Australia's National Science Agency

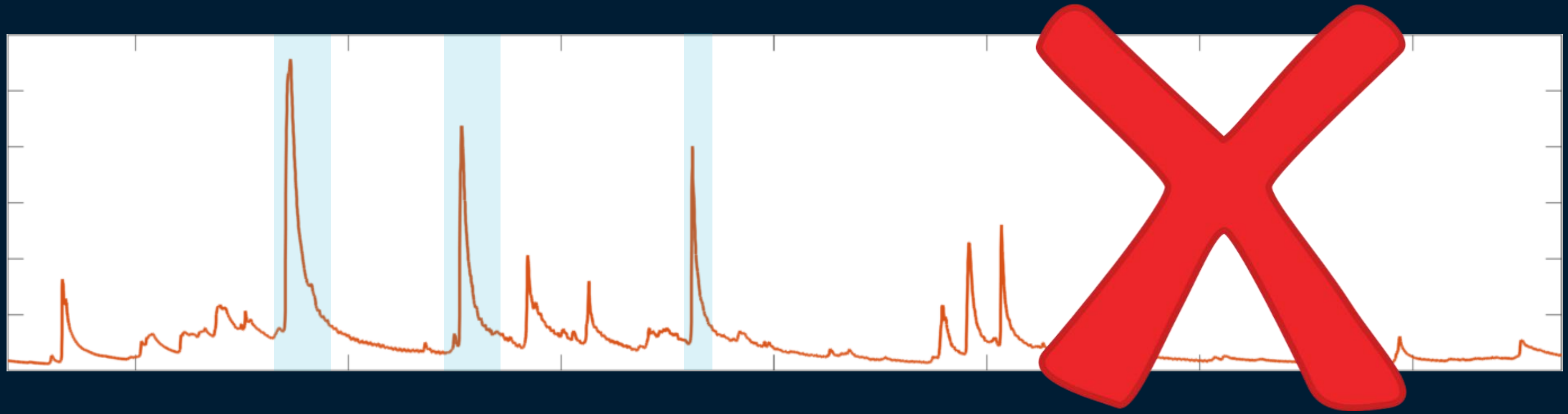
How can we check the reliability of ensemble flood forecasts?

James Bennett & David Robertson | 19 Nov 2020

The problem

- Low streamflows are not like floods!
- How to verify the bits we want?

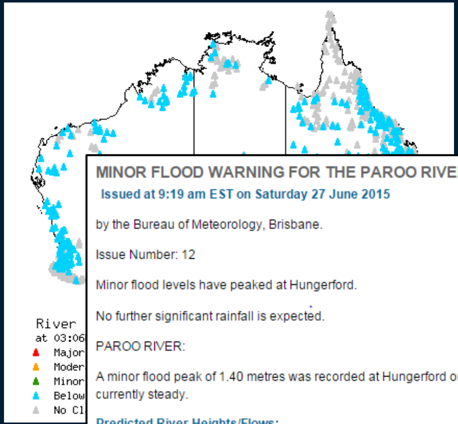
The problem



- Low streamflows are not like floods!
- How to verify the bits we want?

Some context: Aus forecasting services

Flood forecasting



MINOR FLOOD WARNING FOR THE PAROO RIVER

Issued at 9:19 am EST on Saturday 27 June 2015

by the Bureau of Meteorology, Brisbane.

Issue Number: 12

Minor flood levels have peaked at Hungerford.

No further significant rainfall is expected.

PAROO RIVER:

A minor flood peak of 1.40 metres was recorded at Hungerford on Friday morning. River levels are currently steady.

Predicted River Heights/Flows:

PAROO RIVER at:

HUNGERFORD: River levels will remain steady during Saturday and start to fall on Sunday. River levels may fall below the minor flood level during Monday.

