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Interactive comment on "Improving SWAT model performance in the Upper Blue Nile River Basin using meteorological data integration and catchment scaling" *by* Erwin Isaac Polanco et al.

Anonymous Referee #1

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Improving SWAT model performance in the Upper Blue Nile River Basin using meteorological data integration and catchment scaling.

By Polanco et al.

General comment: The work presented here certainly lies within the scope of HESS Journal and further contributes to the body of hydrological literature. However, I still would like to present my critics on the paper, serving as further improvement to bring the paper into publishing level. The paper presents improving SWAT performance by use of meteorological data integration and sub-catchment discretization in the upper Blue Nile basin.

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The authors tried to show the improvement of SWAT model performance with and without the Climate Forecast System Reanalysis (CFSR), the ground meteorological data, integration of these data and catchment discretization. Moreover, the manuscript has introduced SWAT error index which is an additional performance measure during calibration. However, this index has to be verified by comparing the published work within the basin or elsewhere. The title needs modification. In my opinion catchment scaling is not appropriate word which did not covered in the article. "Catchment scaling" refers to scale representation of the catchment starting from the smallest plot scale in the order of 1m*1m to large river basin scale greater than 1000 km2 (see e.g. BlÖschl and Sivapalan, 1995; Didszun and Uhlenbrook, 2008). When one read the title of the article, expecting that the process conceptualization in relation to various catchment scales, how the various processes are changing with scales and the reflection of these effects on the SWAT model performances. Thus, I suggest replacing the word with sub-catchment discretization is appropriate and goes well with what has covered in the article.

In general, I can see structural problems in organizing the article. For instance in most of the results section methods are mixed up and vise versa. Furthermore, one of the weaknesses of the article is that it lacks interpretations and discussions by comparing previous modeling works in the region or elsewhere in the globe.

Specific comment:

Abstract:

The abstract is good but needs to be incorporating the SUFI-2 results. On line 32-33, it is not clear to me how an integrated data set provides realistic representation of land use and soil condition of the region?

Introduction:

Introduction should comprise the current state of thinking with regard to hydrological

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modelling. The section lacks in revealing process representation, parsimony, handling uncertainty, model diagnostic measures, model complexity/simplicity etc. Please enrich the introduction part by take in to account recent publication with regard to modeling.

-On page 2, Line 9 the citation Shimelis, 2008 should be corrected as Setegn et al., 2008. Please correct the citation and make correction also in the reference list.

-All most all the reference lists are not provided as per the journal guideline. I recommend re-checking the style of the journal for the completeness of the references.

Data and Methodology

-On page 2, Line 33-35 mention the core reason why CFSR data did not work for Roth and Lemman, 2016.

-On page 5, Line 11-12 the Ministry of Water and Energy should replaced with the Ministry of Water, Irrigation and Electricity.

-On page 7 Line 24-25, please correct the citation Tekleab and Uhlenbrook, 2011. Replace with Tekleab et l., 2011; Uhlenbrook et al., 2010).

-On page 8 Line 13-18 the agreement of the CFSR with the ground data has to be verified using at least scatter plot by showing their regression and statistical significance of their matching. Figure 3 only show their pattern not revealed the degree of matching.

-As far as I know the CFRS are also reanalysis data obtained from the ground stations even though not representing the ground stations in the majority the ground station in the region. My main concern is that the quality of the ground data is poor in the region. Thus integrating this poor quality data with CFSR would multiply the input data uncertainty into your model. As a result of it the uncertainties from different sources increasing and your outputs are becoming dubious. Thus, I suggest testifying the data integration in the Lake Tana sub-basins (e.g at the Gilgel Abay catchment) or elsewhere to elucidate the importance of data integration. The data in the Lake Tana sub-basin is

believed to be relatively having good quality. You can Compare with past works (e.g. Setegn et al., 2010) using concurrent data sets (spatial and temporal) based the same SWAT model to scrutinize the ground data, CFSR and integrated data set might gaining an insight about the dominant processes at multiple time and space in the region. In fact, I didn't see the method of data integration in the methodology section. How did you handling such work?

-On page 9, Line 32-34 the sentences are results. Avoid mixing results with methods.

-On page 10 the citation (Abbaspour, et al., 2015) for the equation 7 and 8 is not important.

-On the same page 10, the authors tried to put about SUFI2 but failed to describe about the basis of SUFI-2 and how SUFI-2 is expressed in a form of "P" and "R" factor.

