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Hydrology and Earth System Sciences Discussions

Interactive comment on "Seasonal hydrologic prediction in the United States: understanding the role of initial hydrologic conditions and seasonal climate forecast skill" *by* S. Shukla and D. P. Lettenmaier

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This study attempts to synthesize the contribution of hydrologic initial conditions and climate forecast skill to the overall skill of seasonal hydrologic predictions over CONUS at all seasons, based on ESP and revESP experiments with VIC model. Similar work was done over other regions by other researchers, so there is no signiïňĄcant contribution in research methodology, but the more comprehensive results are still of great values. There are several issues that the authors need to address before the paper can be published.

- We thank reviewer 3 for the thoughtful comments.

Major issues

1) The reverse ESP approach to study the impact of hydrologic initial condition on seasonal hydrologic prediction skill of soil moisture and runoff is a bit flawed, although it has been used in several studies. The current forecast approaches to estimate the hydrologic initial conditions won't necessarily create errors as large as that represented by the interannual variability. So using initial conditions from 31 years as the ensemble initial conditions will overestimate the uncertainties associated with hydrologic initial conditions, which means that contribution of hydrologic initial condition to the overall forecast skill will likely be overestimated. The conclusion that improving hydrologic initial condition will significantly improve the forecast skill of runoff and soil moisture months in advance is unintentionally inflated. The authors need to address this issue in the study.

Response: We respectfully disagree with the reviewer's comment that the reverse ESP method is flawed. It is true that it provides an upper bounds, since, as the reviewer states, the distribution of ICs is unconditional. For purposes of determining the relative role of ICs and climate forecast skill, we believe it is entirely appropriate. However, we do feel that it is worth emphasizing that it provides a bounding case, and we now emphasize this point in section 4.

2) Equations 1 and 2 need to be redefined for soil moisture since soil moisture forecast is evaluated for individual month and runoff is evaluated as the accumulation during the forecast period, so the summation over lead time does not apply to soil moisture. The current form only works for accumulative runoff. This also leads to another issue on page 6576 and several other places in the discussion. Since soil moisture and runoff are evaluated differently, a direct comparison between how hydrologic initial condition and climate forecast skill contribute to soil moisture and accumulative runoff forecast

HESSD

8, C4224–C4228, 2011

are inappropriate. Statement like "Overall, the relative contributions of IHCs are greater for forecasts of SM than for forecasts of CR (page 6576 line 18)" should be avoided because the authors are comparing apples and oranges.

Response: Equations 1 and 2 estimate RMSE of ESP and reverse ESP experiments respectively for any given lead-time and forecast initialization date. The equations do not perform summation over lead-time. For example the RMSE of cumulative runoff forecasts at lead-n is estimated using runoff values accumulated over month 1 to n and the RMSE of soil moisture (SM) forecasts is estimated using the mean SM during the n-month. We consider monthly SM (at nth month) and CR (of month 1 to n) because both quantities directly reflect the impact of total precipitation during the 1 to n month forecast period. Sentences like the one on page 6576 mainly emphasize the fact that overall, most regions in the U.S. show relatively high contribution of IHCs (i.e. RMSE(ESP)/RMSE(revESP) <1) for SM forecasts at lead-1 month even though the ratio may not be < 1 for runoff forecast at lead-1. For example in Fig 6 there are more regions showing RMSE ratio < 1 than in the figure 5. We do agree with the reviewer that that statement in current form (without mentioning the lead-time) is confusing. We have revised that statement on page 6567 and elsewhere in the manuscript.

Minor Issues

1) The use of abbreviation is the manuscript makes it difficult to read sometimes. There are already too many acronyms in this field, so one should not introduce new abbreviations/acronyms unless it is necessary. Is it really necessary to use PU for Princeton University, SWM for surface water monitor, USDM for US drought monitor ? In fact many of these abbreviations are only used once or twice in the manuscript, and these are not widely accepted abbreviations, unlike terms such as NCEP, USGS, GEWEX, etc. So I strongly recommend removing the abbreviations as much as possible so that Table A1 won't be necessary.

Response: We agree. We have reduced the number of abbreviations as much as

HESSD

8, C4224–C4228, 2011

Interactive Comment

possible. As noted in our responses to other reviews, we no longer use acronyms for phrases that appear less than three times, in the text.

2) The use of CFS (climate forecast skill) can be confusing for many in the field because this normally stands for Climate Forecast System at NCEP. Although this term is not reserved for the modeling system, it'd be better to avoid confusions. Please consider using the whole phrase.

Response: We agree, that it is possible to confuse "CFS" with its well-known full form "Climate Forecast System", so we now use acronym "FS" instead.

3) Page 6567 line 2 and Page 6570 line 23: multiple references for one particular-work should be cited in chronicle order. This comment applies to other places in the manuscript.

Response: We have corrected the order of the references here and elsewhere in the manuscript.

4)Page 6572 line 5-8: VIC in water balance mode does not require input of radiation, but rather internally generate them, correct?

Response: If the radiative forcings are not provided externally then the VIC model generates radiation forcings internally regardless of the mode it is run (i.e. water balance mode or full energy balance mode). As mentioned on page 6571 line 25-26 and page 6572 line 1-5 we used Precipitation, Tmax , Tmin and wind speed forcings only.

5) Page 6572 line 9-11: The baseline simulation over the entire period should have produced all the initial conditions. If so, this sentence is misleading.

Response: As mentioned on page 6572 line 9, the IHC generated after > 50 years of spinup was used to run the VIC model over 1970-2003 to create the control run/base line simulation. However unlike models such as CLM, SAC and Noah the VIC model currently does not have the capability to save multiple state files during a long term simulation which is why we had to run the VIC model multiple times to generate the

IHCs for the beginning of each month during 1971-2003. In doing so we made sure that the spinup period was at least 1 year long. For example the IHC for 1970-01-01 was used to generate the IHC of 1971-01-01 and so on.

6)Page 6572 line 12, 6570 line 26 and several other places hereafter: The use of "region" and "sub-region" is inconsistent throughout the manuscript. Please modify accordingly.

Response: We have corrected that inconsistency. We now use the phrase sub-region to refer to any of the 48 sub-regions we created in this study and the phrase “region” for the 18 USGS water resources regions.

7)Page 6573 line 14: A better and more clear way to say this can be "“Let O be the observed CR and SM obtained from the baseline run as the synthetic truth..."

Response: We have revised that sentence as suggested by the reviewer.

8)Table 1 is mentioned only once in the manuscript, but the content in this table is actually not used in the manuscript. The authors mentioned 221 USGS regions, and then aggregated to 18 regions. Nowhere in the manuscript had the authors mentioned 18 USGS water resources regions. This table should be eliminated.

Response: Table 1 actually lists the name of all 18 USGS water resources regions. These regions are further divided into 221 sub-regions by the USGS. For this study we grouped together the 221 sub-regions into our 48 sub-regions. Each of those sub-regions was named after the water resources region, it is located in, which is why we listed the names of all the 18 water resources regions along with the acronym used in the manuscript so the reader can easily identify the regions using that table and figure 1.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 6565, 2011.