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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Multi-site calibration and validation of SWAT with satellite-based evapotranspiration in a data sparse catchment in southwestern Nigeria" *by* Abolanle E. Odusanya et al.

Anonymous Referee #2

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General comments

The paper presents an interesting study on the calibration/validation/uncertainty analysis of the SWAT simulated actual evapotranspiration, based on freely available satellite data. The authors tested 2 different dataset and 3 different potential evapotranspiration models and evaluated their performances. They concluded that Hargreaves PET equation calibrated using the GLEAM_v3.0a data provided the most performing solution and gave a good level of confidence for using the SWAT model as a decision support tool. To my opinion the paper is worth to be published, but it needs some

major improvements for it to be sounder.

General comments

a) Literature Review: it lacks of significant contributions in the context of large-scale hydrological model simulation in data scarce area and it mainly focused on previous studies based on SWAT. It could be good to mention and discuss other approaches even if performed in different study areas but with the same problems (data scarce areas) (Kim et al., 2008; Kim and Kaluarachchi, 2009; Gebremicael et al., 2013; Tekleab et al., 2011; Abera et al., 2016 which applied a different hydrological modeling approach (Formetta et al., 2014))

b) I feel that the authors should acknowledge explicitly that the analysis presented needs to be tested against observed data and that the satellite data are them self based on modeling assumptions, which may or may not be plausible in some areas. Of course they provide a huge help and the way in which they are used in the paper nicely show it, but probably assuming them as "measured" can be misleading. At least can be specified once in the text that "measured AET" doesn't mean proper eddy-covariance data.

c) In the paper is claimed the importance of the Curve Number parameter but nothing is said about soil moisture evolution and runoff. I wonder why the authors do not use runoff-measured data as independent validation. This will show the effects of the different ET calibration on the runoff dynamic. The two processes are strongly related and the sensitivity of the CN parameter confirms this. This will be an important added value to the paper. Again, the authors claim: "The average long-term annual of the water balance at the outlet of the study area shows a satisfactory percentage error of closure". Is this referred to modeled data or modeled and measured? The use of measured streamflow data would help to better understand this part as well.

d) Because one of the main points in discussion/conclusion is the fact that: "Hargreaves equation had a superior model performance of the Penman Monteith and the

Priestly-Taylor" the authors should add their equations in the text. This would help to visualize the variables in input for each method, the variables that have been chosen for calibration and the variables that have been excluded.

Specific comments

Page 1 line 20: remove space in the number: River Basin (20 292 km2)

Page 1 line 21: "The novelty of the study is the use of freely available satellite derived AET data for calibration/validation of each of the SWAT delineated subbasins, thereby obtaining a better performing model at the local scale as well as at the whole watershed level": sounds like this is the first time the gleam dataset have been used to validate/calibrate swat, which is a strong sentence. May be in the study area?

Page 1 line 24: "Three different structures of the SWAT model were used in which each model structure was a set-up of SWAT with a different potential evapotranspiration (PET) equation": I would say that three different PET equations are tested: the model setup (in term of all the single components is the same except the pet)

Page 2: mechanistic, what the authors mean? Please explain.

Page 3 line 25: results showed a good Nash-Sutcliffe efficiency (NSE) and Coefficient of determination (R2) value for monthly average: quantify what good means for the authors and the values obtained.

Pag 5: The mean annual rainfall for the watershed is 1224 mm year-1 and the mean annual temperature is about 27o C. Mean annual potential evapotranspiration (PET) estimated by Hargreaves method (Hargreaves and Samani, 1985) is 1720 mm year-1 and the mean AET is about 692 mm year-1. Are this value based on measured or modeled data? Please specify it.

Page 5 typos: is 1224 mm year-1

Page 5: of 4103 ha, and please convert in km2 because all the other areas are in km

Page 7: 30 m spatial resolution digital elevation model (DEM), 17 soil classes, 17 landuse classes, 3 slope categories, meteorological data and landuse with its management (Table 1). Please specify if those data are available, from which web-site, and the accessed date.

Page 7 line 10: "The topHRU program allows the identification of a pareto-optimal threshold which minimizes the spatial error to 0.01 ha for a given number of HRUs and thereby minimizes the trade-off between SWAT computation time and number of HRUs. In this case, topHRU determined the optimum number of HRUs to be 1397 for the Ogun River basin. Thresholds of 0 ha for landuse, 150 ha for soil and 250 ha for slope were used in the SWAT set-up". What are the physical consequences of the thresholds? What happens if you use larger or lower values? How you define them?

Page 7: "delineated into 53 subbasins, with the main outlet in Abeokuta". Can you please give some summary statistics about them: min max average area, elevation, etc.

Daily precipitation 5 data (1984-2012) and minimum and maximum temperature data (1984-2012) at four weather stations (Fig. 1) were used as observed input data. Are you only using 4 stations for the whole basin (20292 km2)? Why not considering satellite products for a variable (precipitation), which sometimes could be even more important than etp? The authors should include this in the discussion.

