ICON-ART-ISO: Implementing water isotopealogues into the new chemistry-transport model ICON-ART

Johannes Eckstein¹, Roland Ruhnke¹, Stephan Pfafl², Daniel Rieger³, Daniel Reinert³

¹ Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany
² Institute for Atmospheric and Climate Science, ETH Zurich, 8092 Zurich, Switzerland
³ Deutscher Wetterdienst, Frankfurtstr. 135, 63067 Offenbach, Germany

ICON (ICOsahedral Nonydrostatic)
- The new nonhydrostatic global modelling system (Zängt et al., 2014), jointly developed by DWD (German Weather Service) and MPI-M (Max Planck Institute for Meteorology)
- Used for weather prediction and climate projections alike
- Local grid refinement down to a resolution of a few kilometers with 2-way coupling to global models

ICON-ART → icon-art.imk-tro.kit.edu
- Extends ICON by Aerosols and Reactive Trace gases (Rieger et al., 2014)
- Simulates gas phase chemistry, aerosol dynamics and their feedback to meteorological variables

ICON-ART-ISO: Goals
- Comparison with CARIBIC 5D samples
- Simulation of convective processes with ICON (Tiedtke-Bechtold scheme)
- Not including:
  - Surface or ground water and biosphere processes
  - Chemical interactions, e.g. stratospheric CH₄ conversion

ICON-ART-ISO: Next steps
- Implementing fractionation in microphysics more closely resembling the 2-moment scheme
- Implementation of the processes during convection (Tiedtke-Bechtold scheme implementation of ICON)
- Finalizing the implementation of evaporation into turbulence routines

ICON-ART-ISO: Implementation
- Implementation of HDO and H₂¹⁸O into ICON-ART
- Considering fractionation during:
  - **Convection**
  - **Evaporation** over the ocean
  - **Grid scale clouds and precipitation**
  - **Microphysics**: Grid scale clouds and precipitation

**Microphysics:**
- Simulating number and mass mixing ratios
- In ICON-ART-ISO, fractionation is considered during:
  - Saturation adjustment
  - Evaporation of rain and of melt water on ice classes
  - Deposition of vapor on ice classes and nucleation

**Testing microphysics:** Typhoon Haiyan (November 2013)
- Convection and turbulence turned off to consider only 2 moment microphysics
- Model run started on 5.11.2013, R02B06 grid (40 km horizontal resolution)
- Q₀ of HDO initialized with 0.003Q_water output after 12h of simulation (5.11.13, 12UTC):

- Depletion in HDO in wake of the storm, visible in dynamical and humidity fields
- Some of the processes taken into account by the 2 moment scheme by A. Seifert, image taken from Seifert, 2002 (PHD)

**Microphysical tendencies:**
- cloud
- rain
- snow
- graupel
- hail

**Depletion in HDO in wake of the storm:**
- Even without parametrized convection and turbulence, the storm is still visible in dynamical and humidity fields
- The model is not perfect yet, there are small positive values of HDO

**References:**