Response to referee 2

M. Mäki (Referee) mari.maki@helsinki.fi Received and published: 7 May 2018

General comments

The manuscript shows rapid mineralization of different BVOCs in temperate and Arctic soils. The manuscript is concise and clear. I appreciate your chosen scientific approach and use of relatively low BVOC concentrations, which are more realistic compared to the earlier studies. I recommend this manuscript for publication after it has been modified. Scientific significance of the manuscript would have been stronger if the number of BVOCs and soil types studied would be higher. Considering the Table 4, I would like you to justify, why you decided to choose the compounds that were not the dominating ones in the ambient air close to the soil surface. Why to choose p-cymene if several other monoterpenes showed much higher concentrations in the atmosphere above the sampled soils? Especially when you say in the conclusions that BVOC degradation by soil microbes could have atmospheric implications. I would also like to read your reasoning behind why you decided to study only six different BVOCs when the spectrum of different BVOCs emitted by vegetation and soil processes is very high. One value of this study is that you studied different soil types. You should mention different soil types already in the abstract.

With regards to the choice of model BVOCs we had the following major considerations. The first was the number of incubations we could handle in the laboratory within the manpower available to the study and six compounds in triplicate plus abiotic controls seemed like a good compromise. Then to choose these six compounds, we wanted some that represented major BVOC groups, since even though you can expect different degradation rates of compounds with similar chemical structures, you may after all expect larger differences between than within chemical groups. The last major consideration was then that the compound should be commercially available as ^{14}C-labelled. The price of commercially available ^{14}C-compounds is typically 1000-2000 Euros compared to non-available where you pay 10000-20000 Euro for a custom synthesis. The compounds we chose were those that may be considered most widespread / best group representatives and at the same time being commercially available. Even though it could have been nice to have a free choice of compound, this is simply not possible when working with 14C-labelled compounds unless you have a very large budget…

With regards to the use of different soil types we state that in the abstract already.

Specific comments

Line 12. You wrote in the text: “Their release into the atmosphere is important with regards to a number of physical and chemical processes.” Please keep in mind that you will sell your manuscript to your readers. Please be more precise. What do you mean with this?

We understand this comment, however, in the Abstract, the general introduction should be limited, we believe. However

“physical and chemical processes”

Will be changed to:

“climate related physical and chemical processes”

Line 33. Please remove “though”.

Will be corrected as suggested

Lines 37-38. Please clarify that this is a chain reaction from BVOCs and oxidants (OH, O3, NOx) to SOA and from there to cloud formation and properties.

Will be corrected as suggested

Line 41. “Owe to” is not good. Please use another verb.

Will be corrected as suggested

Line 43. Please clarify what is a fate model.

“and fate models for these parameters could then be set up”

will be deleted, as this part of the sentence is actually not necessary.

Lines 44-45. You wrote that “The microbial degradability of BVOCs - and especially the rate of degradation - are on the other hand very difficult to predict.” Could you please clarify why microbial degradability of BVOCs is difficult to predict? In soil, there is a high diversity of compounds with varying properties for microbial degradation. Microbial population diversity is high. Chemical transformation from one compound to another happens also in soil. Soil conditions vary in time, which can affect degradability of BVOCs.

The referee is correct that in most soils there is a huge potential for degradation of all sorts of organic compounds. Therefore it is also not a big surprise, if BVOCs are degraded in soil. However, the rate of degradation varies tremendously from compound to compound, and with the current QSAR models this is not predictable. Furthermore, the degradation rates may vary from soil to soil. This is what we mean by this sentence. We will add the following to the sentence to make this clearer:

“, since degradation rates in soil vary a lot from compound to compound and from soil to soil”

Lines 54-55. Field study or laboratory measurements? Which ecosystems/soil types? Please clarify.

Will be corrected as suggested

Line 61. “The ultimate proof” is not scientific language.

Will be changed as suggested

Table 1. Please specify in the table that 16s is bacterial biomass and ITS2 is fungal biomass.

Will be corrected as suggested

Line 105. “A snap-shot” is not scientific language.

We do not agree with the referee, this is often used and we can think of no better word.

Line 110. Please be more precise: a gas chromatograph–mass spectrometer, and please include the instrument details.

Information will be added as suggested.

Line 137. Please correct “all BVOC was present”. It should be: all the BVOCs were present in the headspace of the flasks.

Will be corrected as suggested

Lines 210-220. It would be more easy to read if you would discuss methanol first and benzaldehyde after that. Now you discuss methanol first, then benzaldehyde, then methanol again and so on.

Will be corrected as suggested

Line 344. You talk about communication between soil organisms. Please add a reference.

We will add two references, also included in the previous sentence (Garbeva et al., 2014; Delory et al., 2016).

Line 327. PTR-MS should be the proton-transfer reaction mass-spectrometer.

Will be corrected as suggested

Line 351: It is needless to say “In conclusion”, when the title is Conclusions. Please make the conclusions more concise.

Will be corrected as suggested

Table 2. Please specify in the table that Sw means water solubility.

Will be corrected as suggested

Table 4. You could consider to add reactivity of each compound or reactivity range of each compound group, because it will likely affect your results. You should also present analytical methods and calculations in the M&M section.

We are not sure what the referee refers to. Is it the atmospheric reactivity of the compounds? If so, how could this affect our concentration measurements?

We already present how the samples were taken and analysed in section 2.2 This section is now extended based on a previous comment by the referee. Since it is just concentration measurements (and not e.g. fluxes) there are no calculations involved.

Figure 3. You didn't do any statistical analysis on how the BVOCs behave in the different soil types. You should use valid statistical tests and add p values into the text. Please include statistical methods into the M&M section. Please remove the framing. Same for the Figure S1 in supplements. You should clarify in the figure caption that chloroform was measured for 25 days and others for 150 hours. Finally, it would be nice to see a map that shows locations of the sampling sites in supplements.

The figure caption will be corrected as suggested and a map with locations will be included in the supplementary material.

Regarding the statistical analyses, we have now conducted a Repeated Measures Analysis of Variance followed by a Tukey's post hoc test to test if the mineralization curves in Figure 3 are statistically significantly different. Often, the curves were significantly different despite a low absolute difference. We will therefore change the phrasing in the text a few places to make this clear. A section will be added to the Methods, explaining the type of analysis and conditions used. The result of the test will be added to Figure 3 in the form of letters denoting whether or not differences between soil types were found statistically significant.