A04 Composition and transport of aerosol particles in the UTLS and their interactions with cirrus clouds

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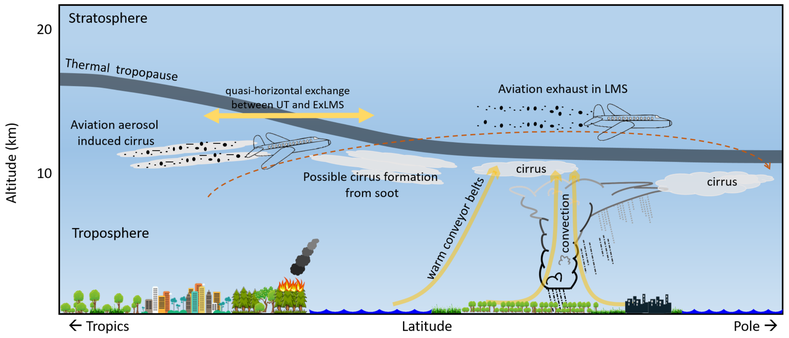
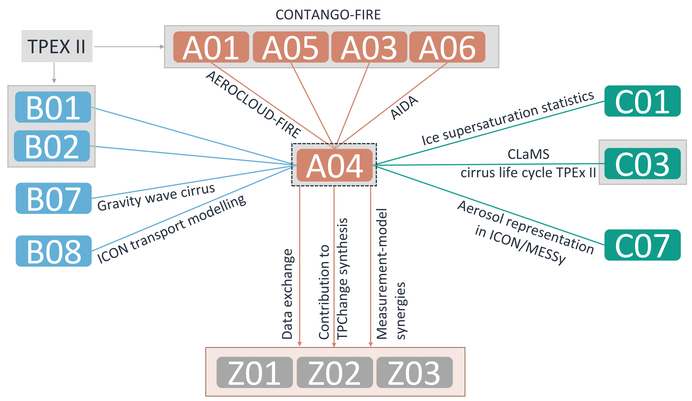
Motivation



- **Leading research questions during phase I:**
  - What is the aerosol composition in the centre of the Asian summer monsoon (ASM) and its outflow?
  - What are the aerosol properties in extratropical UTLS regions in contrast to the tropical UTLS region? How important are small-scale fluctuations and gradients close to the tropopause?
- **Leading research questions during phase II:**
  - How does the long-term trend of UTLS aerosols from in situ measurements look like?
  - What is the role of UTLS aerosols in the extratropics for cirrus formation, with a special focus on aviation aerosols?

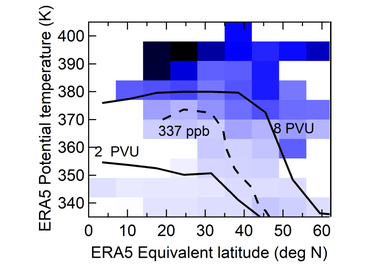
Collaborations within TPChange

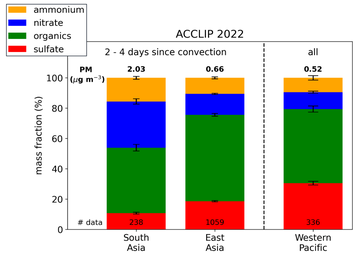


Results from phase I

WP1: In-situ particle composition measurements in the outflow region of the ASM

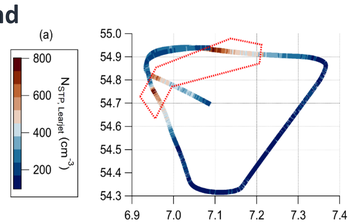
- Enhancement of (ammonium) nitrate observed well above PV > 8 PVU and N_2O < 337 ppb → impact on **stratospheric** aerosol composition in the extratropics.
- Major transport pathway: Cross-tropopause transport within the anticyclone, followed by isentropic northward transport.
  Köllner et al., under review
- Influence from various convective transport regions on the aerosol composition in the outflow of the ASM.
  Eppers at al., ESS Open Arch., 2025

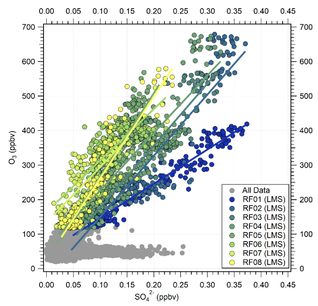




WP2: Small-scale aerosol dynamics and gradients at the tropopause

- Transport of low-level pollution (most likely from biomass burning) into the lowermost stratosphere by warm conveyor belt uplift.
  Joppe et al., EGUsphere, 2025
- Identification of non-stratospheric volcanic eruptions as source for variability of sulphate aerosol in the extratropical lowermost stratosphere.
  Joppe et al., ACP, 2024





WP3: Instrumental development and laboratory intercomparison with HPLC/Orbitrap-MS (in collaboration with A05)

- First deployment of the new OT-AMS measurement mode during the ACCLIP and the PHILEAS mission.
- Successful generation and detection of organic sulfate and organic nitrate as well as aging of secondary organic aerosol using an oxidative flow reactor.

Research plan phase II

Main Goal: Understand the effects of aerosol particles from aviation and other sources on cirrus cloud formation in the tropopause region.

WP1: Aerosol composition in the tropopause region (led by J. Schneider)

- Evaluate UTLS aerosol composition data from previous (since 2014) and upcoming HALO missions as well as from regular IAGOS-CARIBIC flights.
- Measure aerosol size distribution and composition to study aerosol transport processes and aerosol-cloud interactions during the Learjet campaign TPEx II.
- Analyse oxygenation effects of lubrication oil and other aircraft exhaust particles (together with WP3).

WP2: Aerosol and cirrus measurement during the Learjet campaign TPEx II (led by Y. Li)

- Measure and analyse aerosol and cirrus particles with various particle counters and cloud probes.
- Analysis of aerosols and cirrus clouds in combination with Lagrangian models.

WP3: Aircraft lubrication oil oxidation and AIDA cloud chamber experiments (led by A. Vogel)

- Study ice formation and aging of lubrication oil particles.
- Simulate contrail formation by surrogate aircraft engine particles.
- Study ice formation from aircraft surrogate aerosol under realistic UTLS conditions at the AIDAd and AIDAc2.