Transport timescales and tracer properties in the extratropical UTLS

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A comprehensive evaluation of seasonal backward trajectories initialized in the northern hemisphere lowermost stratosphere (LMS) has been performed to investigate the factors that determine the temporal and spatial structure of troposphere-to-stratosphere-transport (TST) and it's impact on the LMS. In particular we explain the fundamental role of the transit time since last TST (tTST) for the chemical composition of the LMS. According to our results the structure of the LMS can be characterized by a layer with tTST<40 days forming a narrow band around the local tropopause. This layer extends about 30 K above the local dynamical tropopause, corresponding to the extratropical tropopause transition layer (ExTL) as identified by CO. The LMS beyond this layer shows a relatively well defined separation as marked by an aprupt transition to longer tTST indicating less frequent mixing and a smaller fraction of tropospheric air. Thus the LMS constitutes a region of two well defined regimes of tropospheric influence. These can be characterized mainly by different transport times from the troposphere and different fractions of tropospheric air.

Carbon monoxide (CO) mirrors this structure of tTST due to it's finite lifetime on the order of three months. Water vapour isopleths, on the other hand, do not uniquely indicate TST and are independent of tTST, but are determined by the Lagrangian Cold Point (LCP) of air parcels. Most of the backward trajectories from the LMS experienced their LCP in the tropics and sub-tropics, and TST often occurs 20 days after trajectories have encountered their LCP. Therefore, ExTL properties deduced from CO and H2O provide totally different informations on transport and particular TST for the LMS.

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