Progress toward ensemble 7-day streamflow forecast for Australia

David Robertson, QJ Wang, James Bennett, Durga Lal Shrestha, Yong Song, Ming Li, Jean-Michel Perraud, Robert Bridgart, Alex Sha

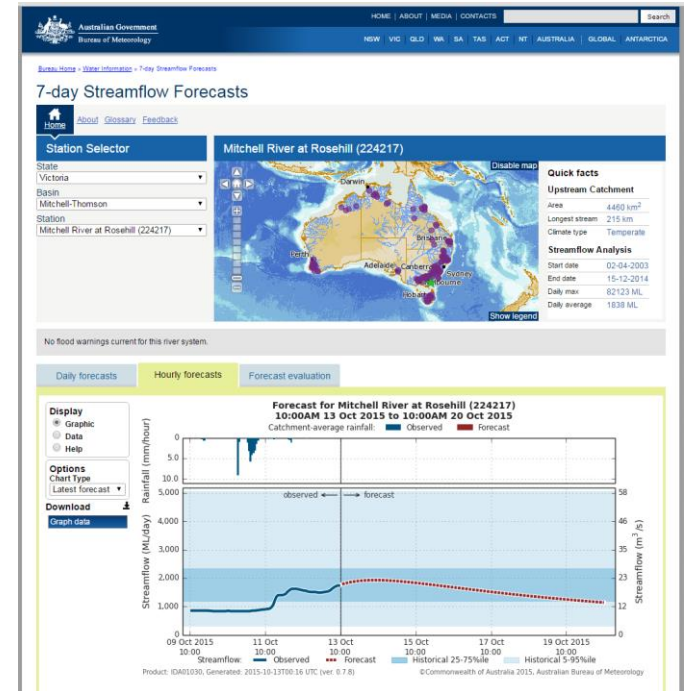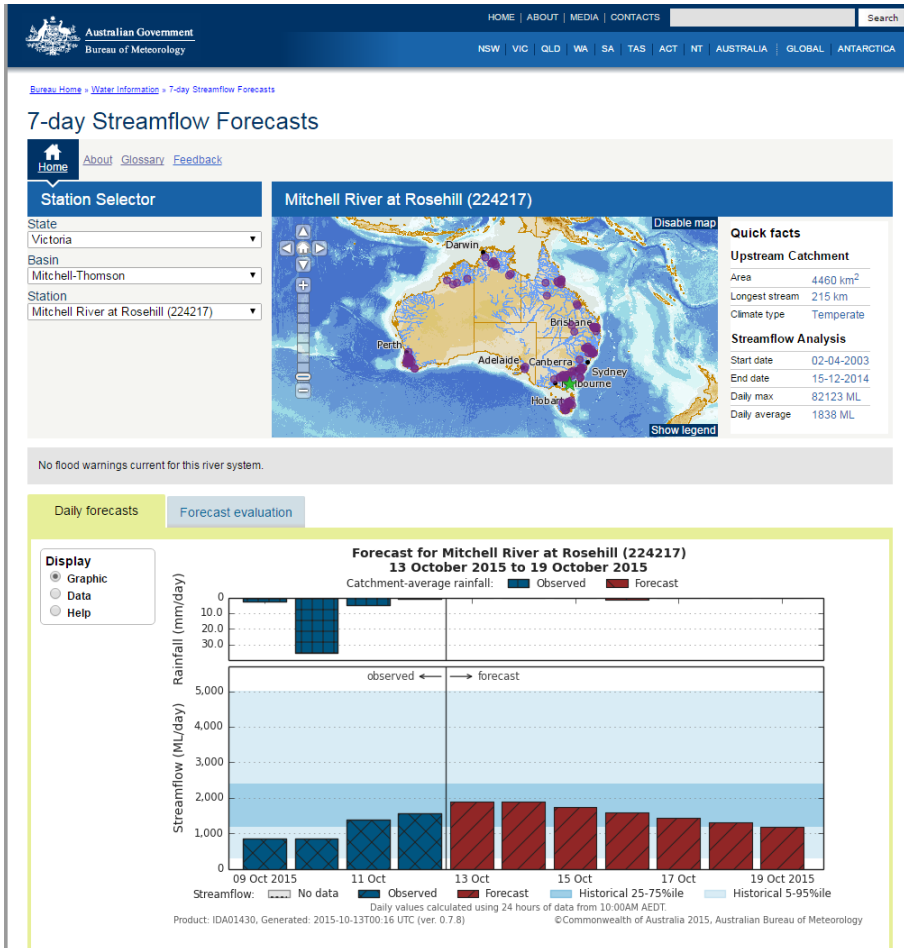Australian Government
Bureau of Meteorology

Water Information
DATA › INFORMATION › INSIGHT

CSIRO

Deterministic 7-day streamflow forecasts

(www.bom.gov.au/water/7daystreamflow)

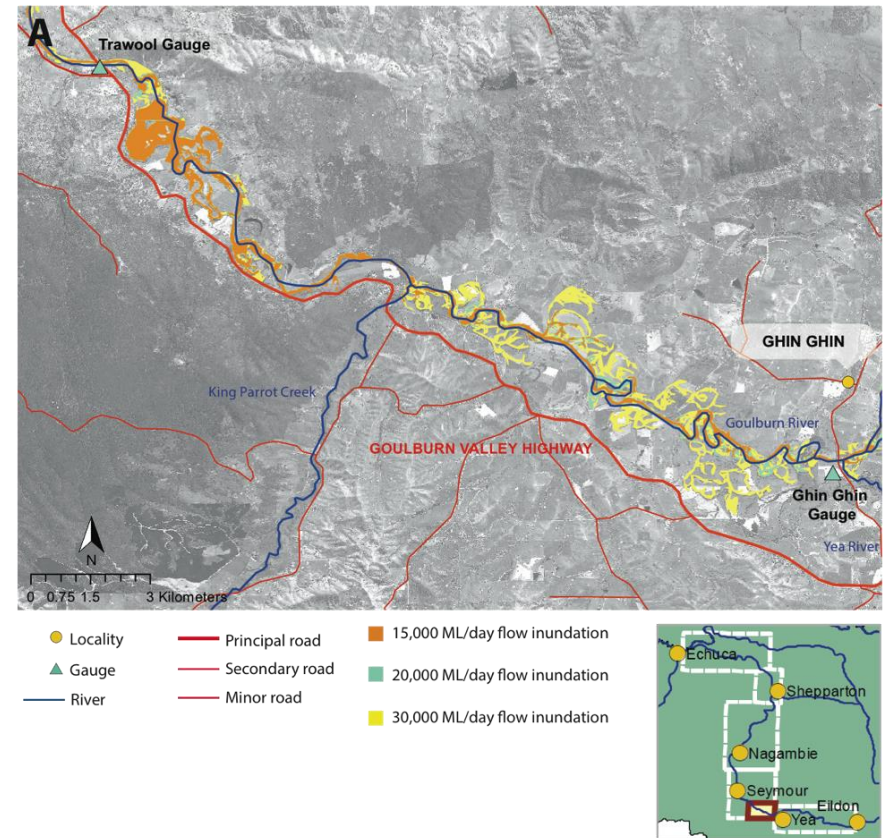# An end-user's case for ensemble forecasts
(Environmental flow manager)

7-day forecasts will allow:

