Impact of photochemical and meteorological processes within boundary layer and stratosphere-troposphere exchange on vertical ozone

Xiaoyang CHEN[1], Yiming LIU[1], Anqi LAI[1], Qi FAN[1,*], Shuangshuang HAN[2,3], Xuemei WANG[4], Zhenhao Ling[1], Fuxiang HUANG[2]

[1] *School of Atmospheric Sciences, Sun Yat-Sen University, Guangzhou 510275, China*

[2] *National Satellite Meteorological Center, Beijing 100081, China*

[3] *School of Earth Sciences and Resources, China University of Geosciences, Beijing 100083, China*

[4] *Institute for Environmental and Climate Research, Jinan University, Guangzhou 510632, China*

To study effects of photochemical and meteorological processes within boundary layer and stratosphere-troposphere exchange on vertical ozone, the Weather Research and Forecasting (WRF) and the Community Multi-scale Air Quality (CMAQ) models as well as the process analysis tool were used to simulate a monthly period of August 2012 in southern China. Data from an in situ monitoring network and five ozone sondes observed by Hong Kong Observatory were analyzed. A sensitive scenario without chemical initial and boundary conditions (ICBCs), especially the stratospheric ozone, from MOZART4-GEOS5 was applied to study the impact of stratosphere-troposphere exchange (STE) on upper tropospheric ozone. By importing lower stratospheric ozone into the CMAQ model, the model would reproduce higher ozone column concentration within above ground height (AGH) of 5 km to 15 km, especially when high tropospheric ozone event occurred. The ozone column concentration observed on 8th AUG and 29th AUG were 26.0 DU and 28.8 DU, respectively. While simulated values were 25.6 DU and 30.1 DU with Mozart ICBCs comparing to 20.7 DU and 20.6 DU with no ICBCs. Results indicate that STE played an important role in mixing the ozone of the upper troposphere and lower stratosphere (UTLS). Additional two sensitive scenarios cut 30% anthropogenic NO_X or 30% VOCs emissions, respectively, to study O_3 formation mechanism at different vertical levels. Results showed that the occurrence of high ozone “tongue” around 500 m and 2 km AGH at Hong Kong downtown are mainly caused by upwind transportation and self-producing of ozone, respectively, with a transition zone locating around 1 km AGH.

Key words: CMAQ, tropospheric ozone, vertical ozone profiles, stratosphere-troposphere exchange