Investigation of the distribution of aerosol-forming trace gases with ICON-ART

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1. Aerosol-forming trace gases
   - Trace gases (e.g. NH₃) come from different sources (anthropogenic, biogenic, biomass burning). They are oxidized to acids in the atmosphere. Some oxidized trace gases can nucleate (e.g. H₂SO₄, HNO₃ and NH₃).
   - Aerosols are important for cloud formation and radiative forcing
   - Stratospheric aerosol: mainly sulfate (60 – 80 %)
   - Tropospheric aerosol: Sulfate, nitrate, ammonium, organic and black carbon
   - Depletion of NH₃:\[NH₃ + \text{OH} + NO → \text{Aerosol}\]

   \[t = 73.75 \text{ days} \quad (\text{with } N_\text{OH} = 10^6, T = 280 \text{ K})\]

2. ICON-ART
   - Global weather and composition model
   - Gasphase reactions and aerosol formation
   - Model settings:
     - ICON-ART 2.2
     - Horizontal resolution: R2/80 (~ 40 km), Vertical: 90 levels
     - Integration timestep: 300 s
     - Output: regular lat-lon grid: 0.5°

3. StratoClim campaign
   - Duration: 20.07. – 11.08.2017
   - Location: Kathmandu (Nepal)
   - 8 successful flights with Geophysica in 21 km altitude (above the asian monsoon)
   - Measurements of transported airmasses (UTLS-region) with GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere: unique imaging Fourier-Transform-Spectrometer)

4. Proof of concept
   - NH₃ concentrations along the flightpath (OH chemistry only):

   ![GLORA measurement](image1)
   ![ICON-ART simulations only gasphase](image2)

5. Sources of NH₃
   - NH₃ from the MACCity inventory:

   ![accumulated NH₃ emissions from the ECCAD-database (July 2017)](image3)

   ![emissions by sectors: The main surface source of NH₃ is agriculture](image4)

6. Results
   - Accumulated NH₃:

   ![sum of NH₃ emissions from model output, from left to right: global and regional distribution in the lowest modellevel, vertical cross-section along the dotted line in regional plot](image5)

   Sectors with the largest contribution to the total emissions of NH₃:

   ![regional NH₃ emissions from agriculture and agricultural waste](image6)

7. Conclusion and Outlook
   - As expected the model run shows too high values in-comparison to the measurements, because NH₃ is only reduced by OH, the uptake of NH₃ by the aerosol phase and rainout/washout is yet to be implemented.
   - Distinguishing NH₃ sources by sectors helps to understand how transport processes contribute to regional NH₃ concentration differences.
   - Improved integrations using a comprehensive gas phase chemistry with coupling to the aerosol module are in preparation.
   - Air mass origins will be diagnosed using artificial tracers


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