Karlsruher Institut für Technologie

Institute of Meteorology and Climate Research
Atmospheric Trace Gases and Remote Sensing

This presentation participates in OSPP
EGU
Outstanding Student Poster & PICO Contest

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

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ICON (ICOsahedral Nonhydrostatic)

- The new nonhydrostatic global modelling system (Zängt et al, 2014), jointly developed by DWD (German Weatherservice) 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 fields

ICON-ART → icon-art.imk-tro.kit.edu

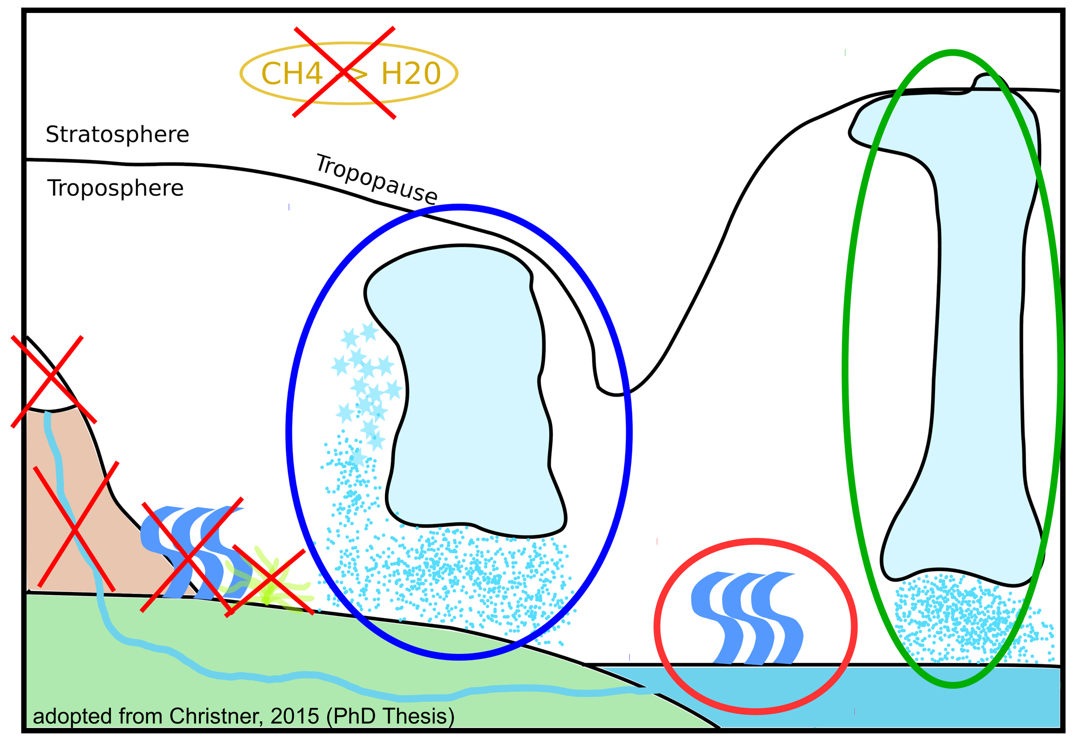
- Extends ICON by *Aerosols and Reactive Trace gases* (Rieger et al., 2014)
- Simulates gas phase chemistry, aerosol dynamics and their feedback to meteorological variables

→ see Posters Rieger et al., X3.156, Session AS4.21 and Schröter et al., X3.66, Session AS1.21

ICON-ART-ISO: The implementation

- Implementation of HDO and H218O into ICON-ART
- Considering fractionation during:
  - Evaporation over the ocean
  - Grid scale clouds and precipitation
  - Convection (Tiedtke-Bechtold Scheme)

  } doubling all water species diagnostically
- Not including
  - Surface or ground water and biosphere processes
  - Chemical interactions, e.g. stratospheric CH_4 conversion
- Based on COSMOiso by Pfahl et al., 2012

