



# FoGSS - A model for generating ensemble forecasts of monthly streamflow out to 12 months

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WATER FOR A HEALTHY COUNTRY FLAGSHIP  
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Australian Government  
Bureau of Meteorology



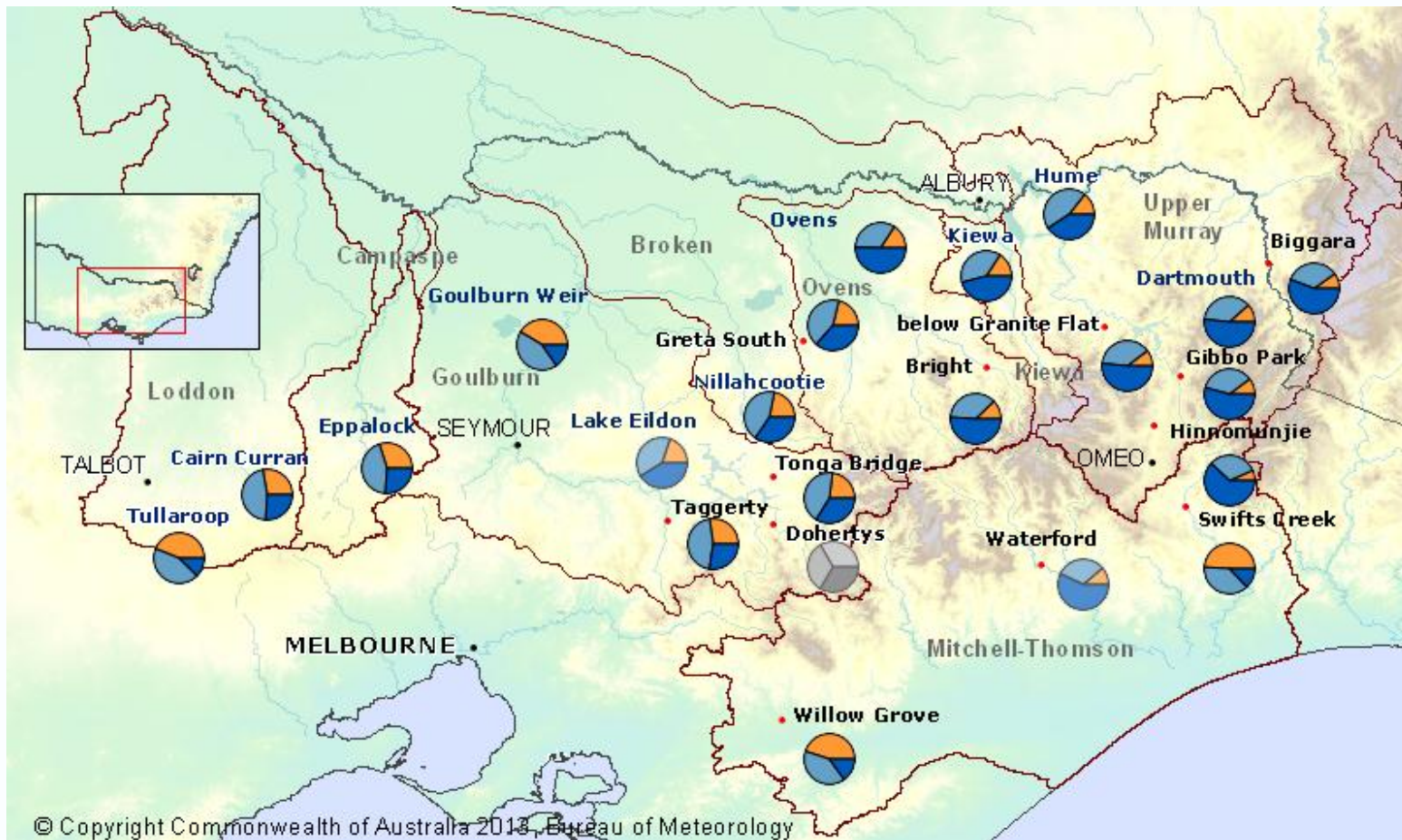
Water Information  
DATA > INFORMATION > INSIGHT



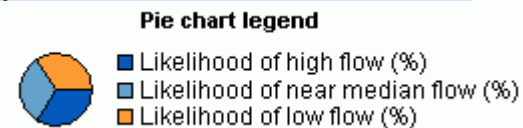
# Managing water in a highly variable climate