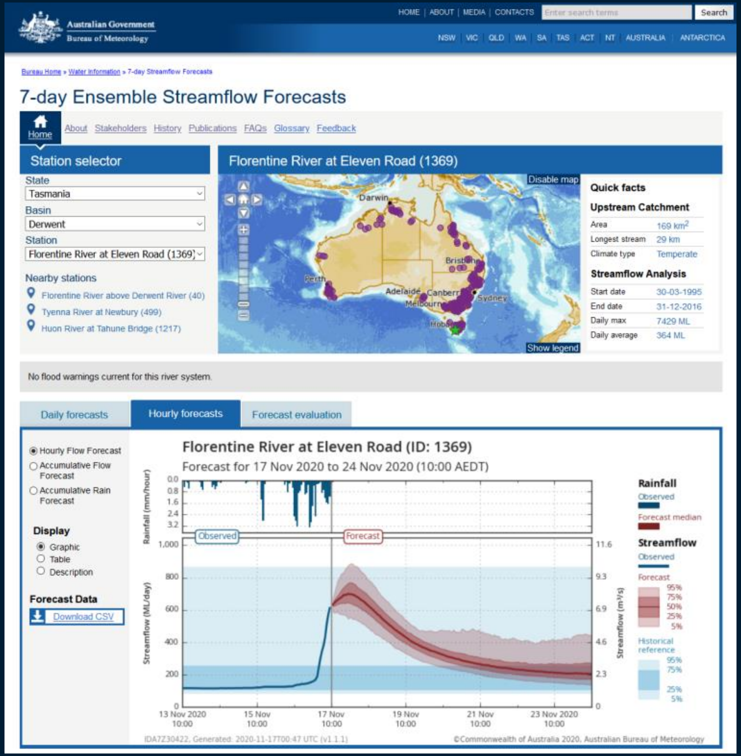
Remember: If it's flooded, forget it.

For flood emergency assistance contact the SES on 132 500

- Flood watch … **situation”**
- Flood warning: **“flooding is occurring or expected to occur”**

http://www.bom.gov.au/water/

7-Day Ensemble service



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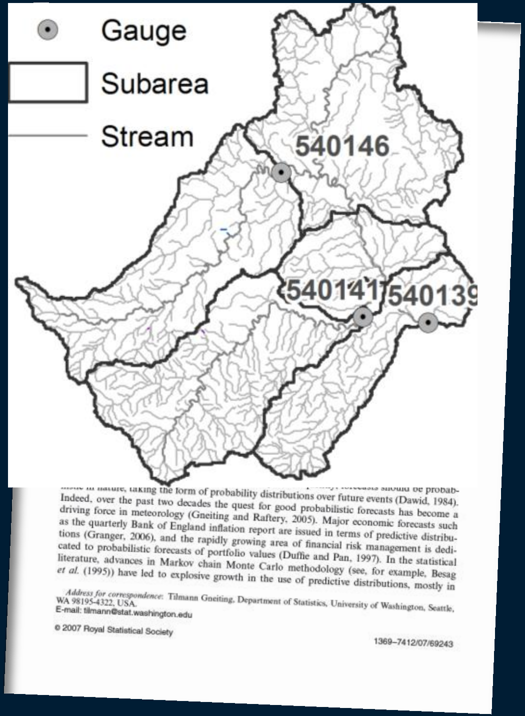
Why care about reliability?

Practical

- Forecast probabilities reflect flood risk
- Uncertainty can be propagated downstream
- Outputs can be used directly
  in decision models

Theoretical

- “Maximise sharpness subject to reliability”
  Gneiting et al.
- No hedging needed



Reliability and forecast selection

- Overall reliability does not guarantee conditional reliability (Hamill 2001)

‘Observation-based’ selection

- Bellier et al. -> Can’t measure reliability
- Lerch et al. -> CRPS not strictly proper

‘Forecast-based’ selection

- Reliability is measurable
- CRPS strictly proper
- False alarms measurable (!)

