First, we would like to thank the editor and the two reviewers for the interest they found in our work. Assuring that the comments and suggestions were very helpful for revising and improving our paper. In addition the point by point response to each review, have been taken into account. The 3 main changes in the revised manuscript are summarized below:

1) The writing must be improved as suggested by ref1.

An effort was made to improve clarity and the writing flow and style of the manuscript, notably by 1) re-writing the abstract and some sentences in the Introduction 2) removing several sentences that are out of the context 3) adding separate sub-sections on Retrieval and calibration of r_{ss}, a_{rss}, b_{rss} and α_{PT}

2) The technical details as suggested by ref1 need to be clearly presented and discussed in text.

A sub-section of residual error analysis of the estimated H and LE with the retrieved soil/vegetation parameters was added.

3) The points raised by ref2 are of critical technical concerns that need to be considered carefully. In particular the stability and sensibility of the obtained parameters need to be quantified.

Reviewer 2 was concerned by the model stability. This issue was addressed by varying the initial values $a_{rss,k=0}$,and $b_{rss,k=0}$ and by analyzing the sensitivity of the calibration output. In fact, our model converges after a couple of iterations, when the initial values are set to 4.3 and 8.2 for $a_{rss,k=0}$ and $b_{rss,k=0}$, respectively. To further assess the model's stability, the initial values of ($a_{rss,k=0}$, $b_{rss,k=0}$) were randomly set to a range of values between 1 and 13. Such a range (1-13) is based on calibrated values found in the literature (Gentine et al., 2007; Chirouze et al., 2014; Yongjiu and Qingcun, 1997; Griend et al., 1994; Oleson et al., 2008).

Finally, we hope that the above changes satisfied the Editor and the Reviewer's requests.

Response to Reviewer 1

The paper titled An evapotranspiration model self-calibrated from remotely sensed surface soil moisture, land surface temperature and vegetation cover fraction: application to disaggregated SMOS and MODIS data' by Ait Hssaine aimed to used LST and disaggregated soil moisture to better constrain the soil evaporation of TSEB model. This is a good idea; however, the presentation of the manuscript needs substantial improvement before being published in HESS. Here are my suggestions and comments, which needs to be considered before being approved for publications.

(1) The abstract is poorly written and does not give a clear message about the novelty of the work. Rework is necessary.

In order to give a clear message about the novelty of the work, an effort was made to re-write the abstract. The revised abstract reads as follows:

Thermal-based two-source energy balance modeling is essential to estimate the land evapotranspiration (ET) in a wide range of spatial and temporal scales. However, the use of thermal-derived land surface temperature (LST) is not sufficient to simultaneously constrain both soil and vegetation flux components. Therefore, assumptions (on either soil or vegetation fluxes) are commonly required. To avoid such assumptions, an energy balance model TSEB-SM was recently developed by (**?**) in order to consider the microwave-derived near-surface soil moisture (SM), in addition to the thermal-derived LST and vegetation cover fraction (f_c) normally used. While TSEB-SM has been successfully tested using in-situ measurements, this paper represents its first evaluation in real-life using 1 km resolution satellite data, comprised of MODIS (Moderate resolution imaging spectroradiometer) for LST and f_c data and 1 km resolution SM data disaggregated from SMOS (Soil Moisture and Ocean Salinity) observations. The approach is applied during a four-year period (2014-2018) over a rainfed wheat field in the Tensift basin, central Morocco . The field used was seeded for the 2014-2015 (S1), 2016-2017 (S2) and 2017-2018 (S3) agricultural season, while it remained not ploughed (as bare soil) during the 2015-2016 (B1) agricultural season. The classical TSEB model, which is driven only by LST and f_c data, significantly overestimates latent heat fluxes (LE) and underestimates sensible heat fluxes (H) for the four seasons. The overall mean bias values are 119, 94, 128 and 181 W/m^2 for LE and -104, -71, -128 and -181 W/m^2 for H, for S1, S2, S3 and B1, respectively. Meanwhile, when using TSEB-SM (SM and LST combined data), these errors are significantly reduced, resulting in mean bias values estimated as 39, 4, 7 and 62 W/m^2 for LE and -10, 24, 7, and -59 W/m^2 for H, for S1, S2, S3 and B1 respectively. Consequently, this finding confirms again the robustness of the TSEB-SM to estimate latent/sensible heat fluxes at large scale by using readily available satellites data. In addition, the TSEB-SM approach has the original feature to allow for calibrating its main parameters (soil resistance and Priestley-Taylor coefficient) from satellite data uniquely, without relying neither on in-situ measurements nor on a priori parameter values.

