

Earth Syst. Sci. Data Discuss., author comment AC2  
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## Reply on RC2

Katerina Sindelarova et al.

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Author comment on "High-resolution biogenic global emission inventory for the time period 2000–2019 for air quality modelling" by Katerina Sindelarova et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-226-AC2>, 2021

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We thank the anonymous reviewer for his/her kind review. The specific question, comments and corrections are addressed below. The reviewer's text was copied and is written in italics.

### SPECIFIC COMMENTS

*Introduction, line 53: I agree that BVOC emissions from vegetation are driven by temperature, radiation, vegetation types and atmospheric composition (CO<sub>2</sub> concentrations for instance), but I don't see how atmospheric chemistry is driving those emissions, as stated in the text. Could the authors clarify this point ?*

By atmospheric chemistry driver at this point we meant processes connected to the formation of tropospheric ozone. When emission of VOCs, via formation of peroxy radicals, impacts concentration of low level ozone, which on the other hand impacts VOC emissions by causing oxidative stress on the plants (e.g. Pinto et al., 2010). High O<sub>3</sub> concentrations may cause damage to plants stomata and decrease photosynthetic rate, therefore decrease VOC emissions. O<sub>3</sub> also activates plants production of the reactive oxygen species, which in turn stimulate various defense mechanism depending on the plant species (e.g. Li et al., 2017).

We realize that this effect can be more simply described as impact of "atmospheric composition" which includes also O<sub>3</sub>. Therefore "atmospheric chemistry" was omitted from the text.

Ref: Pinto, D.M., Blande, J.D., Souza, S.R. et al. Plant Volatile Organic Compounds (VOCs) in Ozone (O<sub>3</sub>) Polluted Atmospheres: The Ecological Effects. *J Chem Ecol* **36**, 22–34, <https://doi.org/10.1007/s10886-009-9732-3>, 2010.

Ref: Li, S., Harley, P., Niinemets, Ü.: Ozone-induced foliar damage and release of stress volatiles is highly dependent on stomatal openness and priming by low-level ozone exposure in *Phaseolus vulgaris*, *Plant, Cell & Environment*, Vol. 40, Issue 9, <https://doi.org/10.1111/pce.13003>, 2017.

*Methodology/Emission model, line 115: it is stated that MEGAN, emission model used for this study, calculates BVOC emissions from vegetation and soils. Later in the manuscript, biogenic emissions are presented and described essentially as vegetation emissions. Is the soil contribution actually taken into account in the estimates given and activated in the*

*model for this work, and could the authors precise the order of magnitude of these emissions, compared to vegetation ones? If considered, how are soil emissions calculated in the model? Do they follow the same dependency than vegetation emissions?*

No, soil emissions were not calculated in this study and are not part of the CAMS-GLOB-BIO dataset. At this point of the manuscript we mention soil emissions as there is an option in the MEGAN model to calculate NO<sub>x</sub> emissions from soils and some of the cited studies present estimates of these emissions. But calculation of soil NO<sub>x</sub> emission was not activated in our study.

*Methodology, lines 225-227: The impact of using EP calculated from PFT coverage is specified for isoprene (-10%) and other compounds. Where does this estimate come from? Is it a general understanding (and if so, relevant papers should be cited) or did the authors run specific simulations to provide this estimate (if so, this should be clarified).*

To evaluate the difference between the emissions calculated based on EP detailed maps and on EP calculated from PFT coverage, we performed specific emission model runs. To clarify this, the following two sentences were added to the text of the manuscript on line 225.

"We performed specific emission model runs to evaluate the difference in resulting emissions when emissions are calculated from EP detailed maps and from EP calculated based on the PFT coverage. All the other input parameters were kept the same. Use of EP calculated from the PFT coverage leads to ~10% decrease of isoprene emission total on global scale..."