The missing values of daily precipitation and minimum and maximum temperatures, along with solar radiation, wind speed and relative humidity were simulated by the ArcSWAT CSFR_World weather generator: it is clear that the ArcSWAT CSFR_World is used for gap filling of precipitation and temperature. The authors should specify: 1) How did you use the dataset for solar radiation, wind speed and relative humidity? 2) At which time resolutions are you specifying that input? 3) For which hydrological processes did you use these "simulated" forcing variables and how this affects your results?

Page 7 line 22-27: it sounds slightly repetitive: please consider to write the full sentence only of one model structure and to generalize for the other 2.

Page 8 line 10: please explain what are the main differences between the two dataset GLEAM_v3.0a and GLEAM_v3.0b and justify why you selected one of the two.

Page 8 line 25: “was implemented in SWAT-CUP. SWAT-CUP (Abbaspour, 2015)” move the citation when you firstly introduce SWAT-CUP.

Pages 8 line 28 to page 9 line 6: Please specify the parameter set that you started the sensitivity analysis with, at least the processes to which they are related. Moreover specify the list of the parameters that resulted sensitive and how you define a parameter as “sensitive”.

Page 9 line 16: A metric among the six can be considered an objective function if it is optimized in the calibration procedure; it can be considered as goodness of fit metric if it is used to quantify how well or bad the model reproduce the measured data. Are those goodness of fit metrics? Which one of these six metrics has been optimized in the calibration procedure? Have you used all of them also as objective function? This is not fully clear.

Page 9 line 20 –Page 10 line 20: Consider to: i) just spell in the text the statistics used, their ranges and their optimal values and ii) move in appendix the explanation of each statistics because they are well known.

Page 10 line 23-26: please specify how the uncertainty is quantified: what are the parameters that are changed/sampled the LHS, what are their ranges?

Page 11: please show a figure of the river basin with the subbasin polygons and the pixel of MODIS and GLEAM. This will help the reader to understand how many pixels of MODIS and GLEAM cover your basins.

Each sub-basins has its own model AET. How did you choose the MODIS or GLEAM pixel to compare with and compute the NSE, R2, etc.

Page 11: figure 3,4,5, and 6 please consider to add a 4th class for the range of KGE and NSE (<0). This indicates where just the mean of the observed data will be more performing than the model itself.

Page 10 line 15: equation is not correct please revise it.

Page 11: figure 3, 4, 5, and 6 please add the North symbol and the scale bar in the maps.

Page 11 line 23: “The results of global sensitivity analysis revealed that the SCS runoff”: please specify from where the reader can see this.

Page 12: all the page can be summarized by just one figure reporting on the x-axis the model configurations and on the y axis the percentage of sub-basin for a given class of the goodness of fit index (NSE, R2, etc).

Page 13 the paper goes from section 3 to subsection 3.3: 3.1 and 3.2 are missing.

Page 14: increases in February from 55mm to 76mm as the space between 55 and mm

Page 15 line 5: “Using the guidelines in Moriasi et al. (2007, 2015) and Kouchi et al. (2017) for” probably these guidelines were drawn for runoff? Is it correct to use it for others hydrological processes? Is this been done in the past? If yes, please add a citation otherwise just clarify this aspect.

Page 15 line 20: “From our results, we agree that the AET from MOD16 tends to overestimate AET”. Overestimate against what? This is a strong statement mainly because there is not direct comparison against measured AET data

Reference

Kim, U. and Kaluarachchi, J. J: Climate Change Impacts on Water Resources in the Upper Blue Nile River Basin, Ethiopia, J. Am. Water Resour. As., 45, 1361–1378, 2009.

Kim, U., Kaluarachchi, J. J., and Smakhtin, V. U.: Generation of Monthly Precipitation Under Climate Change for the Upper Blue Nile River Basin, Ethiopia, J. Am. Water Resour. As., 44, 1231– 1247, 2008.

Gebremicael, T., Mohamed, Y., Betrie, G., van der Zaag, P., and Teferi, E.: Trend analysis of runoff and sediment fluxes in the Upper Blue Nile basin: A combined analysis of statistical tests, physically-based models and landuse maps, J. Hydrol., 482, 57– 68, 2013. Tekleab, S., Uhlenbrook, S., Mohamed, Y., Savenije, H. H. G., Temesgen, M., and Wenninger, J.: Water balance modeling of Upper Blue Nile catchments using a top-down approach, Hydrol. Earth Syst. Sci., 15, 2179–2193, https://doi.org/10.5194/hess-15- 2179-2011, 2011

Abera, W., Formetta, G., Brocca, L., and Rigon, R.: Modeling the water budget of the Upper Blue Nile basin using the JGrass-NewAge model system and satellite data, Hydrol. Earth Syst. Sci., 21, 3145-3165, https://doi.org/10.5194/hess-21-3145-2017, 2017.

Formetta, G., Antonello, A., Franceschi, S., David, O., & Rigon, R. (2014). Hydrological modelling with components: A GIS-based open-source framework. Environmental Modelling & Software, 55, 190-200.

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