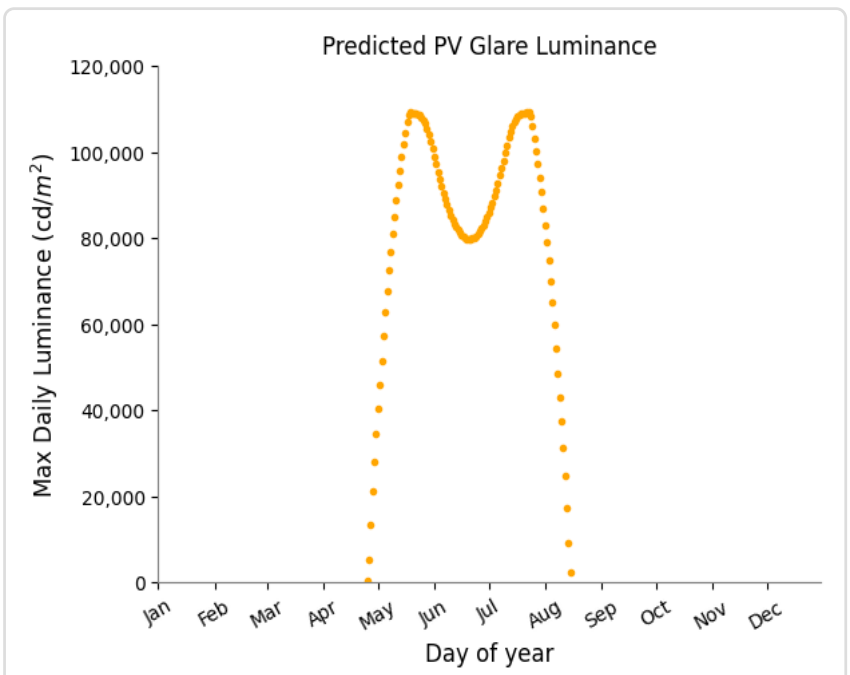
Green glare: 3,208 min.







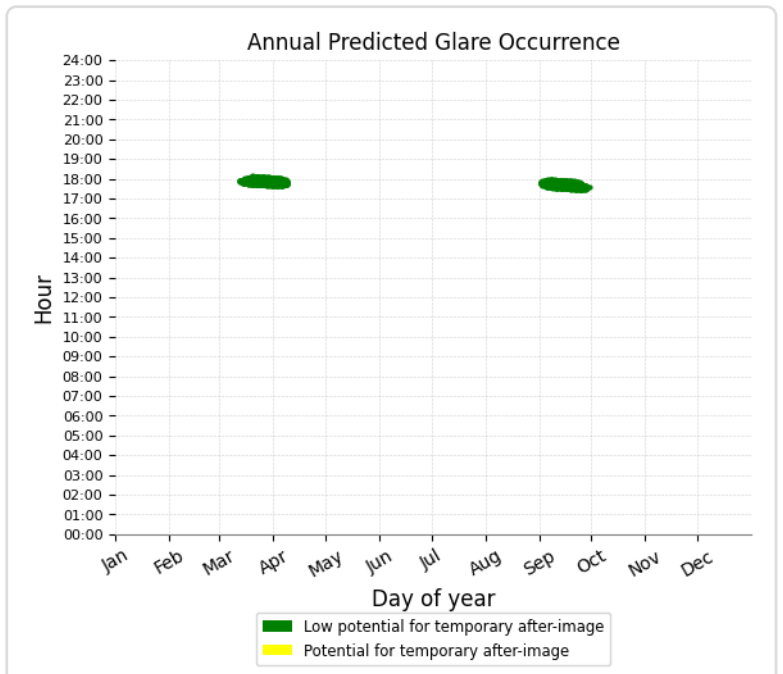


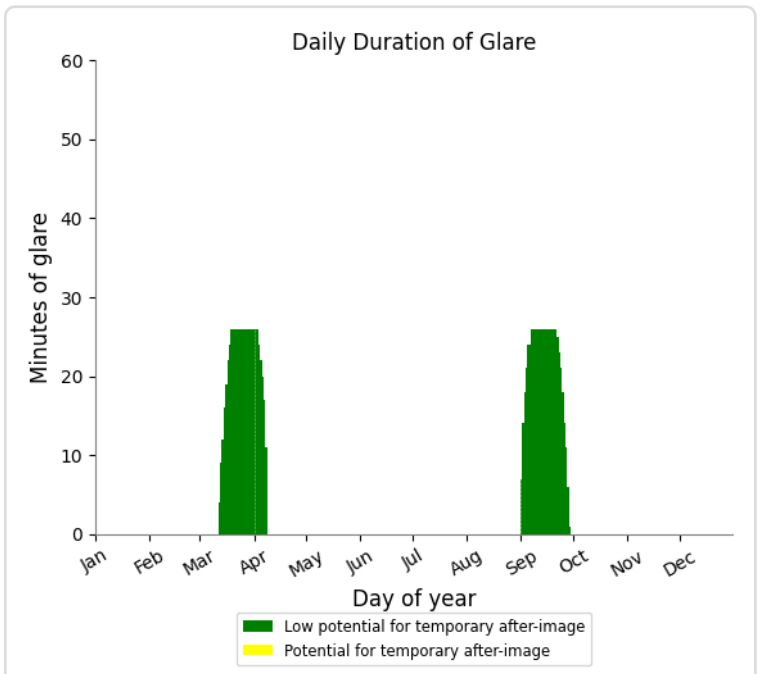


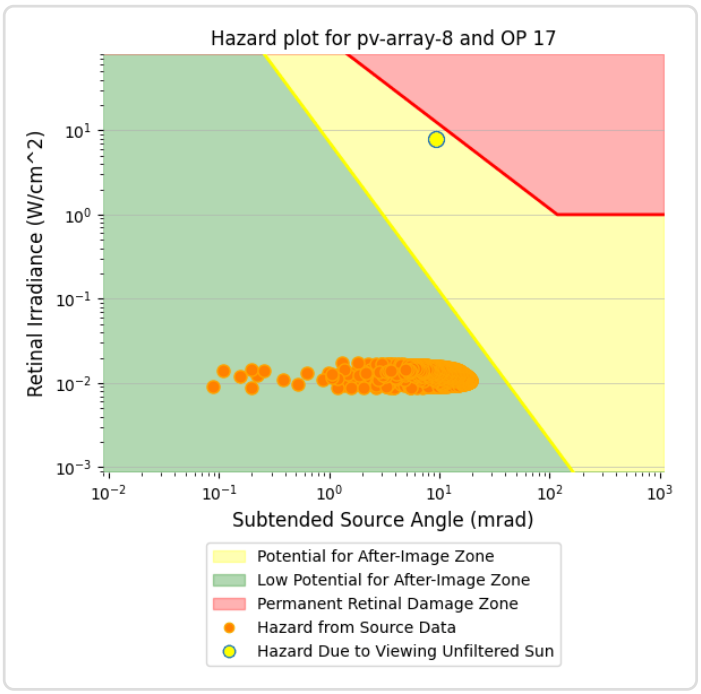
PV array 8 and OP 17

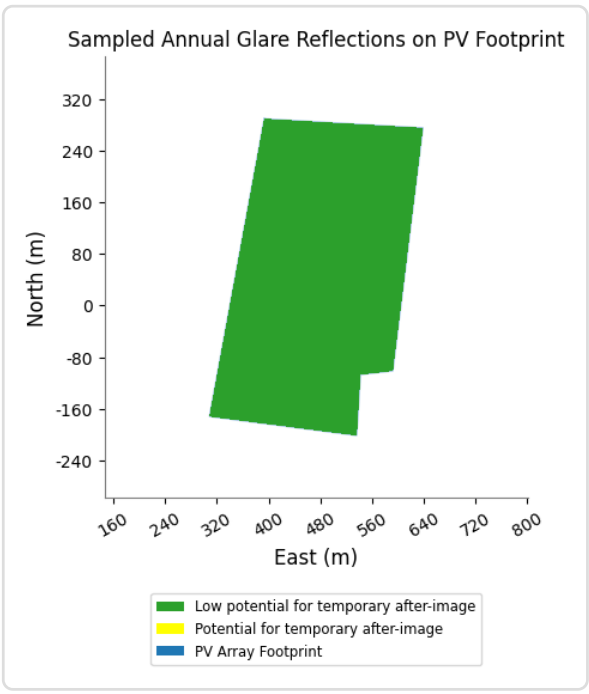
Yellow glare: none

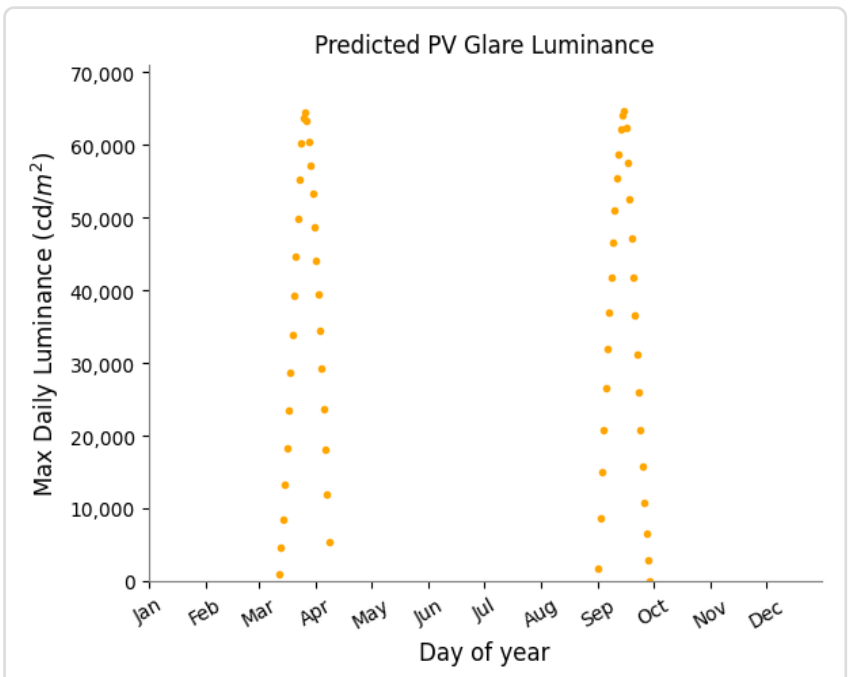
Green glare: 1,233 min.







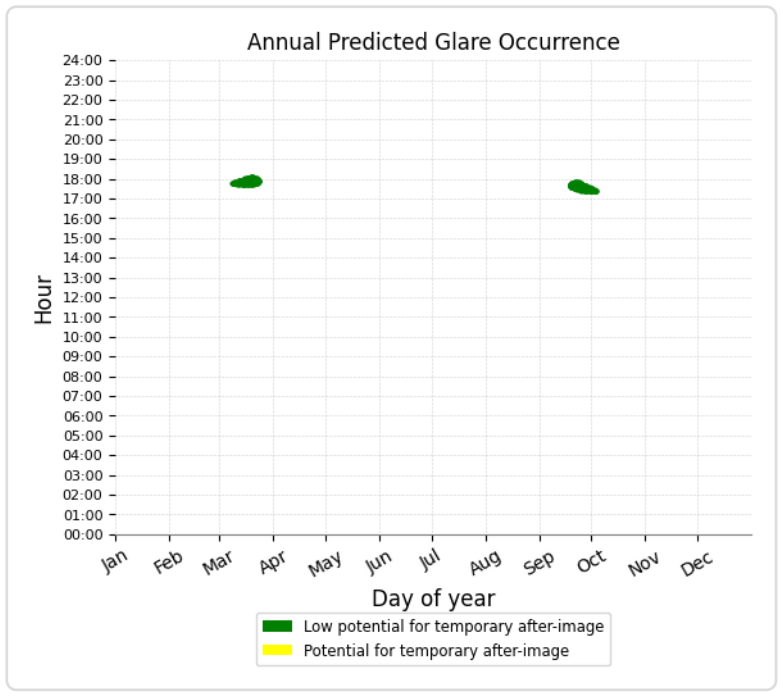


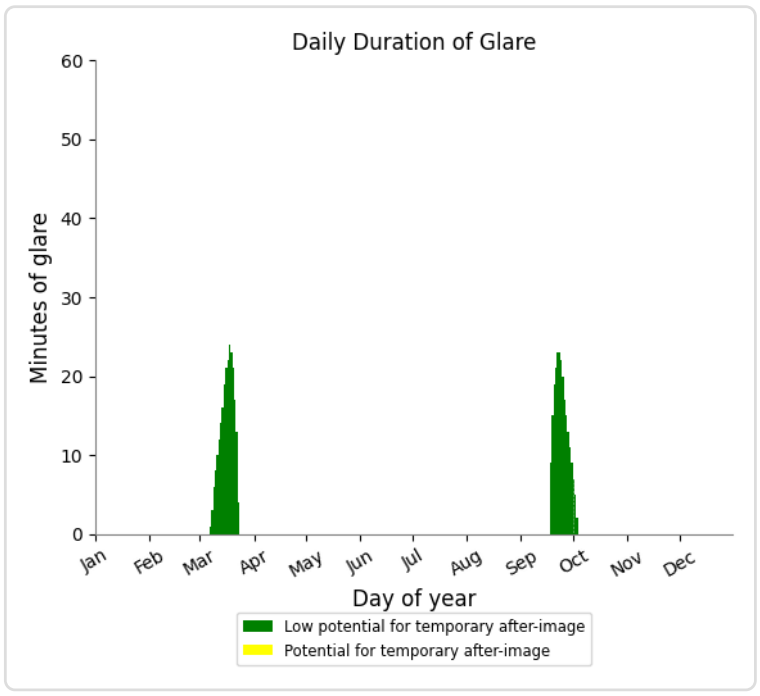


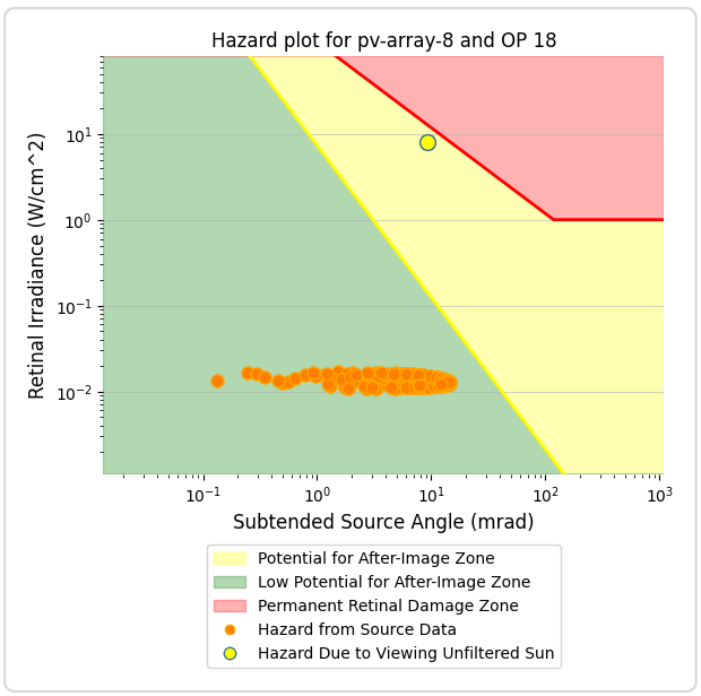
PV array 8 and OP 18

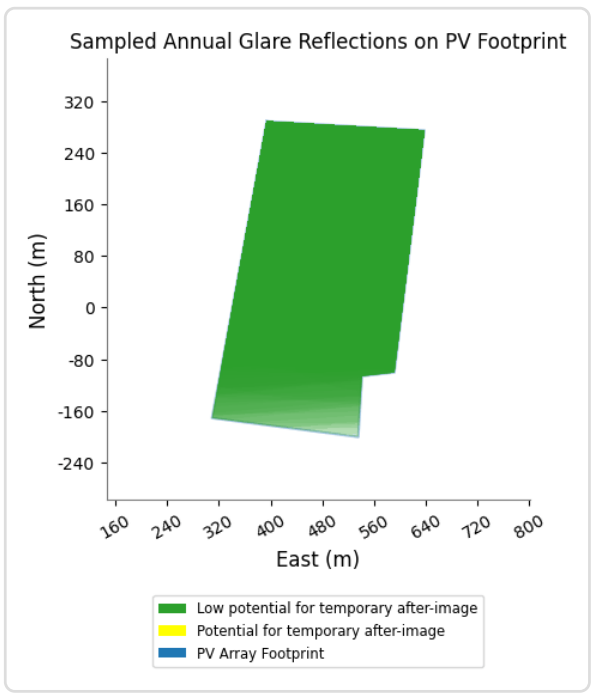
Yellow glare: none

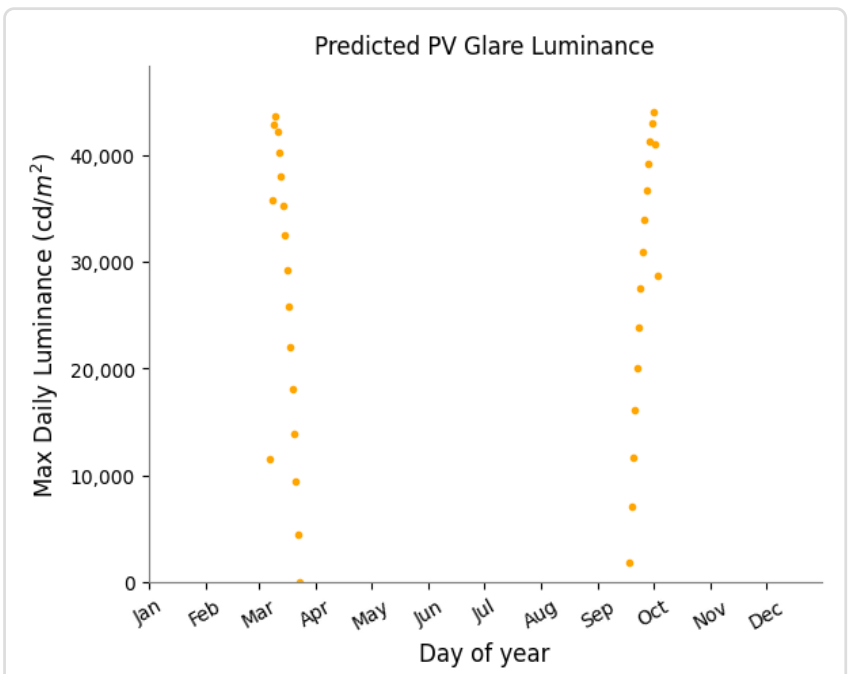
Green glare: 465 min.











PV array 8 and OP 2

No glare found

PV array 8 and OP 3

No glare found

PV array 8 and OP 4

No glare found

PV array 8 and OP 5

No glare found

PV array 8 and OP 6

No glare found

PV array 8 and OP 9

No glare found

PV array 8 and OP 10

No glare found

PV array 8 and OP 11

No glare found

PV array 8 and OP 12

No glare found

PV array 8 and OP 13

No glare found

PV array 8 and OP 19

No glare found

PV array 8 and OP 20

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **BR10356 Normanton Larches Solar**
Site configuration: **Aviation 1500ft 180 and 205 OPs 21-41**

Created 08 Mar, 2024
Updated 21 Mar, 2024
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 113992.19448

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	10,785	179.8	0	0.0	-	168,085
PV array 2	25.0	180.0	9,613	160.2	0	0.0	-	110,158
PV array 3	25.0	180.0	10,672	177.9	0	0.0	-	157,625
PV array 4	25.0	180.0	9,850	164.2	0	0.0	-	138,428
PV array 5	25.0	180.0	11,601	193.3	0	0.0	-	162,497
PV array 6	25.0	180.0	11,822	197.0	0	0.0	-	173,453
PV array 7	25.0	205.0	9,029	150.5	0	0.0	-	173,846
PV array 8	25.0	180.0	14,253	237.6	0	0.0	-	169,260

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	0	0.0	0	0.0
OP 2	1,258	21.0	0	0.0
OP 3	8,523	142.1	0	0.0
OP 4	14,318	238.6	0	0.0
OP 5	16,013	266.9	0	0.0
OP 6	24,719	412.0	0	0.0
OP 7	14,202	236.7	0	0.0
OP 8	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	30	0.5	0	0.0
OP 14	6,407	106.8	0	0.0
OP 15	2,061	34.4	0	0.0
OP 16	94	1.6	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.270453	-1.023592	44.16	3.58	47.74
2	53.270382	-1.026510	38.69	3.58	42.27
3	53.270337	-1.028001	42.19	3.58	45.77
4	53.268374	-1.027819	47.55	3.58	51.13
5	53.267835	-1.027411	47.97	3.58	51.55
6	53.268194	-1.025823	42.76	3.58	46.34
7	53.268605	-1.023538	48.05	3.58	51.63

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272403	-1.022893	44.98	3.58	48.56
2	53.271659	-1.020468	49.10	3.58	52.68
3	53.271146	-1.020629	49.06	3.58	52.64
4	53.270568	-1.020768	49.76	3.58	53.34
5	53.269978	-1.022399	48.94	3.58	52.52
6	53.269490	-1.023494	46.53	3.58	50.11
7	53.270600	-1.023526	44.05	3.58	47.63
8	53.270658	-1.022721	44.52	3.58	48.10

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267270	-1.027453	49.52	3.58	53.10
2	53.267742	-1.026122	44.46	3.58	48.04
3	53.268066	-1.026004	43.25	3.58	46.83
4	53.268361	-1.024577	44.74	3.58	48.32
5	53.268515	-1.023451	48.43	3.58	52.01
6	53.263789	-1.021096	44.95	3.58	48.53
7	53.263606	-1.026144	50.81	3.58	54.39

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267296	-1.022818	47.72	3.58	51.30
2	53.267707	-1.018998	49.22	3.58	52.80
3	53.264120	-1.017373	43.17	3.58	46.75
4	53.264126	-1.017861	43.81	3.58	47.39
5	53.263885	-1.017893	45.60	3.58	49.18
6	53.263795	-1.021085	44.91	3.58	48.49

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.268300	-1.019106	51.65	3.58	55.23
2	53.268197	-1.015587	47.94	3.58	51.52
3	53.267411	-1.014932	45.87	3.58	49.45
4	53.263776	-1.015093	42.99	3.58	46.57
5	53.263904	-1.017175	44.48	3.58	48.06
6	53.266359	-1.018355	43.98	3.58	47.56

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.267286	-1.014793	45.26	3.58	48.84
2	53.263975	-1.015072	41.69	3.58	45.27
3	53.265181	-1.012926	37.52	3.58	41.10
4	53.265759	-1.012132	35.68	3.58	39.26
5	53.266067	-1.011724	35.43	3.58	39.01
6	53.266349	-1.011338	34.83	3.58	38.41
7	53.266619	-1.009836	34.68	3.58	38.26
8	53.267825	-1.010716	42.25	3.58	45.83

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 205.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.272911	-1.013997	31.15	3.58	34.73
2	53.269552	-1.014817	42.96	3.58	46.54
3	53.269645	-1.012452	41.27	3.58	44.85
4	53.270081	-1.011636	34.85	3.58	38.43
5	53.270515	-1.010960	30.84	3.58	34.42
6	53.271044	-1.010349	28.85	3.58	32.43
7	53.271795	-1.010118	28.09	3.58	31.67
8	53.272343	-1.010070	28.01	3.58	31.59
9	53.273148	-1.010638	28.00	3.58	31.58
10	53.273264	-1.012672	29.00	3.58	32.58
11	53.272863	-1.012822	29.79	3.58	33.37

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 25.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.273071	-1.017650	40.15	3.58	43.73
2	53.268840	-1.018985	51.66	3.58	55.24
3	53.268654	-1.015579	47.67	3.58	51.25
4	53.269528	-1.015421	43.73	3.58	47.31
4	53.269528	-1.015421	43.73	3.58	47.31
5	53.269555	-1.014827	42.96	3.58	46.54
5	53.269555	-1.014827	42.96	3.58	46.54
6	53.272917	-1.014018	31.15	3.58	34.73

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.279168	-0.962682	22.00	457.20
OP 2	2	53.275011	-0.957188	26.00	457.20
OP 3	3	53.265823	-0.946545	20.99	457.20
OP 4	4	53.258892	-0.954442	41.64	457.20
OP 5	5	53.253860	-0.968518	33.27	457.20
OP 6	6	53.259816	-0.979075	30.66	457.20
OP 7	7	53.270494	-0.993838	27.91	457.20
OP 8	8	53.282145	-1.005425	52.69	457.20
OP 9	9	53.287327	-0.996241	34.00	457.20
OP 10	10	53.291175	-0.981221	26.10	457.20
OP 11	11	53.286506	-0.974955	25.68	457.20
OP 12	12	53.281991	-0.989976	45.11	457.20
OP 13	13	53.277526	-0.995040	54.66	457.20
OP 14	14	53.268852	-0.946545	21.82	457.20
OP 15	15	53.273523	-0.934529	23.38	457.20
OP 16	16	53.279168	-0.926461	24.89	457.20
OP 17	17	53.284095	-0.934872	29.10	457.20
OP 18	18	53.291278	-0.946460	23.41	457.20
OP 19	19	53.296049	-0.954528	37.14	457.20
OP 20	20	53.293535	-0.965342	36.12	457.20
OP 21	21	53.288918	-0.971350	22.98	457.20

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy	Peak Luminance
	°	°	min	hr	min	hr	kWh	cd/m^2
PV array 1	25.0	180.0	10,785	179.8	0	0.0	-	168,085
PV array 2	25.0	180.0	9,613	160.2	0	0.0	-	110,158
PV array 3	25.0	180.0	10,672	177.9	0	0.0	-	157,625
PV array 4	25.0	180.0	9,850	164.2	0	0.0	-	138,428
PV array 5	25.0	180.0	11,601	193.3	0	0.0	-	162,497
PV array 6	25.0	180.0	11,822	197.0	0	0.0	-	173,453
PV array 7	25.0	205.0	9,029	150.5	0	0.0	-	173,846
PV array 8	25.0	180.0	14,253	237.6	0	0.0	-	169,260

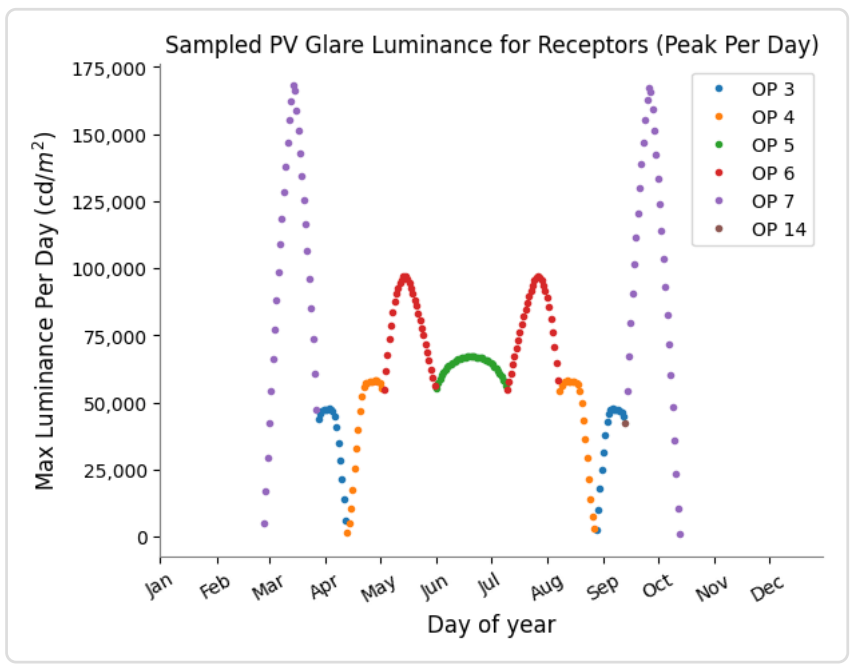
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 1	0	0.0	0	0.0
OP 2	1,258	21.0	0	0.0
OP 3	8,523	142.1	0	0.0
OP 4	14,318	238.6	0	0.0
OP 5	16,013	266.9	0	0.0
OP 6	24,719	412.0	0	0.0
OP 7	14,202	236.7	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	30	0.5	0	0.0
OP 14	6,407	106.8	0	0.0
OP 15	2,061	34.4	0	0.0
OP 16	94	1.6	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

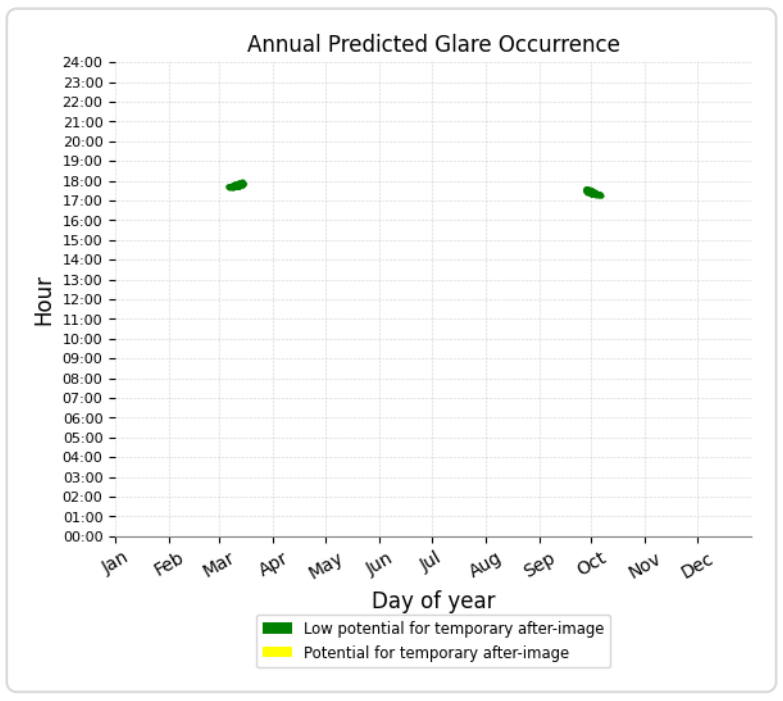
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	162	2.7	0	0.0	31,496
OP 3	1,079	18.0	0	0.0	47,683
OP 4	1,500	25.0	0	0.0	58,087
OP 5	1,951	32.5	0	0.0	67,148
OP 6	3,066	51.1	0	0.0	97,125
OP 7	1,709	28.5	0	0.0	168,085
OP 14	958	16.0	0	0.0	44,675
OP 15	360	6.0	0	0.0	27,339
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

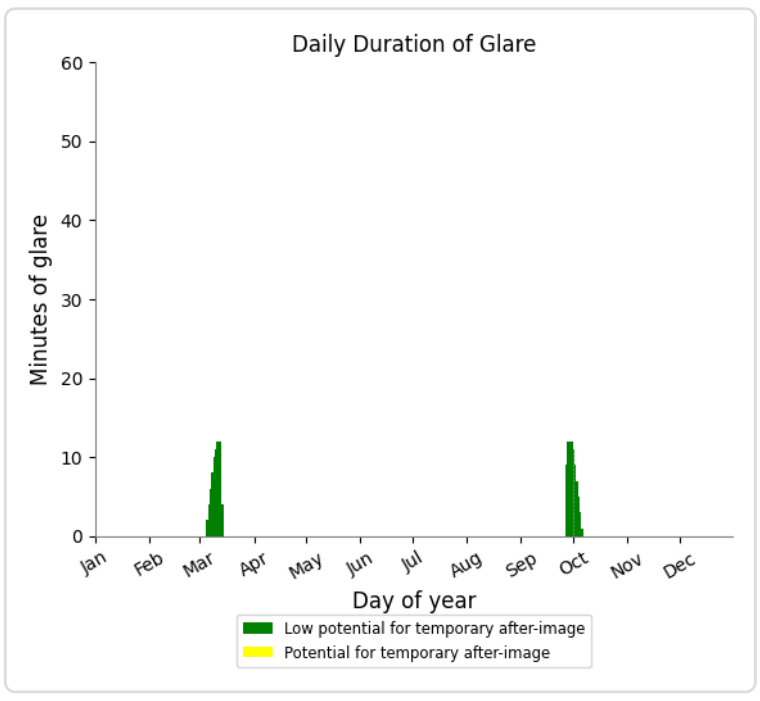


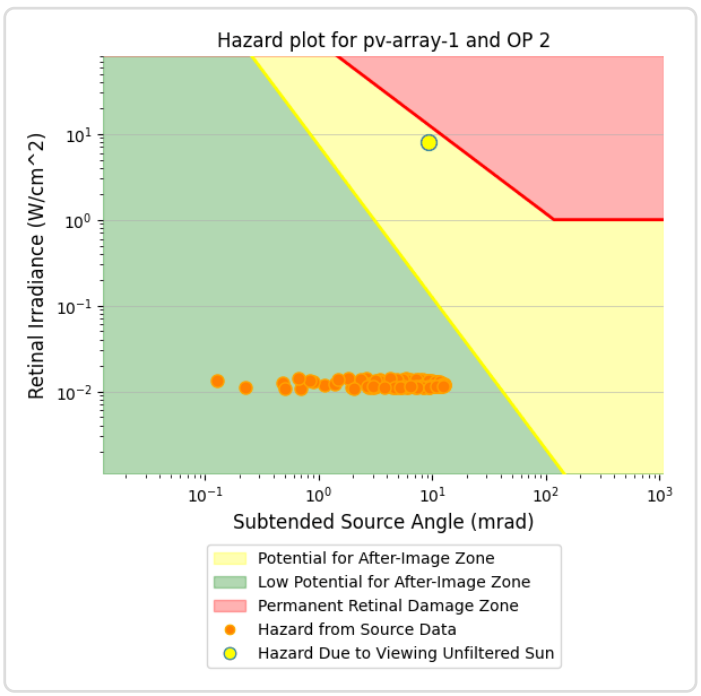
PV array 1 and OP 2

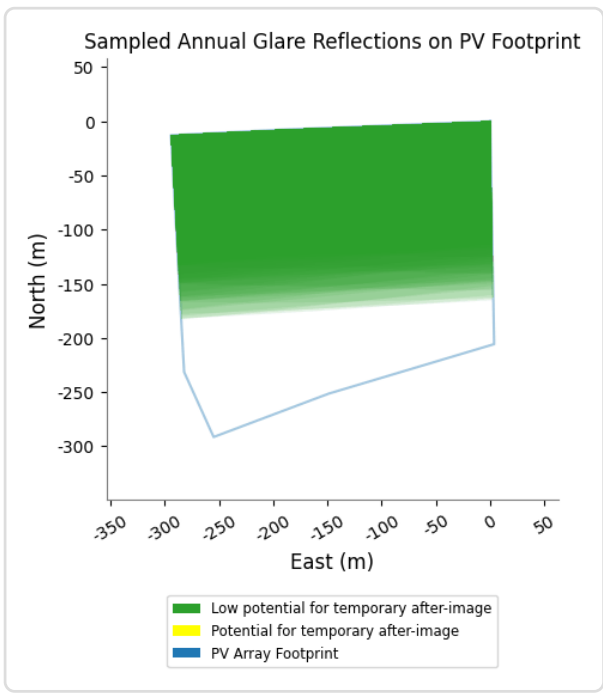
Yellow glare: none

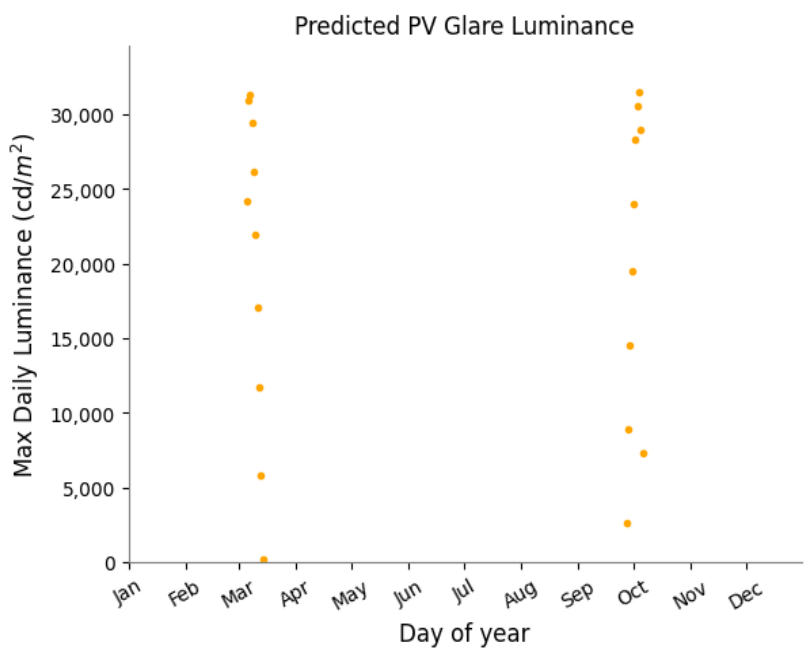
Green glare: 162 min.







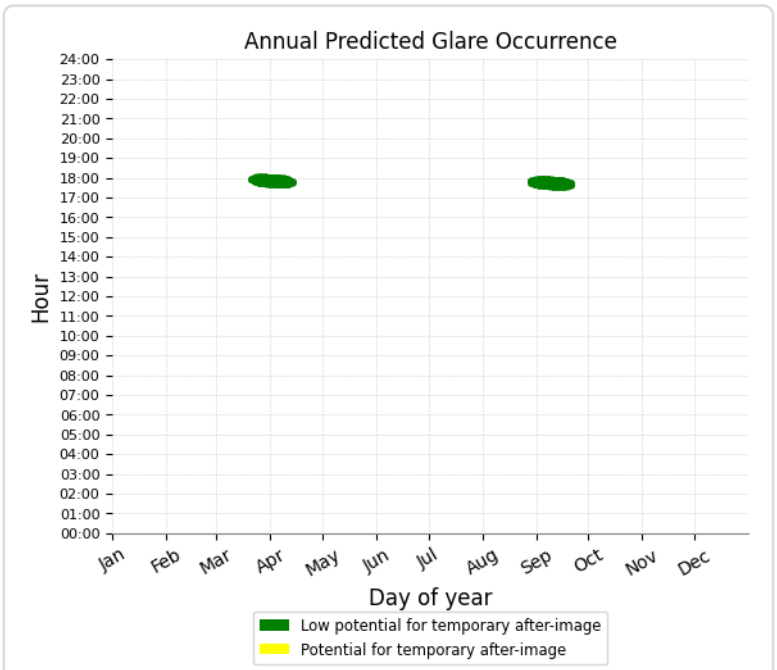


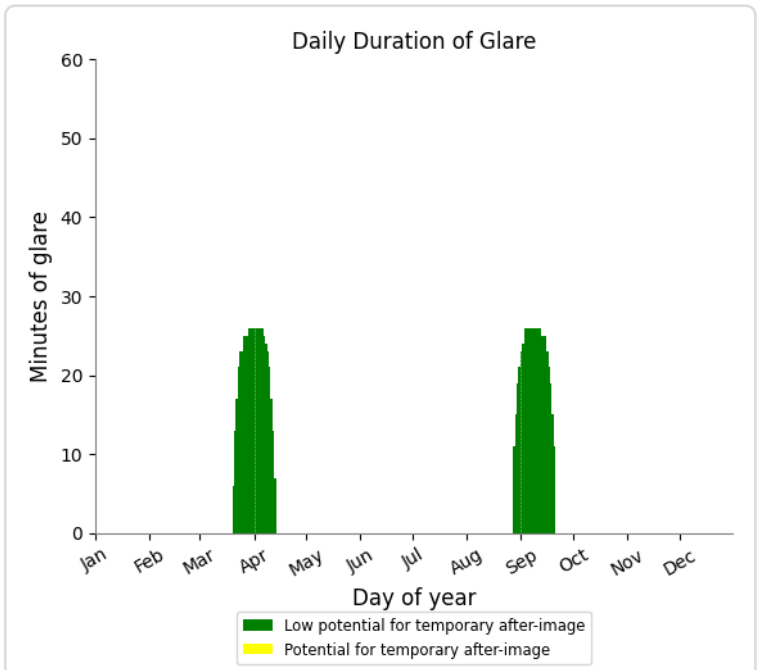


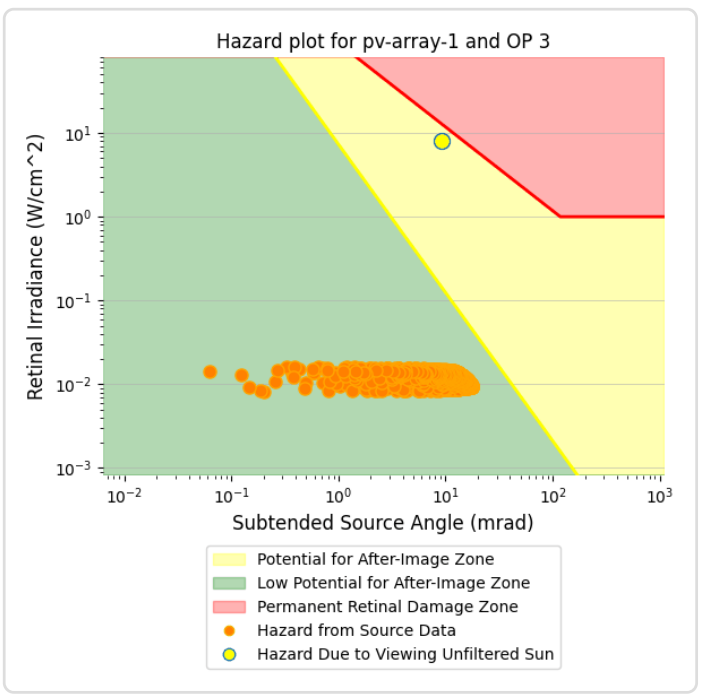
PV array 1 and OP 3

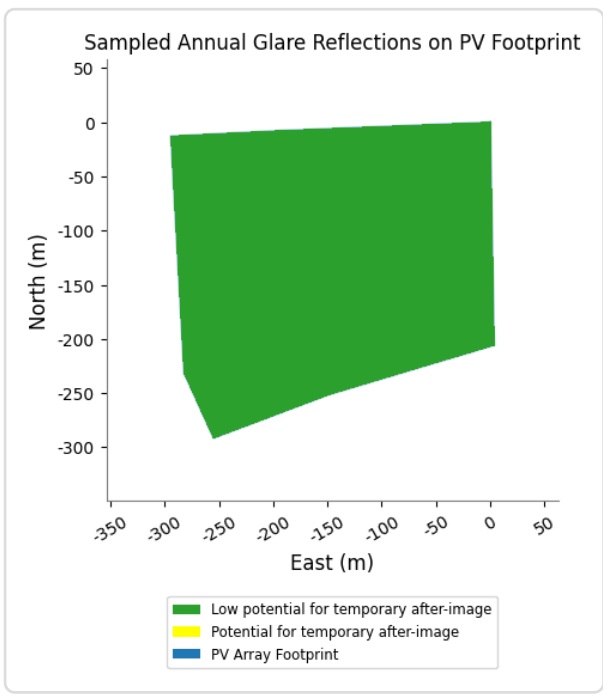
Yellow glare: none

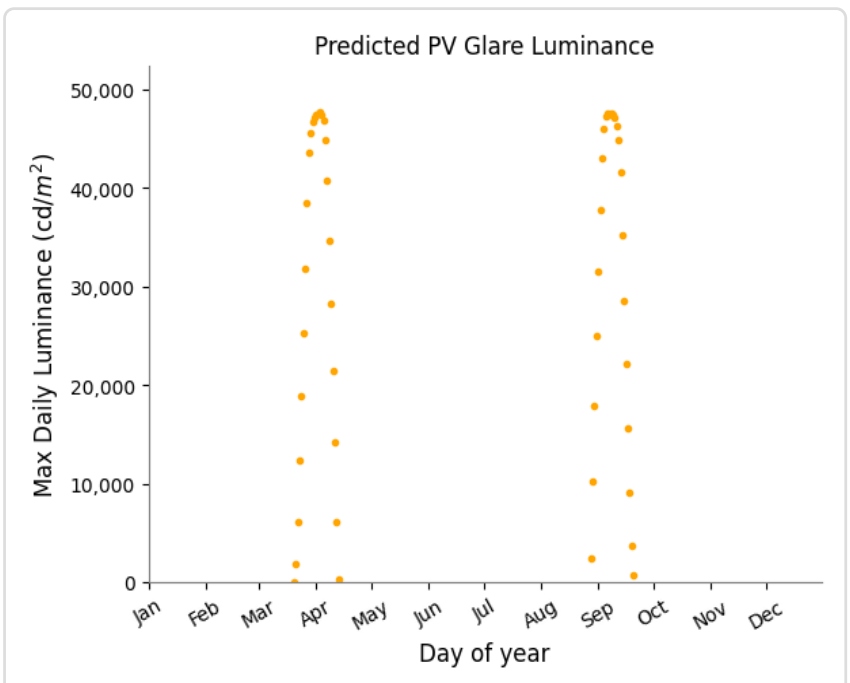
Green glare: 1,079 min.







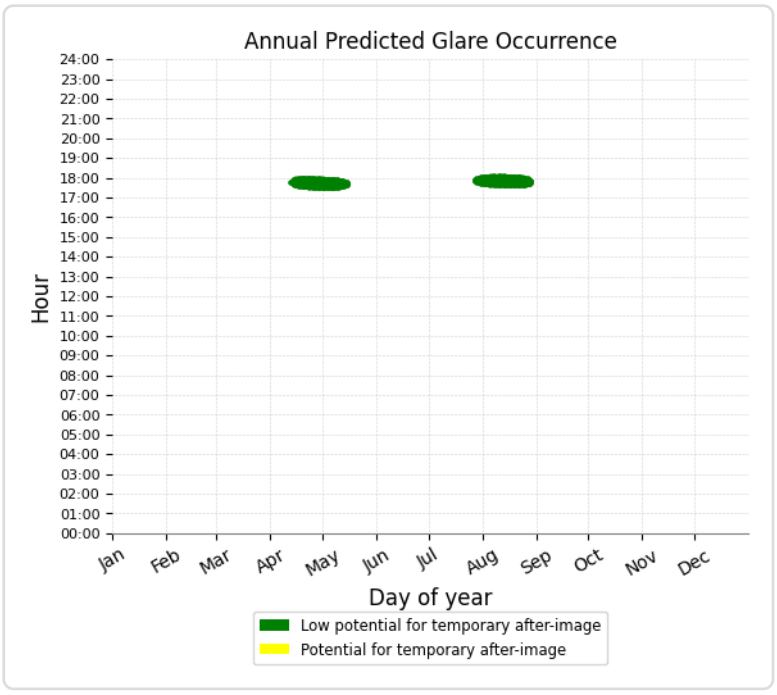


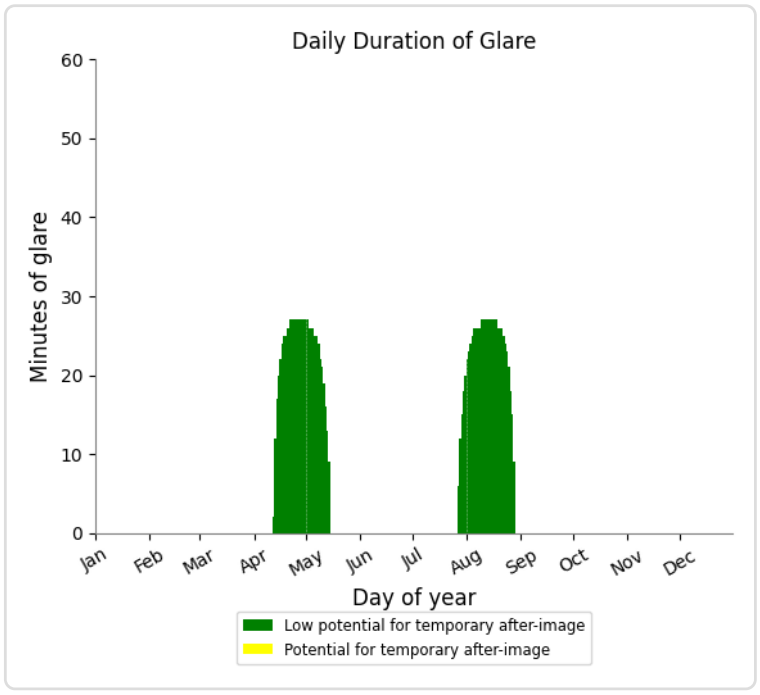


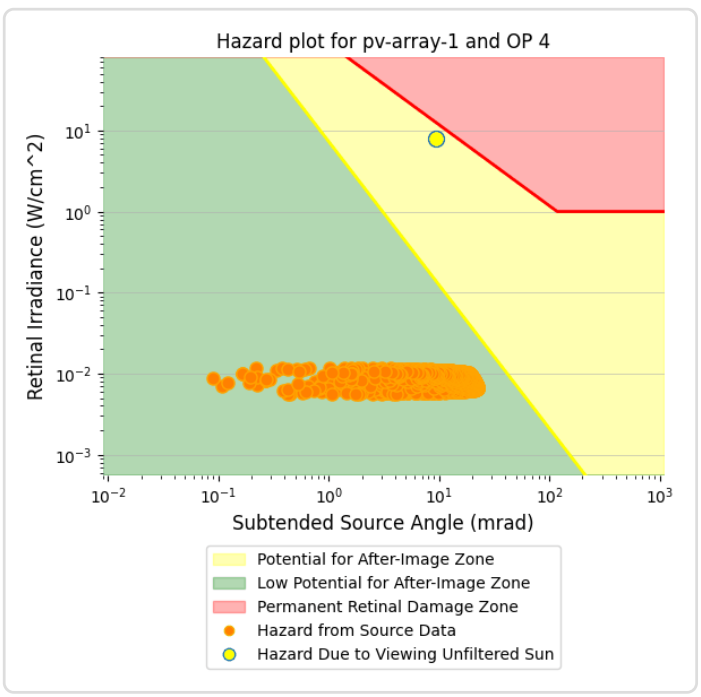
PV array 1 and OP 4

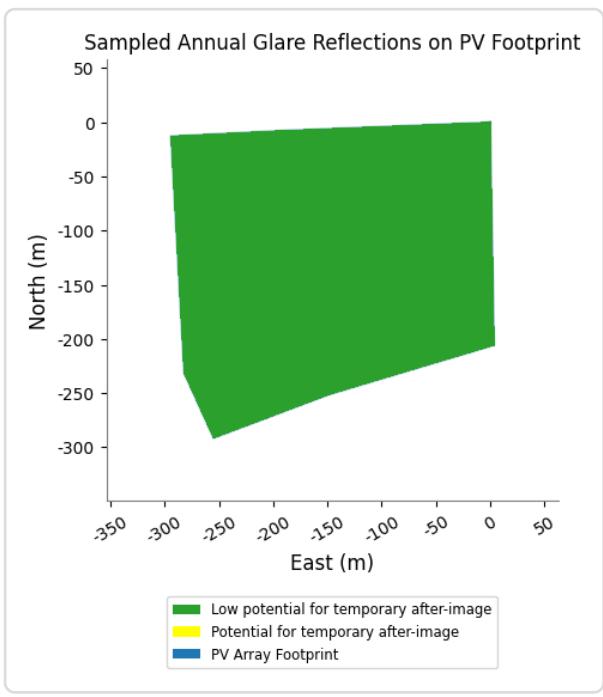
Yellow glare: none

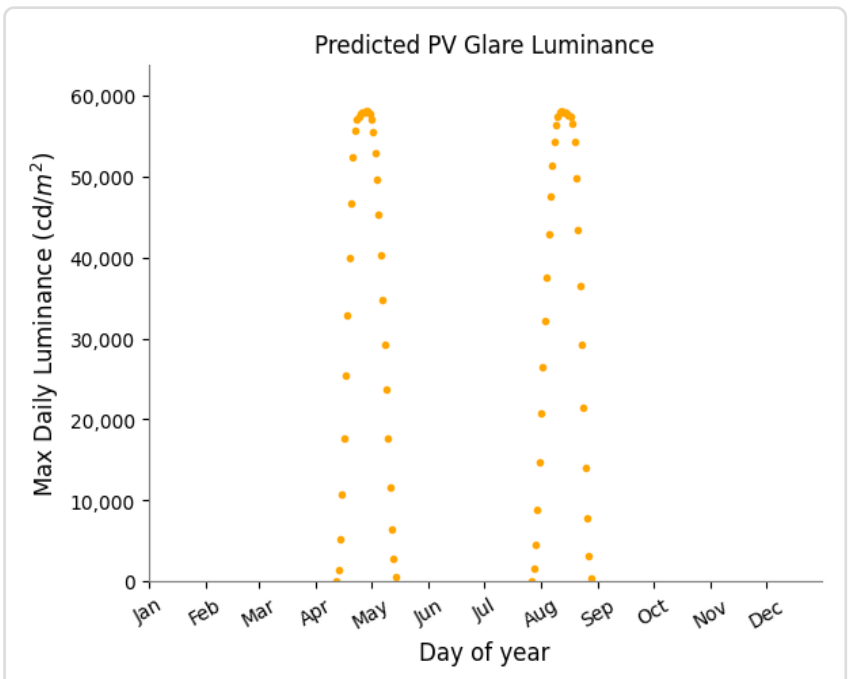
Green glare: 1,500 min.







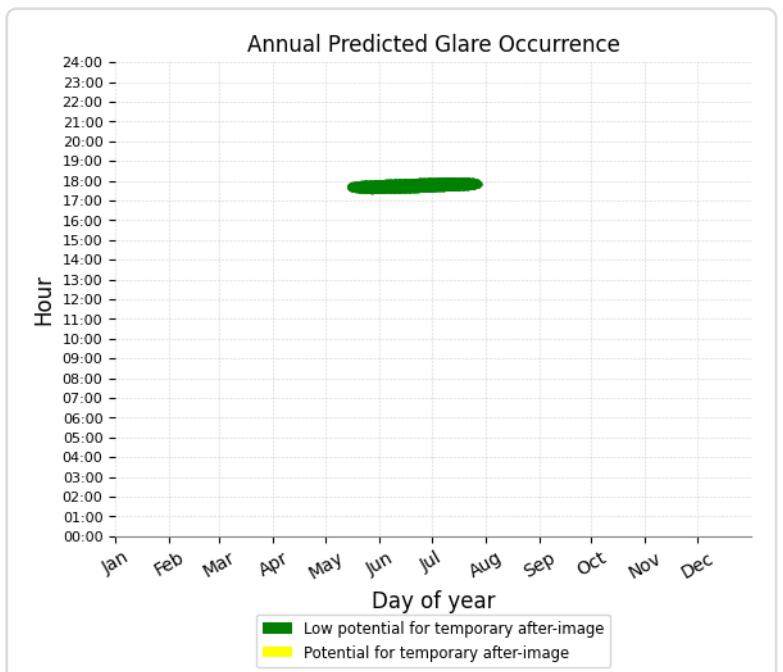


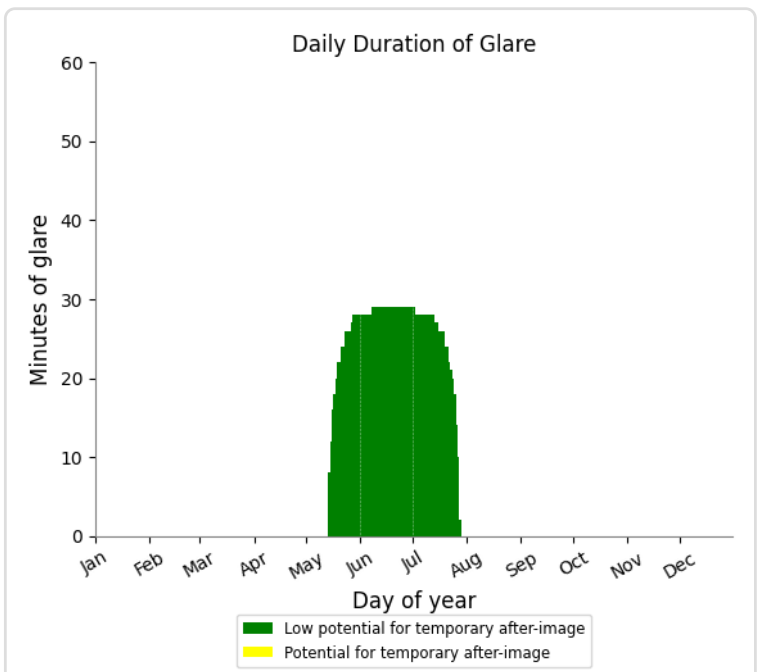


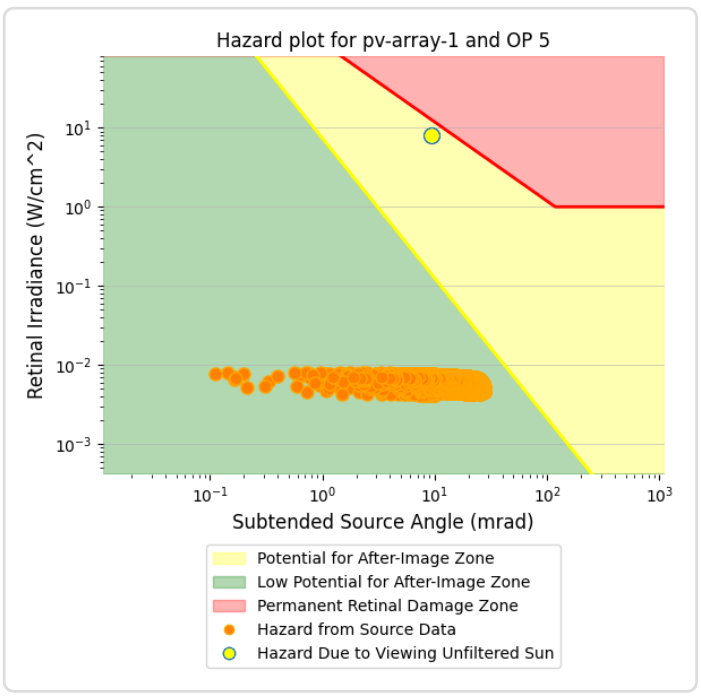
PV array 1 and OP 5

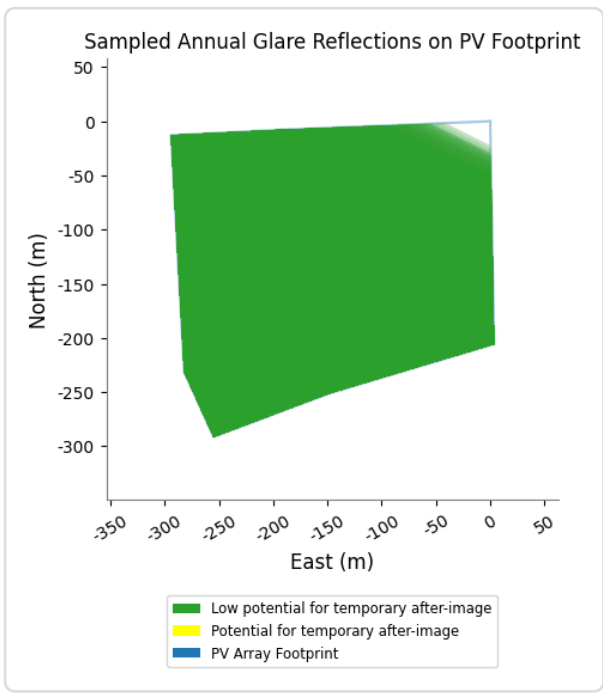
Yellow glare: none

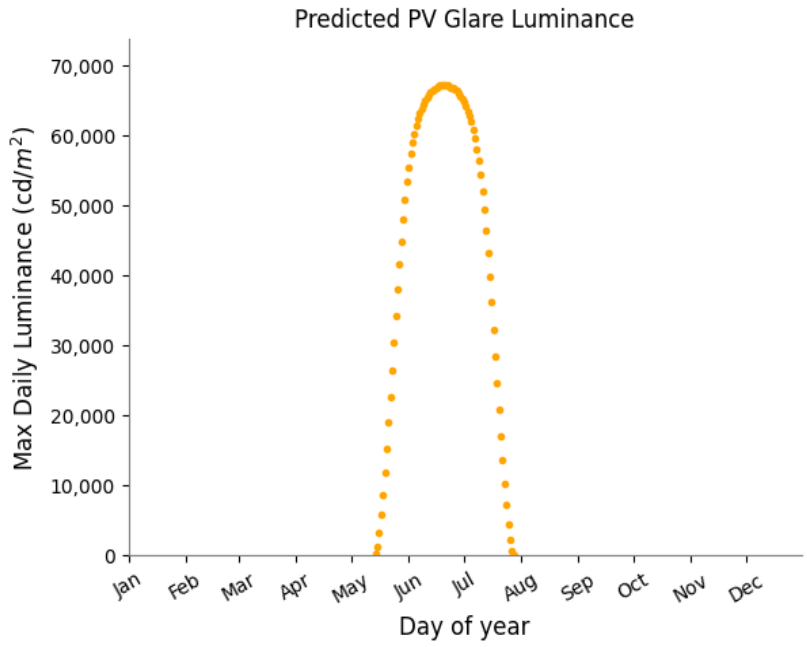
Green glare: 1,951 min.