(2) Introduction: The flow should be logical. Since the objective of the manuscript is to improve the soil evaporation in TSEB to meet up field-scale ET mapping challenges, I do not see any need of line 5 – 10 in page 2.

We agree with the reviewer proposition. The lines 5-10 in page 2 were deleted.

(3) Introduction: 'Evapotranspiration (ET) is a crucial water flux in semi-arid areas'; should be supported by recent literature. The authors should be aware about some recently published ET modeling and mapping studies that particularly addressed the challenges semi-arid and arid ecosystems (that deserves to be cited here); for example, Mallick et al. (2015). Reintroducing radiometric surface temperature into the Penman-Monteith formulation, Water Resources Research, 51, 6214–6243, http://doi.org/10.1002/2014WR016106. Mallick et al. (2014). A surface temperature initiated closure (STIC) for surface energy balance fluxes, Remote Sensing of Environment, 141, 243 - 261. Bhattarai et al. (2019). An automated multi-model evapotranspiration mapping framework using remote sensing and reanalysis data. Remote Sensing of Environment, 229, 69 - 92. Gerhards et al. (2019). Challenges and Future Perspectives of Multi-/Hyperspectral Thermal Remote Sensing for Crop Water Stress Detection: A Review, Remote Sensing, 11(10), 1240; https://doi.org/10.3390/rs11101240. Bhattarai et al (2018). Regional evapotranspiration from image-based implementation of the Surface Temperature Initiated Closure (STIC1.2) model and its validation across an aridity gradient in the conterminous United States, Hydrology and Earth System Sciences, 22, 2311-2341, https://doi.org/10.5194/hess-22-2311- 2018. Mallick et al. (2018). Bridging Thermal Infrared Sensing and Physically-Based Evapotranspiration Modeling: From Theoretical Implementation to Validation Across an Aridity Gradient in Australian Ecosystems, Water Resources Research, 54, 3409–3435. https://doi.org/10.1029/2017WR021357. Garcia et al. (2013); https://www.sciencedirect.com/science/article/abs/pii/S0034425712004828. Morillas et al. (2013); https://agupubs.onlinelibrary.wiley.com

The above recent papers about the modeling and mapping ET are now cited in the revised version. See P2:L2-L3 in the revised manuscript

(4) P2: L15-L20 (Introduction). The authors mentioned that LST based ET models fall into two categories. It is worth mentioning other categories where LST is integrated into Penman-Monteith energy balance (PMEB) equation to directly estimate ET.

To address this issue, the following paragraph was inserted to replace the Lines 15-20 of the revised: In this context, numerous models based on land surface temperature (LST) data have been developed such as : (i) residual balance methods that consider ET as the residual term of the energy balance like TSEB (Two-Source Energy Balance, Norman et al., 1995) and SEBS (Surface Energy Balance System, Su et al., 2002), (ii) contextual methods that estimate ET as the potential ET times the evaporative efficiency (Moran et al., 1994) or as the available energy times the evaporative fraction (Merlin et al., 2013; Roerink et al., 2000) and (iii) other categories of models that integrate LST into a water balance model (Olivera et al., 2018) or into Penman-Monteith energy balance (PMEB) equation to directly estimate ET (Amazirh et al., 2017; Mallick et al., 2015)

(5) P3: L12 – L20: I do not see the necessity of such texts. This paper talks about TSEB model improvement and constraining soil evaporation. Yao et al. (2017); Purdy et al. (2018) only used soil moisture data into empirical PT model. I do not see any relevance of these sentences here. The current study is LST based, and the authors should mention why the additional use of SM along with LST can produce good ET estimates.

We agree with the reviewer's opinion, and accordingly the texts on page 3 Lines 12-30 were removed.

(6) P3: L25-L30: This is very significant. Therefore, the texts 'One difficulty lies in developing a consistent representation of the soil evaporation (as constrained by SM, (Chanzy and Bruckler, 1993)), the total ET (as constrained by LST, (Norman et al., 1995)): : :..' should replace the texts in P3 L12 – L20.

