Predicting eye exposure to UV and blue light to prevent adverse effects to human health

Michele Marro[1], Laurent Moccozet[1], David Vernez[2]

PROBLEM

Overexposure to light can trigger certain eye diseases[1][2]. Although the underlying mechanism is well understood, determining whether the radiation received during a specific exposure period reaches levels that can cause adverse effects on the eyes is challenging.

PROPOSED APPROACH

The approach adopted in this study relies on numerical simulations. By utilizing ray tracing and 3D computer techniques, the radiative interaction between natural and artificial light sources and target surfaces can be accurately simulated.

Triangular meshes are utilized to approximate surfaces with intricate geometry, enabling detailed outcomes. Different scenarios can be created through the use of multiple sources or dynamic target surfaces, specifically tailored to simulate the obstructive and variable nature of the eye's surface.

A human eye model is used to project the received energy on the cornea onto all internal bio-optic elements.

INPUT

1 – TRIANGULAR MESH
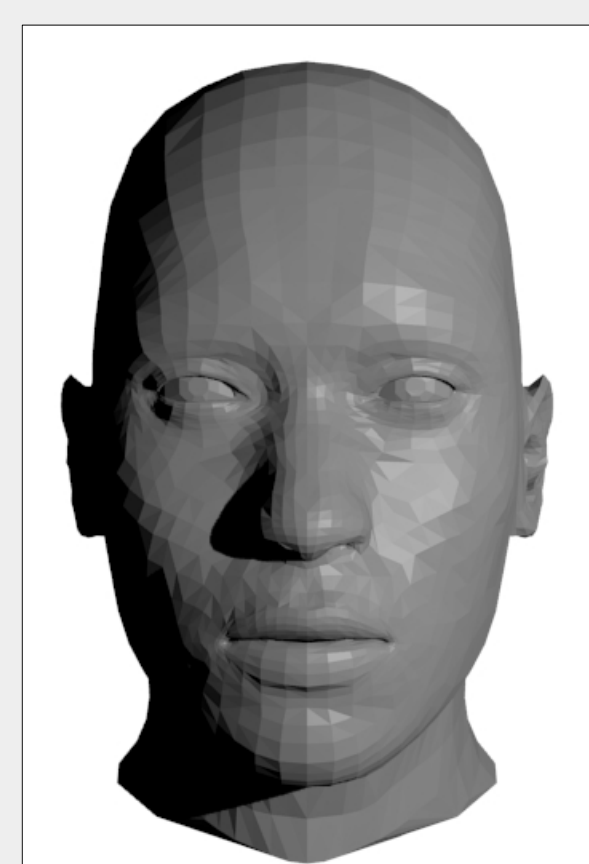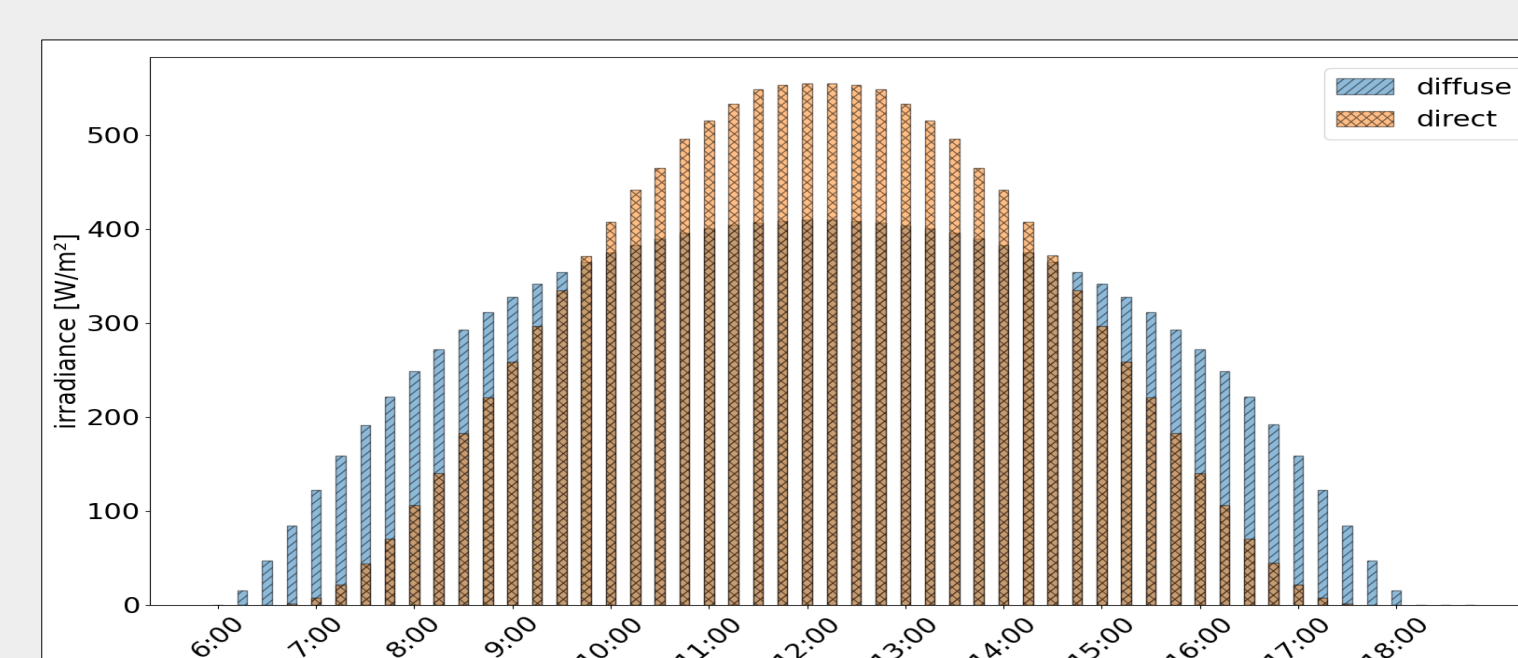
- *ply* or *stl* file format
- composed of points coordinates in space grouped into triangles
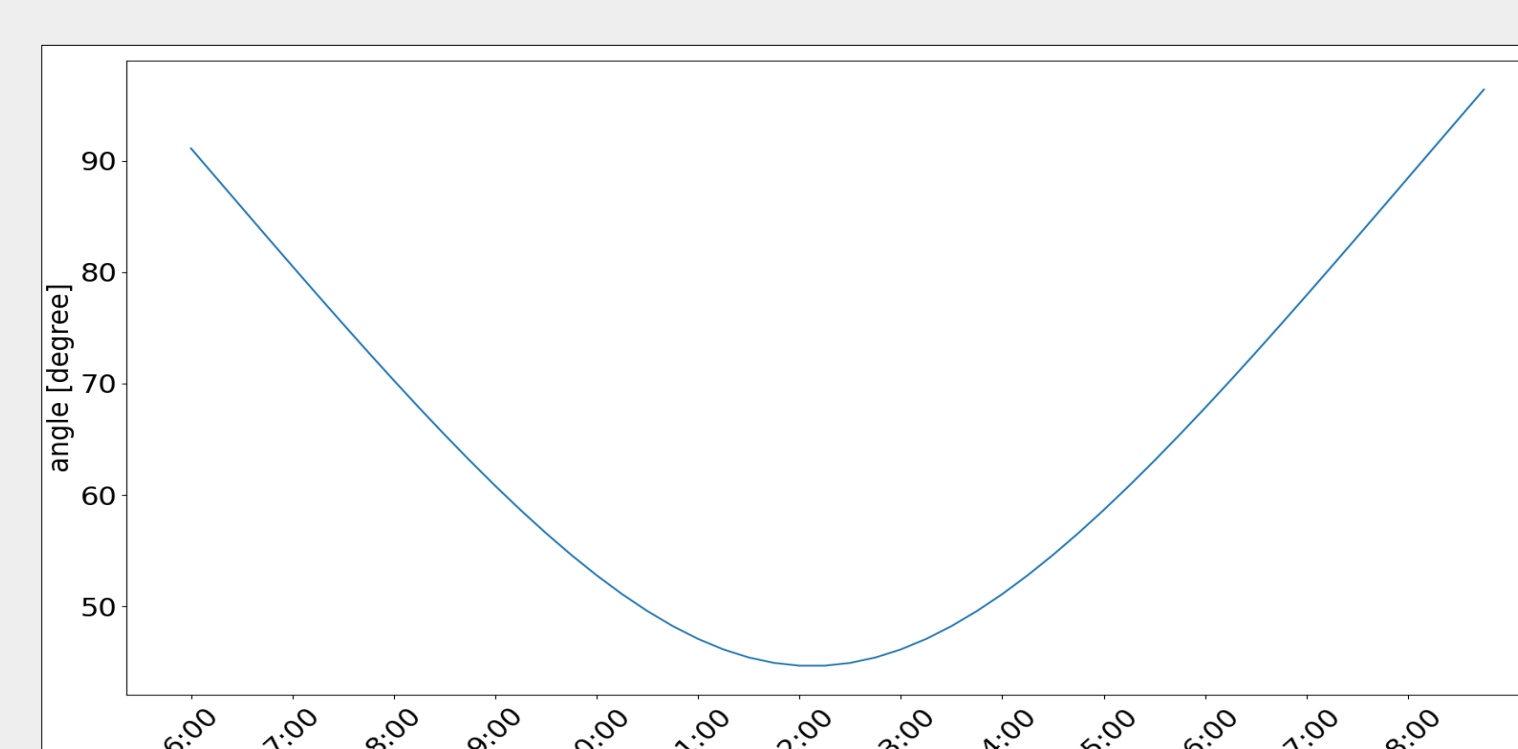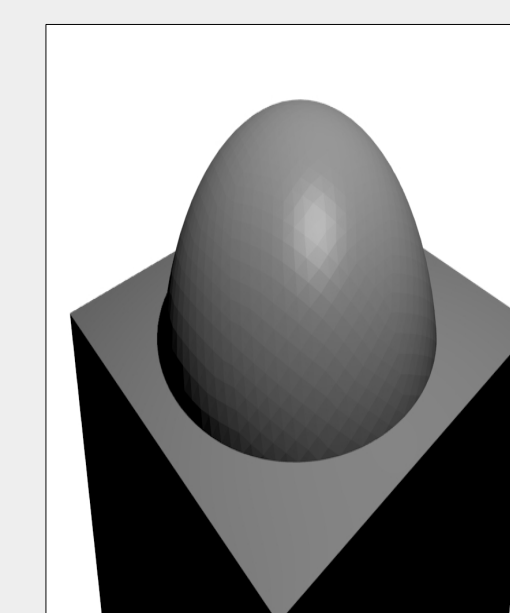- can approximate surfaces with complex geometry
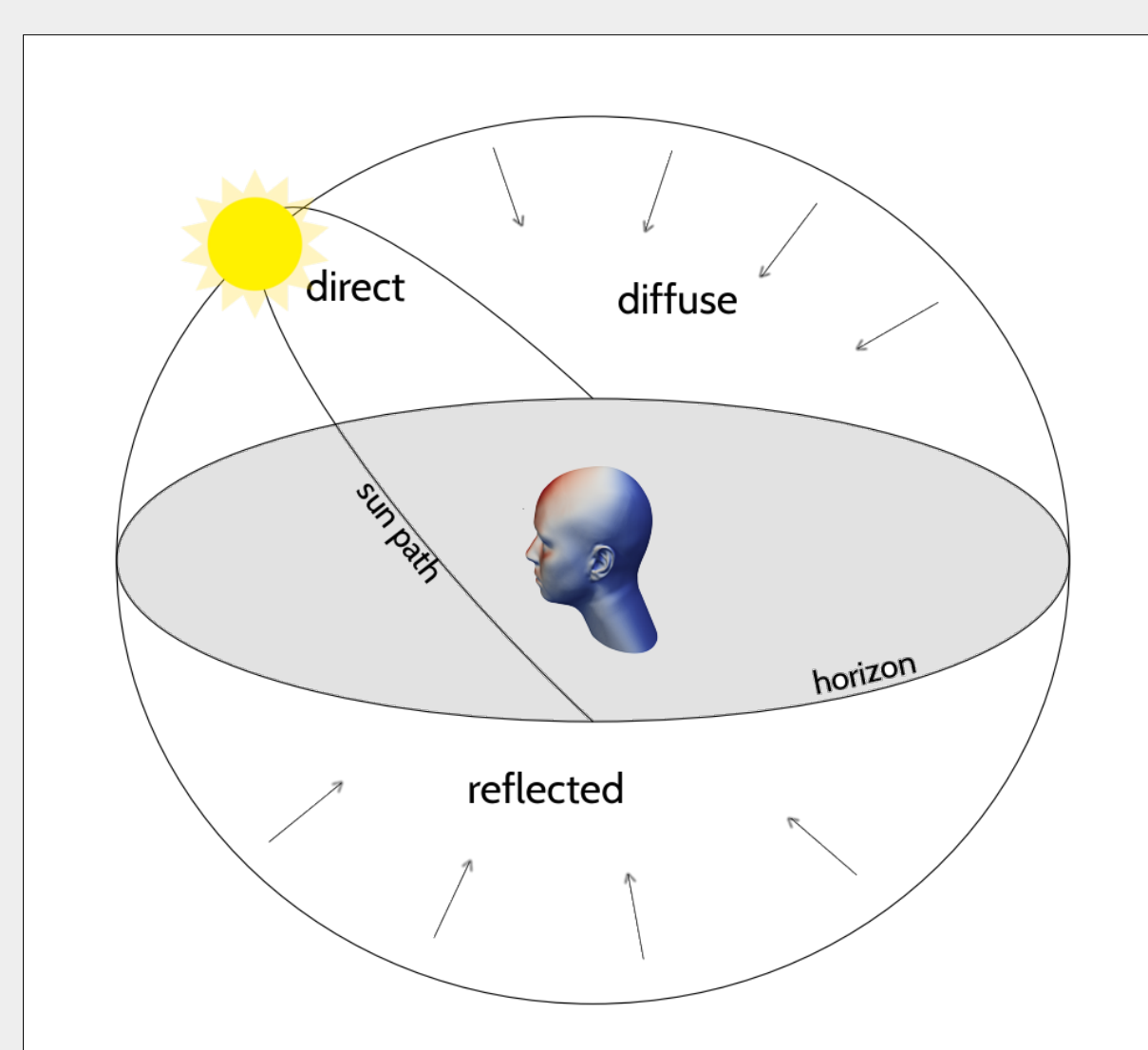
- solar irradiance

