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Biogeosciences Discussions

Interactive comment on "Terpenoid emissions from fully grown East Siberian *Larix cajanderi* trees" *by* M. K. Kajos et al.

Anonymous Referee #2

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GENERAL COMMENTS:

The manuscript of Kajos et al. describes the terpenoid emissions from two trees of the species Larix canjanderi grown in a subarctic forest of Siberia. Terpenoids emissions were normalized according to the algorithms developed by Guenther et al. and previous modeling studies of some of the authors. Kajos et al. went further in calculating the atmospheric concentrations of the monoterpenes (MTs) and sesquiterpenes (SQTs) detected in the measurements according to published reaction rate constants due to the oxidative reactions with OH radicals and ozone. Among all the measured terpenoids, MT emissions were dominant either for the measured emission rates and calculated atmospheric concentrations.

These data are important and deserve to be published. BVOC measurements from

the Subarctic are scarce and such works definitely contribute to increase the amount of knowledge from this area of the world. As nicely concluded by the authors, such works open the doors to refine the actual models that actually tend to underestimate the BVOC emissions from the Subarctic and Arctic.

This manuscript was nicely and clearly written. My main concerns are described in the specific comments below. Briefly, they are on the subjectivity of the authors in evaluating the trends of the emission rates throughout the three measurement campaigns, the applicability of the algorithms for BVOC emissions measured in the Subarctic and some methodological aspects.

SPECIFIC COMMENTS:

1-P.4640, lines 17-19: “The measurements were conducted during three campaigns in the summer of 2009: 3–24 June, 8–26 July, and 14–30 August.”

Could the authors justify the decision of publishing these results after one season of measurements?

My concern here is the representative character of the dataset for modeling studies.

A dataset of at least two growing seasons would have been more robust, although I am aware that these kinds of measurements done in the subarctic zone of Russia needs a substantial amount of human and material resources.

For the three measurement campaigns: We see a range of days for each campaign but how many actual days of measurements each campaign has? This information should appear in a following sentence. This would describe better the amount of samples used to build the dataset.

2-P.4641, line 10: “Teflon chambers”

What was the proportion of light blocked by the Teflon film?

3-P.4641, line 11: “VOC-free air”

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How VOCs were filtered out, was it with a charcoal filter?

4-P.4641, lines 12-13: “the chambers were put in place at least one day before the measurements started.”

How far is this from natural conditions? There is probably no stress from the manipulations but a chamber put one day prior is not that natural for the shoots.

Were the chamber flushed/purged from the moment they were put on the shoots, i.e. one day prior to measurements or was this done like in Hakola et al 2006, purged only during the measurements?

5-P.4641, lines 16-17: “For more detailed description of the technique see Hakola et al. (2006).”

I suggest putting this sentence before "The measured shoots were enclosed in Teflon chambers that were flushed with constant flow (5 lmin−1) of VOC-free air", to state clearly the method from the start.

6-P.4641, line 27: “filled with Tenax-TA and Carbopack-B”

Would it be possible to specify how many mg of Tenax-TA and Carbopack-B there were in the cartridges?

7-P.4642, lines 2-3: “The PAR was measured with a Li190 quantum sensor (Li-Cor Inc., USA).”

Was the PAR measured under the Teflon film? I ask the question because it was not mention how much PAR was blocked by the Teflon film (see comment #2).

8-P.4642, lines 8-9: “The sample cartridges were stored in a refrigerator before they were shipped to Finland, and were later analysed in the laboratory of the Finnish Meteorological Institute.”

What kinds of caps were used to seal the cartridges? It should be mentioned here.

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How long was the period (in average) between the sampling on the field and the analyses at the GC-MS in Helsinki? It should be mentioned here.

Have you tested if this period could cause the loss of some compounds or a decrease in the concentration before the analyses at the GC-MS? It should be mentioned here.

9-P.4642, section 2.3

The algorithms described in Guenther et al. publications were built in conditions that were totally different than from those observed in the Eurasian boreal and subarctic forests. Moreover the species used to build these algorithms were different than those growing in the boreal and subarctic forests.

How the authors could justify the use of the algorithms built in conditions that were different from those observed in the present study?

Did the authors consider using a standard temperature of 20°C instead of 30°C as it was done in Ekberg et al. (2009. Biogeosciences 6: 601-613. www.biogeosciences.net/6/601/2009/) for isoprene emission)?

A standard temperature of 20°C is more representative of the one observed in the present study as described in line 2-4 of page 4641:"The annual mean air temperature at the site is −10.4 C, with mean temperature of the coldest month, January, being −39.5 C and that of the warmest month, July, 18.6 C (Dolman et al., 2004)."

However, I see in table 2 that the authors calculated variable β coefficients, which can account for the different conditions observed in the present study compared with those in which the algorithms were built.

Please, could the authors address these questions in one or two sentences in section 2.3?

10-P.4646, section 3.1

In this section, the total emission rates are used to make some comparisons while

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figures 2 to 4 show median and percentiles that are not used here. Thus I recommend showing the mean and total emission rates below the pie charts of figures 2 to 4 instead of the median and percentiles.

