Response to the Editor for hess-2018-170

Dear Editor, thank you very much for the opportunity to resubmit a revised copy of our paper entitled 'Multi-site calibration and validation of SWAT with satellite-based evapotranspiration in a data sparse catchment in southwestern Nigeria'. The constructive comments and suggestions offered by the reviewers have been immensely helpful. We greatly appreciate their insightful comments on revising the paper. The manuscript has been revised again to address the reviewer's concerns and a point-by-point reply to the reviewer's comments has been made. The changes arising from the comments have clearly improved our manuscript. The new version of the manuscript is uploaded alongside this document. As requested, all the modifications are highlighted (**in Turquoise**) in the manuscript.. We look forward to hearing from you in due time regarding our submission and to respond to any further questions and comments you may have.

Response to the Reviewers Comments for hess-2018-170

We thank the anonymous referees #1 and #2 for reviewing our manuscript. We are especially grateful for the many insightful and constructive comments and their valuable suggestions; these changes have clearly improved the quality of the manuscript. We have to the best of our abilities responded to them and address the referees' comments in the following point by point response. Note the following conventions: RC = referee comments, AC = authors comments (replies) printed in italic. All the modifications are highlighted **in Turquoise** in the revised manuscript.

Reply to comments of Anonymous Referee #1

RC 1: Precise what satellite data is used by GLEAM (I think there is also surface soil moisture from scaterrometer data)

AC1*: The Global Land-surface Evaporation Amsterdam (GLEAM) combines a wide range of remote sensing observations from* ***different satellites*** *to separately estimate the different components of terrestrial evaporation and surface soil moisture through a process-based methodology at a global scale and 0.25-degree spatial resolution (Martens et al., 2017).*

This additional statement of GLEAM using a process-based methodology to estimate land-surface evaporation from multi-satellite information is included in page 10 line 15-27 in the revised manuscript as suggested but for detail information on the different satellite data used by GLEAM the reader is referred to Martens et al., 2017 in page 11 lines 15-17 of the revised manuscript.

The different satellite data used by GLEAM is briefly stated below for GLEAMv3.0a and v3.0b used in this study.

<u>*GLEAMv3.0a (used for AET calibration and validation in this paper)*</u>

a. *Radiation fluxes from the current reanalysis of the European Centre for Medium-Range Weather Forecasts (ECMWF), ERA-Interim (Dee et al., 2011), were processed and used.*
b. *For the precipitation forcing, the Multi-Source Weighted Ensemble Precipitation (MSWEP) data set was used. MSWEP is based on a merger of selected satellite-, reanalysis-, and gauge-based products.*
c. *Air temperature estimates from ERA-Interim are also selected for the long-term GLEAM data set (GLEAMv3.0a).*
d. *The phenological controls on transpiration are derived from observations of microwave VOD (Vegetative Optical Depth). The 0.25◦ product from Liu et al. (2011) was used, which is based on retrievals from several passive microwave sensors using the Land Parameter Retrieval Model (LPRM, Owe et al. (2008)). To cover the period 1980–2015, it was merged with LPRM-based VOD retrievals from SMOS (van der Schalie et al., 2015, 2016) using a similar cumulative distribution functions (CDF) matching approach to the one used by Liu et al. (2011).*
e. *For the assimilation of microwave surface soil moisture, the SMOS Level 3 soil moisture product (Jacquette et al., 2010) and the ESA Climate Change Initiative soil moisture (ESA CCI SM v2.3) data set (Liu et al., 2012; Wagner et al., 2012) were selected. The ESA CCI SM v2.3 data is a blended product of soil moisture retrievals from several active and passive microwave sensors, available for the period 1978–2015 at the global scale.*

GLEAMv3.0b (used for AET verification in this paper)

a. *Radiation inputs are based on measurements from the Clouds and Earth's Radiant Energy System (CERES) onboard Terra and Aqua (Wielicki, 1996).*
b. *For the precipitation forcing, the Tropical Rainfall Measurement Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) 3B42v7 product was used.*
c. *Air temperatures are derived from measurements of the Atmospheric Infrared Sounder (AIRS, Aumann et al., 2003).*
d. *The phenological controls on transpiration are derived from observations of microwave VOD (Vegetative Optical Depth). The 0.25◦ product from Liu et al. (2011) was used, which is based on retrievals from several passive microwave sensors using the Land Parameter Retrieval Model (LPRM, Owe et al. (2008)). To cover the period 1980–2015, it was merged with LPRM-based VOD retrievals from SMOS (van der Schalie et al., 2015, 2016) using a similar cumulative distribution functions (CDF) matching approach to the one used by Liu et al. (2011).*
e. *For the assimilation of microwave surface soil moisture, the ESA Climate Change Initiative soil moisture (ESA CCI SM v2.3) data set (Liu et al., 2012; Wagner et al., 2012) were selected. The ESA CCI SM v2.3 data is a blended product of soil moisture retrievals from several active and passive microwave sensors, available for the period 1978–2015 at the global scale.*

