Assessment of isoprene and near-surface ozone sensitivities to water stress over the Euro-Mediterranean region

Susanna Strada[1], Andrea Pozzer[2,3], Graziano Giuliani[1], Erika Coppola[1], Fabien Solmon[4], Xiaoyan Jiang[5], Alex Guenther[5], Efstratios Bourtsoukidis[3], Dominique Serça[4], Jonathan Williams[2,3], and Filippo Giorgi[1]

[1]The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy
[2]Max Planck Institute for Chemistry, Mainz, Rhineland-Palatinate, Germany
[3]Climate and Atmosphere Research Center, The Cyprus Institute, Nicosia, Cyprus
[4]Laboratoire d'Aèrologie, Toulouse, France
[5]Department of Earth System Science, University of California, Irvine, CA, USA

Correspondence: Susanna Strada (sstrada@ictp.it)

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Abstract. Plants emit biogenic volatile organic compounds (BVOCs) in response to changes in environmental conditions (e.g. temperature, radiation, soil moisture). In the large family of BVOCs, isoprene is by far the strongest emitted compound and plays an important role in ozone chemistry, thus affecting both air quality and climate. In turn, climate change may alter isoprene emissions by increasing temperature as well as the occurrence and intensity of severe water stresses that alter plant functioning.

The Model of Emissions of Gases and Aerosols from Nature (MEGAN) provides different parameterizations to account for the impact of water stress on isoprene emissions, which essentially reduces emissions in response to the effect of soil moisture deficit on plant productivity.

By applying the regional climate–chemistry model RegCM4chem coupled to the Community Land Model CLM4.5 and MEGAN2.1, we thus performed sensitivity simulations to assess the effects of water stress on isoprene emissions and near-surface ozone levels over the Euro-Mediterranean region and across the drier and wetter summers over the 1992–2016 period using two different parameterizations of the impact of water stress implemented in the MEGAN model.

Over the Euro-Mediterranean region and across the simulated summers, water stress reduces isoprene emissions on average by nearly 6 %. However, during the warmest and driest selected summers (e.g. 2003, 2010, 2015) and over large isoprene-source areas (e.g. the Balkans), decreases in isoprene emissions range from −20 % to −60 % and co-occur with negative anomalies in precipitation, soil moisture and plant productivity. Sustained decreases in isoprene emissions also occur after prolonged or repeated dry anomalies, as observed for the summers of 2010 and 2012. Although the decrease in isoprene emissions due to water stress may be important, it only reduces near-surface ozone levels by a few percent due to a dominant ~~NO_x-limited regime~~ over southern Europe and the Mediterranean Basin. Overall, over the selected analysis region, compared to the old MEGAN parameterization, the new one leads to localized and 25 %–50 % smaller decreases in isoprene emissions and 3 %–8 % smaller reductions in near-surface ozone levels.