# Seasonal streamflow forecasting service

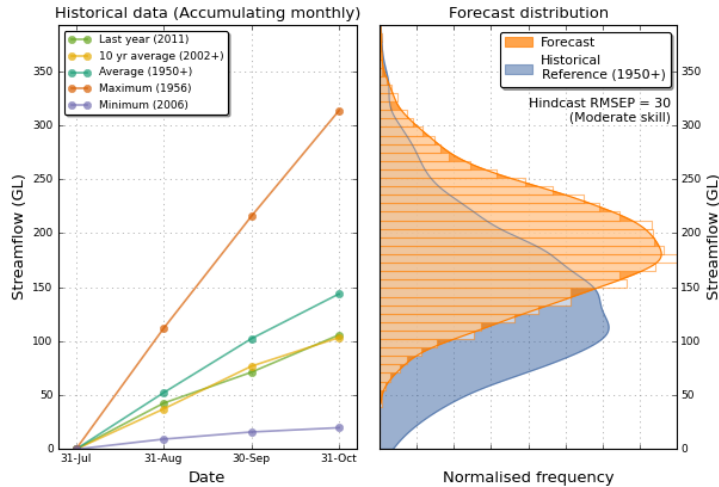


<http://www.bom.gov.au/water/ssf/>

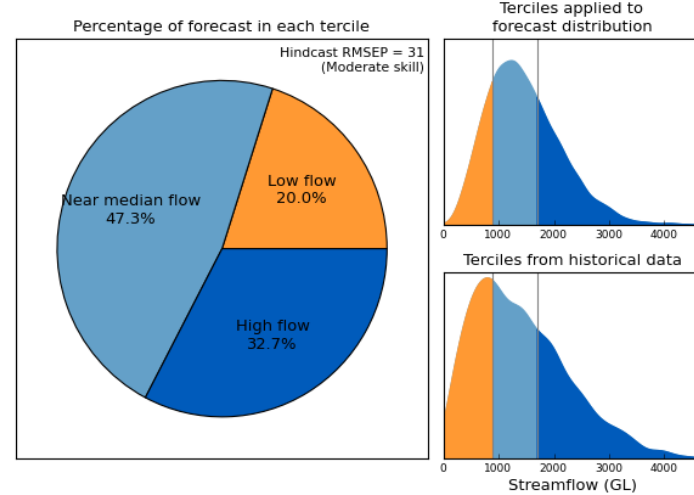


# Seasonal streamflow forecasting service

**Acheron River at Taggerty (405209)**  
Forecast period: Aug 2012 - Oct 2012



**Unregulated inflow to Hume Dam**  
Forecast period: Aug 2012 - Oct 2012



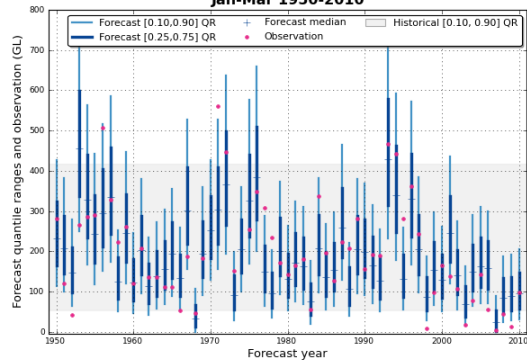
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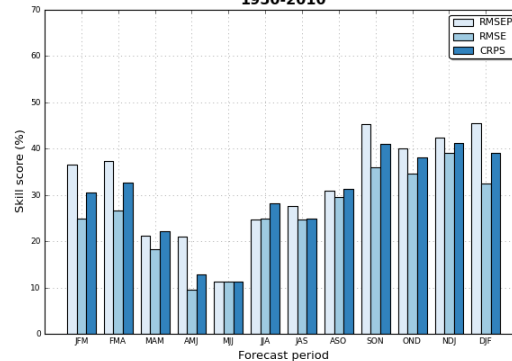
**Forecast quantiles and observations versus year**  
Unregulated inflow to Hume Dam  
Jan-Mar 1950-2010



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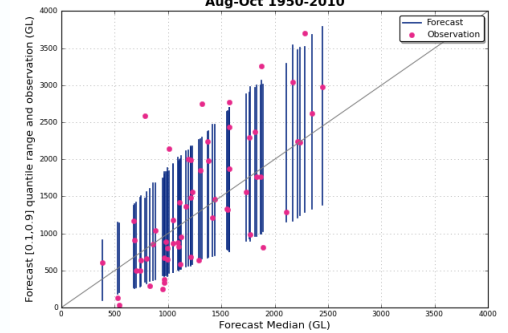
**Skill scores**  
Unregulated inflow to Hume Dam  
1950-2010



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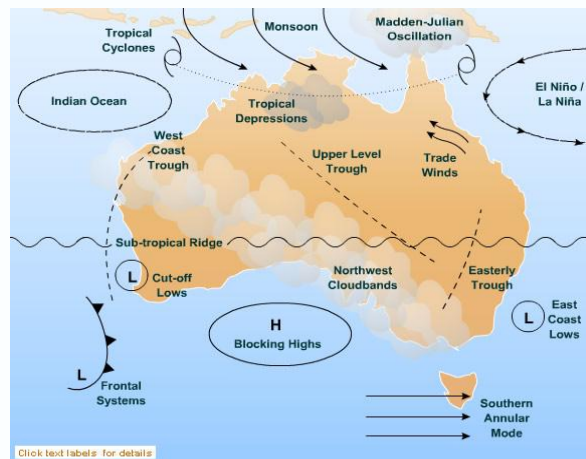
**Forecast quantiles and observations versus forecast median**  
Unregulated inflow to Hume Dam  
Aug-Oct 1950-2010



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# The Bayesian joint probability (BJP) model



Wang, Robertson and Chiew (2009) **Water Resources Research**

Wang and Robertson (2011) **Water Resources Research**

Robertson and Wang (2012) **Journal of Hydrometeorology**

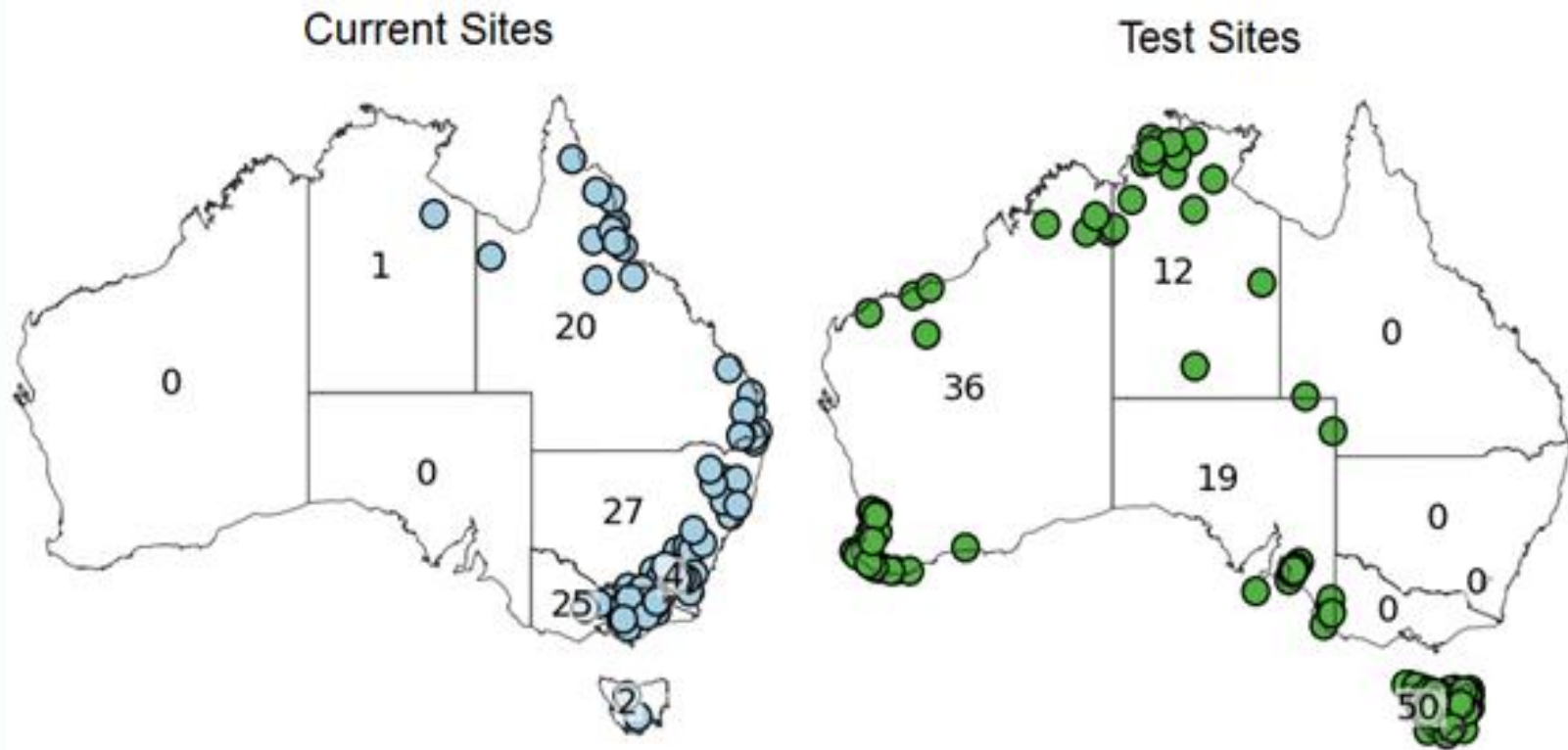
Robertson, Pokhrel and Wang (2013) **Hydrology and Earth System Sciences**

