



# Verification methods for probabilistic streamflow forecasts

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A water information R & D alliance between the Bureau of Meteorology and CSIRO's Water for a Healthy Country Flagship



**Australian Government**  
**Bureau of Meteorology**

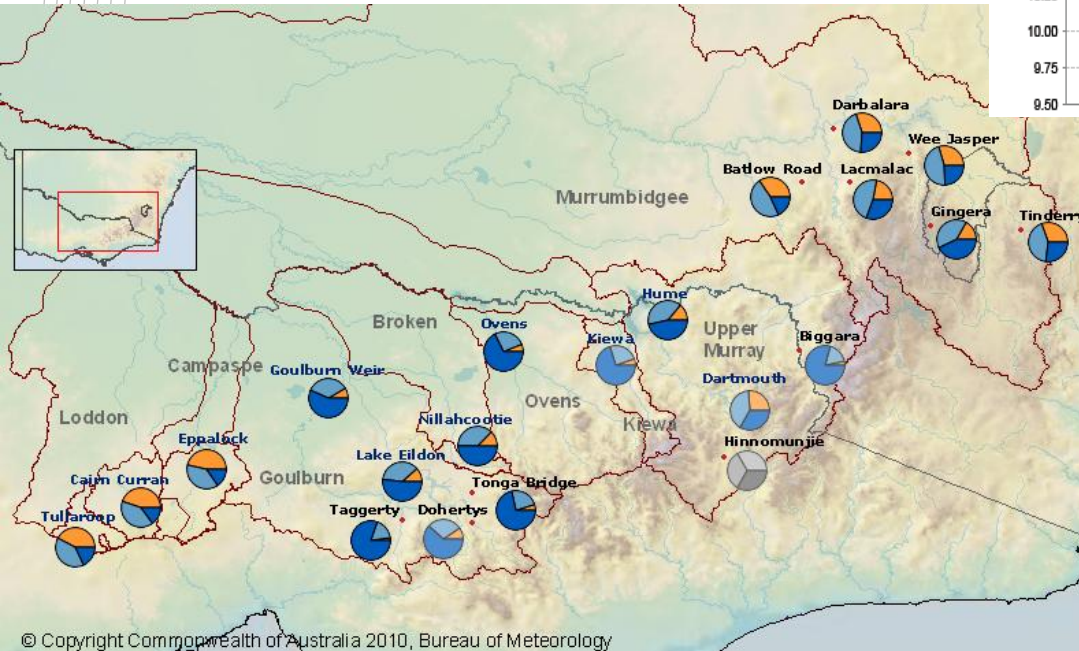
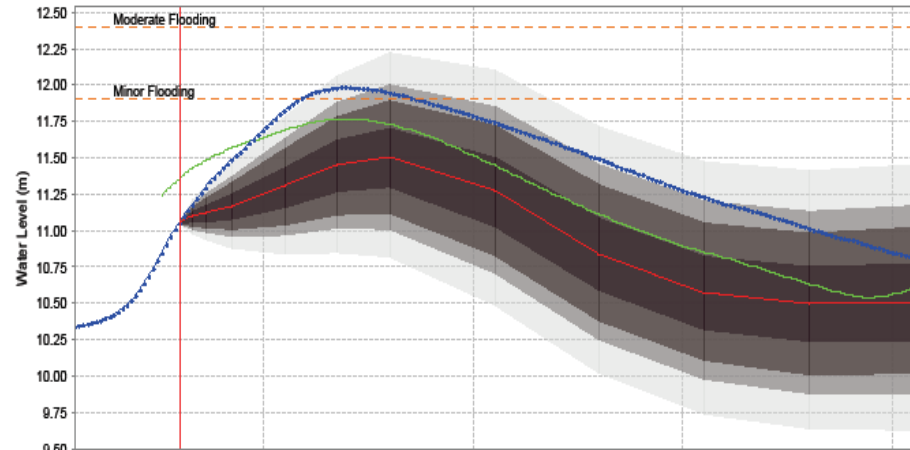