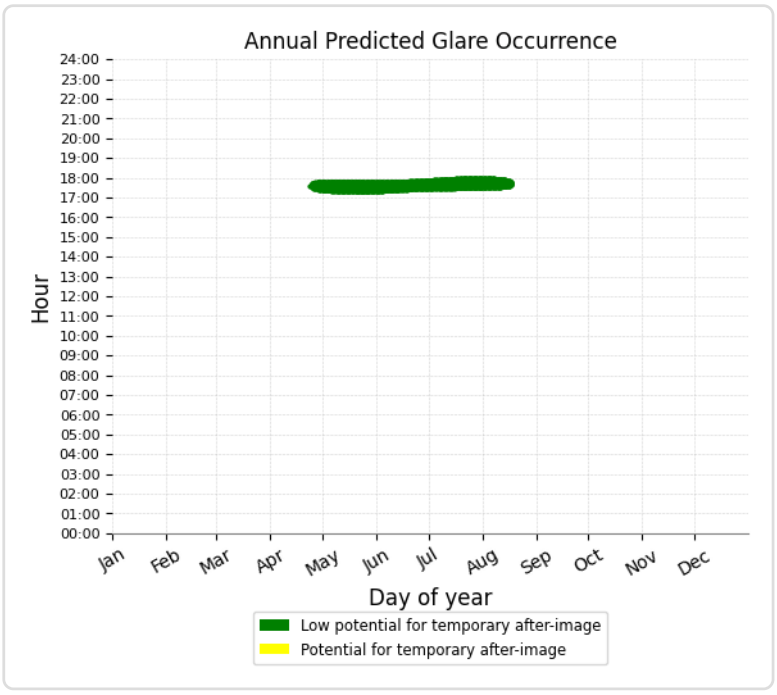


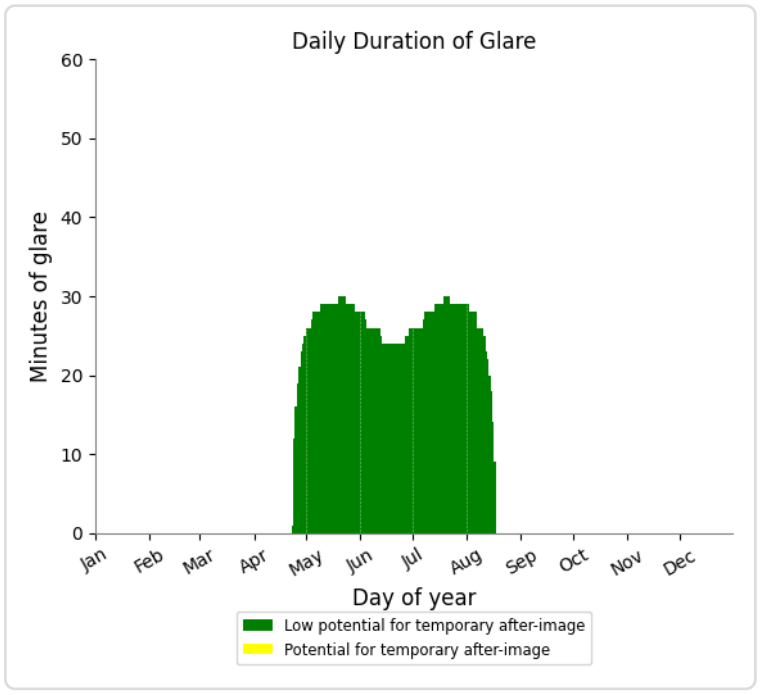


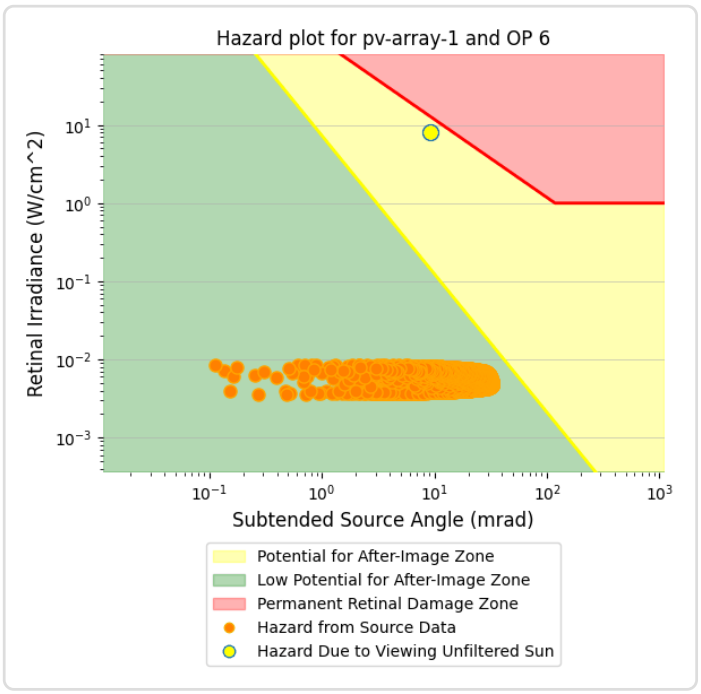
PV array 1 and OP 6

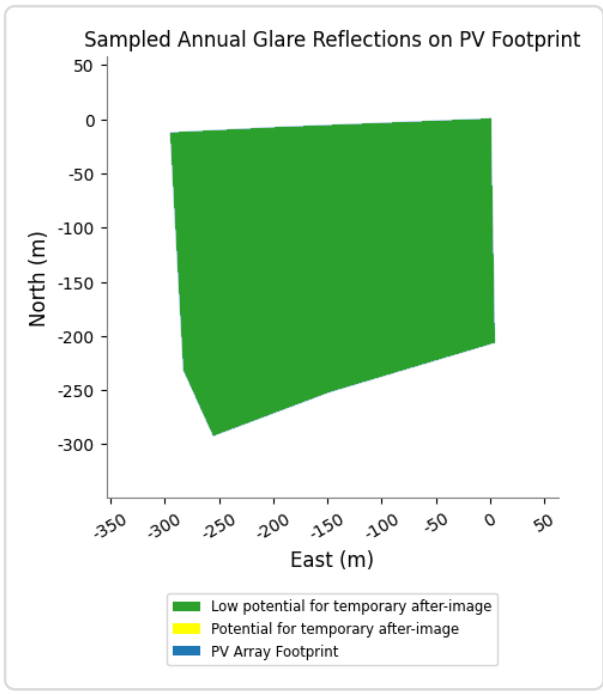
Yellow glare: none

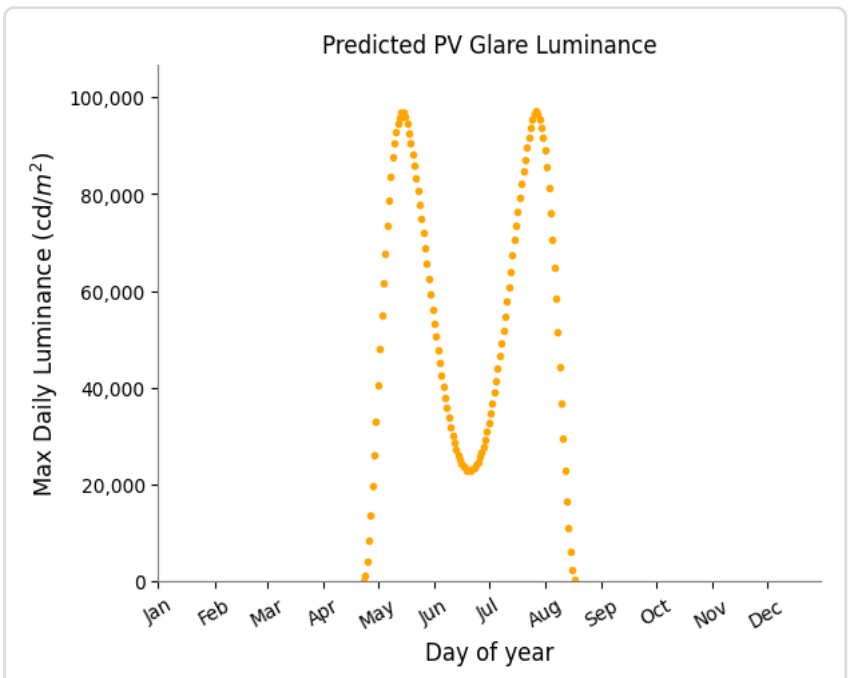
Green glare: 3,066 min.







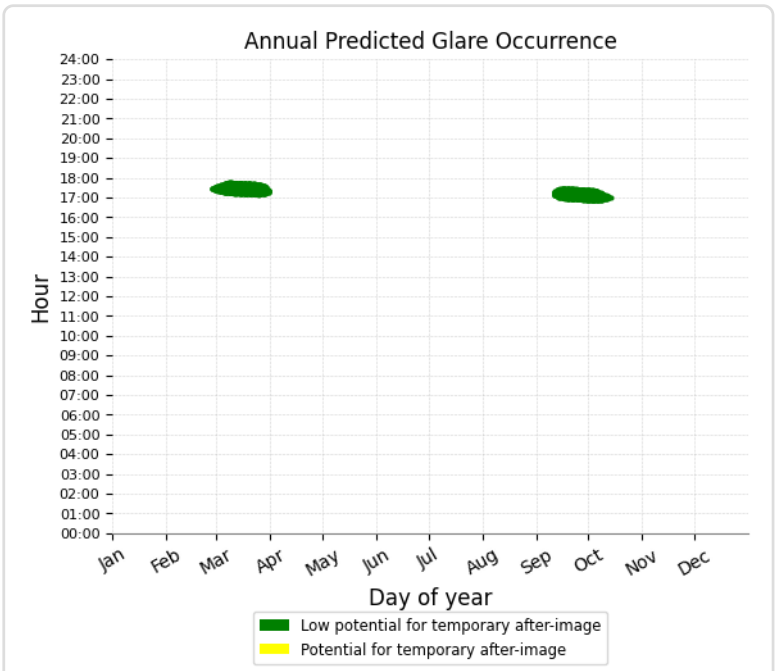


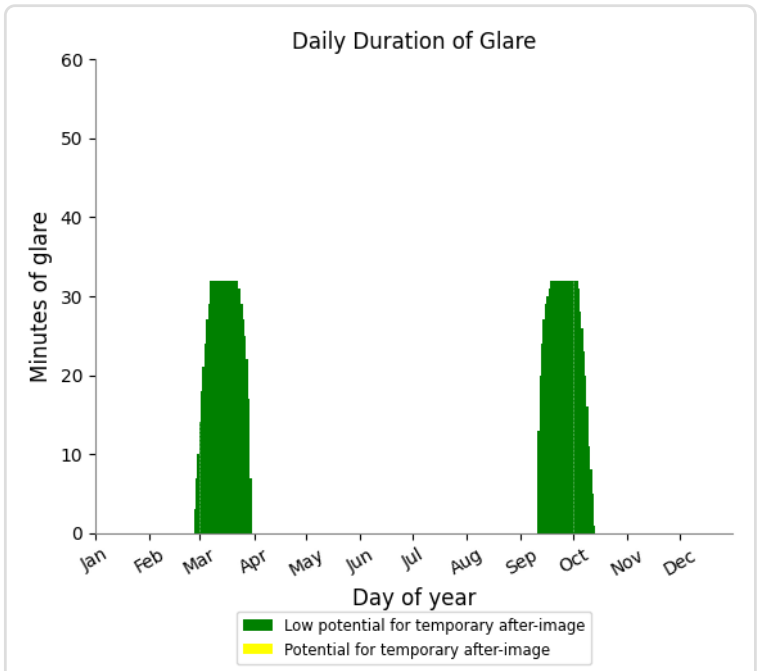


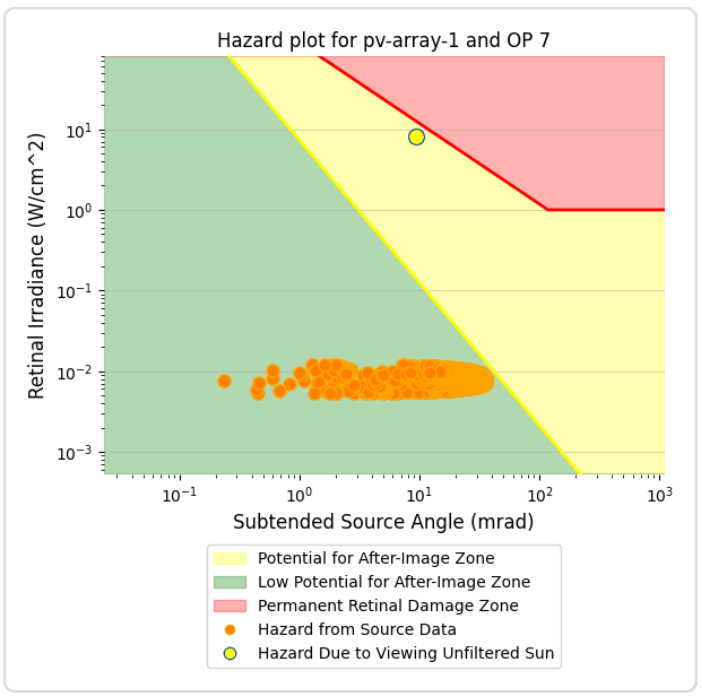
PV array 1 and OP 7

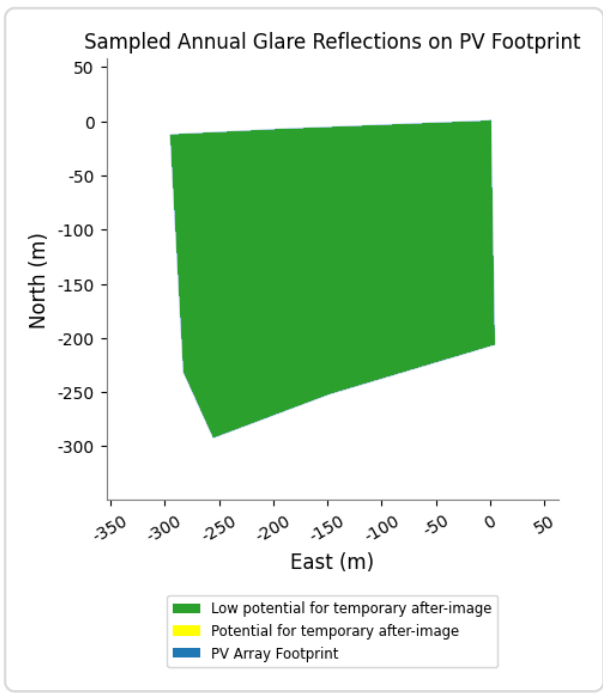
Yellow glare: none

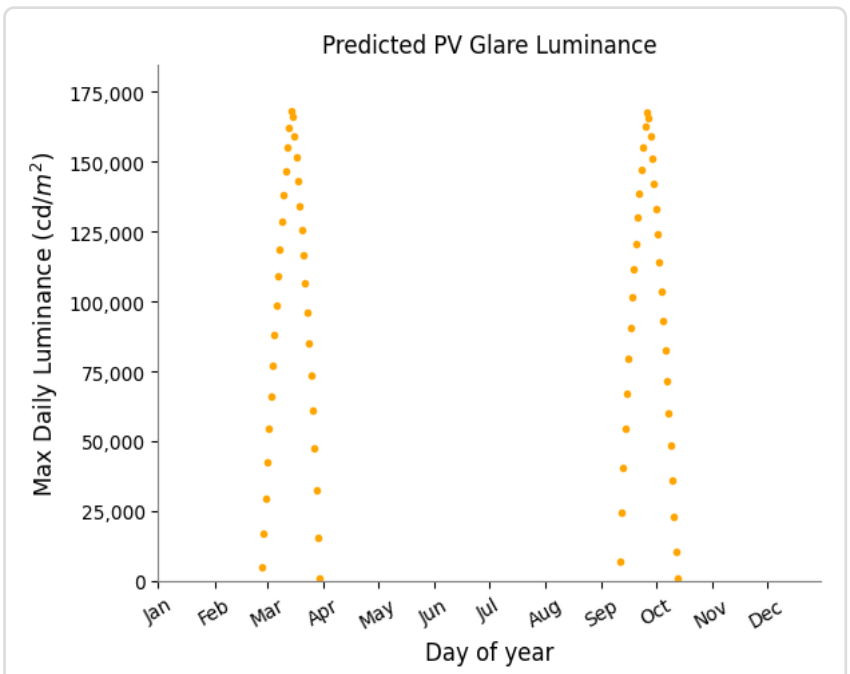
Green glare: 1,709 min.







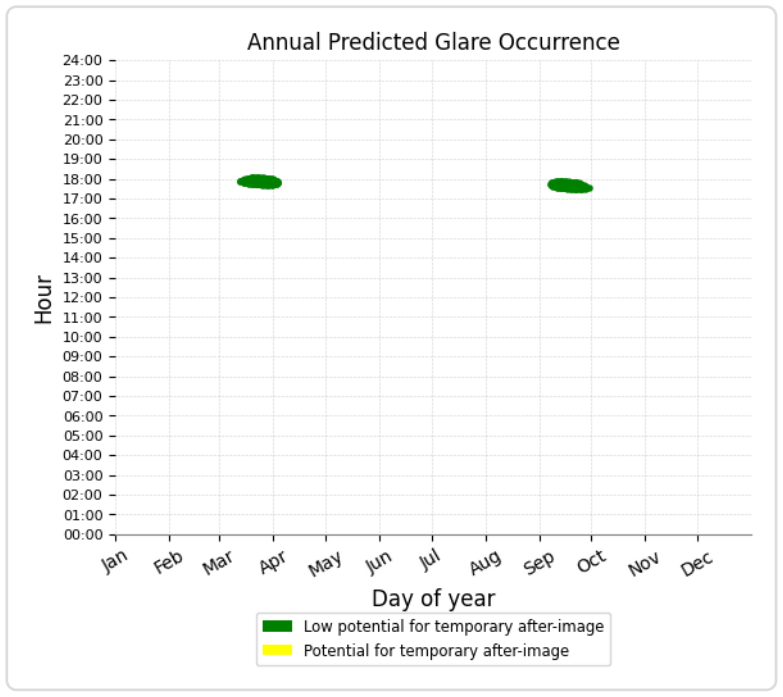


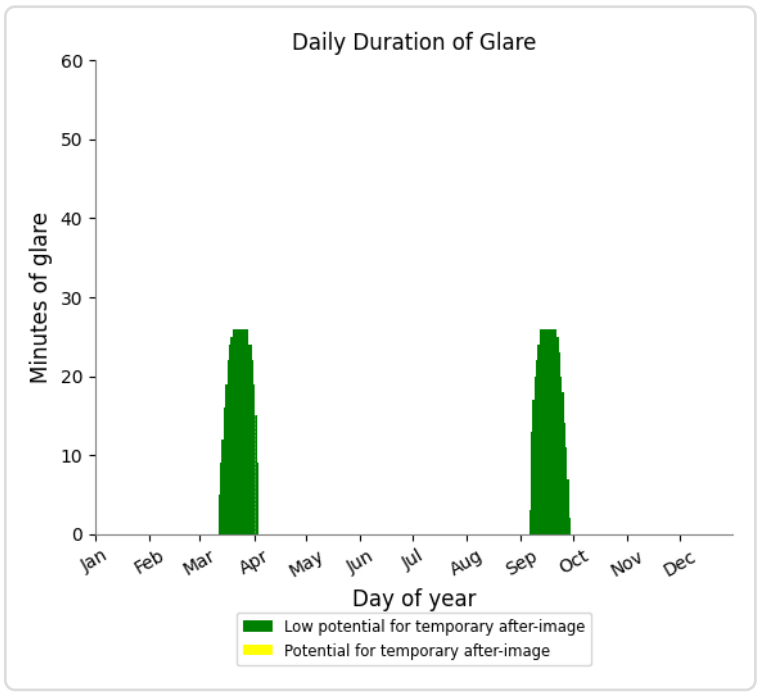


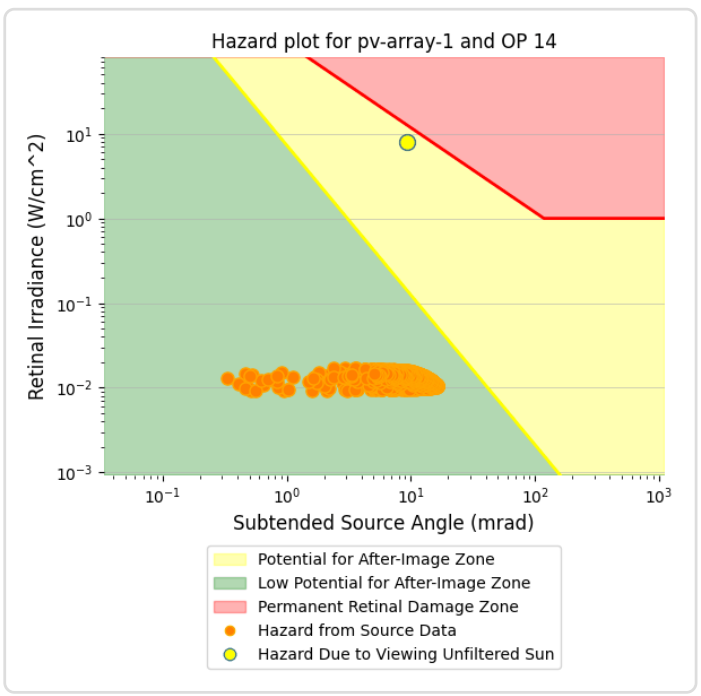
PV array 1 and OP 14

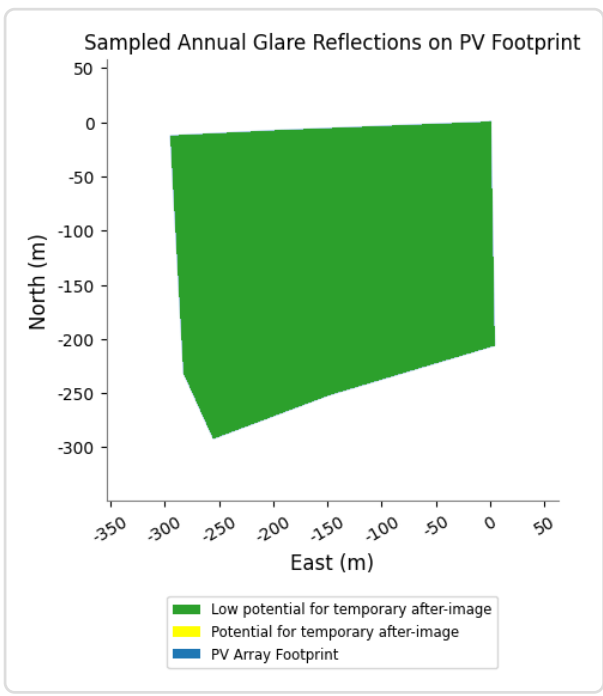
Yellow glare: none

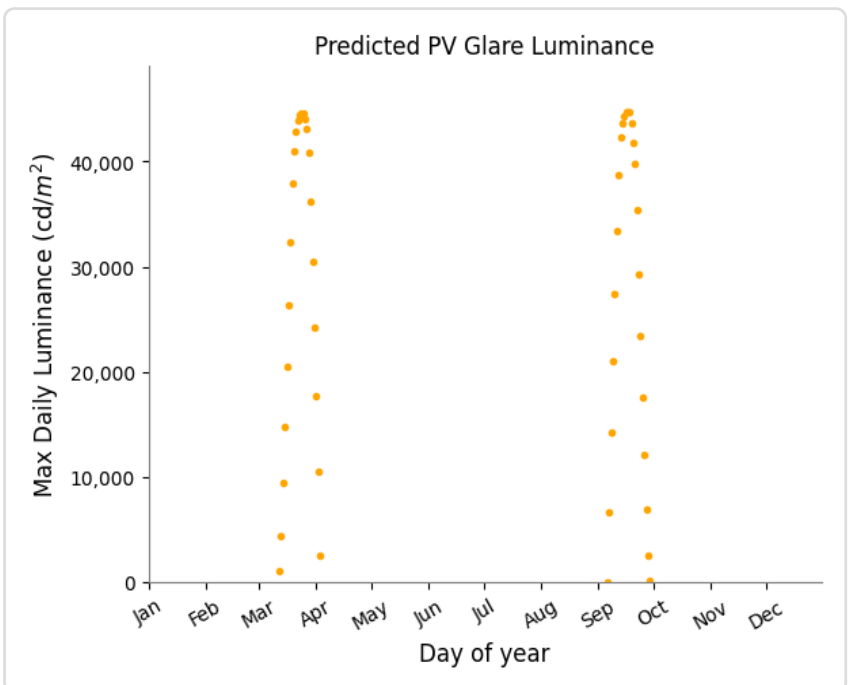
Green glare: 958 min.







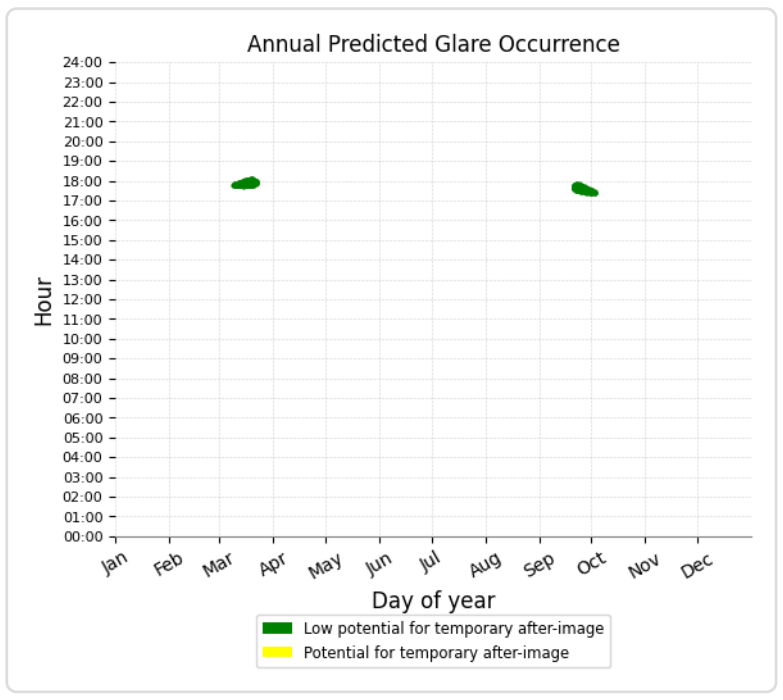


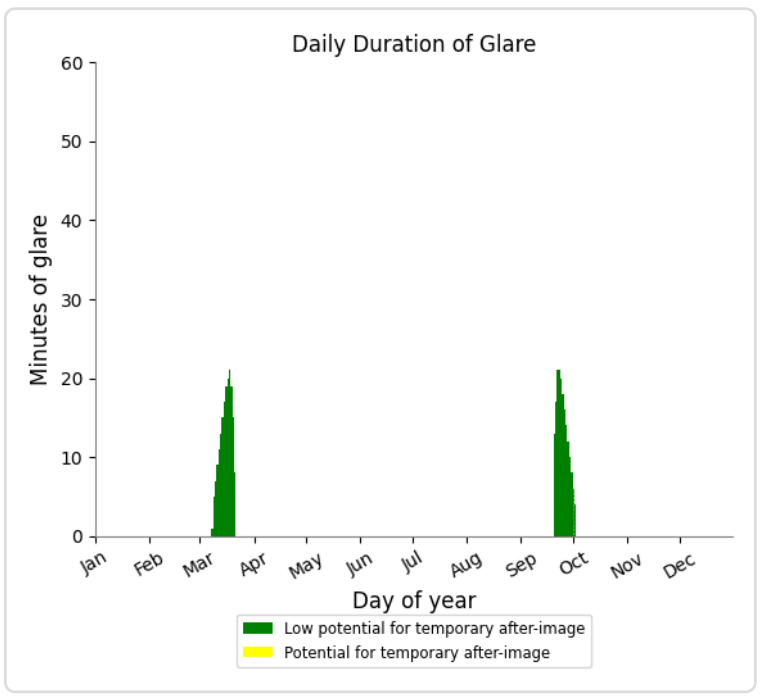


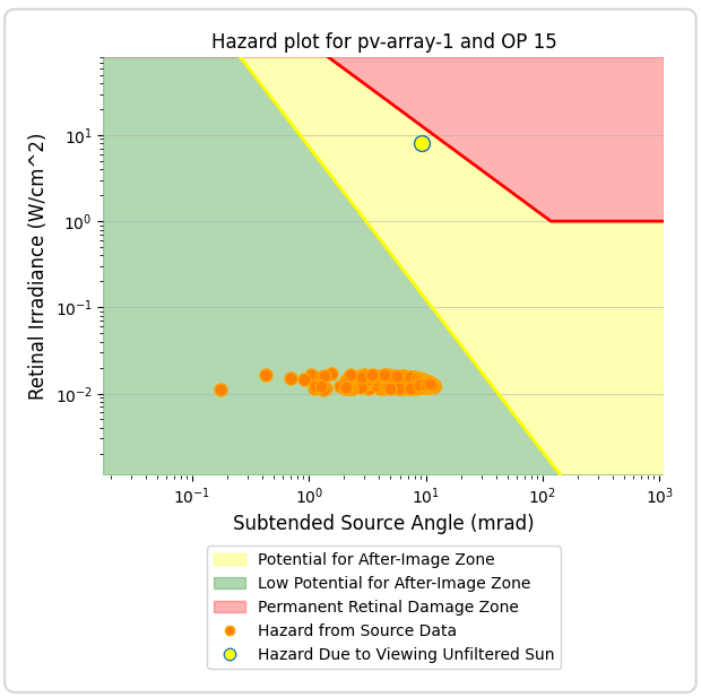
PV array 1 and OP 15

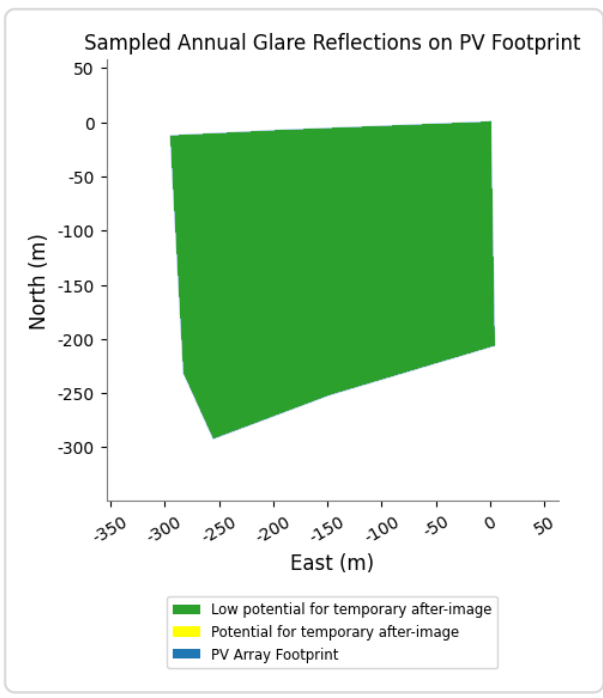
Yellow glare: none

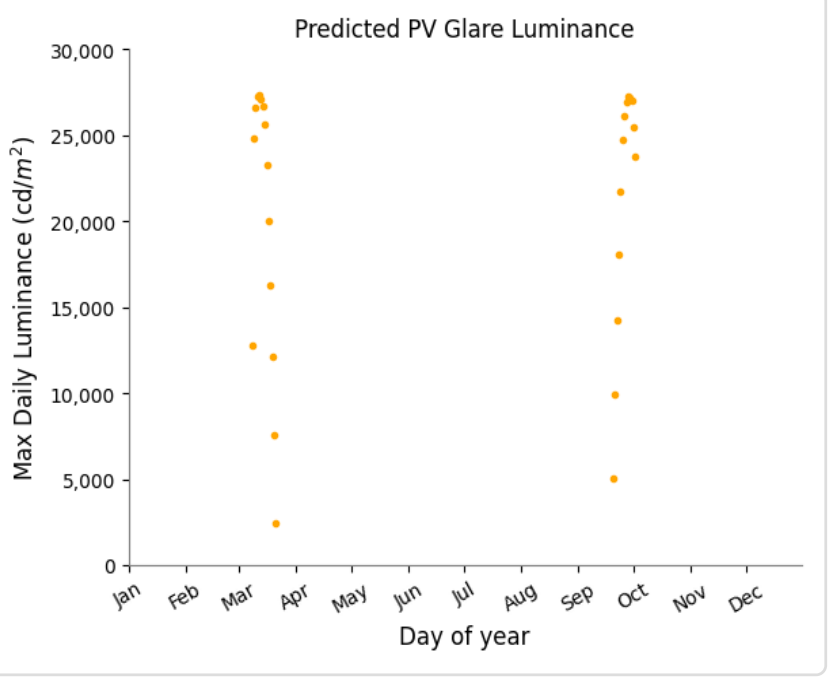
Green glare: 360 min.











PV array 1 and OP 1

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 16

No glare found

PV array 1 and OP 17

No glare found

PV array 1 and OP 18

No glare found

PV array 1 and OP 19

No glare found

PV array 1 and OP 20

No glare found

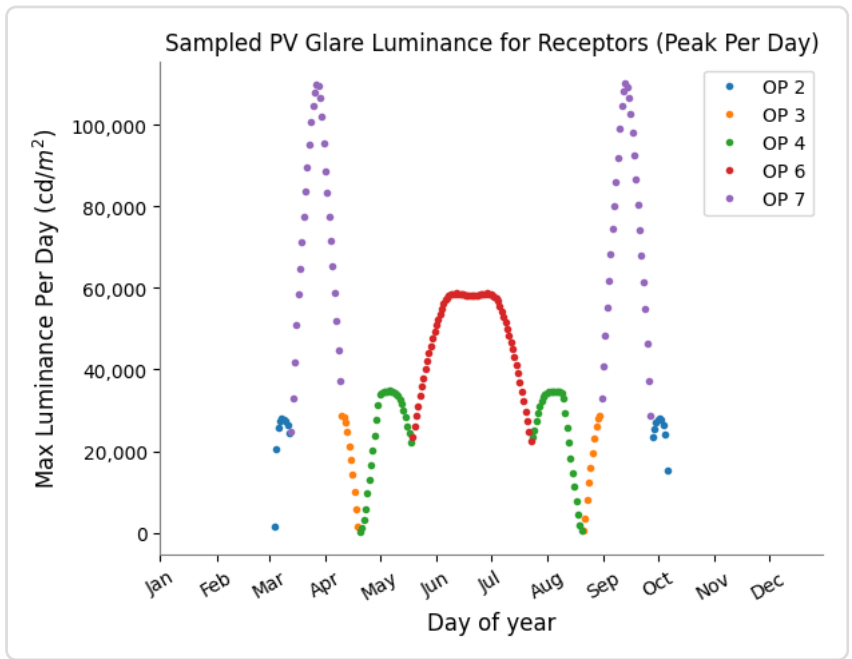
PV array 1 and OP 21

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

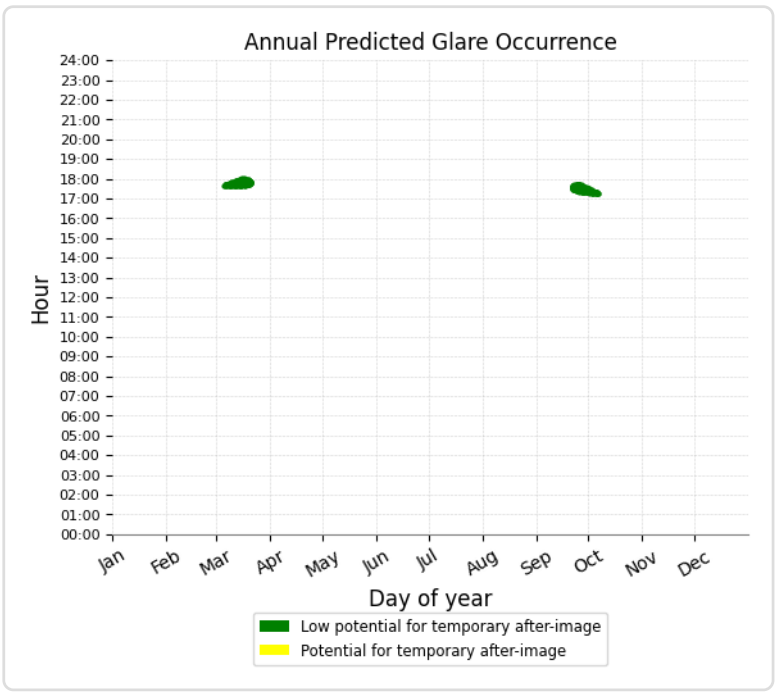
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	453	7.5	0	0.0	28,056
OP 3	1,032	17.2	0	0.0	28,919
OP 4	1,714	28.6	0	0.0	34,763
OP 5	562	9.4	0	0.0	4,252
OP 6	2,302	38.4	0	0.0	58,801
OP 7	1,963	32.7	0	0.0	110,158
OP 14	1,004	16.7	0	0.0	27,849
OP 15	553	9.2	0	0.0	17,650
OP 16	30	0.5	0	0.0	1,837
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

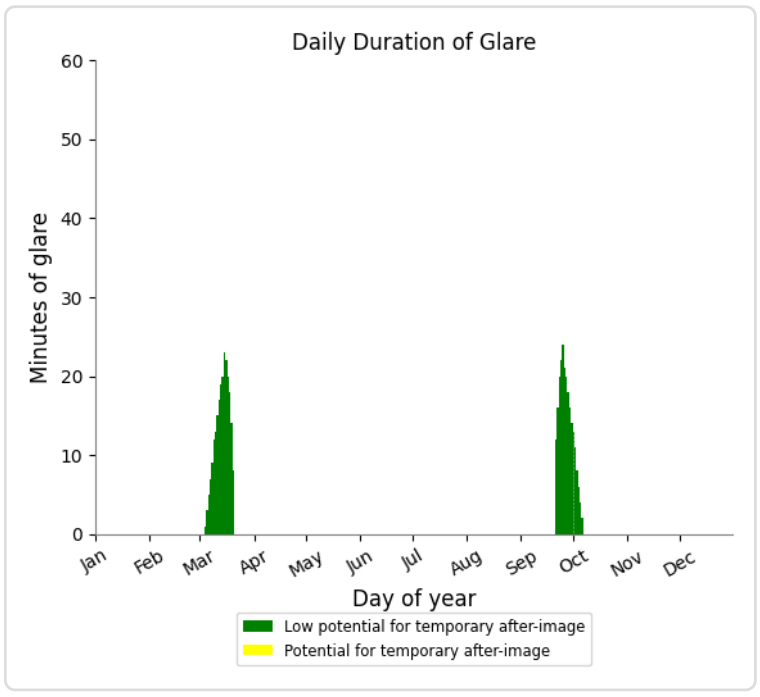


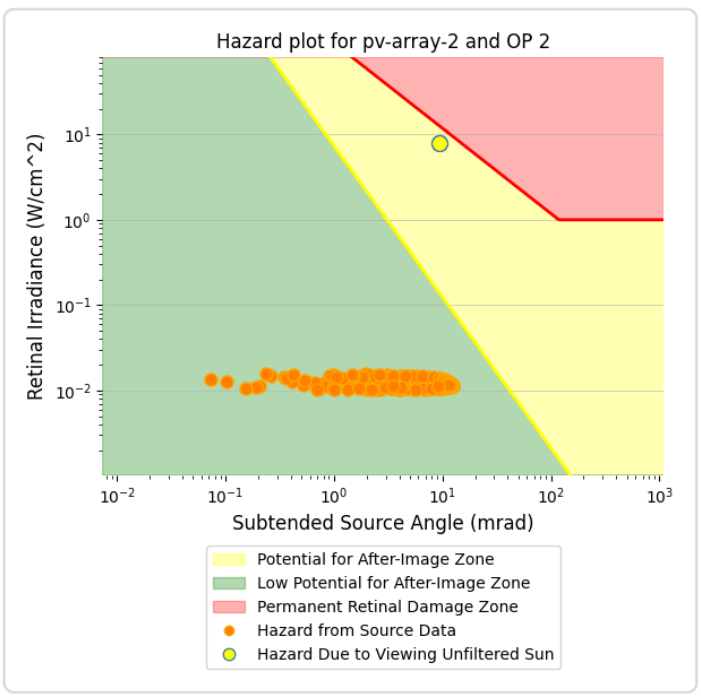
PV array 2 and OP 2

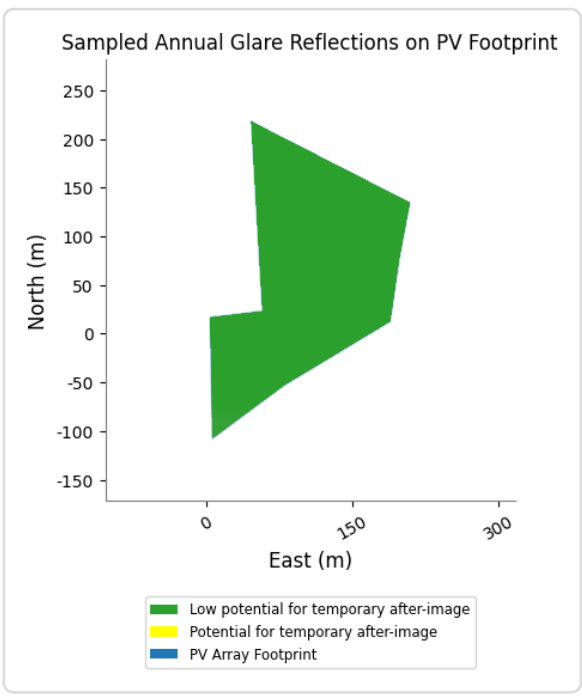
Yellow glare: none

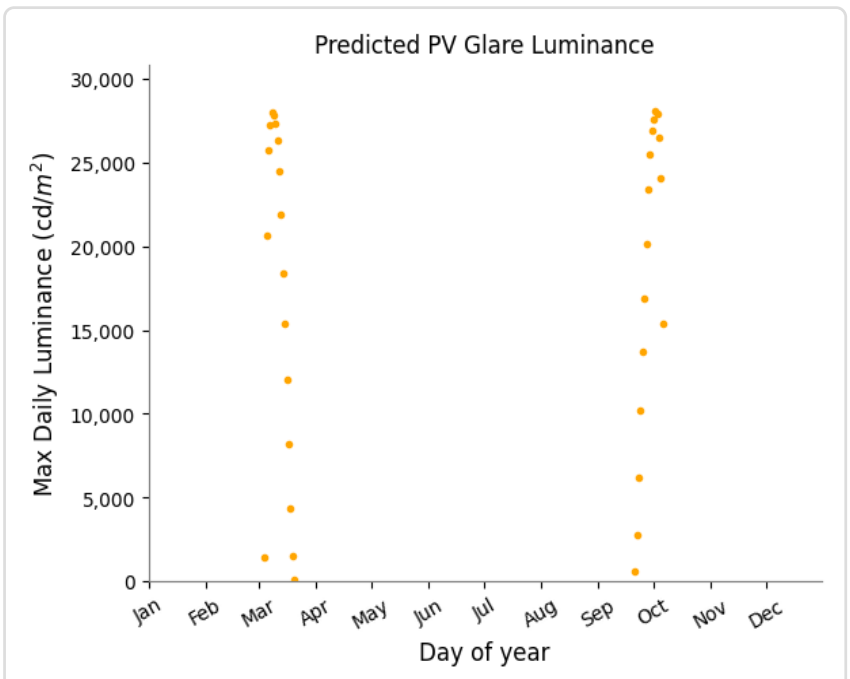
Green glare: 453 min.







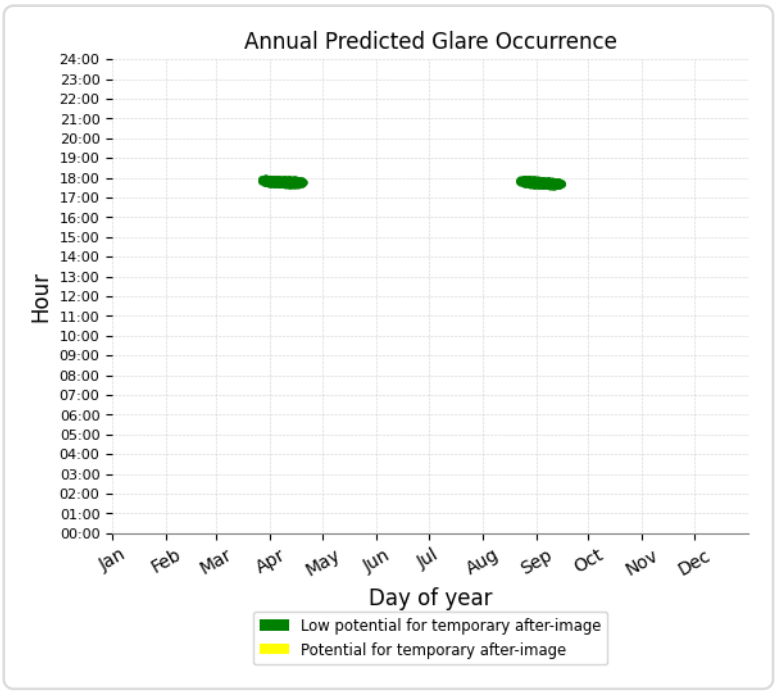


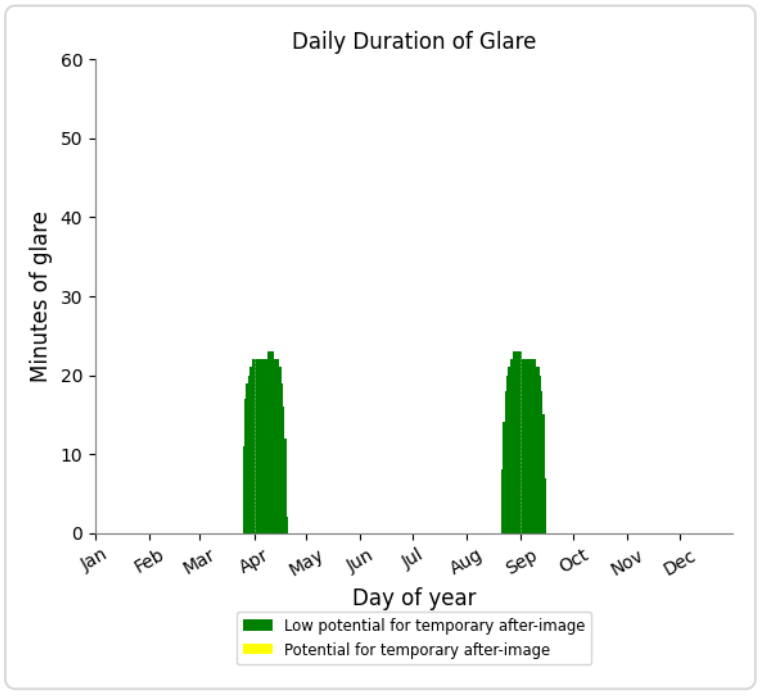


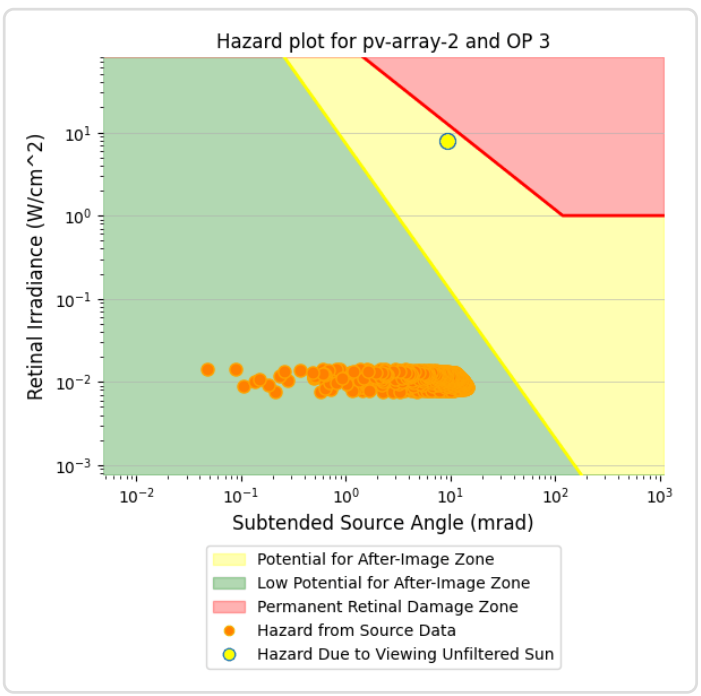
PV array 2 and OP 3

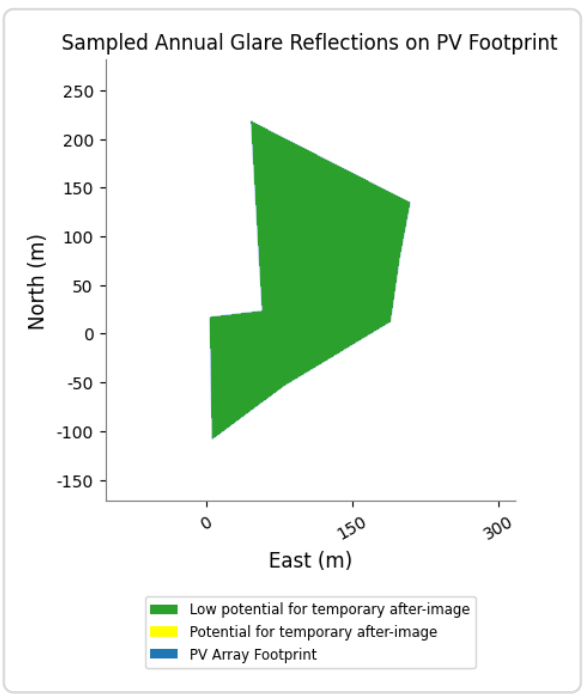
Yellow glare: none

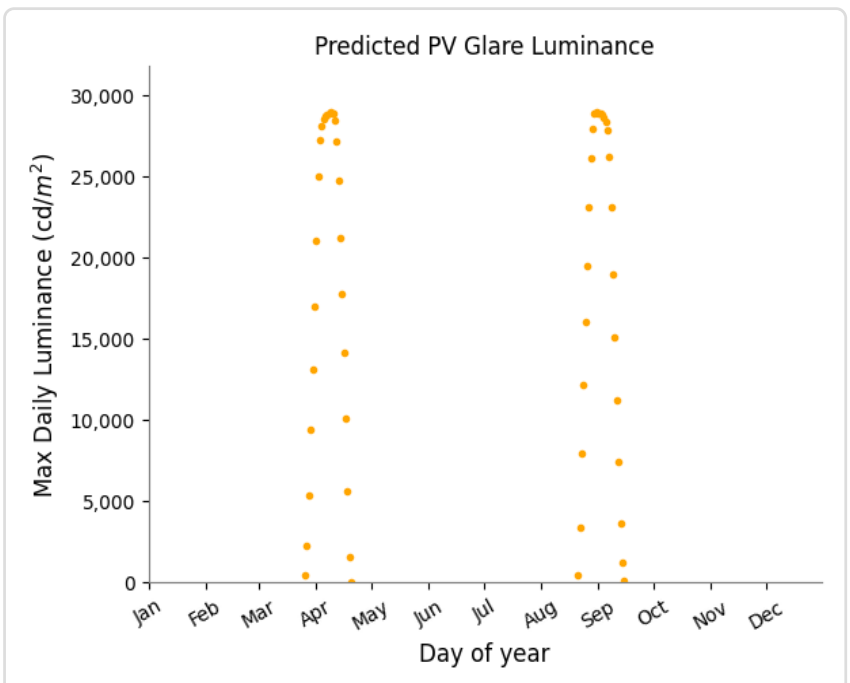
Green glare: 1,032 min.







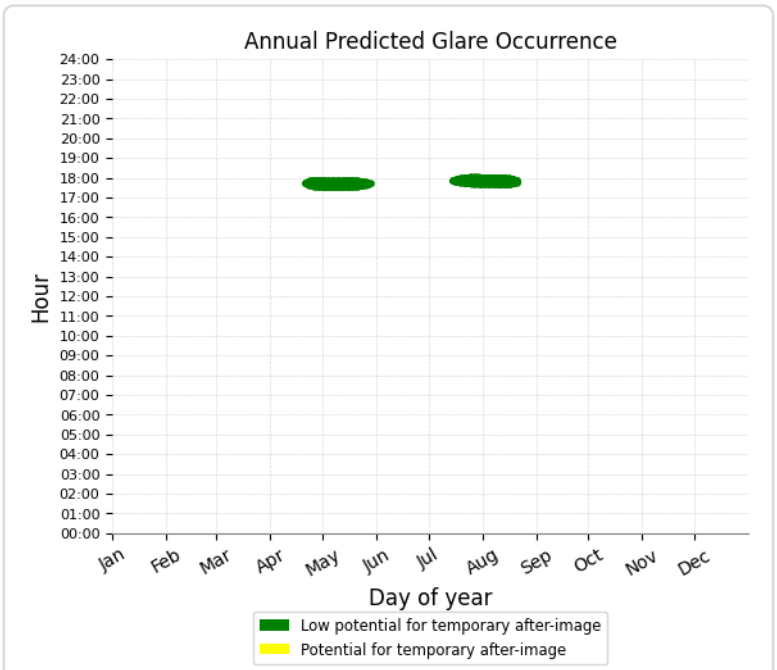


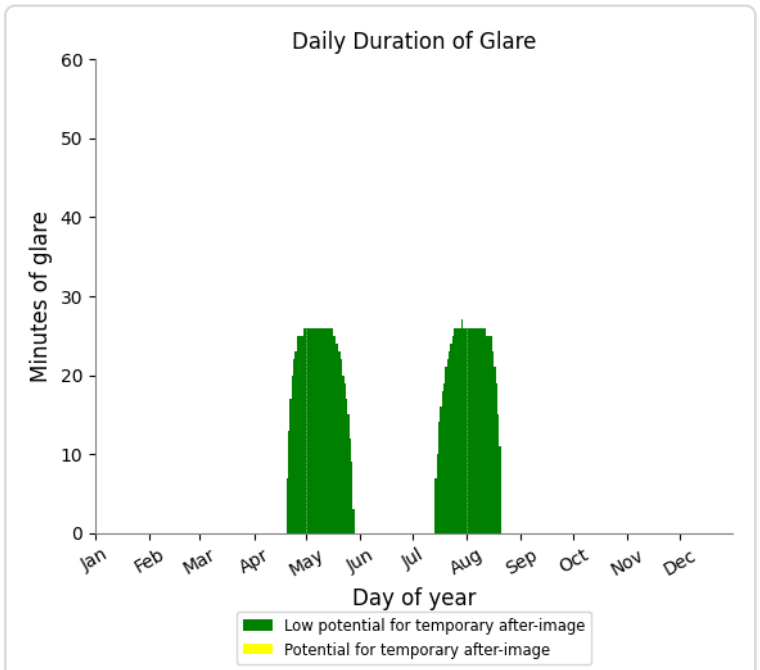


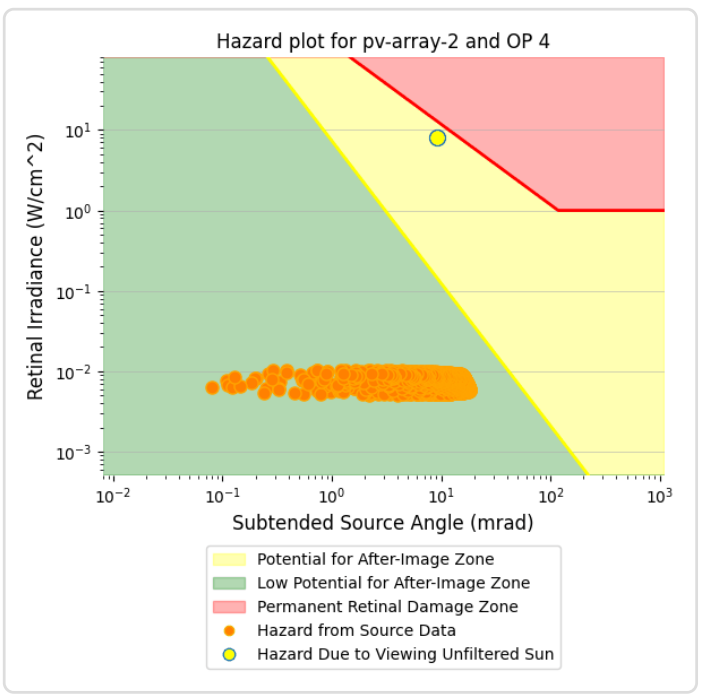
PV array 2 and OP 4

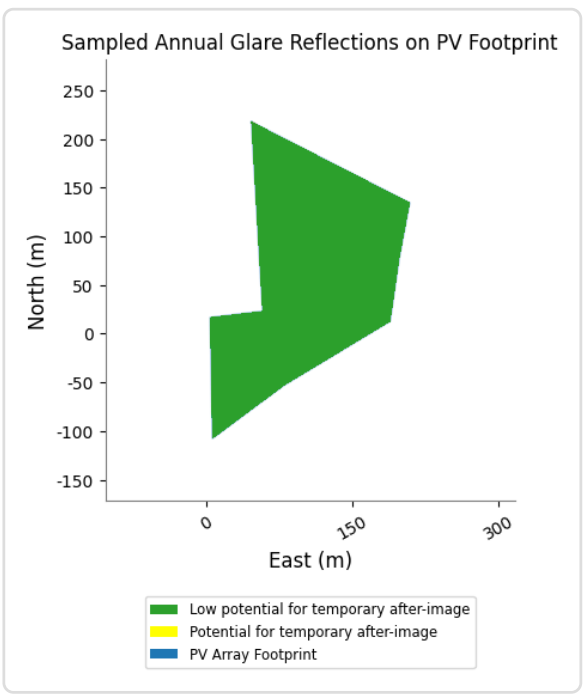
Yellow glare: none

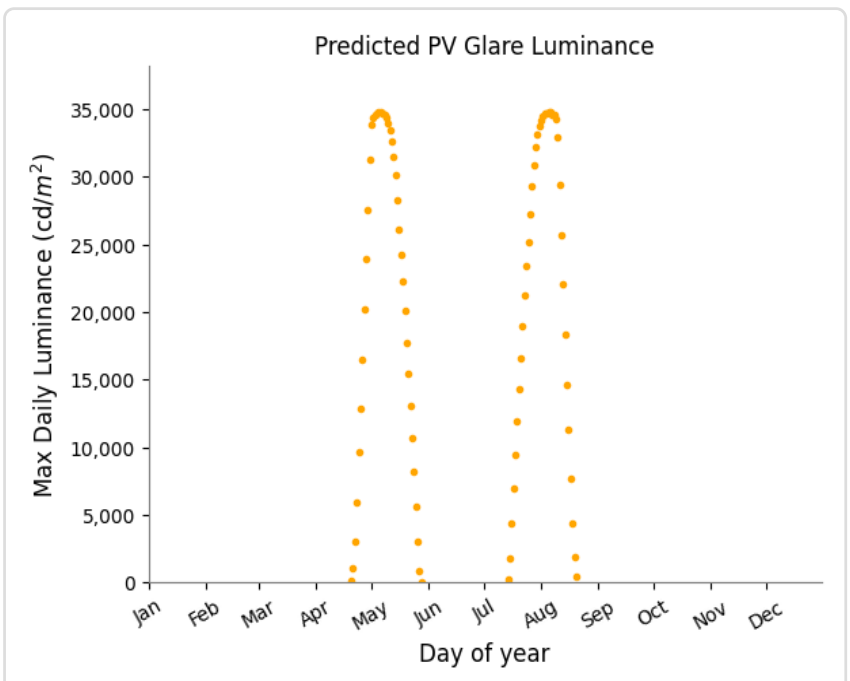
Green glare: 1,714 min.







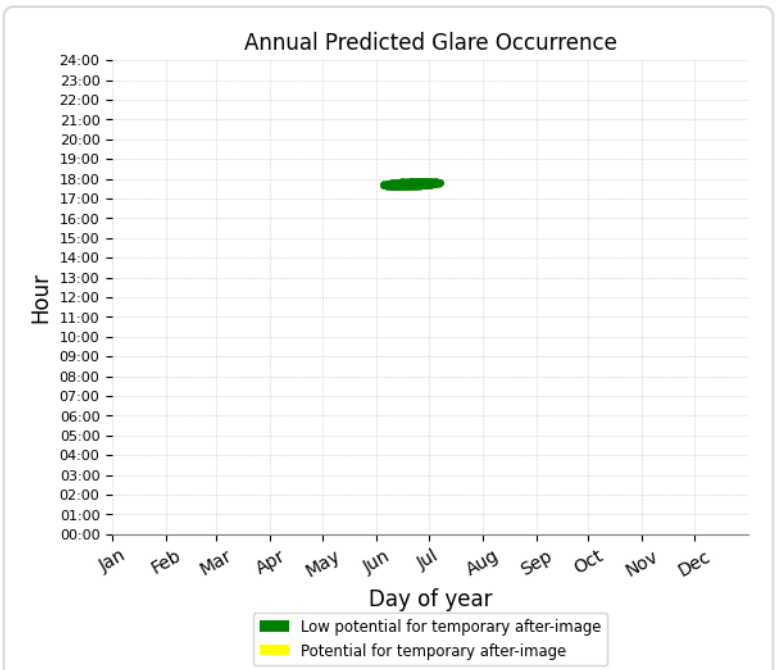


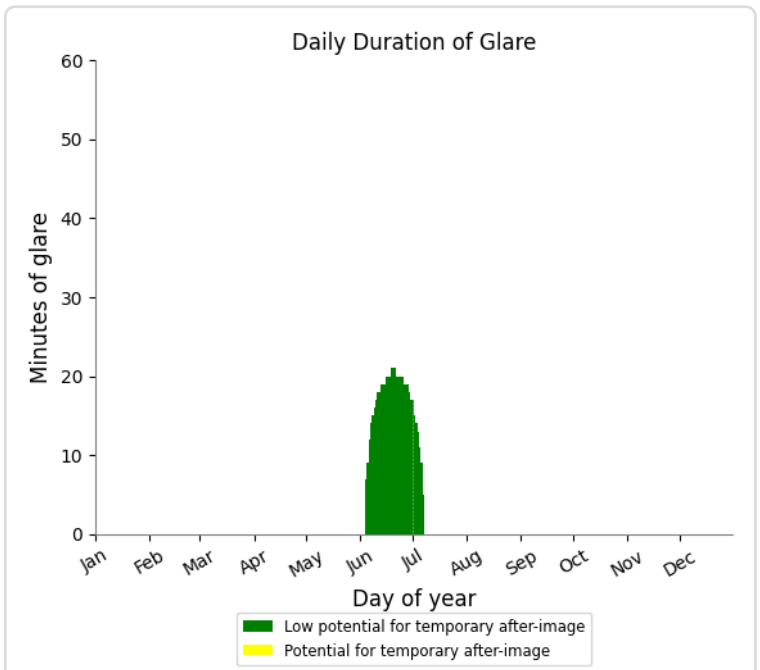


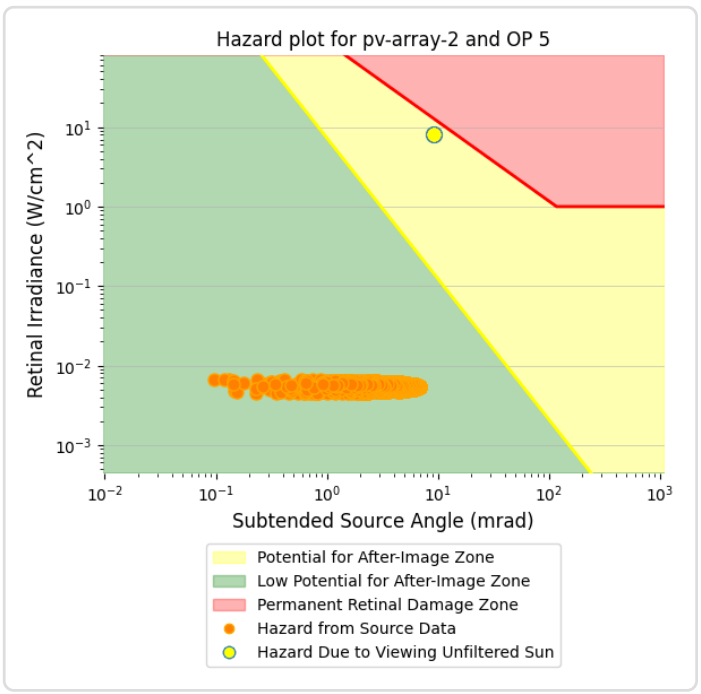
PV array 2 and OP 5

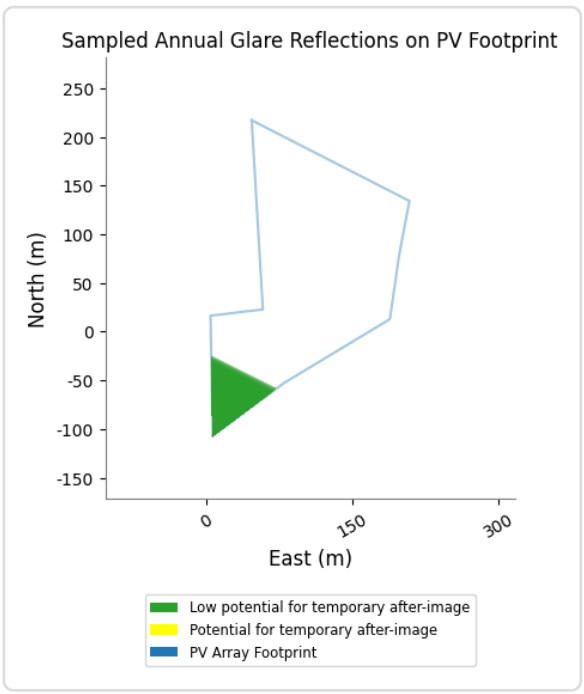
Yellow glare: none

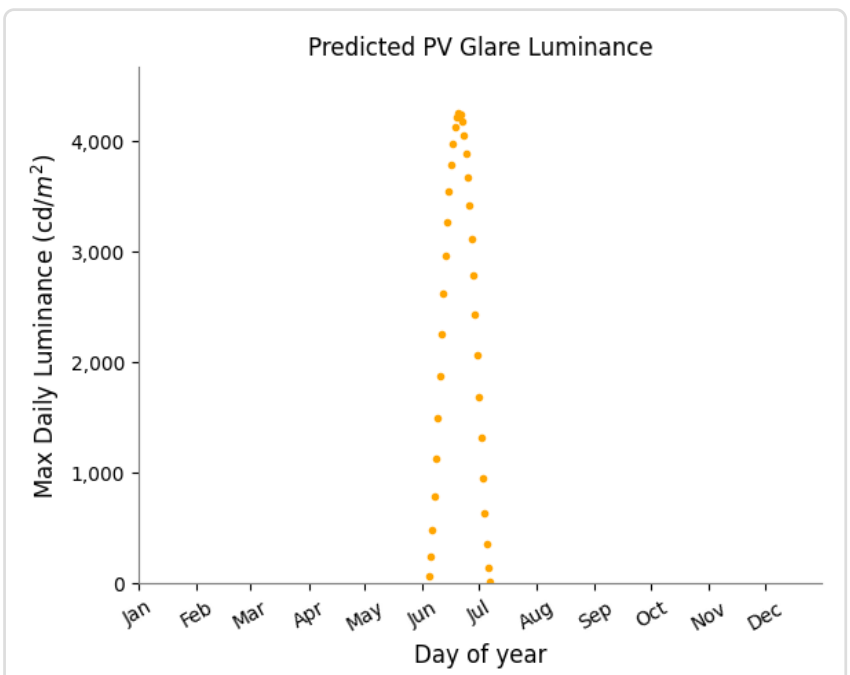
Green glare: 562 min.







