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Implementation of a gridded river routing scheme for land surface models and evaluation of streamflow simulations across Australia

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Abstract: The Australian Bureau of Meteorology provides hydrological forecasts and projections at various timescales, including near real-time, short-term, seasonal, and long-term across Australia (www.bom.gov.au/water/). As part of the ongoing research and development efforts, the Bureau sets out a vision to incorporate an improved gridded hydrological model in a whole of earth system modelling approach, including surface routing. This sets a path to seamless hydrological analysis and prediction capabilities at various spatio-temporal scales.

This study focuses on implementing a river routing model to improve the representation of rivers and their role in the gridded hydrological models. We implement the global Catchment-based Macro-scale Floodplain (CaMa-Flood) (Dai et al. 2011) hydrodynamic model for land surface models across Australia at a range of spatial resolutions. Through routing runoff outputs from two configurations of JULES (BARRA-R2 and JASMIN), AWRA-L and ERA5-Land, we investigate the performance of the three models for simulating daily and monthly streamflow. We also examine the influence of spatial resolution, meteorological forcing as well as the topographic and hydro-climatic conditions of Australia. For the streamflow evaluation, more than 460 high quality hydrological reference stations (HRS) (Amirthanathan et al. 2023) across Australia have been considered.

Preliminary results suggest that streamflow simulations based on global configurations of CaMa-Flood perform reasonably well for perennial catchments while the performance is lower for intermittent and ephemeral catchments. Assessment of simulated streamflow in various natural resource management (NRM, https://www.climatechangeinaustralia.gov.au/en/overview/impacts-and-adaptation/nrm-regions/) clusters indicate that high model performance is achieved across northern Australia (particularly the monsoonal-driven regions and wet tropics) and along its east coast. However, the performance is low in the Rangelands and Southern and South Western (SSW) Flatlands. In terms of the evaluation timescale, better performances are observed at the monthly timescale for all the verification metrics compared to the daily data. Model intercomparisons suggest that BARRA-R2, JASMIN and AWRA-L perform reasonably well for high flows, however, BARRA-R2 generally overestimates low flows. On the other hand, ERA5-Land perform reasonably well for low flows while overestimating the higher flows. These differences in the performances of the models could be attributed to the differences in the modelled runoff generation, as well as variations in the meteorological forcing.

Future improvements will include better representation of the river network with higher resolution Digital Elevation Model (DEM), implementing surface- and groundwater interactions, as well as improvements in the runoff generation for the land surface model, particularly JULES.

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