Geophysical Research Abstracts
Vol. 20, EGU2018-4067, 2018
EGU General Assembly 2018

Ozone seasonal evolution and photochemical production regime in polluted troposphere in eastern China derived from high resolution FTS observations

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A precise knowledge of ozone seasonal evolution and photochemical production regime in polluted troposphere in China has important policy implications for ozone pollution controls especially in megacities where ozone pollution is common throughout the year. In this study, we used tropospheric ozone, CO and HCHO columns derived from high resolution Fourier transform infrared spectrometry (FTS) in Hefei, China, tropospheric NO_2 columns deduced from overpass Ozone Monitoring Instrument (OMI), surface meteorological data, and a back trajectory cluster analysis technique to investigate ozone seasonal evolution and photochemical production regime in eastern China from 2014 - 2017. A pronounced seasonal cycle for tropospheric ozone is captured by FTS, where high levels of tropospheric ozone occurs in spring and summer, and low levels of tropospheric ozone occurs in autumn and winter. Day-to-day variations in spring and summer are in most cases larger than those in autumn and winter. At the same time, it shows that the tropospheric ozone roughly increases over time at the first half year 30 and reaches the maximum in June, and then it decreases over time at the second half year. Tropospheric ozone columns in June are, on average, 0.5×10^{18} molecules*cm^{-2} (47.6%) higher than those in December which has a mean value of 1.05×10^{18} molecules*cm^{-2}. The OMI time series shows similar behaviour. The measured features can basically be reproduced by GEOS-Chem and WRF-Chem data but with slight shifts in the timing of the seasonal maximum. Back trajectories analysis shows that: air pollutions in megacities in central-southern China, northwest China, and the key pollution area, i.e., Yangtze River Delta area in eastern China, dominates the contributions to the observed tropospheric ozone levels, while the contributions from the other two key pollution areas, i.e., Beijing-Tianjin-Hebei in north China and Pearl River Delta in south China, are very small; Air masses generated from polluted areas have more transportations to the observed area in spring and summer than in autumn and winter, and hence have more contributions to the observed tropospheric ozone levels. Correlations between tropospheric ozone and meteorological data disclosed that spring and summer is more favorable to photochemical ozone production than in autumn and winter. Finally, the HCHO/NO_2 ratio is used as a proxy to investigate the chemical sensitivity of ozone production (PO_3). The results show that the PO_3 is mainly NO_x limited in summer, while it is mainly VOC or mix VOC-NO_x limited in winter. Statistics show that NO_x limited, mix VOC-NO_x limited, and VOC limited PO_3 accounts for 60.1%, 28.7%, and 11%, respectively.