Review of Carbon balance of a grazed savanna grassland ecosystem in South Africa by Rasanen et al. 2016

General comments:

The number of EC sites sampling Carbon fluxes at African savannas is very limited, and this manuscript thereby fills a very important gap in our knowledge regarding terrestrial C cycling. The manuscript thereby fits well into the objectives of Biogeosciences. It has recently been shown that grazing has a tremendous effect on CO2 fluxes in savanna ecosystems, and it is thereby very important to measure fluxes in these ecosystems. However, the manuscript is written in a quite unclear way. It can easily be constrained at many parts, whereas many more details are needed in others.

Major concerns:

Generally, the language needs to be improved and the manuscript must be much more concise. This goes for all sections.

A large section of the results is about testing different partitioning methods, but it is not included as an aim in the introduction. In case an aim of the study is to investigate different partitioning methods, please clarify this already in the introduction. Otherwise, I would recommend using the one that works the best. I fully understand why the night-time methods are not working well, since it has generally been seen that at a diurnal time scale respiration is not strongly linked to temperature for savanna ecosystems. But I cannot understand why the daytime method is working so poorly. Are you sure that you fitted the equation correctly? After putting a lot of effort into partitioning of the data, the partitioned data is not even shown except in the format of monthly averages. Please, show the partitioned data as well.

Why did you use monthly averages in the investigation of seasonal variation? I cannot see any reason for not using daily sums or averages. By using monthly estimates you hide a lot of the variability and it is more difficult to see the relationship to the environmental variables.

There is no statistical testing of relationships of the fluxes to the environmental variables. It is just stated that high flux values can be explained by some variables. But you do not explain how you have tested for this.

Specific comments:

L19-20. There is a contradiction in this sentence: are the balances yearly or are they for the growing season, please rephrase.

L23-24 Please clarify in the abstract why: This study underlines the difficulty in establishing a functional relation between the total ecosystem respiration and the environmental drivers in savanna ecosystems.

L24-25 There must be something that explains the inter-annual variability, even though it might be that you have not seen any explanations in your data sets.

L32 reference for the 20% of global area please.

L35. Please rephrase, it sounds like the humans are grazing.

L42 reference please

L45 . instead of ,

L51 This is not correct: Tagesson, Ago and Quansah is all sites affected by either grazing or agriculture, there are also EC towers in Wankama Falls, Agofou, and Demokeya, which are all affected by grazing or agriculture; see (Tagesson et al., 2016a)

L55 please include (Tagesson et al., 2016a) that investigated annual budgets for 6 different sites across the Sahel.

L61 I do not understand why you use NDVI as a proxy for GPP. You have EC measurements, why not use them directly? Please clarify.

L70 Do you have any data on number of sheep and cattle?

L86 please give exact sampling dates.

L91 What do you mean, did you count all plants inside the 100m^2 plot or did you identify all species?

L101 Are not all these measurements relevant to Ecosystem dynamics? Please use a different word than ecosystem dynamics.

L103 At 2 and 8 m height or at several heights between 2 and 8 m? What was the height of the tipping buckets?

L102 What sensors were used for the meteorological measurements?

L108 What sensor? what did it measure?

L115 Why 20 m when height of the sensor was only 9m, should be possible to have a much shorter tube than this. What sort of tube did you use, inner diameter? No filter between the IRGA and the incoming air? What was the separation length between the inlet tube and the anemometer?

L137-140 and Figure 2. The footprint is never this uniform for different wind directions, if you have estimated the footprint for each 30 min period; it would be easy to show an average for the different wind directions.

L140 If the footprint is homogeneous thornveld, why do you report vegetation sampling for all other vegetation types? Looking at figure 2 with the footprint, is seems like the only vegetation cover which is affecting the EC measurements are the thornveld. If you want to present all the other data as well, I think you should you must incorporate a reason for this in the introduction, and a link to the EC data.

L145-151 Please give equations for the all partitioning models.

L163 Why in two steps? Why give E0 an annual value and not using the moving window?

L166 What is Fp? Why fitting this at all? Why not using the light response function that was used in the "daytime method"?

L170 This is probably a good choice, but why not always use 1 September to 31 August or something similar? Why only estimating the growing seasons?

L174 This is incorrect MCD43A4 is not an NDVI product, it is a BRDF product, please rephrase. Why using monthly averages, when data is available as an 8 day product? It is not clear if you extracted the values of one single pixel, or did you use an average of several pixels?

