Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-101-AC2, 2016

Hydrology and Earth System Sciences
Discussions

Interactive comment on "An experimental seasonal hydrological forecasting system over the Yellow River basin – Part I: Understanding the role of initial hydrological conditions" *by* Xing Yuan et al.

Xing Yuan et al.

yuanxing@tea.ac.cn

Received and published: 23 April 2016

We are very grateful to the reviewer for the positive and careful review. The thoughtful comments have helped improve the manuscript. The reviewer's comments are italicized and our responses immediately follow.

This manuscript presents a seasonal hydrological forecast system for the Yellow River basin and investigates the contribution of hydrological initial condition and meteorological forcing to the predictability of soil moisture and streamflow over the study region. The topic is suitable for HESS, and the research method is scientifically sound. The

manuscript is generally well written with good quality illustrations. It is a good piece of work. But I am a little disappointed with the scientific contribution of this work to our knowledge and understanding about seasonal hydrological forecasting, at least in the way that was presented. This is one of my major concerns. There are also a number of places in the manuscript that needs clarification or justification. Overall, I think a major revision is necessary to improve the quality of the paper.

Response: We thank the reviewer for the comments. Please see our clarification of the novelty and the responses to the comments below.

Major concerns:

This is a solid piece of research work, but there isn't really anything new in terms of research methods or scientific understanding. Several previous studies have adopted the exact same methodology and answered the exact same questions, but just over different basins. So besides applying the same methodology in a forecast system over the Yellow River basin (new to some degree), there is not enough evidence to support the novelty of this research. The authors argue that a new meteorological dataset with higher resolution is used, but it was not demonstrated how this improved resolution actually help with the hydrological forecasting.

Response: We thank the reviewer for the comments. The two companion papers introduce an experimental seasonal hydrological forecasting system over the Yellow River basin in northern China to provide adaptive support in a changing environment. The system draws from a legacy of a global hydrological forecasting system (Yuan et al., 2015), but with the VIC land surface hydrological model re-calibrated against high resolution meteorological forcing data and the naturalized streamflow data along the main course of the Yellow River. As compared with the VIC model in the global hydrological forecasting system, the Nash-Sutcliffe efficiency (NSE) calculated against observed streamflow at the outlet of the Yellow River basin increases from less than 0.5 (Yuan et al., 2015) to 0.63 (Yuan, 2016). Moreover, the calibration has been done sub-basin by sub-basin, constrained by the naturalized streamflow data from 12 hydrological gauges from upper to lower reaches. As the first companion paper, it also explores the natural hydrological predictability by using the reverse ESP simulations. Some of the key findings, as illustrated in the abstract, are as follows. (1) Difference in predictability from upper to lower reaches: for the streamflow forecasts initialized at the end of the rainy season, the influence of ICs for lower reaches of the Yellow River can be 5 months longer than that for the upper reaches, while such difference drops to 1 month during the rainy season. (2) The role of surface water ICs: the initial surface water state is the main source of streamflow predictability during the first month, beyond which other sources of terrestrial memory become more important. (3) Predictability during extremes: the dominance of ICs on the streamflow predictability can be extended by a month during the dry/wet periods, suggesting the usefulness of the ESP forecasting approach after the onset of the hydrological extreme events.

My other concern is on the revESP approach as a way to estimate the impact of IC uncertainties on hydrological forecasting. Although this approach has been used in several published studies, it is still necessary to point out that this approach significantly overestimates the uncertainty associated with IC as it uses all historical ICs. This is more so than the ESP approach for meteorological forcing. Please note that the meteorological forcing is during the forecast period which is unknown at the time of forecast, but the IC is just not able to be completely observed. The IC is the result of past meteorological conditions that have been observed to a large degree. So cautions need to be raised when interpretation of the results (ESP vs revESP), and some discussion is necessary on this issue in the end.

Response: We thank the reviewer for the comments. The revESP provides a "theoretical" framework to compare the importance of ICs and meteorological forcings in terms of hydrological predictability. In this study, both the ESP and revESP uses all historical meteorological forcings and ICs respectively, with 28 ensembles for both. However, in a real forecast, the forecaster do not necessarily use all ensemble members, i.e., both the

uncertainty (sample) in ICs and meteorological forcings can be reduced through prior information. The ESP/revESP simulation comparisons just show the major sources of predictability for a given basin, and they will guide the investment in the refinement of ICs or the improvement in climate predictions. We will add discussion in the end of the revised manuscript as follows: "2) the revESP method only assesses the theoretical predictability control by using all historical ICs. Actually, operational forecaster can refine the ICs to some extent before issuing the forecasts because of the tendency in the ICs (i.e., prior information). In this regard, the revESP may overestimate the uncertainty in the ICs. On the other hand, the ESP method may also overestimate the uncertainty in the meteorological forcings because a conditional ESP method that is based on certain teleconnections (van Dijk et al., 2013) can be used to select the meteorological forcings from all historical samples. A more elastic method that is recently proposed by Wood et al. (2016) could be used to understand the role of ICs in the seasonal hydrological forecasting with various level of uncertainty;"

Minor issues

1. Page 2 line 9: what is a more extreme climate?

Response: We will remove it to avoid confusion, and the sentence will be revised as "The intensification of the water cycle leads to an increase of hydrological extreme events. . ."

