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BRAIN: building a national, hourly, kilometre-scale precipitation analysis product for Australia

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Abstract: High-resolution precipitation products are important for hydrometeorological applications such as extreme weather monitoring and flood forecasting. In Australia, early efforts have produced national precipitation products at monthly and daily scales, such as the Australian Gridded Climate Data (AGCD v2, monthly, 1 km) (Evans et al. 2020) and AGCD v1 (formerly known as the Australian Water Availability Project (AWAP), daily, 5 km) (Jones et al. 2009), primarily based on interpolation of daily gauge observations. However, the number of sub-daily gauges (~2000+) is substantially lower than daily gauges (~5000+) (Bureau of Meteorology, 2025), and sub-daily precipitation exhibits greater spatial and temporal variability, making interpolation from sparse gauge networks less reliable. As a result, Australia currently lacks an operational national-scale sub-daily rainfall product, leaving a significant gap in high-resolution precipitation data availability.

The NextGen Rainfall Project, led by the Bureau of Meteorology, aims to address this gap by developing improved rainfall reference products for the water industry, including national, hourly, kilometre-scale precipitation analyses and forecasts. This project is initially focused on producing a historical (~2000) to near-real-time gridded precipitation analysis to support operational applications such as flood forecasting, while also providing a foundation for post-processing numerical weather prediction (NWP) forecasts to improve precipitation forecasts. To achieve this goal, multiple data sources are considered for blending to leverage their complementary strengths. Gauge observations provide direct measurements but are limited in coverage; radars offer high-resolution spatial information but are affected by measurement uncertainties and are primarily deployed in densely populated regions; satellites provide broad coverage but may suffer from retrieval errors. Given the distinct and varying uncertainties associated with each data source, we have developed a practical and scalable blending system (BRAIN, Blended Rainfall) based on the optimal interpolation technique, which explicitly accounts for varying uncertainties associated with different data sources. Key components of the BRAIN system also include data source selection and quality control, system implementation, and performance evaluation. Our first version integrating three key data sources from the Bureau of Meteorology: (1) Himawari-based Convective Rainfall Rate from Cloud Physical Properties (CRRPH) satellite rainfall estimates (2-km, 10-min) (Bureau of Meteorology, 2024); (2) Rainfields' calibrated radar estimates (1-km, 5-min) (Bureau of Meteorology, 2022); and (3) sub-daily gauge observations. Trial results (2022-2023) demonstrate promising performance, and ongoing efforts are being made to further enhance system capability and operational readiness.

Keywords: *Precipitation, Multi-source blending, Sub-daily, Kilometre-Scale*

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