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Hydrology and Earth System Sciences Discussions

Interactive comment on "Predictability of soil moisture and river flows over France for the spring season" *by* S. Singla et al.

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Reviewer 1 General comments

The article presents a sensitivity analysis of seasonal flow forecasts for the spring season (March-April-May) to soil moisture and future meteorological scenarios. The authors apply the Isba-Modcou model over a large set of 881 catchments spread over France. The skill of the probabilistic forecasts is evaluated using as reference the simulation obtained by the Isba-Modcou model fed with the observed meteorological inputs (Safran reanalysis). The article is generally clear and easy to follow. It provides interesting insights on the variables that mostly influence seasonal flow predictability on this data set.

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Interactive Discussion
Discussion Paper

One concern I have is that no evaluation against observed data is made in the article since the references being used are synthetic flow series simulated by the model. Although this is clearly acknowledged by the authors, I wonder to which extent this may influence the reliability of the results presented here. It is likely that in catchments or zones where the model is poor, the sensitivity shown in the article should be taken with more caution than in others where it is successful. I think it would be most useful that the authors introduce a discussion on this point, to better characterize the reliability of the results they propose on their catchment set considering model efficiency. For example, what is the behaviour of the Isba-Modcou model in mountainous areas which are often known to be difficult to model (partly due to the difficulty to estimate actual precipitations) and which are largely discussed in the article? A map showing efficiencies in simulation on the target period (MAM) could be introduced and discussed. Such a discussion would make the proposed modelling exercise a bit less "academic" and a bit more useful for the model's users. I also give a few other minor comments below, which could be considered by the authors when revising their manuscript. Minor revision is requested.

- Response : We thank reviewer 1 for his valuable comments.

General comments :

- Response : We agree with the reviewer on the importance of a comparison with observations. It is out the scope of this paper, but this point will be treated in future work. In the revised version of the paper a discussion (see hereafter) on this point and two additional maps are now introduced in the "discussion and conclusions" section as proposed by the reviewer. The discussion is based on the discharge ratio in Spring (ratio of simulated vs observed riverflows) (i) and the interannual correlation between simulated and observed spring mean riverflows (ii). (i) The first criterion qualifies the ability of SIM to simulate the observed volume. It is similar to already published comparisons over the whole year (Habets at al., 2008). The discharge ratio is usually well simulated, with some noticeable exceptions in the Alps. It is partly the consequence of

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numerous dams used for hydropower production, and influencing river flow observed. However, as Lafaysse et al (2011) show, the overestimation of river flow over the Alpine region is also explained by the grid discretization (the elevation range over each 8 km grid square is often wider than 1000 m). The consequence is a poor estimation of meteorological variables (like snowfall), vegetation and snow cover. Moreover, in the Alpine region, the SIM model does not include water storage and release from aquifers nor ice melt from glaciers, inducing a time lag of snowmelt which occurs earlier than observed. (ii) The second criterion qualifies the ability of SIM to simulate the interannual variability. This criterion is very important in the framework of seasonal forecast. In most cases the correlation is very high (above 0.85), indicating that SIM is able to correctly predict this variability, even if the score on the discharge ratio is poorly simulated. For the Durance at Embrun, a typical Alpine river not influenced by dams, the discharge ratio is very poor (overestimation of 40% of the discharge in Spring because of grid discretization and lack of local aquifers and glaciers in the model), while the interannual correlation on spring discharge with observation is 0.88. Hence, it is relevant to use SIM for seasonal prediction on this river.

The quoted reference is now added in the bibliography : Lafaysse, M., Hingray, B., Etchevers, P., Martin, E., and Obled, C. : Influence of spatial discretization, underground water storage and glacier melt on a physically-based hydrological model of the Upper Durance River basin, Journal of Hydrology, 403, 1-2, 116-129, doi:10.1016/j.jhydrol.2011.03.046, 2011.

Detailed comments

1.Page 7948, Line 7: "881" instead of "800"

- Response : corrected.

