Response to Reviewer #1

General comments

The authors implemented and evaluated the performance of a bias-correction and spatial-disaggregation (BCSD) approach to seasonal precipitation, temperature and radiation forecasts of the latest long-range seasonal forecasting system SEAS5/ECMWF. The method was applied in four different semi-arid basins of the World: the Karun (Iran), the São Francisco (Brazil), the Tekeze-Atbara and Blue Nile (Sudan, Ethiopia and Eritrea), and the Catamayo-Chira (Ecuador and Peru).

The proposed approach was compared to the ERA5-Land/ECMWF and outperformed it in terms of spatial resolution (from 36 km to 0.1◦) and spatial patterns agreement. Also, according to their results, it remarkably reduced lead-dependent drift effects. It would be important to have an idea of the proposed approach relative performance to systems that are available for those regions, but I recognize the amount of work this would demand. Thus, I only suggest the authors to include in their paper a brief comment on the information available to water managers in these four regions. I commend the authors to made freely available the SEAS5 BCSD forecasts (from 1981 to 2019) to the public through the World Data Center for Climate (WDCC), which is hosted by the German Climate Computing Center (DKRZ) in Hamburg, Germany.

My main concern about this paper is not on the method itself, since that was clearly demonstrated its improved performance relative to the competing method, but it is on the raised constraints to the usefulness of seasonal forecasts, particularly in developing countries. The authors point out that there are, based on the literature, different reasons for the effectiveness usefulness, among them: 1. proper communication and application of these forecasts (White et al., 2017); 2. credibility, legitimacy, scale, cognitive capacity, procedural and institutional barriers, and available choices (Patt and Gwata, 2002).

However, the problem goes far beyond these issues:

1. *Too much emphasis on the infrastructure solution, which overshadows the importance of preparedness, for example, contingency plans for specific sectors. The focus on developing countries is on the increase of the water supply, but little, or none, effort is undertaken on demand management;*
2. *There is an institutional challenge in terms of the need for more collaboration among institutions, in particular, when they belong to different levels of administration. Most institutions operate the same way when they were created and they have to face new challenges (environment, society, ...);*
3. *The water management system does not reach the local level, even this impacting the large management systems. In some regions the density of small (unmonitored) dams is of the order of 0.6 dams/km2. At this scale, farmers use water as long as it is available. When water is no longer available, they look for new sources. There is an urgent need for rethinking the water governance at this level: more engagement of municipalities and local communities is necessary. In my opinion, the key for disaster preparedness and adaptation is governance at local level, in particular, in dealing with extreme events.*

I would add to this list that is key to understand the decision-making process for these basins: What is the decision calendar in these basins? What decisions are made and on what basis? What

information has the potential to be used for the studied basins (depending on the water system, the interest in the forecast is specific)? How could the information produced be incorporated? Another point, is the forecast issued in a moment compatible with this decision calendar (in some systems this is simply not possible)? It would be important to include a discussion on these points for these basins. In my view, the promise of the usefulness of seasonal forecasts has been largely due to not trying to answer these questions before designing the information system based on seasonal forecasts.*
In my view the topic is of interest of reader of ESSD and the paper does represent a significant contribution for this journal. However, since the authors highlighted the constraints in the effective usefulness of seasonal forecasts, I stress the importance in introducing some discussion on the points raised by this reviewer.

**Note: It may be necessary the combination of scenario drawing in the moment the decisions are made and revisit such decisions in the moment the climate forecast system can provide useful information to the water sector.*

Reply: We would like to thank the reviewer for the generally positive feedback for our study. Furthermore, we highly appreciate the constructive and thoughtful comments about the usage and transfer of seasonal forecasts into practice.

First of all, we would like to acknowledge the reviewer's comment that we should at least mention similar products and initiatives in our manuscript. We fully agree and will add such a list including global initiatives like the WMO Long-Range Forecast Multi-Model Ensemble (https://www.wmolc.org), the North American Multi-Model-Ensemble (NMME, https://www.cpc.ncep.noaa.gov/products/NMME/), the C3S Seasonal Forecasts (https://climate.copernicus.eu/seasonal-forecasts), and the International Research Institute for Climate and Society (IRI, https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/) as well as regional initiatives like the forecasts from the IGAD Climate Prediction and Application Centre (ICPAC, https://www.icpac.net/seasonal-forecast/) or the EURO-Brazilian Initiative for improving South American seasonal forecasts (EUROBRISA, http://eurobrisa.cptec.inpe.br) and a short discussion to our paper. With respect to a quantitative comparison of our forecasts with such products, we have to state that this is extremely difficult as particularly ensemble-based categorical forecast highly depend on several fundamental aspects (e.g., which "baseline-period" and reference products were used for defining the climatology? which thresholds were used for defining categories? how were the forecasts from different issue dates combined?). Thus, we should rather aim at a qualitative comparison (e.g., did both systems predict a dry or wet month? what was the probability of > 300mm of rainfall?). This, however, would be a comprehensive study on its own and is something that we are already looking into.

Furthermore, we also agree that there are many other issues with respect to the usefulness of seasonal and longer-term forecasts particularly in developing countries. But, at the same time, we must state that finding solutions for these issues are far beyond the scope of this study as this is first and foremost a scientific publication about a dataset and, hence, would not be the right place to discuss fundamental challenges in the practice transfer of seasonal forecasts.

Especially the three additional issues that the reviewer defines require substantial societal and administrative reorganization of the water sector. We have also experienced conflicts between authorities and institutions in our target regions by ourselves, which often make a direct and efficient collaboration difficult. Furthermore, with respect to a sustainable transfer of such forecasts

into practice, we would have to put a lot of effort in the education and coordination of potential end-users of such information as well as in the definition of well-coordinated action plans, that are approved by various local stakeholders.

All these challenges cannot be addressed in such a technical manuscript. However, one aspect, that was communicated during the various meetings we had in the target regions, is the lack of tailored regional and freely available seasonal forecasts as well as an introduction in the handling with such ensemble-based information. While there are several global products available, most of these products are “raw” forecasts and still require a lot of post-processing in order to fulfill the demands allowing to serve as a decision-support for local water management. Due to the lack of computational resources, an insufficient experience with the treatment of large ensemble forecasts, a limited bandwidth for the download, and other reasons, this post-processing is often a major obstacle for many institutions in developing countries.

Hence, this particular step was done in this study by obtaining a long period of global re-forecasts from ECMWF and applying a bias-correction and spatial disaggregation for improving the spatial resolution and making the forecasts consistent with a state-of-the-art reference product. Moreover, the SEAS5-BCSD-forecasts, can be (and already are) freely accessed and used directly for deriving probabilistic forecasts for e.g., extreme warm or wet conditions and other forecast quantities, which are required for the day-to-day water management. In that sense, we think that our and similar products are an important contribution towards an improved governance of the water sector in developing countries.

The reviewer also mentions that any newly developed decision-making system has to take the decision-making process in the basins into account. Again, we completely agree with these points and can confirm that regionalized forecast quantities (e.g., drought indicators, categorical forecasts, etc.) have to be consistent with local conditions and needs. And these requirements can only be identified in consultation and close iteration with local water experts.

We also acknowledge that there is a gap between the scientific developments in seasonal and longer-term forecasting during the recent years and the efforts to bring this information to authorities and institutions particularly in developing countries, where such forecasts could be crucial for an improved and more sustainable water management. We therefore hope that our dataset and publication are a small step for overcoming this gap.

To conclude, we fully agree with the concerns raised by the reviewer. As these are important challenges that have to be addressed for ensuring a successful transfer of such newly developed products into practice, we will include a dedicated part in the discussion.