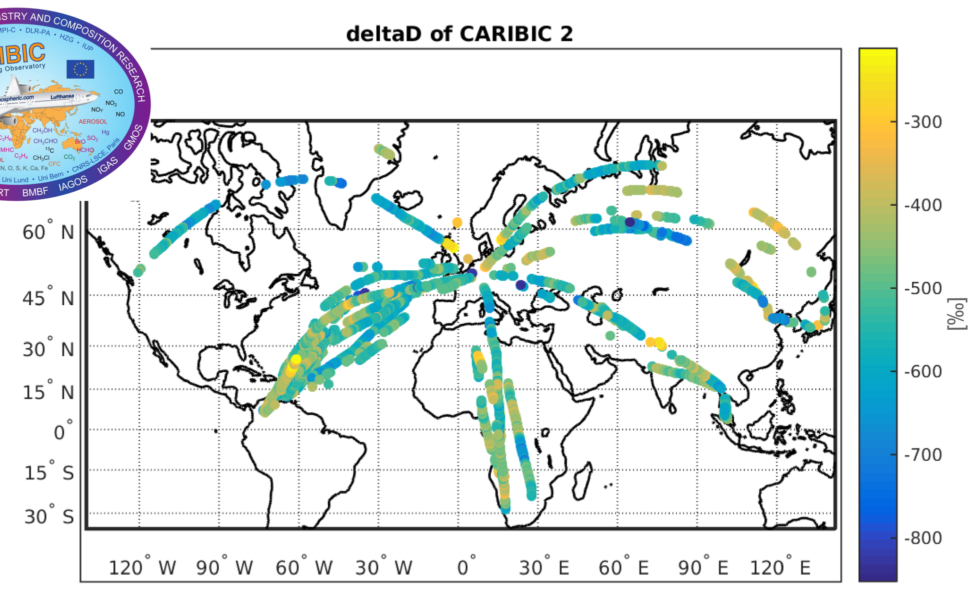


adopted from Christner, 2015 (PhD Thesis)

ICON-ART-ISO: Goals

- Comparison with CARIBIC δD samples
- Taken on 4 flights/month by the laser spectrometer ISOWAT
- Focus on tropical storms
  - Haiyan (11/2013)
  - Danielle (08/2010)
  - Igor (09/2010)

  } influence of land surfaces is minimal, error of neglecting them is therefore minimized



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

Microphysics: Grid scale clouds and precipitation

- Using 2 moment microphysical scheme by Seifert and Beheng, 2005
- 7 water classes (vapor, cloud water, rain, ice, snow, graupel, hail)
- Simulating number and mass mixing ratios
- In ICON-ART-ISO, fractionation is considered during
  - Saturation adjustment

$$q_c^h = \alpha_e q_c^l \frac{q_v^h}{q_v^l}$$ (Blossey et al., 2010, Eq. B21)

  - Evaporation of rain and of melt water on ice classes

$$S^h = S^l \cdot \left(\frac{D^h}{D^l}\right)^n \frac{\alpha_e q_v^{*,l} q_r^h / q_r^l - q_r^h}{q_v^{*,l} - q_v^l}$$ (Pfahl et al., 2012, Eq. 4)

