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Developing a high-resolution regional atmospheric reanalysis for Australia

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A dynamically consistent, long-term atmospheric reanalysis can be used to support high-quality assessments of environmental risk and likelihood of extreme events. Most reanalyses are presently based on coarse-scale global systems that are not suitable for regional assessments in fire risk, water and natural resources, amongst others. The Australian Bureau of Meteorology is currently working to close this gap by producing a high-resolution reanalysis over the Australian and New Zealand region to construct a sequence of atmospheric conditions at sub-hourly intervals over the past 25 years from 1990.

The Australia reanalysis consists of a convective-scale analysis nested within a 12 km regional-scale reanalysis, which is bounded by a coarse-scale ERA-Interim reanalysis that provides the required boundary and initial conditions. We use an unchanging atmospheric modelling suite based on the UERRA system used at the UK Met Office and the more recent version of the Bureau of Meteorology's operational numerical prediction model used in ACCESS-R (Australian Community Climate and Earth-System Simulator-Regional system). An advanced (4-dimensional variational) data assimilation scheme is used to optimally combine model physics with multiple observations from aircrafts, sondes, surface observations and satellites to create a best estimate of state of the atmosphere over a 6-hour moving window.

This analysis is in turn used to drive a higher-resolution (1.5 km) downscaling model over selected subdomains within Australia, currently eastern New South Wales and Tasmania, with the capability to support this anywhere in the Australia-New Zealand domain. The temporal resolution of the gridded analysis fields for both the regional and higher-resolution subdomains are generally one hour, with many fields such as 10 m winds and 2 m temperatures available every 10 minutes. The reanalysis also produces many other variables that include wind, temperature, moisture, pressure, cloud cover, precipitation, evaporation, soil water, and energy fluxes.

In this presentation, we report on the implementation of the Australia regional reanalysis and results from first stages of the project, with a focus on the Tasmanian subdomain. An initial benchmarking 1.5 km data set – referred to as the 'Initial Analysis' – has been constructed over the subdomains consisting of regridded and harmonised analysis and short-term forecast fields from the operational ACCESS-C model using the past 5 years (2011-2015) of archived data. Evaluation of the Initial Analysis against surface observations from automatic weather stations indicate changes in model skills over time that may be attributed to changes in NWP and assimilation systems, and model cycling frequency. Preliminary evaluations of the reanalysis across Tasmania and its inter-comparisons with the Initial Analysis and the ERA-Interim reanalysis products will be presented, including some features across the Tasmanian subdomain such as means and extremes of analysed weather variables.

Finally, we describe a number of applications across Tasmania of the reanalysis of immediate interest to meteorologists, fire and landscape managers and other members of the emergency management community, including the use of the data to create post-processed fields such as soil dryness, tornados and fire danger indices for forest fire danger risk assessment, including a climatology of Continuous Haines Index.