Atmos. Chem. Phys. Discuss., 11, C8547–C8550, 2011
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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "The summertime Boreal forest field measurement intensive (HUMPPA-COPEC-2010): an overview of meteorological and chemical influences" *by* J. Williams et al.

**J. Williams et al.**

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Received and published: 5 September 2011

We thank the reviewer for the careful assessment of our paper.

The minor points raised have been addressed as described below.

1) Abstract 8 – The description of southerly flow has been amended for clarity to read: "Back trajectory analyses show that meteorological conditions at the site in 2010 were characterized by a higher proportion of southerly flow than in the other years studied."

2) The reviewer requests further detail concerning the effects of ozone on forest

ecosystems. The following sentence already gives some explanation (In particular through analysisof ozone dry deposition flux measurements in relation to photosynthesis and micrometeorologicalmeasurements.), however, in addition we have added the following text and references: “Furthermore, the surface reaction of ozone on leaves could lead to specific VOC oxidation products as has been seen on human skin (Wisthaler and Weschler 2010)” Wisthaler, A andWeschler, C.J. Reactions of ozone with human skin lipids: Sources of carbonyls, dicarbonyls, and hydroxycarbonyls in indoor air. Proc. Nat. Acad. Sci.107, 15, 6568-6575, DOI: 10.1073/pnas.0904498106, 2010.

3) Regarding the turbulent timescale – in order to provide a reference we have revised the sentence “For example, at 14:00 LT the characteristic turbulent time scale is estimated to be around 10 minutes.” to ““For example, at 14:00 LT the free convection time scale (Stull, 1988) is estimated to be around 10 min.” and included the Stull reference. Note this was also requested by reviewer 1.

4) On reflection we agree with the reviewer that the link to Arctic haze formation is tenuous and have removed both instances it was mentioned.

5) Referee 2 (like referee 1) is concerned that the relevance of the dataset to future climate scenarios in the boreal regions may be overstated. We certainly do not wish to imply that the short term effects of a heatwave can be taken as a direct analogy of far future climate conditions, in which numerous ecological feedbacks can play a role and meteorological patterns may differ. To address this, the abstract has been modified slightly to “the campaign is relevant for the analysis of possible future climate impacts”, however, the main clarifications/caveats to this point are now inserted in the conclusion section as follows: The unusually high temperatures experienced on this campaign are also useful to gauge the response of the Boreal forest to warmer conditions, at least in the short term. For example strong increases in highly reactive mono- and sesquiterpene emissions were observed during this campaign at higher temperatures, leading to higher OH reactivities. Temperatures in boreal regions are predicted to rise over



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this century, and datasets such as HUMPPA-COPEC 2010 can help verify proposed feedbacks to atmospheric properties. It should be noted, however, that over longer climate-scale periods ecological feedbacks as well as larger scale synoptic shifts may dominate.

6) Airmass origins - We agree with the reviewer that the text concerning Figure3a was unclear.It has been made more specific by adjusting the explanatory caption texts. The caption text of Figure 3a and the caption text of Table 3 have been changed to clarify the analysis of the trajectories, as follows: “Table 3. The percentage distribution within the sectors (NW, SW, SE, NE) for the 10th July-12 August (period of the HUMPPA-COPEC campaign) are shown for the years 2005-2010. The trajectories used percentage is the fraction of trajectories that did not hit ground or were otherwise not attributable to a wind sector. “Figure 3a. A map showing schematically the proportion of airmasses influencing the site during the HUMPPA-COPEC campaign, deduced from 3 day back trajectory analysis and segregated into wind sectors (NW, NE, SW, SE). The arrow sizes approximate to the proportion of trajectories and the statistics of the analysis are given in Table 3.” Instead of amending Figure 3a as suggested (which makes the plot only more complicated) we have followed the suggestion of reviewer 1 and added the wind directions from 2005-2009 to the histogram plot so as to show how 2010 stands out.

7) This expansion of the conclusion section was also requested by referee 1. First point, transport regimes – the following text in now included to summarize this work “During the campaign air was advected mostly from the SW (53.7%) of the time with smaller influences from the SE (20.7%) and the NW (10.3%). In comparison with the previous five years the campaign period in 2010 was more impacted by air from the south (SW and SE) leading to higher ozone and temperature values at the site.” Second point, boundary layer. The following text was added: “Analysis of meteorological sonde data has shown that the boundary layer height, although variable during the campaign, increased typically from less than 200 m in the early morning to around 1700 m at the



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end of the afternoon." Third point, sawmill extension of VOC:NOx space. The following text has been inserted "The latter has the effect of extending the VOC:NOx space measured in the campaign and was a valuable test of the OH reactivity measurements." Finally, we have additionally inserted a summary sentence on the regional landcover analysis for completeness thus: ". A regional 50km wide surface cover analysis showed that the southern sectors (SW and SE) contain more anthropogenic influence than the NW sector, although coniferous forest was found to dominate in all sectors."

8) Table 1. – There really is no room to further expand the information in table 1 to include references to each instrument. The instrument description information given under "technique" should suffice to locate more detail of each technique either from journals or in textbooks e.g. Warneck and Williams, "The Atmospheric Chemist′s Companion" 2011, Springer.

9) Typos – All done Specific moisture has been replaced by specific humidity which indeed the more correct term.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 15921, 2011.