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Transport processes in the lowermost stratosphere - interhemispheric differences from trace gas observations during WISE and SouthTRAC

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The lowermost stratosphere (LMS) plays an important role in determining the Earth's energy budget. The chemical species that absorb and re-emit radiation in the LMS have a large spatial and temporal variability, which is controlled by mixing and transport processes. The troposphere and middle stratosphere affect the LMS through large scale isentropic transport across the tropopause or downwelling from higher altitudes.

The data presented in this study originates from two HALO measurement campaigns that allow an interhemispheric comparison of the composition of the lower stratosphere: First the WISE campaign which took place in September and October 2017 over Europe and the North Atlantic, and second the mission SouthTRAC (September and November 2019) where measurements focused on South America and the region around the Antarctic Peninsula.

We use high resolution in-situ measurements of different trace gases (N_2O, O_3, CO_2, CO, SF_6) in order to quantify transport time scales, to estimate tracer fluxes and to examine the prevalent transport pathways. Particularly correlations of trace gases of different lifetime can provide insight in the origin of air masses in the lower stratosphere and their transport histories.

During WISE a remarkable change of the N_2O-O_3 correlation at the 380 K potential temperature isentrope indicates a surprisingly strong distinction between the lowermost stratosphere and the stratosphere, suggesting two mixing regimes. Above 380 K, isentropic mixing occurs between stratospheric air masses from the tropics towards high latitudes leading to a slope flattening effect. In the lowermost stratosphere isentropic mixing connects the stratosphere with the tropical tropopause layer (TTL). Based on CO observations we quantify the contribution of air from the TTL

to reach 60 % - 80 % in the LMS. Using CO_2 measurements we estimate a typical time scale of less than 30 days for transport from the TTL into the LMS.

These methods are applied to the observations during SouthTRAC as well. Preliminary CO budget calculations suggest a smaller contribution of TTL air to the LMS in the order of 50 %. This analysis along with correlation slope studies allow for an interhemispheric and interseasonal comparison of the transport processes that were observed during the two measurement periods.