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Measurements of HCl and HNO_3 with the new research aircraft HALO – Quantification of the stratospheric contribution to the O_3 and HNO_3 budget in the UT/LS

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Dynamic and chemical processes modify the ozone (O_3) budget of the upper troposphere/lower stratosphere, leading to locally variable O_3 trends. In this region, O_3 acts as a strong greenhouse gas with a net positive radiative forcing. It has been suggested, that the correlation of the stratospheric tracer hydrochloric acid (HCl) with O_3 can be used to quantify stratospheric O_3 in the UT/LS region (Marcy et al., 2004). The question is, whether the stratospheric contribution to the nitric acid (HNO_3) budget in the UT/LS can be determined by a similar approach in order to differentiate between tropospheric and stratospheric sources of HNO_3.

To this end, we performed in situ measurements of HCl and HNO_3 with a newly developed Atmospheric chemical Ionization Mass Spectrometer (AIMS) during the TACTS (Transport and Composition in the UTLS) / ESMVal (Earth System Model Validation) mission in August/September 2012. The linear quadrupole mass spectrometer deployed aboard the new German research aircraft HALO was equipped with a new discharge source generating SF_5^- reagent ions and an in-flight calibration allowing for accurate, spatially highly resolved trace gas measurements. In addition, sulfur dioxide (SO_2), nitrous acid (HONO) and chlorine nitrate ($ClONO_2$) have been simultaneously detected with the AIMS instrument.

Here, we show trace gas distributions of HCl and HNO_3 measured during a North-South transect from Northern Europe to Antarctica (68°N to 65°S) at 8 to 15 km altitude and discuss their latitude dependence. In particular, we investigate the stratospheric ozone contribution to the ozone budget in the mid-latitude UT/LS using correlations of HCl with O_3. Differences in these correlations in the subtropical and Polar regions are discussed. A similar approach is used to quantify the HNO_3 budget of the UT/LS. We identify unpolluted atmospheric background distributions and various tropospheric HNO_3 sources in specific regions.

Our observations can be compared to data from remote sensing instruments. Further, they will help to validate global chemistry-climate models to gain a better understanding of the trace gas distribution in the UT/LS.

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