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SkyPole - A bio-inspired method to locate the north celestial pole



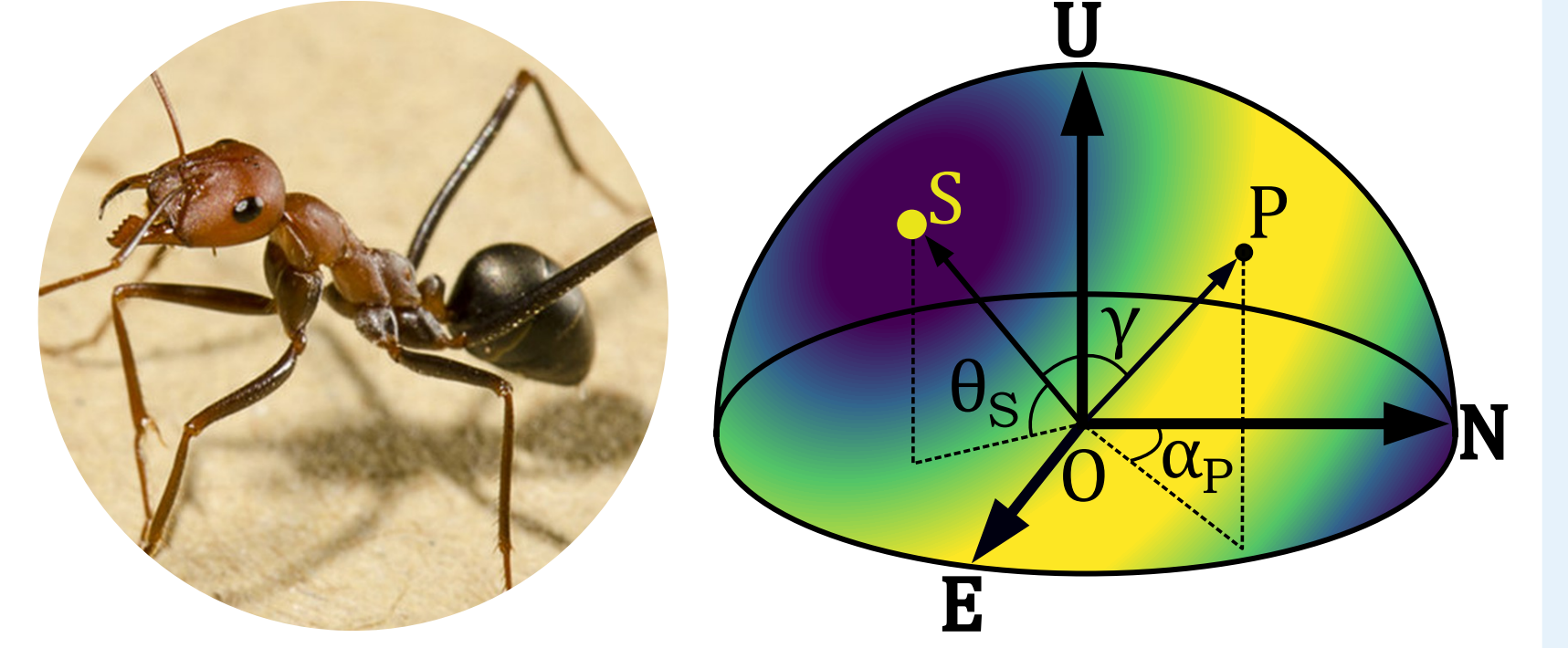
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Animal Navigation

Polarization vision

- Insects such as *Cataglyphis* desert ants use **skylight polarization to navigate** [1]
- Skylight polarization can be described by its angle and degree of linear polarization (**AoLP** and **DoLP**), modeled from **Rayleigh single scattering model** [2]



Celestial rotation

- Migratory birds such as homing pigeons use the **celestial rotation as a reference for calibrating their magnetic compass** [3] [4]
- Celestial rotation helps finding the **north celestial pole**, giving access to **geographical north bearing and latitude** [5]
- Celestial rotation can be observed **during night or daytime** [6]

