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GLINT AND GLARE FOR AVIATION ASSESSMENT

Brotherton House, S73 Application
Wythenshawe

23 July 2026
GIA No: **23002**

PROJECT DATA:

Client	**Muse**
Architect	**Feilden Clegg Bradley Studios**
Project Title	**Brotherton House, S73 Application**
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1 EXECUTIVE SUMMARY

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GIA Surveyors Ltd shall have no liability for any loss, damage, injury, claim, expense, cost or other consequence arising as a result of use or reliance upon any information contained in or omitted from this Report.

GIA have been instructed to undertake a Glint and Glare assessment to aviation receptors for the S73 amendments to planning permission for Brotherton House within the Wythenshawe Masterplan (Manchester City Council planning ref. 144656/FO/2025).

The Proposed amendments include the addition of roof PV panels to the dwellings along Cornfield Drive. These are presented in Appendix A.

In line with the methodology and assessment for the original application, the following receptors have been considered for Manchester Airport:

- Runway Approach Paths
- Air Traffic Control Tower
- Runways departure/arrival
- Visual Flight Routes (sample)

In addition, the following receptor has also been assessed:

- Wythenshawe Hospital Helipad

The results of the assessment are presented in Appendix B. A summary of results is presented in Section 7 of this Report.

Overall, both assessments have identified no instances of yellow glare.

Pilots would experience either no glare, or green glare, which is normally considered acceptable. The peak luminance for the runway approach paths is always less than 20,000 cd/m^2.

There would be no glare to the ATC Tower.

2 INTRODUCTION

Glint and Glare are phenomena occurring in the eye that is caused by the presence of bright light sources within the visual field. Glint is a momentary flash of light that may be produced as a direct reflection of the sun from a reflective surface, whereas glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from a reflective surface. The term *'solar reflection'* is generally used to refer both types of effects.

Glint and Glare can lead to visual discomfort and, if the solar reflection is very bright compared to its surrounding, even be disabling in the sense that objects become hard or impossible to see. This is because they are cloaked by the high intensity glare source, whose light gets scattered within the eye.

The CIE 146:2002 Collection on Glare expresses the latter type of glare more formally as:

"Disability glare is glare that impairs vision (CIE, 1987). It is caused by scattering of light inside the eye [...]. The veiling luminance of scattered light will have a significant effect on visibility when intense light sources are present in the peripheral visual field and the contrast of objects to be seen is low. "

"Disability glare is most often of importance at night when contrast sensitivity is low and there may well be one or more bright light sources near to the line of sight, such as car headlights, streetlights or floodlights. But even in daylight conditions disability glare may be of practical significance: think of traffic lights when the sun is close to them, or the difficulty viewing paintings hanging next to windows."

Whether or not a sun reflection will cause an instance of glare depends upon a number of factors, these are summarised below:

- The location of the observer and his view direction;
- The sun's position in the sky, which changes not only with the hour of the day, but with the seasons too;
- The location and orientation of the reflective surface in relation to the observer's view direction;
- The specific quality of the reflective surface, e.g. sheen, specularity, etc.;
- The observer's physiology, e.g. age and eye pigmentation; and
- The background brightness defining the state of adaptation in the observer's eye.

Understanding whether solar glare is likely to occur is based on the observer's position and view direction. Given the transitory nature of the phenomenon, due to the sun's constant movement, any glare assessment should be carried out for a number of representative locations and view directions.

Such studies are often carried out with the help of sun path protractors or with the aid of computer simulations.

3 LEGISLATION AND GUIDANCE

Legislation and guidance in relation to glint and glare from solar PV Developments has fast evolved in the past decade, with the UK and the US playing a leading role in setting out the methodology and criteria of assessment, now widely recognised internationally.

Relevant documents for the assessment of glint and glare from Solar PV Developments include:

- UK - National Policy Statement for Renewable Energy Infrastructure (EN-3, December 2025 - valid in England and Wales and in the UK Renewable Energy Zone (REZ) except any part of a REZ in relation to which Scottish Ministers have functions)
- UK - Planning Practice Guidance: Renewable and Low Carbon Energy (August 2023 - valid in England only)
- UK - Renewable Energy Developments: Solar Photovoltaic Developments - CAST Aerodrome Safeguarding Guidance Note (July 2023), supported by the Civil Aviation Authority (CAA)

Consideration is also given to the following US policy:

- US -Federal Aviation Administration (FAA) Policy: Review of Solar Energy System Projects on Federally-Obligated Airports (May 2021)

National Policy Statement for Renewable Energy Infrastructure (EN-3)

The content of this Policy applies to solar farms with a generating capacity above 100 MW which are considered Nationally Significant Infrastructure Projects (NSIPs), but can also be applied to solar farms with lower capacities.

In relation to proximity of a site to dwellings, Paragraph 2.10.19 states that *"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. These are considered in Landscape, Visual and Residential Amenity [...] and Glint and Glare [...]"*

In relation to Glint and Glare, paragraphs 2.10.94-98 state the following:

"Solar panels are specifically designed to absorb, not reflect, irradiation. 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 qualitatively to 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"

Paragraphs 2.10.126-128 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.."

Paragraphs 2.10.150-151 state:

"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."

Planning Practice Guidance: Renewable and Low Carbon Energy (August 2023)

Paragraph: 013 Reference ID: 5-013-20150327 states that *"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: [...]

- *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; [...]"*

Renewable Energy Developments: Solar Photovoltaic Developments - CAST Aerodrome Safeguarding Guidance Note (July 2023)

This guidance note has been prepared by both the 'Technical focus group for renewable energy developments' and the 'General Aviation focus group' as part of the Combined Aerodrome Safeguarding Team (CAST), supported by the Civil Aviation Authority (CAA).

This guidance note aims to provide safeguarding advice in relation to solar photovoltaic developments. Large-scale solar photovoltaic developments on- or off-aerodrome are increasingly being developed. In certain situations, the glass surfaces of the solar energy systems can reflect sunlight and produce glint and glare.

In relation to safety considerations, the note 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 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).*
- *CNS equipment – Where this infrastructure is present, consideration of specific safeguarding criteria may be required to safely develop solar photovoltaic developments alongside them. There may be a requirement to apply a setback distance to nearby solar panels."*

As to safety impacts, section 3.1 states:

"A key safety concern when considering a solar photovoltaic panel development on- or off-aerodrome is related to the reflection of sunlight off the photovoltaic panels commonly referred to as glint and glare.

'Glint and glare' is the general term used to describe the reflection of sunlight from a reflective surface, typically one that is capable of producing specular solar reflections. The definition of glint and glare is as follows:

- *Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors.*
- *Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.*

Typical surfaces that are considered with respect to glint and glare are glass, metallic structures e.g. roofs, and solar PV panels. The orientation of a solar panel (azimuth and elevation angle) as well as its height will determine whether glint and glare effects are possible towards the assessed receptors.

The receptors that should be considered are usually ATS personnel in a control tower and pilots of aircraft within a suitable distance of an aerodrome. It is essential to conduct a glint and glare assessment when a reflective surface is to be located on or immediately adjacent to an aerodrome. In most cases, an assessment should be undertaken for a solar PV development which is being proposed within a specific distance (indicated by the aerodrome authority) from an aerodrome. 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 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.

Federal Aviation Administration (FAA) Policy: Review of Solar Energy System Projects on Federally-Obligated Airports (May 2021)

The policy applies to proposed on-airport solar energy systems at federally-obligated towered airports and replaces the Interim Policy published on October 23, 2013.

The Interim Policy required federally-obligated airports to conduct an ocular analysis of potential glint and glare effects to pilots on final approach and Air Traffic Control Tower (ATCT) cabs before construction begins. The policy also included a standard for measuring ocular impact and a recommended tool for measuring ocular impact.

Initially, the FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded 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, the FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs. Therefore, the 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.

The May 2021 policy updates and replaces the previous policy by encouraging airport sponsors to conduct an ocular analysis of potential impacts to ATCT cabs. Contextually, the mandated and exclusive use of Solar Glare Hazard Analysis Tool (SGHAT) by Sandia National Laboratories is withdrawn in favour of also other options available in the market. In addition, FAA acknowledges that in some cases a tool may not be required to support a sponsor's statement that a proposed solar energy system will not impact an ATCT cab. The primary example is a proposed on-airport solar energy system that is not visible from an ATCT cab because it is blocked by another structure.

Though this policy does not apply to proponents of solar energy systems located off airport property, they are encouraged to consider ocular impact for proposed systems in proximity to airports with ATCTs. In these cases, solar energy system proponents should coordinate with the local airport sponsor.

Standard for Analysing Ocular Impact

For federally-obligated towered airports, the airport sponsor will revise an Airport Layout Plan to depict proposed solar installations of any size that are not co-located with an existing structure and require a new footprint. The FAA will rely on the airport sponsor to include a statement that the proposed solar project will not result in ocular (i.e. glint or glare) impacts to the airport's ATCT cab. The airport sponsor is encouraged to conduct an ocular analysis of potential impacts to ATCT cabs.

Tools To Assess Ocular Impact

The FAA encourages airport sponsors of federally-obligated towered airports to conduct a sufficient analysis to support their assertion that a proposed solar energy system will not result in ocular impacts. There are several tools available on the open market to airport sponsors that can analyse potential glint and glare to an ATCT cab. For proposed systems that will clearly not impact ATCT cabs (e.g. on-airport solar energy systems that are blocked from the ATCT cab's view by another structure), the use of such tools may not be necessary to support the assertion that a proposed solar energy system will not result in ocular impacts. The FAA suggests that airport sponsors with questions about conducting this analysis contact their local FAA Airports District Office (or Regional Office for those Regions without District Offices) during the early stages of a solar energy system siting process. Regional and Airports District Offices are available to provide assistance with this process.

4 METHODOLOGY, ASSUMPTIONS AND LIMITATIONS

Site Configuration

To determine the accurate location of PV arrays and aviation receptors, 3d-modelling software has been used. Within this model, which is georeferenced, the following information has been collated:

- photogrammetric 1,000m by 750m 3d-model of the context surrounding the Proposed Development, produced by Zmap (Fig.01)
- the 3d-model of the Proposed Development and drawings of the proposed PV arrays provided by Feilden Clegg Bradley Studios in July 2026 (Fig.01)
- Aviation receptors based on the information by the UK Aeronautical Information Service Provider NATS for the Manchester Airport available at:https://www.aurora.nats.co.uk/htmlAIP/Publications/2021-08-12-AIRAC/html/eAIP/EG-AD-2.EGCC-en-GB.html
- Information for the Wythenshawe Hospital Helipad available at: https://metar-taf.com/airport/GB-0344-wythenshawe-hospital-helipad

The assessment is undertaken based on the industry standard Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandia National Laboratories (U.S.).

The international metric system has been used within the software. Imperial and nautical metrics have been converted into metres.

The SGHAT software uses Google Maps as base information, including terrain levels. However, in most cases measurements from Google Maps have been overridden where more accurate information based on the 3d-model.

Sensitive receptors and other parameters are then identified based on current guidelines and professional judgment.

The pilots' field of view has been set based on an azimuthal view angle of 50 degrees in both directions (100 degrees total) and a downward view angle of 30 degrees in both directions (60 degrees total).

A 1,000 W/sqm Peak Direct Normal Irradiance is considered for the PV location.

The assessment is carried in 1-minute intervals throughout the year.



Fig. 01: View of the Photogrammetric context 3d-model and the proposed additional PV panels

Glare Analysis

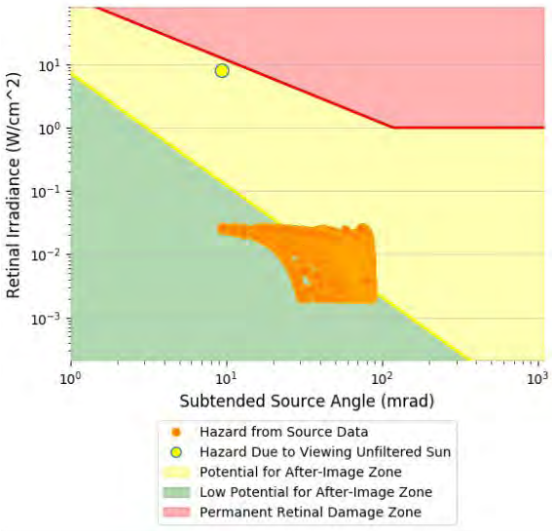
The glare analysis aims to detect reflections which may cause an after-image effect, i.e. an effect similar to the short temporary (a few seconds) blinding from a camera flash. To achieve this, the angle subtended by the visible glare spots from each receptor assessed and the retinal irradiance impacting the observer are calculated.

Results are then plotted in diagrams identifying thresholds for:

- *'green glare'*, where there is low potential for after image
- *'yellow glare'*, where there is potential for after image
- *'red glare'*, where there would be permanent retinal damage

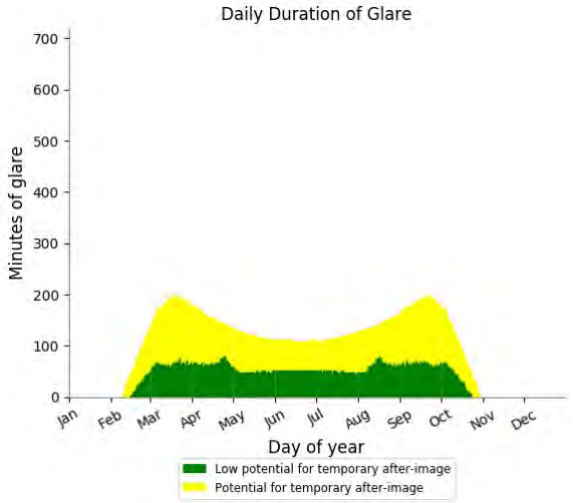
Glare Hazard Plot

The glare hazard plot presents the expected ocular impact of each minute of predicted glare. The three hazard zones, described by the colours green, yellow, and red, are derived from literature[1] and indicate the expected impact. The reference point (yellow with blue outline) indicates the hazard due to viewing the unfiltered sun.



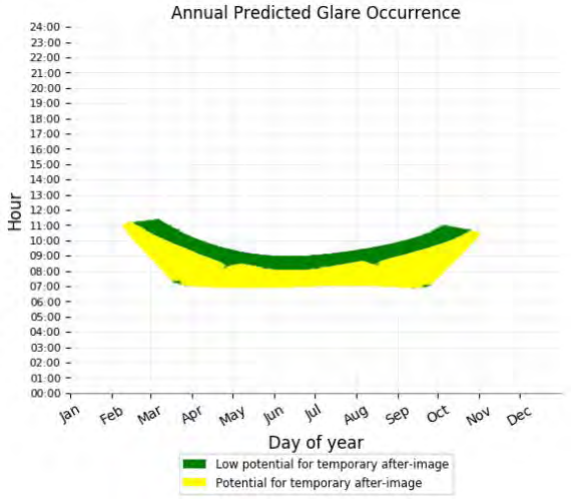
Daily Glare Duration Plot

The daily glare duration plot sums expected minutes of glare on a daily basis to provide an approximation of the total number of minutes glare will be evident each day, on an annual basis.



Annual Glare Occurrence Plot

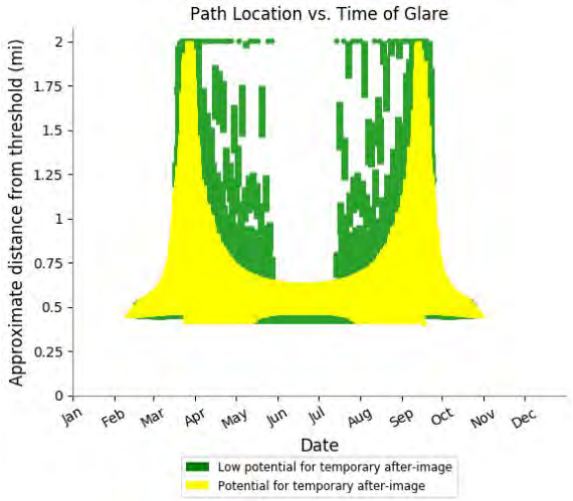
The annual glare occurrence plot displays the approximate times of year and times of day for which glare is expected for the specified receptor.



1 Ho, C. K., Ghanbari, C. M., and Diver, R. B., 2011, "Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation", ASME J. Sol. Energy Eng., 133.

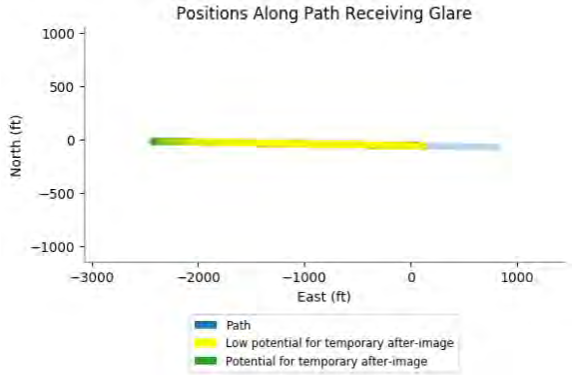
Plot of Path location and Time of Glare

The Path Location vs. Time of Glare plot visualizes the approximate distances along the approach path from which glare will be evident, relative to the time of year.



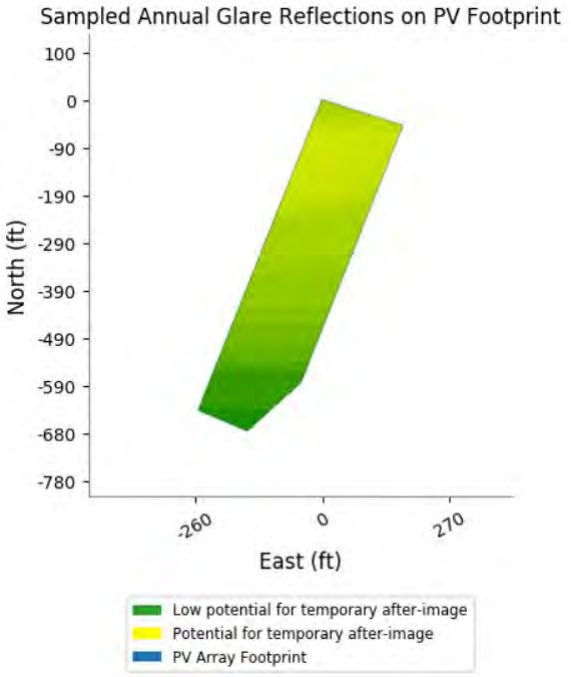
Plot of Path Positions Receiving Glare

This plot visualizes the approximate locations along the path receptor for which glare will be evident. In other words, this image highlights the estimated affected portions of the path receptor.



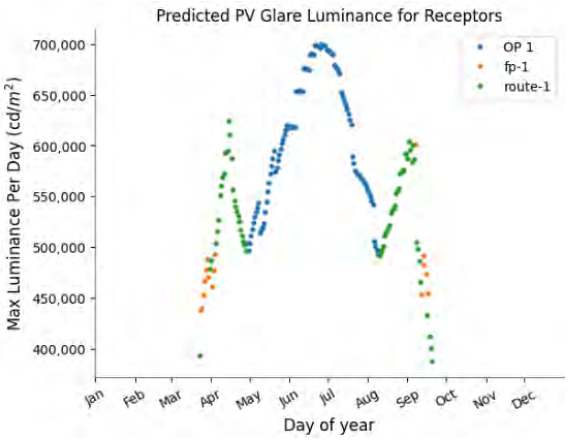
PV Footprint Glare - Spot Heatmap Plot

The PV Footprint Heatmap plot displays the approximate aggregate locations within the drawn PV footprint at which the glare-spots are expected to appear, from the point-of-view of the receptor, on an annual basis. The plotted polygonal areas are color-coded based on the expected glare hazard.



Peak Luminance Charts

Luminance charts extract and display the peak luminance per day for the given PV array and/or receptor.



Review of Results

Different glare thresholds are deemed appropriate for different receptors. 'Green glare' is typically considered acceptable for most receptors including pilots. No glare is typically required for air traffic services receptors (the Air Traffic Control Tower).

From the diagrams of the assessment, it is possible to identify the portions of the PV array(s) generating glint and glare, time of the day/year and their duration.

The assessment is based on a simplified schematic model which does not take into account trees, topography or obstacles (unless modelled) in between the PV arrays and the receptors, or other factors. As such, professional judgment is used to determine whether the outputs of the assessments present an effective risk to receptors.

Assumptions and Limitations

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Detailed system geometry is not rigorously simulated.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Whilst reasonable assumptions have been made, actual values and results may vary.

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 modelling methods.

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.

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.)

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

5 THE PROPOSED DEVELOPMENT

Brotherton House is located within Plot 3.3 of the Wythenshawe Masterplan, approximately 2.3km from Manchester Airport and 1.6km from the Wythenshawe Hospital Helipad (Fig. 02).

The proposed additional PV panels to the dwelling along Cornfield Drive are located on the south-facing roofs (Fig. 03).

For the purpose of the assessment, they have been grouped in seven planar arrays (Fig. 04), with an orientation of 227 from due north, a tilt angle of 27 degrees.

The modelling parameters of the PV arrays are presented in Appendix A.



Fig. 02: Overview of the Site



Fig. 03: View of the proposed additional PV panels under the S73 application

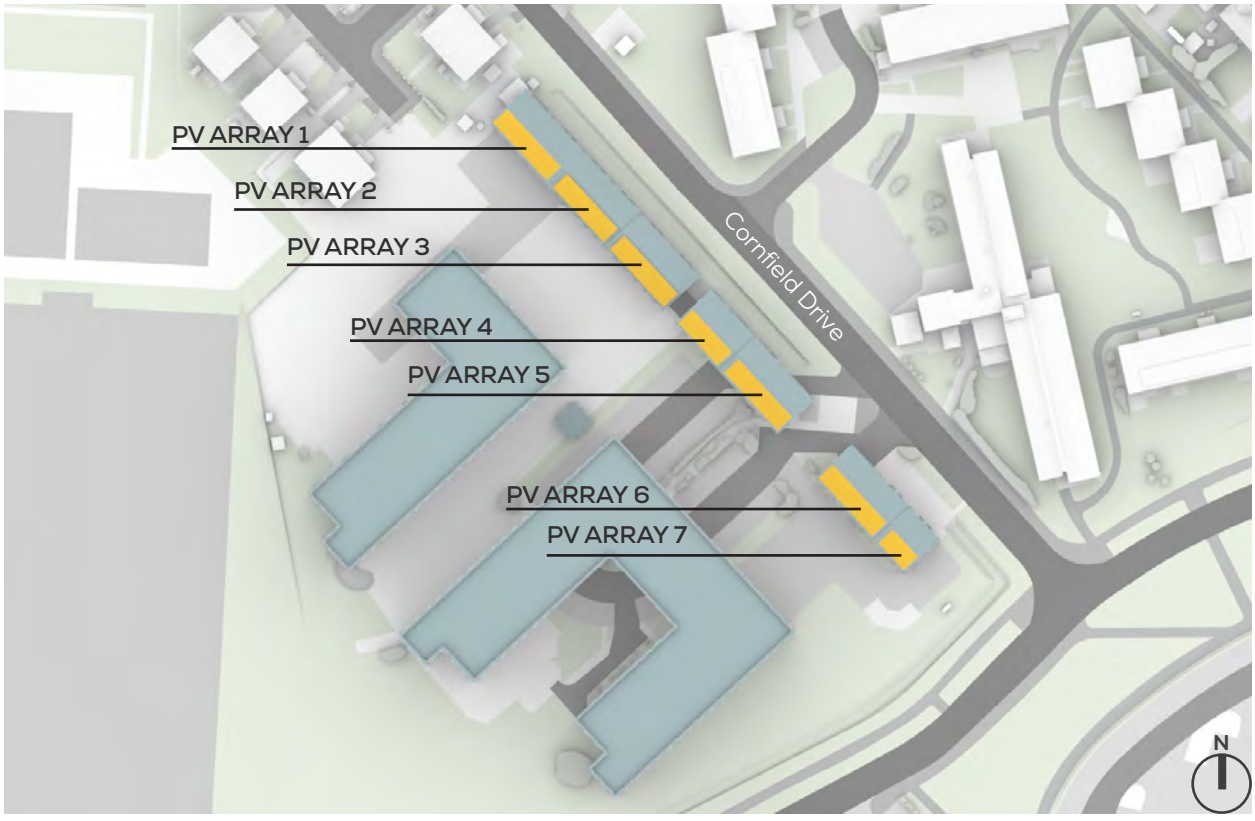


Fig. 04: View of the PV Arrays modelled for the purpose of the technical assessment

6 RECEPTORS

Based on the Pre-App Advice obtained from Planning Officers at Manchester City Council on 24 September 2025, the following receptors have been considered for Manchester Airport:

- Runway approach paths starting at 10NM from the runway threshold at 3000ft at a 3-degree glide slope down to 15m above the runway threshold in a straight line. With a receptor located at least at every 1NM interval.
- 2 Mile Runway approach paths – expected luminance is not to exceed 20,000 cd/m^2
- ATC Tower visual cab – we request predictions of no glint and glare towards ATC
- Runway i.e. aircraft during departure/arrival on the runway. This receptor is to be assessed for the length of the runway at a height of 4.04m above ground level
- Visual flight rule routes as defined within the UK Aeronautical Information Package

In addition, the following receptor has also been assessed:

- Wythenshawe Hospital Helipad

Runway approach paths

Runway approach paths have been modelled in the SGHAT software as "route receptors" with 11 points spaced 1NM (1,852m) apart at the following elevations from the runway thresholds (Fig. 05):

Point 1: 15.0m

Point 2: 112.0m

Point 3: 209.1m

Point 4: 306.2m

Point 5: 403.2m

Point 6: 500.3m

Point 7: 597.3m

Point 8: 694.4m

Point 9: 791.4.0m

Point 10: 888.5m

Point 11: 914.4m (3,000ft)

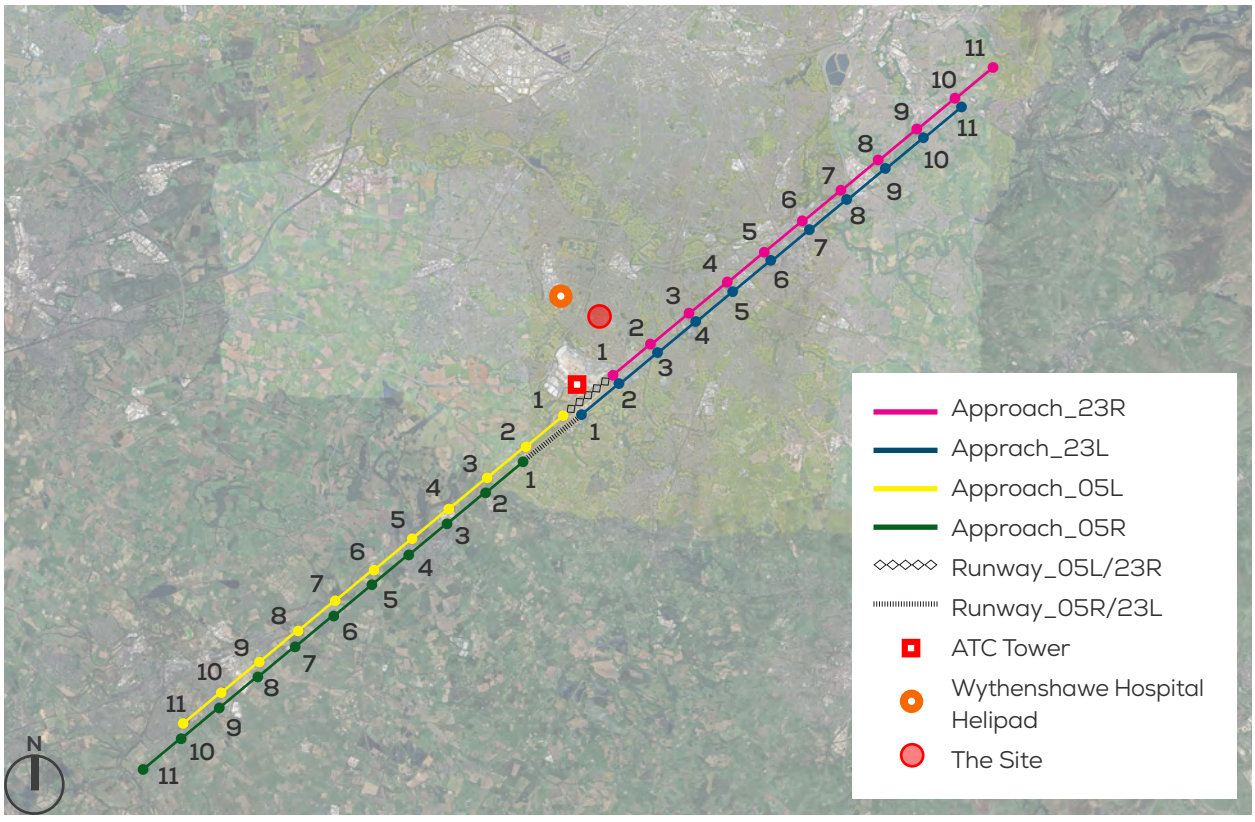


Fig. 05: View of the Site, ATC tower, Wythenshawe Hospital Helipad, Runways and Approach Paths

ATC Tower

The Air Traffic Control Tower cabin has been modelled as an "observation point" (OP 1) with the following coordinates:

Latitude: 53.3574 (53 ° 21' 26.64" N)

Longitude: -2.27972 (02 ° 16' 46.98" W)

Elevation: 130m AOD (60m above ground level)

Runways departure/arrival (taxiing)

Since the altitude of the 4.04m line of sight from the runways is below the parapet of the Proposed Development, this receptor has been assessed geometrically in the 3d-model. An "observation point" in the middle of each runway has also been technically assessed:

- Runway 05L/23R - OP 39:
  Latitude: 53.35444
  Longitude: -2.27353
  Elevation: 74.29m AOD
- Runway 05R/23L - OP 40:
  Latitude: 53.34006
  Longitude: -2.29395
  Elevation: 66.99m AOD

Visual Flight Routes - General Aviation (sample)

The UK Aeronautical Information Package was not received as part of the Pre-App response and so, in absence of this, GIA set out a sample of Visual Flight Routes based on documents available online for similar assessments for Manchester Airport and professional judgment. Eight General Aviation (GA) routes have been considered for each runway. These have been modelled with 26 points spaced 0.5NM (926m) apart for four "route receptors" assessed in both directions with the following specifications:

- Height: 1,000ft (304.8m) above the airfield
- A descent angle of 3 degrees
- 1NM (1,852m) downwind leg distance from runway

These are illustrated in Fig. 05, at the following elevations from the runway thresholds:

Point 1: 15.0m	Point 10: 304.8m	Point 19: 304.8m
Point 2: 63.5m	Point 11: 304.8m	Point 20: 304.8m
Point 3: 112.0m	Point 12: 304.8m	Point 21: 257.6m
Point 4: 160.6m	Point 13: 304.8m	Point 22: 209.1m
Point 5: 209.1m	Point 14: 304.8m	Point 23: 160.6m
Point 6: 257.6m	Point 15: 304.8m	Point 24: 112.0m
Point 7: 304.8m	Point 16: 304.8m	Point 25: 63.5m
Point 8: 304.8m	Point 17: 304.8m	Point 26: 15.0m
Point 9: 304.8m	Point 18: 304.8m	

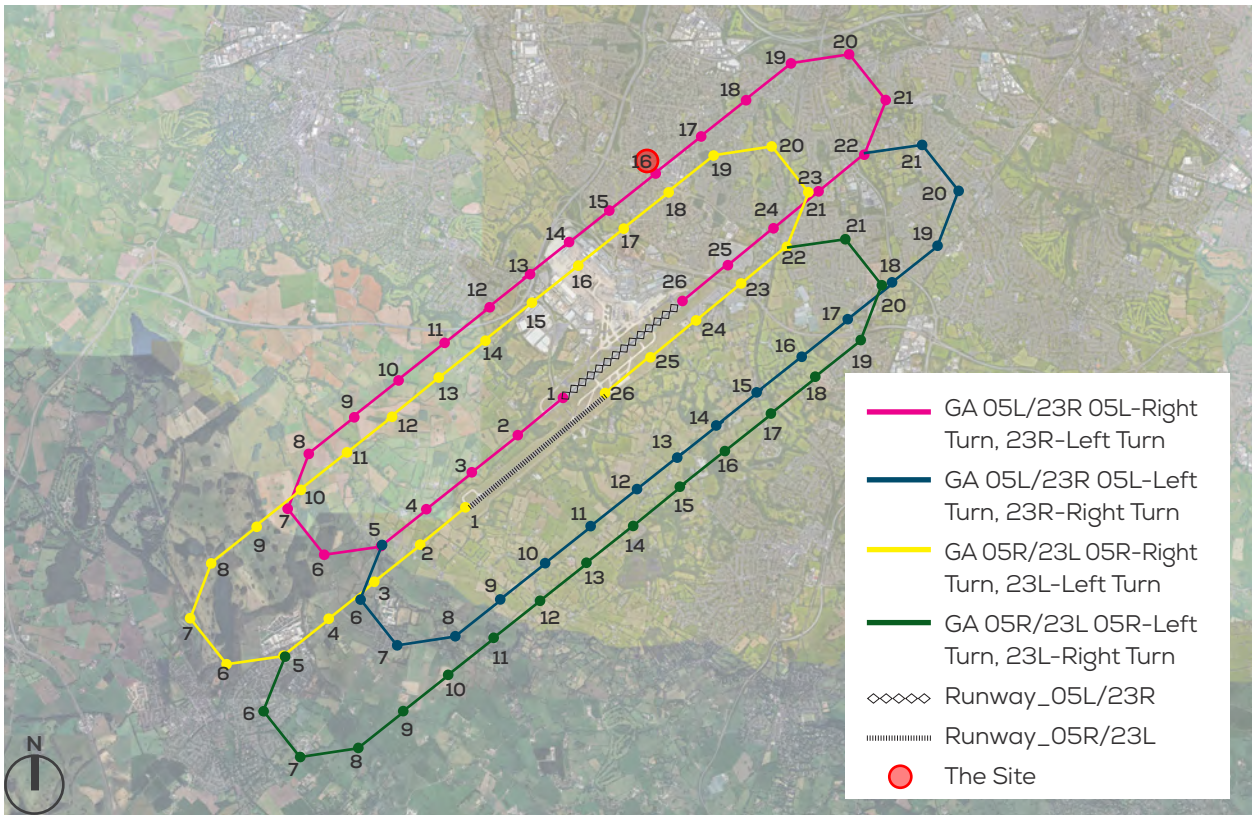


Fig. 06: View of General Aviation Visual Flight Routes

Visual Flight Routes - Commercial Aviation (sample)

Similar to the General Aviation routes, eight Commercial Aviation (CA) routes are relevant for assessment.

For these, however, only four have been modelled with 24 points spaced 1NM (1,852m) apart for two "route receptors" assessed in both directions for a total of four routes with the following specifications:

- Height: 1,500ft (457.2m) above the airfield
- A descent angle of 3 degrees
- 2NM (3,704m) downwind leg distance from runway

These are illustrated in Fig. 07, at the following elevations from the runway thresholds:

Point 1: 15.0m	Point 9: 457.2m	Point 17: 457.2m
Point 2: 112.0m	Point 10: 457.2m	Point 18: 457.2m
Point 3: 209.1m	Point 11: 457.2m	Point 19: 456.9m
Point 4: 306.2m	Point 12: 457.2m	Point 20: 403.2m
Point 5: 403.2m	Point 13: 457.2m	Point 21: 306.2m
Point 6: 456.9m	Point 14: 457.2m	Point 22: 209.1m
Point 7: 457.2m	Point 15: 457.2m	Point 23: 112.0m
Point 8: 457.2m	Point 16: 457.2m	Point 24: 15.0m

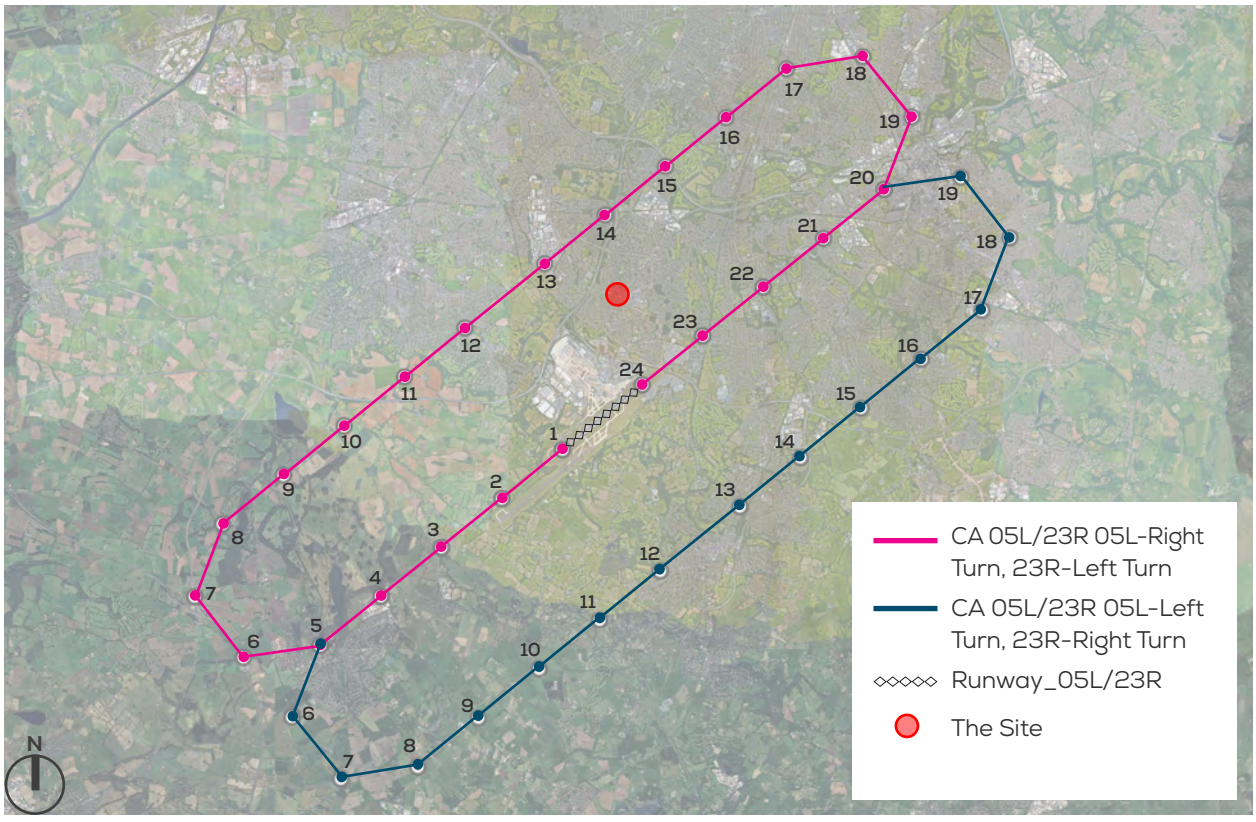


Fig. 07: View of Commercial Aviation Visual Flight Routes

Overhead Assessment (sample)

A 5km by 5km grid over the PV panels at a height above ground of 2,500ft (762m) with "observation points" spaces 1km apart has also been assessed, simulating the effects of slower aircrafts such as Helicopter Emergency Medical Services (HEMS). This is shown in Fig.08.

Wythenshawe Hospital Helipad

An "observation point" (OP 38) 10m over the helipad has been assessed to gauge glare whilst helicopters hover mid-air during landing or taking off:

Latitude: 53.38841

Longitude: -2.28963

Elevation: 10 metres above ground

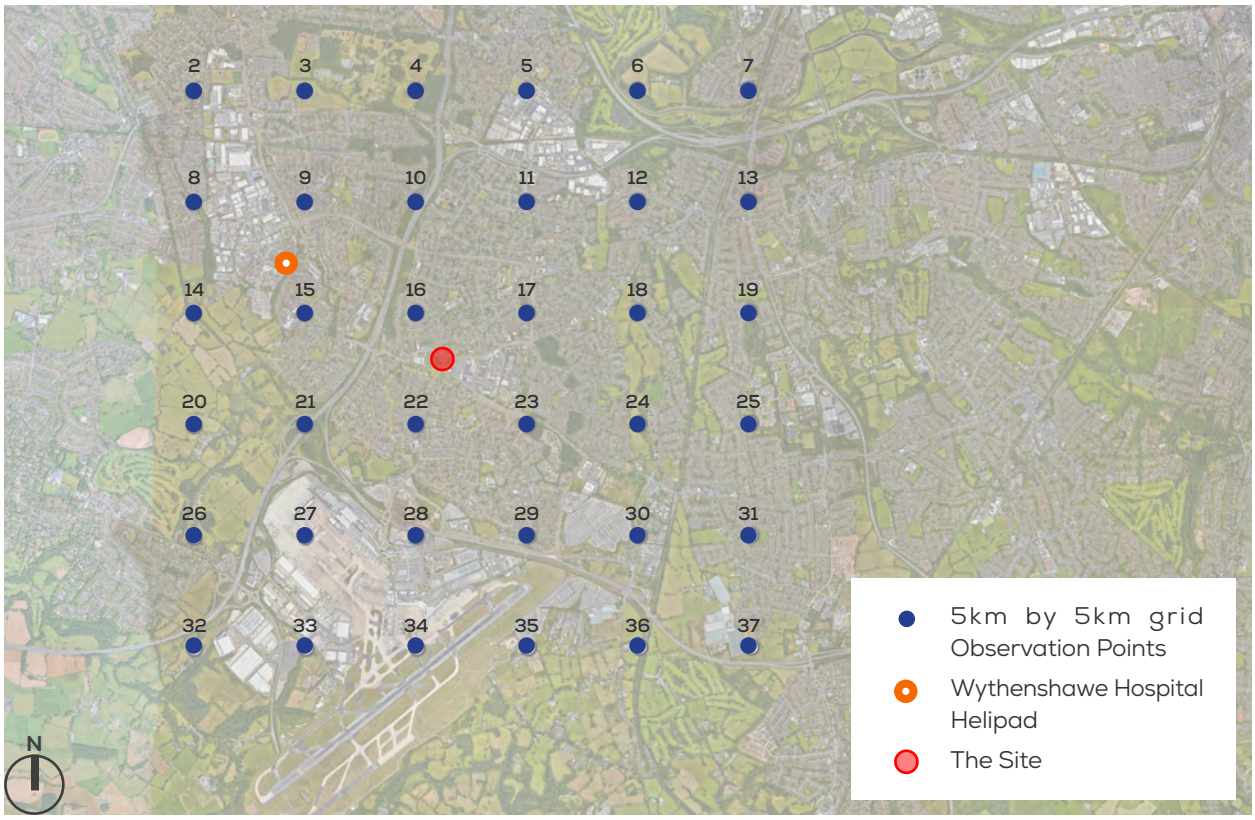


Fig. 08: View of 5km by 5km grid and Wythenshawe Hospital Helipad observation points

7 RESULTS

MANCHESTER AIRPORT
(IATA: MAN, ICAO: EGCC)

The results of the assessments are included in Appendix B and are summarised below.

The hours shown in the diagrams and described in the text reflect Standard Time (equivalent to Greenwich Mean Time - GMT) and do not take into account Daylight Savings (i.e. British Summer Time - BSM). For BSM, add one hour.

- Runway Approach Paths
  - » 05L: no glare
  - » 05R: no glare
  - » 23L: no glare
  - » 23R: no glare
- ATC Tower: no glare
- Runways departure/arrival (taxiing): no glare
- Visual Flight Routes - General Aviation:
  - » GA 05L/23R 05L-Left Turn, 23R-Right Turn: no glare
  - » GA 05L/23R 05L-Right Turn, 23R-Left Turn: no glare
  - » GA 05R/23L 05R-Left Turn, 23L-Right Turn: no glare
  - » GA 05R/23L 05R-Right Turn, 23L-Left Turn: no glare
- Visual Flight Routes - Commercial Aviation:
  - » CA 05L/23R 05L-Left Turn, 23R-Right Turn: no glare
  - » CA 05L/23R 05L-Right Turn, 23R-Left Turn: green glare for a total of 366 hours
- Overhead assessment: no glare for 27 observation points (OP), green glare to all other OPs for a maximum of 150 hours at OP2.
- Wythenshawe Hospital Helipad: green glare for a total of 53 hours.

Overall conclusions

Overall, the assessments have identified no instances of yellow glare.

There would be no glare to the ATC Tower.

Pilots would experience either no glare or green glare, which is normally considered acceptable. The peak luminance for the runway approach paths is always significantly less than 20,000 cd/m^2.

APPENDIX A
PV ARRAYS

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381715	-2.268456	67.06	0.10	67.16
2	53.381608	-2.268290	67.06	0.10	67.16
3	53.381581	-2.268335	64.92	0.10	65.02
4	53.381688	-2.268501	64.92	0.10	65.02

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381590	-2.268260	67.36	0.10	67.46
2	53.381491	-2.268109	67.36	0.10	67.46
3	53.381464	-2.268154	65.22	0.10	65.32
4	53.381572	-2.268305	65.22	0.10	65.32

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381473	-2.268079	67.66	0.10	67.76
2	53.381366	-2.267913	67.66	0.10	67.76
3	53.381339	-2.267958	65.52	0.10	65.62
4	53.381455	-2.268124	65.52	0.10	65.62

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381339	-2.267867	70.51	0.10	70.61
2	53.381258	-2.267746	70.51	0.10	70.61
3	53.381231	-2.267791	68.37	0.10	68.47
4	53.381312	-2.267912	68.37	0.10	68.47

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381249	-2.267716	70.81	0.10	70.91
2	53.381133	-2.267550	70.81	0.10	70.91
3	53.381106	-2.267595	68.67	0.10	68.77
4	53.381222	-2.267761	68.67	0.10	68.77

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.381043	-2.267415	70.96	0.10	71.06
2	53.380936	-2.267248	70.96	0.10	71.06
3	53.380909	-2.267293	68.82	0.10	68.92
4	53.381025	-2.267460	68.82	0.10	68.92

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 27.0°
Orientation: 227.0°
Rated power: -
Panel material: Smooth glass without AR coating



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.380927	-2.267233	71.26	0.10	71.36
2	53.380873	-2.267158	71.26	0.10	71.36
3	53.380846	-2.267203	69.12	0.10	69.22
4	53.380900	-2.267278	69.12	0.10	69.22

APPENDIX B
RESULTS

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	27.0	227.0	11,147	185.8	0	0.0	-	4,180
PV array 2	27.0	227.0	11,123	185.4	0	0.0	-	3,583
PV array 3	27.0	227.0	11,146	185.8	0	0.0	-	3,765
PV array 4	27.0	227.0	11,040	184.0	0	0.0	-	2,972
PV array 5	27.0	227.0	11,233	187.2	0	0.0	-	3,958
PV array 6	27.0	227.0	11,204	186.7	0	0.0	-	3,461
PV array 7	27.0	227.0	10,976	182.9	0	0.0	-	1,820

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
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0
1500Ft-CA_5L23R_05L-R_23R-L	21,954	365.9	0	0.0
Approach_05L	0	0.0	0	0.0
Approach_05R	0	0.0	0	0.0
Approach_23L	0	0.0	0	0.0
Approach_23R	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
OP 2	8,964	149.4	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	0	0.0	0	0.0
OP 8	3,092	51.5	0	0.0
OP 9	8,199	136.7	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	3,764	62.7	0	0.0
OP 15	3,336	55.6	0	0.0

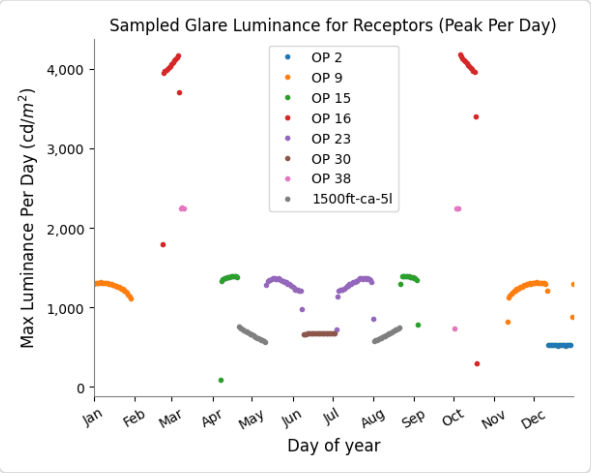
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 16	3,888	64.8	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	6,842	114.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	7,830	130.5	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	6,819	113.7	0	0.0
OP 38	3,181	53.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	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
1500Ft-CA_5L23R_05L-R_23R-L	3,148	52.5	0	0.0	855
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,292	21.5	0	0.0	528
OP 8	439	7.3	0	0.0	642
OP 9	1,072	17.9	0	0.0	1,316
OP 14	565	9.4	0	0.0	505
OP 15	498	8.3	0	0.0	1,397
OP 16	558	9.3	0	0.0	4,180
OP 23	1,074	17.9	0	0.0	1,374
OP 30	1,085	18.1	0	0.0	673
OP 37	964	16.1	0	0.0	288
OP 38	452	7.5	0	0.0	2,254
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

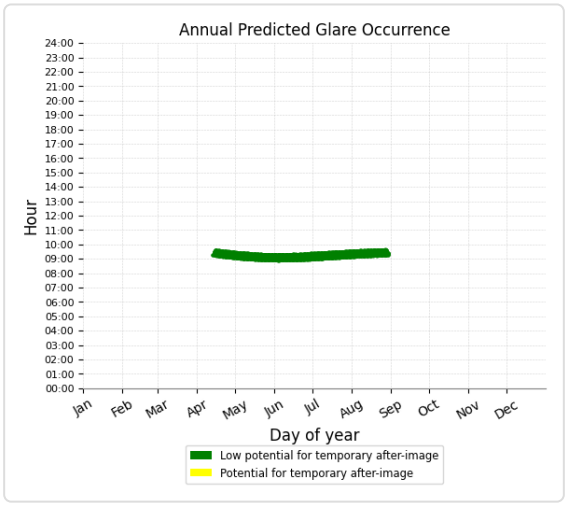
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

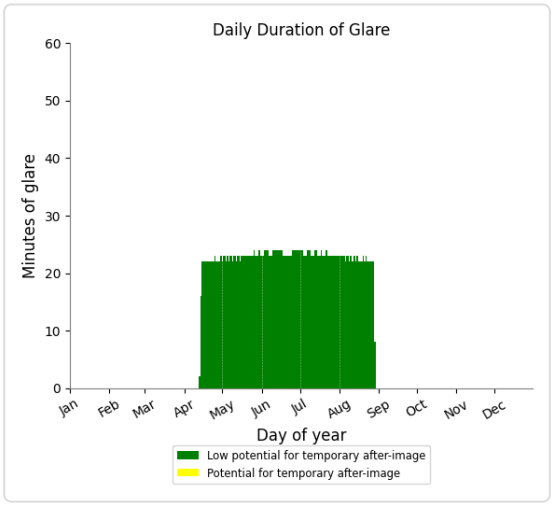


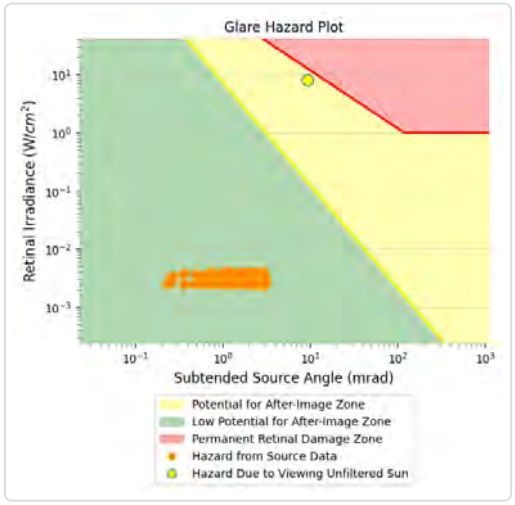
PV array 1 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

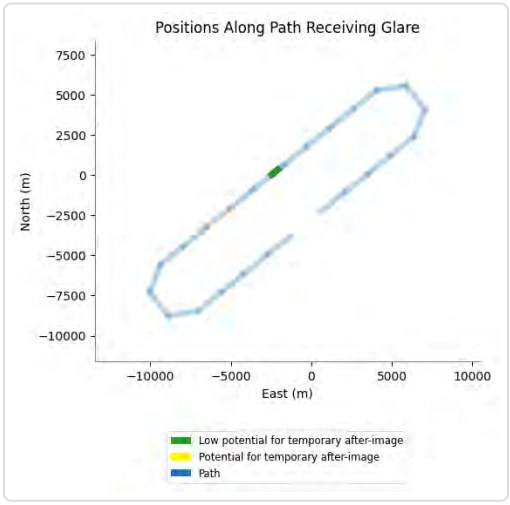
Yellow glare: none

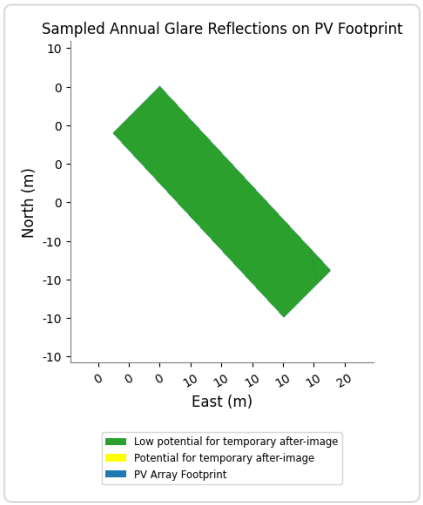
Green glare: 3,148 min.

