

Hydrologic process and error modelling methods for river basin scale prediction and forecasting in Australia

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LAND AND WATER

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Context

Research focus

- Forecasting emphasis
- Operational applications
- Basin scale
- Hours - seasons
- Quantitative predictions and forecasts
- Supporting national services – consistent methods across locations



Australian hydrology

- Very high interannual variability
- Intermittent and ephemeral streams important




What are we trying to achieve?

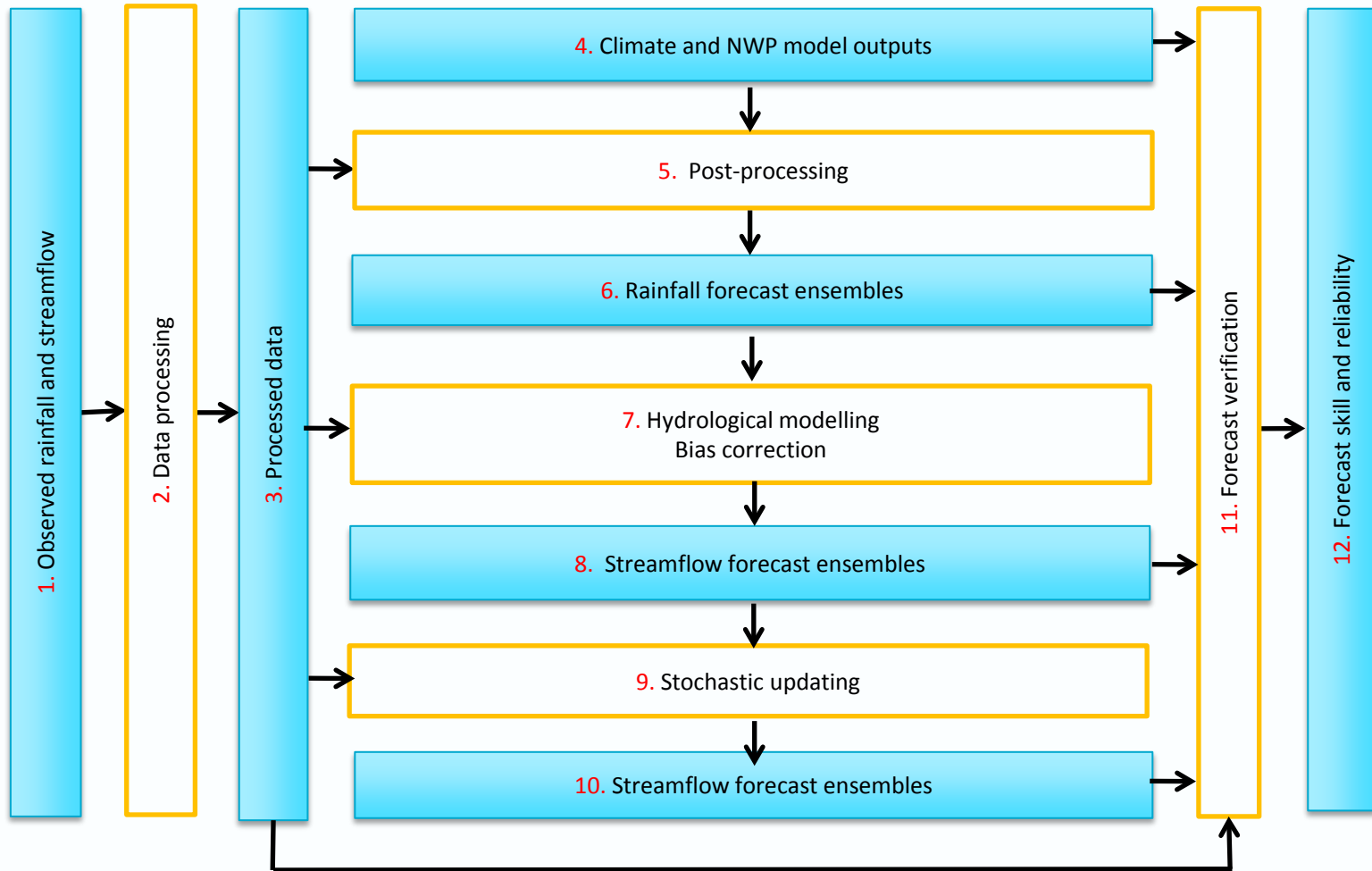
Quantitative ensemble predictions and forecasts displaying:

