Analysis of Scattering Angle Sampling by Multi-Angle Imaging Polarimeters for Different Orbit Geometries

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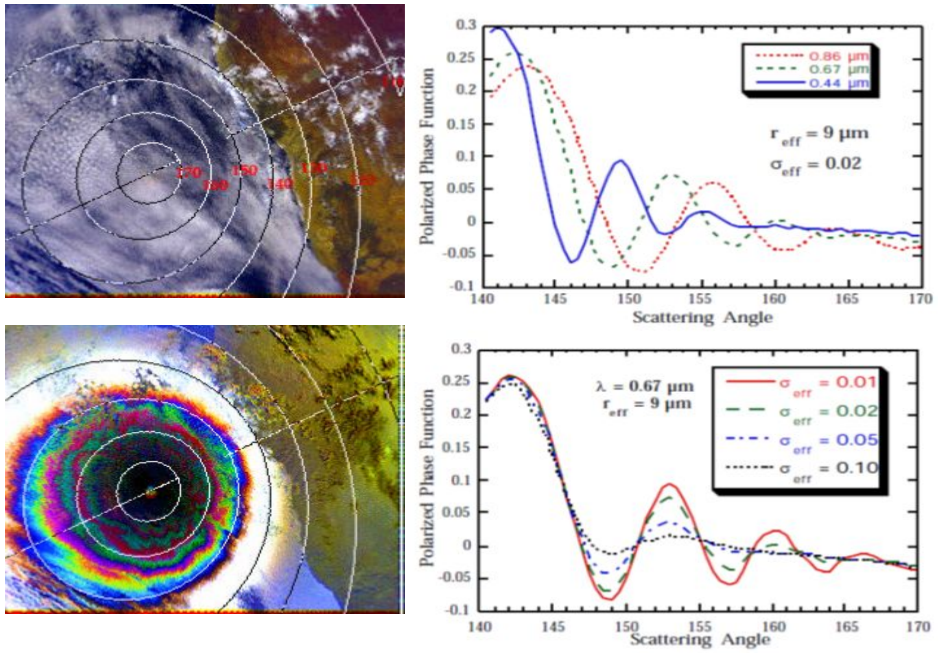
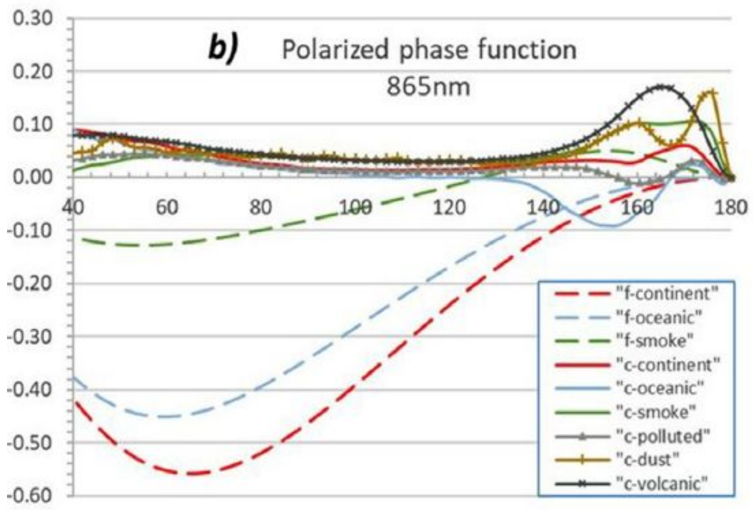
Introduction/Background

- Motivated by the 2017-2027 Decadal Survey for Earth Science and Applications from Space (ESAS 2017), Aerosols and Clouds, Convection, and Precipitation (A-CCP) studies are being conducted to develop new observation strategies for future missions.
- Precessing orbits (i.e., with a shifting local equator crossing time) offer unique opportunities to observe the diurnal variation in clouds and aerosols, but may be unfamiliar to a community used to sun-synchronous polar orbiter observations



