General comments

We thank Reviewer#2 for the positive revision of this manuscript, and for contributing to its improvement. According to his/her general comments, we rewrote the abstract and the conclusion to include more specific findings of our study. In-depth explanations were given as to EBR results that we found. The seasonal trend of the fluxes was shown in our study, including the highlight of years when data were poor for further analysis. We hope that this effort will improve the manuscript, by strengthening the weak points highlighted by this Reviewer. We tried to answer every comment in detail (see supplement file).

Specific comments

Line 21-24: This paragraph is not really needed in the Abstract.

Thank you for the comment. The abstract has been rewritten as:

L16-35: Flux towers provide essential terrestrial climate, water and radiation budget information needed for environmental monitoring and evaluation of climate change impacts on ecosystems and society in general. They are also intended for calibration and validation of satellite-based earth observation and monitoring efforts, such as assessment of evapotranspiration from land and vegetation surfaces using surface energy balance approaches.

In this paper, 15 years of Skukuza eddy covariance data, i.e. from 2000 to 2014, were analysed for surface energy balance closure and partitioning. The surface energy balance closure was evaluated using the ordinary least squares regression (OLS) of turbulent energy fluxes (sensible (H) and latent heat (LE)) against available energy (net radiation (Rn) less soil heat (G)). Partitioning of the surface energy during the wet and dry seasons was investigated, as well as how it is affected by atmospheric vapor pressure deficit (VPD), and net radiation.

After filtering years with bad data, our results show an overall mean surface energy balance closure of 0.93. Seasonal variations of EBR also showed summer had best EBR with winter having the least closure. Nocturnal surface energy closure was lowest, and this was linked to low friction velocity during night-time, and an increase in friction velocity showed an increase in closure. The high surface energy balance closure gives confidence on the usability of these data for calibrating and validating

The surface energy partitioning of this savanna ecosystem showed that sensible heat flux dominated the energy partitioning between March and October, followed by latent heat flux, and lastly the soil heat flux, except during the wet season where latent heat flux was larger than sensible heat flux. An increase in net radiation was characterised by an increase in both LE and H, with LE showing a higher rate of increase than H in the wet season, and the reverse happening during the dry season. An increase in VPD is characterised by a decrease in LE and increase in H during the wet season, and an increase of both fluxes during the dry season.

Line 27: Please cancel the word concept.

See above response.

Line 39: Because there are besides canopy and ground heat storage other minor flux terms, I suggest to rewrite the sentence as follows: ": : : (G) heat fluxes and other minor flux terms such as heat stored by the canopy and ground."
Line 40: The sentence has been modified, and now reads:"…and other minor fluxes such as heat stored by the canopy and the ground."

Line 65: Please rewrite as follows: ": : : is an accepted performance criterion of EC flux data : : :". Remark: Please use everywhere the introduced abbreviations.
Line 64: Corrected.

Line 86: The abbreviation EB was not introduced before.
Line 82: It has been introduced as "energy balance".

Table 1: Please state here the number of replicates of the soil heat flux measurements. And it remains unclear, whether the authors considered the soil heat storage change in the upper 5-cm layer in their calculation of the soil heat flux at the surface. Please explain!
Thank you for your comment.
The information on the replicates of soil heat flux measurements has been included in Table 1 as "Soil heat flux at 5 cm depth with 3 replicates, i.e. two under tree canopies and one on open space". In this study, however, we did not consider the heat storage terms because we did not have the full dataset of soil temperature and soil moisture to estimate the soil heat storage. Other studies ignore the heat storage terms based on the assumption that they have opposing behaviours at day and night-time, hence cancelling their overall effect (Papale et al. (2006)). However, for the sake of reporting on sources of error in our study, it is important that we mention that neglecting the minor storage terms is in itself a source of error, and their inclusion could have improved the EBC.

Table 1: Please state the exact installation depths of the CS615 probes.
The information has been added on Table 1 – "Volumetric soil moisture content at 3, 7, 16, 30, and 50 cm in the clayey *Acacia* – dominated soils downhill of the tower, and 5, 13, 29, and 61 cm in the sandier *Combretum* – dominated soils uphill".

Line 117: Please explain here or in the Discussion why you decided to switch from a closed-path to an open-path gas analyser. Is the change in the instrumentation somehow related to the performance of the EC system?
This has been explained:

Line 195–197: The closed-path gas analyser was changed to open-path gas analyser in 2006. An analysis of the 2006 data (which had very low data completeness of 7.59 %) showed that there were no measurements recorded until September, possibly due to instrument failure. In their study, Wilson et al. (2002) mention that there were no differences in the EBR between sites using open and closed path gas analyzers.

Line 120: As in line 117: Please explain why you did not continue to measure net radiation with the CNR2 sensor.

