HD(CP)$^2$ S6: Cloud-radiative interactions with the North-Atlantic storm track

within the BMBF-funded research initiative HD(CP)$^2$: High Definition Clouds and Precipitation for Advancing Climate Prediction

**Project lead:** Dr. Aiko Voigt, Karlsruhe Institute of Technology, Institute for Meteorology and Climate – Tropospheric Research

**Abstract:**

This project provides the umbrella for the modeling activities of the HD(CP)$^2$ junior research group on storm tracks and cloud processes. HD(CP)$^2$ seeks to foster understanding of clouds and precipitation processes by combining high-resolution modeling and observational approaches, and by advancing the representation of these processes in global climate models aims to improve projections of short- and long-term climate change. Within HD(CP)$^2$ the junior research group will articulate the coupling of small-scale cloud processes with the large-scale circulation of the extratropics. The group will study how diabatic cloud processes interact with and shape the extratropical circulation and its response to climate change, with a particular focus on the North Atlantic storm track and the role of cloud-radiative effects. To this end we will apply the new ICON atmosphere model over a hierarchy of spatial resolutions and setups, and combine these simulations with the analysis of observations and theoretical approaches.

While the ultra-high resolution simulations at the large-eddy scale will be performed centrally by the HD(CP)2 modeling team, this project collects the global ICON simulations performed by the group at lower resolution and with free and prescribed cloud-radiative properties. Three main areas of research will be addressed:

1. Impact of cloud-radiative interactions on the evolution of single extratropical cyclones

We will study the evolution of individual cyclones over a period of 10 days to understand how a cyclone is impacted by the radiative effects of the clouds that it produces, to what extent this depends on the character of the cyclone, and how model errors in cloud-radiative interactions [Bodas-Salcedo et al., 2014; Booth et a., 2014] contribute to model errors in extratropical cyclones [Zappa et al., 2013]. The simulations will include baroclinic lifecycle simulations, hindcasts of observed extratropical cyclones, and Transpose-AMIP simulations for the NAWDEX field campaign.

2. Impact of cloud-radiative interactions on short-term internal variability of the extratropical circulation

This work will focus on two-way interactions of clouds and storm tracks. The aim is to separate dynamic from thermodynamic cloud controls and to study the implications of cloud-circulation coupling for short-term storm track variability on timescales of days to weeks. This will allow us to, for example, test recent observational work that hypothesized that cloud-radiative interactions shorten the timescale of the North-Atlantic oscillation [Li et al., 2014], which suggests that model biases in clouds might contribute to model biases in the variability of the extratropical circulation.
3. Impact of cloud-radiative interactions on the long-term climate change response of the extratropical circulation

Recent work with global climate models showed that half or more of the extratropical circulation response to global climate change is mediated by changes in cloud-radiative properties [Ceppi and Hartmann, 2014, 2016; Voigt and Shaw, 2015, 2016]. We will build upon this work using the ICON model in realistic as well as idealized setups and with prescribed and interactive sea-surface temperatures to assess the role of remote and local as well as atmospheric and surface cloud-radiative changes. This will help us to identify which clouds are most important for the storm track response to climate change and to constrain which radiative aspects of clouds are most important to adequately model the storm track in current and future climates.

**Funding agency:** BMBF

**References:**


