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Biogeosciences Discussions

Interactive comment on "Monoterpene and sesquiterpene emissions from *Quercus coccifera* exhibit interacting responses to light and temperature" *by* M. Staudt and L. Lhoutellier

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The authors present a thoroughly-researched and well-documented set of experiments designed to elucidate and disentangle the influences of light and temperature; the 2 major (and often confounded) drivers of biogenic isoprenoid/terpenoid compound emissions using an important (though perhaps somewhat unique) Mediterranean oak species. After a very comprehensive, well-presented literature review on the subject, the authors present their experimental design, replete with standard measurement variables (PPFD, enclosure temperature, BVOC emissions), but also including some variables that are not measured routinely in BVOC emissions studies: Photosynthesis

and chlorophyll fluorescence. Following the data analysis and presentation of observed trends, the authors then perform a simulation using well-accepted light and temperature emissions algorithms to extrapolate the significance of the findings using environmental conditions typically observed during a summer day in a Mediterranean ecosystem. The results section is of an appropriate length and is followed by a very thorough discussion of the results viewed through a lens of their significance with respect to the current and potential future distribution of the studied tree species, an interpretation of the results from a well-researched biochemical perspective, and finally, the implications of the observed temperature-light interactions on the prediction of BVOC emissions.

For the most part, I think this study represents a well-researched and very comprehensive attempt to shed some light on a topic that is still very much beset by uncertainty, and is a novel and ultimately useful manuscript that should be published. There is, in my opinion, one very important and apparently unmeasured variable in the study whose significance was actually eluded to in the discussion section but for some reason apparently not considered in the experimental design: leaf temperature.

In the methods section (p 5698, lines 20-21) the authors state that only enclosure temperatures were measured, not leaf temperatures. From Figure 1, (p 5724), we can see that monoterpenoid emissions continued to increase at increasing light (at 30 deg C) levels beyond the ~250 PPFD light threshold above which photosynthesis apparently became light-saturated. For example, if one considers that (according to Figure 1) emissions of non-oxygenated monoterpenes increased from anywhere from ~350-370 ng (m-2 s-1) at ~250 micromoles PPFD (m-2 s-1) up to ~540-550 ng at ~1500 micromoles PPFD and asks whether increasing leaf temperature might play a role in the observed trends, one could assume(for the sake of the question) that at the 1000 micromoles PPFD light level (at which emissions were ~500 ng), leaf temperatures were indeed 30 deg C (standard light and temperature conditions).

If one then assumes a temperature-only dependence and ask what the leaf temperature would have to be at the higher light intensity of 1500 micromoles PPFD to pro-

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duce emissions of ∼540 0r 550 ng, then, solving for leaf temperature using Equation 3 from the manuscript (p. 5703 line 10), and assuming a generic beta factor value of 0.1 (commonly reported and used for monoterpenes), leaf temperature at this higher illumination level would only have to be ∼30.77 to 30.95 (depending on the actual emissions values which I only visually estimated for the different light levels using Figure 1). These temperatures seem modest and realistic at a relatively high light level, especially for a species in which leaf temperatures have been reported to be up to 10 deg C higher than ambient during hot dry periods (a fact that is reported by the authors in the discussion section (p 5714, lines 11-16)! This likelihood can't be excluded since we cannot know whether transpiration was also increasing (since it wasn't measured) to cool the leaves even as light increased beyond the relatively low intensity at which photosynthesis plateaued. I think this likelihood is only heightened by the observation that NPQ was also increasing over this range, which, as the authors state (p 5699 line 28) involves heat dissipation.

Obviously, at the lower light levels, emissions were clearly increasing as light increased and these light levels were probably too low to increase leaf temperature; these observations along with others in the paper as well as anecdotal conclusions made based on the author's literature review (especially of the biochemical pathways described in the discussions section) do argue for a light dependence of emissions, but I would point out that at higher light levels, there may be some question as to whether leaf temperatures were = enclosure temperatures, and so I feel that the discussion and conclusions should treat this consideration more directly in the final version of the paper. This is especially poignant since the simulation section relies on equations that assume leaf temperature is being used.