Agreed and done.

(7) Site description: Please provide a table describing the characteristics of S1, S2 etc.

According to the Reviewer's suggestion a table describing the characteristics of the 4 agricultural seasons was presented (Table 1 in the revised manuscript).

Table 1. Characteristics of the study site.

Study period	R ainfall amount (mm)	Field status
Oct 2014- Jun 2015 (S1)	608	Cultivated
Aug 2015- Sep 2016 (B1)	157	Bare soil
Sep 2016- Jun 2017 (S2)	214	Cultivated
Oct 2017- Jun 2018 (S3)	481	Cultivated

(8) Suggesting to provide a Table on main equations of TSEB-SM and sub-equations related to LEsoil; the parameters involved in LEsoil model, their significance, what parameters did you calibrate, what are their value range etc. This would improve the readability of the manuscript.

According to the Reviewer's suggestion, a new Table (Table 2) was inserted to present the main equations of TSEB-SM and the sub-equations related to LEsoil and LEveg.

Table 2. Mean equations of TSEB-SM.

Variable	E quation	Value range
Soil heat flux	$LE_{soil} = \frac{\rho c_p}{\gamma} \frac{e_s - e_a}{r_{ah} + r_s + r_{ss}}$	0-600 W/m^2
Resistance to vapor diffusion in the soil	$r_{ss} = \exp(a_{rss} - b_{rss} \times \frac{SM}{SM_{sat}}$	a_{rss} and b_{rss} : (1-13)
Soil moisture at saturation	$SM_{sat} = 0.1 \times (-108 \times f_{sand} + 49.305)$	0,47m^3/m^3
Cost function for minimizing r_{ss}	$F_{inst} = (T_{surf,sim} - T_{surf,mes})$	F_{inst} = 5 K
Vegetation latent heat flux	$\alpha_{PT} . f_g . \frac{\triangle}{\triangle + \gamma} . R_{n,veg}$	α_{PT} (0-2) f_g =1

(9) Section 2.3: There should be a separate sub-section on Retrieval and calibration of r_{ss}, a_{rss}, b_{rss}. The current description is unclear. How the parameters were calibrated? With respect to which observation they were calibrated? All these aspects should be crystallized in the methods section.

A detailed description and the main equations used for the calibration of the two soil parameters a_{rss} and b_{rss} as well as α_{PT} have been presented in our article published in AFM 2018 (Ait Hssaine et al., 2018b). For clarity, the lines 14-18 in page 9 have been restructured as follows:

'In Ait Hssaine et al. (2018b), an innovative calibration approach of α_{PT}, a_{rss} and b_{rss} is developed from in-situ SM, LST and f_c data (Ait Hssaine et al., 2018b). The calibration methodology is briefly reminded below.

2.3.1.1. Retrieval and calibration of r_{ss}, a_{rss} and b_{rss}

The r_{ss} is first adjusted by minimizing a cost function defined by:

$$F_{inst} = (T_{surf,sim} - T_{surf,mes})^2 \tag{1}$$

With $T_{surf,sim}$ and $T_{surf,mes}$ being the simulated and measured LST, respectively. The inverted r_{ss} is then correlated to the SM (in-situ or DisPATCh) to determine the a_{rss} and b_{rss} parameters by considering that, when f_c is lower than a given threshold ($f_{c,thres}$), the dynamics of total LE is mainly controlled by the temporal variation of soil evaporation. Meaning that both soil parameters are estimated when the PT coefficient can be set to a constant value.'

(10) There should also be a sub-section on daily ALFApt (Priestley-Taylor parameter) retrieval.

The P7: L18-L21 was replaced by a sub-section

2.3.1.2. Daily α_{PT} retrieval

Once the soil resistance has been calibrated, the PT coefficient is retrieved on a daily basis when f_c is larger than $f_{c,thres}$, by minimizing a cost function at the Terra and Aqua-MODIS overpass times:

$$F_{daily} = \sum (T_{surf,sim} - T_{surf,mes})^2 \tag{2}$$

In fact, an iterative loop is run on soil (r_{ss}) and vegetation (α_{PT}) parameters to reach convergence of all parameters.

(11) Results and discussion: I am surprised to see the use of old reference (e.g., Sellers et al., 1992). There should be huge amount of literature on soil resistance and soil moisture that deserved citation.

