Observing the Earth as an exoplanet from the Moon

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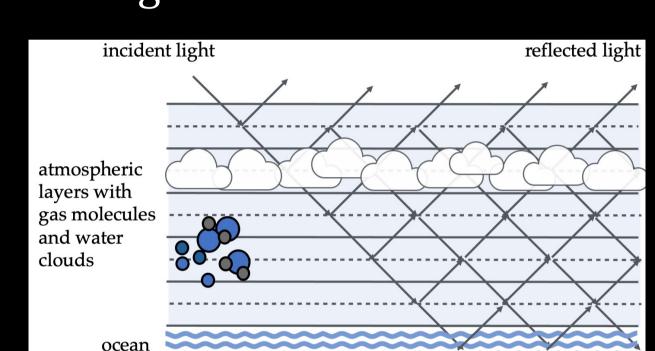
Introduction

What the Earth looks like for a rover on the lunar surface depends on the precise location of the rover, on the position of the Moon with respect to the Earth and the Sun, and on the day and time, as those determine which continents and oceans are illuminated and rotated towards the Moon.

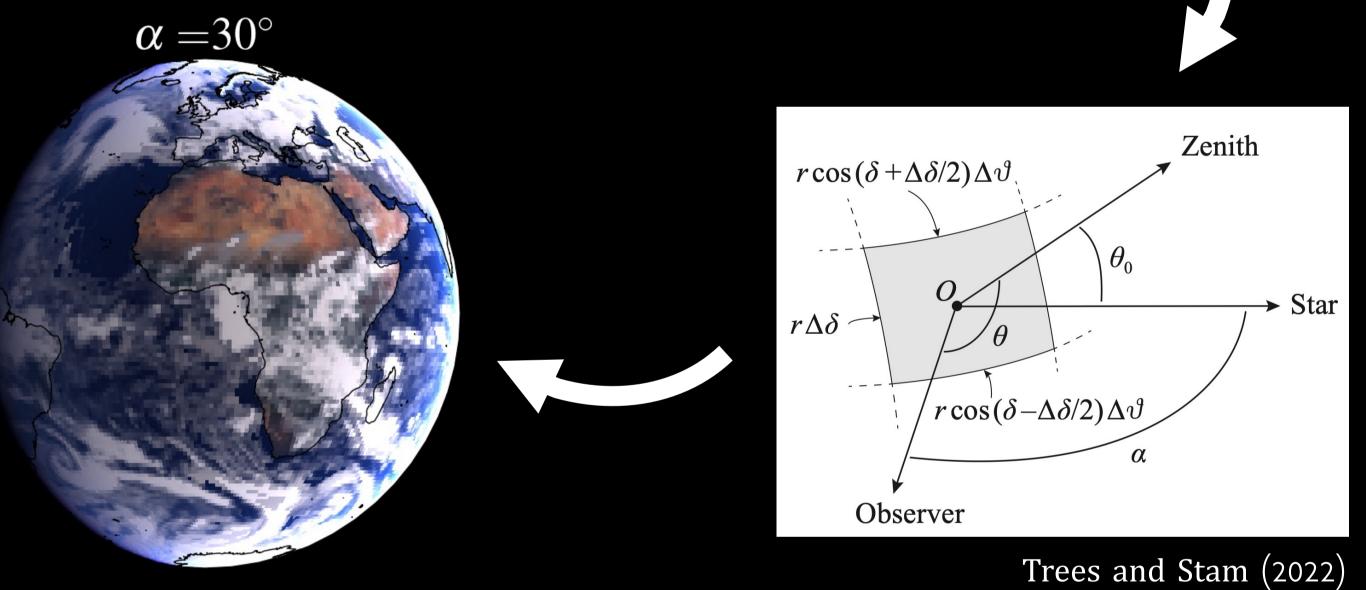
The view of the Earth from the Moon not only allows for inspiring pictures but is also important for observations of the Earth from afar by instruments like LOUPE (Klindžić et al., 2021) on lunar landers or rovers, such as the Lunar Zebro rover(s) in the Moonshot initiative of TU Delft.

Modelling the reflected sunlight by the Earth

- 1. First, we do radiative transfer simulations of sunlight reflected by the local atmosphere-surface. Using a doubling adding program (De Haan et al. 1987, Trees and Stam 2022), we generate Lookup Tables (LUTs) of the reflected total and polarized light for various
- solar zenith angles
- observer zenith angles
- azimuth angles
- wavelengths
- surface reflectivities (ocean or dry)
- cloud types (low/high/thick/thin)

