Atmos. Chem. Phys. Discuss., 4, S2879–S2882, 2004
www.atmos-chem-phys.org/acpd/4/S2879/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Flux measurements of biogenic VOCs during ECHO 2003" *by* C. Spirig et al.

C. Spirig et al.

Received and published: 8 December 2004

Authors' response
We thank the three referees for their reviews and constructive comments on our manuscript. Uwe Kuhn and Peter Harley mainly commented on our presentation and interpretation of the flux measurement results. We will address their concerns and suggestions with appropriate corrections and clarifications. However, the focus of the paper will remain on the methodology and therefore it is not intended to extend the interpretation of the measurements significantly. Accordingly, the abstract of the manuscript needs to better reflect this focus and will also be adjusted, as postulated by P. Harley.
Before submitting a revised manuscript, we would like to contribute to the discussion

with a few comments on the major issues addressed by the reviewers.

Flux calculations

J. Rinne criticised that our flux calculation has an unnecessary loss of high-frequent flux contributions that could be avoided by using the virtual disjunct method, as introduced by Karl et al. (2002). We demonstrated that the missed high frequency contributions are small (11 percent in average) because most of the flux is transported in large eddies. Additionally, we applied a high frequency correction based on the assumption of identical frequency behaviour of different scalars. The heat flux is used as a reference because this measurement has the highest time resolution in this data set.

To complement this discussion, we followed the suggestion of J. Rinne and repeated the flux calculations for the west tower data using the disjunct VOC time series rather than the expanded VOC data. The comparison of these virtual disjunct eddy fluxes to the uncorrected fluxes calculated by the method presented in the manuscript shows an almost perfect linear relationship (R-squared =0.997). As expected, the calculation from the expanded VOC time series results in smaller fluxes due to the loss of some high frequency contributions. This is reflected in a linear regression slope of 1.07, showing that the calculation from the expanded time series looses 7 percent as compared to the disjunct calculation. The good correlation reveals that the high frequency correction as applied in the manuscript (stability independent correction) is appropriate. The high frequency correction factor in our calculation is 1.11, thus yielding systematically higher fluxes than would be obtained by the disjunct calculation. We attribute this difference to the combined effects of tube damping, sensor separation and mass integration time, causing a high frequency damping even in the disjunct calculation.

The comparison of the two calculation methods showed cases where an unambiguous detection of the flux (identified from the maximum in the covariance function) was possible when using the expanded data, but not in case of the disjunct calculation,

because the covariance function derived from the disjunct data exhibited more noise. It appears that the low-pass filtering by using the expanded data improved the detection of the (mainly low frequent) flux signal. In such cases, it may well be worth omitting part of the high frequent information (resulting in a less direct measurement of the flux) for the advantage of detecting a flux, at all. In this context, it can be stated that the benefit of our method is primarily of practical nature (including the efficient identification of the cospectral peaks).
It is our intention to investigate the difference between these calculation methods further, but the data set of ECHO is not suitable for a more rigid discussion in this respect: The resulting differences from the two methods lie clearly below the overall measurement uncertainties. A more profound assessment of the advantages and disadvantages of the two approaches requires flux measurements with stronger high frequent flux contributions, as can be found over grasslands, for example.

Relation of above canopy fluxes and leaf level emissions

The intention of this section of the manuscript is to give a rough top-down estimate of leaf level emissions as an additional qualitative argument to support the plausibility of the above canopy fluxes. A detailed investigation of the relationship between leaf level emissions and above canopy fluxes would require the application of a canopy model, preferably including chemistry. The ECHO data set might provide a good opportunity for such an investigation, but this is beyond the scope of this work. Nevertheless, we agree that even such a rough estimate needs to be described in a way the readership can retrace the presented results. The major reason for the unclarities questioned by both U. Kuhn and P. Harley was the different way of normalising biogenic emissions/fluxes in different parts of the manuscript without explicit declaration. This will be revised and clarified. For the normalisation of above canopy fluxes with respect to PAR, we do not go into more detail than using a single layer canopy model, as the objective here is an order of magnitude calculation rather than a discussion of emissions upscaling. As will be shown in the revised manuscript, the improvements in the normalisation

ACPD
4, S2879–S2882, 2004

Interactive Comment

EGU

result in only a minor modification of the previously presented leaf level emission estimates. It means that the main message is not affected by these corrections. The fluxes observed above the canopy are consistent with leaf level emission measurements.

Reference

Karl, T. G., Spirig, C., Rinne, J., Stroud, C., Prevost, P., Greenberg, J., Fall, R., and Guenther, A.: Virtual disjunct eddy covariance measurements of organic compound fluxes from a subalpine forest using proton transfer reaction mass spectrometry, Atmos. Chem. Phys., 2, 279-291, 2002.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 6603, 2004.