Biogeosciences Discuss., 5, S1432–S1437, 2008
www.biogeosciences-discuss.net/5/S1432/2008/

Biogeosciences Discussions

BGD

5, S1432–S1437, 2008

Interactive Comment

Interactive comment on "Response of carbon fluxes to water relations in a savanna ecosystem in South Africa" *by* W. L. Kutsch et al.

W. L. Kutsch et al.

Received and published: 18 August 2008

Final Authors comment on BGD 2008-0045

We thank all the referees for their mostly helpful comments. Since some referees have pointed to the same issues, we have sorted the most important comments. Comments of minor importance (delete space between 'sto' and 'matal') will be dealt with in the revision of the manuscript but not in this more general response.

Site differences There are several comments on the fact that the tower is located (deliberately) at the border between two apparently different ecosystem types. Referee 1 sees the potentials and limitations of this approach when he states: Referee1: The site at Kruger 'sees' two different footprints and vegetation types. This attribtute is a strength and a weakness of this study. For ecological questions it is best to produce

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

annual budgets of fluxes from different vegetation types. This objective is impossible to meet at Kruger, as partial budgets from the acacia and broad-leaf Combretum savanna can only be produced. On the other hand, the investigators are able to construct canopy-scale response functions between surface fluxes and driving meteorological variables. First, it is important to note that, in principle, it is possible to produce annual budgets from sectoral analyses, using gap-filling. The first author has shown this in another study (Kutsch et al. 2005, Global Change Biology). However, it was not the goal to derive annual budgets in this study because we were interested in principle ecosystem-physiological characteristics of the different vegetation types. This is stated in the Introduction. It turned out, to our surprise, that the differences were hardly detectable. Referee 3: As this study focuses on the influence of water availability on ecosystem fluxes, is there an effect of landform on soil water? In other words, in the methods section the topography is described and it is explained that the Combretum vegetation type is found on the 'crests'; and Acacia found below on the lower part of the slope. How does this influence results? Does the topographic position influence the Q10 response? Please explain if this influenced results. There is an effect of landform on soil water since there are different soil types: the Combretum savanna is on coarse sandy soils while the Acacia savanna is on clayier soils. Volumetric soil water content differs between the sites, but relative soil water availability (RSWA) does not. Thus, we used RSWA for the analysis. We know that it would be best to have the soil water potential and will calculate this with a pF-curve derived from soil properties that are known for the sites.

Q10 Referee 1: I need to know more about how Q10 was computed. Many investigators convolve seasonal changes in metabolism and temperature and produce unrealistically and wrong Q10s much greater than 2.5. When smaller data windows are used many find Q10 to be well constrained between about 2 and 2.5, unless water deficits force it to be lower. I want to be assured that the investigators are computing Q10 correctly. I suspect they may be doing it correctly as later in the manuscript (pg 2209) they refer to using the method of Reichstein et al, which is standard and appropriate.

BGD

5, S1432–S1437, 2008

Interactive Comment

But I look at the data in Fig 4 and see data from 2 to 3 month periods with clumps of data from different phenological stages. It is appropriate that the authors separate the data by moisture class and the plots are informative.

Our hypothesis was that respiration was affected by 1.) soil moisture 2.) soil temperature and 3.) phenological stage. That is the reason for separating for phenological stages. While analysing the data we found that the influence of the phenological stage may be statistically minor. We decided to use the Reichstein et al. model that needs moisture and temperature as input and calculated the R15 (for high soil moisture) for each period. As shown in Figure 9 there is only a small variation of R15 during the growing season but some increase during the dry season, which might simply result from curve fitting issues (small variation of relatively cold soil temperatures) or may be a hint of increased availability of easily decomposable organic substance. We will discuss this more deeply.

Soil moisture Referee 1: Soil moisture is very important in interpreting these data. Do the trees tap deep water sources? Is the integrated soil moisture weighted with respect to where the roots are? This operation is critical for producing information on the moisture sensed by the trees. Yet little information is presented on nuances associated with water budgets.

Very few of the trees use deep water, as evidenced by the fact that almost all the trees frop their leaves in the dry season. The bedrock is a poor aquifer and is not highly fissured. The roots of both trees and grasses fully occupy the entire soil layer, which is less than 0.6 m deep on average, so root-weighting is inappropriate.

Canopy physiology Referee 1: In fig 6 the authors compare canopy conductance vs vapor pressure deficit. But canopy conductance is derived from measurements of vpd. This plot provides no new knowledge, insights or information due to autocorrelation. The findings that water use efficiency scales with vpd can be considered to be trivial too. We've known this since the 1960s and the important and pioneering papers of

BGD

5, S1432–S1437, 2008

Interactive Comment

Slatyer and Bierhuizen. The authors need to move away from the obvious analyzes that are well treaded in many papers and try and plow new paths and give alternative and innovative insights on how this system functions and operates. Other aspects of the paper are noteworthy.

The important thing is not that the canopy conductance scales with VPD but that it scales differently depending on the soil moisture. The mid-term response to climate and /or soil moisture, respectively, is a relatively new and important path. Although described by Kutsch et al. (2001, Basic and Applied Ecology) for the leaf level, it is not included in any of the common models. It is important to note that the decrease in stomatal conductance goes together with the down-regulation of photosynthetic capacity. As a consequence, Ci/Ca may remain relatively stable and the isotopic fractionation will not be affected as severely as expected. Therefore, predicted values of isotopic fractionation from large scale modeling may be wrong. We will include this aspect in our discussion.

Referee 2: If possible, the authors should provide more detailed information on the seasonal course of LAI in the adjacent ecosystems. Provide a table or a brief discussion in results. This data would improve the understanding and presentation of results. Referee 5: Seasonal change in LAI is also necessary, since both of photosynthesis and respiration are affected by LAI. You should consider the water influence on the CO2 fluxes separately from the amount of plant.

We will provide LAI data measured at the site using an Accupar sensor and weekly satellite derived data FAPAR data in the revised version of the manuscript.

Methods

Referee 3: However, the authors do not provide much discussion on the limitations of the EC method to derive their results or clearly highlight the results which make this study unique.

BGD

5, S1432–S1437, 2008

Interactive Comment

Referee 4: However, the authors do not explain enough the implication of using EC method to explain the processes they study. They intend to partition Fc measured from EC to partition between canopy assimilation and respiration but they did not use it to argue their discussion.

There are several important papers that focus on the limitations of the EC method. Most of them state that deriving annual budgets from EC may be biased by advection or other problems with nighttime data or by other systematic errors resulting in inappropriate gap-filling. We support this opinion. Therefore, we chose another path: we used only high-quality data to derive ecosystem-physiological knowledge by deriving response functions. These may be used in a further step to model annual budgets and compare them to the gap-filled EC data. We will briefly highlight this in our introduction and refer to recent papers.

Figures Referee 5: At least, time courses of CO_2 fluxes (Fc, Fp, and Fr) and (air or soil) temperature should be illustrated in addition to the soil moisture.

Referee 1: The presentation of the figures is odd and inappropriate. Fig 6 is discussed, then fig 9 is introduced, then fig 7. I looked several times for discussion of fig 8. I finally found it going back several pages and it was in the section on nocturnal respiration. Then I found fig 8 presented after fig 9.

Referee 3: There are two many figures. In addition, the figures are out of order (e.g. referencing fig. 8c before fig 5). This needs to be corrected in order to improve the flow of the manuscript.

We will follow the suggestion of Referee 5 and will present a 9 month plot of FC, FP and FR ½ hourly values together with the course of soil moisture. To balance this, we will do without Fig. 8 because water use efficiency may be fashionable within the community, but is not important to our reasoning in this manuscript.

The reviewers are right to criticize the order of the figures. The idea was to combine

BGD

5, S1432–S1437, 2008

Interactive Comment

all the integrative graphs at the end of the manuscript. However, we did not realize that some of these graphs (Respiration) are discussed earlier in the text. We will correct that.

Language Referee 1: The text needs much editing and revision. I recognize that the lead author is not a native English speaker. I encourage him to have an editor revise the text. Many sentences are awkwardly phrased. They make reading the text distracting and the presentation of complex material unclear.

The native speakers within our team will definitely revise the final version of the manuscript, as they did with earlier versions...

Interactive comment on Biogeosciences Discuss., 5, 2197, 2008.

BGD

5, S1432–S1437, 2008

Interactive Comment