- "understand *risk* of catchment runoff at time of release"
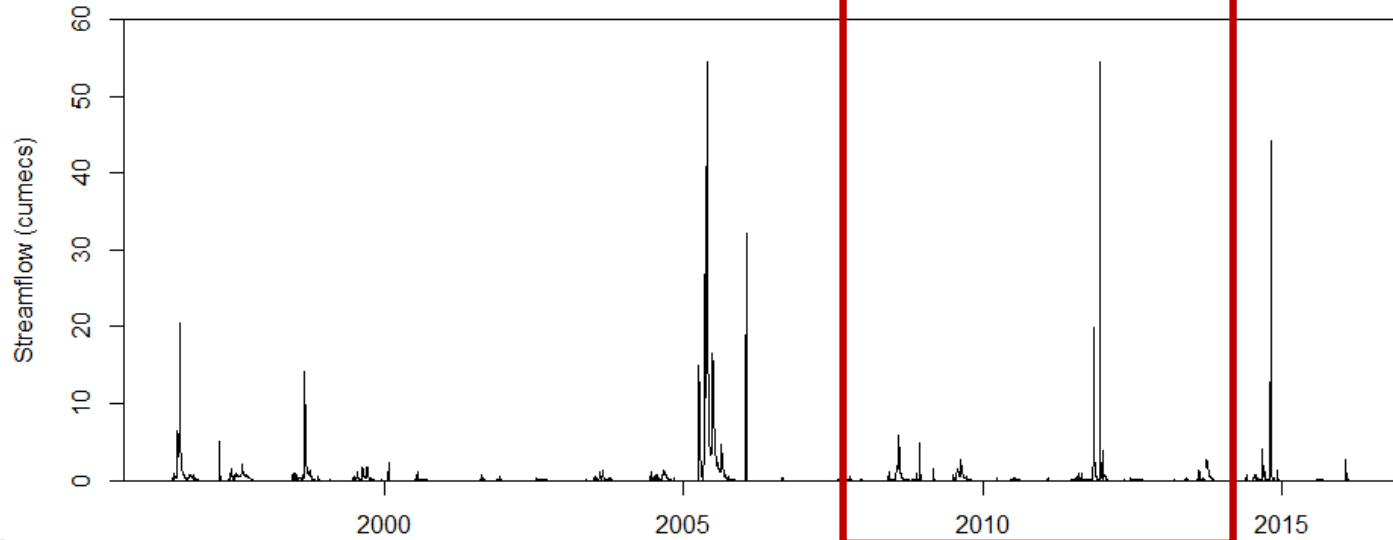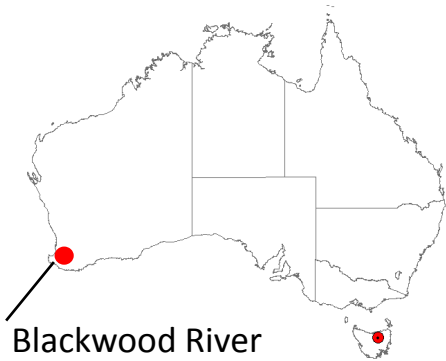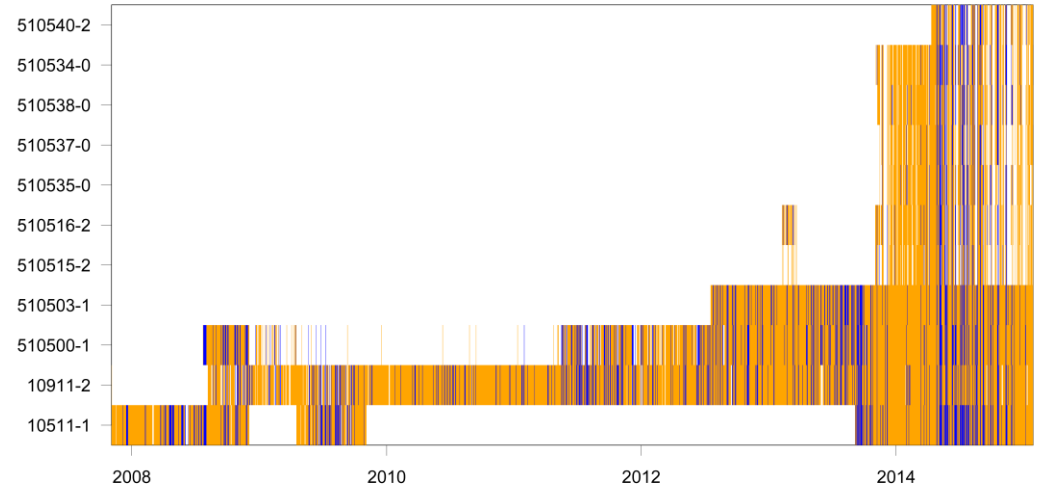
- "manage flooding *risk*"
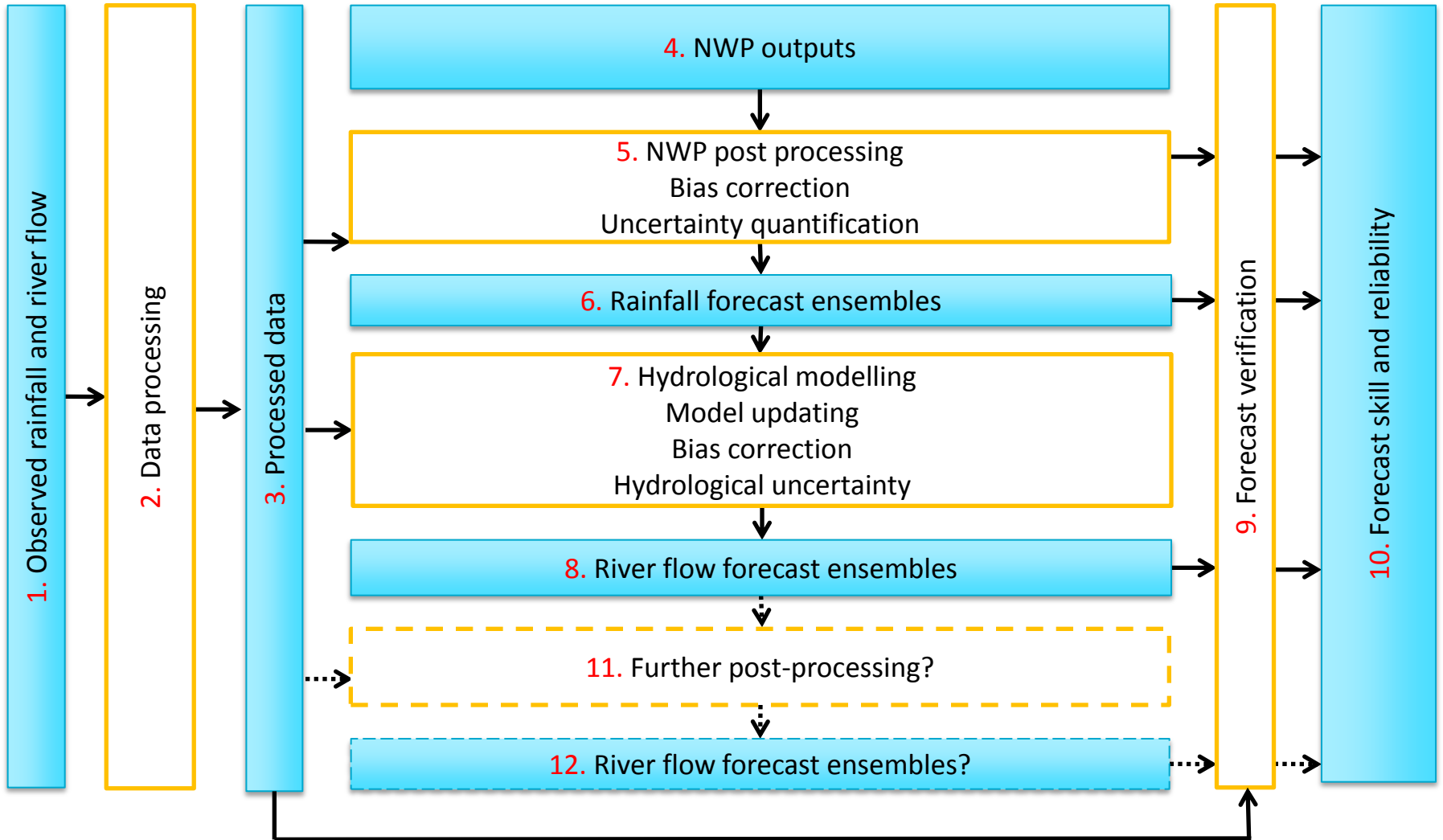
Risk = likelihood × consequence

"Good handle on consequences"

A deterministic service only gives an expected flow scenario and not likelihood of different scenarios

Forecasting challenges

Blackwood River

Ensemble forecasting framework

Ensemble forecast system components

- Observed data

  Adapted from existing flood forecasting service

- Rainfall forecasts

  RPP (Bayesian rainfall forecast post-processor)

- Runoff and routing models

  Semi-distributed; GR4H, Muskingum …

- Hydrological error

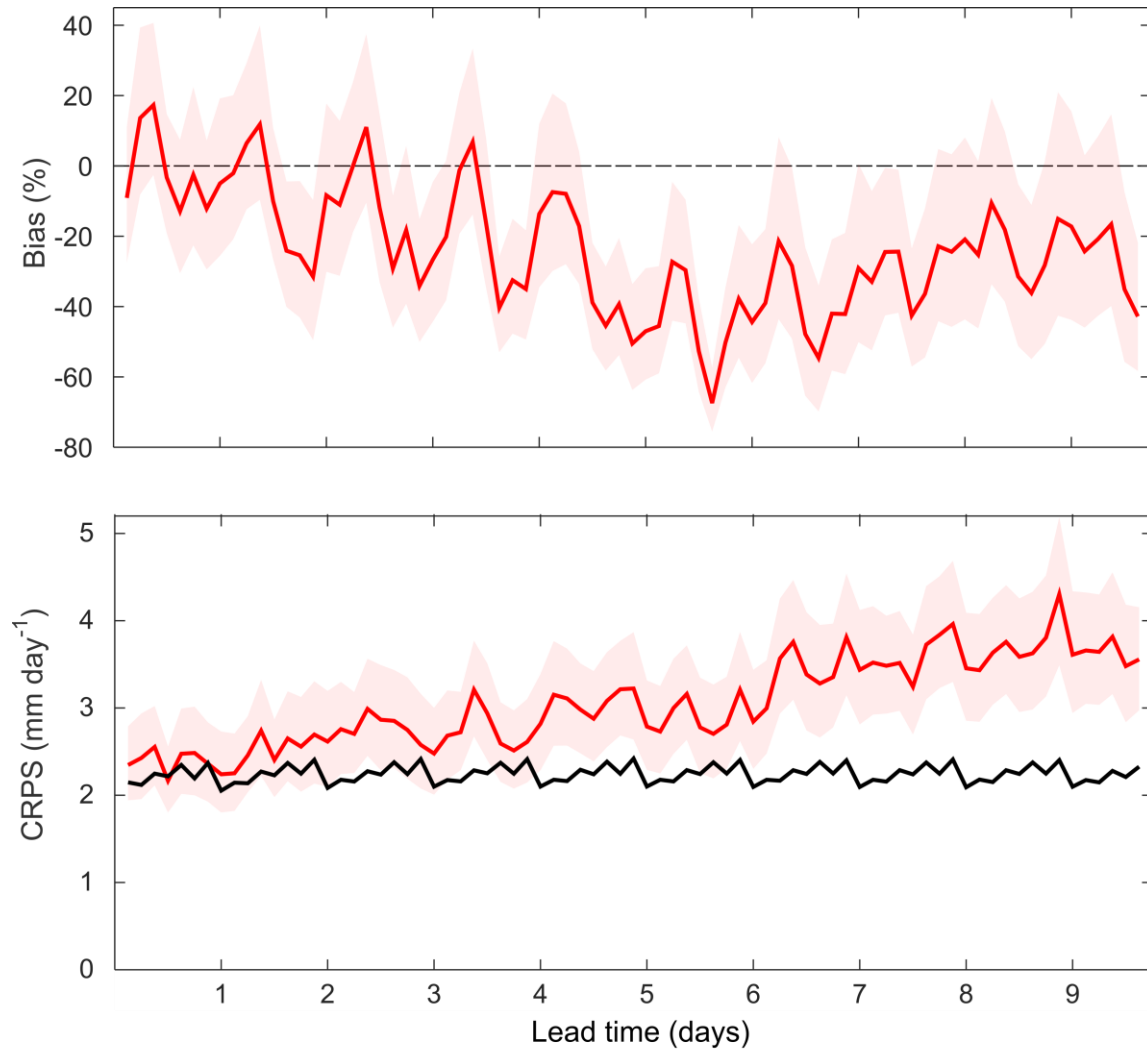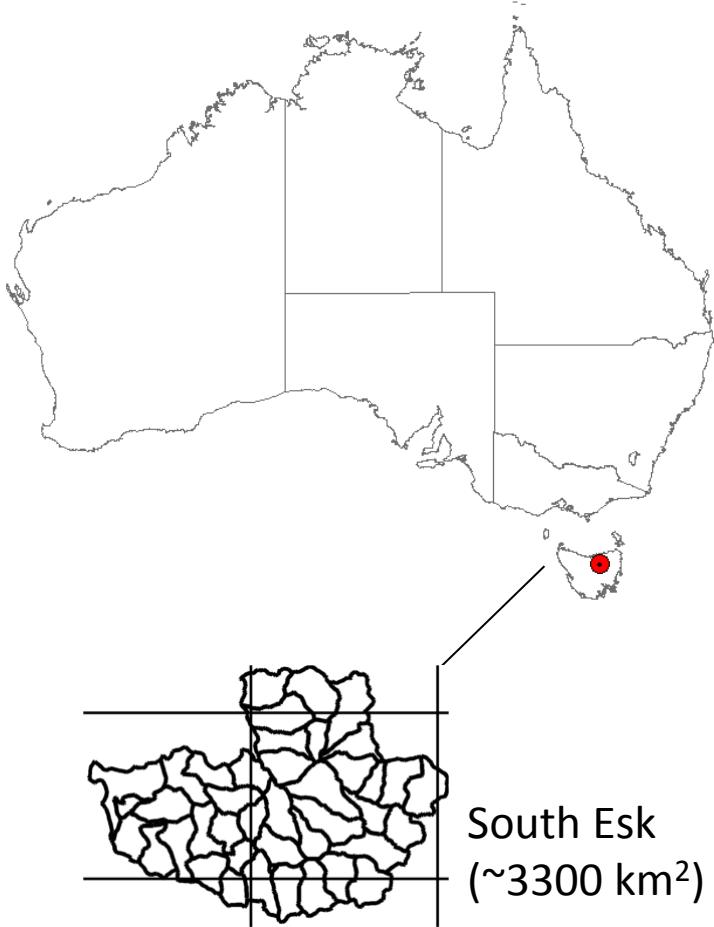 Dual pass error correction (Pagano, Wang, Hapuarachchi, Robertson, 2011, JoH)