L176 What do you mean by that NDVI is better to use than the LAI and GPP product for vegetation structure? First, you are not studying vegetation structure, you are studying fluxes. Different products are good for different things. I agree that NDVI is a useable parameter, but it is not a real value like LAI and GPP. You cannot claim that it is better to use than these other parameters for studying vegetation dynamics. It is so far very unclear what you are going to use these data for. Please clarify. I would state that NDVI is a proxy for vegetation phenology.

L180 please give sum of rain

L192 In figure 4, it does not look like a linear increase until the saturation level. It is rather asymptotic

L197 How could the parameters get unrealistically high? In case data looks like in Figure 4, parameters should be fine. In case the relationship is very linear, the saturated GPP level gets unrealistically high, but this does not really matter for the partitioning as long as the equation is well fitted to the data. As the manuscript is written now, it seems like you want to test several different partitioning methods, if this is the case then you must show how all these different partitioning methods differ in their output. In the results section, you do not show the output of the different methods at all.

L209 I would not say that it was fitted successfully in case the R2 value is 0.11.

L210-215, in case you want to make a proper comparison of the different partitioning methods, you should give statistics for all methods. Please also show a figure with modelled versus measured values. In order to make a proper comparison you must separate a part of the data set to be used for the model parameterisation and one part for the model evaluation. A suggestion would be to use a bootstrapping simulation methodology.

L216 Where did this suddenly come from. If you want to write a section about the effect of one point and two point measurements of the storage term this should be given a section of its own. Please clarify in the method section how the one point and two point storage terms were estimated. This has nothing to do with partitioning.

Section 3.2 What about the partitioned GPP and ecosystem respiration data? Why did you not show the diurnal cycle of them? Additionally, what was the environmental variables controlling the diurnal dynamics. You set out in the introduction to investigate which environmental variables that affect the diurnal, seasonal and interannual dynamics, but there is no proper description of what controls the diurnal dynamics.

Section 3.3

L235 Why did you analyse using monthly averages? Is there any reason for not using daily averages? A lot of dynamics can be hidden in case you average like that.

How did you test for all these things that you claim? You state that rainfall and low VPD causes the seasonal dynamics, but there is absolutely no statistical tests done to show that these variables are determining the fluxes? A large part of the section is rather about interannual dynamics than about seasonal variation.

L266 from which date to which date?

Why is NDVI included as an own section and not just incorporated in the other sections as an explanatory variable giving the phenology of the vegetation?

L274 The Merbold study is rather in the spatial domain than in the temporal domain, and it is comparing sites from tropical rain forest to semi-arid savanna ecosystems so it is not strange that they see a spatial relation to rainfall.

L275 Which results show this?

What about interannual variation in respiration?

L285 Demokeya has approximately 7% tree cover, i.e. about half of Welgegund. This is not a similar canopy cover.

L287 Why is it that NDVI over and underestimates at different parts of the season?

L309 The strong grazing pressure cannot explain the difference as there is a very strong grazing pressure at the Dahra field site as well. Please see (Tagesson et al., 2016b). How come that the missing data of Tagesson et al can explain the difference between Dahra and Welgegund? The uncertainty estimates of Tagesson et al indicate that the missing data should not be a reason for huge uncertainty in the annual budgets?

Have you tried to make any uncertainty estimate of the annual budgets?

Table 1, please explain what the abbreviations under Species are? Example what does P.J.H.Hurter mean?

Table 3 and 4, please give exact sampling dates instead of column 1-4, it seems like Table 3 and 4 can be combined.

Figure 1, please include error bars.

Figure 2. Why did you use a different point for the NDVI comparison? If this is the case, then it is more important to show the MODIS pixel surrounding that point. In case you want to present the results for all different vegetation types, please show the transects used for the vegetation samplings.

Figure 3 please include GPP and respiration

Figure 4 Why was the data binned and what was the size of the bins? When was this data used?

Figure 5 how come that soil moisture is up to 20% during the dry season, this is very high.

Figure 6 I like this figure, except why monthly sum per hour, it is just a confusing unit. Why not hourly average, it would make more sense?

Figure 7 why not include all months? Again why hourly per month. February with 28 days will be different than January just because of # of days in the month.

References

Tagesson, T. et al., 2016a. Spatiotemporal variability in carbon exchange fluxes across the Sahel Agric. For. Meteorol., 226–227: 108-118.

Tagesson, T. et al., 2016b. Very high carbon exchange fluxes for a grazed semi-arid savanna ecosystem in West Africa. Danish Journal of Geography: accepted.