According to Reviewer's suggestion, the following papers were cited in the revised version (P7:L4): Li et al., 2006; Chirouze et al., 2014

(12) Scatterplot of ALFApt (Priestley-Taylor parameter) versus residual ET and H errors (TSEB-SM – observed) should be shown to reveal the importance of this variable.

Figure 1 (Figure 12 in the revised manuscript) plots retrieved α_{PT} vs residual H and LE error. The retrieved α_{PT} is poorly correlated to residual H (R=-0.27) and ET (R=0.27) errors especially for the seasons S1 and S2. For the season S3, few retrieved α_{PT} values were available because of the non-availability of MODIS products during cloudy days. It is shown that the trend between α_{PT} and residual H error is slightly negative for S1 while it is slightly positive for S2. According to these results, no information linked to the variability of α_{PT} versus residual ET and H errors can be derived.

(13) How the retrieved soil resistance is related to the residual ET and H errors (TSEB-SM – observed)? What is the magnitude of variability of r_{ss} with LST? Such analysis would look excellent.

Figure 2 (Figure 13 in the revised manuscript) plots retrieved r_{ss} vs residual H and LE error and LST for the four study periods. The retrieved r_{ss} is negatively correlated (R=-0.33) with residual H error (predicted–observed) for the four seasons, while it is positively correlated (R=0.33) with residual LE error. The residual error covers a wide range (between -150 and 150 W/m^2) for the lower r_{ss} values, while it is biased for the higher r_{ss} values. Such a result indicates that the r_{ss} formulation as a function of near-surface SM needs further improvements (Merlin et al., 2016;2018) in order to reduce systematic uncertainties in evaporation estimates, especially in dry (moisture-limited) conditions. Consistent with the general decrease of LST with SM, LST is positively correlated to retrieved r_{ss} (R=0.45). This is very coherent since r_{ss} decreases with the increase of SM.

(14) Residual error analysis should be done to show how the errors in ET and H estimates (TSEB-SM – observed) are related to both DisPATCH soil moisture and observed soil moisture.

Regarding the sensitivity analysis of residual H and LE errors to observed SM, Figure 3 (Figure 14 in the revised manuscript) shows that SM is positively correlated with residual H error, while it is negatively correlated with residual LE error for the entire study period. The correlation coefficient is about 0.3 when using DisPATCh SM while it is about 0.4 when using in-situ SM. This difference can be explained by the uncertainty (including spatial representativeness issues at the localized scale) in DisPATCh SM. The positive correlation coefficient between residual LE error and observed SM is likely to be due to the systematic errors in r_{ss} estimates for dry conditions as mentioned previously. For S2, B1 and S3, the residual H error ranges between -150 and 50 W/m^2 for SM between 0-0.10 m^3/m^3 while it is slightly overestimated for the higher range of SM. The residual LE error is also found to be influenced by SM, but in the opposite sense.

I believe the authors put major emphasis to improve the ET and sensible heat flux simulation. But the intermediate parameters should be thoroughly analyzed to give it good scientific quality.