- Minimal bias
- Accuracy
- Coherence (errors no worse than climatology)
- Reliable uncertainty (ensemble spread consistent with forecast errors)

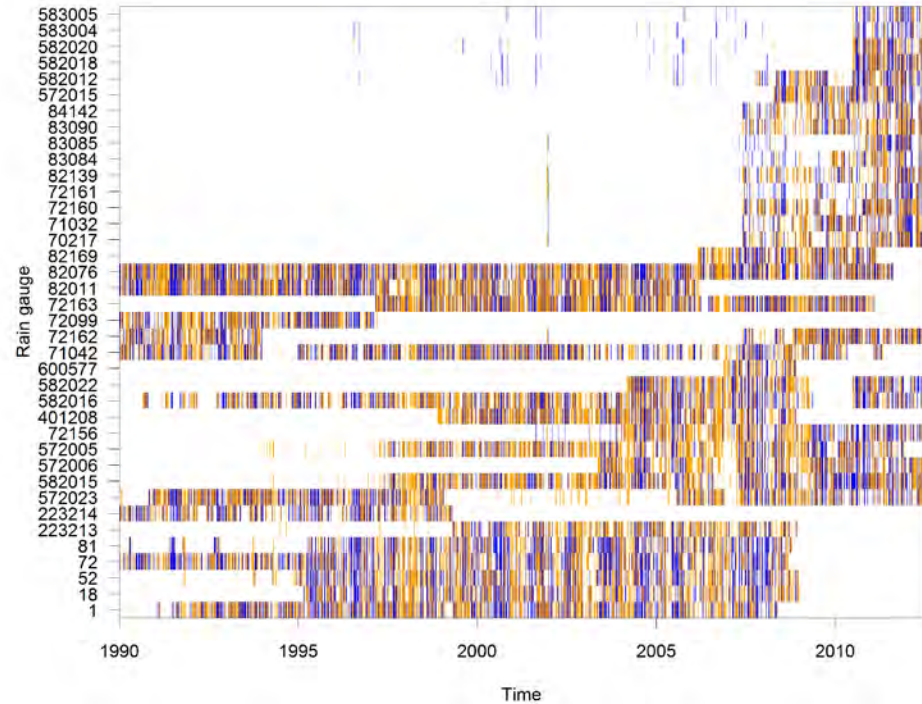
For flood and water resource management applications

- Individual locations and lead-times
 - Spatial and temporal accumulations
 - Realistic ensemble members usable for downstream applications
- 