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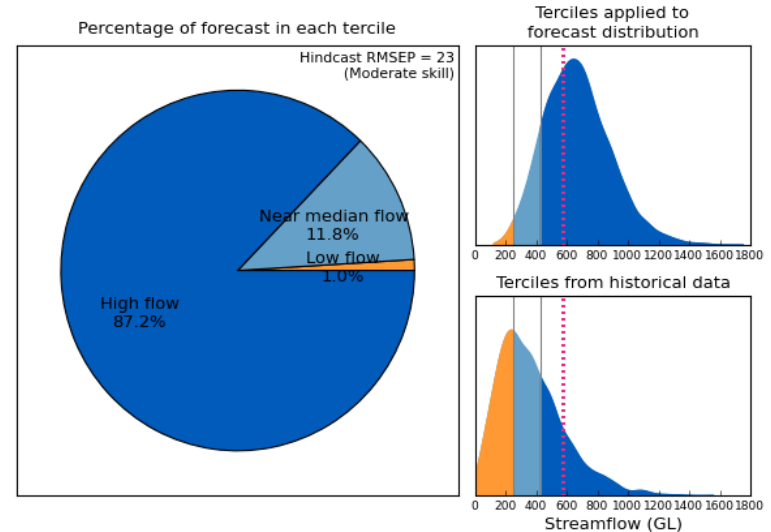
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# Context



**Total inflow to Lake Eildon**  
Forecast period: Oct 2010 - Dec 2010



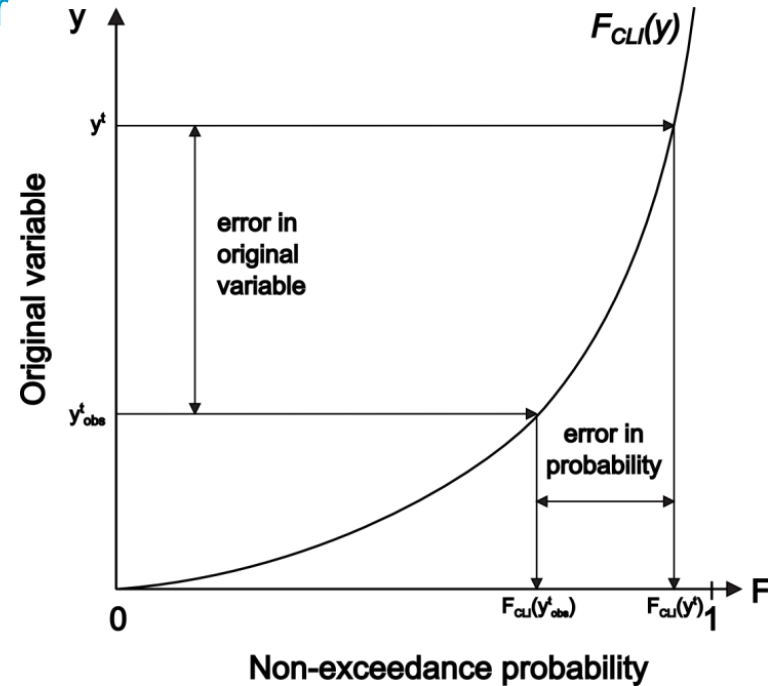
Source: Bureau of Meteorology

# Forecast verification

- Comparison of forecasts and actual observations
- Purposes
  - Benchmarking performance
  - Diagnosing improvements
  - Comparing forecast systems
- Application to retrospective and real-time forecasts
- Verification of probabilistic forecasts is complex
- Aspects of probabilistic forecast performance
  - Accuracy, skill, reliability, robustness