The explanation has been given as:

L205-211: Between 2000 and 2004, the CNR2 net radiometer was used to measure long and shortwave radiation, and these were combined to derive Rn. However, when the pyrgeometer broke down in 2004, Rn was derived from measured shortwave radiation and modelled longwave radiation until the CNR2 was replaced by the NRLite net radiometer in 2009. This was a high source of error, as shown by the low EBR between 2004 and 2008. The closed-path gas analyser was also changed to open-path gas analyser in 2006. An analysis of the 2006 data (which had very low data completeness of 7.59 %) showed that there were no measurements recorded until September, possibly due to instrument failure.

Line 157: The summation sign is not needed here. Write the equation simply as (H+LE)/(Rn-G).

Corrected.

Line 174: The authors should give at the beginning of the Results section an overview of the weather conditions over the last 15 years. Which years were particularly dry or wet. Which years were particularly warm or cold. Did you observe any long-term trend in the weather data.

Line 172-186: Fig 1 shows the 15-year average daily temperature at the Skukuza flux tower. The annual average temperatures over the 15-year period ranged between 21.13°C in 2012 and 23.23 °C in 2003, with a 15-year average temperature of 22.9 °C. A slight decrease in temperature from 2000 to 2014 was observed. While 2003 was the hottest year, it was also the driest year, with annual rainfall of 273.6 mm, and 2002 also recording very low rainfall of 325.4 mm, both receiving rainfall amounts below the recorded mean annual. The wettest years were 2013, 2000, 2014 and 2004 which received 1414, 1115.6, 1010.2 and 1005.7 mm, respectively. 2007 and 2008 had incomplete rainfall data records to assess their annuals. The low rainfall during 2000-2003 seasons was also reported by Kutch et al. (2008), who were investigating the connection between water relations and carbon fluxes during the mentioned period.

Line 176: From Figure 1 I would expect that the year 2013 was the year with the largest number of missing values and not the year 2001. Please explain.

Line 190: This has been rectified.

Line 214: What do you mean here with combined? Please explain. Did you not exclude where the years with low EBRs? Why does the mean EBR here does not agree with the figure (0.93) you gave in chapter 3.1.1?

Here were took the whole 15-year data, excluding the years with bad data (2000-2004 and 2013) and partitioned them into seasons to determine the seasonal EBR.

Line 236-242: Here it is not sufficient to explain the low EBR over the night time by referring to other studies. Please check you statement/conclusion against your own data. Are low EBRs related to low friction velocities?

We did the analysis on how whether friction velocity is related to low EBR at night and found the results below:

Line 259-268: To understand the effect of friction velocity on the energy balance closure, years 2010 and 2012, which had friction velocity data, were used. Using friction velocity, the data were separated into 4 25-percentiles, and the EBR and OLS evaluated. Results show that the first quartile, the EBR was 3.94, with the 50-percentile at 0.99, the third quartile at unity, and the fourth quartile at 1.03 (Fig 5). The slopes were between 1.01 and 1.12, with the intercepts ranging between -9.26 and -0.17 Wm^{-2}, whereas R^2 were 0.82, 0.86, 0.85 and 0.81 for the first to the fourth quartiles, respectively.

A quick assessment shows that the time associated with the low friction velocities, i.e. the first quartile are night-time data constituting 81 % of the whole first quartile dataset, and the last quartile had the highest number of daytime values at 79.29 % of the fourth quartile dataset.

(Figure 1)

Line 249: I think it would be better to compile all the numbers in a table, and please do not aggregate the data to multi-year daily means. You lose so much information.

The authors should think about, for example, to give mean, minimum, and maximum monthly fluxes for every year.

The annual means of the surface energy components were summarized as suggested in Table 2 as shown below:

Table 1: Statistical summary of annual values of the energy balance components

Year	% data completion		H	LE	G	Rn
2000	14.16	Max	470.31	422.89	191.53	817.60
		Min	-139.77	-72.43	-61.60	-95.93
		Mean	45.82	36.11	5.32	91.46
2001	12.78	Max	790.82	513.09	292.87	899.90
		Min	-159.87	-85.95	-90.27	-116.58
		Mean	58.56	43.68	9.27	128.27
2002	17.77	Max	415.93	174.07	171.93	583.30

