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

Understanding and evaluating atmospheric gravity waves 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.

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 CO_2 - 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 atmospheric gravity waves in ICON-ML simulations with observations or reanalysis data. Atmospheric gravity waves are key processes to control global atmospheric circulation. By propagating horizontally and vertically over large distances, gravity waves transport energy and momentum and can influence the temperature distribution and winds in the middle atmosphere. The successful candidate will compare the ability of the ICON-ML model with an ML-based gravity wave 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 the influence of gravity waves and to improve process understanding.

Your Tasks

- Identification of suitable diagnostics for the evaluation of climate simulations with respect to atmospheric gravity waves and their integration into the ESMValTool
- Evaluation of ICON-ML simulations in comparison to ICON-A and EMAC

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
- Good knowledge in data analysis and visualization is desirable
- Very good communication and teamwork skills

Starting date

As soon as possible

Contact

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