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Hydrologic forecasting and uncertainty research in Australia

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CSIRO is performing research to support the development and improvement of an operational short-term (i.e. <14 days into the future) streamflow forecasting service at the Australian Bureau of Meteorology. This project aims to (1) extend the Bureau's current event based flow modelling for flood prediction to provide continuous flow forecasting through the use of soil moisture accounting models; (2) improve the accuracy of flow and flood prediction at both catchment outlet and internal (ungauged) points through using spatially variable rainfall input; (3) improve forecast accuracy through statistical post-processing and model updating; (4) improve forecast lead-time through using Numerical Weather Prediction products; (5) improve model initializations through the use of blended multi-sensor precipitation estimates; (6) develop practical methods for quantifying forecast uncertainty; (7) develop a hydrological modelling system for providing flash flood guidance; (8) evaluate potential modelling frameworks for upgrading the Bureau's current flood forecasting system. To achieve some of the above goals, CSIRO has developed a modelling application called Short-term Water Information Forecasting Tools (SWIFT).

This talk details the latest progress towards developing SWIFT, its rainfall runoff models, its parameter calibration routines and performance evaluation measures. It also evaluates the ability of the models to simulate historical flow and to use recent simulation errors to keep the simulations on track (i.e. error correction). In addition to the Particle Filter, Ensemble Kalman Filter and the Danish Hydrologic Institute's algorithm for phase-based error correction (as used in the MIKE 11 model), SWIFT offers a novel "dual-pass" method for correcting slowly varying errors in simulations of streamflow. The dual-pass method is ideally suited for catchments with long-lasting shifts in runoff efficiency that the hydrologic model poorly simulates.

In a first pass, the simulation is rescaled (i.e. multiplicative correction is applied), based on the cumulative error over the prior 365 days. In a second pass, a correction is added to the adjusted series, based on the error from the most recent timestep. When tested on 330 Australian and 183 United States catchments, the dual-pass approach improved the median four-measure validation skill score from 0.83 to 0.89 for the GR4J model and from 0.56 to 0.79 for a naïve coefficient model. The majority of improvement comes from the second pass (the short-memory component). The magnitudes of correction at each pass are controlled by two tuneable parameters; a global sensitivity analysis determined that satisfactory performance could be had without tuning of the long-memory (first pass) error-correction parameter. For most catchments, the use of the long-memory error-correction neither degrades nor significantly improves performance. International hydrological modelling datasets have relatively fewer catchments with slowly varying errors than might be encountered in operational forecasting environments, therefore, there is a need for better identification and study of such problem catchments.