

***Interactive comment on “Drought reduced  
monoterpene emissions from *Quercus ilex* trees:  
results from a throughfall displacement  
experiment within a forest ecosystem” by  
A. V. Lavoir et al.***

**A. V. Lavoir et al.**

Received and published: 29 May 2009

Finale author comments on "Drought reduced monoterpene emissions from *Quercus ilex* trees: results from a throughfall displacement experiment within a forest ecosystem"; by A. V. Lavoir et al.

We thank referees 1 & 2 and Rüdiger Grote for their comments on our manuscript. We have considered them carefully and try to answer referee comments and R. Grote's comment cumulatively at the best. Answers to referee 2 were already done in our previous comments but principal statements are mentioned here again. Regarding to all comments of the interactive discussion, five points needs to be detailed:

S1091

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



- Some references (1) and data (2) are lacking.
- The overall relevance of field experiments should be more discussed (3) and the suitability of the throughfall displacement experiment should be clarified (4).
- Conclusions of the study should be taken with more caution (5).

Please find our statement below.

#### 1. To complete references...

Both referees and R. Grote asked for a revision of the bibliography. Thirty references dealing with the BVOC/drought context were studied to argue and discussed the topic of our manuscript. All references were not quoted because of the length of the paper. The choice of literature is discussed here regarding to referees comments:

- In the introduction, we selected studies to underline the heterogeneity of literature in the context of drought effects on BVOC emissions. I agree with Referee 2 who asked to quote the first study addressing this question: Tingey et al. (1981) showed the effects of drought on isoprene emission from young-potted plants of *Quercus virginiana*. Referee 1 asked for studies focusing on *Q. Ilex* species which will be indeed more pertinent to illustrate our topic. We suggest adding some studies referring to monoterpene emission from other Mediterranean plants that do not store monoterpenes inside their leaves (p. 866 l. 21-25). Here, the Ormeno et al.'s study (2007) is justified, because it focused also on *Q. coccifera* species which is a Mediterranean evergreen oak, emitting monoterpenes compounds without storing them.

- In this part, we also quoted field studies proposing drought as a hypothesis to explain variation in seasonal emission patterns (p. 867, l8-9). To focus on *Q. Ilex*, we added other references (Bertin et al. 1997; Nunez et al. 2002 and Plaza et al. 2005) as requested by R. Grote and Referee 1.

- The paper from Llusia et al (2009) was not already published at the date of our submission to BGD. This study was added and discussed in the revised manuscript

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

as an example of field studies on the BVOC/drought relationship. On the other hand, Llusia et al (2006) was omitted, because this study dealt with stored compounds but not with emitted compounds.

- At last, we already answered referee 2 about the pertinence of the citation of the Brilli et al's (2007) paper: this study was done on young potted poplar plants which were isoprene emitters and highly sensitive to drought. Moreover in Brilli et al. the plant water status was assessed by the relative soil water content whereas in our study by the pre-dawn plant water potential, which further limits a direct comparison of the results of these two studies. Nevertheless, this study was added and discussed in the revised manuscript.

## 2. Requested data

The manuscript submitted to BGD was already very long and therefore we decided to not show all results in graphs or tables. However, the referees considered that some data are missing: (i) composition of the emission, (ii) comparison of ES between one-year-old and current year leaves and (iii) additional physiological measurements:

- We think that the relative composition of the VOC blend emitted by the individual trees is a topic lying outside of the main scope of the paper and it is sufficient to describe these results by words in the text.

- Concerning the comparison of emission rates/factors between one-year-old leaves and current leaves we added a graph as an appendix in the revised manuscript (Figures cannot be uploaded here).