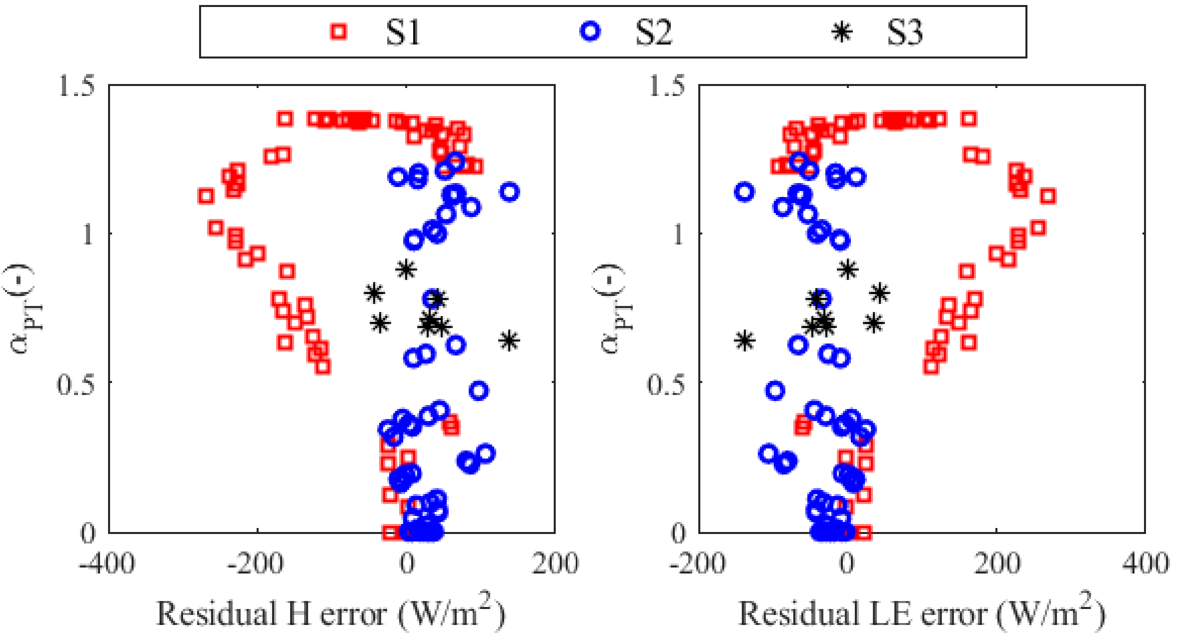

Figure 1. α_{PT} vs Residual H and LE error .

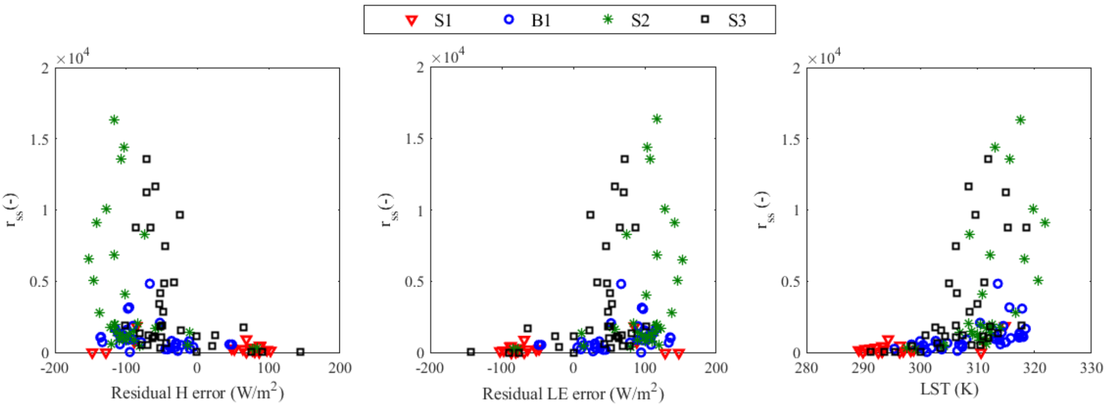

Figure 2. r_{ss} vs Residual H and LE error and LST for the four study periods .