-On page 11, Line 23 the citation Ruhoff 2013 should be replaced by Ruhoff et al., 2013. On the same page Line 25, the citation Sun Z et al., 2007 should be corrected as Sun eta al., 2007. Moreover on the same page line 25 the citation Setegn et al., 2009a should be corrected as Stegne et al., 2009 since there is no publication by the same lead author in the same year.

-On page 12, Line 5, what does it mean the quality of SWAT model? How SEI measures the quality? The term is not clear. Model quality or model reliability/Fidelity?

-The introduction of SWAT Error Index (SEI) is good but it needs justification how it works and is that the authors introduced for the first time in the region? If so it needs strong evidences as a science to accept this index. For example the improvement or the use of this index in making the hydrological models reliable should be testified by comparing it with the statistical measures commonly used in one test catchment. What is the basis of taking the weights (w1 and w2) for discharge and evaporation during calibration? It is clear that SEI means the ratio of the root mean squared error between the observed and simulated discharge to the range of observed discharge plus the

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ratio of the mean squared error between MoOD16 ET and ET SWAT to the range of SWAT predicted evapotranspiration. When I see the equation the denominator i.e. the range always favor the index to close to zero value.

In my opinion the authors have taken twice the evaporation term during calibration when computing SEI. That means the root mean squared error by itself looking the error differences between the observation and the model by taking into account the evaporation term in the measured and predicted discharge. Thus, the SEI considered the evaporation term twice during calibration. Moreover, how do you justify the second term in equation 10, ETsi is the MOD16 value which is the output of the evaporation data from the remote sensing which is also uncertain and you have taken as measured /true value. The SWAT predicted ETsi also predicted data mainly depend on the ground climate variables based on Penman Monteith or Hargreaves methods also have lot of errors due to climate data quality. Due to this fact, I feel that the authors have to persuade the scientific community with sound evidences about the SEI how it helps in improving the water balance components and making the SWAT model outputs reliable. Finally, I suggest you to test this index with the same SWAT model in the region with good data quality both in climate and discharge.

Results and Discussions:

-On page 13 Line 11, the citation Cherie Z, 2013 is not correct. Please replace with Cherie, 2013. How did you take Cherie, 2013 results of water balance components as reference? What is your justification? Since there are quite many research that have been conducted at the larger scale in the upper Blue Nile basin (e.g., Betrie et al., 2011; Easton et al., 2010; Mengstu and Sorteberg, 2012; Gebremichael et al., 2012 etc) among many others.

-on the same page 13, line 13-15 your reference is only basis one article. Give annual rainfall period of analysis.

-Referring to figure 1, below Kessie stream gauging station the ground data is hardly

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seen. How and which ground stations did you used for your input to calibrate your model at the El-Diem gauging site? What I have seen is only the CFSR stations. Your ground stations only covered quarter of the Upper Blue Nile area ~65,000 km2 above Kessie station. -No doubt that if you discretized the catchment into many sub-catchments and results many HRU's doesn't a surprise which resulting in good model performances. One thing your calibration is at the larger scale and secondly, as you have increased the number of HRU's the over parameterization also increases or create good opportunity/degree of freedom for the parameters to fit your observation due to parameter inter-correlation during calibration.

On page 13, Line 26-28 what does it mean when you say good water balance results?

-On page 15, the results of SEI presented in table 5 for the ground and integrated data sets are almost the same. Thus, how your integrated data improve the SWAT performance?

-The authors described about SUFI-2 uncertainty assessment. But the result out of this algorithm is not presented. Please provide the uncertainty assessment results for each discretization at Kessie and El-Diem gauging stations.

The conclusions seem too much focused on summary rather than providing concluding statement out of the research.

Figures and Table:

-All tables caption needs some modifications. For example, correct the citation given in table 1 caption. Complete table 3 caption as: Water balance analysis in the Upper Blue Nile River Basin (GIVE PERIOD OF ANALYSIS). The water balance component given in table 3 is not complete. The groundwater/base flow is missing. In addition at least on the annual time scale the water balance has to be closed. Please check a closure problem in the water balance after incorporating the groundwater flow.

-Table 4: Statistical results for the calibrations and validations discharge at Eldiem and

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Kessie gauging stations.

-In table 5 the values for different data set given in parentheses are not clear. Are they weights??

-All figures are visible. But not having vertical axis name.

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