- In addition a figure illustrating stomatal conductance, transpiration and  $C_i$  was added as an appendix was added as an appendix: Stomatal conductance and transpiration showed the same seasonal variation than photosynthesis even during water limited periods. This result agreed with literature which considers that photosynthesis is limited by stomatal conductance in the early stages of the drought (e. G. Flexas et al 2002,

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

2004; Galmès et al 2007...). However, intercellular CO<sub>2</sub> concentration  $C_i$  remained stable until the leaf water potential reached -3MPa. From this value, the fluorescence parameter  $F_v/F_m$  started to decline, reflecting metabolic limitations. Variability of these parameters from *Quercus ilex* trees was addressed in two studies: Limousin et al. (2008) and Limousin et al. (submitted).

### 3. Relevance and emphasis of field data

Rüdiger Grote well illustrated this subject in his comment title: "ideal field data can not be expected", which summarizes the difficulty to provide data under non-controlled conditions and to further interpret them considering all the influencing factors of either biotic or abiotic origin. However, field measurements are necessary, because the drought responses of trees growing in their natural multi-stress and competitive environment might be different to the response of seedlings or saplings kept under controlled growth conditions. In the manuscript, we seriously discuss seasonality, leaf development, and pests attack and we removed them one by one to explain the observed variations of monoterpene emission (p.879).

### 4. Usefulness and interest of the throughfall displacement experiment (TDE)

Misunderstandings exist around the use of TDE. To answer to referee 1, this TDE was set up in the frame of the European MIND project to evaluate the impact of changes in water input as predicted for the current century (27% decline) p. 869, l 6-7). The main issue of this MIND project was not only to better understand the current variability of drought but also to assess the impact of an increased drought stress on ecosystem functioning in the future. At the experimental level, annual variability of drought is studying comparing years of measurements (seasonal and inter-annual variations) and long-term effect of drought is studying comparing treatments: The drought treatment was thus built in order to exclude 27% of the rainfall comparing to the control treatment. Since the setting up in 2003, differences between treatments (drought and control) were identified for some ecophysiological and growth parameters (see Limousin

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

et al 2009 and Limousin et al submitted). But here, no statistically significant difference between the mean emissions rates of the control and water-limited treatment could be seen (p. 880, l. 18-29) because of the fast and non linearly response of the monoterpene emission rate to drought. Thus, as explained by referee 2, a clear influence of water limitation on monoterpene emission was observed: (i) Via a drastic drop of monoterpene emissions accompanied by a cessation of leaf gas exchange in summer when climate conditions (light and temperature) were stable and optimal for emissions. These periods corresponded exactly to the periods of severe drought, as measured by plant and soil water status (p. 877, l. 6-10). (ii) Via a significant difference between the irrigated plot and other plots which were exposed to natural or accentuated drought.

## 5. Moderate conclusions

Referees asked for more moderate conclusions in the abstract but we disagree. Results of the study were clearly and strictly quoted (l. 7-21). The potential effects of other factors than water limitation were clearly discussed and eliminated one by one in the discussion part. In our opinion, it would be cumbersome if added to the abstract. We disagree also with Referee 2 comments about the interpretation of Figure 5. In the first version of our manuscript, we indeed discussed the threshold effect of water limitation on monoterpene emission rates. A threshold response of emissions to water stress is not incompatible with an exponential-way response: it was represented by the curve inflexion. Moreover, the inherent and potential mechanisms were discussed in the rest of the discussion part (P. 881 l. 1 and following). At last, Referee 1 mentioned that our results obtained on *Q. ilex* cannot easily be extrapolated to all Mediterranean evergreen forests. We agree and changed our conclusions accordingly (P. 865, l. 22; P. 882, l. 15).

As a conclusion, we tried to consider all comments and to integrate corrections in a revised version of the manuscript which will be submitted to BG. According to referee 1, we were looking for a more punchy title and we suggested: "Drought reduced monoterpene emissions from the evergreen Mediterranean oak *Q. ilex*: Results from a

throughfall displacement experiment". Moreover both referees point at unclear definitions, particularly for the emission. Differences between the intrinsic capacity of plants to emit (representing by the parameter of the Guenther algorithm) and the measured emission under given environmental conditions have to be clearly defined, as proposed in the M&M part (P. 873, I 27-28). In the introduction part (P. 866, I. 6-10), the terms employed were confused and thus will be change in a revised version. Please find below the list of corrections proposed for the new version of the manuscript.

