Atmospheric
Measurement
Techniques
Discussions

Open Access

Interactive comment on "Net ecosystem CO$_2$ exchange measurements by the closed chamber method and the eddy covariance technique and their dependence on atmospheric conditions – a case study" *by* M. Riederer et al.

M. Riederer et al.

michael.riederer@uni-bayreuth.de

We thank the anonymous reviewer for his comments which helped us to improve our formulations.

General Comments:

The eddy covariance method (EC) is by definition a direct measuring method (Montgomery, 1948; Obukhov, 1951; Swinbank, 1951) to determine turbulent fluxes. How-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

ever, several conditions must be fulfilled before the method can be applied as a reference method. Most important in this context are steady state conditions, flat and homogeneous terrain and turbulent exchange conditions (Lee et al., 2004; Foken 2008; Aubinet et al., 2012). The control of these conditions is achieved by applying data quality tools (Foken and Wichura, 1996; Vickers and Mahrt, 1997; Foken et al., 2004), the application of which has recently come to represent the state of the art. In Section 2.2 we explained that we only use EC data which fulfils the highest quality criteria.. Nevertheless, we agree with the reviewer that such a statement would be also helpful in the introduction. We and will include that.

General Technical Comment:

Thank you for the remark. We will reformulate any overly complicated sentences.

Specific comment:

Abstract, line 3-4:

We will delete the sentence.

Section 2.4, 2nd paragraph, p. 8790, line 9-12:

We have not made any carbon concentration measurements close to the surface. Our statement is based on the physics of the oasis effect, which is – besides the day time and night time exchange situations – the third situation within the diurnal cycle of the turbulent exchange (Stull 1988). In the late afternoon, with already reduced solar radiation but still moderate wind velocity, the evapotranspiration is only slightly reduced and the energy consumption by evaporation causes cooling of the surface. Therefore, the sensible heat flux is directed towards the surface (Oncley et al. 2007). This internal temperature boundary layer is often very shallow (20-100 cm) and the measuring height of the EC system is often above, i.e. in the still unstable stratified atmosphere. In the stable layer close to the surface, respired carbon dioxide is highly concentrated. A comparable situation above a forest floor is shown for instance in Foken et al. (2012).

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

The NEE is calculated as the sum of the storage term and the covariance term (Eq. 1.24 in Aubinet et al., 2012), but if the layer below the EC system is decoupled due to stable stratification and the layer is not mixed, the storage term cannot be determined from a single measurement at the level of the EC complex. Therefore, these fluxes are underestimated. The statement that the partial pressure of CO_2 near the ground equals that within the soil stretches the point. It is, rather, the CO_2 enrichment due to stable conditions and a reduced gradient between within the soil and a short distance above, which consequently reduces the gas exchange.

Section 3, Page 8792:

We agree that it takes some sentences before all four situations are mentioned and described (up to page 8793). We will modify the paragraph to improve clarity. We did not investigate the sunset and sunrise situations in detail because of insufficient data quality, e.g. due to dewfall on chamber and infrared gas analyzer of the EC system.

Section 3, Page 8793:

The carbon flux in the chamber is nearly constant at night because it is only controlled by microbiological activity. There is no shortwave radiation and therefore assimilation and transpiration are absent and the evaporation is very limited due to a negligible energy input. On the other hand, the long wave net radiation in the chamber is almost zero due to nearly identical temperatures of the soil and the top of the chamber. The air mixing in the chamber by the LICOR pressure system is constant. Outside the chamber - and this is measured with the EC system - we have a large amount of long wave outgoing radiation (the radiation temperature of the sky can be up to -55 K) which is the reason for very stable stratification and calm conditions and very low EC fluxes. Especially in the second half of the night two additional effects occur. With the beginning of dewfall, the condensation heat reduces the downward sensible heat flux and the strong stable stratification. The consequence is a higher turbulent exchange. More significant is an increase of turbulence due to braking gravity waves or the influence of

low level jets – both generate turbulent conditions with significant higher fluxes (Karipot et al. 2008). Such conditions are also typical in the region of investigation (Foken et al. 2012). Heating due to dewfall and influences of processes in the atmospheric boundary layer are related to slightly higher wind speed (Fig. 4b) and larger EC fluxes (Fig. 1). We will check that these processes are clearly identified in the text.

Conclusion section 1:

Because the LICOR Chamber LI-8100-104C can only be used above very low vegetation, the paper is restricted to this vegetation type. We will add such a statement.

Conclusion section 2:

We will add a sentence in the conclusion about the periods when the different methods were in agreement.

References:

Aubinet M, Vesala T and Papale D (2012) Eddy Covariance: A Practical Guide to Measurement and Data Analysis. Springer, Dordrecht, Heidelberg, London, New York, 438 pp.

Foken T and Wichura B (1996) Tools for quality assessment of surface-based flux measurements. Agric Forest Meteorol. 78:83-105.

Foken T, Göckede M, Mauder M, Mahrt L, Amiro BD and Munger JW (2004) Post-field data quality control. In: Lee Xet al (eds.), Handbook of Micrometeorology: A Guide for Surface Flux Measurement and Analysis. Kluwer, Dordrecht, 181-208.

Foken T (2008) Micrometeorology. Springer, Berlin, Heidelberg, 308 pp.

Foken T, et al.(2012) Coupling processes and exchange of energy and reactive and non-reactive trace gases at a forest site – results of the EGER experiment. Atmos Chem Phys. 12:1923-1950.

Karipot A, Leclerc MY, Zhang G, Lewin KF, Nagy J, Hendrey GR and Starr D (2008) Influence of nocturnal low-level jet on turbulence structure and CO2 flux measurements over a forest canopy J Geophys Res. 113:D10102.

Lee X, Massman WJ and Law B (eds) (2004) Handbook of Micrometeorology: A Guide for Surface Flux Measurement and Analysis. Kluwer, Dordrecht, 250 pp.

Montgomery RB (1948) Vertical eddy flux of heat in the atmosphere. Journal Meteorology. 5:265-274.

Obukhov AM (1951) Charakteristiki mikrostruktury vetra v prizemnom sloje atmosfery (Characteristics of the micro-structure of the wind in the surface layer of the atmosphere). Izv AN SSSR, ser Geofiz. 3:49-68.

Oncley SP, et al. (2007) The energy balance experiment EBEX-2000, Part I: Overview and energy balance. Boundary-Layer Meteorol. 123:1-28.

Stull RB (1988) An Introduction to Boundary Layer Meteorology. Kluwer Acad. Publ., Dordrecht, Boston, London, 666 pp.

Swinbank WC (1951) The measurement of vertical transfer of heat and water vapor by eddies in the lower atmosphere. J Meteorol. 8:135-145.

Vickers D and Mahrt L (1997) Quality control and flux sampling problems for tower and aircraft data. J Atm Oceanic Techn. 14:512-526.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 8783, 2013.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper