Efficient high-resolution climate simulations for Western Australia: optimising domain design and resource allocation

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Abstract: The Climate Science Initiative (CSI), established in 2021 by the Western Australian Government Department of Water and Environmental Regulation (DWER) in partnership with Murdoch University, the Pawsey Supercomputing Research Centre, and the New South Wales Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), delivers high-resolution climate projections for Western Australia extending to 2100.

This study optimises regional climate simulations using the Pawsey Supercomputing System, focusing on a refined domain covering southwest Western Australia. By implementing one-way nesting via ndown method, cropping the coarse domain data to WA only, we also ensure consistent dynamics and improved representation of local atmospheric processes. The computational time is reduced to half resource requirement while compared to the standard two-way nesting. Storage efficiency is also improved by saving cropped AU-18 domain data, reducing disk usage by approximately 50%.

CSI has produced the most up-to-date regional climate projections for the state by dynamically downscaling Global Climate Models (GCMs) from the Coupled Model Intercomparison Project phase 6 (CMIP6) to 4 km resolution using the Weather Research and Forecasting (WRF) model. We dynamically downscaled five CMIP6 GCMs using two WRF configurations for the southwest of Western Australia. These Simulations require 52.6 million service units (MSU) and 1.36 petabytes (PB) of storage, with runtimes of 5–14 months. For CSI phase 2, i.e. northwest Western Australia, the compute and storage demands are increased to 465 MSU and 1.84 PB respectively, while postprocessing tasks add 14.7 MSU, with memory-intensive jobs requiring up to 980 GB. The total postprocessed data storage ranges from 1.5 to 3.2 PB. Our modelling methodology enhances computational efficiency, enabling precise climate projections that support scalable impact assessments and inform resource allocation for regional climate modelling in Western Australia.

Simulations are evaluated against the Australian Gridded Climate Data (AGCD) product over the period 1951 to 2014. Results show that WRF significantly reduces precipitation biases along the coast of WA, especially during winter, as well as minimum temperature biases in all seasons across the domain as compared to the driving GCMs. Reductions in maximum temperature biases were generally limited to coastal areas. We will also present a preliminary analysis of future projections under SSP1-2.6 and SSP3.70 (2015 to2 100) for the region.