*Biogenic VOC emissions are driven in particular by temperature and radiation. Therefore, they are strongly variable over the course of a day, and can vary significantly from one day to another. For climate or air quality modeling purposes, considering as forcings monthly means or monthly averages daily profiles (even if subsequently interpolated hourly) instead of hourly emissions could impact the results of the investigations. Can the authors give an estimate of this impact, considering ozone for instance?*

Indeed, temporal resolution of the input meteorological data has an impact on the resulting emissions. Ashworth et al. (2010) evaluated differences in the calculated emissions between emission model runs driven by hourly, daily average and monthly average data. They found that using monthly mean meteorology instead of hourly leads to ~ 7 % reduction of the global annual isoprene emissions, with local reductions up to 55%.

Estimating the impact of such emission difference on the tropospheric ozone concentrations requires inclusion of the atm. chem. model, as the impact will depend on other atm. conditions such as NO<sub>x</sub> concentration and whether the atmosphere is in the VOC or NO<sub>x</sub> limited state. However, such evaluation is out of the scope of the presented paper.

Ref: Ashworth, K., Wild, O., and Hewitt, C. N.: Sensitivity of isoprene emissions estimated using MEGAN to the time resolution of input climate data, *Atmos. Chem. Phys.*, 10, 1193–1201, <https://doi.org/10.5194/acp-10-1193-2010>, 2010.

*A great effort has been made in improving and updating emission factors for the different PFT classes considered in the model. Could the authors specify if/how biofuel crops are considered? As usually high BVOC emitters, especially regarding isoprene, these vegetation species could strongly impact global and regional emissions, but are not always considered, and easy to consider, in emission models.*

No, biofuels are not considered. The main basis for European BVOC emissions in Europe in

the EMEP system is a map of forest species generated by Köble and Seufert (2001), which was based upon surveys from the 1990s. As in Simpson et al. (1999), isoprene emissions from crops were neglected, based upon some low emission rates reported in the literature, but also as emissions from forests were believed to dominate.

Inclusion of biofuels would of course be a good improvement in principle. Although emission factors for some species can be specified, the major problem would be to specify the spatial distribution, phenology and agricultural practices related to such vegetation. This is likely a major effort, and should be combined with a general update in the underlying forest-species maps where possible.

Ref: Köble, R. and Seufert, G.: Novel Maps for Forest Tree Species in Europe., in: A Changing Atmosphere, 8th European Symposium on the Physico-Chemical Behaviour of Atmospheric Pollutants, Torino, Italy, 17-20 Sept., 2001.

Ref: Simpson, D., Winiwarter, W., Borjesson, G. et al., Inventorying emissions from Nature in Europe, J. Geophys. Res., 104, 1080 8113-8152, 1999.

## **TECHNICAL CORRECTIONS**

*Line 44: for a better reading replace at the beginning of the paragraph "Their oxidation" by "BVOC oxidation". Same line, replace "an important role in formation of low-level ozone" by "an important role in the formation of low-level ozone".*

Corrected.

*Line 71: change the second sentence to "The models differ in the approach used to estimate BVOC, in the level of complexity in processes considered and in factors affecting the emission".*

Corrected.

*Line 96: replace "calculated with modified version" by "calculated with a modified version".*

Corrected.

*Line 178: replace "Yuan et al." by "Yuan et al. (2011)".*

Corrected.

*Line 254-255: remove "to" in "maps are well suited to for the tropical region".*

Corrected.

*Line 311: replace "The crops category" by "The crop category".*

Corrected.

*The different inventories v3.0, v3.1 and v1.2 are characterized each by specific conditions for spatial resolution, time-period, land-cover map and emission factors/potentials, which are given in different locations in the text but are not easy to put together. The simulation description would really gain in clarity by adding a table presenting the different conditions for the 3 inventories.*

Table summarizing and describing each dataset was added in the text for the reader to better see the characteristics of each dataset.

*Table 4, caption: please specify what NMVOC means (not used anywhere else in the manuscript).*

The acronym NMVOC (non-methane volatile organic compounds) was replaced by BVOC (biogenic volatile organic compounds) to harmonize with the rest of the text.

*Line453: replace "Temporals variation" by "Temporal variations".*

Corrected.

*Line 566: replace "to more detail described in Sect. 2.5" by "described in more detail in Sect. 2.5".*

Corrected.