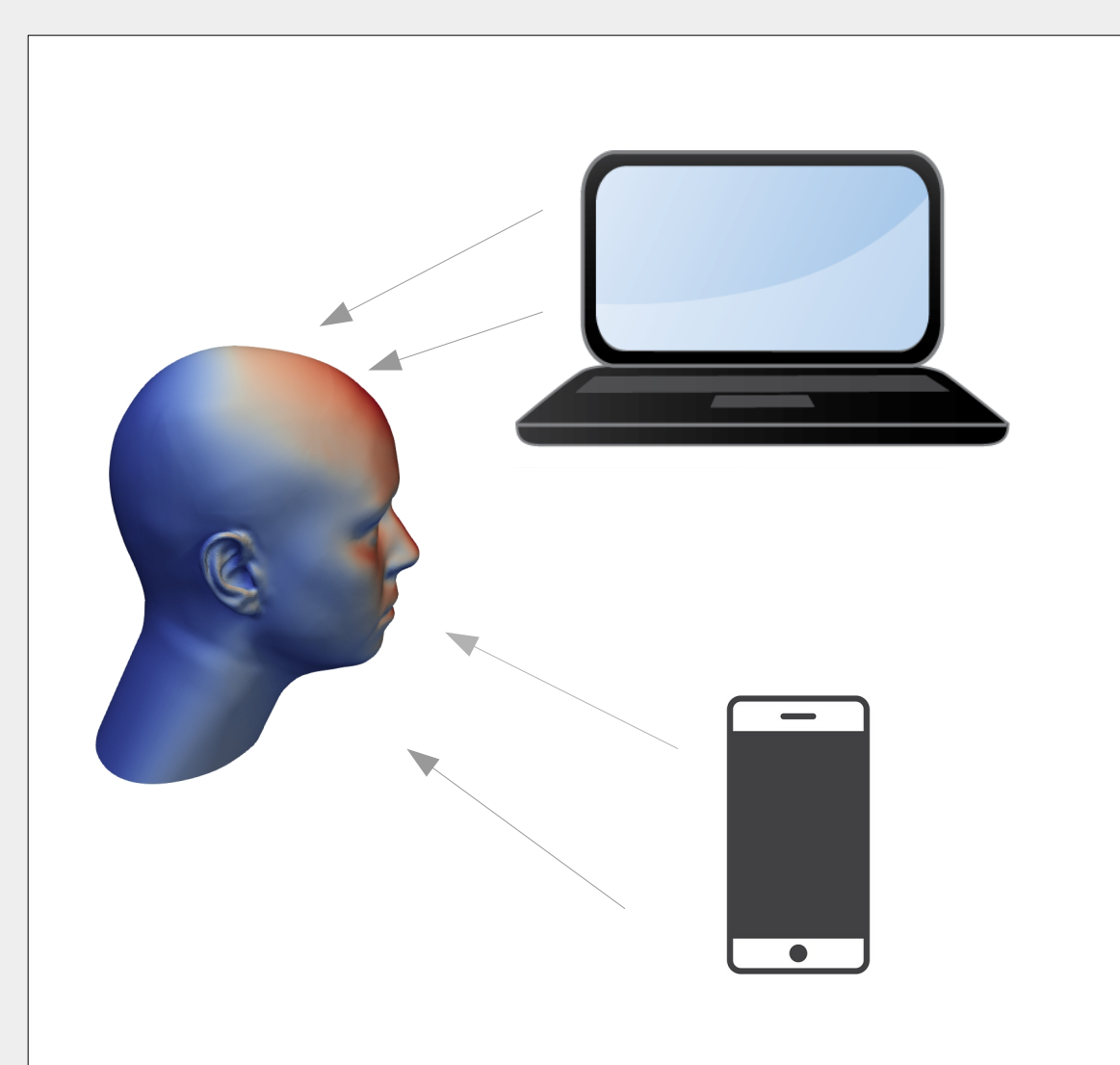- sun coordinates

2 – LIGHT SOURCES

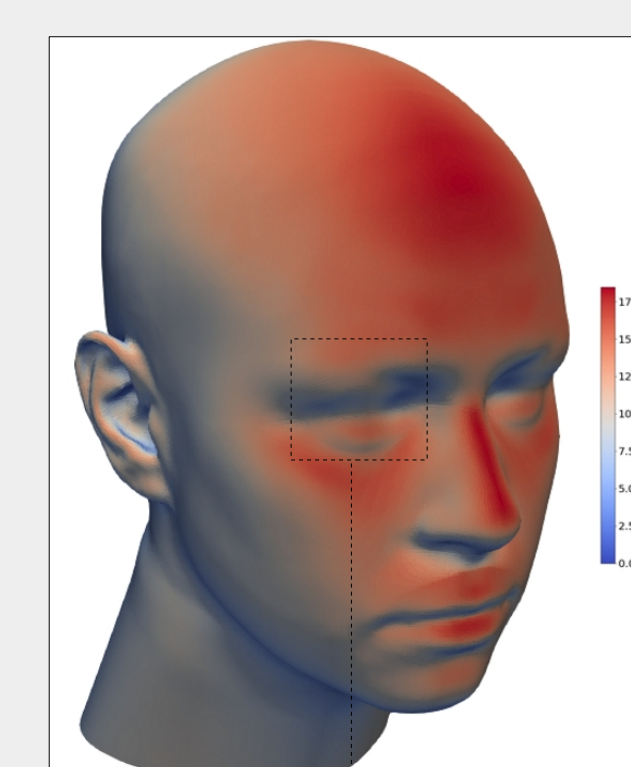- source mesh

EXTERNAL EXPOSURE ASSESSMENT
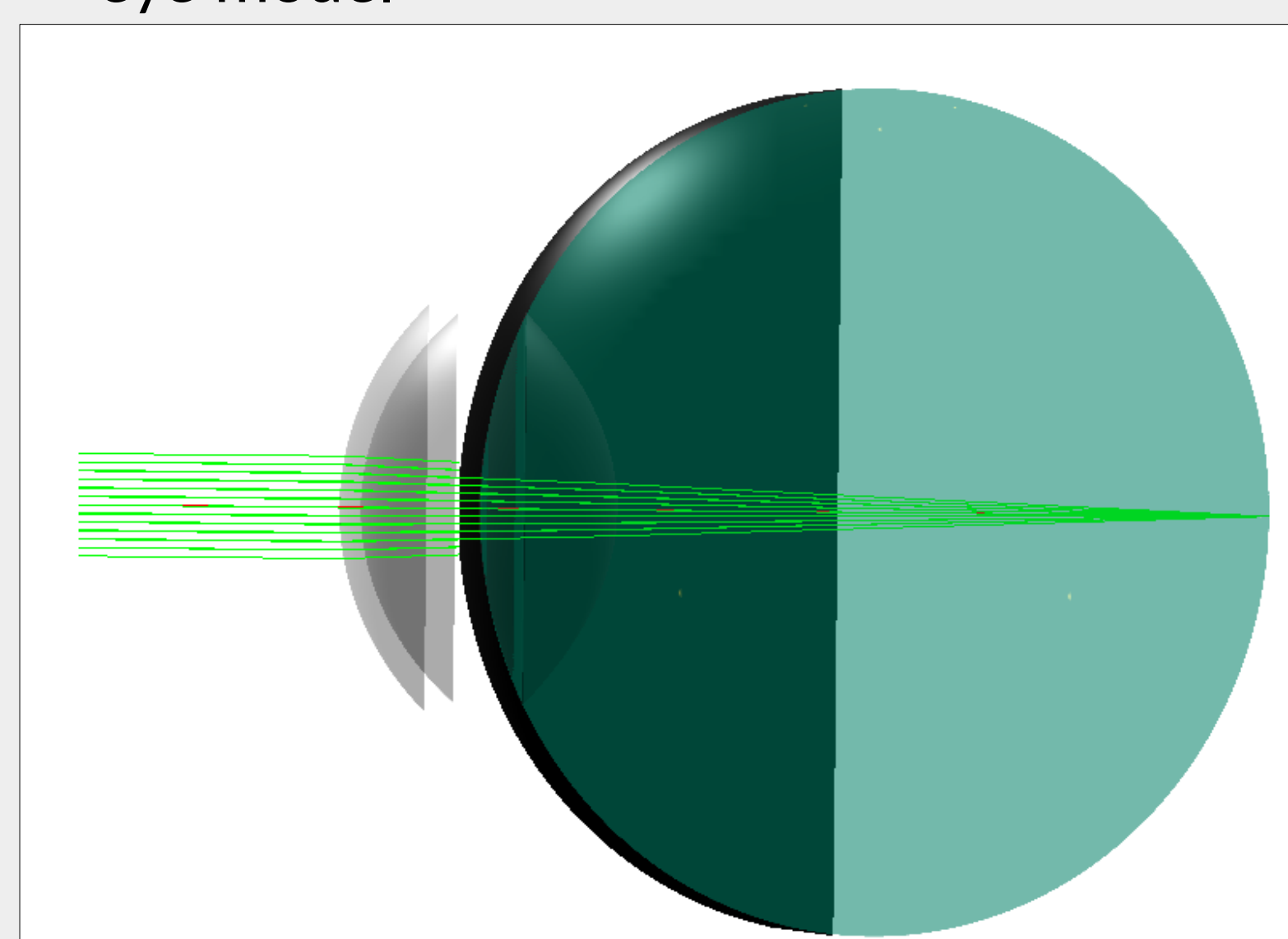
AMBIENT LIGHT


ARTIFICIAL LIGHT

→ TYPICAL OUTPUT

what we need for the next step

INTERNAL EXPOSURE ASSESSMENT

- obtained by using an eye model composed of 4 optical surfaces and a spherical retina
- can accommodate and has a variable pupil
- distribution of irradiance received can be tracked for any optical surface
- example of ray tracing obtained from the eye model

