

Geosci. Model Dev. Discuss., referee comment RC3  
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## Comment on gmd-2021-29

Anonymous Referee #3

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Referee comment on "Modeling sensitivities of BVOCs to different versions of MEGAN emission schemes in WRF-Chem (v3.6) and its impacts over eastern China" by Mingshuai Zhang et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-29-RC3>, 2021

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Adding the capability of MEGAN v3.0 into WRF-chem is a great advancement for the community. However, the paper needs to be restructured and more evaluation of the model updates against observations are needed. The main problem is that the overall conclusions of the paper (there are large uncertainties in the BVOC emission schemes) are not supported by the results of the paper. Differences between sequential updates of MEGAN v1, v2, and v3 does not demonstrate uncertainty as presumably the later versions are more accurate as explained further below. The paper could easily be restructured to show how the sequential updates of MEGAN v1, v2, and v3, which increase in process complexity, have led to improvements (or not) in BVOC emissions, ozone, and PM<sub>2.5</sub>. This restructuring should better emphasize the isoprene observations specified in Table 3 and compare to other observations such as ozone and PM<sub>2.5</sub> that may be more readily available than isoprene as explained more below. Also as further explained below related to Figure 12, please confirm that soil NO<sub>x</sub> does not change between your MEGAN v1, v2, and v3 configurations?

Specific comments:

Line 35 and 61: Because the differences in BVOC emissions from MEGAN v1, v2, and v3 are sequentially improving, the differences between the versions do not demonstrate uncertainty in BVOC emissions, but instead model advances. Certainly, there is still a lot of uncertainty in BVOC emissions, but this paper does not really address these uncertainties. For example, testing the uncertainty in the MEGAN inputs like emission factors and vegetation types or comparing MEGAN to an entirely different BVOC emission scheme would be a way to evaluate uncertainty, but comparing MEGAN to older versions

of itself without a more thorough comparison against observations than that provided in this work is not an appropriate way to demonstrate uncertainty.

Line 153, Please add a reference for MEGAN v3.0 here.

Line 211: Please be very clear in this section how your version of MEGAN v2.0 differs from the released version. For example, state what is available in the released version and then specify which options you use or adjust in this work.

Line 243: Is there an estimate on the uncertainty on this alpha value? Some sensitivity tests showing the range of possibilities of this alpha value and its impact on isoprene would demonstrate existing uncertainty in BVOC emission schemes.

Line 262: It appears this VEG-2015 is a land cover map calculated in this work. Has this or a similar approach been used in other papers even if for different regions of the world or for different models? If so, please reference them. If not, please include more references on the advantages to using this new approach to make it clearer to the reader, which land cover type is better.

Figure 4: Why is v2.0 here not separated by land cover type like v1.0 and v3.0 in this figure? And which land cover type is used here for v2.0?

Figure 5: For clarity, please list what PFT-1, -4, and -6 refer to in the figure or figure caption.

Line 414: Which MEGAN versions do you mean by "current versions of MEGAN"

Line 449: This section is quite interesting and demonstrates important improvements to MEGAN v3.0 versus v2.0 and why future model simulations should move to MEGANv3.0. Seems like these advances and results should be highlighted more clearly in the overall conclusions.

Line 507: Please provide references here. From Figure 10, the formaldehyde concentration looks to be quite different between the MEGAN versions especially in the northern part of the domain. These are not large enough differences to see on a satellite? Plotting formaldehyde from anthropogenic VOC emissions here would be useful to fully explain this.

Table 3: Please provide significantly more detail about the observations listed in Table 3. For example, are these observations averaged over some time period? Is the averaging in the model and observations the same? When (year, season, month) were the observations collected? If the time was different than the model runs, how would this impact the comparison? For the first observation, this is no reference listed. Please add more info about where this data came from.

Line 533: Please explain in more detail how you got these biogenic VOC and biogenic formaldehyde values. Did you run the model without anthropogenic VOC emissions or without anthropogenic VOC and NO<sub>x</sub> emissions or did you use a tag for formaldehyde

production from biogenic VOCs? This is important to describe as anthropogenic NO<sub>x</sub> will impact the production rate of formaldehyde from BVOC emissions.

Line 535: Adding similar plots of the total VOC and total formaldehyde would make it clearer that BVOCs contribute significantly to total VOCs over East China. This statement is contradictory to your statement previously for why you could not use satellite formaldehyde to evaluate the changes in BVOC emissions, please explain further.

Figure 11: These are large differences in surface ozone. Please describe more what is meant by "ozone due to biogenic emissions" is this the ozone value for the simulation with all emissions on minus that without anthropogenic emissions? And in the simulation without anthropogenic emissions does this include removing NO<sub>x</sub> and VOC emissions? Because the combination of anthropogenic NO<sub>x</sub> and biogenic VOCs leads to ozone production. It is important to be very clear here what you mean by ozone due to biogenic emissions. Is this biogenic VOCs only or is this biogenic VOCs and anthropogenic NO<sub>x</sub>? Most of the model domain is maxed out in MEGAN v3.0 please increase the range of this color bar. Also given the large impact these MEGAN inventories have on surface ozone and possibly surface PM<sub>2.5</sub> through SOA formation, comparisons against surface ozone and PM<sub>2.5</sub> observations would be useful for evaluating the updates to the model. Since there are not a lot of isoprene measurements available, evaluating ozone and PM<sub>2.5</sub> is a good second choice.

Line 568 and Figure 12: Does soil NO<sub>x</sub> change at all in these simulations between MEGAN v1.0, v2.0, and v3.0 or do you turn soil NO<sub>x</sub> off in these simulations? The differences in Figure 12 look more like differences in soil NO<sub>x</sub> than changes in the NO<sub>x</sub> lifetime? If soil NO<sub>x</sub> is different between these simulations, please calculate the total soil NO<sub>x</sub> emitted and make sure the values seem reasonable compared to other studies.

Line 644: I do not agree that differences in BVOC emissions calculated by MEGAN v3.0 compared to older versions of MEGAN especially very old versions like v1.0 that are not used in any current model demonstrates uncertainty. See first comment. Restructuring this paper toward evaluating the differences in the MEGAN versions and determining

whether MEGAN v3.0 improves (or not) model performance of BVOCs, ozone, and PM2.5 would be more useful.

Technical corrections:

-In key point 4, do you mean "is sensitive to the MEGAN version"?

-Line 39 "coupled in the model"

-Line 39, do you mean "chemical processes" and I would restructure this sentence to be clearer.

-Line 74 "VOCs play"

-Line 97 "the impact of BVOCs on air pollutants" or rephrase in another way

-Line 150 "to investigate"

-Line 194 "loss and production"

-Line 263 "over all of China"

-Line 309 Remove extra spaces and "emissions are"

-Line 311: "More details"

-Line 336: "USGS, large differences"

-Line 379 "Over the southwest domain"

-Line 395 "when estimating"

-Line 475 and 478 "Light-dependent"

-Line 504: "for use in this study"

-Line 588: "MEGAN v3.0 includes"

-Line 595: "Physical and chemical"

-Line 1201 "dataset"