Robertson and Wang (2013) **Water Resources Management**

Pokhrel, Wang and Robertson (2013) **Water Resources research**

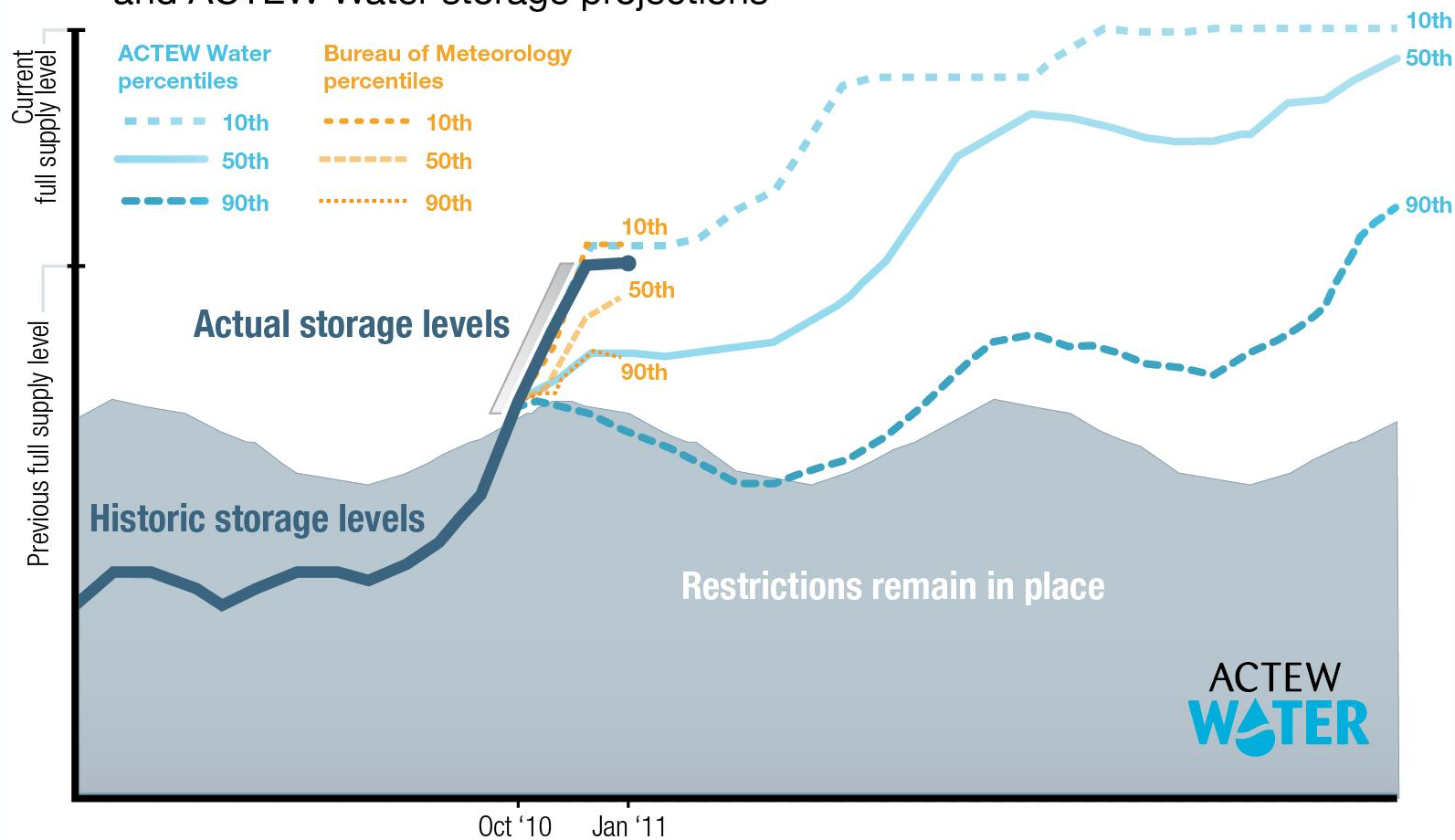
Bennett, Wang, Pokhrel and Robertson (2014) **Natural Hazards and Earth System Sciences**

# Seasonal streamflow forecasting service



# Use of forecasts in water management

Figure 1. Comparison of the Bureau's seasonal streamflow forecast and ACTEW Water storage projections



# The FoGSS model

- For generating Forecast Guided Stochastic Scenarios
- Ensemble forecasts of monthly volumes of streamflow out to 12 months
- The forecasts become more like natural stochastic scenarios as skill decreases with lead time



# The FoGSS model

- Use CBaM to post-process GCM seasonal climate forecasts
  - GCM: The predictive ocean atmosphere model for Australia (POAMA)
  - CBaM: Calibration, Bridging and Merging

Schepen, Wang and Robertson (2011) **Journal of Climate**

Wang, Schepen and Robertson (2012) **Journal of Climate**

Schepen, Wang and Robertson (2012) **Journal of Geophysical Research**

Schepen and Wang (2013) **Monthly Weather Review**

Hawthorn, Wang, Schepen and Robertson (2013) **Water Resources Research**

Schepen and Wang (2014) **Journal of Hydrology**

Schepen, Wang and Robertson (2014) **Monthly Weather Review**

Peng, Wang, Schepen, Pappenberger et al. (2014) **Journal of Geophysical Research**

# The FoGSS model

- Stage 1: Monthly water balance modelling using WAPABA
- Stage 2: Bias correction
- Stage 3: Updating, injecting and propagating hydrological uncertainty
- Stage 4: Benchmarking and touching up

Wang, Pagano, Zhou, Hapuarachchi, Zhang and Robertson (2011) **Journal of Hydrology**