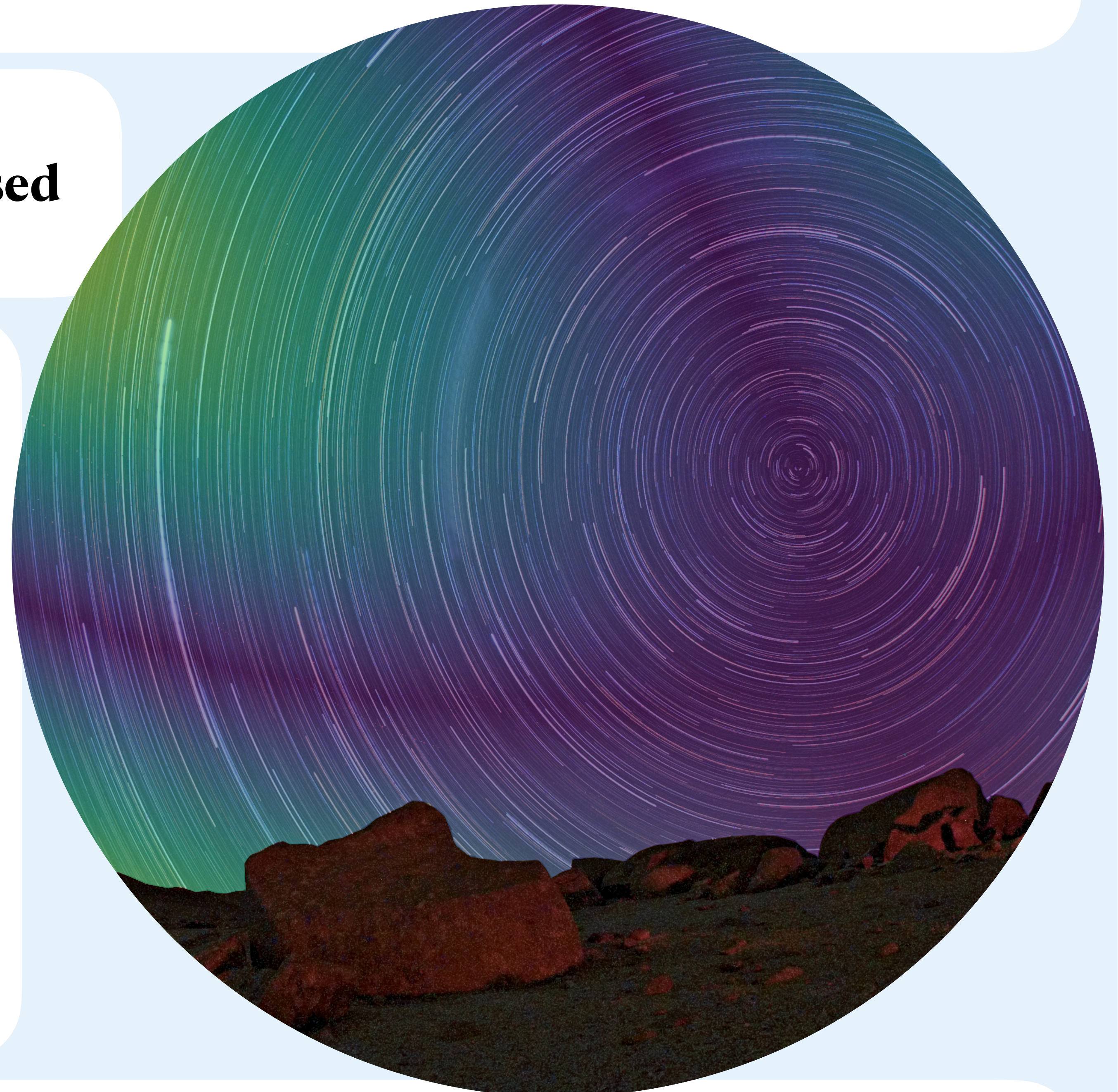