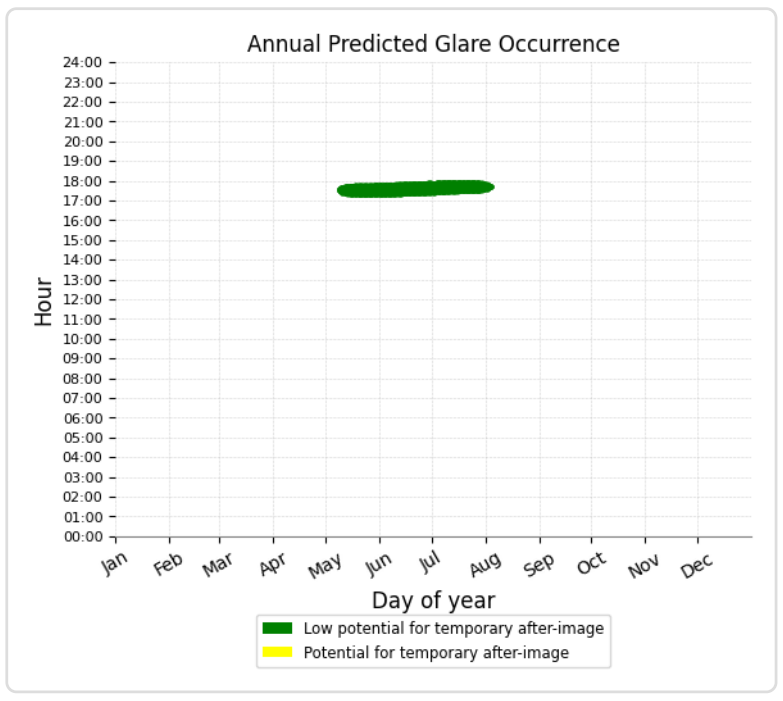


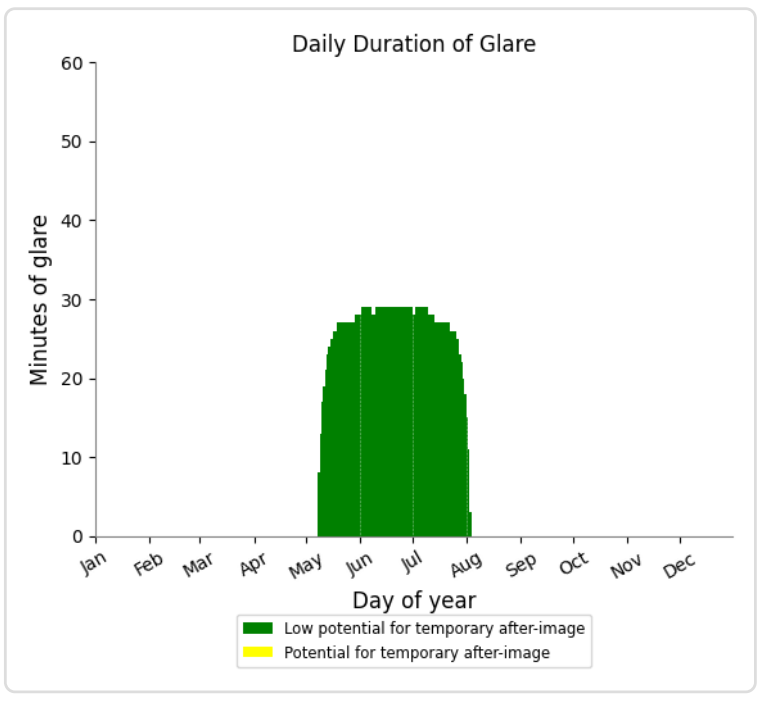


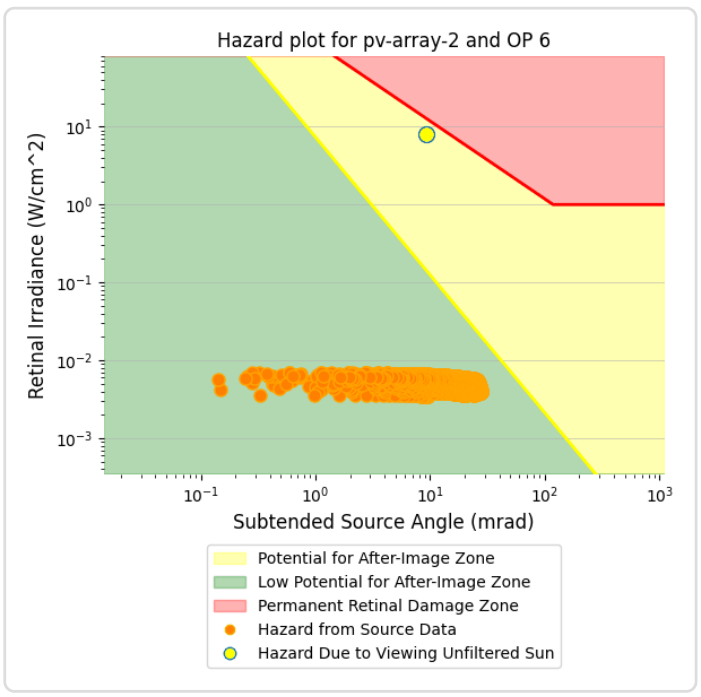
PV array 2 and OP 6

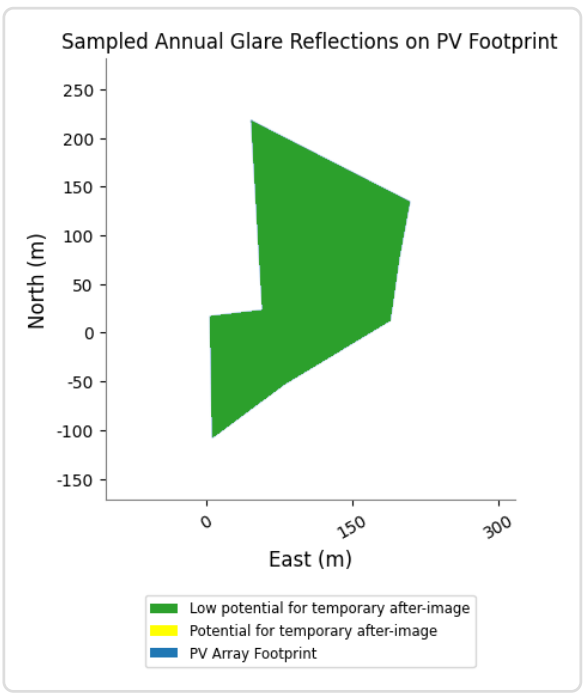
Yellow glare: none

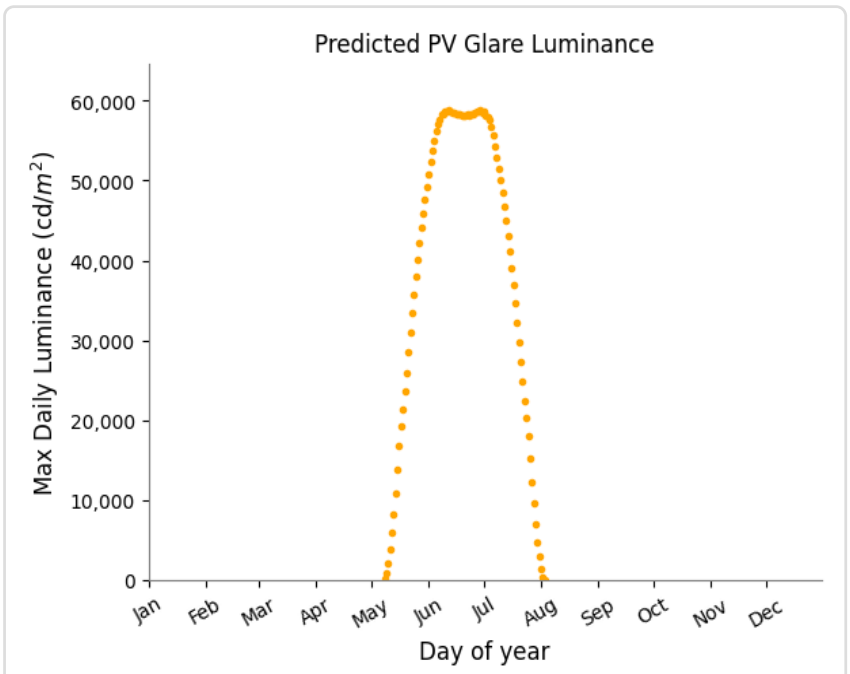
Green glare: 2,302 min.







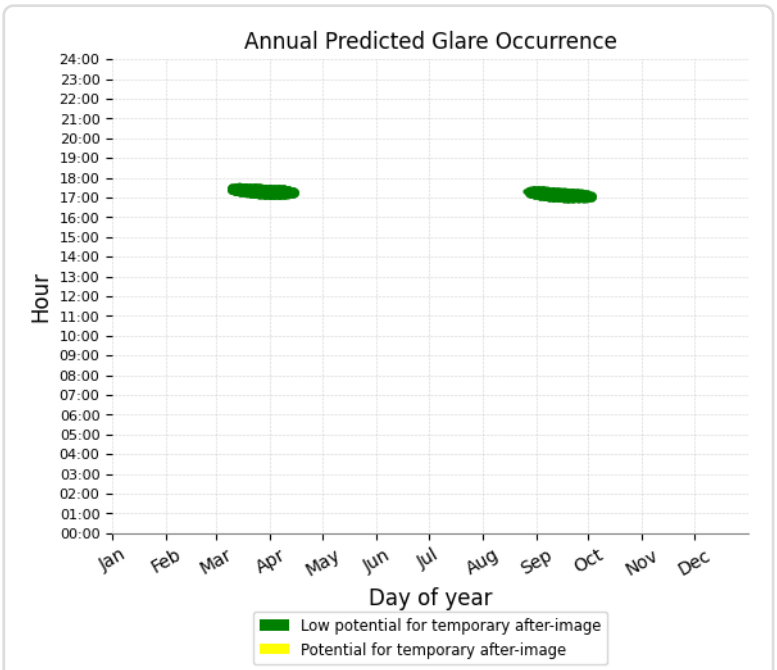


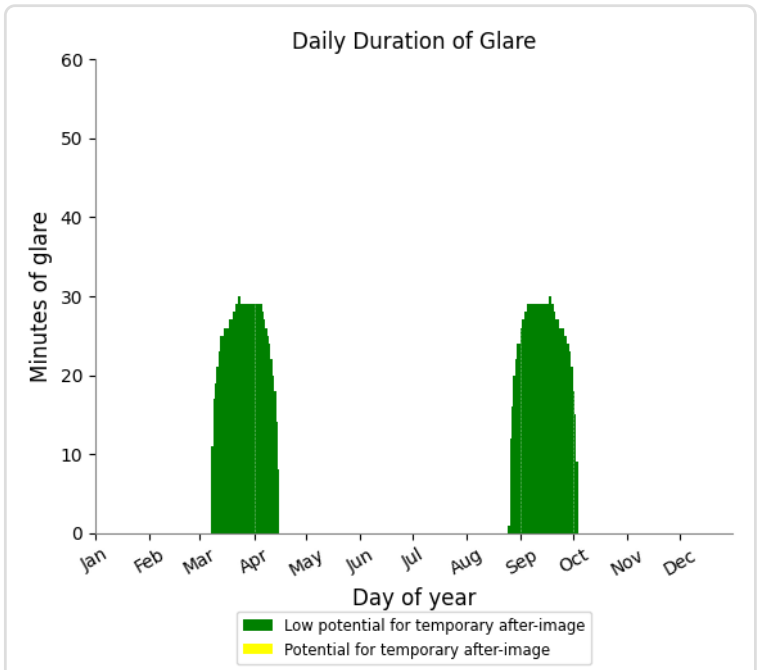


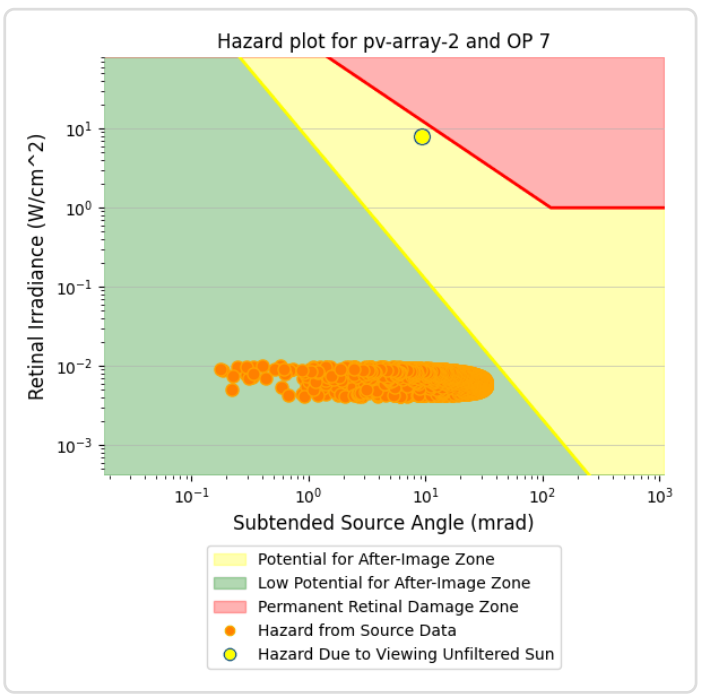
PV array 2 and OP 7

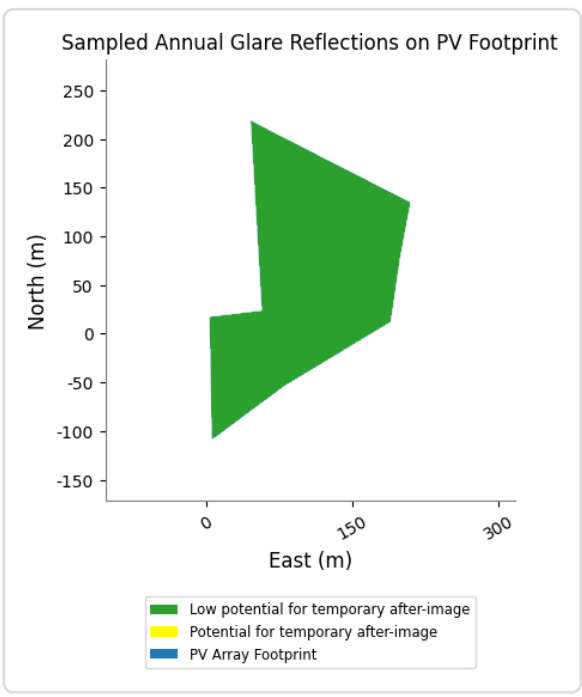
Yellow glare: none

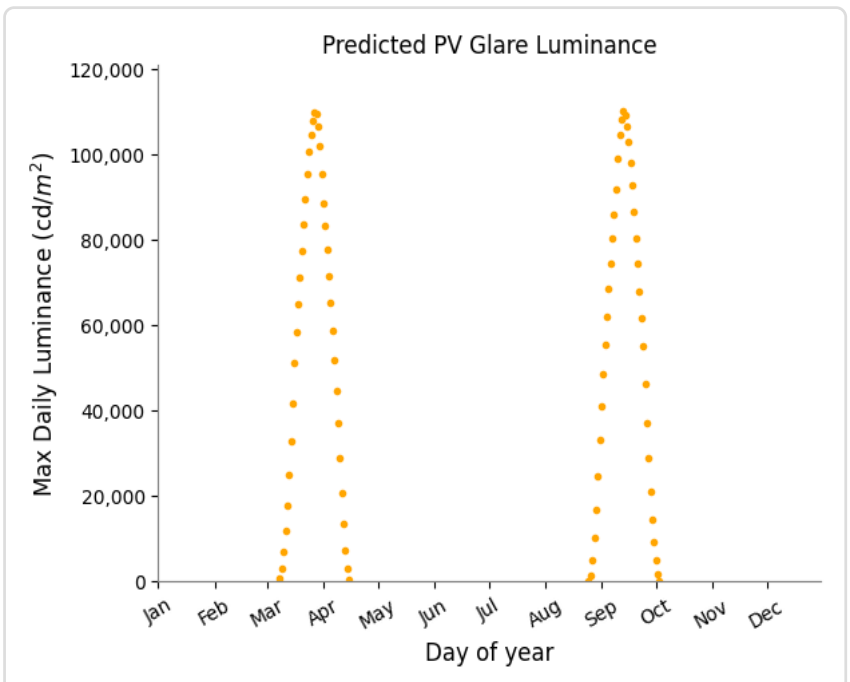
Green glare: 1,963 min.







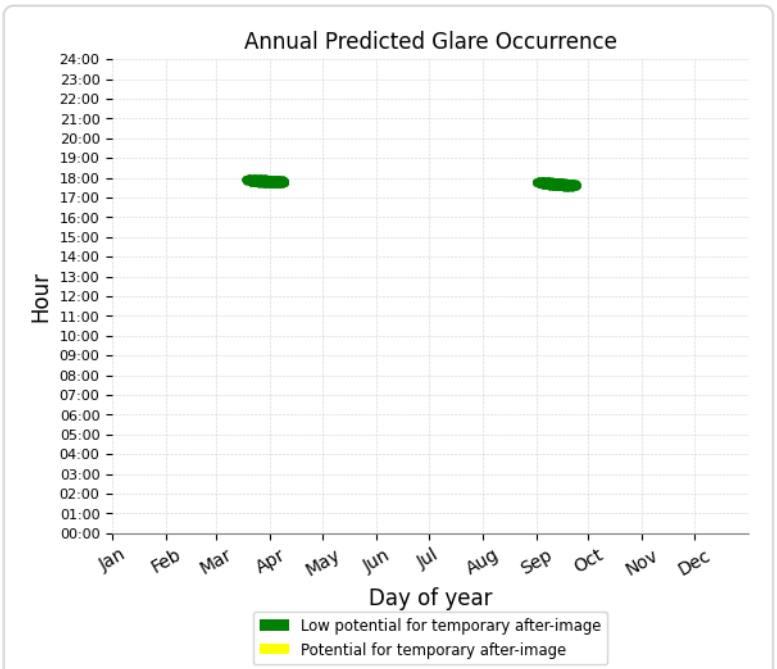


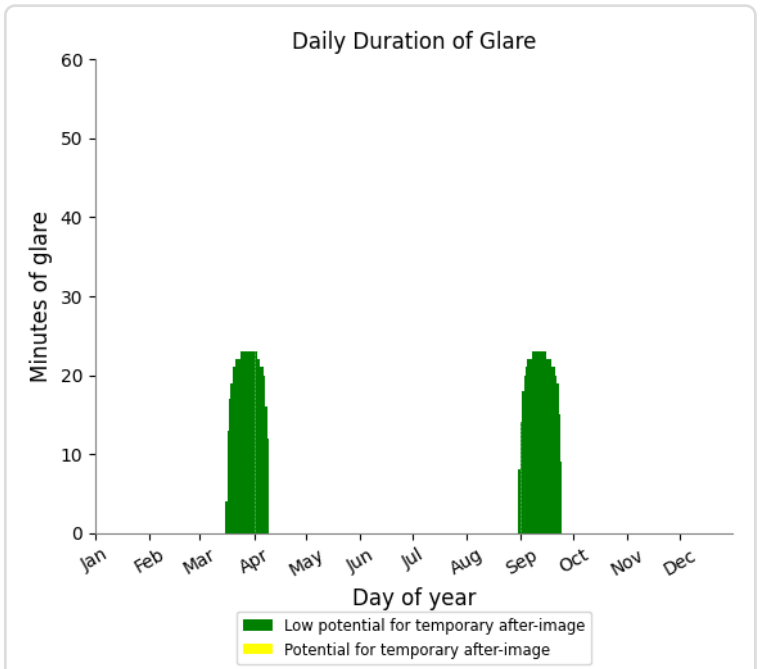


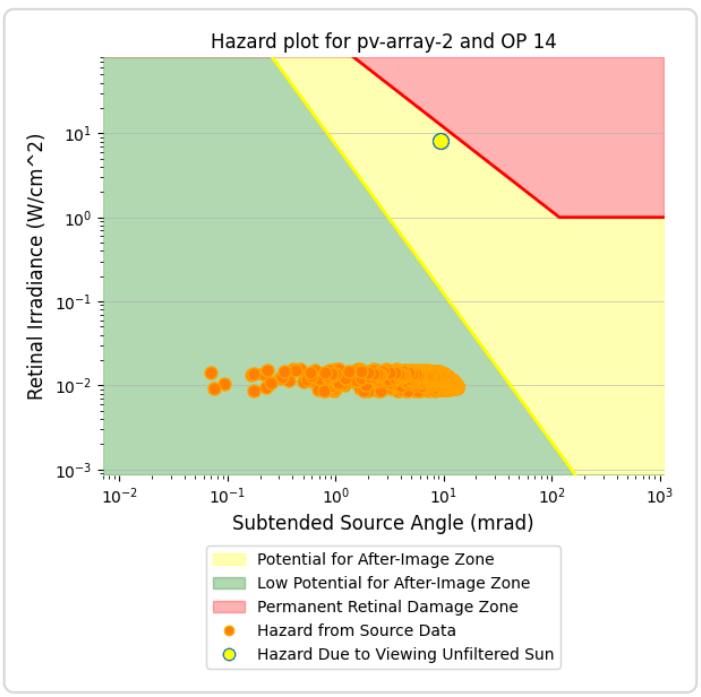
PV array 2 and OP 14

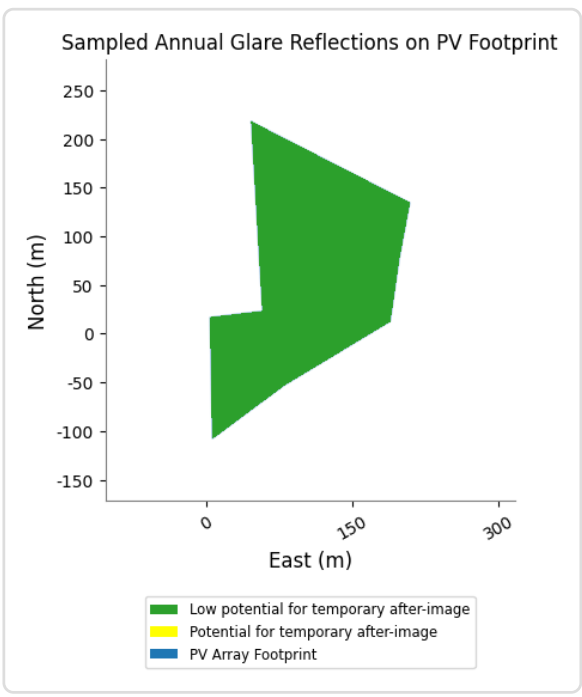
Yellow glare: none

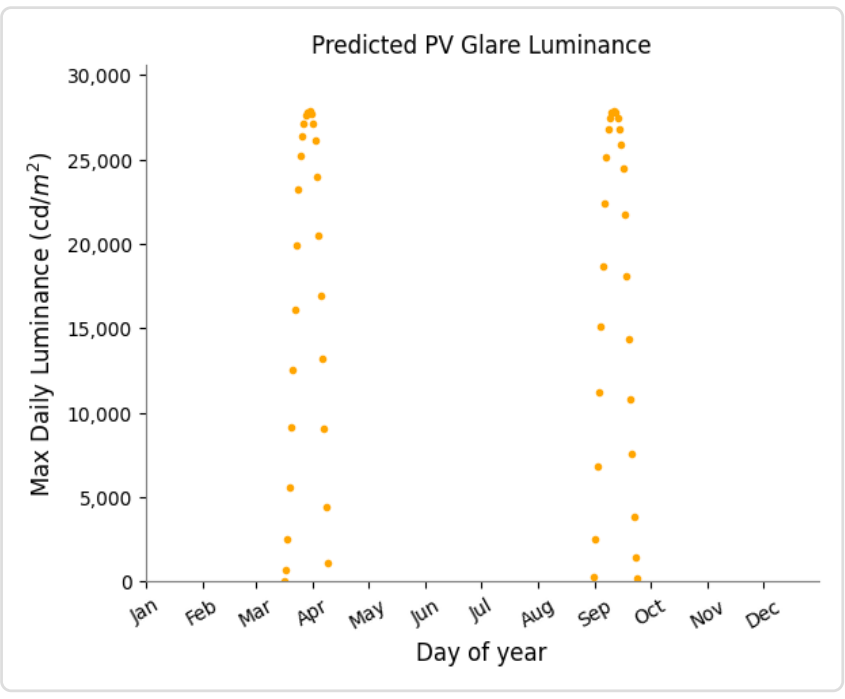
Green glare: 1,004 min.







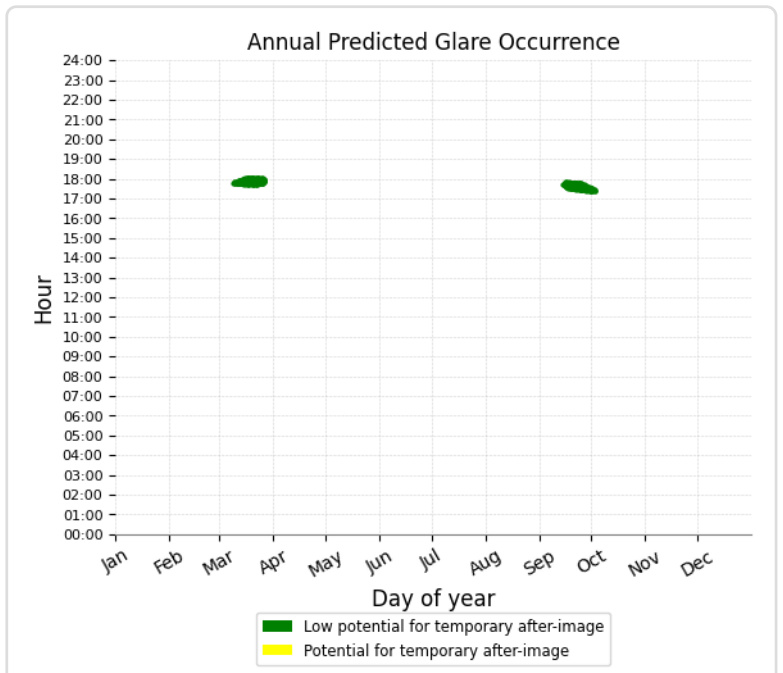


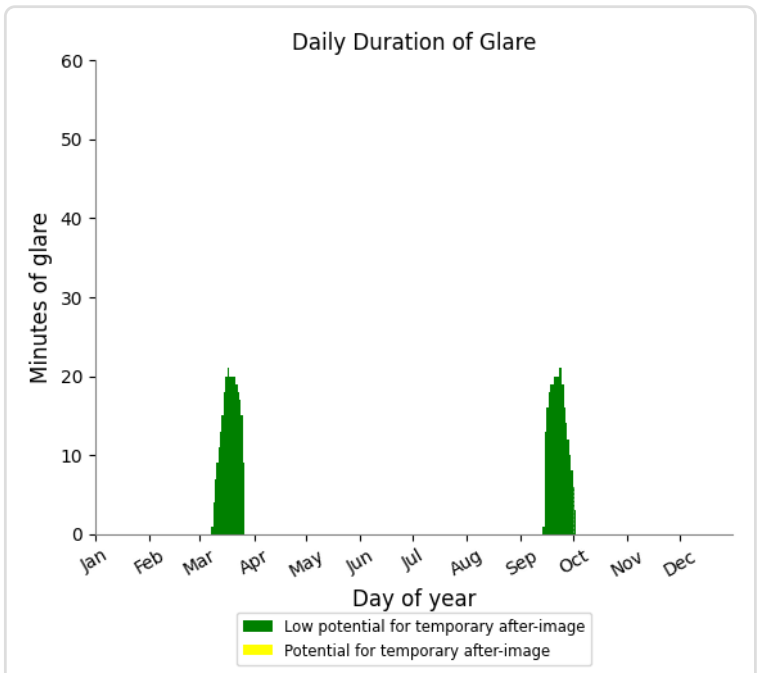


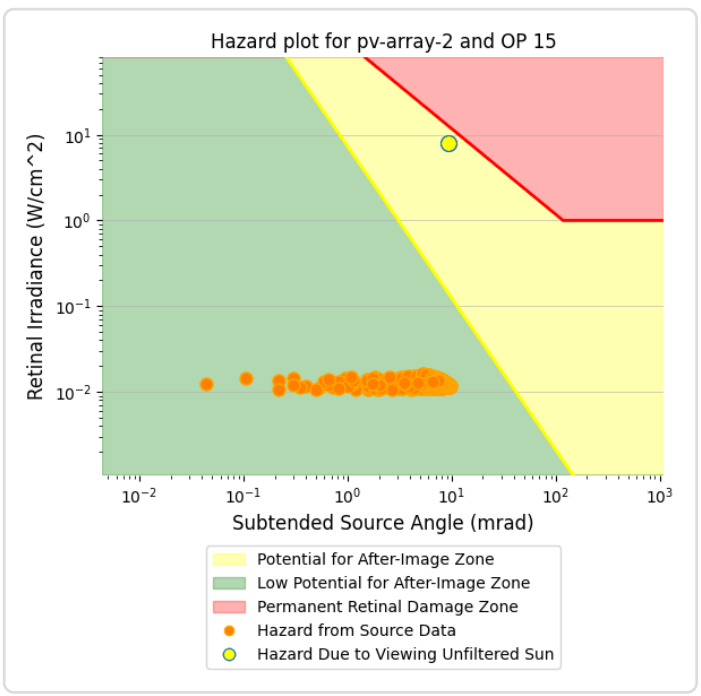
PV array 2 and OP 15

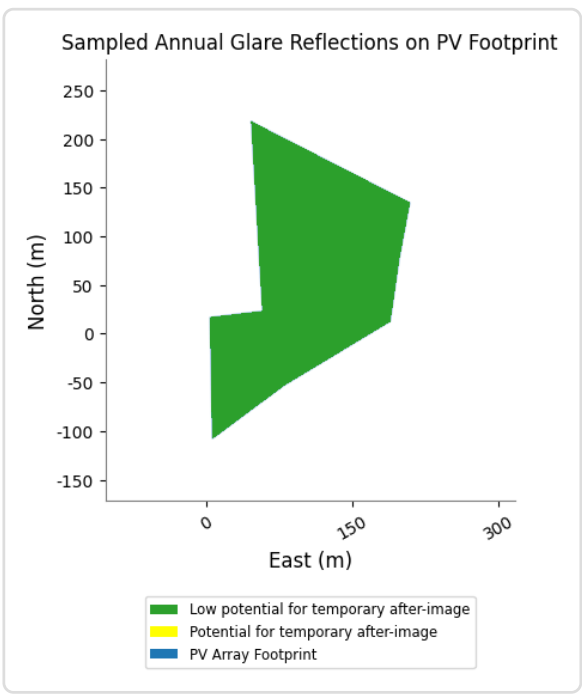
Yellow glare: none

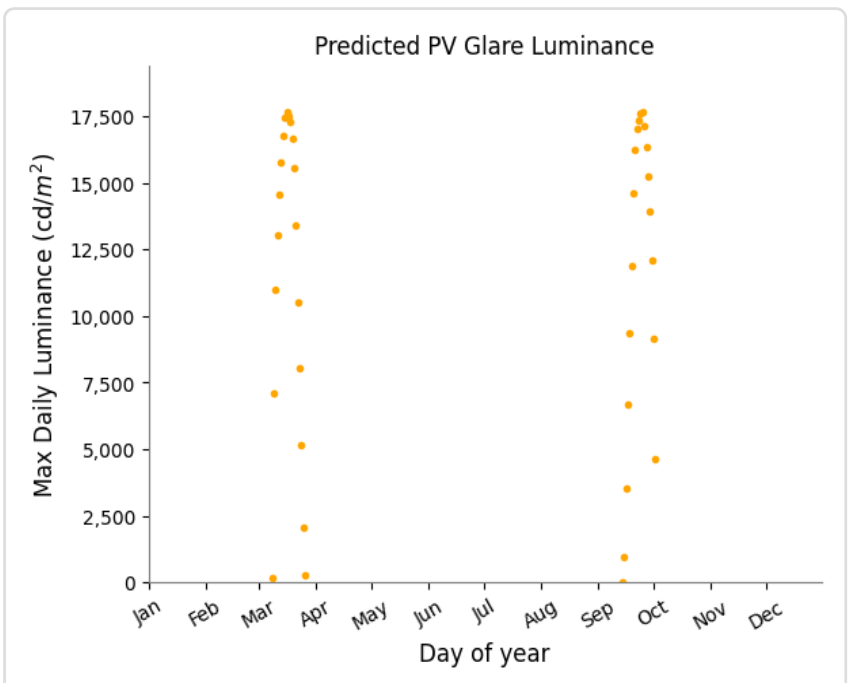
Green glare: 553 min.







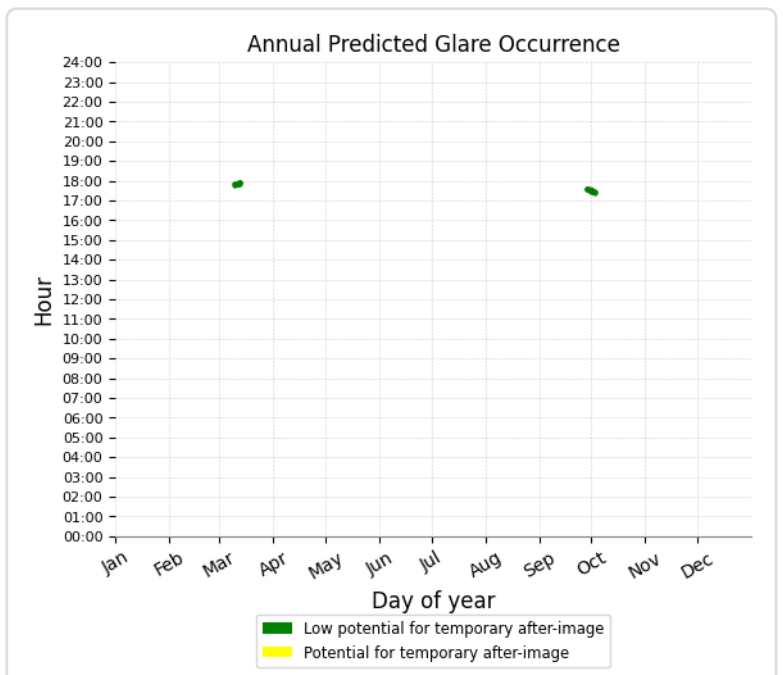


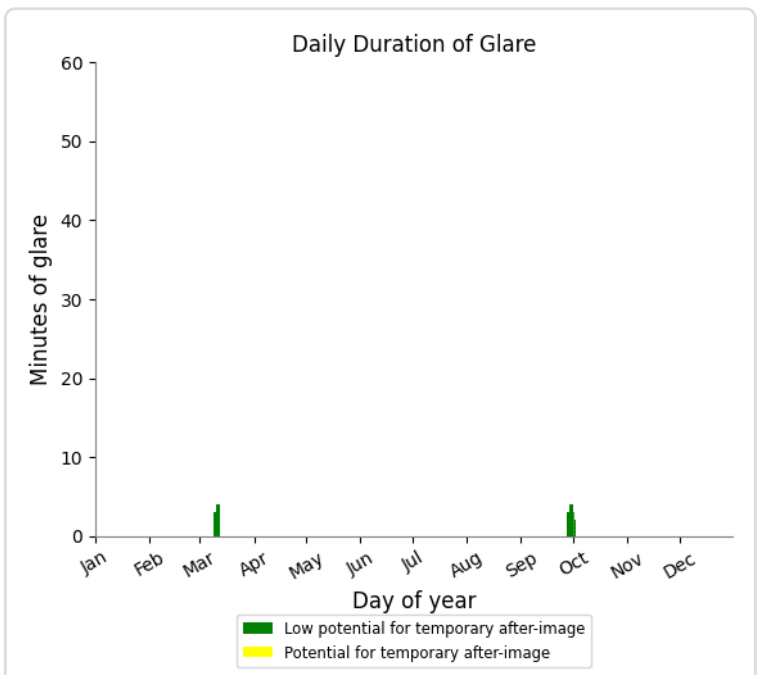


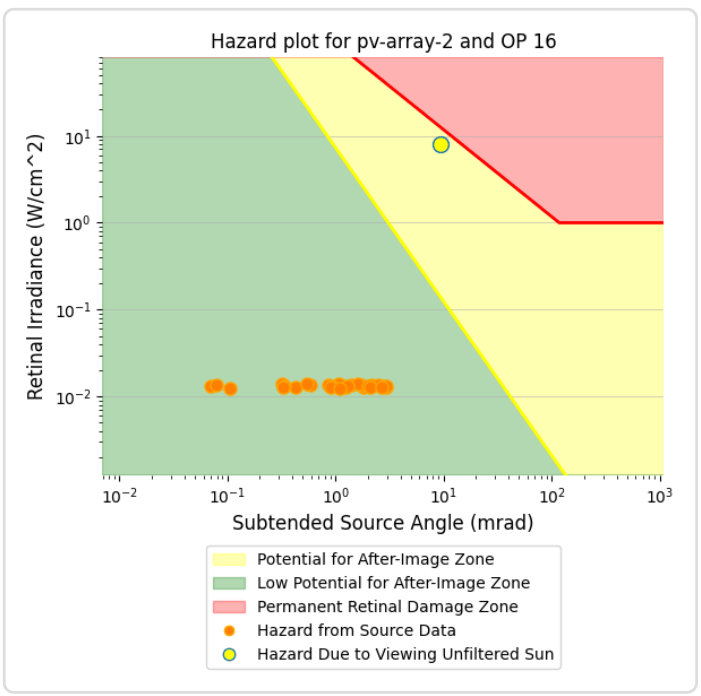
PV array 2 and OP 16

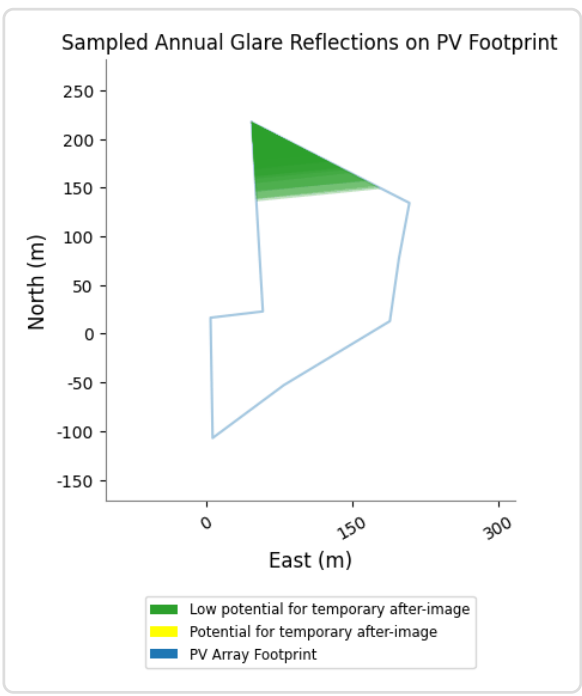
Yellow glare: none

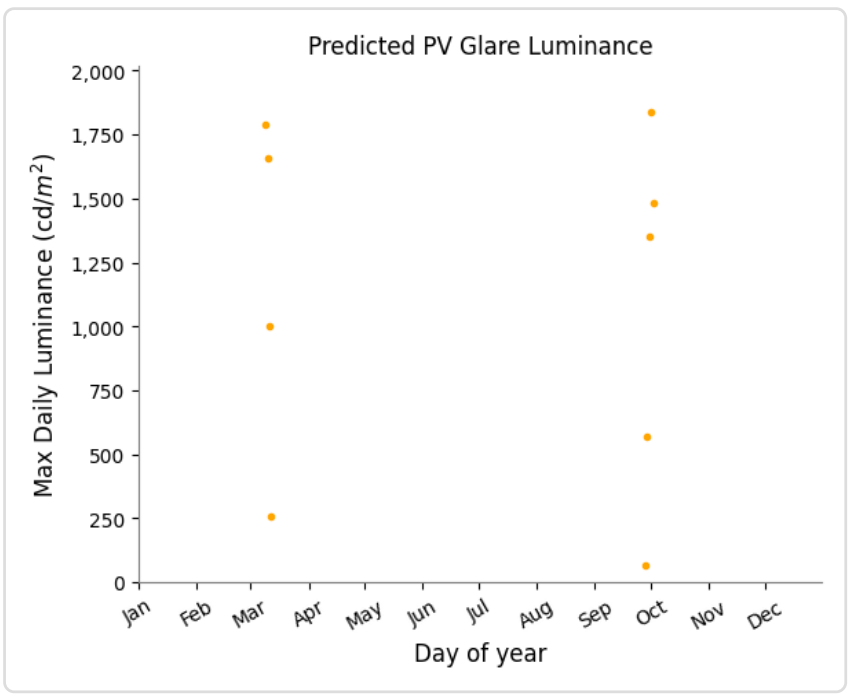
Green glare: 30 min.











PV array 2 and OP 1

No glare found

PV array 2 and OP 8

No glare found

PV array 2 and OP 9

No glare found

PV array 2 and OP 10

No glare found

PV array 2 and OP 11

No glare found

PV array 2 and OP 12

No glare found

PV array 2 and OP 13

No glare found

PV array 2 and OP 17

No glare found

PV array 2 and OP 18

No glare found

PV array 2 and OP 19

No glare found

PV array 2 and OP 20

No glare found

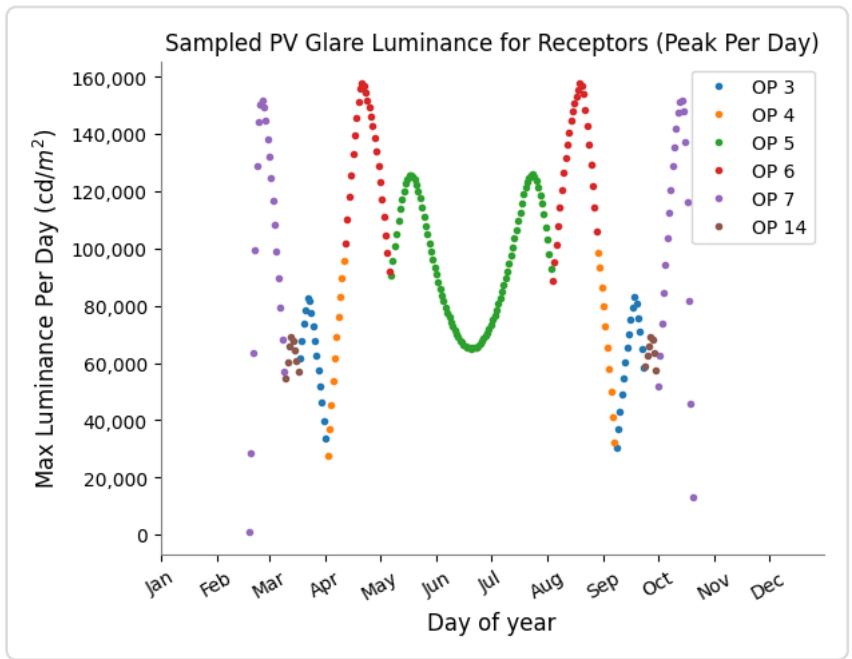
PV array 2 and OP 21

No glare found

PV: PV array 3 low potential for temporary after-image

Receptor results ordered by category of glare

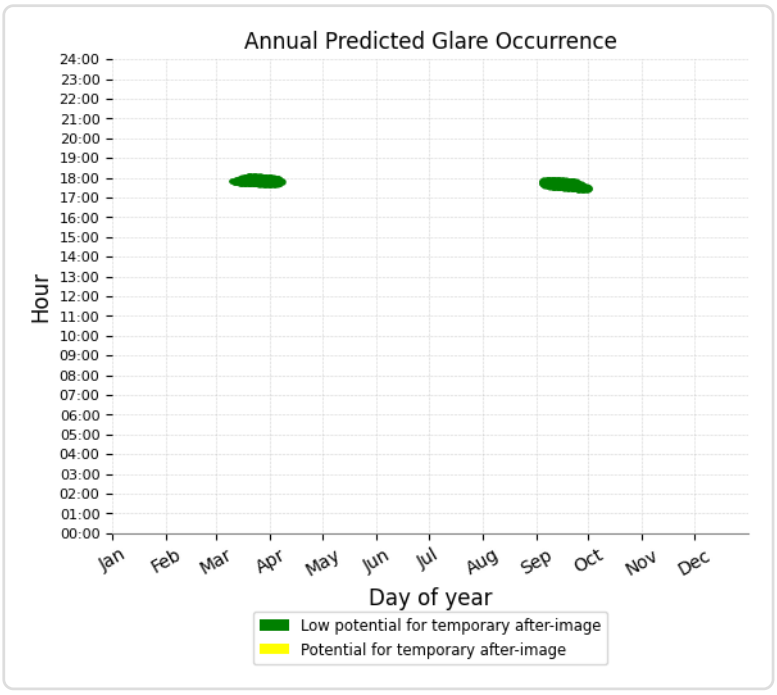
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	1,213	20.2	0	0.0	83,358
OP 4	1,742	29.0	0	0.0	110,535
OP 5	3,119	52.0	0	0.0	125,835
OP 6	2,768	46.1	0	0.0	157,625
OP 7	918	15.3	0	0.0	151,662
OP 14	768	12.8	0	0.0	68,998
OP 15	144	2.4	0	0.0	20,152
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

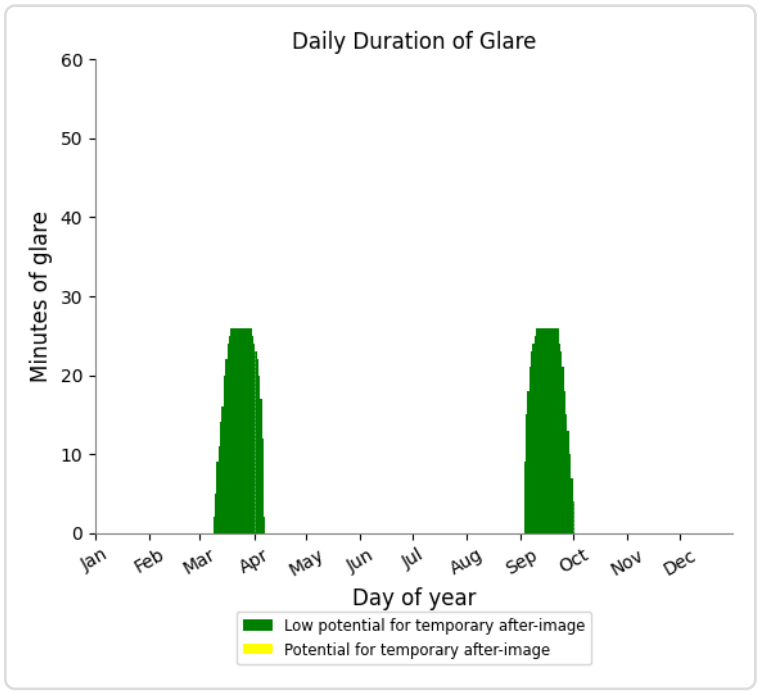


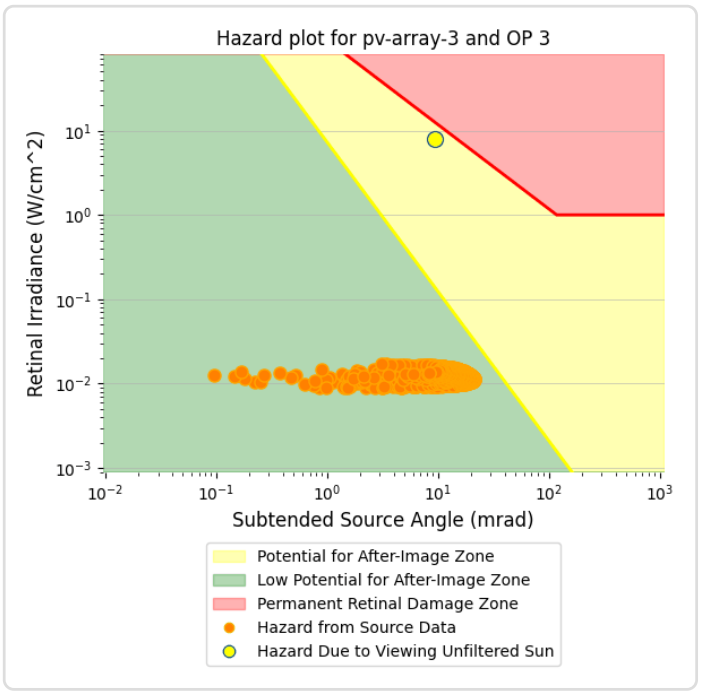
PV array 3 and OP 3

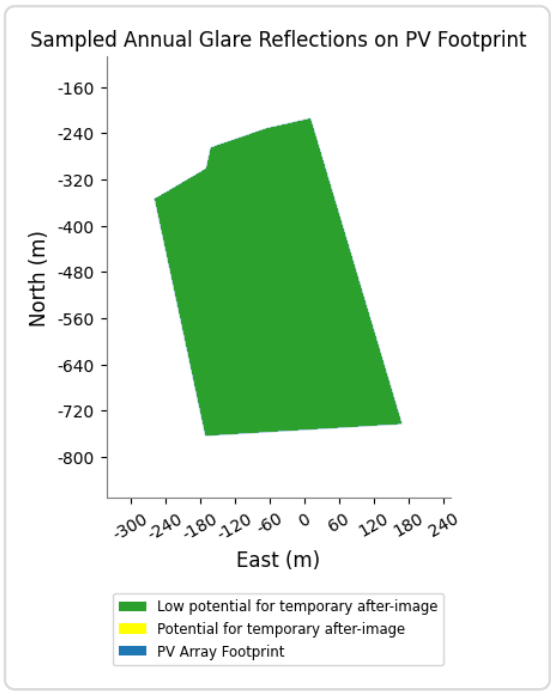
Yellow glare: none

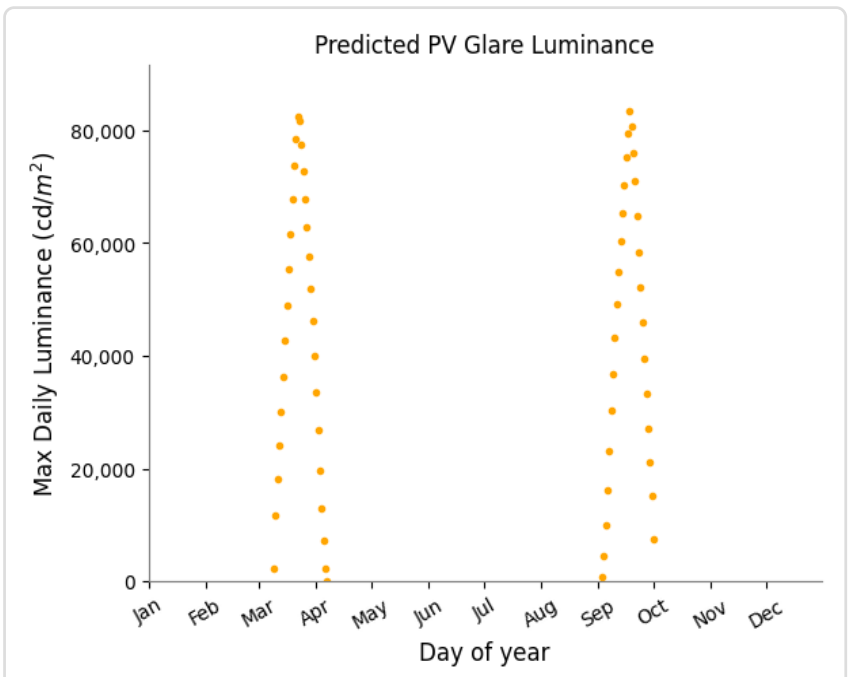
Green glare: 1,213 min.







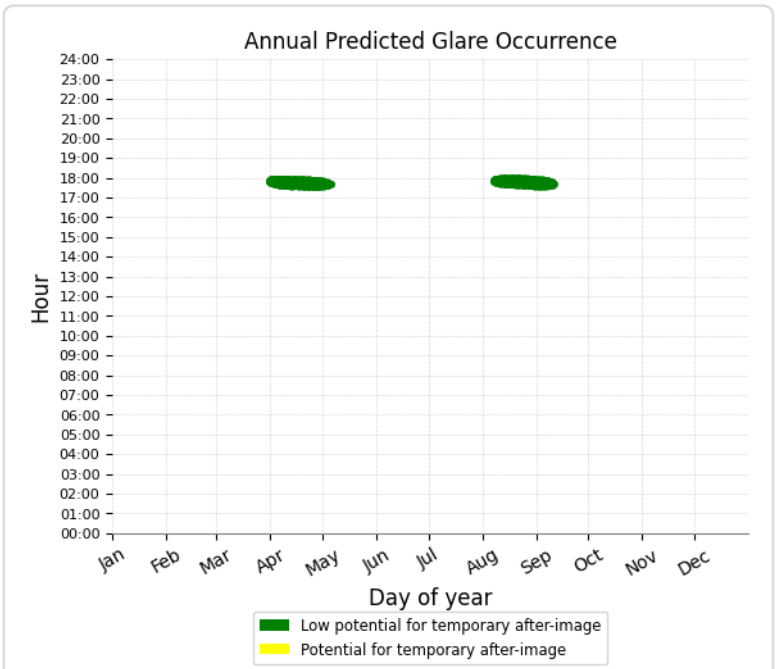


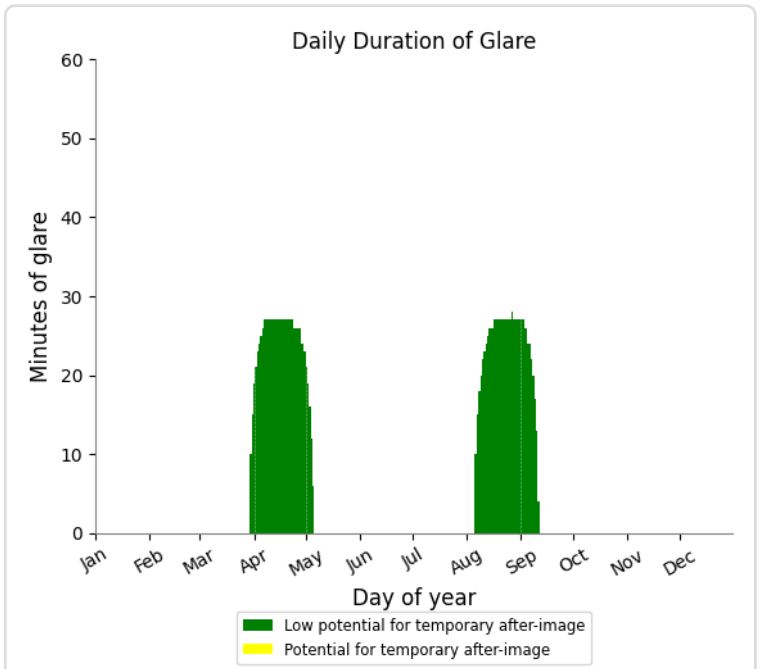


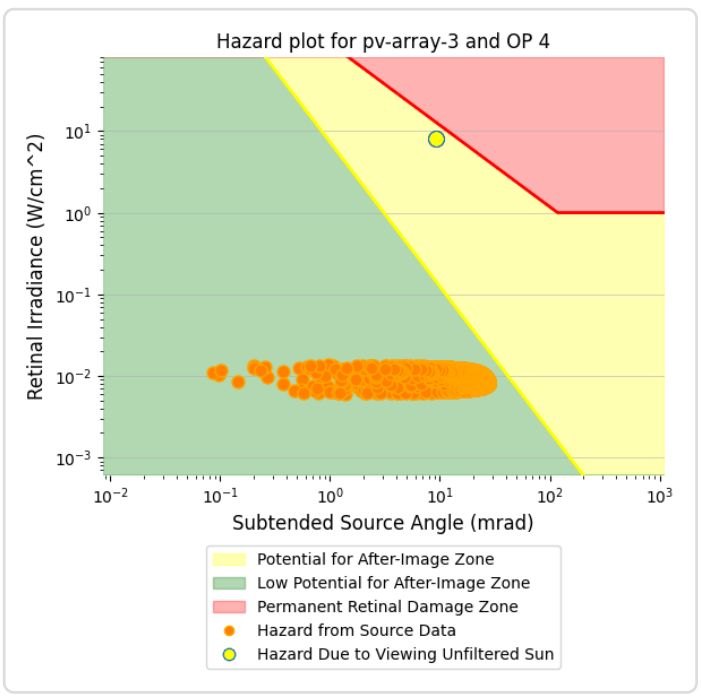
PV array 3 and OP 4

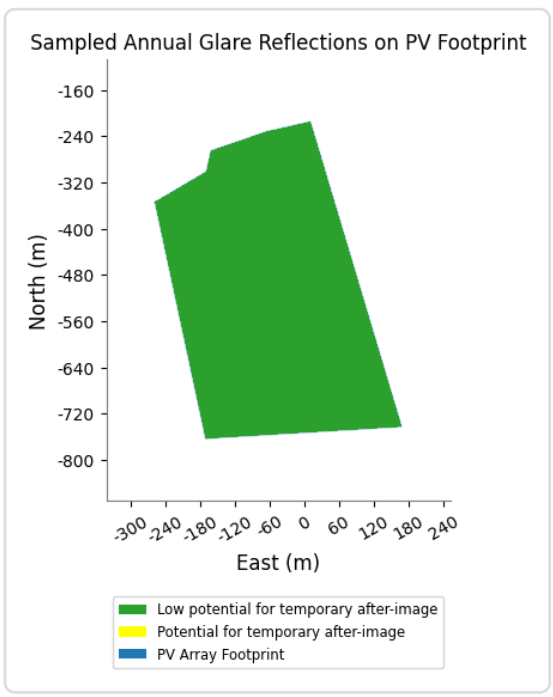
Yellow glare: none

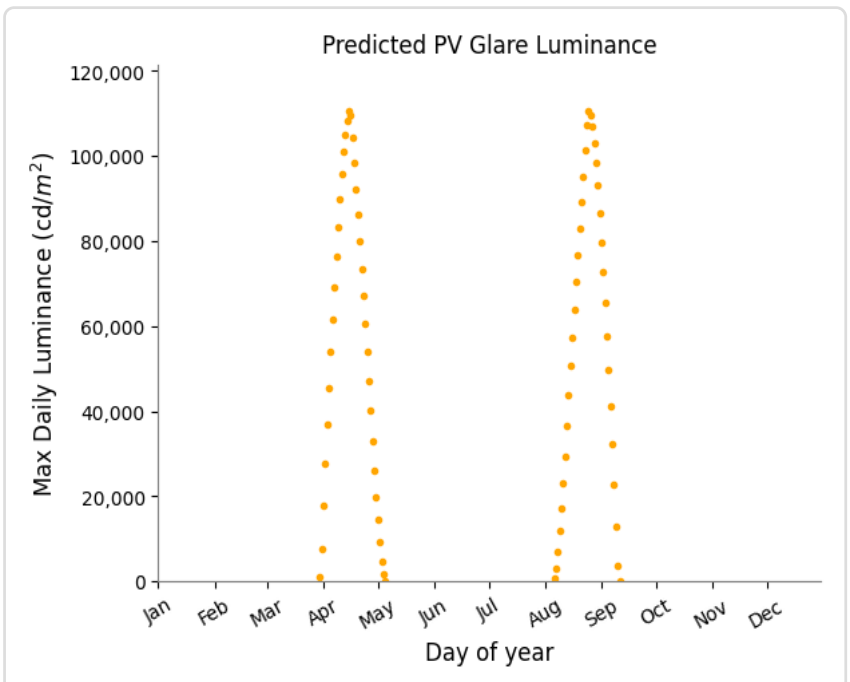
Green glare: 1,742 min.







