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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.

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Reviewer #2

Seasonal drought forecasting in food-insecure regions such as East Africa is important for reducing drought risks in terms of decision making. This paper is targeted at augmenting the Famine Early Warning System Network (FEWS NET) through incorporating dynamical climate forecast models and a physically-based large-scale land surface hydrologic model. It is an interesting topic and it will benefit local agencies for drought vulnerable regions. I think the paper will finally fit HESS, but currently it suffers from insufficient validation and inappropriate presentation on its difference against previous studies. I would recommend for its publication after the comments below are

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addressed.

Response: We thank the reviewer for the thoughtful comments that certainly improved the manuscript. Please see our response to your comments below.

Major comments:

1. The title has to be changed, given that Sheffield et al. 2014 and Yuan et al. 2013 already introduced an African drought forecasting system based on CFSv2 and VIC which are also used in this paper. We know that climate forecast model and land surface hydrologic model (with non-trivial calibration) are the most important component for a dynamical-model-based seasonal hydrologic forecasting system, although an update of observation climatology with CHIRPS data is not trivial. Actually the novelty of the paper, in my opinion, is to assess CFSv2/VIC system for growing season in East Africa, and is more targeted at agricultural/crop management. I would suggest changing the title as "Seasonal forecasting of agricultural drought for food-insecure regions of East Africa" to avoid using "system development".

Response: We respectfully disagree with the reviewer's comment. It is correct that we used the same temperature and wind forcings and model parameters as in Sheffield et al., 2014 and Yuan et al., 2013 (we acknowledge this in the manuscript as well). However we believe that this forecasting system has enough differences with Princeton's Africa Drought Monitor to be recognized as a separate system. Primary differences between both systems are: (1) The primary focus of this system is to forecast agricultural drought in East Africa. (2) Our approach for bias correction of CFSv2 forecasts and generating climate scenarios is indeed an unique addition and sets us apart from the approaches of Sheffield et al., 2014 and Yuan et al., 2013. We use dynamical forecasts over Indo-Pacific region (as shown in Fig. 3) to bias correct dynamical precipitation forecasts over EA region, whereas in in Africa Drought Monitor the dynamical forecast over the domain itself is downscaled and bias corrected. Since the skill of dynamical forecast for the MAM season and EA region is negligible, forecast that is

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directly downscaled also have negligible skill. Whereas 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. (3) We use a rainfall dataset that has been recently developed and takes advantage of both satellite based precipitation estimates and stations data. (4) Finally the future directions that we mention for this system will further set it apart from Africa drought monitor.

Please also see section 4 where we describe the differences between our approach and others in detail.

2. Validation. I was excited when I was looking at the title because I was supposed that the paper will address the application of seasonal hydrologic forecasting in crop management in a food-insecure region. But I finally realized that, as pointed out by the authors, the paper is a first step toward augmenting the FEWS NET. It's a reasonable argument because we have to validate the system before application. But I could not find any reference forecast to compare with the CFSv2/VIC forecast throughout the paper. While comparison with ESP/VIC (although straightforward) might be a huge task for revising the paper, at least the comparison with the FEWS NET seasonal climate outlooks (no matter precipitation or soil wetness) would be beneficial to show the rationale of implementing such CFSv2/VIC system.

Response: Thank you for your suggestions. We have now added figures showing the comparison of VIC-SM with an independent multi-satellite based soil moisture product. We have also added the comparison between ESP-VIC and CFSv2-VIC and highlight the added skill in CFSv2/VIC SM forecasts with respect to ESP-VIC forecasts.

3. The recent 2011 East of Horn Africa drought is a severe drought, which has been addressed in terms of seasonal forecasting by several papers (Dutra et al., HESS, 2013; Sheffield et al., 2014). Given that the hindcast period in this paper is 1993-2012 that also covers 2011, I would suggest adding a figure to show the system's performance on the prediction of 2011 drought for comparison with other studies.

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Response: Agreed. We have added a figure showing the performance of this system for 2011 drought event.

Minor comments:

4. P3053. For the introduction of experimental/operational seasonal hydrologic forecasting system, the Princeton's CONUS seasonal drought forecast system that is based CFSv2 and VIC (http://hydrology.princeton.edu/forecast/current.php; Yuan et al., J Climate, 2013) would also be relevant.

Response: Agreed. We now cite that website and the reference.

5. P3056, generation of seasonal climate scenarios. The hindcast period is 1993-2012, while CFSv2 became operational in 2011 where different numbers of ensemble are generated: there are 24 ensemble members during CFSv2 hindcast period (1982-2010), while up to 124 members in the real-time forecast from 2011 to present. I am wondering how to handle them in post-processing CFSv2 forcings in this paper. Do you use all real-time members or just the 5-day gap members that are exactly the same as the hindcast? Is there any significant difference between them?

Response: Great point! From the real-time CFSv2 forecasts we only used ensembles that were initialized on the same days (i.e. 5-day gap members) as in the hindcasts, keeping the number of ensembles consistent with the hindcasts. We mention this in the manuscript as well.

6. P3057. It is not clear how the bias correction is carried out. Some key equations should be introduced. Although the authors mentioned that the general method was introduced and validated in previous study, it will be useful for the readers to understand the paper if the authors could introduce that in this paper by showing a bias correction example with CFSv2 data. The bias correction might be another unique feature of the system and so it needs to be addressed clearly.

Response: We have now revised the section 2.3 to make our description of the process

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of bias-correcting CFSv2 forecasts for the focus domain, clearer. Our approach for bias correction CFSv2 forecasts and generating climate scenarios is indeed an unique addition and sets us apart from the approaches of Sheffield et al., 2014 and Yuan et al., 2013. The MAM precipitation forecast skill of CFSv2 over East Africa is negligible at best so using the forecasts over East Africa itself would not have provided much skill beyond the climatology. Therefore we used CFSv2 forecasts over Indo-Pacific Ocean to get bias-corrected forecasts over the focus domain. In doing so our approach benefits from the strong teleconnection between Indo-Pacific precipitation and East Africa precipitation during MAM as well as the high skill of CFSv2 over tropical Indo Pacific region.

7. P3064. For the NMME/drought topic, Yuan and Wood, GRL, 2013 is also relevant.

Response: Thank you for your suggestion. We cite that reference now.

8. Figure 3. How to explain the big negative correlations over west tropical Pacific? Are they reasonable?

Response: Yes, they are reasonable. This recent (post 1999) negative relationship between EA MAM rainfall and west tropical pacific precipitation and SST has been documented in a few recent studies, such as Lyon and Dewitt 2012, Lyon et al., 2013 and Hoell and Funk 2013 (please see the reference below). We also cite these references in the manuscript now.

Reference:

Hoell A and Funk C.:Indo-Pacific sea surface temperature influences on failed consecutive rainy seasons over eastern Africa Clim Dyn 1–16. 2013.

Lyon, B. and DeWitt, D. G.: A recent and abrupt decline in the East African long rains, Geophys. Res. Lett., 39, L02702, doi:10.1029/2011GL050337, 2012.

Lyon B, Barnston A G and DeWitt D G.: Tropical pacific forcing of a 1998–1999 climate shift: observational analysis and climate model results for the boreal spring season

Clim Dyn 1–17, 2013.

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