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How do improved injection heights and trace gas emission factors from biomass burning affect the performance of a global model against satellite and ground-based observations of trace gases?

Trissevgeni Stavrakou (1), Jean-Francois Müller (1), Maite Bauwens (1), Mikhail Sofiev (2), Thijs van Leeuwen (3), Guido van der Werf (3), Isabelle De Smedt (1), Michel Van Roozendael (1), Maya George (4), and Cathy Clerbaux (4)

(1) Belgian Institute for Space Aeronomy, Brussels, Belgium (jenny@oma.be), (2) Finnish Meteorological Institute, Helsinki, Finland, (3) Faculty of Earth and Life Sciences, VU University Amsterdam, The Netherlands, (4) UPMC Univ. Paris 06; Université Versailles St-Quentin; CNRS/INSU, LATMOS-IPSL, Paris, France

Vegetation fires are major contributors of trace gases and aerosols in the atmosphere affecting its composition and chemistry at different scales. The accurate quantification of fire emissions and their potential atmospheric impact is hampered by the strong spatiotemporal variability of this source, despite significant progress achieved over the last years in the development of fire emission inventories using fire detection and burned area mapping from satellite, as well as new constraints from inverse modelling studies of atmospheric trace gases.

This study is motivated by recent developments regarding (i) the derivation of vertical profile of smoke released by wildland fires, and (ii) the spatiotemporal variability in biomass burning emission factors, both representing important sources of uncertainty in biomass burning emissions. More specifically, monthly 3D global maps of the injected smoke fraction in the atmosphere, deduced from records of active fires from the MODIS instrument combined with a plume-top height parameterization (Sofiev et al. 2013), exhibit strong seasonal variations which are expected to be more representative of real atmospheric conditions than a unique injection profile as currently used in global models. Furthermore, accounting for the variability in space and time of trace gas emission factors from biomass burning (van Leeuwen et al. 2011, 2013), rather than static emission factors as in most studies, is a more physically plausible hypothesis owing to the strong spatiotemporal variability in different environmental parameters influencing the emission factors.

Here, we use the IMAGES global atmospheric model to evaluate the impact of improved injection heights and trace gas emission factors from biomass burning. To this purpose, different scenarios are designed with pyrogenic emissions emitted either at the surface, or according to the static latitude-dependent AEROCOM profile (Dentener et al. 2006), or using the injection heights of Sofiev et al. (2013), whereas either static or dynamic emission factors are used to convert biomass burnt into emitted trace gases. The surface mixing ratios and total columns of key compounds over biomass burning regions in each of these sensitivity cases are confronted with satellite and ground-based observations. Finally, the relevance of these parameters in the context of inverse modelling of emissions is assessed through source inversion experiments using the IMAGES model constrained by HCHO columns retrieved from the GOME-2 sounder.