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Biogeosciences Discussions

Interactive comment on "Quality control of CarboEurope flux data – Part I: Footprint analyses to evaluate sites in forest ecosystems" *by* M. Göckede et al.

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Answers to main concerns

1. Influence of particle release height on latent heat flux quality

The authors agree with the editor that the setup of the particle release height in the Lagrangian Stochastic footprint model is a sensitive issue with potentially high impacts on the computed source weight functions. We also agree that the vertical distribution of sources and sinks in the forest canopy is different for the different fluxes analyzed here (e.g. CO2 flux vs. latent heat flux), so that the uncertainty introduced by our choice to simulate only sources close to the ground may affect the accuracy of our findings differently, depending on the fluxes.

However, the quality assessment of the fluxes is only dependent on the scheme by Foken and Wichura (1996) in the revised version by Foken et al. (2004), so that the setup of the footprint model cannot cause any differences between the different fluxes. The significant differences in the quality evaluation of CO2 flux vs. latent heat flux, as pointed out by the editor, can be attributed to measurement problems such as water in the tubing systems of closed-path gas analyzers, which affect the stationarity of the measured scalars differently. This is discussed in Section 4.2 in the manuscript.

Changing the release height of the particles would basically modify the fetch distances (see below for a more detailed discussion). Since the quality evaluations and also the wind direction would remain unchanged, figures such as Figure 2 in the manuscript would look the same as in the current version, only the scale would change. Therefore, an adaptation of the particle release height would certainly yield more accurate results, but with a significant increase in processing time, while the overall evaluation of the site would remain the same.

2. Sensitivity analysis of particle release heights

Sensitivity analyses concerning the particle release heights have been performed for exactly the same Lagrangian Stochastic footprint algorithm as employed in this study by Rannik et al. (2003) and Markkanen et al. (2003). In both studies, figures are presented that demonstrate that elevated sources produce a (crosswind-integrated) source weight function that is characterized by shorter fetches and a more pronounced peak, as compared to sources at the forest floor. Results for different vertical source distributions may differ significantly from case to case. It is certain, however, that the release of particles at the forest floor produces the longest fetch distances of all possible setups, and thus can be regarded as the most conservative footprint estimate (as discussed in Section 5 of this manuscript).

As pointed out in the first paragraph of the discussion section, the setup for the footprint calculations had to be simplified for the presented study to allow processing of the large

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number of data months. The most important simplification was that we did not calculate customized footprints for each site, but used a fixed setup for the vertical velocity profiles within the canopy to produce pre-calculated source weight functions that were applied to all sites. Since the canopy structure is supposed to be different at each of the sites, we decided therefore to go with the most conservative setup concerning particle release heights, with particles starting close to the forest floor. See also Göckede et al. (2007) for a detailed study on the role of velocity statistics on Lagrangian Stochastic footprint prediction.

3. Expected changes in the quality evaluations

The authors agree that a uniform particle release height close to the forest floor introduces a bias into the results, and that this bias can be expected to differ between e.g. the fluxes of CO2 and latent heat, or over the course of a day, since the vertical distribution of sources and sinks varies between emitted scalars, or depending on time of day. However, the quality evaluation of the flux measurements is carried out independently with the approach by Foken et al. (2004), and therefore an adaptation of the particle release heights would maybe change the scale of the maps for the overall quality assessment, but not the general patterns of sectors with high or low quality, so that the overall site evaluation would not be affected.

Summarizing, we agree that the role of the particle release height deserves more attention in the context of this study, due to the reasons pointed out by the editor. We therefore added an additional paragraph with a discussion on this subject into the manuscript text (2. paragraph in Discussion section). Additional sensitivity analyses concerning the particle release height could only deliver the same results as already presented by Rannik et al. (2003) and Markkanen et al. (2003), so we will include their references instead of re-running their studies.

Answers to minor comments

1. Add paragraph on landscape heterogeneity assessment

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The second paragraph of the introduction section as extended to provide an overview on studies treating the influence of landscape heterogeneity on measurement and interpretation of atmospheric data.

