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Biogeosciences Discussions

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5, S2496–S2500, 2008

Interactive Comment

Interactive comment on "Drivers of interannual variability in Net Ecosystem Exchange in a semi-arid savanna ecosystem, South Africa" *by* S. Archibald et al.

S. Archibald et al.

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We thank the reviewers for their comments on our manuscript, and have spent some time and effort in ensuring that we address the issues that have been raised. We believe the revised manuscript to be a substantial improvement on the original submission.

Some of the issues raised by the reviewers were similar. In particular, more than one reviewer had questions about the effect of the fact that the flux tower was placed on an ecotone between two different soil/vegetation communities. Also, two reviewers requested us to add error bars to our annual sums, and asked about the relationship between fAPAR, APAR, and precipitation. We therefore first respond to these questions in detail, and then we list our responses to the other comments by the three authors. There are some instances where we would like to illustrate our point with figures but the format does not allow for it. For this reason we have added them to the end of the revised manuscript for the reviewers to look at if required.

0.1 Effect of the ecotone

We agree that we did not go into enough detail on this topic, but that is not because we have not considered it. Indeed, the reason the flux tower was located on the seepline was because we were hoping to see differences in water, energy and carbon exchange between the two different vegetation types. However, none of the analyses that we have done suggest that this is the case. After separating all fluxes into predominantly broad-leafed and predominantly fine-leafed (based on the wind direction - Figure 1) we summarised these monthly over the 6 years (Figure 2). Although night time carbon flux seemed to be slightly higher in the broad-leaved savanna over the dry season (months 4-8) the results were not significant enough to justify running these analyses separately for the two different systems. Kustch (this edition) similarly notes that the data 'show no significant differences between the savanna types in terms of fluxes'.

Similarly, one reviewer asked about soil moisture differences between the two ecotones. Although the soils upslope and downslope from the tower are clearly different, and would have different water-holding properties, we chose not to run this analysis for the two ecotones separately. Firstly, because we could perceive no difference in the fluxes, and secondly because it would have halved the amount of data which was already a limiting factor.

All landscape level analyses have to find some way to integrate the various soil moisture profiles found within the landscape into one value to be used in analysis. Indeed, the data from the four soil moisture probes at the site (two in the broad leafed and two in the fine leaved savanna) indicate how localised the soil moisture profiles can be (Figure

BGD

5, S2496–S2500, 2008

Interactive Comment

3), and did not clearly separate the two soil types. To perform this landscape-level integration we chose a) to use volumetric soil water content instead of soil water potential, as this represents water availability to plants while being less influenced by differences in soil properties b) to use modelled data based on the soil properties measured in the field at the site and calibrated against the data from the soil moisture probes (See Archibald and Scholes 2007 for details). The date at which different parts of the landscape within the footprint hit field capacity is unlikely to be the same. However, the pattern of dry-down is consistent throughout the site, and the fact that all three of our chosen soil moisture measures are identified as important in all analyses indicates that they are in fact picking up useful information.

ACTION TAKEN: We have altered the manuscript to report on some results of the ecotone analysis (see site description), and explain why we therefore used one analysis on all the data. We have added a figure summarising the fluxes recorded from the different ecotones.

0.2 Adding error bars

A second point raised by more than one reviewer was the question of error bars around our estimates of annual carbon exchange. We have spent some time investigating how best to approach this and chose to estimate the random error component following Richardson et al (2008). We are unable at this stage to estimate systematic error but this is something we want to consider in the future.

ACTION TAKEN: We have added a section to the methods describing our error estimation methods, and have added 95% confidence limits in Table 5 and Figure 6.

BGD

5, S2496–S2500, 2008

Interactive Comment

0.3 Linking precipitation, Fapar and Apar

Two reviewers requested clarity on our assumption that fAPAR (and therefore also APAR) was closely linked with precipitation.

A separate analysis at the site using field measurements of leaf phenology and satellite data showed that soil moisture was an important driver of seasonal patterns of leaf display (Archibald and Scholes 2007). Grass phenology is determined by soil moisture, but several of the common tree species do flush before the first rains (presumably using stored stem water to put out leaves). The timing of leaf drop in both trees and grass depends on soil moisture. Fapar therefore tracks soil moisture, but it does not show as much variation on the hourly/daily time scale. It could be seen to represent a time-integrated index of the soil moisture status of the system. It therefore seems rational to us that soil moisture measures should be important in driving NEE at a daily scale, and that APAR should be identified as closely related to NEE at an annual scale.

ACTION TAKEN: We extend our discussion of the drivers of annual NEE to add some discussion on the links between precipitation, soil moisture, fapar and APAR in the manuscript.

0.4 Figures referred to in text - appended to the revised manuscript

Figure 1: Showing dominant wind directions at the flux site, and the approximate fetch of the broad-leaved Combretum savanna and fine leaved Acacia savanna

Figure 2: Showing mean monthly carbon (Fc) and water (LE) flux at the site for the two main vegetation types (calculated from the wind directions). Carbon fluxes are separated into daytime and nighttime fluxes.

Figure 3: Soil moisture time series from the four sets of soil moisture probes at the site. Data presented as volumetric water content over the entire profile.

BGD

5, S2496–S2500, 2008

Interactive comment on Biogeosciences Discuss., 5, 3221, 2008.

BGD

5, S2496–S2500, 2008

Interactive Comment