SPARC Workshop SHARP2016

Diagnostis of the Upper Troposphere-Stratosphere exchanges using CO2 tracer gas

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Currently, most of our knowledge of the upper-tropospheric-stratospheric global distribution of the carbon dioxide (CO2), is limited by the uncertainty in the sparseness of in situ measurements and in transport and mixing processes. With a strengthening shallow branch of the Brewer-Dobson circulation (BDC) , the CO2 and other halocarbons increases is expected in the UT/LS and can change the stratospheric radiative forcing.

This study uses the estimated mean AoA and the inert feature of the CO2 over the 2000-2010 period to investigate the stratospheric transport and mixing processes and the possible increase of the stratospheric CO2 due to the BDC changes. The monthly mean CO2 and AoA reconstructed from the backward trajectories guided by ERA-Interim re-analyses is compared with those from stratospheric balloons, SOLVE and CONTRAIL campaigns and ACE-FTS satellite retrieval CO2. The inter-comparison between the in situ observations and reconstructions revealed a fairly good agreement. That demonstrates the potentiality of using lagrangian reconstruction in order to better understand the stratospheric transport and mixing processes. The zonal distribution exhibits a high CO2 in the tropical stratosphere due to the tropical upwelling of BDC and to the efficiency of Rossby wave strengthening the fast quasi-horizontal mixing. In winter and spring, the tropical pipe is confined in the tropical band while it is spread during summer and autumn permitting high CO2 to reach the high stratosphere. The seasonal variations of the mean AoA and CO2 anomalies are dominated by the seasonal variation of the mixing barriers such as the subtropical barrier, which isolates the tropical pipe from surf zone in the overworld, and the tropopause barrier, which limits cross-tropopause mixing between the tropical tropopause layer and the mid-latitude lowermost stratosphere in winter. The variation of the barriers permeability seasonally modulates the efficiency of the UT/LS exchanges.