- Verification

  Cross validation scheme

Ensemble forecast system components

- Observed data

    Adapted from existing flood forecasting service

- **Rainfall forecasts**

    RPP (Bayesian rainfall post-processor)

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    Cross validation scheme

Rainfall forecasts

South Esk
(~3300 km^2)

Shrestha, Robertson, Bennett, Wang (2015) MWR

Rainfall forecast post-processing

(Robertson, Shrestha, Wang, 2013, HESS)

Step 1: Correct biases and quantify uncertainty

- Modified Bayesian joint probability (BJP) model
    - Log-sinh transformation (Wang, Shrestha, Robertson, Pokhrel, 2012, WRR)
    - Treatment of zero data
    - Continuous bivariate normal distribution

Step 2: Instill temporal and spatial patterns

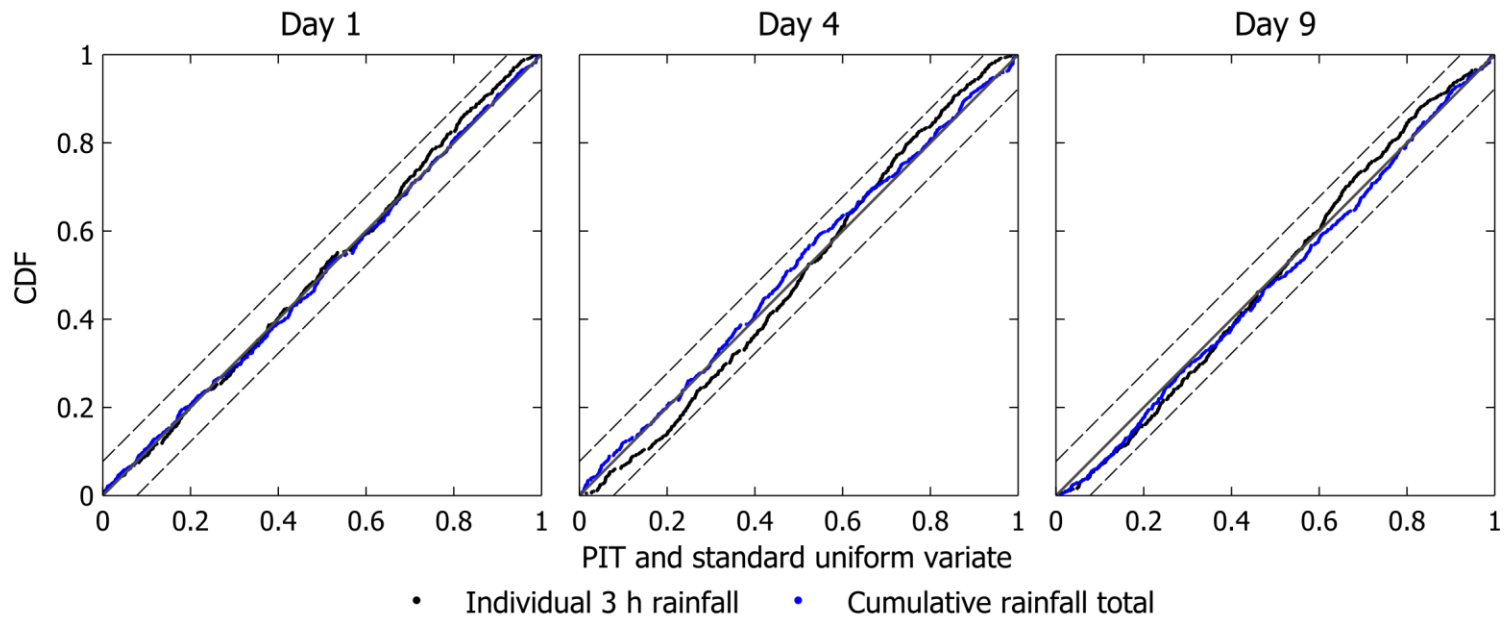- Schaake Shuffle (Clark, Gangopadhyay, Hay, Rajagopalan, Wilby, 2004, JHM)
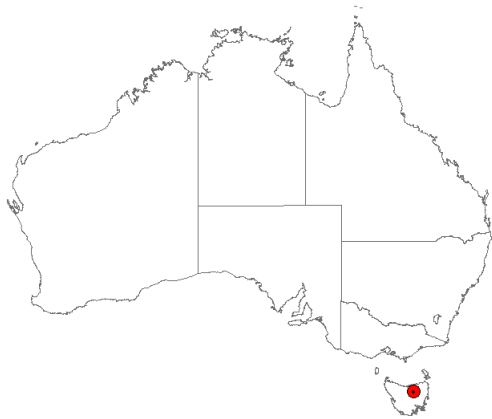
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Rainfall forecast post-processing

