Solving The Entrainment Puzzle (STEP) - WP3

This computing time proposal is for the modelling part with ICON-LEM (work package 3) of the Marie Skłodowska-Curie Actions (MSCA) Individual Fellowship Solving The Entrainment Puzzle (STEP).

Entrainment, which is the mixing of cloudy and cloud free air at the cloud edges, is a key cloud process central to understanding cloud morphology and microphysical processes such as precipitation formation. Up to now, no reliable formulation exists that allows to describe and understand entrainment in terms of cloud- and environmental physical quantities ("the entrainment puzzle"). Differences in representation of entrainment in climate models are a main cause for spread in climate sensitivity estimates. The realistic treatment of entrainment in climate models will help to reduce a large part of the uncertainty in predictions of climate sensitivity.

Therefore, this project seeks to identify the main physical parameters that govern the amount of air entrained into and detrained from clouds using controlled laboratory measurements; and in a second step aims at translating the experimental results into a new mathematical formulation to use in Large Eddy Simulations of clouds using computational fluid dynamics modelling. Solving the entrainment puzzle will allow quantifying the entrainment processes reliably and thus deliver the basis for climate model improvements.

In WP 3 of STEP - LES case studies - the ICOsahedral Nonhydrostatic (ICON) atmospheric model will be used in its LES configuration (ICON-LEM). Two main LES setups will be used, one to simulate a stratiform cloud case and one for a stationary convective cloud case from the ACORES campaign. These two cases have also been chosen for the laboratory experiment boundary conditions in WP 1 of STEP. The LES simulations will be used to derive entrainment parameters in the 'traditional' way which will be compared to entrainment parameters derived by the new entrainment formulation that is established from the results of the laboratory and computational fluid dynamics simulation experiments. The results from the differing calculation schemes will be assessed and compared to the experimental results from the laboratory and the field measurements. This will help to refine the new entrainment calculation formulation.