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Evaluation of soil moisture stress parameterizations in MEGAN model against MOFLUX field data and satellite observations of formaldehyde from OMI

Beata Opacka[1], Trissevgeni Stavrakou[1], Jean-François Müller[1], Maite Bauwens[1], Diego Miralles[2], Akash Koppa[2], Biranna Pagán[2,3], and Alex B. Guenther[4]

[1]Royal Belgian Institute for Space Aeronomy, Tropospheric Chemistry Modelling, Belgium (beata.opacka@aeronomie.be)
[2]Ghent University, Hydro-Climate Extremes Lab (H-CEL), Ghent, Belgium
[3]Space Sense.ai, Information Technology and Services, Paris, France
[4]University of California, Irvine, Department of Earth System Science, Irvine, CA, United States

Biogenic volatile organic compounds (BVOCs) are emitted globally at about 1,100 Tg per year, with almost half of the share entailed by isoprene. Isoprene is highly reactive in the atmosphere, and its degradation impacts the atmospheric composition through the generation of ozone (in presence of NOx typical of polluted areas) and secondary organic aerosols, which both pose a risk to human health. Extreme weather conditions like heatwaves and droughts can substantially affect the emissions of isoprene in ways that are largely unknown. This limited knowledge is owed to the scarcity of isoprene flux measurements under drought stress conditions. The Missouri Ozarks AmeriFlux (MOFLUX) site is located in a high isoprene-emitting oak-hickory forested region with recurring drought occurrences. Until today, it is the only site with isoprene flux measurements that capture drought behaviour.

In this study, we use the state-of-the-art MEGAN biogenic emission model (Guenther et al., 2006; 2012) coupled with the canopy model MOHYCAN (Müller et al., 2008) to estimate isoprene emissions and evaluate two different parameterizations of the soil moisture stress factor (γ_{SM}): (a) the one used in MEGANv2.1, which consists of a simple dependence on soil water content and the permanent wilting point with inputs either from ERA-Interim or the GLEAMv3 reanalysis (Martens et al., 2017), and (b) the parameterization available in MEGANv3 (Jiang et al., 2018), which considers the physiological effects of drought stress on plant photosynthesis as defined in the Community Land Model (CLM4.5), which embeds the MEGAN model. The effect of γ_{SM} on isoprene estimates is assessed against measurements of isoprene fluxes at the MOFLUX field site collected during the mild summer drought in 2011 (Potosnak et al., 2014) and the severe drought in 2012 (Seco et al., 2015). Based on the comparisons at the MOFLUX site, we perform an optimization of the empirical parameters of the MEGANv2.1 soil moisture stress parameterization. In addition, the parameterization is further evaluated using spaceborne formaldehyde (HCHO) columns observed by the OMI sounder. To this end, we perform multiyear simulations (2005-2016) of atmospheric composition with the IMAGES global chemistry-transport model (Müller et al., 2019) using isoprene emission datasets obtained for several variants of the parameterization. We evaluate the resulting

HCHO column distributions and their interannual variability against OMI HCHO columns over drought-prone regions.

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