South Esk
(~3300 km²)
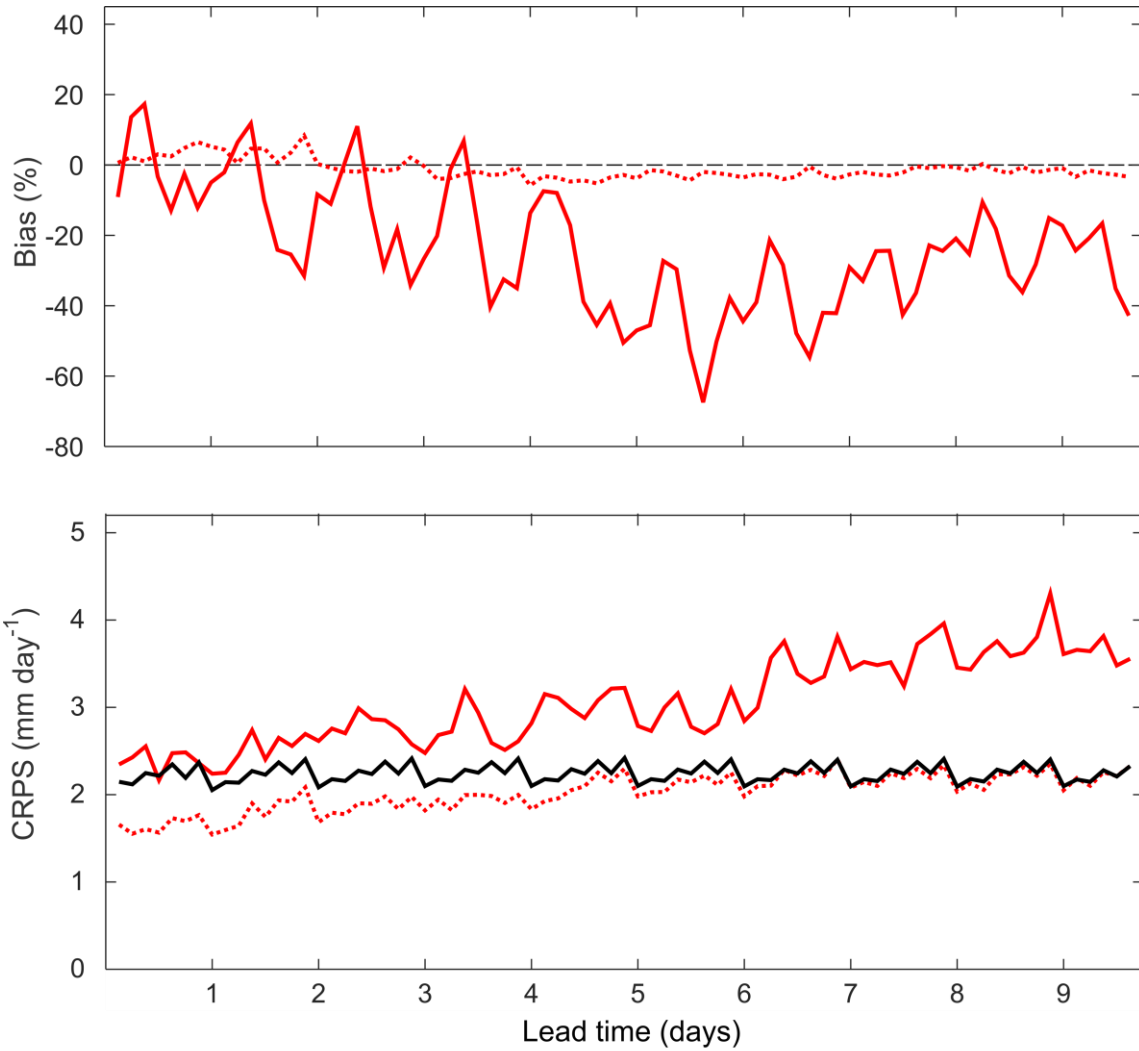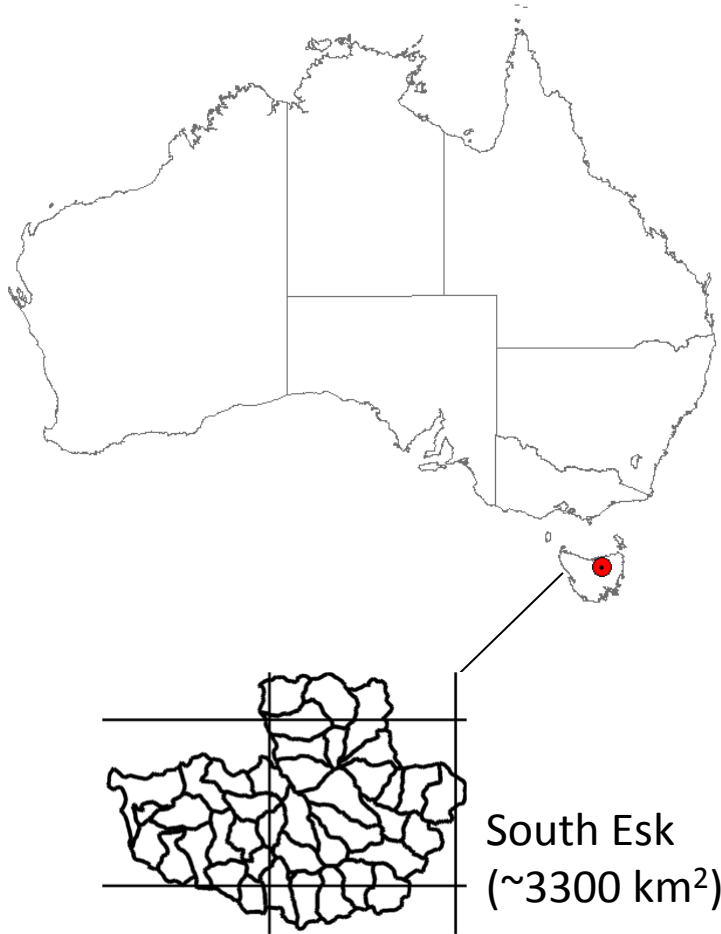
Shrestha, Robertson, Bennett, Wang (2015) MWR

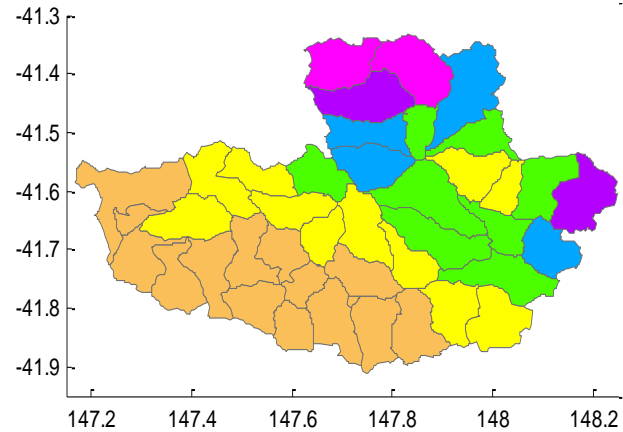— Raw ACCESS-G ····· Post-processed ACCESS-G — Climatology

Rainfall forecast reliability

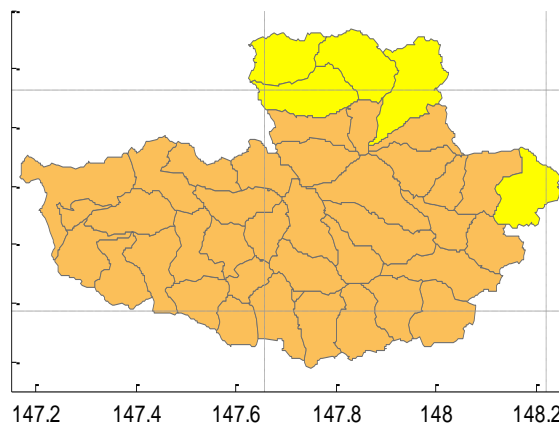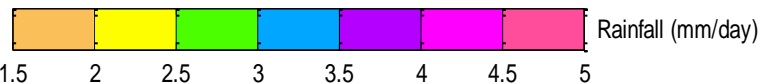# Rainfall forecast post-processing – spatial effects
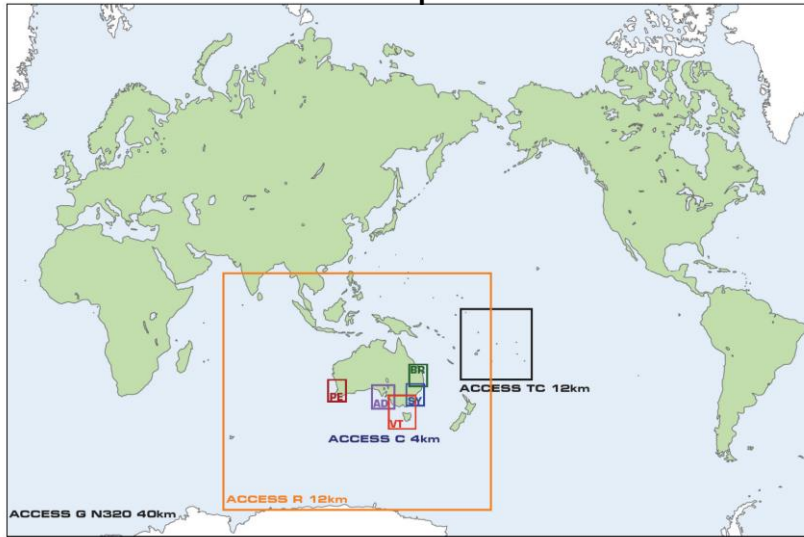

Observations

Raw ACCESS-G

Post-processed ACCESS-G

Day 9

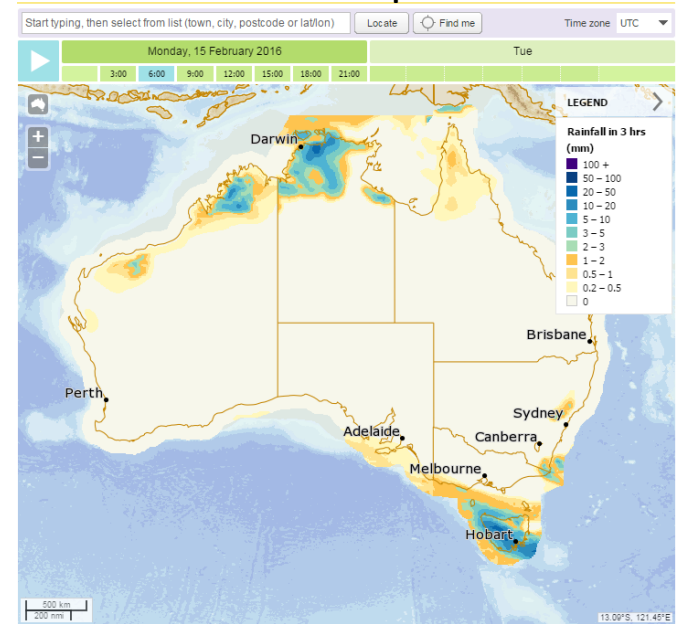Rainfall (mm/day)