Ensemble forecasting framework

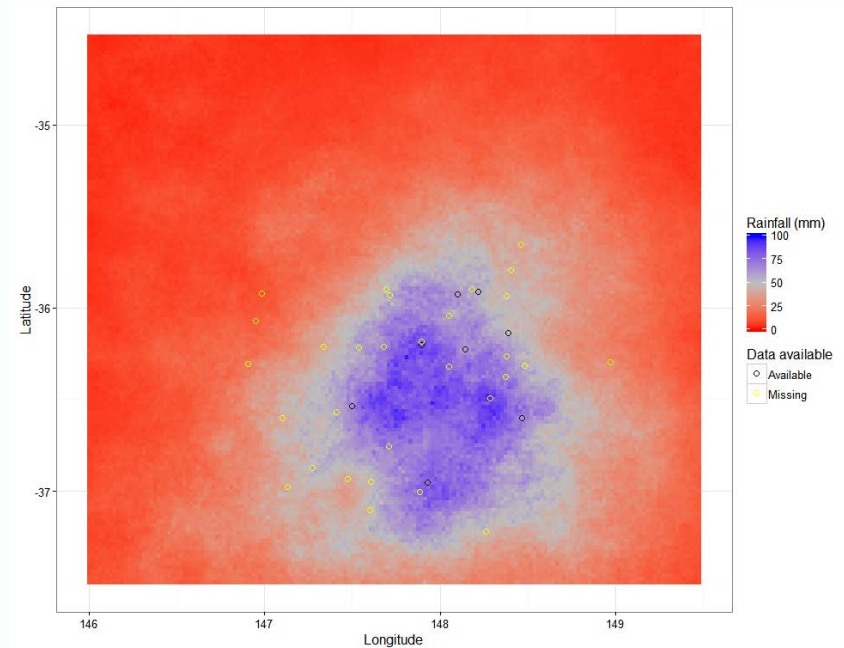


Making best use of available observations



Real-time hourly data

- Missing observations
- Inconsistent observation network
- Spatial characteristics - topography



Data infilling and interpolation

- Bayesian hierarchical model
- Explicit consideration of covariates
- Infill missing data with ensembles
- Ensemble interpolation to catchment and rainfall fields
- Locally consistent rainfall for hydrological modelling

Extracting signal from weather and climate predictions

Raw forecast challenges:

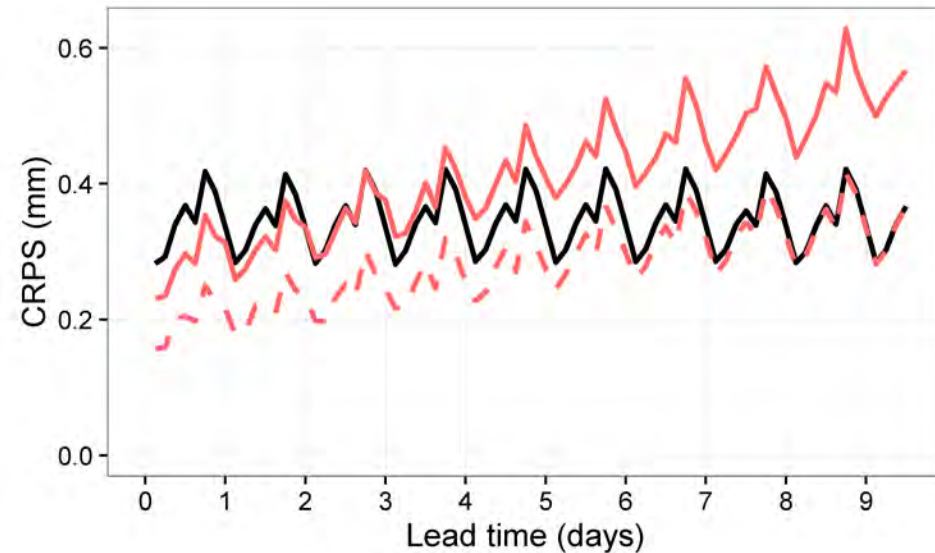
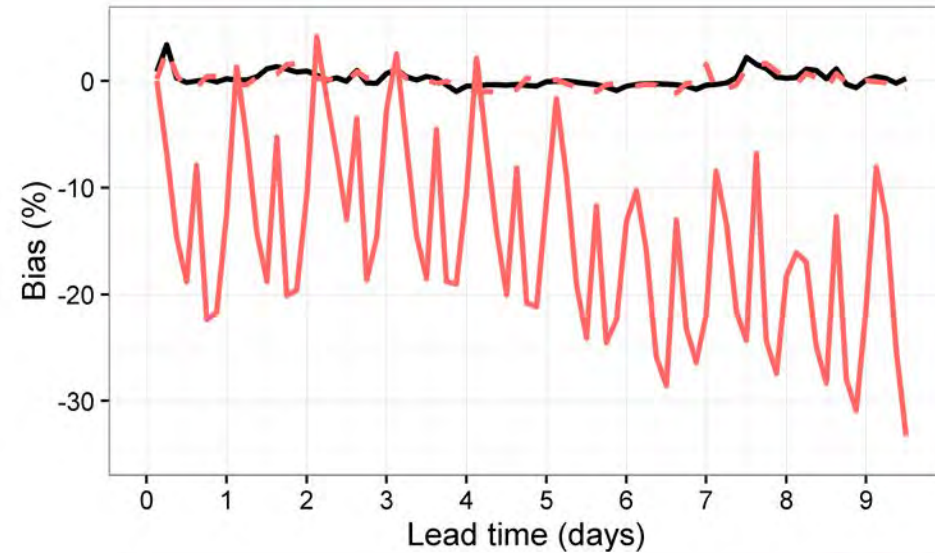
- Bias
- Coherence
- Reliability