Wang, Shrestha, Robertson and Pokhrel (2012) **Water Resources Research**

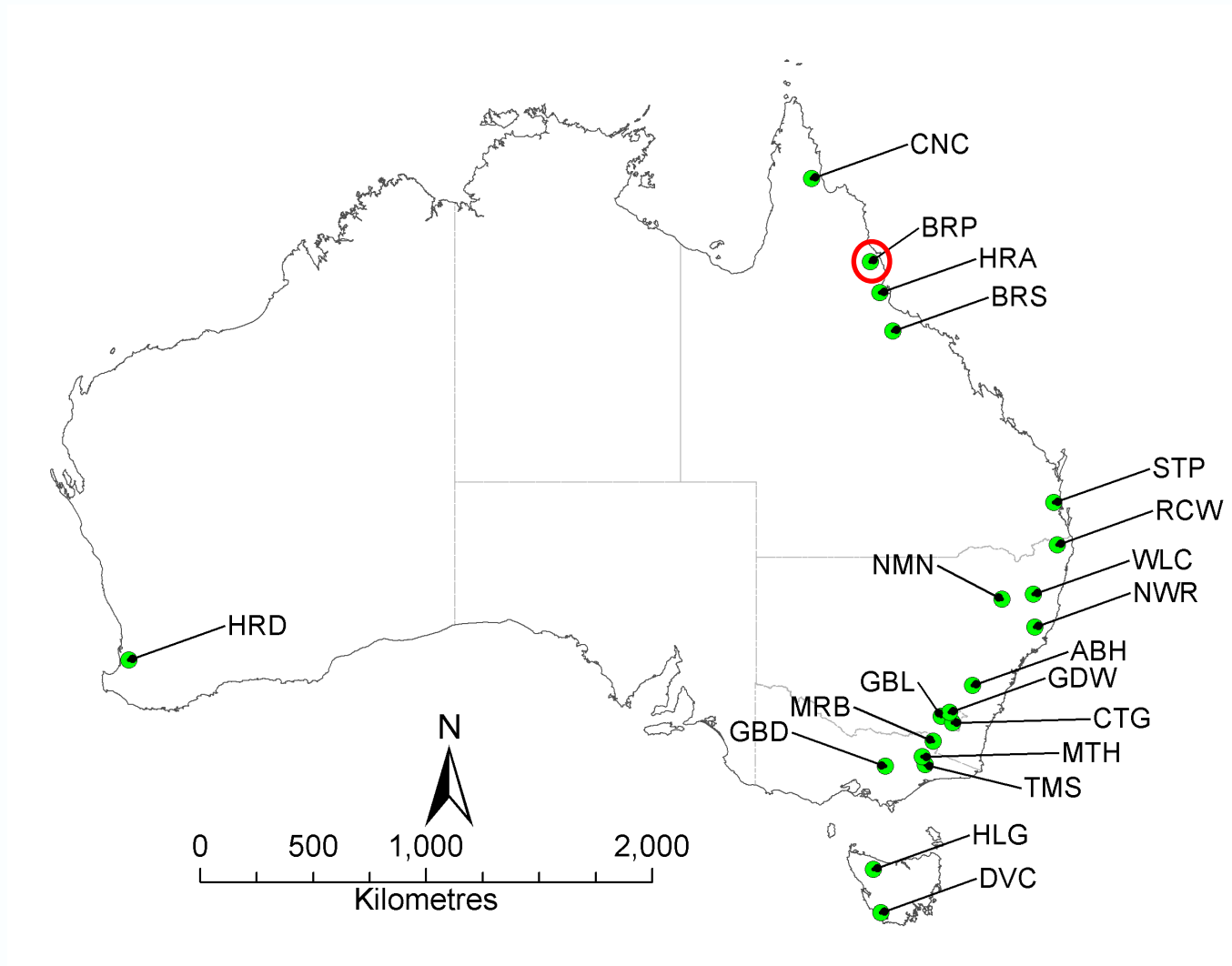
Li, Wang and Bennett (2013) **Water Resources Research**

Pokhrel, Robertson and Wang (2013) **Hydrology and Earth System Sciences**

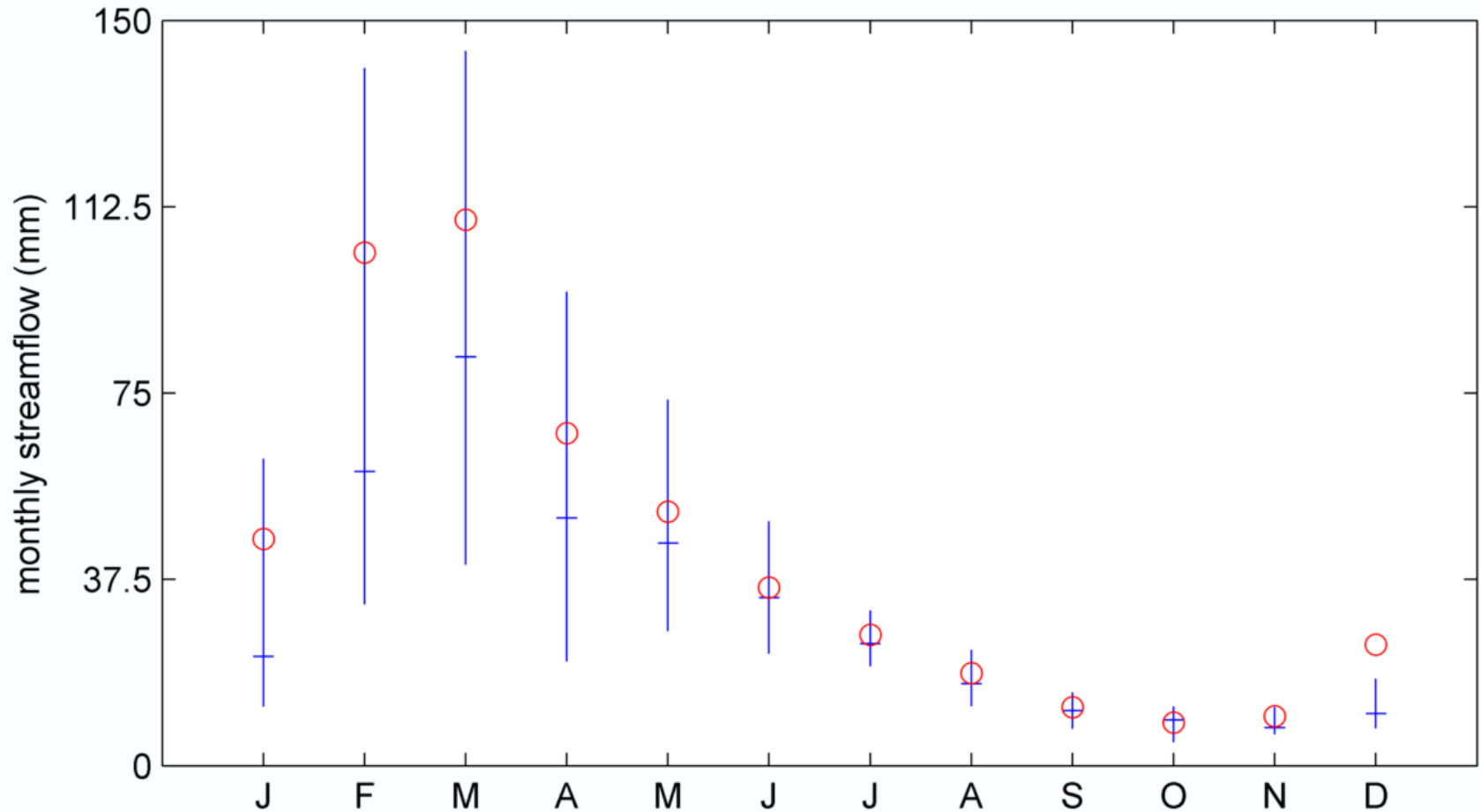
Li, Wang, Bennett and Robertson (2014) **Hydrology and Earth System Sciences (submitted)**