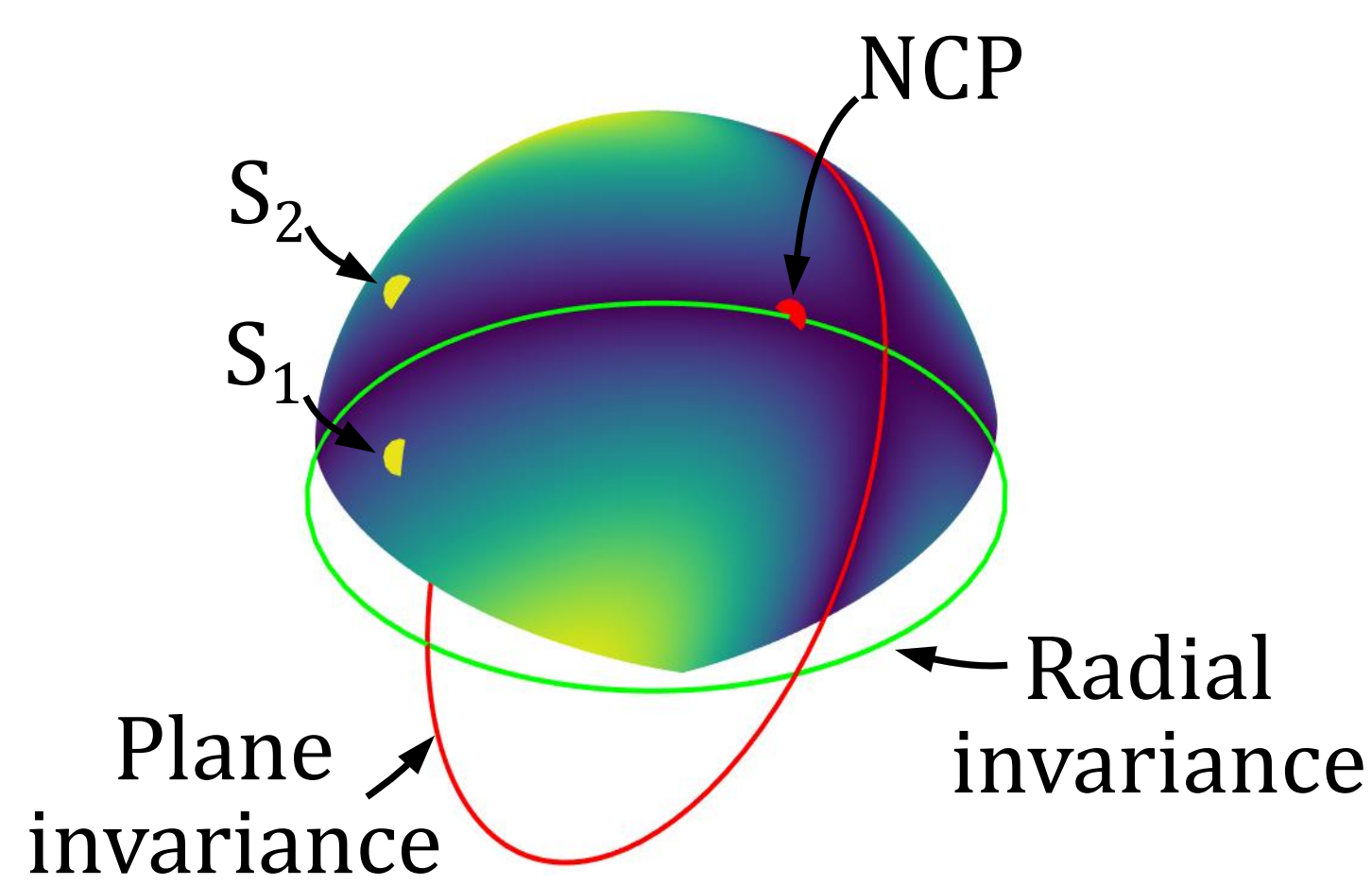