Table 1 *provides summary information on the forcing variables used to produce the GLEAMv3.0a and v3.0b datasets together with type of satellite, reanalysis and gauge-based dataset used by GLEAM.*

GLEAM Data set	***Variable***	***Data set***	***Type***
v3a	*Radiation*	*ERA-Interim*	*Reanalysis*
v3b		*CERES L3 SYN1deg*	*Satellite*
v3a	*Air Temperature*	*ERA-Interim*	*Reanalysis*
v3b		*AIRS L3 RetStd v6.0*	*Satellite*
v3a	*Precipitation*	*MSWEP v1.0*	*Merge*
v3b		*TRMM 3B42*	*Merge*
v3a	*Snow Water Equivalents*	*GLOBSNOW L3Av2 & NSIDC v01*	*Satellite*
v3b		*GLOBSNOW L3Av2 & NSIDC v01*	*Satellite*
v3a	*Vegetation Optical Depth*	*LPRM(MERGE)*	*Satellite*
v3b		*LPRM(MERGE)*	*Satellite*
v3a	*Surface Soil Moisture*	*ESA-CC1v2.3*	*Satellite*
v3b		*ESA-CC1v2.3*	*Satellite*

Source: Martens et al.2017

Reply to comments of Anonymous Referee #2

Major comments

RC1: On the authors reply to reviewer 2 comment C: If it is completely understandable that runoff measurements are not available, how about assess the model calibrated on etp using soil moisture data (potentially satellite retrieved)? All the SWAT applications studies the authors used in the reference have verified their simulations against streamflow measurement. Please could you refer to studies that used hydrological models forced by GLEAM and do not account for runoff or soil moisture in the validation process? I would at least point out the conclusion that this step (of independent model verification) is missing and need further developments. This has consequences on the quantification of the water balance discussed in the paper.

AC1: Many thanks for the suggestion. We have included the validation of our model calibrated on etp using ESA ICC soil moisture data (potentially satellite retrieved) as suggested in the revised manuscript (e.g, page 12 lines 4-19, page 15 lines 21-31 and page 44 figure 13-14)

Minor comments

RC1: pag 14 lines 22-24: could you please specify the units of the terms in the equation 7 and 8.

***AC1**: Thank you! We have specified the units of the terms in the equation 7 and 8 in page 15 lines 14-19*

RC2: pag 17 line 20-32: a 5 lines sentence probably is too long please consider to split it in 2.

AC2: We agree with the referee and we have made the changes in page 18 lines 24-31.

RC3: Figures 3 to 6: looking at the figure as it is now the reader cannot understand that classes of the NSE or KGE are 5. For example figure 5 NSE: the legend shows three classes of which the last is NSE <= 0.5 which can include also NSE<0 (at it is). The same olds for the KGE (KGE<0.5 includes KGE<0). Please consider to show in the legend all the classes and all the colors you have used for each of the indicators. For Pbias, what happens to the class >+-25?

AC3: We agree with the referee and we have made the changes in Figures 4 to 7 to show in the pie chart legend all the classes and all the colours we have used for each of the indicators of Ogun River subbasins performance in page 35 to 38 as suggested. The Pbias for GS1 and MS6 in both calibration and validation period do not exceed ±20. The legend has been reset to reflect c(-20,0,+20).

RC4: On the authors reply to reviewer 2 comment 19: Please report the way in which you compared the results in the main text and then refer to the appendix D for the figures, now there is no reference in the main text. The background of the figures in appendix D is probably too dark especially for the gleam application. What the grey shadow means, it is not specified in the legend.

AC4: We agree with the referee. We have reported how we compared the results of our model calibration using GLEAM AET and MOD16 AET and we have referred to the appendix D figures in the main text as suggested in page 13 lines 12-13 and page 15 line 26. The background of the figure in appendix D has been changed and the mean monthly GLEAM (1989-2012) and MOD 16 AET (2000-2012) values has been added in the legend in page 50.

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