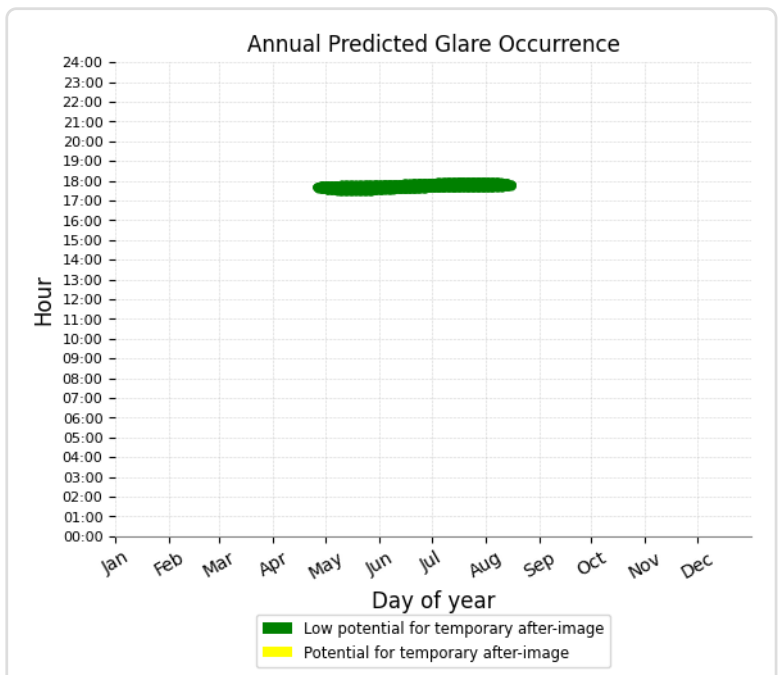


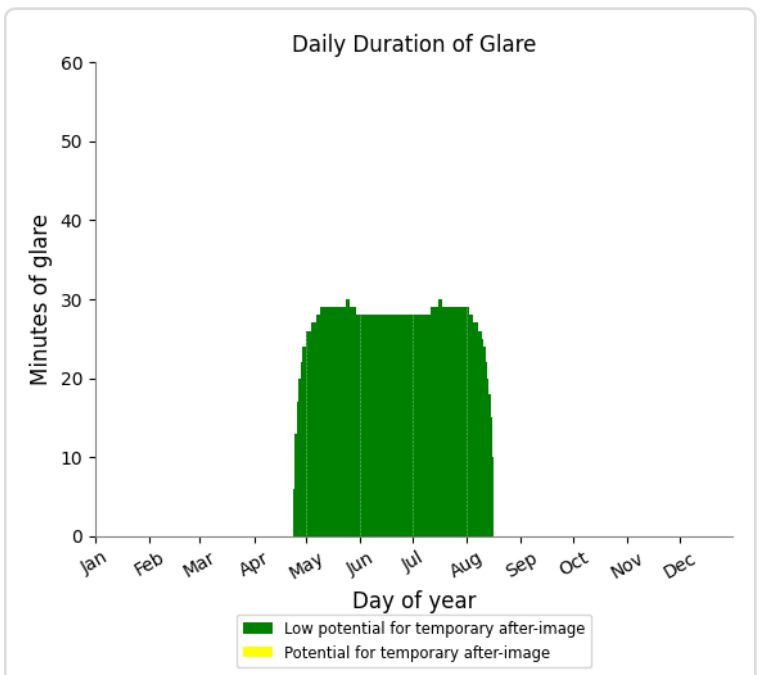


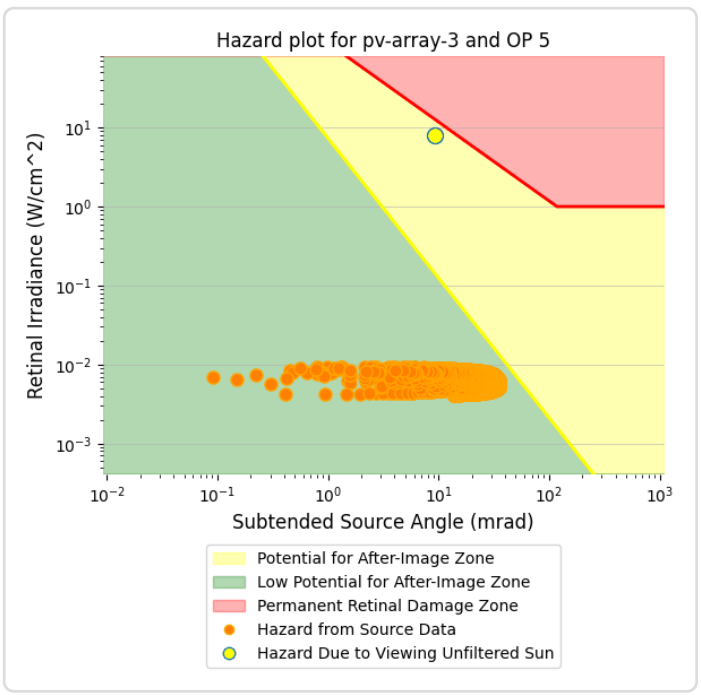
PV array 3 and OP 5

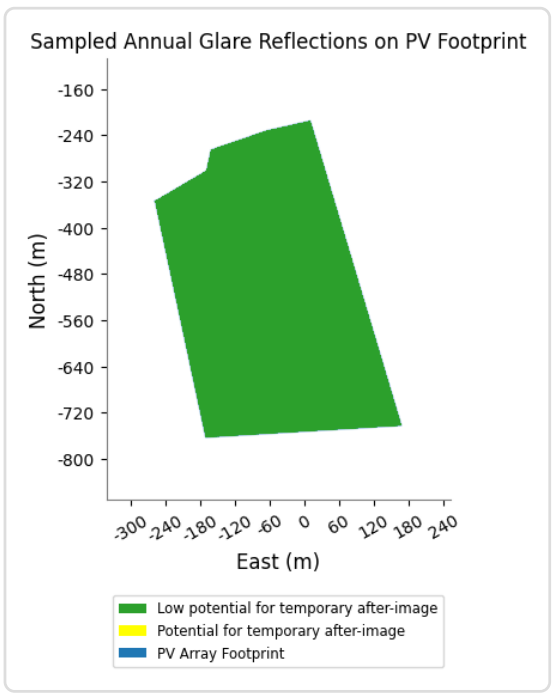
Yellow glare: none

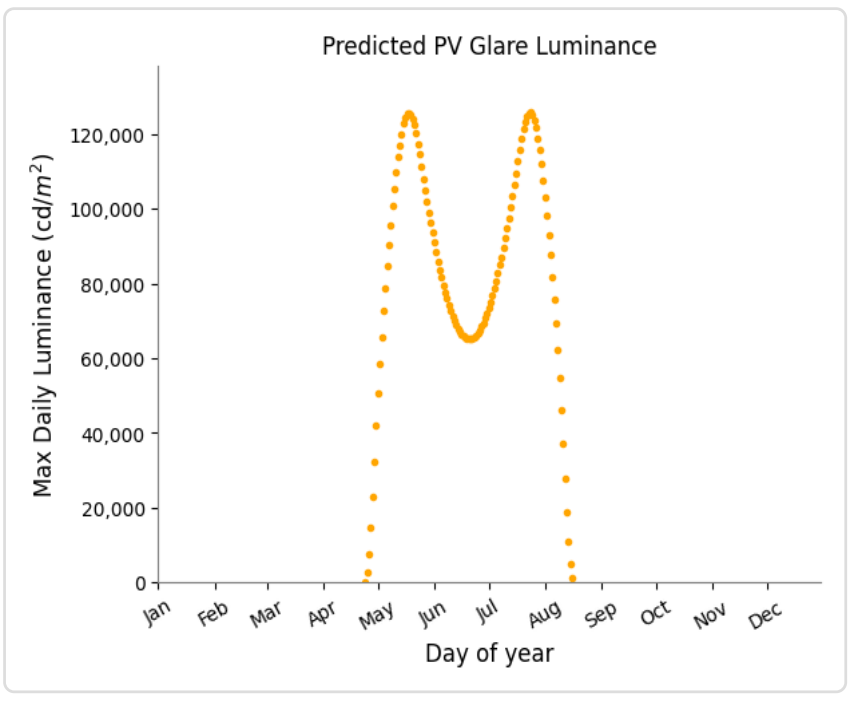
Green glare: 3,119 min.







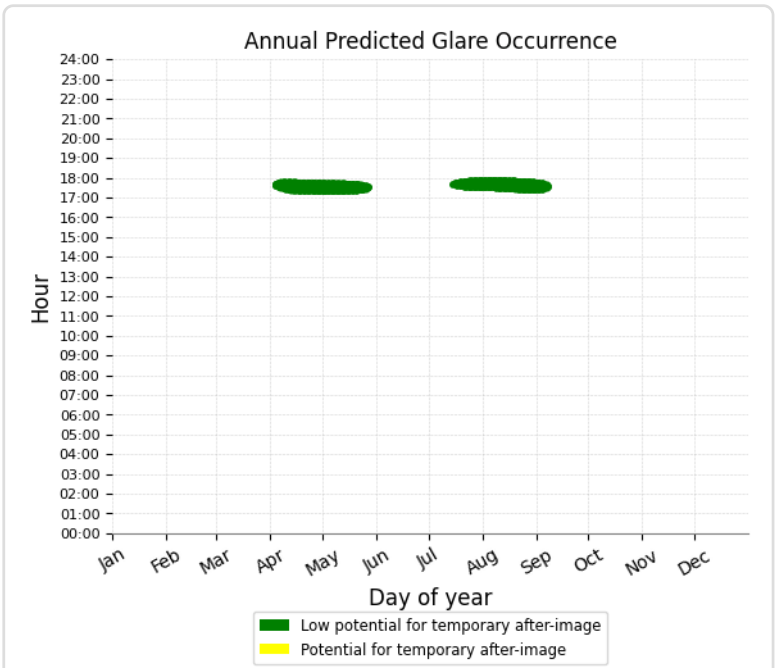


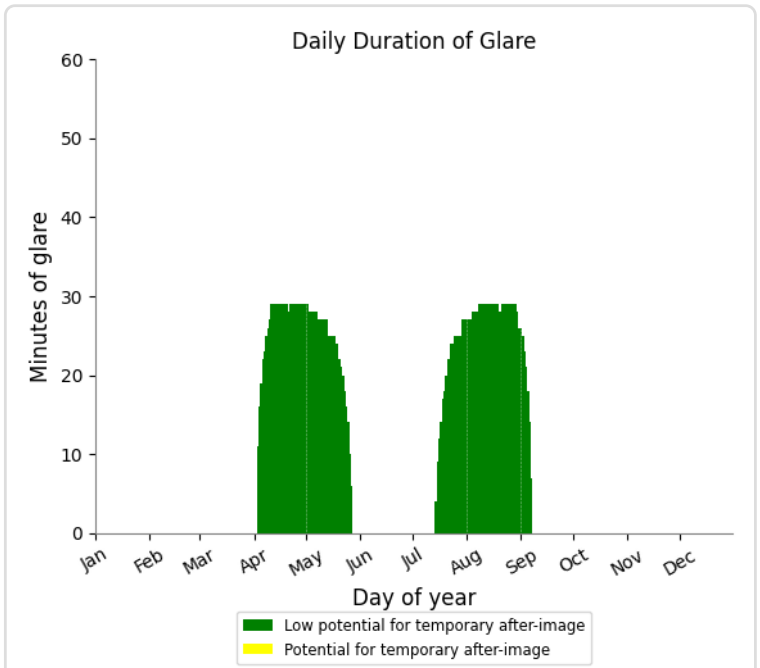


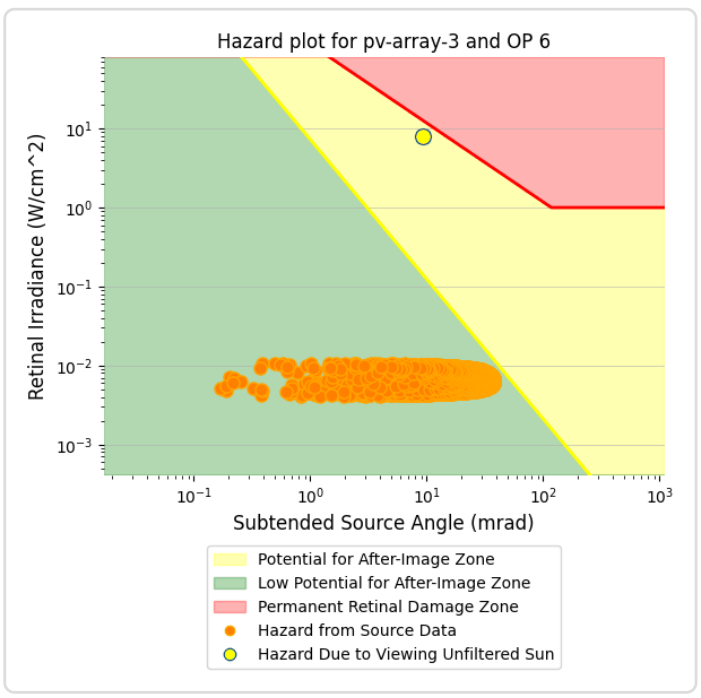
PV array 3 and OP 6

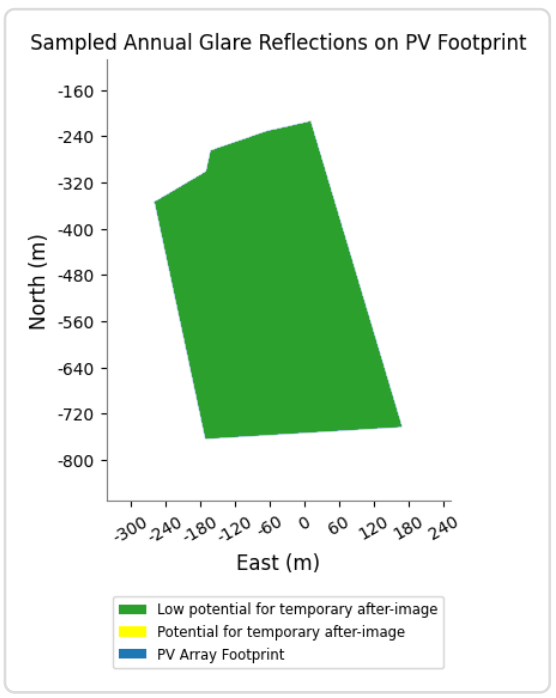
Yellow glare: none

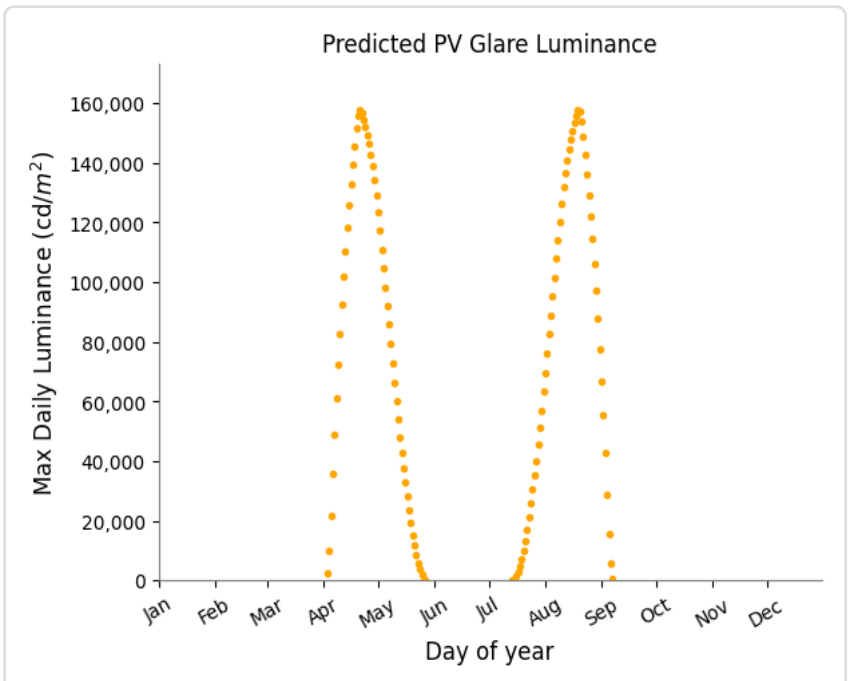
Green glare: 2,768 min.







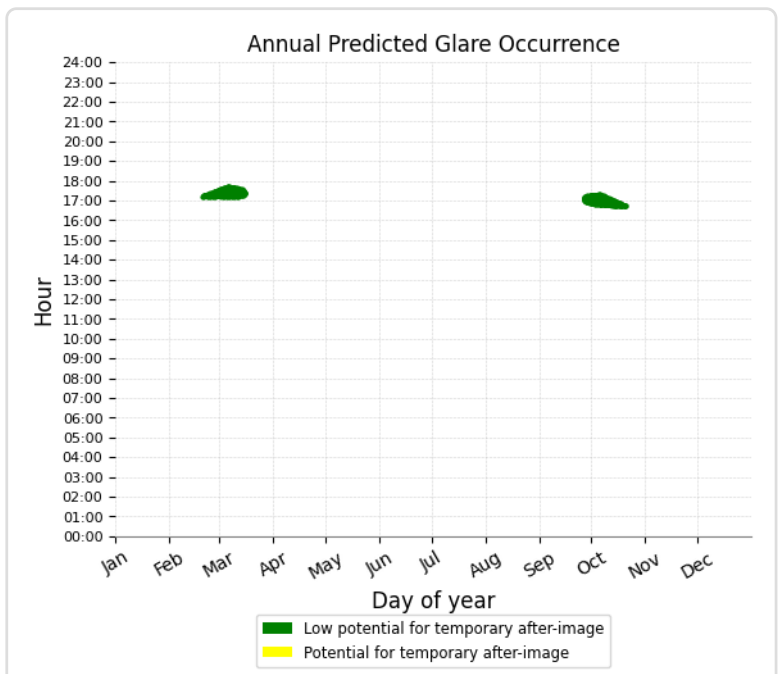


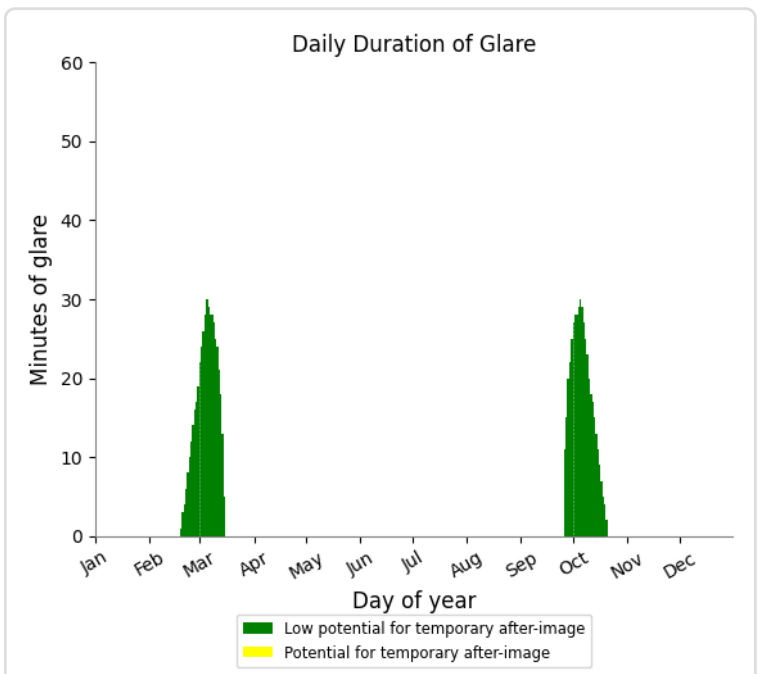


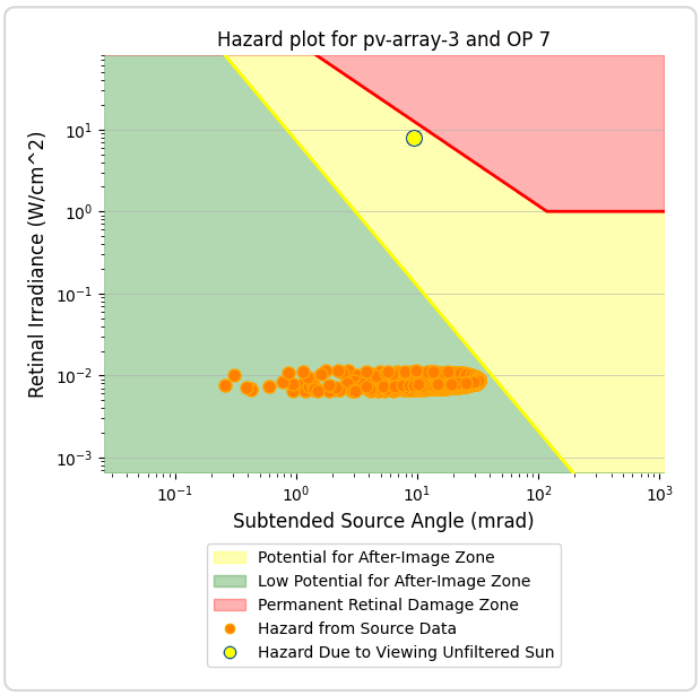
PV array 3 and OP 7

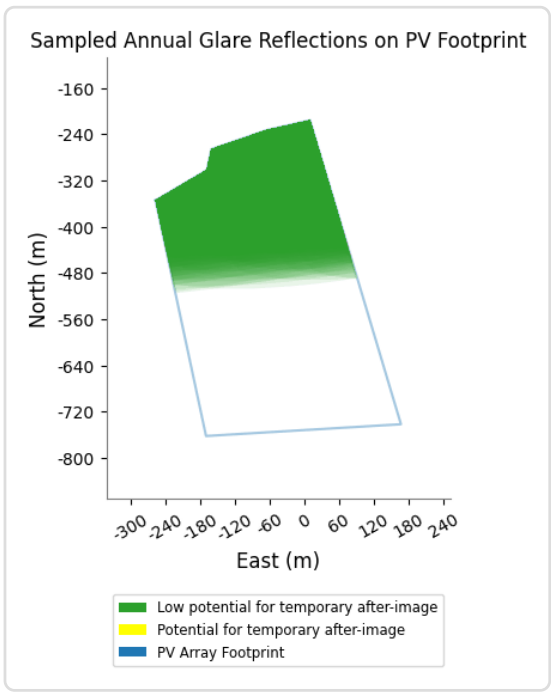
Yellow glare: none

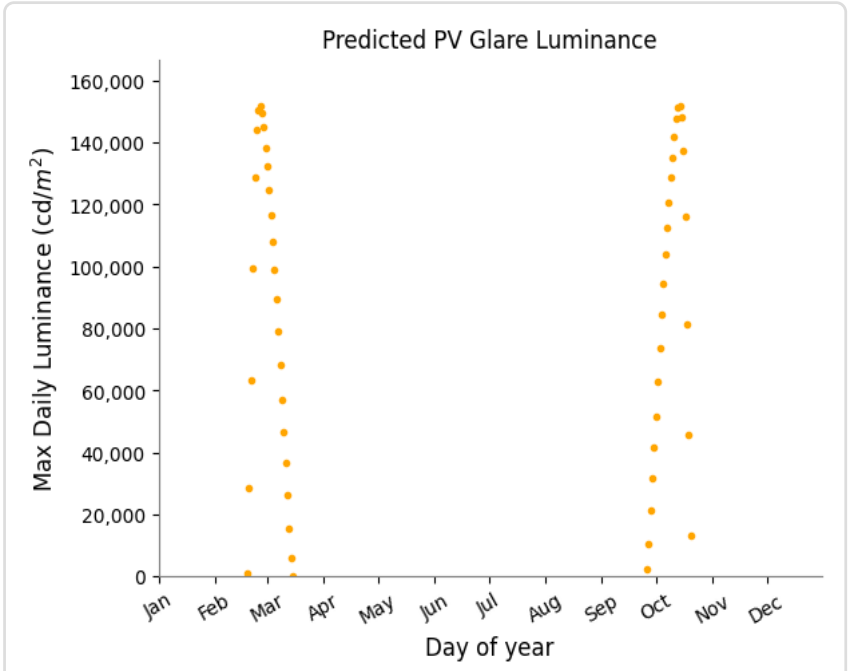
Green glare: 918 min.







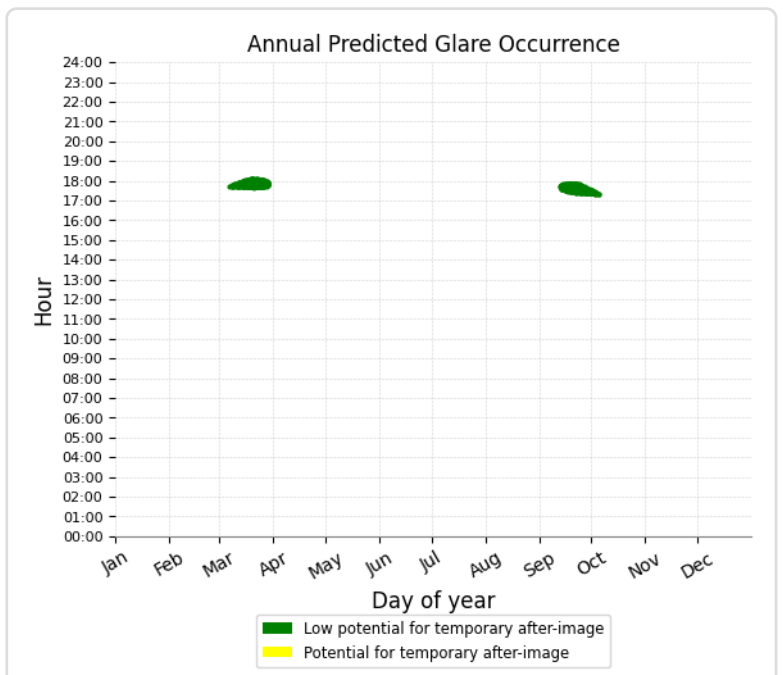


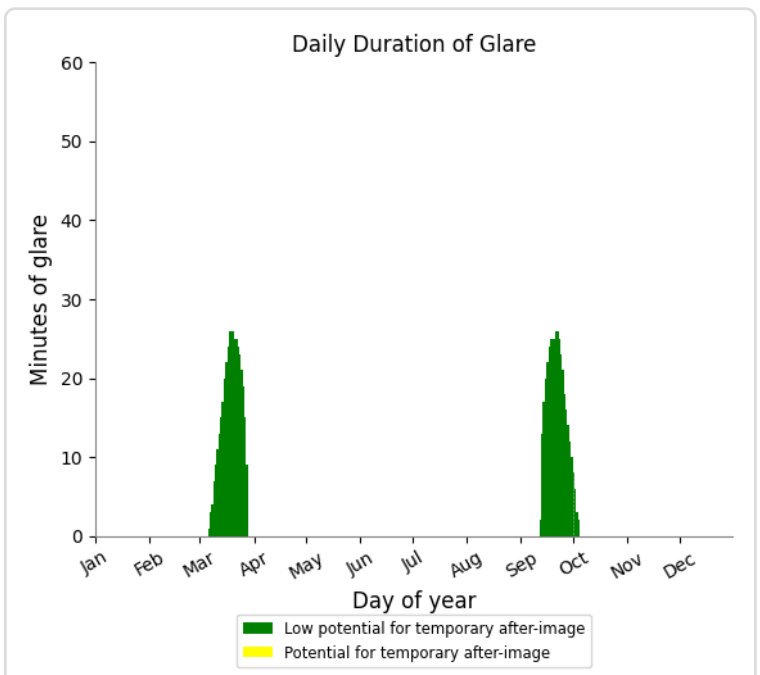


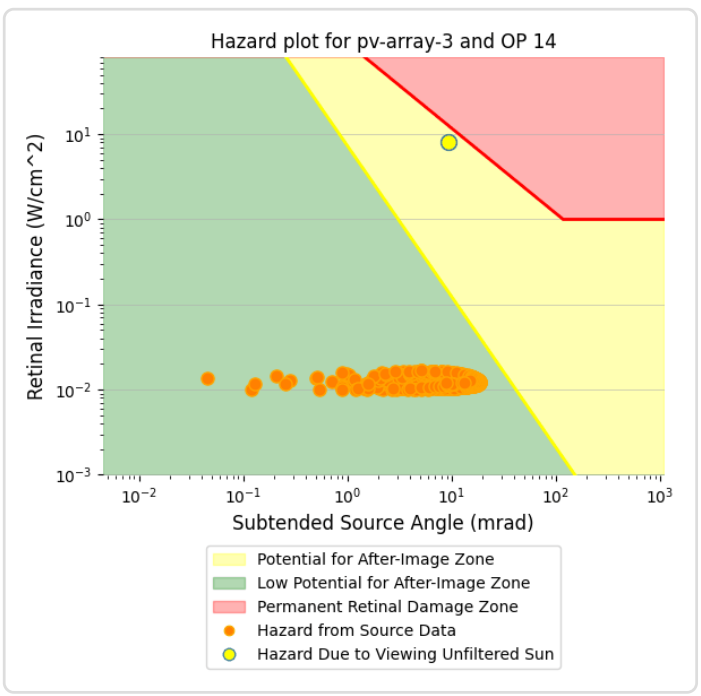
PV array 3 and OP 14

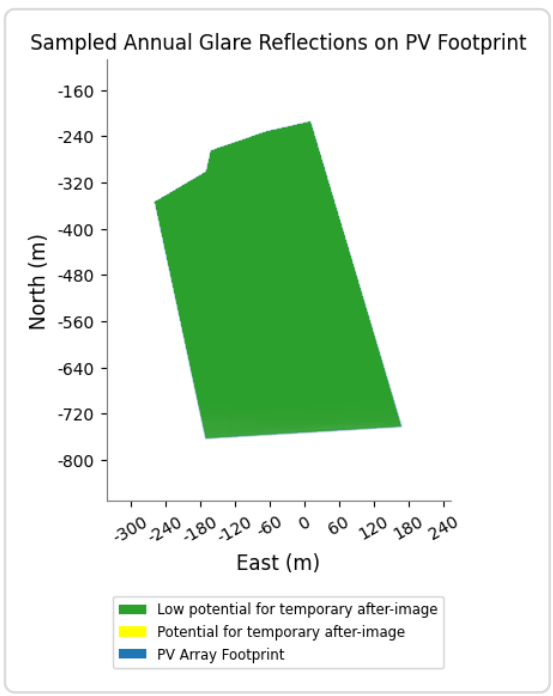
Yellow glare: none

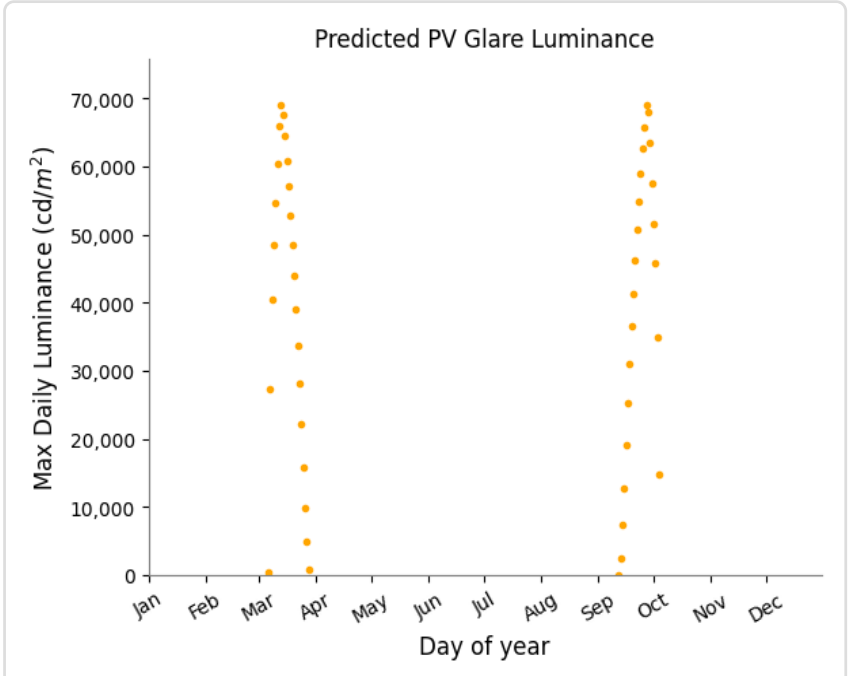
Green glare: 768 min.







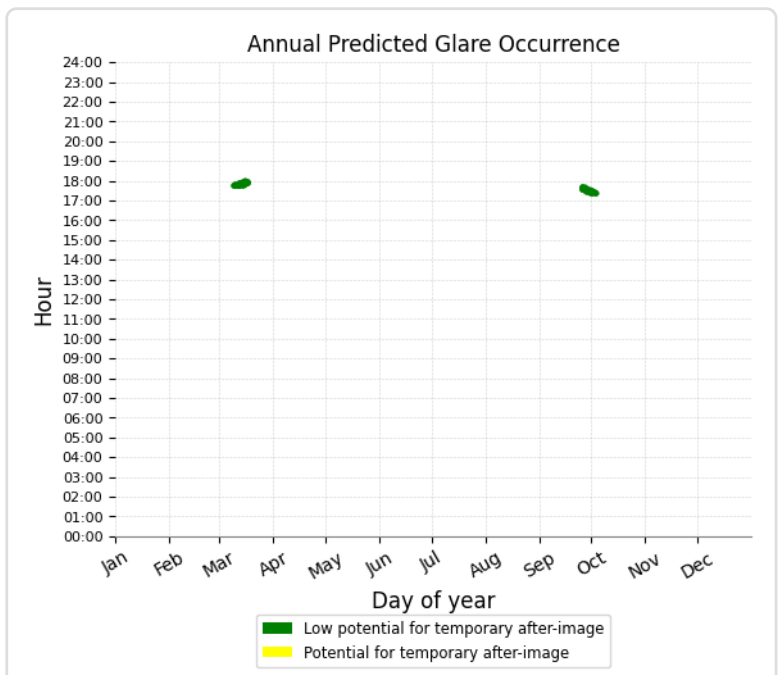


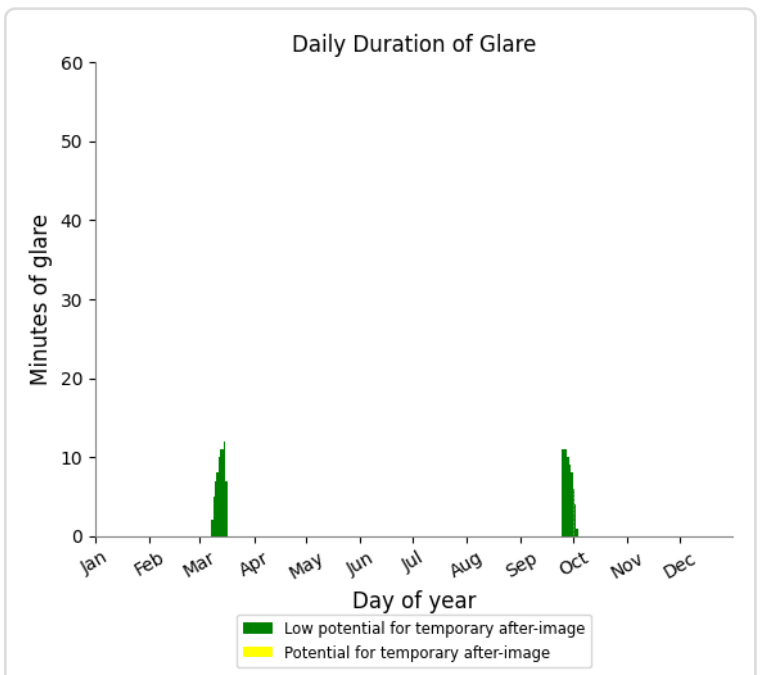


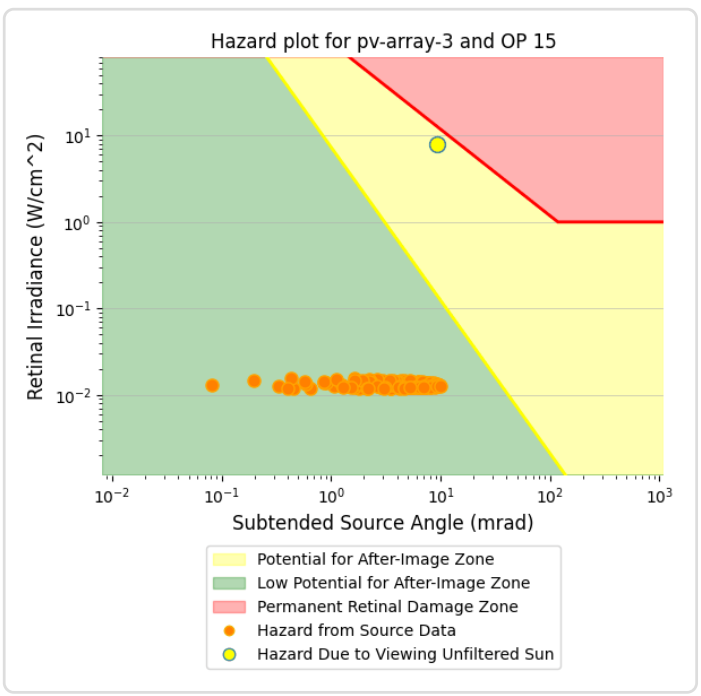
PV array 3 and OP 15

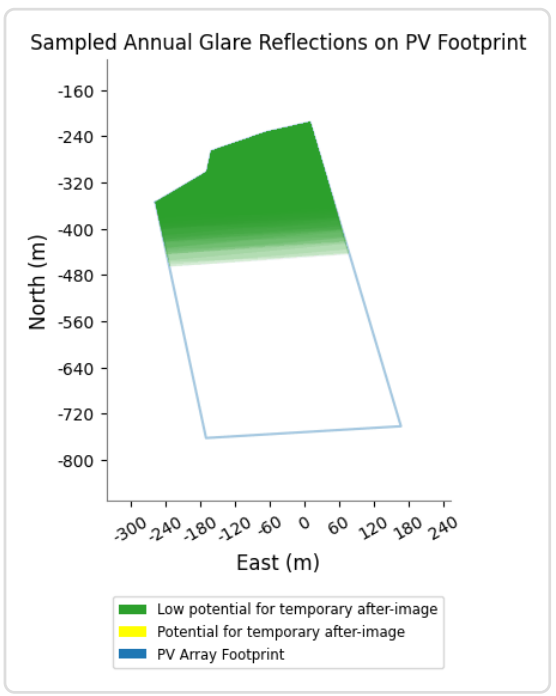
Yellow glare: none

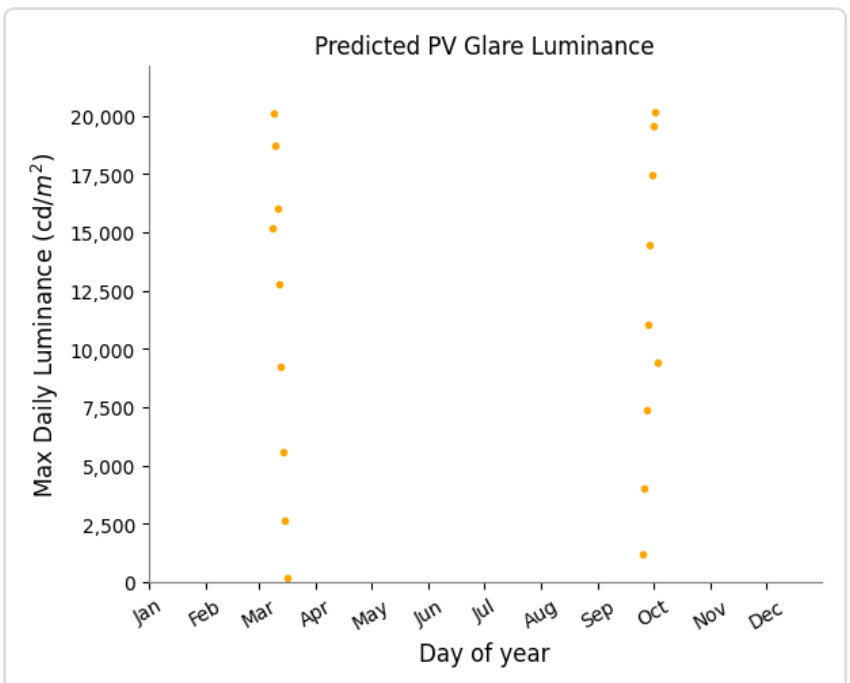
Green glare: 144 min.











PV array 3 and OP 1

No glare found

PV array 3 and OP 2

No glare found

PV array 3 and OP 8

No glare found

PV array 3 and OP 9

No glare found

PV array 3 and OP 10

No glare found

PV array 3 and OP 11

No glare found

PV array 3 and OP 12

No glare found

PV array 3 and OP 13

No glare found

PV array 3 and OP 16

No glare found

PV array 3 and OP 17

No glare found

PV array 3 and OP 18

No glare found

PV array 3 and OP 19

No glare found

PV array 3 and OP 20

No glare found

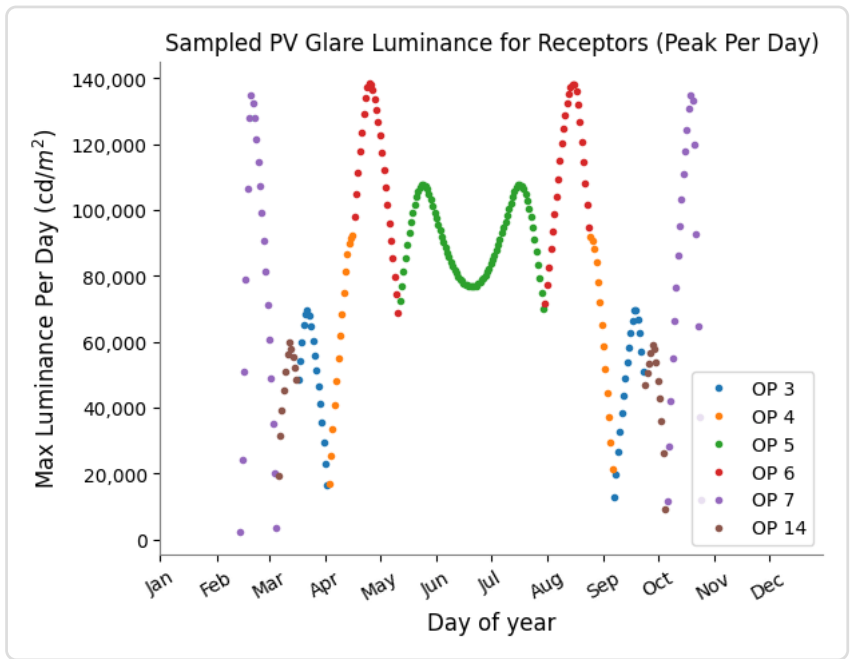
PV array 3 and OP 21

No glare found

PV: PV array 4 low potential for temporary after-image

Receptor results ordered by category of glare

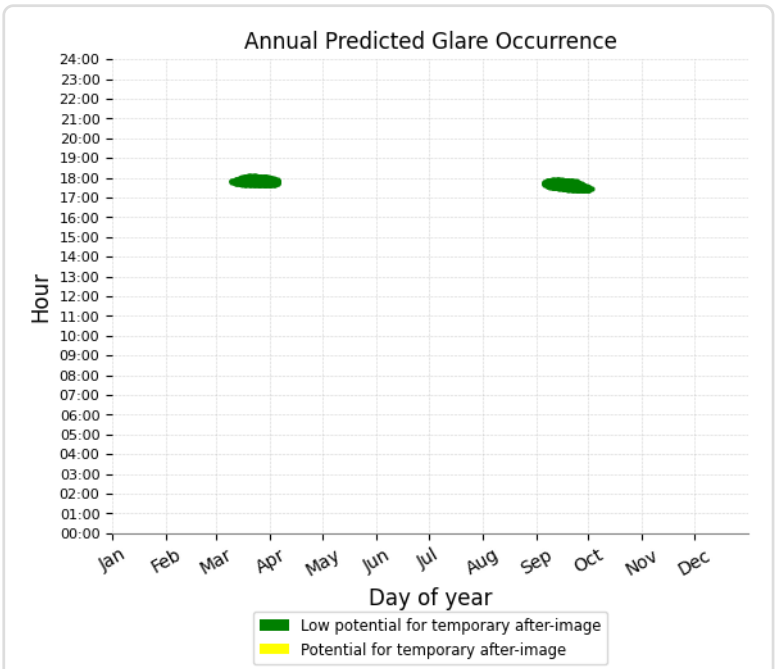
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	1,152	19.2	0	0.0	69,728
OP 4	1,613	26.9	0	0.0	92,219
OP 5	2,926	48.8	0	0.0	107,934
OP 6	2,702	45.0	0	0.0	138,428
OP 7	704	11.7	0	0.0	135,024
OP 14	685	11.4	0	0.0	59,827
OP 15	68	1.1	0	0.0	12,746
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

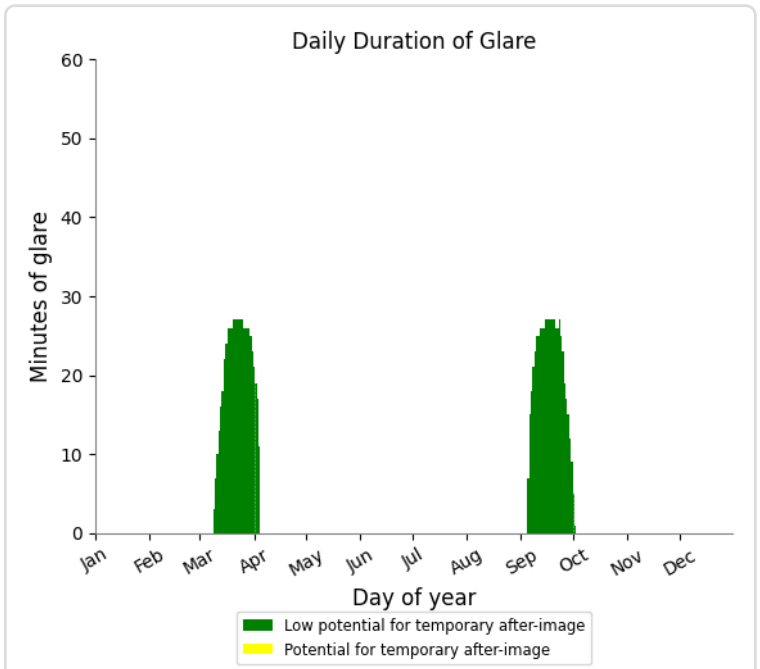


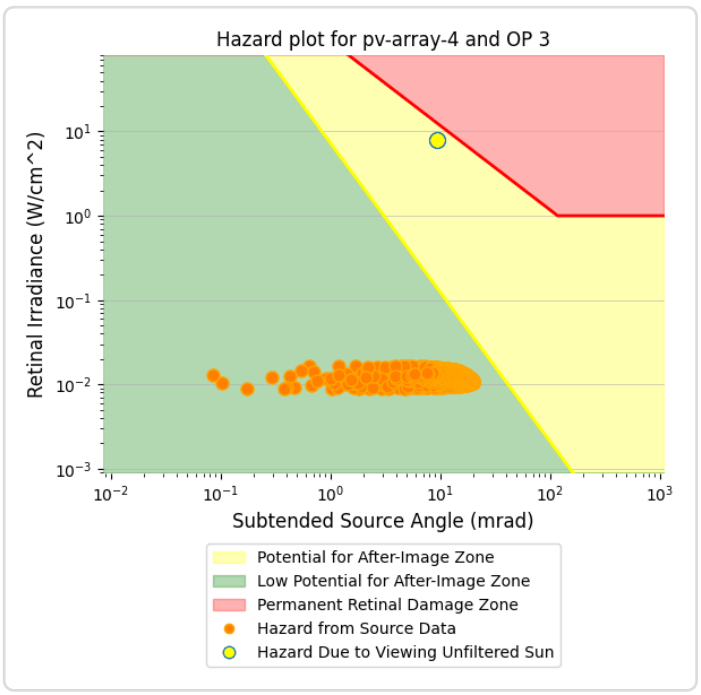
PV array 4 and OP 3

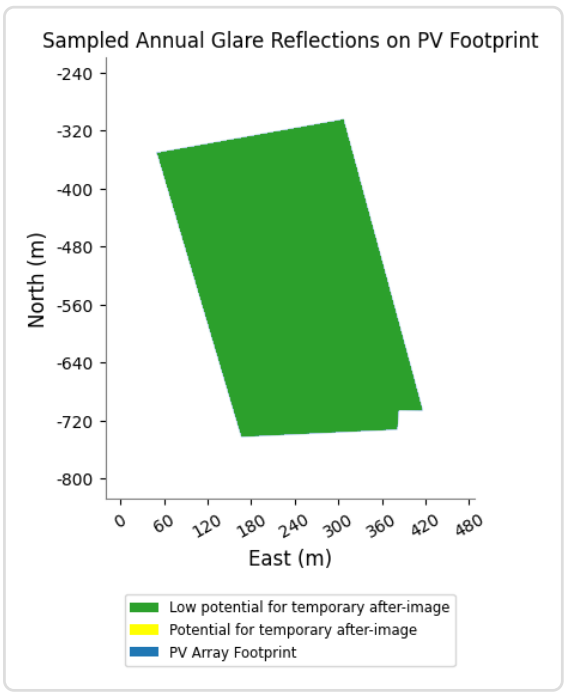
Yellow glare: none

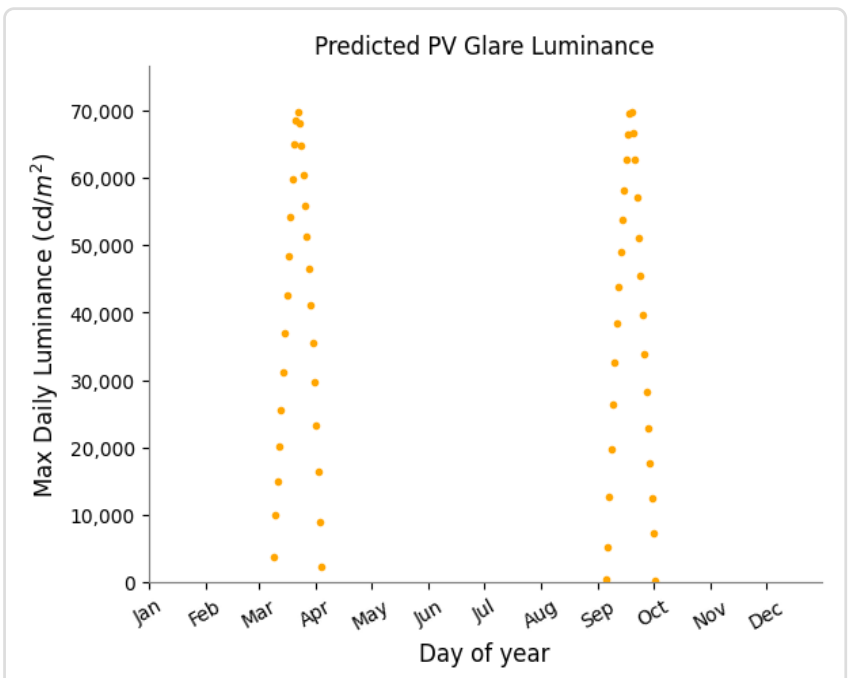
Green glare: 1,152 min.







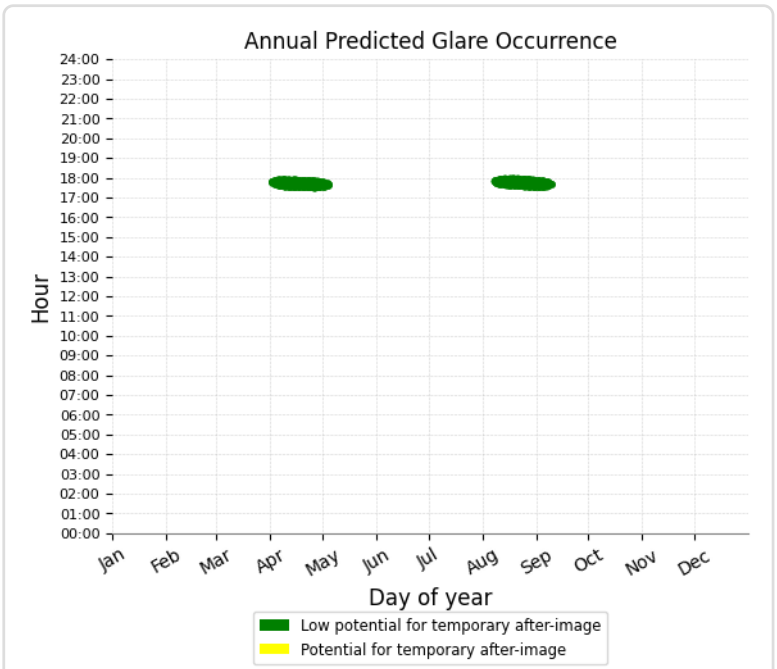


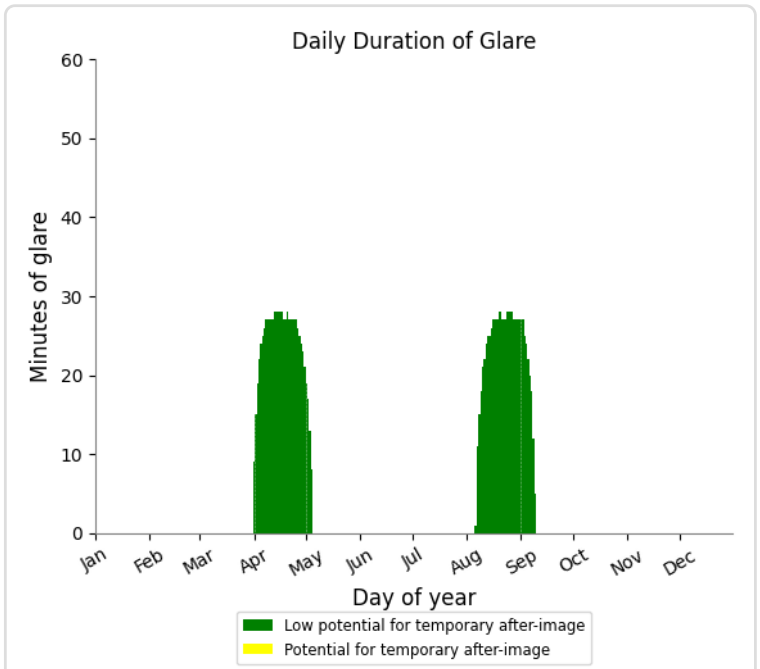


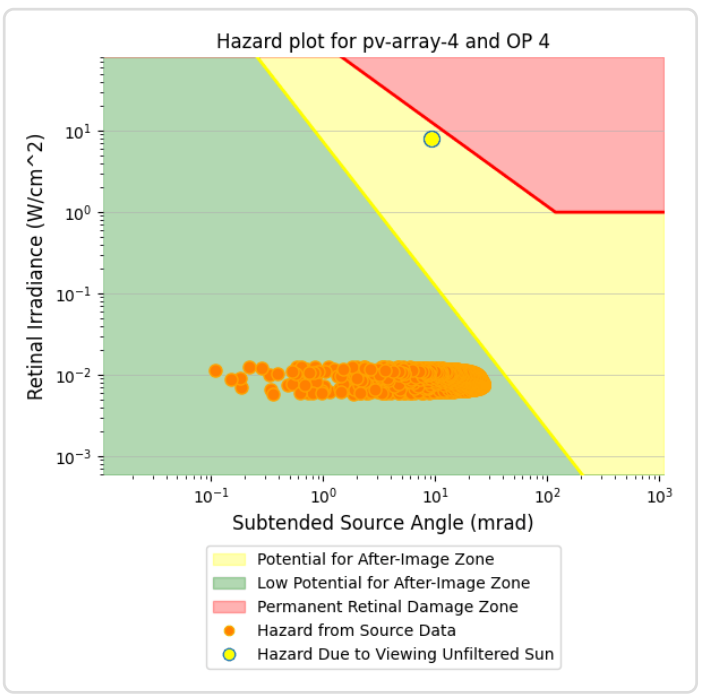
PV array 4 and OP 4

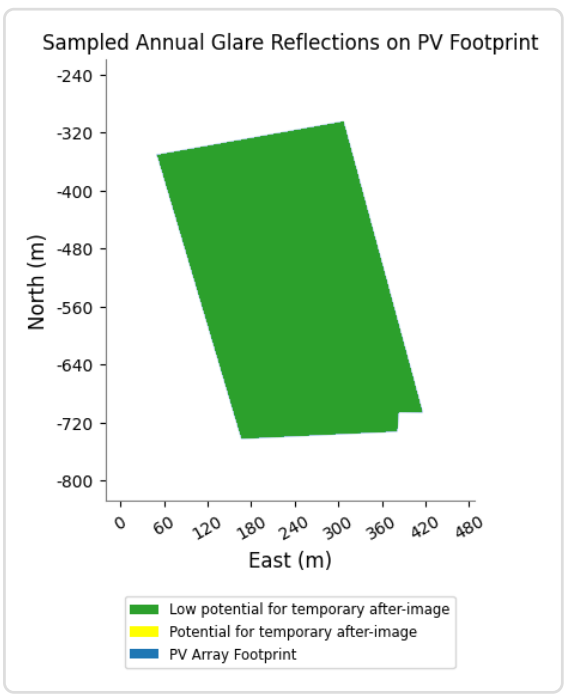
Yellow glare: none

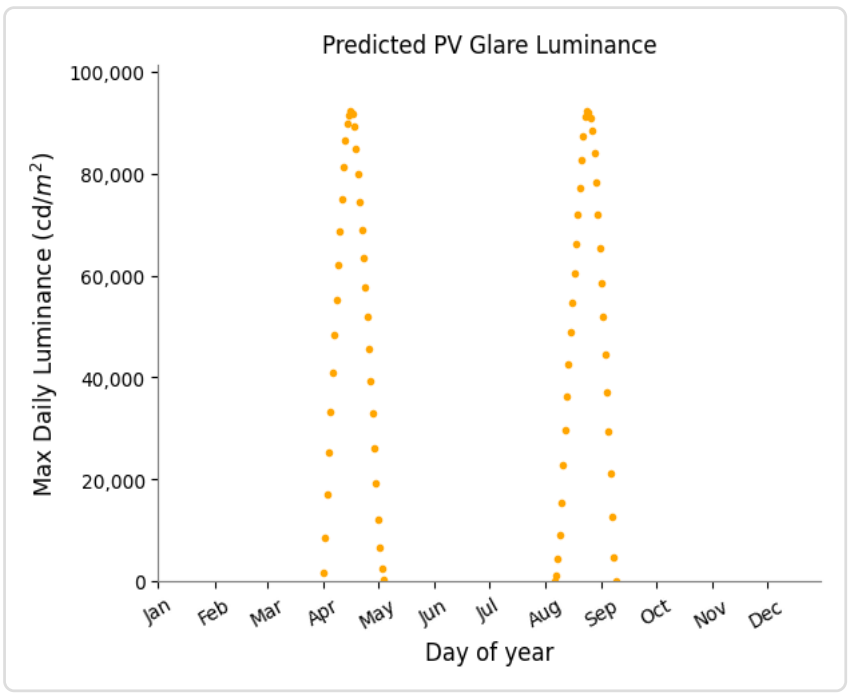
Green glare: 1,613 min.







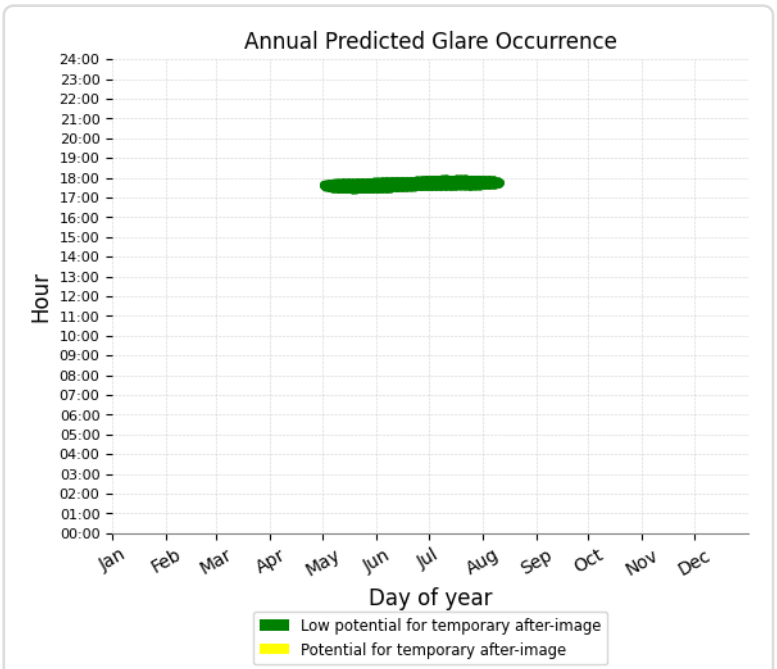


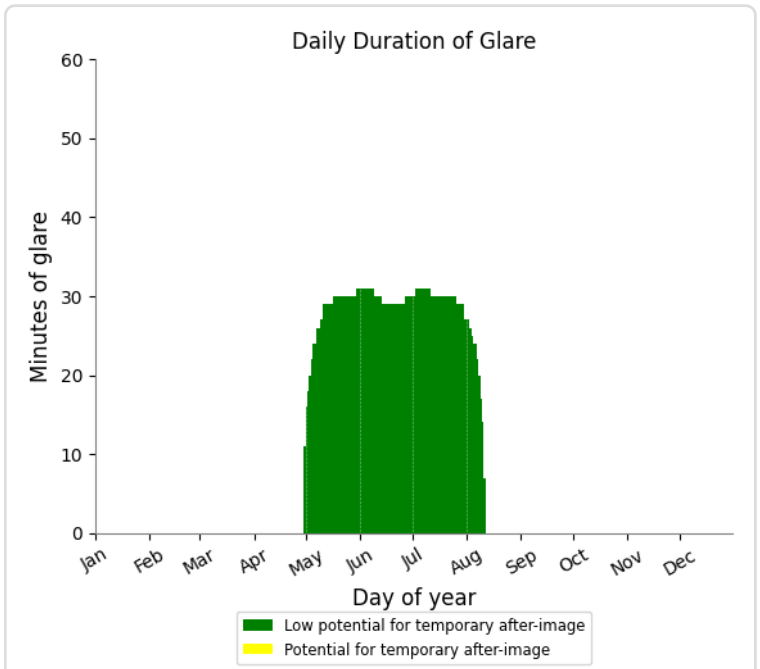


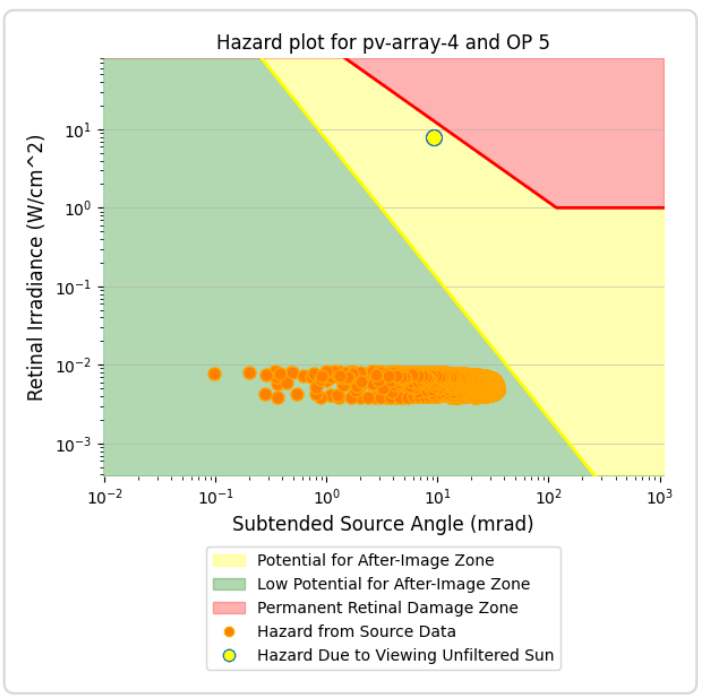
PV array 4 and OP 5

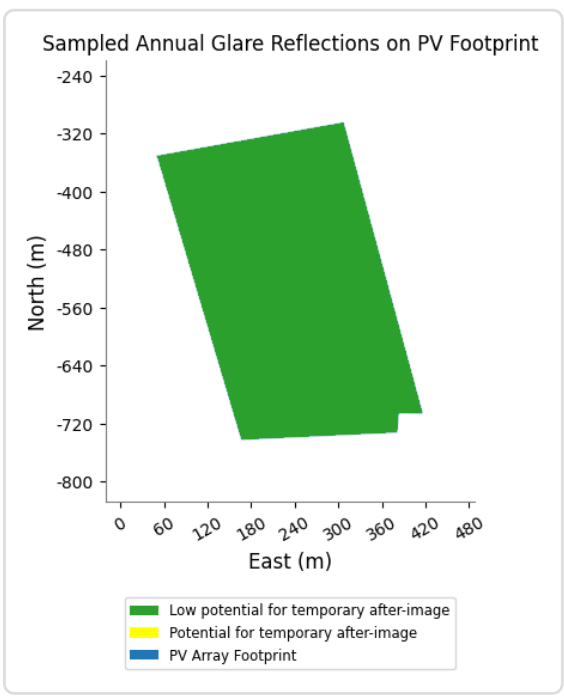
Yellow glare: none

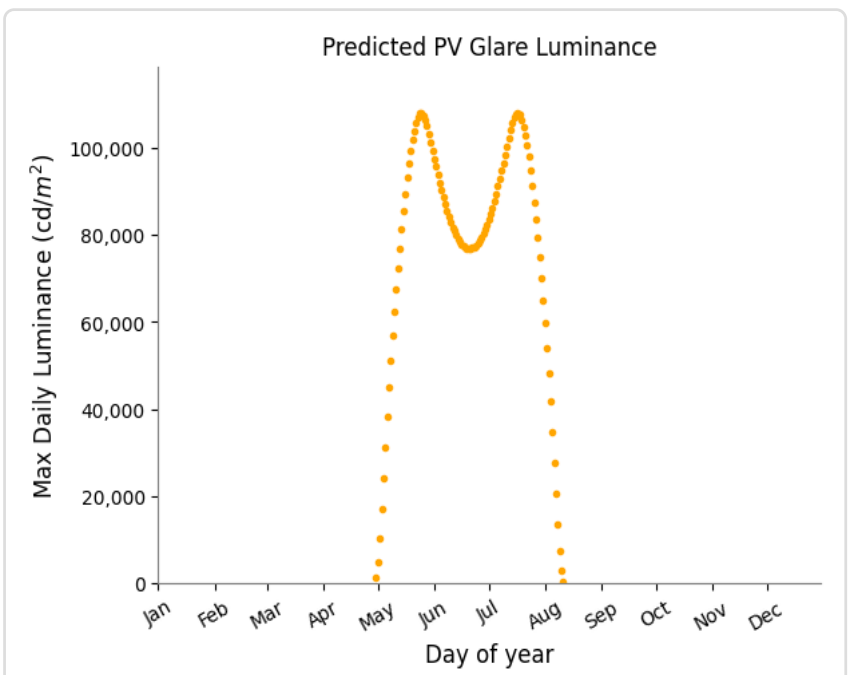
Green glare: 2,926 min.