September 2017 BELLIER ET AL. 3529

Sample Stratification in Verification of Ensemble Forecasts of Continuous Scalar Variables: Potential Benefits and Pitfalls

Joseph Bellier and Isabella Zin

Guillaume Bontron

ABSTRACT

1. Introduction

Forecaster’s Dilem

Forecast Evaluatio

Sebastian Lerch, Thordis L. Thorarins

550

NOTE

Interpretation of Rank

1. Introduction

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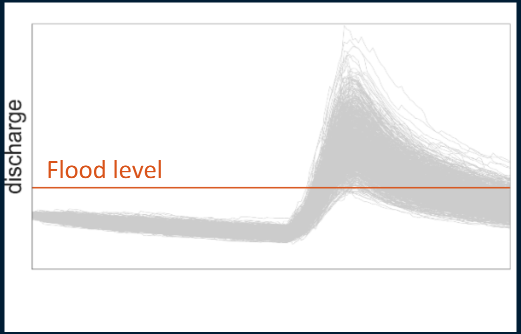
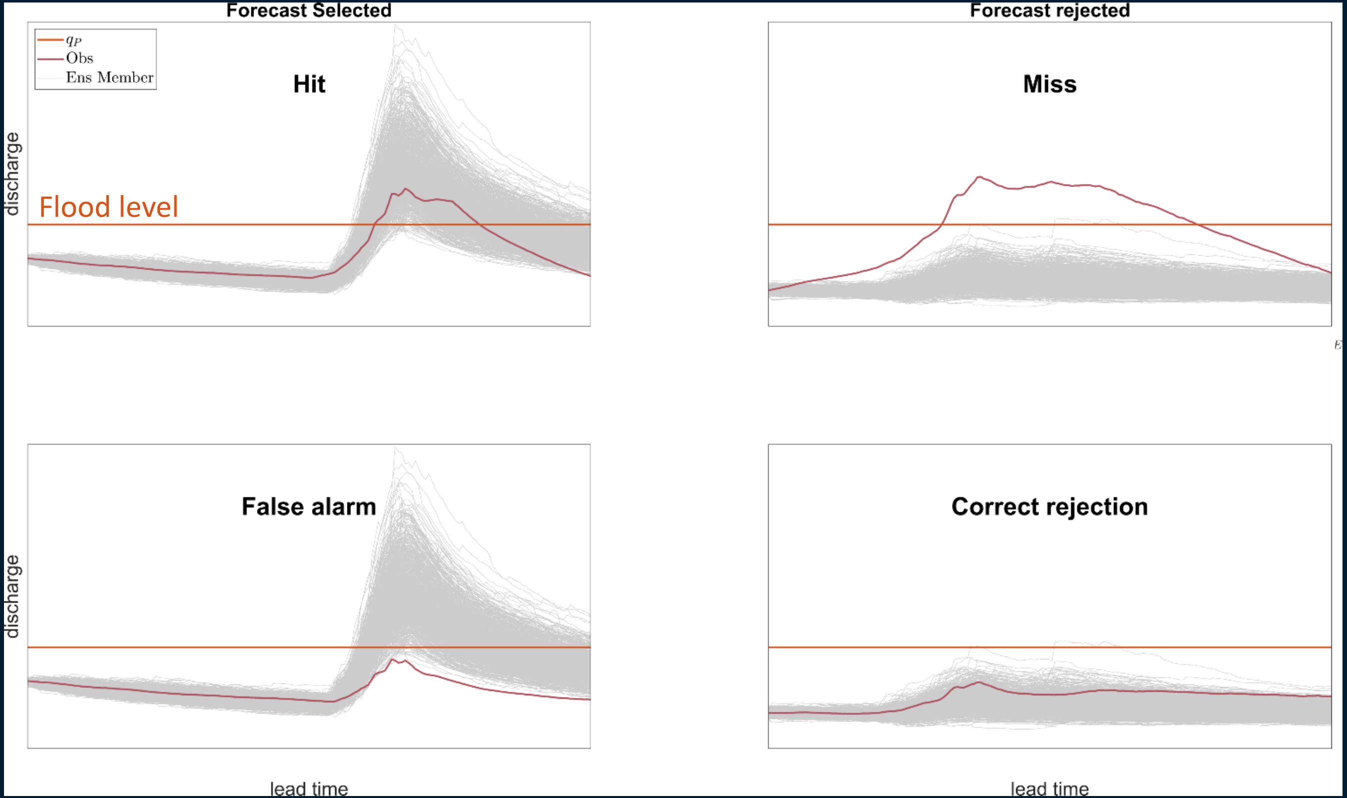
Forecast-based selection

