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Seamless Hourly Rainfall Ensemble Forecasts for 0 – 10 days

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The Australian Bureau of Meteorology uses a number of Numerical Weather Prediction (NWP) models to generate deterministic rainfall forecasts over a range of lead-times, each with a different resolution in space and time and with different forecast domains. High resolution regional NWP models are used to generate forecasts for the first three days, and are typically more accurate than lower resolution Global NWP models that produce forecasts for longer lead times. Consequently, there is a requirement for a seamless forecast system that is able to blend the various NWP forecasts into a single forecast with a uniform resolution over the entire forecast period. NWP rainfall forecasts contain errors at scales that are significant for even large river basins, and ensemble hydrological prediction systems require ensembles of the order of 100 members, which is well beyond the size that can be generated by NWP ensemble systems. The idea, therefore, is to blend the NWP models in such a way that recognises the skill of the NWP at a particular scale and lead time and to use a stochastic model of forecast errors to perturb the blended deterministic forecast to generate a large ensemble.

NWP uncertainties are scale and forecast lead time dependent, especially at long forecast lead times, and are characteristic to each model. By blending the models scale by scale it is possible to recognise the increased skill of the models at larger spatial scales and shorter lead times. The stochastic model is applied at each scale, adding increasingly more variability at smaller spatial scales, while preserving the space-time structure of rain. This process allows an ensemble to be generated by blending deterministic forecasts.

Two NWP models from the Bureau, ACCESS-G (Global) ($\sim$40 km by $\sim$40 km, 3 hourly out to 10 days) and ACCESS-R (Regional) ($\sim$12 km by $\sim$12 km, 1 hourly out to 3 days), are downscaled and blended with the stochastic model to produce an ensemble of hourly forecasts out to 10 days. A 50 ensemble is output a 2 km by 2 km grid, over 1000 km by 1000 km domains.

A year of ensemble forecasts (accumulated to daily rainfall totals) have been verified against the daily Australian Water Availability Project (AWAP) analyses (0.05 degree x 0.05 degree resolution) that are based on an interpolation between rain gauges and show the system is able to produce reliable forecasts out to 5 days over these domains with appropriate ensemble spread.