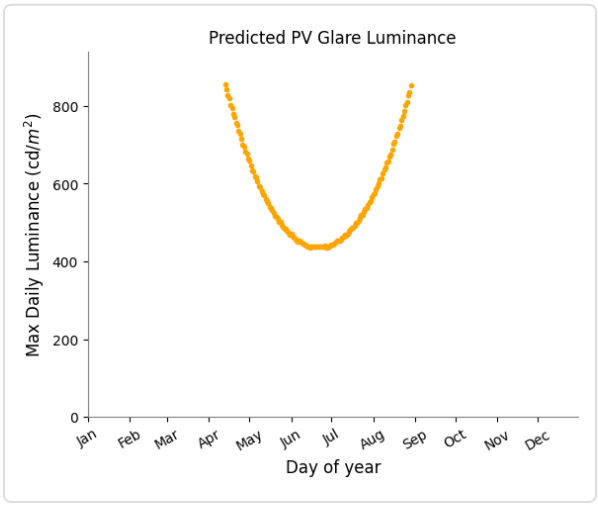












PV array 1 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 1 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 1 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 1 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 1 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 1 and Route: Approach_05L

No glare found

PV array 1 and Route: Approach_05R

No glare found

PV array 1 and Route: Approach_23L

No glare found

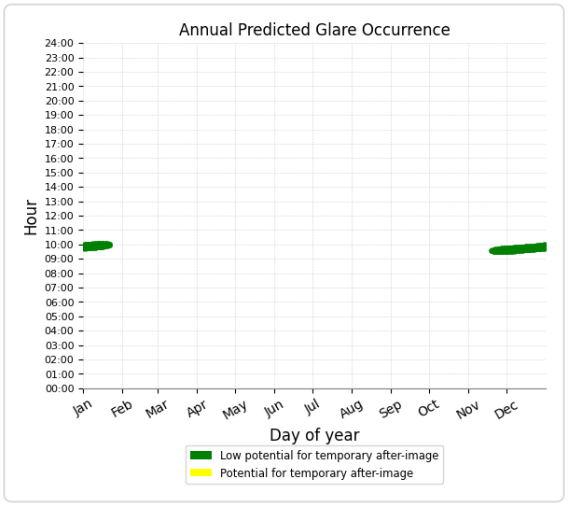
PV array 1 and Route: Approach_23R

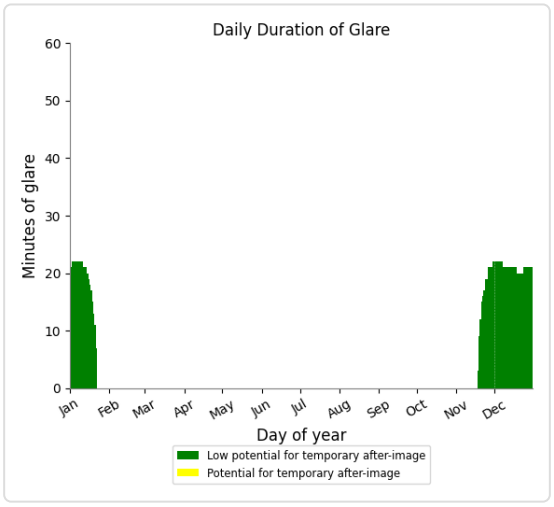
No glare found

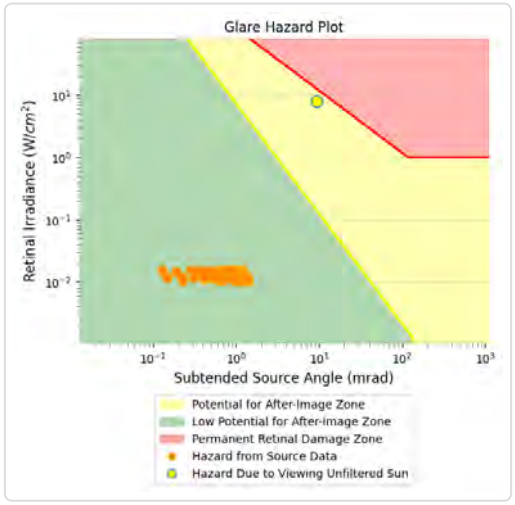
PV array 1 and OP 2

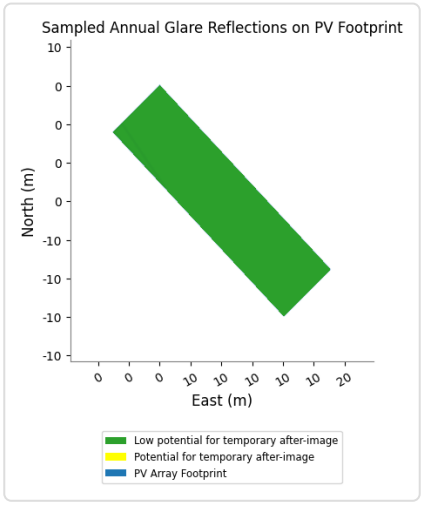
Yellow glare: none

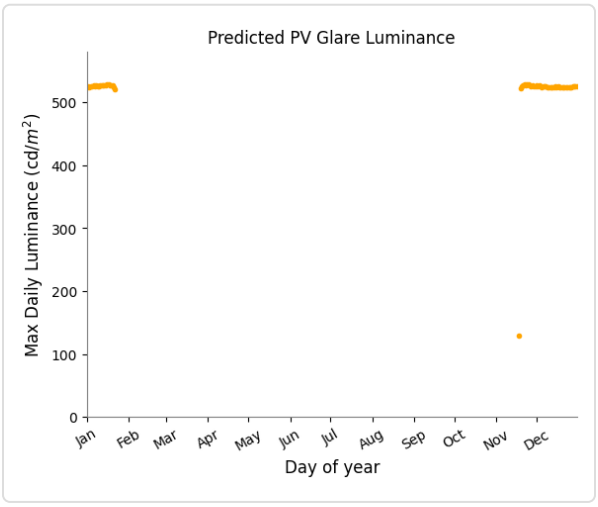
Green glare: 1,292 min.







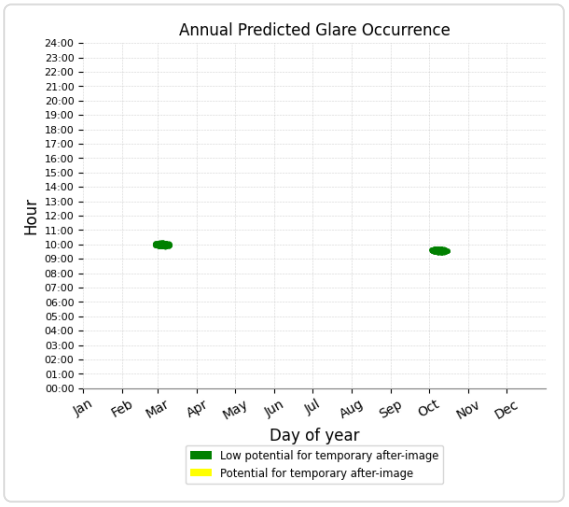


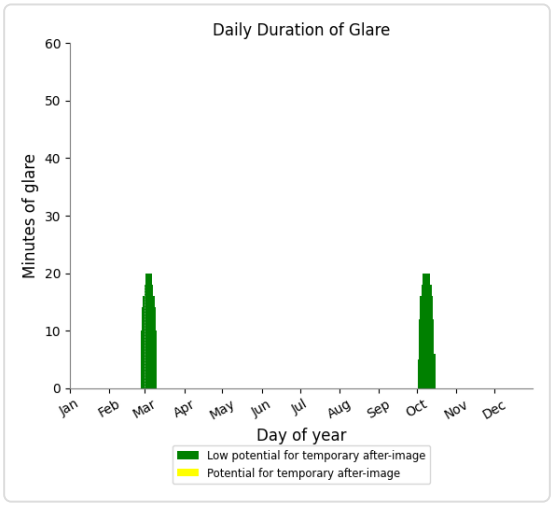


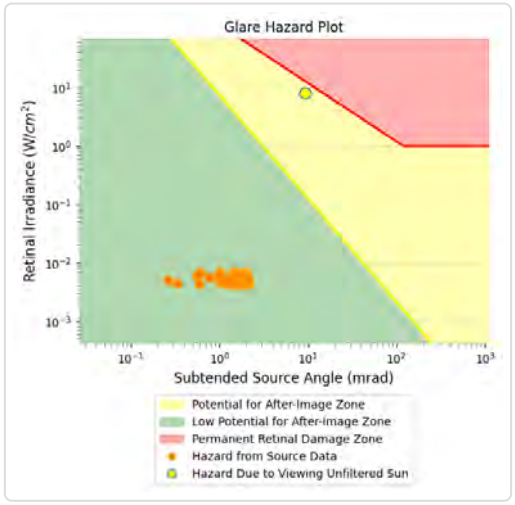
PV array 1 and OP 8

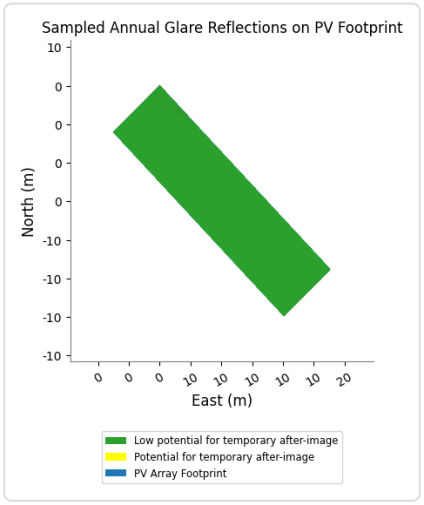
Yellow glare: none

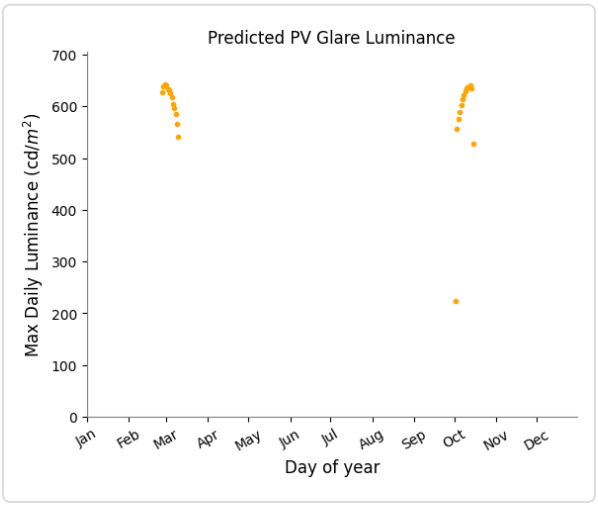
Green glare: 439 min.







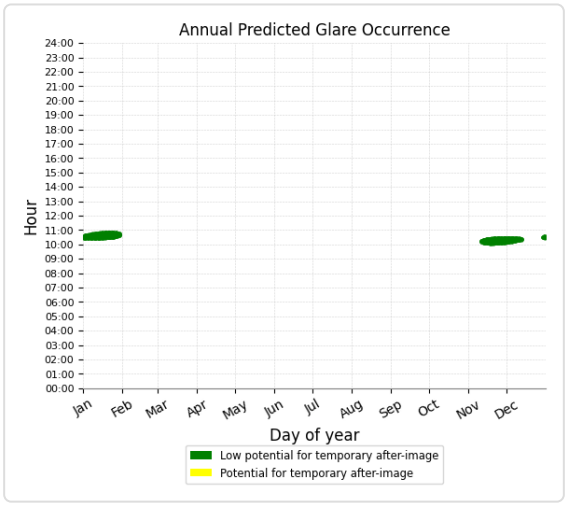


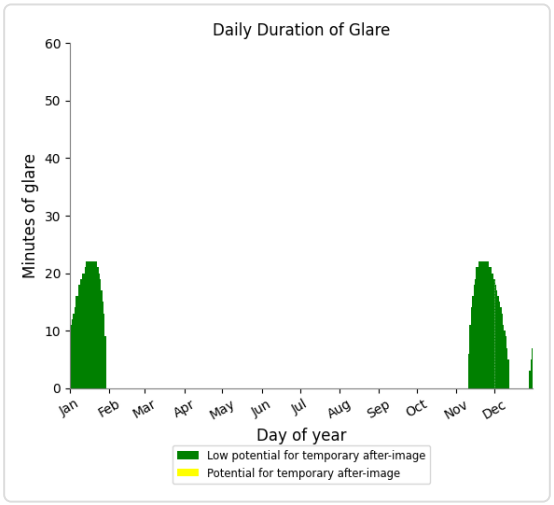


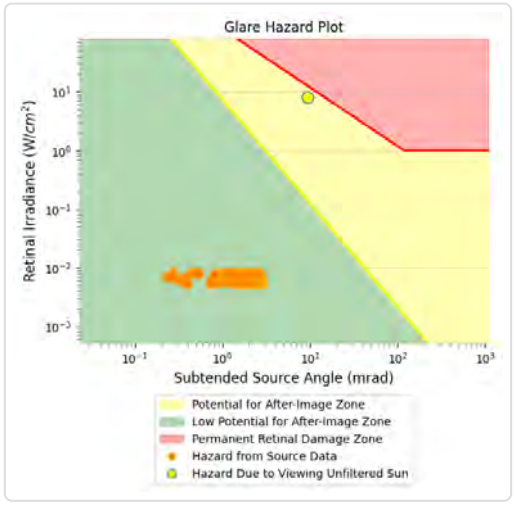
PV array 1 and OP 9

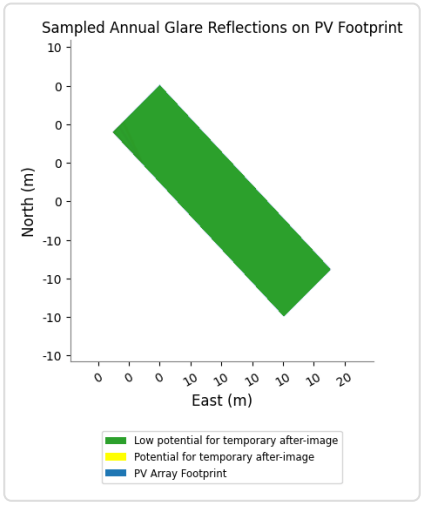
Yellow glare: none

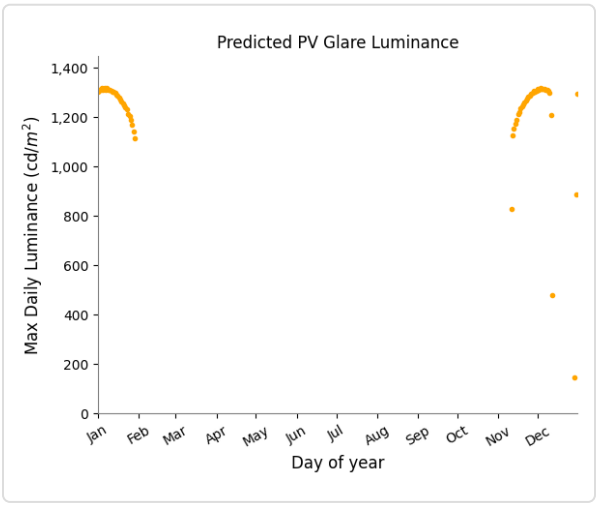
Green glare: 1,072 min.







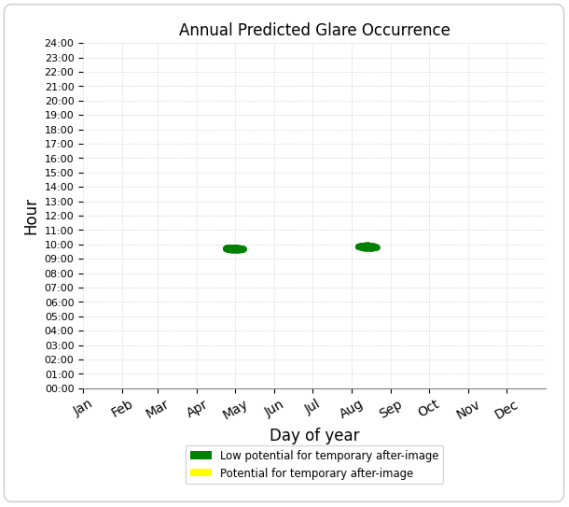


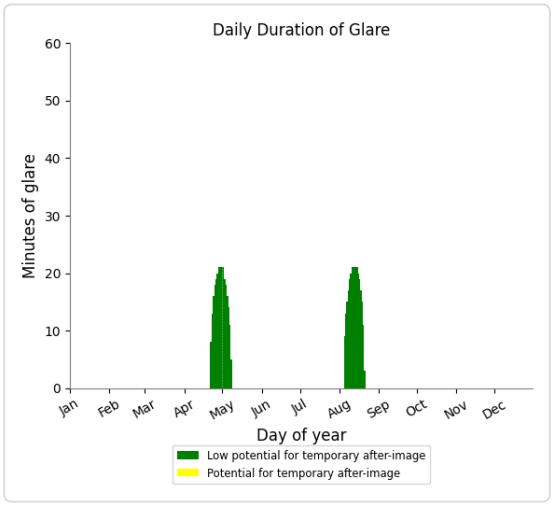


PV array 1 and OP 14

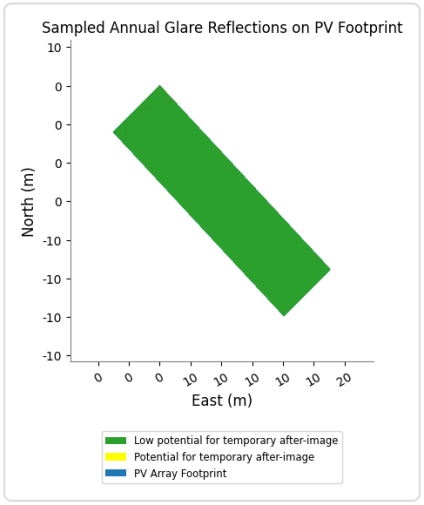
Yellow glare: none

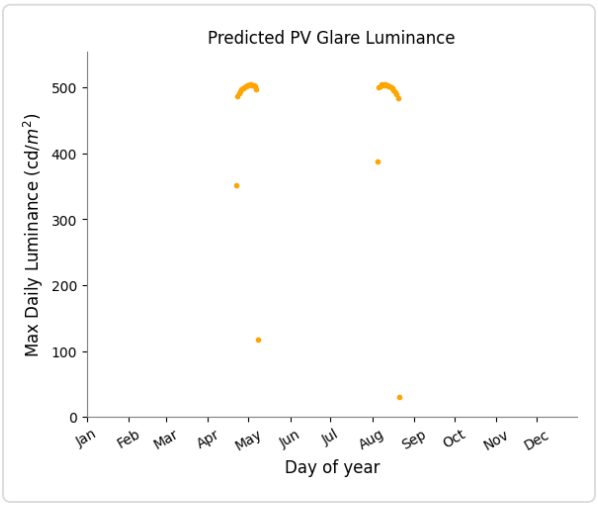
Green glare: 565 min.







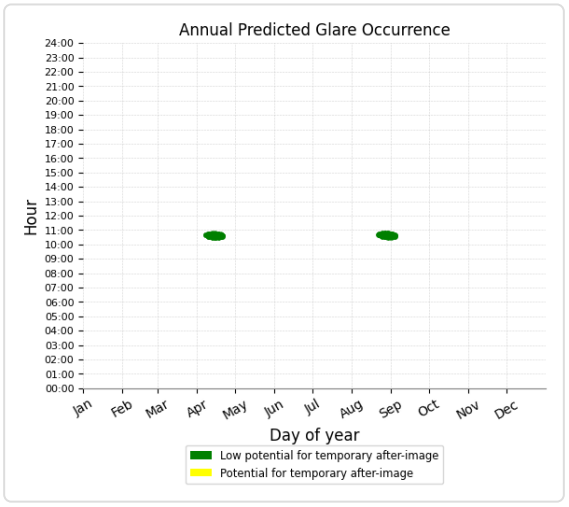


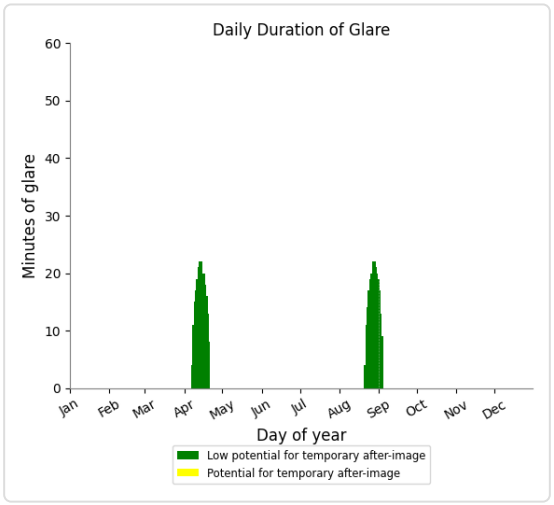


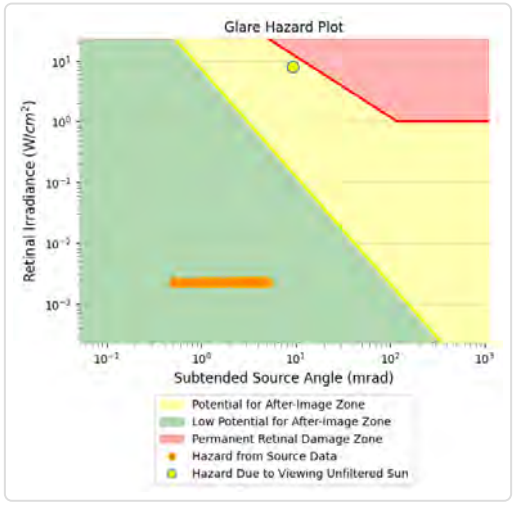
PV array 1 and OP 15

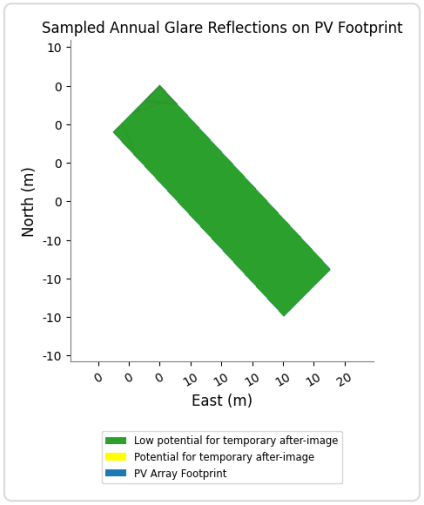
Yellow glare: none

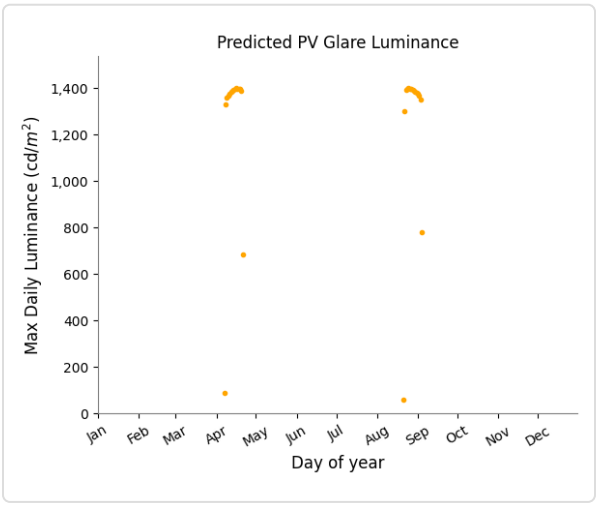
Green glare: 498 min.







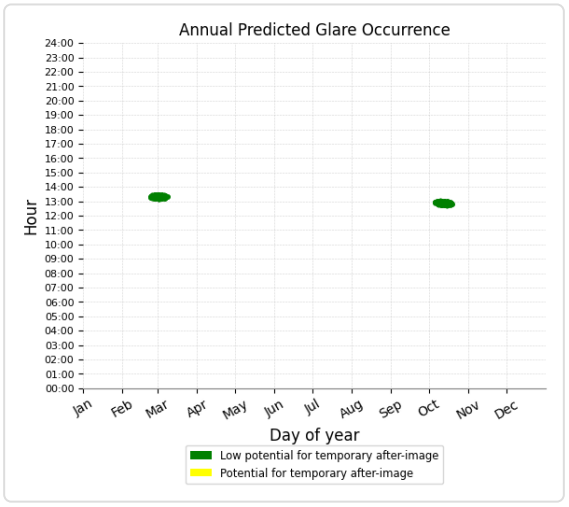


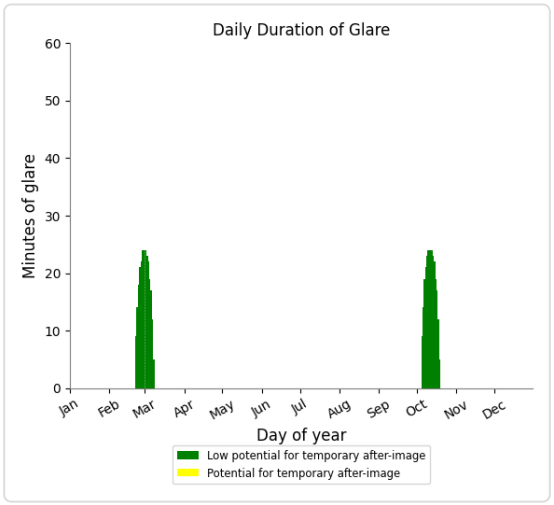


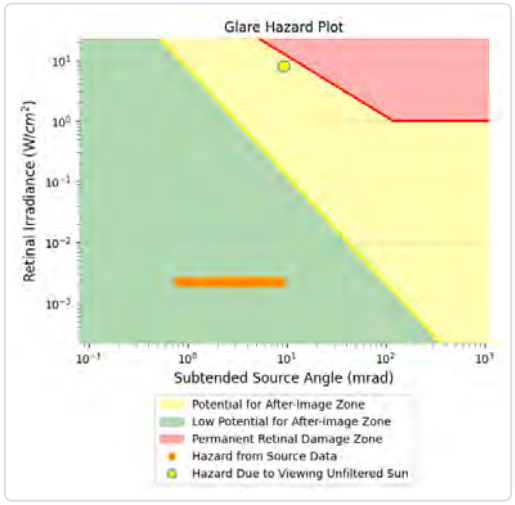
PV array 1 and OP 16

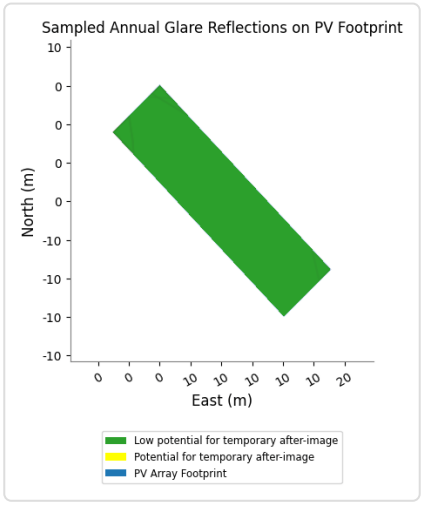
Yellow glare: none

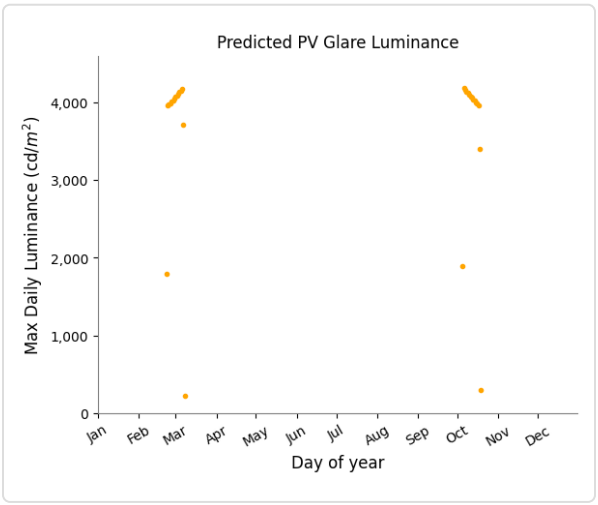
Green glare: 558 min.







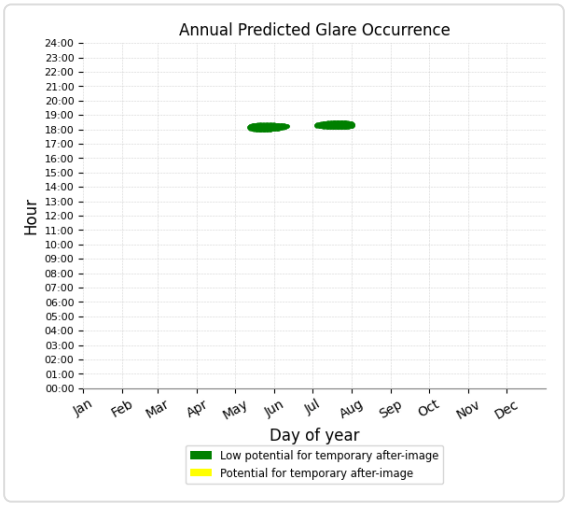


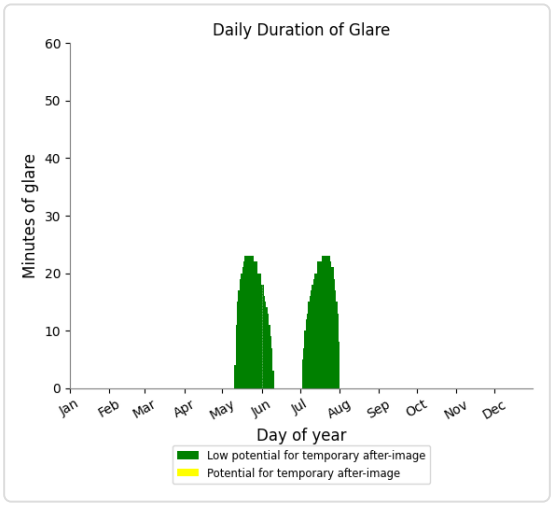


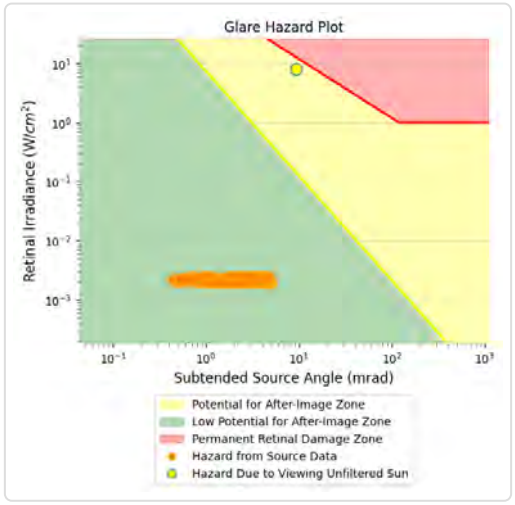
PV array 1 and OP 23

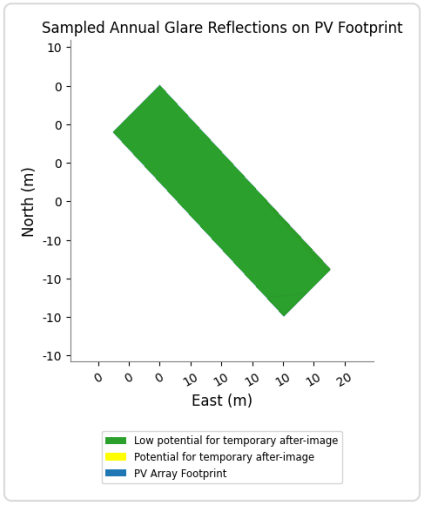
Yellow glare: none

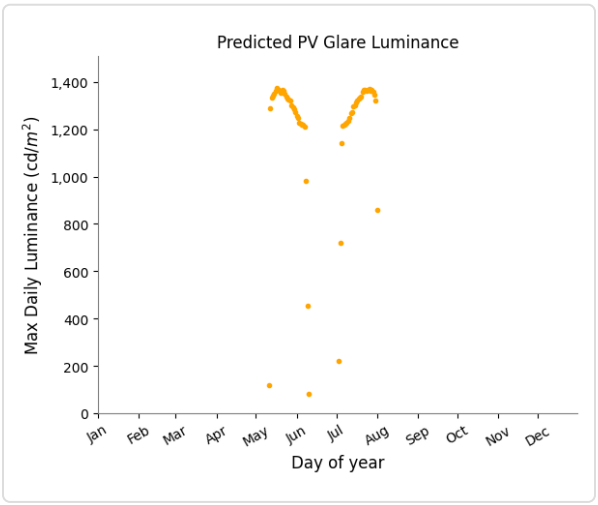
Green glare: 1,074 min.







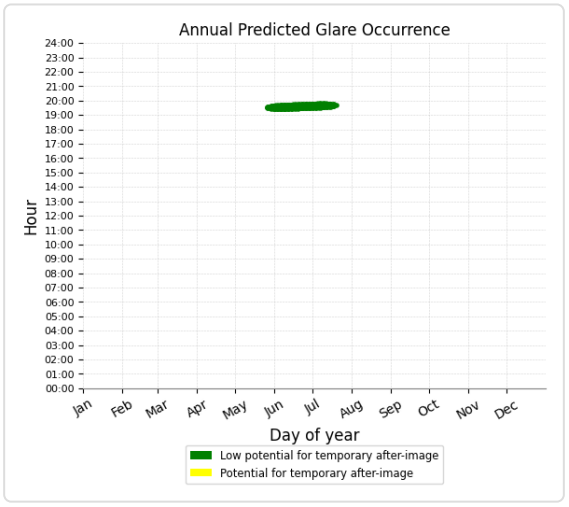


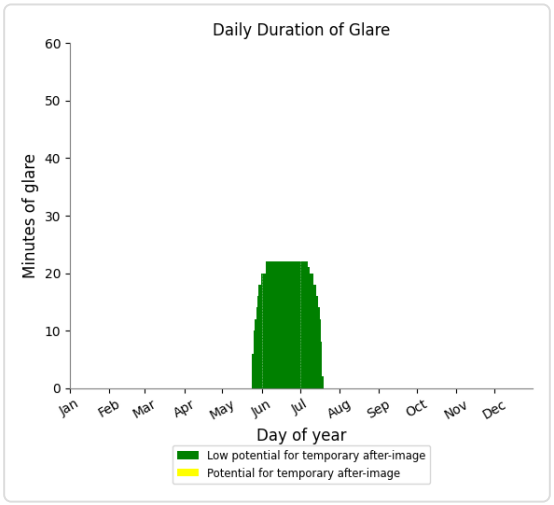


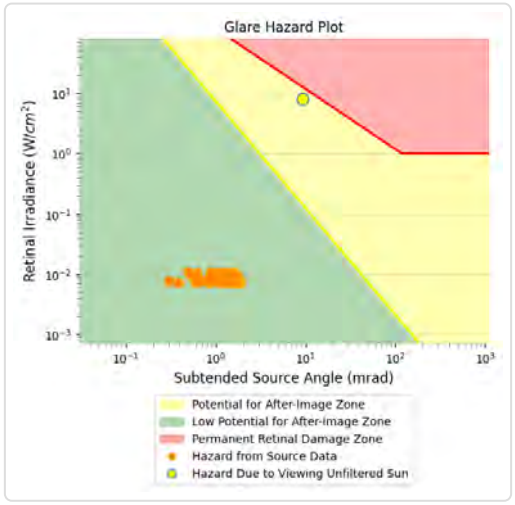
PV array 1 and OP 30

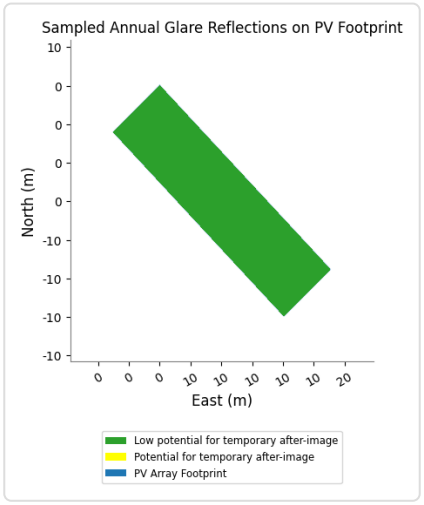
Yellow glare: none

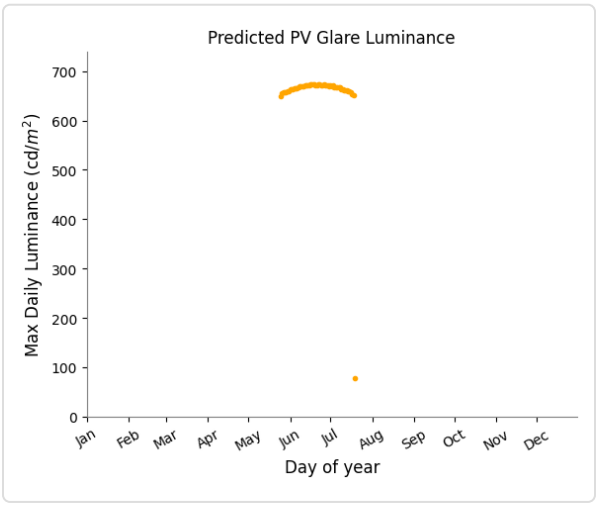
Green glare: 1,085 min.







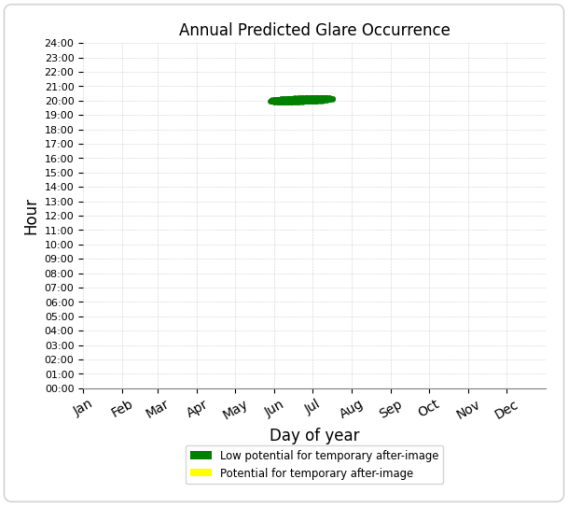


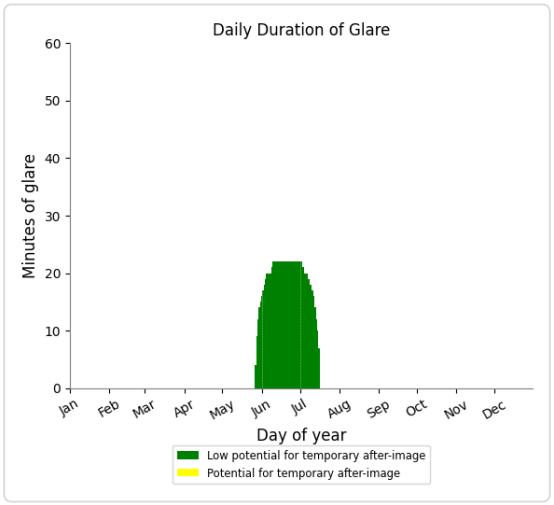


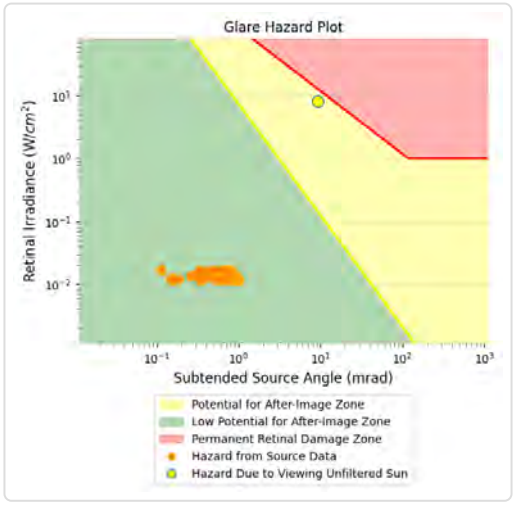
PV array 1 and OP 37

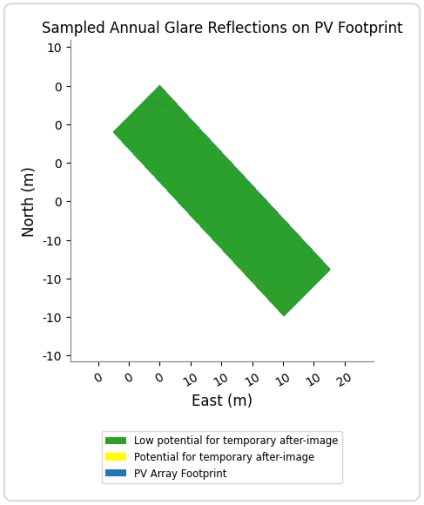
Yellow glare: none

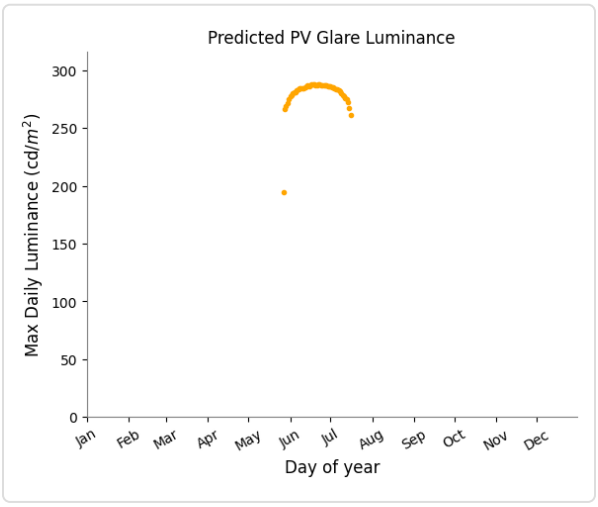
Green glare: 964 min.







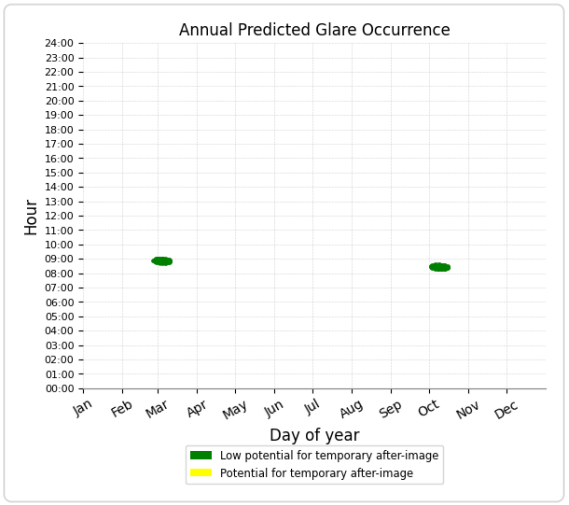


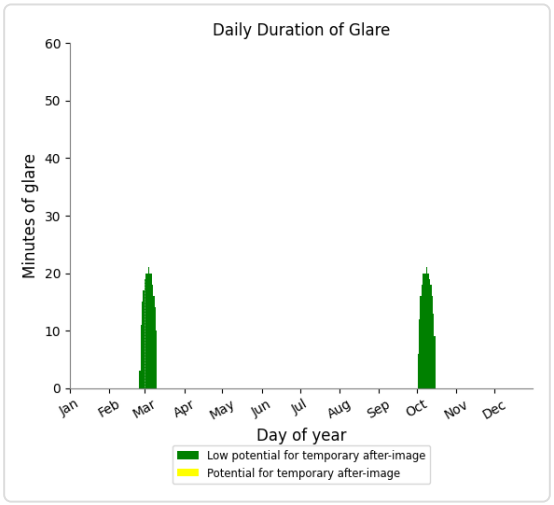


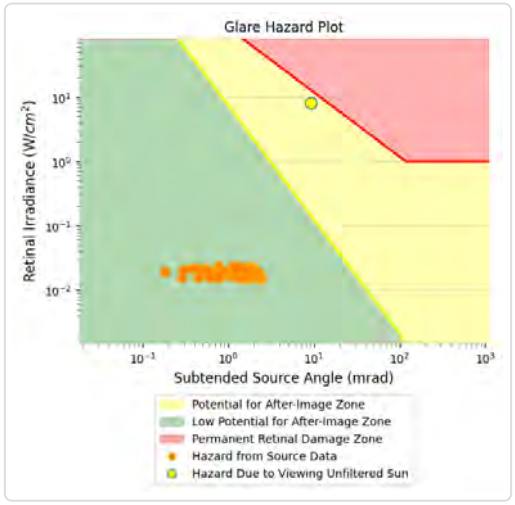
PV array 1 and OP 38

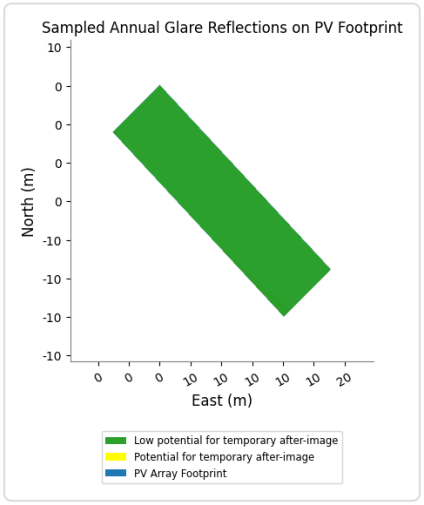
Yellow glare: none

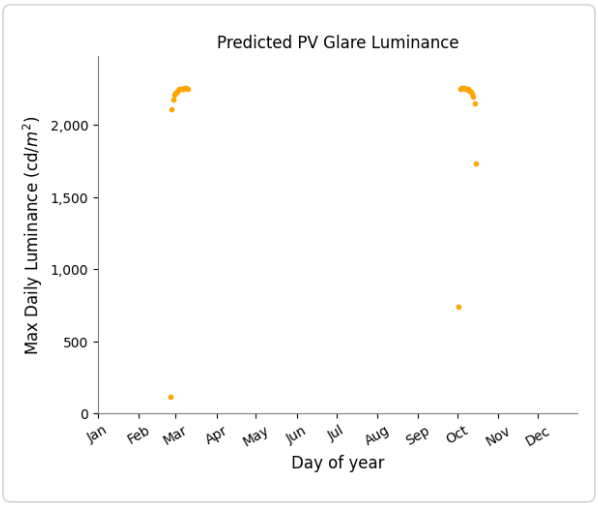
Green glare: 452 min.











PV array 1 and 1-ATCT

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 7

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 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 array 1 and OP 22

No glare found

PV array 1 and OP 24

No glare found

PV array 1 and OP 25

No glare found

PV array 1 and OP 26

No glare found

PV array 1 and OP 27

No glare found

PV array 1 and OP 28

No glare found

PV array 1 and OP 29

No glare found

PV array 1 and OP 31

No glare found

PV array 1 and OP 32

No glare found

PV array 1 and OP 33

No glare found

PV array 1 and OP 34

No glare found

PV array 1 and OP 35

No glare found

PV array 1 and OP 36

No glare found

PV array 1 and OP 39

No glare found

PV array 1 and OP 40

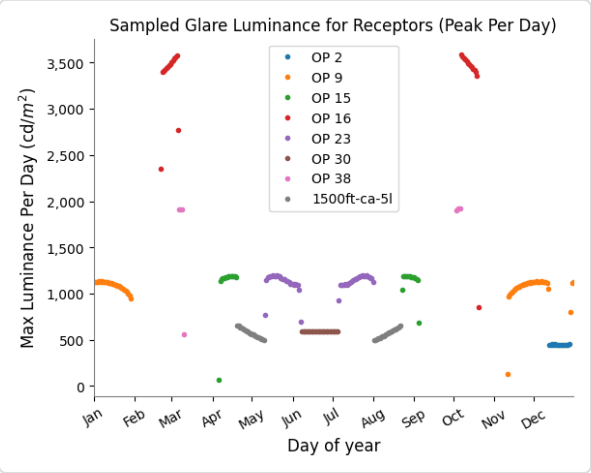
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,146	52.4	0	0.0	733
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,286	21.4	0	0.0	453
OP 8	440	7.3	0	0.0	554
OP 9	1,099	18.3	0	0.0	1,132
OP 14	550	9.2	0	0.0	433
OP 15	484	8.1	0	0.0	1,191
OP 16	551	9.2	0	0.0	3,583
OP 23	1,034	17.2	0	0.0	1,199
OP 30	1,114	18.6	0	0.0	591
OP 37	965	16.1	0	0.0	252
OP 38	454	7.6	0	0.0	1,917
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

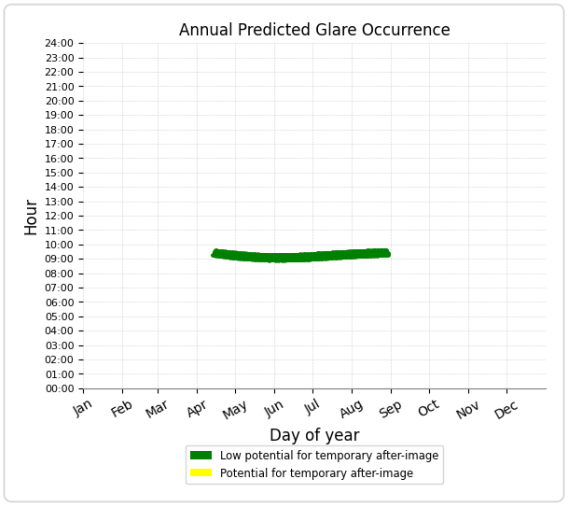
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

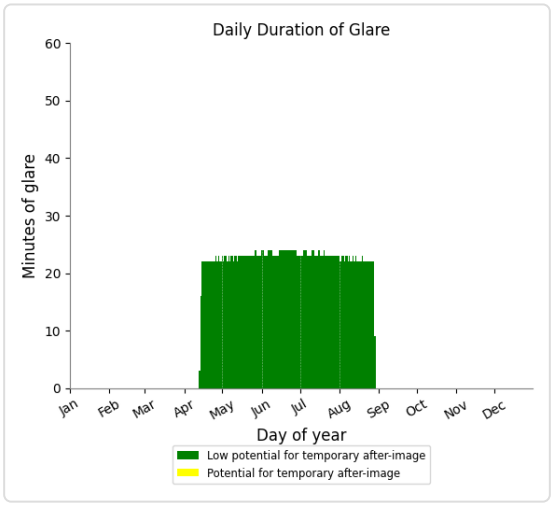


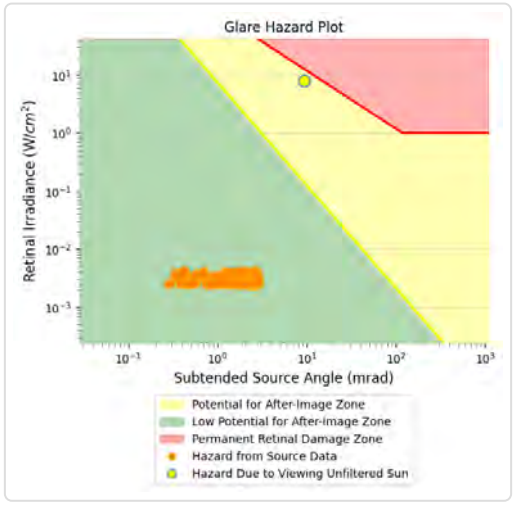
PV array 2 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

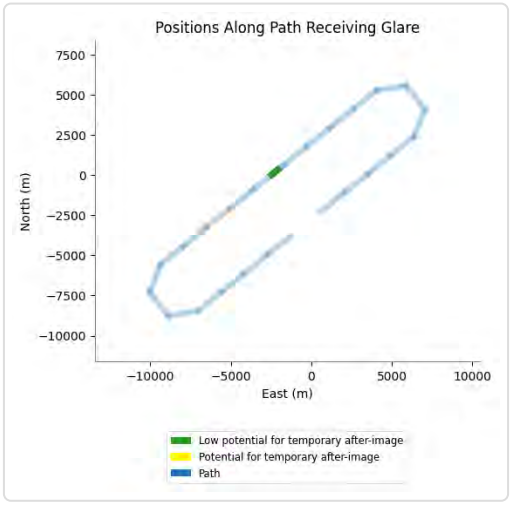
Yellow glare: none

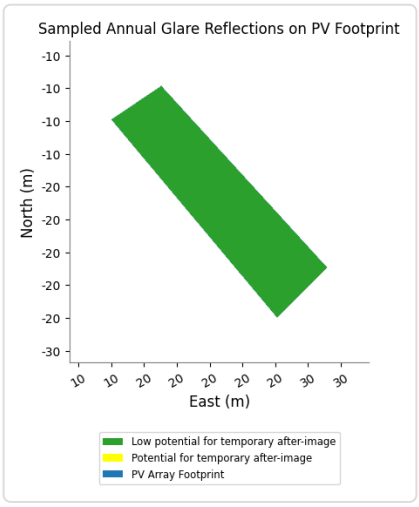
Green glare: 3,146 min.