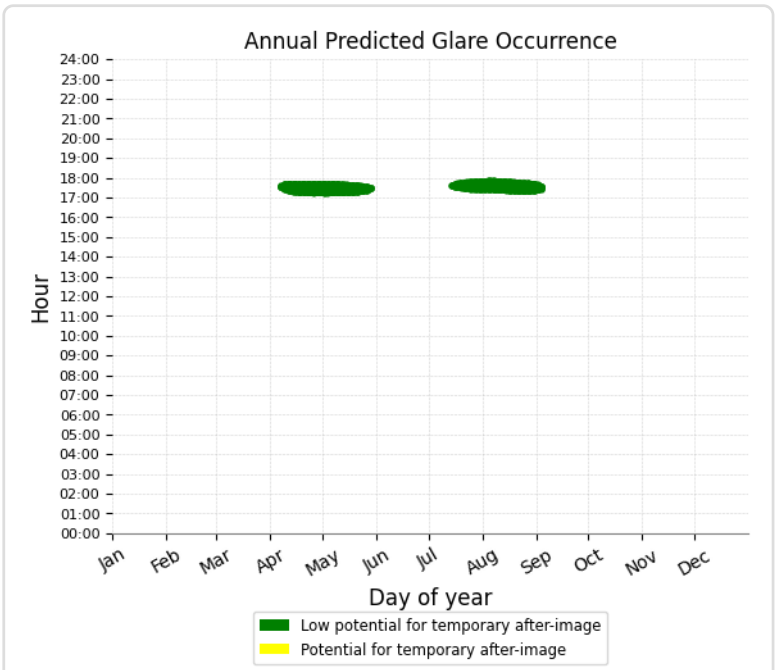


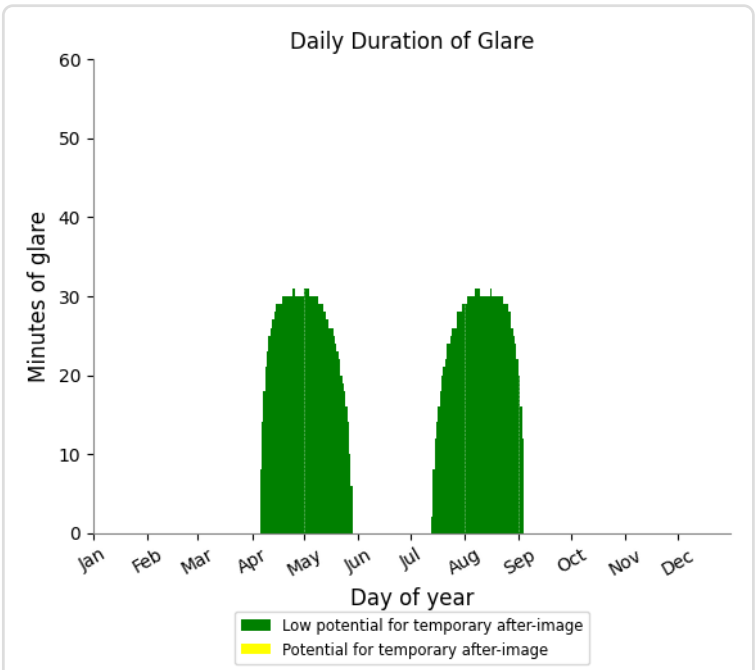


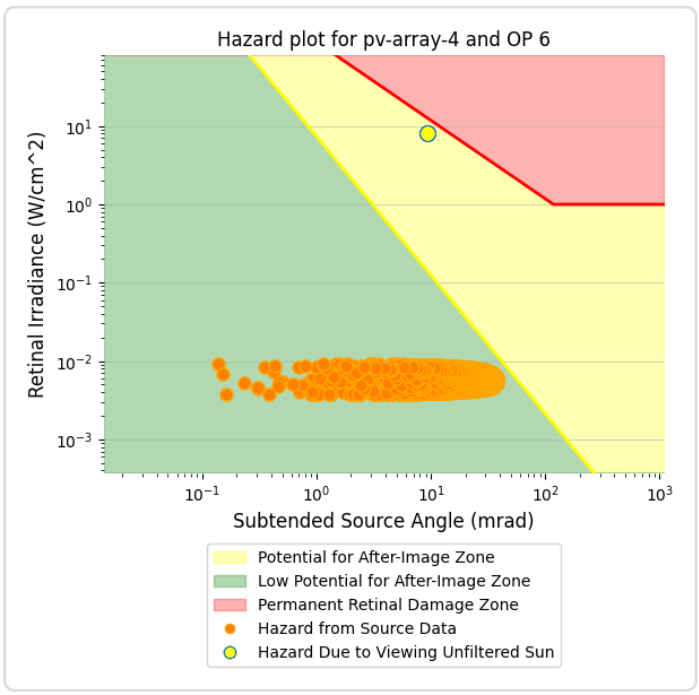
PV array 4 and OP 6

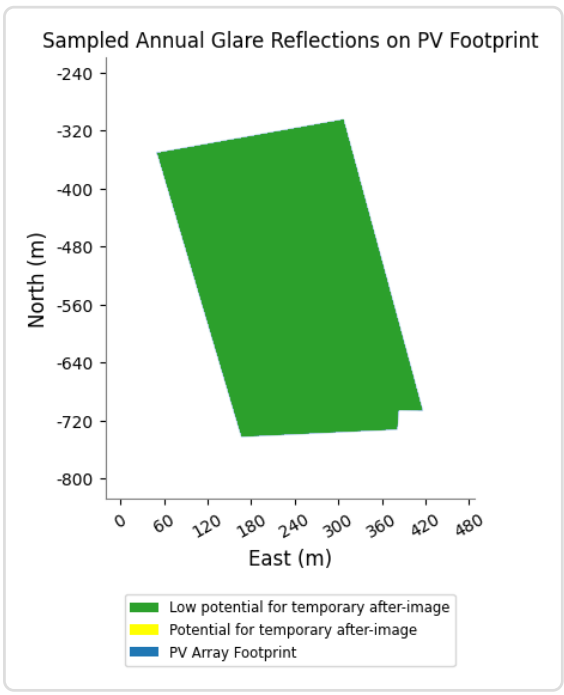
Yellow glare: none

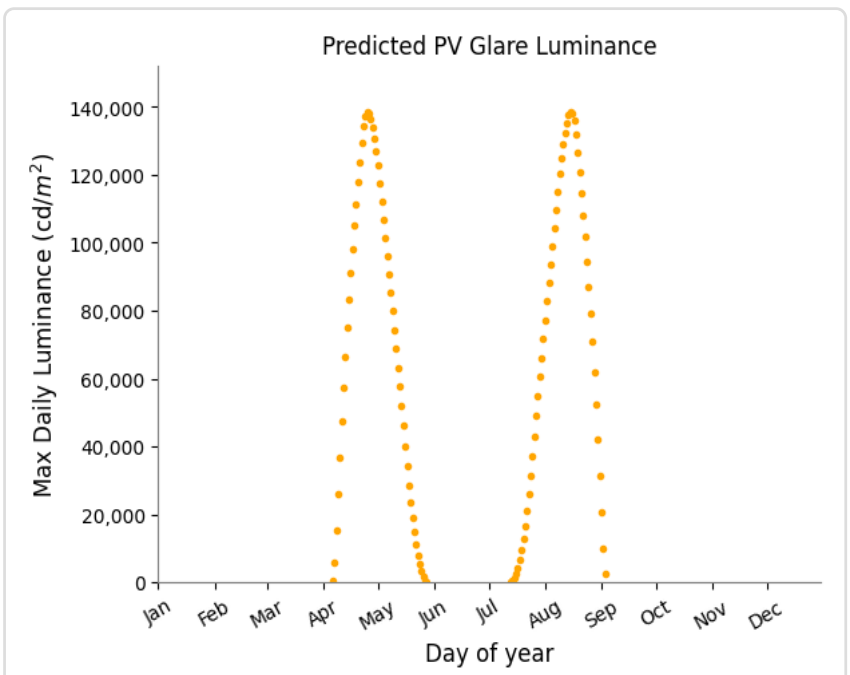
Green glare: 2,702 min.







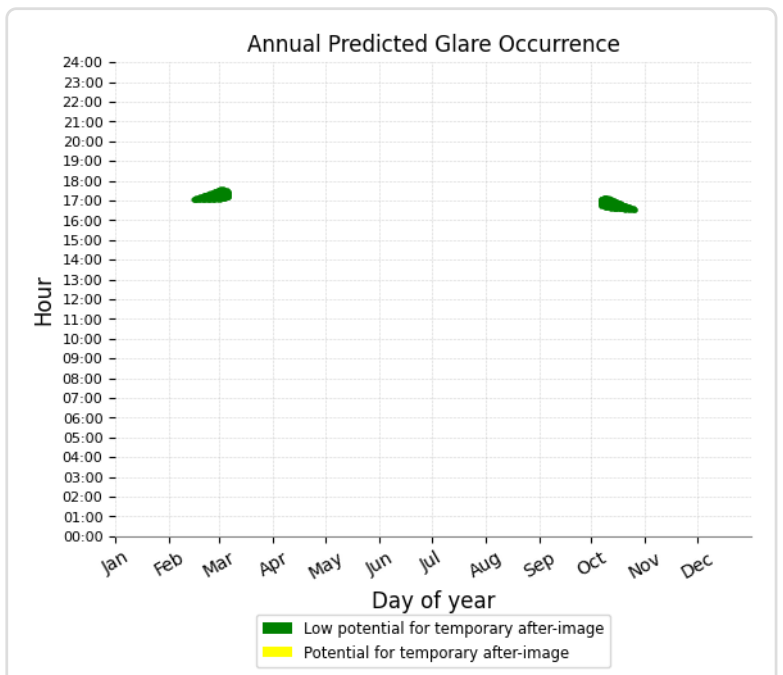


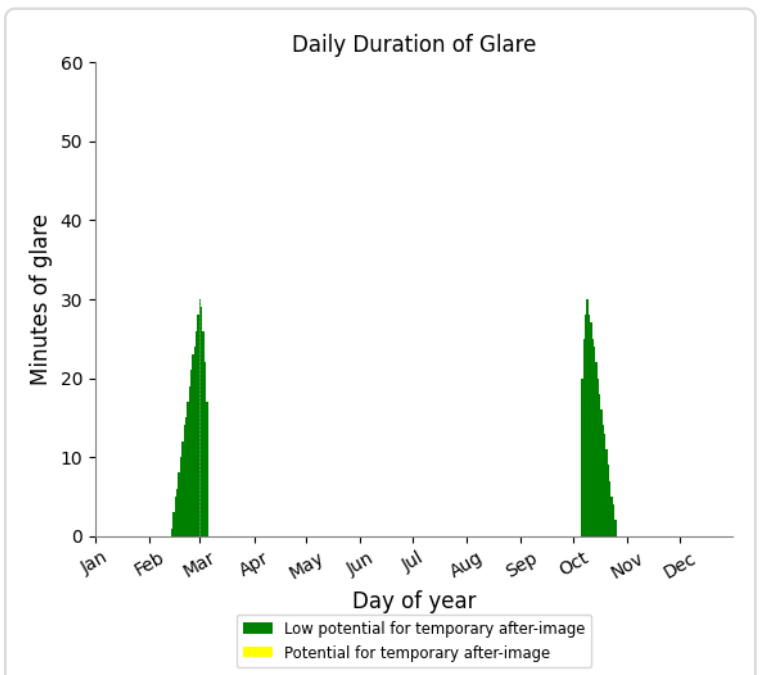


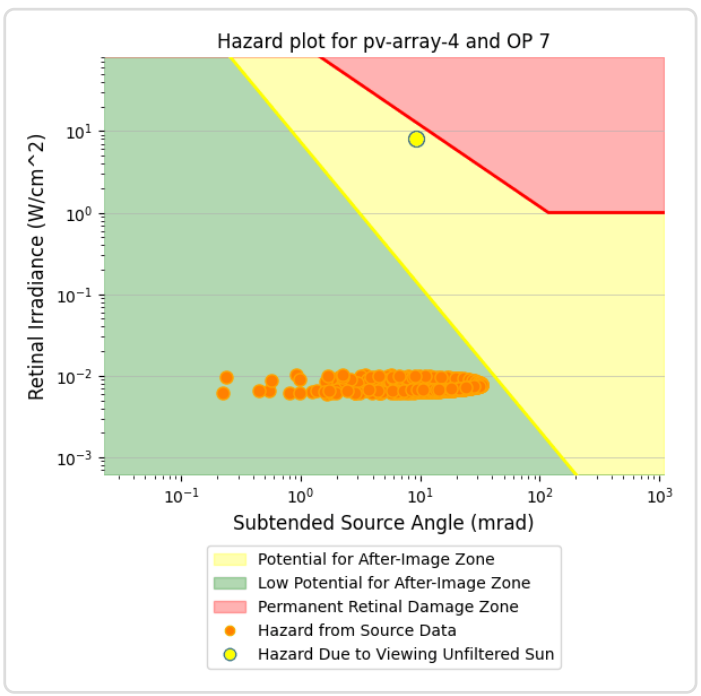
PV array 4 and OP 7

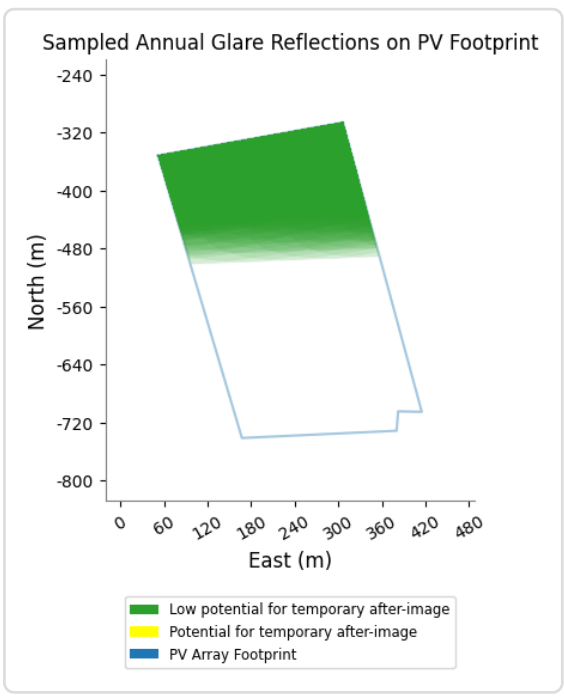
Yellow glare: none

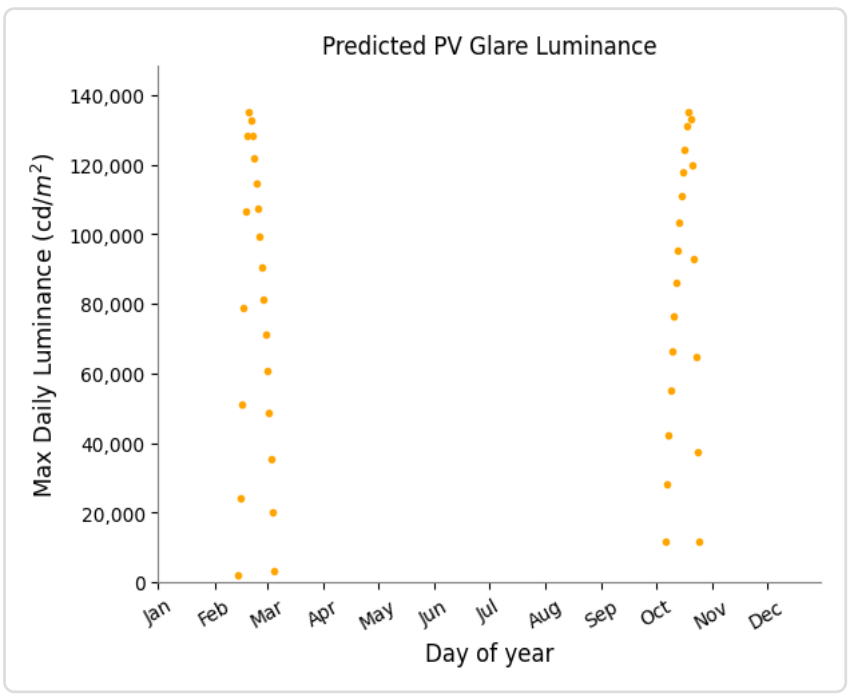
Green glare: 704 min.







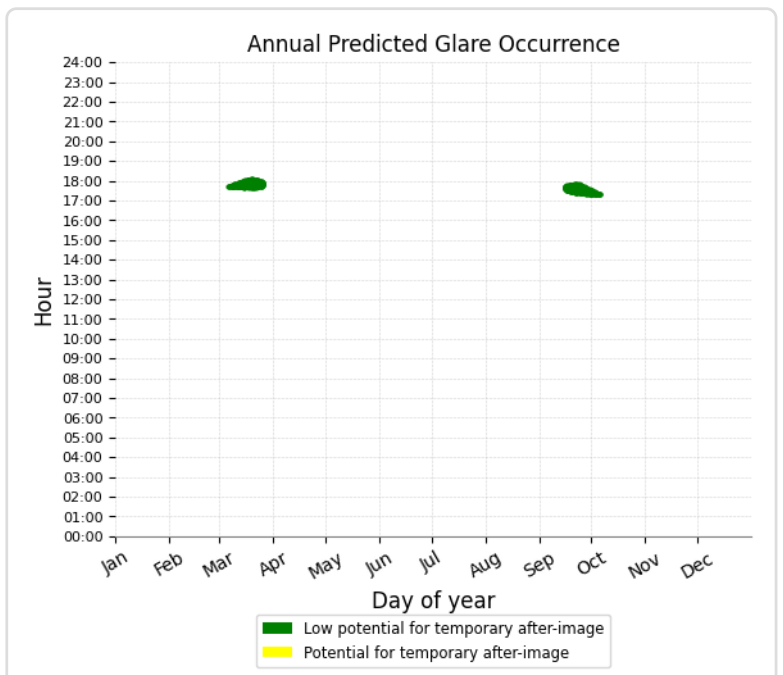


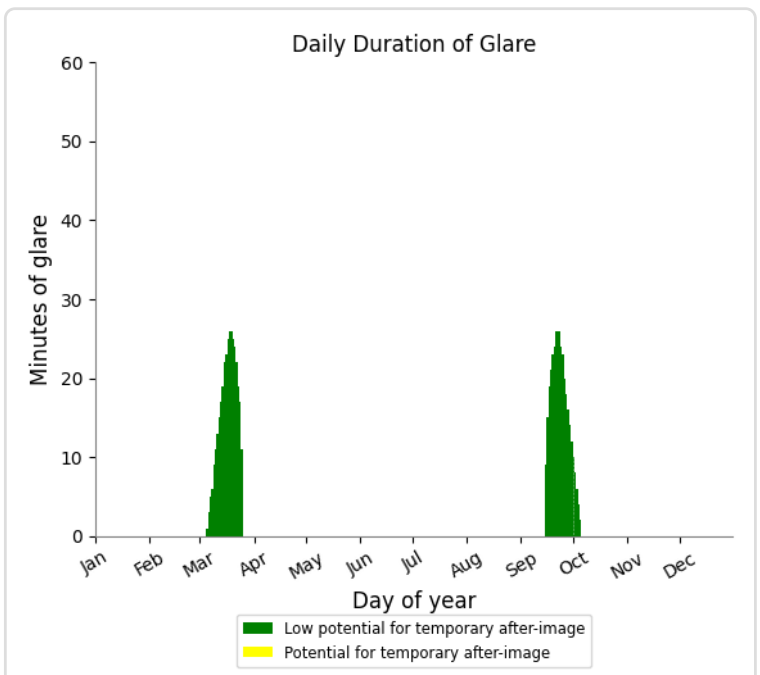


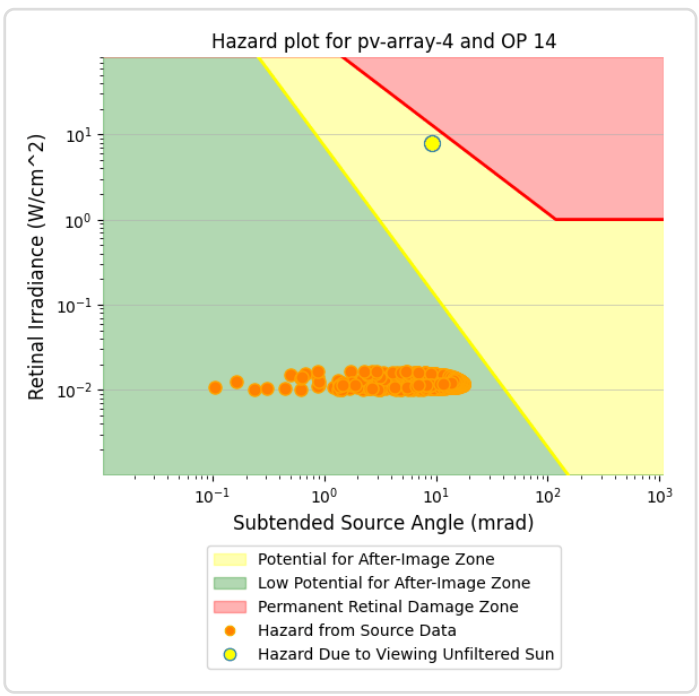
PV array 4 and OP 14

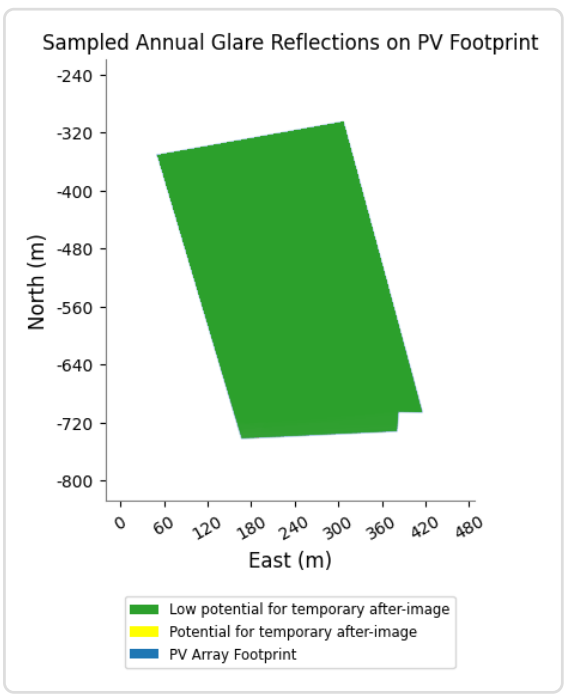
Yellow glare: none

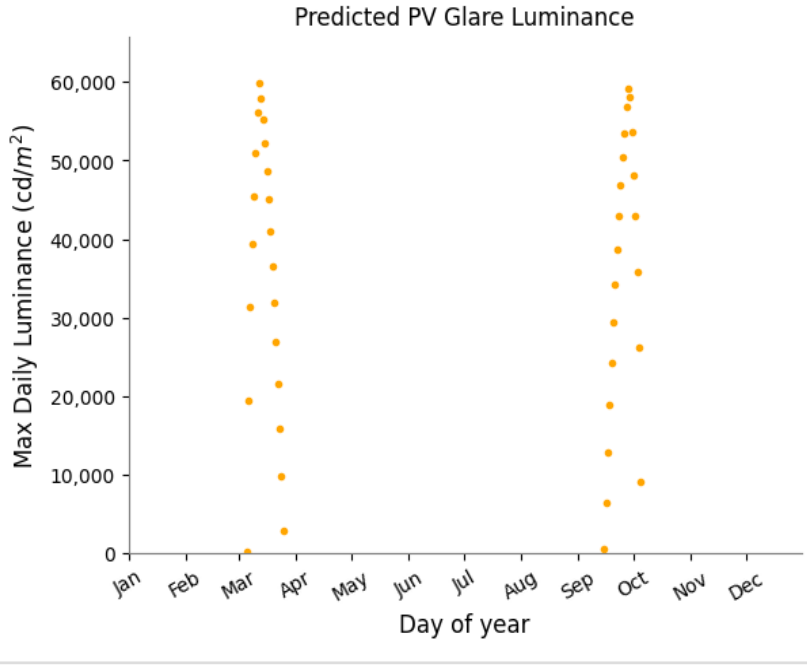
Green glare: 685 min.







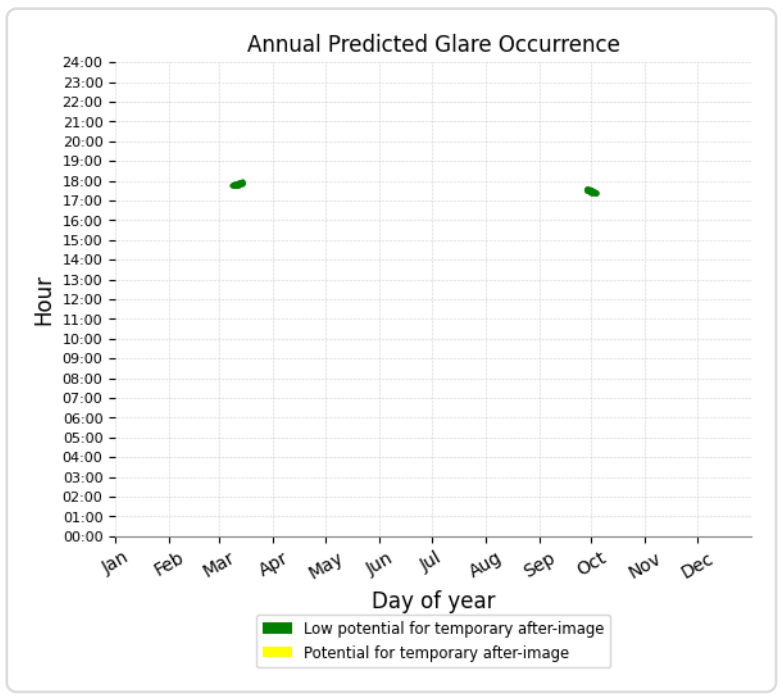


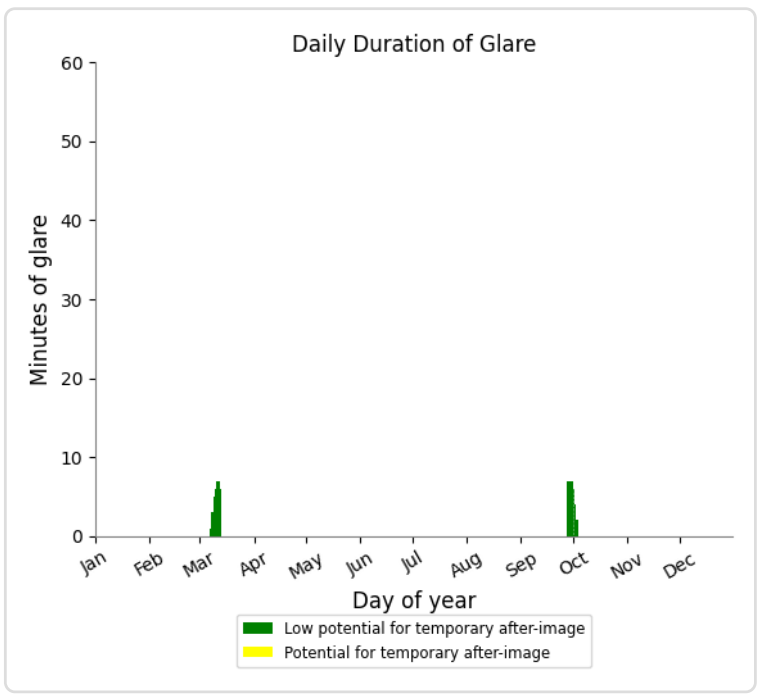


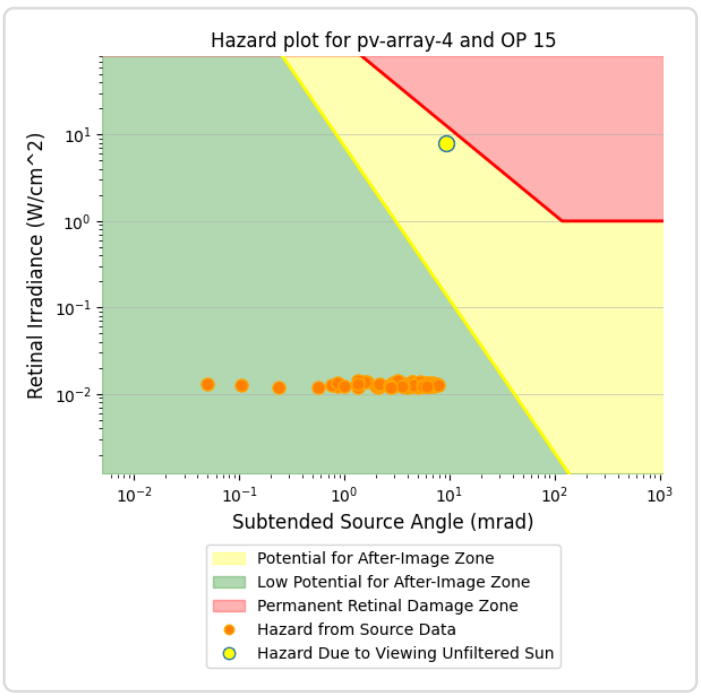
PV array 4 and OP 15

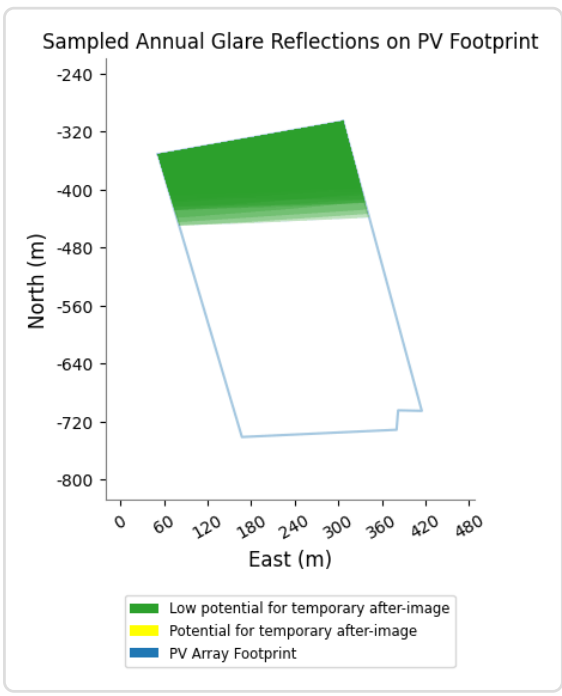
Yellow glare: none

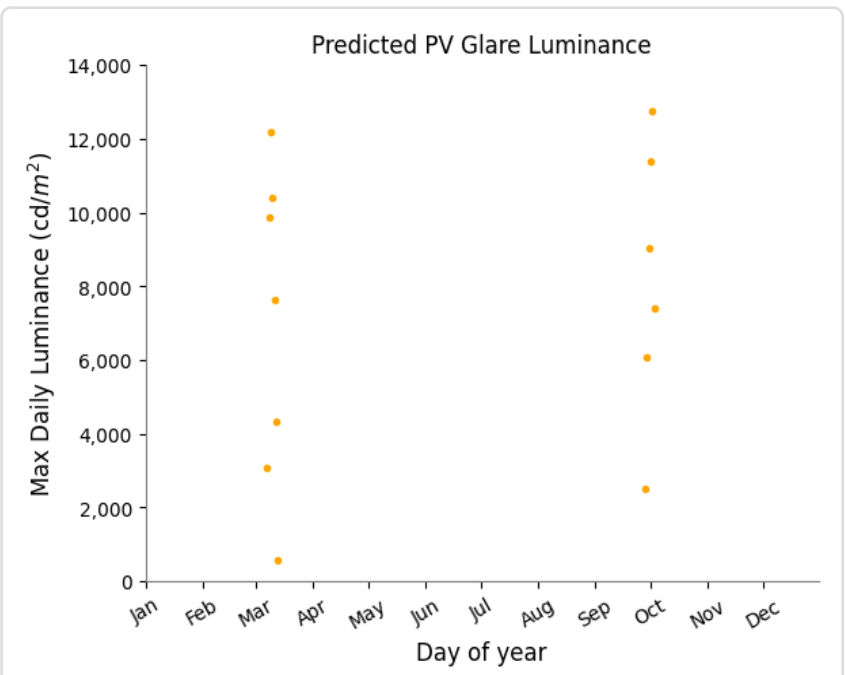
Green glare: 68 min.











PV array 4 and OP 1

No glare found

PV array 4 and OP 2

No glare found

PV array 4 and OP 8

No glare found

PV array 4 and OP 9

No glare found

PV array 4 and OP 10

No glare found

PV array 4 and OP 11

No glare found

PV array 4 and OP 12

No glare found

PV array 4 and OP 13

No glare found

PV array 4 and OP 16

No glare found

PV array 4 and OP 17

No glare found

PV array 4 and OP 18

No glare found

PV array 4 and OP 19

No glare found

PV array 4 and OP 20

No glare found

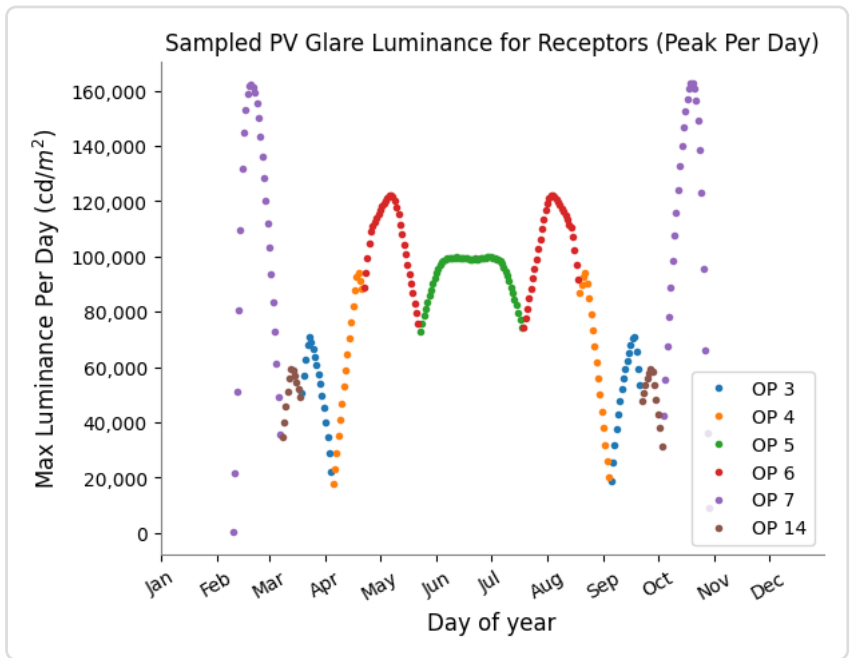
PV array 4 and OP 21

No glare found

PV: PV array 5 low potential for temporary after-image

Receptor results ordered by category of glare

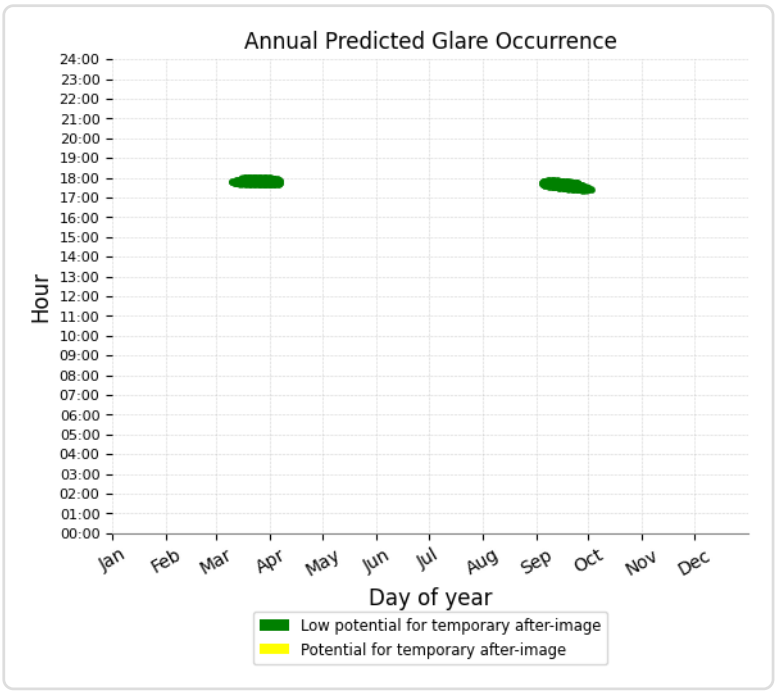
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	1,270	21.2	0	0.0	70,925
OP 4	1,781	29.7	0	0.0	94,258
OP 5	2,575	42.9	0	0.0	99,706
OP 6	3,820	63.7	0	0.0	122,314
OP 7	1,245	20.8	0	0.0	162,497
OP 14	796	13.3	0	0.0	59,325
OP 15	114	1.9	0	0.0	18,639
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

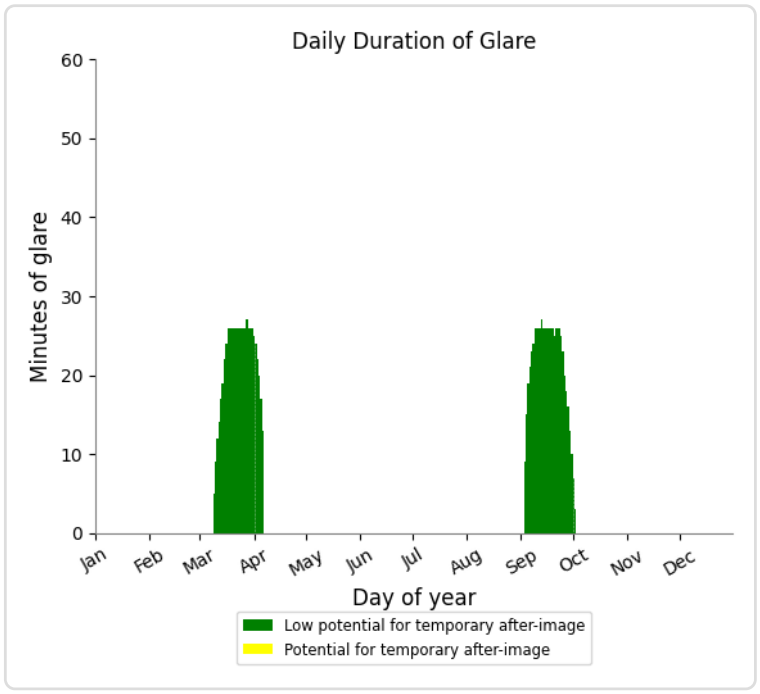


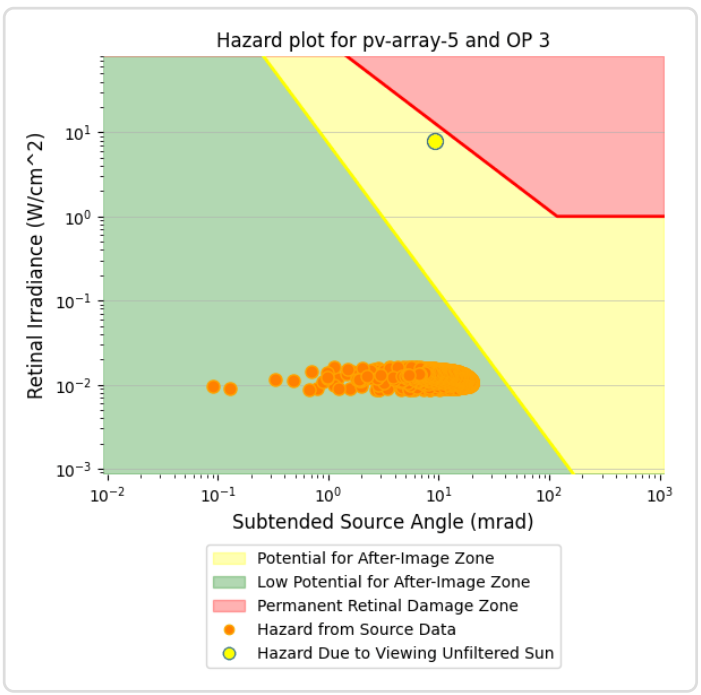
PV array 5 and OP 3

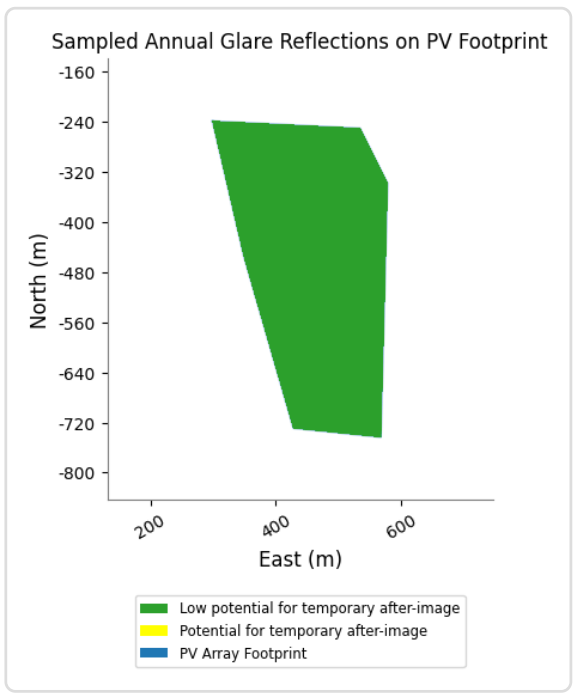
Yellow glare: none

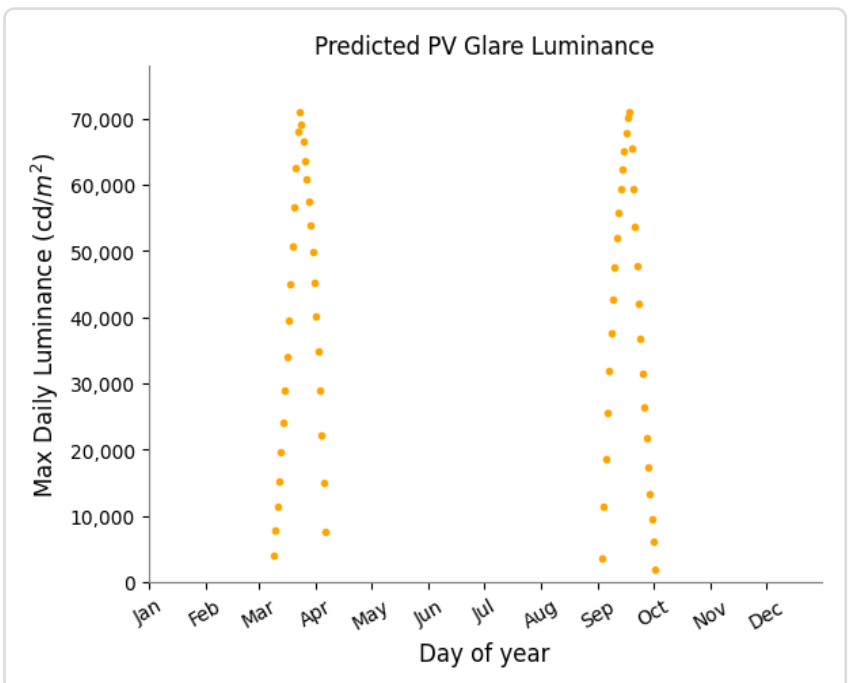
Green glare: 1,270 min.







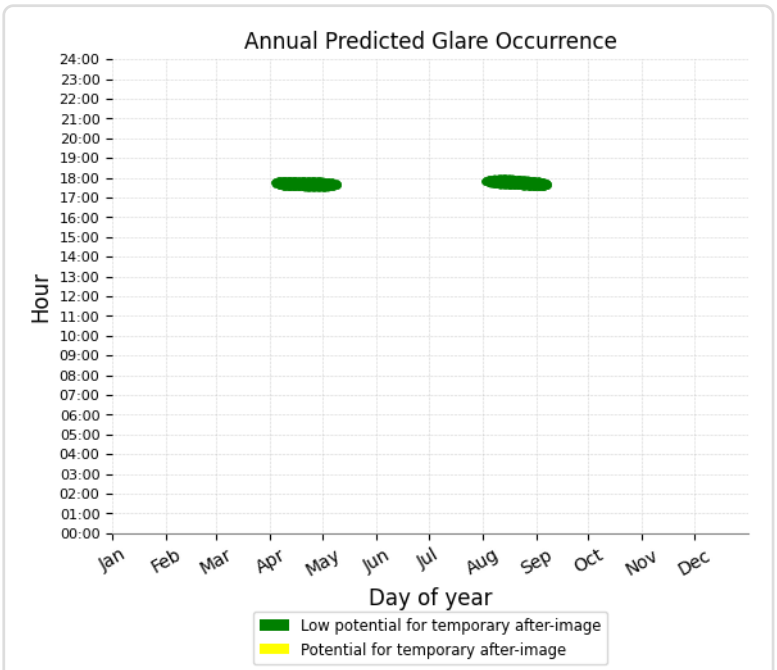


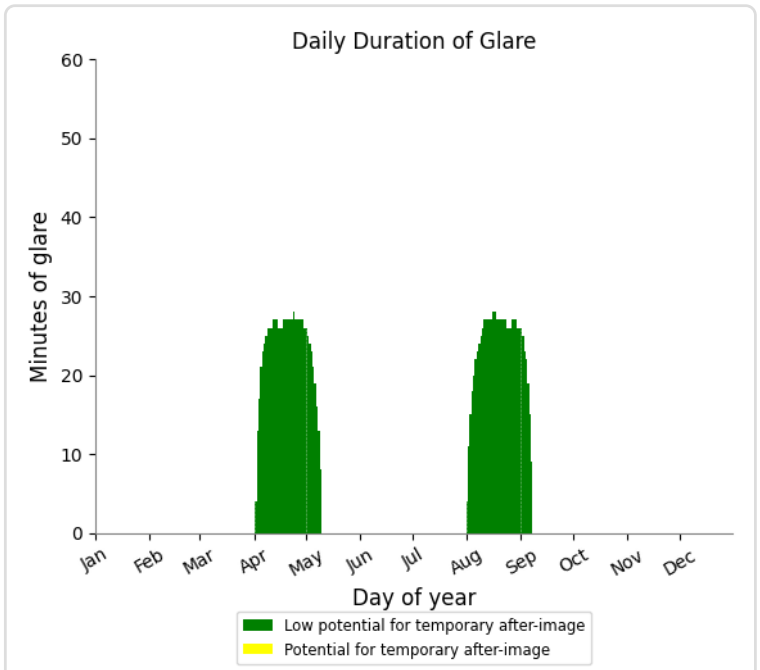


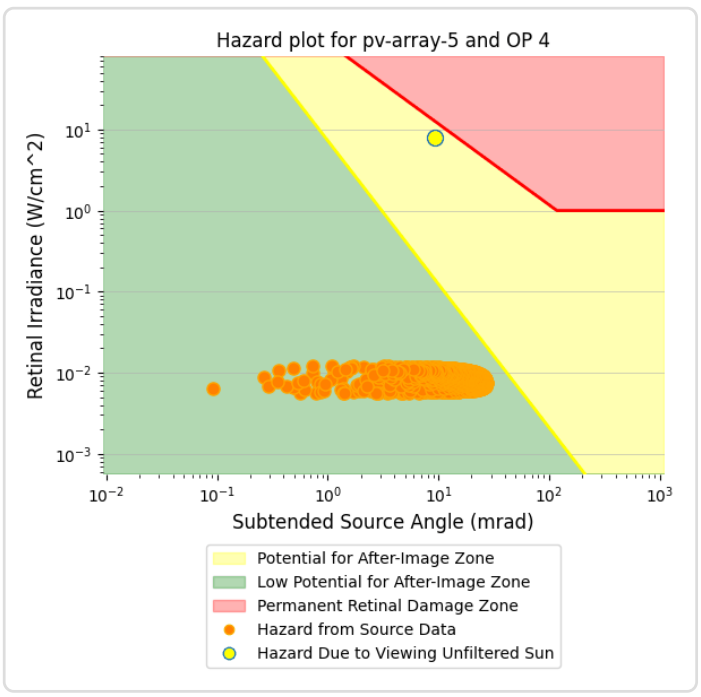
PV array 5 and OP 4

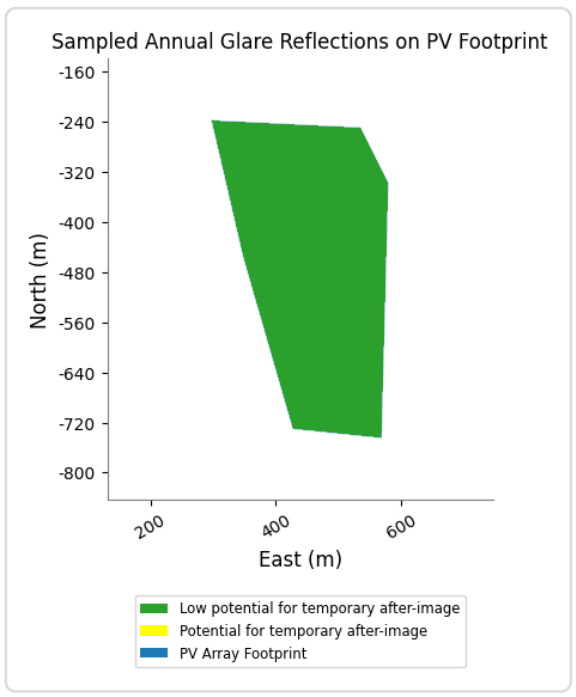
Yellow glare: none

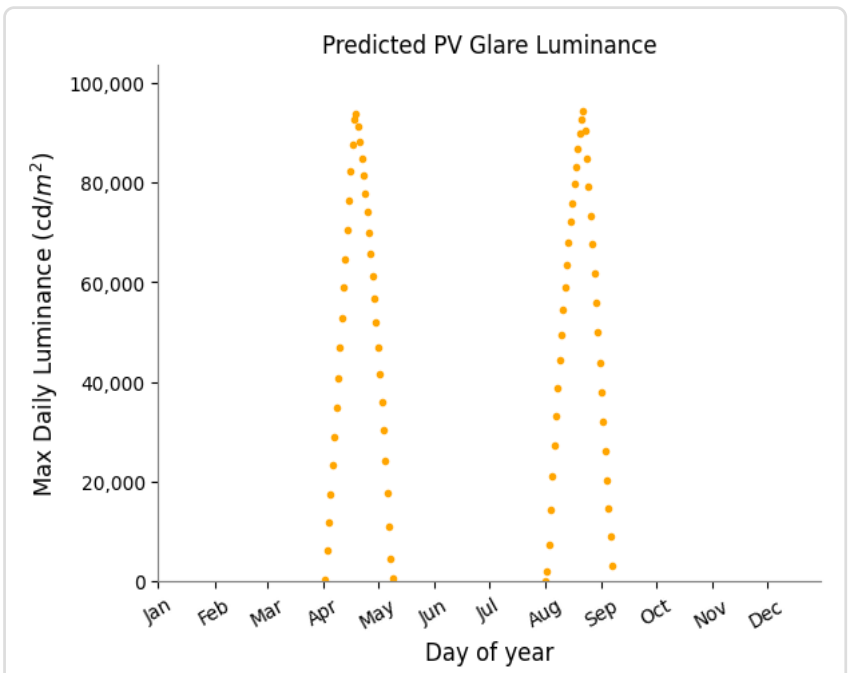
Green glare: 1,781 min.







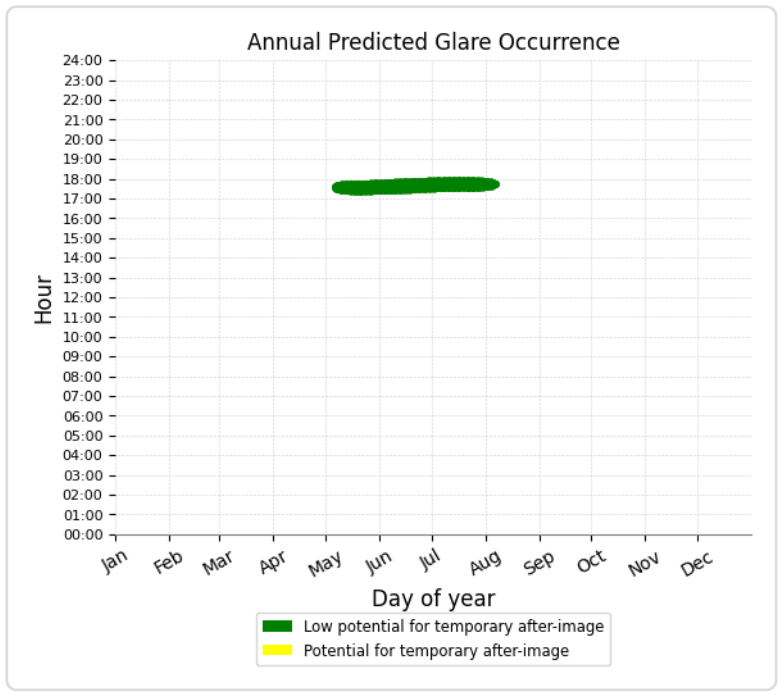


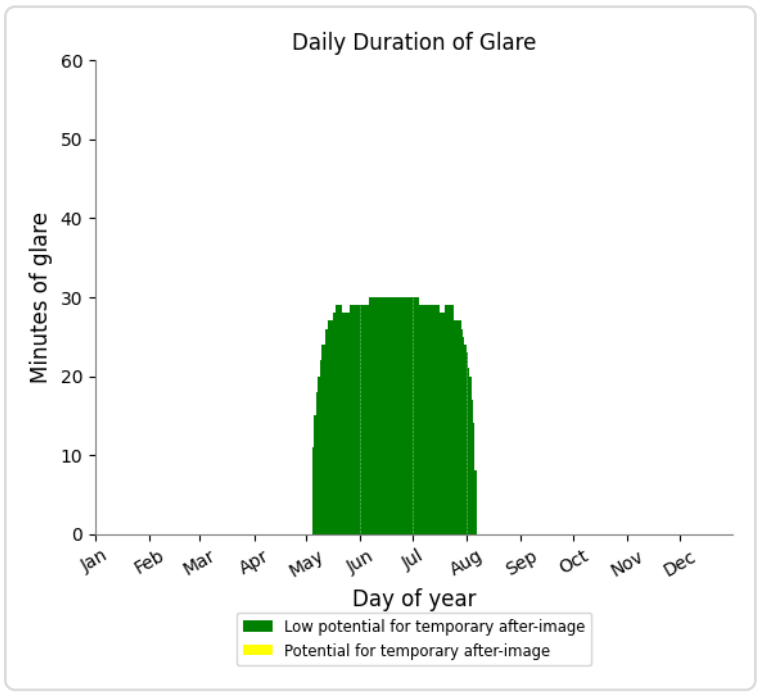


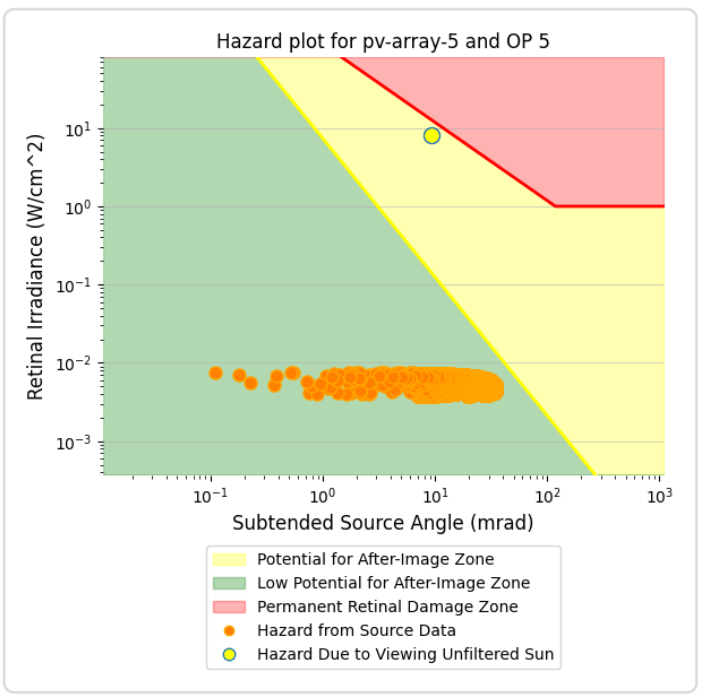
PV array 5 and OP 5

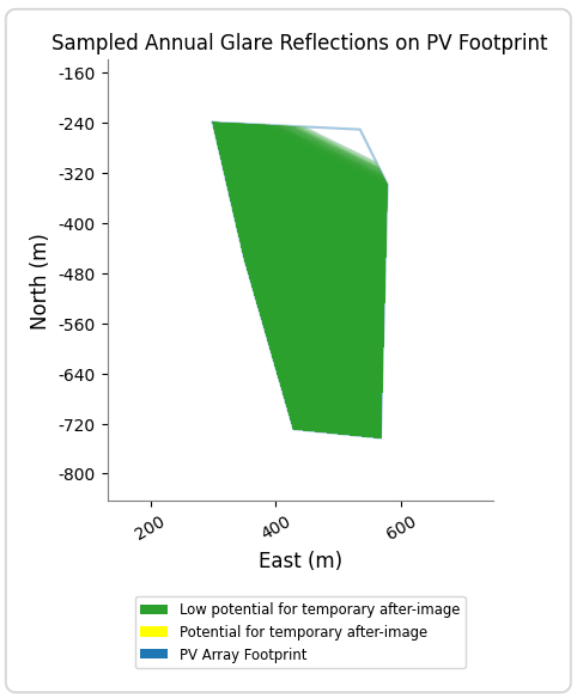
Yellow glare: none

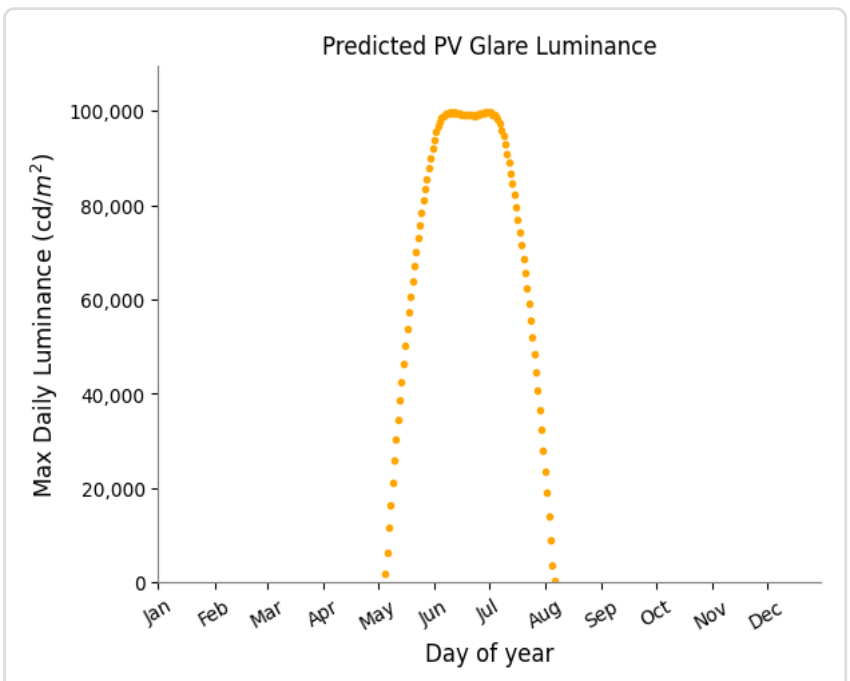
Green glare: 2,575 min.







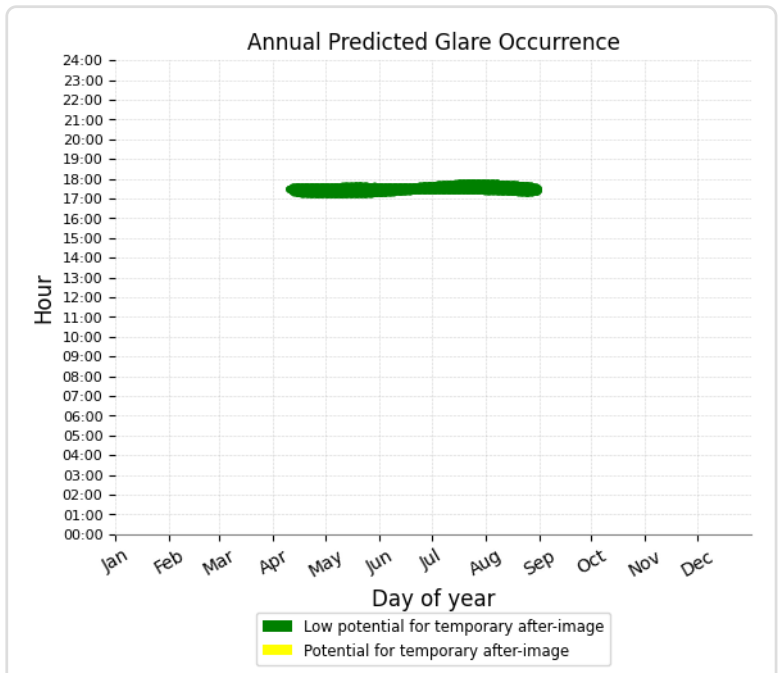


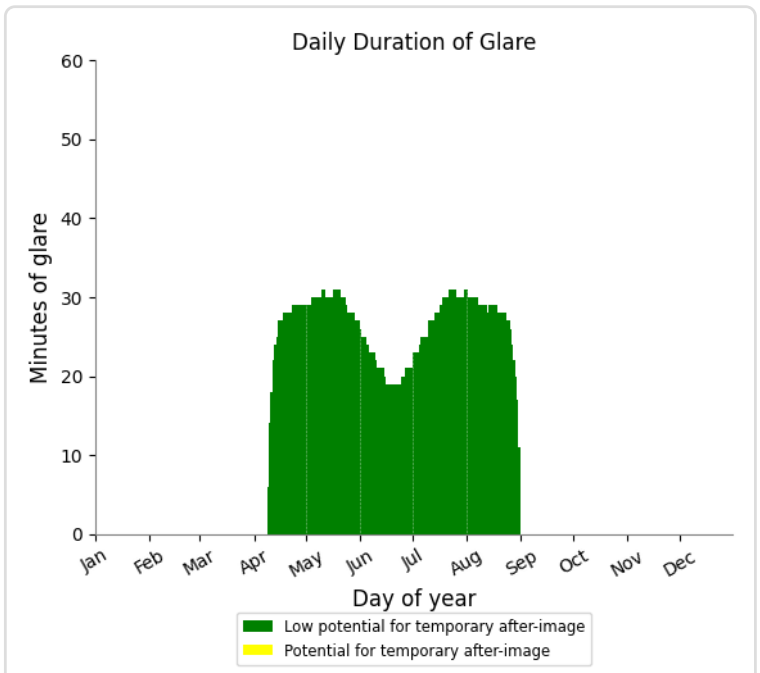


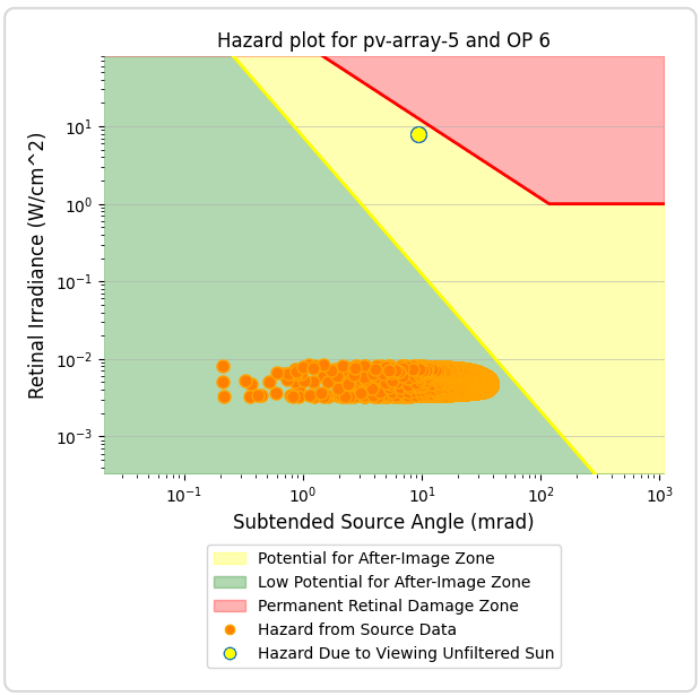
PV array 5 and OP 6

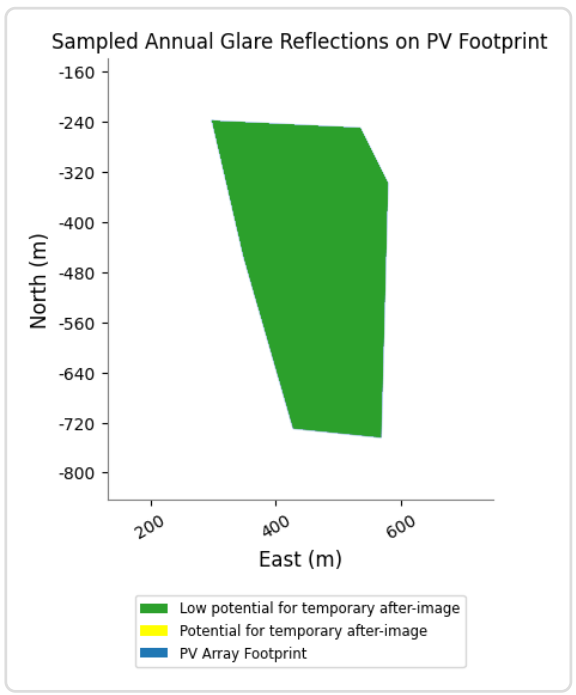
Yellow glare: none

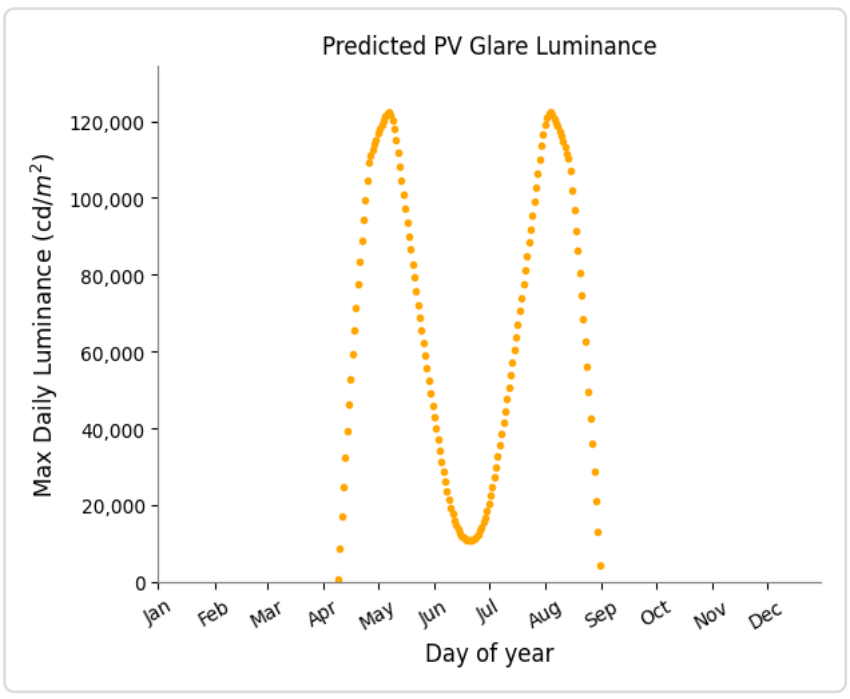
Green glare: 3,820 min.