		Min	-117.66	-89.16	-86.00	-122.21
		Mean	61.35	10.29	4.10	90.72
2003	41.50	Max	556.21	308.71	217.60	879.30
		Min	-92.99	-97.81	-106.23	-116.04
		Mean	58.15	21.68	6.17	94.53
2004	28.21	Max	505.36	498.10	129.96	925.30
		Min	-150.08	-89.07	-69.76	-5.88
		Mean	56.46	17.99	7.97	156.10
2005	35.37	Max	606.28	737.43	288.20	933.20
		Min	-130.40	-97.00	-107.37	-4.92
		Mean	51.43	17.82	0.99	159.09
2006	7.59	Max	583.66	331.25	335.30	1003.30
		Min	-72.45	-119.09	-72.80	-6.56
		Mean	84.67	35.94	19.69	247.70
2007	48.77	Max	552.93	426.34	340.67	1011.30
		Min	-131.40	-130.79	-129.70	-6.71
		Mean	59.04	14.32	4.14	169.84
2008	54.30	Max	616.43	439.76	238.57	1038.50
		Min	-140.13	-144.97	-104.60	-5.91
		Mean	63.06	26.30	6.22	191.26
2009	42.69	Max	551.34	776.62	328.93	1060.50
		Min	-96.68	-135.43	-94.20	-155.90
		Mean	55.42	96.54	6.87	207.77
2010	57.65	Max	626.68	624.38	199.33	888.00
		Min	-173.11	-135.62	-66.35	-180.70
		Mean	57.23	52.54	3.74	105.10
2011	41.34	Max	591.16	688.46	171.27	832.00
		Min	-135.77	-127.02	-58.59	-96.50
		Mean	63.88	73.11	1.75	127.94
2012	27.62	Max	572.11	566.88	185.80	899.00
		Min	-171.83	-148.49	-50.92	-99.69
		Mean	59.25	52.49	2.16	111.31
2013	3.25	Max	317.98	661.09	79.67	742.05
		Min	-62.96	-27.19	-30.49	-90.30
		Mean	1.79	34.08	-15.64	-6.09
2014	28.66	Max	533.46	726.31	89.50	893.00
		Min	-238.65	-134.39	-33.36	-89.70

		Mean	59.37	69.55	1.18	147.30

Line 255-260: Why did you limit this analysis to the year 2012? Please explain.
With the inclusion of the description of the weather patterns for the 15 year period (Section 3.1), we then went on to do the analysis for the whole 15 years again. See Section 3.3.1.

Line 270-272: Here the meaning of the months in brackets remains unclear. Also here it would be better to compile the data in a table. Please give in this context also the Bowen ratios.
The months in brackets indicate when the values were recorded, for instance 97.48 Wm^{-2} (June) means 97.48 Wm^{-2} recorded in June.

Figure 6: I suggest to plot the data as stacked columns and to include in the figure the residual! In this context it would be also important to give the possible range of fluxes due this residual (see e.g. Falge et al., 2005; Ingwersen et al., 2015) and to discuss whether the residual hampers the use of the data to validate satellite-based evapotranspiration methods.
Thank you for your comment.
Given that the Skukuza flux tower EBR is already an average of 0.93, we conclude that these data can be used to validate satellite-derived evapotranspiration models. This would require applying methods to force closure before these data are used for validation, such as the Bowen ratio method. The scope of this paper does not cover the post-closure methods, as these will be part of a follow-up study.

Line 338: This sentence reads strange. The sensible heat flux is not a part of net radiation. Please rewrite.
The conclusion has been rewritten:
L357-377: This study investigated both surface energy balance and its partitioning into turbulent fluxes during the wet and dry seasons in a semi-arid savanna ecosystem in Skukuza using eddy covariance data from 2000 to 2014. The analysis revealed a mean multi-year energy balance ratio of 0.93, The variation of RBR based on season, time of day and as a function of friction velocity was explored. The seasonal EBR varied between 0.50 and 0.88, with winter recording the highest energy imbalance. Daytime EBR was as high as 0.72, with negative EBR for the nighttime. The high energy imbalance at night was explained as a result of stable conditions, which limit turbulence that is essential for the creation of eddies. The assessment of the effect of friction velocity on EBR showed that EBR increased with an increase in friction velocity, with low friction velocity experienced mainly during night-time.

The energy partition analysis revealed that sensible heat flux is the dominant portion of net radiation in this semi-arid region, except in summer, when there is rainfall. The results also show that water availability and vegetation dynamics play a critical role in energy partitioning, whereby when it rains, vegetation growth occurs, leading to an increase in latent heat flux / evapotranspiration. Clearly an increase in Rn results in a rise in H and LE, however their increases are controlled by water availability. During the wet season, the rate of increase of LE is higher than that of H, whereas in the dry season the reverse is true. The rate of increase of LE is controlled by the availability of soil water (precipitation), and during the wet season it increases steadily with increasing Rn, whereas the rate of increase of H shows saturation with an increase in Rn. The opposite is true during the dry season, with limited water availability, the rate of increase of LE reaches saturation with increase in Rn and a steady increase of H with Rn increase. An increase in VPD, on the other hand, results in an increase in H and decrease in LE, with higher VPD experienced during the dry season, which explains the high H, although the evaporative demand is high.

Line 331: Please revise the conclusions. They remain too general and on the level of text book knowledge. There must be something novel that we can learn from this 15-year long-term EC data record.

The conclusion has been rewritten.

References: Falge, E., Reth, S., Brüggemann, N., Butterbach-Bahl, K., Goldberg, V., Oltchev, A., Schaaf, S., Spindler, G., Stiller, B., Queck, R., Köstner, B., and Bernhofer, C. (2005): Comparison of surface energy exchange models with eddy flux data in forest and grassland ecosystems of Germany, Ecol. Model., 188, 174–216.

Ingwersen, J., Imukova, K., Högy, P., Streck, T. (2015): On the use of the post-closure methods uncertainty band to evaluate the performance of land surface models against eddy covariance flux data, Biogeosciences, 12 (8), pp. 2311-2326.