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Seasonal cycles and variability of O_3 and H_2O in the UT/LMS during SPURT

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Abstract. Airborne high resolution in situ measurements of a large set of trace gases including ozone (O_3) and total water (H_2O) in the upper troposphere and the lowermost stratosphere (UT/LMS) have been performed above Europe within the SPURT project. SPURT provides an extensive data coverage of the UT/LMS in each season within the time period between November 2001 and July 2003.

In the LMS a distinct spring maximum and autumn minimum is observed in O_3, whereas its annual cycle in the UT is shifted by 2–3 months later towards the end of the year. The more variable H_2O measurements reveal a maximum during summer and a minimum during autumn/winter with no phase shift between the two atmospheric compartments.

For a comprehensive insight into trace gas composition and variability in the UT/LMS several statistical methods are applied using chemical, thermal and dynamical vertical coordinates. In particular, 2-dimensional probability distribution functions serve as a tool to transform localised aircraft data to a more comprehensive view of the probed atmospheric region. It appears that both trace gases, O_3 and H_2O, reveal the most compact arrangement and are best correlated in the view of potential vorticity (PV) and distance to the local tropopause, indicating an advanced mixing state on these surfaces. Thus, strong gradients of PV seem to act as a transport barrier both in the vertical and the horizontal direction. The alignment of trace gas isopleths reflects the existence of a year-round extra-tropical tropopause transition layer. The SPURT measurements reveal that this layer is mainly affected by stratospheric air during winter/spring and by tropospheric air during autumn/summer.

Normalised mixing entropy values for O_3 and H_2O in the LMS appear to be maximal during spring and summer, respectively, indicating highest variability of these trace gases during the respective seasons.

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