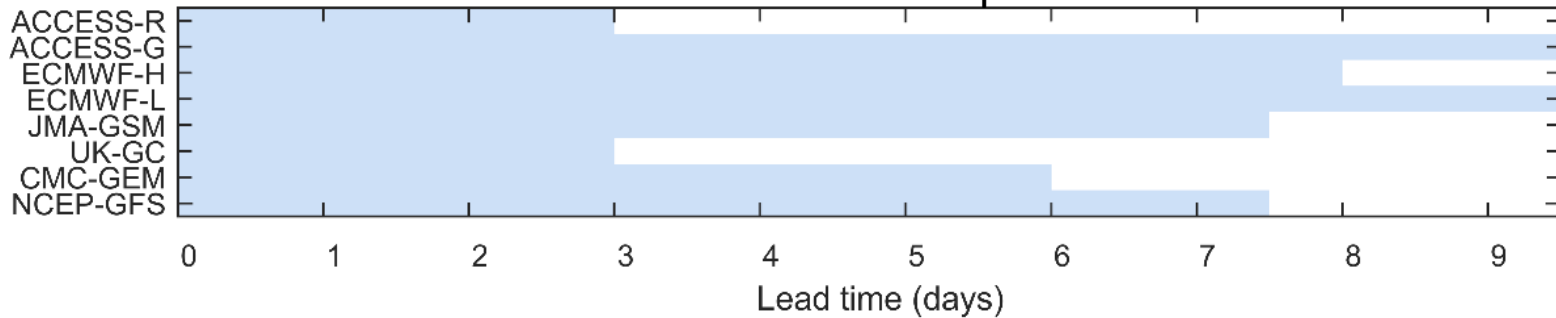1.5   2   2.5   3   3.5   4   4.5   5
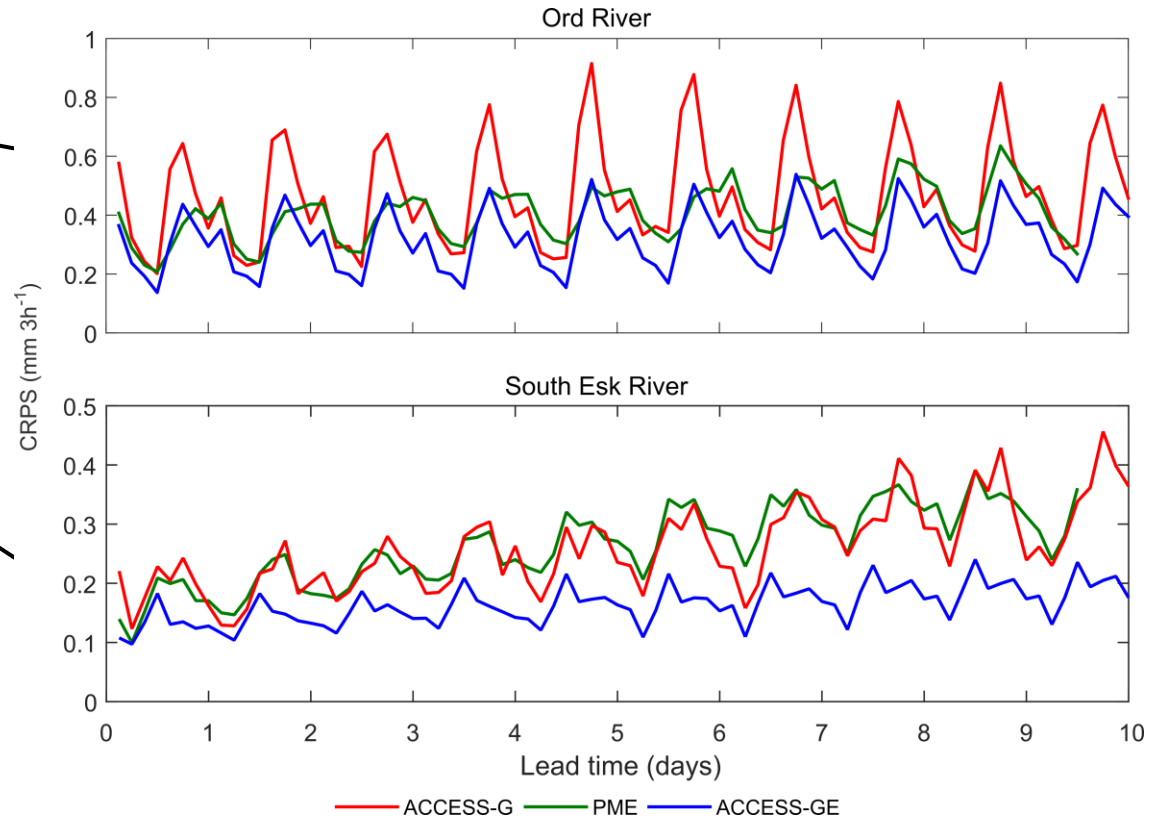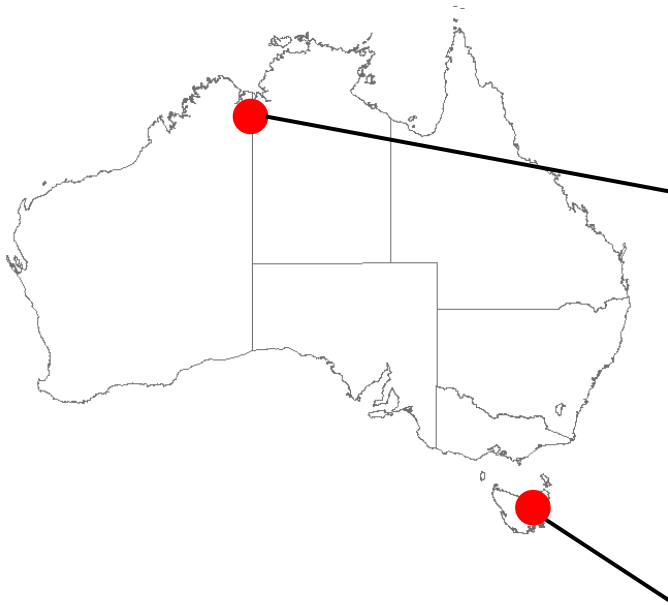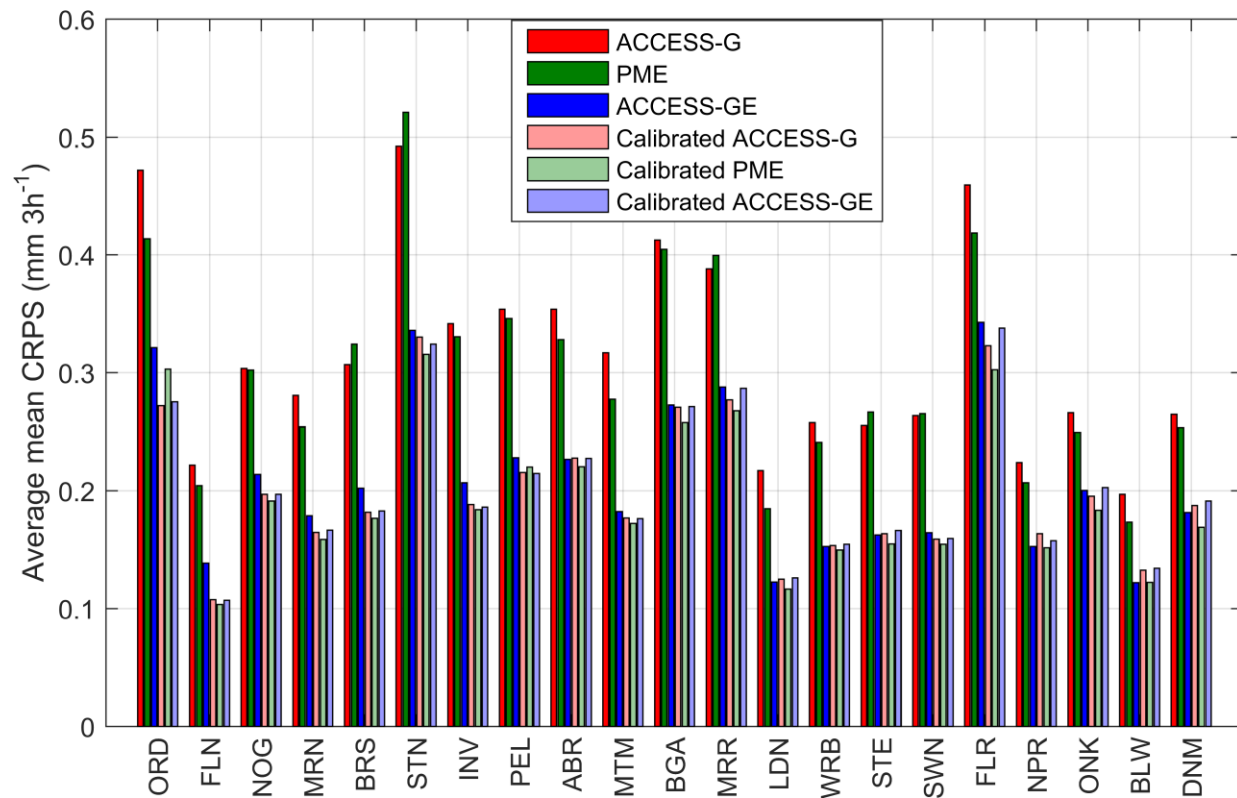
CSIRO
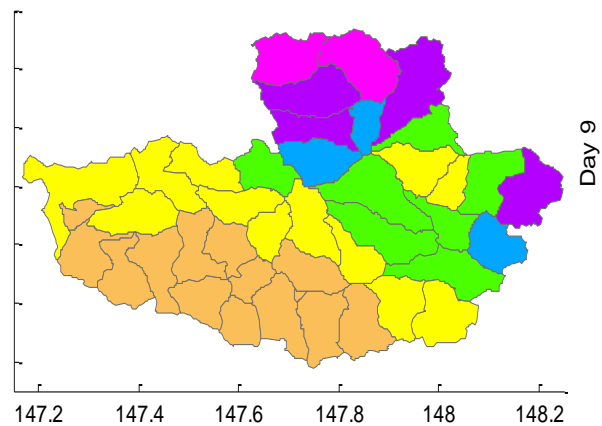
What rainfall forecast product?

NWP output

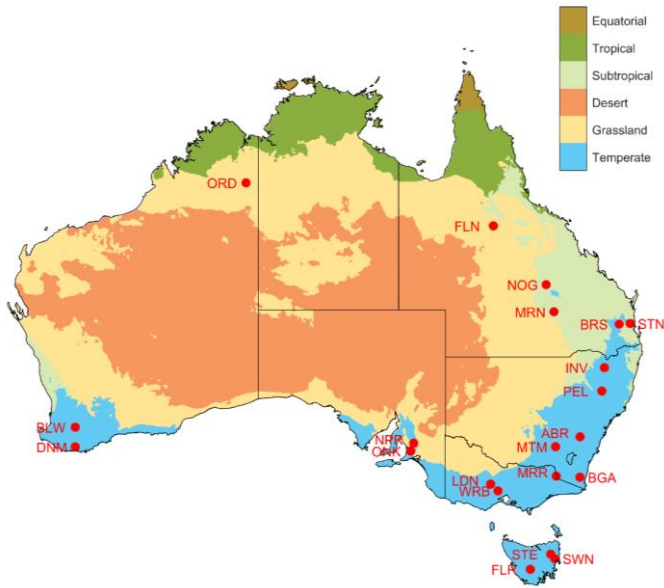Forecaster updated

Combined NWP output

What forecast product?