Schepen and Wang (2014) **Water Resources Research (to submit)**

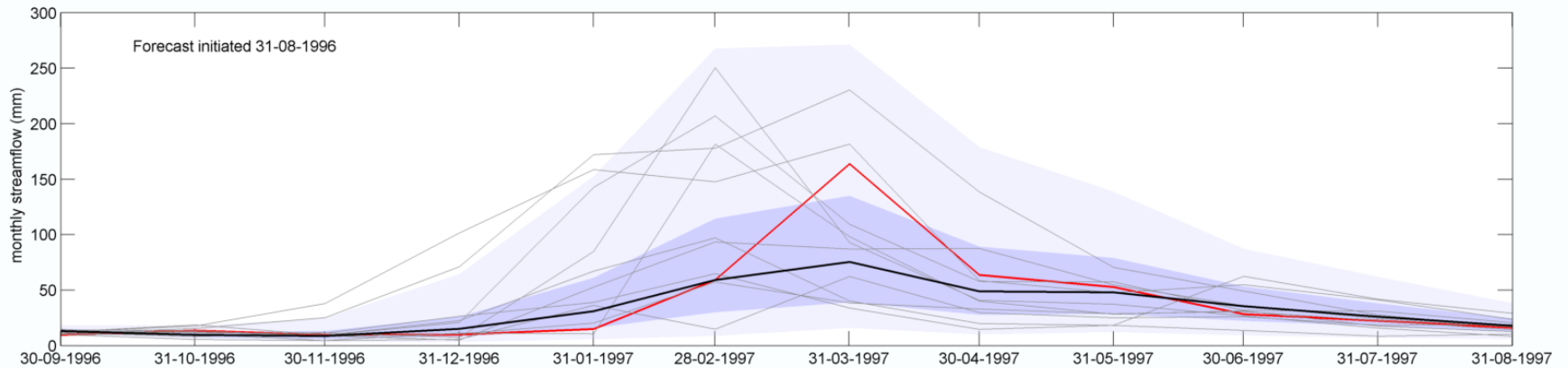
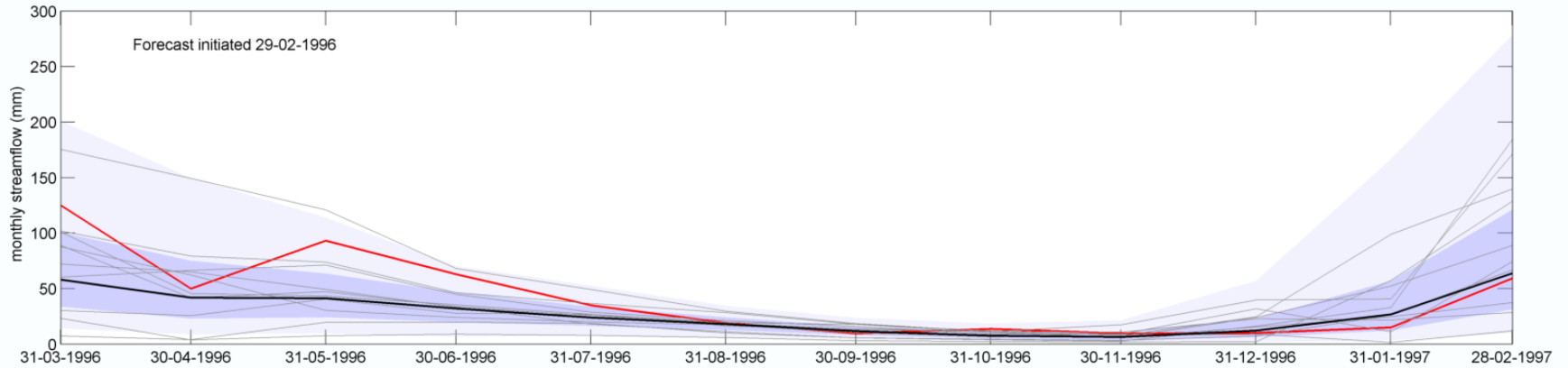
# Evaluation



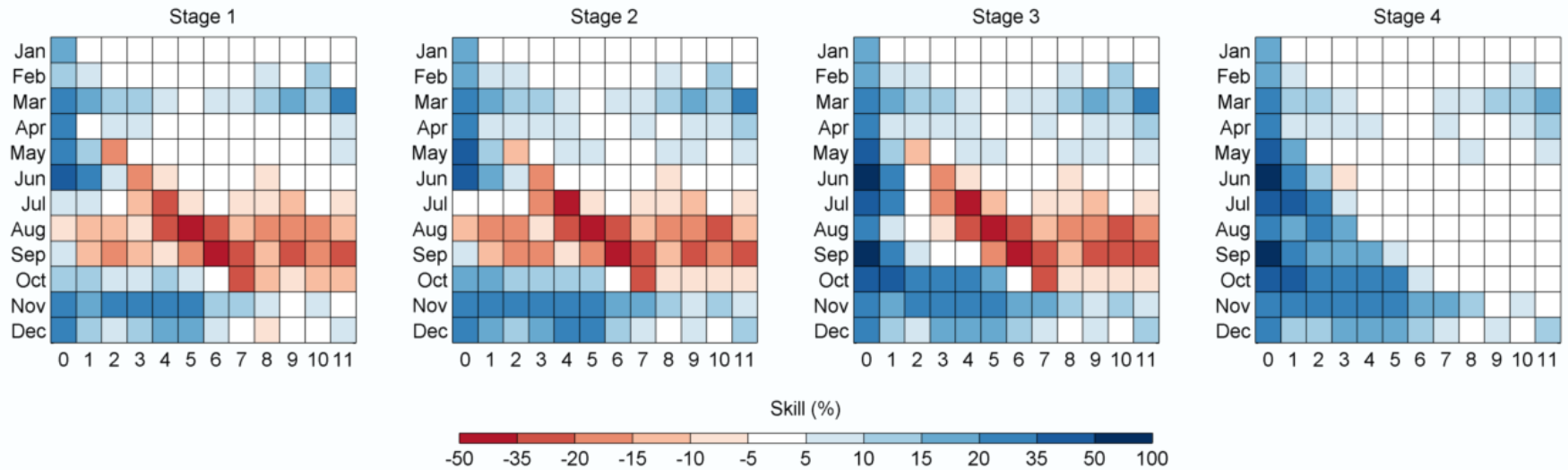
# BRP - Barron River above Picnic Crossing



