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

Cheng Liu¹, ², Youwen Sun², Mathias Palm³, Corinne Vigouroux⁴, Justus Notholt³, Martine De Mazière⁴
1 University of Science and Technology of China, Hefei, 230026, China
2 Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Hefei, 230031, China
3 University of Bremen, Institute of Environmental Physics, P. O. Box 330440, 28334 Bremen, Germany
4 Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, Belgium
Correspondence email: chliu81@ustc.edu.cn

Site Description and Instrument Description

Site descriptions:
- Located in an island in the western suburbs of Hefei city (the capital of Anhui province) in central-eastern China.
- Adjacent to a lake with a longitude of 117° 10′E, latitude of 31° 54′N and altitude of 30m.

Instruments descriptions:
- Consists of a FTS spectrometer IFS 125HR and a solar tracker. Both of them are purchased from Bruker Company.
- The MIR spectra are recorded over a wide spectral range (about 600 – 4500 cm⁻¹) with a spectral resolution of 0.005 cm⁻¹. The instrument is equipped with a KBr beam splitter & a MCT detector for O³ and a KBr beam splitter & an InSb detector for other gases, and it has seven optical filters to avoid detector non-linearity.

Methodology

Retrieval strategy:
- The SFIT4 (version 0.9.4.4) software based on optimal estimation algorithm is used in the profile retrieval.
- Tropospheric O³, CO and HCHO columns derived from FTS retrievals via integration over ground to 12km. Tropospheric NO₂ columns deduced from overpass OMI observations.

Evolution and production regime:
- The back trajectory cluster analysis tool HYSPLIT is used to determine the relative contribution ratio to the observed O³ level.
- The sensitivity of ozone production (PO₃) relative to meteorological parameters, CO, HCHO, and NO₂ changes are used to determine O₃ production regime.

Results

- The tropospheric O₃ roughly increases over time at the first half year and reaches the maximum in June, and then it decreases over time at the second half year.
- Air pollutions in megacities in central-southern China, northwest China, and the Yangtze River Delta area in eastern China, dominates the contributions, 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.
- The PO₃ is mainly NOₓ limited in summer and mainly VOC or mix VOC-NOₓ limited in winter. NOₓ, mix VOC-NOₓ, and VOC limited PO₃ accounts for 60.1%, 28.7%, and 11%, respectively.

Sun & Liu et al., Atmos. Chem. Phys., 2018