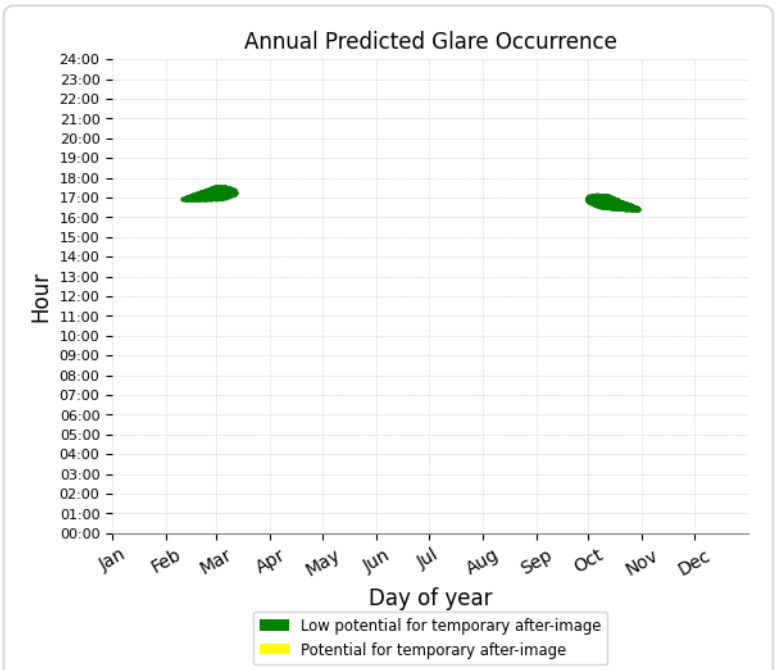


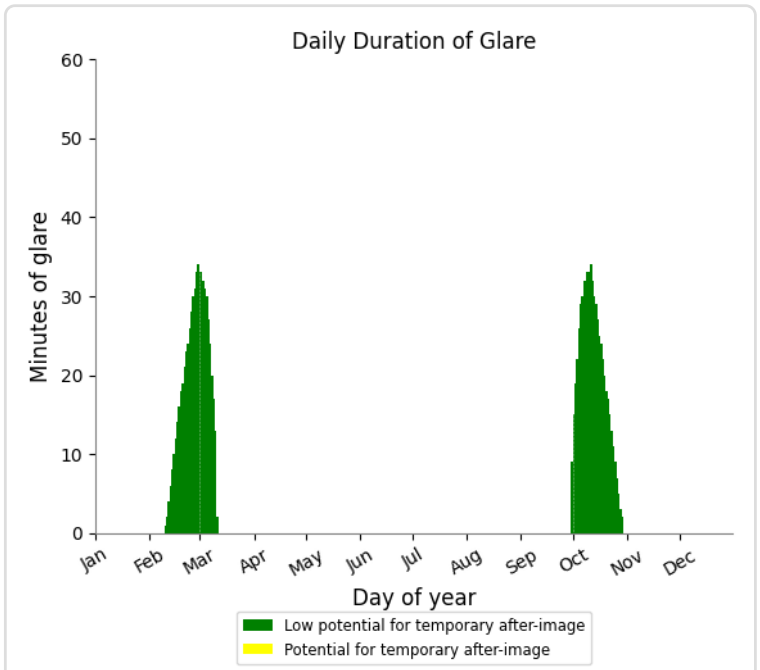


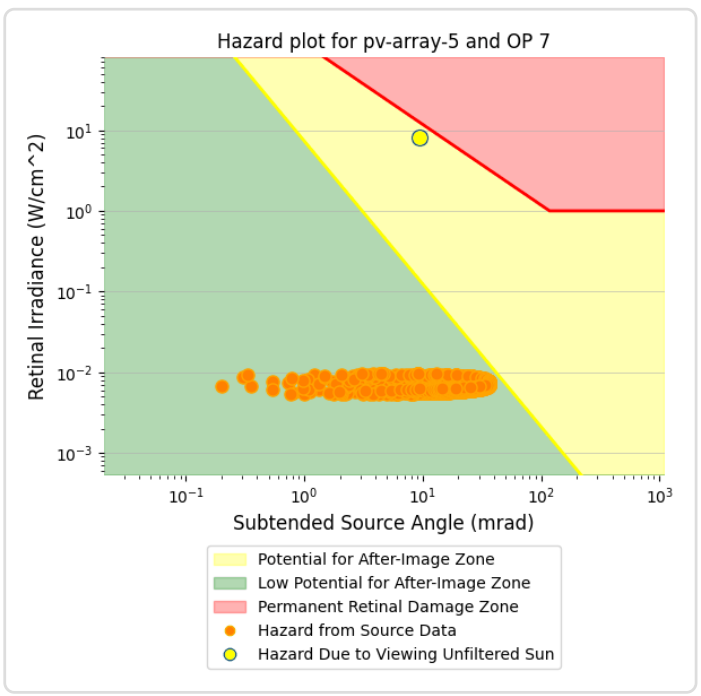
PV array 5 and OP 7

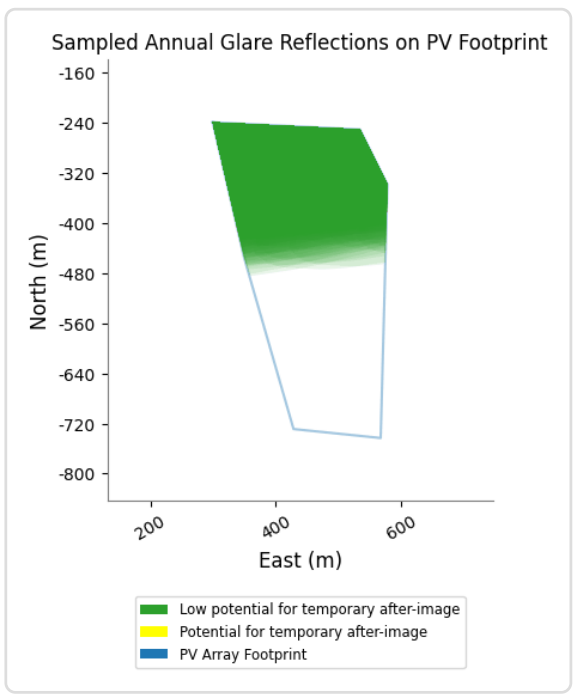
Yellow glare: none

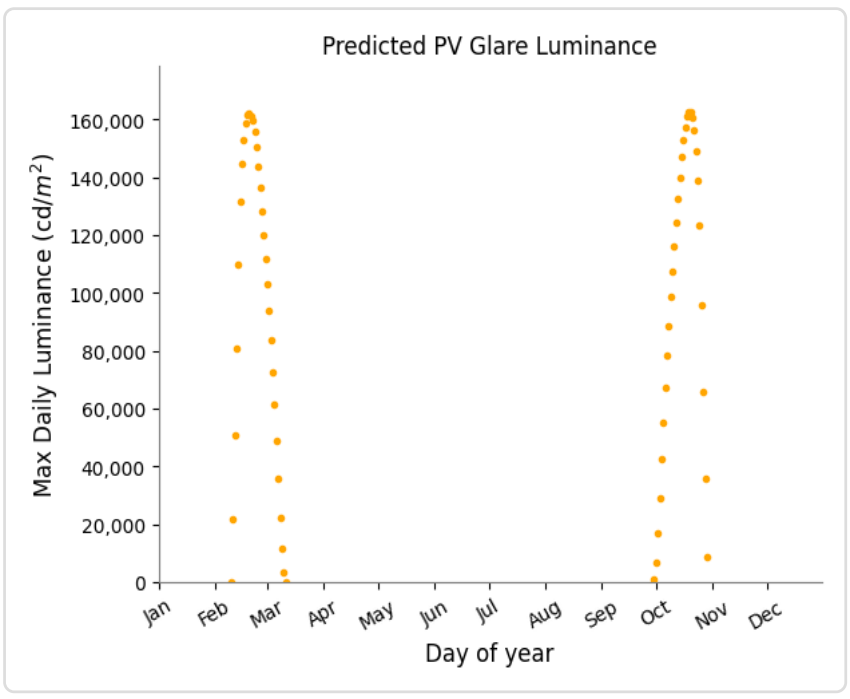
Green glare: 1,245 min.







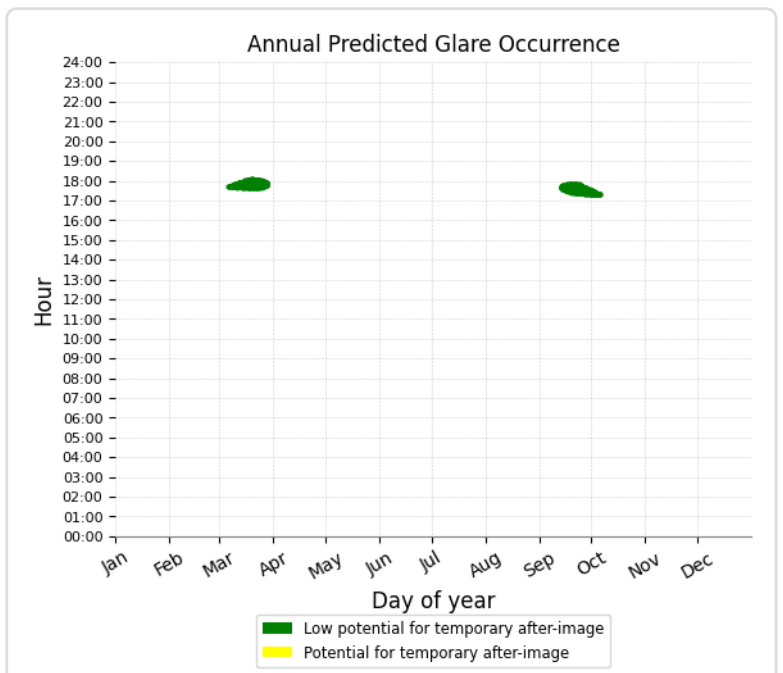


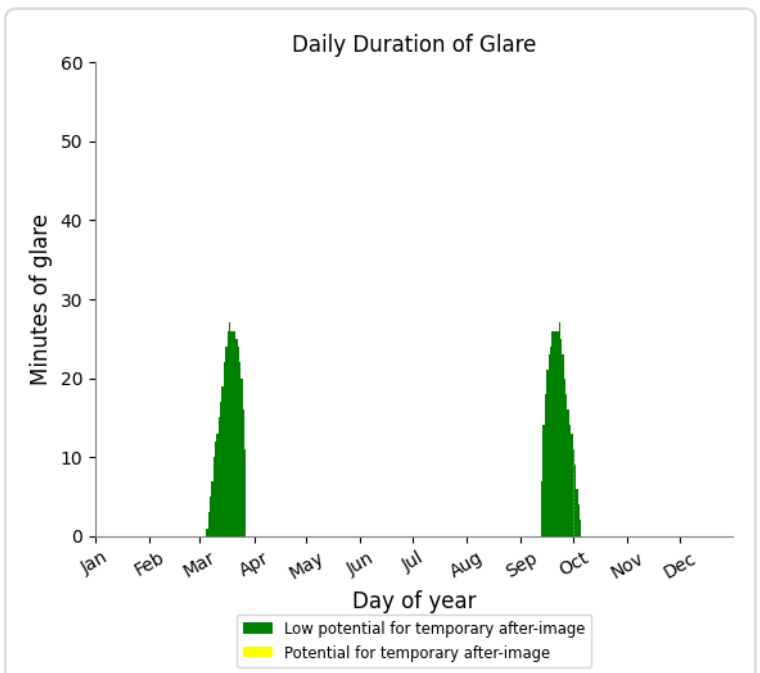


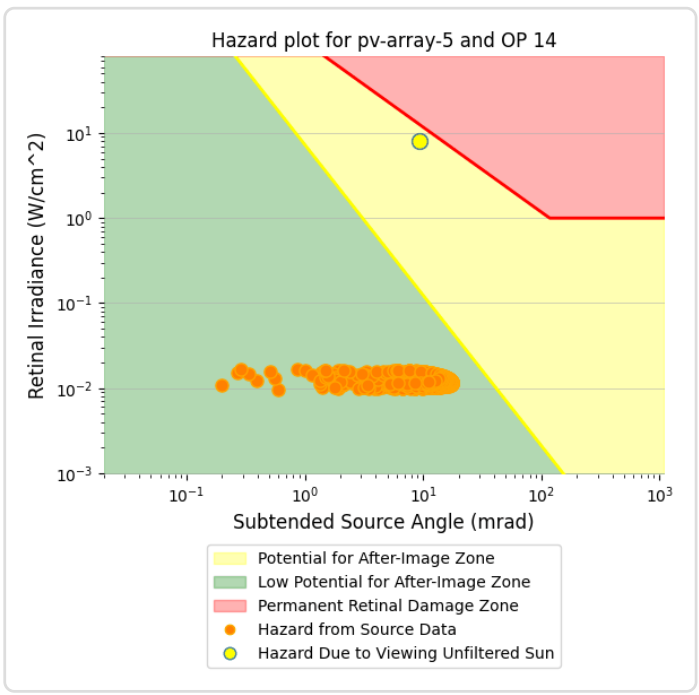
PV array 5 and OP 14

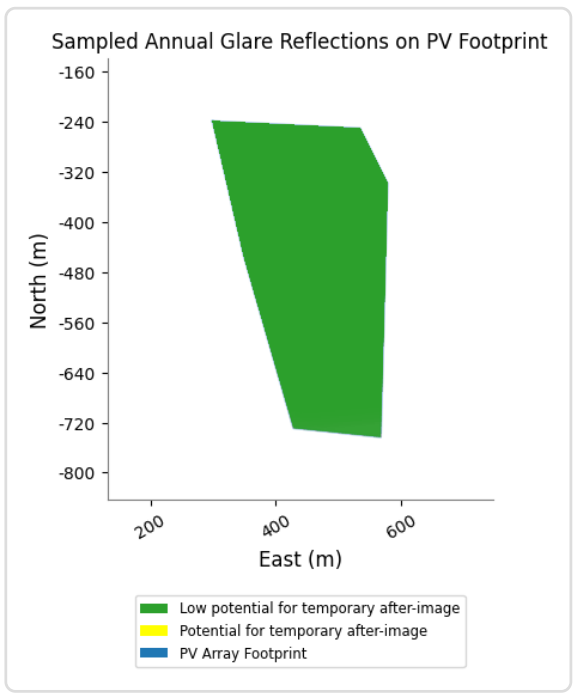
Yellow glare: none

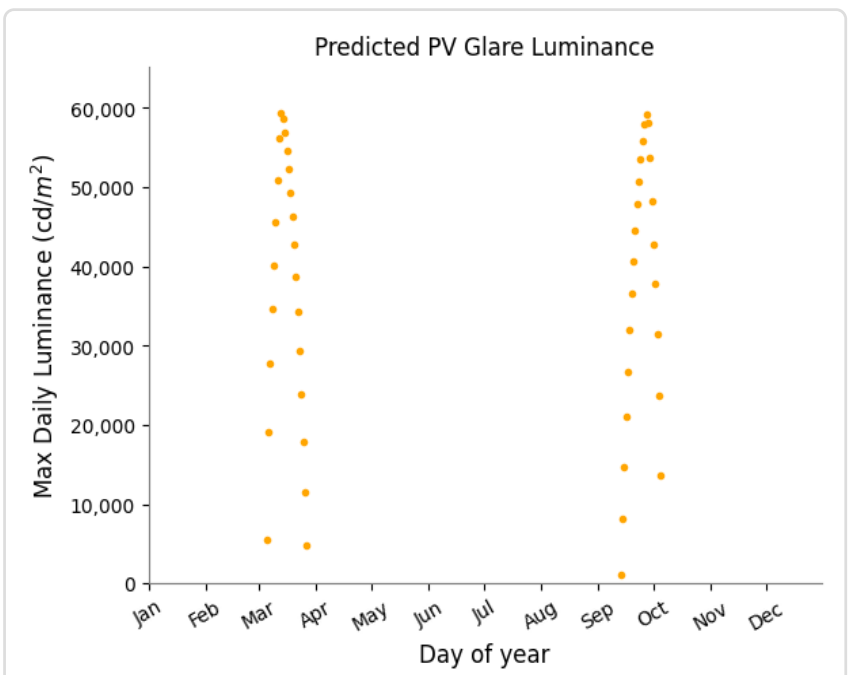
Green glare: 796 min.







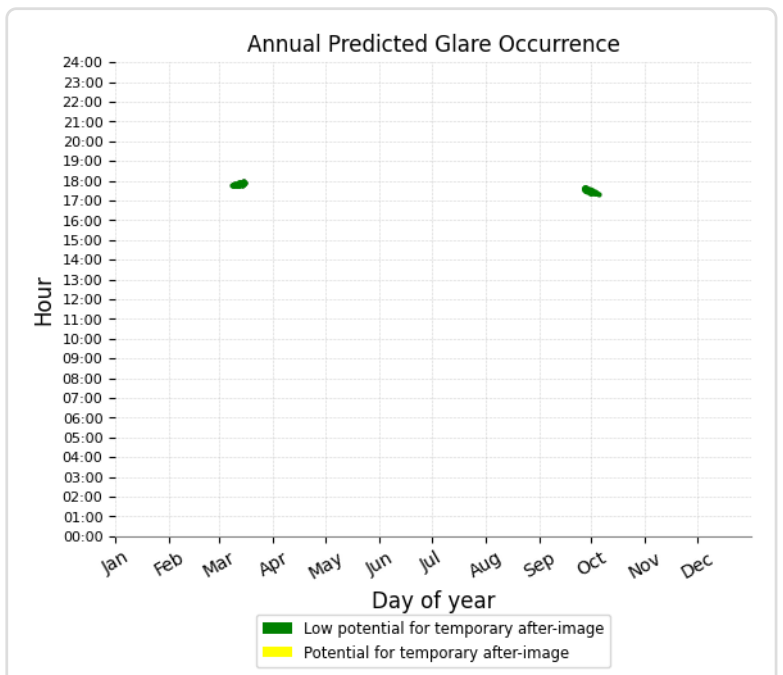


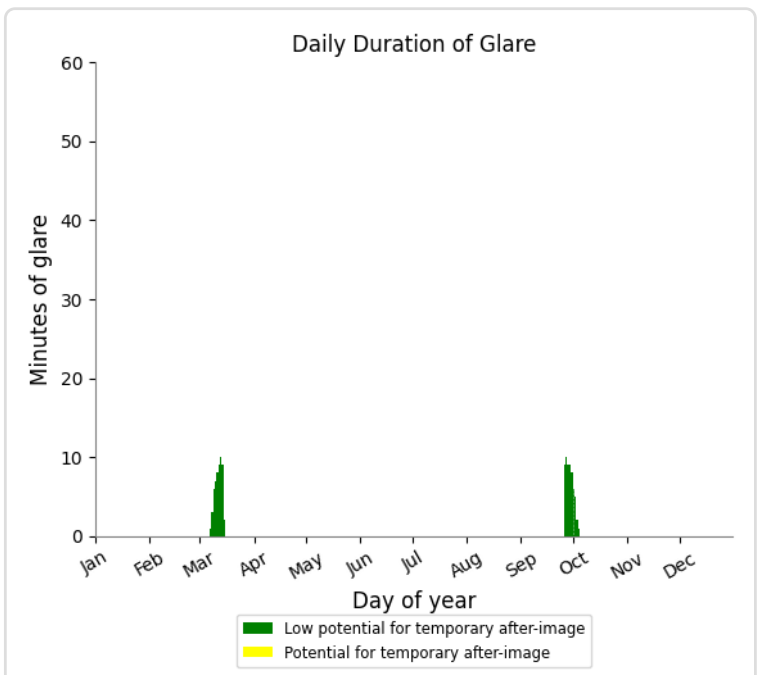


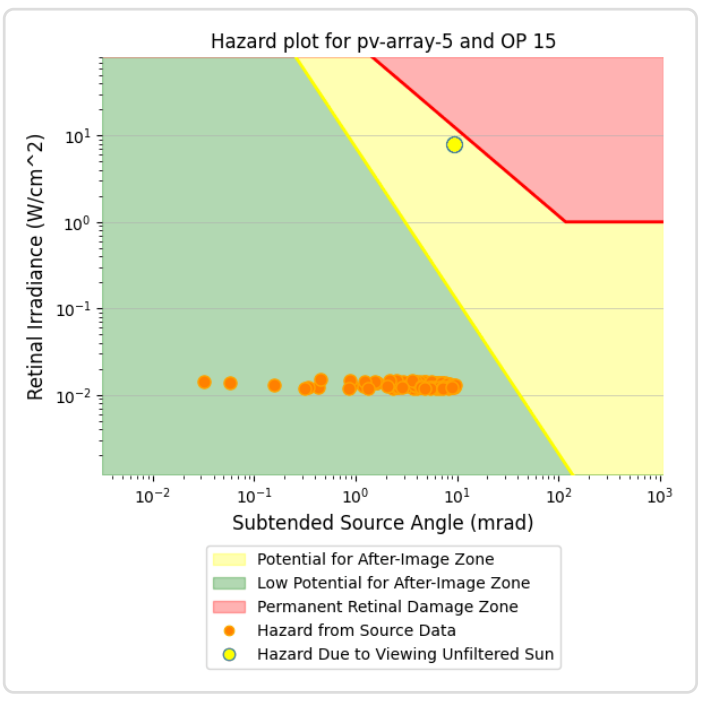
PV array 5 and OP 15

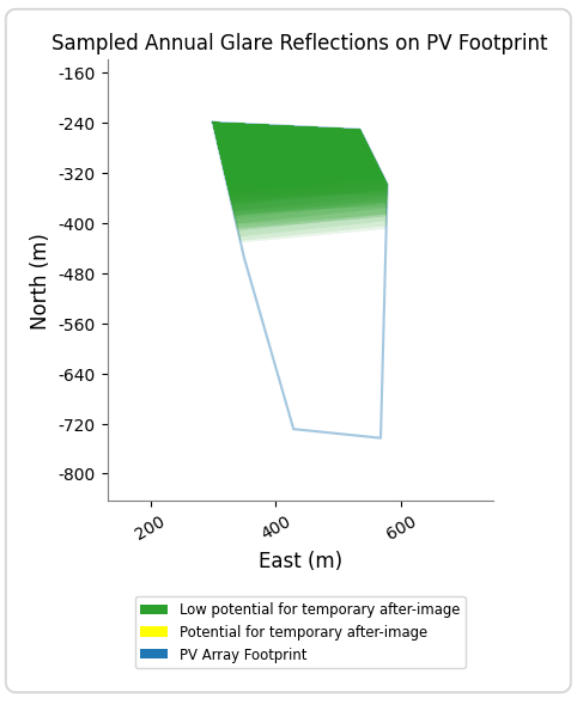
Yellow glare: none

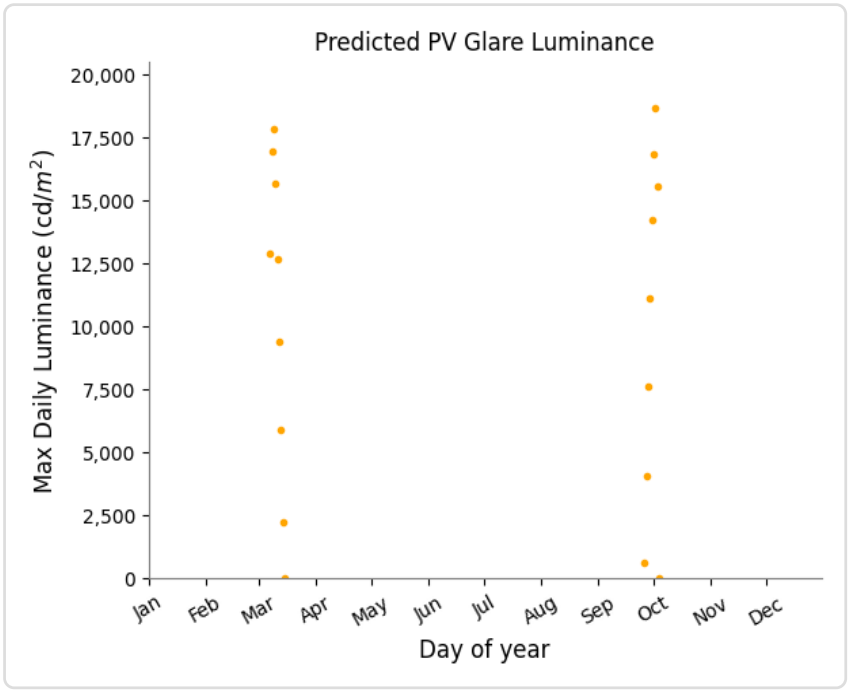
Green glare: 114 min.











PV array 5 and OP 1

No glare found

PV array 5 and OP 2

No glare found

PV array 5 and OP 8

No glare found

PV array 5 and OP 9

No glare found

PV array 5 and OP 10

No glare found

PV array 5 and OP 11

No glare found

PV array 5 and OP 12

No glare found

PV array 5 and OP 13

No glare found

PV array 5 and OP 16

No glare found

PV array 5 and OP 17

No glare found

PV array 5 and OP 18

No glare found

PV array 5 and OP 19

No glare found

PV array 5 and OP 20

No glare found

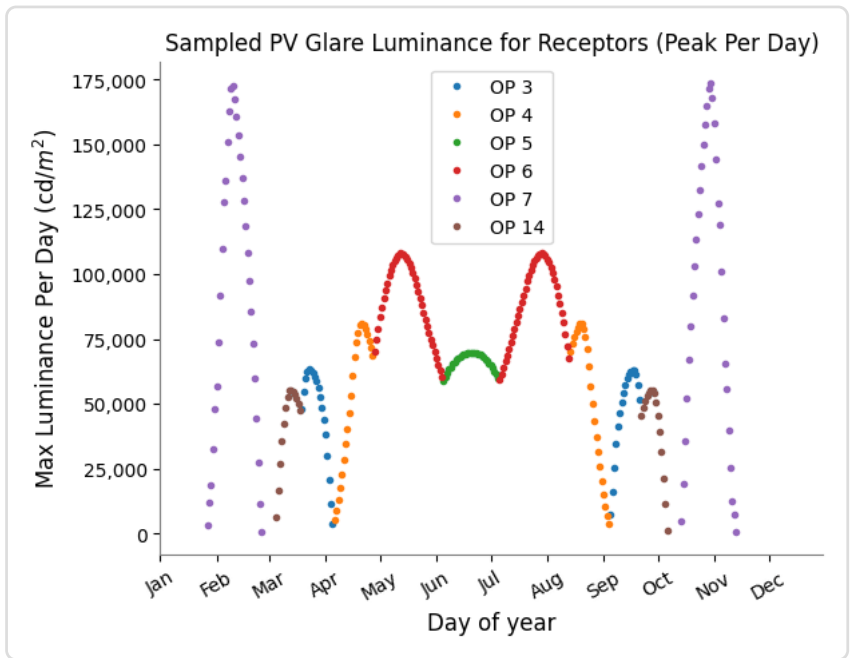
PV array 5 and OP 21

No glare found

PV: PV array 6 low potential for temporary after-image

Receptor results ordered by category of glare

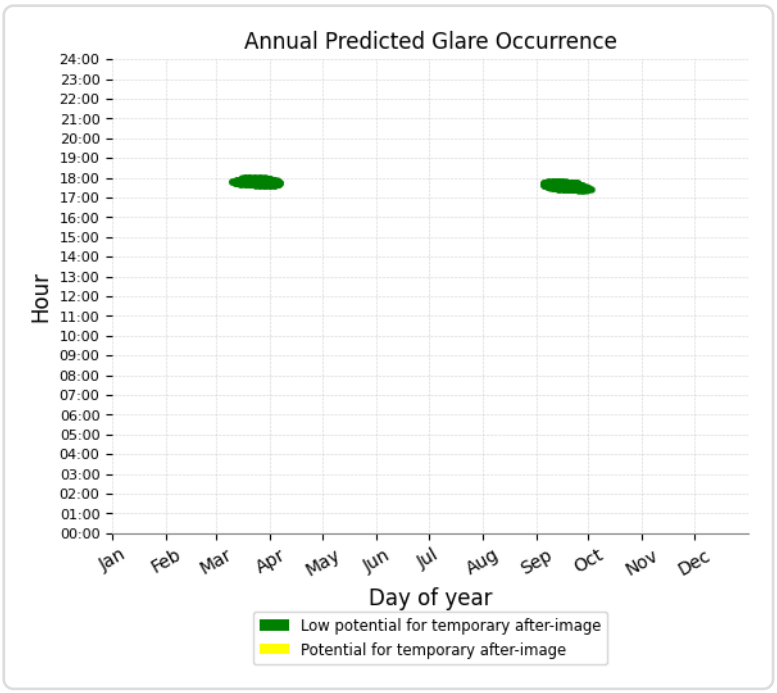
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 3	1,259	21.0	0	0.0	63,333
OP 4	1,877	31.3	0	0.0	81,117
OP 5	2,360	39.3	0	0.0	69,809
OP 6	4,134	68.9	0	0.0	108,193
OP 7	1,374	22.9	0	0.0	173,453
OP 14	753	12.6	0	0.0	55,364
OP 15	65	1.1	0	0.0	13,094
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

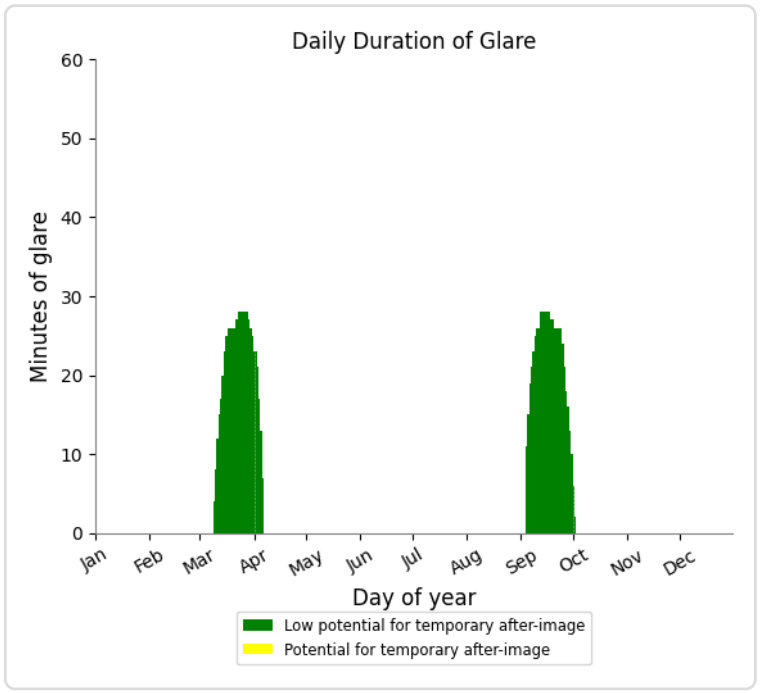


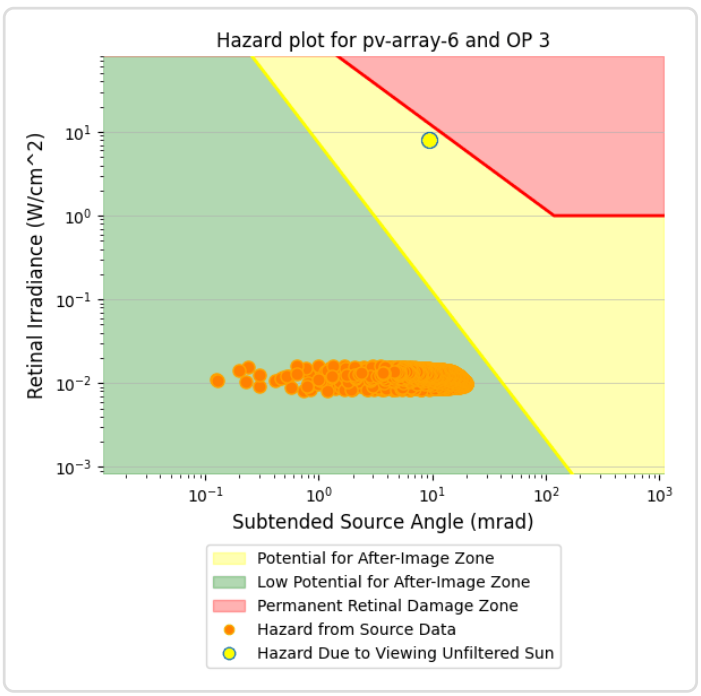
PV array 6 and OP 3

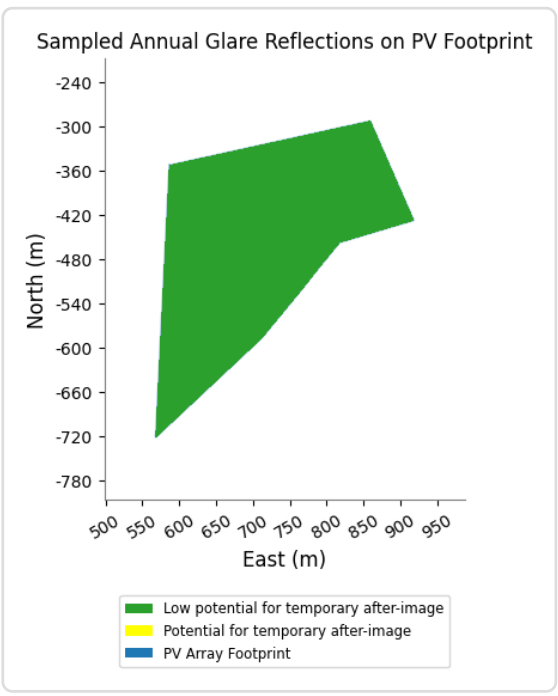
Yellow glare: none

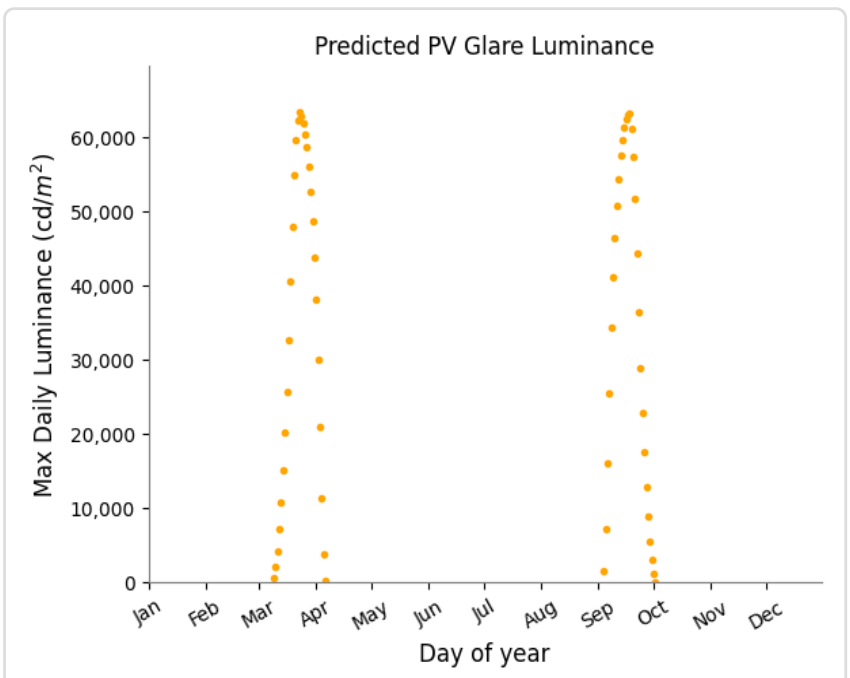
Green glare: 1,259 min.







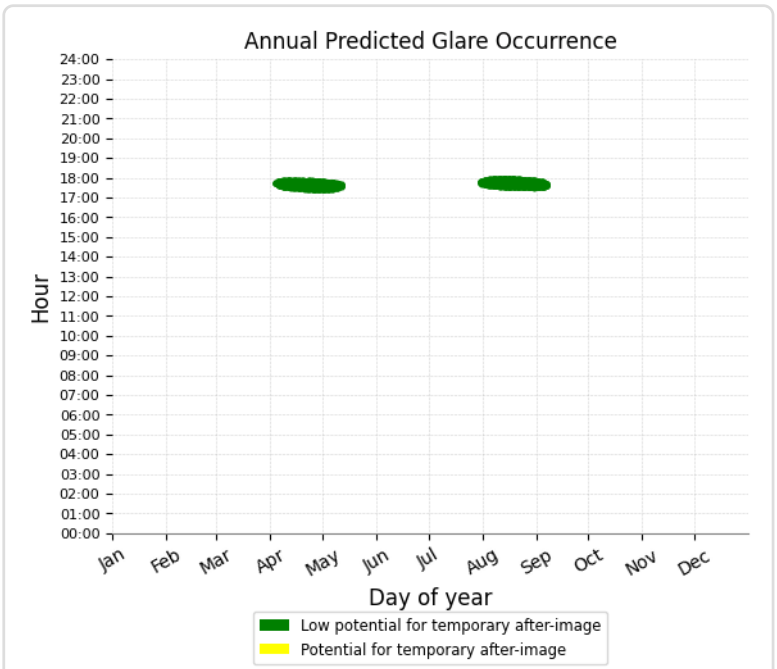


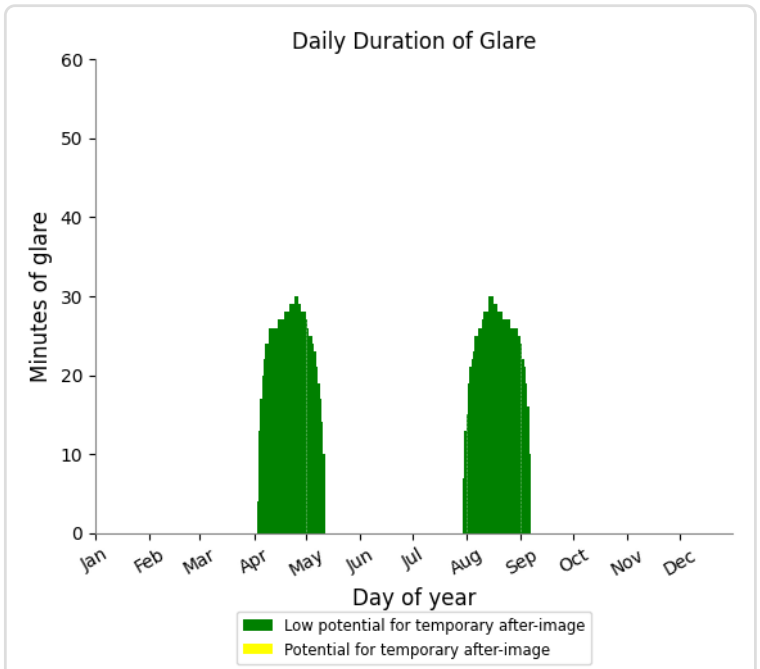


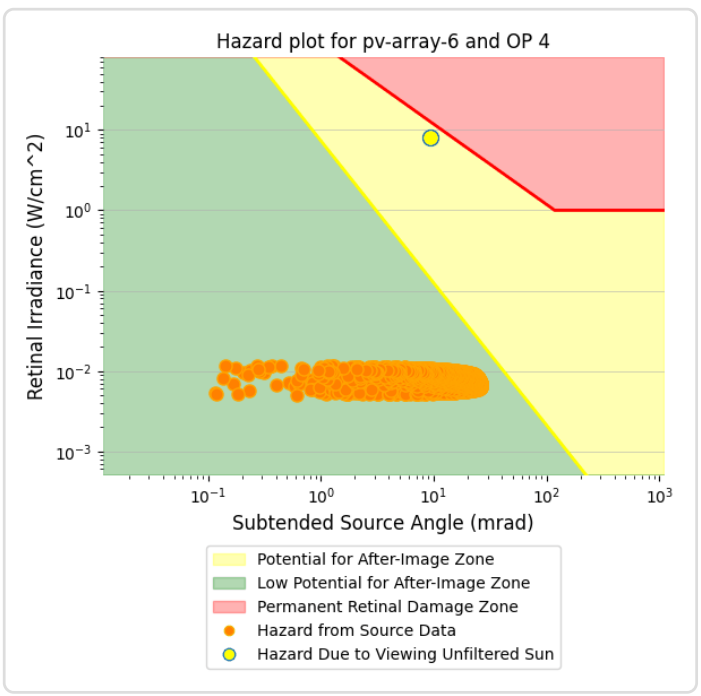
PV array 6 and OP 4

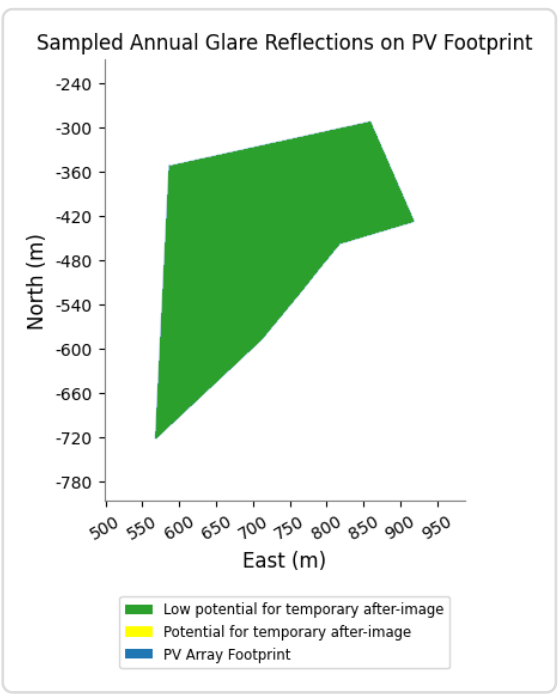
Yellow glare: none

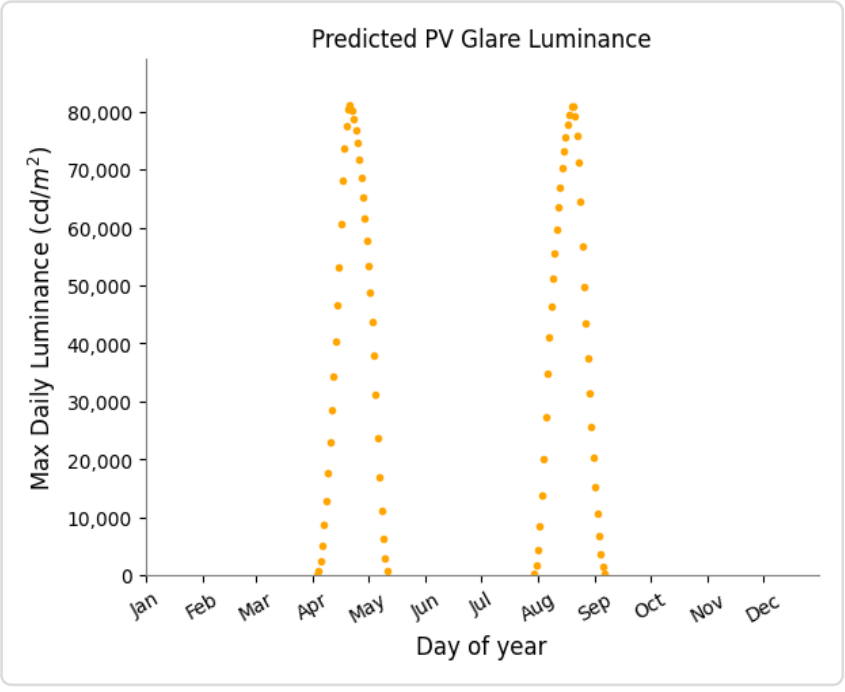
Green glare: 1,877 min.







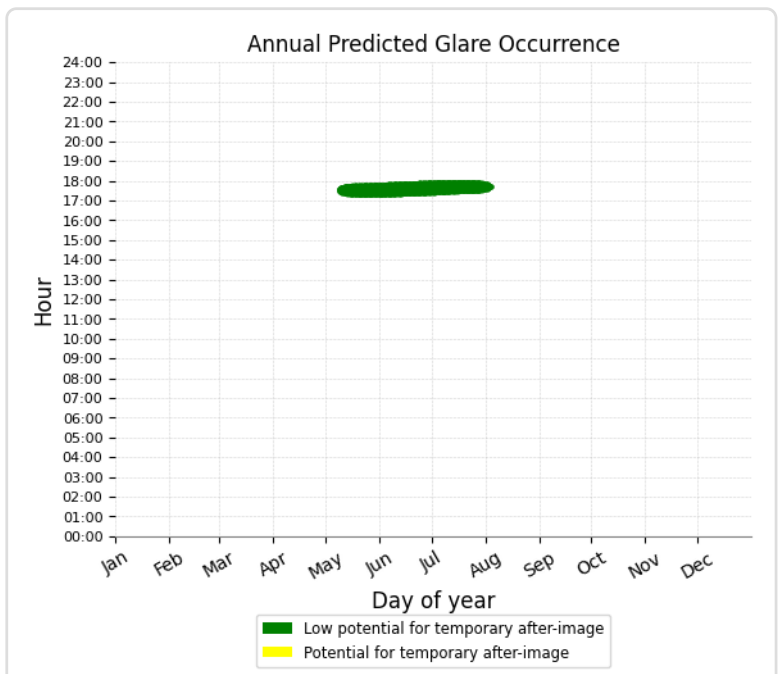


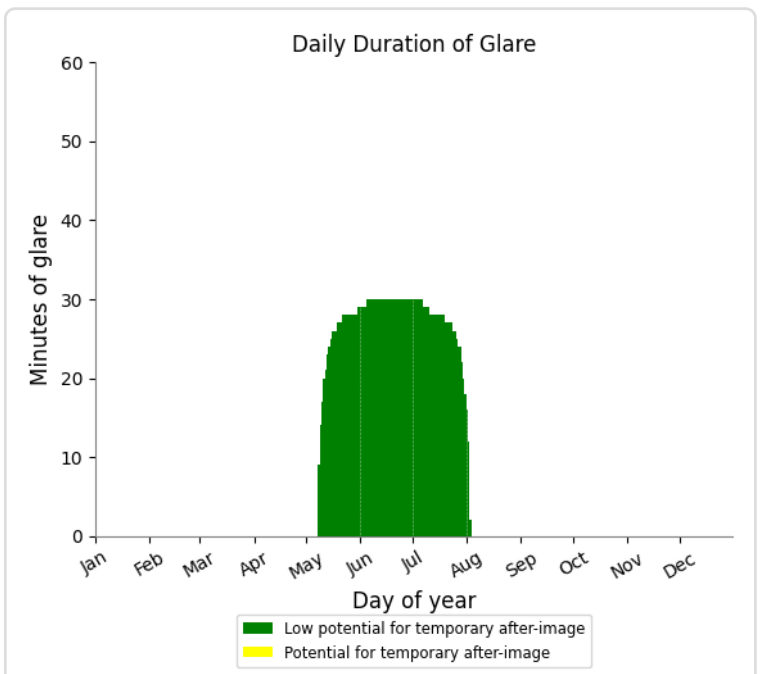


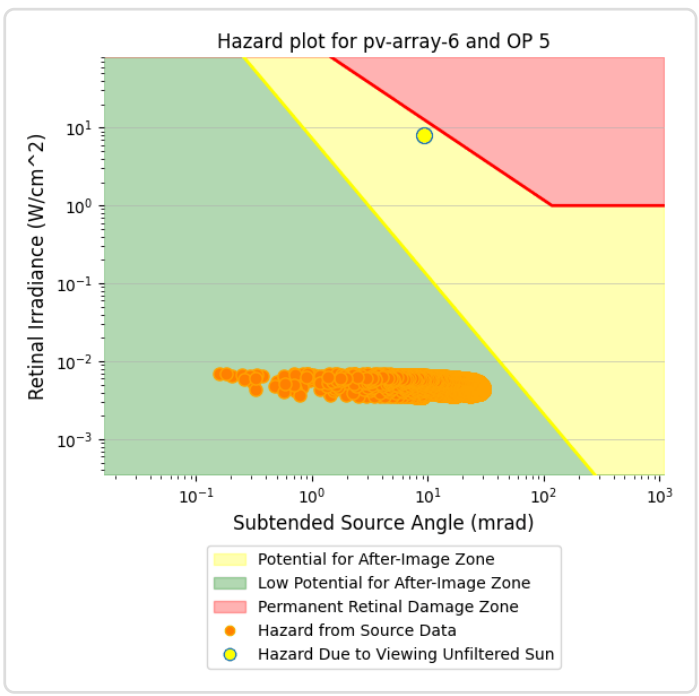
PV array 6 and OP 5

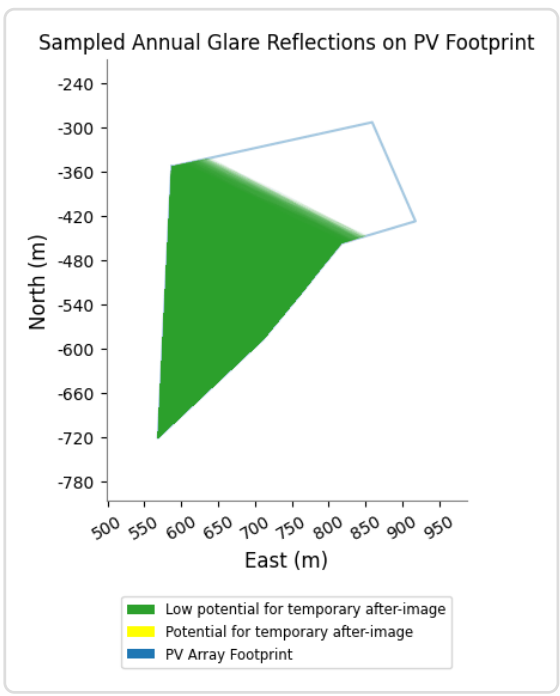
Yellow glare: none

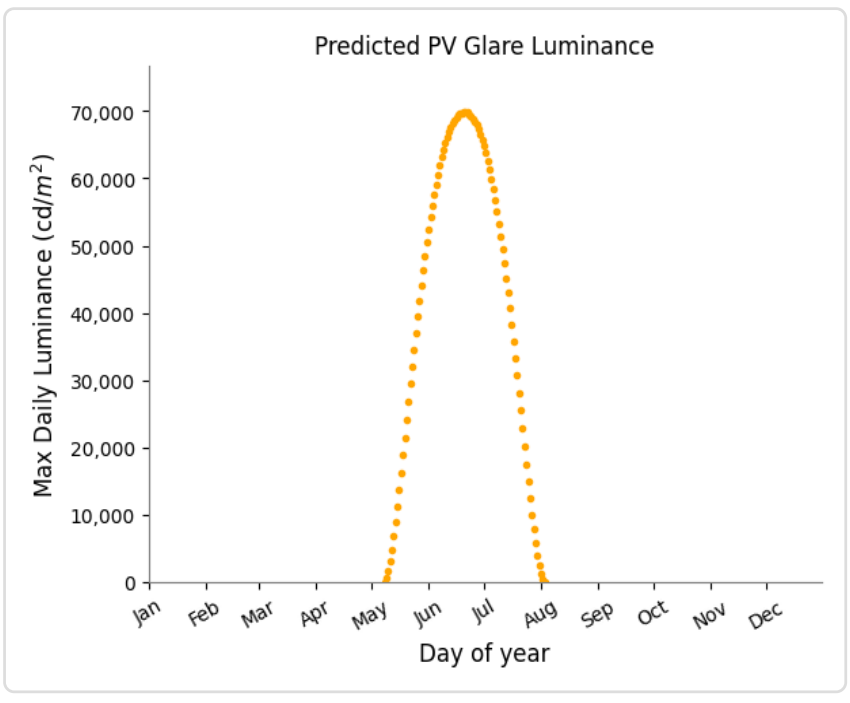
Green glare: 2,360 min.







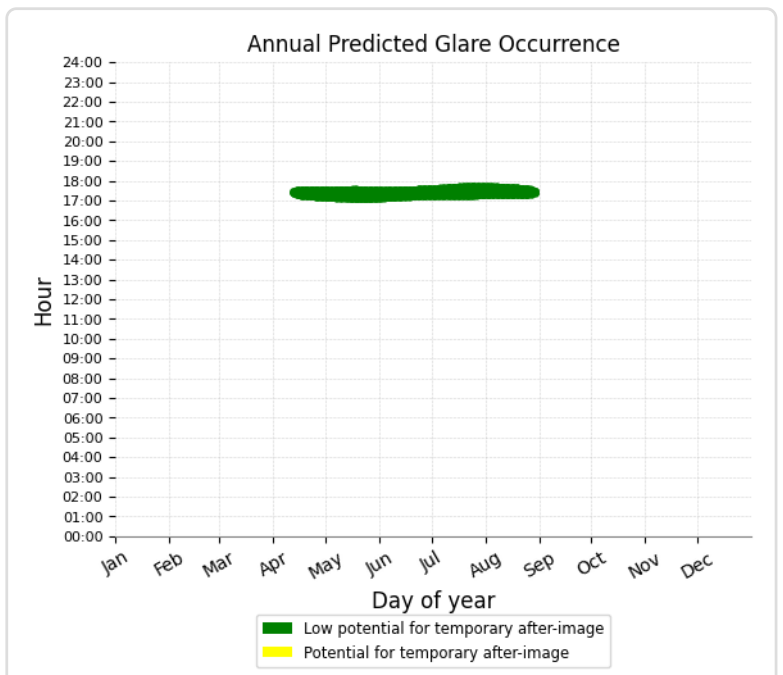


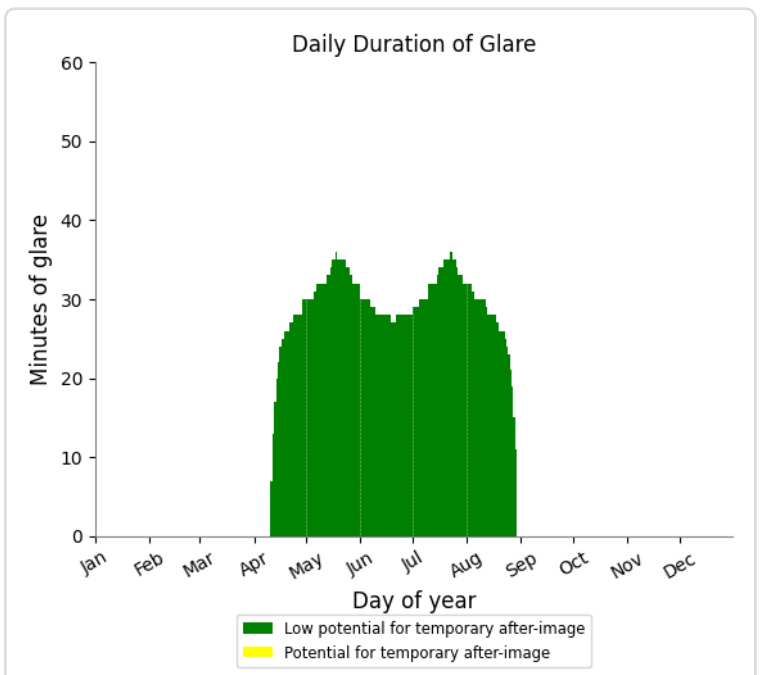


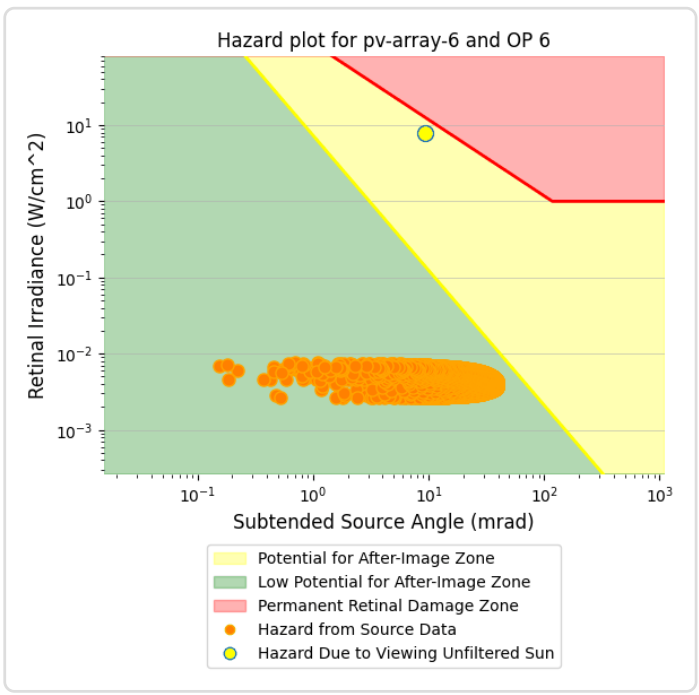
PV array 6 and OP 6

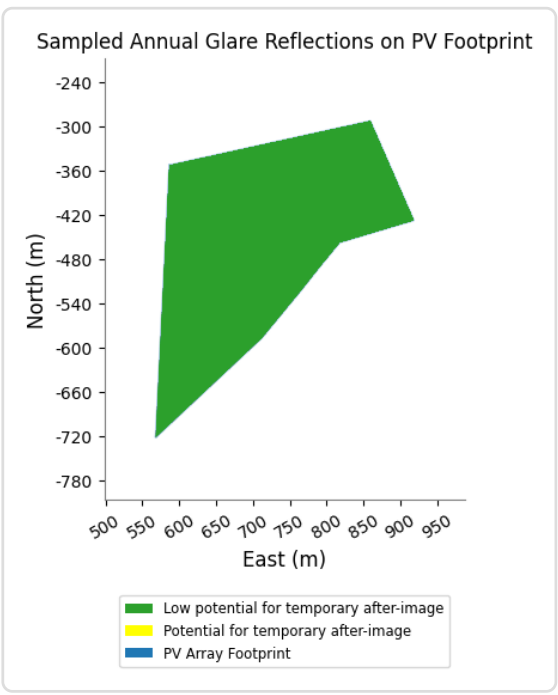
Yellow glare: none

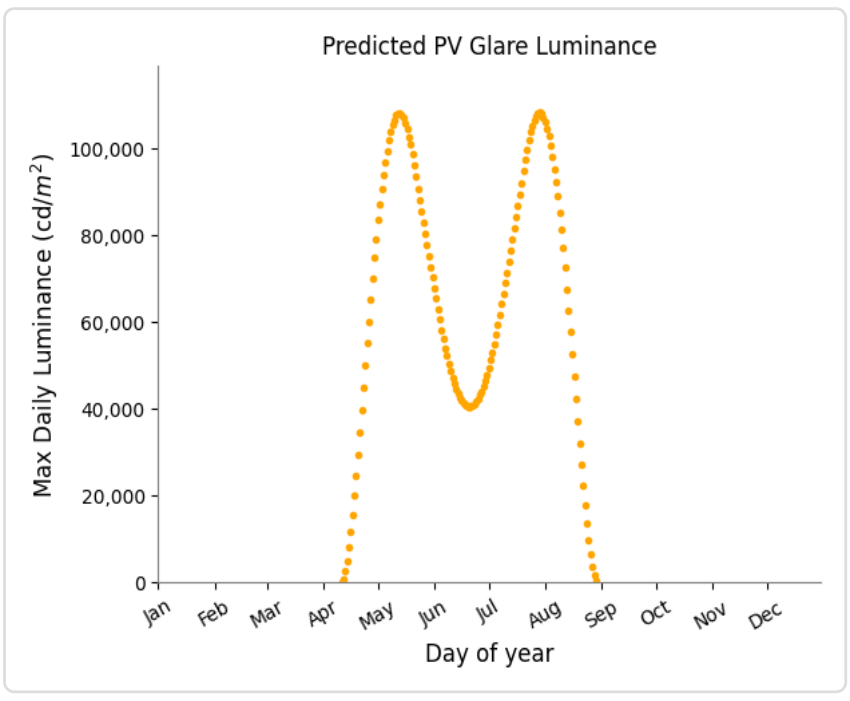
Green glare: 4,134 min.







