Review of Hoch et al. (2022) ‘Hyper-resolution PCR-GLOBWB: opportunities and challenges of refining model spatial resolution to 1 km over the European continent’

This manuscript aims to evaluate the 1 km PCR-GLOBWB model along with the challenges and opportunities associated with running the model at such finer scales. Further, the study also tests the effect of the spatial resolution of forcing datasets on model simulations. Overall, the manuscript is well written and fits within the scope of the journal.

I am not well acquainted with global hydrological modelling and some questions come to my mind automatically on reading the manuscript. The authors are requested to include answers (from their own perspective and based on what is available in the literature) to these questions in the introduction/discussion sections of the manuscript for improved understanding of readers like me.

- What spatial extent constitutes a global hydrological model? Is the continental scale as given in the present study can be treated global? This question arises because of the statement that few studies have attempted hyper-resolution modelling over CONUS, but they do not have global coverage. In a strict sense, why can’t this study be termed as a continental scale application?
- The major issue in hyper-resolution modelling is modelling the physical processes happening at smaller scales. When developing a hyper-resolution model over large spatial extent, the physical processes to be considered would vary from region to region. How to account for the spatial variation in physical processes in the model? Can a generic model be applied over the entire continent/globe without accounting for region specific physical processes? Or how to develop model which can consider automatically, the various hydrological processes appropriate for a region within the model domain?
One reason that is often mentioned as an advantage of hyper-resolution modelling is the ability to simulate hydrological processes over data scarce regions. If data scarcity prevents us from developing a detailed model over a particular catchment, then how can we be confident about the processes simulated by a global model over such data scarce regions? Further, in hydrology, studies are there to demonstrate the transfer of information obtained over a data-rich region to a data scarce region with similar characteristics. How global hyper-resolution modelling will add value to the existing methods in understanding the processes over data scarce regions?

On a similar note, is it possible to develop a nested model structure that is followed in numerical weather modelling? i.e., develop coarse resolution model over large region and the outputs of this would act as boundary conditions of a nested model over a smaller spatial extent but at a much finer spatial resolution.

Can the authors throw some light on the improvements to be made on the numerical aspect of the models? i.e., how to improve the efficiency of the models through novel and recent numerical schemes? This might save time during model runs.

Why can't the 1K model be validated on a grid-by-grid basis using the available high quality in situ observations even for a smaller time period? For example, soil moisture and ET can be validated using in-situ datasets. Further, for soil moisture, comparison can be made against SMAP data that are available at relatively higher spatial resolutions than the ESA-CCI data? Similarly, for ET too, comparison can be made against available high-resolution products such as MODIS 16 ET, PML-V2 product (Zhang et al., 2019) etc. This can be useful to test if the model is really performing in a hyper-resolution manner. At present, I feel the model evaluation is not rigorous enough.

References: