Interactive comment on "A national-scale seasonal hydrological forecast system: development and evaluation over Britain" *by* Victoria A. Bell et al.

Victoria A. Bell et al.

vib@ceh.ac.uk

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Response to Anonymous Referee #2 Received and published: 2 June 2017

Authors' responses interleaved with reviewers comments.

This manuscript explores the potential for 1 month and 3 month hydrologic forecasts on a national scale, for different seasons. As a precursor, the manuscript describes how high resolution spatial information from a hydrologic model can be used to estimate

initial conditions in a simplified manner.

General: Overall, the paper is well written and the structure provides for a coherent progression through the various sections. The main takeaway points, relative to the stated intention of development an evaluation of the system, are clear in that the seasonal differences in forecast skill are prominently noted and discussed. However, as the manuscript as identifies the desire to link to decision making, I would suggest clarifying that link, maybe providing a section, as slight mentions of this link are unconvincing. I recommend the manuscript for publication in HESS after addressing minor revisions.

Reply: Thank you. With the aim of clarifying links to decision-making, extra sentences will be added to the manuscript (in the conclusions) to say: "The HOUK has been in operation for 4 years (publically available from autumn 2013) and thus is a relatively new product. At present, automated web statistics indicate approximately 300 readers or users of the HOUK website per month (Prudhomme et al., under review). Exactly how water managers use the HOUK in practice has not yet been assessed, but ongoing evaluations of the skill in the different methods used in the construction of the Outlook will undoubtedly help provide the evidence required to support use of the product in decision-making."

Specific comments: Page 2 Line 5-7 What is meant by perceived lack of skill? Is there skill or not? I would clarify as the lack of skill could discourage development of forecasts or it can also be the case that there is skill, yet amongst key people making decisions of research priorities, it could be perceived to not have skill. The second condition is more complicated and likely will need to be resolved with social science.

Reply: This sentence will be re-worded to emphasise that published literature as recently as 2011 indicated that seasonal forecasts of rainfall in extratropical areas (such as Britain) had little skill at lead times of more than 1-month. Thus there was little incentive to use the forecasts to support decision-making.

Line 26 A general note overall, and referencing the potential value for practitioners in

line 29 of the abstract, it is important not to state skill acceptability in an overarching sense. In the literature differences in both perception of skill and more importantly acceptable levels of skill in order to justify using that forecast can vary across sectors and will likely be different for users compared to forecast developers. For more on this see: Hartmann, H. C., Pagano, T. C., Sorooshian, S., & Bales, R. (2002). Confidence builders: Evaluating seasonal climate forecasts from user perspectives. Bulletin of the American Meteorological Society, 83(5), 683-698.

Reply: This is a good point. The sentence in the abstract will be clarified to say "Given the high spatial heterogeneity in typical patterns of UK rainfall and evaporation, future development of skilful spatially distributed seasonal forecasts could lead to substantial improvements in seasonal flow forecast capability, potentially benefitting practitioners interested in predicting hydrological extremes, not only in the UK, but also across Europe."

Page 3 Line 16 – Correct in stating that downscaling would be necessary, but is there any evidence that downscaling would be a 'worthwhile' activity for improving national estimates of water flows?

Reply: The sentence will be re-worded to make it clear that we aim to provide flow estimates nation-wide, rather than at a national scale: "... seasonal rainfall forecasts do not provide detailed weather information at this resolution and would typically require spatio-temporal downscaling to achieve good estimates of river flow for catchments or regions nation-wide".

Line 17 – What is meant by realistic water flows? I suggest adding context or changing the word as, in the current form, this is at unnecessarily high risk for misinterpretation.

Reply: We have changed the word "realistic" to "good". Please see re-worded sentence above.

Page 4 Line 19 – I suggest clarifying the period in which the long term average is

calculated over. I think it can be interpreted as monthly or seasonally, which could impact the result.

Reply: The sentence will be clarified to say "long term monthly average".

Page 7 Line 14 Does 'relative to the rainfall forecast climatological mean' imply the 3 month anomaly will be distributed over each month based on a month's relative mean contribution to the total seasonal precipitation?

Reply: Yes. The sentence can indeed be simplified to say "Disaggregation of the 3-month ahead forecast into monthly rainfall amounts is achieved through distributing the 3-month rainfall forecast anomaly between the 3 individual months according to their relative contribution to the UK mean seasonal rainfall (1962 to 2010)."

Page 10 Line 1 The Forth region has median model performance for 1 month or 3 month leads? Or both combined?

Reply: This is for the 1-month lead time and the text has been clarified.

Line 14 Seems that a comma is in error or a capital T is in error

Reply: Ah, thank you. The offending comma will be changed to a full stop.

Line 16 2a shows persistence on a 1 month lead more skillful than GloSea5+HIC. Can you explain why? Or I suggest noting that for overall assessments on a 1 month lead, persistence forecast should be explored in more depth.