Model output statistics style post-processing:

- Reduces bias
- Ensures coherence and reliability

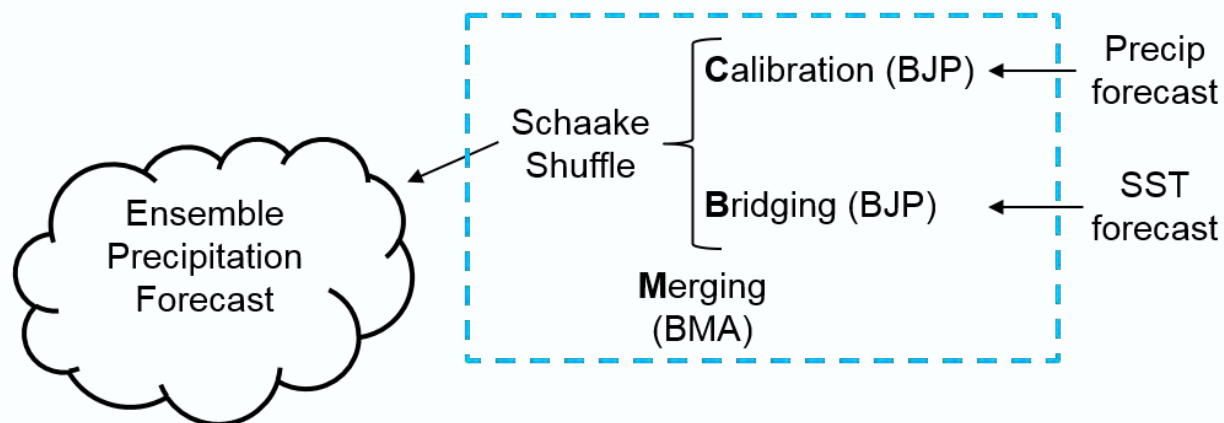
Australian technology combines:

- BJP statistical model
- Schaake shuffle – space-time correlations
- Other predictors for seasonal forecasts

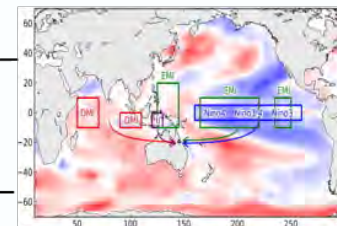


Getting the best seasonal precipitation forecasts

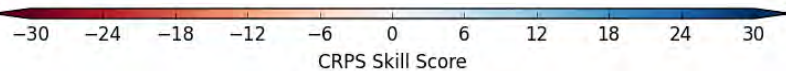
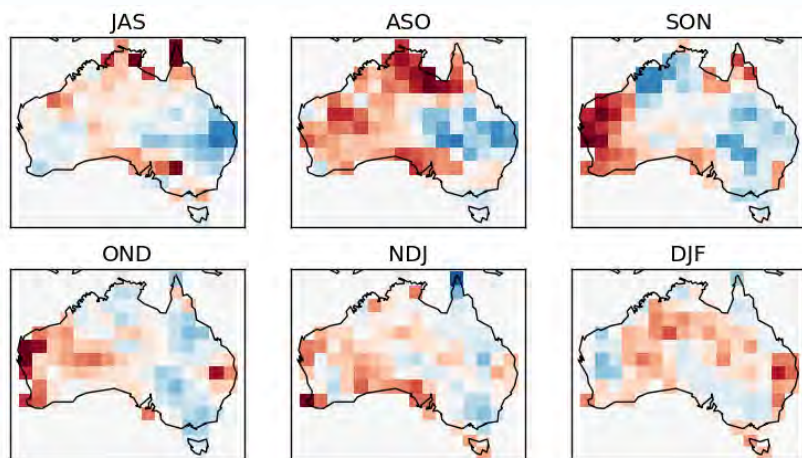
CBaM



