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Diabatic processes associated with stratosphere-troposphere exchange and the link to synoptic and mesoscale features

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Air mass and the enclosed pollutants are transported across the tropopause (here defined as the 2 pvu isosurface) in so-called STE (stratosphere-troposphere exchange) events. Several studies focused on the dynamical features associated with these STE events, among them breaking Rossby waves and extra-tropical cyclones. In this study we combine several data sets derived from ERA-40 and ERA-15 reanalysis to shed further light on the physical processes associated with STE.

In a first part, we adopt a fluid parcel's perspective, and follow its 3d trajectory from the stratosphere to the troposphere (for STT) and vice versa for the opposite direction (TST). Thereby, the state of the atmosphere is sampled along the trajectory with respect to diabatic processes, for instance turbulence indicators, condensational and radiative heating. This will finally allow to determine which diabatic processes are associated with the crossing of the tropopause, which constitutes a barrier for any adiabatic flow. Special focus will also given to the possibility of STE on isentropic surfaces, so-called isentropic transport. Detailed case studies illustrate that nearly isentropic transport is possible and indeed fairly common.

In a second part, consideration is given to the meso- and synoptic-scale features which are associated with STE events, including extratropical cyclones and anticyclones, tropopause folds and atmospheric blockings. Particular focus is given to the link with potential vorticity (PV) streamers, which are defined as extrusions of stratospheric (tropospheric) air towards the south (north). The PV streamers (based upon ERA-15

reanalysis) are identified on isentropic surfaces from 300 to 350 K, and are then used to quantitatively determine their impact on STE. It turns out that most STE events can be found in the vicinity of PV streamers.