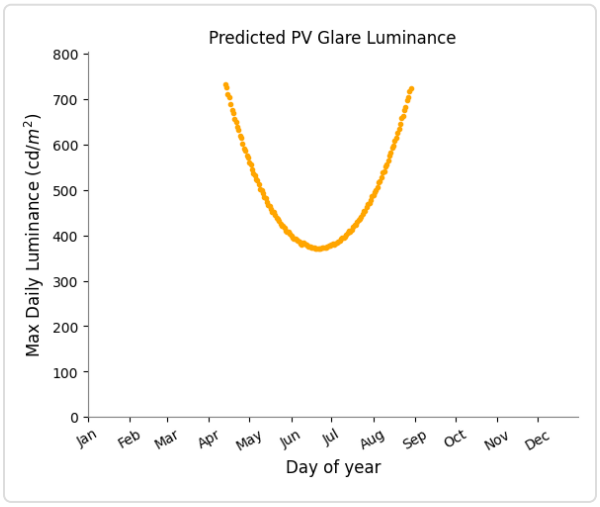












PV array 2 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 2 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 2 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 2 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 2 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 2 and Route: Approach_05L

No glare found

PV array 2 and Route: Approach_05R

No glare found

PV array 2 and Route: Approach_23L

No glare found

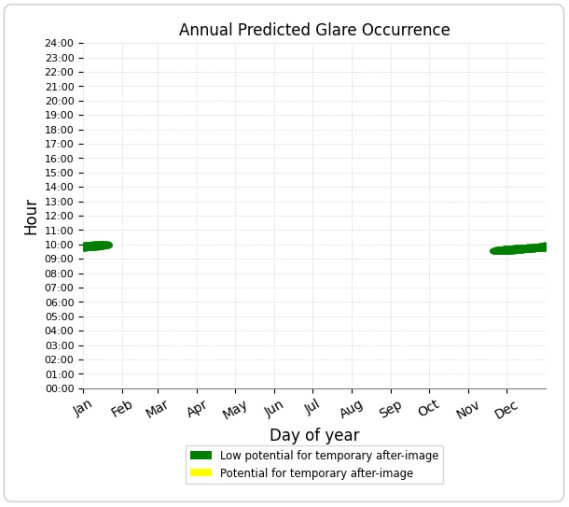
PV array 2 and Route: Approach_23R

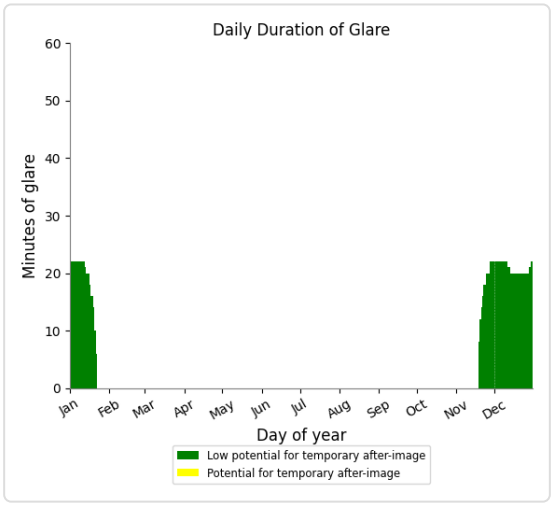
No glare found

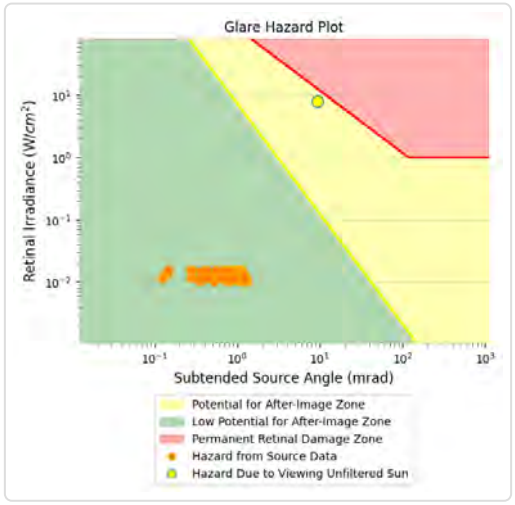
PV array 2 and OP 2

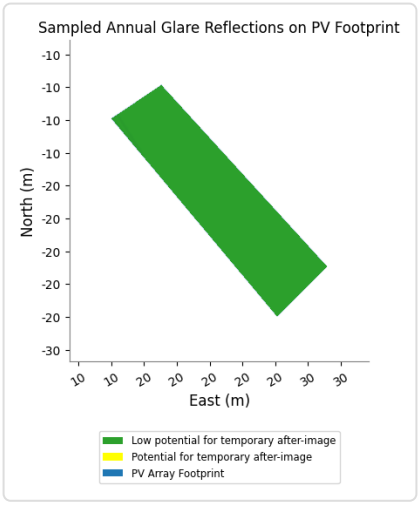
Yellow glare: none

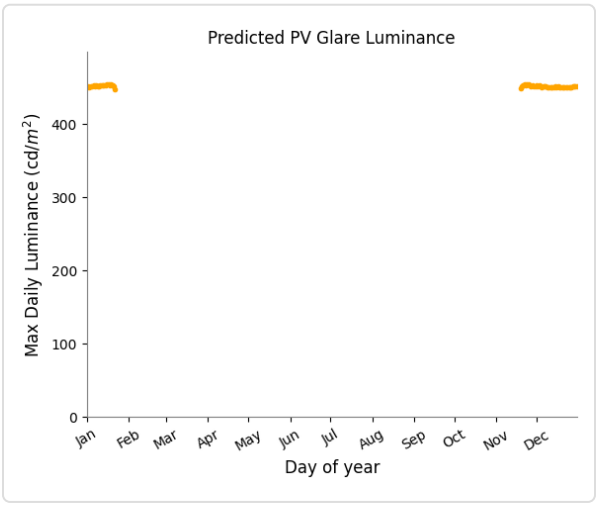
Green glare: 1,286 min.







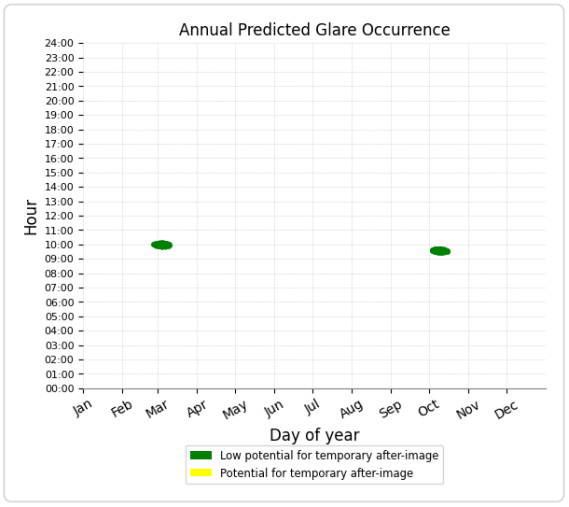


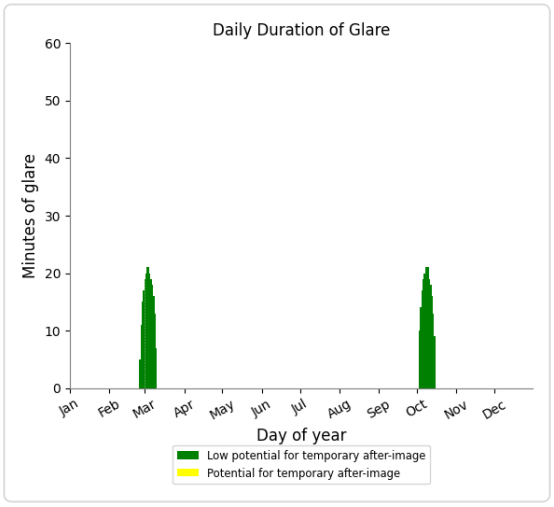


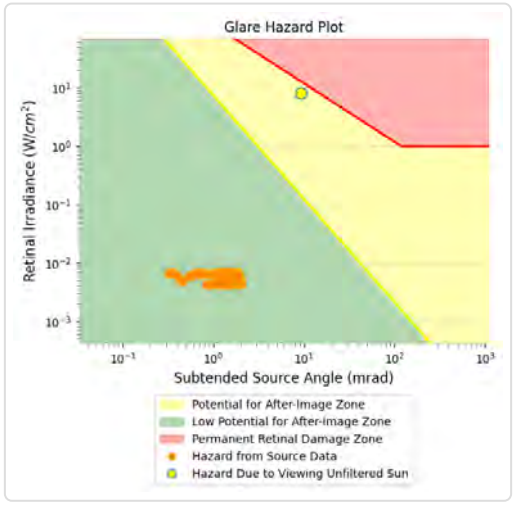
PV array 2 and OP 8

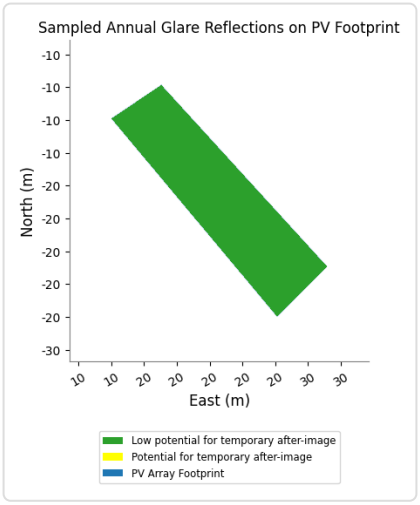
Yellow glare: none

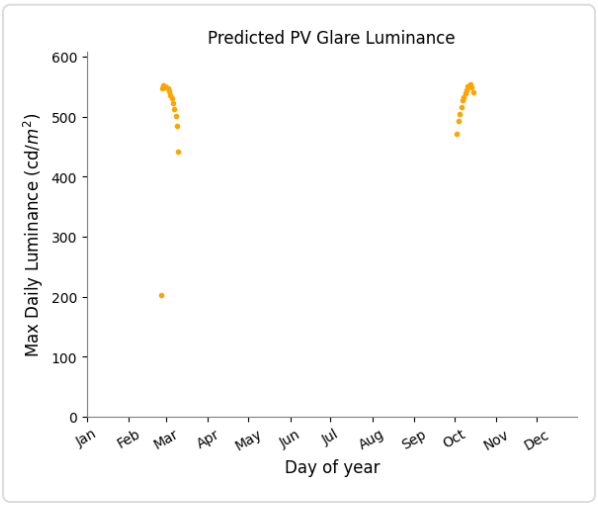
Green glare: 440 min.







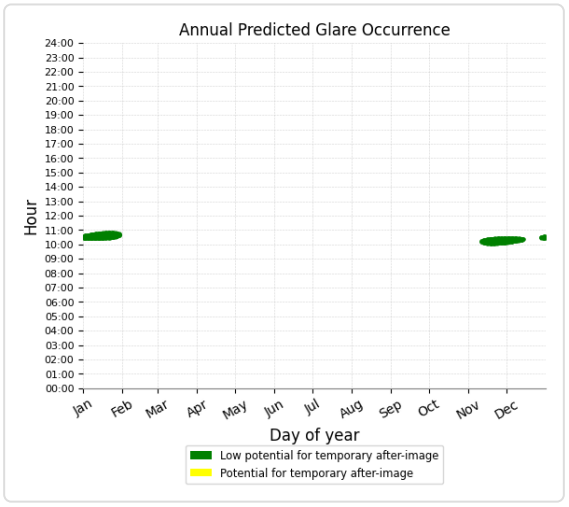


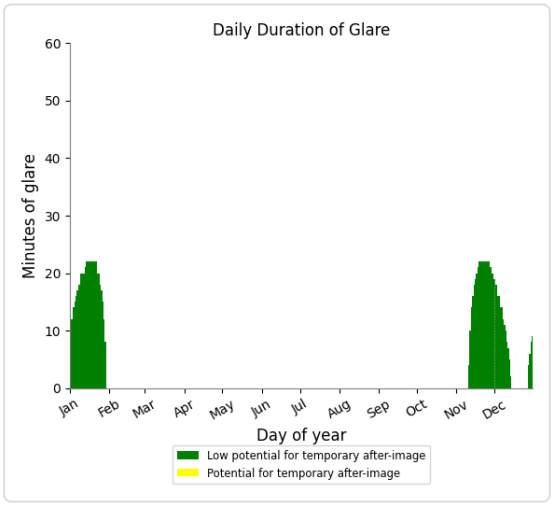


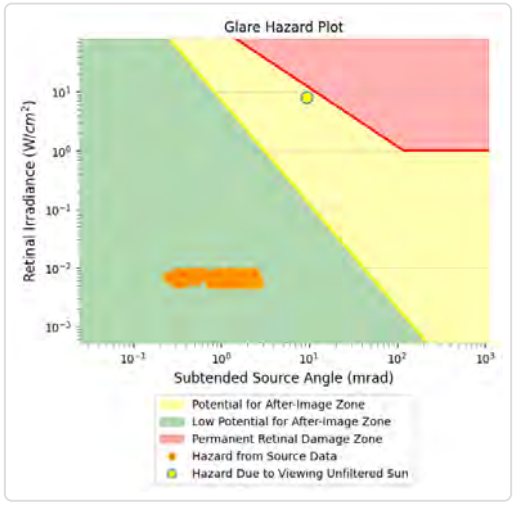
PV array 2 and OP 9

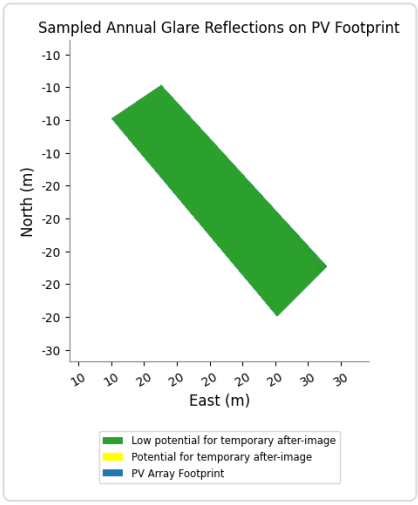
Yellow glare: none

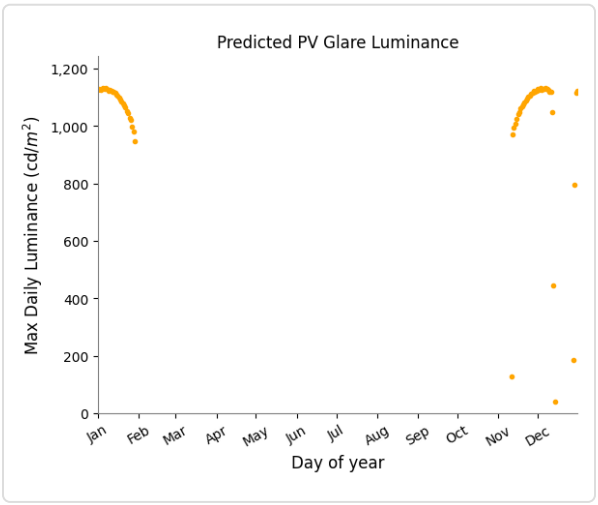
Green glare: 1,099 min.







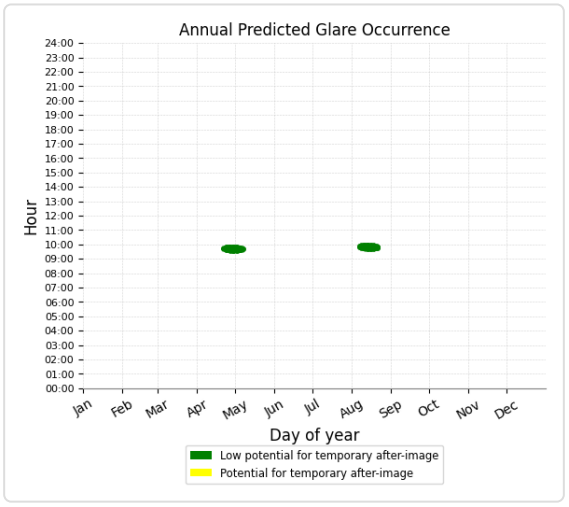


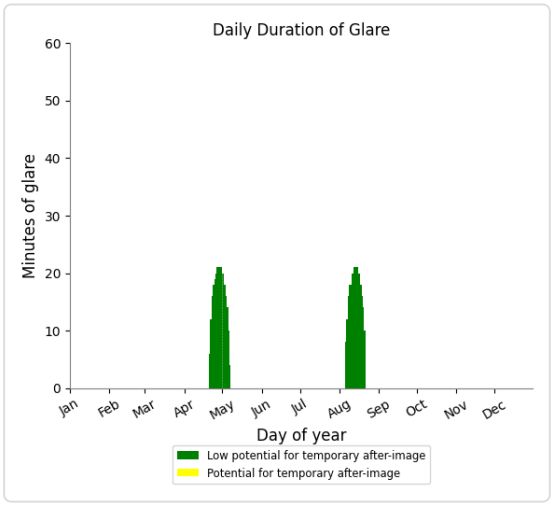


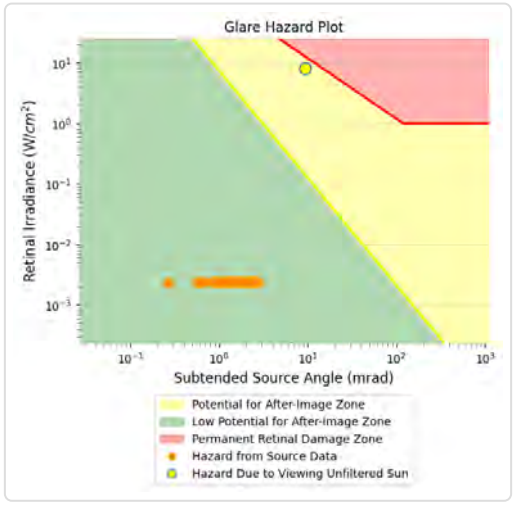
PV array 2 and OP 14

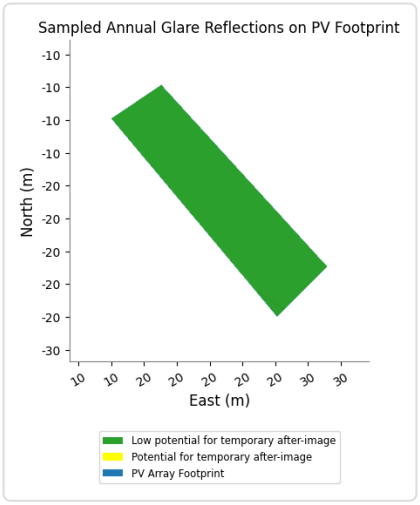
Yellow glare: none

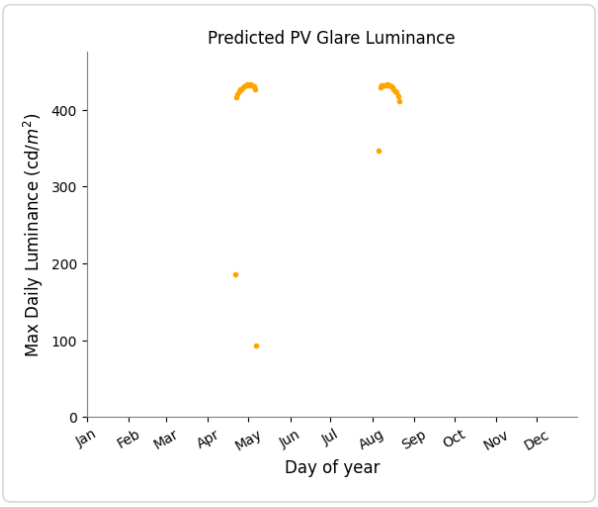
Green glare: 550 min.







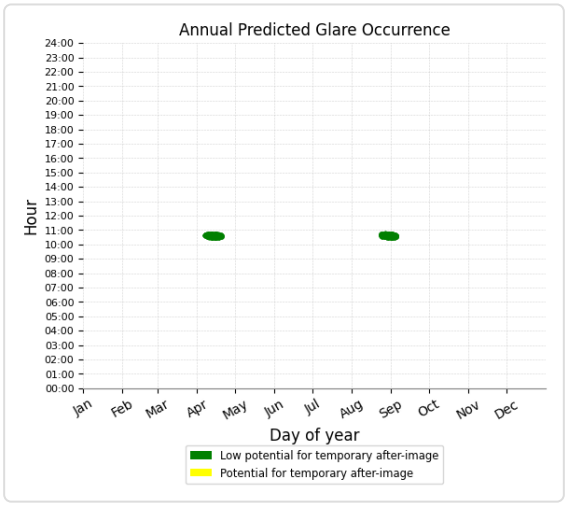


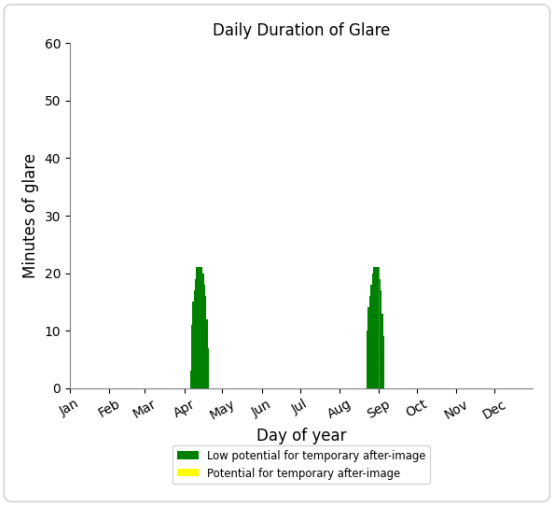


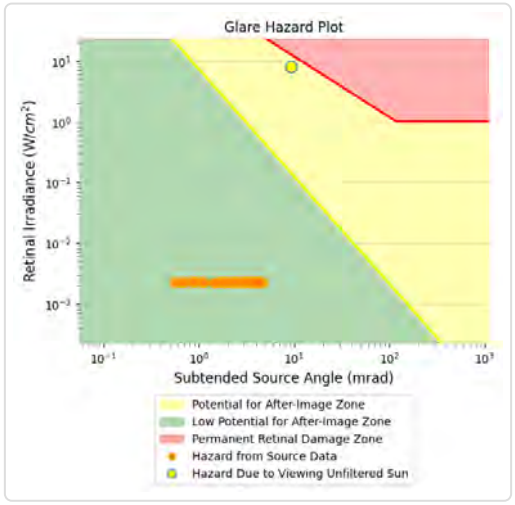
PV array 2 and OP 15

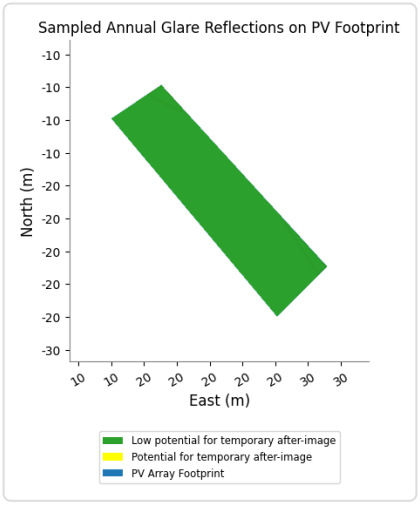
Yellow glare: none

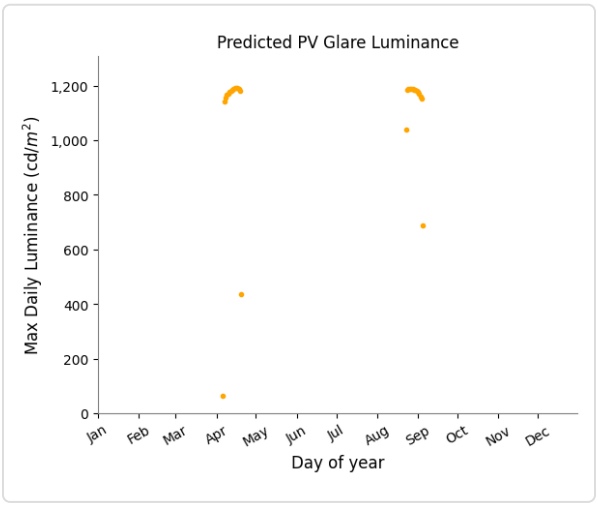
Green glare: 484 min.







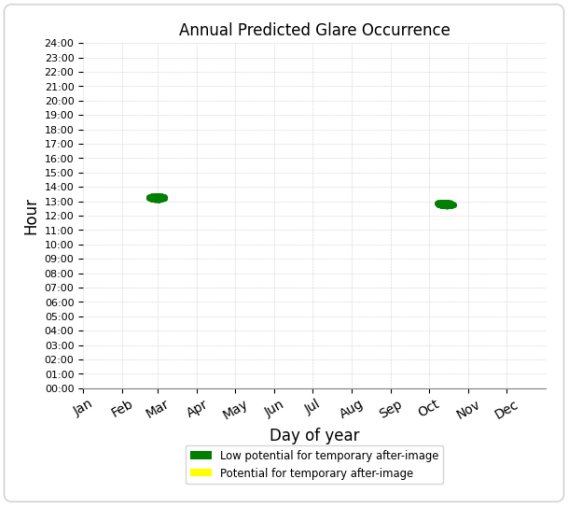


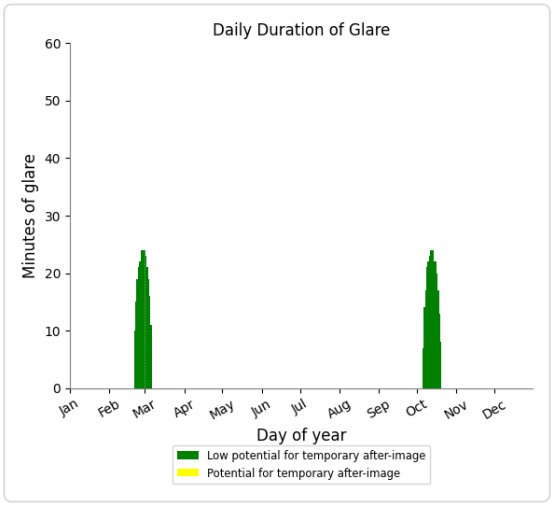


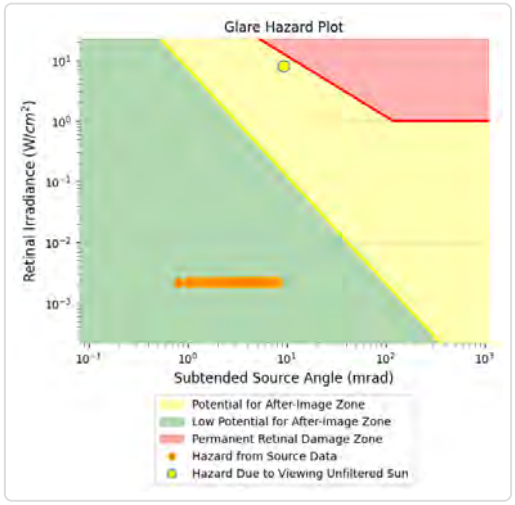
PV array 2 and OP 16

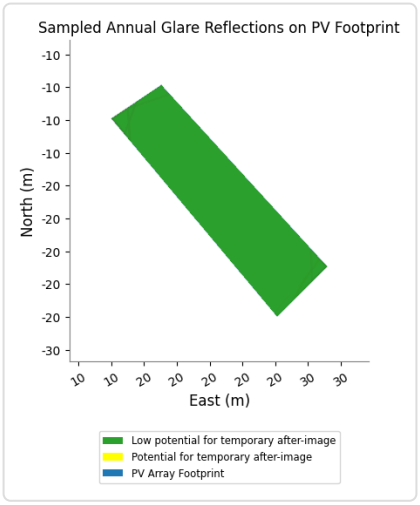
Yellow glare: none

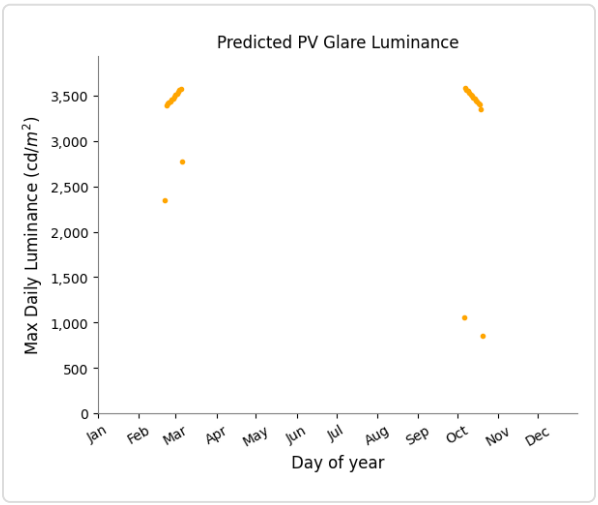
Green glare: 551 min.







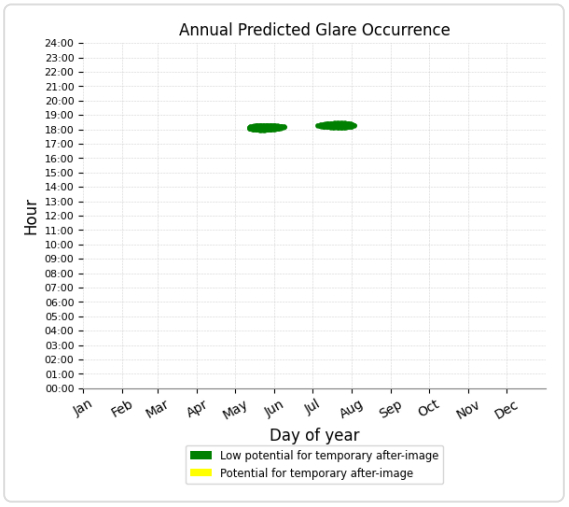


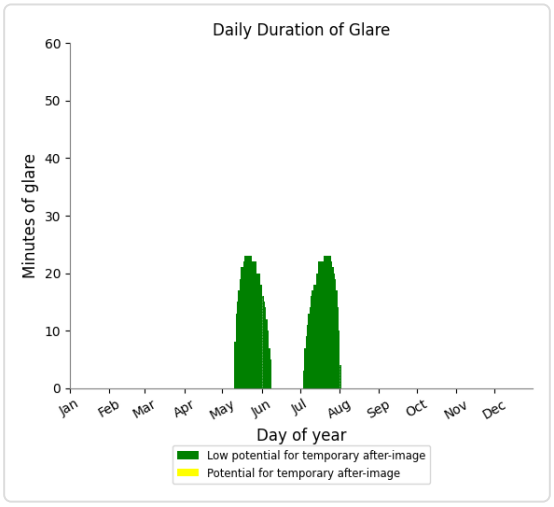


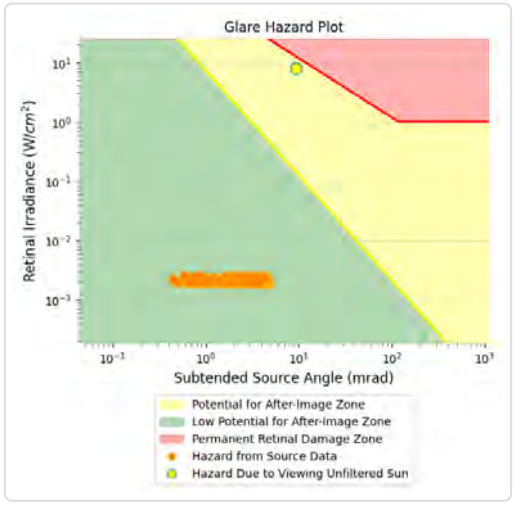
PV array 2 and OP 23

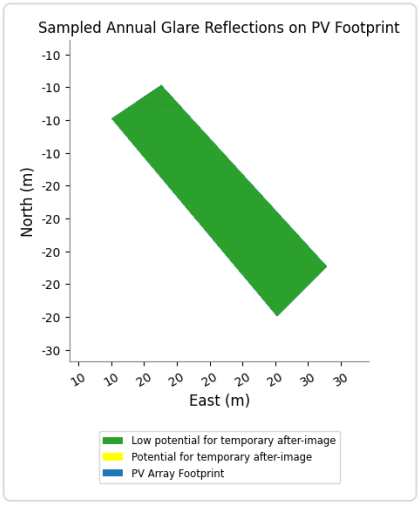
Yellow glare: none

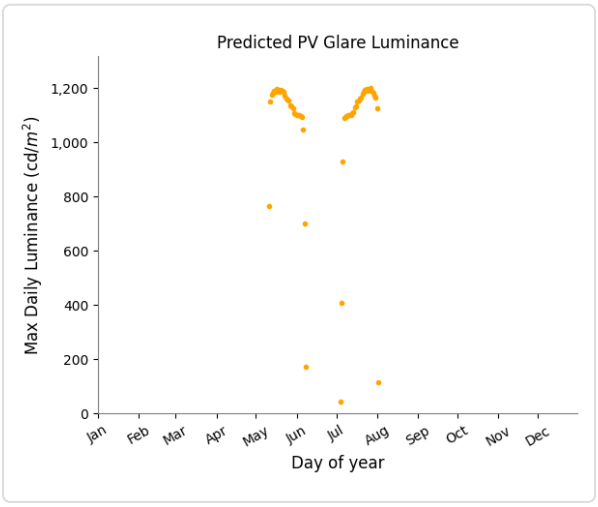
Green glare: 1,034 min.







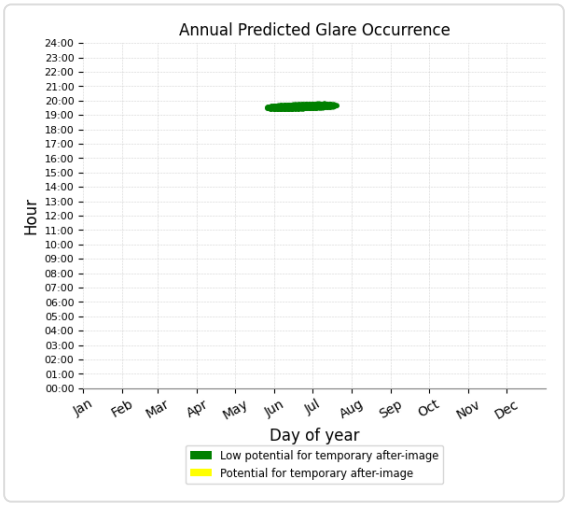


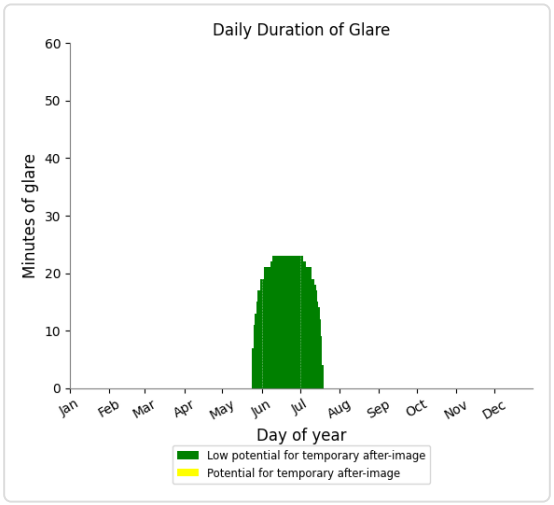


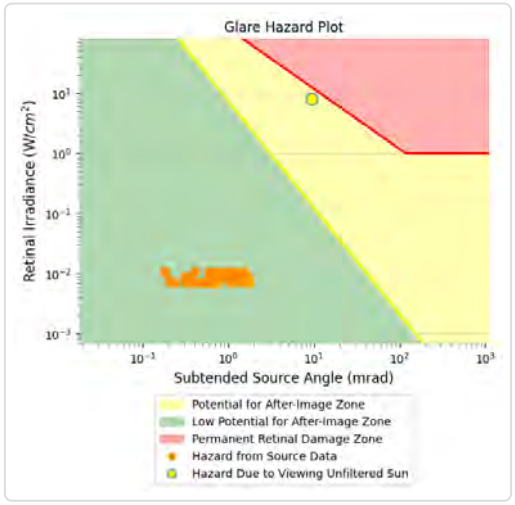
PV array 2 and OP 30

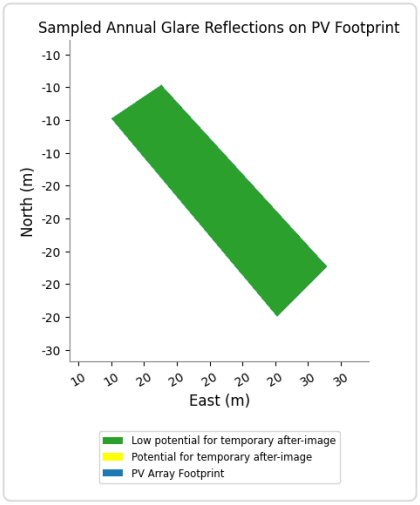
Yellow glare: none

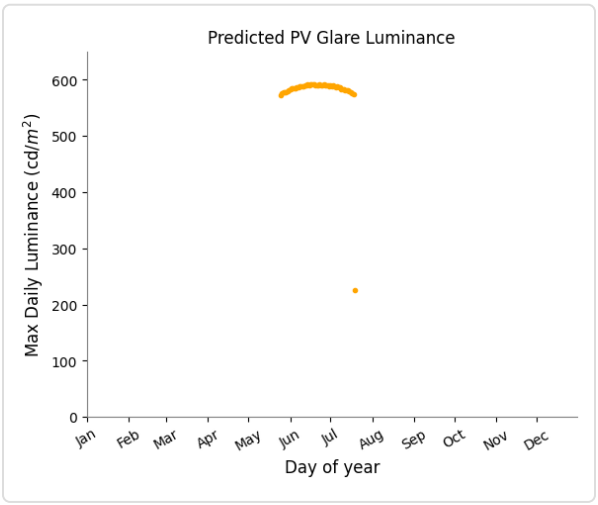
Green glare: 1,114 min.







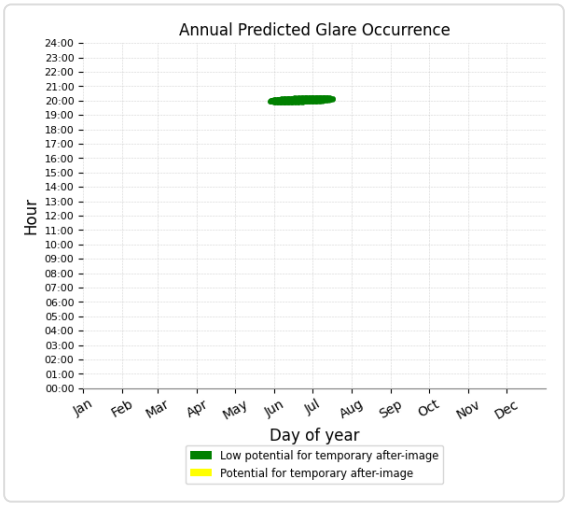


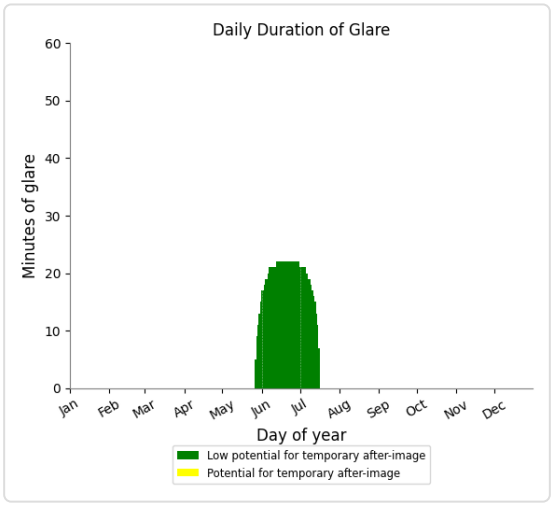


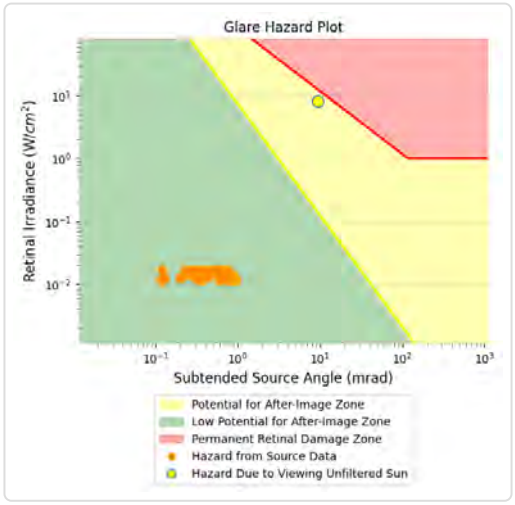
PV array 2 and OP 37

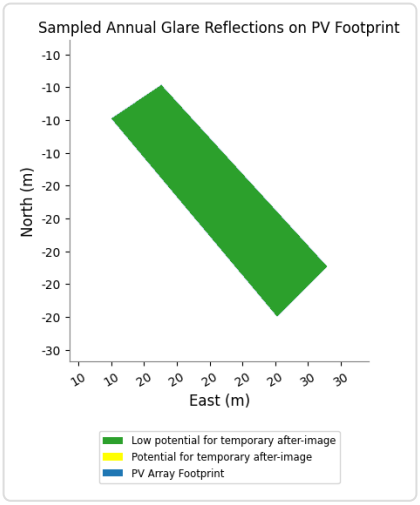
Yellow glare: none

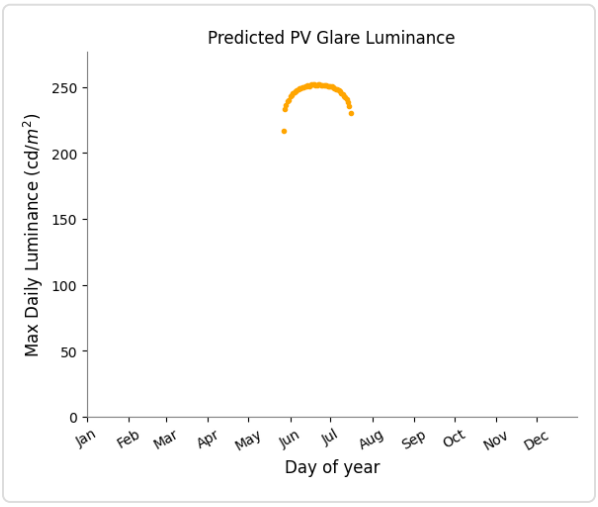
Green glare: 965 min.







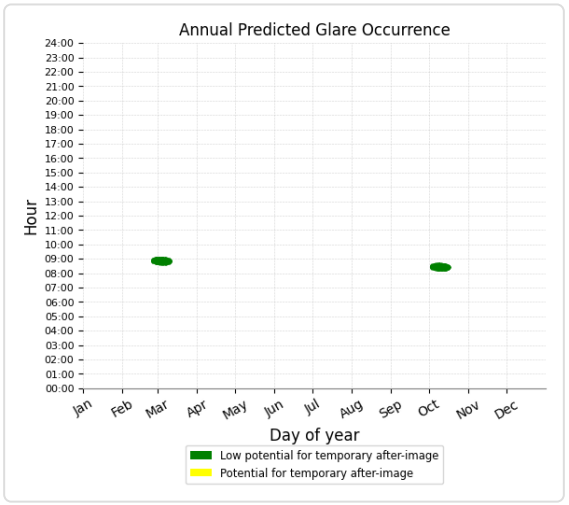


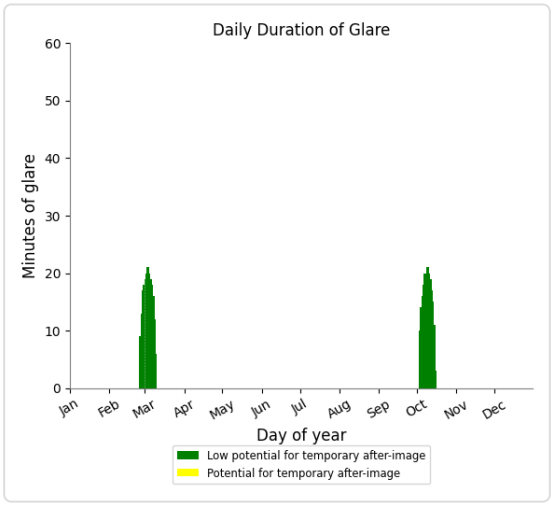


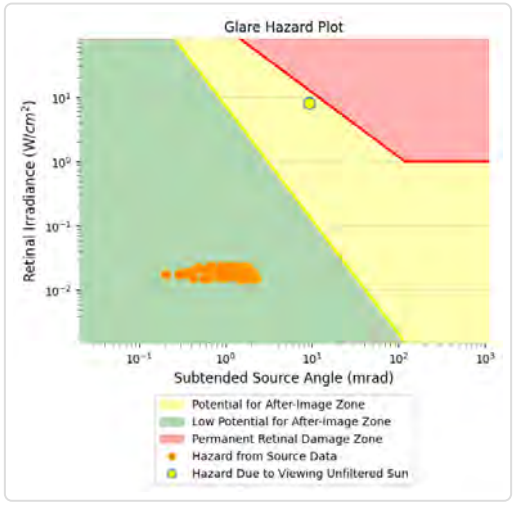
PV array 2 and OP 38

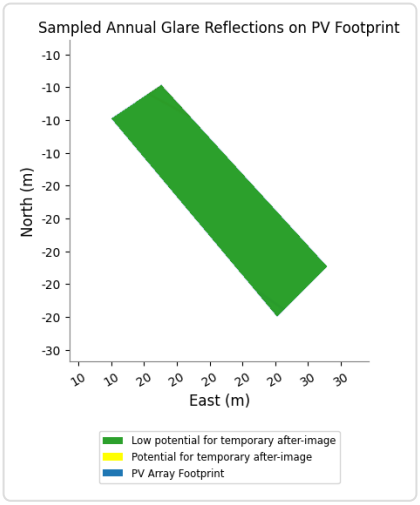
Yellow glare: none

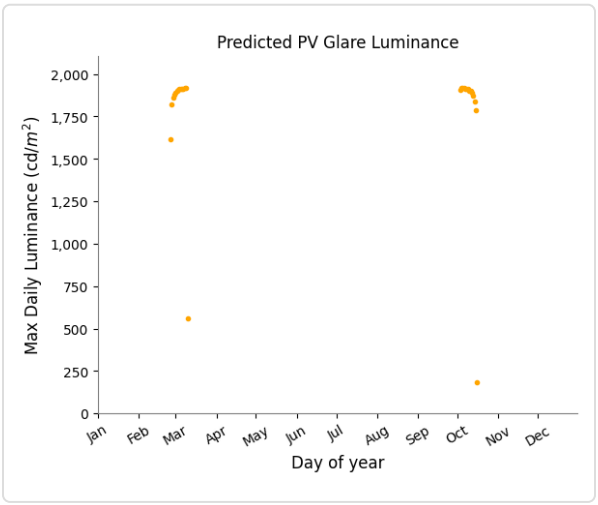
Green glare: 454 min.











PV array 2 and 1-ATCT

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 7

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 array 2 and OP 22

No glare found

PV array 2 and OP 24

No glare found

PV array 2 and OP 25

No glare found

PV array 2 and OP 26

No glare found

PV array 2 and OP 27

No glare found

PV array 2 and OP 28

No glare found

PV array 2 and OP 29

No glare found

PV array 2 and OP 31

No glare found

PV array 2 and OP 32

No glare found

PV array 2 and OP 33

No glare found

PV array 2 and OP 34

No glare found

PV array 2 and OP 35

No glare found

PV array 2 and OP 36

No glare found

PV array 2 and OP 39

No glare found

PV array 2 and OP 40

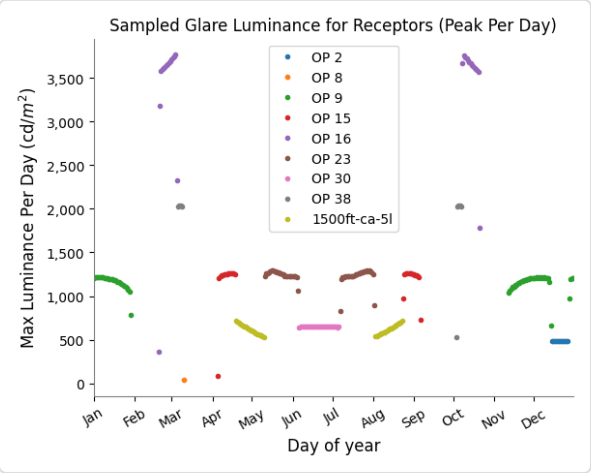
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,145	52.4	0	0.0	788
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,285	21.4	0	0.0	487
OP 8	444	7.4	0	0.0	599
OP 9	1,125	18.8	0	0.0	1,214
OP 14	551	9.2	0	0.0	463
OP 15	485	8.1	0	0.0	1,261
OP 16	566	9.4	0	0.0	3,765
OP 23	1,015	16.9	0	0.0	1,296
OP 30	1,103	18.4	0	0.0	651
OP 37	970	16.2	0	0.0	276
OP 38	457	7.6	0	0.0	2,037
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

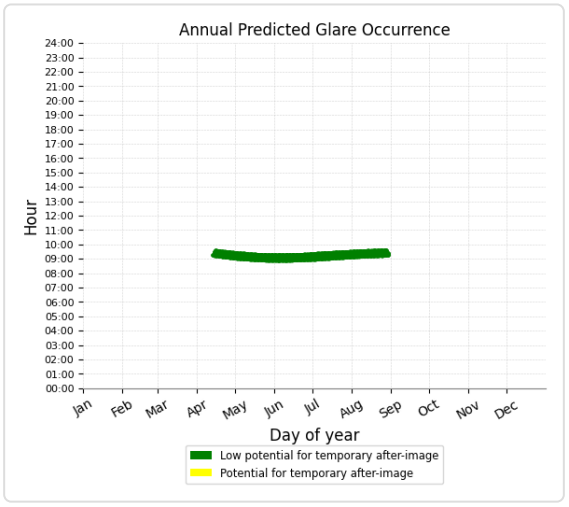
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

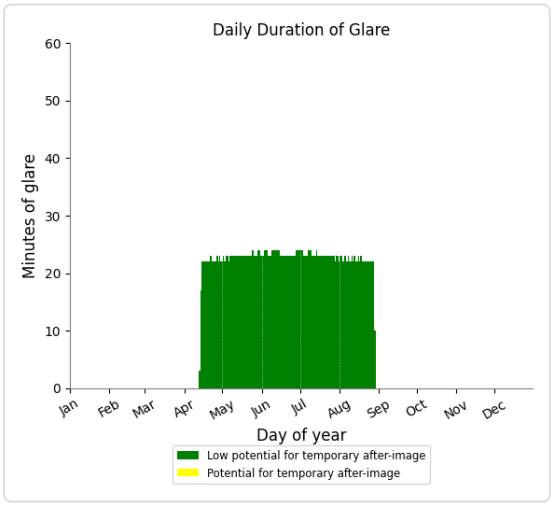


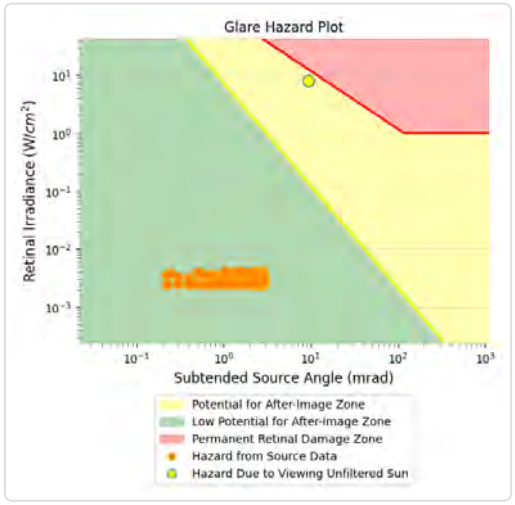
PV array 3 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

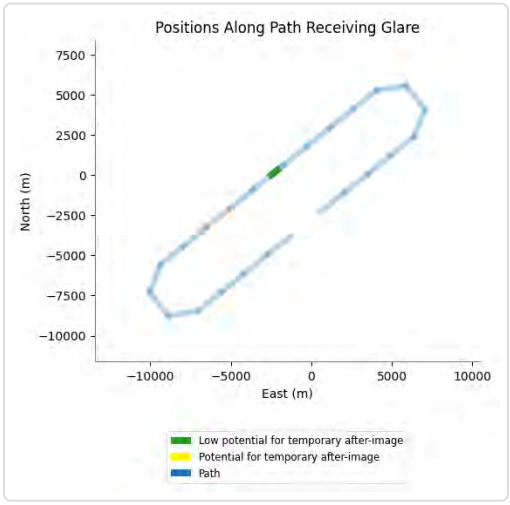
Yellow glare: none

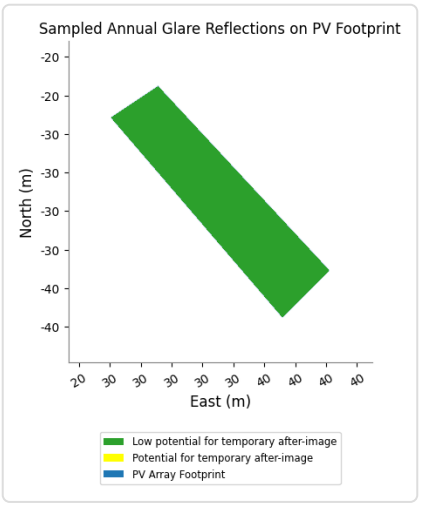
Green glare: 3,145 min.