What forecast product?

Ensemble forecast system components

- ## Observed data

    Adapted from existing flood forecasting service

- ## Rainfall forecasts

    RPP (Bayesian rainfall post-processor)

- ## **Runoff and routing models**

    Semi-distributed; GR4H, Muskingum …

- ## **Hydrological error**

    Dual pass error correction (Pagano, Wang, Hapuarachchi, Robertson, 2011, JoH)
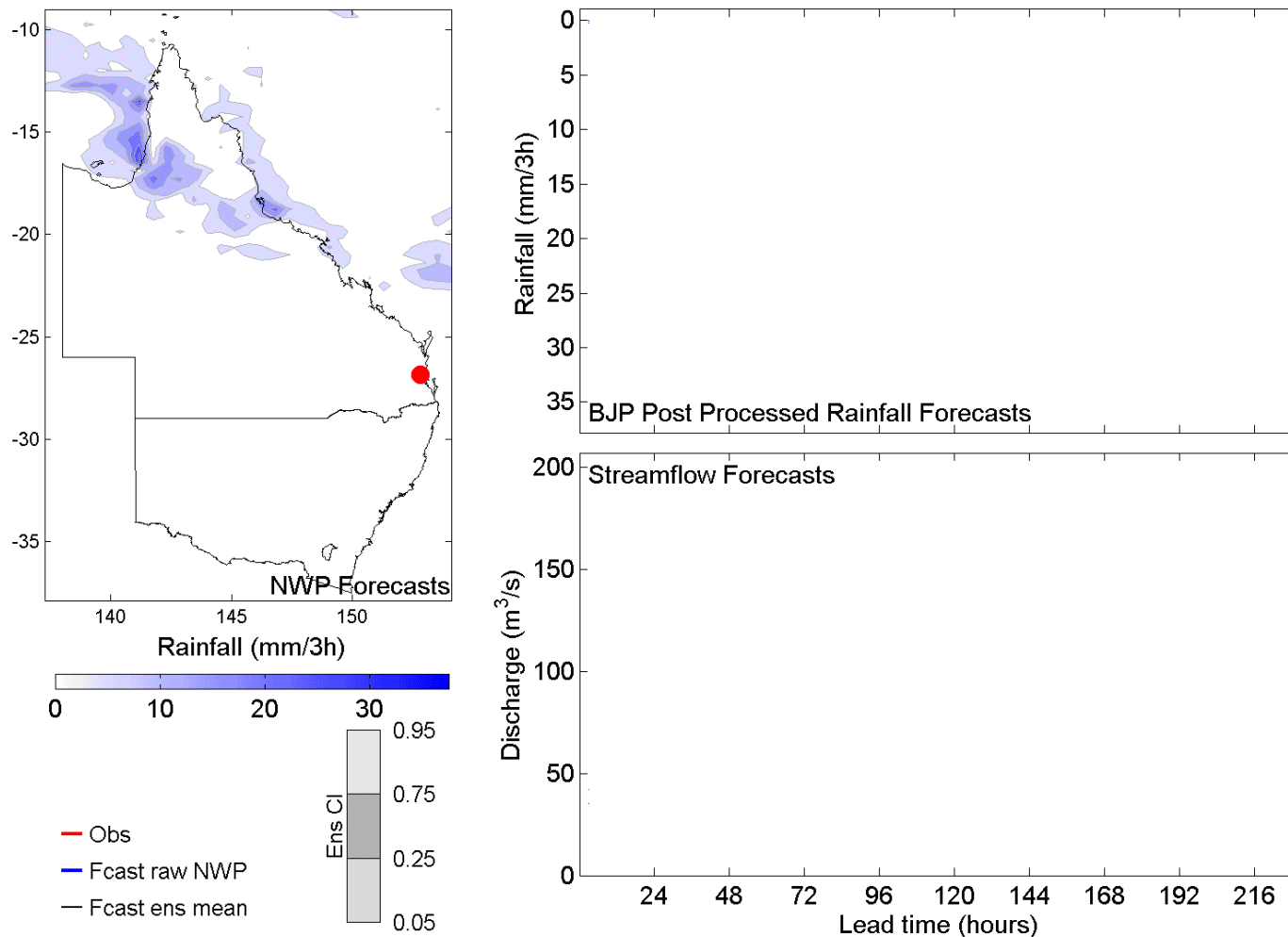
- ## Verification

    Cross validation scheme

Hydrological modelling

DEM: Murray, WA

Node Link: Murray, WA
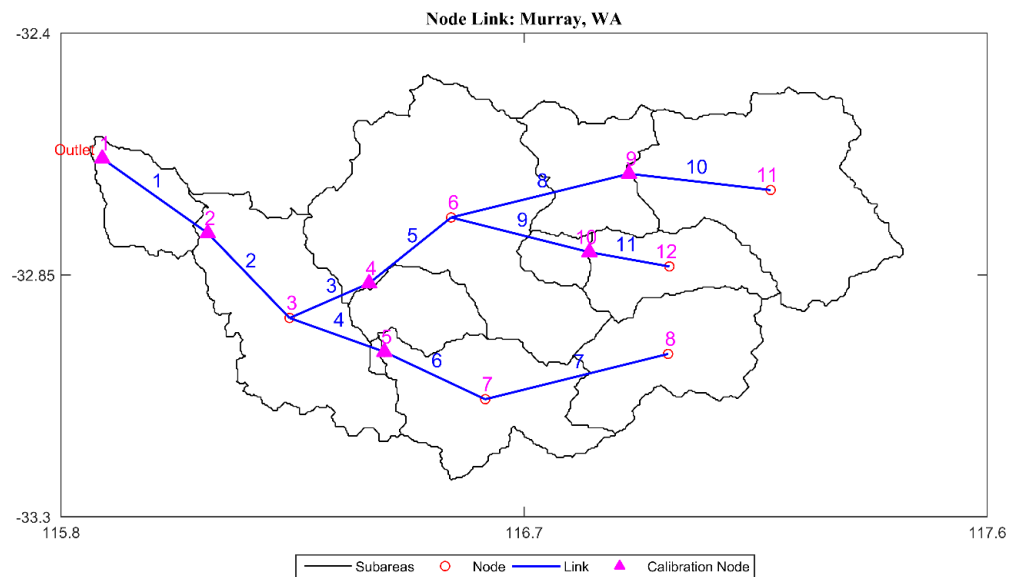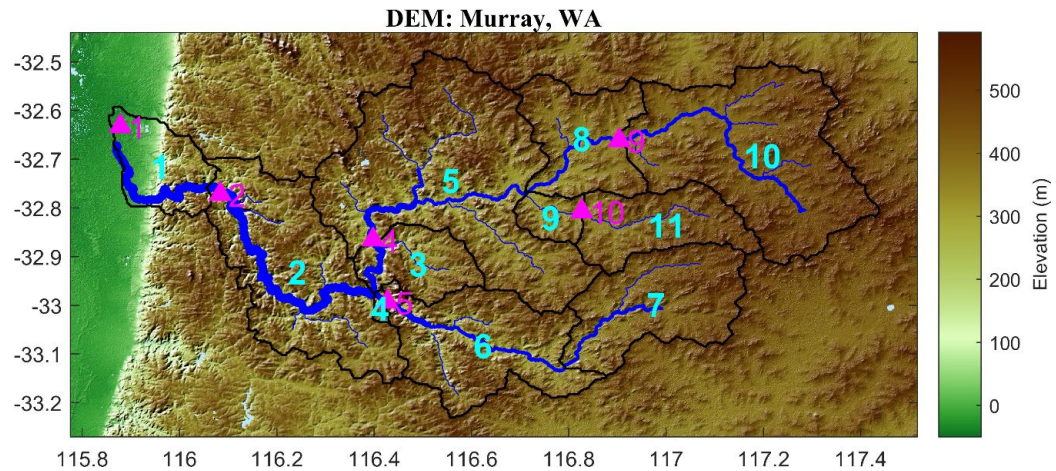
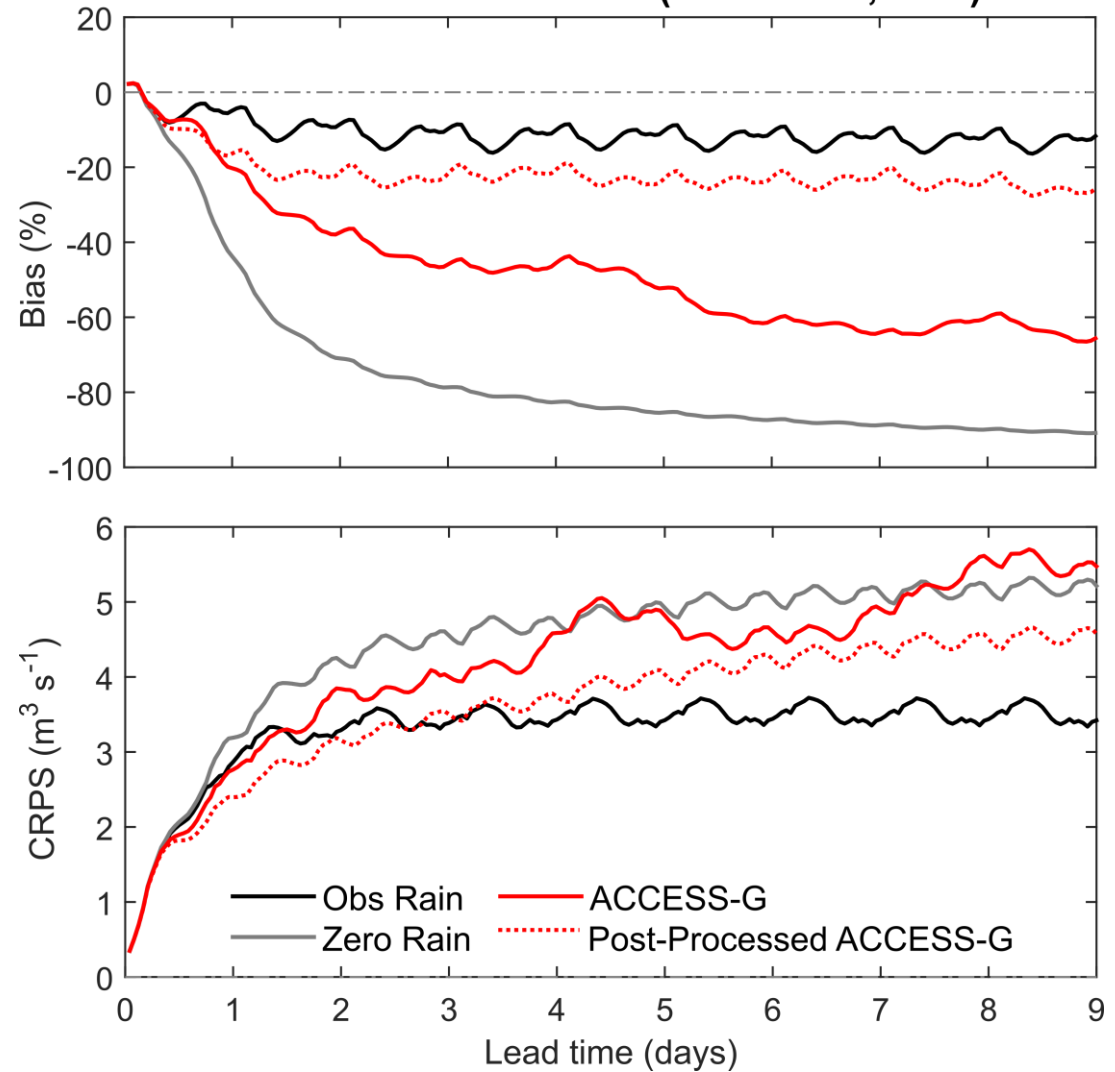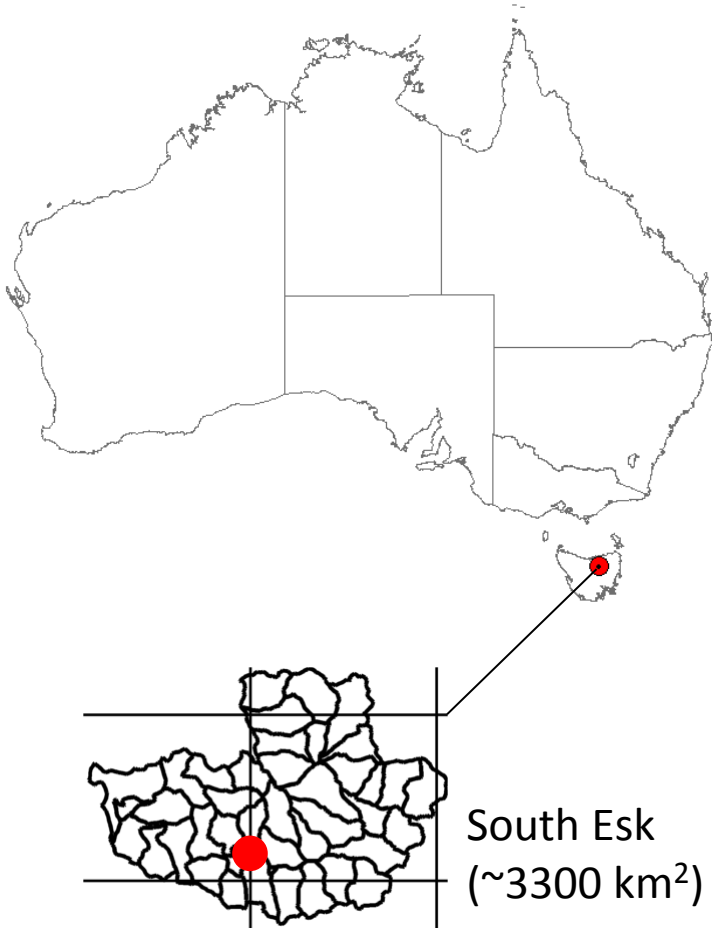Bennett, Robertson, Shrestha, Wang, Enever, Hapuarachchi, Tuteja (2014) JoH

