

Interactive comment on “Analysis of coherent structures and atmosphere-canopy coupling strength during the CABINEX field campaign: implications for atmospheric chemistry” by A. L. Steiner et al.

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We thank the reviewer for these comments; however, we disagree with the reviewer's recommendation that the manuscript is not suitable for publication. The reviewer highlights a single conclusion that is not a new finding (“that the coherent structures play an important role in heat and momentum transport”), yet this conclusion is only one aspect of the work contained in the manuscript. In addition to quantifying the role of coherent structures on transport between the forest canopy and atmosphere, we compare two different detection methodologies and ascertain the coupling strength between the up-

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per canopy and the atmosphere. This analysis adds to the paucity of field observations of mixing within and above forest canopies.

From our perspective, there are three specific aspects of this publication that are novel and warrant publication in ACP:

1. To date, the majority of discussion of coherent structures has been confined to micrometeorological journals. As noted in the original manuscript (page 21029, lines 11–19), there have been many field campaigns with gradient atmospheric chemistry measurements, yet little discussion in the atmospheric chemistry community about the implications of coherent structures on vertical mixing. Therefore, this paper is targeted towards atmospheric chemists highlighting the need for turbulence measurements in conjunction with chemical observations. The inclusion of this manuscript in the CABINEX ACP Special Issue highlights the intersection of physical and chemical processes at work in this field campaign. Describing this analysis in sufficient detail is necessary so that the broader scientific community other than micrometeorologists can understand the implications of intermittent coherent structures.
2. While the individual detection methodologies are not novel, these two detection methodologies have not been compared in the literature. In fact, only one manuscript compares the number and duration of coherent structures using two methodologies (Thomas and Foken, 2007) for one site and ecosystem. Here we use a different wavelet technique (Barthlott et al., 2008) than Thomas and Foken (2007) and find consistent results. This adds value to the scientific discussion about coherent structures in that it provides a second study with comparative methodologies. We noted this point in the original manuscript (page 21027, lines 9–13).
3. The UMBS experimental facility has a broad research community using the site for a wide variety of flux measurements, ranging from biogenic VOC to carbon dioxide and nitrogen fluxes. There are multiple atmospheric research towers at this facility including the PROPHET tower (established in 1996) and the AmeriFlux tower (established

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in 1998) (<http://www.lsa.umich.edu/umbs/researchanddata/researchfacilities>). While these results are useful for the CABINEX community and other papers in this ACP Special Issue, they are also useful for other UMBS and AmeriFlux scientists trying to understand fluxes in and out of the forest. Further, this work can be useful for scientists studying atmospheric chemistry at other ecosystems. Therefore, this manuscript has scientific relevance beyond the CABINEX science team.

Regarding the request to shift the emphasis to atmospheric chemistry, we agree with the reviewer that these are important questions. Steiner and co-authors have a second manuscript in preparation for this ACP Special Issue using a one-dimensional chemistry-canopy model. In this second manuscript, vertical mixing is increased according to the sonic calculation of friction velocity and used as a driver for increased mixing in the canopy in accordance with coherent structures. Additionally, Edburg and co-authors have a manuscript recently accepted to *Boundary Layer Meteorology* that uses large-eddy simulation to examine turbulence and chemical reactions within and above the same forest canopy. Modeling studies such as these require an observational dataset that quantifies mixing and coupling strength at the same site, which is one goal of this manuscript. We expect additional manuscripts to be prepared using the results from the coherent structures and coupling analysis in conjunction with chemical gradient measurements. We expect that the reviewed manuscript will provide the baseline for these other studies by reporting the turbulence observations and highlighting the importance of turbulence measurements to the atmospheric chemistry community.

Manuscript revisions

We have made three changes to the manuscript to address the reviewer's concerns:

1. Motivation of work: We have revised the final paragraph of the introduction to more clearly state the utility of this paper:

"In this paper, we estimate and evaluate the contribution of coherent structures to vertical mixing within and above a forest canopy during a recent field campaign in the sum-

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mer of 2009 at the University of Michigan Biological Station (UMBS). The Community Atmosphere-Biosphere Interactions Experiment (CABINEX) field study was designed to elucidate the role of biogenic volatile organic compounds (VOC) and atmospheric oxidation within the canopy. As part of CABINEX, physical and chemical measurements were conducted at multiple heights within the forest canopy. While studies have evaluated turbulence at the UMBS AmeriFlux site (e.g., (Su et al., 2008; Villani et al., 2003)), a detailed analysis of coherent structures at the same spatial location and time of CABINEX chemical measurements is required for interpretation of chemical gradient measurements and other flux measurements at the UMBS facility. This description of canopy-atmosphere coupling can be useful in conjunction with chemical gradient measurements (e.g. Sörgel et al., 2011) and modeling to understand the role of mixing in atmospheric chemistry studies. The UMBS experimental facility has a broad research community using the site for a wide variety of flux measurements, ranging from biogenic VOC to carbon dioxide and nitrogen fluxes. Further, this work can be useful for scientists studying atmospheric chemistry at other similar ecosystems. The goal of this paper is to identify coherent structure contributions to mixing in the forest canopy and highlight time periods when the canopy is coupled to the atmosphere. The use of two coherent detection methods provides a comparison of techniques that is infrequently implemented in existing literature (Thomas and Foken, 2007)."

2. We have added a reference to the forthcoming study by Steiner and others to address the issue of in-canopy chemistry and amplified vertical mixing at the end of the conclusions section (final paragraph on page 21029):

"The implications of this increased vertical mixing on atmospheric chemistry are explored in a separate paper in this Special Issue (Bryan et al., in preparation)."

3. We have revised the title to reflect the concern of the reviewer that we are not including enough detailed discussion on atmospheric chemistry. The revised title will read:

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“Analysis of coherent structures and atmosphere-canopy coupling strength during the CABINEX field campaign”

We believe that the points presented in this response and the manuscript changes have addressed the reviewer’s concern and demonstrated that this paper is suitable for publication in this ACP Special Issue.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 21013, 2011.

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