Hydrol. Earth Syst. Sci. Discuss., 11, C1685–C1693, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C1685/2014/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "A seasonal agricultural drought forecast system for food-insecure regions of East Africa" *by* S. Shukla et al.

S. Shukla et al.

shrad@geog.ucsb.edu

Received and published: 2 June 2014

Reviewer #1

This is an interesting paper addressing the hot topic of providing high quality and timely agricultural drought forecasts information in a region hit by frequent droughts and famines. The methodology follows and compares with earlier work and similar approaches, although the exact objective and added value of this approach as compared to existing and similar ones should be given some more attention. However section 2.3 is extremely difficult to follow and clearly needs more explanations (see detailed comments below). By reading the methodology again it is not completely clear whether the main envisaged result of the paper are the soils moisture forecasts or the derivation

of daily rainfall amounts from cumulated seasonal forecasts and despite the complete introduction a clear statement of the objectives is missing. And whatever is the main objective, the benefit of the expected results on agricultural drought forecasting has to be better explained as well. Eg. are we talking about drought occurrence only or also drought impact? Finally it could be interesting to compare the results with some remote sensing derived Soil Moisture product.

Response: Thank you for your valuable comments! We have rewritten the section 2.3 in the revised version of the manuscript and also specifically mentioned the objectives of this study. The main focus of this manuscript is indeed SM forecasts however rainfall forecast is a crucial piece of that. We also now better explain how VIC based soil moisture forecasts can be useful for agricultural drought forecasting and compare the results with a multi-satellite based soil moisture product.

Specific comments: 1. P3051 L10-14 I think it's not completely appropriate to put the need for early warning systems and early response following the 2011 famine on the same level. In general there is a high consensus that early warning systems worked relatively well while the lack of appropriate and timely response was one of the main reasons that lead to the famine.

Response: We agree with you and have revised that statement accordingly.

2. Fig 1. CHIRPS appears here first, introduce the acronym.

Response: Done!

3. P 3052 L5-15 I understand that you take SM (for crop areas only?) as a direct predictor of agricultural drought, as opposed to rainfall only which would be meteorological drought. Can this be stated more clearly? Also later on SM is compared directly with the WRSI, but could SM be used to improve the WRSI model? Also maybe worth to mention that, with the exception of limited areas in Southern Somalia, the study area is predominantly a pastoral area.

Response: We have revised those sentences based on the reviewer's suggestion. Yes, SM could be used to improve the WRSI model. This was the focus of a study led by one of the co-authors (Dr. McNally) and has been described in McNally et al., 2014 (currently in revision for JHM special issue "SMAP early adopters"). We now mention that our study area is predominantly a pastoral area.

4. P 3052 L29 and following. What is the link between the statement "Reliable rainfall forecasts over .." and the following one? What rainfall forecasts are meant? Long term climatological forecasts or seasonal forecasts? Is the debate concerning only the causes of the decline in rainfall or the decline itself? If seasonal forecasts are meant this would have a negative impact on the relevance of the paper since it is not clear how soil moisture forecasts based on debatable rainfall forecasts are expected to improve the final drought forecast. So please specify.

Response: We refer to seasonal rainfall forecasts here (we have now revised that sentence to clarify that) however that statement stands true for decadal scale rainfall forecasts as well.

We meant debate concerning the sources of the decline in rainfall.

Through that statement were reiterating what previous studies focusing on MAM seasonal rainfall forecasts have concluded. The rainfall forecasting approach used in this manuscript does result into skillful rainfall forecasts so we expected SM rainfall forecasts to be skillful as well.

5. P 3053 L13 It would be nice to briefly outline the main differences with the mentioned approaches and also explain what is exactly the expected benefit of introducing an additional similar approach.

Response: Good suggestion. We have added a few sentences describing the differences between our approach and similar approaches and also the need of developing such system in section 4. The two primary differences between our approach and oth-

ers are: (1) We use dynamical forecasts over Indo-Pacific region (as shown in Fig. 3) to bias correct dynamical precipitation forecasts over EA region. In contrast, in other approaches, dynamical forecast over the EA domain itself is downscaled and bias corrected. Since the skill of dynamical forecast for the MAM season in the EA region is negligible, a forecast that is directly downscaled also have negligible skill. We show that through our approach useful precipitation forecast skill (0.67 as shown in Fig. 7) can be attained over the EA region for MAM season. (2) We use a rainfall dataset that has been recently developed and takes advantage of both satellite based precipitation estimates and station data.