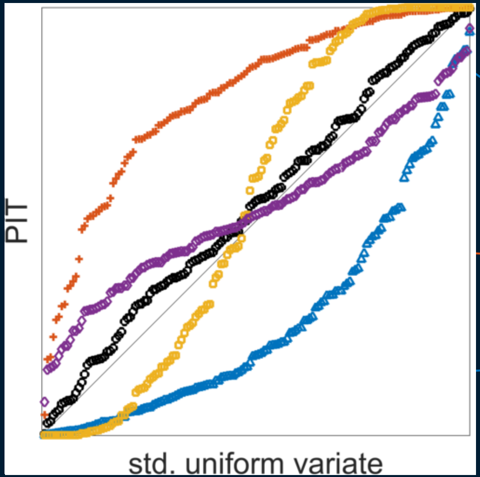


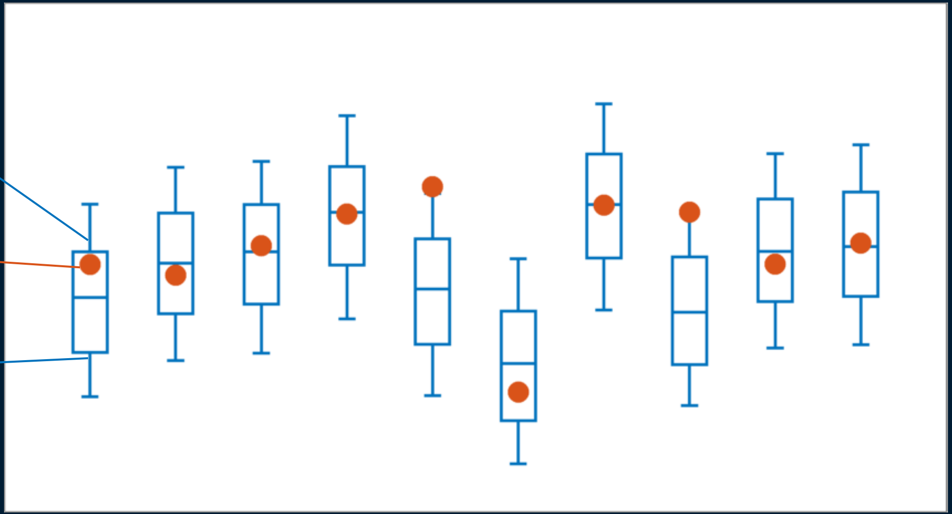
- Heightened probability of flood is forecast -> forecast selected
- Analogous to a ‘flood watch’

