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GLORIA Observations of Dichloromethane and Peroxyacetyl Nitrate Filaments in the UTLS during PHILEAS 2023

The limb-imaging Fourier transform infrared spectrometer GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere) enables high-resolution remote sensing of trace gases in the upper troposphere and lower stratosphere (UTLS). During the PHILEAS (Probing High Latitude Export of Air from the Asian Summer Monsoon) campaign in August and September 2023, GLORIA was deployed aboard the German research aircraft HALO (High Altitude and Long Range Research Aircraft) to investigate stratosphere-troposphere exchange processes and long-range pollutant transport from the Asian Summer Monsoon (ASM).

Observations revealed extensive filaments enriched in dichloromethane (CH_2Cl_2) and peroxyacetyl nitrate (PAN) within the free troposphere and tropopause region over the Northern Pacific, Canada, and Alaska. CH_2Cl_2 , an industrial solvent and precursor chemical with reported increased emissions primarily from East and Southeast Asia, has been described as a potential contributor to stratospheric ozone depletion. Concurrently, PAN, a key tracer of pollution, was detected in similar structures. While PAN is primarily associated with biomass burning, it also forms as a secondary product of anthropogenic combustion processes. Notably, smaller filaments of both species were identified in the tropopause region.

To analyze transport mechanisms and timescales, we utilized backward trajectories computed with HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory model). Furthermore, we used ICON-ART (ICOsahedral Nonhydrostatic weather- and climate model with Aerosols and Reactive Trace gases) surface tracers to compare the measured cross sections from GLORIA to different origin regions and to follow the transport of ASM air within and into the UTLS. We discuss the vertical uplift processes in the ASM region and the fast transportation pathways across the North Pacific.

Topic

Atmospheric composition (Earth and planets), chemistry and transport

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