Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-1154-AC1, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Terpenoid measurements at a Northern wetland revealed a strong source of sesquiterpenes" *by* Heidi Hellén et al.

Heidi Hellén et al.

heidi.hellen@fmi.fi

Received and published: 6 May 2020

Thank you for the very good comments! We have considered them and we have improved our manuscript based on them as explained in more detail here.

Terpenoid emissions from high latitude wetland ecosystems have been poorly characterized, but important for understanding biological functions and atmopsheric impacts as environmental drivers change.

The study by Hellén et al., 2020 provides valuable data on both biogenic emissions of terpenoid compounds and their ambient concentrations at a sub-Arctic wetland in Finland (Lompolojänkkä). Observations were made using an in-situ thermal desporption-GC-MS which is ideal for studying terpenoid volatile emissions as other sensitive at-

mospheric techniques (e.g. PTR-TOFMS) have a limited ability to distinguish isomers. The study confirms previous work that isoprene is one of the most abundant terpenoid emitted by the wetland ecosystem. Consistent with many ecosystems across the world,monoterpene emissions appeared at roughly 10% of isoprene emissions. However,while many ecosystems show significant sesquiterpene emissions, they are generally low relative to isoprene and monoterpenes. In contrast, in Lompolojänkkä, higher sesquiterpene emissions

Abstract: The abstract is highly qualitative, lacking quantitative data (with uncertainties). Simply stating that something is higher or lower is not acceptable, especially without statistical tests.

-more quantitative data has been added

Which monoterpenes and sesquiterpenes were observed? How did their composition change with the growing season?

-we added to the abstract 'The main MTs emitted were α-pinene, 1,8-cineol, myrcene, limonene and 3Δ-carene. Of the SQTs cadinene, β-cadinene and α-farnesene had the major contribution.'

"Isoprene, MT and SQT emissions were dependent on temperature." What is the correlation? Positive, negative? Were there emissions at night? Are they light-dependent or independent?

-it was added that correlation with temperature was exponential with temperature R2 values being 0.75, 0.66 and 0.52 for isorepene, MTs and SQTs, reapectively.

"Isoprene emission rates were also found to be well-correlated with the gross primaryproduction of CO2.

-sentence was changed to 'Isoprene emission rates were also found to be exponentially correlated with the gross primary production of CO2 (R2=0.85 in July)'

Even with the higher emissions from the wetland, ambient airconcentrations of isoprene were clearly lower than MT concentrations. This indicatesthat wetland was not the only source affecting atmospheric concentrations at the site,but surrounding coniferous forests, which are high MT emitters, contribute as well."The authors need to consider uptake by the soil of isoprene, how can they rule this out? There seems to be a number of other possible scenarios to explain the findings.

-There are a few studies where deposition of both monoterpenes and isoprene over grasslands have been detected (Spielmann et al. 2017 and Bamberger et al. 2011). In addition Trowbridge et al. (2020) detected soil uptake of isoprene in a deciduous hardwood forest, but due to strong emissions detected from the Lompolojänkkä wetland, soil uptake of isoprene is expected to be insignificant here. Since the lifetimes of these compounds are few hours, concentrations of these compounds are low. However, the area which affects the concentrations is quite large. Vegetation around the site within 10 km is mainly spruce and pine forests, which are known to emit mainly monoterpenes. As discussed in the manuscript (section 3.3) emission potential of MTs from the nearby forest is 860 μg m$-$2 h$-$1 while emission potential of isoprene from the wetland is 93 μg m$-$2 h$-$1 and therefore these forests are expected to have huge effect on concentrations. More discussion on this was added to the manuscript into section 3.3.

"In May concentrations of SQTs and MTs at Lompolojänkkä were higher than in earlierboreal forest measurements in southern Finland. At that time the snow cover on theground was melting and soil thawing and VOCs produced under the snow cover, e.g.by microbes and decaying litter, can be released to the air." Not clear which site theauthors are referring to here and seems there is too much speculation.

-this too speculative sentence was removed from the abstract

"Daily mean MT concentrations were very highly negatively correlated with daily mean ozone concentrations indicating that vegetation emissions can be a significant chemical

sink of ozone at this sub-Arctic area." Please provide statistics!

-Correlation coefficients were added

This is fascinating, can the authors look further into this and estimate atmospheric terpene ozonolysis rates?

-a figure and discussion on ozone reactivity of the measured compounds were added to the manuscript into section 3.3

What is the relationship between the emission rates and the atmospheric concentrations?

-simultaneous measurements of emission rates and atmospheric concentrations were not possible since only one instrument was available

Introduction: The introduction needs to be expanded to include background on the atmospheric and biological roles of terpenes. Especially the later as there is no mentionof this here. I would like to see some sort of introduction on isoprene, monoterpenes, and sesquiterpenes.

-Introduction was expanded

Methods: Please cite references for the liquid standards in methanol. If only SQTs were present in the calibration solution, how were MTPs and isoprene calibrated?

-more details on the calibration was added into section 2.4

Graphs: Please use different colors for alpha-pinene and other MTPs, they look the same!

-colors have been changed

Why did 2/07 show huge atmospheric concentrations of isoprene >150 ppb but theother days did not? That does not seem like a reasonable isoprene concentration.

-The value is 150 pptv and not 150 ppbv. The higher value is due to higher temperature

and higher PAR. Due to exponential dependence this can have a huge effect.

Figure 7 with the diurnal patterns is beautiful data. I would be very interested to knowif the composition of the terpenes changed across the day as previously observed inother sites.

-Thank you for the very valuable comment. Changes in terpene composition was observed and additional figure (S1) was added to the supplement. Discussion on this was added to the manuscript: 'Supplement Figure S1 show the mean diurnal variation of the individual SQTs and MTs for the same periods. Relative contribution of a SQT, β-cadinene, clearly increases during the daytime. Of the MTs daytime increase was observed for the 1,8-cineol, myrcene and limonene. Higher daytime contribution indicates light dependent source of these compounds. Earlier light dependence of 1,8-cineol emissions has been observed in Scots pine emissions (Tarvainen et al., 2005).'

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1154, 2020.