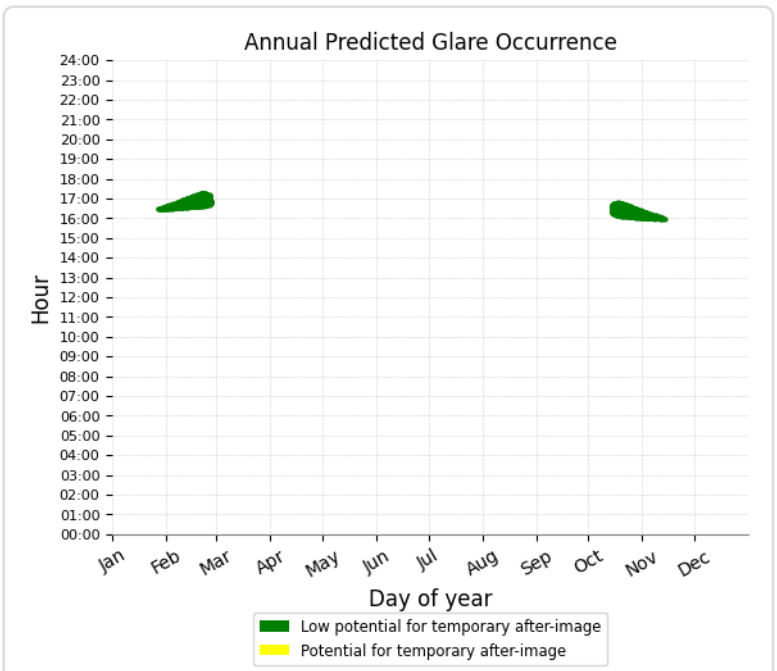


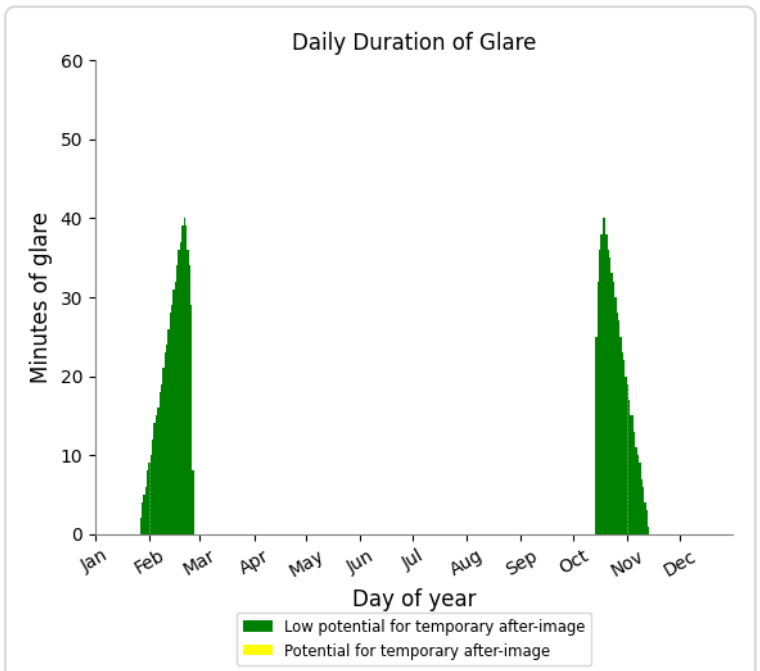


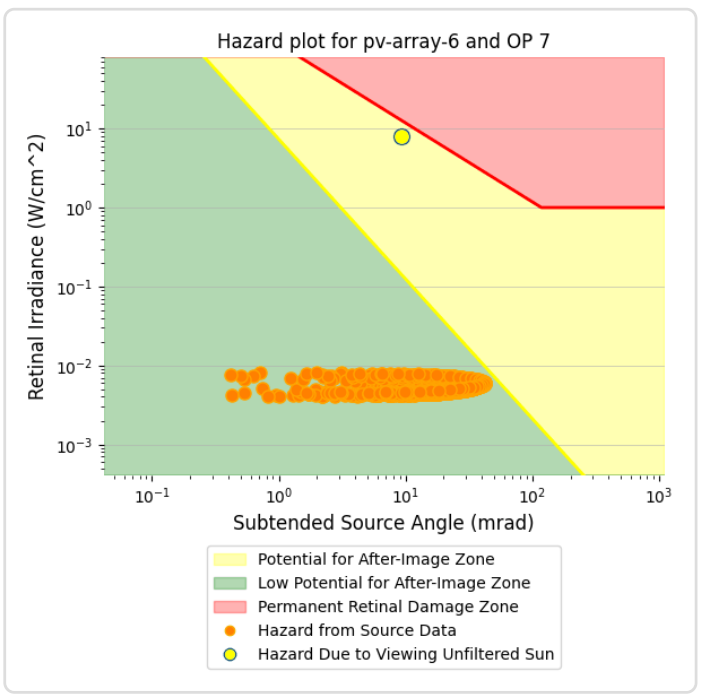
PV array 6 and OP 7

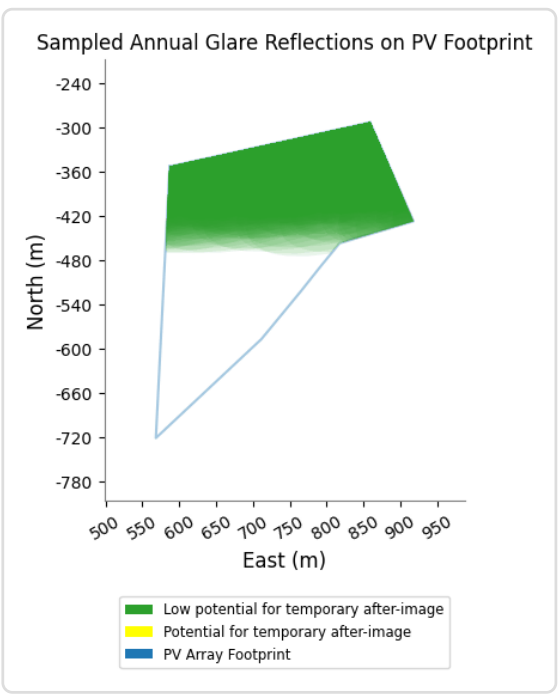
Yellow glare: none

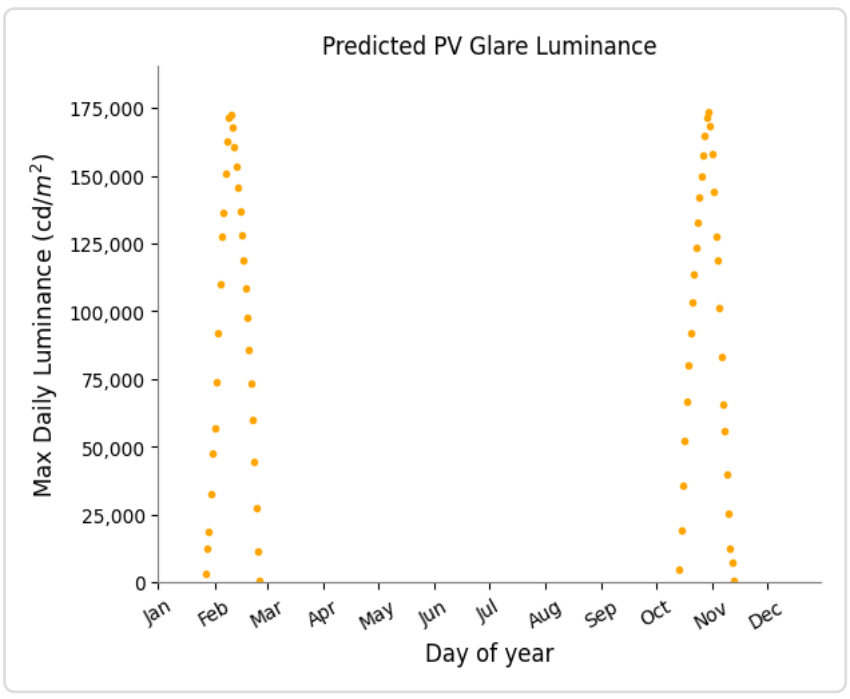
Green glare: 1,374 min.







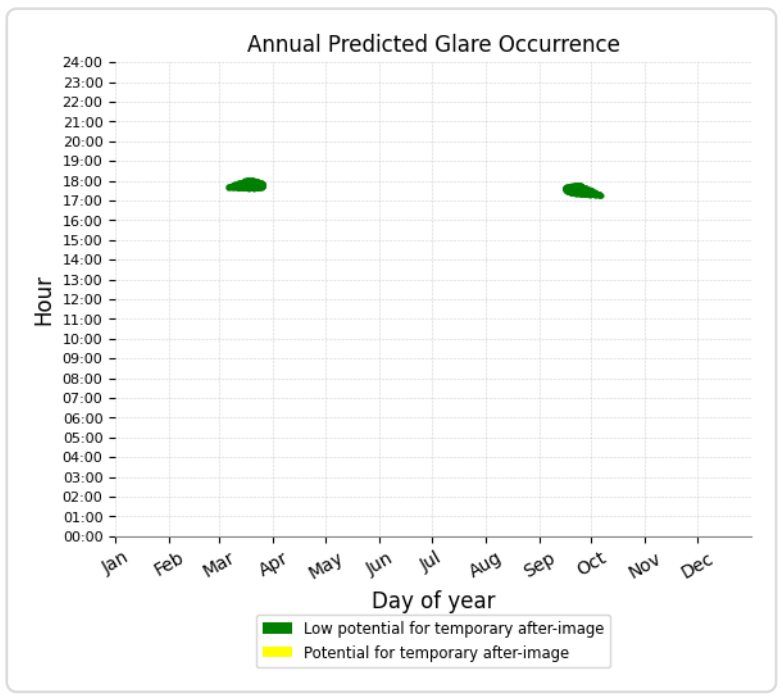


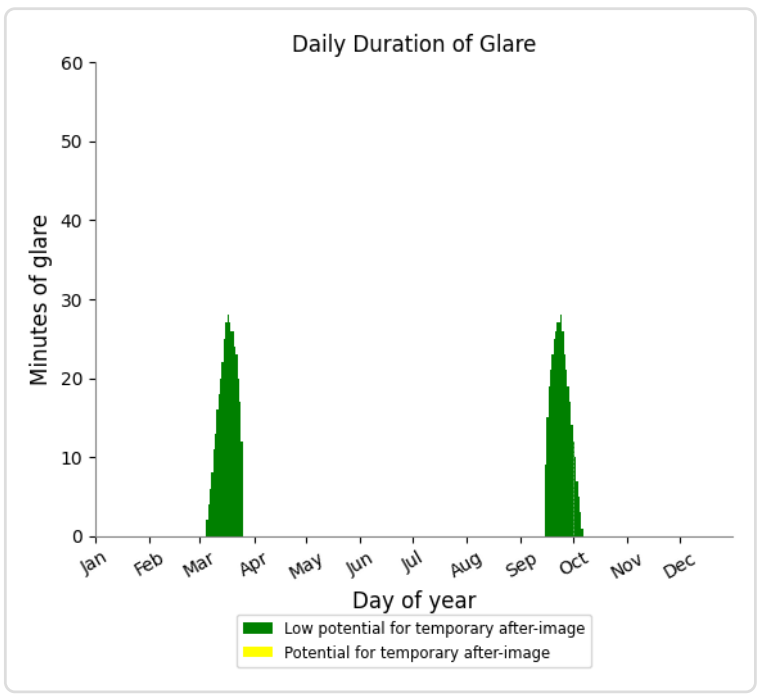


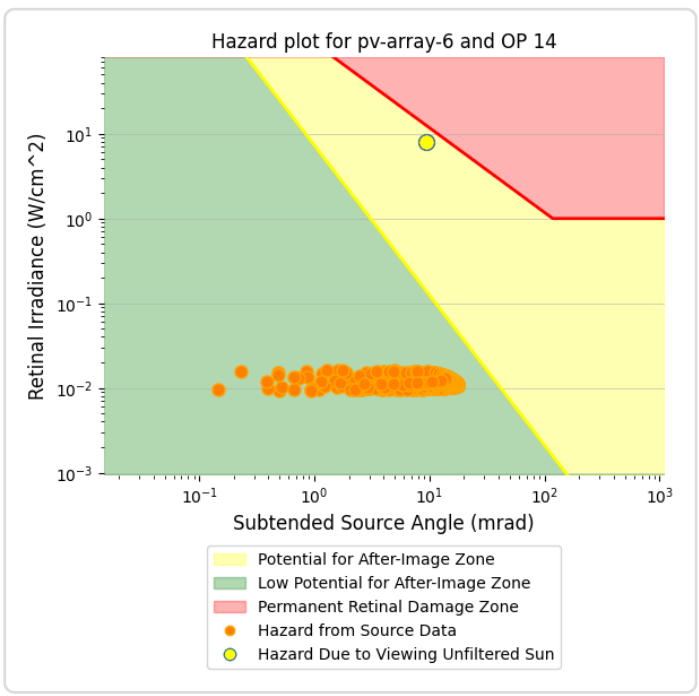
PV array 6 and OP 14

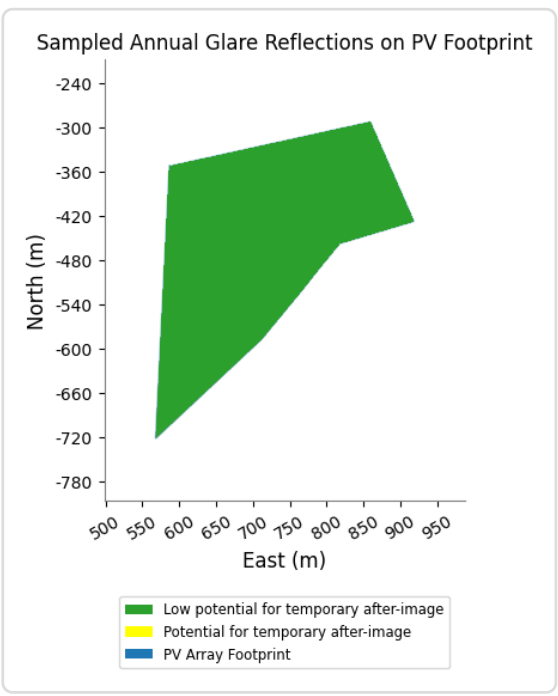
Yellow glare: none

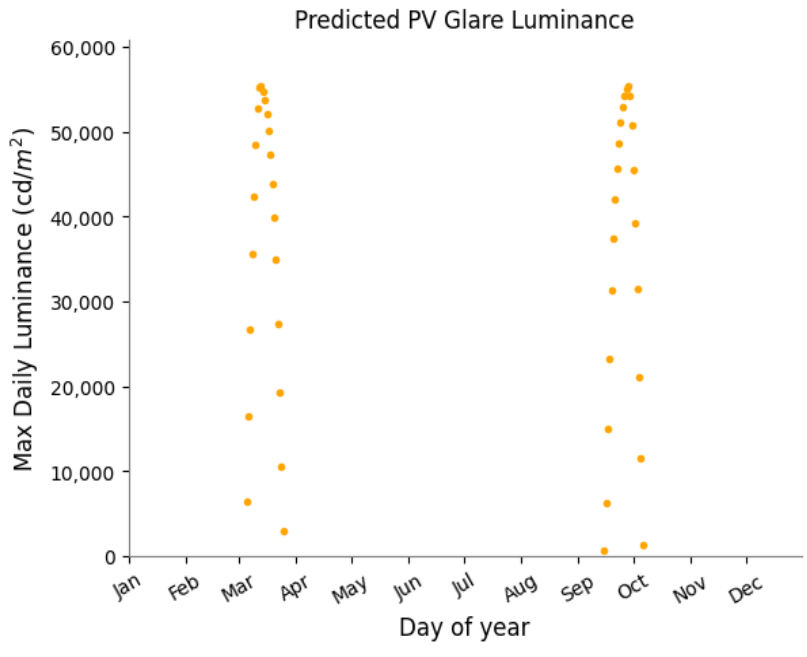
Green glare: 753 min.







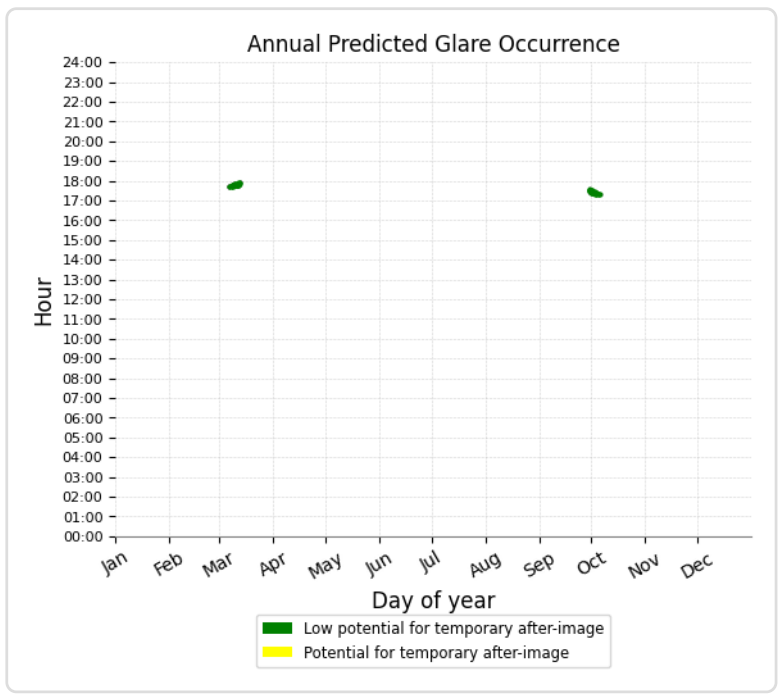


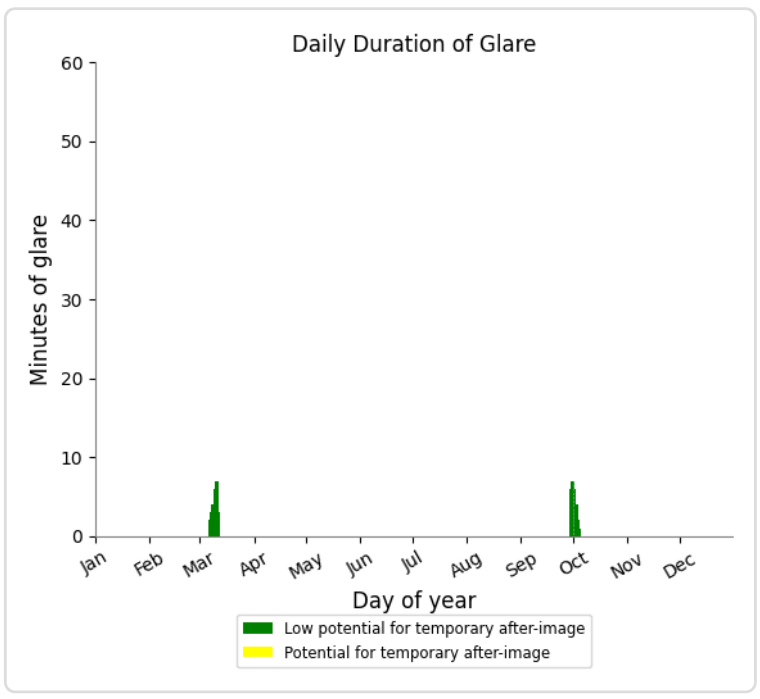


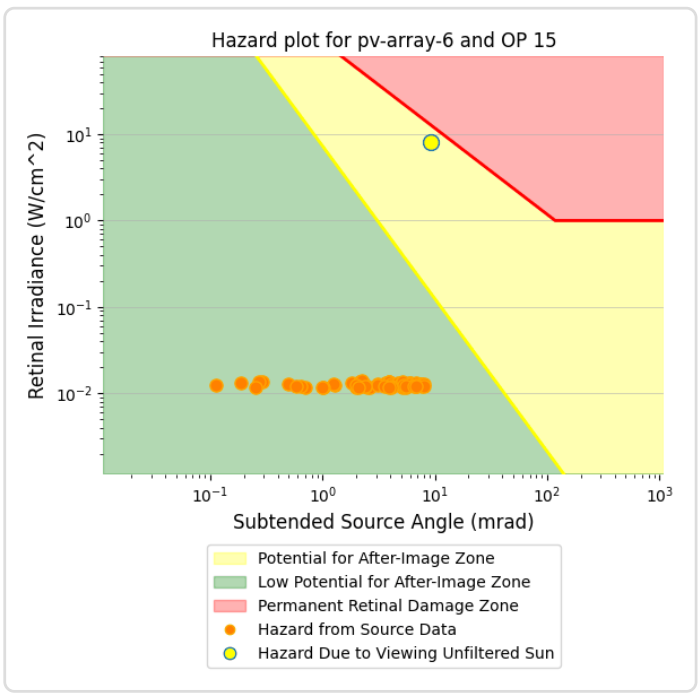
PV array 6 and OP 15

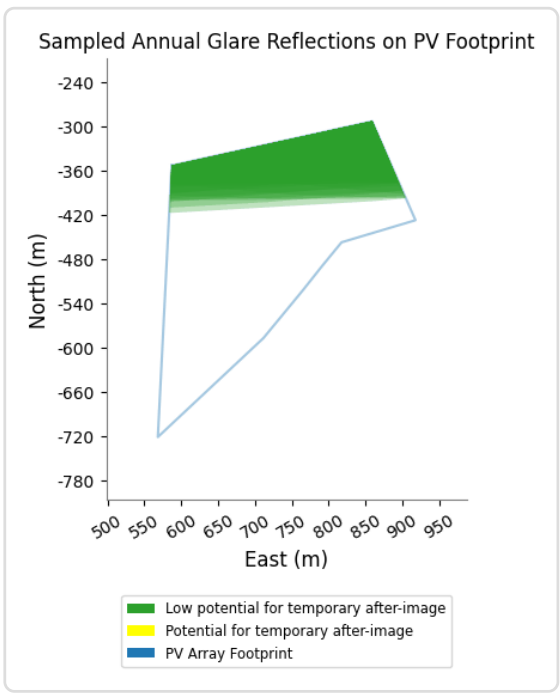
Yellow glare: none

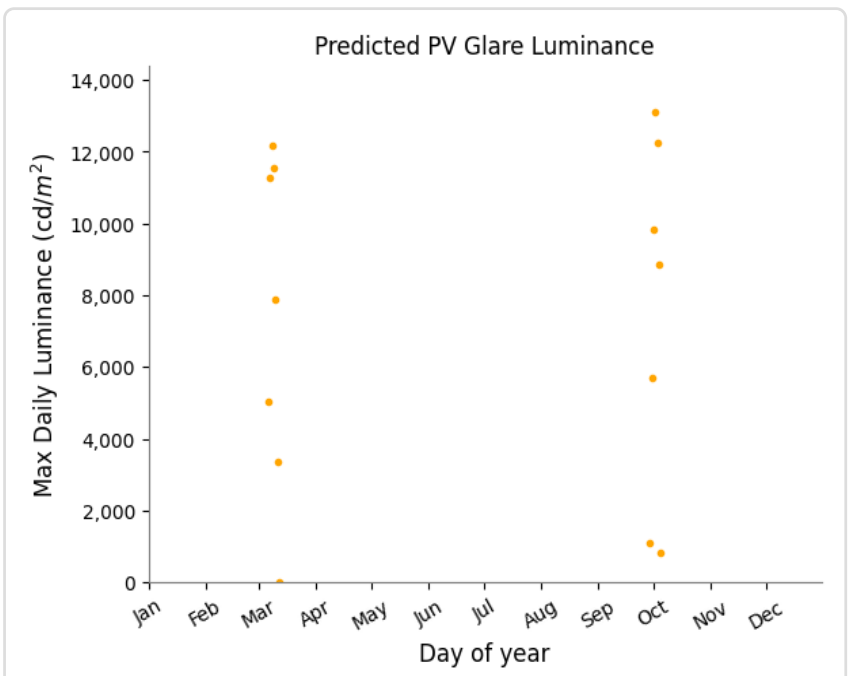
Green glare: 65 min.











PV array 6 and OP 1

No glare found

PV array 6 and OP 2

No glare found

PV array 6 and OP 8

No glare found

PV array 6 and OP 9

No glare found

PV array 6 and OP 10

No glare found

PV array 6 and OP 11

No glare found

PV array 6 and OP 12

No glare found

PV array 6 and OP 13

No glare found

PV array 6 and OP 16

No glare found

PV array 6 and OP 17

No glare found

PV array 6 and OP 18

No glare found

PV array 6 and OP 19

No glare found

PV array 6 and OP 20

No glare found

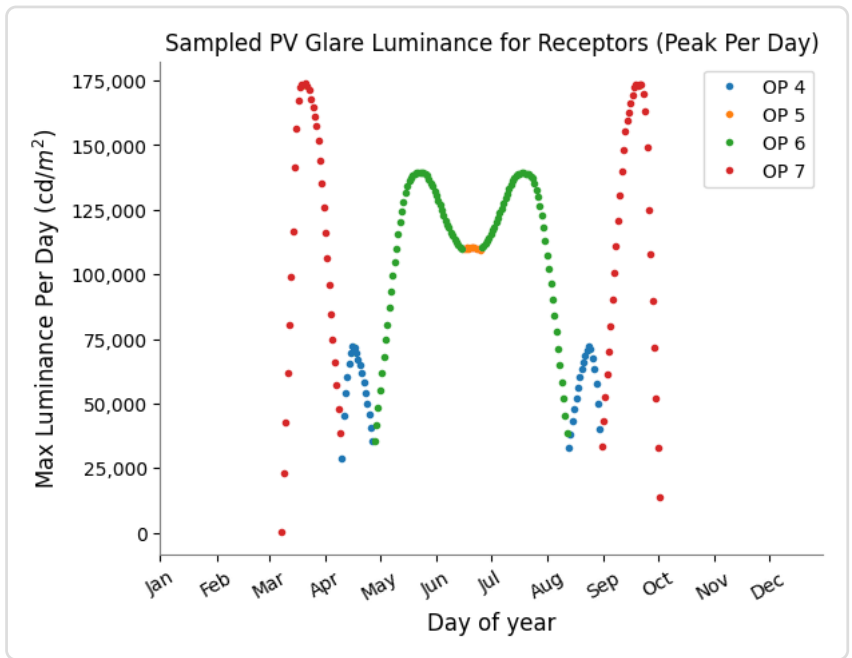
PV array 6 and OP 21

No glare found

PV: PV array 7 low potential for temporary after-image

Receptor results ordered by category of glare

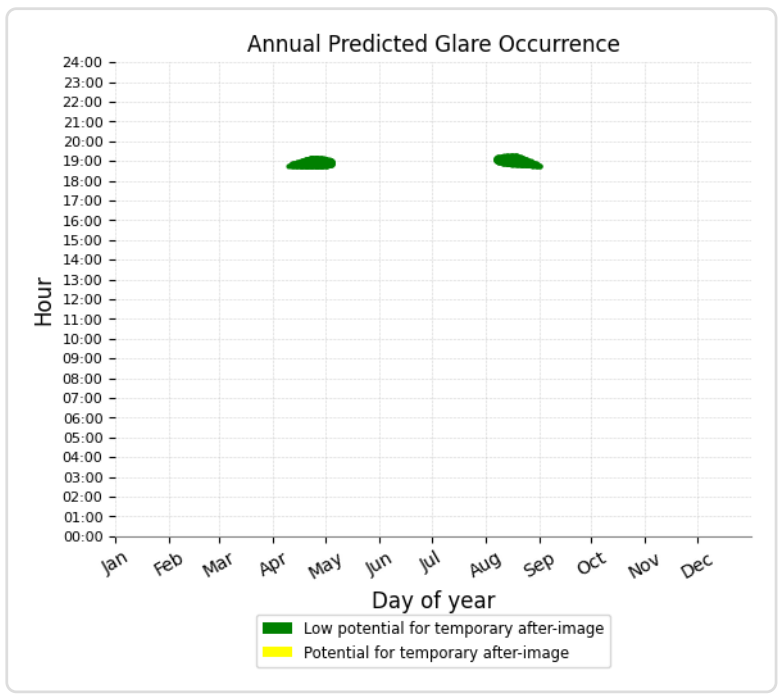
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 4	945	15.8	0	0.0	72,248
OP 5	2,489	41.5	0	0.0	110,273
OP 6	3,639	60.6	0	0.0	139,430
OP 7	1,956	32.6	0	0.0	173,846
OP 1	0	0.0	0	0.0	0
OP 2	0	0.0	0	0.0	0
OP 3	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 13	0	0.0	0	0.0	0
OP 14	0	0.0	0	0.0	0
OP 15	0	0.0	0	0.0	0
OP 16	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

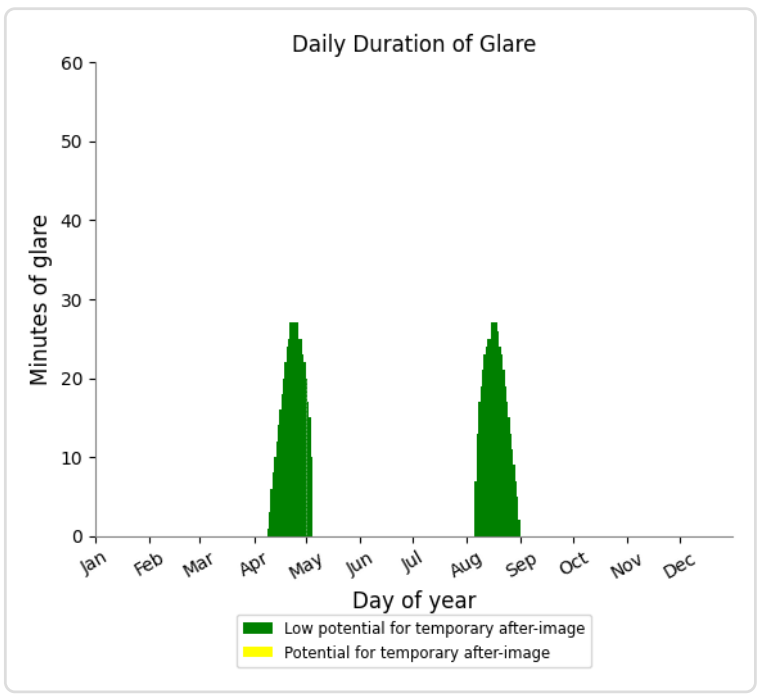


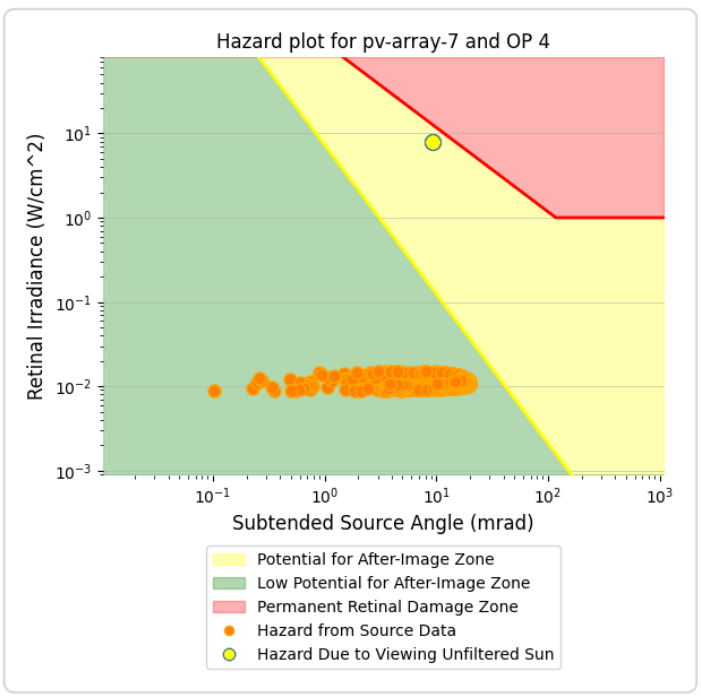
PV array 7 and OP 4

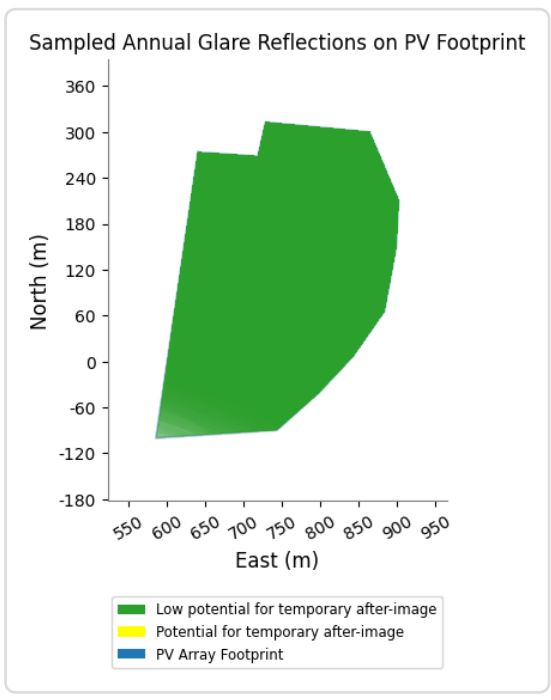
Yellow glare: none

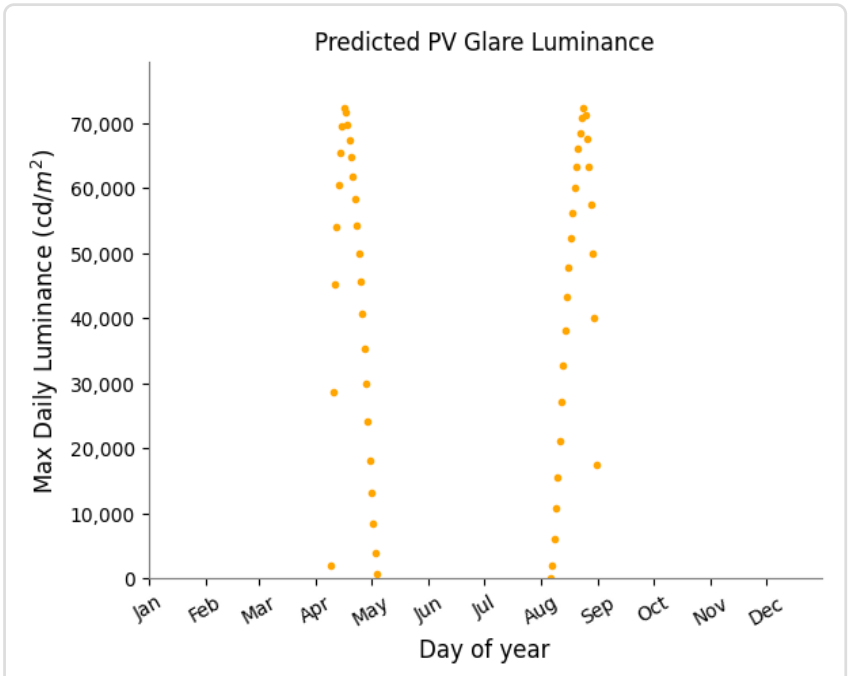
Green glare: 945 min.







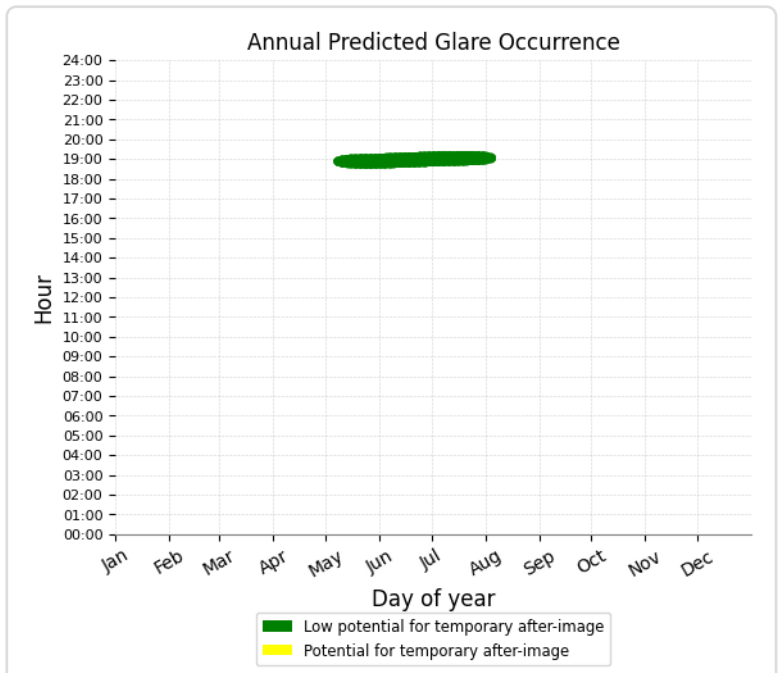


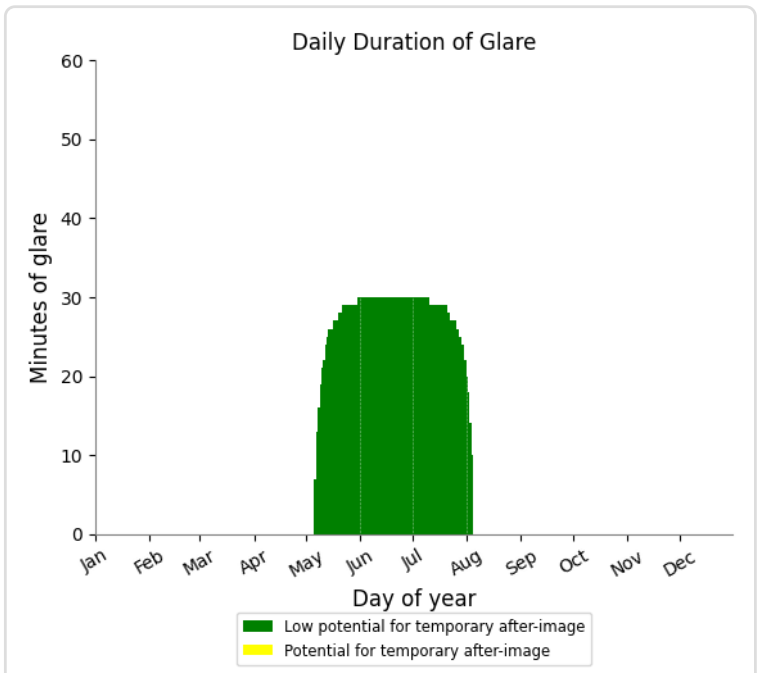


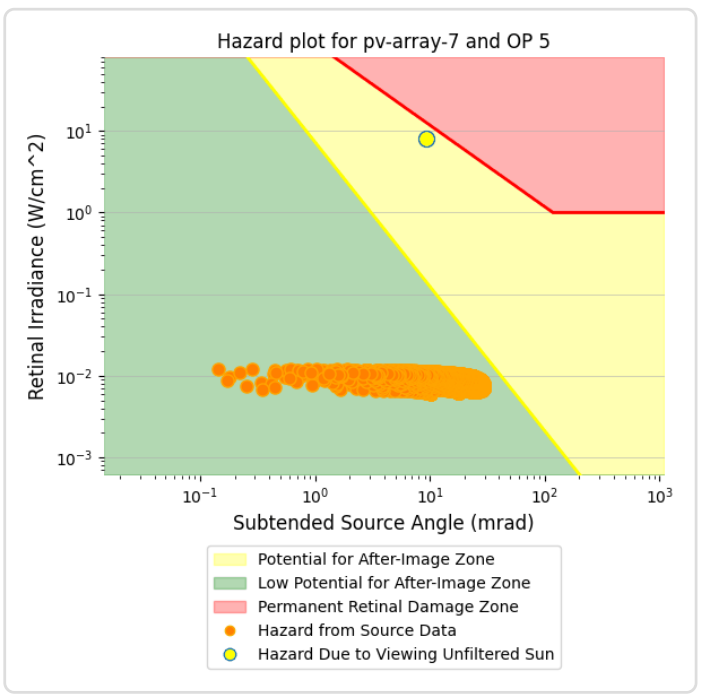
PV array 7 and OP 5

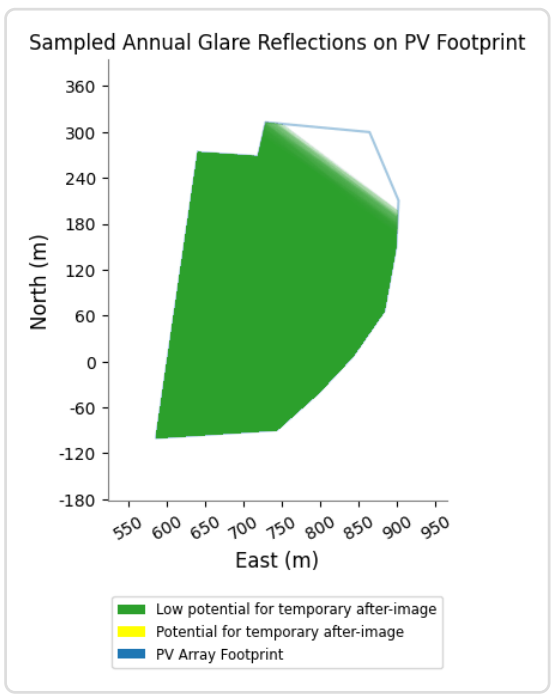
Yellow glare: none

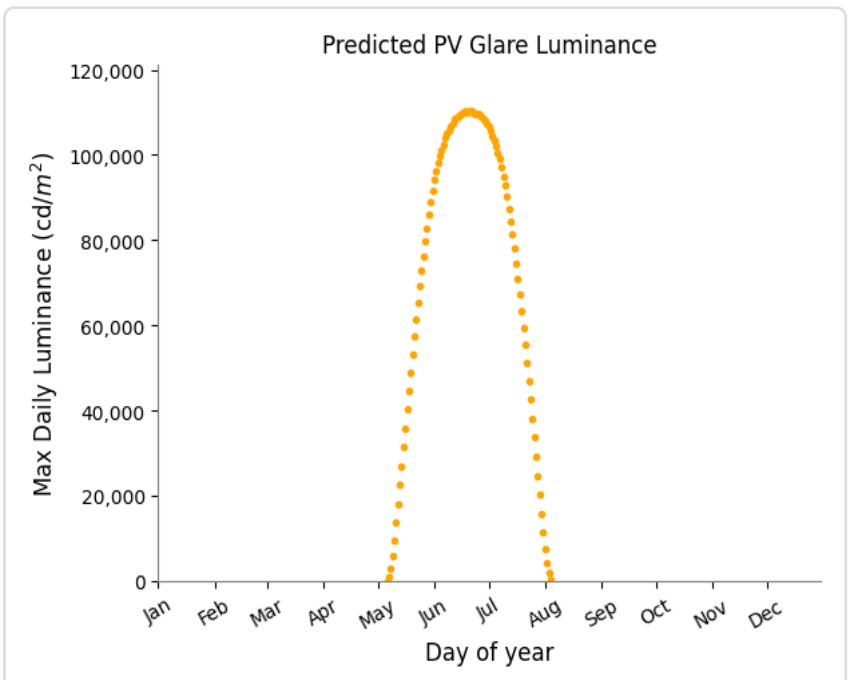
Green glare: 2,489 min.







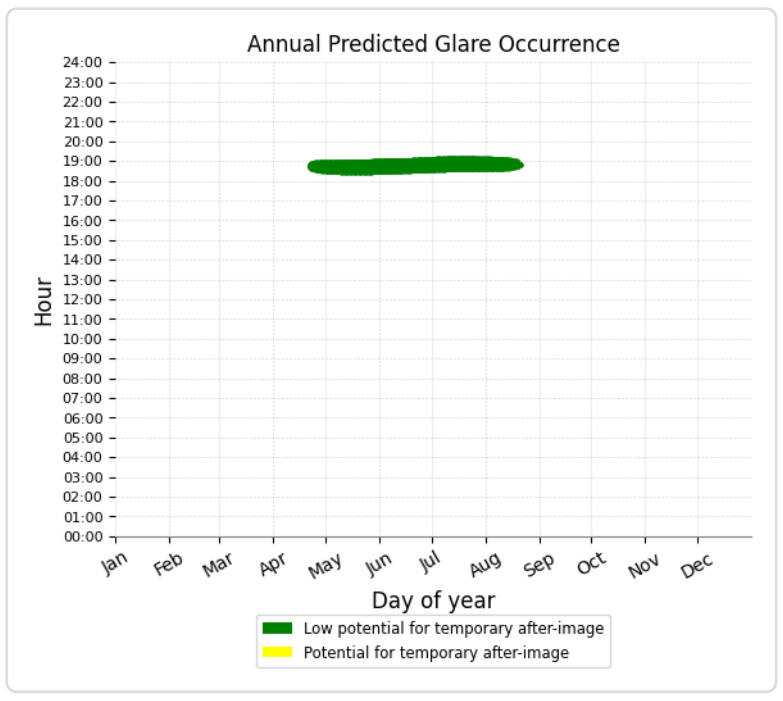


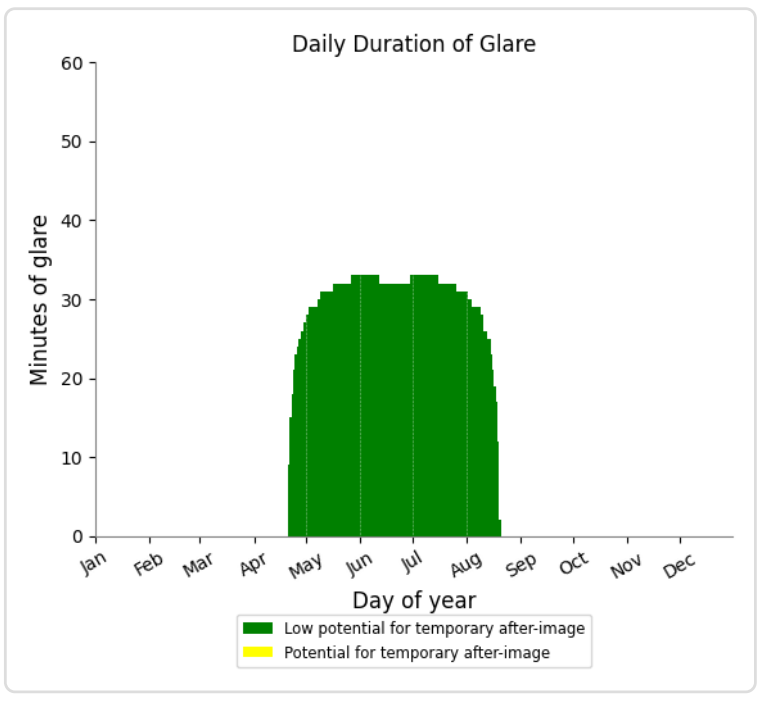


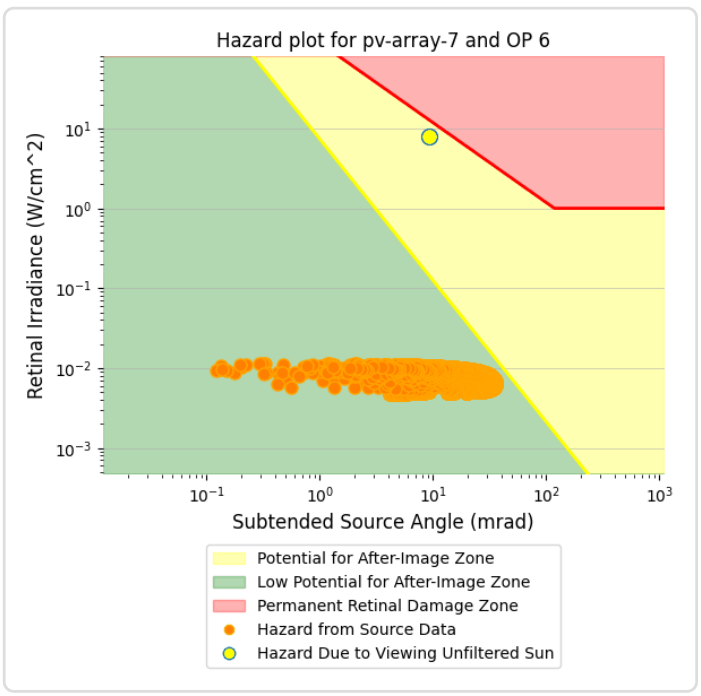
PV array 7 and OP 6

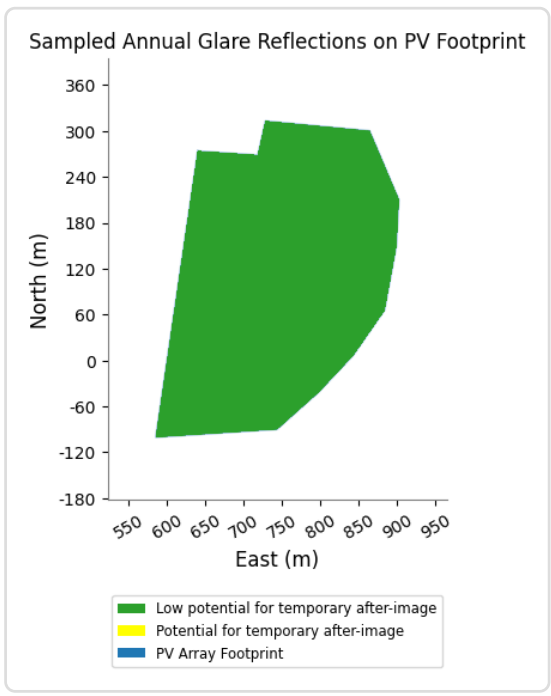
Yellow glare: none

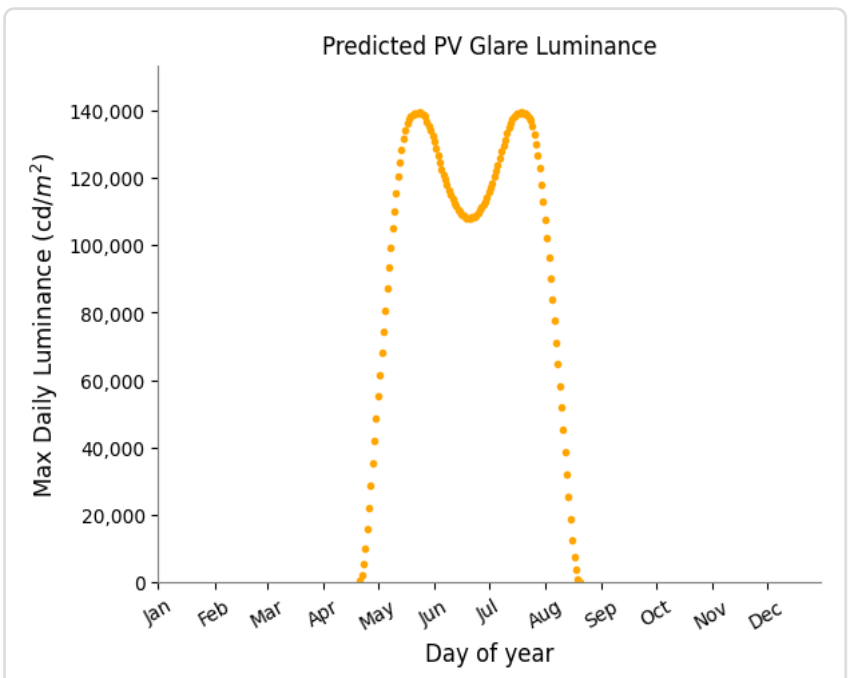
Green glare: 3,639 min.







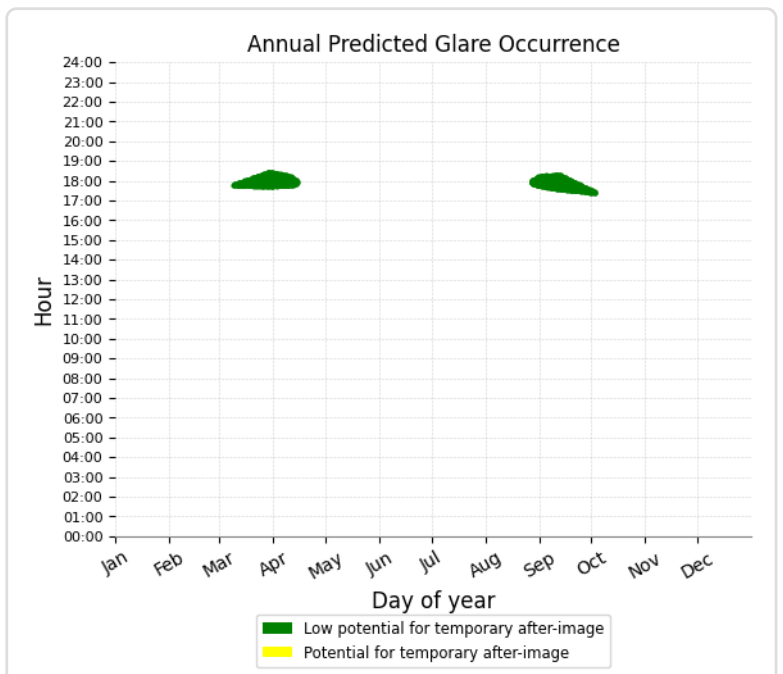


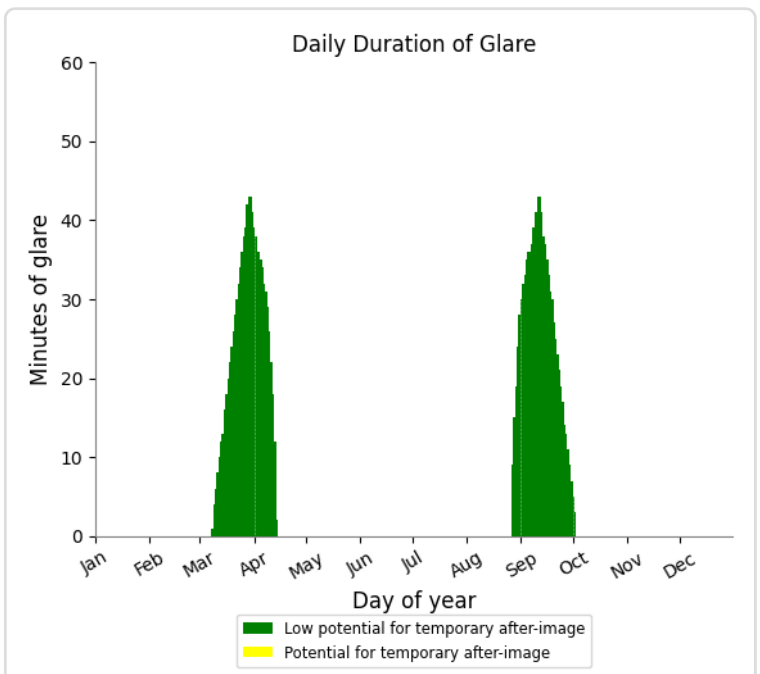


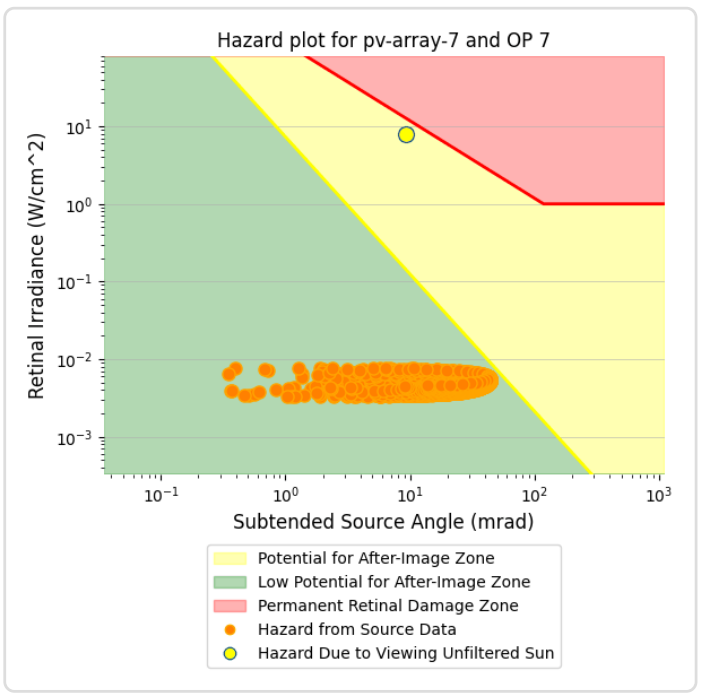
PV array 7 and OP 7

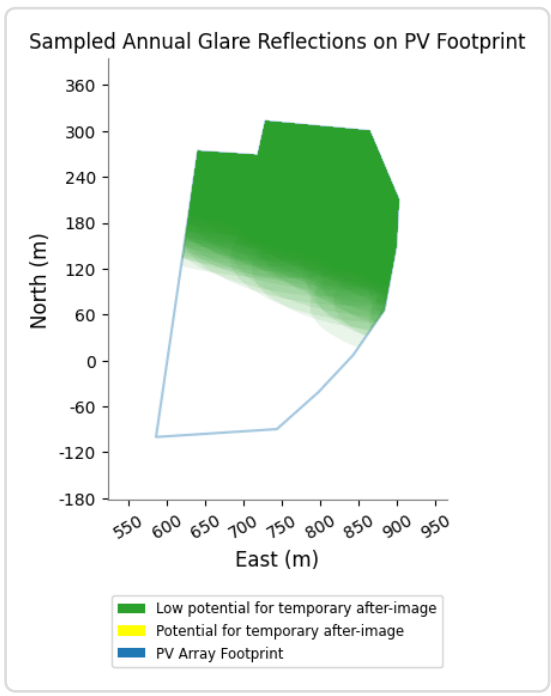
Yellow glare: none

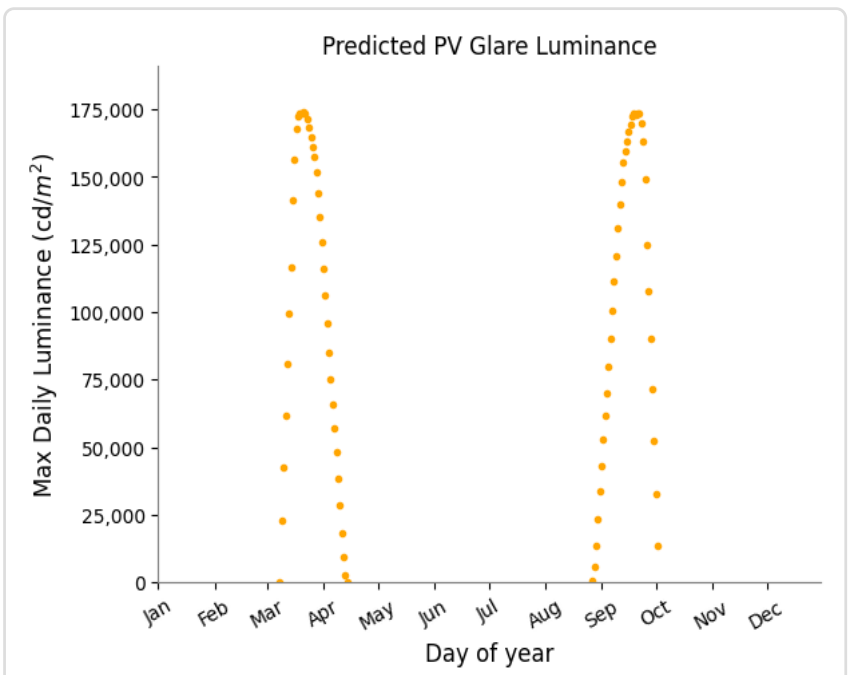
Green glare: 1,956 min.











