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A Lagrangian climatology of stratosphere-troposphere exchange derived from the ERA-40 data set - its features and limitations

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A Lagrangian diagnostic to identify stratosphere-troposphere exchange (STE) is applied to the ERA40 data set and other existing data sets from the ECMWF. In principle, the availability of the ERA40 data set offers for the first time the possibility to investigate STE of mass and ozone on multi-decadal time periods with relatively high resolutions.

As the ongoing debate about stratospheric influence on the troposphere and UT/LS chemistry shows, a reliable knowledge of the regions of STE is of great interest also for future climate change policies. The climatologies for mass and ozone STE fluxes presented here show preferred regions of stratosphere-to-troposphere transport (STT) and troposphere-to-stratosphere transport (TST) in the mid-latitudes. This emphasizes the importance of synoptic-scale features for STE in addition to then mean Brewer-Dobson circulation pattern.

Furthermore, different ECMWF data sets are used to assess the sensitivity of Lagrangian STE fluxes to the underlying meteorological data set. The experiments show a certain dependence of the integrated mass fluxes to the data assimilation system used (optimum interpolation vs. variational methods) and (less important) to the spatial and temporal resolution of the input data. In contrast hereto, the geographical patterns of the fluxes vary much less. The sensitivity experiments can be used to estimate the accuracy of the derived fluxes.

On the other hand, homogeneity issues, i.e. shifts in the assimilated data types, e.g.

from the terrestrial based observing system in the earlier parts of the ERA-40 to the current, satellite-dominated earth observing system are of crucial importance. The inherited inhomogeneities in the ERA-40 time period may hamper a trend analysis and add non-negligible uncertainties to a wide range of tools applied to diagnose fluxes across atmospheric levels. This is shown by analysis of a observation system experiment (OSE) in the late ERA-40 period.