Master student position in the field of Earth System Model Evaluation at the University of Bremen or at the Institute of Atmospheric Physics of the German Aerospace Center (DLR) in Oberpfaffenhofen near Munich

Understanding and evaluating clouds in machine learning based climate models

Your Mission

The “Climate Modelling” department at the University of Bremen and the “Earth System Model Evaluation and Analysis” department at the DLR Institute of Atmospheric Physics (DLR-IPA) jointly invite applications for a Master Thesis in the field of Earth System Model Evaluation in collaboration with the Department of “Earth System Modelling” at DLR-IPA.

Despite significant progress in climate modelling over the last few decades, systematic biases and substantial uncertainty in the model responses remain. For example, the range of simulated effective climate sensitivity - the change in global mean surface temperature for a doubling of atmospheric CO2 - has not decreased since the 1970s. A major cause of this is differences in the representation of processes occurring at spatial scales smaller than the model grid resolution (e.g., clouds or atmospheric gravity waves). These need to be approximated through parametrisations that represent the statistical effect of that process at the grid scale of the climate model. This impacts the models’ ability to accurately project global and regional climate change, climate variability, extremes and impacts on ecosystems and biogeochemical cycles. As part of the European Research Council (ERC) Synergy Grant on „Understanding and Modelling the Earth System with Machine Learning (USMILE, https://www.usmile-erc.eu/)“, machine learning based parametrizations for the ICOsahedral Nonhydrostatic (ICON) model are developed with the goal to improve the representation of these subgrid-scale processes in ICON-ML.

In this Master Thesis, the successful candidate will evaluate the representation of clouds in ICON-ML simulations with observations. Simulating clouds with global climate models is particularly challenging as relevant physics involves many non-linear processes covering a wide range of spatial and temporal scales. The successful candidate will compare the ability of the ICON-ML model with a ML-based cloud parametrization to high-resolution ICON simulations as well as to other climate models that are based on physical parametrizations (ICON-A and EMAC) and will assess possible differences.

The work will start with the identification of appropriate evaluation diagnostics and observational data from a literature review, followed by incorporating them in python into the Earth System Evaluation Tool (ESMValTool, https://www.esmvaltool.org/), an open source evaluation software package being developed by IPA in collaboration with international partners. The candidate will apply these diagnostics to climate models to compare their performance with respect to the models’ ability to simulate clouds. This will be followed by applying causal discovery techniques to identify the drivers of cloud formation and to improve understanding.

Your Tasks

- Identification of suitable diagnostics for the evaluation of climate simulations with respect to Identification of suitable diagnostics and observational datasets for the evaluation of clouds in (high-resolution) climate simulations and their integration into the ESMValTool
- Evaluation of ICON-ML simulations in comparison to ICON-A and EMAC
- Application of causal discovery to identify drivers of cloud formation

Your Qualifications

- Bachelor or equivalent degree in physics, meteorology or atmospheric sciences

- Fluency in English (written and spoken)
- Excellent analytical skills, and the ability to work both, independently and as part of a team
- Good programming skills, preferably with experience in processing large datasets, and with data analysis tools such as Python, etc.
- Enthusiasm, motivation and creativity
- Basic knowledge in data analysis and visualization is desirable.
- Very good communication and teamwork skills
- Creative work is advantageous

Starting date

As soon as possible

Contact

Please send your application documents to

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or by email (please as a file in PDF format) to mierk.schwabe@dlr.de.

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