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Mixing processes and exchanges in the tropical and the subtropical UT/LS

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Abstract. Both in situ measurements and satellite observations indicate evidence of mixing in the upper troposphere (UT) and the lower-stratosphere (LS). In this study, the measurements performed during the Pre-AVE and Costa-Rica AVE campaigns are analysed with diffusive back-trajectories to assess mixing properties in the tropical and the subtropical UT/LS. A description of cross-tropopause pathways and mixing time scales is provided.

In the subtropics, Troposphere-Stratosphere mixing processes are found to differ in the vicinity of the tropopause and at higher altitudes. Below 350 K, a mixing line observed during Pre-AVE is shown to result from fast and local cross-tropopause irreversible exchange, involving two initially distant air masses with distinct chemical compositions. For measurements located above 350 K, mixing of the tropospheric air in the subtropical stratosphere occurs over a period of a month, the origins of the tropospheric source being localised in the tropical UT and the tropical boundary layer.

In the tropics, quantitative reconstructions of CO and O₃ profiles above 360 K are obtained for one month back-trajectories calculations, pointing out that long term mixing is essential to determine the chemical composition in the tropical ascent. In particular, the existence of two-way meridional irreversible exchanges between 360 and 450 K is found to export tropical air in the subtropical stratosphere and to entrain old stratospheric air in the tropical ascent. Mean age of air calculated with a Lagrangian model is shown to be in agreement with the CO₂ observations.

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