2. Alternative methods for data quality analysis

The QA/QC approach by Foken & Wichura (1996) in the revised version by Foken et al. (2004) is commonly applied worldwide, and integrated in most available flux data processing packages (Mauder et al., 2007). No further comprehensive quality assessment approach for eddy-covariance fluxes is known to the authors. Alternatives can be found e.g. in Vickers and Mahrt (1997), who provide tests for stationarity, skewness and kurtosis, or comparing correlation coefficients of different fluxes (e.g. Kaimal et al., 1990; Kaimal and Finnigan, 1994). The latter approaches have been discussed in Foken & Wichura (1996), and proven to provide comparable results. Some extensions for quality tests were discussed by Foken et al. (2006) and Liu et al. (2006), but these are not relevant for this paper.

3. Move discussion of map properties

The major part of the last paragraph of Section 2 was moved into Section 5.

4. Soroe reference by Ibrom et al.

The Ibrom reference was included into the text describing and interpreting Figure 2.

5. References for u* filtering methods

Included u* criterion references by Gu et al. (2005) and Massman and Lee (2002).

6. Values displayed in Figure 8

We included the values displayed in Figure 8 as an additional column in Table 3.

References

Foken, T. and Wichura, B., 1996. Tools for quality assessment of surface-based flux

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measurements. Agr. Forest Meteorol. 78, 83-105.

Foken, T., Göckede, M., Mauder, M., Mahrt, L., Amiro, B.D. and Munger, J.W., 2004. Post-field data quality control. In: Lee, X., Massman, W.J. and Law, B.E. (Eds.), Handbook of Micrometeorology: A guide for Surface Flux Measurements. Kluwer Academic Publishers, Dordrecht, pp. 181-208.

Foken, T., Wimmer, F., Mauder, M., Thomas, C. and Liebethal, C., 2006. Some aspects of the energy balance closure problem. Atmos. Chem. Phys. 6, 4395-4402.

Göckede, M., Thomas, C., Markkanen, T., Mauder, M., Ruppert, J. and Foken, T., 2007. Sensitivity of Lagrangian Stochastic footprints to turbulence statistics. Tellus B 59, 577-586.

Gu, L., Falge, E.M., Boden, T., Baldocchi, D.D., Black, T.A., Saleska, S.R., Suni, T., Verma, S.B., Vesala, T., Wofsy, S.C. and Xu, L., 2005. Objective threshold determination for nighttime eddy flux filtering. Agr. Forest Meteorol. 128, 179-197.

Kaimal, J.C., Gaynor, J.E., Zimmerman, H.A. and Zimmerman, G.A., 1990. Minimizing flow distortion errrors in a sonic anemometer. Bound.-Lay. Meteorol. 53, 103-115.

Kaimal, J.C. and Finnigan, J.J., 1994. Atmospheric Boundary Layer Flows: Their Structure and Measurement. Oxford University Press, New York, 289 pp.

Liu, H.P., Randerson, J.T., Lindfors, J., Massman, W.J. and Foken, T., 2006. Consequences of incomplete surface energy balance closure for CO2 fluxes from open-path CO2/H2O infrared gas analysers. Bound.-Lay. Meteorol. 120, 65-85.

Markkanen, T., Rannik, Ü., Marcolla, B., Cescatti, A. and Vesala, T., 2003. Footprints and fetches for fluxes over forest canopies with varying structure and density. Bound.-Lay. Meteorol. 106, 437-459.

Massman, W.J. and Lee, X., 2002. Eddy covariance flux corrections and uncertainties in long-term studies of carbon and energy exchanges. Agr. Forest Meteorol. 113,

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121-144.

Mauder, M., Foken, T., Bernhofer, C., Clement, R., Elbers, J., Eugster, W., Grünwald, T., Heusinkveld, B. and Kolle, O., 2007. Quality control of CarboEurope-IP flux data. Part II: Intercomparison of eddy-covariance software. Biogeosciences Discussion 4, 4067-4099.

Rannik, Ü., Markkanen, T., Raittila, J., Hari, P. and Vesala, T., 2003. Turbulence statistics inside and over forest: Influence on footprint prediction. Bound.-Lay. Meteorol. 109, 163-189.

Vickers, D. and Mahrt, L., 1997. Quality control and flux sampling problems for tower and aircraft data. Journal of Atmospheric and Ocean Technology 14, 512-526.

Interactive comment on Biogeosciences Discuss., 4, 4025, 2007.