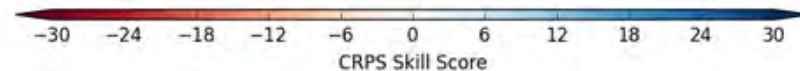
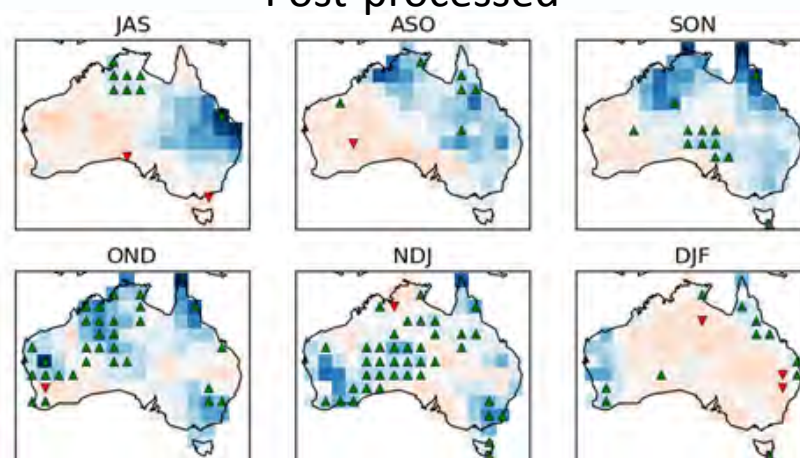
Coupled GCM (POAMA)



Raw (Mean-corrected)

