Geophysical Research Abstracts
Vol. 15, EGU2013-4700, 2013
EGU General Assembly 2013

Satellite observation of lowermost tropospheric ozone by multispectral synergism of IASI thermal infrared and GOME-2 ultraviolet measurements

Juan Cuesta (1), Maxim Eremenko (1), Xiong Liu (2), Gaëlle Dufour (1), Zhaonan Cai (3), Michael Höpfner (4), Thomas von Clarmann (4), Pasquale Sellitto (1), Gilles Forêt (1), Benjamin Gaubert (1), Matthias Beekmann (1), Johannes Orphal (4), Kelly Chance (2), Robert Spurr (5), and Jean-Marie Flaud (1)

(1) Laboratoire Interuniversitaire des Systèmes Atmosphériques / UPEC - IPSL, Créteil, France (juan.cuesta@lisa.u-pec.fr), (2) Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA, (3) Key Laboratory of Middle Atmosphere and Global Environment Observation, IAP, CAS, Beijing, China, (4) Karlsruher Institut für Technologie, IMK, Karlsruhe, Germany, (5) RT Solutions Inc., Cambridge, USA

Lowermost tropospheric ozone is a major factor determining air quality in densely populated megacities. During pollution events, knowledge on the 3D regional distribution of ozone in and around these urban areas is key for assessing its impact on health of population and ecosystems damages. Temporal and spatial coverage of spaceborne observations are particularly fitted for monitoring tropospheric ozone spatial distribution at the regional scale and offers a great potential for improving air quality forecasting with numerical regional models. However, current tropospheric ozone retrievals using uncoupled either ultraviolet (UV) or thermal infrared (TIR) spaceborne observations show limited sensitivity to lowermost troposphere ozone (up to 3 km of altitude), which is the major concern for air quality, and they are mainly sensitive to ozone at the free Troposphere (at lowest 3-4 km of altitude). In this framework, we have developed a new multispectral approach for observing lowermost tropospheric ozone from space by synergism of atmospheric TIR radiances observed by IASI and earth UV reflectances measured by GOME-2. Both instruments are onboard the series of MetOp satellites (in orbit since 2006 and expected until 2022) and their scanning capabilities offer global coverage every day, with a relatively fine ground pixel resolution (12-km-diameter pixels spaced by 25 km for IASI at nadir). Our technique uses altitude-dependent Tikhonov-Phillips-type constraints, which optimize sensitivity to lower tropospheric ozone. It integrates the VLIDORT and KOPRA radiative transfer codes for simulating UV reflectance and TIR radiance, respectively. We have used our method to analyse real observations over Europe during an ozone pollution episode in the summer of 2009. The results show that the multispectral synergism of IASI (TIR) and GOME-2 (UV) enables the observation of the spatial distribution of ozone plumes in the lowermost troposphere (LMT, from the surface up to 3 km msl, above mean sea level), in good quantitative agreement with the CHIMERE regional chemistry-transport model. When high ozone concentrations extend vertically above 3 km msl, they are similarly observed over land by both the multispectral and IASI retrievals. On the other hand, ozone plumes located below 3 km msl are only clearly depicted by the multispectral retrieval (both over land and over ocean). This is achieved by a clear enhancement of sensitivity to ozone in the lowest atmospheric layers. The multispectral sensitivity in the LMT peaks at 2 to 2.5 km msl over land, while sensitivity for IASI or GOME-2 only peaks at 3 to 4 km msl at lowest (above the LMT). The degrees of freedom for the multispectral retrieval increase by 40 % (21 %) with respect to IASI only retrievals for atmospheric partial columns up to 3 km msl (6 km msl). Validations with ozonesondes show that our synergetic approach for combining IASI (TIR) and GOME-2 (UV) measurements retrieves lowermost tropospheric ozone with a mean bias of 2 % and a precision of 16 %, when smoothing by the retrieval vertical sensitivity (1 % mean bias and 24 % precision for direct comparisons).