

Review of the manuscript

## **Constraining Light Dependency in Modeled Emissions Through Comparison to Observed BVOC Concentrations in a Southeastern US Forest**

by Panji et al.

The submitted manuscript from Panji et al. presents comparison of modeled and measured concentrations of BVOC species, with special focus on monoterpenes, at the Virginia Forest Research Laboratory site (VFRL). The study focuses on the dependence of BVOC emissions on light and therefore proper setting of the light dependence factor (LDF) of individual BVOC compounds in the emission model. To be able to compare the measured concentrations with modeled values, the 0-dimension box model was applied. The authors compare performance of the emission model (MEGANv3.2) through the box model concentrations with MEGAN default LDF values, LDFs obtained from measurements at the VFRL site and LDF values best correlating with the observed concentrations. The paper investigates annual as well as time-varying (monthly) LDF values. The paper suggests new LDF values for selected monoterpene species.

The paper is well written and comprehensively structured. It falls well within the scope of ACP. I suggest accepting the paper for publication after addressing the following questions and minor comments.

Missing measurements of NO<sub>x</sub> and O<sub>3</sub> at the VFRL site at the time of BVOC sampling were substituted by either measurement from previous years or by measurements from 15-53 miles distant stations. Though I understand the need to deal with lack of data, I think these assumptions need at least more discussion of the impact on results. The ozone stations are relatively far away from VFRL with cities such as Charlottesville or Richmond close by that can impact the O<sub>3</sub> levels. Do the authors have some evidence that NO<sub>x</sub> and O<sub>3</sub> levels do not have much inter-annual variability at these locations? The NO<sub>x</sub> and O<sub>3</sub> data are crucial for calculation of BVOC concentrations from emissions, therefore can have a substantial impact on the final model to observation comparison.

Apart from LDF values and their seasonal changes, there are other parameters of the emission model that can (partially) explain the discrepancy of the modeled and measured results throughout the year. E.g. emission factors. Though not often used that way, EF can also vary during the annual cycle (*Helmig et al., 2013, <https://doi.org/10.1016/j.chemosphere.2013.04.058>*). The EF intra-annual changes could be another factor that explains a different BVOC concentrations during winter and summer months. Could the authors include this in the discussion?

Can the authors please share their opinion (and include it in the paper 'Discussion' or 'Conclusion' section) on why the modeled concentrations are "consistently underpredicted in the winter months"? Actually, the modeled concentrations of limonene and sabinene are underpredicted also in July (Figs. 7 and 9).

The authors point out well that the LDF values play an important role in the BVOC models and their precise setting is important in order to obtain sensible emission results. Can the authors please elaborate if the LDF values obtained from the measurements at VFRL can be upscaled from this local site to global representation? If the authors think their values could be used for other studies as well, it would be extremely useful if they could add a Table summarising LDF values per species and per month that they recommend to use according to their study. This would be a very good benefit for other emission modelers.

Minor comments:

L73: please replace (McGlynn et al., 2021) by McGlynn et al. (2021)

L81: please replace “at Chan et al. (2011)” by “in Chan et al. (2011)”.

L90: please replace “vegetation” by “vegetation type j”

L159: Please make clear what is AMDAR – dataset of observed boundary layer heights?

L162: please describe which airports are IAD and RDU

L194: (4) should be (Figure 4)?

L195: the sentence ‘Although there are no isoprene emissions ...’ does not make sense to me. There are no isoprene emissions shown in Figure 3. Furthermore, Figure 4 actually shows the opposite, i.e. almost zero night-time isoprene concentrations in observations. Should ‘observed’ be replaced by ‘modeled’?

L214: The following statement applies to limonene only, or not? “with a peak in light dependence during the summer and less light-dependence during the rest of the year”.

The description of results on Figure 6 is not very clear. Did you interpolate (with 0.01 value step) the modeled emissions or concentration values? Do I understand correctly, that for each month you calculated correlation between observed and modeled values and for a particular month you selected the LDF value that has the highest correlation (and this correlation value is the one shown in the plot)? If yes, please explain better in the text.

L224: “3 monoterpenes: isoprene,  $\alpha$ -pinene,  $\beta$ -225 pinene, and limonene.” Please remove isoprene.

p13: Caption of Fig 8 – please review the last sentence.

Supp. material:

- Fig S4 does not show results for January. Please edit the caption.
- Please review the caption of Figure S6. The last sentence does not make sense to me.
- Caption of Table S5 – emphi should be specific font of i?
- Caption of Fig S6 – please review the last sentence.