Streamflow forecasts - putting it all together

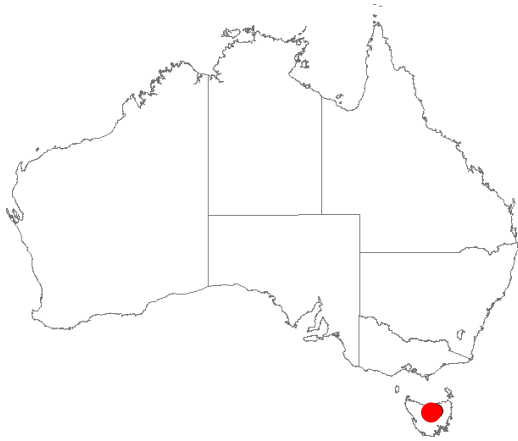Forecasts issued on 18-Mar-2012 21:00 for 19-Mar-2012 00:00 (UTC)

Bennett, Robertson, Shrestha, Wang, et al. (2014) JoH

Performance of streamflow forecasts

St. Pauls R a/b Avoca (South Esk, TAS)

South Esk
(~3300 km²)

Streamflow forecast reliability

Florentine River (169 km^2)

1 hour lead

60 hour lead

Error Reduction and Representation in Stages (ERRIS)

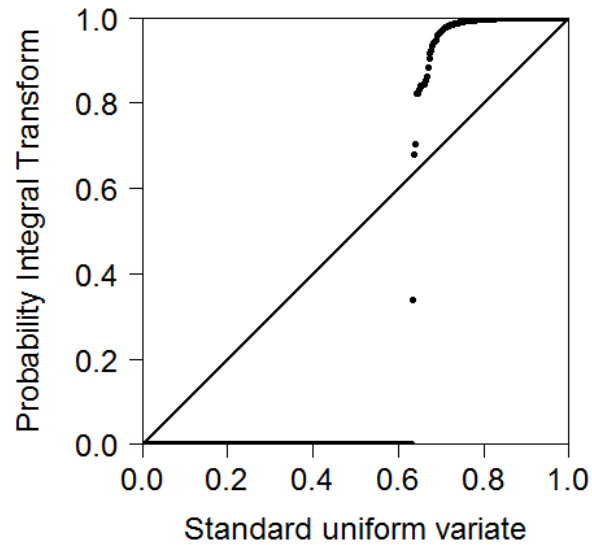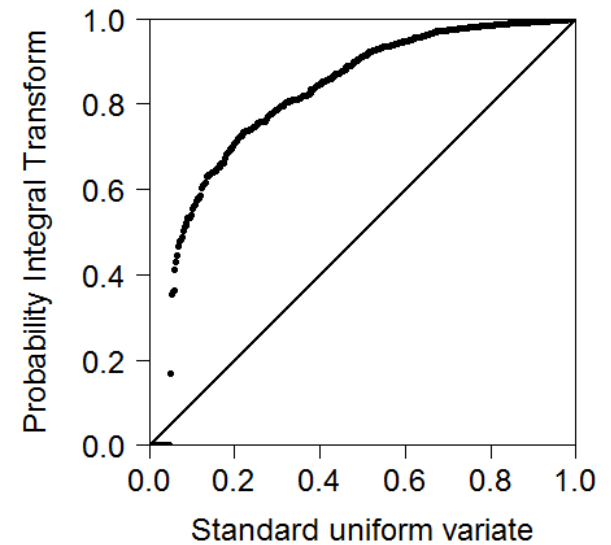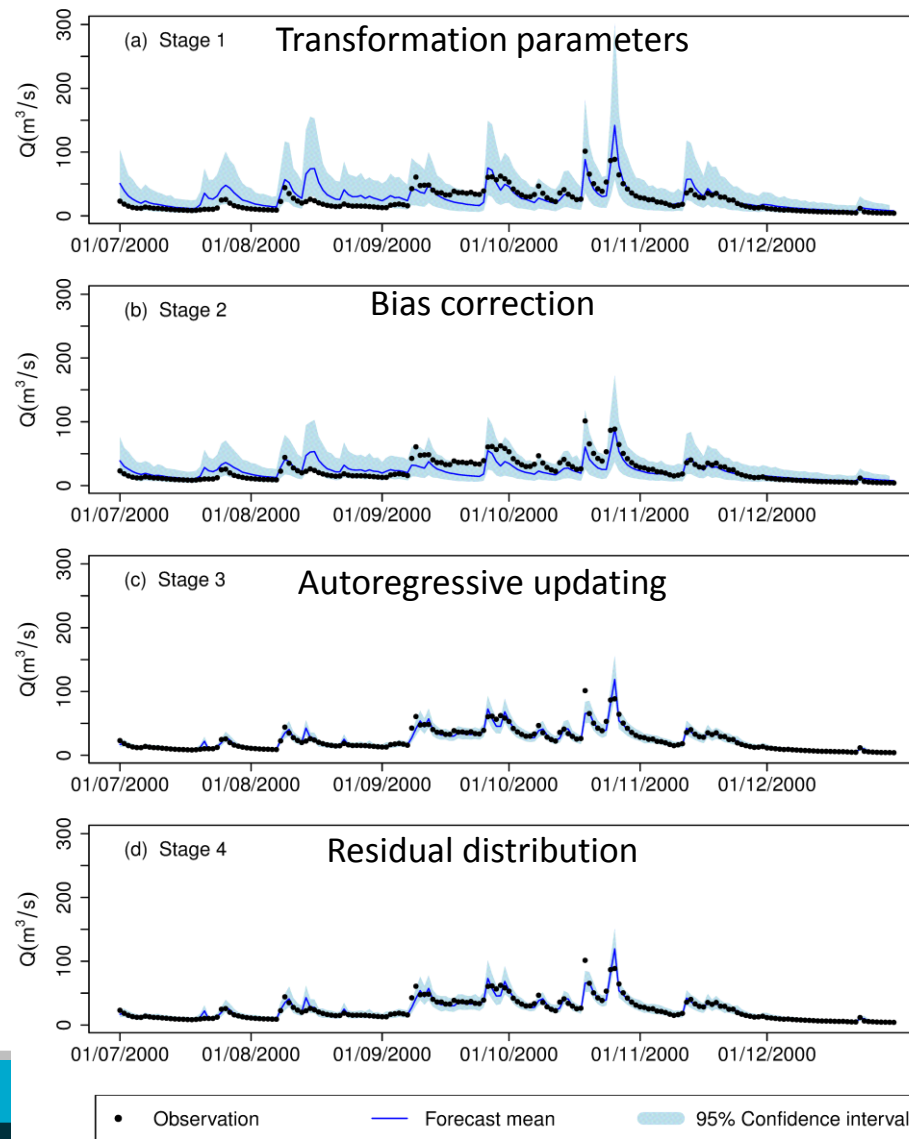# Performance of streamflow forecasts