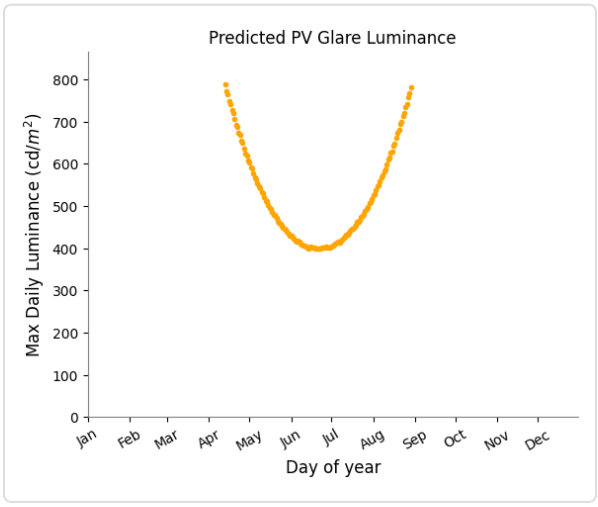












PV array 3 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 3 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 3 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 3 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 3 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 3 and Route: Approach_05L

No glare found

PV array 3 and Route: Approach_05R

No glare found

PV array 3 and Route: Approach_23L

No glare found

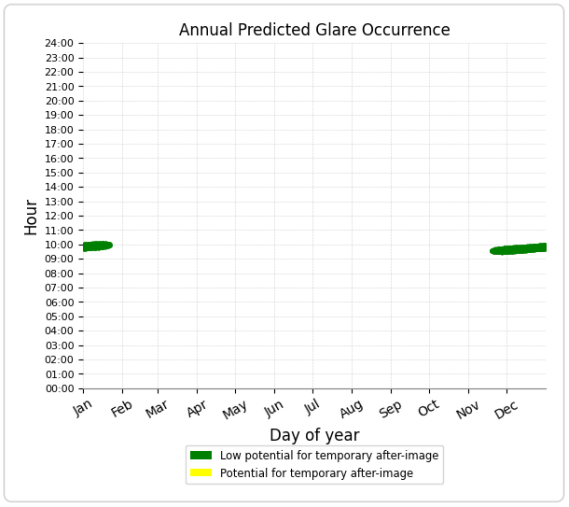
PV array 3 and Route: Approach_23R

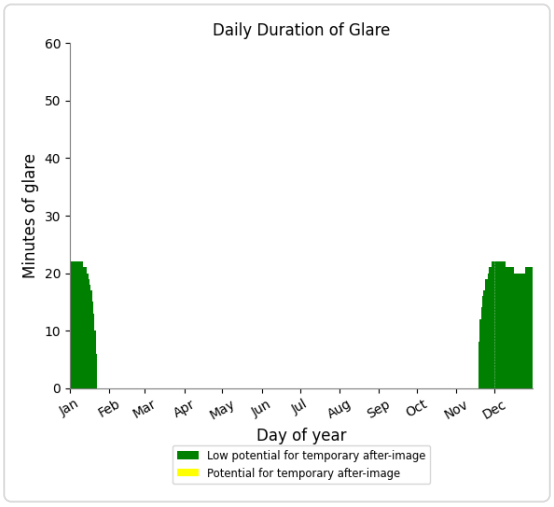
No glare found

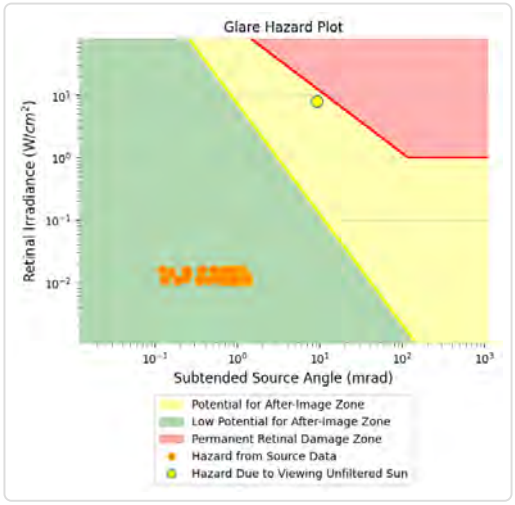
PV array 3 and OP 2

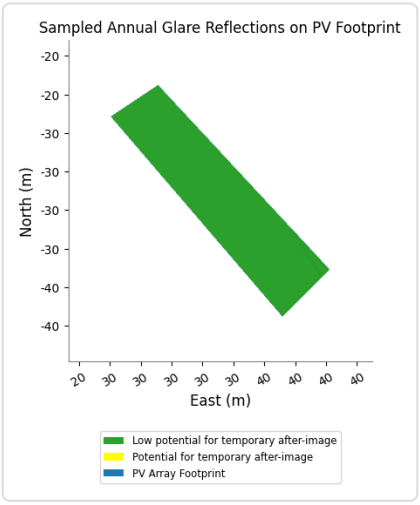
Yellow glare: none

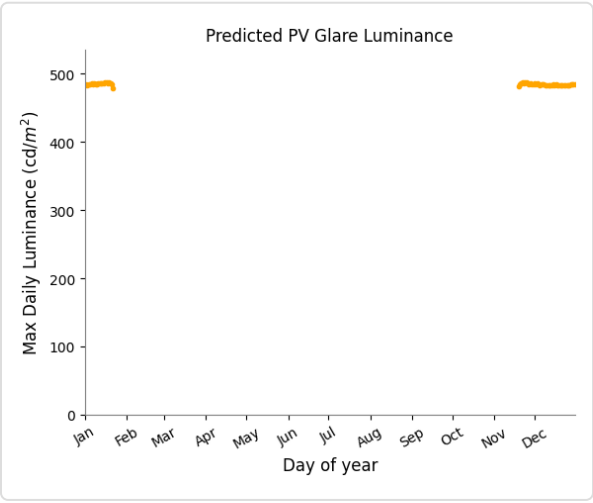
Green glare: 1,285 min.







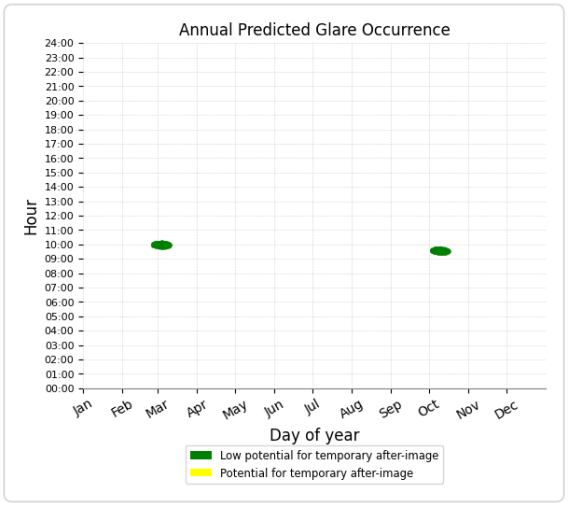


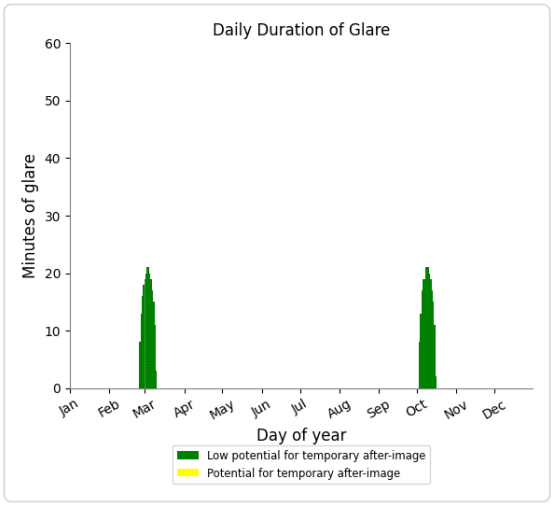


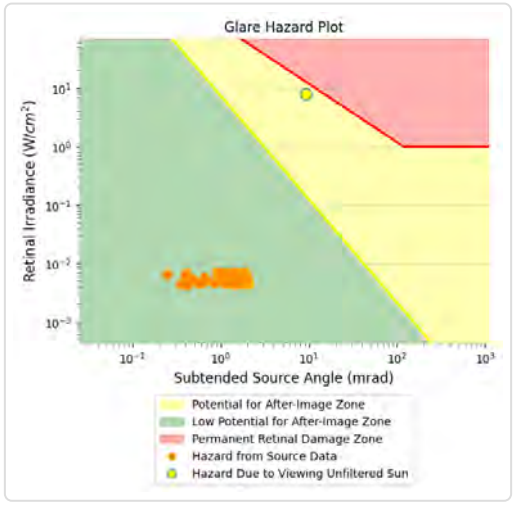
PV array 3 and OP 8

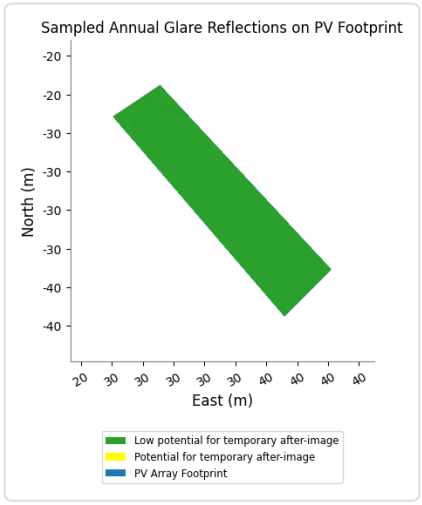
Yellow glare: none

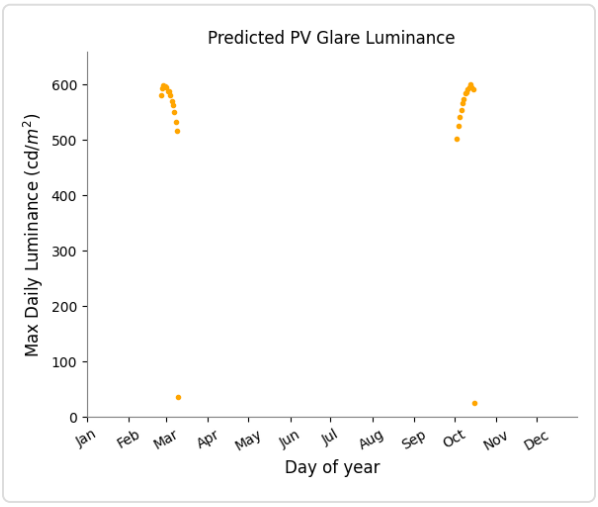
Green glare: 444 min.







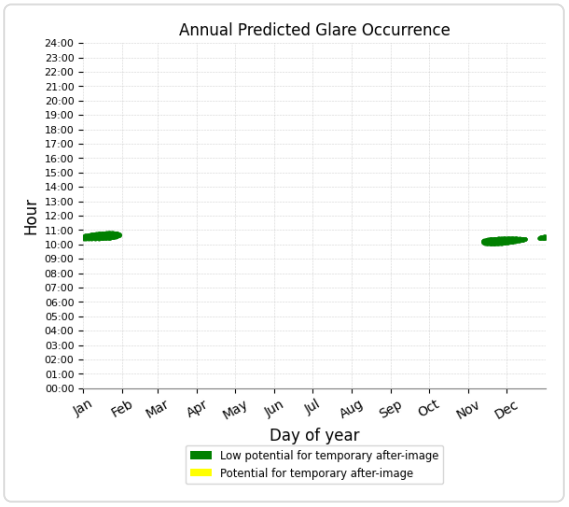


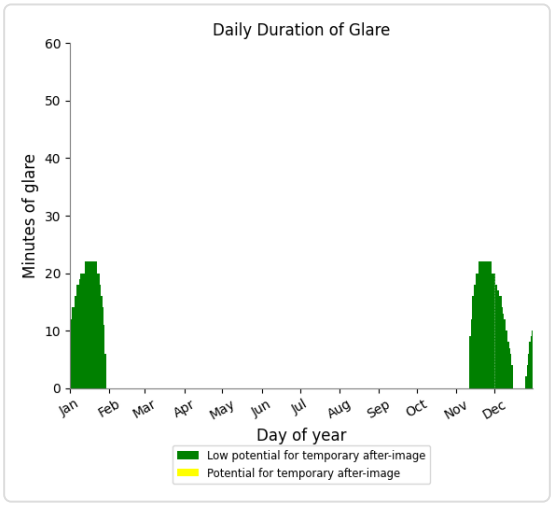


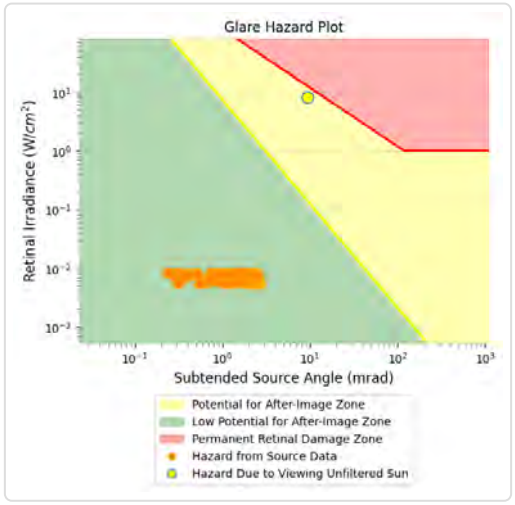
PV array 3 and OP 9

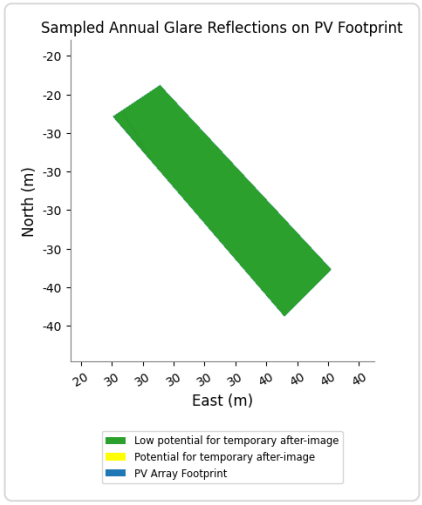
Yellow glare: none

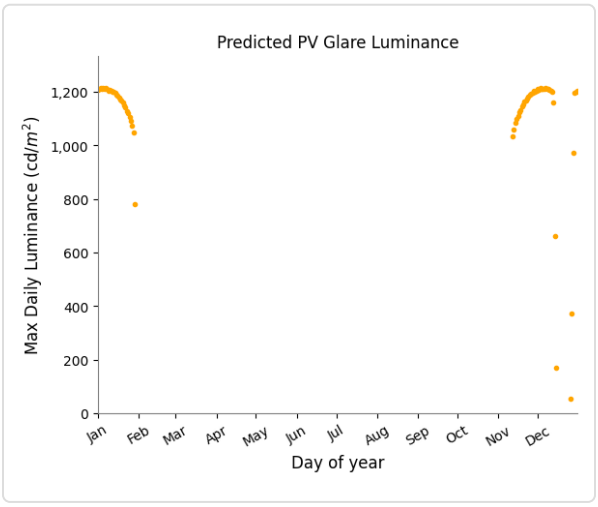
Green glare: 1,125 min.







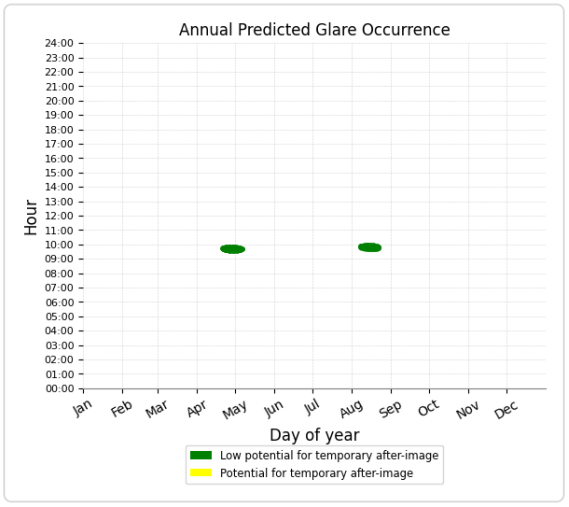


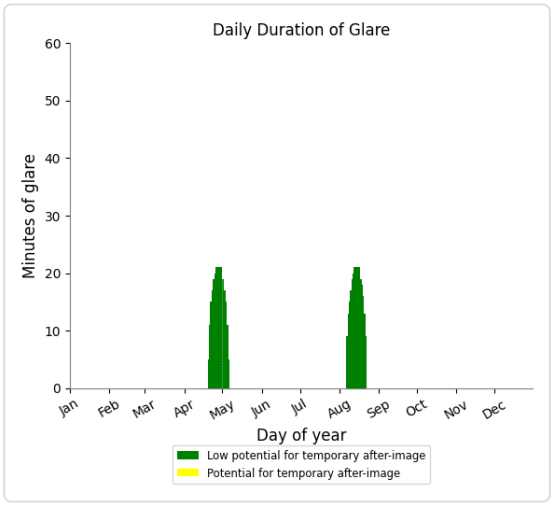


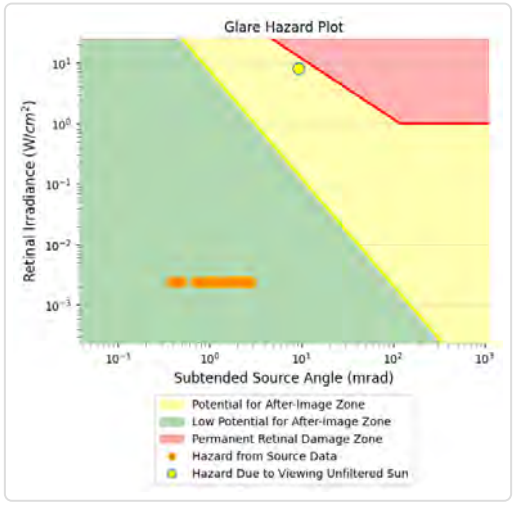
PV array 3 and OP 14

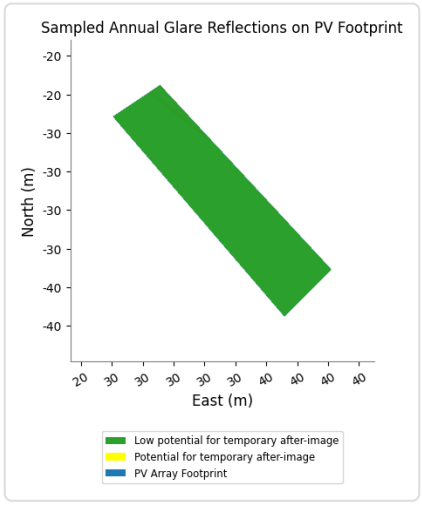
Yellow glare: none

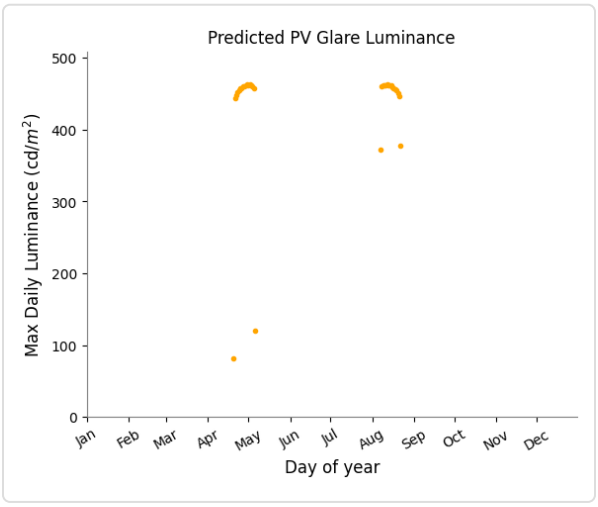
Green glare: 551 min.







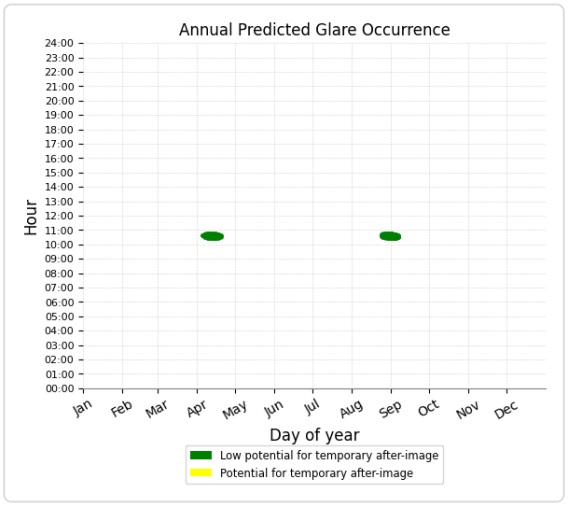


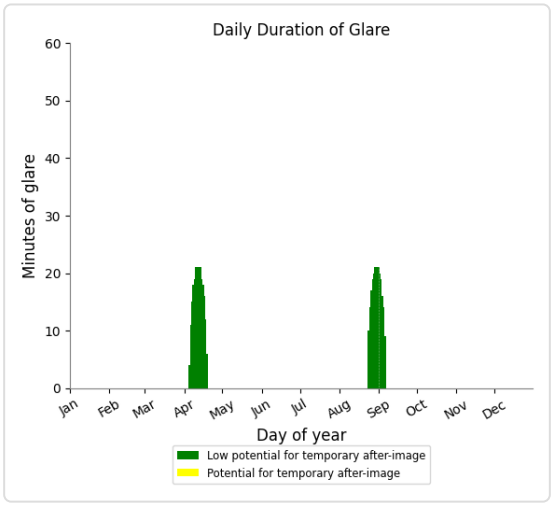


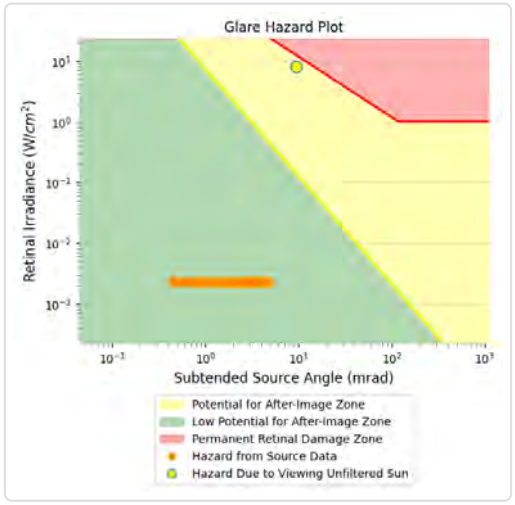
PV array 3 and OP 15

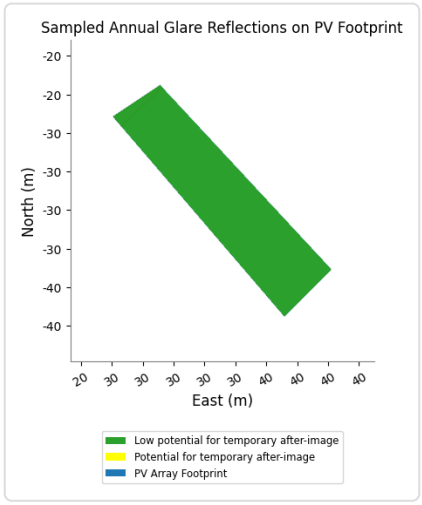
Yellow glare: none

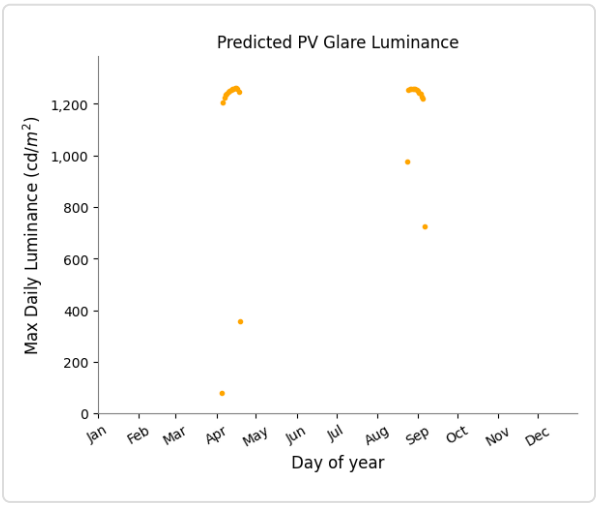
Green glare: 485 min.







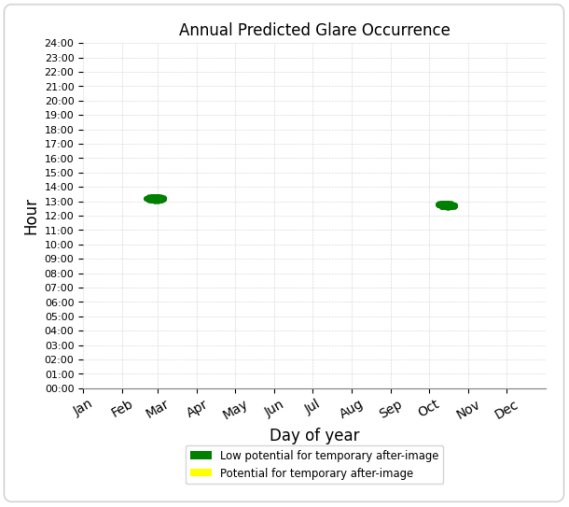


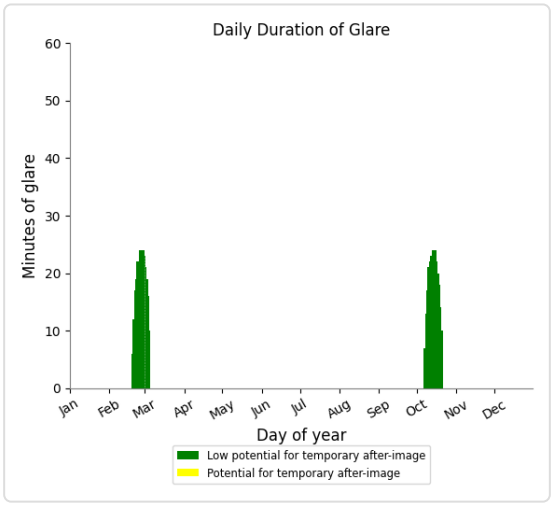


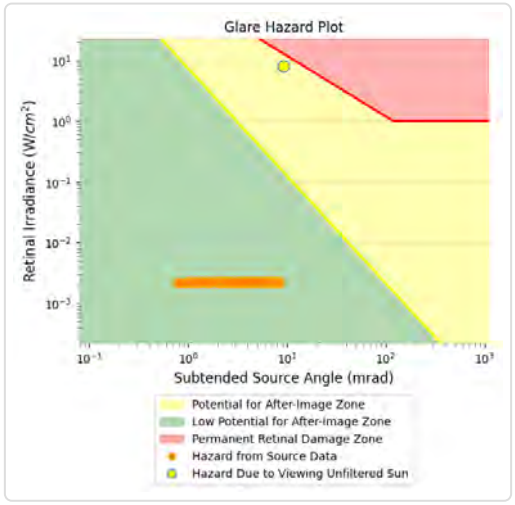
PV array 3 and OP 16

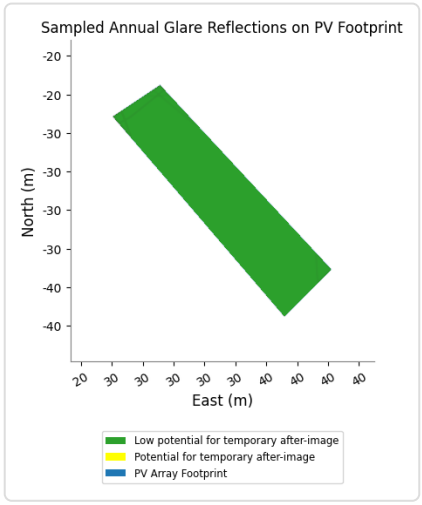
Yellow glare: none

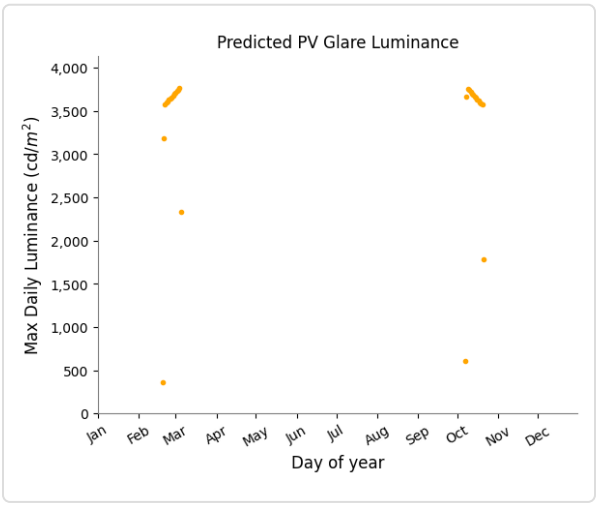
Green glare: 566 min.







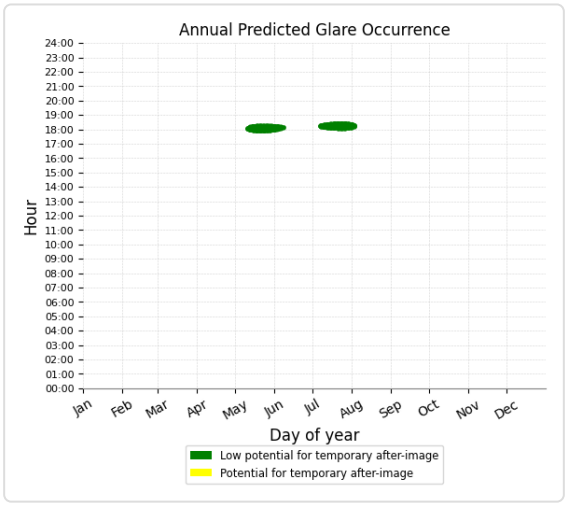


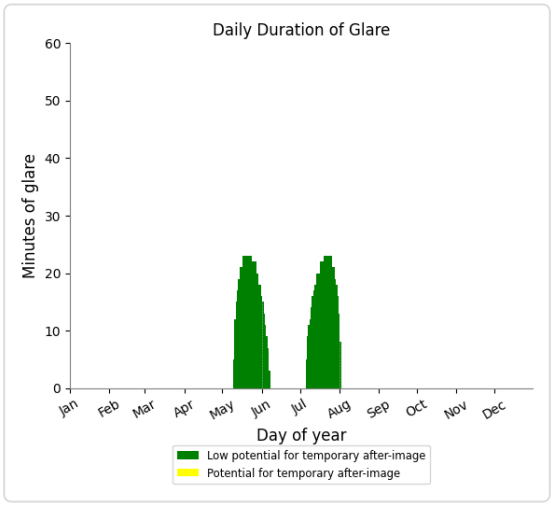


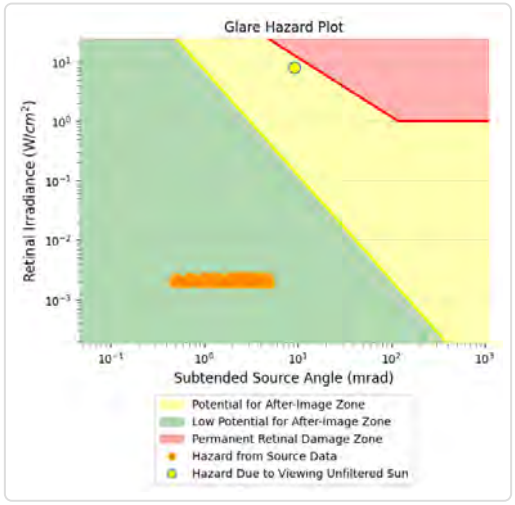
PV array 3 and OP 23

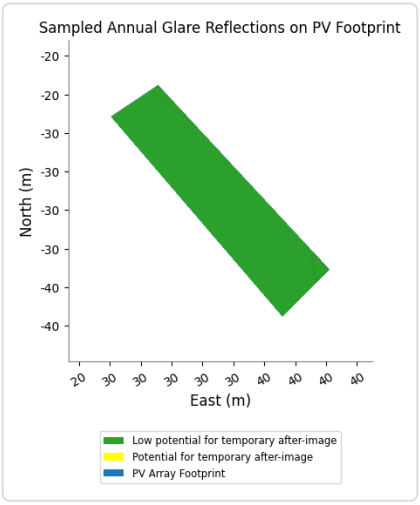
Yellow glare: none

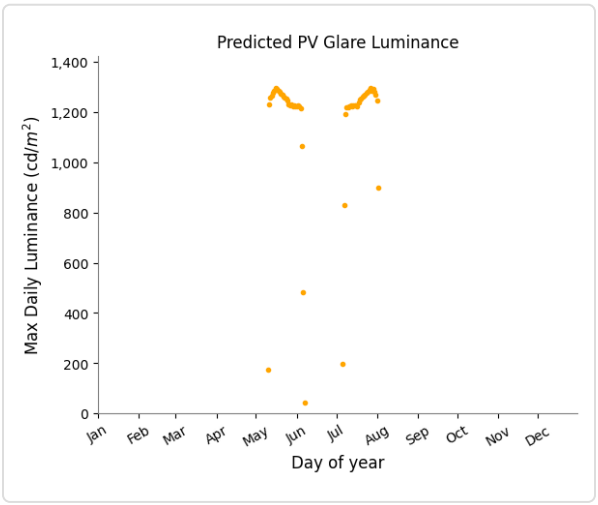
Green glare: 1,015 min.







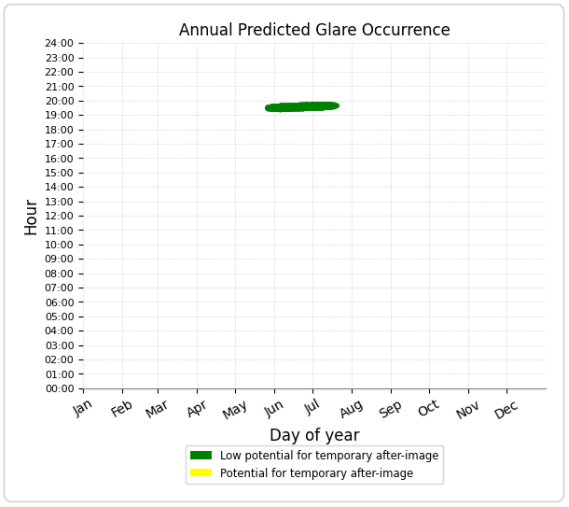


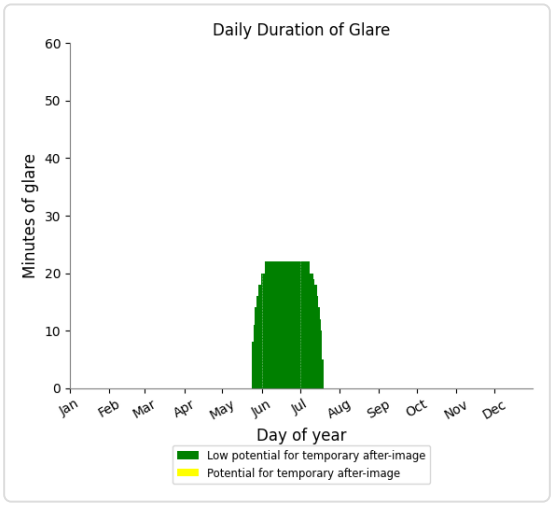


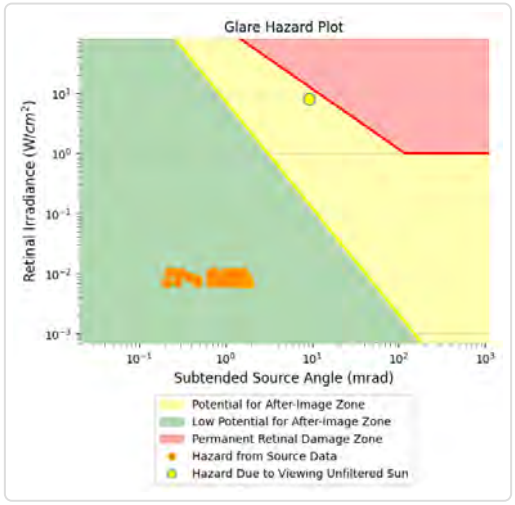
PV array 3 and OP 30

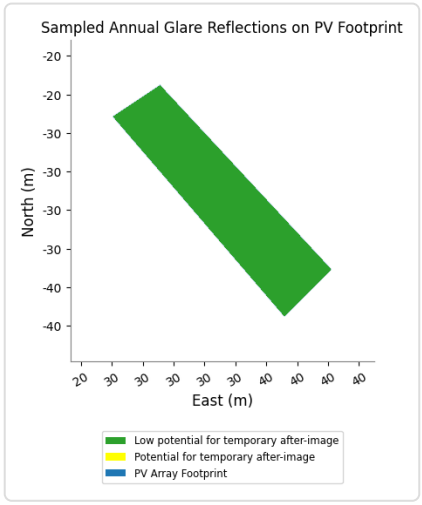
Yellow glare: none

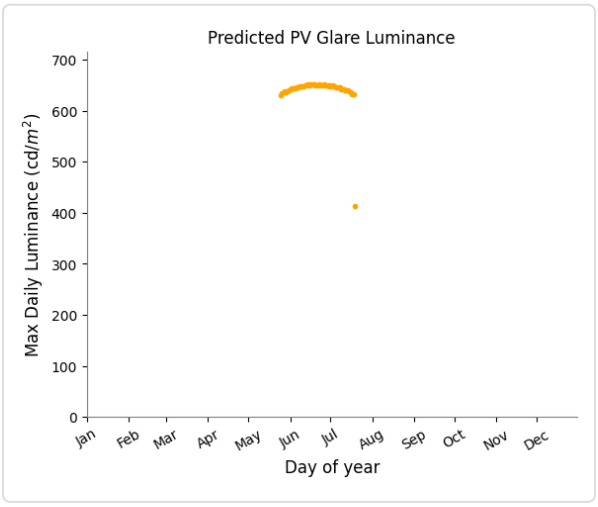
Green glare: 1,103 min.







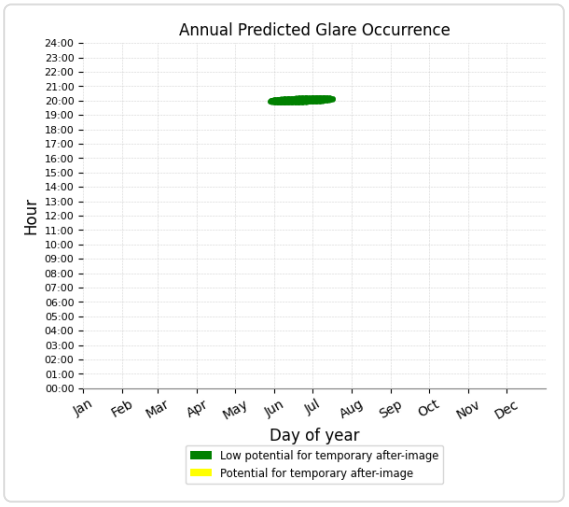


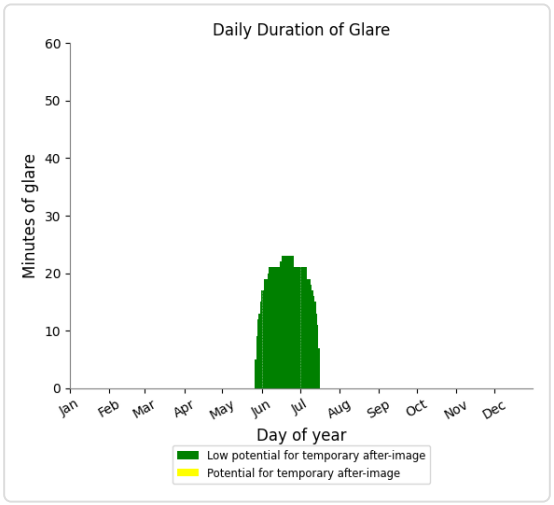


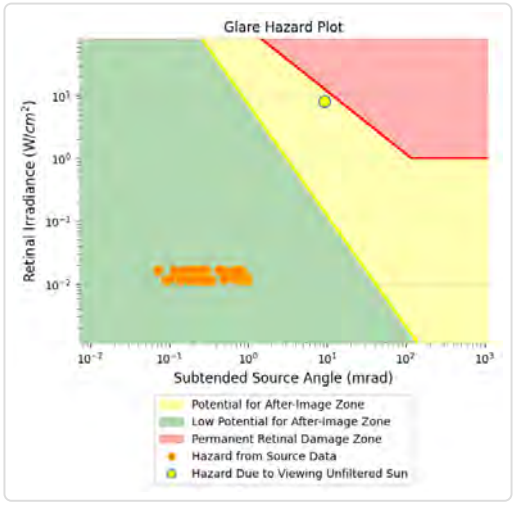
PV array 3 and OP 37

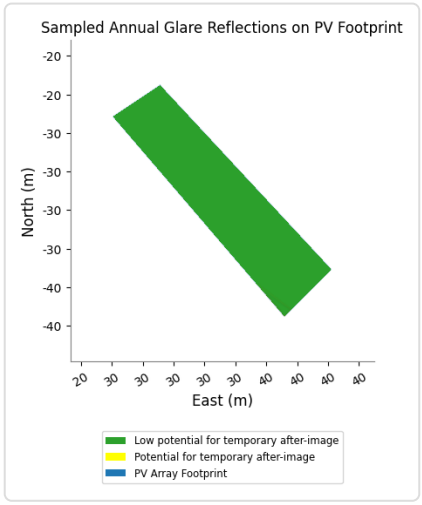
Yellow glare: none

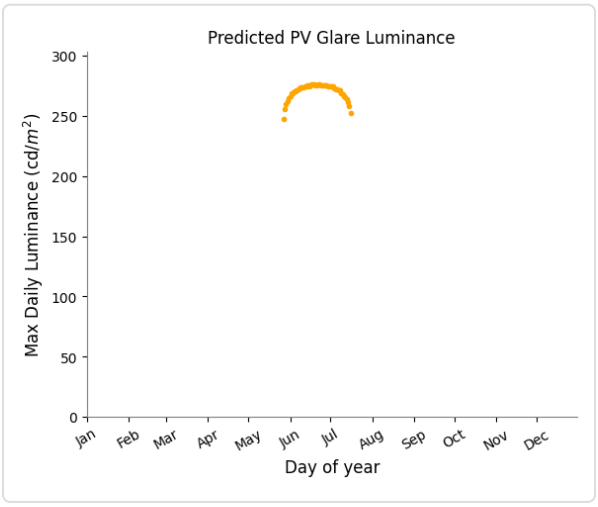
Green glare: 970 min.







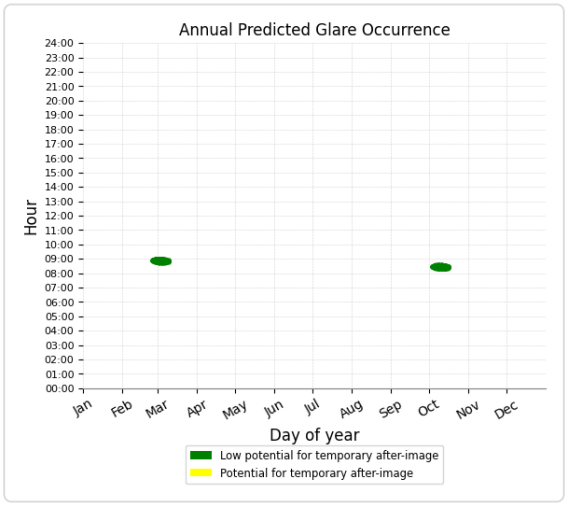


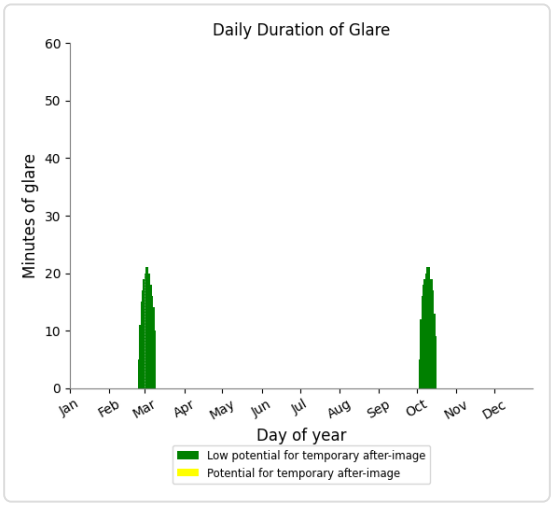


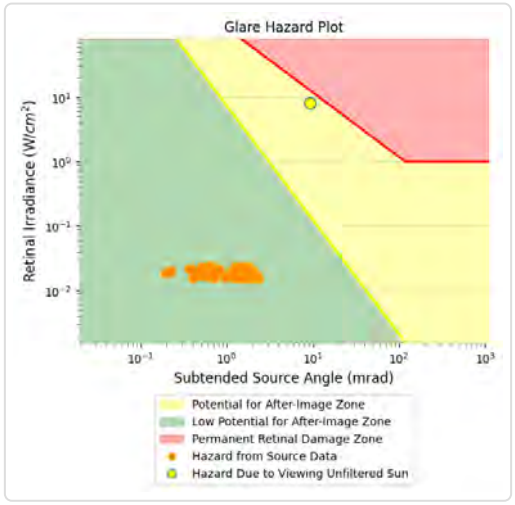
PV array 3 and OP 38

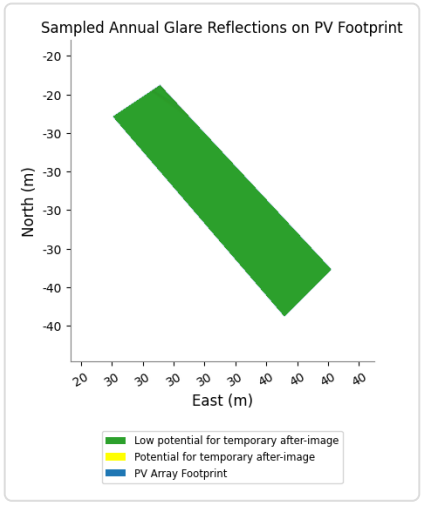
Yellow glare: none

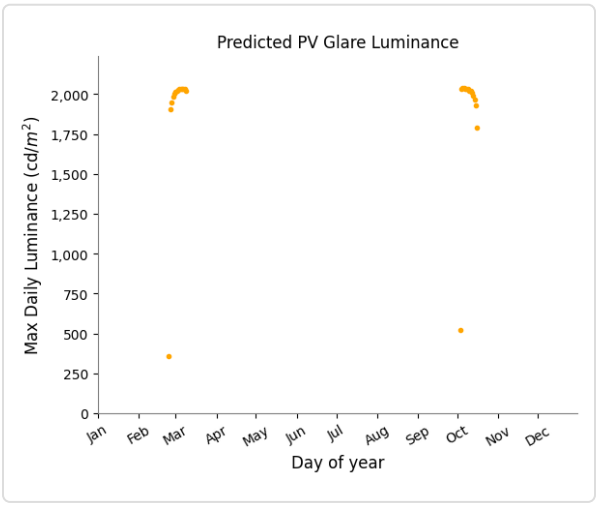
Green glare: 457 min.











PV array 3 and 1-ATCT

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 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 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 array 3 and OP 22

No glare found

PV array 3 and OP 24

No glare found

PV array 3 and OP 25

No glare found

PV array 3 and OP 26

No glare found

PV array 3 and OP 27

No glare found

PV array 3 and OP 28

No glare found

PV array 3 and OP 29

No glare found

PV array 3 and OP 31

No glare found

PV array 3 and OP 32

No glare found

PV array 3 and OP 33

No glare found

PV array 3 and OP 34

No glare found

PV array 3 and OP 35

No glare found

PV array 3 and OP 36

No glare found

PV array 3 and OP 39

No glare found

PV array 3 and OP 40

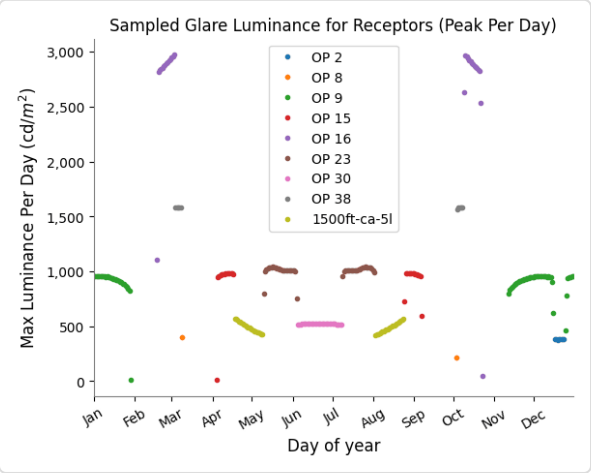
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,131	52.2	0	0.0	619
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,281	21.4	0	0.0	382
OP 8	440	7.3	0	0.0	473
OP 9	1,169	19.5	0	0.0	957
OP 14	530	8.8	0	0.0	363
OP 15	471	7.8	0	0.0	984
OP 16	538	9.0	0	0.0	2,972
OP 23	958	16.0	0	0.0	1,043
OP 30	1,107	18.4	0	0.0	522
OP 37	967	16.1	0	0.0	220
OP 38	448	7.5	0	0.0	1,583
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

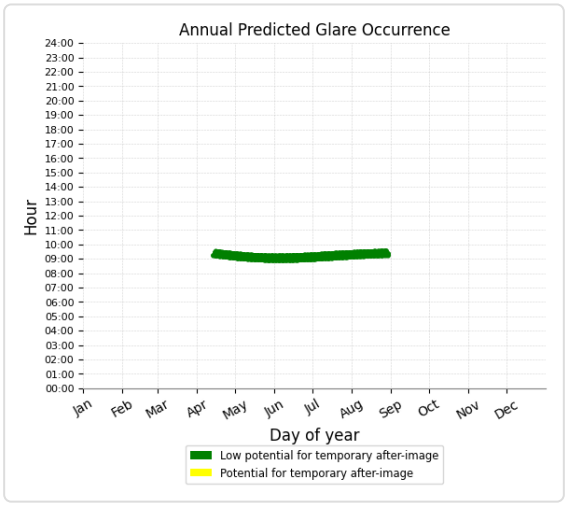
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

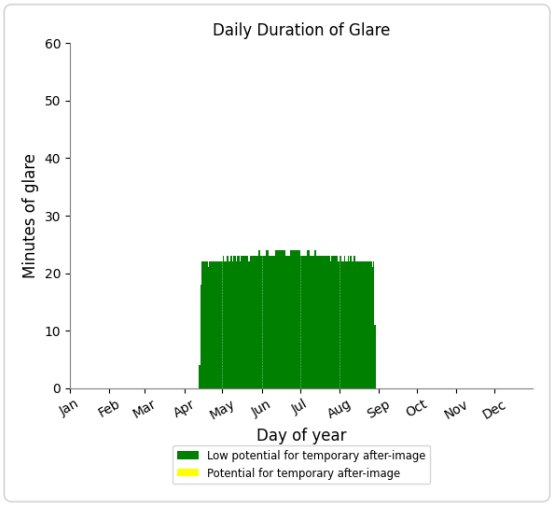


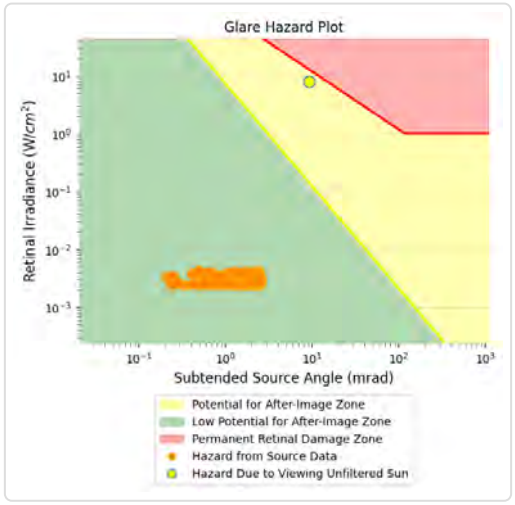
PV array 4 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

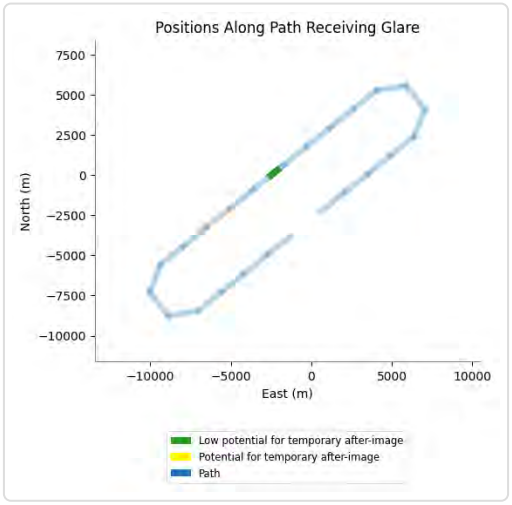
Yellow glare: none

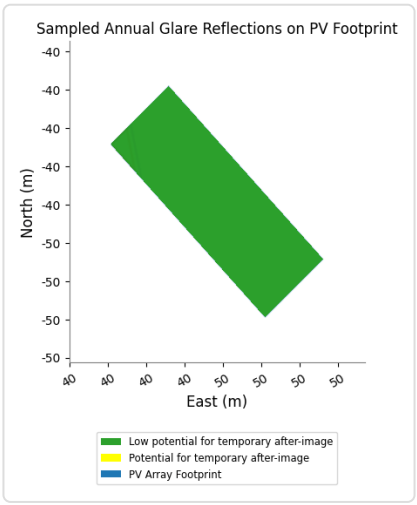
Green glare: 3,131 min.

