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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global terrestrial isoprene emission models: sensitivity to variability in climate and vegetation" *by* A. Arneth et al.

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This manuscript presents a detailed investigation of how isoprene emission estimates respond to 1) the choice of the emission model (among LPJ-GUESS, BVOCEM and MEGAN) and 2) the input datasets for vegetation and climate. Interestingly, whereas the three models calculate relatively comparable emission distribution and seasonal variations when they are used in their standard configuration, their results vary wildly when alternative vegetation or climate datasets are used. Most strikingly, the use of MEGAN vegetation increases the global emission estimate by LPJ-GUESS by up to a factor of 2 (see Fig. 2b,d), compared to a simulation using the standard vegetation

distribution of that model, while it cuts in half the global emission estimate by BVOCEM (Fig. 2j,k). Large differences are also found regionally and in terms of seasonal variation. The choice of the climate dataset (i.e. CRU or NCEP) is found to have a comparatively lower impact, in part due to compensating effects of radiation and precipitation vs. temperature. The topic is relevant for ACP, due to the importance of isoprene in atmospheric chemistry and in global change. The results indicate that great caution is needed when implementing an emission model with input data differing from those used in the original publications.

The paper is well written and remains clear despite the relatively complex array of simulations performed and extensively discussed. I recommend the paper for publication in ACP, after correction/adaptation for the following comments.

Minor comments

The first half of the abstract consists only of general, introductory statements. The abstract should include more concrete results. Try to summarize the outcome of the study in a more quantitative manner.

P. 10616 L. 14-15, rephrase "with the aim to investigate the degree of between- vs. within model variation that is introduced by varying..." (unclear).

P 10616 L. 22-23, "to a degree that cannot be reconciled with today's understanding of isoprene atmospheric chemistry": either change into e.g. "to a very large degree", or explain how our understanding of isoprene chemistry might (in)validate isoprene emission estimates. Note that the published top-down estimates of isoprene emissions rely on chemical oxidation mechanisms which are known to fail in low-NOx regions and even at mid-latitudes (Stavrakou et al. (2010) and references therein).

P. 10618 L. 8-12: Besides these regional inverse modeling studies, global top-down isoprene emission estimates have been obtained based on GOME and SCIAMACHY HCHO columns (Shim et al., 2005; Stavrakou et al., 2009).

P. 10620 L. 7-17: A canopy-based emission factor is indeed not required as input in LPJ-GUESS. But since the amount of electrons used for isoprene production (at standard conditions) is prescribed for each PFT, the model doesn't account for large known differences in emission factor between different tree species, such as different oak species (some are large isoprene emitters, others don't emit isoprene). This should be commented. Could the model be refined in some way to account for such differences?

P. 10621 L. 10-11 "not all of these factors are included here (See Sect. 2.2)": Sect. 2.2 does not provide more detail on the MEGAN version used in this study. Please provide more details (which activity factors are included?).

P. 10622 L.4-5: why not correcting for crop cover in BVOCEM and LPJ-GUESS? This would have eased interpretation of the comparisons with MEGAN.

P. 10623 L 9-12: the use of semicolons seems inappropriate in this sentence.

P. 10626 L. 8-9: this large difference in global emission (378 vs. 530 TgC/year) cannot be due to the temporal average. Or if it is the case, which I doubt, provide emission estimates for specific years including 2003. Note that a global emission estimate of ca. 360 TgC/year was found by Müller et al. (2008) when implementing MEGAN with ECMWF climate. This lower value compared to Guenther et al. (2006) is partly due to differences in the estimated soil moisture activity factor.

P. 10626 L. 19: Note that these strong variations shown by BVOCEM are greatly reduced when MEGANV vegetation is used in the model (Fig. 2k).

L. 10628 L. 15-17: Rephrase "Only a few observations can be made with respect to a uniform response..." (awkward).

L. 10631 L. 2 "with minima occuring around months 6 and 11": are there really two minimas? What is the time of the maximum?

L. 10631 L. 14-19: Indeed, Fig. 2 is not helpful to discuss the seasonal variations over Amazonia, which could be displayed in a separate Figure. How do the models compare

with the previous studies mentioned in the text (e.g. Levis et al., 2003; Barkley et al.)? Note that the isoprene emission rate measured at Tapajos and reported in Müller et al. (2008) show an even larger seasonal variation of almost an order of magnitude between april and october.

L. 10633, L. 12-13: rephrase "a decrease in emissions when LPJ vegetation vs. MEGAN vegetation was applied" (unclear)

L. 10635 L.23: a 10th of a percent is one thousandth. I suppose the emission decreases were much larger.

Figure 2: The legend should identify the solid vs. dash-dotted curves on Fig. 2b

Figure 6: "ci/ca": unclear labelling.

References

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Shim, C., Yang, Y., Choi, Y., Palmer, P. I., Abbot, D., and Chance, K.: Constraining global isoprene emissions with Global Ozone Monitoring Experiment (GOME) formaldehyde column measurements, J. Geophys. Res., 110, D24301, doi:10.1029/2004JD005629, 2005.

Stavrakou, T., J.-F. Müller, I. De Smedt, M. Van Roozendael, G. van der Werf, L. Giglio, and A. Guenther: Global emissions of non-methane hydrocarbons deduced from SCIAMACHY formaldehyde columns through 2003-2006, Atmos. Chem. Phys., 9, 3663-3679, 2009.

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