Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-768-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Terpenoid, acetone and aldehyde emissions from Norway spruce" *by* Hannele Hakola et al.

Anonymous Referee #2

Received and published: 31 October 2016

Review of Terpenoid, acetone, and aldehyde emissions from Norway spruce.

This study provides new information about the emission patterns of isoprene, monoterpenes, sesquiterpenes, acetone and c4-c10 carbonyl compounds in Norway spruce, one of the dominant species from boreal ecosystems. The manuscript reads well and it is providing new information that it is interesting for the scientific community and under the scope of ACP. Therefore, I accept it for publication; however, some requisites must be fulfilled before.

Abstract

Please state objectives and conclusions

Introduction

Printer-friendly version

Discussion paper

It is missing an overview on the boreal forest. Norway spruce has only been mentioned once. Please rewrite the introduction taking into account a better explanation of the boreal ecosystem and the role that VOC emissions have in such ecosystems

What is the objective? Very few data on emissions? I suppose there is another rationale, please state.

Page 1, Line 14: please insert references that show forested boreal emissions of mt, sqt and OVOCs. Page 1, Line 16: contribute to the increase of methane lifetime? How? Please explain. Page1, Line 26: You say in addition to isoprene, but is the first time you mention isoprene. Please expand. Page 1, Line 28: please give an example of saturated aldehydes.

Methods

The methods sections needs considerable attention. The measurement times and tress are expressed in a confusing manner, and better explanation of sampling must be given. Another important issue is the comparison among trees.

The tree measured in 2011 was different from the tree measured in 2014 and 2015, therefore I think they are not comparable as different processes such as age or different climatic conditions may come into play. This different tree should be removed from the comparison. Not necessarily from the study.

To begin with, a table with the different measured trees, years and techniques shall be stated. Furthermore, a better explanation of the cuvette used is needed, a picture of the setting will help the reader considerably. Is there a blank cuvette? How do you take into the possible effects of the cuvette on the branch used?

Page 2, line 50: You say here the samples were collected. What do you mean by that? Which samples? GC cartridges? You take samples from the outlet of the cuvette? Please specify. Page 2 line 55: you mention you have a thermometer inside the enclosure. What brand? Is this thermometer having a possible artefact effect? Page 2 line

56: how did you measure PPFD? Please include brand. Page 2 line 66: Please explain how the quantification of sabinene can be done suing the calibration curve of b-pinene. Page 2 line 70: please include the manufacturer of the calibration solutions. Page 3 line 72-75: here you say that in 2015 you were able to measure acetone and C4-C10 aldehydes. Then you say acetone was coeluted with propanal. Either you give a proof that you were able to properly calibrate acetone or you do not report acetone. In addition, please specify which C4-C10 aldehydes were you analysing. Page 3 line 93: there are more recent studies (Guenther et al., 2012) that suggest the slope value should be 0.1. Page 4 line 102: you say that you have used a temperature dependence for monoterpenes and a light and temperature dependence for isoprene. Please calculate also the temperature only dependence for isoprene and the light and temperature dependence for monoterpenes to conclude which is the best choice. Page 5 line 128-133: This part is confusing. You need to properly explain how the sampling was performed in the different years. So for this day on the 24th of June of 2014, you analysed 6 different spruces which then you compare to the 7th tree which is the one continuously measured in 2014. I don't understand how can they be comparable if the sampling is different (tree number 7 uses the Teflon cuvette via the dynamic flow through, whereas the other 6 tress were sampled with a Teflon bag. Did you have a blank? For how long were you sampling? I also noticed that for the cuvette tree the adsorbents are different than for the Teflon bag, and disturbances can be different, therefore I would not compare them together. You need to give tree numbers from the beginning of the methodology, so it is clearer to the reader. Furthermore, a more detailed information about sampling and how this is different to the main sampling is provided. I supposed these samples are analysed with the same instrument that is measuring cuvette air. Please state. Page 5 line 139: you say that when experimental data was not available you use this software. Then use it to estimate the reaction coefficient for b-farnense and nitrate, as you mention its importance (linked to page 9 line 288).

Results and discussion

3.1. Weather patterns during the measurements.

Here you need a graph showing the year to year variability. In the table you cant really see what are the changes. Furthermore, in table 2 you say that those are mean values, therefore is needed to use standard deviations. For the rain you must state the mm, is it mm per month?.

A better explanation of how do you consider the seasons is needed, therefore perhaps pointing in the new meteorological figure when it is spring, early summer, late summer, etc, can help and then you express in the text why.

Page 5 line 145: you say temperatures are exceptionally high and precipitation is extremely low. what is high, what is low.... This must be stated! Page 5 line 151: you mention a warm spell in June and a cold spell in July. Please show on new meteorological graph and explain what is a warm/cold spell. A clear and "based on meteorological data" election of the seasons must be stated. This can be added into the measurements table (i.e. year, tree, measurement technique (Cuvette, Teflon bag)...)

