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Middle East emissions of VOCs estimated using OMI HCHO observations and the MAGRITTE regional model

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Air quality in the Middle East has considerably deteriorated in the last decades. In particular tropospheric ozone reaches very high levels during summer due to the combination of high solar irradiances with often very high and rapidly evolving anthropogenic emissions of NO_x and VOCs associated to oil/gas exploitation and fast urbanisation. In addition, high biogenic VOC emissions are expected in non-desert areas, in particular during summer due to scorching temperatures and high solar irradiances. Both anthropogenic and biogenic VOC emissions are poorly known, however, due to near-absence of experimental constraints on emission factors for local vegetation and industrial and extraction processes. Furthermore, the dependence of emissions on environmental conditions (e.g. soil moisture in the case of biogenic isoprene emissions) is only very crudely parameterized in emission models.

Here we use spaceborne (OMI) observations of formaldehyde, a known product of anthropogenic and biogenic VOC oxidation, as constraint in an inversion framework built on a regional model, MAGRITTE (Model of Atmospheric composition at Global and Regional scales using Inversion Techniques for Trace Gas Emissions). MAGRITTE is run at 0.5x0.5 degree resolution, with lateral boundary conditions provided by the global CTM IMAGESv2 (Bauwens et al., 2016). The global and regional models share essentially the same chemistry and physical parameterizations. Emission inversion with MAGRITTE is performed using an adjoint-based iterative procedure, similar to previous inversions using IMAGES. Biogenic VOC emissions are calculated using MEGAN (Muller et al., 2008; Stavrakou et al., 2015), whereas the HTAPv2 emission dataset is used for anthropogenic emissions, with several adjustments for oil/gas exploitation and traffic emissions.
The OMI data are regridded onto the model resolution and averaged seasonally in order to reduce noise. Preliminary results indicate that biogenic isoprene emissions are a major VOC source in summertime throughout the "Fertile Crescent" from the Nile Valley to Iraq. Anthropogenic emissions from many large cities (e.g. Bagdad and Cairo) as well as from known oil extraction/refining/handling sites are well detected, while other cities (such as Riyadh) are elusive.