

Interactive comment on “Interactions between nocturnal turbulent flux, storage and advection at an ‘ideal’ eucalypt woodland site” by Ian D. McHugh et al.

Ian D. McHugh et al.

ian.mchugh@monash.edu

Received and published: 10 September 2016

Thanks to the reviewer for efforts and constructive critique. Please find responses to specific items below.

Reviewer Comment: The paper is well written, but there are still some inaccuracies in the use of terms (e.g., carbon at the place of CO₂) and possibly a couple of too speculative argumentations. Some of the last graphs and a few paragraphs can be removed for sake of conciseness. I strongly recommend this paper for publication having considered the following specific indications.

Response:

C1

See specific points below.

Reviewer comment (P3, L16):

‘when the nocturnal u^* correction is applied’. There are some groups that apply the ustar correction at night only (a minority, to my knowledge), some others to the whole day. I recommend, for completeness of the information, to provide the carbon balance estimates with the use of the (uncommon) use of the night ustar correction, as it was already done, and with the 24 hours ustar correction.

Response:

We have rerun analyses using both cases.

Reviewer comment (P5 L19):

‘... change in carbon exchange...’ CO₂ is the main form with which carbon is exchanged from the ecosystem to the atmosphere, but it is not the only one; methane and VOCs are exchanged too. So please avoid this synecdoche here and elsewhere, including in some of the graphs (like Figure 13).

Response:

We amend all references to carbon to CO₂ where appropriate throughout.

Reviewer comment (P6 L23):

‘... micrometeorological convention suggested by Chapin ...’ I believe that the micrometeorological convention was established well before than the paper from Chapin.

Response:

Reference to Chapin has been removed.

Reviewer comment (P10 L4):

‘Much higher random error in storage. ...’ To avoid this large random error, in the current

C2

ICOS protocol on storage flux measurements it is recommended to add air receivers along the lines if sequential sampling is performed, and to add some ramifications at the lower levels of air intakes to sample a wider portion of the control volume. The same argument of uncertainties originated by profile measurements is repeated in the conclusion, with possibly a technical mistake there: It is not the profile-based storage measurement that induces large uncertainty, but probably the used setup and maybe the applied computational procedure.

Response:

It is likely that our setup increases the random error in the profile data relative to that described by the reviewer. Our system can sample the entire 36 m profile in 2 minutes because air is drawn through all lines simultaneously, although this reduces pump speed and results in a lag from intake to analysis of slightly greater than 1 m. We calculate the storage term as the difference between the height-integrated CO₂ molar density between the beginning and end of the half-hourly period corresponding to the flux averaging period. For example, we use the 14:30-14:32 interval and the 15:00-15:02 interval to calculate the storage term for the 15:00 flux estimate, which represents 14:30-15:00. The 2-minute lag is introduced to account for the system lag between intake and IRGA.

Adding upstream volume to the system (i.e. a buffer chamber at the intake) would be expected to reduce random error by smoothing near-instantaneous fluctuations in [CO₂], but this is effectively equivalent to using a longer time average. We can use a longer time average because we measured all 2-minute periods and can use a 2, 4 or 8 minute period at the beginning and end of the half-hour. However, according to Finnigan (2006): '... there is an irreducible error associated in calculating the storage from a single tower, where the worker must choose between the random error associated with using instantaneous profiles and a certain loss of high frequency information if the storage term is calculated from time-averaged vertical profiles.'

C3

For this reason, we think that our choice of a single 2-minute period is defensible. We believe that the best-designed profile system will increase the amount of random error observed when F_c is summed with S_c compared with F_c alone. Thus, we do not entirely agree that 'It is not the profile-based storage measurement that induces large uncertainty, but probably the used setup and maybe the applied computational procedure.' Our setup may increase random error over and above the 'ideal' profile system, but random error will not be eliminated from the ideal system. That said, a different intake design in which there is some horizontal spatial sampling would further reduce random fluctuations, and our system does not have this (single inlet). Therefore, we acknowledge this as a limitation of the design, and accordingly make conclusions on this aspect of the analysis less general.

Reviewer comment (P10 L27):

'Given ... canopy'. A verb (are?) is missing in this sentence.

Response:

Amended.

Reviewer comment (PP 11-14):

The section 3.3 is very long and increasingly speculative; I lost progressively my interest and I have doubts about the argumentations. I recommend stopping at page 13, line 24, after '... in this study'.

Response:

Acknowledged. Section 3.3 will be shortened and speculative aspects removed.

Reviewer comment:

Caption of Figure 4: '... LH axis) profile system ...' I cannot understand.

Response:

C4

Amended so that description of data precedes the indication of which axis it is associated with (Figure 4: CO₂ mole fraction time series (11/02/2012 – 19/02/2012) for all profile heights (LH axis) and corresponding friction velocity time series (RH axis)).

Reviewer comment:

Figure 11: consider removing.

Response:

This figure demonstrates that the addition of the profile data to the flux data substantially increases the nocturnal random error relative to the flux data alone, and also the very large error associated with the point storage method when fluxes are small. This seems important given that we dismiss the point-based storage estimates partially on the basis that the model parameterisation becomes unstable when using these data (this figure illustrates why!). If the reviewers consider that such information can be stated in the text without recourse to a figure, we will remove it.

Reviewer comment:

Figure 12: I cannot understand what the authors mean with ‘... are here baselined to the height integrated profile...’. In any case, also this figure is not essential, consider removing.

Response:

This figure pertains to some of the more speculative aspects in section 3.3 critiqued above. Will be removed as part of the process of clarifying and shortening section 3.3.

Reviewer comment:

Figure 13. Also this figure is not essential and unnecessarily complicated in my view, consider removing.

Response:

C5

We considered this a novel finding. It is often argued that in the absence of profile measurements, nocturnal measurements with $u^* > u^*$ threshold immediately following low u^* conditions should be filtered out because they result in an overestimation of ER due to the release of stored carbon. We show here that while this occurs late at night (as indicated by the negative storage term >5 hours after sunset in Figure 13), in the early evening, the storage term is positive, and NEE is therefore underestimated. This has implications for the calculation of relationships between temperature and ER, in turn for the extrapolation of these data to the daytime (as is typically done as part of the partitioning process). It may perhaps be that this finding is not made sufficiently clear in the discussion, or it may be that it is not considered relevant by the reviewer. If the latter, we can potentially remove this analysis and publish in a separate paper.

Reviewer comment:

Table 1: ‘*Cassinia arculeata*’->‘*Cassinia aculeata*’.

Response:

Amended.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-184, 2016.

C6