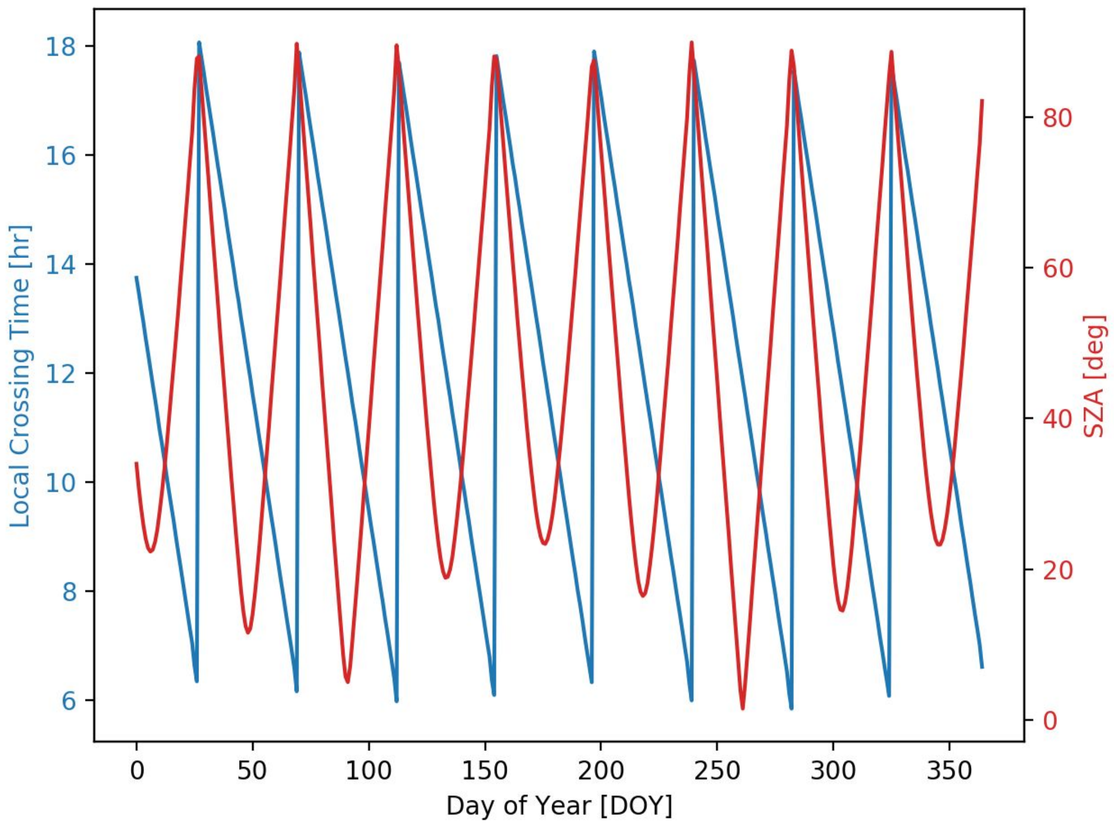
Information about cloud thermodynamic phase can be reached using angular signature (behavior/responses), mainly in the rainbow region (Source: Bréon et al. [3])



