

Development of a Convective-Scale Numerical Weather Prediction Ensemble Encompassing Australia: ACCESS-AE

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1. Introduction

The Bureau of Meteorology is developing its next generation km-scale numerical weather prediction system, which covers all of Australia. This national domain consolidates the current seven smaller domains over the most populated areas of the country. The system contains a deterministic model with a horizontal grid spacing of 1.5 km called ACCESS-Australia (ACCESS-A) and a 12-member ensemble with a horizontal grid spacing of 2.2 km called ACCESS-Australia Ensemble (ACCESS-AE) – the focus of this article. A variable resolution horizontal grid is used on the edge of the domain, with the total number of horizontal grid points equal to 2524 x 2088. A 4 km horizontal grid spacing is used at the boundaries before the spacing is reduced to 2.2 km in the inner region, denoted by the orange rectangle in Figure 1A. There are 90 vertical levels with a 40 km model top. ACCESS-A and ACCESS-AE use the Regional Atmosphere and Land (RAL) version 3.2 science configuration of the Unified Model (Bush et al. 2024). The ACCESS-AE initial and lateral boundary conditions are provided by the global ensemble system.

2. Early Testing Results

An 8-day Austral summer trial has been conducted with two runs per day (00Z and 12Z basetimes) from December 10 through December 17, 2023. Tropical Cyclone Jasper was one of the major weather phenomena impacting Australia during this period. TC Jasper formed in the Coral Sea, deepening to Category 5 on December 8, 2023. By the time the system made landfall on December 13, it had weakened to Category 2. After landfall, it quickly weakened below TC intensity, however the ex-TC system stalled over the Cape York Peninsula for several days with 5-day rainfall totals exceeding 2000 mm recorded at 3 stations (Prasad, 2024).

Precipitation forecasts from a sub-domain over far north Queensland (Figure 1A, red rectangle), the region impacted by TC Jasper, have been verified against radar/rain gauge blended quantitative precipitation estimates produced by Rainfields (Seed et al., 2007). The observations were regridded onto the ACCESS-AE grid for the analysis. Figure 1B presents the 6-hourly precipitation accumulation Relative Operating Characteristic (ROC) Curves for 100 mm (solid blue) and 75 mm (dotted red) thresholds, with the Area under the Curve (AUC) for both thresholds shown in the bottom right corner. The results show that the ensemble was able to discriminate between events and non-events for these 6-hourly rainfall accumulations, with the AUC exceeding 0.8 for both thresholds, which is considered a good result. Fractions Skill Score (FSS) analysis over the tropics has also been performed (not shown) against Integrated Multi-satellite Retrievals for Global Precipitation Measurement (IMERG) version 6 (V06) level 3 product (Huffman et al., 2020) with the ensemble found to have skill at spatial scales of ~ 50 km and above for 6 hourly rainfall amounts up to 12 mm.

For the near-surface weather evaluation, hourly screen temperature, dewpoint temperature, 10 m instantaneous winds and wind gusts have been verified. The 1.5m temperature generally has a good spread-skill ratio (the ratio between the ensemble spread and error spread) although there are some regional differences. The average root mean square errors (RMSEs) tend to be larger for the central (~2.3C) and north-western (~2.5C) parts of

the country, with a more pronounced diurnal cycle. Gusts tend to be biased slightly high overall, with the highest bias generally in the early afternoon.

Additional trial periods will be run for ACCESS-AE including an Austral winter period. Verification of these results will assist in understanding if the skill of the temperature forecasts in the arid regions of Australia are consistently poorer than in other regions for example. Individual high impact weather events, such as tropical cyclones, severe thunderstorm outbreaks, fire weather and fog, are also being evaluated. Future development work will assess impacts on the ensemble skill and spread if the initial conditions are centered an ACCESS-A high resolution analysis, in addition to testing a time-lagged ensemble, increasing the ensemble size and running for longer than 48 hours.

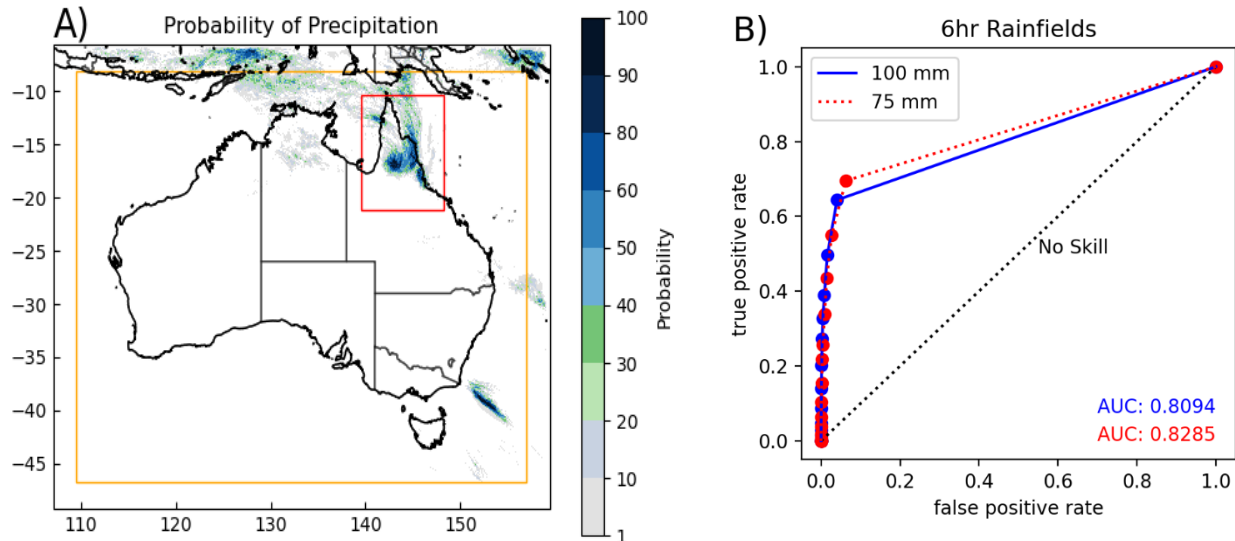


Figure 1: A): Probability of Precipitation exceeding 20 mm in 6 hours for an 18-hour forecast, valid 2023-12-15 21Z. The image shows the full ACCESS-AE domain. The orange rectangle indicates that start of the uniform inner core of the grid. The red rectangle represents the ROC Curve verification subdomain. B): ROC Curves for two thresholds: 100 mm (solid blue) and 75 mm (dotted red). The AUC for each threshold is also shown.

References

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