3.2. Variability of VOC emissions

Page 6 line 157: what do you mean by early season? Page 6 line: 159-161: you cant compare the measurements of year 2011 to the measurements on 2014 and 2015 as they are different tree, so please only use 2014 and 2015 data for comparison. Furthermore, you present seasonal means and do no report of standard deviation. Please report standard deviations. Page 6 line 162: what is a low and a moderate emitter? Please report about values. Furthermore, this kind of information suits much better in the introduction. It would also be good to have a comparison among other high emitting species from the boreal region. Page 6 line 164: you say that you studies confirmed the low isoprene and moderate monoterpene emitters but the seasonal patterns were clearly different. Different to what? I have no indication of the seasonality of low isoprene and moderate monoterpene emitters, please mention and discuss. Page 6 line166: this is the only mention of MBO (apart from the methodology). I would skip

it or expand the explanation on MBO. Page 6 line 162-170: you report several emission rates but no uncertainty, please report. Page 6 line 171-172: you are still talking about monoterpenes and sesquiterpenes from your data, so this should go in the above paragraph. Table 3: In order to have an easier visibility of the data I prefer to see a bar graph of table 3, with uncertainties! Page 6 line 171-184: here you do a comparison with Bourtsoukidis et al., 2014b. This is a nice comparison. But I prefer that first you mention the why of your found seasonality in the boreal forest to then start stating the difference to the German forests and thus differences in emissions. Furthermore, you mention only a difference between 0-84 ng g(dw)-1h-1 for SQT in your study, and this is a big part of your results. Please expand your SQT results and then compare to other studies. Page 6 line 186: you say that the main sqt is b-farnense, can you comment about the other SQT measured? Page 6 line 189: this is an important result and statement, therefore please show a graph showing the Linalool and sqt increase together. Furthermore this can be another conclusion from you study. Page 7 line 193-207: This role should also be mentioned in the introduction. Furthermore, there has to be a better integration between the results from this study and the literature research. Page 7 line 209: If you cant measure most volatile aldehydes then it does not make sense to say that the amount of measured carbonyl compounds was comparable to the monoterpenes, as it is misleading. Page 7 line 212: Could you provide with mean values for the percentages? Was this percentage calculated from both early and late summer, or they were calculated separately? Page 7 line 213: you mention the possibility of bidirectional exchange when moist vegetation. Why? What is the link to your study? Please state. Figure 1: please include light as well to see the effect that light can have. Please remove/separate the graph from 2011 as it is not comparable to the other years as you were measuring a different tree. Please report as well standard deviations, name the compounds in the sum of C4-C10 aldehydes. If you were not able to give a proper explanation of the calibration for acetone, please remove from graph. In addition just a as help for the reader indicate which months comprehend the different selected seasons.

3.3. Tree to tree variability in emission pattern

It is expected to have different emission patterns in threes that have a considerable difference in age. Furthermore, the climatic variability among years makes it harder for comparison. The comparison is ok for the trees measured in 2014 so I would stick only to it.

Page 8 line 232: variability of what, please state. Page 8 line 234: if the tree number 2 has a different sampling technique than the other trees, can this be really comparable? Have you check the differences among sampling? Please make sure tree 2 and 3-8 are comparable to each other. Page 8 line 236: the values for monoterpenes were not statistically significant different from 0? Please state what you mean by significant. Page 8 line 242-244: please expand in how this study shows the importance of species specific measurements.

3.4 Standard emission potential.

As commented in the methodology, make a comparison between the temperature only and the temperature and light dependency, to see why the choosing of the algorithms makes sense.

Table 5: please change to bar graphs to see the comparison among species and seasons. Page 9 line 266: please insert similar behaviour to monoterpene emission potentials. Page 9 line 268-275: This section needs some reviewing in the sense that past studies have fit a temperature and light dependency emission dependency for carbonyl compounds (SHAO and Wildt, 2002). You mention that the best fit was obtained with the temperature dependent algorithm, please then state how better was as compared to the light and temperature dependency algorithm. Page 9 line 279: how this variability may reflect past temperature history or effects of incident or previous stress events? What is your explanation for saying this? Page 9 line 280: please state better what shall be taken into account, is past temperature history or effects of incident or previous stress events, or other? Page 9 line 281: what is reaction potential? Please

explain.

3.5 Total reactivity of emissions

You mention total reactivity of emissions, but you never give a total reactivity values, please do so, or else change to relative reactivity of emissions. Page 9 line 292: As you don't show these compounds in the graph, please state the contributions. Page 9 line 295: you mention Nölscher et al., 2013 paper, can you please state at what time of the year these measurements were carried out?

Conclusions

The first paragraph of the conclusion is just a brief summary of your results. The only actual conclusion I read is that the monoterpene emission pattern varies a lot (what is a lot?) from tree to tree. From your results and discussion I got the following messages, that if expressed as implications for boreal ecosystems can be used as conclusion from your study - What is the seasonality? - There is low isoprene and moderate monoterpene emitters - Sqt emissions - Defence role b-farnense and linalool - OVOC roles, - Diurnal variability - Importance of tree to tree variability - Importance towards reactivity. Please redo the conclusions trying to show what are the take home message from your study.

References Guenther, A.B., Jiang, X., Heald, C.L., Sakulyanontvittaya, T., Duhl, T., Emmons, L.K., Wang, X., 2012. The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions. Geosci. Model Dev. Discuss. 5, 1503–1560. doi:10.5194/gmdd-5-1503-2012 SHAO, M., Wildt, J., 2002. Quantification of acetone emission from pine plants. Sci. China Ser. B 45, 532. doi:10.1360/02yb9070

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