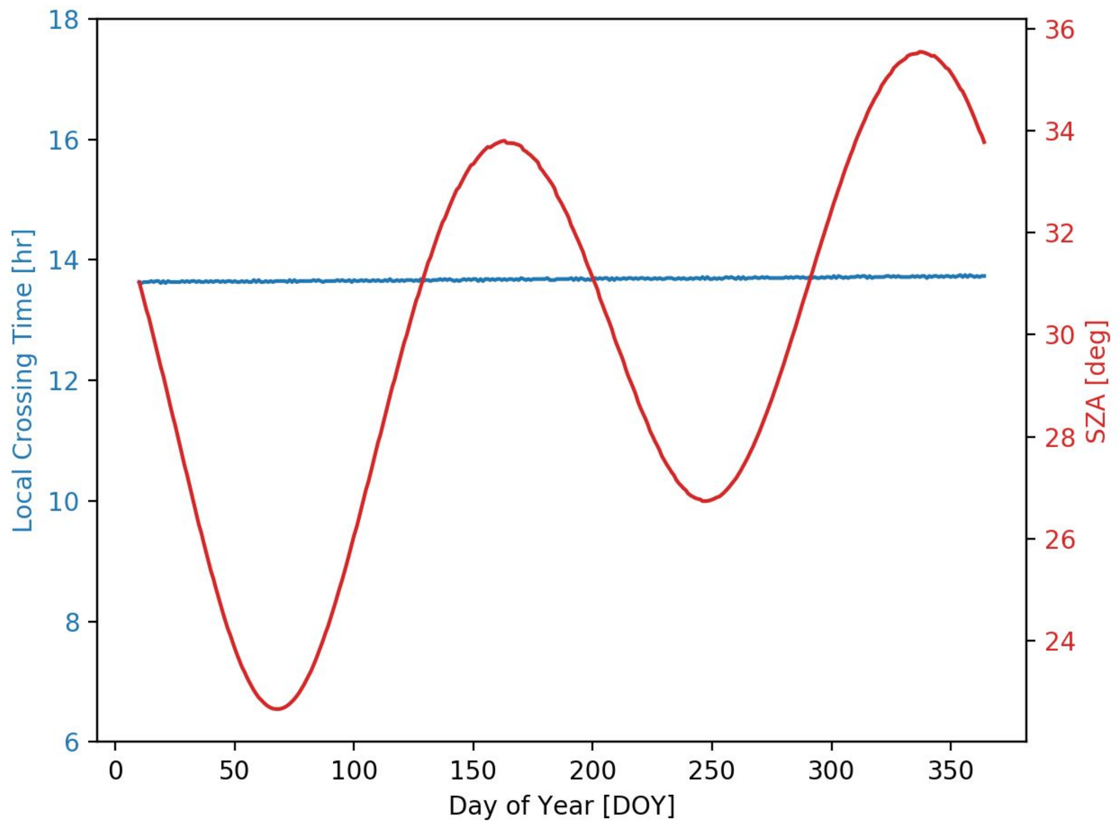
Source: Fougnie et al. [1]

- Multi-angle imaging polarimeters determine cloud droplet size distribution by observing the cloud bow, which occurs at specific measurement geometries
  - Typical scattering angle range for cloud bow retrieval: 135 - 165
- Information content of multi-angle polarimetric measurements depend on the minimum, maximum and range of scattering angles sampled.
  - Recent studies have shown scattering angle range distribution has a major impact on aerosol retrieval performance (***Fougnie, 2020***).
- A better understanding of how scattering angle statistics vary as a function of solar/viewing geometry, as well as, season, latitude, and local crossing time, are imperative for the development of cloud and aerosol retrieval algorithms.

