

***Interactive comment on* “Temperature and light dependence of the VOC emissions of Scots pine” by V. Tarvainen et al.**

V. Tarvainen et al.

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We would like to thank the referee for his very relevant comments which contributed towards a much improved final version of our manuscript. The comments and questions of the referee are addressed below under their respective titles.

General comment:

Our main focus in this work, in addition to the speciation of VOCs emitted by Scots pine as well as the seasonal variability of the emission potentials and the spectra of the emitted compounds, is the applicability of the simple mechanistic light and temperature related emission algorithms in describing these emissions during different seasons. These algorithms are the ones most commonly used in parameterising biogenic emis-

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sions in e.g. atmospheric chemistry models. However, their development is based on measurements made in warmer climates, and it is not guaranteed that they can be used to depict the light and temperature dependence of the emissions in the boreal conditions. A detailed understanding and/or modelling of the plant physiological processes affecting the emissions is thus outside the scope of our work. There have, indeed, been other measurements carried out by other groups during the QUEST campaign, and they have been and/or are being used in modeling the details of the monoterpene emissions within the plant. However, at this point it is not possible to combine these different modeling approaches, and our discussion involving the plant developmental stages must stay on a more general, and hence more speculative, level.

Specific comments:

1) The ozone scrubber consisted of a pack of MnO₂ copper nets used for ozone analyzers. They were tested prior to the sampling and they removed ozone from the air. Furthermore, we observed sesquiterpenes also later in the summer which does not support the hypothesis of decreasing performance efficiency due to aging during the course of the measurements. However, after the referee's comment we tested the scrubbers again and they were still performing well.

2) The unit used for the emissions has been corrected and is now in accordance with the SI system.

3) Altogether three darkening experiments were carried out during the campaign, one in April, one in June, and one in August. In the first two experiments the cuvette was darkened around noon. The behaviour of the first set of compounds (a- and b-pinene, b-phellandrene, and 3-carene) was quite similar in all experiments. However, the most likely candidates for light dependence, MBO and 1,8-cineole, as well as b-caryophyllene were observed only during the last experiment, which is why only this experiment is discussed in the paper. The behaviour of the emissions of the different compounds during and after the darkening is in accordance with the stomatal conduc-

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tance modeling results of Niinemets and Reichstein (J. Geophys. Res. 108(D7), 2003), and this is now discussed in the text. As our emission algorithms are not capable of describing the stomatal effect, we have not applied them to the data from this experiment. The detection limits for the observed compounds are now included in the experimental section, and the temperature during the darkening experiment is shown in Figure 2.

4) The behaviour of the monoterpenes after the darkening of the cuvette is in agreement with that described by Niinemets and Reichstein (2003) as typical for highly volatile compounds whose emissions are not under stomatal control. The analysis of Niinemets and Reichstein (2003) further predicts bursts of emission after stomatal opening for less volatile compounds, such as MBO. According to them, stomatal closure also leads to increases in gas- and liquid-phase VOC concentrations within the leaf. No sudden temperature jump was observed in any of the experiments after the removal of the cover, thus it could not have caused the emission bursts. As already stated in the reply to Referee #1, the removal of the cover did not disturb or injure the branch. Furthermore, the branch moved more when the cover was put in place, and there was no emission burst following that.

5) The detection limits of the various compounds have been added to the experimental section.

6) The poor correlation of MBO emission with light is, indeed, strange, as it has been reported to be light dependent by other authors. Our results from the darkening experiment also suggested a light dependence. However, the nonlinear regression with the light and temperature dependent emission algorithm failed during all seasons, while the temperature algorithm captured the emission pattern fairly well in summer. Harley et al. (J. Geophys. Res. 103, 1998) have pointed out that quantitative analysis of MBO presents several challenges. Although the standard solution behaved well in the analysis, we cannot totally rule out the possibility of dehydration of MBO in real samples since small amounts of isoprene were also detected. Further measurements of the MBO emissions of Scots pine, preferably during high summer, a period which was

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somewhat poorly represented during this campaign, are obviously needed to resolve the light dependence issue.

7) The Conclusions section has been revised to make it sound less like a summary.

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