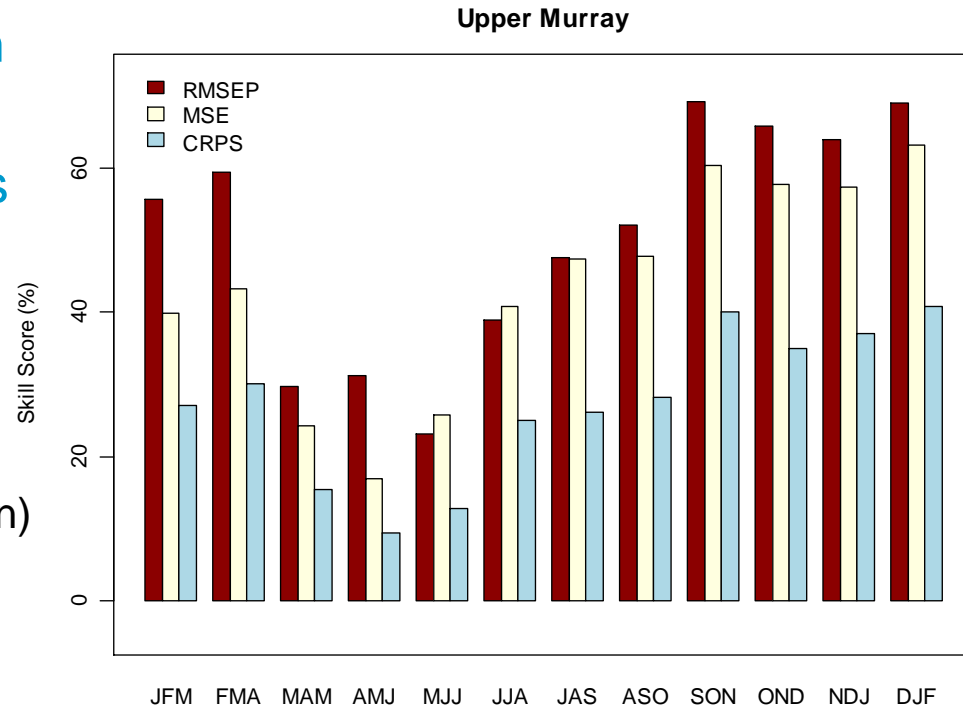
# Forecast accuracy

- Accuracy is a measure of forecast error
- Many scales to measure error
  - Original variable e.g. MSE, MAE
  - Probability e.g. LEPS, RMSEP
  - Combination e.g. CRPS
- Aspects for forecast distribution
  - Error of mean, median, mode
  - Expected value of error
- Different sensitivities



# Forecast skill

- Reduction in error relative to an alternative forecasting method
- Alternative forecasting methods
  - Climatology
  - Persistence
- Adopted measures
  - MSE skill score (forecast median)
  - RMSEP skill score (forecast median)
  - CRPS skill score
- Method comparison of requires reliable probability distributions

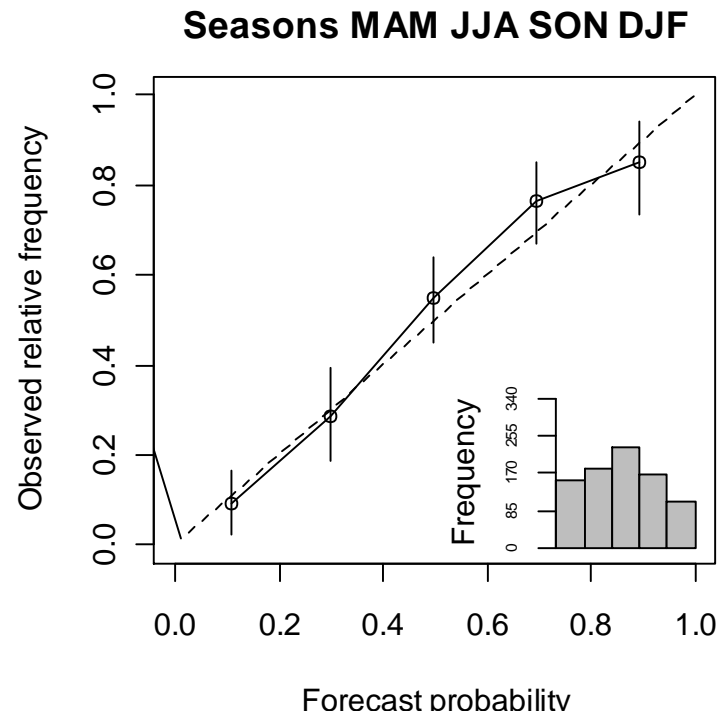


# Forecast reliability

- Quality of probability distribution
  - “Correspondence between forecast probability and observed frequency of associated events”
- Adopted tools
  - Reliability diagrams
  - PIT diagrams