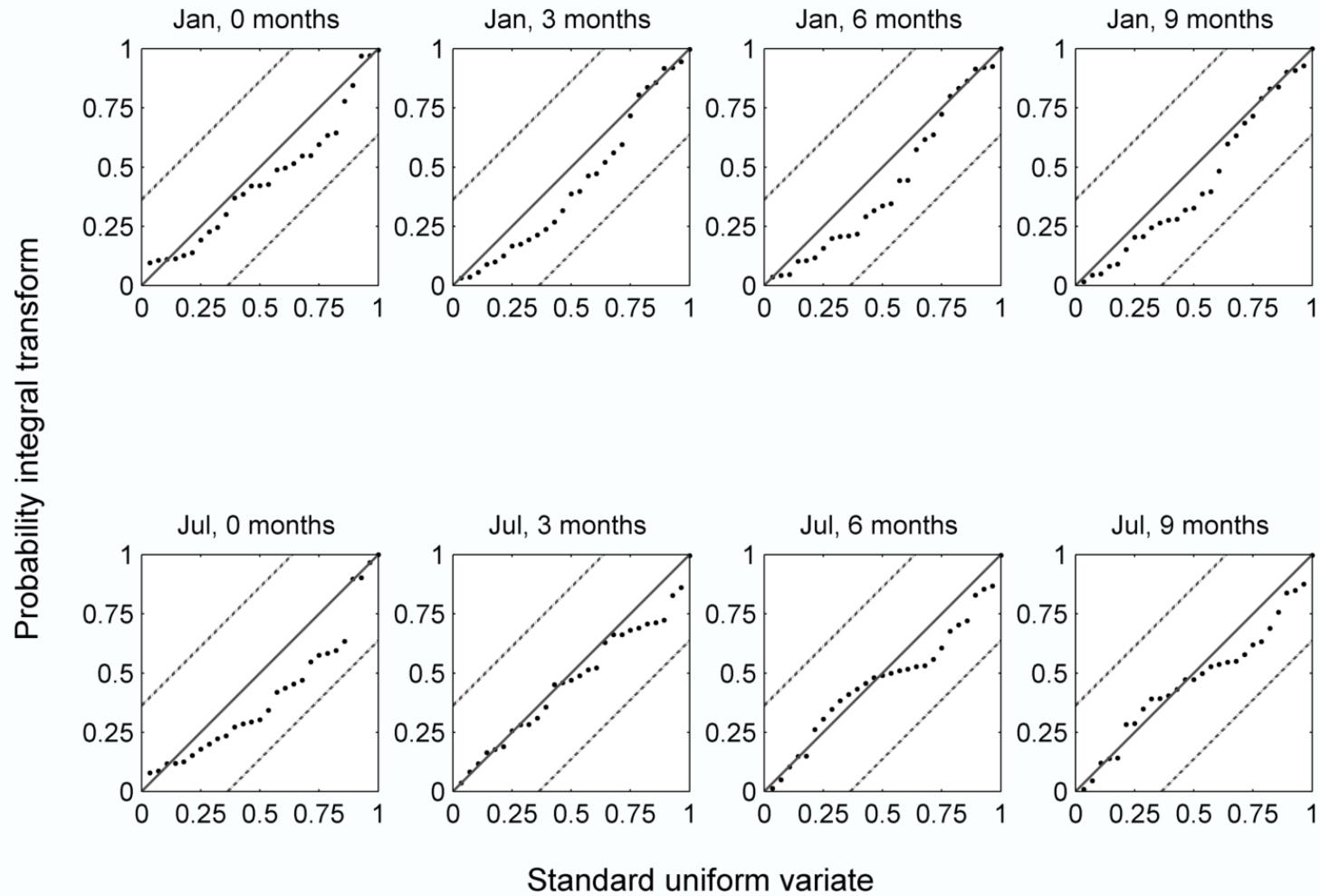
# BRP - Two example forecasts



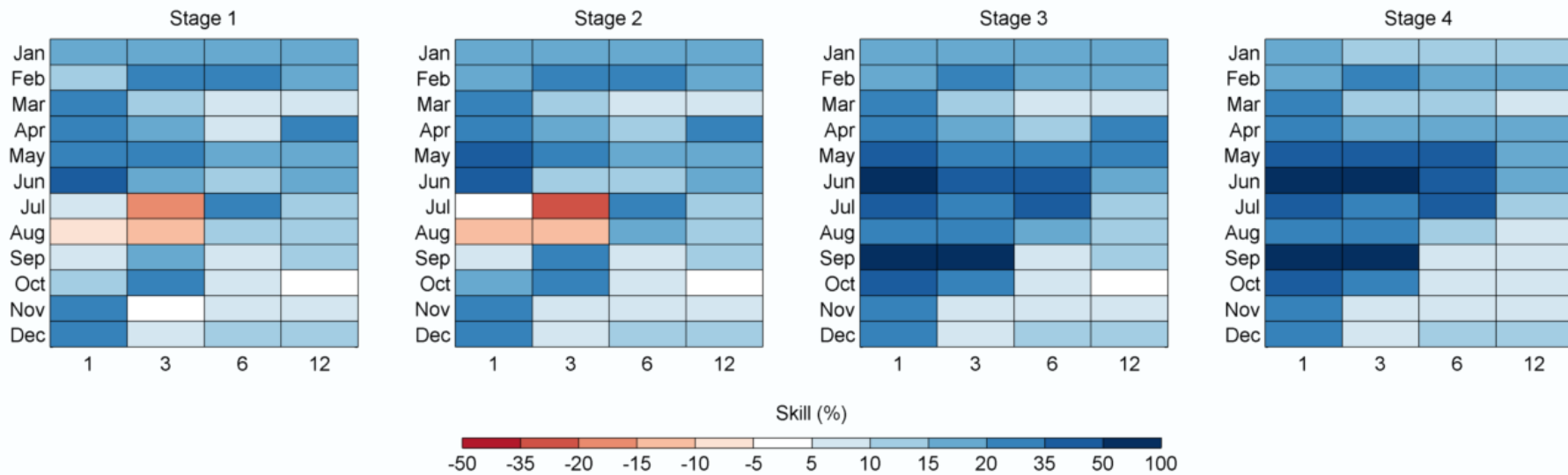
# BRP - CRPS skill score (monthly)



