Earth Syst. Sci. Data Discuss.,
doi:10.5194/essd-2015-38-AC3, 2016

Open Access Earth System Science Data Discussions

Interactive comment on "Observational gridded runoff estimates for Europe (E-RUN version 1.0)" *by* Lukas Gudmundsson and Sonia I. Seneviratne

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Received and published: 19 April 2016

We would like to thank Christel Prudhomme for the open and overall positive rating of our manuscript and the associated data product. In the following we provide point by point answers to her comments. For the sake of clarity we first repeat the reviewer's comments (*in italic*) and then provide our response.

Comment 1:
The paper describes the development of a monthly gridded runoff time series for Europe generated from river discharge observational network using machine learning statistical techniques. The paper is well written, in particular the method, quality checks and cross validation sections. The product is made available free of charge and will be a great asset to the scientific community. Impacts can range from improving hydrologi-

cal process understanding to hydrological model calibration.

While I very much like the paper and welcome its publication, I have one major concern and therefore suggest a major revision. Below are also some additional specific points that would benefit being addressed.

Reply 1:
Thanks a lot for the overall positive rating as well as the constructive criticism. This did motivate us to revise aspects of our analysis as detailed below.

Comment 2:
My main concern relates to the treatment of 'values with more than 10 consecutive equal days' [which could be re-worded as 'periods with more than 10 consecutive days with equal values']. As pointed out by the other reviewers, such periods could be legitimate, especially during the summer in arid regions and in the winter in high altitude/high latitude regions when flows are null, describing non perennial rivers. Flagging those periods as suspect and then to missing data effectively removes any non perennial rivers from the dataset. This might have two consequences: first, the resulting sub-sample used for the rest of the analysis to be biased towards higher runoff; second to reduce the density of stations in those regions and hence increase uncertainty. In fact the authors themselves acknowledge that uncertainty in the generated runoff is largest in arid regions – which coincides with regions with the largest proportion of 'suspect'/ missing data. One alternative is to change the criterion to ONLY remove those data points when consecutive equal values DIFFERENT from zero are recorded. This is likely to increase the used sample in particular in southern Europe and the Iberian Peninsula and to overall improve the accuracy of the generated runoff. More discussion about the setting up of missing data and the consequence for the estimated runoff should be provided as this also is the same as where performance is worse, e.g. for southern Europe.

Reply 2:

We acknowledge that our initial decision to flag episodes with more than 10 consecutive zero values as “suspect” may have introduced a “wet bias” in our data set. Therefore we are currently working on a refined observational basis, following the reviewers suggestion.

In addition we will relax some of the data availability criteria to allow for a more dense observational basis in arid regions.

Comment 3:
Specific points:

- Page 2, line 15: the authors should give a value of what is a ‘relatively small catchment;

Reply 3:
We will mention that catchments with an area $\leq$ 500 km^2 were considered.

Comment 4:
- The authors should justify the rationale from producing a monthly runoff product from daily river discharge: why not daily runoff? If monthly runoff is the only scientifically robust product, why have the authors limited their sample to daily river discharge time series, excluding monthly time series? Those could help increase gauged density and ultimately increase the accuracy/ reduce uncertainty in the monthly runoff estimates. This might be particularly beneficial for regions/ periods where fewer daily time series are available.

Reply 4:
Thanks a lot for this comment, which motivated us to also consider monthly data provided by the GRDC. We are currently working on incorporating these in the presented data product and will provide details in the revised version of the article.

Comment 5:
- P5, line 26: ‘very likely missing’ is a new terminology not defined in the text

Reply 5:
We will remove ‘very likely missing’ from the text.

Comment 6:
- Section 5.2.2. It would be good if the authors could provide range of error measures associated with good/poor performance. This would help with the interpretation of fig 8

Reply 6:
We will include the theoretical range of the considered performance metrics in the text.

Comment 7:
- Section 5.3.2. The authors should provide the range of standardized runoff anomalies corresponding to drought periods

Reply 7:
We deliberately did not choose drought periods according to fixed thresholds but did present the anomaly maps for events that are well documented in the scientific literature. Note also that a detailed drought assessment is beyond the scope if ESSD.

Comment 8:
- Fig11, 4, 5: dots are very small and difficult to see. Please increase the size e.g. to that of fig2

Reply 8:

1. There is no Fig 11 in the manuscript
2. Figure 2 is designed to be a single column figure and we find that using two columns would be excessive.
3. We will consider to reformat Fig 5.

4. Reviewer #2 suggested to provide high-resolution versions of the figures in the supplementary information. This might resolve this issue.

Comment 9:
Fig 3, 4, 5, 10: the continuous colour bars make it very difficult to distinguish the different colours. A larger palette, for example with more pale colours, might work better

Reply 9:

1. We will consider to replace "continuous" colour scales with categories if appropriate.

Comment 10:
- Fig9 legend is not colour-blind friendly

Reply 10:

1. The first panel (mean annual runoff) is colour-blind friendly according to http://colorbrewer2.org/ (see "diverging" colour scales).
2. We acknowledge that the two other panels may be difficult to read for colour blind people. As the colours represent the 12 calendar months we opted to choose colours along the colour wheel to emphasise that "December" and "January" are similar. We are open for concrete suggestions for alternative (colour blind friendly) colour scales.

Comment 11:
- Fig 8: it would be good to have the same colour tone for 'good' performance. At the moment it is difficult to quickly compare the different maps

Reply 11:
For all metrics except "BIAS" high values indicate good performance. We will make this clear in the revised article.

Comment 12:
- Maps of fig 5, 8., 9 and 10 are too small and difficult to read. We will try to enhance the readability of the maps in the revised article.

Comment 12:
- Fig 6 : there is a lot of season-to-season variability in the number of spatial information time series. For me this is a spurious consequence of setting up missing data to rivers with no flow. This does not look right and requires an explanation; I think this justifies exploring a new criteria for instrument failure / equal values records.

As mentioned above we have revised the QC criteria according to your suggestions.

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