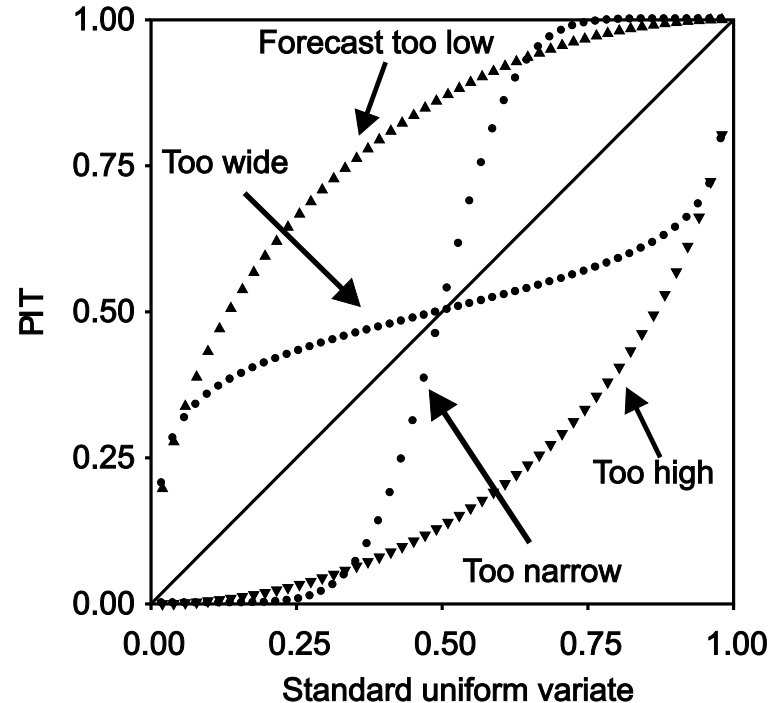
# Reliability Diagrams

- Assess reliability of the probability of a forecast event
  - e.g. probability of exceeding median
- Require many forecasts
  - Pooling of forecast locations/seasons
- Sensitivities
  - Sample variability
  - Binning



# PIT Diagrams

- Probability of observation given the forecast probability distribution
- Uniform distribution if forecasts reliable
- PIT diagrams
  - PIT – Uniform probability plot
  - PIT Histogram
- Statistical tests for uniform distribution

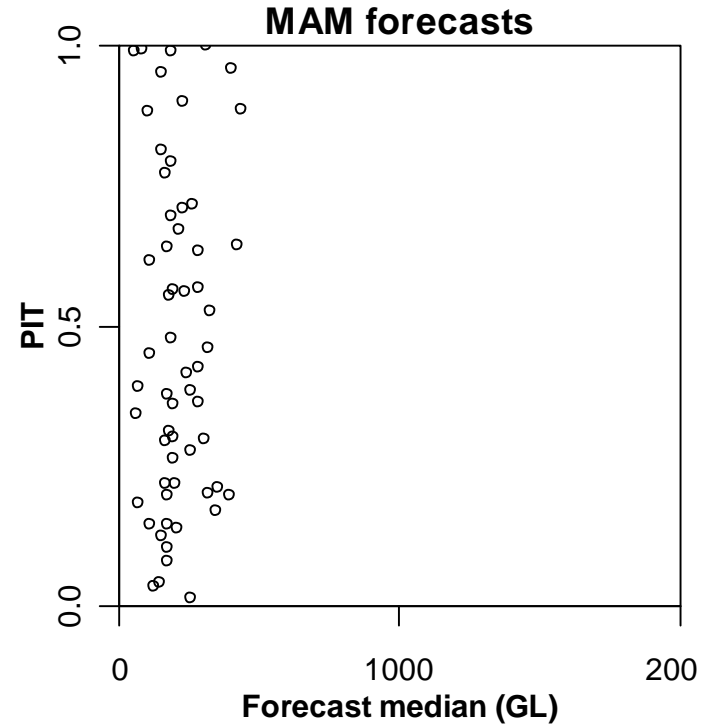
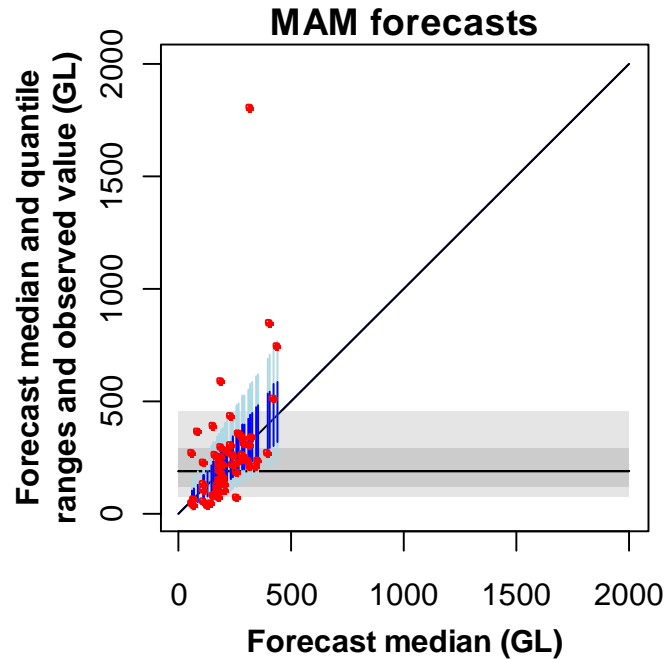




