C07 The composition of the global UTLS nowadays and at the end of the 21st century

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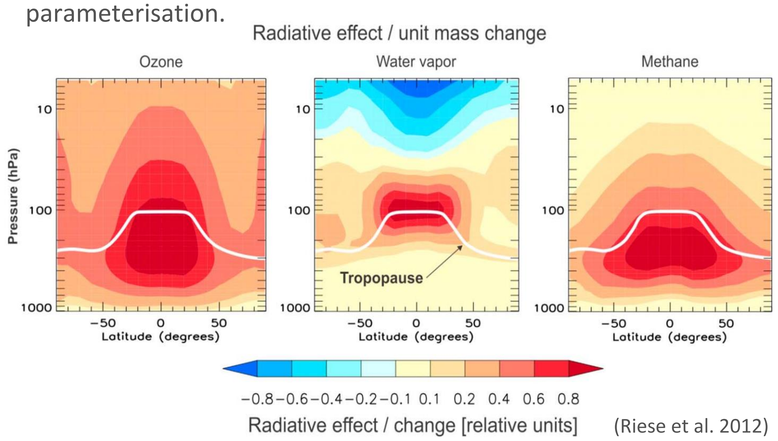
Motivation

- How does the UTLS composition change in future?
- How do process/model uncertainties affect the simulated UTLS composition?
  - UTLS processes are parameterised in models and therefore subject to assumptions and uncertainties.
- We exploit the unique methodology of MESSy to replace single aspects of the simulation setup, e.g. the choice of the convection parameterisation.

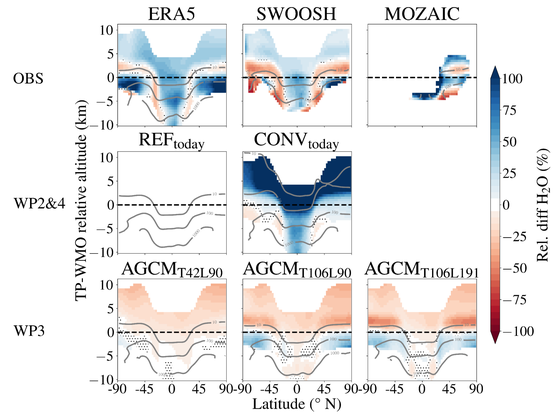


(Riese et al. 2012)

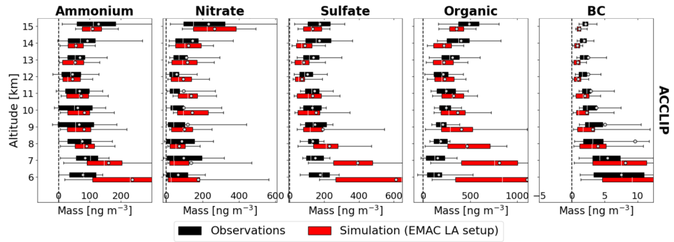
Collaborations within TPChange

- **A04** Provided aerosol observations for model evaluation.
- **B01** Used global initial conditions of EMAC for MECO(n) simulation.
- **C01** Provided H_2O climatology based on MOZAIC data for model evaluation.
- **C02** Compared observed AirCore data with results from EMAC along flight tracks.
- **C05** Analysed the LMS O_3 budget of the O_3 climatology of ERA5 with results from EMAC with interactive chemistry.
- **C06** Received support setting-up an EMAC simulation to investigate the transport from the tropical UT using artificial tracers.
- **Z02** Collected EMAC data sampled along flight tracks of research aircrafts and along the orbits of sun-synchronously orbiting satellites.
- **Z03** Used results of aerosol optical properties for model development and will use results as reference for ICON/MESSy simulations in phase II.

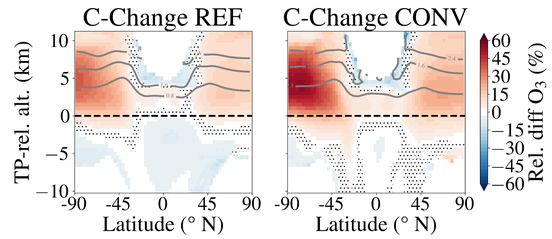
Results from phase I



- Increasing model resolution reduces the moist bias in the LMS, due to a strengthened tropopause transport barrier.
- The UTLS composition is affected significantly by the chosen convection parameterisation.



- Simulated and observed aerosol composition for the ACCLIP campaign show a good agreement from the surface to the stratosphere.

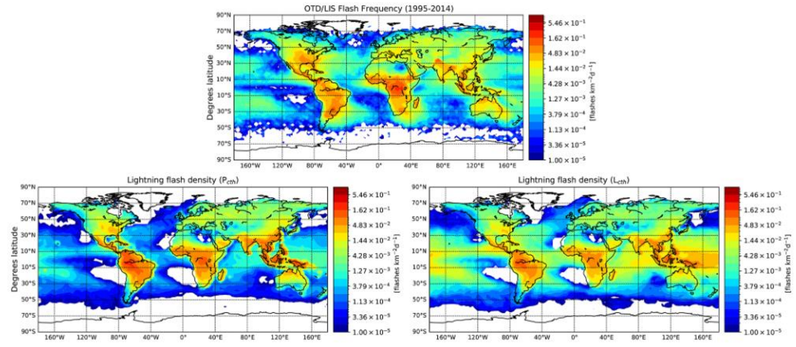


- The relative difference between a future projection and the state of today is of similar magnitude for two model setups that differ solely with regard to the used convection parameterisation.

Research plan phase II

Main goal: Quantifying the controlling factors for oxidants and aerosol formation in the UTLS with ICON/MESSy.

- The work of phase I will be extended to investigate the UTLS composition with focus on oxidants and aerosols by applying the new modelling system ICON/MESSy with improved process descriptions.
- **WP1**: Set-up the ICON/MESSy model with focus on the UTLS oxidants and aerosol budgets, followed by an evaluation of the new model using the EMAC simulation results achieved in phase I.
- **WP2**: Determine sources of oxidants and related budgets in the UTLS and their sensitivities towards
  - source regions and emitters using the MESSy diagnostic capabilities for source attribution (TAGGING) and processes analysis (TENDENCY).
  - lightning emissions of NO_x by applying several different parameterisations (LNOX).



(Pérez-Invernón et al. 2022)

- **WP3**: Investigate the influence of gas-phase chemistry on the aerosol budget, and disentangling contributions of condensation from those of nucleation and dynamical transport.
- **WP4**: Estimate the influence of anthropogenic emissions to the UTLS trace gas and aerosol budgets.