Please also see the last two paragraphs of section 4.

6. P 3054 L 10-11. Was a land cover classification used to assign some fixed values to each vegetation type? It is not mentioned in the following description.

Response: Yes. The vegetation parameters that we used are based on UMD AVHRR vegetation classes. We now mention that in the manuscript.

7. Fig 3. Can you explain why the correlation figure is covering nearly the whole globe? It is not clear how the correlations outside the study area, Eg. in the ENSO area, are used for the following steps of the analysis

Response: The analog years for the target forecasts were assigned based on spatial pattern of CFSv2 precipitation forecasts over Indo-Pacific Ocean. There are two main reasons for using a larger area to select analogs: (1) strong teleconnection between precipitation over Indo-Pacific region and East Africa rainfall over MAM season (2) higher skill of dynamic forecast models over Indo-pacific ocean than over terrestrial regions of East Africa. We have now clarified that in the manuscript as well.

8. Section 2.3. It is really hard to a fully understand the method presented in this section. I suggest that this section is deeply revised.

8.1 Some ideas: - Introduce the section by stating what is the general purpose of

the production of seasonal climate scenarios (producing daily sequences of rainfall forecast from CFSv2 seasonal forecast - I assume it's a single map updated time to time,

Response: Done.

8.2 Explain clearly what time of forecast you get from CFSv2 and how you treat the fact that they are dynamical forecasts).

Response: Done.

8.3 EA MAM rainfall is compared to CFSv2 precipitation forecasts at global scale? - Point 2 and 3. Response: Yes, we now specify that in the manuscript.

8.4 Always describe on which domain the computations are performed (EA or Global).

Response: Done.

8.5 Explain why you use the absolute value. Negative correlations are considered equally important as positive ones?

Response: Yes, negative correlations are equally important as positive ones. We wanted to focus on those grid cells that in the analog domain that had strong correlation with the EA MAM rainfall regardless of the sign.

8.6 Explain which similarity metric you use.

Response: The metric used was the distance (i.e. absolute difference) between the forecast and observed seasonal precipitation total. The inverse of these distances were used to produce a set of sampling frequencies that summed to 1. The final weights are a blend of these distance-based frequencies and a set of equiprobable frequencies. The blend is based on the overall forecast correlation c (see Fig. 3). If f is a vector of distance-weighted frequencies and e is a vector of equal probabilities, the final probabilities are cf + (1-c)e. Therefore in the case of no correlation (i.e. c$\sim$0) our approach will essentially produce climatological forecasts. We now mention this in the

manuscript as well.

8.7 Explain clearly how the daily sequence is produced staring from all other years daily sequences.

Response: We have now clarified that in the manuscript. Briefly the steps that we take to generate daily sequences are as following: (1) We start with the metrics (i.e. weights as mention in the response 8.6) of how similar any target year (say year T) is to other climatological years (all years between 1993-2012 except the year T). We use those weights to guide our bootstrapping process from the climatological years. The years that have higher weights get selected more often than other years. The frequency of selection is proportionate to the weights. (2) Bootstrapping is performed for one dekad at a time. For example we start with bootstrapping for the first dekad of the season (March 1-10) from a sample of March 1 -10 daily data of all years between (1993-2013, except the target year T) we sample entire dekad based on the weights as mentioned in the previous steps. We then move on to perform bootstrapping for another dekad and so on. (3) We perform total 30 repetitions of the step 2 for entire MAM season resulting in total 30 climate scenarios for a given target year. Although the frequency of selection of years (i.e. years with higher weights getting selected more often than others and so on) remain about the same among different climate scenarios (for a given target year) the sequence of dekads vary. This was done to account for the uncertainties in the evolution of daily weather patterns for the same seasonal forecast.