Additional minor comments and suggestions for typographical corrections: 1. Delete 'already' p 5692, line 23. 2. Insert a hyphen in the phrase 'man made' p 5693, line 16. 3. Change 'level' to 'levels', p 5693, line 21 4. Change 'Early, light' to 'Early on, light', p 5693, line 22 5. Change 'have been' to 'were', p 5693, line 22 6. Move 'such

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as the isoprene synthase' from the end of the sentence on p 5694, line 19 to after the word 'enzymes' (and insert a comma after 'enzymes'), on line 18 (p 5694). 7. Change 'more insight in the emission control' to 'more insight into the controls over emissions', p 5694, line 22 8. Change 'understanding on' to 'understanding of', p 5694, line 24 9. Delete 'however', p 5694, line 26 10. Change 'overview' to 'overviews', p 5695, line 4 11. Delete 'been', p 5695, line 10 12. Insert ', even then,' after 'conditions and' and before 'over a rather limited' to read 'conditions and, even then, over a rather limited', p 5695, line 11 13. Change 'metabolisms' to 'metabolites', p 5695, line 17 14. Change 'endogenic' to 'endogenous', p 5695, line 21 15. Insert a hyphen in the phrase 'stress induced' p 5697, lines 12-13 16. Change 'rise' to 'increase', p 5697, line 13 17. Could the variable humidity range of 30-60% affect emissions observed during the experiement? (p 5698, line 19) 18. Were the same leaves used to measure F(m), as described on p 5699 lines 9-10, which were exposed to intensely high white light levels (10,000 micromoles), then placed in the enclosure and used for BVOC emissions measurements? If so, could this large pulse of light have damaged any leaf tissue/photosynthetic apparatuses prior to emissions measurements and thereby affected results? 19. 19. Suggest re-wording of 'on overnight dark-adapted leaves' on p 5699, line 5 because this is hard to understand. Do you mean leaves were simply left in the dark for 1 night prior to measurement? 20. Similarly to comment 19, re-word 'temperatures response and again in the morning afterwards' to 'temperature response and again the following morning', p 5699, line 6 21. Insert a hyphen in the phrase 'dark adapted' p 5699, line 10 22. Change 'data bases' to 'databases' p 5700, line 28 23. I am confused by what you are trying to say the 2 sentences on p 5701 lines 19-22 that begin with 'The decreases were faster'. . . is this just meant to let the reader know that artifact effects were considered and minimized by observing how long it took for emissions to decline when leaves were removed from the enclosure? If this is what you meant, state it as such. 24. I think it's important to emphasize that there were, in some (or most?) instances only a few hours allowed for emissions to stabilize after installation of the enclosures and prior to initiation of BVOC sample collection,

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and many studies have reported longer equilibration times of 12-24 h necessary for confidence that emissions are not stress-induced (see for example, Duhl et al., 2008 which is cited in the manuscript). 25. In methods section 2.4, was there just one measurement made per tree? I think this is not very clear to the reader. 26. Insert 'and sampling time' after 'airflow', and 'the' before 'airflow', to read 'multiplied by the airflow and sampling time and divided by', p 5702, line 14 27. Change 'Eq. (1)' to 'Eq. (2)' on p 5703, line 1, and also change 'Eq. (2)' to 'Eq. (1)' on p 5703, line 2 because these are apparently swapped in their descriptions. 28. Eucalyptol is an oxygenated monoterpene even though it is apparently grouped by the authors with non- oxygenated monoterpenes on p 5704, line 6 and again on p 5713, line 24 29. Why didn't the authors repeat the dark BVOC emissions measurements again after the light- and temperature-ramping experiments? This could have shed more light (no pun intended) on wether the GLV emissions were in fact caused by damage to leaf tissues during enclosure installation (and sampling soon after installation) or whether they could also be associated with low light levels? 30. Could the observation of Germacrene-D (often associated with stress-induced emissions) being emitted at the higher temperature level of 37 deg C possibly be related to activation of the Shikimate pathway caused by thermal stress? Perhaps this should be discussed in more detail. 31. Suggest using a different word than 'primordial' on p 5714, line 25; this word sounds strange here. Maybe try 'paramount' instead? 32. Insert 'for non-terpene-storing vegetation species' in between 'processes' and 'should', Page 5716, line 1 33. Change 'of' to 'from', p 5716, line 5 to read 'far from being accomplished' 34. Delete 'too' after 'accomplished', p 5716, line 5

Interactive comment on Biogeosciences Discuss., 8, 5691, 2011.