11-P.4646, lines 5-7: “The emission rates determined from the data are thus representative for L. cajanderi trees during the growing season, excluding the potentially important and different VOC emission spectra and rates during the burst of the needles or the initial growth of the needles.”

Please, could the authors add a reference supporting this fact?

12-P.4646, line 15: “significant”

As pointed out earlier by referee #1, it is preferable not to use the word “significant” in this context as no statistical analyses were done to compare the measured emission rates between trees A and B.

The term "important" or another term describing the fact that linalool has a high proportion in the relative emissions could be used.

13-P.4647, lines 1-2: “The relative fraction of sesquiterpenes had a somewhat increasing trend towards the end of the summer.”

How the authors judged that a SQT proportion starting from 1% in June and ending to 3% in August was "a somewhat increasing trend"? This was only observed for tree B. To my judgment, the trend is rather constant throughout the summer.

In Fig. 3, the authors judge that the MT spectra were similar throughout the summer between trees A and B while differences between compound proportions were within or higher than 1-3%.

My concern here is that such sentences relate to a subjective judgment and not objectivity.

14-P.4647, lines 2-7: “This trend was clearer for tree B. Sesquiterpene emissions can

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also be related to herbivore attacks or other damages the tree may have experienced. Haapanala et al. (2009) found large α-farnesene emissions from mountain birches in northern Sweden two years after an outbreak of autumnal moth; when the measurements were repeated the following year, α-farnesene was not found any more."

Have the author noticed signs of herbivore attacks during the summer of 2009? It seems so as described later in section 3.2: the white "cotton like" spots. However, it is not clear here, in this part of the text, why the authors have the hypothesis of the herbivore attacks. I would recommend transferring the description of the white "cotton like" spots already here.

15-P.4647, line 8: "although the total emission rate of the monoterpenes was notably higher for tree B."

The total emission rates are not shown for trees A and B. This refers to comment #10.

16-P.4648, line 2: "Generally speaking"

For tree species in the boreal or subarctic forests?

This sentence is too general, please specify for which trees in which forests β-caryophyllene is the most abundant.

17-P.4648, section 3.2

Why the authors did not show the measured emission rates for all campaigns in fig. 5? The results discussed in this section justify showing the MT and SQT emission rates for all the campaigns.

18-P.4648, lines 6-7: "Measured emission rates of L. cajanderi had a distinct daily pattern following both temperature and light (Fig. 5)."

Is this also true for other measurement periods than the one shown in Fig. 5? I recommend softening this affirmation if the data are not planned to be shown or if the authors do not mention that this was also observed in all the measurement periods/campaigns.

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19-P.4648, line 28: “However, the measured shoot was not visibly affected by this herbivore.”

This is a nice hypothesis that can explain the different emission rates between trees A and B although the authors write later that it could be a within-species variation.

Could the author add a reference supporting that the VOC patterns of a branch/shoot of a tree, although not attacked by herbivores, can be affected by herbivore attacks done on another branch/shoot of the same tree? A reference would support better the hypothesis explained here.

20-P.4649, lines 11-19.

These sentences would belong to section 2.3. Why the authors put them here?

21-P.4649, lines 18-19: “(ii) β was kept as a free parameter when fitting the algorithm to the observations.”

Could the authors justify the reasons for keeping the β value free when fitting the algorithms?

22-P.4650, line 25: “Several studies have been done on the emissions of other boreal tree species.”

Are the authors still referring to MT emissions here? It seems so but it should be clearly written.

23-P.4651, paragraph between lines 8-16.

Is it possible to compare this result with other studies or the authors are the firsts to keep the β value free when fitting the algorithms?

24-P.4651 lines 19-28 and P.4652, lines 1-3.

These sentences would belong to section 2.4. Why the authors put them here?

25-P.4651, line 26: “weighted mean reaction rate constants”

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This is not written in the title of table 1, should it be?

26-P.4652, lines 11-13: “Sesquiterpene emission rates were increasing as the summer progressed, yielding an increased contribution to the calculated air concentrations, especially in case of tree B.”

This refers to comment #13, the judgment on the increasing trend.

27-P.4652, lines 13-15: “For isoprene the atmospheric levels increased somewhat compared to the emission rates for both trees A and B, however isoprene was negligible overall in both emissions and concentrations.”

How the authors judge that the atmospheric levels of isoprene can somewhat increase if the emissions and concentrations are negligible? No trend could be judged if it is negligible.

28-P.4652, lines 17-19: “δ-3-carene, which has the highest emission rate, is also dominating the calculated monoterpene air concentrations; however due to its reactivity, its fraction is smaller in air concentrations.”

How the author judged that the air concentrations were smaller than the emission rates for δ-3-carene? To my eye, it is rather similar. Could the author soften the argument or support it by adding the means of the fractions of total in this sentence?

TECHNICAL CORRECTIONS:

1-P.4649, line 16: “value 0.19”

Please, correct for “value of”

2-P.4649, line 17: “of value 0.143”

Please, correct for “value of”

3-P.4650, line 14: “trend during growing season has”

Please, correct for “trends during the growing have”

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4-Fig. 7

Please add the tree A or B and the month over each graph as it is done in Fig. 6.

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