2.Page 7948, Lines 24-26: "irrigation purposes. Predicting low ïnËĞC′ ows and droughts"

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- Response : corrected.

3.Page 7948, Lines 25-26: Although this general objective is true, the targeted period in this article is March to May, which is not really the low-flow season in France. To avoid introducing some confusion about the objectives of the study, a clearer link to the context of the work proposed here could be made.

- Response : We now explain that we expect to detect signals of drought onset in spring in order to help water resources managers taking decisions for summer.

4. Page 7949, Line 5: The term "skill" is not so clear at this stage of the article. Should not it be defined here?

- Response : The term has been changed to “prediction skill”. The soil moisture memory may last up to two month leading to some prediction skill.

5. Page 7949, Lines 12-13: "The size of the river basin"

- Response : corrected.

6. Page 7949, Lines 12-13: Is that a general result? Could a few words be added on the results of the cited studies? Do the results presented in the article corroborate these previous findings? This could be discussed in the Discussion section at the end of the article.

- Response : This is a result for the Ohio River Basin case study only (Li et al., 2009).. It is now specified in the article that this is valid for the Ohio River Basin with a wide range of basin sizes, from a hundred to over a 10 thousand square miles.

7. Page 7949, Line 23: "monsoon"

- Response : corrected

8. Page 7952, Line 7: For those not familiar with the French context, the total area of France could be mentioned here.

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- Response : The total area of continental France is now added : about 544 000 km2.

9. Page 7954, Lines 2-5: Maybe add a few words on what this method consists in.

- Response : the method is already described line 7-12 page 7954.

10. Page 7954, Line 12: "threshold temperature" (?)

- Response : corrected.

11. Page 7954, Line 16: "at the daily time step for total"

- Response : corrected

12. Page 7955, Lines 4-6: I found this sentence unclear. Can the authors clarify it?

- Response : the text is now modified as follow : the prediction skill for temperature was higher than that for total precipitation in ARPEGE-DEMETER (previously used in Céron et al., 2011) and ARPEGE-ENSEMBLES (currently used) atmospheric forcings versions. Next, when looking at rainfall and snowfall scores, there was an overestimation of rainfall and an underestimation of snowfall in both ARPEGE versions. An additional study (not shown) shows that a 1.5 °C threshold temperature may fit better than 0.5°C for the snowfall/rainfall partition. Finally, for both ARPEGE versions there is low predicting skill over the Mediterranean area for temperature and total precipitation as compared with other regions in France.

13. Page 7955: Maybe a section could be added to give a short and synthetic description of the catchment set used here (range in size, mean flow, mean catchment area rainfall, mean altitude, regime types, etc.). This information is probably published elsewhere, but this would make this article more self-contained. This section could also include a short description of the example catchments used later in Section 4.3.2. This would help situating these catchments within the whole catchment set.

- Response : a section is now added as proposed by the reviewer with a table providing information about the six example catchments used in Section 4.3.2 with the basin

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area, the mean altitude and the mean flow.

14. Page 7955, Sections 3.1 – 3.2: I found a bit unclear how the model was actually tested. The authors mention that a one-month lead time is considered. So does it mean that on 1st February, a forecast is made for the day one month later, on 2nd February a forecast is made for the day one month later, etc., and then that the series of one-month ahead forecast are considered for evaluation? In that case, a new initial condition should be considered for each day when a forecast is issued (not only 31st January). Is that what was done? Please clarify this point.

- Response : Seasonal meteorological forecasts are issued on the 1st February for a period ending on 31st May and they are used to force the ISBA-MODCOU hydrological model from 1st February to 31st May, without considering the first month (February) for skill scores.

15. Page 7955, Lines 22 and 24: What "parameters" means here?

- Response : “parameters” is now replaced by “variables”. In order to preserve the consistency between temperature, total precipitation, humidity. . .(all the atmospheric variables used in the atmospheric forcing), we took all variables from the same year. This is the same for the land surface variables (snow cover, soil moisture, river discharge, piezometric level..), we took all variables from the same year.