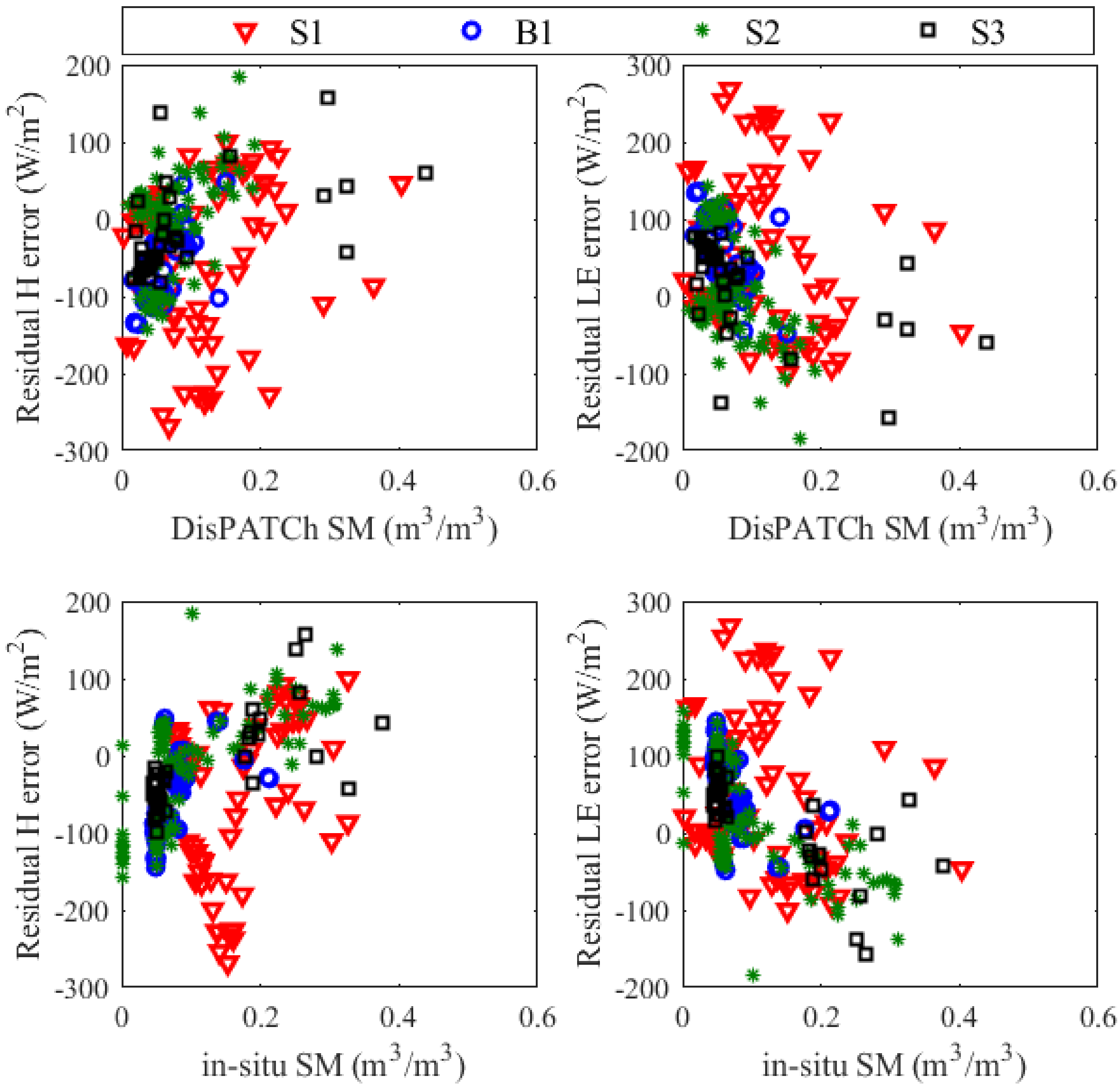

Figure 3. Residual H and LE error vs SM .

Response to Reviewer 2

I read the cited paper, Ait Hssaine et al. AFM 2018b, which is quite similar to this paper. I don‘t think it is necessary to republished the work on HESS again.

We emphasize that our previous paper published in AFM 2018 was a feasibility study of the TSEB-SM algorithm using field measurements. In this article, we tested the same algorithm in real life using readily available satellite thermal and microwave data. Such an application is fully original and raises new research questions clearly not addressed elsewhere. To our knowledge, there is still no evapotranspiration model that has been coupled to remotely sensed soil moisture and land surface temperature at such high (1 km) resolution. This is now possible using the formalism of TSEB-SM (Ait Hssaine et al. 2018) and the high-resolution soil moisture data sets derived from the disaggregation of SMOS-like data (Molero et al. 2016, Peng et al. 2017). To clarify this point, the following sentence was inserted as soon as the abstact of the revised : “While TSEB-SM has been successfully tested using in-situ measurements, this paper represents its first evaluation in real-life using 1 km resolution satellite data, comprised of MODIS (Moderate resolution imaging spectroradiometer) for LST and f_c data and 1 km resolution SM data disaggregated from SMOS (Soil Moisture and Ocean Salinity) observations”.

Another thing is that TSEB-SM model parameters must be calibrated with ground measurement when they are used to a new region.

We totally disagree with the Reviewer. The main feature of the TSEB-SM approach actually is to calibrate two fundamental parameters (controlling the soil evaporation and the plant transpiration separately) from soil moisture, land surface temperature and vegetation cover fraction data. In this study, all the data used for calibration are derived from remote sensing. Therefore, we do not rely on any in situ measurement, as notably stated by the title.

