Response to Anonymous Referee #3

We thank referee #3 for the constructive and critical comments. In the following, we provide an item-by-item response to the comments. Reviewer's comments are written in italic; authors' responses are shown in upright font.

The submitted manuscript sets out to address an important subject matter in the quantitative estimation of actual evapotranspiration using a satellite remote sensing based modeling approach. In this modeling approach, the evaporative fraction (EF) plays a crucial role in extrapolating from an instantaneous moment in time to a daily ET flux for example as used in the SEBS algorithm (Su, 2002) and as further elaborated by Jia et al. (2009) and Rwasoka et al. (2011) . However, the self-preservation of the EF is a subject of debate and research, thus this paper attempts to address an important subject area, which is also relevant for the HESS journal. The use of multiple FLUXNET sites is also commendable. However, there are number of caveats inherent in the submitted manuscript as outlined below;

Title and content 1. The title of the manuscript makes it seem as if the authors will present a comprehensive assessment of the subject and yet the contents focus on just but one of the factors that influence the self-preservation of the EF. There is thus need to adjust the title such that it shows the focus on the effect of cloud cover on the EF. Suggestions would be to add, ":::under varying cloud cover conditions" or changing it to bring out the issue of FLUXNET sites and the statistical analysis approach taken.

Response：Thank you for the comment. We think the title of the manuscript is in accordance with the contents. The main objective of the present study is to examine the representativeness of instantaneous EF for daytime fluxes. In order to systematically evaluate the EF performance, we classified the weather conditions into clear sky, partly cloudy and cloudy conditions. In the revised version we also further stratified into different biomes. However, the stratification is not the major focus of the manuscript, rather than providing additional insight into the robustness of the EF representativeness. Besides, FLUXNET sites and the statistical analysis approach are the data and methods we used to carry out our study. We don't see a need to emphasize these in the title. Thus, we decide to keep the original title.

2. In any case, the satellite remote sensing approach should not be applied on cloudy images. The authors need to justify their focus on cloudiness. One might argue that since cloud free images are used, is it necessary to look at EF behavior under cloudy conditions? By not explaining this aspect, it might appear to some that the sole focus on cloudiness of the manuscript undermines its own purported usefulness to satellite remote sensing based actual evapotranspiration modeling.

Response：We thank the reviewer for this useful comment. There are two main reasons for testing the effects of cloudiness on EF. Firstly, it is very important to analyze the EF behavior under different conditions to systematically examine the EF self preservation assumption. Secondly, to be useful for hydrology, estimates of actual evapotranspiration should represent both clear sky and cloudy conditions, not just clear sky condition. Under this background, Brutsaert and Sugita (1992) and Van Niel et al. (2012) emphasized the importance of cloudiness in upscaling energy fluxes through inspecting the ability of could amount to correct for upscaling

with energy fluxes. Sun et al. (2012) and Mu et al. (2009) explored the ability of microwave sensors (AMSR-E) for estimating evapotranspiration under full sky conditions. Therefore, it is important to explore the EF self preservation under cloudy conditions. Last, but not least fully clear sky conditions are rather rare in satellite applications and highly depend on spatial scale of the observing system. The stratification for cloudy and clear sky conditions therefore provides additional information on the uncertainty resulting from cloudy sky conditions for the EF daytime estimates.

3. Of more concern is that whilst the authors tried to be concise, which is commendable, it seems that the content of the manuscript is too thin to warrant publication on its own. Adding other aspects that influence the EF (e.g. land use and land cover etc.) would improve the quality and richness of the manuscript.

Response：Thank you for pointing this out. The influence of land cover on EF has been added to the manuscript according to the suggestion. Since the same suggestion is also given by referee 1, please find detailed results in our reply to referee 1.

Uniqueness/Niche The authors should have also taken time to better explain the uniqueness or niche of their work in relation to other studies done before on the subject of the self preservation of the EF. Is there anything new? Are they just adding more evidence on a seemingly contentious issue? Is the use of FLUXNET data the catch? What is the selling point?

Response：As described in the Introduction Section, most of the previous studies were based on limited measurements from relatively short time periods and across a small range of environmental and climatological conditions (e.g. dedicated field experiments, airborne campaigns). The time periods of these studies were restricted to a few days or weeks only. For some of these studies, the results were obtained for particular conditions such as dry, moist, bare soil or full vegetation cover. Thus, such a comprehensive analysis based on global FLUXNET observations over a wide range of ecosystems and climates has not been done before. Besides, the added analysis about the effects of land cover types to EF self preservation is also new to our knowledge.

Methods Any processing of the flux datasets? Data quality checks? Gap-filling? What was the data time step used?

Response：The FLUXNET datasets used in our study are half-hourly measured and non gap-filled data, which are all calibrated and quality controlled. The relevant FLUXNET methodologies and summaries can be found in the research of Aubinet et al. (1999) and Baldocchi et al. (2001), as well as on the Fluxdata.org website. In the manuscript, the previous description has been changed to “For each site, in situ measurements (non gap-filled) of net radiation, ground heat flux, latent heat flux and sensible heat flux are used to test the EF self preservation hypothesis. These measurements are half-hourly measured. Quality flags provided with the data have been applied to ensure the usage of best quality data in the present analysis.”

Results and Discussion 1. It appears that the limited findings in the manuscript were not well discussed. A few statements/reasons were probably stated, but overall authors seem to have rushed through this important component of the manuscript. Addressing in detail, questions such

as what do the findings mean for quantitative actual ET estimation? How do their findings relate to the findings of other studies that have also used long-term measurements, modeling and spectral analysis? Any EF responses to radiative fluxes? Did the results show anything that was or was not expected – would one have expected better self-preservation of the EF around solar noon? Could theR2 or RMSD indicators be misinformative – as in do they have limitations that could affect the interpretation of the results? Could the flux data time-step have influenced the results? The duration of cloudiness in intermittently-cloudy conditions will have an influence on the result. The averaging time-step of the flux data thus becomes very critical in that case.

Response：Thank you for the constructive comments. The Results and Discussion Section have been revised. The relative error between instantaneous and daytime EF has been added in Figure 3 to quantitatively explain the results. In addition, the performance of EF self preservation around solar noon over different land cover types was also analyzed. The results have been summarized into Table 2. The box plots of the comparisons between EF in different time periods and daytime EF under different biome types are provided in the Supplementary material Figure 1. In the previous studies, the EF self preservation is assumed to be valid when all times within the integration period are clear sky. However, cloud free for the entire daytime restricts the practical applications. In our study, only the specific time of day measurement must be could free, the rest of the day can be clear or cloudy. Thus, the duration of cloudiness in intermittently-cloudy conditions has no influences on our results.

2. In the presentation and discussion of Fig 3(a) [pg 2019], it would have been good to highlight that results are for clear sky conditions.

Response：Thank you, the clear sky condition has been highlighted in the first sentence "In order to find the relationships between instantaneous EF and daytime EF under clear sky conditions, statistical results between the EF at different time periods and daytime EF are illustrated in Figure 3a."

3. Whilst I appreciate that cross-comparison of Fig 3 a, b & c is used or should be used in the analysis and to draw some of the conclusions in section 4 of the manuscript, this however seems counter-intuitive. In addition, 3 or 4 representative scatter graphs that show R2 values across the different cloudiness conditions on one graph for a few different sites would have aided the presentation as they would be more intuitive.

Response：Thank you for your suggestion. The layout of Figure 3 has two functions. The first is as you mentioned for cross comparison. The second is to show the performance of EF at all times under different conditions. Therefore, we decide to use the original form of Figure 3.

4. Wouldn't it have been more informative to also group the sites according to the Land Use and Land Cover (LULC) in the footprint or fetch distance and do a similar boxplot analysis? Or to even better communicate your message of cloud cover, wouldn't it have been more interesting to at least, based on your data, discuss some factors the influence the self-preservation of the EF such as incoming solar radiation, friction velocity and LULC (and even attempt to take out the effect of different LULC types if necessary.

Response: Thank you for this useful suggestion. We fully agree that it is interesting to check the influence of land cover types on the EF constant assumption. The corresponding analysis work

was done and the results are summarized in Table 2. Besides, the box plots of the comparisons between EF in different time periods and daytime EF under different biome types are provided in the Supplementary material Figure 1. An additional paragraph has also been added in Section 3 to discuss the effects of land cover types to EF self preservation. About the influence of solar radiation and friction velocity on the self preservation of EF, Gentine et al. (2011) has comprehensively examined the dependence of the diurnal behavior of EF on environmental parameters (friction velocity, solar radiation intensity, relative humidity).

5. There were also some loose or incomplete or hanging statements used, e.g Pg 2019, Line 21-25, "Since the analysis was based…to 1400 LT", and what about discussing the results outside the time window you mentioned? The box plots show a much wider range outside the time window you mentioned. Pg 2020, Line 2: "In summary, the above results have strong implications for…" what are these strong implications? Pg 2020, Line 14: "But these increases are probably in different degrees". Why probably? What degrees? Instead of being so speculative, what is the data saying about this or provide a much better explanation.

Response：The corresponding descriptions have been changed in the manuscript. Please see below for details.

"The relatively low R^2 and high RMSD and RE values for these time periods indicate the large variations in EF in the early morning and late afternoon. This agrees with Rowntree (1991) and Nichols and Cuenca (1993), who found that the EF at low level of radiation loading was higher than through the midday period."