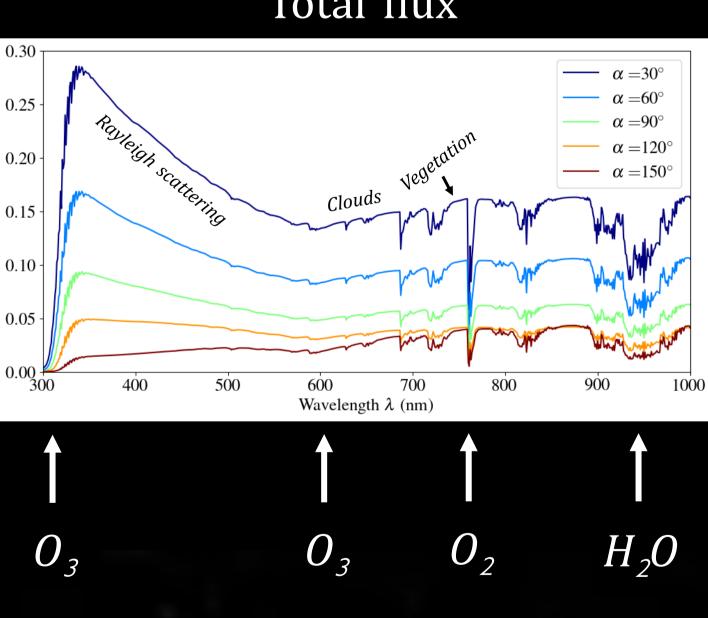


2. Then, we interpolate between the LUTs to obtain the locally reflected light towards the observer for every latitude-longitude pixel of the Earth model.

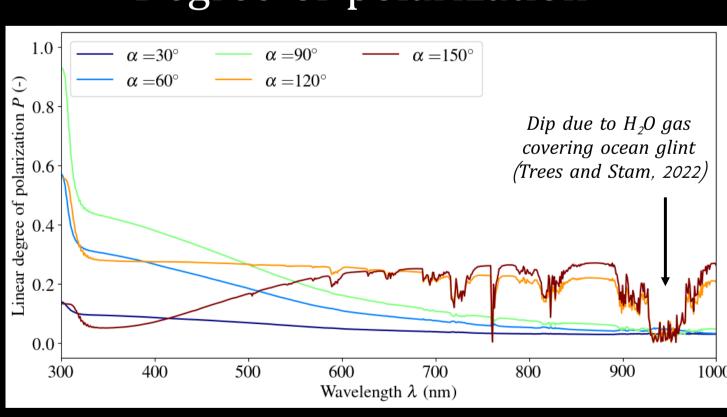


3. Finally, we simulate the Earth's reflectance spectrum by integrating the results over the planetary disk back to one pixel.

Total flux



Degree of polarization



The shape of the degree of polarization spectrum depends strongly on phase angle!

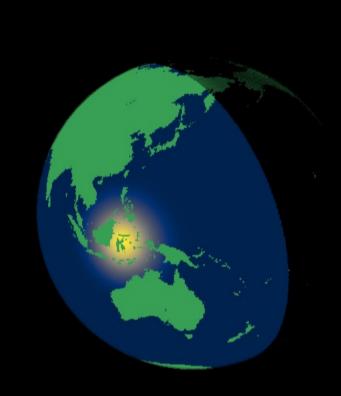
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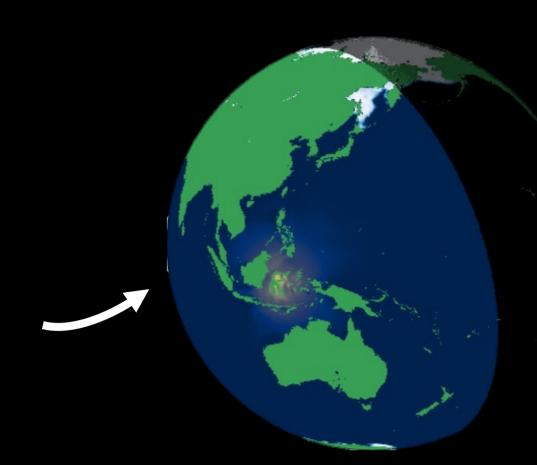
Observation strategy from the Moon

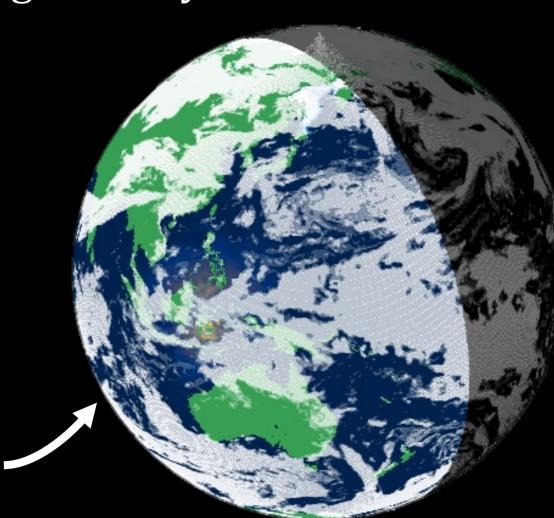
We build a versatile tool that quickly predicts what the Earth looks like from a given location on the Moon, at a given day and time.

