Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-685-AC1, 2017

Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Analysing surface energy balance closure and partitioning over a semi-arid savanna FLUXNET site in Skukuza, Kruger National Park, South Africa" *by* Nobuhle P. Majozi et al.

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Received and published: 7 March 2017

We thank the reviewer for his thorough and positive evaluation of this manuscript; his positive feedback has contributed to its improvement. Further analysis of G was done to investigate how it impacts the surface energy balance closure, as recommended by the reviewer. We hope that this effort will improve the manuscript, by strengthening the weak points highlighted by the Reviewer. We tried to respond to the comments of each reviewer with as much detail as possible to the best of our ability.

General The article presents an impressive multi-year dataset of energy fluxes over an

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under sampled part of the world. The focus is on the energy balance closure.

Major remarks The article points out the difficulties of collecting valid data over long periods of time.

My first question is if the cleaning procedures may have introduced any biases? For example, periods with rainfall often produce problems with sonic anemometers. Could you comment on this? Response: Thank you for your comment. When measuring the different variables using the eddy covariance system, apart from instrument failure, instruments like the sonic anemometer and the net radiometer are affected by different phenomena, like rainfall events and wind gusts, resulting in faulty diagnostic signals, outliers and data gaps, which are sources of error and bias. Thus data cleaning, which involves screening, diagnosing and editing, of these half-hourly surface energy data, was done to reduce bias and error. In our study we used the Amelia II software, an R-program designed to impute missing data using Expectation-Maximization with Bootstrapping (EMB) multiple imputation algorithm (Honaker et al., 2011). This program resamples the original dataset using bootstrapping, where it then imputes the missing data The iterations done in this algorithm ensure that any bias is limited, if not completely eliminated.

The second is a pet peeve of mine and concerns the ground heat flux. If I understand correctly (the text is not so clear, see also below under minor remarks), you report EBR per half hour. Over the period of half an hour, ground heat flux can typically play an important role. Ground heat flux is also not very well captured with ground heat flux plates, which basically measure the temperature difference between the top and bottom of a piece of plastic in the ground. Even if the plates would work as intended, they are clearly biased as 2/3 of the plates are under canopies while only 30% of the area has a canopy. I don't ask for you to go back and repeat the measurements with better measurements of G but a critical discussion is needed. A simple way to get some idea is to compare half hourly results with daily averaged EBRs. G will generally be negligible at daily scales while it can easily make up 50% of the energy balance at

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a half hourly basis. Response: Thank you for the comment. The authors agree that soil heat flux plays a significant role on the surface energy balance, as it determines the amount of energy available for the turbulent fluxes. In this study, however, we did not do detailed investigation of the influence G has on the surface energy balance, as this would be a subject of study on its own, especially in this study area. We, hence, only highlighted the effect G has on the surface energy balance by calculating how the exclusion of G in the EBR computation ((H+LE)/Rn) affects the results compared with the initial EBR ((H+LE)/(Rn-G)) values. The results reported as follows: Line 300-305: Soil heat flux (G) plays a significant role in the surface energy balance as it determined how much energy is available for the turbulent fluxes, especially in areas with limited vegetation cover. In this study, we examined how G, i.e., its presence or absence, impacts on the EBR. Our results revealed a decrease of up to 7 %, with an annual mean of 3.13$\pm$2.70, in EBR when G was not included in the calculation. During the daytime, the absence of G resulted in a decrease of approximately 10 % of the initial EBR, while at night-time EBR was as low as 50 % of the initial EBR, showing that G has greater impact on the surface energy balance at night. Also, the G used was a weighted mean of the three measurements to avoid any biases associated with the fact that 2/3 of the plates are under canopies while only 30% of the area is on bare ground.

Finally, the article would become ten times more valuable if you make the (cleaned?) dataset available online. Response: Noted, thank you. The issue of publishing this dataset will be discussed with all parties involved.

Minor remarks Line 29: Winter & summer are not so obvious terms for people not familiar with Kruger National Park. Either use months or, my preference, talk about dry and wet, as you do later under 2.1. Response: Summer changed to wet, and winter changed to dry (Line 29, 30).

Line 36: characterized by or rather correlated with? Response: Thank you, this has been changed (Line 37).

Line 41: Is the heat stored in the ground not the ground heat flux G? Response: Thank you for your comment. The heat stored referred to in this context is the heat exchange between the ground and the depth of the plate, and not the flux measured by the soil heat flux plate.

Line 47: Potential evapotranspiration is a problematic term. Better use “reference evaporation”. Response: Changed, thank you (Line 48).