"In summary, the above results confirm that the self preservation of EF can be used to calculate daytime ET from instantaneous estimates based on sun synchronous satellite observations during clear sky conditions."

"This is because cloudiness causes significant fluctuations in available energy and the rate of surface heating, which further leads to variability in both instantaneous EF and daytime EF. Thus, the EF tends to be more variable during cloudy sky conditions."

Conclusions

1. Pg 2020, Line 24-25, "It is found……0.087)," – I cannot quite get how the conclusion of the constancy of the EF is arrived at basing on R2 and the RMSD. I am of the impression that these performance metrics were used to compare instantaneous and daytime EF. R2 would thus, for example, show the strength of the linear association between instantaneous and daytime EF, and so how does constancy of the EF come in? Is it possible to measure or infer the constancy of the EF based on R2 or the RMSD? Please explain!! The same line of argument also applies to the use of the RMSD. The reasoning leading to this conclusion should have been clearly discussed earlier by the authors, as it is seemingly contentious.

Response：We fully agree on this. From the high R^2, it is indeed not suitable to conclude that the EF is constant from 11:00 LT to 14:00 LT under clear sky conditions. The sentence has been modified to "It is found that the EF during daytime from 11:00 LT to 14:00 LT agrees well with daytime EF under clear sky conditions (R^2>0.75, RMSD<0.087, -10.15%<RE <3.79%) ". In order to

support our conclusion, Figures 3 was adjusted by adding the RE (relative error) between instantaneous EF and daytime average EF. It can be seen from Figure 3a that the RE between instantaneous and daytime average EF during daytime from 11:00 LT to 14:00 LT is in the range from -10.15% to 3.79%.

2. Pg 2020, Line 25, "…and the EF... daytime EF" – Is it almost equal across all three cloud cover conditions? Be specific! Quantify the "almost equal" element. Also add the range of R2 and RMSD in brackets.

Response：Done, the sentence in the manuscript has been modified to "The midday (12:00 LT to 13:00 LT) EF is closest to daytime EF with R^2 = 0.920±0.053, RMSD = 0.050±0.013, RE = -4.47%±2.48%. "

References 1. Some of the references are not the most appropriate. 2. The following key references should have been reviewed and included: Rowntree (1991) , Sugita and Brutsaert (1991) , Brutsaert and Sugita (1992) , Crago (1996) and Farah et al. (2004) .3. The discussion should have been done taking into consideration some of these key papers.

Response：Thank you for providing the references to these papers. They have been incorporated into our Results and Discussion Section.

Abbreviations should be written in full when used for the first time. LT on page 2016, line 11.
Grammar The manuscript needs serious revision to correct; sentence construction errors, missing conjunctions, a mix of tenses and poor grammar used.

Response：Done.

Technical corrections: Generally make your references follow some chronological order either from oldest to the most recent or the most recent to oldest. Throughout the manuscript "…of EF…" should be changed to "…of the EF…"

Response：Done.

Pg 2016, Line 13: "The increase in cloud cover……during daytime" – I suggest that it be changed to, "Furthermore the results showed that an increase in cloud cover resulted in an increase in the variability of the EF during daytime".

Response：Done.

Pg 2016, Line 14:The sentence that begins, "Future works will…" is unnecessary. Delete!

Response：Done.

Pg 2016,Line 19 -12: mention some of the models and their references rather than just citing those review papers.

Response：Done. The sentence has been modified to "For a review, see e.g. Kalma et al. (2008) and Wang and Dickinson (2012)."

Pg 2016, Line 25: Surely the self-preservation of the EF was well studied and pioneered way earlier than Deloguet al. (2012). Please cite the appropriate citations in addition. The work of Sugita and

Brutsaert (1991) , Brutsaertand Sugita Brutsaert and Sugita (1992) and Crago and Brutsaert (1996) seem to be more natural options.
Response：Done.

Pg 2019, line 3: You cannot say the widely used clearness index and you only put two citations. Two citations fall short of being wide use. Add more citations or rephrase!
Response：Done. “the widely used” has been deleted.

Pg 2019, line 14: what do you mean by the word “best”? Revise!
Response：Done.

Pg 2019, line 15: add “a” between “…for such” and “result is that…”
Response：Done.

Pg 2020, line6: “displayed” – keep to one tense in the whole manuscript. Revise
Response：Done.

Pg 2020, line 8: revise the sentence, “The EF exhibited…clear skies.”
Response：Done. The sentence has been changed to “The EF is more variable under partly cloudy conditions compared to clear sky conditions”

Pg 2020, line 20: revise this part of the sentence, “…and the EF in 12:00-1300 LT...”
Response：Done. The sentence has been changed to “and the midday (12:00 LT to 13:00 LT) EF is closest to daytime EF with R^2 = 0.920±0.053, RMSD = 0.050±0.013, RE = -4.47%±2.48%”

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