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Satellite Multispectral Remote Sensing of Ozone Pollution

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Abstract : Satellite observation is a fundamental component of air pollution monitoring systems, such as the large-scale Copernicus Programme. Next-generation satellite sensors, in orbit or programmed in the future, offer great potential to observe major air pollutants, such as tropospheric ozone, with unprecedented spatial and temporal coverage. However, satellite approaches developed for remote sensing of tropospheric ozone are based solely on measurements from a single instrument in a specific spectral range, either thermal infrared or ultraviolet. These methods offer sensitivity to tropospheric ozone located at the lowest at 3 or 4 km altitude above the surface, thus limiting their applications for ozone pollution analysis. Indeed, no current observation of a single spectral domain provides enough information to accurately measure ozone in the atmospheric boundary layer. To overcome this limitation, we have developed a multispectral synergism approach, called "IASI+GOME2", at the Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA) laboratory. This method is based on the synergy of thermal infrared and ultraviolet observations of respectively the Infrared Atmospheric Sounding Interferometer (IASI) and the Global Ozone Monitoring Experiment-2 (GOME-2) sensors embedded in MetOp satellites that have been in orbit since 2007. IASI+GOME2 allowed the first satellite observation of ozone plumes located between the surface and 3 km of altitude (what we call the lowermost troposphere), as it offers significant sensitivity in this layer. This represents a major advance for the observation of ozone in the lowermost troposphere and its application to air quality analysis. The ozone abundance derived by IASI+GOME2 shows a good agreement with respect to independent observations of ozone based on ozone sondes (a low mean bias, a linear correlation larger than 0.8 and a mean precision of about 16 %) around the world during all seasons. Using IASI+GOME2, lowermost tropospheric ozone pollution plumes are quantified both in terms of concentrations and also in the amounts of ozone photo-chemically produced along transport and also enabling the characterization of the ozone pollution, such as what occurred during the lockdowns linked to the COVID-19 pandemic. The current paper will show the IASI+GOME2 multispectral approach to observe the lowermost tropospheric ozone from space and an overview of several applications on different continents and at a global scale.

Keywords : ozone pollution, multispectral synergism, satellite, air quality
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