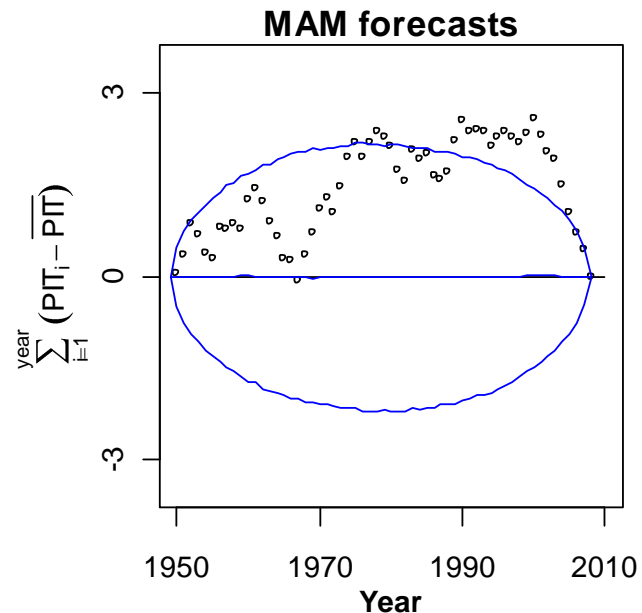
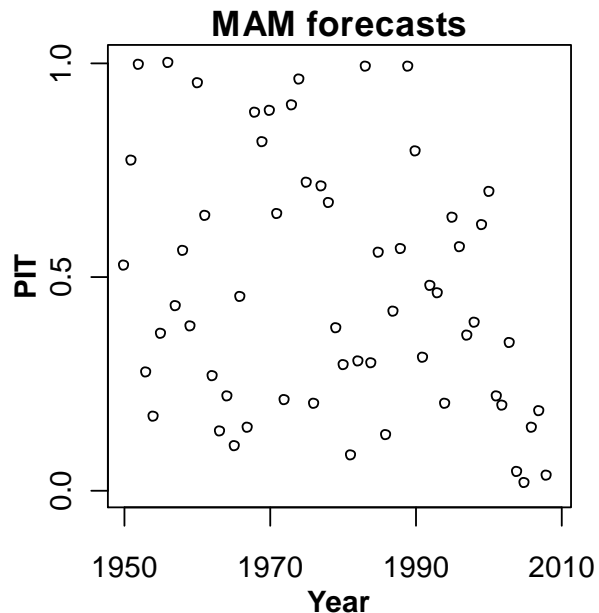
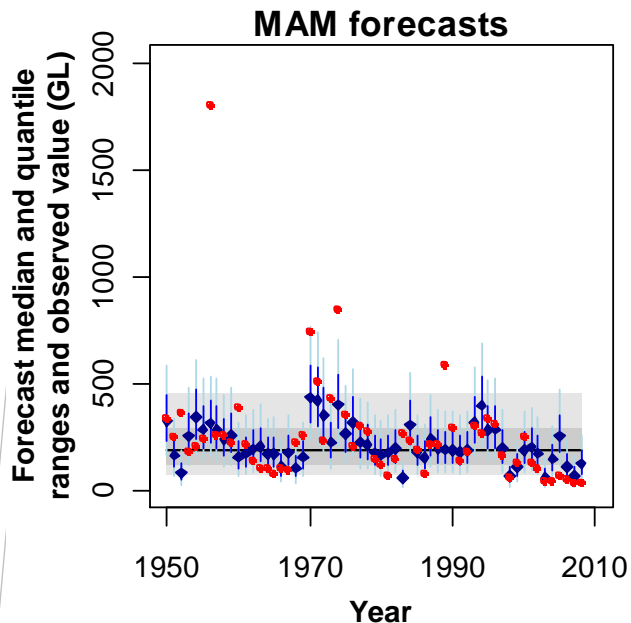
# Forecast robustness

- Accuracy and reliability measures of overall performance
- Robust forecasts have no conditional bias
  - Event size
  - Time
- Adopted tools
  - Forecast quantiles and observed values vs forecast median and time plots
  - PIT vs forecast median and time plots
  - Cumulative deviation plots

# Forecast robustness - event size



# Forecast robustness - time



# Concluding comments

- Many aspects to verification of probabilistic forecasts
  - Accuracy, skill, reliability and robustness
- A range of techniques exist to assess different aspects
  - Graphical tools
  - Statistics used to understand impact of sample variability
- Careful application and interpretation necessary
  - Availability of data
  - Implicit assumptions

## CSIRO Land and Water

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# Thank you

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