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What do CO and Water Vapour tell us about transport in the UTLS?

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Any given air parcel in the UTLS (upper troposphere/lower stratosphere) can be regarded as a mixture of air with distinct histories involving different chemical composition and transport pathways. Time scales and transport regimes in the lowermost stratosphere can be assessed by tracers with different properties and chemical lifetimes and relatively constant stratospheric backgound values. We use comprehensive in-situ data of O_3, CO and H_2O from airborne measurements from the mid nineties to present day to investigate the relation of CO, H_2O and transport regimes in the extratropical UTLS. This observational-based analysis is complemented by an investigation of large sets of seasonal backward trajectories originating in the UTLS.
Using H_2O-variability and ozone to determine the hygropause in the extra tropics we find a seasonally varying upper isentropic boundary of enhanced water vapour. It is largely controlled by the annual temperature cycle at the (sub-)tropical tropopause and the strength of the downwelling induced by the Brewer-Dobson circulation rather than by processes at the extratropical tropopause. From the CO-distribution, different transport boundaries can be deduced. At the Θ=450 K isentropic level, a robust transition to the stratosphere is evident from the observations. Below, CO-deduced transport regimes indicative for more recent tropospheric influence show a larger variability. This can be related to shorter transient times between the troposphere and the stratosphere and to a larger variability of source regions including the extra tropics.