Biogeosciences Discuss.,
doi:10.5194/bg-2016-113-RC2, 2016

Biogeosciences Discussions

Interactive comment on "What are the challenges for modelling isoprene and monoterpene emission dynamics of subarctic plants?" *by* Jing Tang et al.

Anonymous Referee #2

Received and published: 10 May 2016

General comments:

This is a nicely written manuscript which addresses an important question in BVOC estimation – namely the representation of cold environments in global estimates and the uncertainties of modelling in this respect. It is also well timed since a lot of new information has recently been published about this topic and the implementation of this knowledge into a model is overdue. However, I feel like I have to urge the authors to be more careful in what they regard as 'good agreement' between measurement and simulation or at which point they conclude that the model's suitability has been 'demonstrated'. Overall, I see a lot of model deficiencies and uncertainties in this study which should probably be the prime focus of the investigation. In this respect, I would welcome figures or statistics that show the actual relation between measurements and simulations rather than column- or point diagrams. Apart from this, I think that the

model description part needs some elaboration.

Specific comments:

P1, L22: 'Short time scales' not only need to be defined, mentioning them here is also irritating. In fact, the question about simulations and observations referring to different time periods is troubling me throughout the manuscript.

P1, L24: The model 'was able' to reproduce carbon fluxes for the majority of the vegetation period but showed considerable weakness in representing the seasonality, probably due to mismatch of phenological phases. This should be recognized.

P1, L26: The difference of effective temperature in model and observation is certainly one reason for a mismatch in emission simulations which has been correctly acknowledged here. However, giving this as the only reason for a possible deviation is misleading at this point.

P2, L17ff: Major uncertainties are also other driving factors for emissions that are usually not considered in models, namely air chemistry, soil water availability, UV light and biological stress impacts. Also the representation of seasonality (which is composed of phenology and enzymatic activity changes) is a point worth mentioning here. The authors are mentioning most of these points at a later stage but I feel that it needs mentioning here.

P3, L5: I think that in the Pacifico and Unger papers, the Niinemets approach is used. So this is to some degree a repetition here.

P3, L10: seasonality and/or past weather conditions? In fact this is the same problem. You might differentiate into effects of phenology and enzymatic activity shifts though.

P4, L15: From the later remarks I take it that the BVOC emissions were not taken round the clock so the time or time period during the day when the measurements were made should be mentioned.

P5, L7ff: I am a bit irritated here. The Haxeltine and Prentice photosynthesis approach is for seasonal or annual photosynthesis estimation, assuming a kind of optimal adjustment to average environmental conditions. Nevertheless, the model seems to work on daily timesteps here. The description given about the model itself looks very much like the Collatz approach – so what is taken from Haxeltine here? Regarding the description, many abbreviations are introduced here that seem not to be used later on – please check.

P5, L14ff: Since emissions depend on temperature in a highly non-linear fashion, I think it is generally acknowledged that calculating them with daily average values is necessarily not capturing the dynamics. Regarding the Niinemets model, for example Unger et al. used a 15 minutes time steps. From the description it sounds like LPJ feeds daily photosynthesis results into daily emissions. Can you elaborate on the problem? Also, I think that the reference temperature used in equation 3 and/or the parameter in the response function needs to be adjusted because the model is not using them as an immediate response value anymore but as parameter for daily average emission. (30 degrees as an average value throughout the day would probably exhaust the emission apparatus so that the response curve would not be valid anyway.)

P5, L15: Instead of using I for isoprene as well as monoterpenes shouldn't you use Ei and Em or similar? This can further be modified for storage (e.g. Ems) in equation 4.

P5, L22: Here, the influence is named 'phenology' while later the same function refers to 'seasonality' (L30). Since these are two different things – is this a lumped index? Specific or specifically parameterized for PFTs? Empirical or dependent on weather or climate?

P5, L27ff: see also comment from L14ff. It seems that the reduction of reference temperature is rather a necessity from applying the model on a daily time step than a particular feature of arctic plants.

P5, L29: it is stated that the reference temperature is changed. This is to 20 oC as

elaborated on later, correct?

P6, L2: fCO2 according to? Since it seems that variable CO2 air concentrations are used, it would be helpful to know to which degree CO2 might be responsible for differences between the years (probably small, but anyhow. . .).

P6, L14: If the energy balance calculation was modified specifically for this study and is not published elsewhere, this modification should be explained.

P8, L15: I don't get how this can give you LAI values. Could you elaborate a bit? Looking at figure 3 there seems to be a difference between Lai and what is measured but the measurements are nevertheless used for evaluation. So how are the two related?

P8, L21: I agree that model results in daily resolution might not be comparable to measurements done at noon. This seems to be a general problem as mentioned above. I also agree that you can calculate noon temperature from average temperature to get a representative value of noon emission – but why don't you do the same with PAR? Instead of using the average value which is definitely wrong you can estimate maximum PAR from average PAR (e.g. Berninger F (1994) Simulated irradiance and temperature estimates as a possible source of bias in the simulation of photosynthesis. Agric. Forest Meteorol. 71:19-32)? Have you estimated the sensitivity of this error on the results?

P9, L3: Check wording. I think it should be the modelled co2 fluxes that are sensitive to a change of parameter. This should also be indicated in some kind of measure, i.e. the degree to which the parameter was varied.

P9, L9ff: In fact, the deviations are considerable. Not only GPP and thus emission is considerably overestimated in both years early seasons – which should be quantified and considered in annual estimates – but LAI is totally wrong in all PFTs except LSE+EPDS and CLM under current climate where the overestimation is a mere 10-15 percent. In L15/16 it is stated that these are the most important PFTs but in the

next sentence the other PFTs are described to have a 'large coverage'. Are there any numbers that I have missed that give an objective picture about the abundances?

P10, L5: Monoterpene emissions seem to be met particularly because measurements occurred mostly on days with low emissions (according to figure 4). This is a problem because the high simulated emissions practically lack evaluation that should be addressed. I can certainly imagine other ways of representation or statistical analysis that can be used to elaborate on the point.

P10, L10: Similarly, I have large difficulties agreeing that figure 5 supports the statement that isoprene emissions were mostly captured by the model.

P11, L26ff: The simulated annual emissions include the largely wrong response of LAI as well as the wrong response in early season emission, right? Can the error somehow be estimated? I have the feeling that these calculations might be too far off to be considered here.

P12, L14ff: The discussion seems to be overall comprehensive. Still, as for example in the first line, I think the authors are overenthusiastic about their results. This also applies for the conclusions.

P14, L23ff: The comparison with common parameterization should not only be concentrated on the arctic environment but also on the problem with the time resolution (see above).

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-113, 2016.