Question

How could the moving skylight polarization pattern be used to locate the north celestial pole?

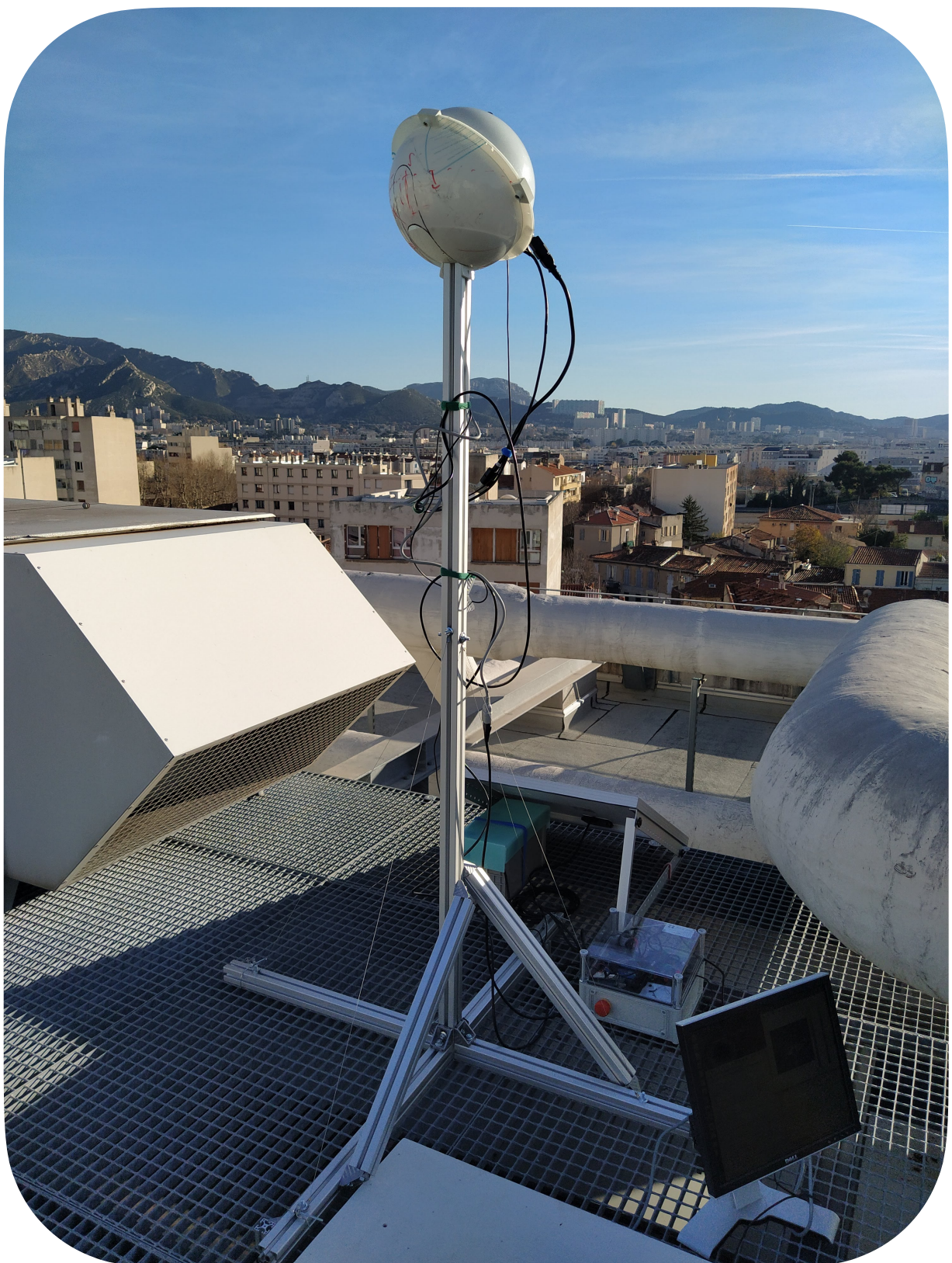
Method

- DoLP has **plane and radial symmetries**
- Due to those symmetries, comparing DoLP at two moments leads to **radial and plane invariance axes**
- **North celestial pole (NCP) is always located on the radial invariance axis**

