Biogeosciences Discuss., 9, C5149–C5153, 2012
www.biogeosciences-discuss.net/9/C5149/2012/

Biogeosciences Discussions

Interactive comment on "Impact of heat stress on the emissions of monoterpenes, sesquiterpenes, phenolic BVOC and green leaf volatiles from several tree species" *by* E. Kleist et al.

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Received and published: 24 October 2012

Biogeosciences Discuss., 9, 9533-9570, 2012

Interactive comment on "Impact of heat stress on the emissions of monoterpenes, sesquiterpenes, phenolic BVOC and green leaf volatiles from several tree species"

Kleist et al.

We thank both reviewers and in particular the interested reader Peter Harley for their comments. All remarks were considered.

Response to remarks of referee #2 (RC C4099)

Remark referee #2: The authors studied the effects of heat stress treatments on foliar VOC emissions from European beech, Palestine oak, Scots pine, and Norway spruce. The work described in the study provides useful data towards a better understanding of abiotic stress impacts on plant VOC emissions. The paper is overall well written although clarifications and corrections are needed in all sections. After revision, it should be acceptable for publication. I want to stress that 13CO2 labeling technique is a very nice technique which permit to distinct between BVOCs synthesized and stored. But there are many other concerns about this experiment: As can be seen from table 1 only one plant of Palestine oak and one plant of Norway spruce were used.

Our response: See also our response to referee #1: To check the impacts of heat on de novo emissions we used the four tree species listed above in 12 independent experiments in total (including the experiments where no stress impacts were found). Impacts of heat on pool emissions were studied with 7 individuals in 7 independent experiments. The spruce was used to check whether or not the effects of damaged resin ducts would also be observable for another conifer (compare P. 9536 lines 8, 9 and P. 9546 lines 19 ff.). We do not compare the results for pine and spruce quantitatively, we show that we can find the same effect for emissions with the same basic emission mechanism.

Remark referee #2: The stress application on the plants has not any logic (at least I cannot find one). In almost everyone have been used different ranges of temperature and different application times.

Our response: The compromises we had to find with respect to the chosen temperatures and duration are described in the responses to the remarks of Peter Harley. As described in our text the threshold for heat acting as stress most probably depends on many other factors than temperature and duration alone (P. 9951 lines 4 ff.). To exactly determine such thresholds it will need much more experiments than described here. We therefore first describe the effect itself with its possible impacts on future BVOC emissions.

Remark referee #2: It were used many different GC –MS systems (even that they are similar). As the emissions are at the level of picomol m-2 s-1 this procedure should not be used.

Our response: All GC-MS systems were regularly calibrated and the same results were obtained independent to the GC-MS system used in the respective experiments. We furthermore use plants with quite large leaf areas. Emission rates at the level of picomol m-2 s-1 are no problem for our analytics (see our response to the respective comment of referee #1).

Remark referee #2: I cannot understand the linking with insect interactions

Our response: Besides constitutive BVOC emissions there are many emissions observable when plants are under biotic stress. We believe that also these emissions are important for estimating the BVOC source strengths and the impacts of BVOC on atmospheric chemistry. We therefore also checked the impacts of heat stress on biotic stress induced emissions; we described our findings in the manuscript and leave this part in the manuscript.

Remark referee #2: To keep the plants at 45 deg for 48 h continuously is not likely to happen. Even 51 deg for 4 h is unlikely

Our response: With respect to the choice of temperatures we again refer to our response to the remarks of Peter Harley. Parts of the answers to Peter Harley's comments are repeated here: We agree with Peter Harley, that in combined heat and water stress situations the temperatures chosen here are conceivable. Furthermore we would like to point out, that comparing visible responses of plants treated here with those observed in the environment show that the plants in our experiment were less affected. During heat waves such as the summer 2003 in mid Europe many deciduous trees (we observed this in particular for Silver birch) lost most of their leaves. This behavior is well known and certainly due to the connected impacts of heat and drought. However, none of the plants used during our measurements showed visible

stress symptoms of comparable severeness. We therefore conclude that the stress application (with heat alone) was less severe than the stress appearing periodically in the real environment. We are aware that both, heat and drought were responsible for the plants' responses in the environment. However to understand the impacts of both stresses requires to check the impacts separately in a first step and thereafter checking the combined effects. This was the reason to first determine impacts of heat for well watered plants although such situations will most probably be uncommon in the environment. More common will be combined effects. In combination both stresses will put much more stress on the plants than that we applied.

Remark referee #2: Something is not right with the plants: even in no stress conditions assimilation and transpiration rates are very low.

Our response: In some cases assimilation seemed somewhat low, however these were the data we measured.

Remark referee #2: The importance of this data in interpretation of future climate change and the expected increase of VOC emissions with temperature is quite difficult to be assessed by this MS. Is not clear what will happen with this emission when temperature will increased.

Our response: We totally agree. It is not clear what will happen in future with ongoing climate change. The whole system atmosphere-vegetation-biotic/abiotic stress is coupled and clear answers cannot be given from our measurements alone. We therefore do not want to over-interpret our results.

Remark referee #2: The MS would benefit by a editing by native English speaker as some phrases are not clear (eg. page 9547 (line 13-14),

Our response: Text was rephrased and now reads: "Heat and drought periods are often coupled. Thus the impact of heat may be enhanced by parallel drought because reduction of transpiration causes less cooling of leaves."

page 9555 (line 1-5)

Our response: Text was changed to: “The general response of such stress induced de novo emissions to heat stress was similar to that of constitutive de novo emissions. In all cases when the heat acted as stress de novo emissions decreased. An increase was not observed. The reason for the decrease of biotic stress induced de novo emissions is likely the same as that causing decreases of constitutive de novo MT emissions; a general decrease of the plants performance as a consequence of the heat. The decrease in performance may be due to the denaturation of enzymes which synthesize the respective VOC, the breakdown of plant internal signalling cascades, or reduction of carbon supply caused by decreased CO2 uptake.”

Interactive comment on Biogeosciences Discuss., 9, 9533, 2012.