8.8 If you are doing a weighted average of all annual profiles, you might have small rain contributions from a large number of days. How is this deal with? More information is needed to really understand what is done here

Response: No, we are not doing weighted average of all annual profiles, we instead use the value of similarity matrics to assign the probability of selection from different annual profiles. For example if an year X has higher probability than an year Y then X was selected in the bootstrapping process more often than the year Y. Since we picked

one full dekad at a time the frequency of rainy days for any dekade is within the range of its climatological values. We have now clarified this in the manuscript as well (see section 2.3)

8.9 Fig 4. Bottom panel refers to a uniform distribution? If this is the case it is not really adding information, I suggest to omit it. In addition, if uniform, why is the frequency not exactly the same? - Fig 4. Revise English of the caption.

Response: We have removed the bottom panel and also revised the caption of Figure 4.

9. Fig 5. This figure adds very little to the simple statement in the text. I strongly suggest to omit it. A more meaningful one should be constructed with actual model runs.

Response: We have now removed that figure and since figures 8 and 9 already broadly convey our message about the variability of forecast skill during a season, we have decided to not replace this figure with a figure based on actual model runs. Please note that we have added 3 additional figures in the revised manuscript already.

10. Section 3. I suggest to emphasize that the initial comparison with WRSI is made with VIC-SM in retrospective mode (not using forecast). I suggest this because the title of the section is focused on forecast.

Response: Great suggestion. Done!

11. P 3059 L7-10. Here I am a bit confused by the terminology. Are the SMs forecasted by VIC?

Response: Yes. SM forecasts were generated by forcing the VIC model with the climate scenarios. We have now clarified that in the manuscript.

12. Fig 7 Why are the results presented here as spatial aggregates and later on they are pixel based?

Response: As described in the section 2.3 the rainfall forecasts were for aggregated rainfall over the entire focus domain and entire season. During the bootstrapping step the forecasts are disaggregated into gridded forecasts at daily scale for forcing the VIC model. Therefore we thought it would be appropriate to provide assessment of rainfall forecast skill aggregated over entire region. SM forecasts evaluation were done at pixel scale because that is how they are used by the decision makers. A spatial map of soil moisture forecasts helps in demonstrating areas with higher skill during a given time of season and we now clarify this point in the manuscript as well.

13. P 3059 L 15. Referring to SM estimates (using the VIC model when all info are available) as SM observations sounds confusing to me. The exercise of comparing the two is meaningful but the nomenclature is confusing. Would it make sense to refer to “SM forecast” and “SM a posteriori estimates”?

Response: We have incorporated reviewer’s suggestion.

14. Section 4. There is no discussion in this section (move the text to conclusion and introduction). The discussion is mostly in section 3. When referencing Rojas et al. 2011 consider referencing Meroni et al. 2014 (Early detection of biomass production deficit hot-spots in semi-arid environment using FAPAR time series and a probabilistic approach. Remote Sensing of Environment, 142, 57-68) more focused on drought forecasting instead of drought monitoring.

Response: We have now moved the content of the discussion section to conclusions and summary section. We now cite Meroni et al., 2014. Thanks for your suggestion.

15. P 3062 L23. Where are the station data described in section 2 used? Do you mean the station data used in CHIRPS?

Response: Yes. We mean the station data used in CHIRPS. We have now removed that sentence from the revised version of the manuscript.

16. P 3063 Point 1. Please explain what is the benefit of transferring the system to

LDAS with regards to the problem stated above. What observation do you plan to assimilate?

Response: In lines 1-4 of the page 3064 of the original manuscript we explain benefit of transferring the system to LDAS. The primary benefit of that is it allows us to use more than one model to get the estimate of initial conditions and NASA's Land Information System (LIS) has inbuilt capabilities to work with ensembles of forcings and implement data assimilation. We now mention the observations that we plan on assimilating (i.e. soil moisture and total water storage)

17. P 3064 Point 3. The point is very relevant given the complexity of the paper and also the difficulty of representing forecasts in an easily understandable way. However the sentence "We recognize .." does not add much. It would be better to specify how exactly you plan to improve the presentation of the forecasts.

Response: We have now added a few sentences giving an example of how we might improve our forecast presentation. Specifically, we plan to improve the presentation of our forecasts by incorporating the feedback of the end users (FEWS NET's food analysts) on our forecasts. Thus far we have learned that providing the forecasts in terms of the chances of drought onset/persistence/recovery and best analogs is well receipted by the FEWS NET analysts. âĂČ

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 3049, 2014.