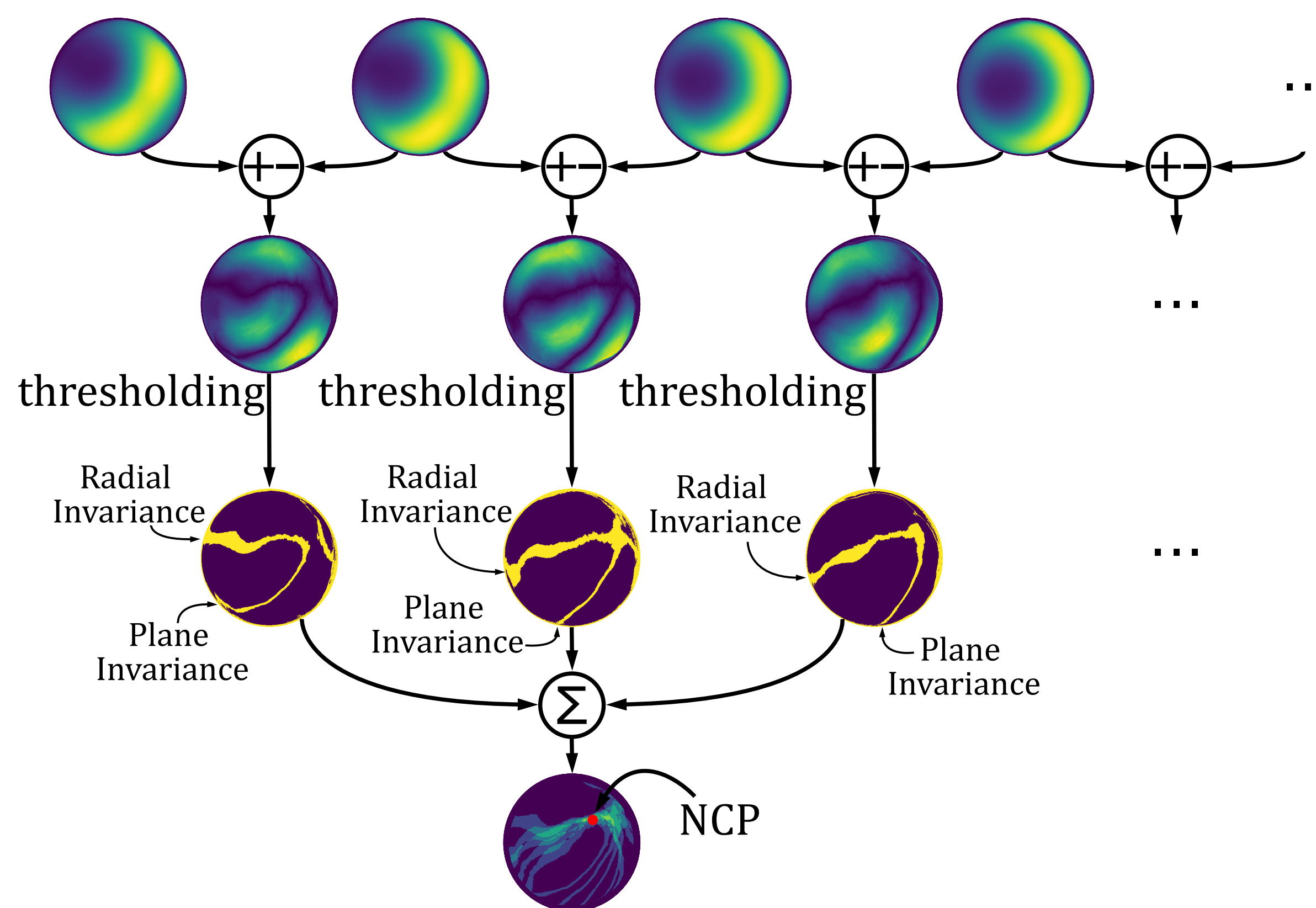


Results

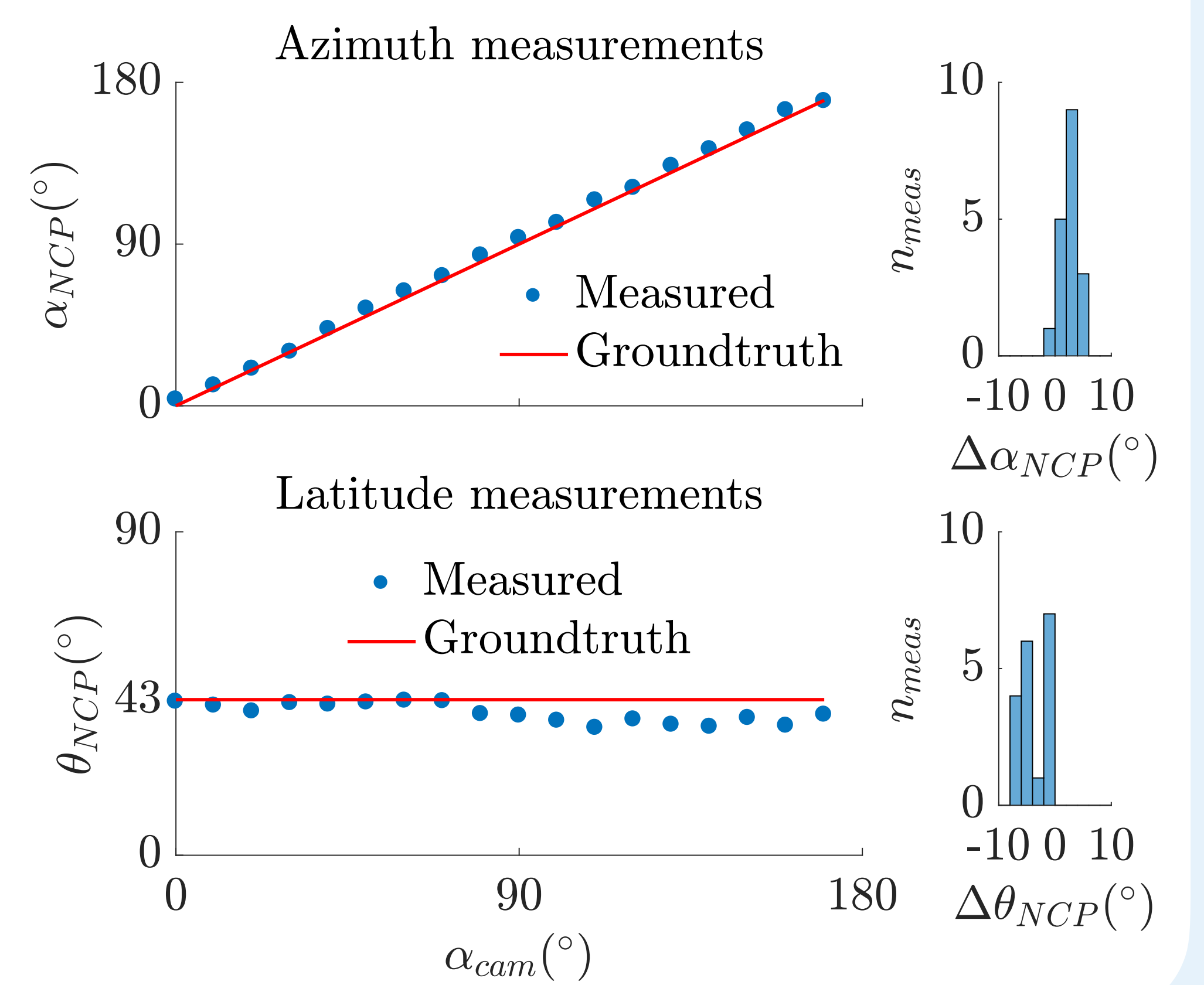
Measurement device



Method implemented on real polarimetric images



Measured north celestial pole's coordinates



Conclusion

The proposed method is, to our knowledge, the **only method providing global navigation cues based only on sky polarization images**. No ephemeris, time or GPS signal are required, and its simplicity results in **low computational cost and resources**.

References [1] Wehner, Harvard University Press, 2020
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Image References

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