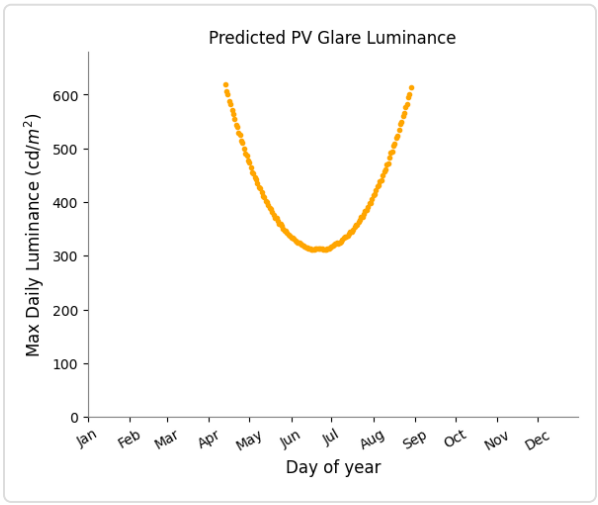












PV array 4 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 4 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 4 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 4 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 4 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 4 and Route: Approach_05L

No glare found

PV array 4 and Route: Approach_05R

No glare found

PV array 4 and Route: Approach_23L

No glare found

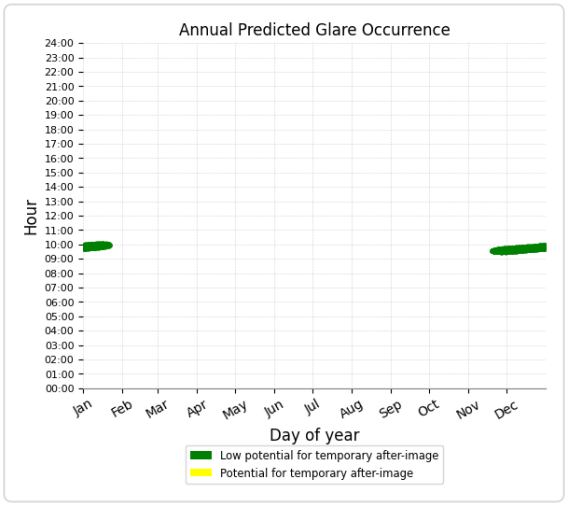
PV array 4 and Route: Approach_23R

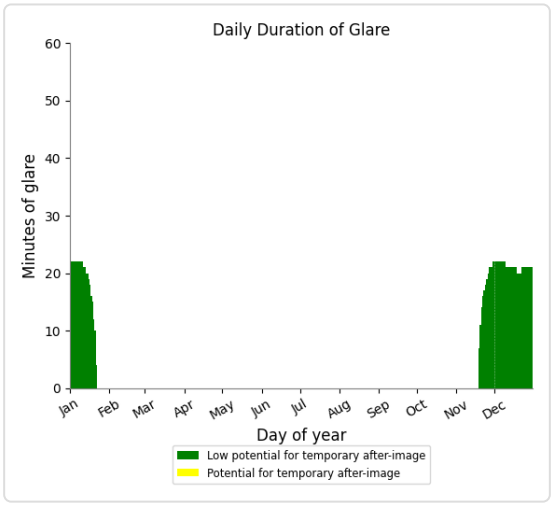
No glare found

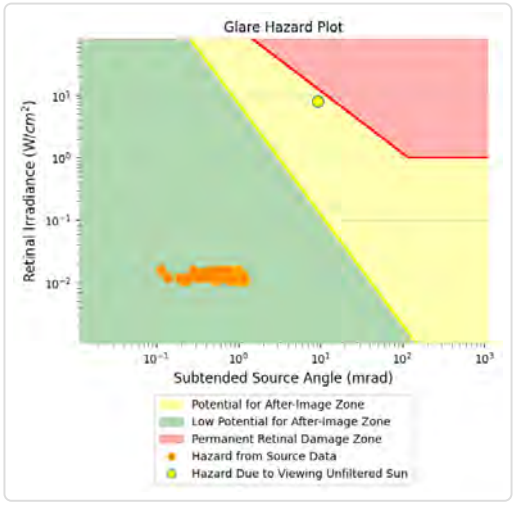
PV array 4 and OP 2

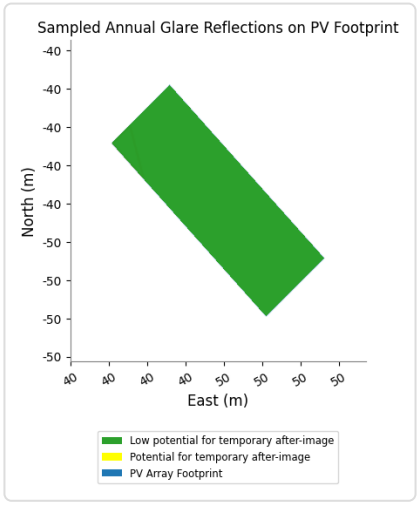
Yellow glare: none

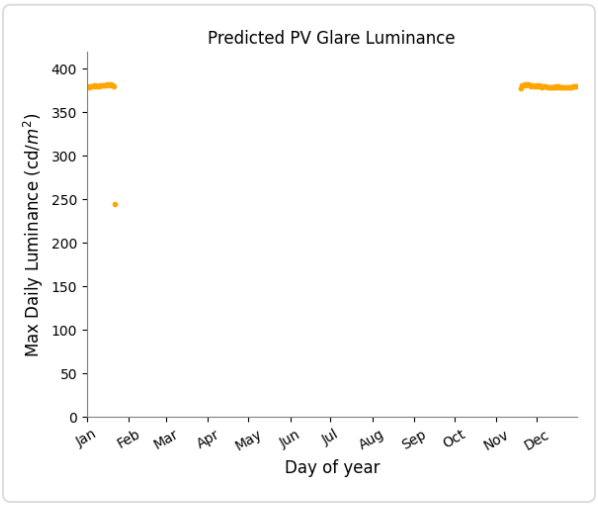
Green glare: 1,281 min.







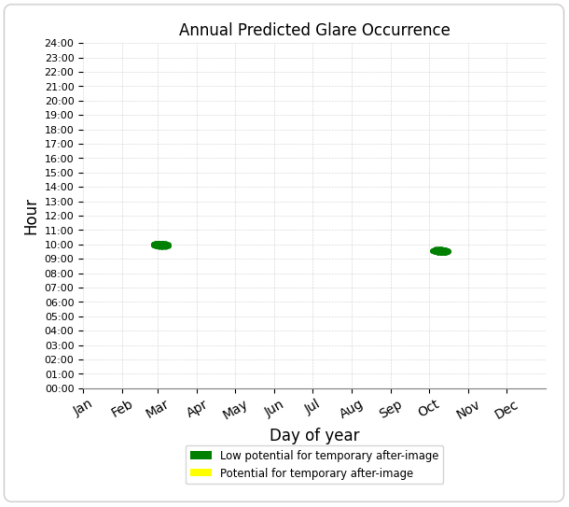


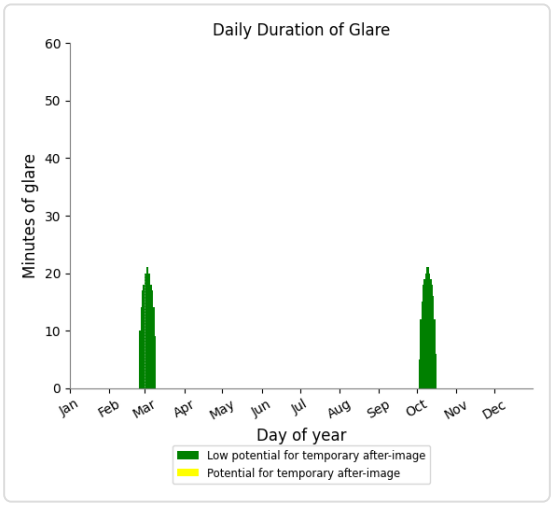


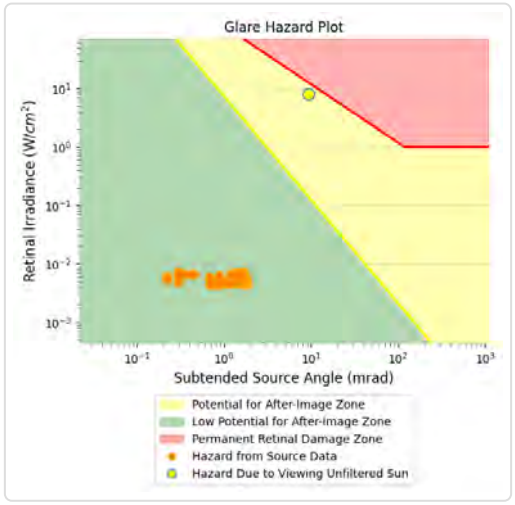
PV array 4 and OP 8

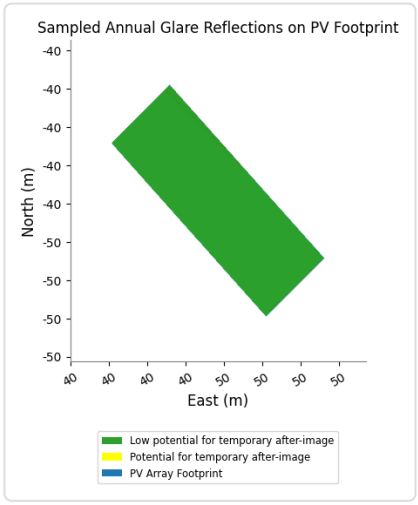
Yellow glare: none

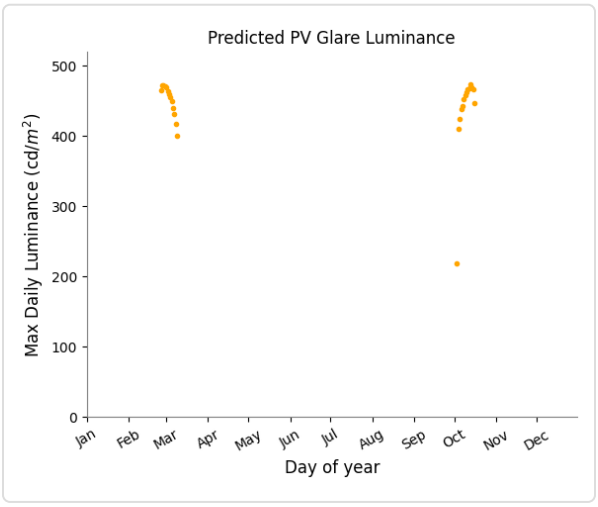
Green glare: 440 min.







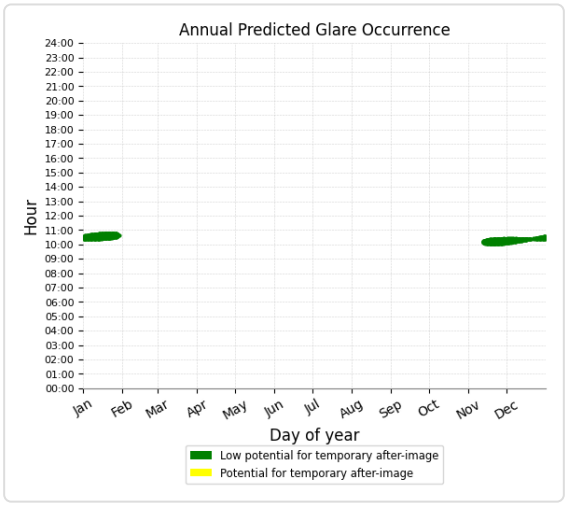


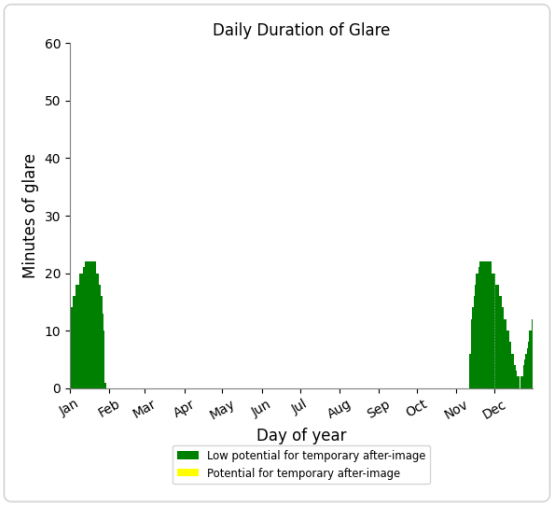


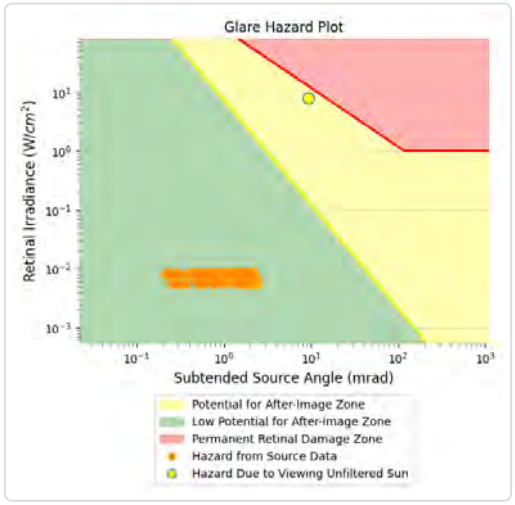
PV array 4 and OP 9

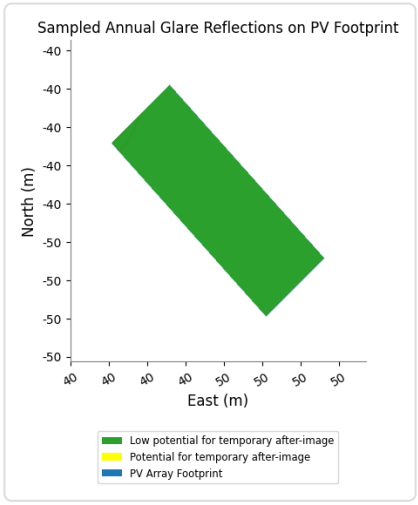
Yellow glare: none

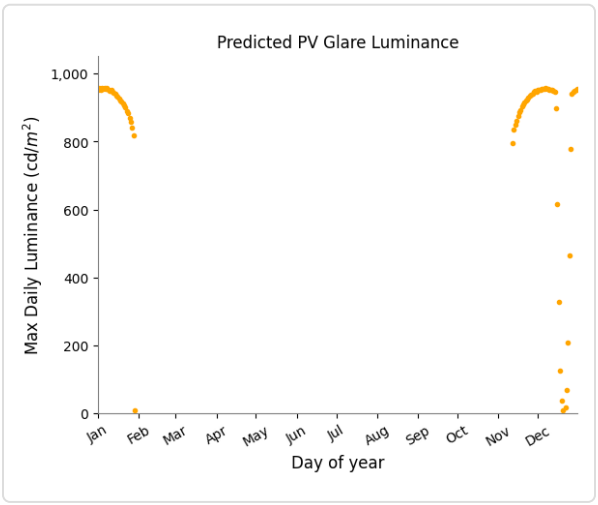
Green glare: 1,169 min.







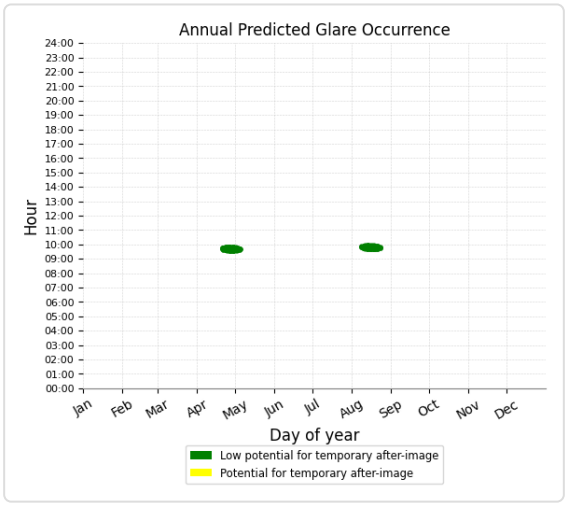


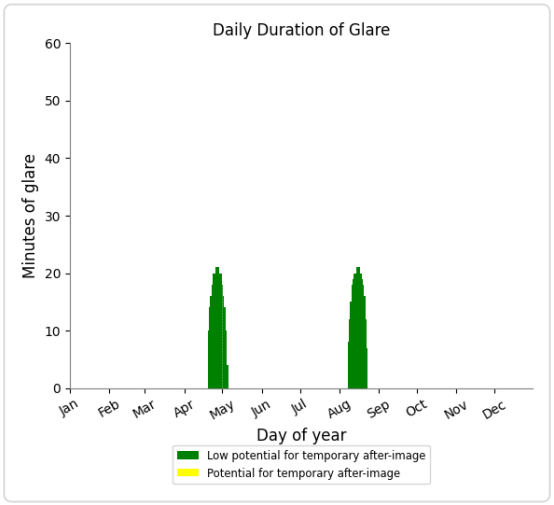


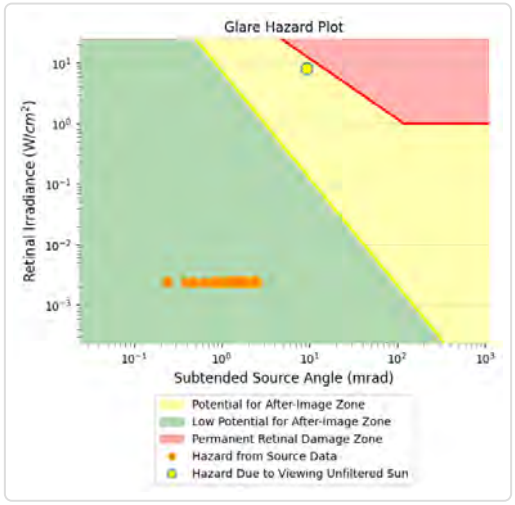
PV array 4 and OP 14

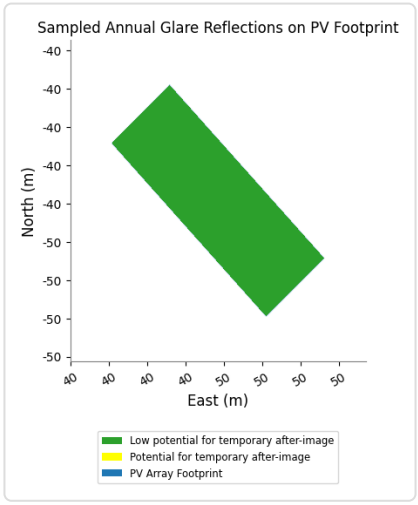
Yellow glare: none

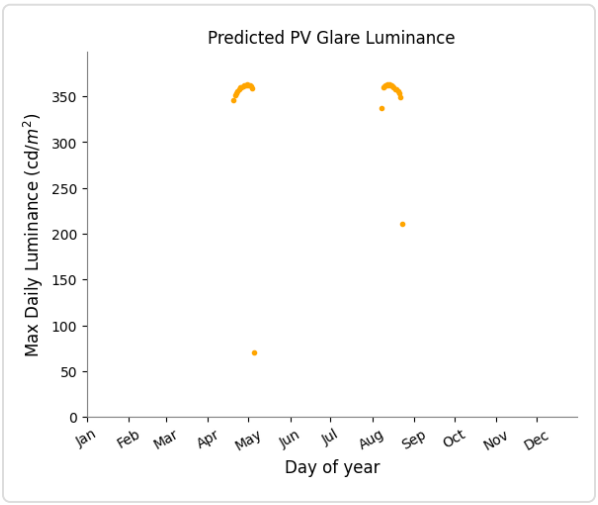
Green glare: 530 min.







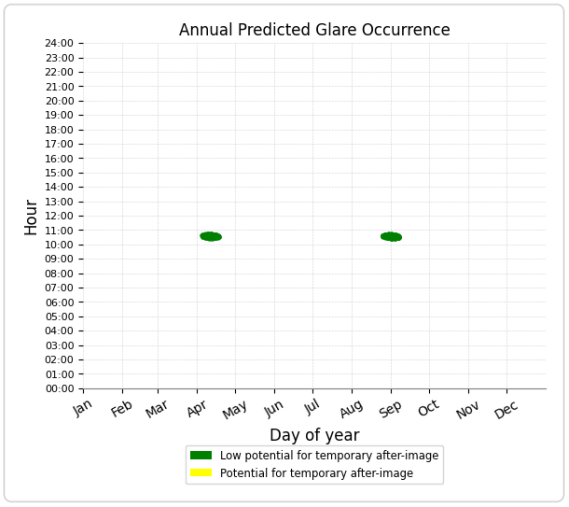


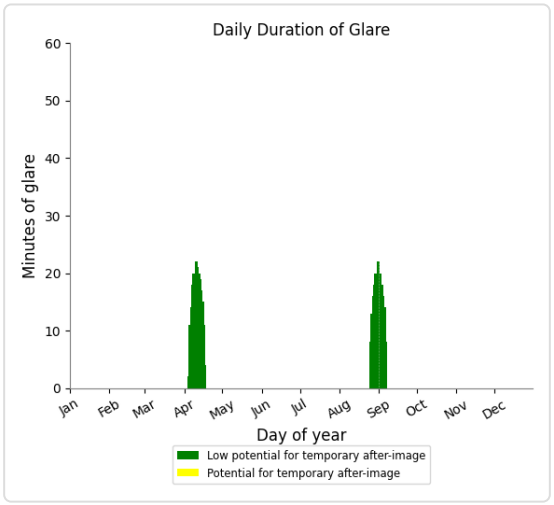


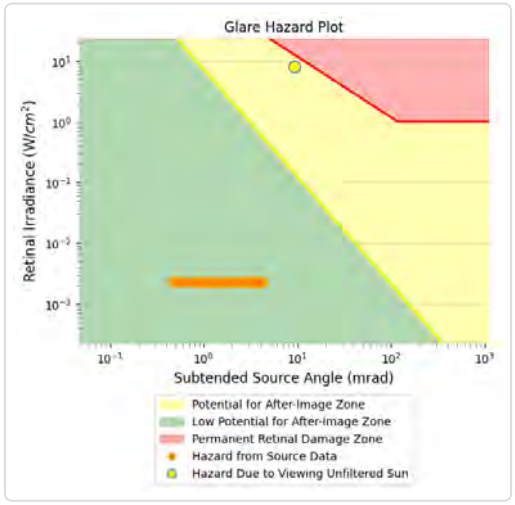
PV array 4 and OP 15

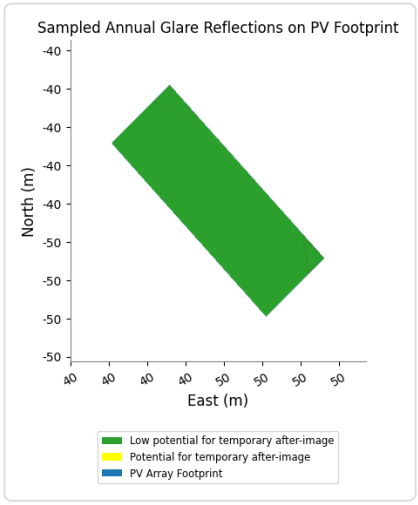
Yellow glare: none

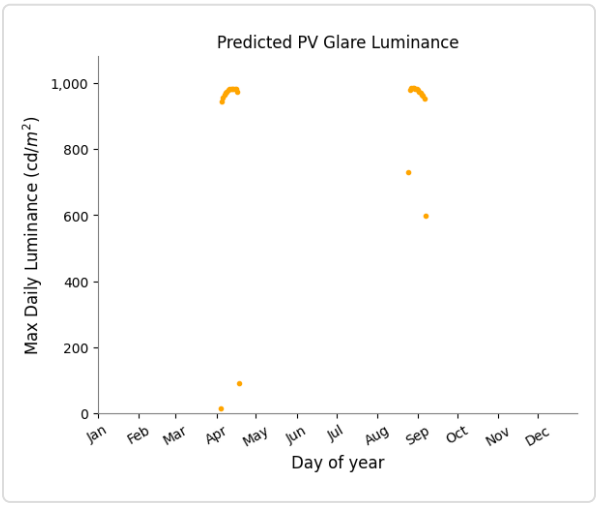
Green glare: 471 min.







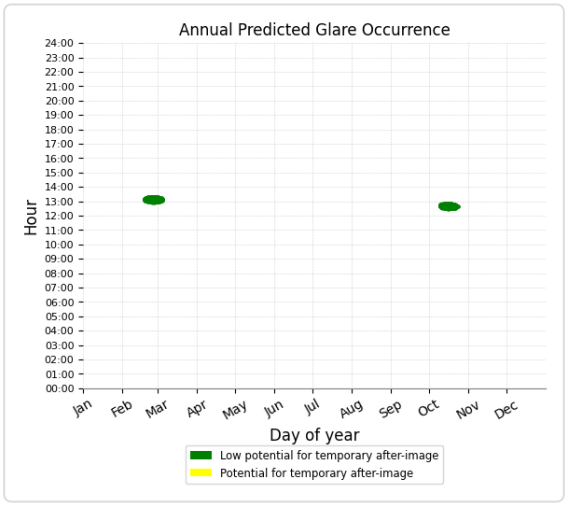


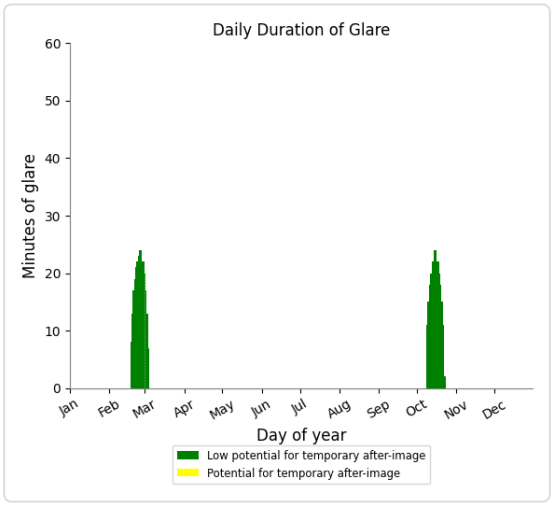


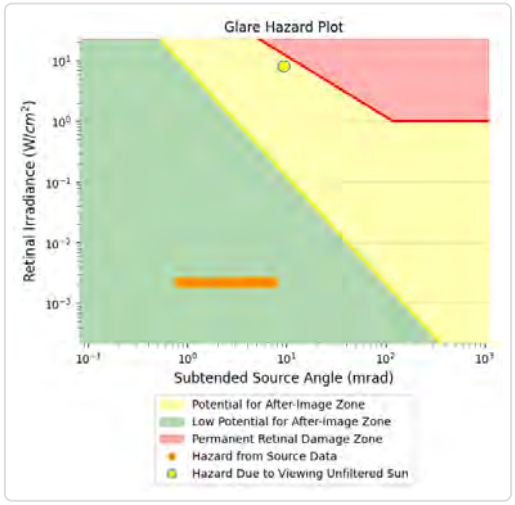
PV array 4 and OP 16

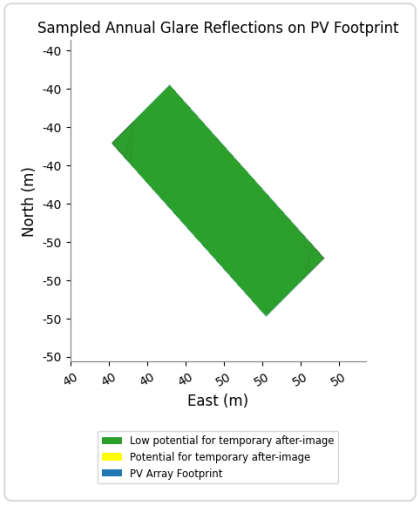
Yellow glare: none

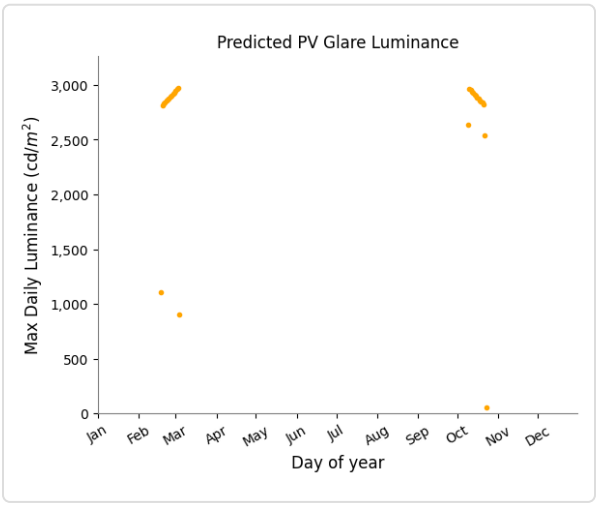
Green glare: 538 min.







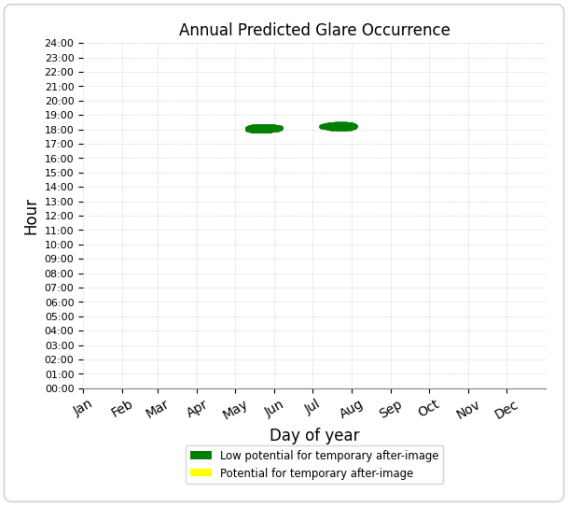


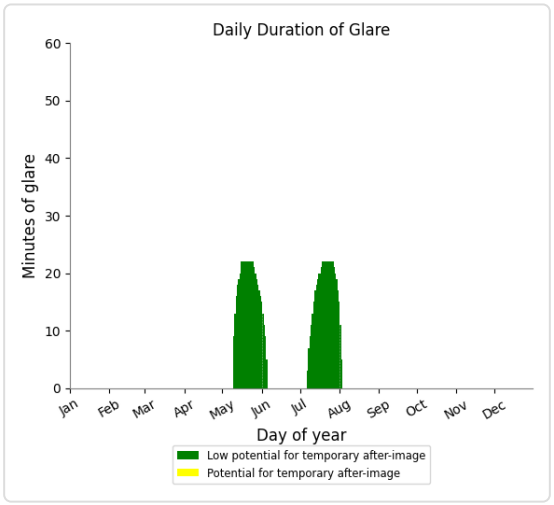


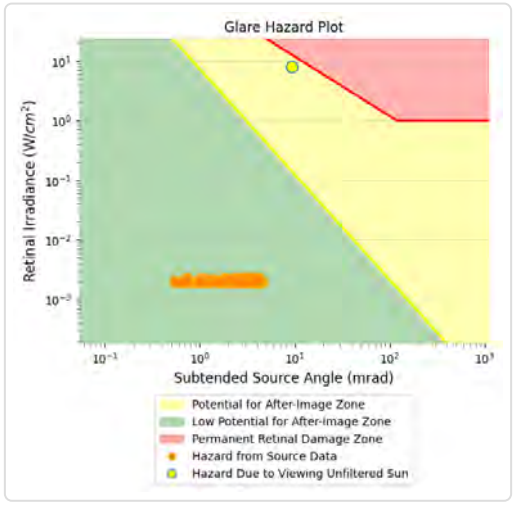
PV array 4 and OP 23

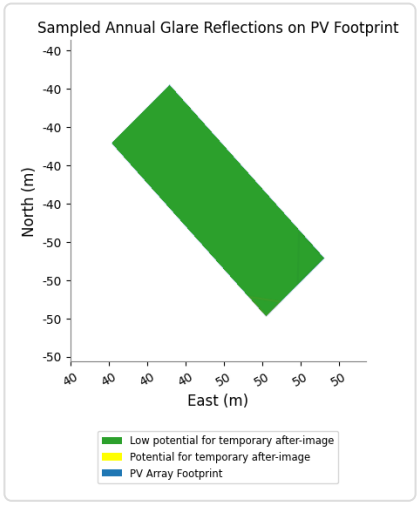
Yellow glare: none

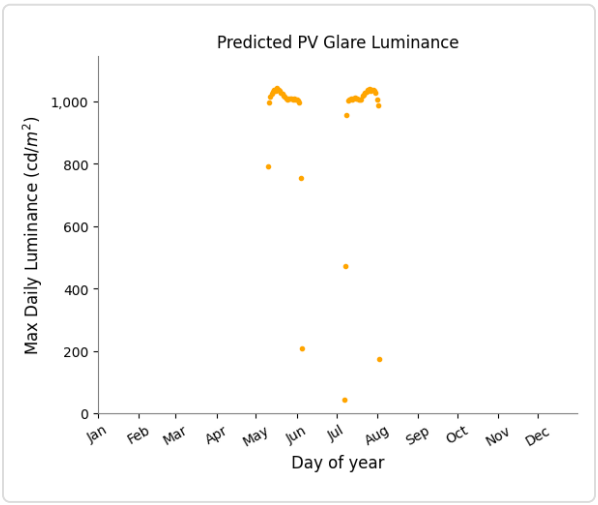
Green glare: 958 min.







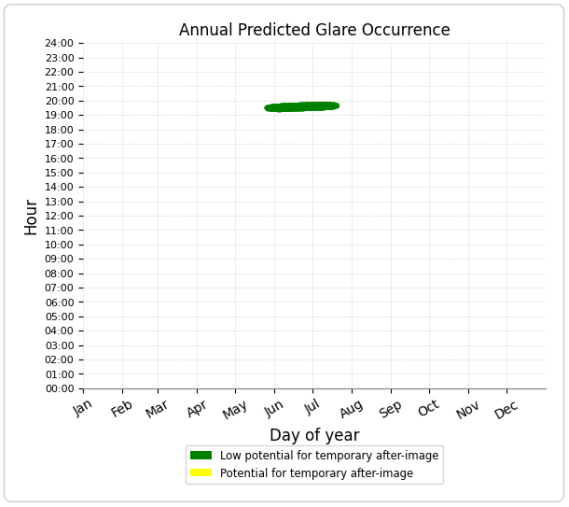


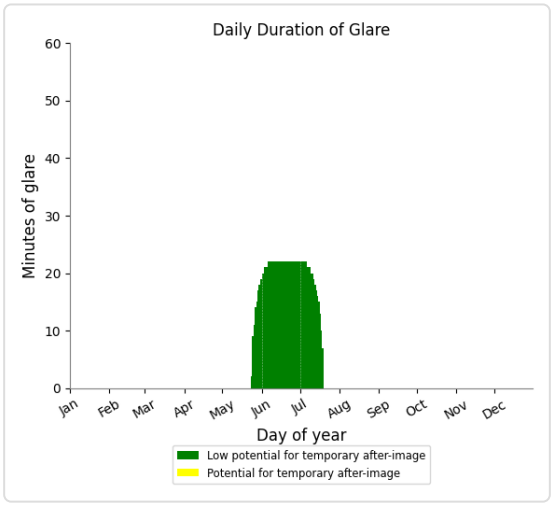


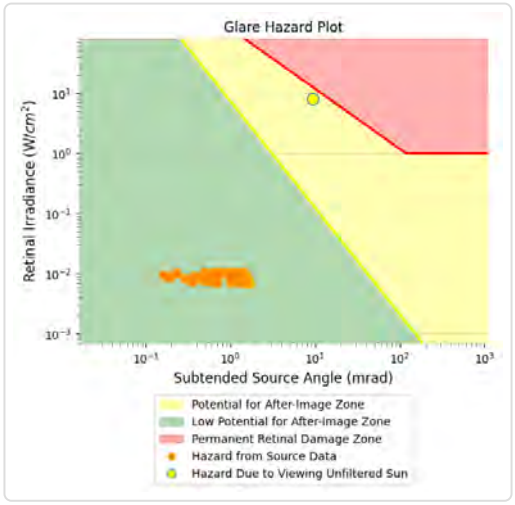
PV array 4 and OP 30

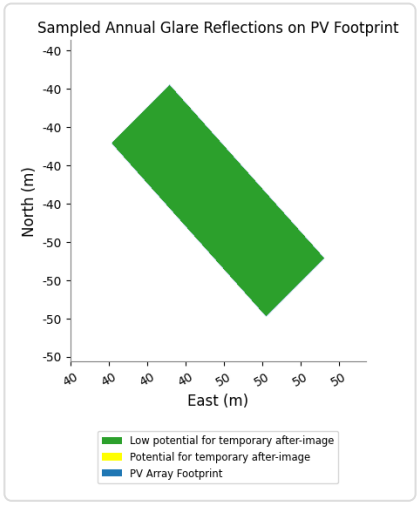
Yellow glare: none

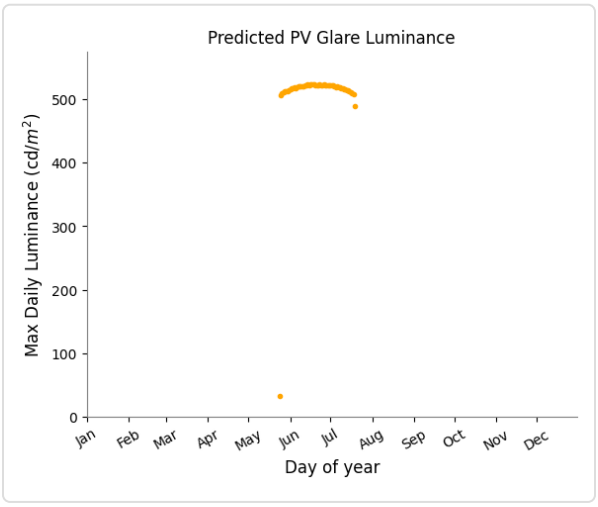
Green glare: 1,107 min.







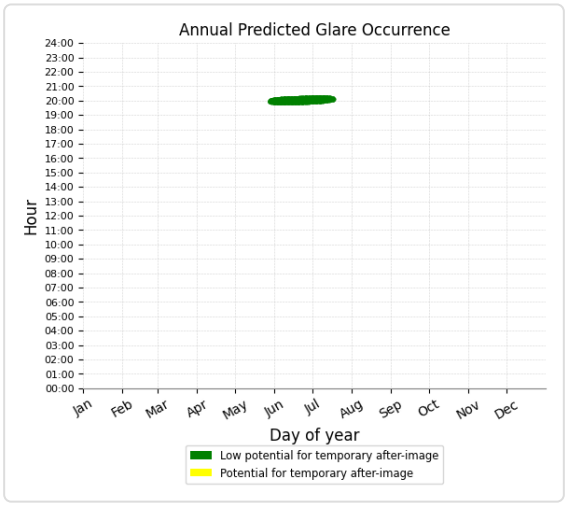


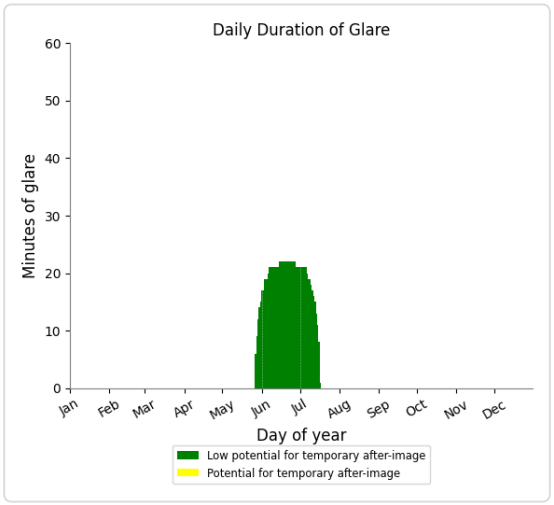


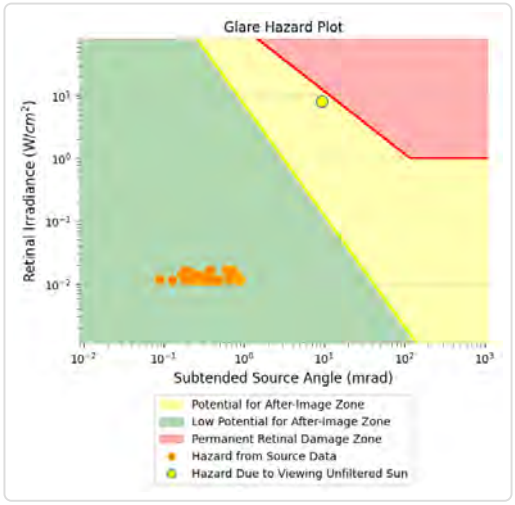
PV array 4 and OP 37

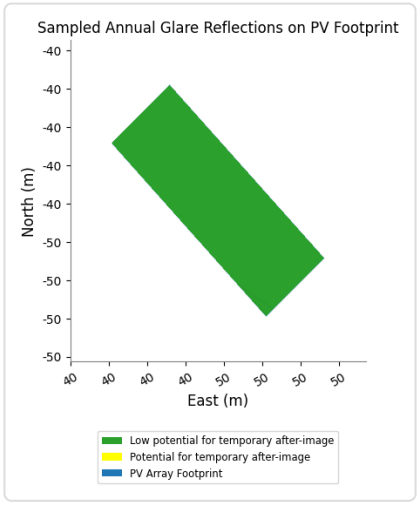
Yellow glare: none

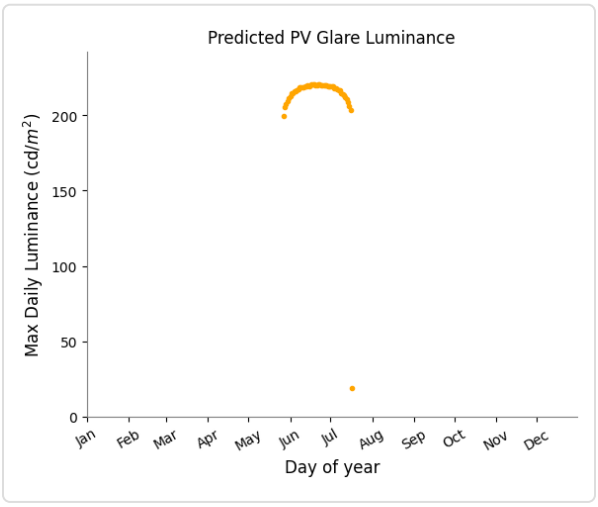
Green glare: 967 min.







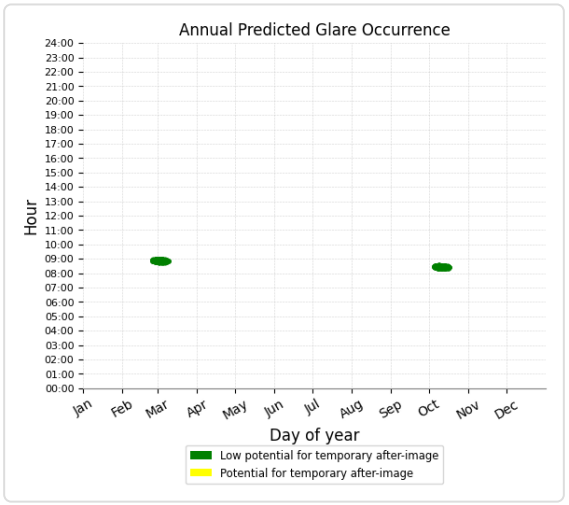


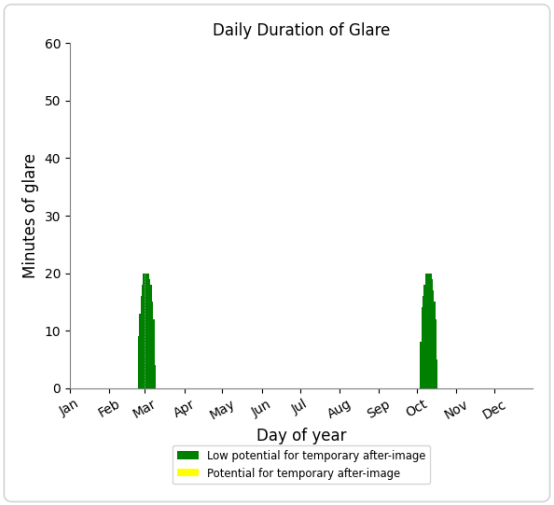


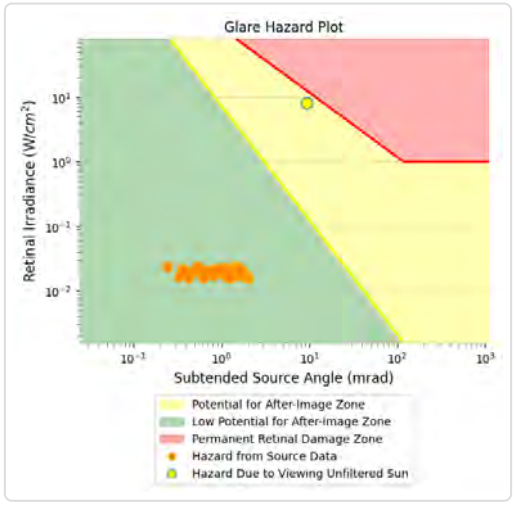
PV array 4 and OP 38

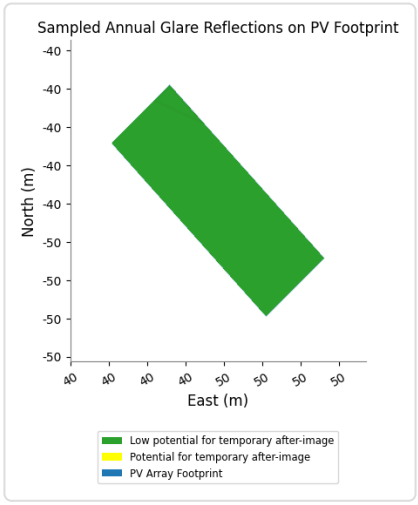
Yellow glare: none

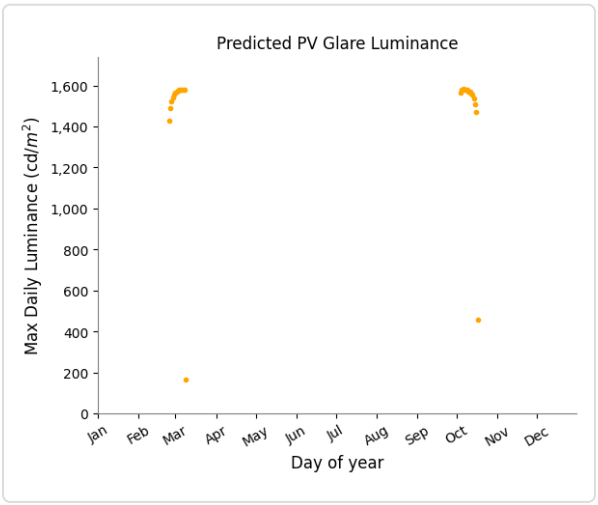
Green glare: 448 min.











PV array 4 and 1-ATCT

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 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 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 array 4 and OP 22

No glare found

PV array 4 and OP 24

No glare found

PV array 4 and OP 25

No glare found

PV array 4 and OP 26

No glare found

PV array 4 and OP 27

No glare found

PV array 4 and OP 28

No glare found

PV array 4 and OP 29

No glare found

PV array 4 and OP 31

No glare found

PV array 4 and OP 32

No glare found

PV array 4 and OP 33

No glare found

PV array 4 and OP 34

No glare found

PV array 4 and OP 35

No glare found

PV array 4 and OP 36

No glare found

PV array 4 and OP 39

No glare found

PV array 4 and OP 40

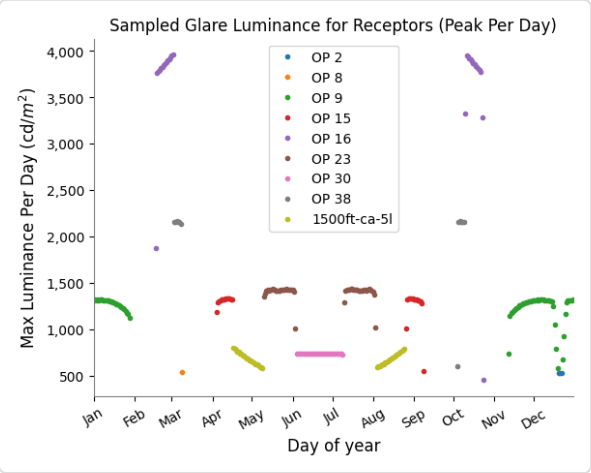
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,141	52.4	0	0.0	848
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,280	21.3	0	0.0	529
OP 8	448	7.5	0	0.0	657
OP 9	1,221	20.4	0	0.0	1,321
OP 14	537	8.9	0	0.0	498
OP 15	481	8.0	0	0.0	1,332
OP 16	577	9.6	0	0.0	3,958
OP 23	975	16.2	0	0.0	1,434
OP 30	1,137	18.9	0	0.0	739
OP 37	978	16.3	0	0.0	311
OP 38	458	7.6	0	0.0	2,165
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

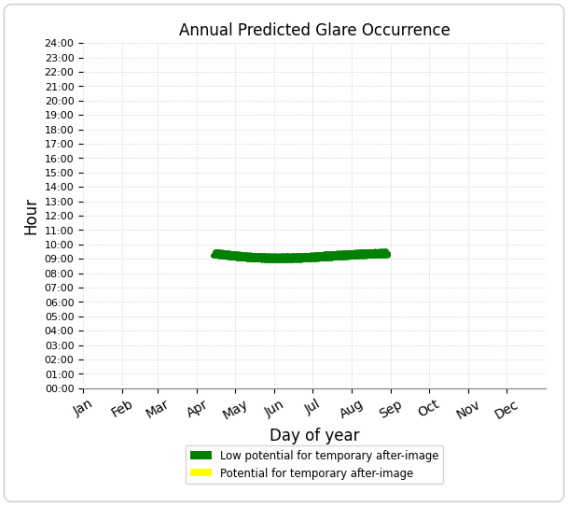
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

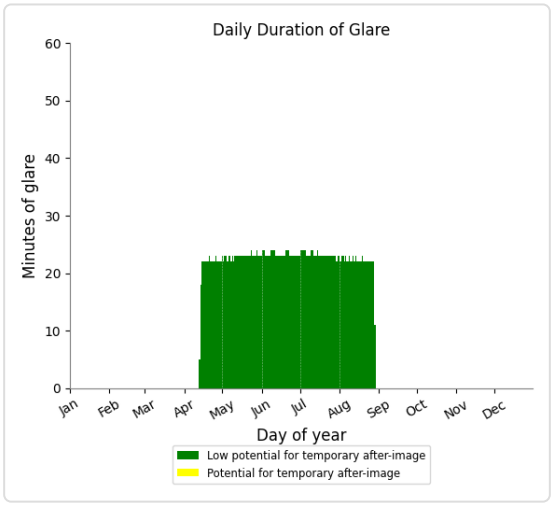


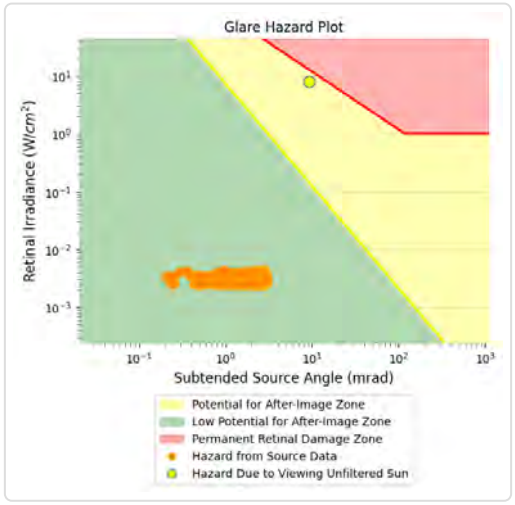
PV array 5 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

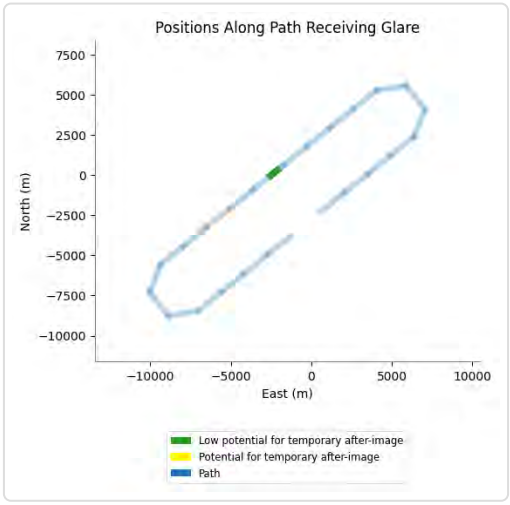
Yellow glare: none

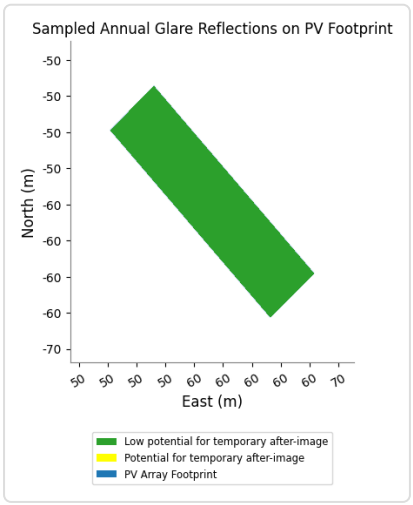
Green glare: 3,141 min.

