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Global distributions of five major OVOCs retrieved from IASI measurements

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Oxygenated volatile organic compounds (OVOCs) have a significant impact on the atmospheric oxidative capacity and hence on methane lifetime. However, large uncertainties are associated with their current atmospheric budget estimates, mainly because of the paucity of global consistent measurements to constrain the distribution and magnitude of their various primary and/or secondary sources (e.g., terrestrial vegetation, anthropogenic emissions, biomass burning, oceans and the oxidation of precursor hydrocarbons). The global, spatially dense observations from nadir-viewing infrared sensors onboard meteorological satellites can help reducing these uncertainties but retrieving concentrations of atmospheric OVOCs from spaceborne infrared radiance spectra is challenging due to their weak, sometimes broadband spectral absorptions.

Here we present a general framework for fast retrieval of OVOC total columns from the Metop/IASI (Infrared Atmospheric Sounding Interferometer) observations. Initially developed for the retrieval of ammonia, the ANNI (Artificial Neural Network for IASI) method relies on a hyperspectral range index (HRI) for the quantification of the gas spectral signature and on an artificial neural network to convert the HRI into a gas total column. This method reveals particularly robust and sensitive to the detection of weak absorbers in IASI spectra and is used to retrieve twice-daily global total column distributions of five major atmospheric OVOCs: methanol, formic acid, PAN, acetone and acetic acid. Furthermore, its computing efficiency allows processing the decadal time series (from 2007) of IASI observations.

The comparison between the OVOC columns retrieved via this approach and those obtained using a physical inversion (optimal estimation method) shows an overall good agreement and is consistent with the conceptual differences between the two approaches. Independent OVOC measurements from aircraft campaigns and ground-based FTIR observations are also used to validate the IASI data. These new satellite products offer the opportunity to further investigate the distribution, sources, transport and seasonal and inter-annual variability of these dominant OVOCs. A 10-year climatology is presented for each species. Moreover, the retrieved IASI data allow the production of daily global pictures and regional quick-looks of OVOC columns, which we use to illustrate the spatial and temporal heterogeneity of these species as well as their dominant transport patterns, and to study specific events (e.g., fires and biomass burning plumes).