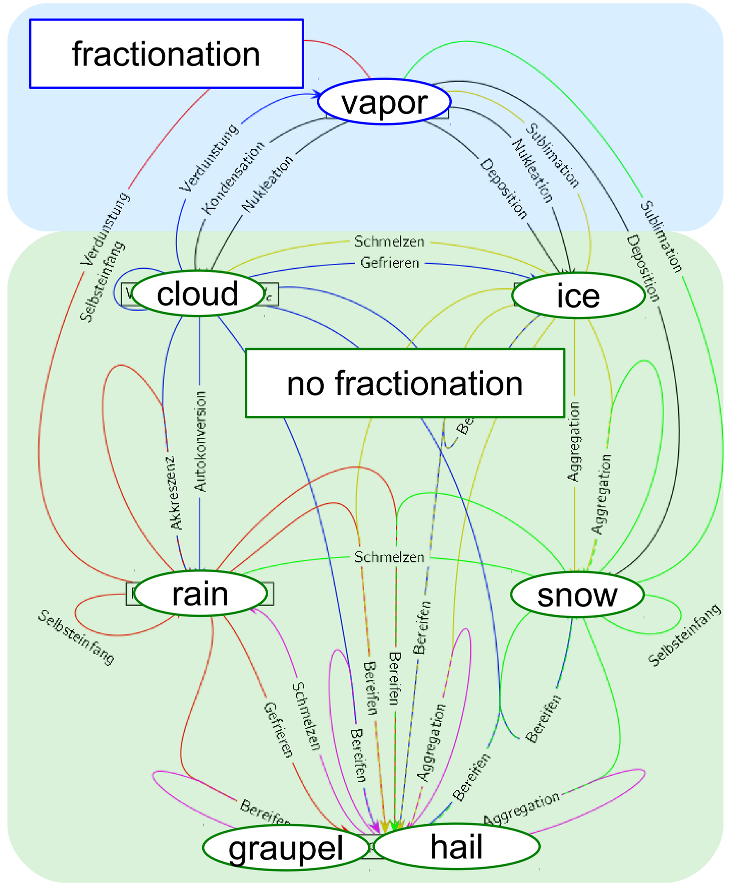
  - Deposition of vapor on ice classes and nucleation

$$S^h = S^l \cdot \alpha_e \alpha_k \frac{q_v^h}{q_v^l}$$ (Blossey et al. 2010, Eq. B25)

- For non-fractionating processes, tendencies are given by

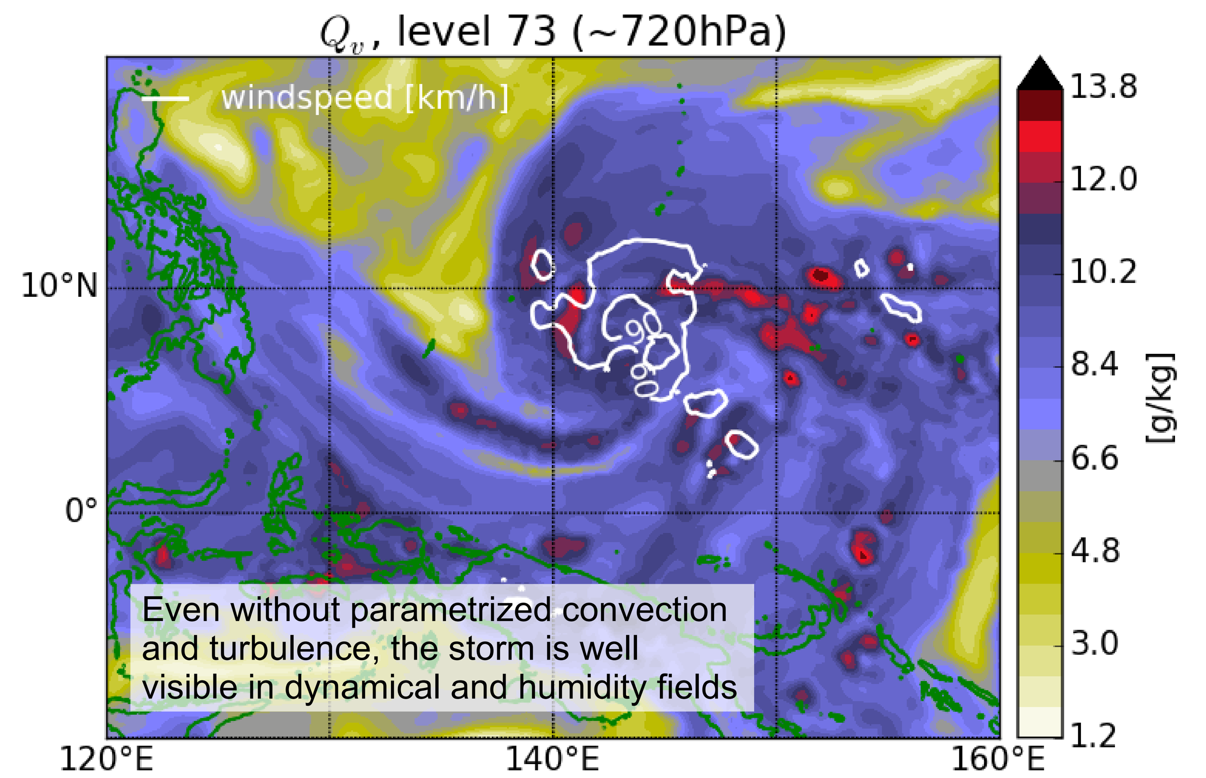
$$S^h = S^l \cdot \frac{q^h}{q^l}$$ (Pfahl et al., 201, Eq. 2)

