Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-546-AC1, 2019

Hydrology and Earth System Sciences
Discussions
Open Access

Interactive comment on "Evaluation of soil moisture from CCAM-CABLE simulation, satellite based models estimates and satellite observations: Skukuza and Malopeni flux towers regional case study" *by* Floyd Vukosi Khosa et al.

Floyd Vukosi Khosa et al.

vukosikhosa@yahoo.com

Received and published: 25 January 2019

1. "As a hydrologist, I am interested in the daily (sometime even hourly) dynamics of the individual components of the water cycle. As a water manager, we have to provide runoff predictions on hourly to daily timescales to hydropower producers or to release warnings on flood and low flow conditions. The question for me is, to what extend is a soil moisture estimate relevant that compares on a monthly level with an R2 of 0.5? What is the performance on daily estimates?"

Printer-friendly version

Discussion paper

We agree with the reviewer that for application purposes it is desirable to have predictions at finer temporal scales such as hourly or daily. In principle, process-based models such as CCAM-CABLE, which is also one of the discussed models in this paper, could be configured for such short time scale operational mode runs. The success of such a set-up depends on the forcing data in which case it becomes important to force the models with the observed climate states. Such short time scale investigations are outside the scope of this paper. The investigated setup for CCAM-CABLE simply dynamically downscale ERA interim forcing data from a 50 resolution to a to 8km resolution leading to soil moisture estimates at the same resolution. The R2 value reflects uncertainty between the models at the analysed time scales. A sizable effort is expanded in this regard to highlight aspects of model uncertainty (i.e., L548-558 and L624-626) some of which alludes to the assumptions about homogeneity of vegetation and hence soil texture classes in these models. A full quantification and attribution of model uncertainly is indeed a topical issue and deserves a separate treatment.

2. “It seems that all products use different sources of precipitation input. How does the precipitation input differs and compares to the measurements of the two flux tower sites. I assume that at least some of the deviations in the soil moisture dynamics stem from differences and deviation in the precipitation dynamics.”, “The same hold for temperature, humidity and other inputs used for ET-calculation.”

As stated on the manuscript in L104-124 the goal is to compare models estimates within situ observations, particularly in capturing the seasonal cycles of soil moisture for local conditions to uncover strengths and weaknesses of the various products. Models evaluated range from complex to simple with regard to structure.

3. “How representative are the averaged soil moisture data for the 25*25km2 pixels. My experience is that soil moisture data largely vary in space with short correlation lengths. What is the variation in soil texture over the 25*25km2 domain? I still see a large gap in scale that at least has to be discussed.”

Printer-friendly version

Discussion paper

We agree with the reviewer that soil moisture is highly variable over space and time. This issue of scale is often found to be debatable in field. The models make a homogeneity assumption per grid-box for most meteorological and environmental drivers such as temperature, vegetation and soil texture types within a chosen grid scale. Clearly, within, this model assumption, soil moisture signal averaged over a monthly time scale, yields an effective pattern. Point comparison, or multi scale, between observations and model outcomes mostly are mostly assumed to be interpretable when the homogeneity assumption are consistent with the site specific details on drivers. In particular, a well-developed signal at small length scale, by deduction, may be deemed representative of a larger region belonging to the same climate system and having similar drivers.

4. “How do temporal difference in soil moisture behave of different time scales (days, weeks, months)? Perhaps that is an information, which is more similar covered by all products/estimates.”

On very short times scales such as hourly to daily time scales, local effects can lead to a pronounced noise of the observations however such noise is anticipated to lead to compensating effects upon long term averaging. In this paper we focus on much longer time scales when the soil moisture signal is well developed.

Specific Comments

“P2l49ff It should be mentioned that soil moisture itself is not the driving force for water transport and evapotranspiration, rather it is the soil matric potential. Often difference in soil moisture only reflect differences in soil texture.”

Thank the reviewer for highlighting that soil matric potential is an important driver for water transport. Attributing it as the sole driver as the reviewer suggests might obscure the fact that there are other driving factors such as gravity, potential energy, capillary forces and hydraulic activity as discussed in Bonan (2008). In response to the reviewers comment, we will update the manuscript with a comprehensive list of all dominating drivers of water transport and evapotranspiration.

“P3l96: Could you explain data constrains more precisely. My experience is, that there are hundreds of FLUXNET locations available, some of them also providing soil moisture data. So I do not see that you are limited or constrained by available data!”

In terms of the study domain, our high-resolution domain covers northeastern South Africa, including Kruger Park. Understanding the soil-moisture over the semi-arid regions of Kruger Park where we have the flux towers is important from a conservation perspective. Moreover, northeastern South Africa has a strong ENSO signal (Engelbrecht et al., 2011) and understanding soil-moisture in this region is important in terms of understanding the impacts of climate variability and change on agriculture, live-stock production, biodiversity and thus also tourism. Unfortunately, for this region of interest there is only one station reporting to FLUXNET, which is the one used in this study. To this effect, we would like to humbly reiterate to the reviewer that FLUXNET station density is indeed seriously constrained for studies on soil moisture, including the present study.