PV array 7 and OP 1

No glare found

PV array 7 and OP 2

No glare found

PV array 7 and OP 3

No glare found

PV array 7 and OP 8

No glare found

PV array 7 and OP 9

No glare found

PV array 7 and OP 10

No glare found

PV array 7 and OP 11

No glare found

PV array 7 and OP 12

No glare found

PV array 7 and OP 13

No glare found

PV array 7 and OP 14

No glare found

PV array 7 and OP 15

No glare found

PV array 7 and OP 16

No glare found

PV array 7 and OP 17

No glare found

PV array 7 and OP 18

No glare found

PV array 7 and OP 19

No glare found

PV array 7 and OP 20

No glare found

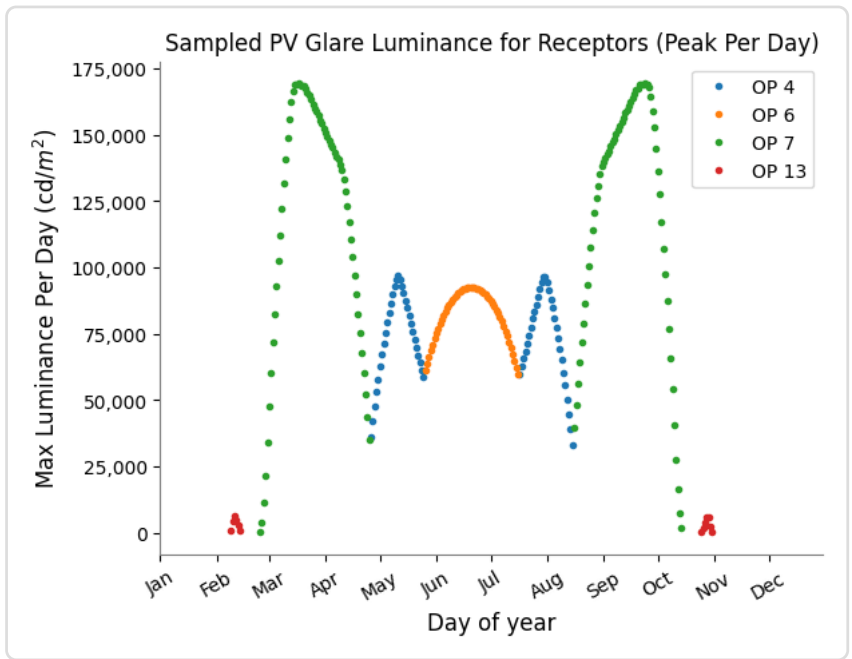
PV array 7 and OP 21

No glare found

PV: PV array 8 low potential for temporary after-image

Receptor results ordered by category of glare

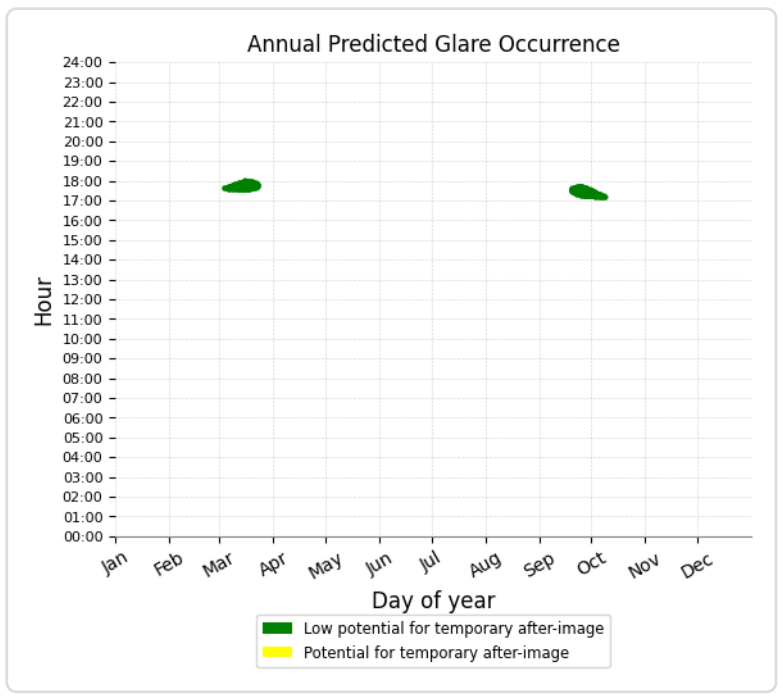
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 2	643	10.7	0	0.0	76,694
OP 3	1,518	25.3	0	0.0	89,909
OP 4	3,146	52.4	0	0.0	96,814
OP 5	31	0.5	0	0.0	46
OP 6	2,288	38.1	0	0.0	92,504
OP 7	4,333	72.2	0	0.0	169,260
OP 13	30	0.5	0	0.0	6,142
OP 14	1,443	24.1	0	0.0	85,935
OP 15	757	12.6	0	0.0	54,213
OP 16	64	1.1	0	0.0	11,447
OP 1	0	0.0	0	0.0	0
OP 8	0	0.0	0	0.0	0
OP 9	0	0.0	0	0.0	0
OP 10	0	0.0	0	0.0	0
OP 11	0	0.0	0	0.0	0
OP 12	0	0.0	0	0.0	0
OP 17	0	0.0	0	0.0	0
OP 18	0	0.0	0	0.0	0
OP 19	0	0.0	0	0.0	0
OP 20	0	0.0	0	0.0	0
OP 21	0	0.0	0	0.0	0

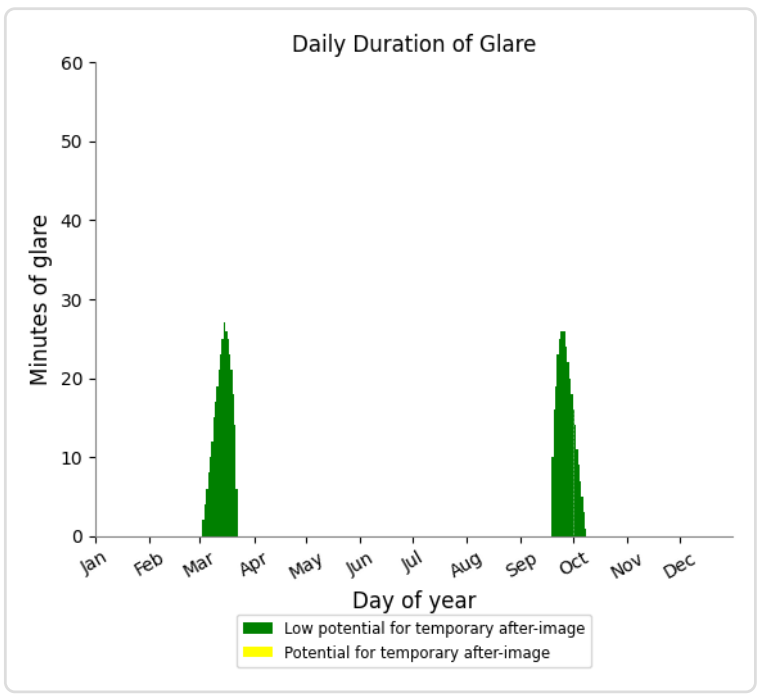


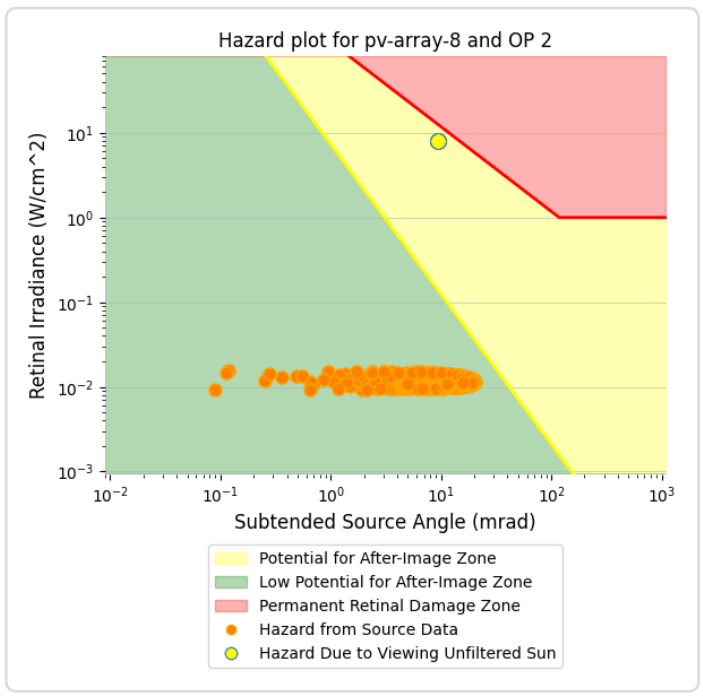
PV array 8 and OP 2

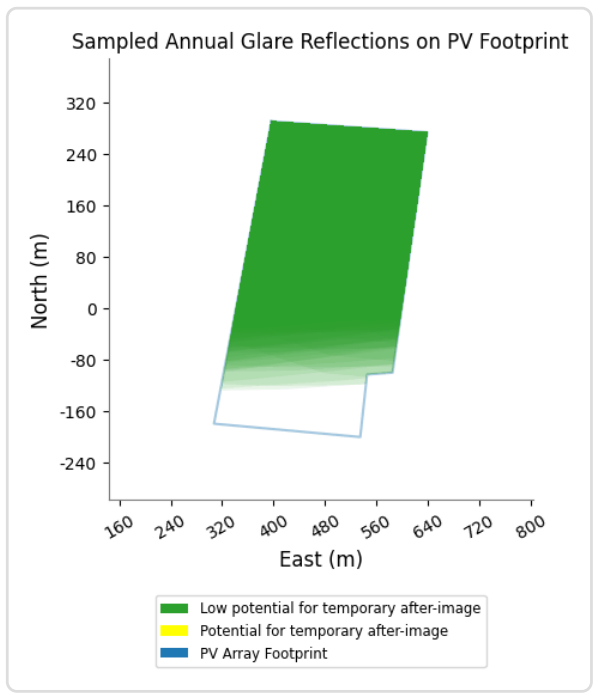
Yellow glare: none

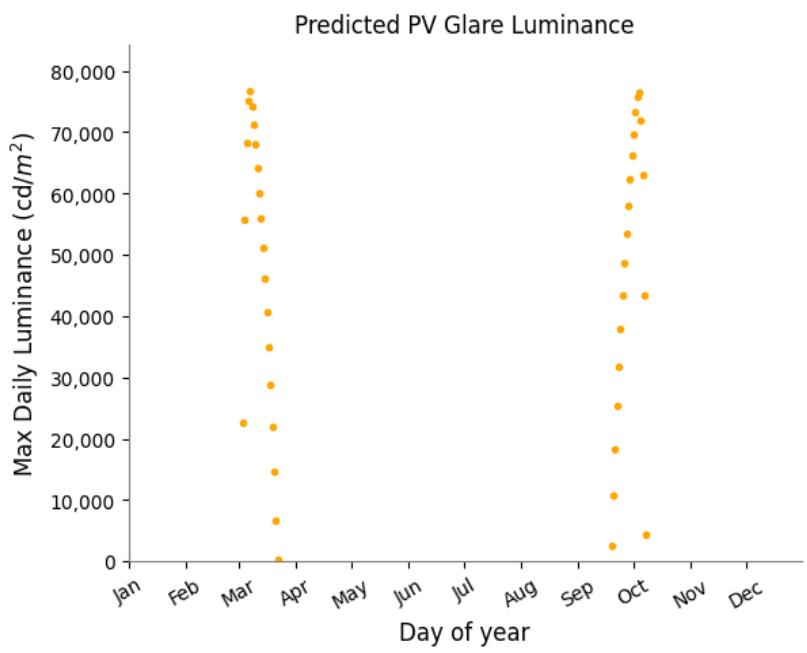
Green glare: 643 min.







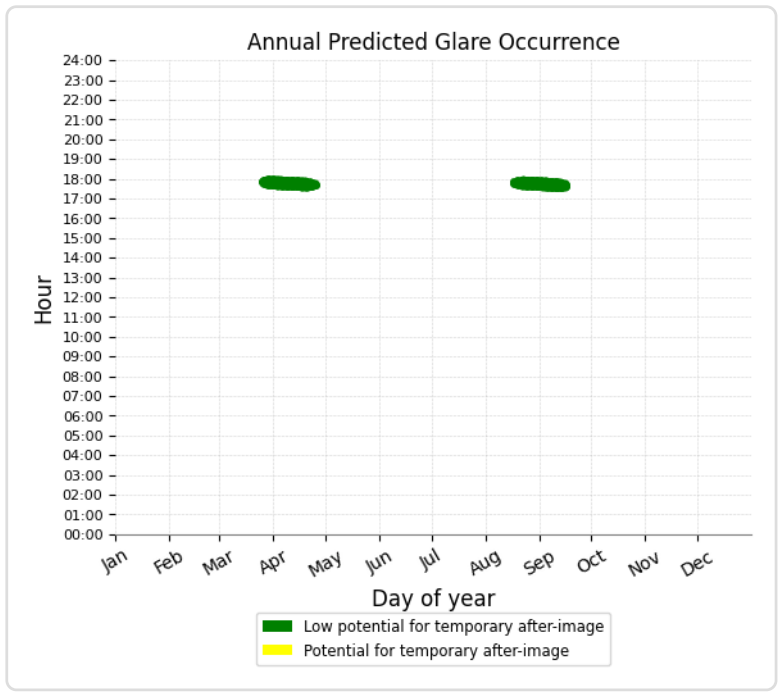


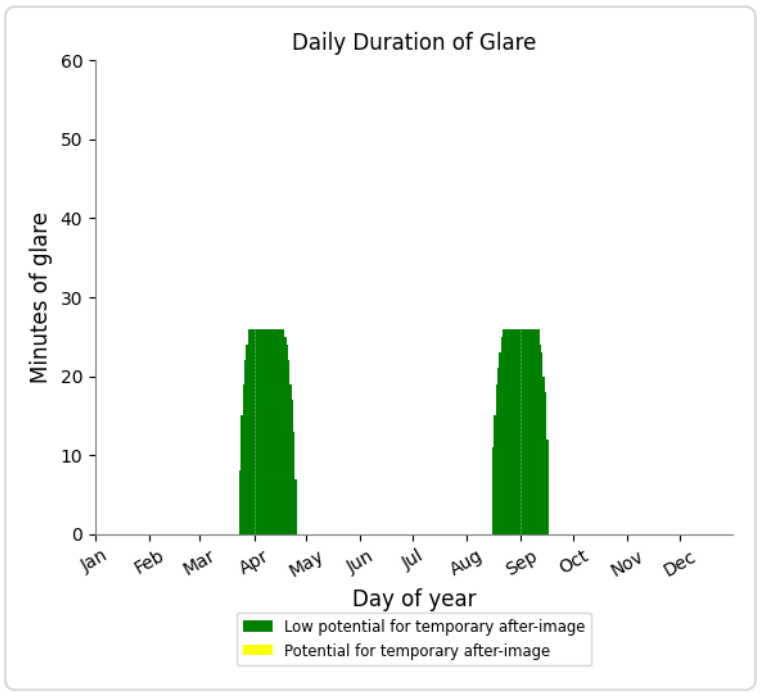


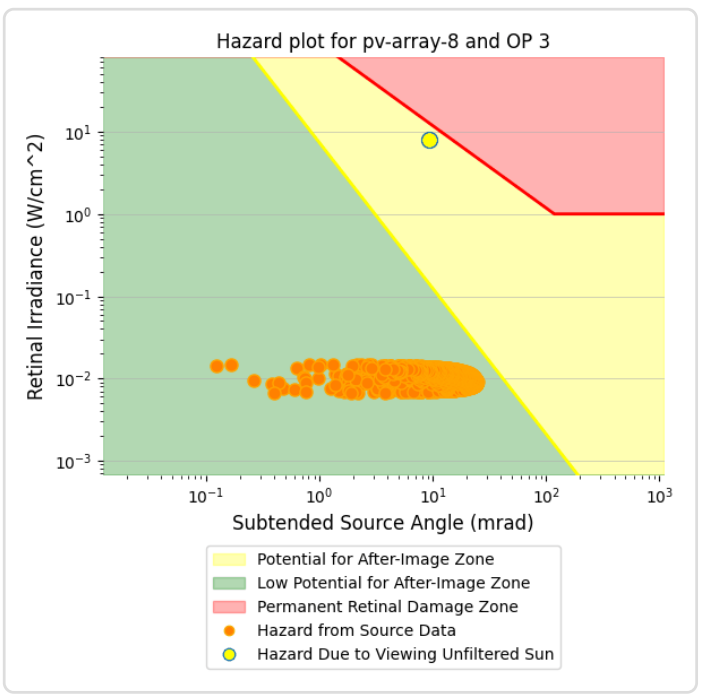
PV array 8 and OP 3

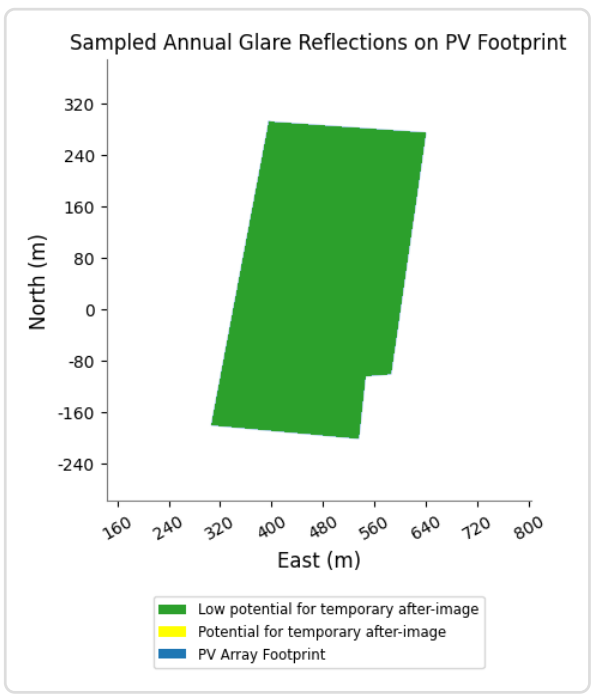
Yellow glare: none

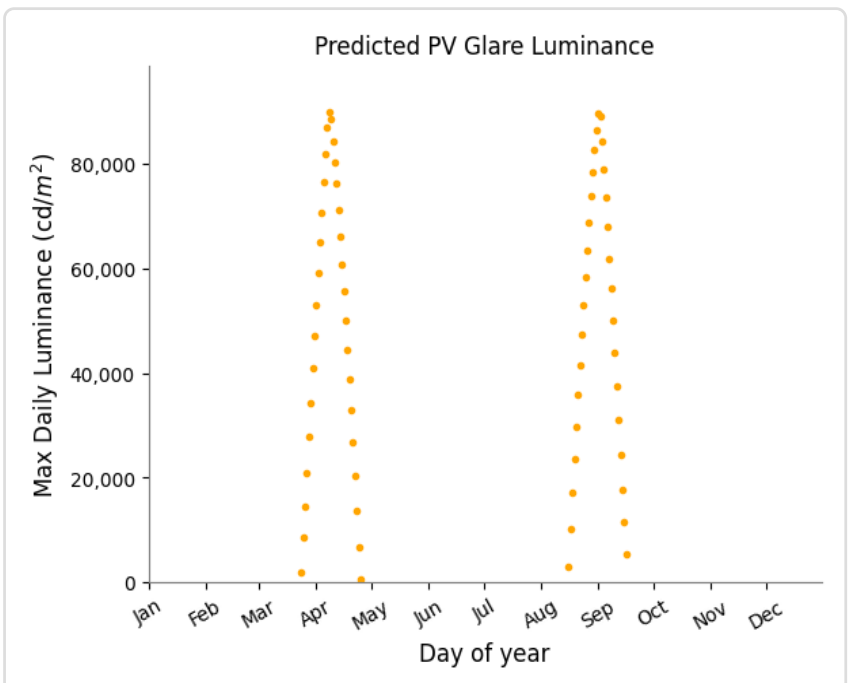
Green glare: 1,518 min.







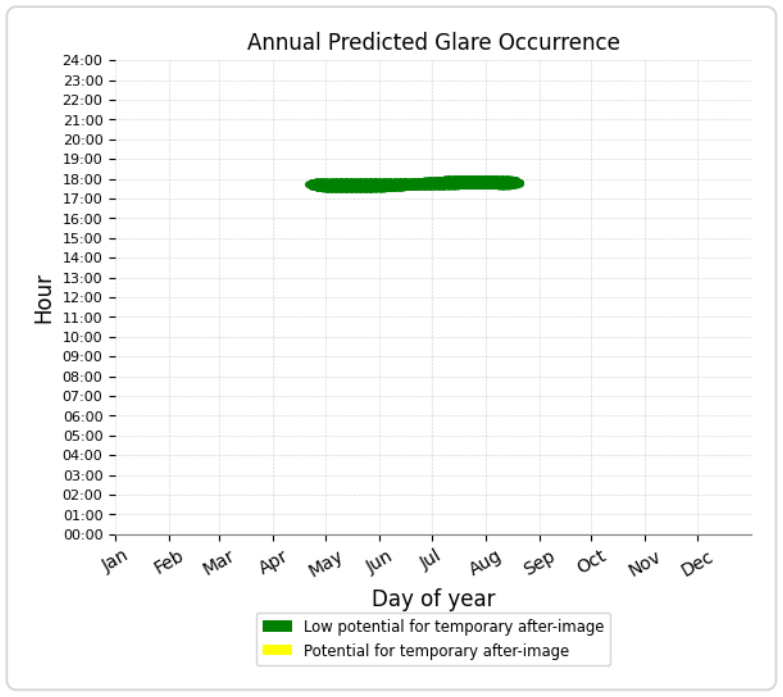


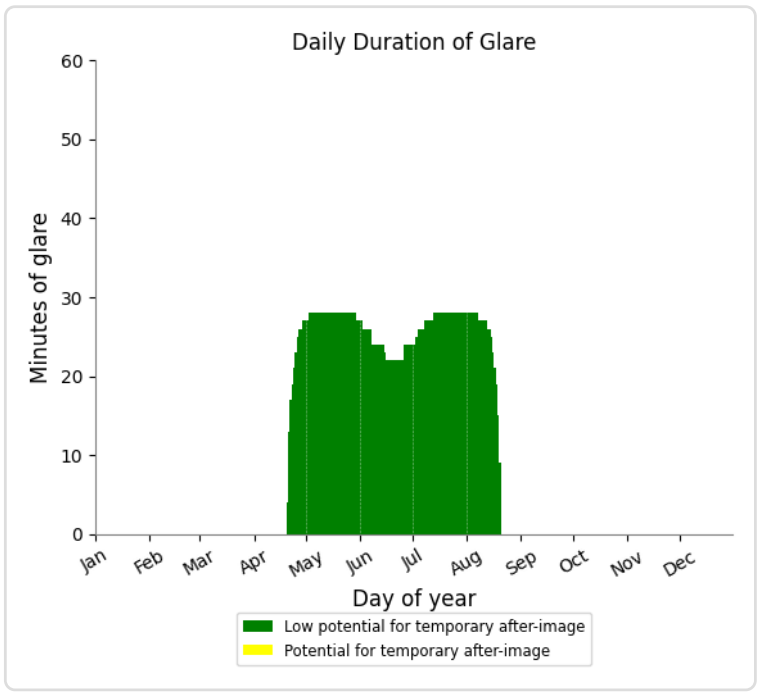


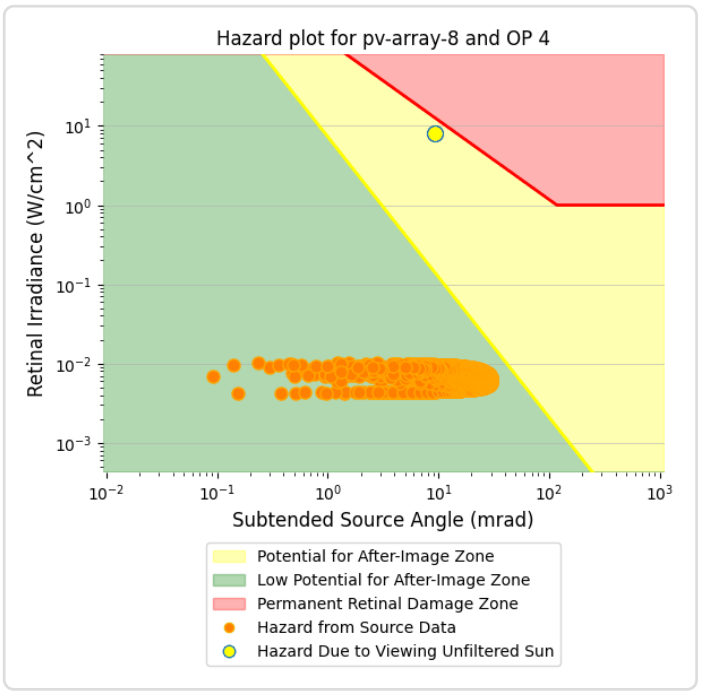
PV array 8 and OP 4

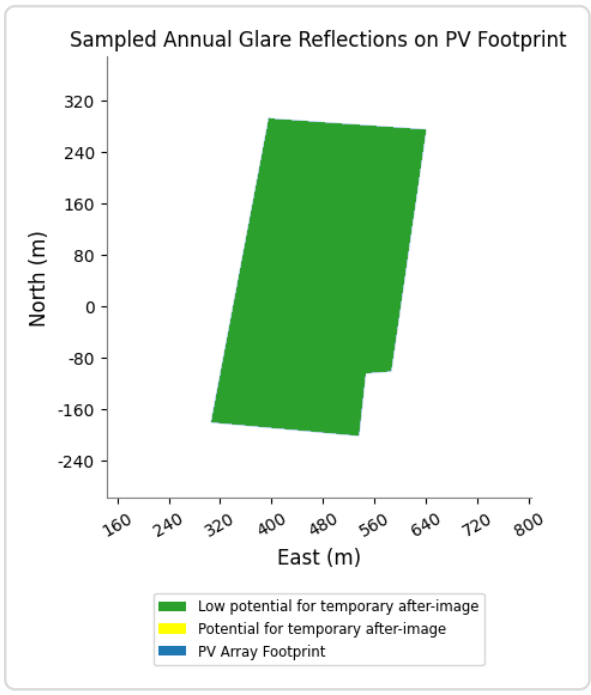
Yellow glare: none

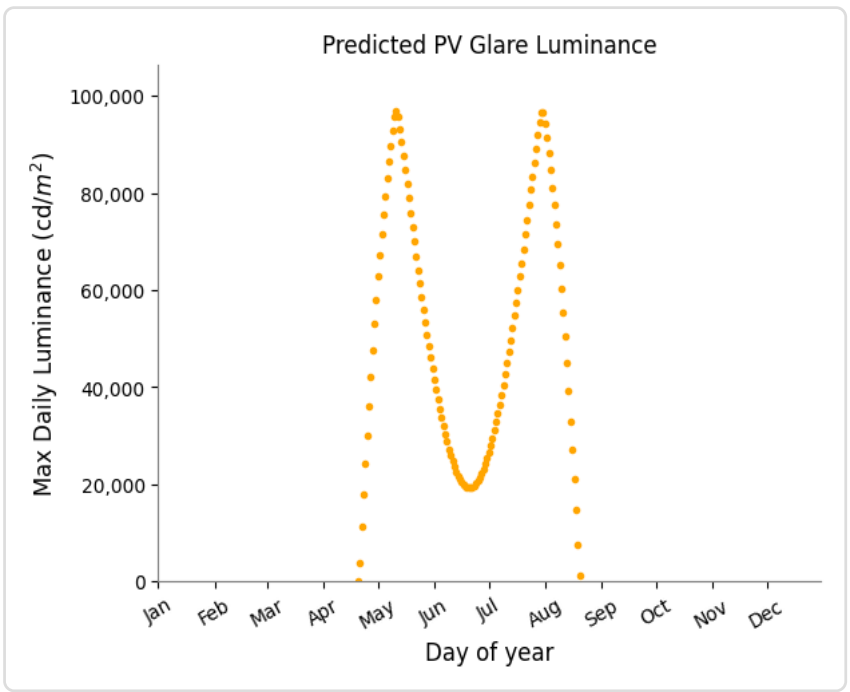
Green glare: 3,146 min.







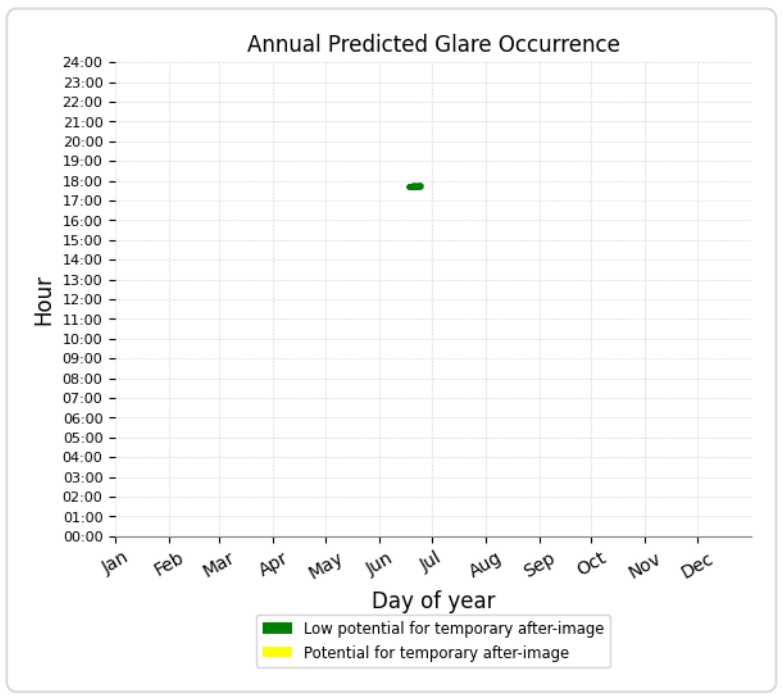


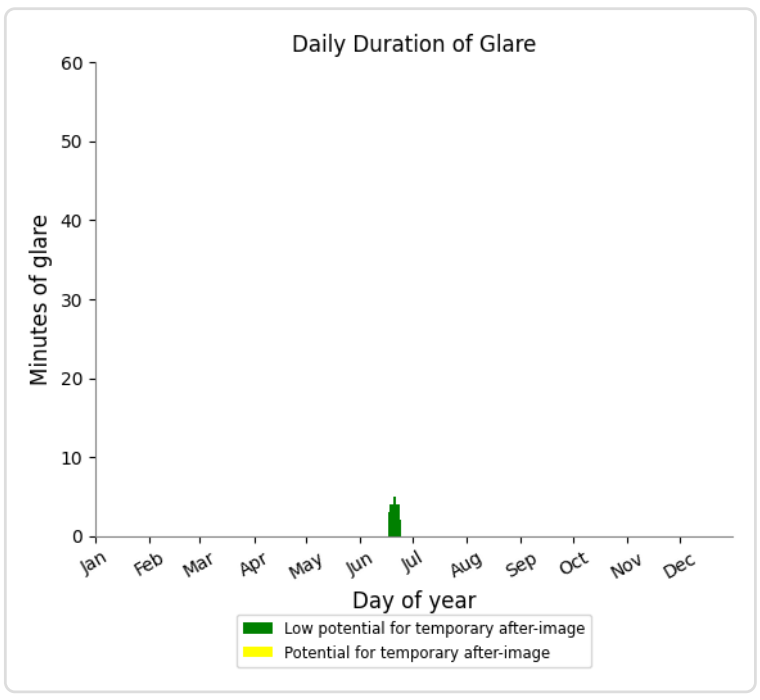


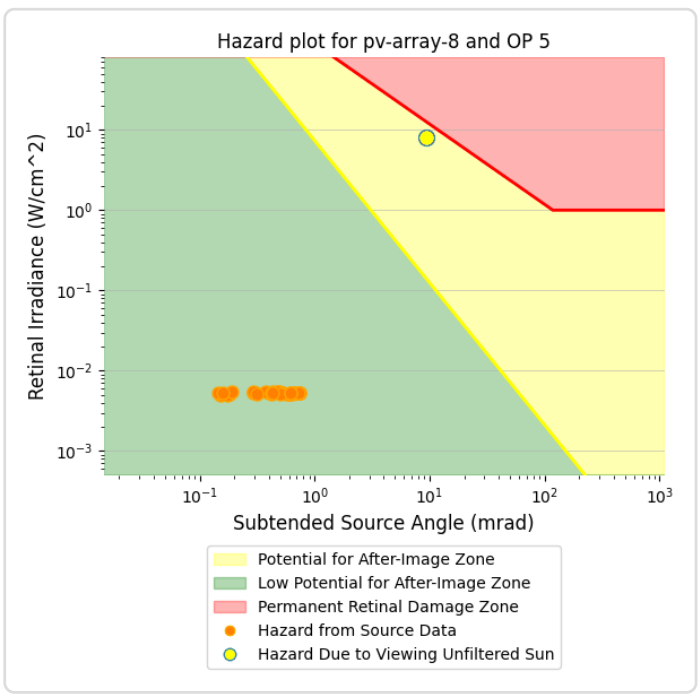
PV array 8 and OP 5

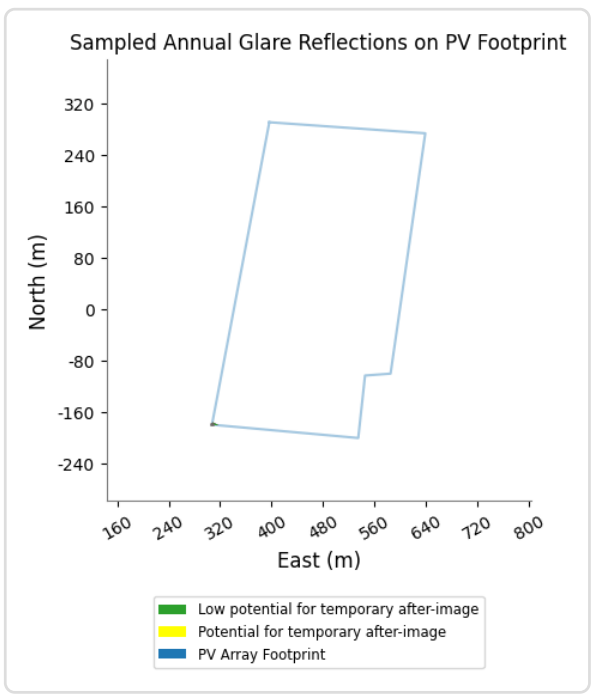
Yellow glare: none

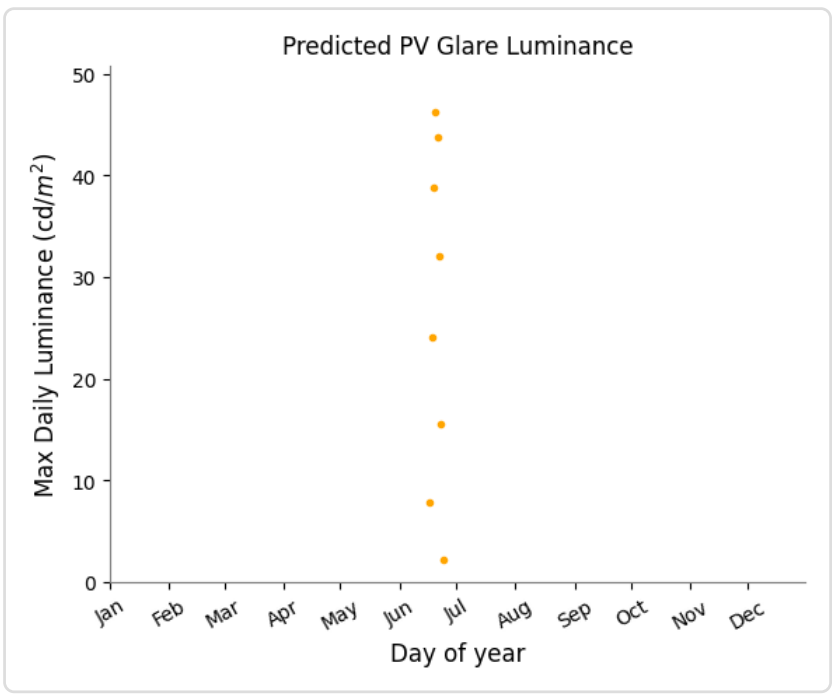
Green glare: 31 min.







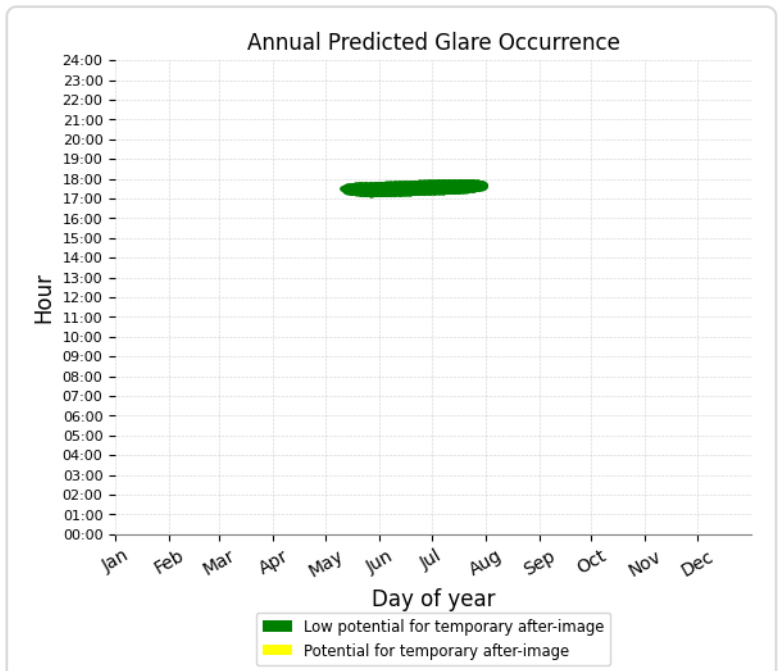


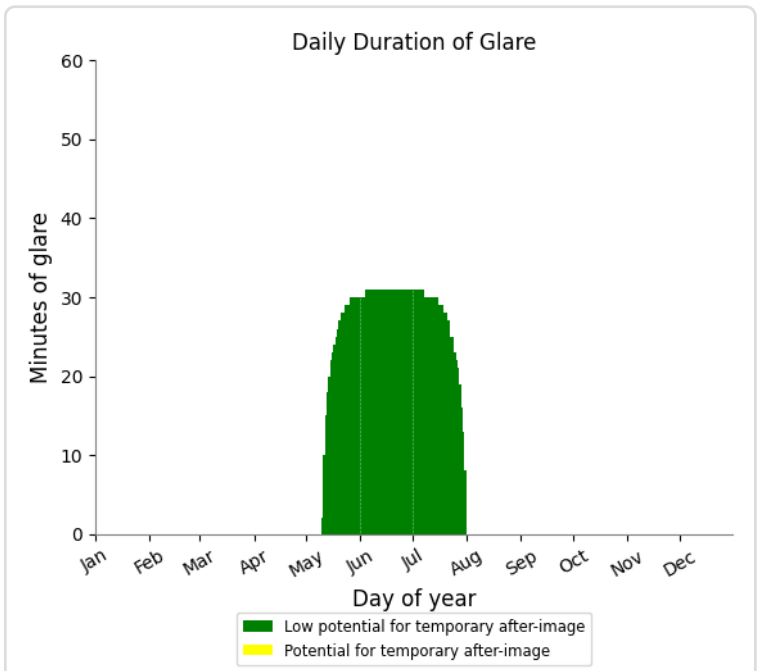


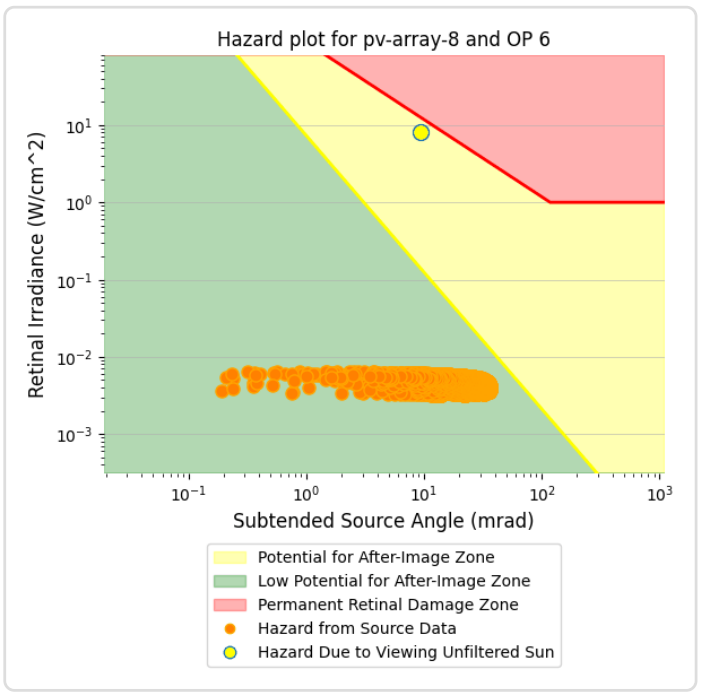
PV array 8 and OP 6

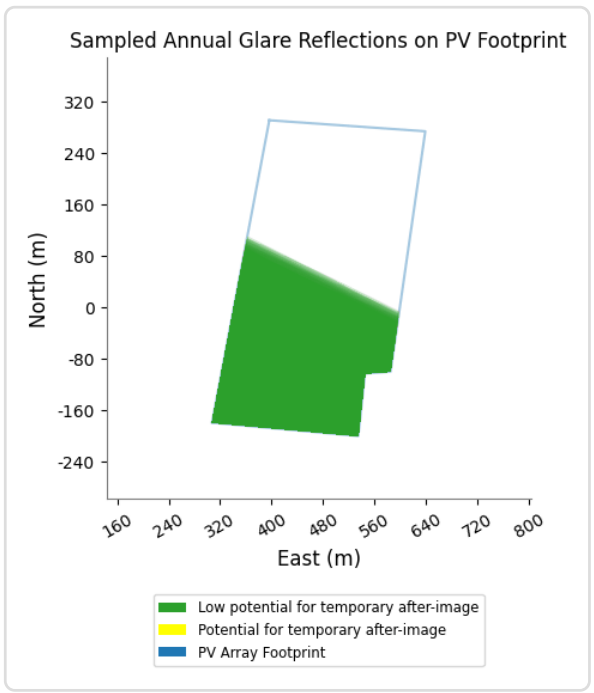
Yellow glare: none

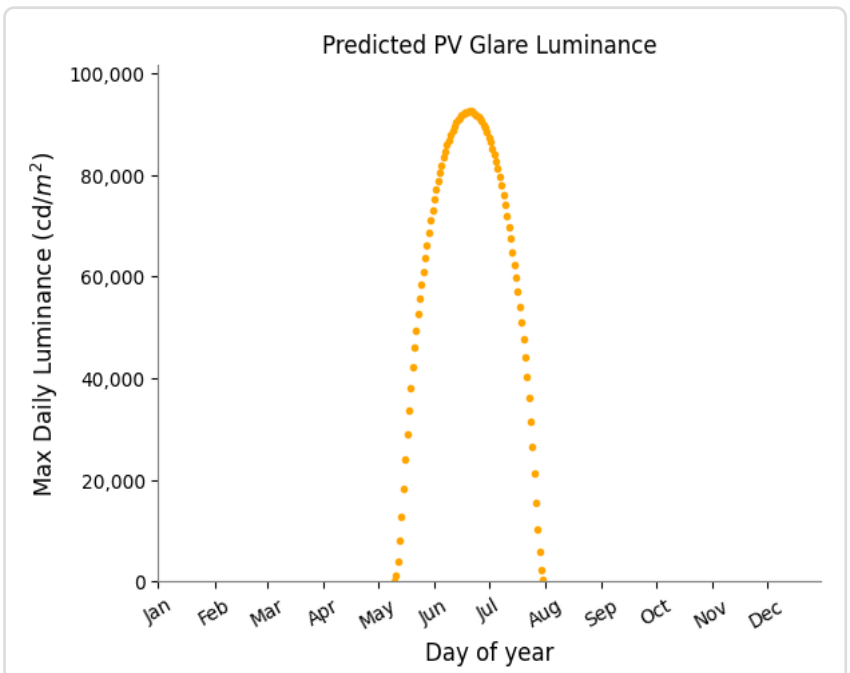
Green glare: 2,288 min.







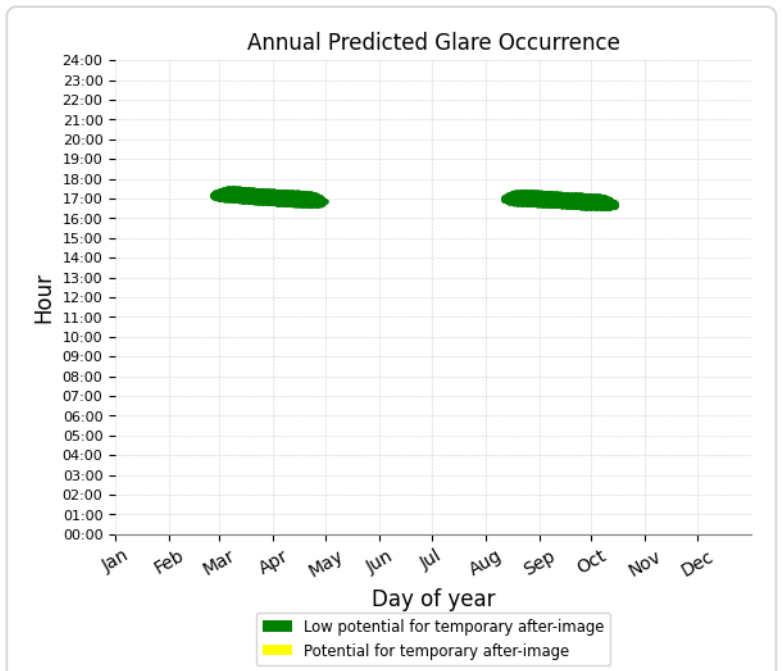


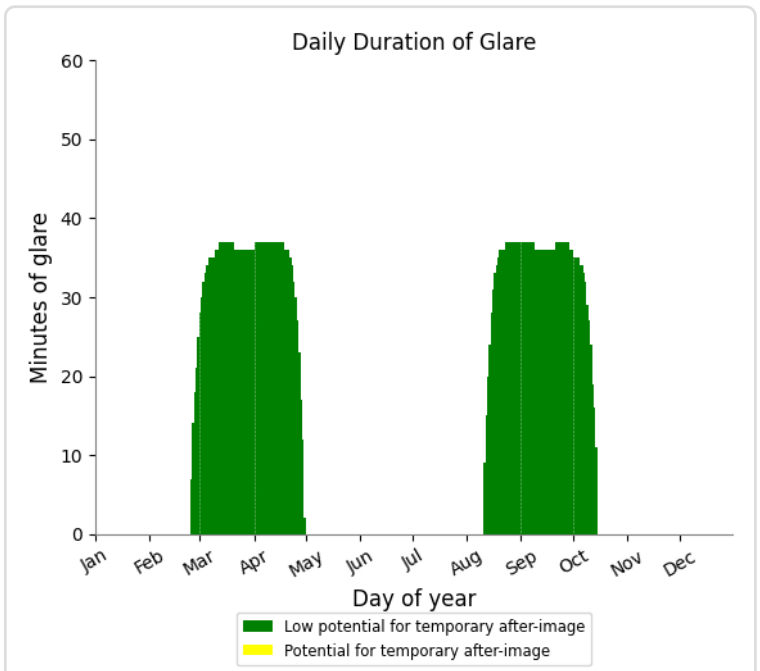


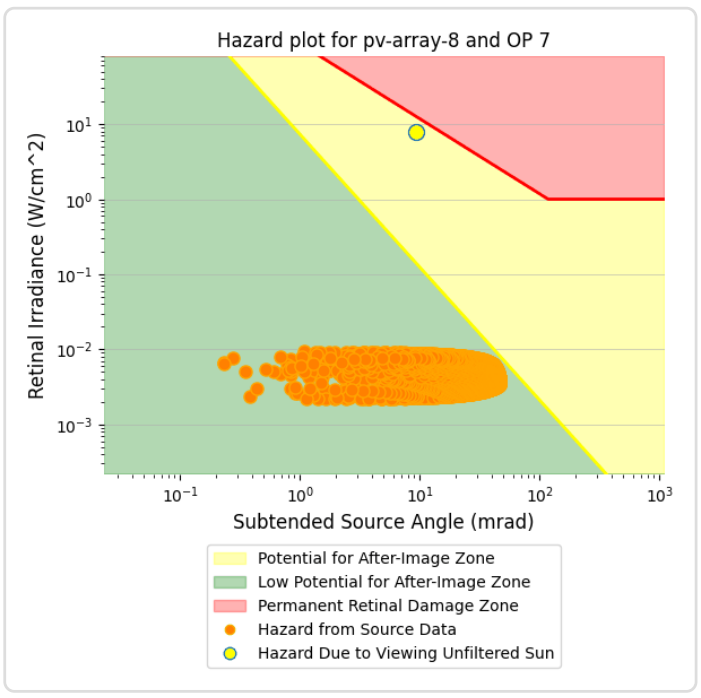
PV array 8 and OP 7

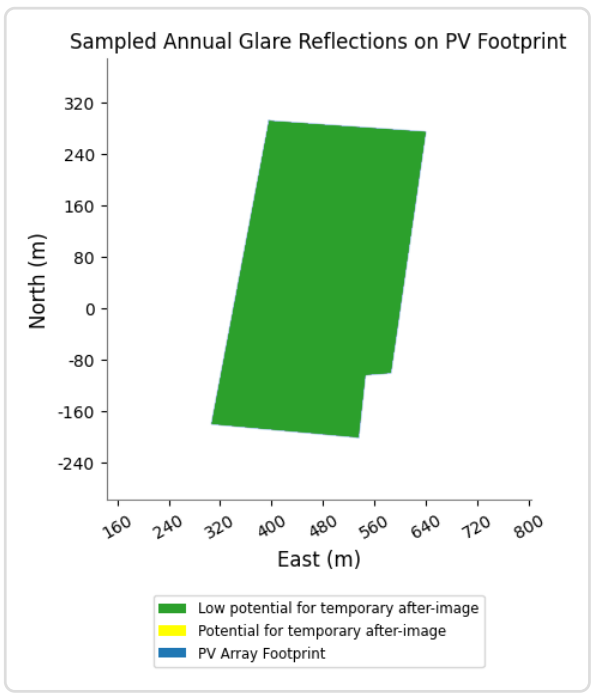
Yellow glare: none

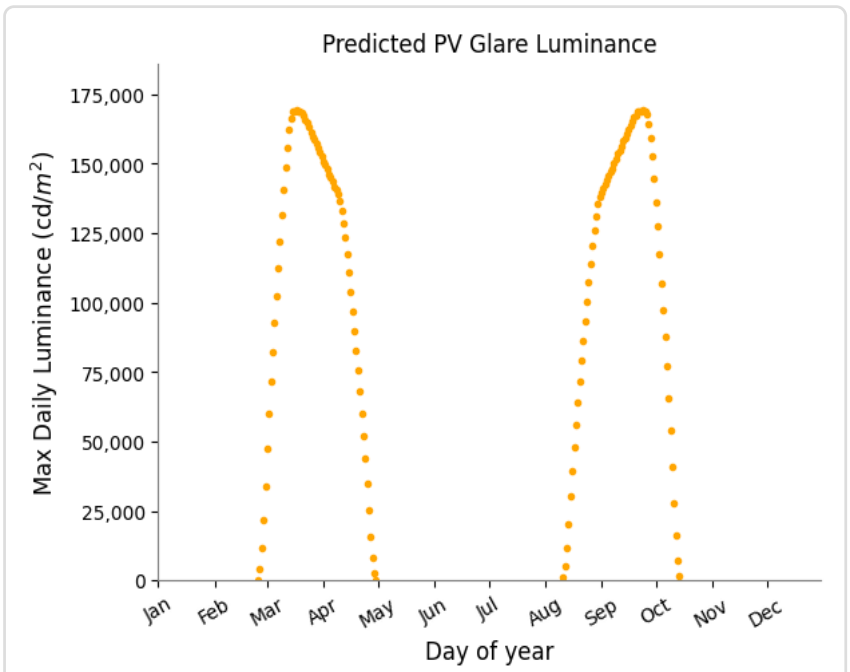
Green glare: 4,333 min.







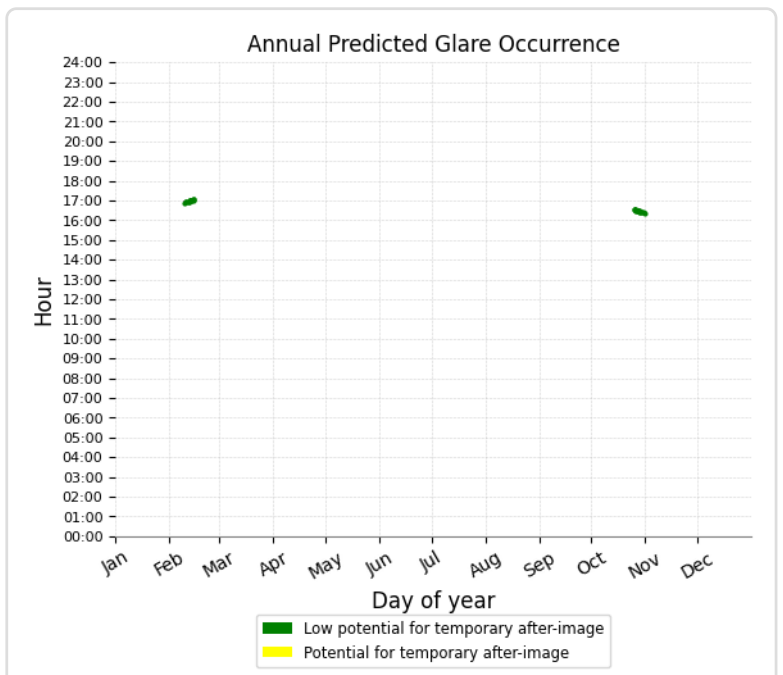


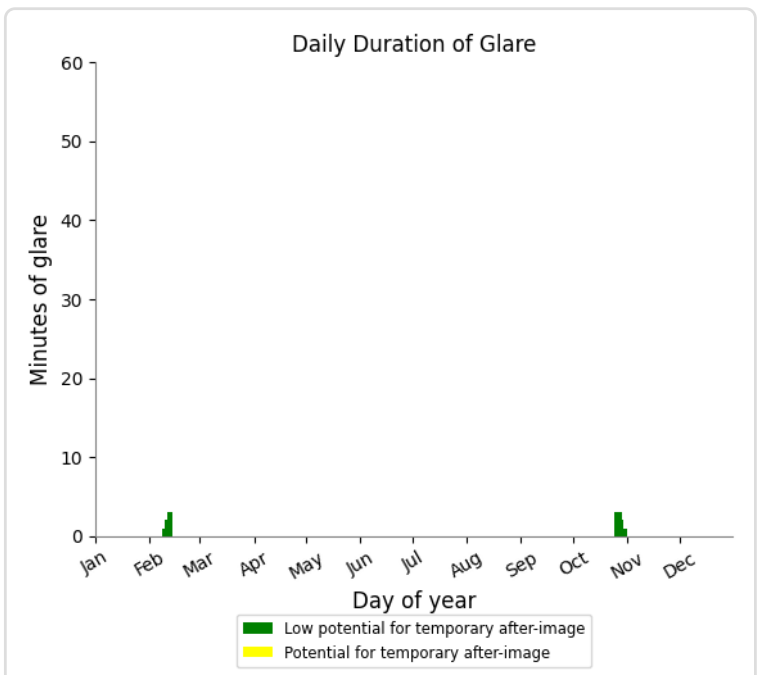


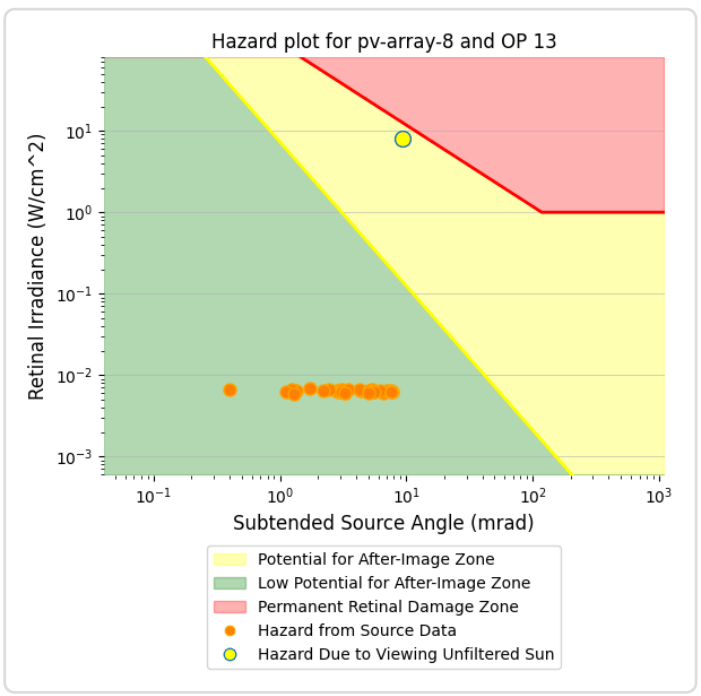
PV array 8 and OP 13

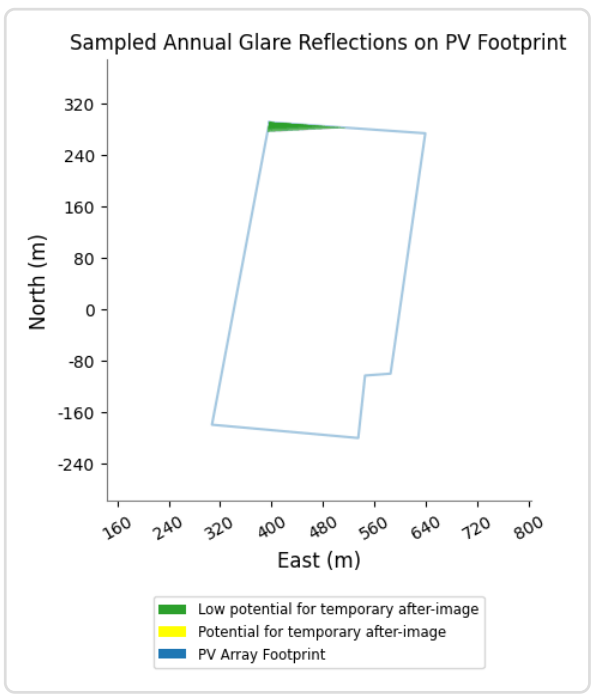
Yellow glare: none

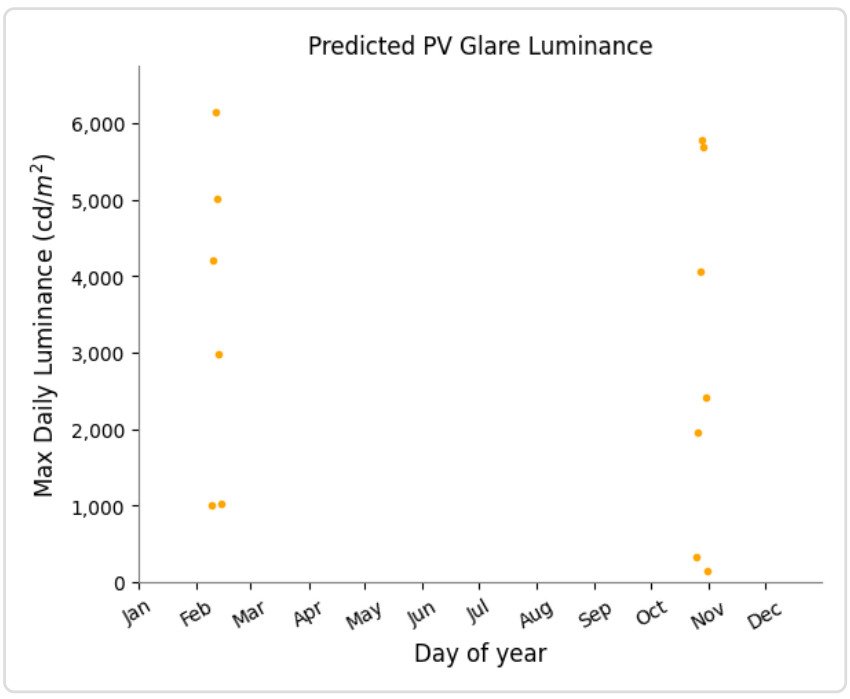
Green glare: 30 min.







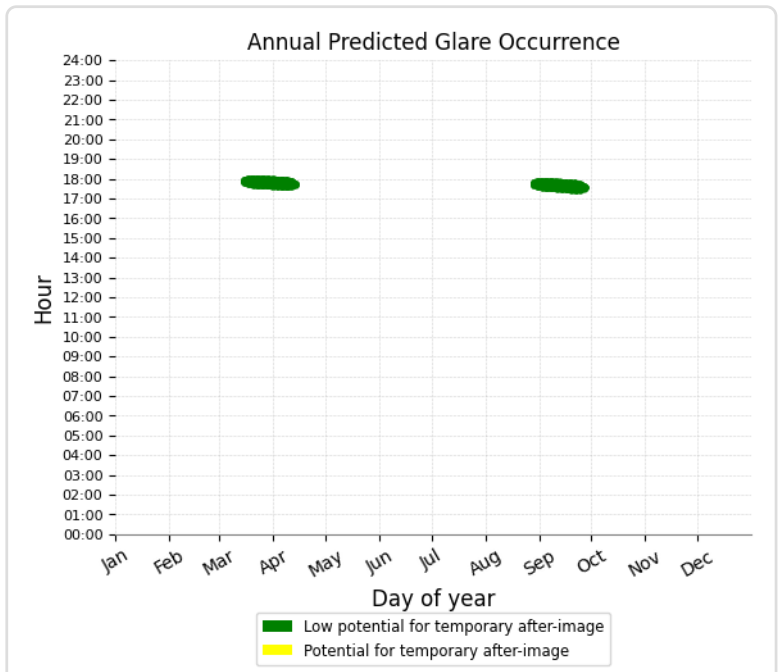


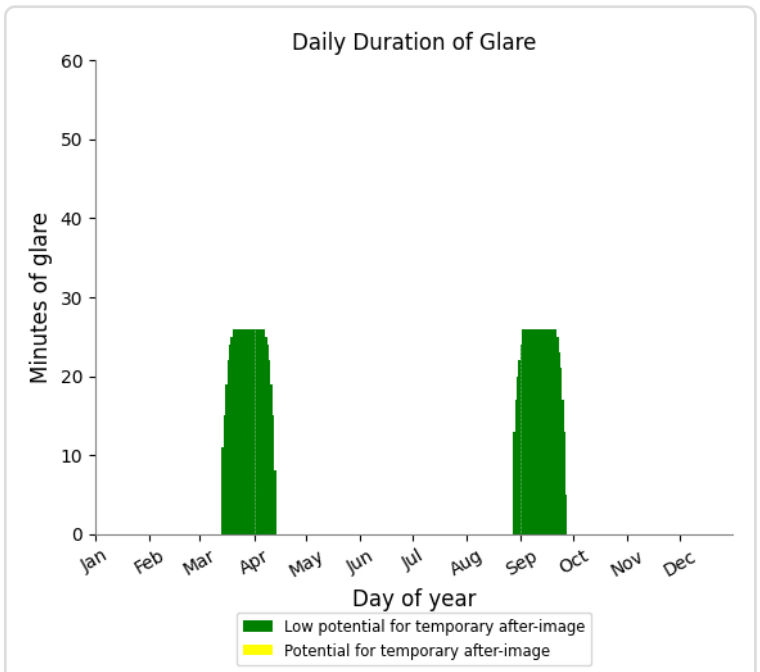


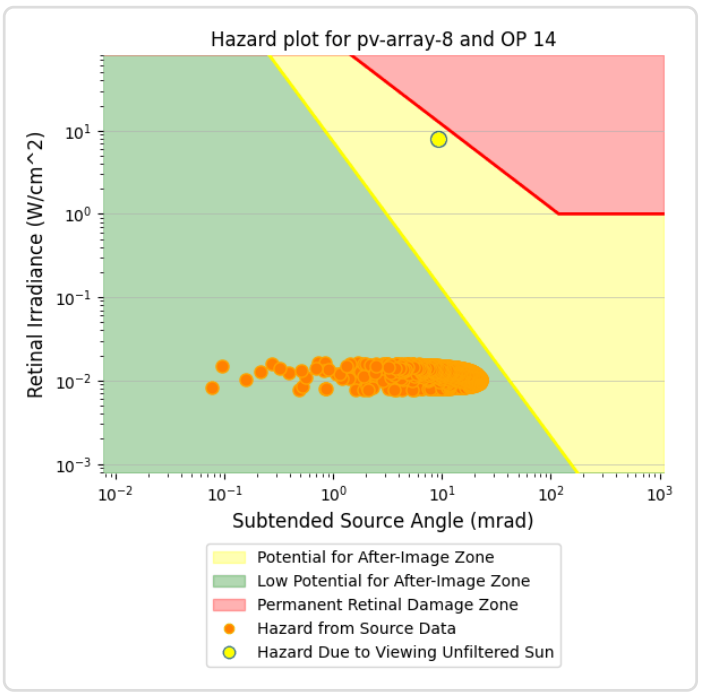
PV array 8 and OP 14

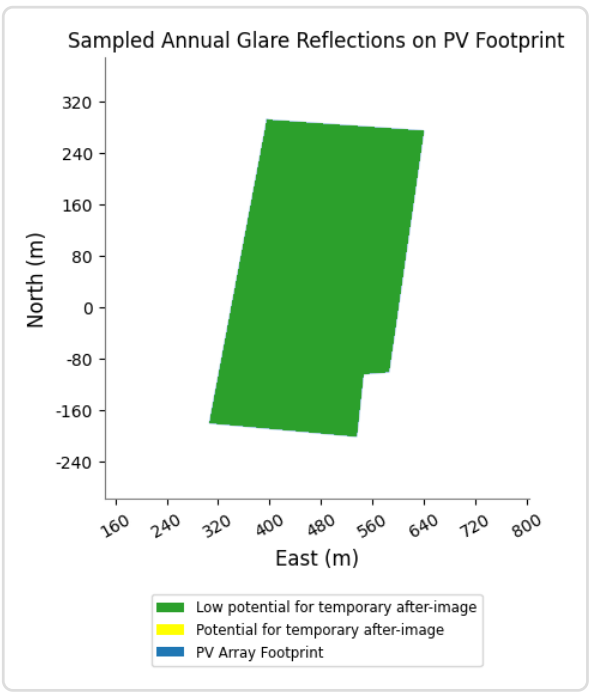
Yellow glare: none

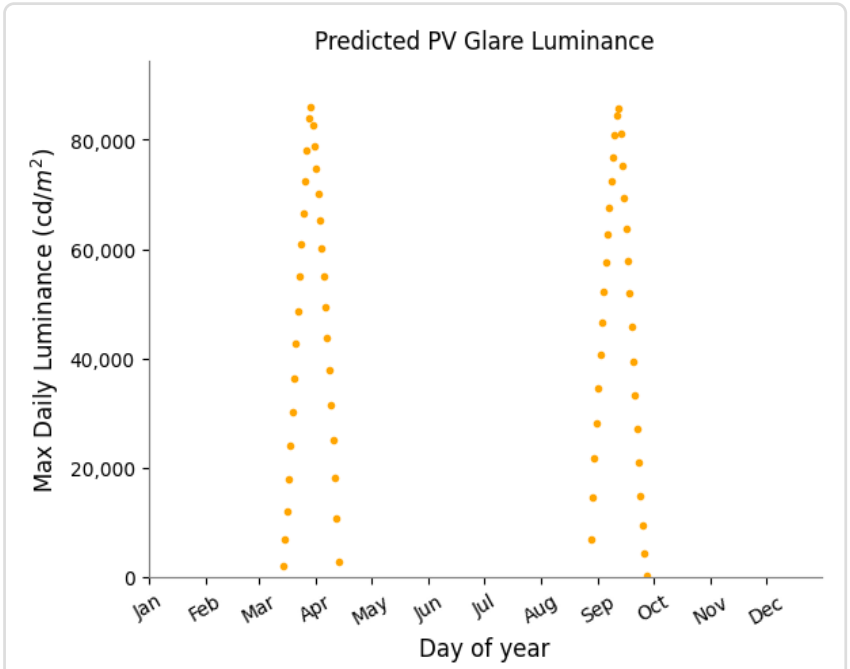
Green glare: 1,443 min.











PV array 8 and OP 15

Yellow glare: none

Green glare: 757 min.