- daily irradiance received by the eye

Retinal Irradiance
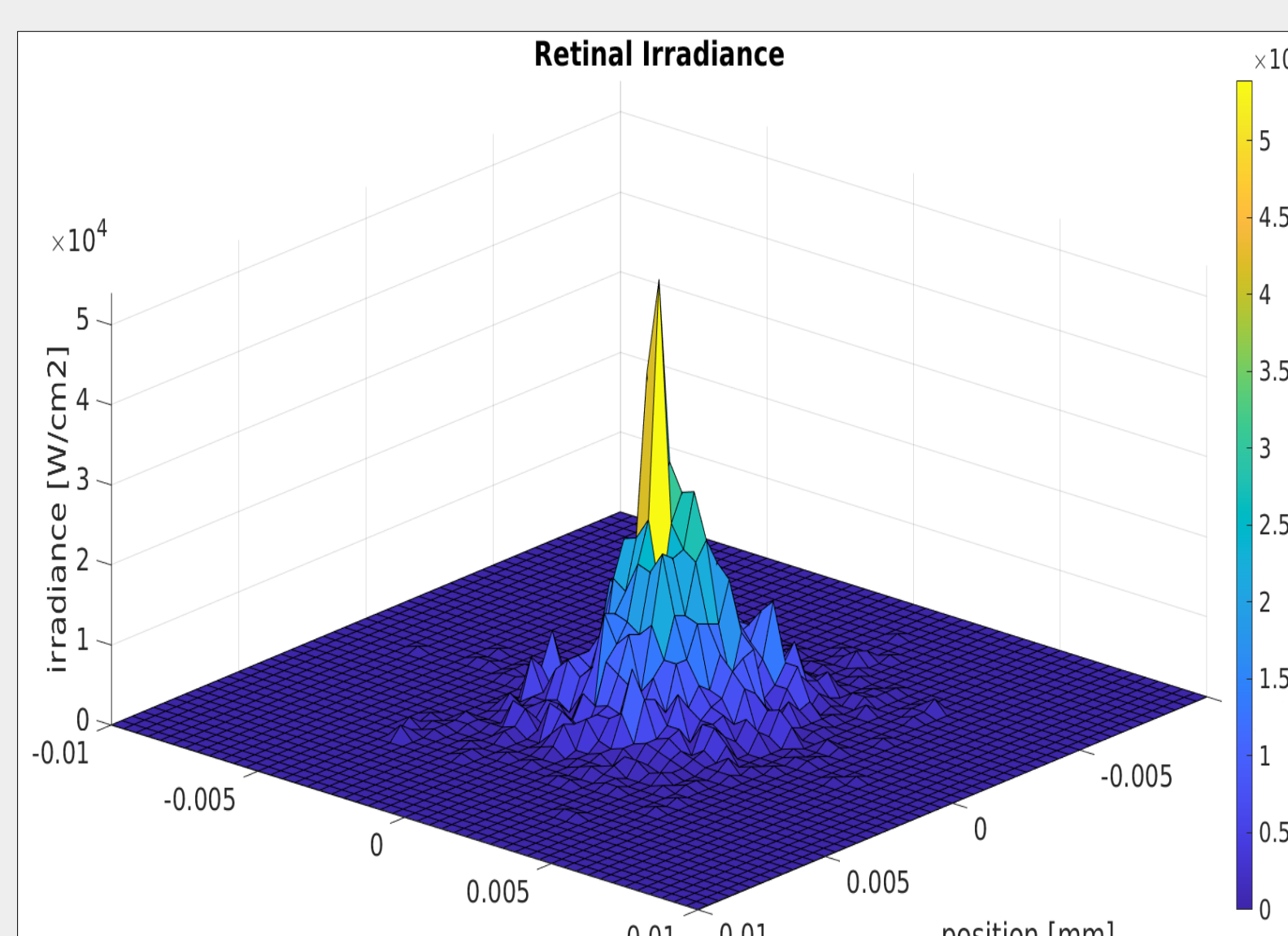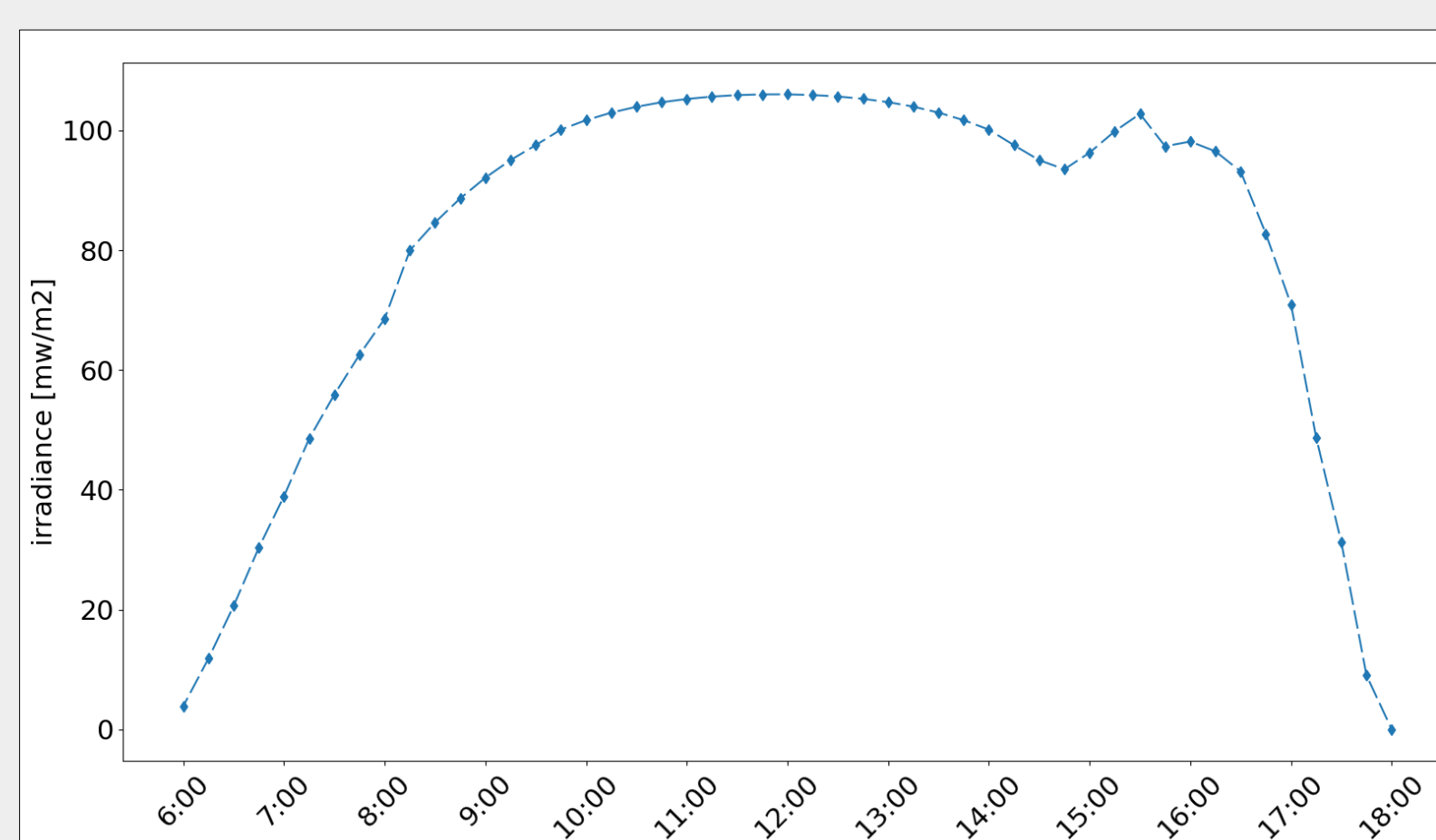
PERSPECTIVES

