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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Process-based estimates of terrestrial ecosystem isoprene emissions" *by* A. Arneth et al.

A. Arneth et al.

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Response to Anonymous Referee #1

We thank the referee for the very helpful comments on our manuscript, which we will incorporate into the revised version of the manuscript as follows:

Title: this can easily be revised to draw attention specifically to the CO2 effect (e.g., "Process-based estimates of terrestrial ecosystem isoprene emissions: incorporating the effects of a direct CO2-isoprene interaction")

Specific comments (1) and (2):

By reviewing the currently available leaf-level models, and summarising their responses to Q, T and CO2 (Figures 1-3), we demonstrated the difficulty in using isoprene models that are designed to be run in conjunction with non-steady-state photosynthesis models in vegetation models that use a steady-state photosynthesis (cf., page 8020 - 8022). With our experimental set-up it is therefore difficult to judge the performance of these types of models and/or to comment on their uncertainties. It is a valuable suggestion, though, to include a Figure that compares the CO2 response of all the models more directly (keeping in mind the above limitations). For the revised version of the manuscript we have prepared such a Figure, showing for each model simulated isoprene fluxes against CO2 concentration at 1000umol m-2s-1 and 30oC and 15oC, and at 600umol m-2s-1 and 30oC. Using the Niinemets et al. routine: there is more than merely the simplicity of this approach that is our justification for its use. We have therefore revised the statement on p. 8023, summarising our arguments as: "As summarised in the Appendix and demonstrated in Figures 1-3, the Niinemets et al. formulation is the prime candidate to be used in a broader model framework to address this issue. As demonstrated above, the model's response to Q, T and [CO2] is in general agreement with today's understanding; furthermore it requires determination of only one chief input parameter (epsilon; cf. Appendix) that scales with carbon assimilation rate over its entire range and that can be modified to describe short and longer term emission responses." The problems associated with using the Bäck et al., or Zimmer et al. modelling approach in a model like LPJ-GUESS have been pointed out above (and cf., page 8020 - 8022). The Martin et al. routine requires estimates of 3 (cf. Appendix) parameters instead of only one; furthermore (page 8041), only two of the three processes involved in the Martin et al. model scale with CO2 concentration. These are shortcomings that limit the model's applicability across a wide environmental and/or species (or PFT) range. Finally, in context of using a DGVM, simplicity is indeed a chief argument: due to the lack of complete process understanding each of the models requires assignment of certain parameter-values for a given PFT. Since the values for these pre-set, PFT-specific parameters are highly uncertain it is preferable to keep their number as low as possible, provided that reasonable model output can be achieved (as demonstrated e.g., in Figure 4).

Specific comments (4) & (5):

The reviewer is correct by pointing to the possible problems of using daytime (not daily, cf. page 8026) temperature averages as model input. That way, a bias can be introduced into mode calculations - particularly so at very warm temperatures due to the highly non-linear temperature response. We had investigated these effects off-line by running the isoprene model for a set of diurnal cycles (temperatures ranging from 5 to 35oC), and compared model output (daily sums) with calculations using average hourly temperatures from these days X daylength. Isoprene emissions derived from using the full diurnal circle were on average 5% higher, which indicates that the use of a daytime temperature average in model calculations cannot explain the model-data differences at the French site. As for the ozone concentrations: The response of isoprene fluxes to elevated ozone is indeed very unclear and we raise this aspect as only one possible reason to explain the model-data inconsistencies, since the model does not yet contain stress-response of isoprene emissions. Maximum daytime ozone concentrations measured at the site during the 2001 campaign were (average) 63 and 71 ppb in the two periods with 'normal' and 'high' fluxes. What is more, the daily amplitude in O3 concentration was much higher in the period of 'high' fluxes (38 vs. 55ppb). During the 2000 campaign, when measured fluxes were overall similar compared to the first part of the 2001 campaign, average maximum O3 levels were only 56 ppbv; while not being conclusive this data may indeed point to a possible O3-isoprene interaction - we will include these numbers into the revised manuscript, but feel that a more detailed discussion is beyond the scope of this paper.

Specific comment (7):

One of the most notable model uncertainties relates to the available information about species (or PFT) isoprene emission potentials, since this value is used to determine epsilon of a species (or PFT). The calculations for Harvard Forest/Q. rubra (p. 8034) provide a good example: the calculated isoprene emissions scale directly with the value of the base rate (I_s). In temperate or boreal ecosystems, where diversity of the dominant species is generally low and where tree growth parameters are relatively well

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studied LPJ-GUESS can describe a forest's structure quite well (Table 3), and sufficient data on I_s is available to determine the possible range of emissions. But as has been pointed out elsewhere (Guenther et al., 2006) this uncertainty increases considerably in tropical forests. There, information about the isoprene emission potentials is very poor. Additionally, lack of information on tree growth and competitive interactions limits the model's capability to reproduce the forest structure and dynamics similarly detailed as possible for temperate forests. We will include this point of discussion in the revised version of the manuscript.

Specific comment (3) & General comments: We will critically revise the manuscript to eliminate confusing grammar and language. We will also seek to further condense the manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 8011, 2006.