Max-Planck-Institut für Meteorologie

Clouds and Precipitation in the Climate System – HD(CP)^2: The 100 Meter Bet

Clouds and Precipitation play a major role in answering the question, how climate will change under human influence. The lack of understanding of physical processes and too little computer capacity is demonstrably one of the largest problems for uncertainty in current climate models. „High Definition Clouds and Precipitation for advancing Climate Prediction (HD(CP)^2“ is an initiative funded by the German Federal Ministry for Education and Research (BMBF). It addresses this cloud-precipitation problem and leverages both the rapid developments in simulation and measurement science. The project is led by Prof Bjorn Stevens, Managing Director of the Max Planck Institute for Meteorology (MPI-M) and head of department „The Atmosphere in the Earth System“, and coordinated by Dr Florian Rauser.

The main concept behind HD(CP)^2 is simple: would the current problems in representing clouds and precipitation be solved if a climate model could simulate a defined area on a grid resolution of 100 m? And how would we know? How would we evaluate and analyse such a model and what would measure progress? Even if such a model were clearly superior to present approaches, how would it help to improve the workhorses of global climate model projections, i.e., models with grid resolutions of 50-100 km? These questions embrace a multifaceted array of scientific and technical problems ranging from questions on high performance computing to advanced *in situ* Earth system observations.

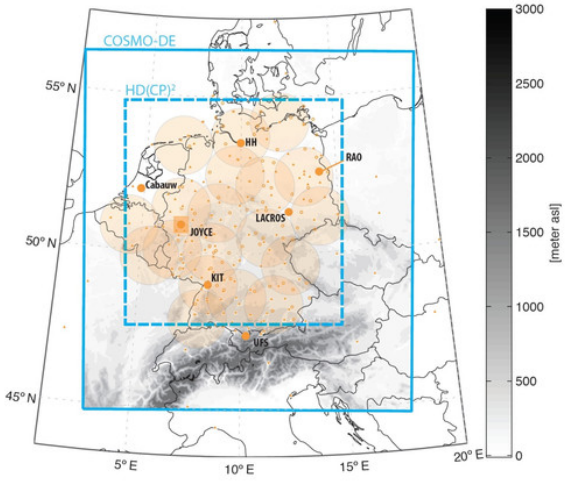

Fig.: *The figure shows a possible HD(CP)^2 target region for modelling and observations. It also illustrates a unique observational network that the project seeks to synthesize and exploit for evaluating the HD(CP)^2 model, and for generating insights to the structure and statistics of cloud and precipitation processes.*

To create a 100 meter climate model the newly developed ICON model framework is being further developed. The central model development of ICON at the German Meteorological Service (DWD) and at MPI-M taps into the energy and creativity of university partners, as well as high performance computing centers, such as the German Climate Computing Center (DKRZ) and the Research Center Jülich. Links to high performance computing centers are essential to allow ICON to run on next generation supercomputers whose processor counts will extend to the millions. Through HD(CP)2 and its development work ICON has been designed to run on the largest computers worldwide, with recent tests showing nearly perfect scaling on as many as 130,000 processors. It has been benchmarked against large-eddy simulations, and is the first global model that has ever been run in a fashion that can simulate idealized boundary layer turbulence, including important cloud regimes. Through these advances ICON will become a tool for cloud resolving simulations. Through the accomplishments of the HD(CP)^2 project the MPI-M and the broader community will gain an instrument to analyse clouds and precipitation using a consistent modelling framework spanning an unprecedented (four decades) range of scales. After two years of development 400 meter simulations have already been produced over local grids and are being evaluated against benchmark simulations from operational models, LES models, and observation data from the „HD(CP)^2 Observational Prototype Experiment“ (HOPE) campaign. HOPE took place near Jülich, Germany, in April and May of 2013 and was designed to provide information on sub grid variability and microphysical properties that are subject to parameterizations even at the high-resolution. Observations during HOPE also serve as a cornerstone for the broader strategy of HD(CP)^2 to advance observations..

Observation and synthesis activities within HD(CP)^2 are designed to answer the broad question as to how a model capable of resolving clouds and convective circulations can be validated and improved. Toward this end HD(CP)^2 integrates the data of an extensive German observation network (consisting of advanced radars, surface observations, and other ground based remote sensing, e.g., Fig) and homogenizes this data by using a consistent data format and making the results available through a community data portal. In this community data portal a diversity of observations are now available, including longterm observations as well as data from the HOPE campaign. The list of available data is growing daily.

Subject to a successful proof of concept, which only after two years of project of support has mostly been achieved, a second phase of the project (from 2016 on) is planned. During the second phase simulations with the HD(CP)^2 model and observations collected and archived through the efforts of the projects first phase will begin to be applied to advance understanding and improve global modelling of clouds and precipitation processes.

More Information on HD(CP)^2:

Project website
Campaign **HOPE**: http://www.hdcp2.eu/index.php?id=2306

Contact:

Prof. Dr. Bjorn Stevens
Max Planck Institute for Meteorology
Project Leader
Phone: +49 (0) 40 41173 422 (Assistant Angela Gruber)
Email: bjorn.stevens@mpimet.mpg.de

Dr. Florian Rauser
Max Planck Institute for Meteorology
Project Coordinator
Phone: +49(0) 40 41173 125
Email: florian.rauser@mpimet.mpg.de