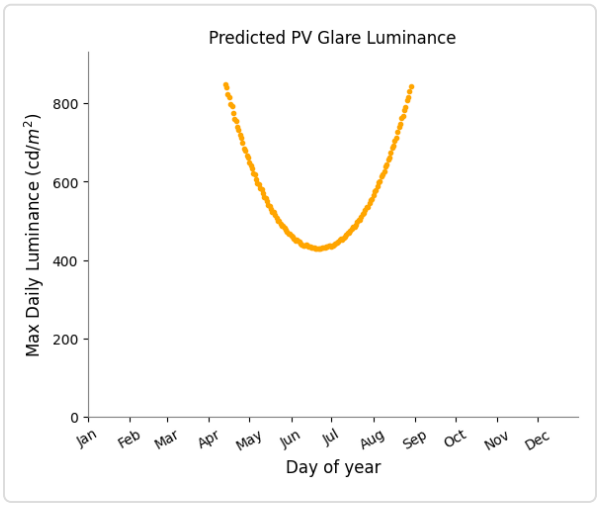












PV array 5 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 5 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 5 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 5 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 5 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 5 and Route: Approach_05L

No glare found

PV array 5 and Route: Approach_05R

No glare found

PV array 5 and Route: Approach_23L

No glare found

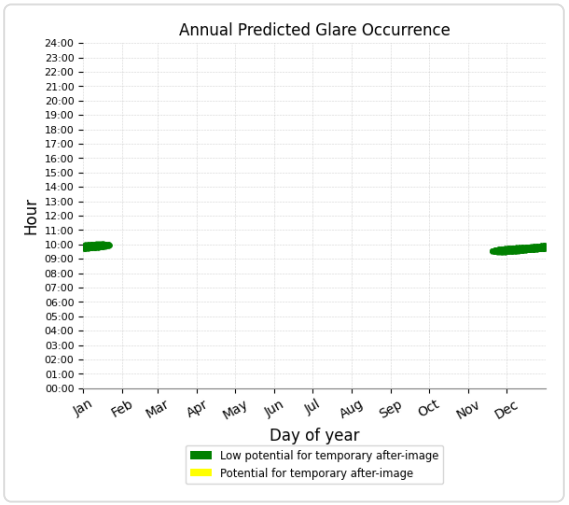
PV array 5 and Route: Approach_23R

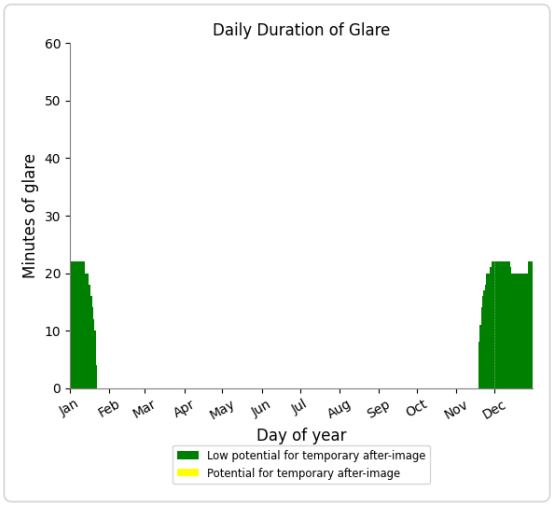
No glare found

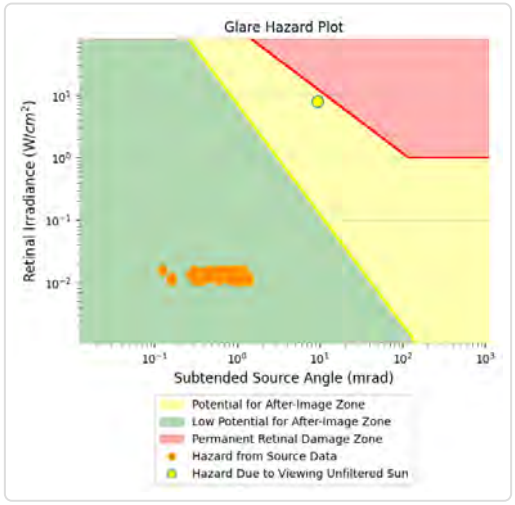
PV array 5 and OP 2

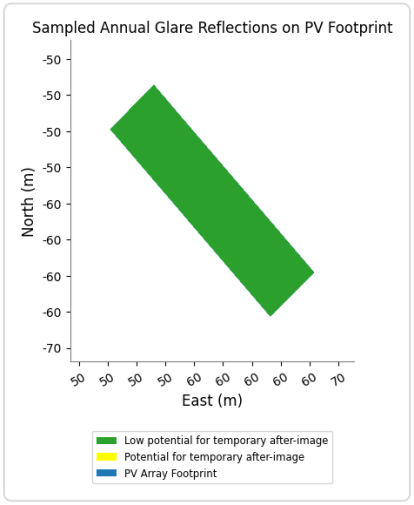
Yellow glare: none

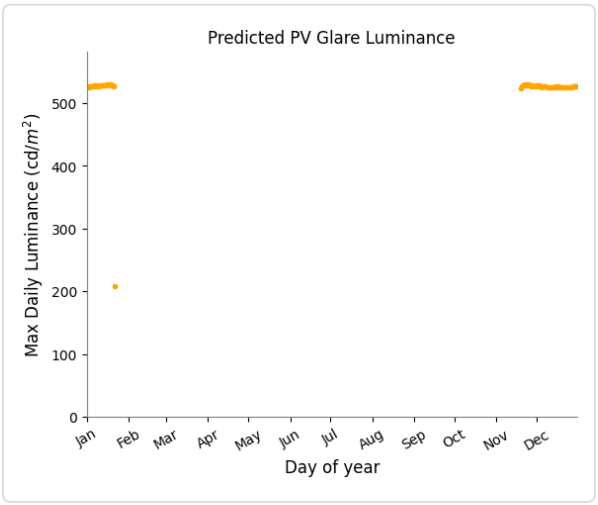
Green glare: 1,280 min.







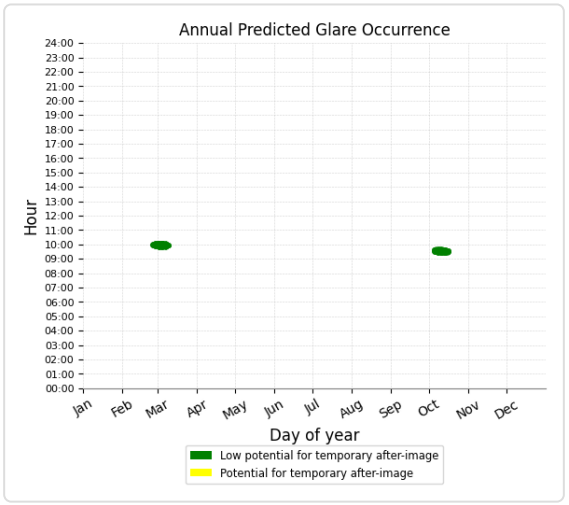


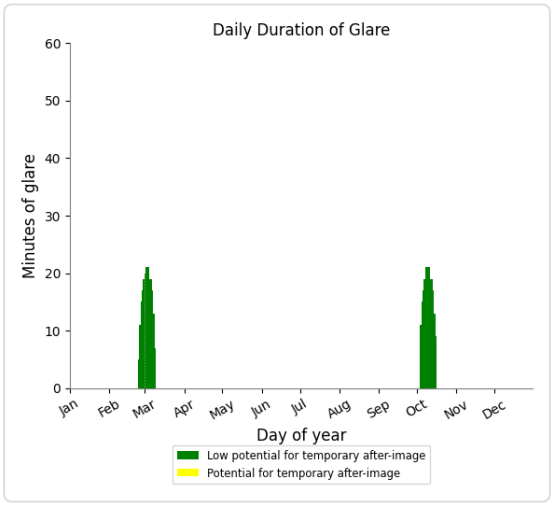


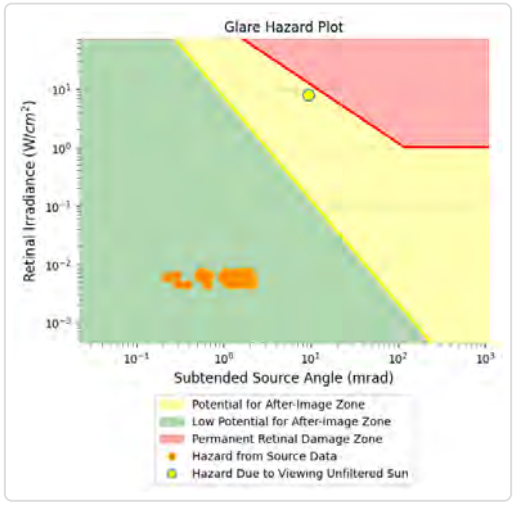
PV array 5 and OP 8

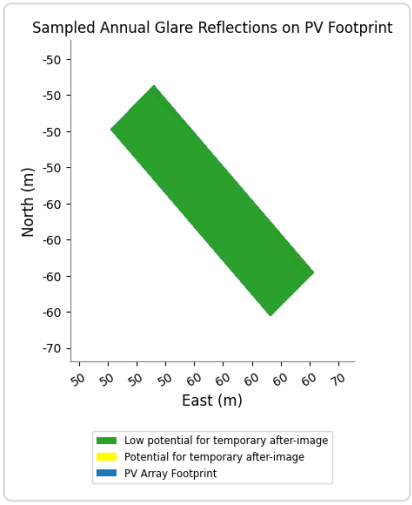
Yellow glare: none

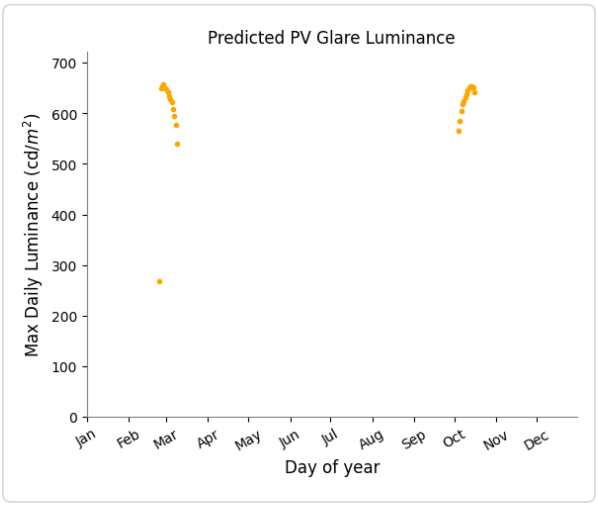
Green glare: 448 min.







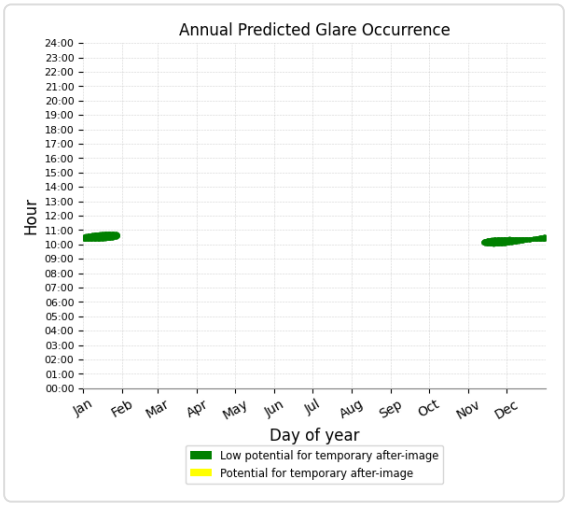


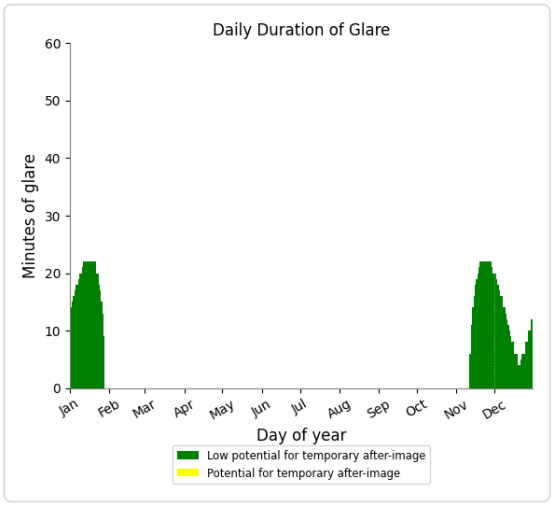


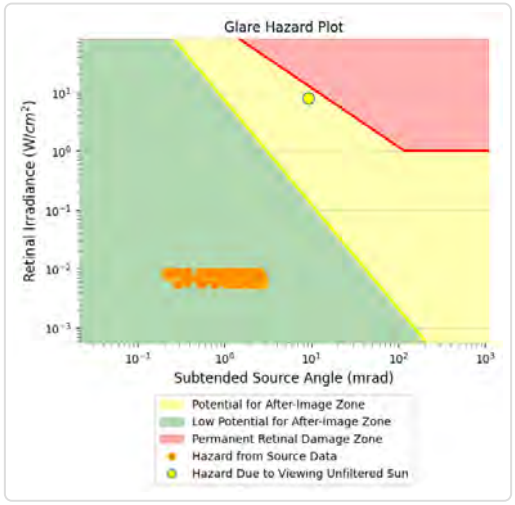
PV array 5 and OP 9

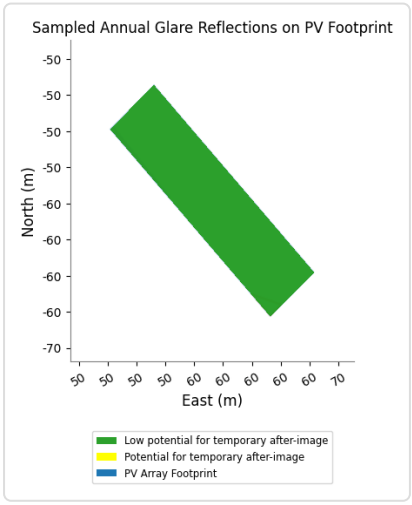
Yellow glare: none

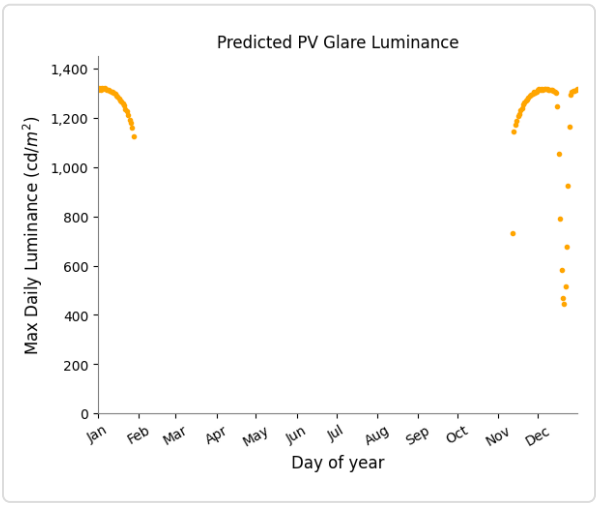
Green glare: 1,221 min.







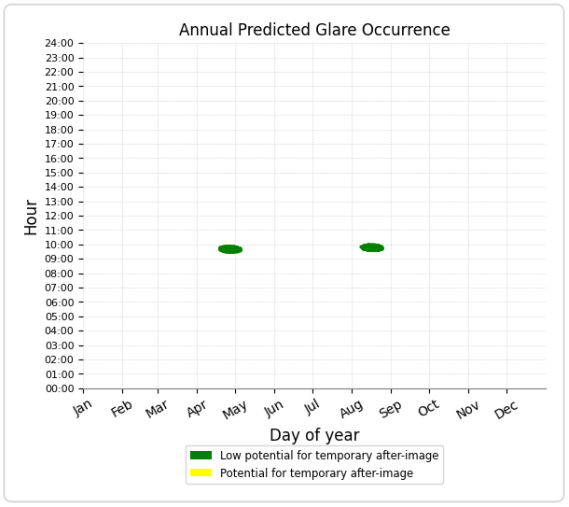


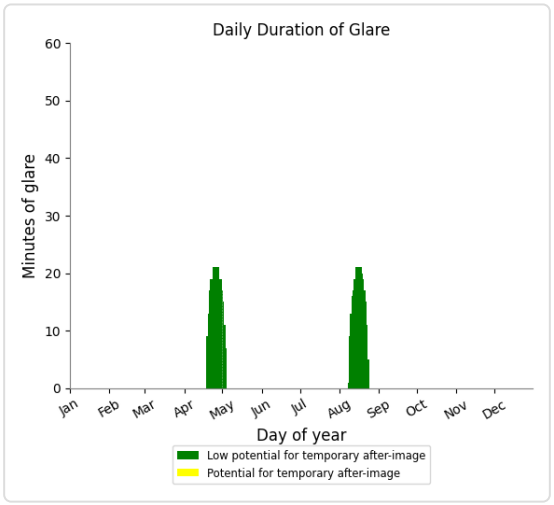


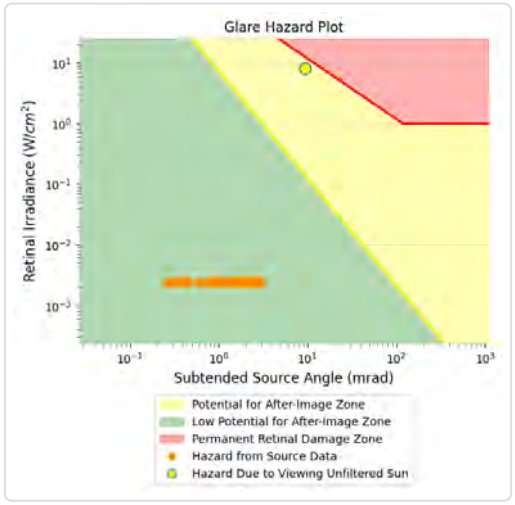
PV array 5 and OP 14

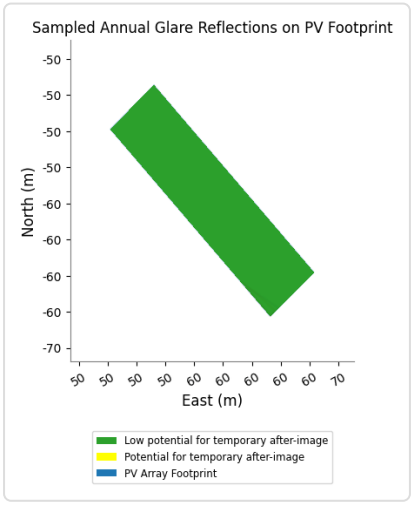
Yellow glare: none

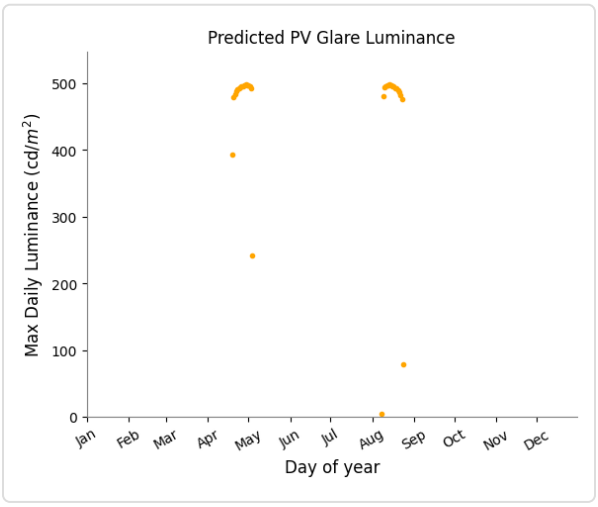
Green glare: 537 min.







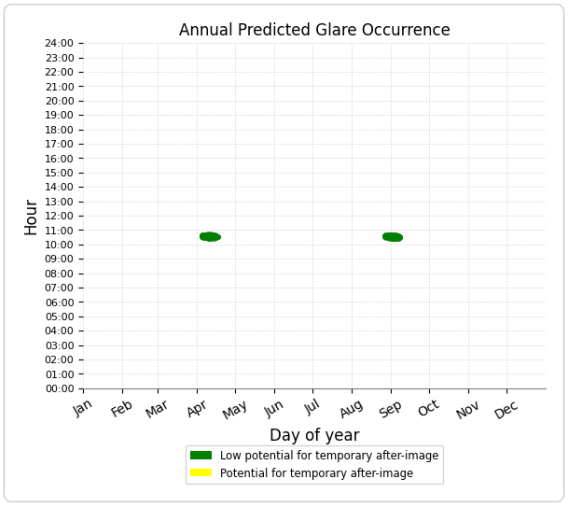


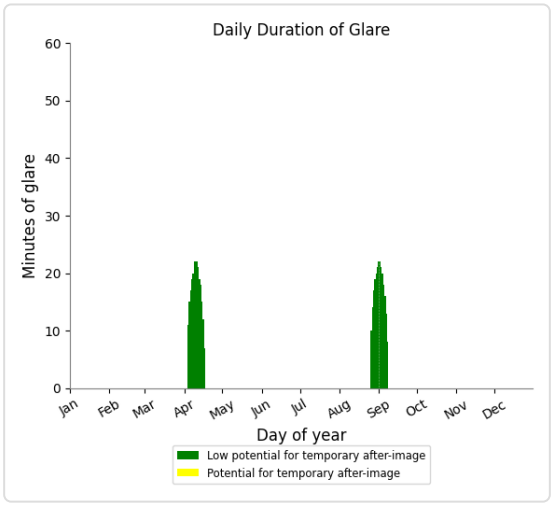


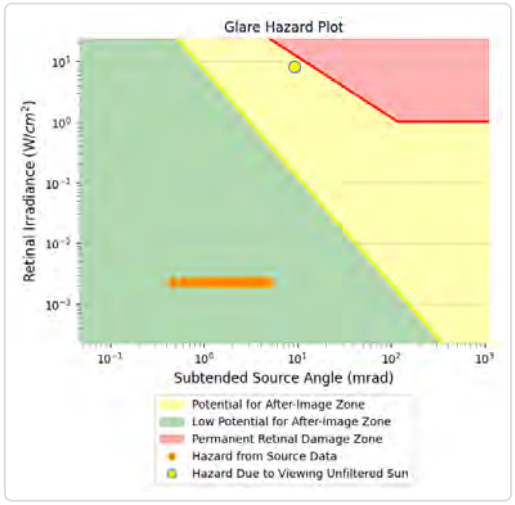
PV array 5 and OP 15

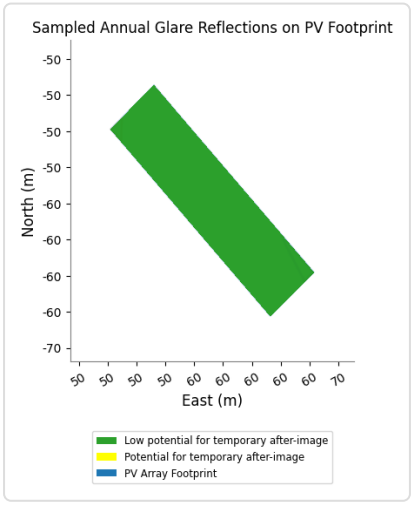
Yellow glare: none

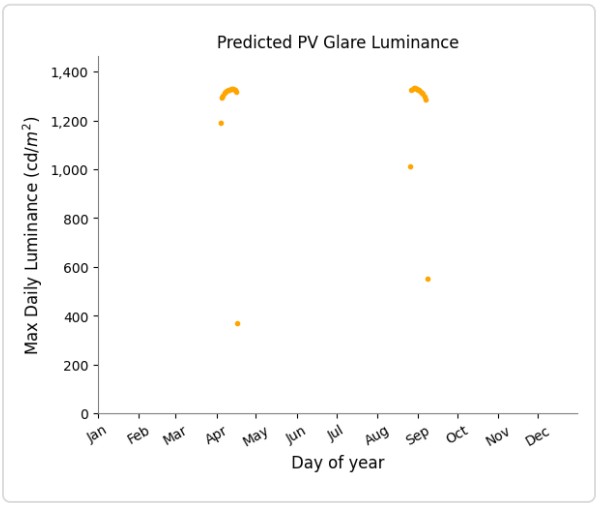
Green glare: 481 min.







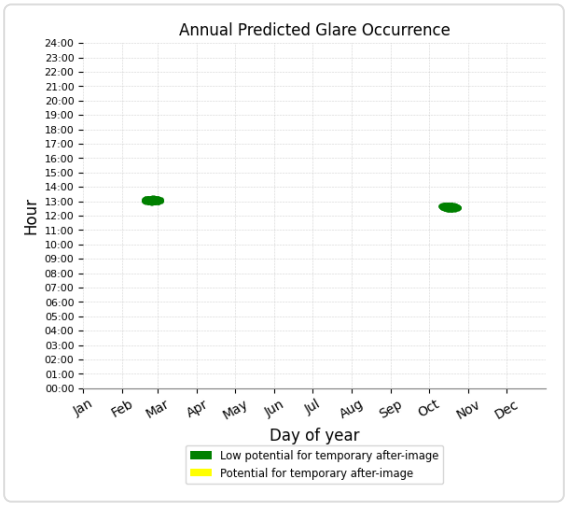


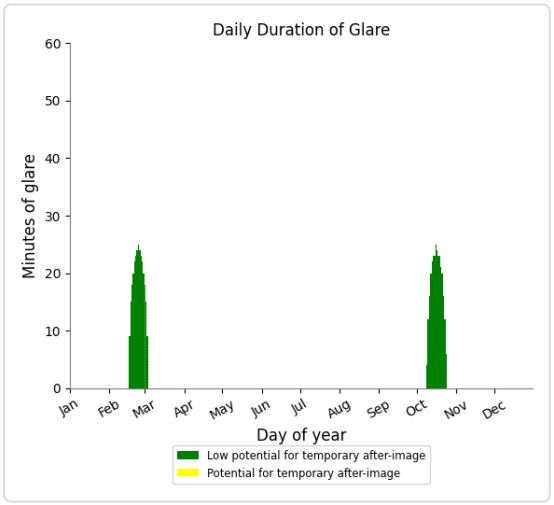


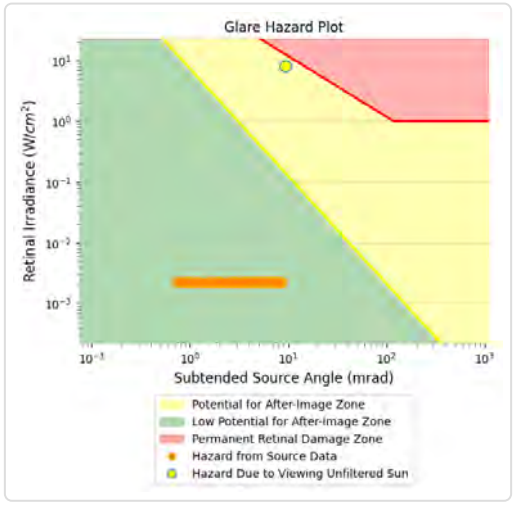
PV array 5 and OP 16

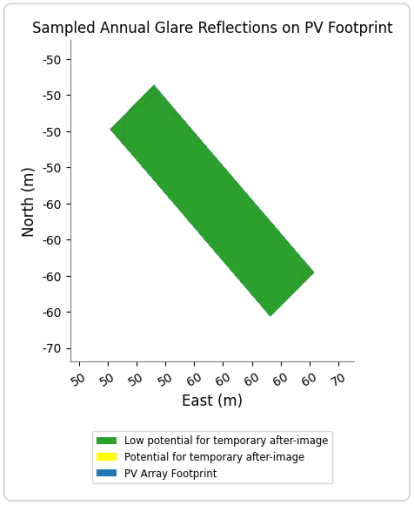
Yellow glare: none

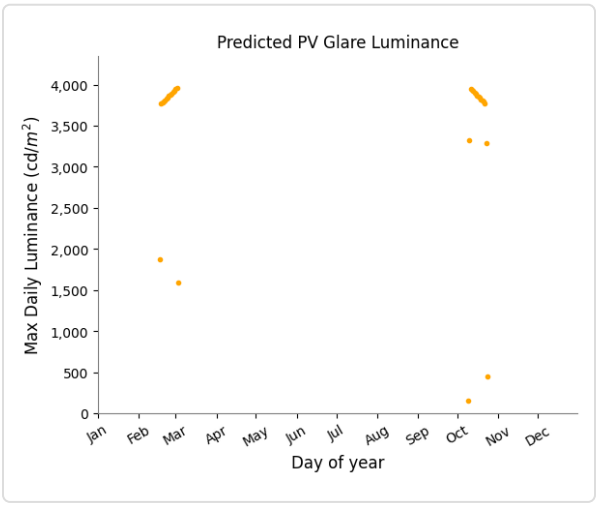
Green glare: 577 min.







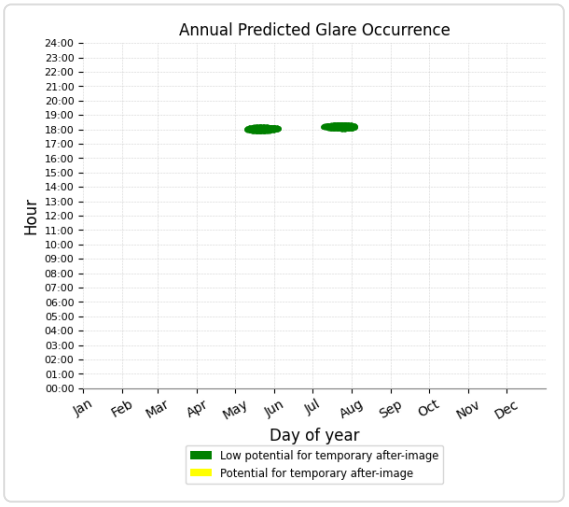


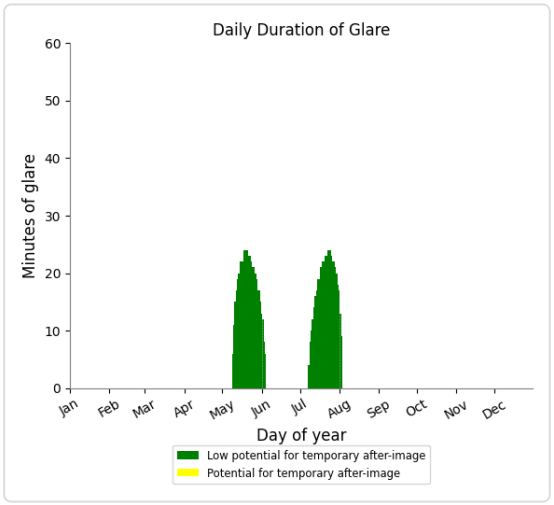


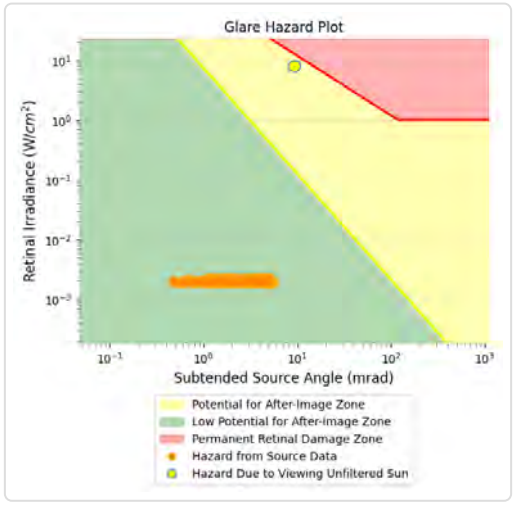
PV array 5 and OP 23

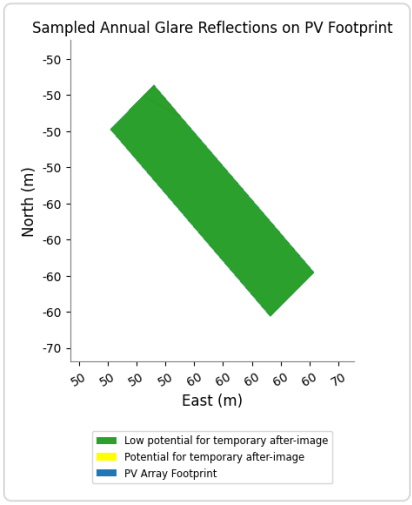
Yellow glare: none

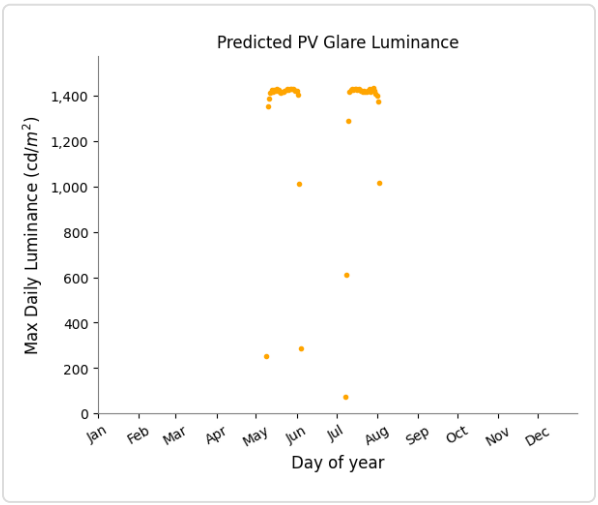
Green glare: 975 min.







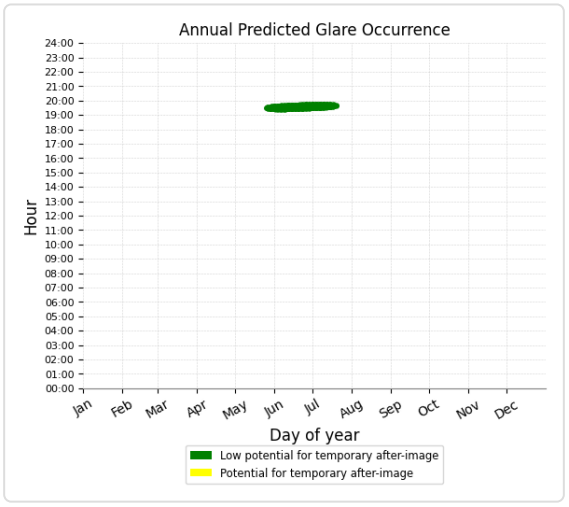


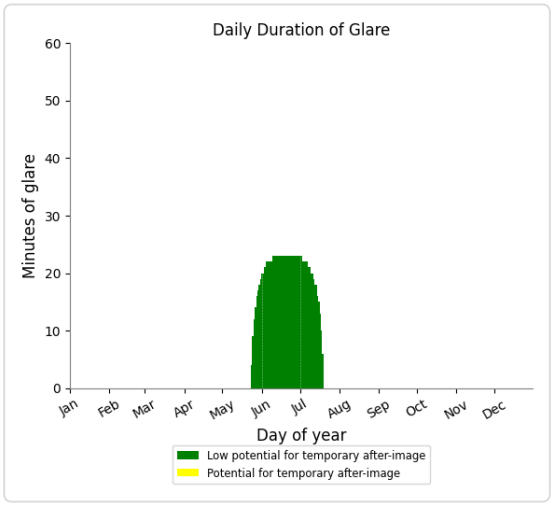


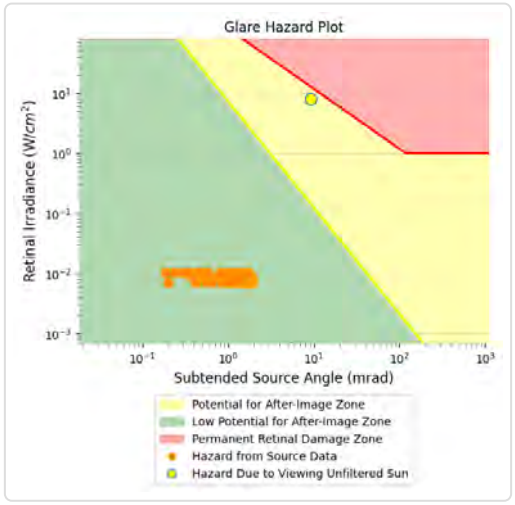
PV array 5 and OP 30

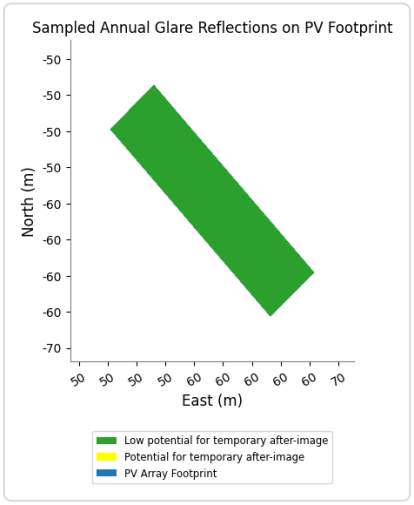
Yellow glare: none

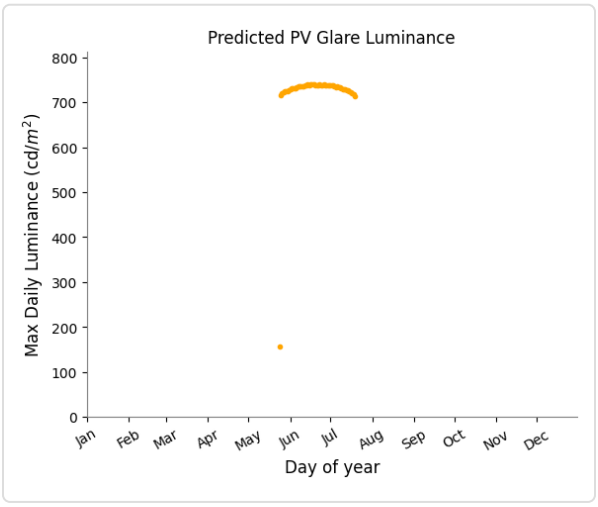
Green glare: 1,137 min.







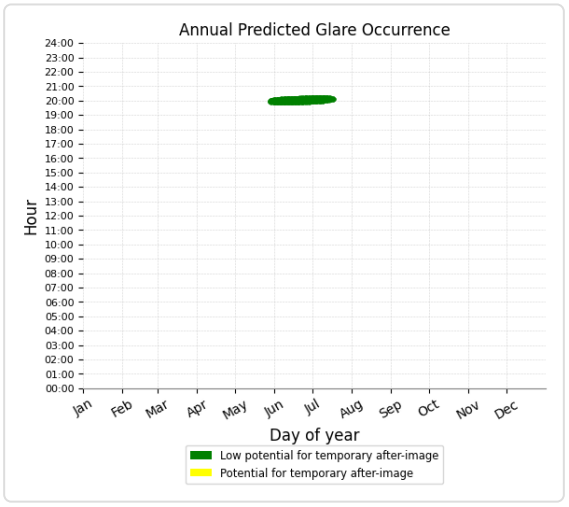


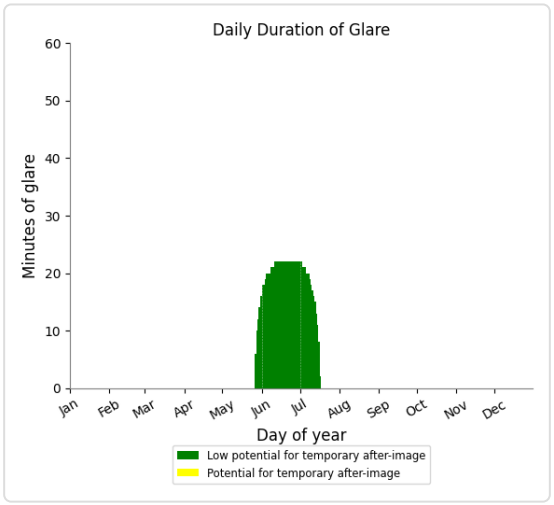


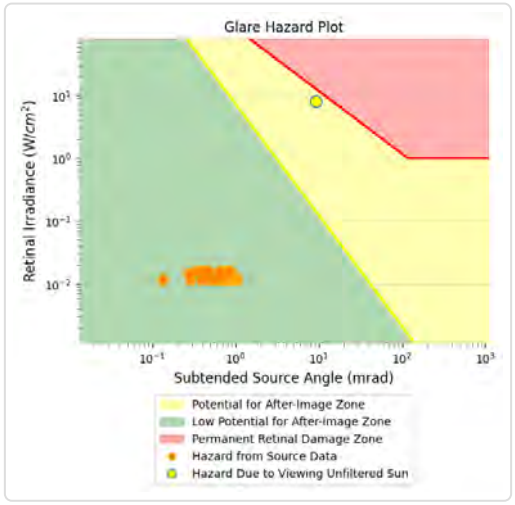
PV array 5 and OP 37

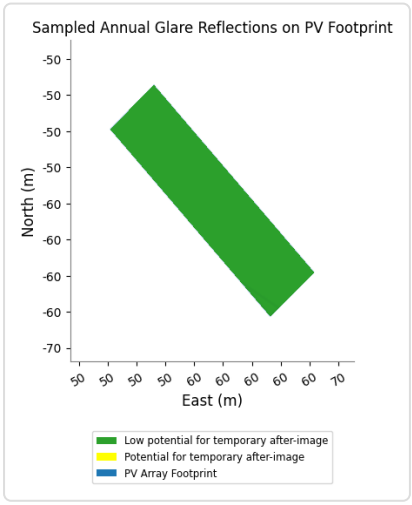
Yellow glare: none

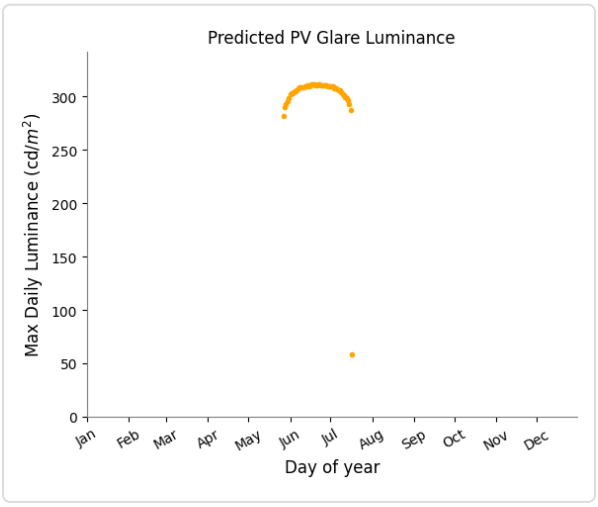
Green glare: 978 min.







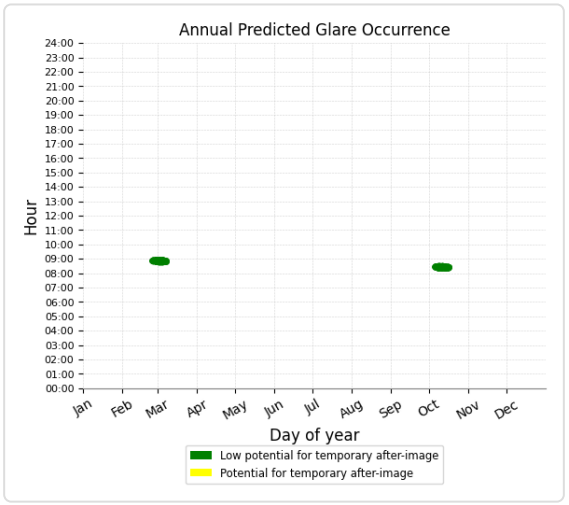


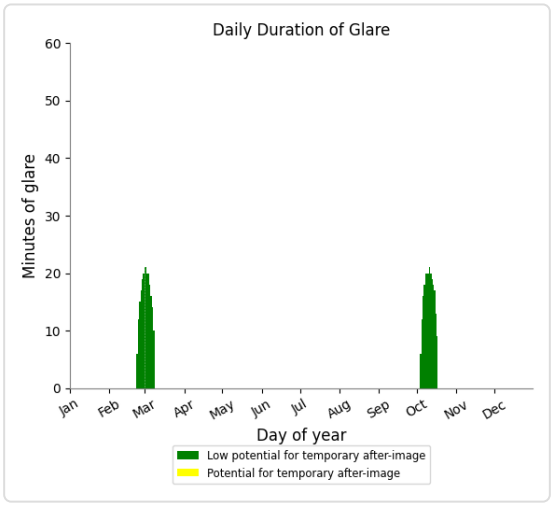


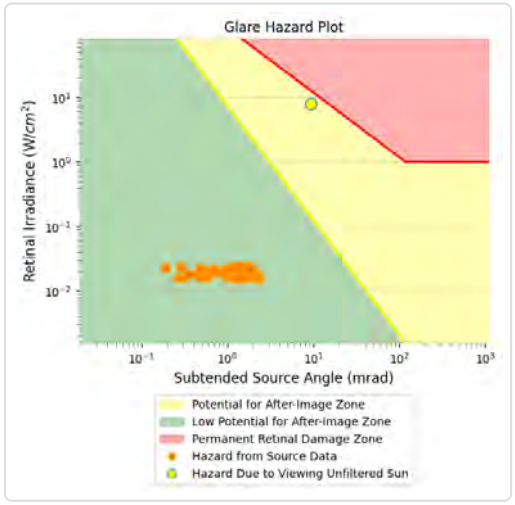
PV array 5 and OP 38

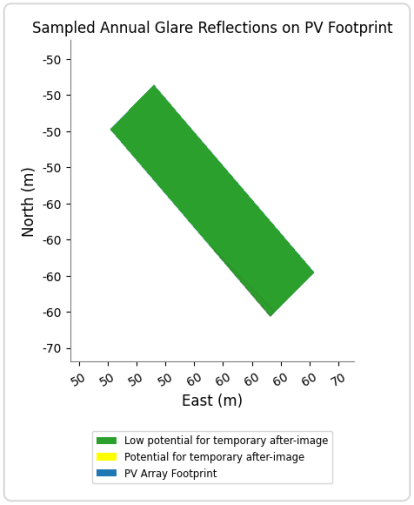
Yellow glare: none

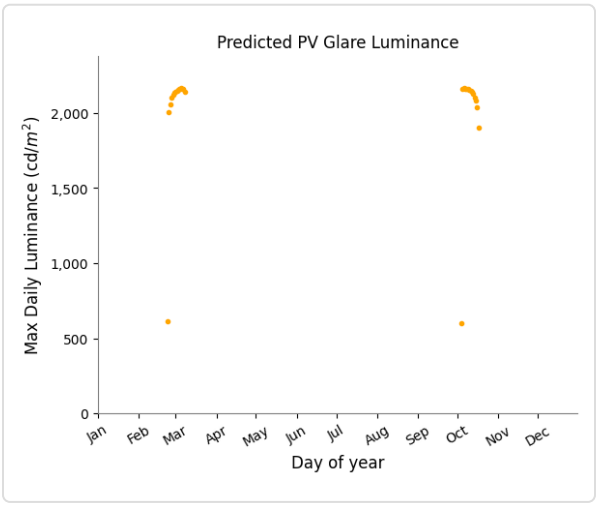
Green glare: 458 min.











PV array 5 and 1-ATCT

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 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 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 array 5 and OP 22

No glare found

PV array 5 and OP 24

No glare found

PV array 5 and OP 25

No glare found

PV array 5 and OP 26

No glare found

PV array 5 and OP 27

No glare found

PV array 5 and OP 28

No glare found

PV array 5 and OP 29

No glare found

PV array 5 and OP 31

No glare found

PV array 5 and OP 32

No glare found

PV array 5 and OP 33

No glare found

PV array 5 and OP 34

No glare found

PV array 5 and OP 35

No glare found

PV array 5 and OP 36

No glare found

PV array 5 and OP 39

No glare found

PV array 5 and OP 40

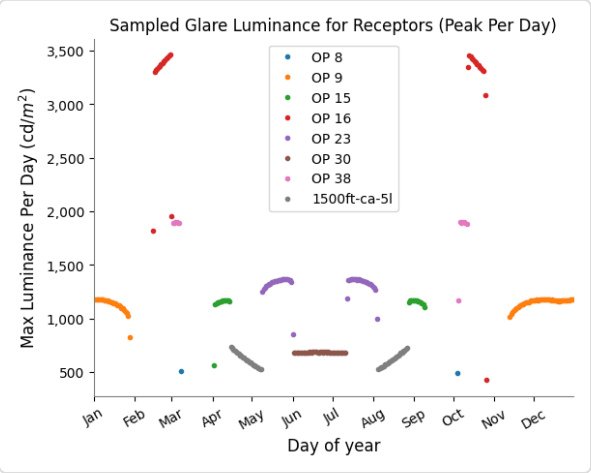
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,137	52.3	0	0.0	753
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,275	21.2	0	0.0	472
OP 8	442	7.4	0	0.0	590
OP 9	1,255	20.9	0	0.0	1,178
OP 14	522	8.7	0	0.0	442
OP 15	468	7.8	0	0.0	1,169
OP 16	574	9.6	0	0.0	3,461
OP 23	928	15.5	0	0.0	1,367
OP 30	1,155	19.2	0	0.0	685
OP 37	987	16.4	0	0.0	287
OP 38	461	7.7	0	0.0	1,898
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

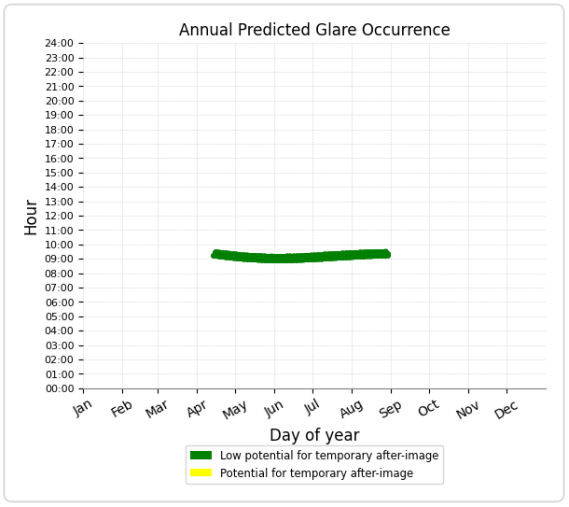
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

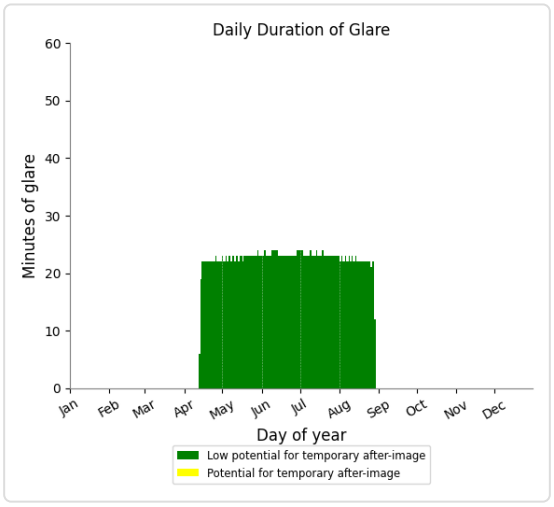


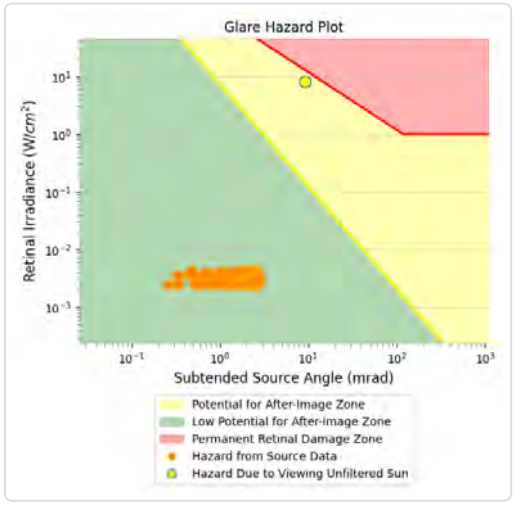
PV array 6 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

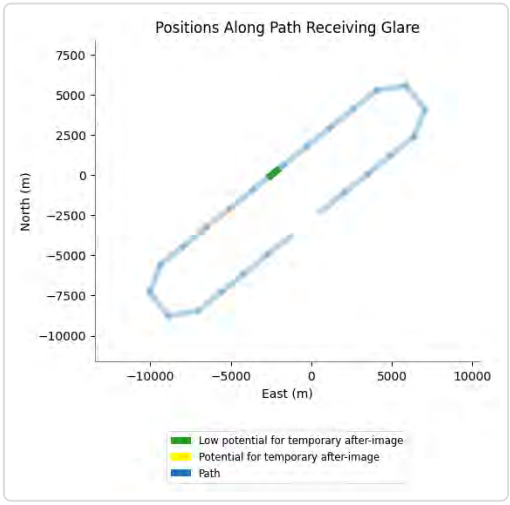
Yellow glare: none

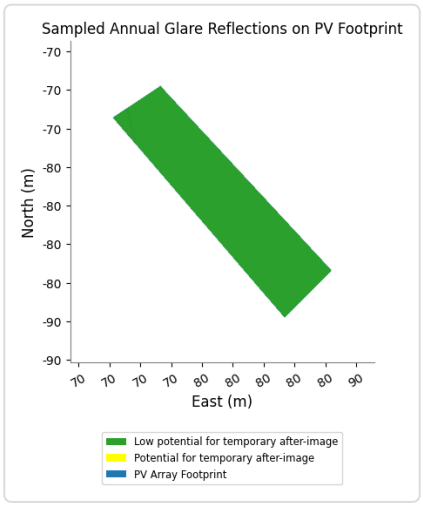
Green glare: 3,137 min.

