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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Process-based modelling of biogenic monoterpene emissions: sensitivity to temperature and light" *by* G. Schurgers et al.

Anonymous Referee #1

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This is a model exercise which compares algorithms of monoterpene emission based on non-storage or storage or a mixture of both storage and non-storage of these compounds. The modelling results are compared to actual observations on ponderosa pine, a species storing monoterpenes in resin ducts. A sensitivity of algorithms to temperature and light is presented. Finally, data are extrapolated to global level yielding estimates of monoterpene emission that are remarkably lower than other estimates.

The modelling is based on currently incomplete knowledge of processes of biosynthesis and storage of monoterpenes, and on several assumptions about mechanisms of spill-over of monoterpenes from storage. Possibly important factors such as the presence of temporary storage (probably occurring for some pine monoterpenes such as trans-b-ocimene, see papers by Staudt and Loreto) and the likely monoterpene

catabolism in the leaves, are not considered. They would of course complicate further the model (as the authors acknowledge for temporary pools) but are likely to play a major role in setting monoterpene emissions from pines and other plants with storage organs. Consequently, modelling is probably premature and may not be enough accurate, especially when scaling-up at global level. However, I was surprised to see that all models predict fairly well monoterpene emission by ponderosa pines. Clearly, the sensitivity of models to their variables is not that high. The model based on photosynthesis seems to predict better high emissions while the models based on storage or both photosynthesis and storage seem to predict better low emissions.

Specific comments.

The title is misleading. Sensitivity to temperature and light is only a part of the paper. Please change the title to make it more informative of the real content of the paper.

The introduction illustrates how monoterpenes influence atmospheric chemistry, but the paper is not on atmospheric chemistry. I think the introduction should be more balanced, briefly listing all aspects for which parameterization and modelling of monoterpene emission are needed. This also include biological roles, e.g. their fundamental roles in plant interactions with environmental constraints and other organisms.

Material and methods: Page 277 line 23: How epsilon is directly derived from the emission capacity by calculation of photosynthesis and J? On page 281 it seems that epsilon is set by a sort of reverse modelling, after equating M and Ms under standard conditions. However, epsilon may (should) be different when the emission is different from standard, and especially when photosynthesis and monoterpene emission are not coupled. Is this true? How this is accounted for?

Page 278 line13. I am not so sure that monoterpene concentration is demonstrated to affect emission. For instance I remember a report in which primary needles of pines emit as secondary needles, yet contains at least twice more monoterpenes. This also indicates that storage organs are very tight. Diffusive resistance to the release of

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monoterpenes from storage organs should perhaps be considered more carefully.

Page 279 line 11: “Storage…..modulates the seasonal cycle of the emissions, but does not affect the annually produced total”. Why? This is unclear, please explain.

What is a “DGVM framework”? Please define abbreviations (also e.g. CRU on page 282).

Line 19: How J is calculated from photosynthesis “on a daily timestep”? More information on methods is generally needed.

Page 281 line 18. It is implicitly assumed that non-storage pools do not vary seasonally. In fact data on photosynthesis-dependent emission show a strong seasonality of these emissions.

Line 25-28. This sentence is unclear.

Page 282 line 3: “a production-derived value for Ms must exceed an emission-derived Ms…”. As noted above, this implies no catabolism of monoterpenes. Is this true? Generally all compounds are metabolized biologically, not only formed.

Line 17: This categorization does not include evergreen trees which may also store monoterpenes and also emit isoprenoids in a photosynthesis-dependent way (e.g. – as noted only in the conclusions - Eucalypts that are widespread both as natural species and in plantations).

Page 284 line 22. Simulation does not account for rainy events. This is a strong limitation and a well-known effect on high humidity on storage organs, since it allows their swelling and the consequent spill-over of monoterpenes.

Page 285 line 8-13. I agree that the findings reveals two pools contributing to the emission, but another explanation is that monoterpenes in the storage organs are in

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part directly released because of mechanical or biotic stresses and this also contributes to the low residence time pool.

Page 286 line 5. The peak of monoterpene concentration in autumn, as estimated by the simulation, is strange. On line 14, it is speculated that, at least in Mediterranean species, have low monoterpene concentrations in summer, due to higher emissions. This contradicts the allegation that production exceeds emission (see above). It also contradicts the statement on page 279 line 9, that emission depends on temperature and on the concentration in the leaves. Please explain.

Page 286 line 20-25. Very speculative sentences. Evidences that photorespiration influences storage and emission of monoterpenes are not presented here. Photorespiration contribution to monoterpene synthesis would also affect the electron transport and epsilon. Is this considered?

Page 287. Figures 2 and 3 are not clear. Why only one simulation is shown in Figures b, c? What are units of the different panels?

Page 289 line 17. I agree that estimates are low. This seems to be a weak point of the paper, as also explained above. Perhaps upscaling to global emission should not be attempted on the basis of current understanding of monoterpene emission.

Page 290 line 11. “….thereby moving part of the production into this storage pool and reducing the emitted amount”. This sentence seems to contradict again the assumption of page 297 line 10.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 271, 2009.