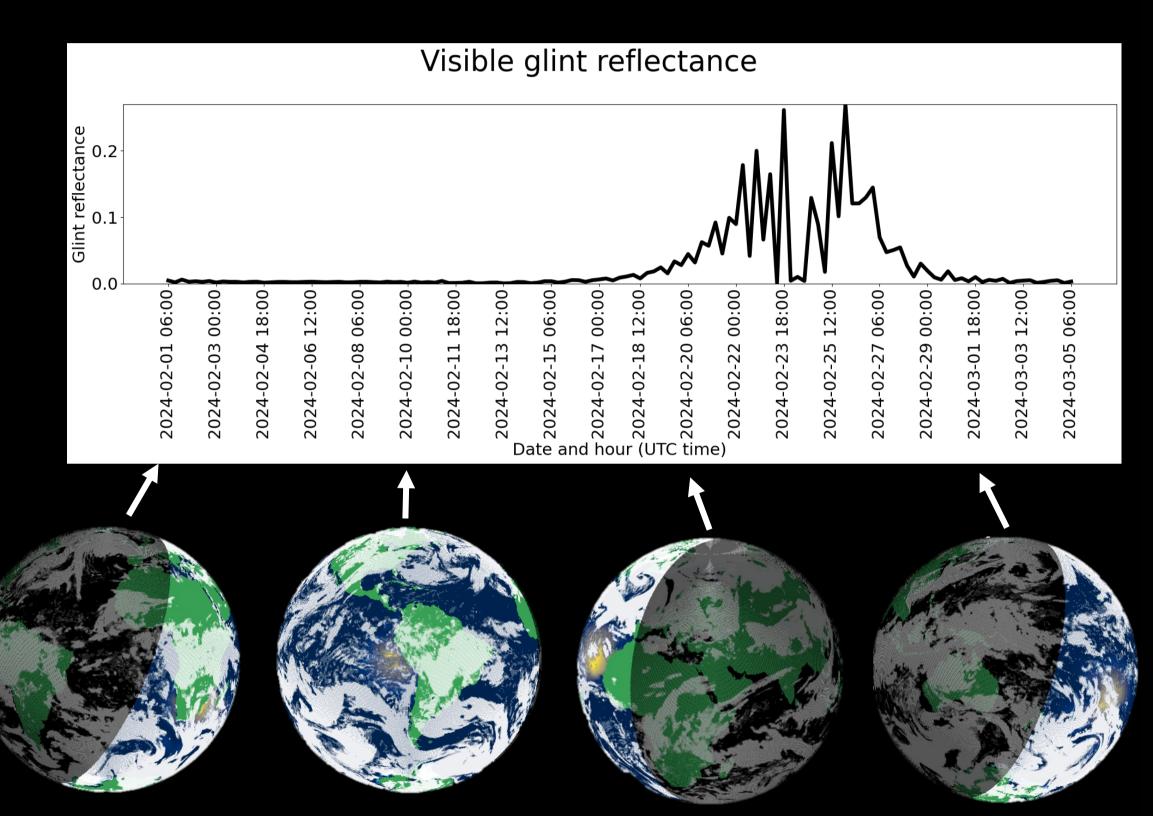
The main variables to consider are:

- Moon-Earth distance
- Moon latitude and longitude
- Phase angle
- Wind speed
- Cloud cover





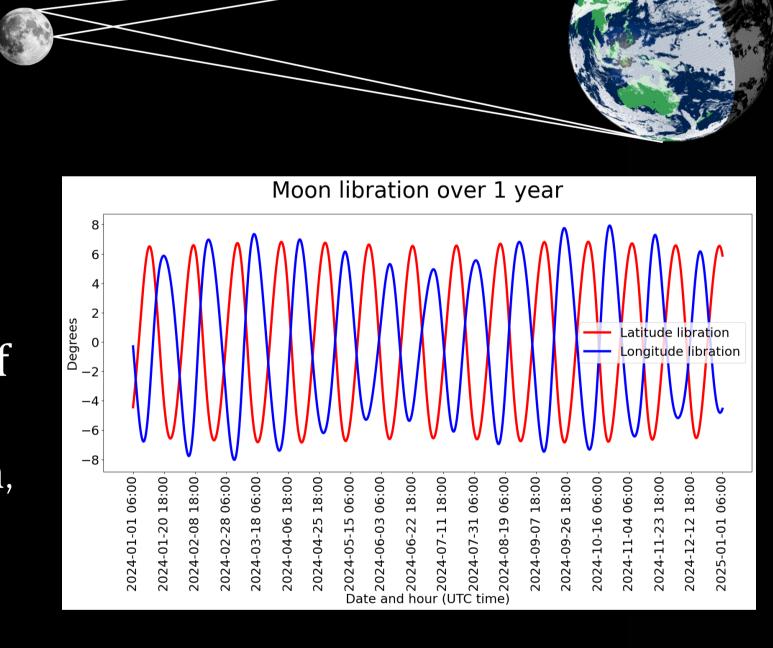




Next step: determine optimal position on Moon's surface

Different positions on the Moon's surface imply different possible measurement windows and different visible surfaces.

Different factors need to be taken into account: libration of the Moon, surface properties, regions illuminated by the Sun, and the seasonal variation.



References

Klindžić et al. (2021), Philos. Trans. R. Soc. London. A, 379, 20190577 De Haan et al. (1987), A&A, 183, 371 Trees and Stam (2022), A&A, 664, A172