Reply: The sentences will be clarified as follows: "At the 1-month lead time the WBM with G2G HIC driven by an historical rainfall (climatology) ensemble performs best, and the forecasts based on persistence or Glosea5+HIC perform less well, but show some skill. For the longer 3-month lead time, the WBM with G2G HIC driven by either historical or GloSea5 rainfall perform similarly; persistence forecasts (Pers) or use of an average HIC are not recommended at this lead time." The explanation for the skill in persistence forecasts is addressed in the regional skill breakdown in the next but one

paragraph in the manuscript.

Page 12 Line 15 Agreed, yet this point (how inclusion of avHIC with GloSea5 lead to 0 skill during some seasons) presents another that may be worth addressing – In figure 3, there exists an interesting pattern of skill at the sub-national level. Any thoughts on why?

Reply: This probably refers to p14 Line 15. Yes, the apparent skill in use of an average HIC with GloSea5 in Figures 3 and 4 is interesting. Figure 4 indicates that these forecasts are only skilful in Autumn and Winter, and particularly at the 3-month ahead lead time. The regions where the skill is greatest (Northern and Western regions, excluding Northern Scotland) are areas with less subsurface storage than the SouthEast regions and Northern Scotland, and thus where persistence forecasts are less skilful. We would speculate that in these areas the skill arises from the improved skill in GloSea5 at the 3-month lead time, coupled with less dependence on a good HIC in these areas.

The sentence in the manuscript will be changed to say: "...Autumn/Winter flow forecasts using ensemble mean GloSea5 rainfall and an average HIC perform surprisingly well across Britain, confirming that there is a significant element of skill associated with GloSea5 forecasts in Autumn/Winter at the 3-month lead time, often resulting in skilful flow forecasts in regions where this skill is less dependent on a good HIC."

Page 15 Figure 5 Is it possible to include a map that labels the regions (abbreviations should suffice)? I think the paper as a whole would benefit from this, even if one of the maps used in a previous figure could do this.

Reply: A map labelling the regions is already included in Figure 1b. It is rather small, and we will make it larger in the revised manuscript. The Figure 5 caption will be changed to reference this map.

Line 9 It would be useful to note which regions are included in the 'Northern' and

'Western' cluster.

Reply: The text will be amended to list the regions (Northumbria, Yorkshire, South-West, Welsh, North-West, Solway, Clyde, Forth, Tweed)

Page 17 Line 7 The presentation of this information to any user does not inherently alert them to anything. If they perceive the information (both the most likely possibility and the full range) to be trustworthy and if they are able to justify making (or changing a from normal protocol) a decision based on that information, then I can justify the use of alert in this context. I would suggest, in an over simplistic manner, what the presentation of the full range of scenarios does – presents the full range and the mean. This could be useful and interesting (and then, maybe advantageous) for a user but only if it is perceived to be relevant by them. Also this sentence uses the phrase 'presentation of the full range of scenarios' twice, so I would suggest re wording even if the above suggestion on content is not followed

Reply: This is useful feedback. The text will be modified to say "Continued presentation of this full range of flow scenarios for the coming 1- and 3-months may be advantageous in that it informs water managers, not only of the most likely possibility, but also to the range of possibilities."

Page 17 Line 14-16 Although the section notes recommendations will be included, I do not find any except for a weak statement regarding how an increase in spatial resolution could lead to improvement. This is not a new finding and I would consider reflecting on the content of the paper to develop recommendations that are more relevant.

Reply: This is a good point. An additional short paragraph will be added to provide recommendations: "Based on the skill analysis presented here, users of the Hydrological Outlook UK would be advised to have greatest confidence in Autumn and Winter flow forecasts that use GloSea5 rainfall, particularly at the 3-month lead time. For Spring/Summer flow forecasts, use of an ensemble forecast based on historical rainfall is surprisingly good and would be recommended for use across Scotland, and flow

forecasts based on persistence were found to be the most skilful in South-East regions (Thames, Anglia, Wessex and Southern)."

It may be interesting to explore the role of ENSO. Referencing 4.3.5 of van Oldenborgh et al 2005, there is potential for some skill from ENSO for parts of the UK, including Scotland. Noting the skill in Scotland (figure 3), it could be a useful exercise to disaggregate by ENSO phase both in the target month and in the month of forecast issuance. Jan van Oldenborgh, G., Balmaseda, M. A., Ferranti, L., Stockdale, T. N., & Anderson, D. L. (2005). Did the ECMWF seasonal forecast model outperform statistical ENSO forecast models over the last 15 years? Journal of climate, 18(16), 3240-3249. Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2017-154, 2017.

Reply: This is an interesting link to make, thank you for the reference. This approach may well be worth exploring in another piece of work, but is beyond the scope of the current manuscript.