Master Thesis

Improving an optimal estimation method used to retrieve geophysical parameters from satellite observations in the Arctic and comparison to MOSAiC measurements

The Institute of Environmental Physics (IUP) has a longstanding history in retrieving sea ice and atmospheric properties from satellite observations. Within the research group for Remote Sensing of Polar Regions (www.seaice.uni-bremen.de) new methods for satellite remote sensing are developed and interpreted in a climate system context.
For example, we are using satellite data from microwave radiometers like JAXA's and NASA's AMSR-E/2 sensors to simultaneously retrieve several geophysical parameters such as sea ice concentration and water vapor. This method is based on a forward model relating these parameters to simulated brightness temperatures, i.e., the quantities measured by the satellite sensors. In order to invert the model and retrieve the parameters from the measurements, an optimal estimation scheme is applied. Optimal estimation methods (OEM) are used in a wide range of fields, especially in geosciences. They take advantage of prior knowledge in order to find the set of parameters that match the observations best. The covariance matrices needed for the optimal estimation method contain the joint variabilities of the parameters and are usually derived empirically. So far in our retrieval, they were not fully taken into account. In this study we aim to exploit the potential of including the information about covariance in the OEM method and evaluate its effect on the accuracy of the retrieved parameters. The latter will also include comparisons to observations of the largest polar expedition in history, the MOSAiC campaign (www.mosaic-expedition.org).

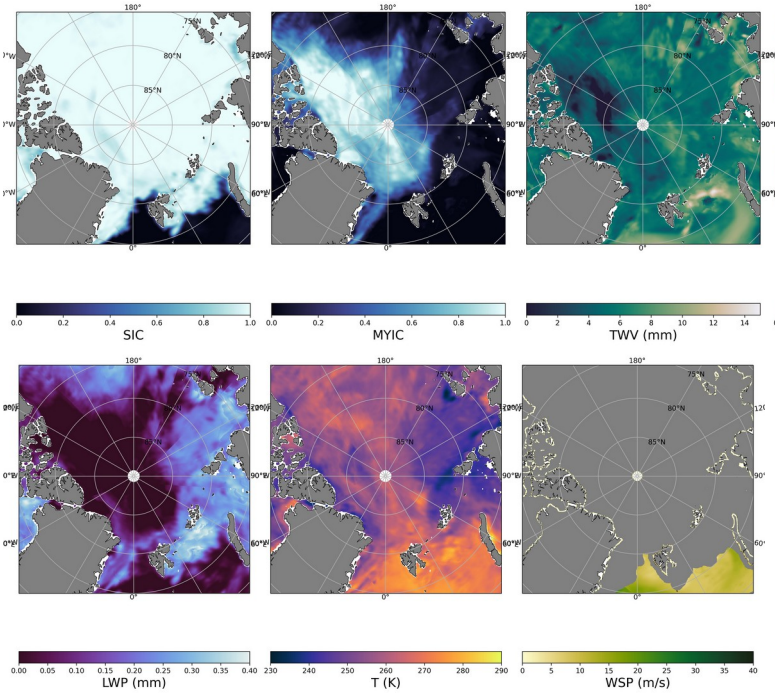

Figure 1: Daily (January 20th, 2020) map of the Arctic showing the different parameters that are retrieved by the optimal estimation method: sea ice concentration (SIC), multi-year ice concentration (MYIC), total columnar water vapor (TWV), liquid water path (LWP), temperature (T) and windspeed over the open ocean (WSP).

What you need and what you will learn
Some basic knowledge in physics and applied statistics is needed and some computer programming experience will be helpful, best Python (or Julia) under Linux.
You will gain insights about optimal estimation methods, and how to evaluate the performance of remote sensing retrievals, which is especially challenging and fascinating in a remote region such as the Arctic. You will also learn how to work with meteorological reanalysis data. Additionally you will use data from the MOSAiC expedition. Our working group offers an open discussion atmosphere and worldwide contacts to the leading institutions in the field.

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Earliest start date is January 2022.