



New Master Thesis Topic

Title: Earth System Model evaluation

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). These need to be approximated through parametrizations 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. A focus of our work is the development of machine learning (ML) based parametrizations for the ICOSahedral Nonhydrostatic (ICON) model with the goal to improve the representation of these subgrid-scale processes in ICON-ML.

In this Master Thesis, the successful candidate will evaluate Earth System Model (ESM) simulations with observations or reanalysis data. We work with different types of ESMs, including ICON-ML and other models participating in the Coupled Model Intercomparison Project (CMIP). Depending on the interest of the candidate, various specialized topics concerning atmosphere, sea ice, or ocean are possible.

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 Model Evaluation Tool (ESMValTool, <https://www.esmvaltool.org/>), an open-source evaluation software package being developed by IPA in collaboration with international partners.

Skills needed:

- 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 experience with python and data analysis
- Enthusiasm, motivation and creativity
- Very good communication and teamwork skills

Department of Climate Modelling, Head: Prof. Dr. Veronika Eyring

The "Climate Modelling" department at the University of Bremen works closely together with the "Earth System Model Evaluation and Analysis" department at the DLR Institute of Atmospheric Physics (DLR-IPA) and plays a pioneering role in the development and application of machine learning (ML) techniques in combination with Earth observations to improve Earth system models (ESMs). Its overarching goal is to reduce long-standing systematic model errors and, through these hybrid (physics + ML) Earth system models, to provide robust climate projections, as well as reliable information to support climate adaptation and mitigation strategies. The department contributes to the international

development of the ESMValTool, which drives the routine and comprehensive evaluation of Earth system models against Earth observations.

Topic for students of

☒ M.Sc. Environmental Physics

☐ M.Sc. Space Sciences and Technologies

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Verschiedene Ausrichtungen im Bereich Atmosphäre, Meereis oder Ozean sind möglich