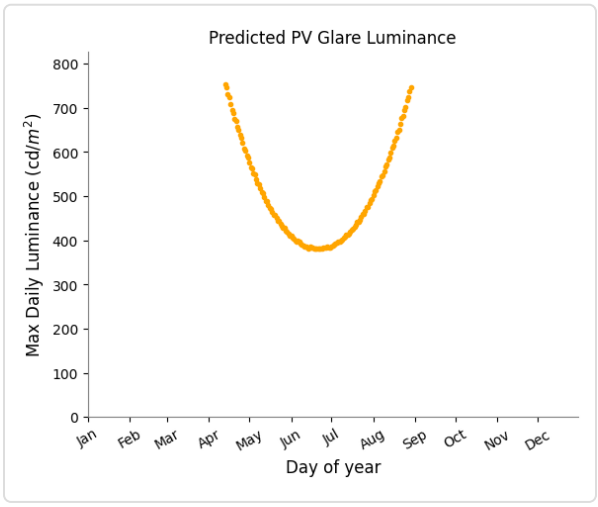












PV array 6 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 6 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 6 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 6 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 6 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 6 and Route: Approach_05L

No glare found

PV array 6 and Route: Approach_05R

No glare found

PV array 6 and Route: Approach_23L

No glare found

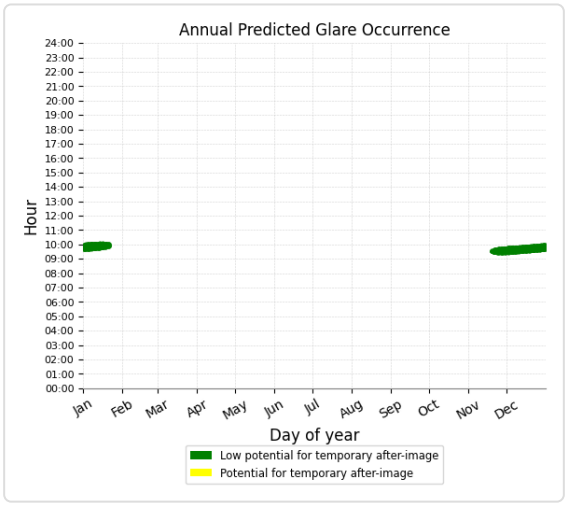
PV array 6 and Route: Approach_23R

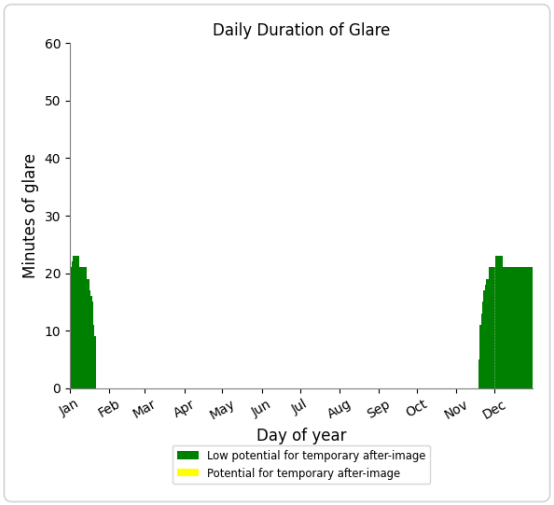
No glare found

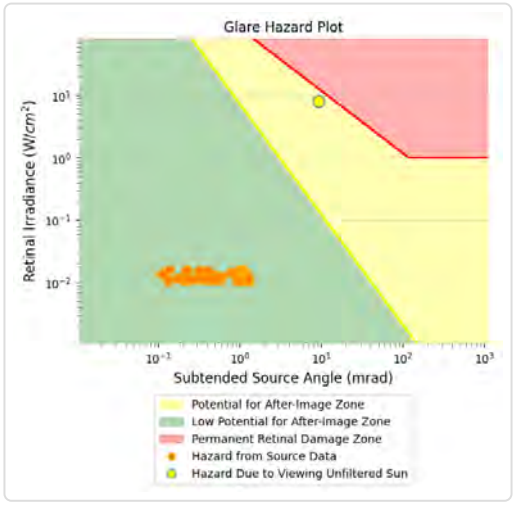
PV array 6 and OP 2

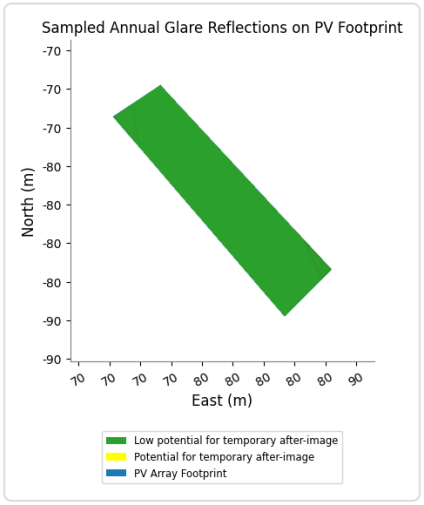
Yellow glare: none

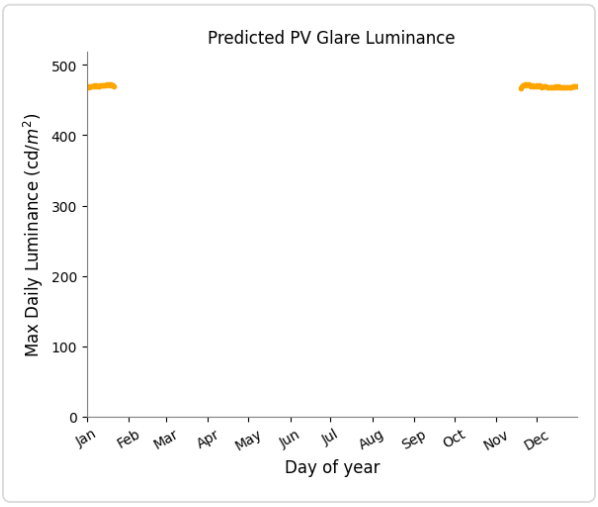
Green glare: 1,275 min.







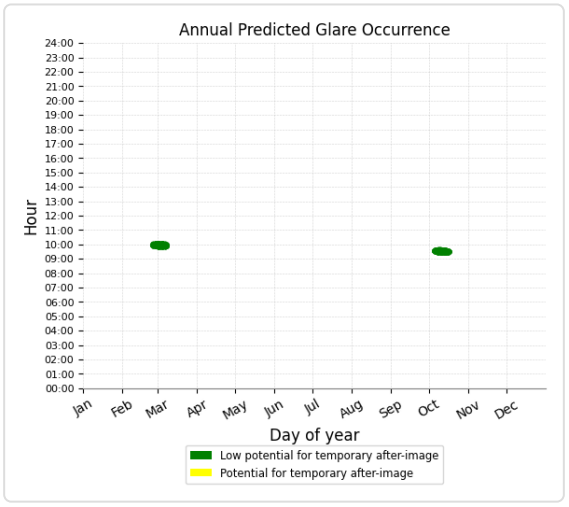


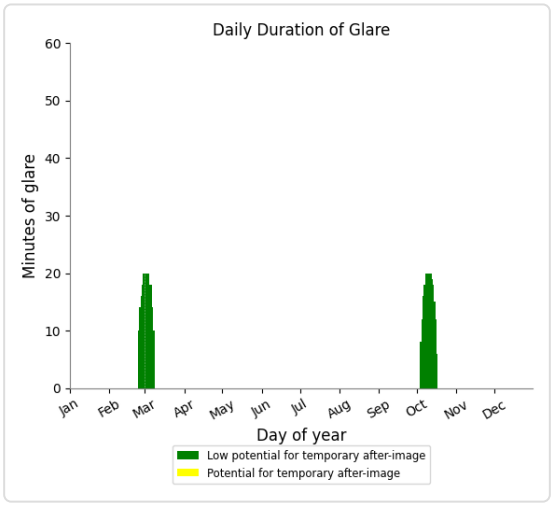


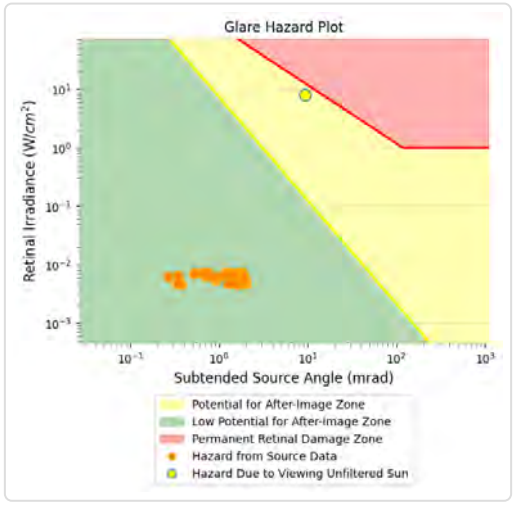
PV array 6 and OP 8

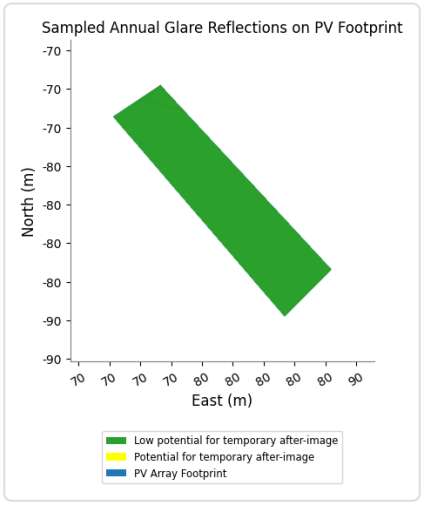
Yellow glare: none

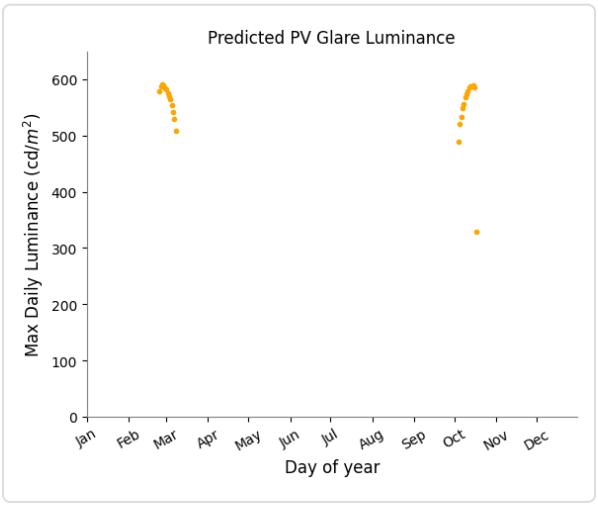
Green glare: 442 min.







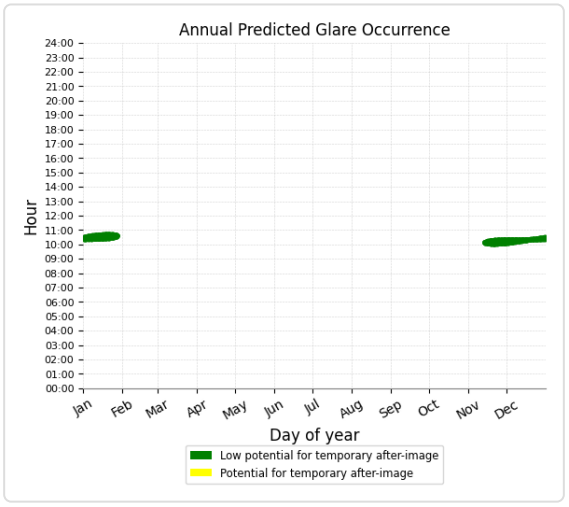


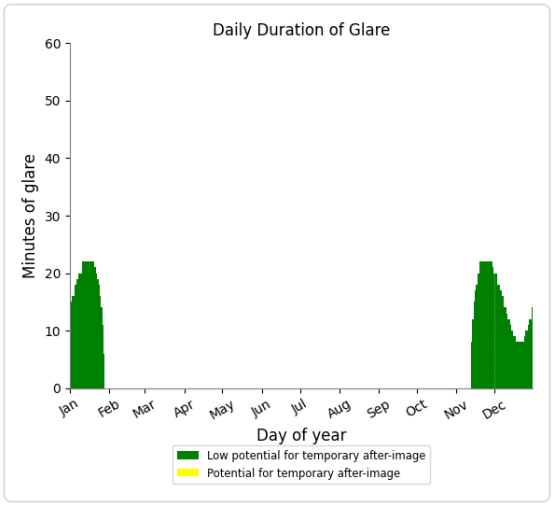


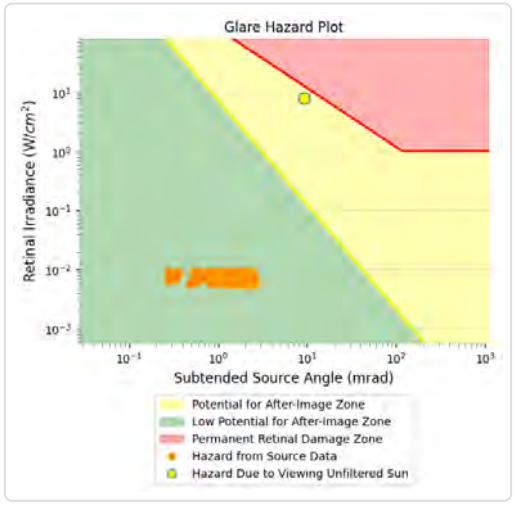
PV array 6 and OP 9

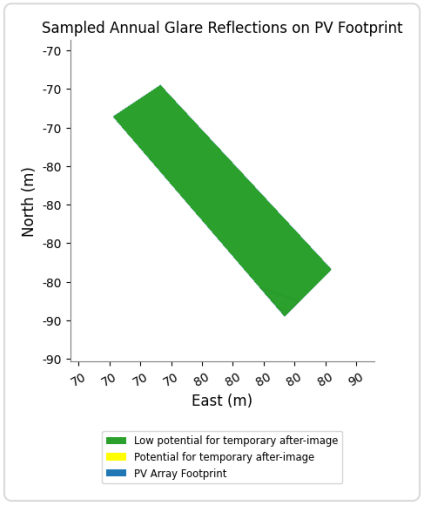
Yellow glare: none

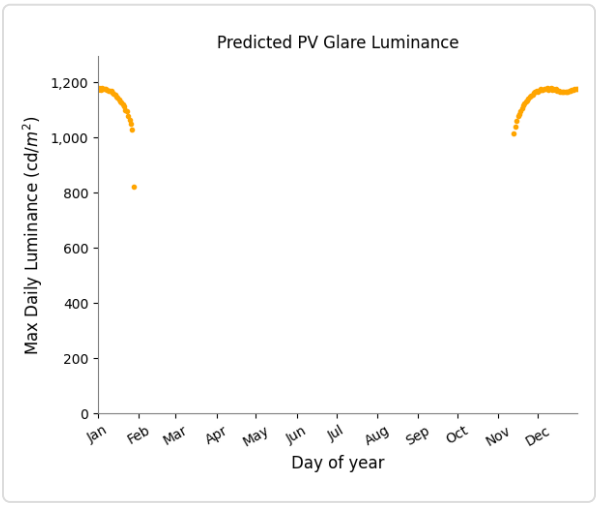
Green glare: 1,255 min.







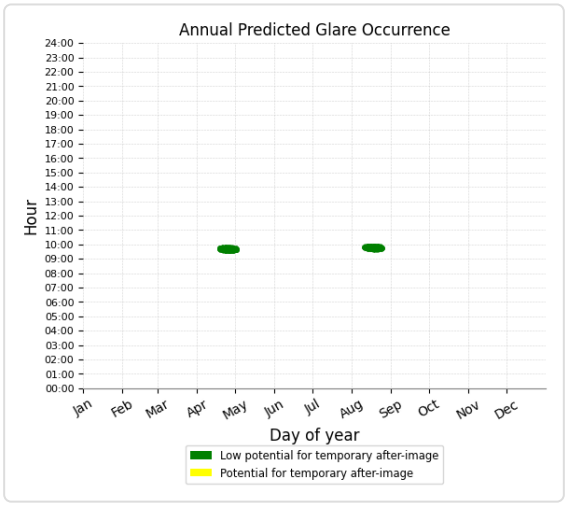


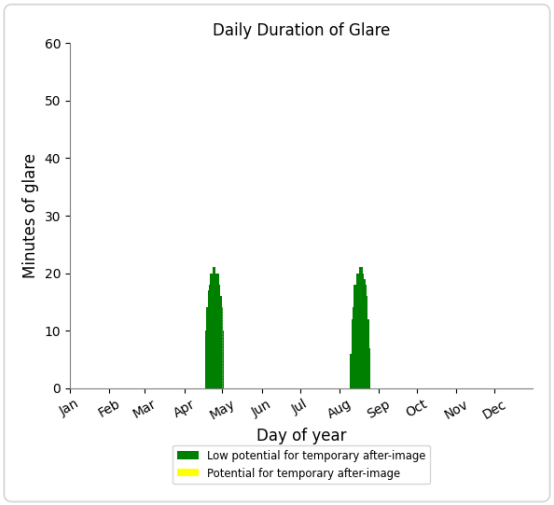


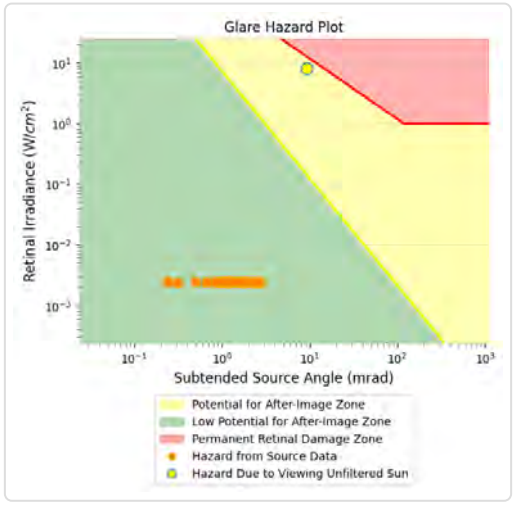
PV array 6 and OP 14

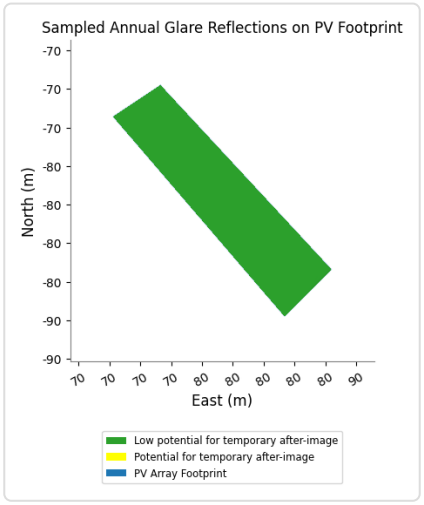
Yellow glare: none

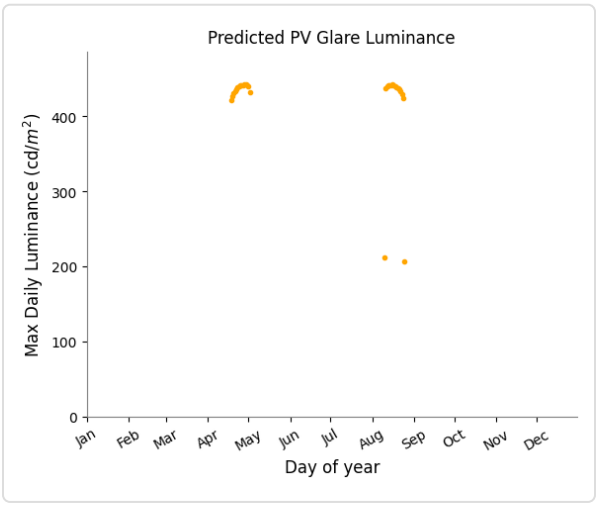
Green glare: 522 min.







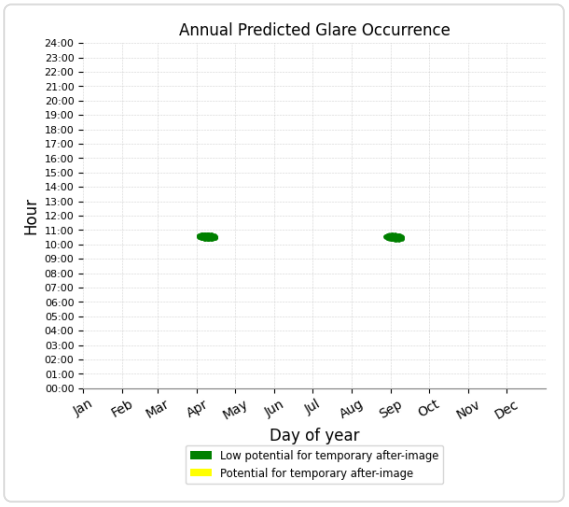


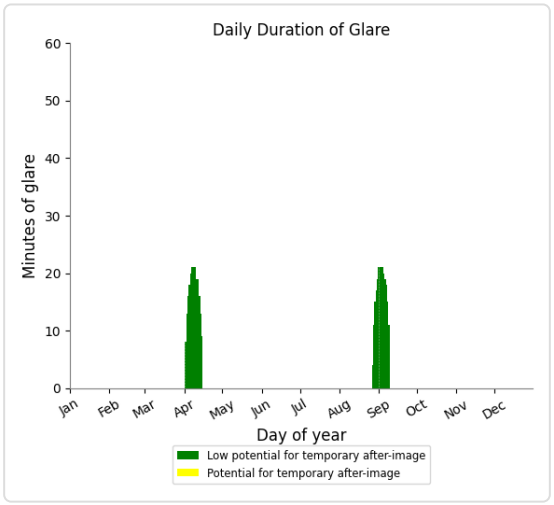


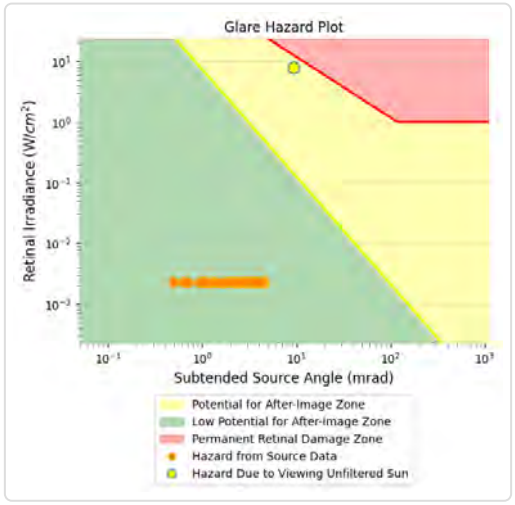
PV array 6 and OP 15

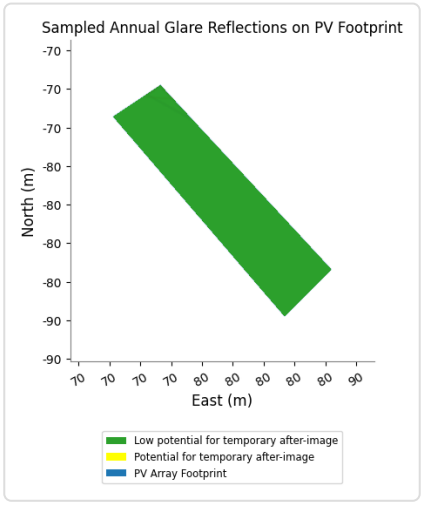
Yellow glare: none

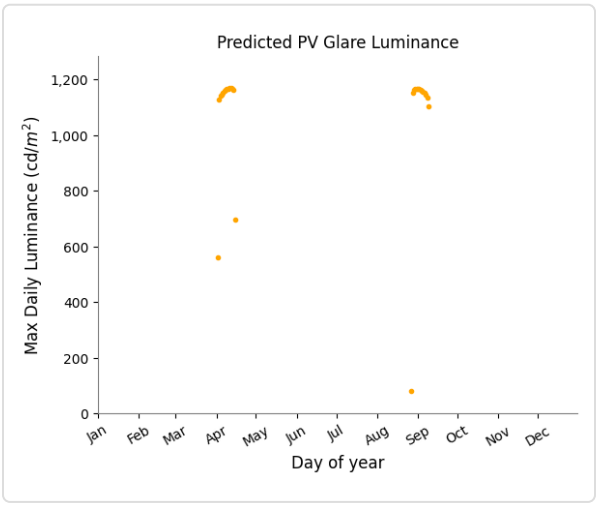
Green glare: 468 min.







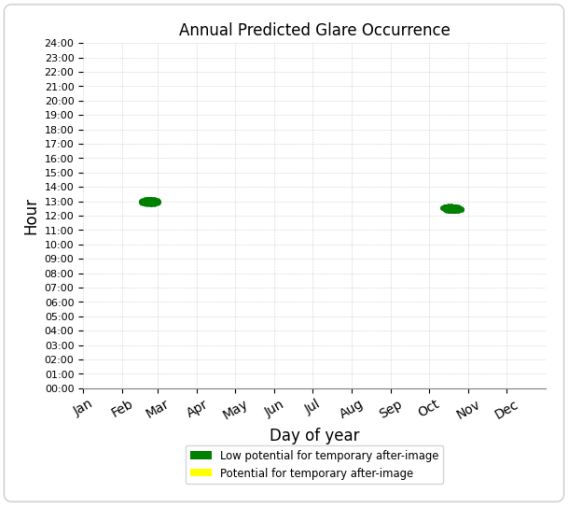


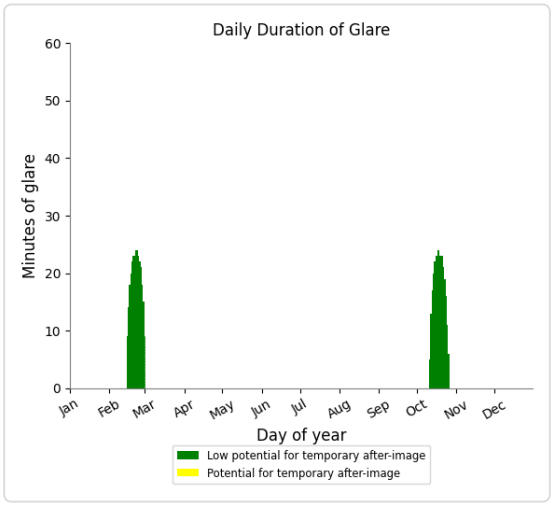


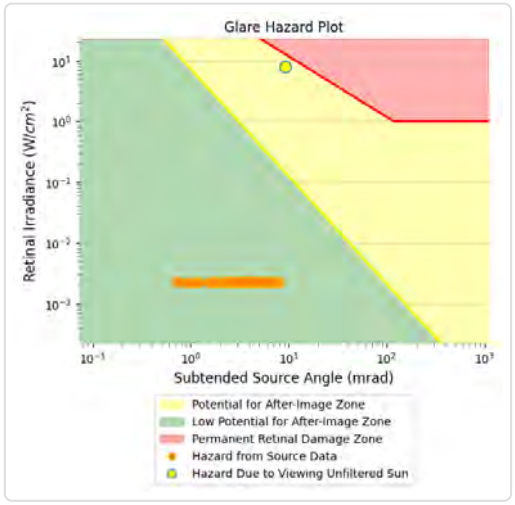
PV array 6 and OP 16

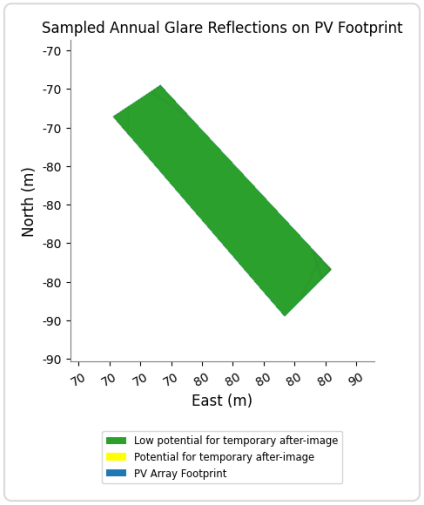
Yellow glare: none

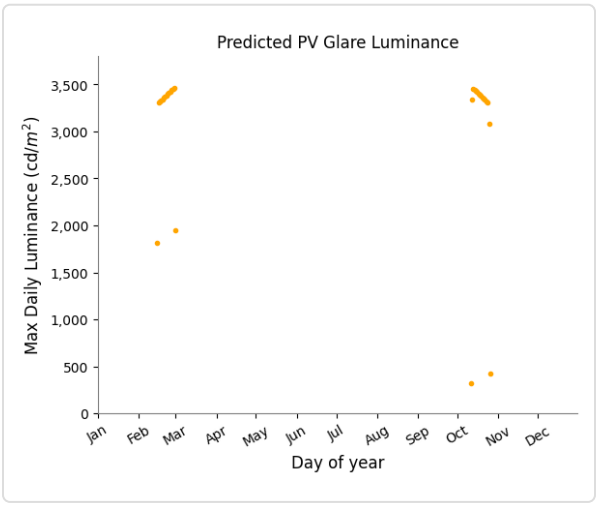
Green glare: 574 min.







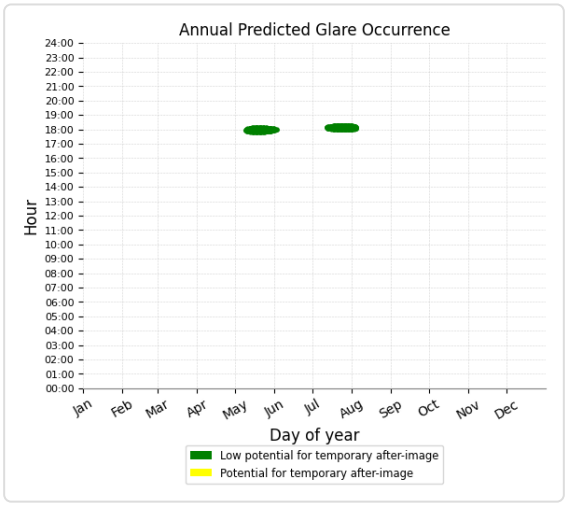


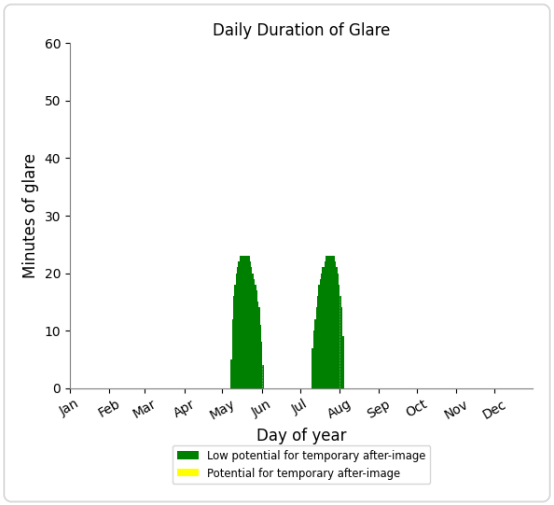


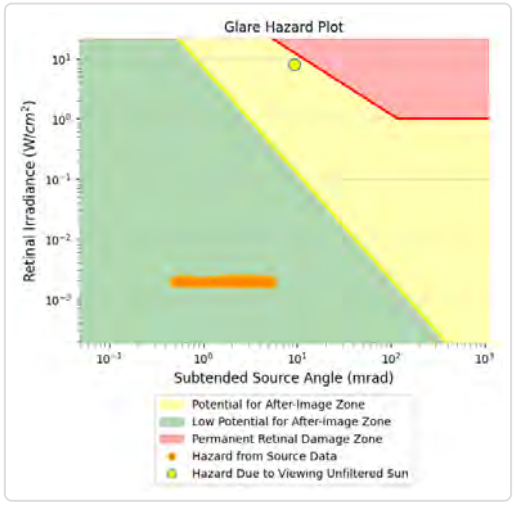
PV array 6 and OP 23

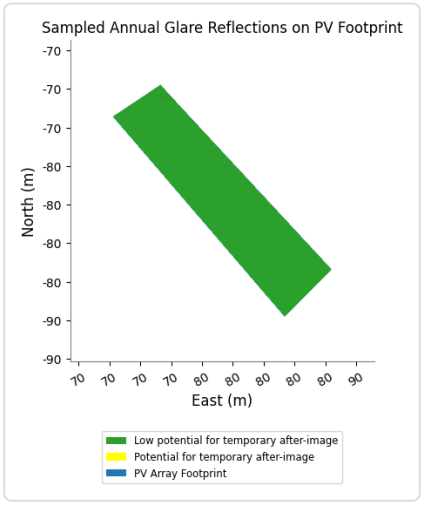
Yellow glare: none

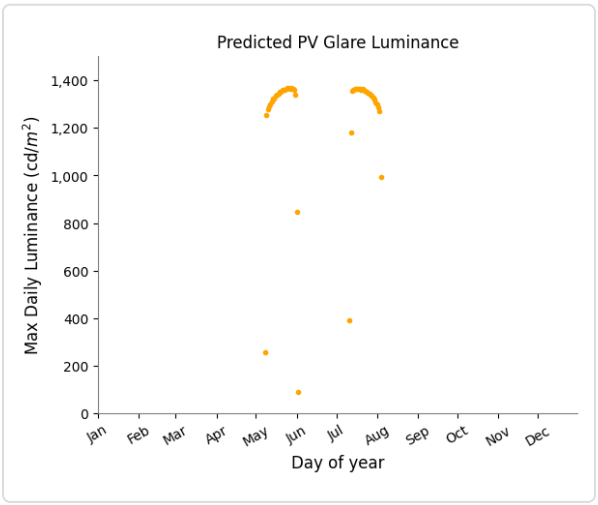
Green glare: 928 min.







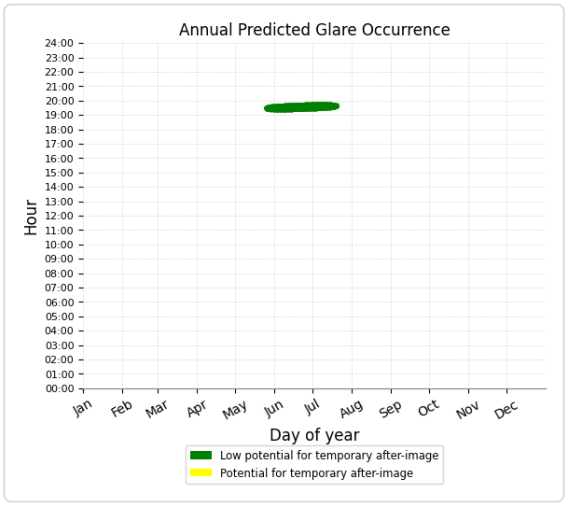


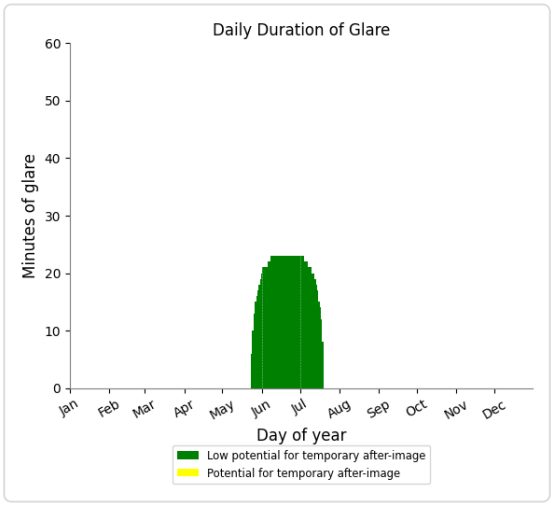


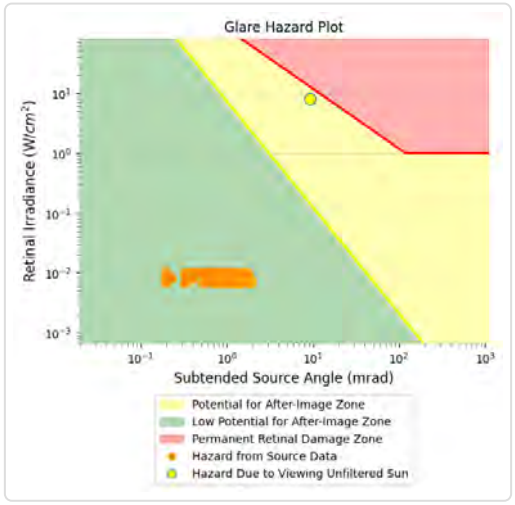
PV array 6 and OP 30

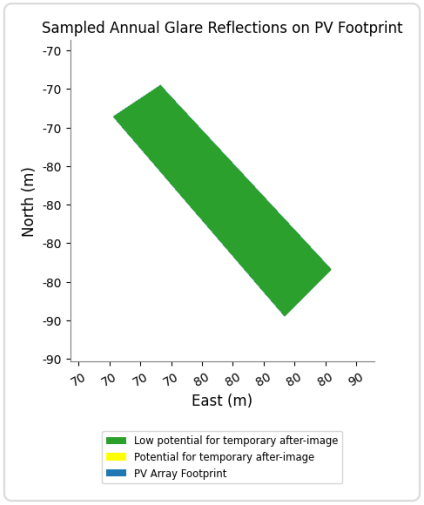
Yellow glare: none

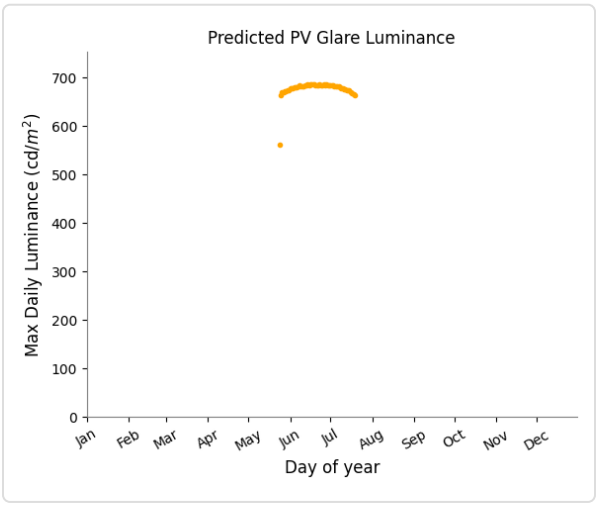
Green glare: 1,155 min.







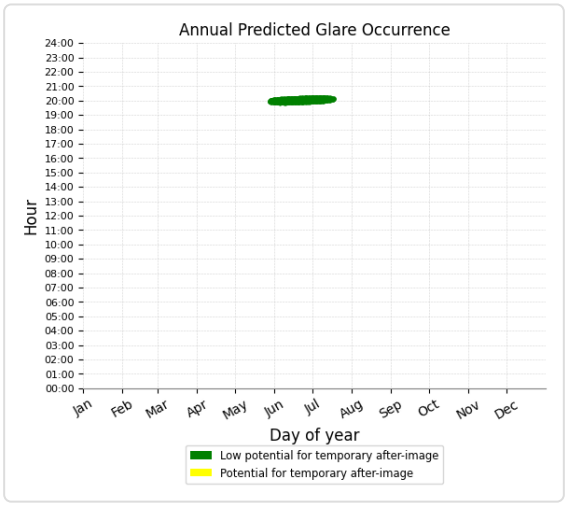


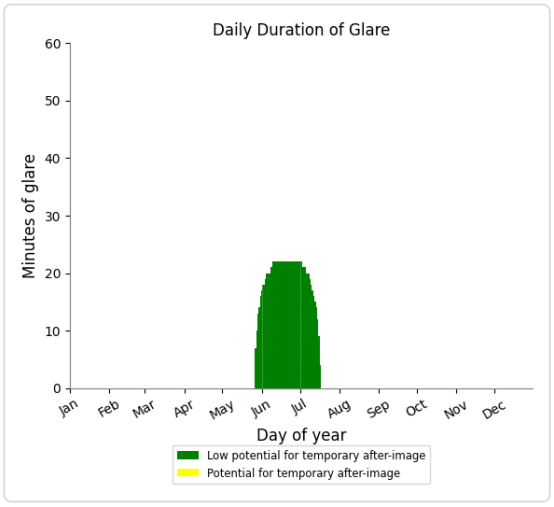


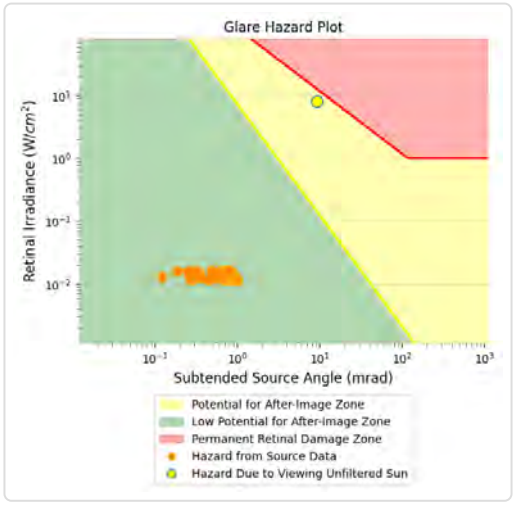
PV array 6 and OP 37

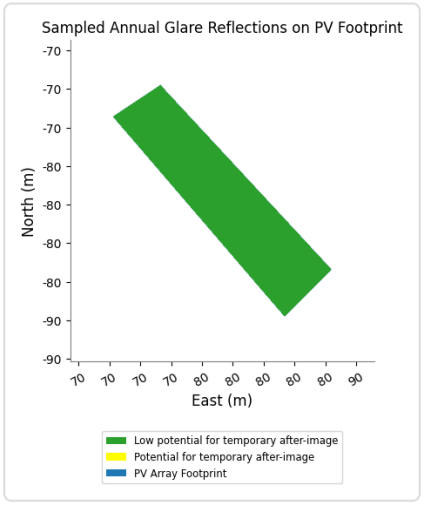
Yellow glare: none

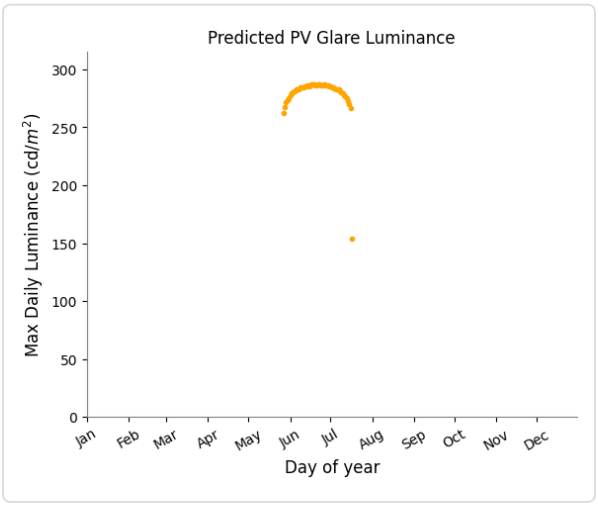
Green glare: 987 min.







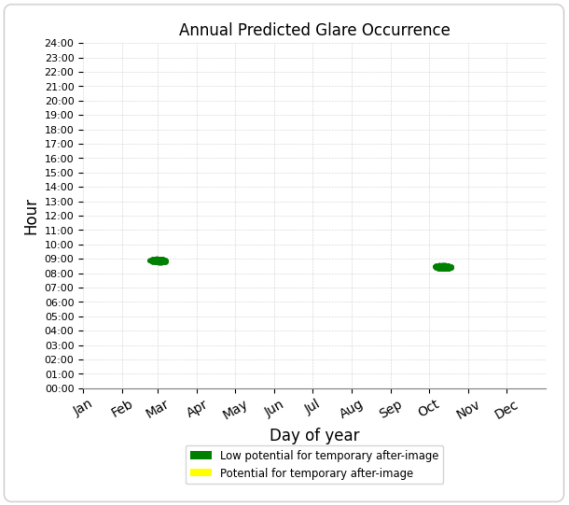


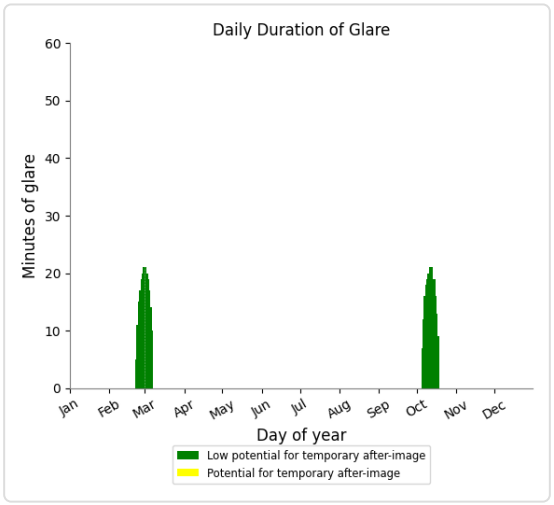


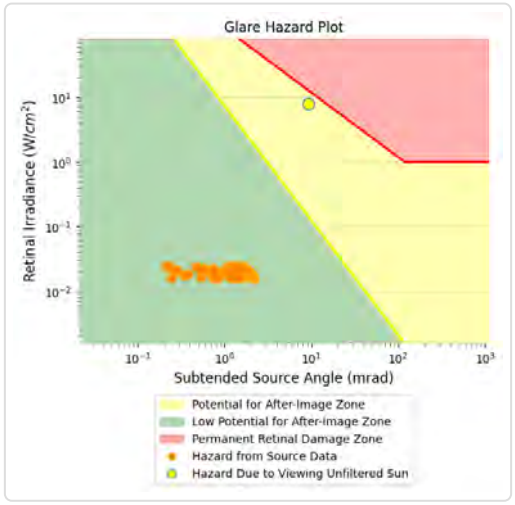
PV array 6 and OP 38

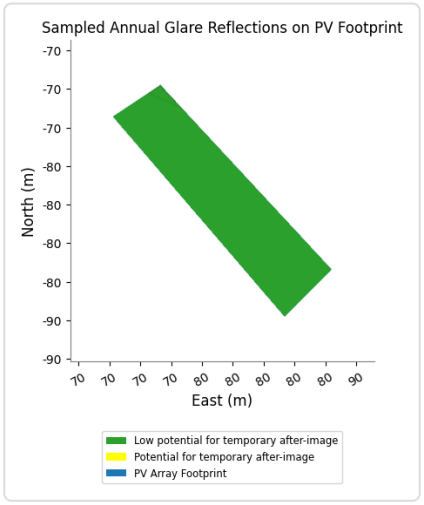
Yellow glare: none

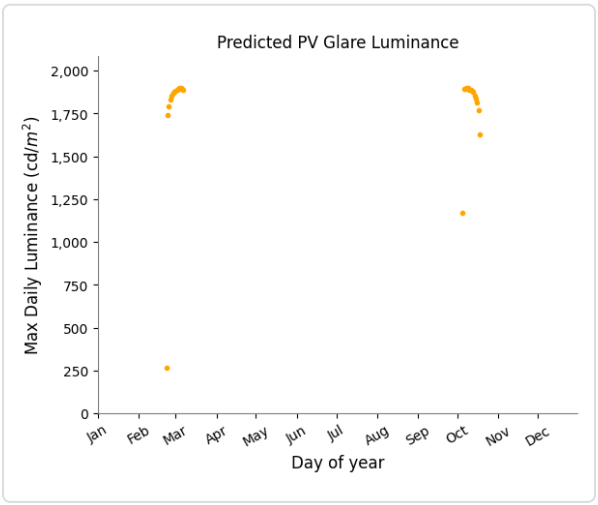
Green glare: 461 min.











