Geophysical Research Abstracts
Vol. 13, EGU2011-4727-1, 2011
EGU General Assembly 2011

CO_2 seasonal variations in the UT/LS region as observed by CONTRAIL and four transport models

Yosuke Niwa (1), Yousuke Sawa (1), Prabir Patra (2), Toshinobu Machida (3), Hidekazu Matsueda (1), and the CONTRAIL-TMI Team

(1) Meteorological Research Institute, Tsukuba, Japan (yniwa@mri-jma.go.jp), (2) Research Institute for Global Change/JAMSTEC, Yokohama, Japan, (3) National Institute for Environmental Studies, Tsukuba, Japan

The upper troposphere (UT) and lower stratosphere (LS) is crossroad of tropospheric air pollution and photochemically produced species in the stratosphere. It is thus important to understand the stratosphere—troposphere exchange (STE) processes that allow transport of chemical species across the tropopause. Recently, transport of chemically and radiatively active short-lived species, such as water vapour, sulphur species, halogenated compounds and aerosols from troposphere to stratosphere has been studied in greater details using atmospheric transport models. Here we used carbon dioxide (CO_2) as a tracer of the interest, which is no photochemical loss/production in both troposphere and stratosphere and has very strong seasonality in surface fluxes, to analyze the role of surface fluxes and UT/LS transport processes in tracer distribution.

We used atmospheric CO_2 observations from the Comprehensive Observation Network for Trace gases by Airliner (CONTRAIL) project. In CONTRAIL project, high-frequency and wide-ranging CO_2 data in the UT/LS region have been obtained by Continuous CO_2 Measuring Equipment (CME) aboard commercial aircraft of Japan Airlines (JAL). Transport simulations of atmospheric CO_2 were performed by four global chemical transport models (ACTM, MJ98-CDTM, NICAM-TM, NIES) using common CO_2 fluxes. The model simulations were first sampled along the individual CONTRAIL flight tracks and then monthly means were constructed. The simulated and CONTRAIL CO_2 concentrations for the period of 2006—2007 were then converted to equivalent latitude and potential temperature coordinate system for analyzing the UT/LS distribution. In the previous study, the models were evaluated for surface CO_2 concentrations and vertical profiles over the airport, which showed satisfactory results. However, transport model abilities to simulate the CO_2 distributions in the UT/LS region have been not fully understood.

During winter—spring, all the models successfully reproduced longitudinal CO_2 variations along the flight paths. Although the magnitudes of the gradients are underestimated in some cases, the patterns of longitudinal variations are mutually similar. On the other hand, in July, some models produced consistent longitudinal variations, meanwhile those simulated by the other models are almost flat. This fact suggests that producing longitudinal variations is more difficult in summer than in winter—spring. Comparison of CO_2 distributions over flight paths between Japan and Europe in the common equivalent latitude—potential temperature coordinate shows that the models reproduced observed CO_2 distributions following the tropopause in winter—spring. The CO_2 gradients across the tropopause are underestimated by approximately 2 ppm between $\Theta = 300$ K and $\Theta = 350$ K surfaces. In summer, the isentropic transport of high CO_2 from the upper-troposphere in lower latitudes to the lower-stratosphere in higher latitudes were well simulated by the models, though significant differences in CO_2 across $\Theta = 340$ K surfaces persist.