Local Crossing Time vs. Day of Year



Precessing Orbit

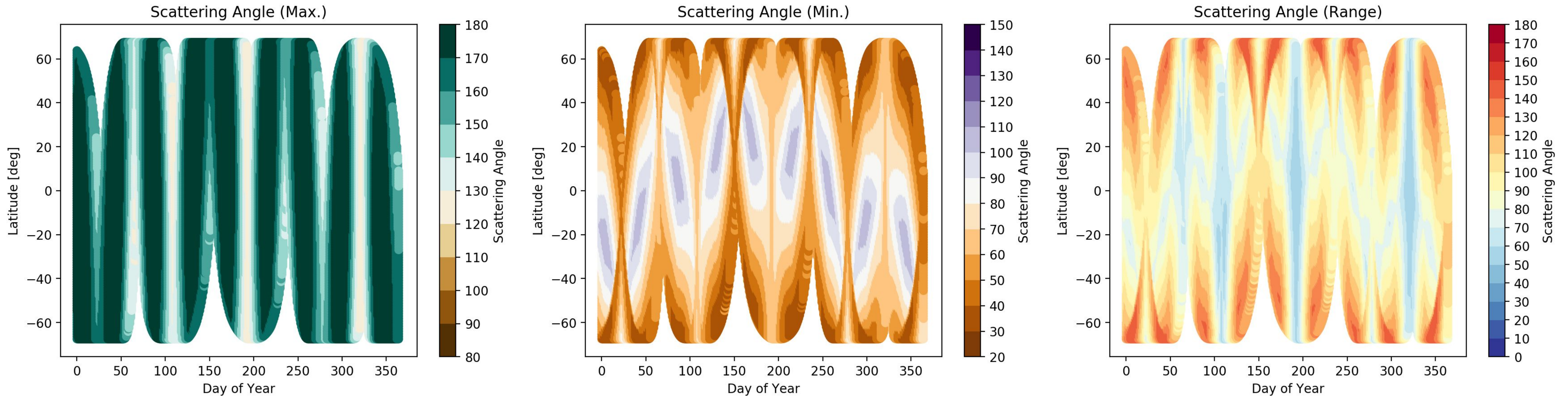


Polar Orbit

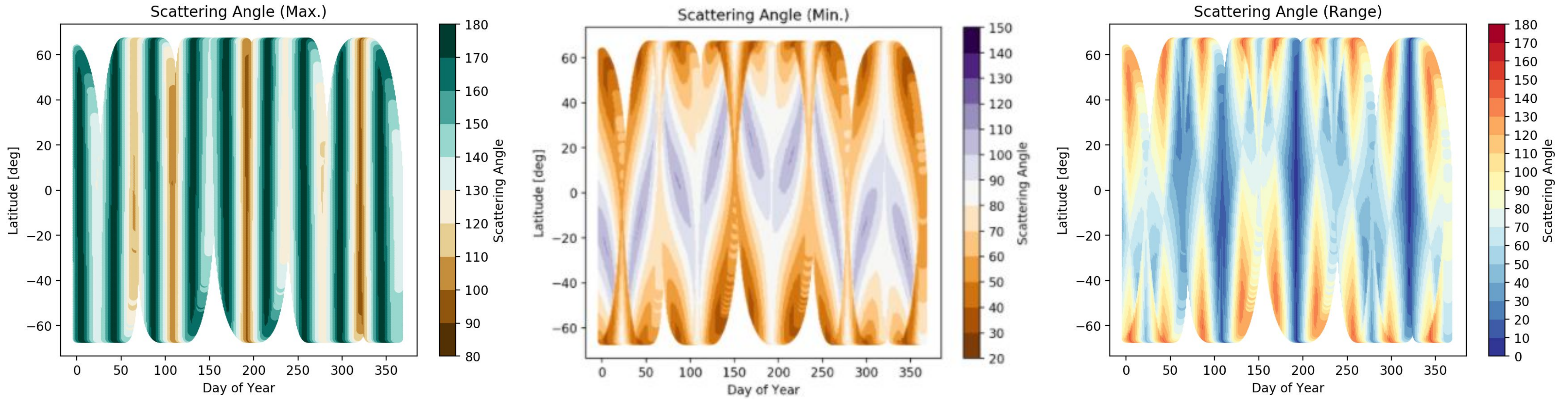
Precessing Orbit

Scattering Angle Statistics

Swath Width: 500 km



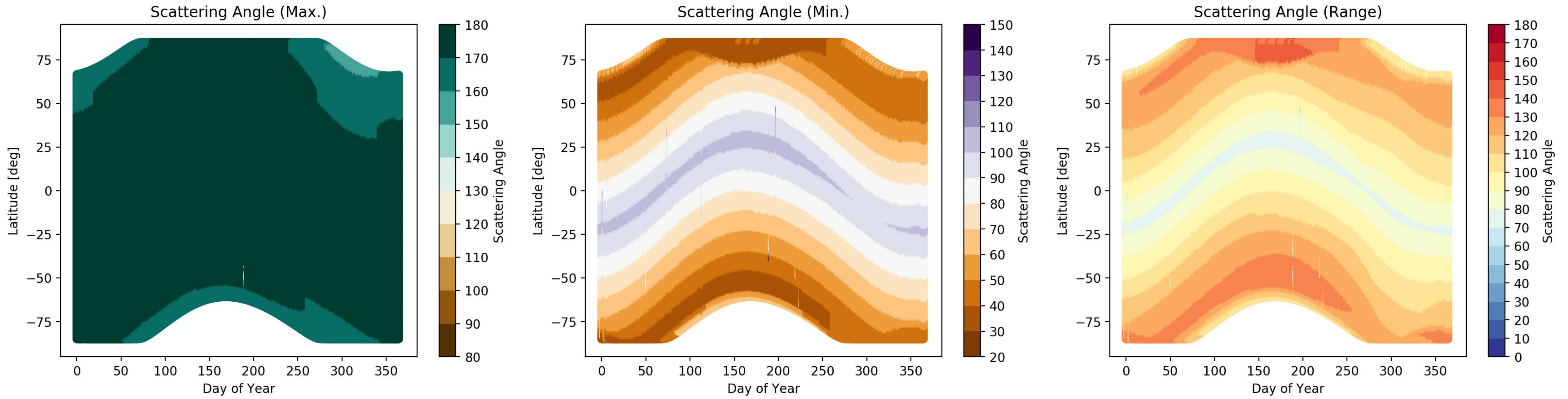
Swath Width: 50 km



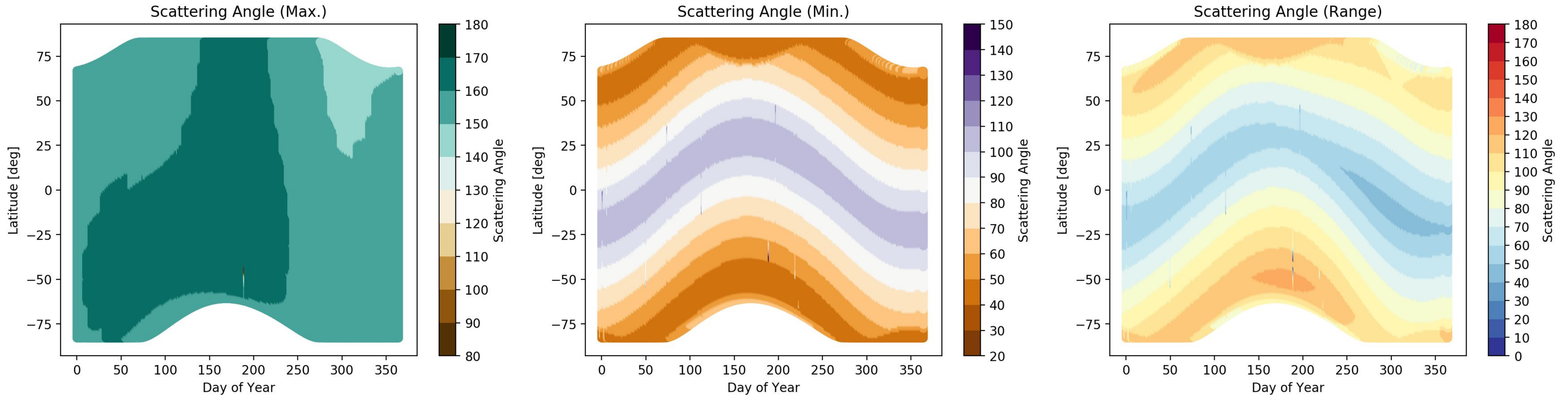
Polar Orbit

Scattering Angle Statistics

Swath Width: 500 km



Swath Width: 50 km



Conclusions

- Precessing orbits offer a unique opportunity to observe diurnal variation in clouds and aerosols.
- Scattering angle statistics for a given orbit are largely determined by local crossing time.
- High maximum scattering angles are generally observed at all latitudes throughout the year (when solar zenith angle is below 90°) for precessing and sun-synchronous orbits.
- Minimum scattering angles are largely determined by solar zenith angle, while maximum scattering angles vary over swath. Scattering angle range is combination of both factors.
- Aerosol and cloud bow retrieval capabilities are reduced with a narrower swath.

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