PV array 6 and 1-ATCT

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 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 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 array 6 and OP 22

No glare found

PV array 6 and OP 24

No glare found

PV array 6 and OP 25

No glare found

PV array 6 and OP 26

No glare found

PV array 6 and OP 27

No glare found

PV array 6 and OP 28

No glare found

PV array 6 and OP 29

No glare found

PV array 6 and OP 31

No glare found

PV array 6 and OP 32

No glare found

PV array 6 and OP 33

No glare found

PV array 6 and OP 34

No glare found

PV array 6 and OP 35

No glare found

PV array 6 and OP 36

No glare found

PV array 6 and OP 39

No glare found

PV array 6 and OP 40

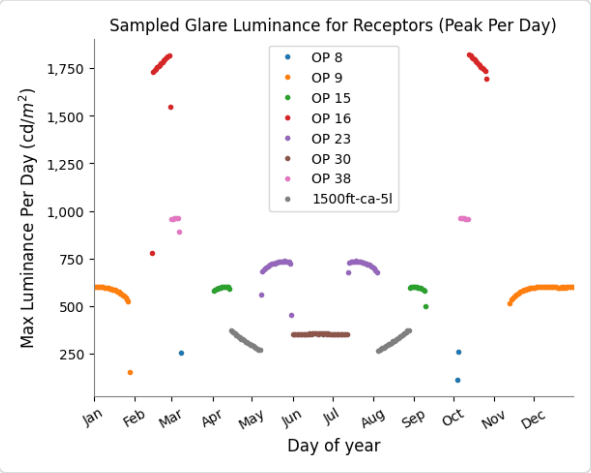
No glare found

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
1500Ft-CA_5L23R_05L-R_23R-L	3,106	51.8	0	0.0	386
1000Ft-GA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
1000Ft-GA_5L23R_05L-R_23R-L	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-L_23L-R	0	0.0	0	0.0	0
1000Ft-GA_5R23L_05R-R_23L-L	0	0.0	0	0.0	0
1500Ft-CA_5L23R_05L-L_23R-R	0	0.0	0	0.0	0
Approach_05L	0	0.0	0	0.0	0
Approach_05R	0	0.0	0	0.0	0
Approach_23L	0	0.0	0	0.0	0
Approach_23R	0	0.0	0	0.0	0
OP 2	1,265	21.1	0	0.0	240
OP 8	439	7.3	0	0.0	303
OP 9	1,258	21.0	0	0.0	604
OP 14	509	8.5	0	0.0	227
OP 15	449	7.5	0	0.0	603
OP 16	524	8.7	0	0.0	1,820
OP 23	858	14.3	0	0.0	738
OP 30	1,129	18.8	0	0.0	356
OP 37	988	16.5	0	0.0	148
OP 38	451	7.5	0	0.0	965
1-ATCT	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 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
OP 22	0	0.0	0	0.0	0
OP 24	0	0.0	0	0.0	0
OP 25	0	0.0	0	0.0	0

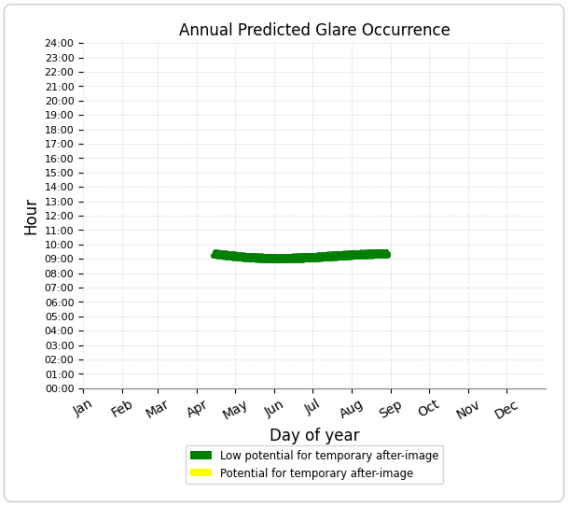
Receptor	Annual Green Glare		Annual Yellow Glare		Peak Luminance
	min	hr	min	hr	cd/m^2
OP 26	0	0.0	0	0.0	0
OP 27	0	0.0	0	0.0	0
OP 28	0	0.0	0	0.0	0
OP 29	0	0.0	0	0.0	0
OP 31	0	0.0	0	0.0	0
OP 32	0	0.0	0	0.0	0
OP 33	0	0.0	0	0.0	0
OP 34	0	0.0	0	0.0	0
OP 35	0	0.0	0	0.0	0
OP 36	0	0.0	0	0.0	0
OP 39	0	0.0	0	0.0	0
OP 40	0	0.0	0	0.0	0

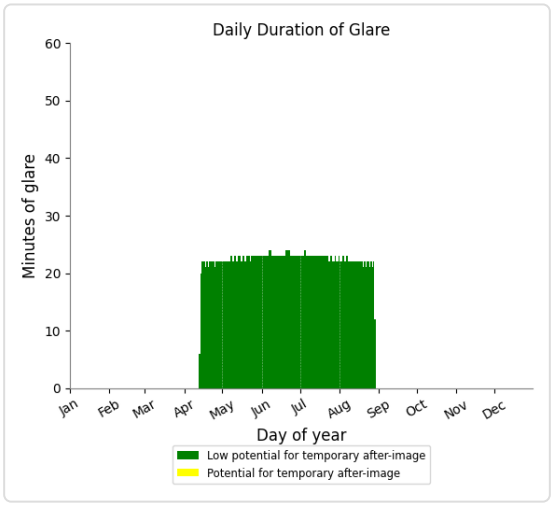


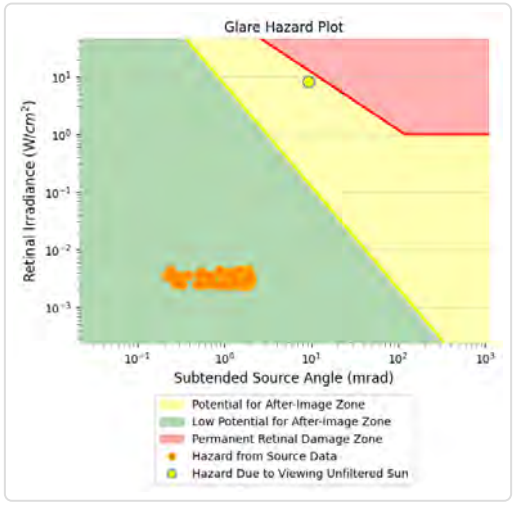
PV array 7 and Route: 1500Ft-CA_5L23R_05L-R_23R-L

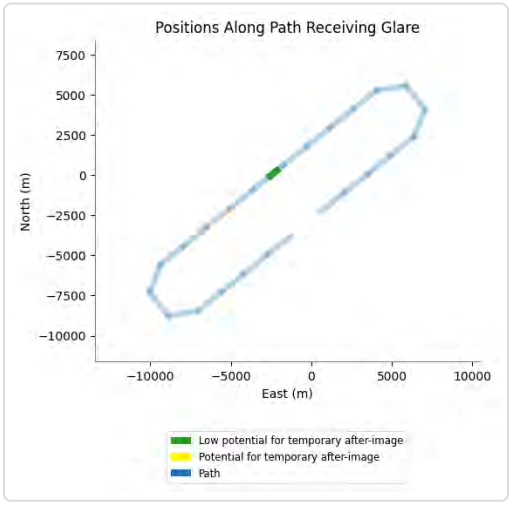
Yellow glare: none

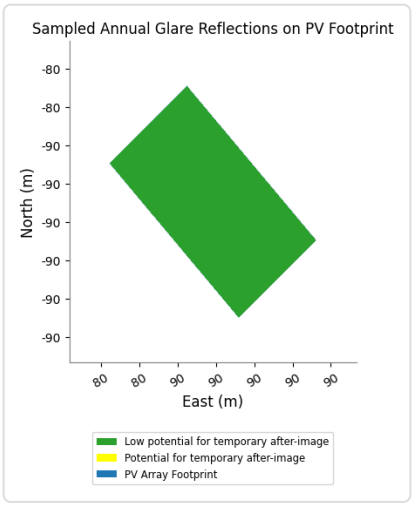
Green glare: 3,106 min.

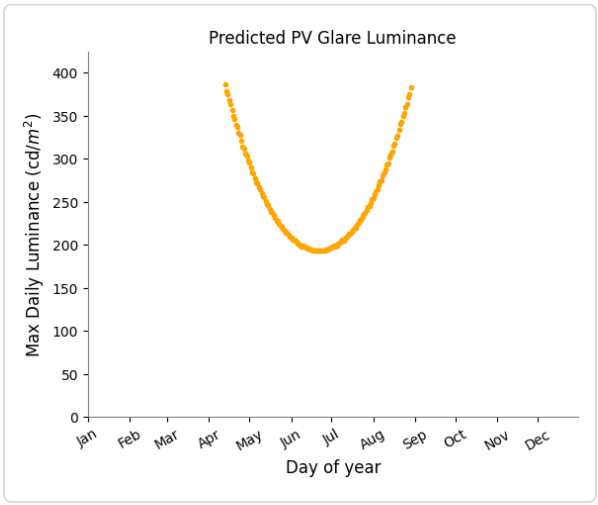












PV array 7 and Route: 1000Ft-GA_5L23R_05L-L_23R-R

No glare found

PV array 7 and Route: 1000Ft-GA_5L23R_05L-R_23R-L

No glare found

PV array 7 and Route: 1000Ft-GA_5R23L_05R-L_23L-R

No glare found

PV array 7 and Route: 1000Ft-GA_5R23L_05R-R_23L-L

No glare found

PV array 7 and Route: 1500Ft-CA_5L23R_05L-L_23R-R

No glare found

PV array 7 and Route: Approach_05L

No glare found

PV array 7 and Route: Approach_05R

No glare found

PV array 7 and Route: Approach_23L

No glare found

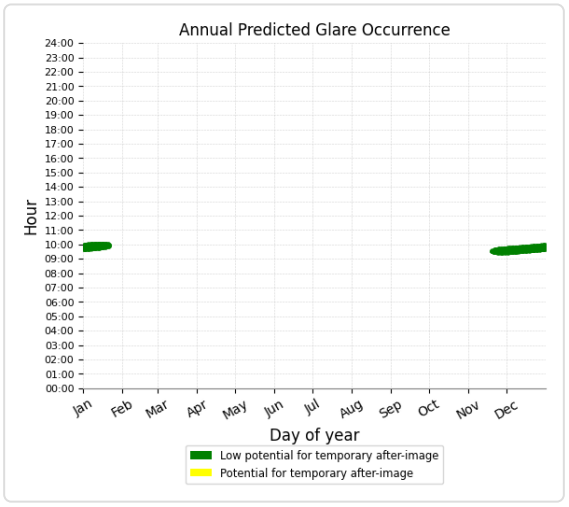
PV array 7 and Route: Approach_23R

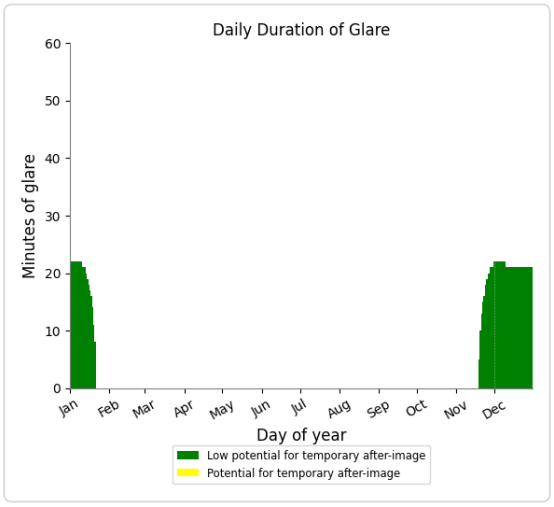
No glare found

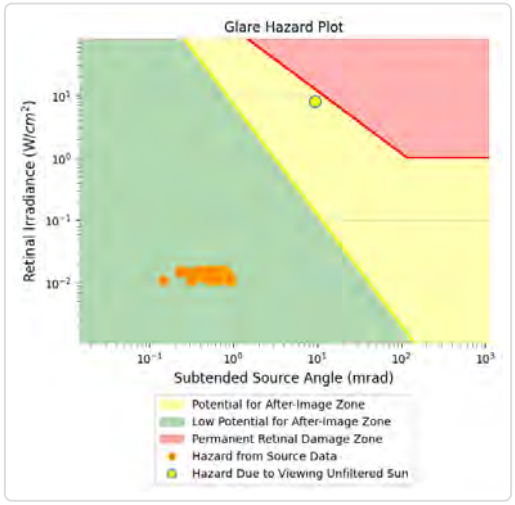
PV array 7 and OP 2

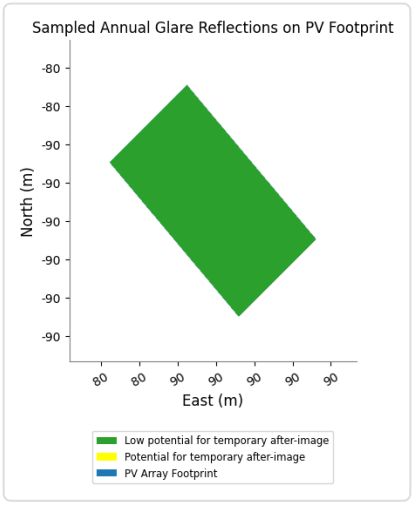
Yellow glare: none

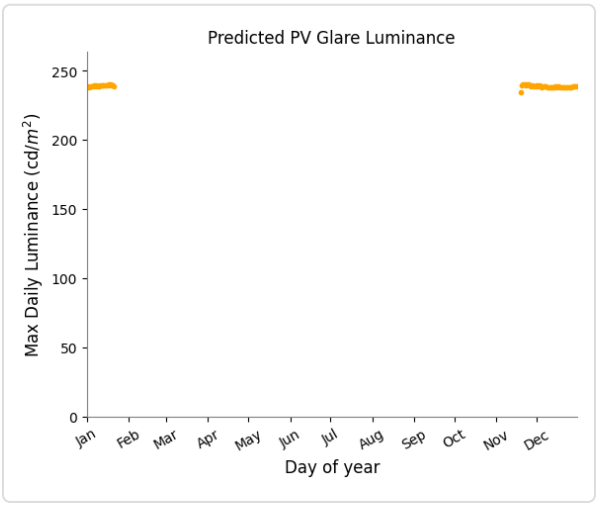
Green glare: 1,265 min.







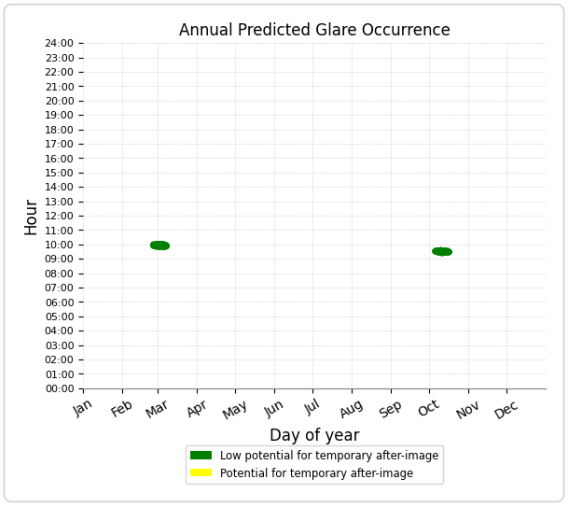


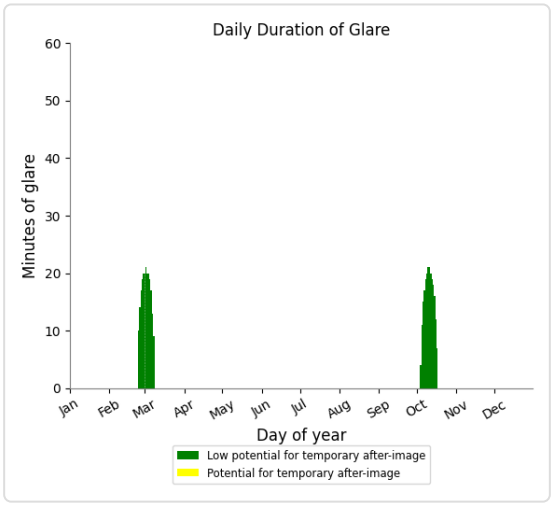


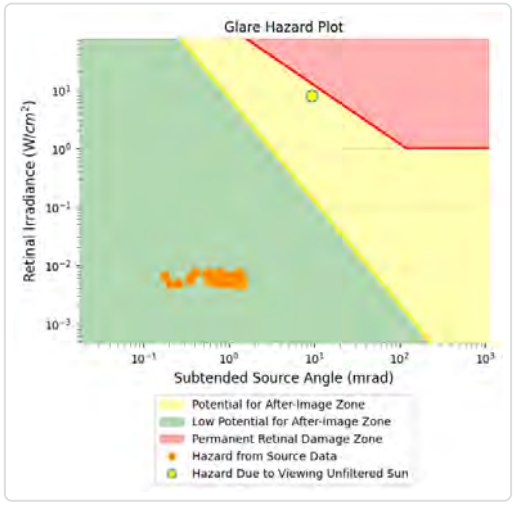
PV array 7 and OP 8

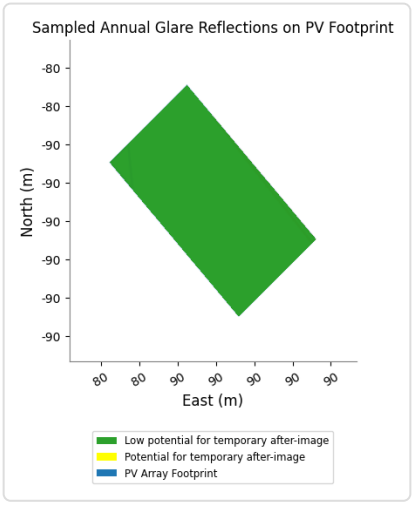
Yellow glare: none

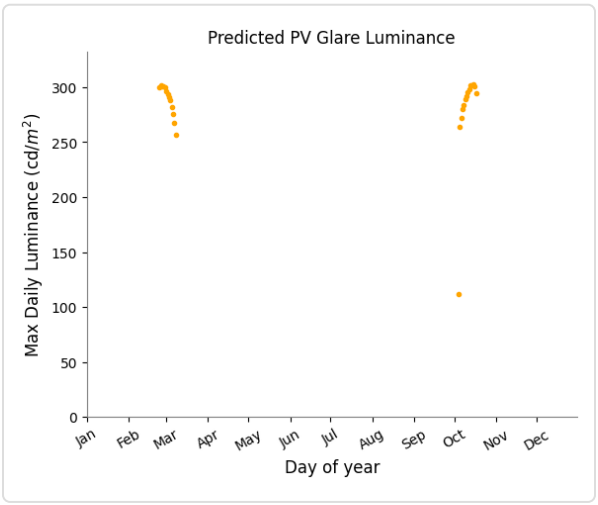
Green glare: 439 min.







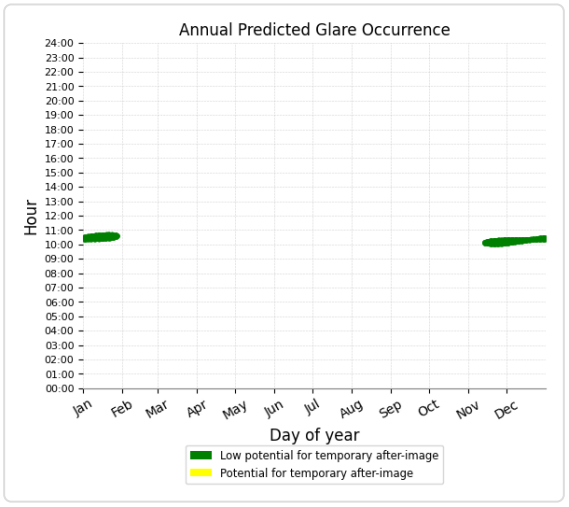


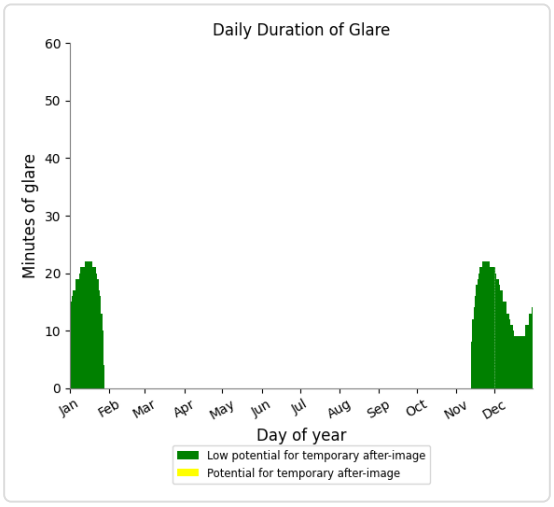


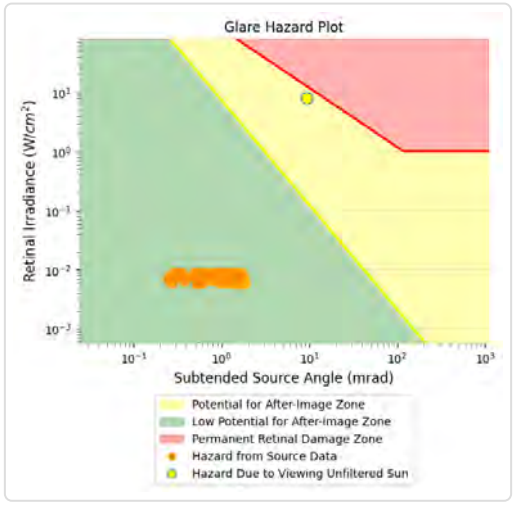
PV array 7 and OP 9

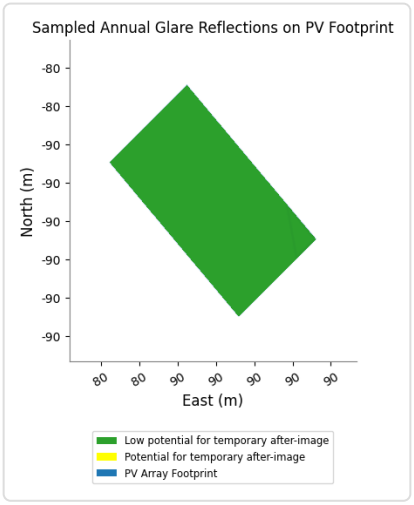
Yellow glare: none

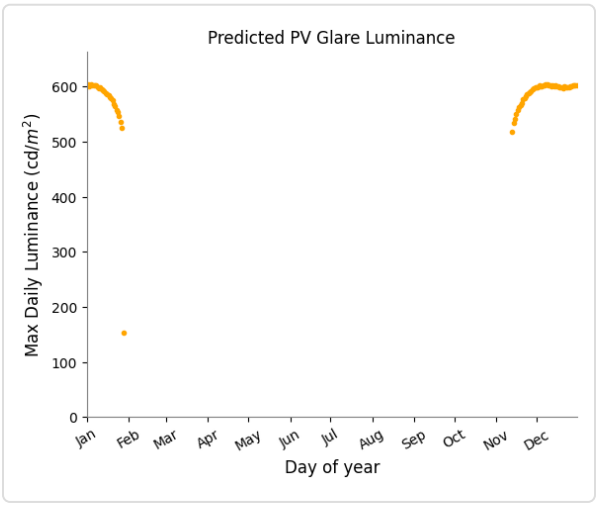
Green glare: 1,258 min.







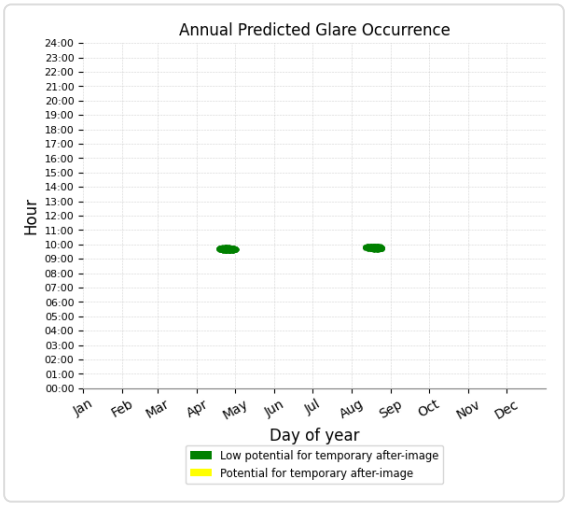


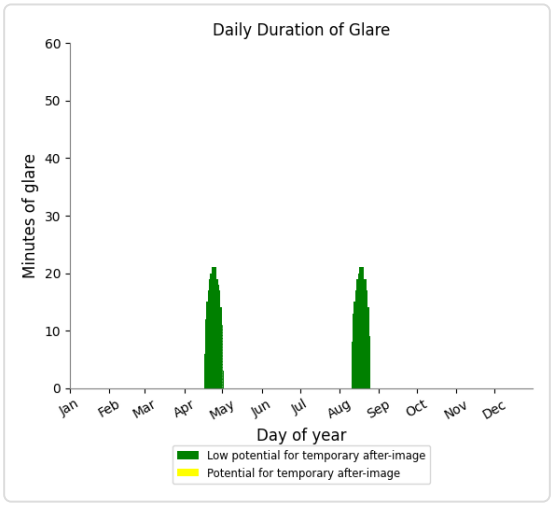


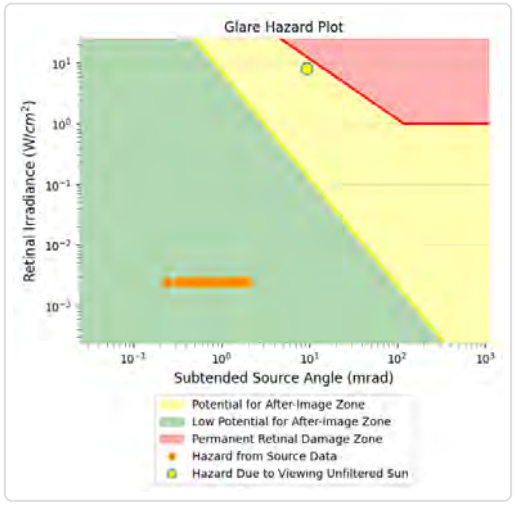
PV array 7 and OP 14

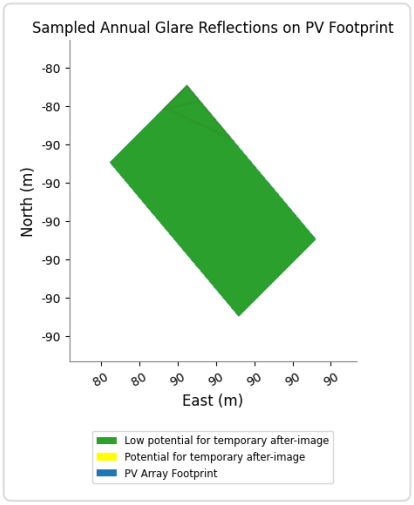
Yellow glare: none

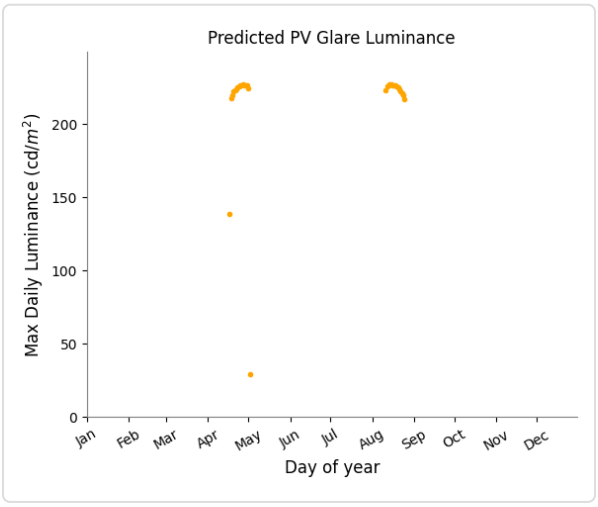
Green glare: 509 min.







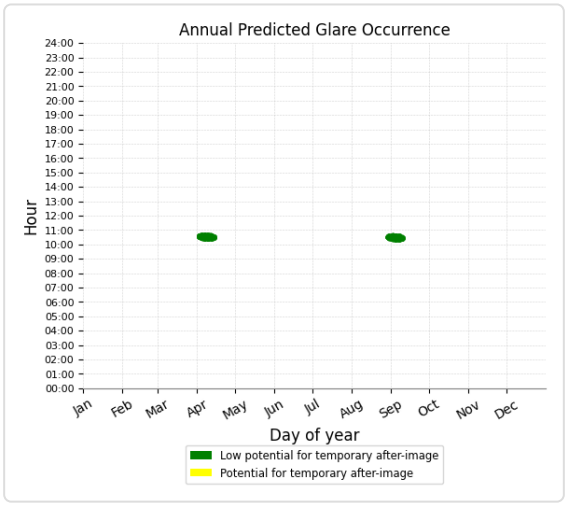


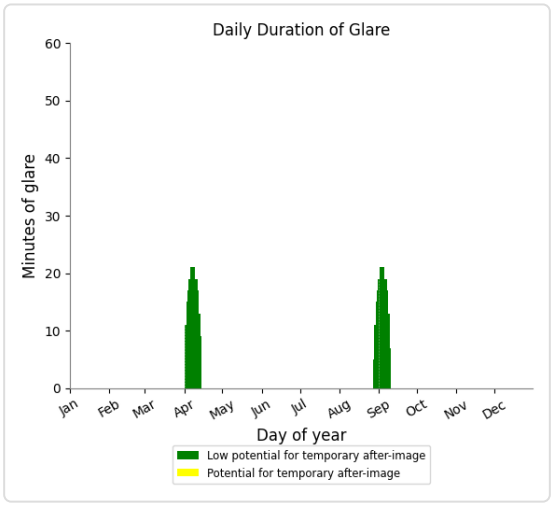


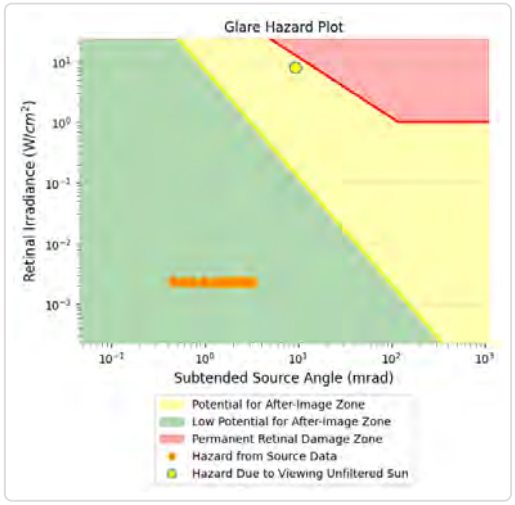
PV array 7 and OP 15

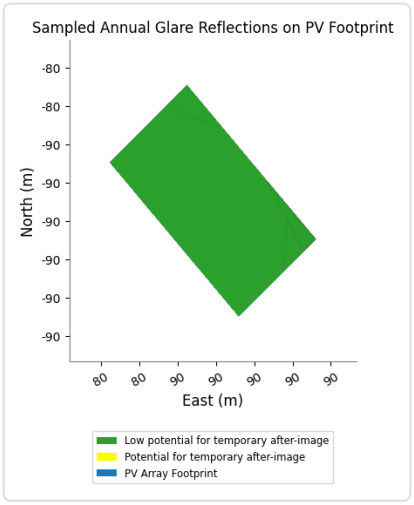
Yellow glare: none

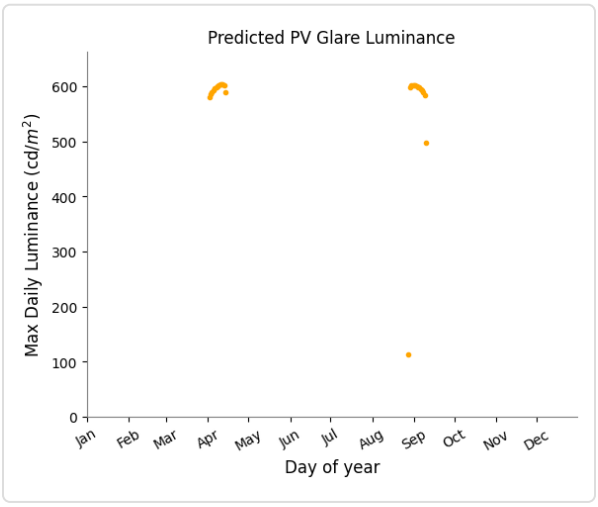
Green glare: 449 min.







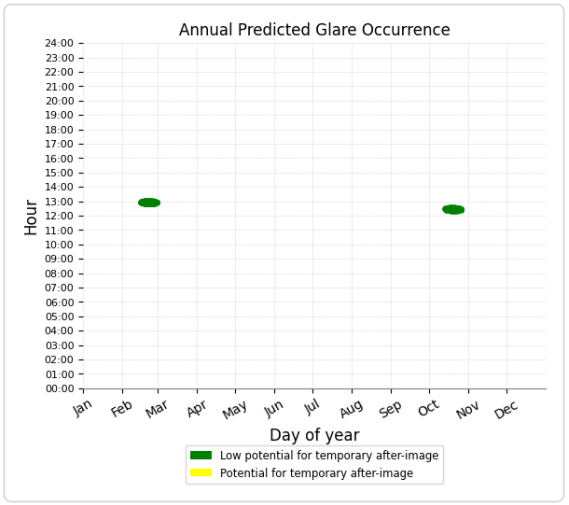


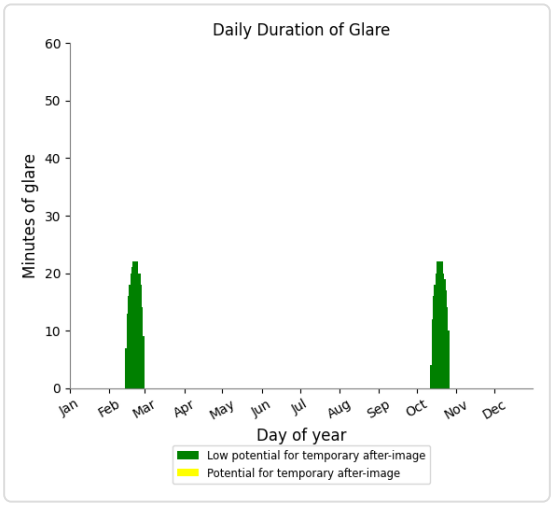


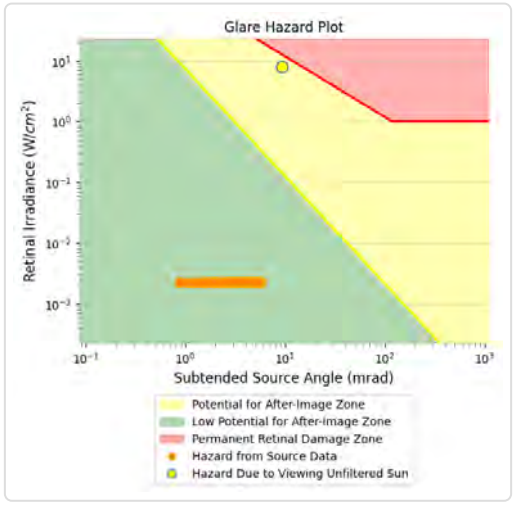
PV array 7 and OP 16

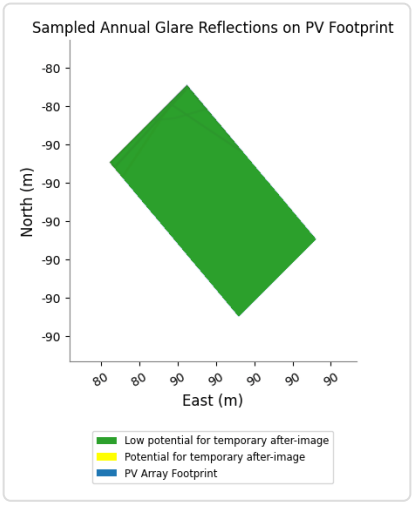
Yellow glare: none

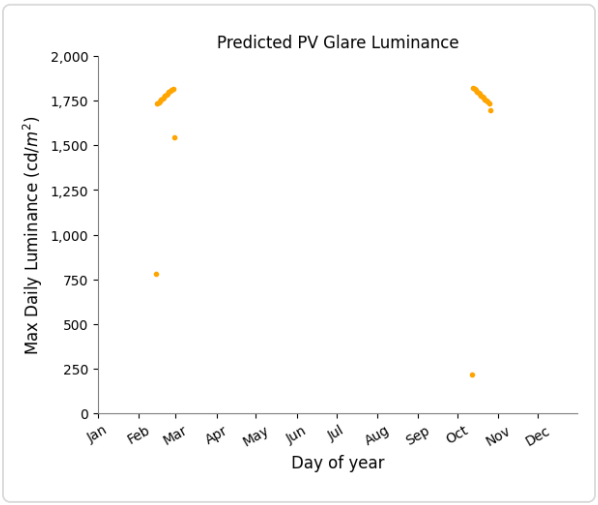
Green glare: 524 min.







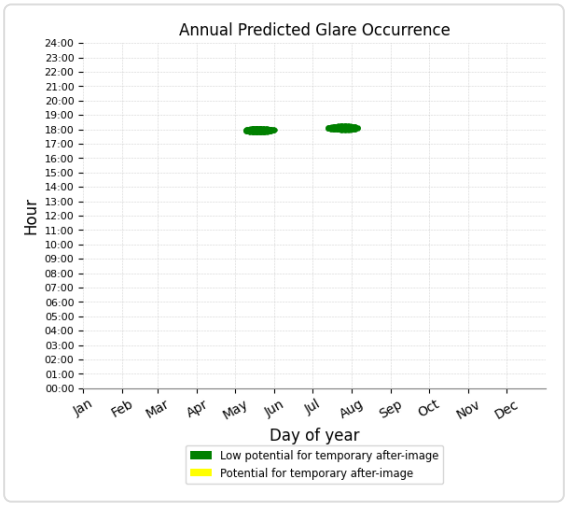


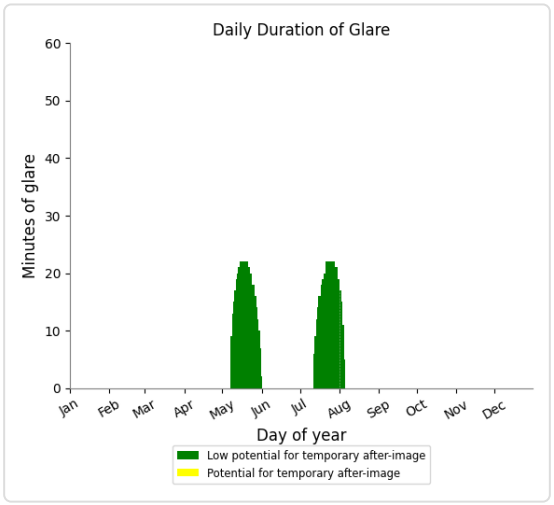


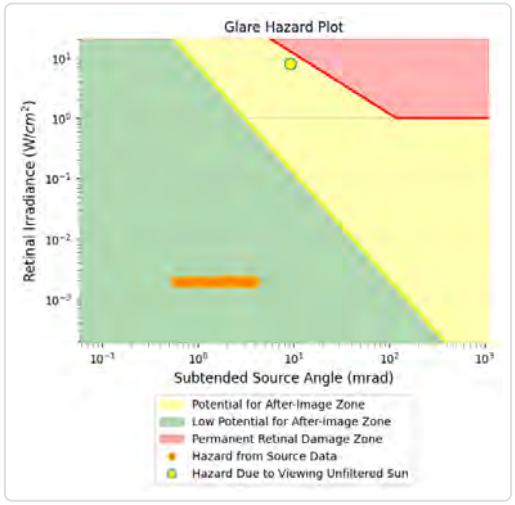
PV array 7 and OP 23

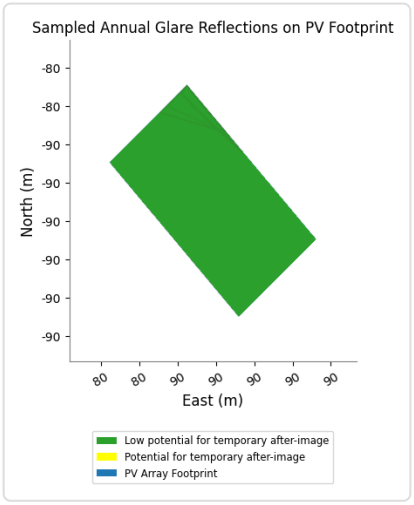
Yellow glare: none

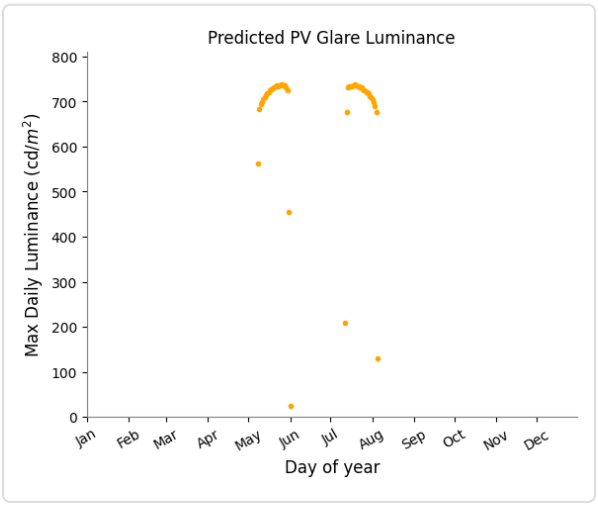
Green glare: 858 min.







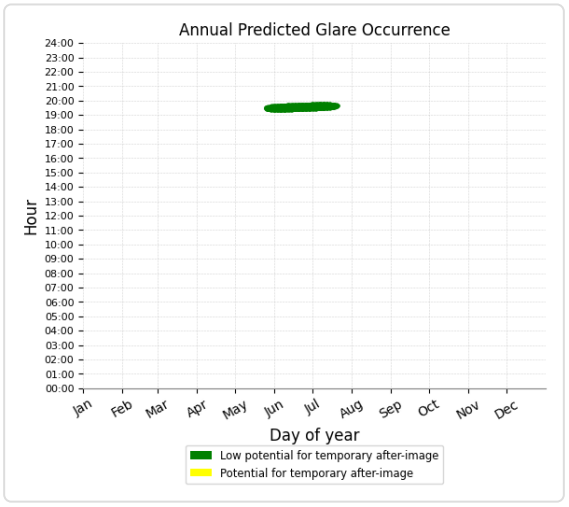


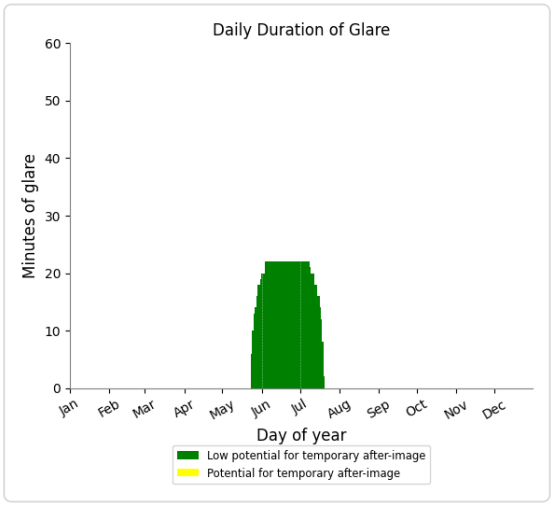


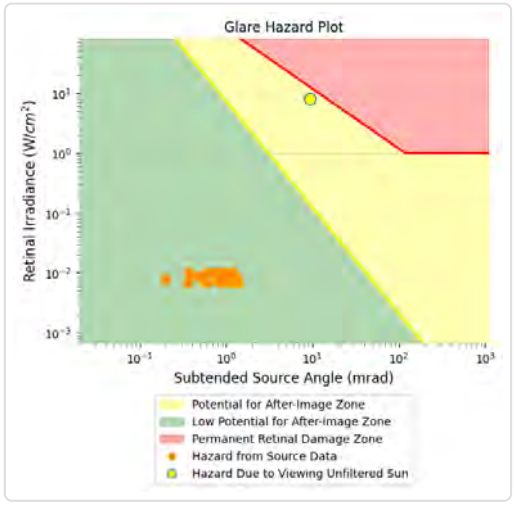
PV array 7 and OP 30

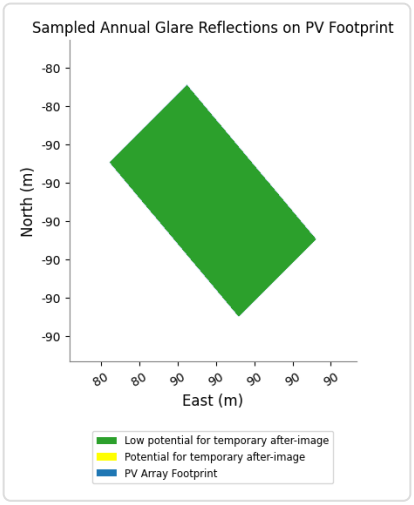
Yellow glare: none

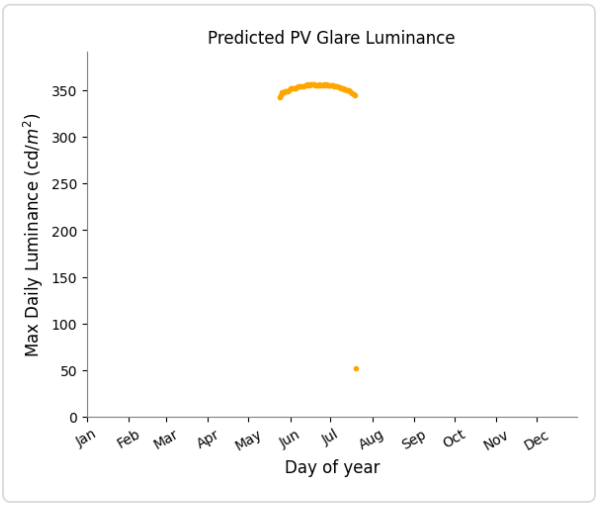
Green glare: 1,129 min.







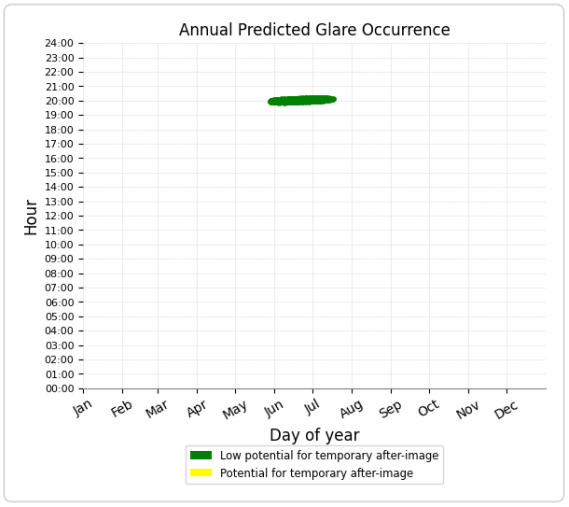


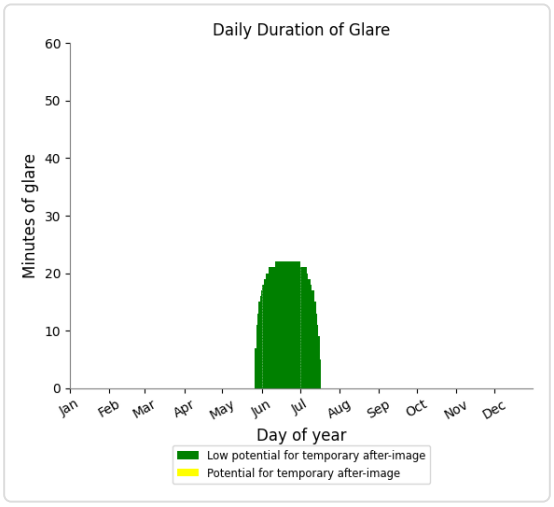


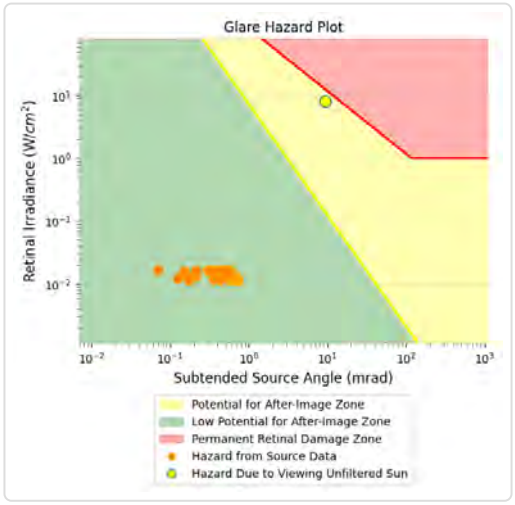
PV array 7 and OP 37

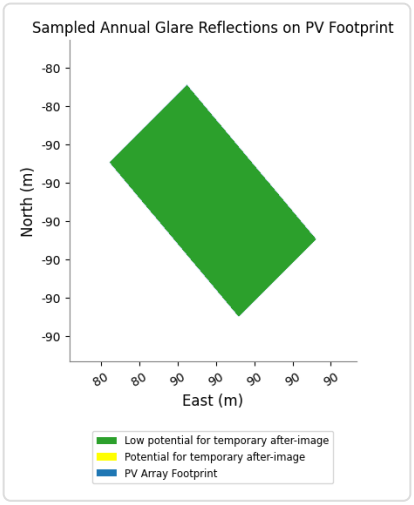
Yellow glare: none

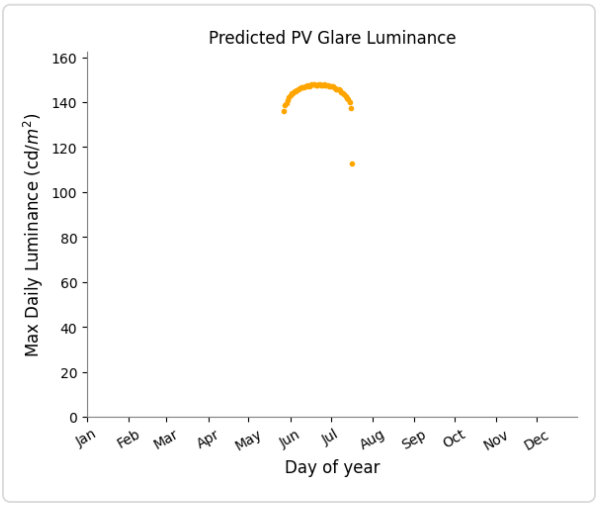
Green glare: 988 min.







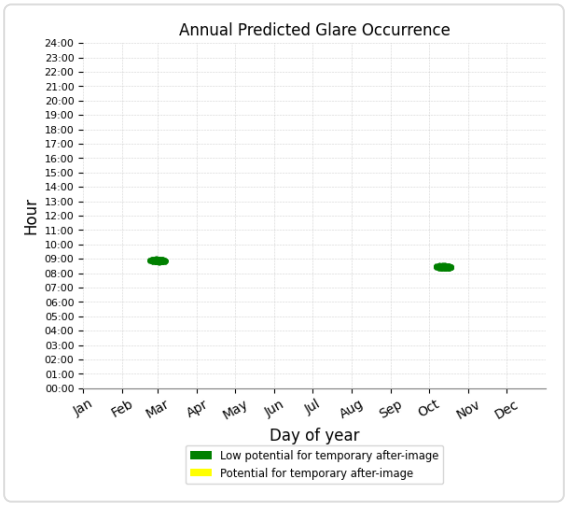


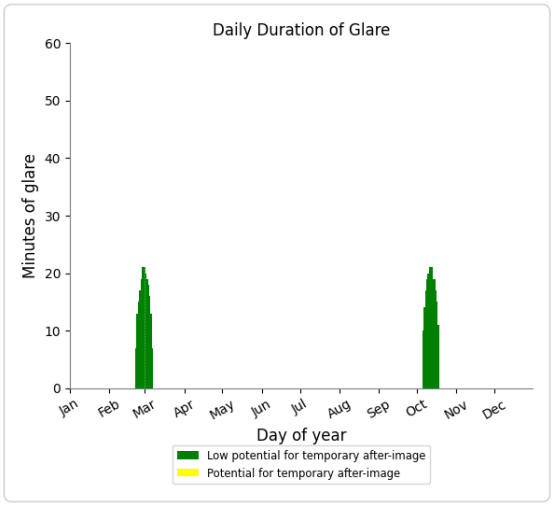


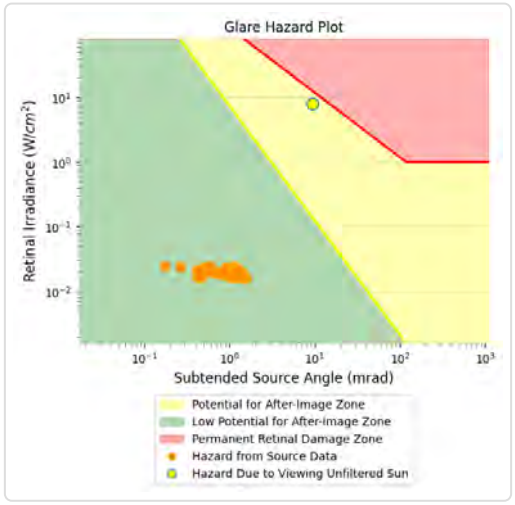
PV array 7 and OP 38

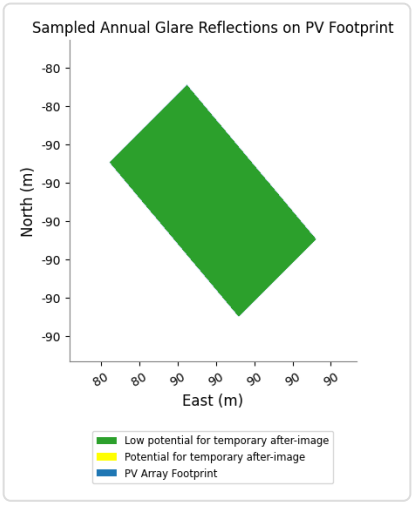
Yellow glare: none

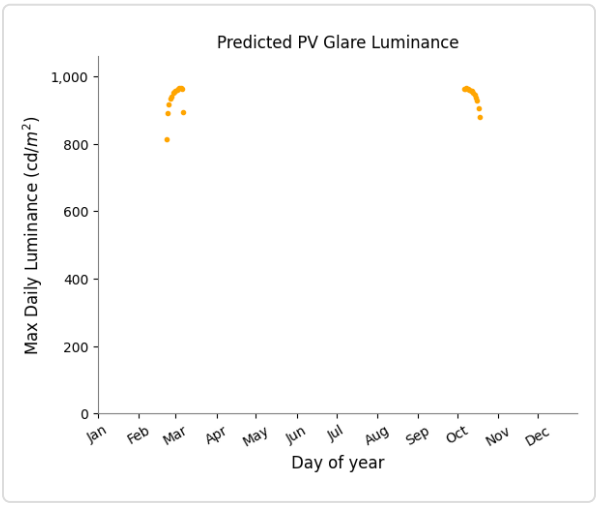
Green glare: 451 min.











PV array 7 and 1-ATCT

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 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 array 7 and OP 21

No glare found

PV array 7 and OP 22

No glare found

PV array 7 and OP 24

No glare found

PV array 7 and OP 25

No glare found

PV array 7 and OP 26

No glare found

PV array 7 and OP 27

No glare found

PV array 7 and OP 28

No glare found

PV array 7 and OP 29

No glare found

PV array 7 and OP 31

No glare found

PV array 7 and OP 32

No glare found

PV array 7 and OP 33

No glare found

PV array 7 and OP 34

No glare found

PV array 7 and OP 35

No glare found

PV array 7 and OP 36

No glare found

PV array 7 and OP 39

No glare found

PV array 7 and OP 40

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.
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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This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.

gia

What we do:

Climate & Resilience
Daylight & Sunlight
Flood Risk & Drainage
Light Obstruction Notices
Measured Surveys
Party Wall & Neighbourly Matters
Rights of Light
Solar PV
Wind Analysis

Where we are:

Belfast
Birmingham
Bristol
Dublin
London
Manchester

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