Atmos. Chem. Phys. Discuss., 13, C6024–C6026, 2013
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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Photosynthesis-dependent isoprene emission from leaf to planet in a global carbon–chemistry–climate model" *by* N. Unger et al.

Anonymous Referee #2

Received and published: 20 August 2013

Review of Unger et al.

The authors present the implementation of a photosynthesis-based isoprene emission simulation into a chemistry climate model. This effort represents an important step in the right direction in terms of the state of science for simulating isoprene emissions, and towards a more process-based approach for examining chemistry-climate couplings. The manuscript is well-written and thoughtfully motivated. While a paper focusing solely on model development and evaluation, such as this, would normally be

better suited for GMD, this work should find sufficiently broad interest in the community for it to fit also in ACP. I recommend publication. Below are some comments and questions for the authors to consider.

- How large are the implications of this model decoupling between LAI and GPP/isoprene emissions? i.e., GPP and isoprene emission are allowed to vary interannually according to environmental drivers, but the LAI is not. To what degree would this dampen the simulated interannual variability of isoprene emission?

- "Equation (5) does not simulate a temperature optimum after which isoprene emission rate decreases with further increases in temperature. Such high temperature conditions in isoprene emitting biomes rarely occur in nature at large ecosystem scales. Canopy-scale temperatures of this magnitude may occur under severe drought stress conditions when transpiration is significantly reduced. (...) Yale-E2 intrinsically captures the effects of changing stomatal conductance on canopy energy balance, which affects the canopy temperature, and thus the isoprene emission rate." But the corresponding effect on isoprene emission would be offset in the model by the accompanying increase in kappa, wouldn't it? Anyway, this model is developed (at least partly) for application in future climate simulations when such high temperature events will probably become more commonplace. So, how big an effect will omitting the isoprene temperature-turnover have then? Is it likely to introduce a significant bias for future (warmer-world) simulations?

- "In the current model, e does not vary with time of day or season". Since in reality base emission rates are higher for mature leaves, this will lead to something of an overestimate early in the growing season, correct? (note: yes, as shown later in the paper). This will have implications in terms of the timing of the seasonal transition from VOC to NOx-limited ozone chemistry in many parts of the world, which would matter if one were to look at interactions between ozone, plant physiology, and isoprene emission.

- “In contrast, the CCM community often assumes significantly lower isoprene emissions in preindustrial versus present day conditions in estimates of anthropogenic ozone radiative forcing”. Say why this would be? Due to temperature changes? In any case, this point is not readily apparent from the references cited. E.g., Fig 1 (panel f) of the Young et al. paper shows quite consistent isoprene emissions from pre-industrial to present-day.

- Section 4.1.1, dependence on GPP versus temperature. But GPP also varies with temperature (Beer et al., 2010), right? Do you have any issues with multicollinearity in this analysis?

- It’s difficult to assess the content in Table 5 as it’s presented. The information content would be more accessible to the reader as a multi-panel bar chart or some other graphical format. Also, it’s unclear what exactly the numbers in the “Measurement” column represent.

- The Guenther et al. references could be updated to include the most recent (2012) paper in GMD.

- 17740, last line, “average diurnal average”?

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 17717, 2013.