Lagrangian-based reconstruction of the tracers for stratospheric variability diagnosis

Mohamadou Diallo[1], Felix Ploeger[1], Bernard Legras[2], Paul Konopka[1], Eric Ray[3], Andreas Engel[4], Juan A. Añel[5], Rölf Müller[1] and Martin Riese[1]

[1]Institute of Energy and Climate Research, Stratosphere (IEK-7), Forschungszentrum Jülich, Jülich, Germany.

[2]Laboratoire de Météorologie Dynamique, UMR8539, IPSL, UPMC/ENS/CNRS/Ecole Polytechnique, Paris, France.

[3]Chemical Sciences Division, Earth Systems Research Laboratory, NOAA, Boulder, Colorado, USA.

[4]Institute for Atmospheric and Environmental Sciences, Goethe University Frankfurt, Frankfurt am Main, Germany.

[5]EPhysLab, Facultade de ciencias, Universidade de Vigo, Ourense, Spain

Correspondence to: M. Diallo (m.diallo@fz-juelich.de)

The small-scale variability of tracers (CO_2, O_3, CO), their strong gradients across the tropopause, and the scarcity of suitable observations for validation purposes lead to a challenging task for CTMs and CCMs in reconstructing their distribution in the Upper Troposphere and Lower Stratosphere (UTLS).

To do so, we construct a new monthly zonal mean CO_2 distribution within the UTLS over the 2000–2010 time period. This reconstructed CO_2 product is based on a Lagrangian backward trajectory model driven by ERA-Interim reanalysis meteorology and tropospheric CO_2 measurements.

Comparisons of our CO_2 product to extra-tropical in situ measurements from aircraft transects, balloon and CLaMS profiles show remarkably good agreement. That demonstrates the potential of the TRACZILLA and CLaMS models to reconstruct CO_2 in the UTLS. The main features of the CO_2 distribution include (1) relatively large mixing ratios in the tropical stratosphere, (2) seasonal variability in the extra-tropics with relatively high mixing ratios in the summer and autumn hemisphere in the 15–20 km altitude layer due to the Summer Asian Monsoon, and (3) decreasing mixing ratios with increasing altitude from the upper troposphere to the middle stratosphere ($\sim$35 km). These features are consistent with expected variability due to the transport of long-lived trace gases by the stratospheric Brewer-Dobson circulation and by the Summer Asian Monsoon anticyclone.

The method used here to construct this CO_2 product is unique from other modeling efforts and should be useful for model and satellite validation in the UTLS, as a prior for inversion modeling and to analyze features of stratosphere-troposphere exchange as well as the stratospheric circulation and its variability.

Finally, we will present our most recent findings about the El niño and La niña influence in the lower stratosphere using the O_3 and CO products from CLaMS model and Microwave Limb Sounder observations.