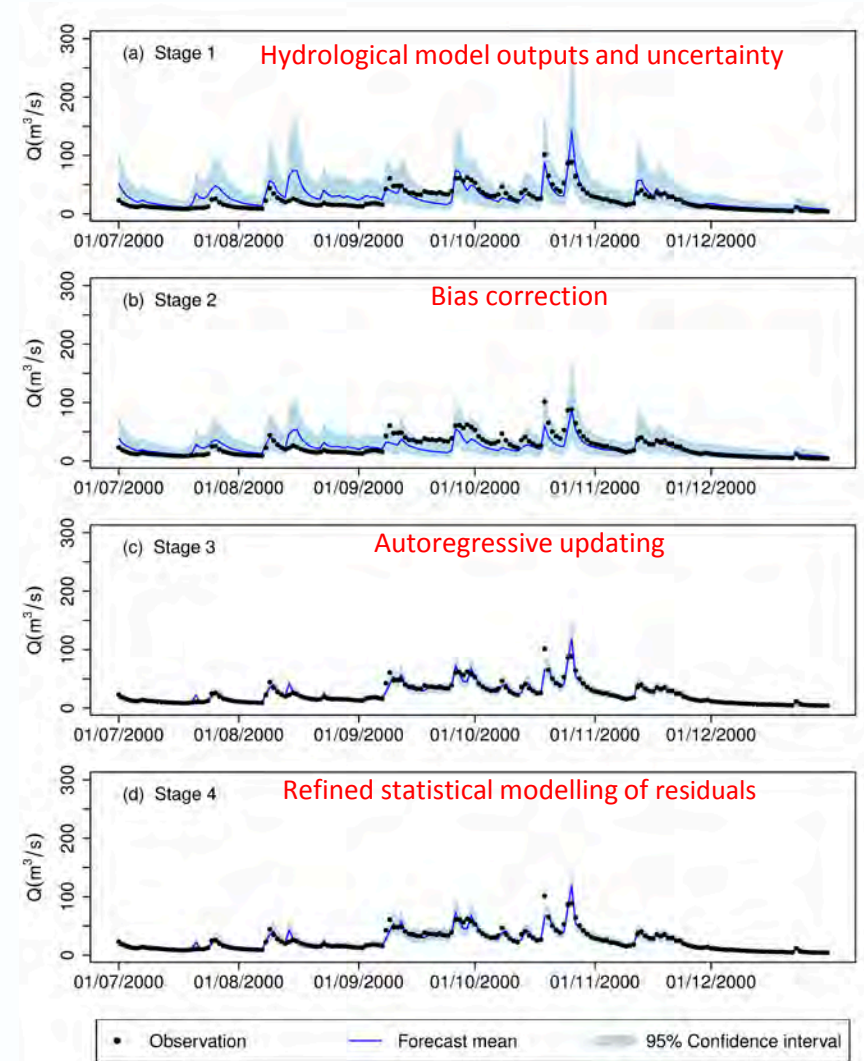


Post-processed

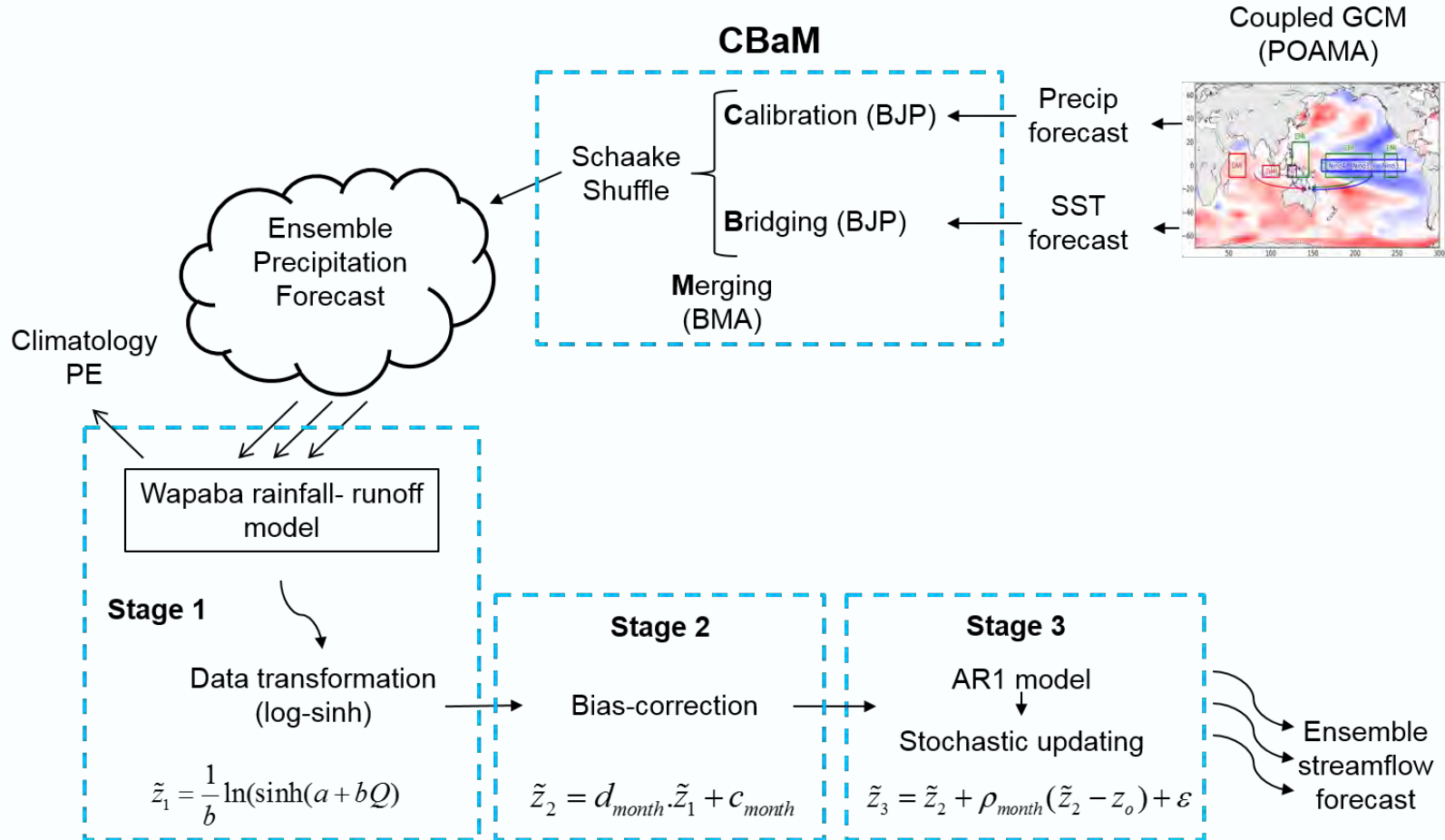


Reducing and representing errors in hydrological models

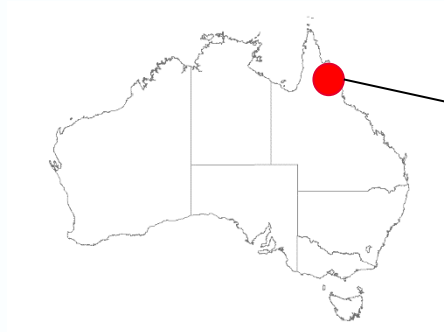
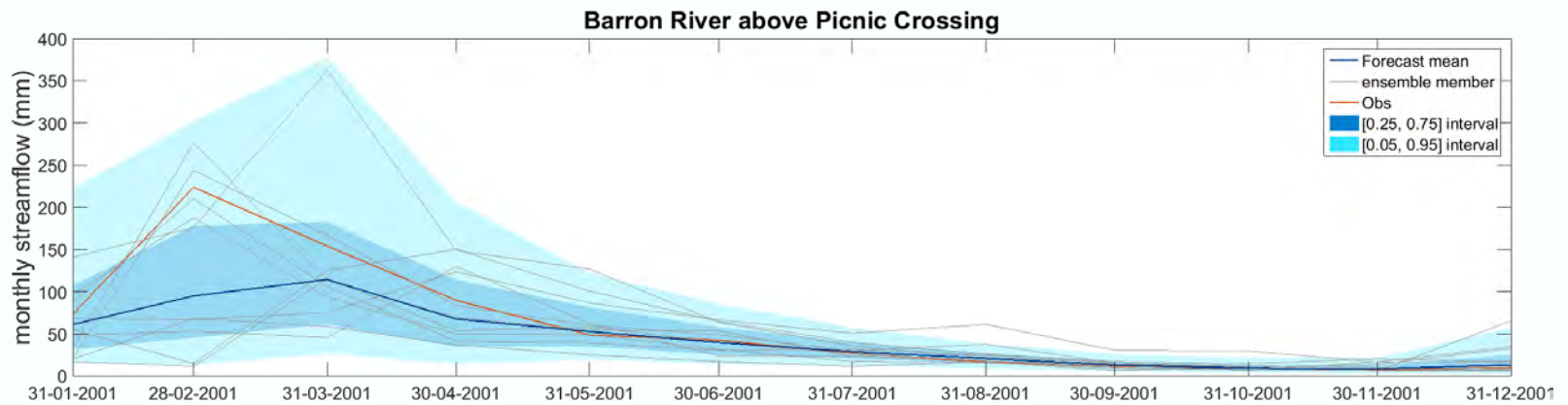
- Hydrological models not perfect
- Some hydrological model errors systematic
- Need to describe hydrological model errors for reliable forecasts
- Observations available to update predictions in real-time
- Errors not normally distributed
- Zero values complicate error distributions
- Complexity of error models need to be appropriate to application



Putting it all together – Forecast Guided Stochastic Scenarios (FoGSS)