16. Page 7956, Line 19: "(See Sect. 2.2)"

- Response : corrected.

17. Page 7958, Line 10: "Figure 3 (left)" or "Figure 3a" (see comment #30)

- Response : for all figures, we now add a and b.

18. Page 7958, Line 17: "the Lauragais region close to the Mediterranean sea" (?)

- Response : corrected.

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19. Page 7958, Line 20: "evapotranspiration"

- Response : corrected.

20. Page 7958, Lines 23-25: What do you mean by "saturation of the signal"?

- Response : The sentence is now corrected in the manuscript as follow : indeed, as we took the land surface initial state, the soil water content is often close to the field capacity for these regions on the 31st of January, when the land surface initial state is considered. It means that the interannual variability is low compared with summer periods when the interannual variability is high.

21. Page 7959, Line 1: "(Fig 3 (right))" or "Figure 3b" (see comment #30)

- Response : corrected.

22. Page 7959, Line 4-7: Is this result not surprising? Soil moisture often plays a key role in generating flows.

- Response : the result is not very surprising. Soil moisture often plays a key role on generating flow of course but not always and especially when it is below the field capacity inducing no river flow.

23. Page 7959, Line 16: Maybe these gauging stations should be located on the map (Fig. 1)

- Response : done.

24. Page 7962, line 14: "and RAF are shown"

- Response : corrected.

25. Page 7962, lines 15-20: It would be useful to present these example catchments before (see comment #13).

- Response : corrected.

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26. Pages 7963-7966, Section 5: This section is a bit long and could be split in two sections could (maybe "Discussion and conclusions" and "Perspectives", the latter starting from Page 7964, line 22). As mentioned in my general comments, I think it would be useful to discuss in details the influence of model performance on the reliability of the results presented here.

- Response : the section has been split into the two sections as recommended. In the “Discussion and conclusions” section, we discuss about the influence of model performance and we add the two maps (Fig. 11 and 12) (see response to the first general comment).

27. Pages 7966-7967, Appendix A: A reference to a paper discussing the BS could be introduced. Which threshold is considered here? (line 17) Which categories are considered (line 5)

- Response : The Brier Score is a quadratic measure of error in probabilistic forecasts for an event that occurs or not. We consider here three probability standardized (as usual for seasonal forecasting) categories : below normal (dry), normal and above normal (wet) compared to the climatology. So these tercile categories are calculated based on the climatology, giving the two tercile thresholds used for computing the BS. The relevant reference is now added : “ Mason, S. : On Using “Climatology” as a Reference Strategy in the Brier and Ranked Probability Skill Scores, Monthly Weather Review, 132,1891-1895. doi: 10.1175/1520-0493(2004)132<1891:OUCAAR>2.0.CO;2 , 2004 Âż .

28. Page 7977, Fig.1: The colour scale could be chosen so that it appears from white to dark when the article is printed in black and white. The same comment applies to the other maps (when possible)

- Response : the color scale has be chosen for the elevation on figure 1 and for the figure 4 so that it appears from white to dark when the article is printed in black and white. For the other figures, we increased the resolution as much as possible, but we

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cannot change colors.

29. Page 7978, Fig.2: I found this figure not so clear. Safran appears in two boxes. Maybe make clearer what is used to compute initial conditions and what is used for scenarios. What means "120 day range" in the figure? Is not it a one-month ahead forecast?

- Response : the figure 2 has been modified. 120 day range is the number of day from March to May, but it is true that is not clear and is a little vague. So we replaced “120 day range” by from March to May and add some precisions for the initial states and scenarios in the figure.

30. Page 7979, Fig.3: Maybe put "a" and "b" on the two graphs, which would ease reference in the text. The same comment applies for the other figures.

- Response : “a” and “b” have been put on the two graphs and for the other figures.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 7947, 2011.