2024 / 2025 Master of Science Project

Geoscience and Remote Sensing

Enabling high spatial and high angular resolution polarimetry for cloud observations

Changes in cloud properties caused by climate change and particulate matter emissions strongly affect weather and climate, but such processes are not well understood. A satellite mission is proposed to observe clouds at spatial resolutions that govern their microphysical processes. This project explores inferring information from such observations.

In this recently started project, hosted by both TU Delft and the Netherlands Institute for Space Research (SRON), we are presently exploring technological and scientific challenges to perform and process multi-angle polarimetric observations at approximately 50m resolution from space. Such measurements can be exploited for cloud, aerosol and surface observations. In particular, such observations enable to infer the 3D shapes and microphysical structure of clouds that are needed to fundamentally understand cloud evolution, precipitation formation and their sensitivity to climate change and emissions of particulate matter. However, if measurements are made from a single space-craft, a cloud is seen from different angles at different times in the space-craft's orbit. To project different views on the same location on the cloud surface, first the cloud height and shape needs to be derived. In this student project, we aim to develop a simple approach to derive cloud height and shape based on existing methods and apply it to observations of the SPEX airborne instrument obtained during the PACE-PAX field-experiment in September 2024 in the US. SPEX airborne is the airborne demonstrator of the Dutch SPEXone instrument that was launched on 8 February 2024 on NASA's PACE mission. This study will contribute to design requirements for the Enabling High Spatial and High Angular Resolution Polarimetry (EHSHARP) study.

Proposed Activities

- Derive cloud top height and 3D cloud structure from multi-angle spectral observations observed by the SPEX airborne instrument.
- Project multi-angle views to tops and sides of the observed clouds to allow to derive their microphysical properties.
- Reflect on the ESHARP design for monitoring clouds, aerosols and vegetation.

TU University Supervisor:
Joris Timmermans
Joris.timmermans@tudelft.nl

SRON Supervisor:
Bastiaan van Diedenhoven
B.van.Diedenhoven@sron.nl

TU Delft