Line 58: “measured” instead of “measurable” Response: Changed, thank you (Line 59).

Line 92: Here you use Earth, elsewhere earth. I have no preference but best stick to one. Response: Noted, thank you.

Line 117: canopies instead of canopiesa Response: Corrected, thank you (Line 122).

Line 125: Did you use any software? Is code available? Response: The Eddysoft software was used to process the raw data (Line 129).

Line 126: You state that all upward fluxes are positive but later you clearly change this in Equation 1 and also when you state that daytime Rn is positive. Response: The statement has been removed.

Line 157: I surmised that you evaluated the dataset by looking at half hourly EBRs. The text here is, however, not very clear on that. Please make explicit. Response: The sentence now reads: Line 173: “. . .the half-hourly data were separated. . .”

Line 198: Is the 0.11 the standard deviation in the estimate of the mean? Or is it the standard deviation? Also, with EBR always being larger than zero, perfect at one, and not upwardly bounded, would a logarithmic averaging scheme not make more sense? Response: Thank you for your comment. $\pm$0.11 is the standard deviation. Our results show a few of the EBR values above 1, i.e. 2010-2012, December-February and September-November, and the 25 and 100 percentiles, and the rest of the values are below zero. This is in line with other studies that show that EBR is almost always less

than 1, i.e. the measured available energy is larger than the sum of the measured turbulent fluxes, as shown by different studies (Chen et al., 2009; Were, Villagarcía, Domingo, Alados-Arboledas, & Puigdefábregas, 2007; Wilson et al., 2002; Xin & Liu, 2010; Yuling, 2005). These studies also alluded to the concern within the micrometeorological community that the turbulent fluxes (LE + H) are frequently (though not always) underestimated by about 10–30% relative to estimates of available energy (Rn-G), making the EBR less than one.

Lines 213 and further and in general throughout this part: You mix literature review with results. It is more common not to introduce too much additional information from outside the study past the introduction. Would probably be better to move this to intro (but don't make it too long!). Response: Thank you for your observation. The authors agree that literature is mixed with the results. The results section is combined with the discussion, hence the literature citations are found in this section.

Line 230 and further: The Results and discussion focus on EBR and other outcomes in a very descriptive way. Would be better to already include more physical insights here as to why you see what you see. Response: Thank you for your observation. The descriptive way shown here is the explanation of the results, since the Results and Discussion sections are combined.

Line 264: Why the hurry? Here also please expand on role of G as mentioned above. Response: Thank you for the comment. The authors have included how G, its inclusion and non-inclusion, impacts on the value of EBR. This was fully explained above.

Lines 334 and further: In general, there is a bit of a mix between the focus on EBR and the more general and the probably more interesting general interpretation of results. The article is built up around EBR and only towards the end do general energy & water availability considerations come up. Perhaps point to these earlier in the text. In any case, please shift the perspective from starting with other studies, such as by Gu et al., and comparing those with your results to a perspective that starts with your results

and then compares those, preferably a bit more systematically, with other studies. Response: Thank you for the observation. The authors would like to point out that this study focuses on two issues, i.e. the energy balance closure first, then how the available energy is partitioned over time in this ecosystem, based on the climate conditions in the region, particularly, precipitation (a proxy of soil water availability), VPD and Rn impact on this partitioning.

Chen, S., Chen, J., Lin, G., Zhang, W., Miao, H., Wei, L., . . . Han, X. (2009). Energy balance and partition in inner mongolia steppe ecosystems with different land use types. Agricultural and Forest Meteorology, 149(11), 1800-1809. Were, A., Villagarcía, L., Domingo, F., Alados-Arboledas, L., & Puigdefábregas, J. (2007). Analysis of effective resistance calculation methods and their effect on modelling evapotranspiration in two different patches of vegetation in semi-arid se spain. Hydrology and Earth System Sciences Discussions, 11(5), 1529-1542. Wilson, K., Goldstein, A., Falge, E., Aubinet, M., Baldocchi, D., Berbigier, P., . . . Field, C. (2002). Energy balance closure at fluxnet sites. Agricultural and Forest Meteorology, 113(1), 223-243. Xin, X., & Liu, Q. (2010). The two-layer surface energy balance parameterization scheme (tsebps) for estimation of land surface heat fluxes. Hydrology and Earth System Sciences, 14(3), 491-504. Yuling, F. U. (2005). Energy balance closure at chinaflux sites.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-685/hess-2016-685-AC1-supplement.pdf

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