A close shave with Occam's razor: managing complexity in a radar rainfall estimation system

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The Bureau of Meteorology is in the final stages of an upgrade to Rainfields, the operational radar quantitative precipitation estimation (QPE) and nowcasting system for the Australian radar network. Radar reflectivity quality control is a key element to Rainfields and includes radar echo identification and corrections for partial occultation, attenuation, and bias due to the vertical profile. The radar reflectivity that is observed aloft is extrapolated to the ground using an anisotropic 3D Kriging algorithm that recognizes the difference between the structure of the reflectivity in the vertical and horizontal and generates a measure for the extrapolation error. Thereafter the surface reflectivity is converted into rainfall using the climatological Z-R relationship for the radar and accumulated over the 6-minute time step.

The Bureau operates a network of 1700 real-time rain gauges that report at 30-minute intervals. The bias at each gauge under a specific radar is updated in real-time using a Kalman filter and a field of adjustment factors for each radar is derived through a Kriging interpolation. Thereafter the multi-radar mosaics are constructed using the error fields that were generated while extrapolating the reflectivity to the surface. The performance of the QPE system is monitored in real-time and summary statistics of QPE error for each radar are generated each month.

Occam's razor, "Everything should be as simple as possible, but not simpler", was major design consideration in the development of the QPE algorithms. In general, simple algorithms are more robust than overly complex alternatives that require large quantities of high quality observations to provide the occasional benefit at the cost of increased computation and parameterization. The least complex option for each stage in the processing chain was investigated first and complexity was only added once it was demonstrated that the more complex algorithms were delivering benefits. The Australian radar network contains 70 radars and Rainfields generates around 4000 products per hour. Therefore a great deal of thought was spent on optimizing the various algorithms for computation speed, which necessarily implied that complexity was kept to a minimum. Not all Australian radars are equal and in general simpler algorithms were assigned to the older radars which did not have the capability to support the more advanced algorithms. This flexibility with the processing chain was made possible by having a system that was highly configurable where both algorithms and parameters could be assigned to a specific radar.

This paper will provide an outline of the Rainfields' algorithms and use them to illustrate the issues of managing complexity in a heterogeneous radar network that covers a continent.