“P5l179ff: As you are using a product combining active and passive microwave data, I would be more specific here. Passive microwave by the way is not dependent on radiation, it emits dependent on it temperature and emissivity. Also, active sensors per se are not necesseraily able to penetrate through vegetation – this will be largely dependent on the wavelength (x-,C-,L-band). Please be more precise on that topics.”

We thank the reviewer on pointing the differences between passive and active sensor, we will precisely discuss these in the updated manuscript.

“P8l293: Why is the focus more on the phase agreement rather than on the magnitude? Because the results are better!? Or because it is more important!?”

Whereas it is appealing to evaluate the models on the basis of agreement in both magnitude and significance, it is instructive to focus on highly predictable part of a climate system which can be bench-marked with an intuition. We focus much on phase agreement or seasonal cycles as these are intuitive features of the climate system which should be effectively predictable by models across the considered length scales. Further motivation of this point is highlighted on the manuscript P3L104-L117 and P7L261-266.

"P9l317: Why are only detrended data analysed? If there are trends that are different, this would be interesting as well!"

We agree with the reviewer that analysing trends on the data would be interesting and we think it deserves a special attention in its own right. However, we do not see how such an analysis can fit within the scope of the present study. Our calculation of the covariance is geared towards depicting the extent of mutual information among the respective models. The underlying statistical assumption for the calculation of covariance is that the input data should be stationary, thus the detrended and deseasonalised time series data is purely dictated by the standard procedure for obtaining the desired statistics.

"P12L390ff: I feel that large parts of the discussion would benefit from some short introduction of how the different products are generated (e.g. GLEAM, built on Priestley & Taylor, Stress-function bsed on VOD derived from mircrowave products : : :). In its current form some of the discussions remain relatively week."

We thank the reviewer for raising this point. For clarity, the manuscript will be revised by reiterating, in the in the discussion section, some of the information highlighted in the introduction section on how different products are generated.

"P20/21 Why is cov used in Fig. 10 and 11. As I do not know the Standard deviation the correlation coefficient would be more intuitive for me!?"

It makes perfect sense to choose correlation as a measure of similarity between variables over covariance, in the case when effects of the change in location and scale

Printer-friendly version

Discussion paper

are not of special interest. A covariance, is utilised in this case as an analogue of mutual information between respective models because its covariance is expressed in units that vary with the data in which case we can also see location and scale induced variation.

"P22l688: Should readers really be surprised by the conclusion that all products/estimates are at least able to reproduce the seasonality in the soil moisture signal! I am sure taking some mean monthly precipitation information, Temperature as a proxy for ETp and some simple bucket model would provide some similar performance. I know this is provocative, but my impression is you should at least demonstrate that all the effort you are doing is significantly better than such a Null-model!"

Presented in this paper are models of with differing construction. The aim, as explain in the introduction section, is to evaluate their performance against well understood seasonal patterns of the system as reflected by in-situ data. Complex process-based models like CCAM-CABLE, as is the case in this study, simulate a climate systems through coupled atmospheric and terrestrial processes modules which exchange information at run time. It is not given that these models should be able to predict climate system patterns at policy relevant length scales as these depends on several factors including the model sensitivity to the forcing data. In the case that such complex models demonstrate such predictive power, even for seemingly simple cases, their demonstrated utility and value stand a chance to translate to various computer experiments including those of climate change projections. In this regard the suggested bucket model is inferior in its assumptions and simplicity. A natural starting point on evaluating the value of process-based mechanistic models is on the predictable aspects of the climate system as demonstrated in this paper. It is not the interest of this paper to embark on inter-model comparison. We are afraid such a comparison, including that of bucket model as suggested, may not lead to conclusive insight. This point is also clearly articulated on the manuscript in L117-120.

Minor comments

"P1l3: should be ": : : satellite based model estimates"" We thank the reviewer for the comment. We will amend manuscript as suggested. "P1l20: should be ": : : turn out"" We thank the reviewer for the comment. We will amend manuscript as suggested .

"P7l263: semicolon should be removed"

We thank the reviewer for the comment. We will amend manuscript as suggested. "P8l283: should be "inter-compares""

We thank the reviewer for the comment. We will amend manuscript as suggested. "P11l378: how are "wet periods" defined?"

The wet period is defined as the summer or the rainfall period (i.e. November to April).

"P18l581: structure of the sentence"

We thank the reviewer for the comment. We will amend manuscript as suggested. "P20l728: What you mean by soil moisture memory!"" Soil moisture memory refers to the ability of soil to "remember" dry and or wet anomaly.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-546, 2018.