# BRP - PIT reliability plot (monthly, Stage 4)

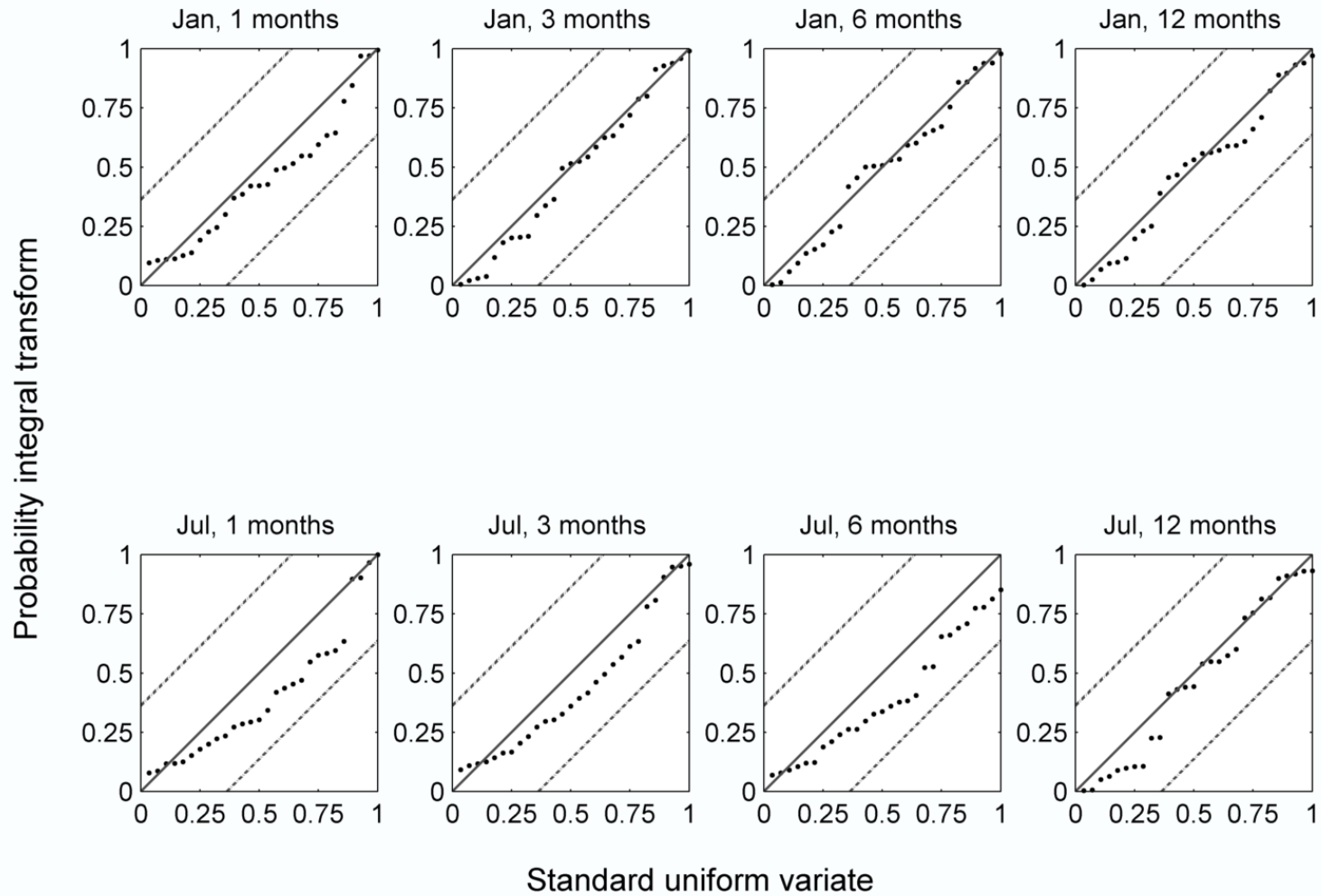


# BRP - CRPS skill score (cumulative)

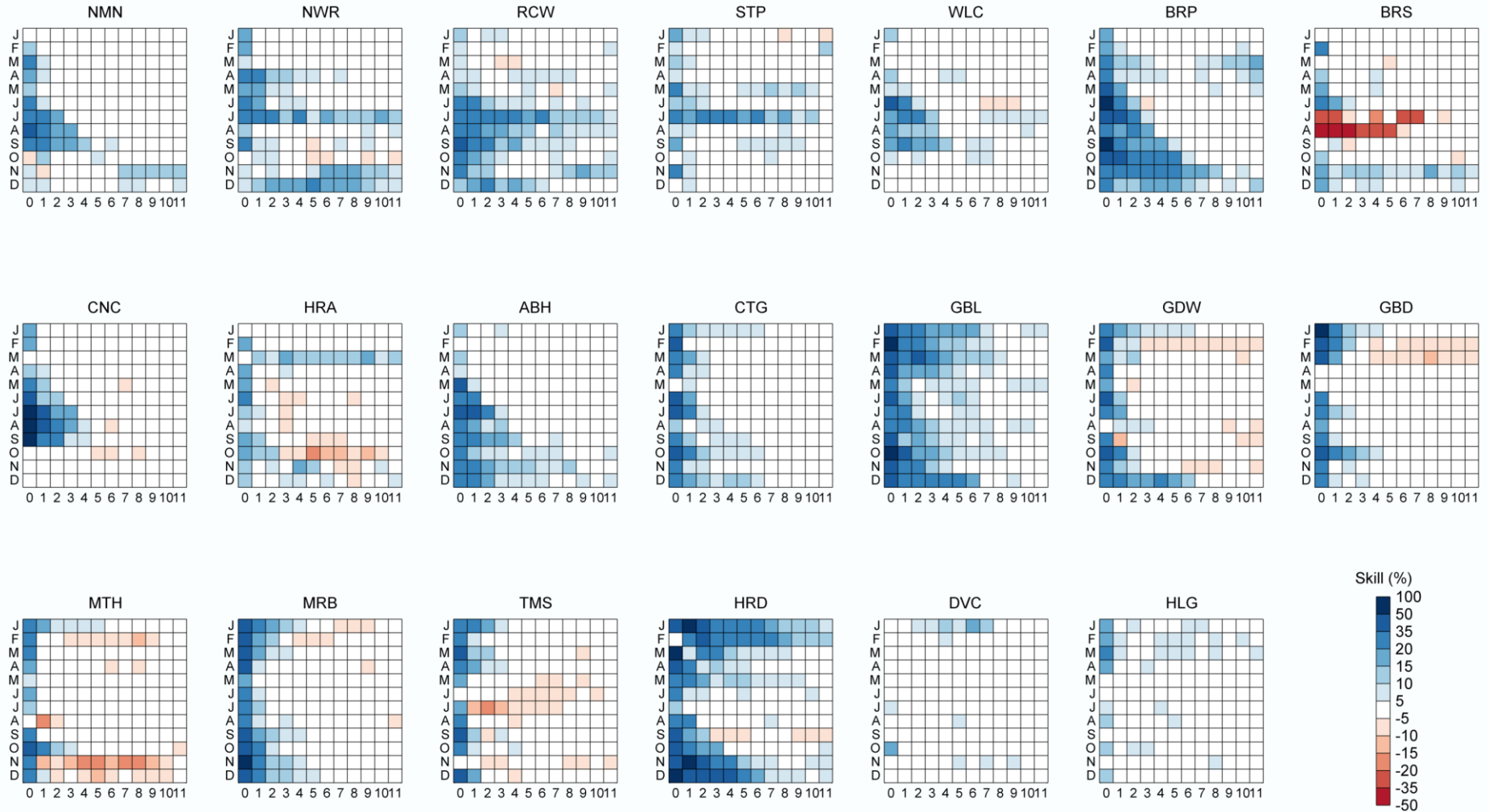




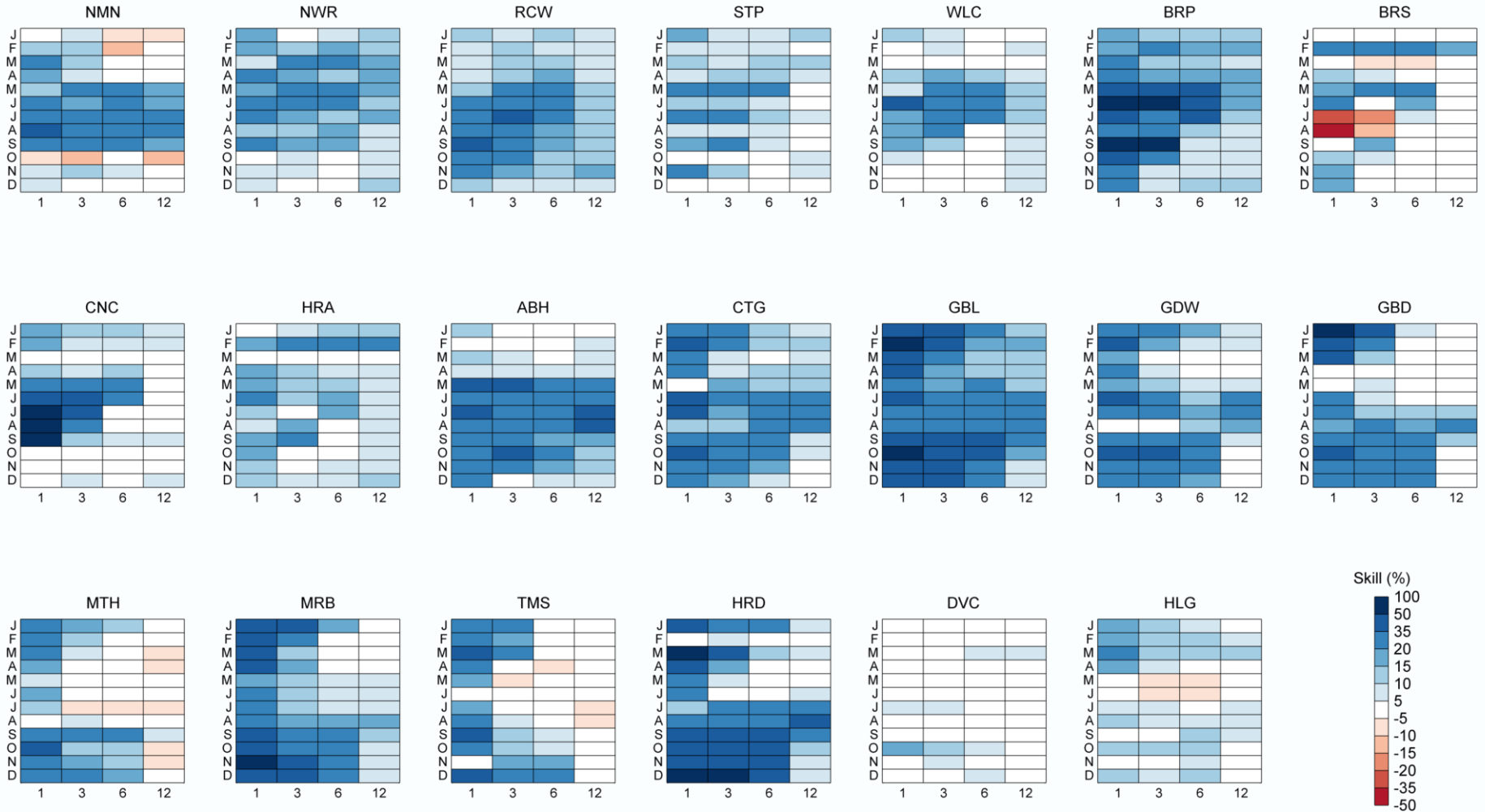
# BRP - PIT reliability plot (cumulative, Stage 4)



# 20 sites - CRPS skill score (monthly, Stage 4)



# 20 sites - CRPS skill score (cumulative, Stage 4)



# Summary

- FoGSS model for ensemble forecasts of monthly streamflow out to 12 months
- Forecasts of monthly streamflow are generally skillful only at short lead times
- Forecasts of cumulative streamflow are much more skillful
- Forecasts are statistically reliable in uncertainty spread
- FoGSS adequately represents
  - Rainfall forecast uncertainty
  - Hydrological uncertainty
  - Persistence in streamflow
  - Uncertainty propagation

# Thank you

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