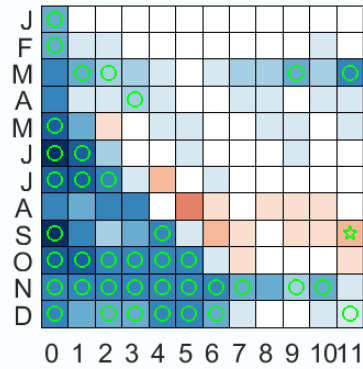


FoGSS example forecast

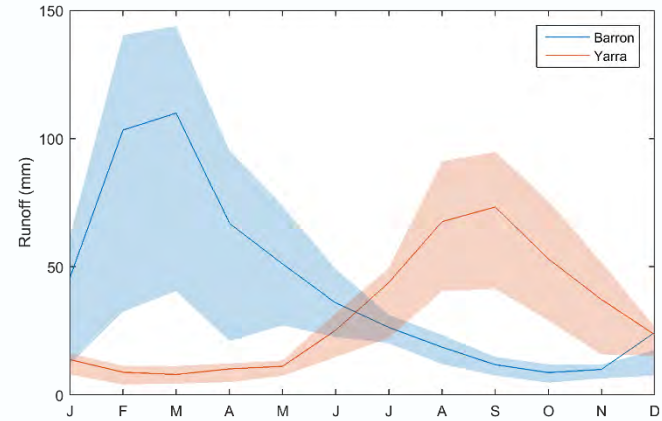
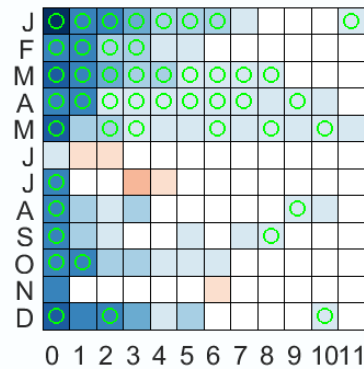


Streamflow forecast skill

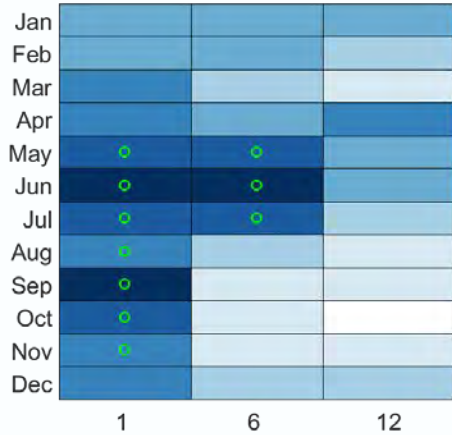
Barron River



Upper Yarra



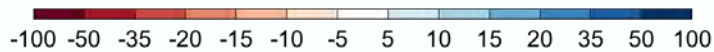
Barron River above Picnic Crossing



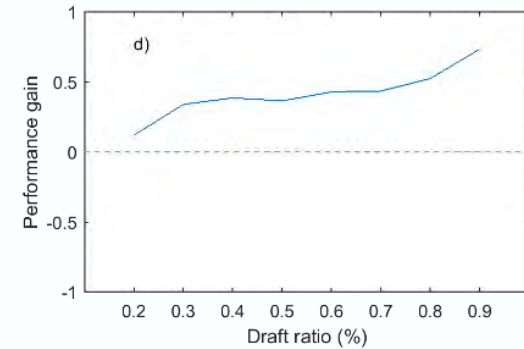
Upper Yarra Reservoir inflows



Skill (%)




Upper Yarra Reservoir



Turner, Bennett, Robertson, Galelli (in press) *HES*

Summary

- All models are wrong but some model predictions are useful
 - Ensemble predictions and forecasts permit honest description of model limitations
 - Combining statistical techniques with process-based models is effective in:
 - Supporting 'downstream' applications
 - Generating coherent predictions and forecasts
 - Reliably quantifying uncertainties
 - We are happy to help and learn as well
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Thank you

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