This method provides a flexible and accurate approach to model light exposure, enabling in-depth examinations of potential risks and impacts on ocular health.
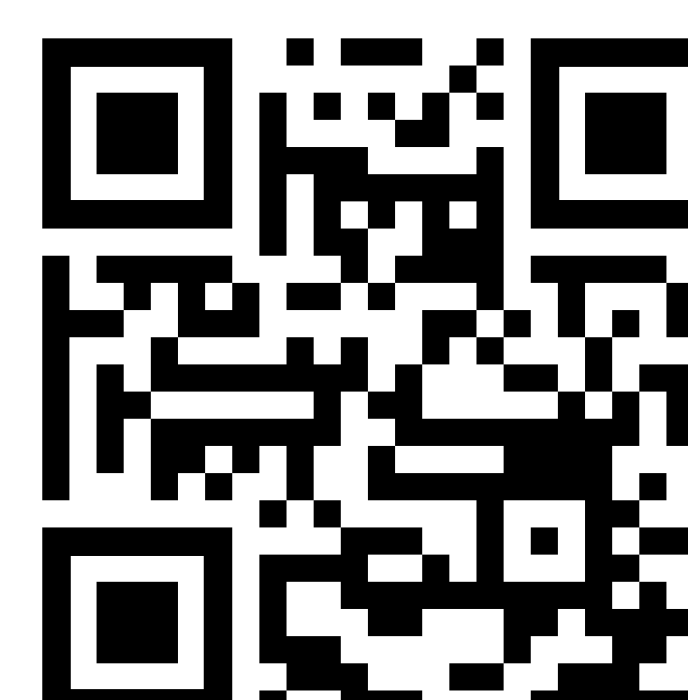
The valuable insights obtained from these simulations contribute to furthering our comprehension of the connection between light exposure and eye diseases. Consequently, this knowledge can guide the development of effective preventive strategies and enhance eye care practices.

ACKNOWLEDGEMENT

Project website

Download the model

AFFILIATION

1 University of Geneva, Computer Science Center, Geneve, Switzerland
2 University of Lausanne, Center for Public Health and Primary Care Medicine (Unisanté), Lausanna, Switzerland

REFERENCES

[1] Yam, Jason C.S. Kwok, Alvin K.H. Ultraviolet light and ocular diseases. International Ophthalmology (2016).
[2] Tsutomu Okuno, "Hazards of solar blue light," Appl. Opt. 47, 2988-2992 (2008)