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Observed fine-scale filamentary structure in chemical tracer distributions near the subtropical jet following a wave breaking event

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This presentation shows a set of observations and analyses of trace gas cross-sections in the extratropical upper troposphere / lower stratosphere (UTLS). The spatially highly-resolved (≈0.5 km vertically and 12.5 km horizontally) cross-sections of ozone (O_3), nitric acid (HNO_3), and peroxyacetyl nitrate (PAN), retrieved from the measurements of the CRISTA-NF infrared limb sounder flown on the Russian M55-Geophysica, revealed intricate layer structures in the region of the subtropical tropopause break.

The chemical structure in this region shows an intertwined stratosphere and troposphere. The observed filaments in all discussed trace gases are of a spatial scale of less than 0.8 km vertically and about 200 km horizontally across the jet-stream. While such filaments are predicted by models, they are often analysed on isentropic surfaces. The presented results shows that these structures also exist in the vertical and that they may not always be aligned with the isentropes.

Backward trajectory calculations confirm that the observed filaments are the result of a breaking Rossby wave in the preceding days. The trajectory study is followed up with an analysis of the trace gas relationships between PAN and O_3 that identifies four distinct groups of air mass: polluted subtropical tropospheric air, clean tropical upper-tropospheric air, the lowermost stratospheric air, and air from the deep stratosphere. The tracer relationships further allow the identification of tropospheric, stratospheric, and the transitional air mass made of a mixture of UT and LS air. Mapping of these air mass types onto the geo-spatial location in the cross-sections reveals a highly structured 2-D image of the extratropical transition layer (ExTL).

In combination, these diagnostics provide the first example of a multi-species two-dimensional picture of a chemically inhomogeneous UTLS region. Since Rossby wave breaking occurs frequently in the region of the tropopause break, these observed fine scale filaments are likely ubiquitous in the region.