To address this concern, we clarified as soon as the abstract and introduction, the remote sensing-based nature of the TSEB-SM approach.

In the previous manuscript (P4: L13-L14): “The objective of this study is to investigate how satellite data can be used to retrieve the main parameters (a_{rss}, b_{rss} and α_{PT}) of TSEB-SM model.” Was replaced (in the new manuscript, P4: L4-L6) by: “TSEB-SM has the cutting edge capability to calibrate its main parameters from remotely sensed data, but the real-life application has not yet been tested. The objective of this paper is thus to demonstrate for the first time this capacity using disaggregated SMOS and MODIS (Moderate resolution imaging spectroradiometer) data”.

Both papers do not show how to get ET result at regional scale.

It is true that the paper Ait Hssaine et al. (2018) does not test the TSEB-SM approach using remote sensing data. This is precisely why the present study is essential to demonstrate the capacity of the model to provide ET results at regional scale. Below, we present an example of a map of evapotranspiration in our area of study ’El Haouz’ derived from the same model TSEB-SM

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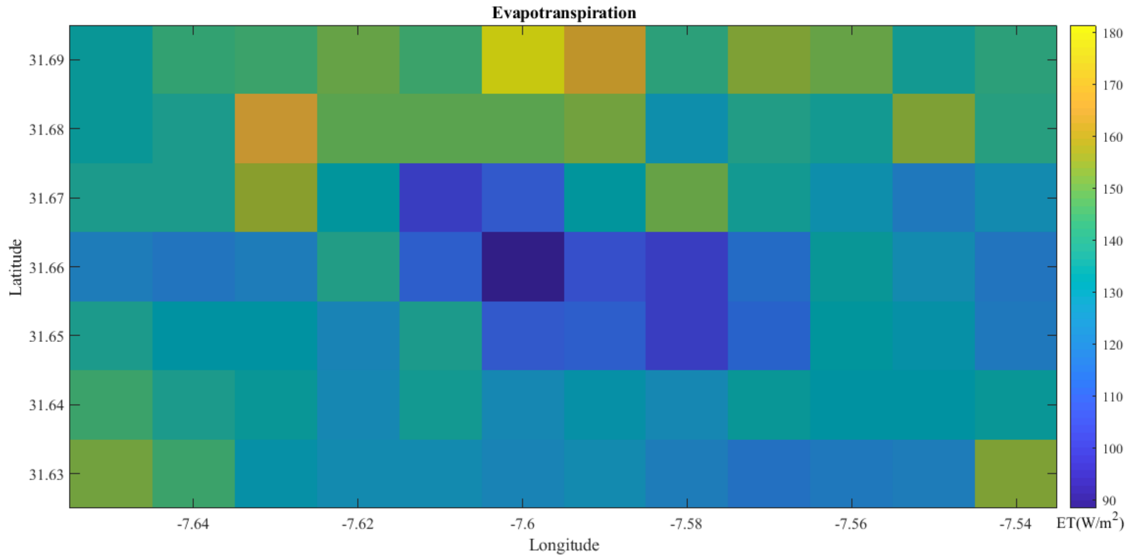

Figure 4. Map of Evapotranspiration using MODIS LST and DisPATCh SM .

The spatial application of ET will not be introduced in the manuscript. Since, this approach will be used in another ongoing study with finer resolution, compatible with the land use of the agricultural zone around Marrakech.

Both the abstract has emphasized on calibration of the model parameters. Furthermore, the calibrated parameters are not a fixed value, it varies with time. If the parameters are not fixed value. The model will always need ET or flux measurement to calibrate the parameter. I do not suggest to accept this work for a publication on HESS.

It is true that α_{PT} varies in time. However, this parameter is estimated from remote sensing data. The flux measurements are needed only for the validation of the TSEB-SM simulated sensible and latent heat fluxes. To clarify this point, the following sentences are inserted as soon as the introduction (P3: L28-L30): “It should be noted that only LST and SM are used for the calibration of yearly a_{rss} and b_{rss} as well as daily α_{PT}, while the flux measurements are needed only for the validation of the TSEB-SM simulated sensible and latent heat fluxes.”

We hope that the above changes have clarified the self-calibrated TSEB-SM approach and its implementation using readily available remote sensing data.