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CO₂ seasonal distributions in the UT/LS region as observed by CONTRAIL and four transport models

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In the Comprehensive Observation Network for Trace gases by AirLiner (CONTRAIL) project, high-frequency and wide-ranging CO₂ data in the upper troposphere(UT)/lower stratosphere(LS) region have been obtained by Continuous CO₂ Measuring Equipment (CME) onboard commercial aircraft operated by Japan Airlines (JAL).

The observed distributions in UT/LS region showed that CO₂ isopleths followed the tropopause during the winter and spring. On the other hand, distributions tracked potential temperature surfaces crossing the tropopause in summer, suggesting fast meridional transport of high CO₂ from the tropical troposphere. However, it is difficult to show how the tropospheric air masses intrude into the lower stratosphere across the tropopause due to the limited observational data.

Recently, we conducted CONTRAIL transport model intercomparison to improve our knowledge of three-dimensional structures of atmospheric CO₂. The distributions in UT/LS region simulated by four global chemical transport models (ACTM, MJ98-CDTM, NICAM-TM, NIES) with common CO₂ flux dataset were used to study the transport processes near the tropopause. It was shown that the models reproduced observed CO₂ distributions following the tropopause in winter-spring season, although the CO₂ gradients across the tropopause are underestimated by approximately 2 ppm between 300 and 350 K in potential temperature surfaces. In summer, the isentropic transport of high CO₂ from the upper-troposphere in lower latitudes to the lower-stratosphere in higher latitudes were well simulated by the models. The detailed processes of transport will be analyzed and shown in the meeting.

Keywords: CO₂, transport model, UT/LS exchange