Florentine River (169 km²)

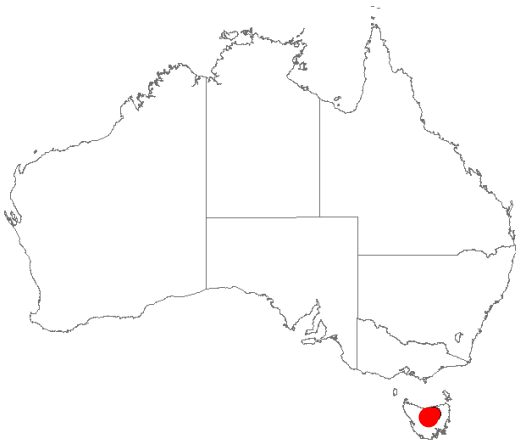# Streamflow forecast reliability
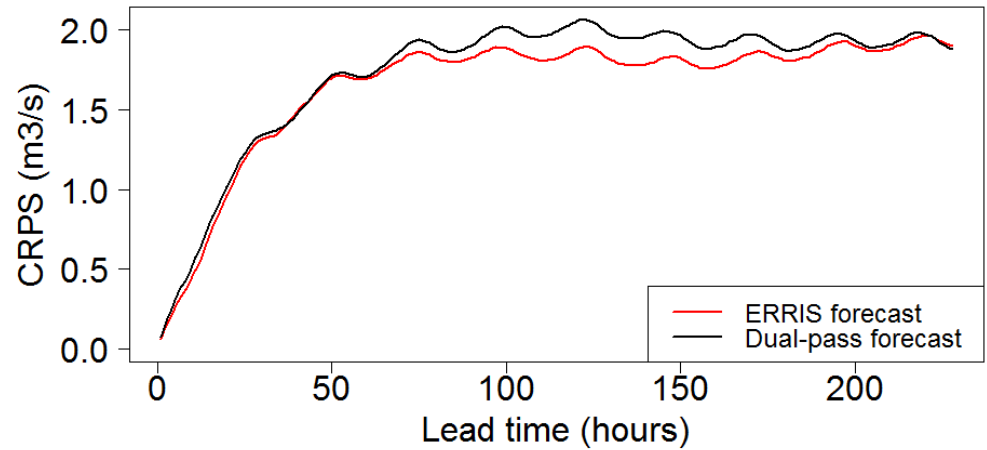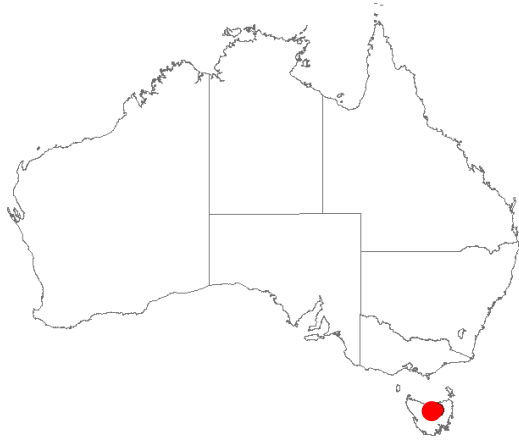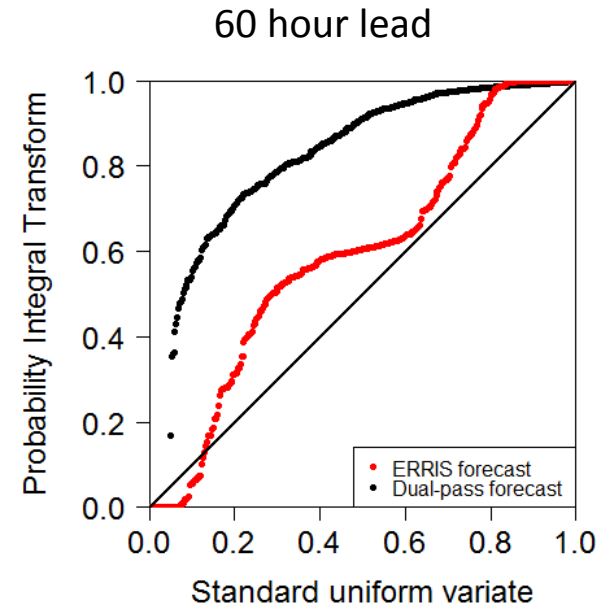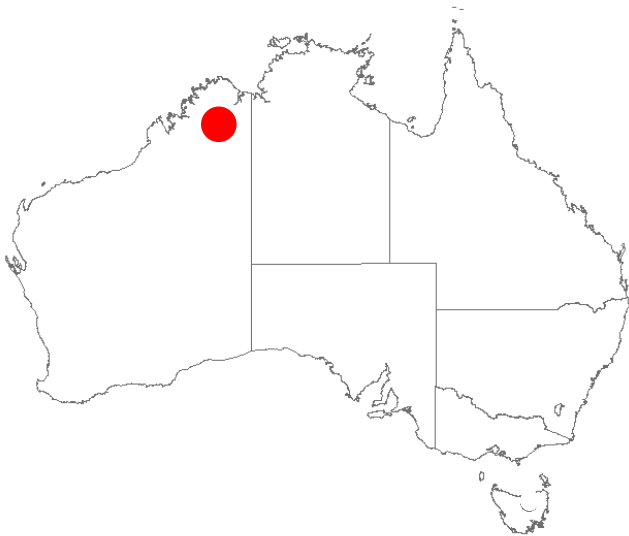
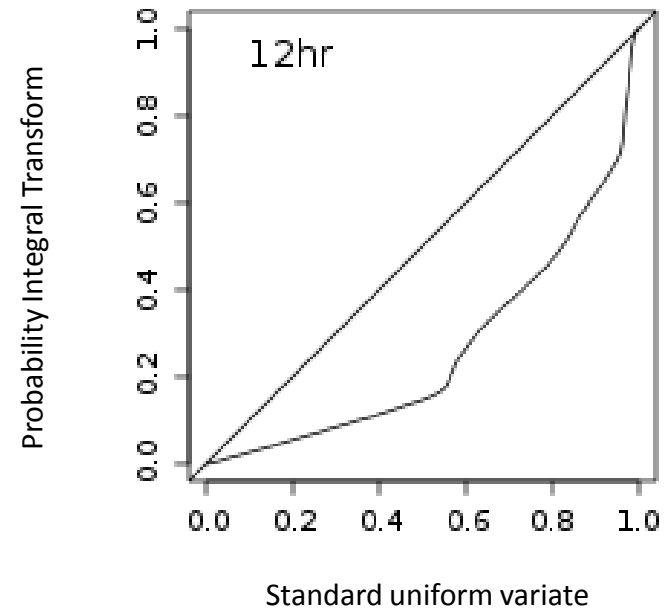Florentine River (169 km²)

1 hour lead
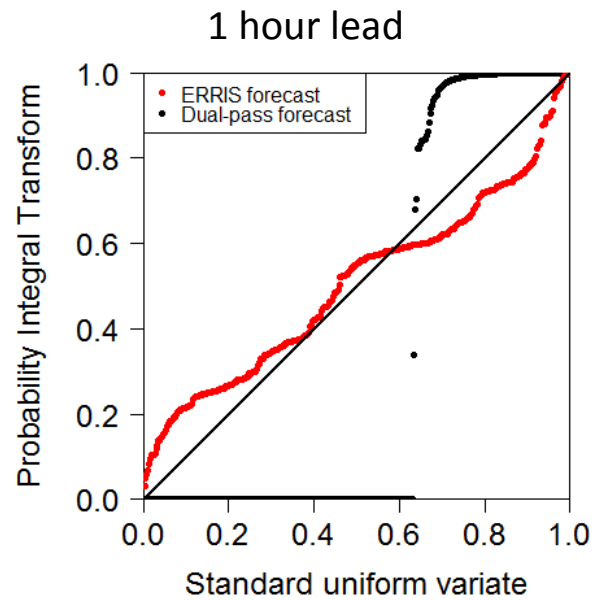
60 hour lead

Forecast reliability in ephemeral catchments

Ord River

ERRIS @ 12 hour lead

Summary

Users are demanding reliable ensemble forecasts for lead-times to 7 days

Post-processing catchment precipitation forecasts

- Necessary for forecasts to 'beat' climatology
- More important that the source of forecast precipitation

Generating accurate and reliable ensemble streamflow forecasts requires

- Reliable ensemble rainfall at the catchment scale with minimal bias
- Correction and quantification of errors in hydrological modelling

Ongoing research directions

- Producing reliable uncertainty in ephemeral catchments
- Dealing with streamflow forecast bias
- Better (ensemble) estimates of catchment rainfall

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