

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

Jing Tang et al.

lu.gistangjing@gmail.com

Received and published: 23 June 2016

This paper presents a very valuable and interesting work, focusing on isoprene and monoterpene emissions from subarctic plants, a topic that has not been investigated or published much so far. I really appreciate the originality of this study, which helps to improve our understanding regarding emission estimates. However, as also raised by the two other referees, I think that this manuscript would really benefit from a deeper and more detailed presentation, of the result analysis and discussion especially, which would help to appreciate more clearly the validity of the conclusions of this work. Here are some feedbacks and corrections that would need to be considered before publication in BG, that I warmly support.

Abstract: in “evaluating BVOC related processes”, which processes for instance do you

C1

refer to, photosynthesis?

Response: Here, we referred to photosynthesis, BVOC temperature responses and vegetation composition. The clarification in the abstract will be added.

Generally in the manuscript, the analysis is rather qualitative than quantitative and should be more detailed and specified. Some elements giving more precise information on the context could also be added. For instance, what is the estimated contribution of subarctic plants to global isoprene and monoterpene emissions? This could be specified for both the present-day case and the different warming scenarios, giving more perspective to the work carried out, and is important to be discussed, especially in section 4.

Response: Thanks for these good points. A statistical analysis of the model performance will be added. Regarding the contribution of subarctic plants' contributions to the global emissions, we would like to address in a coming manuscript where we will integrate multiple sites BVOC emission in the Arctic. We think it is a bit risk to estimate the contribution to global emissions based on one site study. We think the contribution to local atmospheric chemistry is potentially more important than the contribution to global emission (reactive compounds) and the warming-induced strong increase of emissions in this region is very important to address at global perspectives. We will add these two points in the Section 4.

Page 5, section 2.2.2 BVOC modelling: Could you please detail what the seasonality function used in isoprene production calculation stands for?

Response: The seasonality of isoprene production reflects observed changes in the availability of the enzyme for terpenoid synthesis, and is calculated based on a degree-day method in spring and a decrease in autumn based on temperature and day length. The details will be added.

Page 6, section 2.2.2 BVOC modelling: Works published so far agree on the CO₂ in-

C2

hibition effect regarding isoprene emissions, but not regarding other BVOC emissions. Is the $f(\text{CO}_2)$ function considered in the model only for isoprene or for every BVOCs? On which work is it based and is the same parameterization considered for every compounds?

Response: In the model, we used the same CO_2 response function for both isoprene and monoterpenes (and we do not use other BVOCs than those two) and the $f(\text{CO}_2)$ response is based on the work by Arneth et al. (2007). We assume in the model that isoprene and monoterpenes are produced in the same pathway and assume both responses to CO_2 in the same way. We agree with the reviewer that more work agreed on the CO_2 inhibition on isoprene. In the work by Peñuelas and Staudt (2010), they listed some studies (in the supplementary) with CO_2 inhibition effects on monoterpenes. We will extend our discussion on this topic and indicate this response is more robust for isoprene than monoterpenes.

Page 9, line 25: What do you mean exactly with “dynamic vegetation” in “simulating dynamic vegetation enables us to assess the model performance”? Day-to-day variability? Higher frequency? Indeed the term of dynamic vegetation can also refer in vegetation modeling to long-term changes in vegetation distribution due to climate and CO_2 changes.

Response: With the term “dynamic vegetation”, we wanted to stress the model’s ability to capture seasonal variations in leaf area as well as annual-decadal changes in vegetation composition. The sentence will be adjusted to clarify this in the revised manuscript.

The model/data comparison would also really benefit from a deeper analysis. If isoprene and monoterpene emission estimates fall into the data values, it is however difficult to come to a clear conclusion, as data are not that numerous, and as model estimates are given either as daily average or for noon. At what time were emission data collected and how are they compiled for model-data comparison?

C3

Response: Thanks for the great points. Model-data comparison will be further analysed by adding statistics. For each data point, it is an average of six replicates in the field which were measured at different time points of a day (between 9 - 17). Since the model is running at daily time step, it is not possible to average the modelled emission rates at sampling time. We saw this limitation and therefore used the daily average and maximum as an indication about the model’s performance.

The parameterization is calibrated and adjusted in order to better represent BVOC emission from Arctic plants. This is a crucial and one major contribution of this work and yet it is only very quickly mentioned in section 4.2. It is important to add a more detailed and quantitative analysis of the emission improvement, both in the results section and in the discussion part.

Response: Thanks for point out. We agreed with the reviewer that we should discuss the derived new temperature curve in a more detail. We will add more discussion regarding to parameterizing T response for arctic plants.

Specific comments:

Page 1, line 23: change “the model’s responses” to “the model responses”

Response: changed.

Page 1, line 23: change “higher levels’ warming” to “higher warming levels”

Response: changed to higher levels of warming

Page 2, line 4: change “Å/IPFT’s reponses” to “PFT responses”

Response: changed to “physiological responses of PFTs”

Page 2, line 6: change “Biogenic volatile organic compounds (BVOC)” to “Biogenic volatile organic compounds (BVOCs)”

Response: Through the manuscript, we use BVOC as a plural term.

C4

Page 2, line 11: change “atmosphere’s oxidative capacity” to “atmosphere oxidative capacity”

Response: Changed.

Page 2, line 15: change “(. . . respectively (Sindelarova et al., 2014))” to “(. . . respectively; Sindelarova et al., 2014)”

Response: Changed.

Page 3; line 29: change “and to advance our understandings of the” to “and our understanding regarding”

Response: changed.

Page 3, line 30: remove comma in “ecosystem model, LPJ-GUESS”

Response: we will remove comma and add full name for the model.

Page 7, line 28: please change “LAI of the year 2006 and 2007” to “LAI of the years 2006 and 2007”

Response: changed.

Page 7, line 33, change “due to plants’ adaptation” to “due to plant adaptation”

Response: changed.

Page 8, line 20-21: change “Due to lacking of data about the daily maximum” to “Due to the lack of data regarding the daily maximum”

Response: changed.

Page 9, line 26: change “to assess the model’s performance” to “to assess the model performance”

Response: changed.

C5

Page 15, line 11: change “the model’s ability” to “the model ability”

Response: changed.

Figures:

It is hard to distinguish the observations from the emission estimates. Could you please try using another color?

Response: We will modify the figures colors to make it contrast.

Arneth, A., Niinemets, Ü., Pressley, S., Bäck, J., Hari, P., Karl, T., Noe, S., Prentice, I. C., Serça, D., Hickler, T., Wolf, A., and Smith, B.: Process-based estimates of terrestrial ecosystem isoprene emissions: Incorporating the effects of a direct CO₂-isoprene interaction, *Atmospheric Chemistry and Physics*, 7, 31-53, 2007.

Peñuelas, J. and Staudt, M.: BVOCs and global change, *Trends in Plant Science*, 15, 133-144, 2010.

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

C6