Master Thesis

Machine learning-based analysis of cloud microphysical process rates in the ICON model

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Short description

- Cloud microphysical process rates are parameterized in weather and climate models
- Due to computational constraints, these process rates are usually not stored and not available for later analysis
- Use machine learning to develop a tool for post-simulation diagnostics of microphysical process rates in the ICON model with the one-moment microphysics scheme

Summary

Cloud microphysics describes microscale processes that govern the evolution of condensed water in the atmosphere and are critical for weather and climate. In numerical weather prediction and climate models they need to be represented by so-called *parameterization schemes* which model their impact on and coupling to the scale that is resolved by the model. In the ICOsahedral Nonhydrostatic (ICON) model, cloud microphysics is parameterized with a bulk moment parameterization, which represents the particle size distribution by its moments. Most commonly used is the *one-moment scheme*, predicting the mass of the different hydrometeors and, for smaller studies, the *two-moment scheme*, predicting the mass and number concentration. Process rates describe the microphysical processes, however, due to storage space restrictions, they are usually not included in the model output and thus not available for later analysis.

Therefore, we use machine learning to develop tools for post-simulation diagnostics of the microphysical process rates. This allows us to obtain information about microphysical processes in a resource-efficient way, even when the process rates have not been saved initially. While this has already been studied for the two-moment scheme, there is no such tool for the one-moment microphysics scheme. The objective of this project is to develop such a tool with machine learning. This includes performing simulations with the ICON model to generate training data and comparing the method with the existing work on the two-moment microphysics scheme. Potentially, this method could also be extended so that the model can make use of spatial information, e.g. by employing a convolutional neural network or similar.

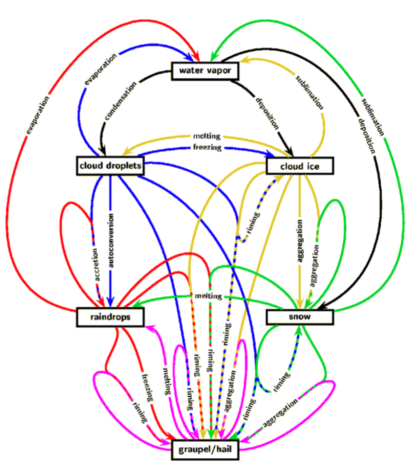
Tasks

- Implementing the output of the microphysical process rates into the source code of the ICON model for the one-moment scheme
- Performing global simulations with the ICON model
- Developing a tool for post-simulation diagnostics of microphysical process rates in the ICON model and the one-moment scheme using machine learning

You should ...

... know the basics of programming with Python

... be interested to learn more about machine learning and numerical modelling with the ICON model



One-moment microphysics scheme.
Image source: Axel Seifert, DWD.

If you are interested or have further questions, please get in touch with me via **email** or find me in my office 13-05/CS 30.32.