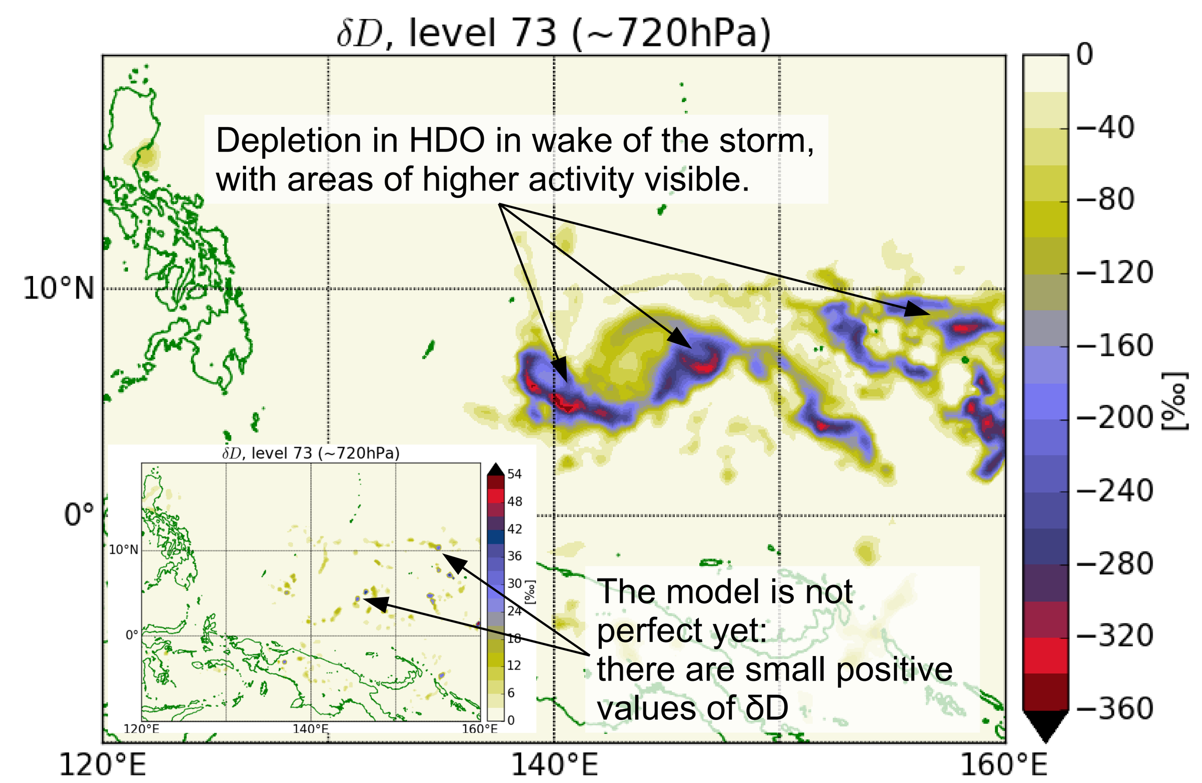
q specific humidity
S microphysical tendency
D diffusion constant in air
α_e equilib. fraction. factor
α_k kinetic fraction. factor
n empirical constant
l light isotopologue
h heavy isotopologue
v vapor
c cloud
r rain
$*$ saturation



Some of the processes taken into account By the 2 moment scheme by A. Seifert, image taken from Seifert, 2002 (PhD)

- 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)
  - Q_v of HDO initialized with $0.0003Q_v$, output after 12h of simulation (5.11.13, 12UTC):





References:
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