2. Page 2 line 11: Some references are needed to back up this statement. 3. Page 2 line 12: Some references are needed here, too.

Response: References (Huntington, 2006; Oki and Kanae, 2006) and (IPCC, 2014) will be included.

4. Page 2 line 14: There is a different between mitigation and adaption. Should seasonal forecast be more helpful with mitigation instead of adaptation? Adaptation usually happens at much longer time scales.

Response: According to the definition of IPCC. Mitigation refers to "An anthropogenic intervention to reduce the sources or enhances the sinks of greenhouse gases", and the adaption refers to "adjustment in natural or human systems to a new or changing environment". Due the inertia of the ocean that has already assimilate much carbon, the effect of reducing CO2 (mitigation) on slowing the temperature will not be significant in a short time; while the adaption is an action to the changing environment or the extremes (e.g., drought and floods). And a well-planned adaptation cannot be achieved without a reliable prediction of the future.

5. Page 2 line 19: Why Atlantic Ocean? What about other oceans?

Response: We will remove it to avoid confusion, and revise the sentence as "While the decadal hydrological prediction is still at an exploring stage due to very limited predictability over land. . ."

6. Page 4, line 10: regridding usually means changing the spatial resolution of a grid data product. Here the station data is interpolated somehow to a fixed grid, so it is not regridding. It is also necessary to mention how the interpolation is done.

Response: Thanks for the comment. We will revise it as "The meteorological forcing datasets from 324 meteorological stations are interpolated into 1321 grids at a 0.25-degree resolution, with a lapse rate correction for temperature at different elevations. The observations from three nearest meteorological stations are interpolated to each grid by using the inverse quadratic distance weighting method."

7. Page 4 line 20: "river is suspended ??" What do you mean by that? I guess what you want to say is that "the riverbed is elevated above the adjacent floodplains due to sediment deposition and man-made levees".

Response: Thanks for the comment. We will revise it as ". . .where the riverbed is elevated above the adjacent floodplains due to sediment deposition and man-made levees."

8. Page 5 line 20-21: Do you have a source for these statistics?

Response: They are reported by the Bulletin of Water Resources. We will mention it in the revised manuscript.

9. Page 7 line 17: "dominant role of IC's for streamflow predictability". See the major concern #2. This interpretation needs to be cautious.

Response: Please see our response to the major concern #2 above. As suggested by the reviewer, we will replace all "dominant" with "prevails over" or "significantly contribute to" throughout the revised manuscript.

10. Page 8, line 7: what is a full initialization?

Response: It means "both the initializations of surface and subsurface water". We will mention it in the revised manuscript.

11. Figure 2: this is useful to show the spatial variation of mean temperature, precipitation and wind. But it is not the most useful ones, for example the wind is never discussed in the study. It is actually necessary to show the seasonal cycle of precipitation (and probably temperature) over the basin, just because you use such information in Figure 8.

Response: Thanks for the comment. We will revise Figure 2 to show the seasonal mean precipitation and temperature, and remove the climatology plots.

12. Figure 8: why are there a number of small streams showing the max lead time of 6 months all the time?

Response: They are caused by slow velocity. We will exclude them to focus on the results along the main courses.

References:

Huntington, T. G.: Evidence for intensification of the global water cycle: review and synthesis, J. Hydrol., 319, 83-95, doi: 10.1016/j.jhydrol.2005.07.003, 2006.

IPCC: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32, 2014.

Oki, T., and Kanae, S.: Global hydrological cycles and world water resources, Science, 313, 1068-1072, 2006.

Wood, A. W., Hopson, T., and Newman, A., et al.: Quantifying streamflow forecast skill elasticity to initial condition and climate prediction skill, J. Hydrometeorol., 17, 651-668, doi: 10.1175/JHM-D-14-0213.1, 2016.

Yuan, X., Roundy, J. K., Wood, E. F., and Sheffield, J.: Seasonal forecasting of global hydrologic extremes: system development and evaluation over GEWEX basins, Bull. Am. Meteorol. Soc., 96, 1895-1912, doi:10.1175/BAMS-D-14-00003.1, 2015.

Yuan, X.: An experimental seasonal hydrological forecasting system over the Yellow River basin – Part II: The added value from climate forecast models, Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-102, in review, 2016.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-101, 2016.