Complete references could be found in the on-line paper. Others are specified here: Limousin JM, Misson L, Lavoit AV and Rambal S: Seasonal variations of leaf photosynthetic capacity in Mediterranean evergreen *Quercus ilex* submitted to summer drought and long-term throughfall exclusion, submitted to *New Phytologist*. Limousin JM, Rambal S, Ourcival JM, Rocheteau A, Joffre R and Rodriguez-Cortina R: Long-term transpiration change with rainfall decline in a Mediterranean *Quercus ilex* forest, doi: 10.1111/j.1365-2486.2009.01852.x, 2009.

Adjustment made on the MS-NR: bgd-2008-0198 for submission in BG. " Drought reduced monoterpene emissions from *Quercus ilex* trees: results from a throughfall displacement experiment within a forest ecosystem" by A. V. Lavoit et al.

- We propose a new title: Drought reduced monoterpene emissions from the evergreen Mediterranean oak *Quercus ilex*: Results from a throughfall displacement experiment.

- P. 865, I. 22: "Mediterranean evergreen forest" was replaced by "Mediterranean Holm oak forest".

- P. 866, I. 6-10: "The quantity and qualitative composition of these emissions depends on the plant's capacity to produce these terpenoid compounds and on environmental factors constantly modulating the basal emission capacity and instantaneous emission rates (Kesselmeier and Staudt, 1999)" was replaced by "The quantity and qualitative composition of these emissions depends on the plant's capacity to produce these terpenoid compounds and on environmental factors constantly modulating this intrinsic

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

capacity and the instantaneous emission rates (Kesselmeier and Staudt, 1999)".

- P. 866, l. 20-28: Tingey et al. (1981) was included in the Introduction. Two other references addressing the effect of water limitation on monoterpene emissions from Mediterranean evergreen oaks were included (Introduction, p. 866): Bertin and Staudt (1996) on Holm oak and Staudt et al. (2008) on Cork oak. Because of that, the paragraph was reorganized and new references were quoted in the section References.

- P. 866, l. 29: A bracket was included to specify that Loreto et al (2001)'s study was apply to mature trees under controlled conditions.

- P. 867, 8-9: To illustrate field data in which water stress water limitation is cited as a hypothesis to explain seasonal and inter-annual emissions patterns, we replaced Fuentes et al. (1999) and Funk et al. (2005) by three studies referring on Quercus ilex species: Bertin et al. 1997), Nunez et al. (2002) and Plaza et al. (2005).

- P. 867, l 27: Results from LLusia et al. (2009) were included in the introduction.

- P. 873: The parameter values of the Guenther et al. model applied in this study were included.

- P. 873, l. 20-26: This paragraph was slightly changed to reduce the description of data normalization.

- P. 880, l. 25 ; P. 881, l. 7 & 28 ; P. : Brill et al. (2007)'s study was included and commented in the discussion part.

- P. 882, l. 15: "Mediterranean oak forest" was replaced by "Mediterranean Holm oak forest".

- Figures have been colored.

- Figure 5, erratum: I realized that there was a mistake on Figure 5: some data were missing on the graph when they were included in statistical calculations (non-linear regression and prediction interval). Even if this correction will not modify the message

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

of the figure, I wish to correct this mistake. Moreover, to add colors in Figure 5 make easier distinction between the various samples. Year and treatment were added and the legend was reorganized.

- Appendix 1 was included to show the (non-) effect of leaf age on monoterpene emission rates and standard emission factor.

- Appendix 2 shown the seasonal variation of stomatal conductance, transpiration and leaf intercellular CO<sub>2</sub> concentration.

---

Interactive comment on Biogeosciences Discuss., 6, 863, 2009.

## BGD

6, S1091–S1098, 2009

---

Interactive  
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

S1098