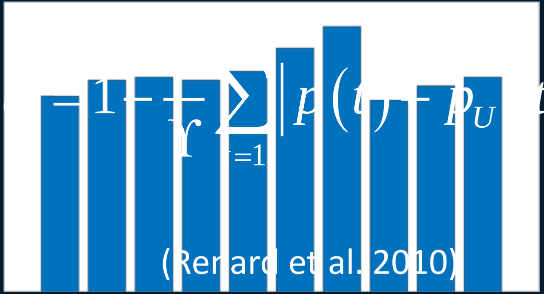
Verifying forecast selection



Reliability – probability integral transform







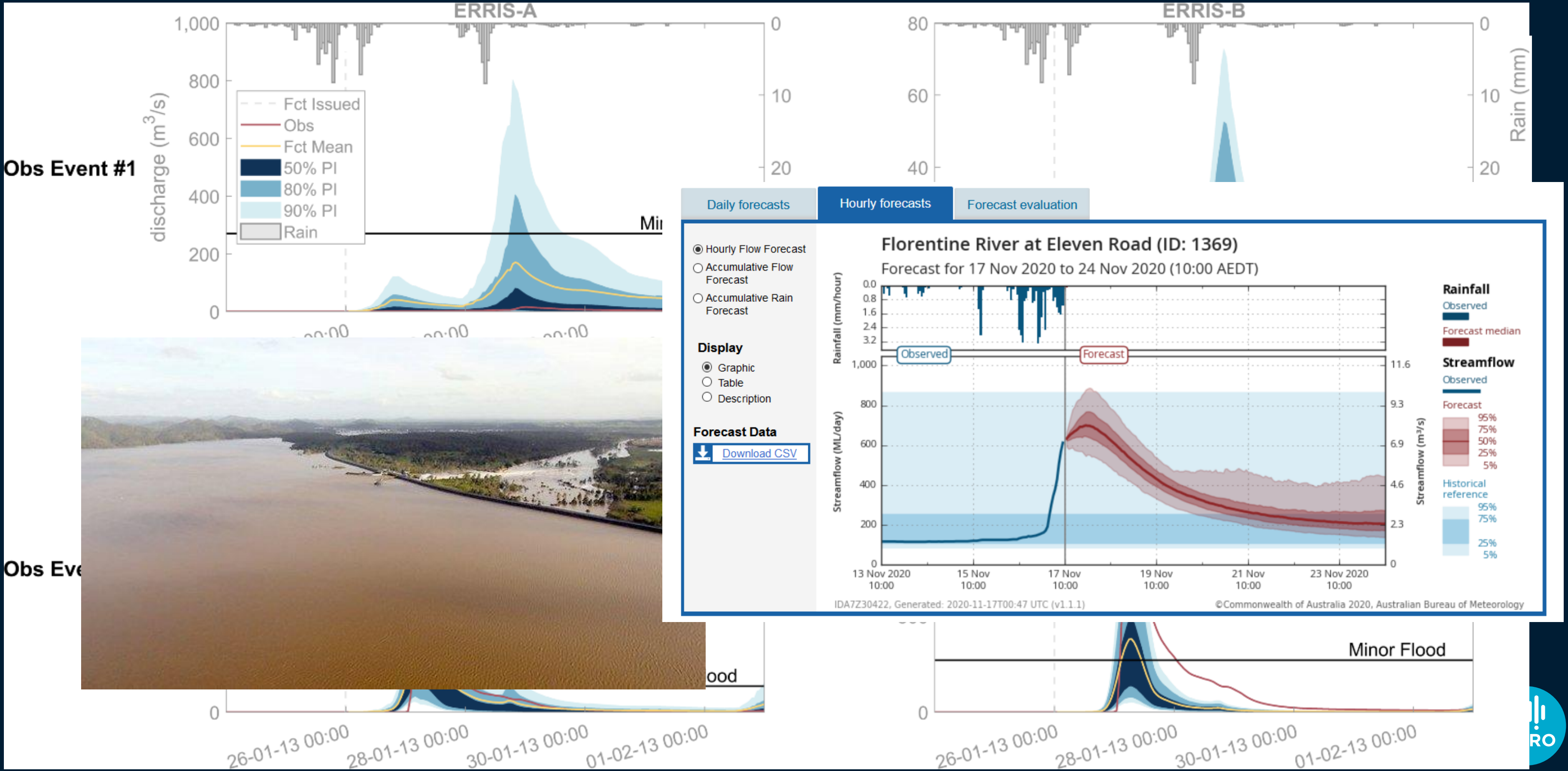
$$= 1 - \frac{1}{Y}\sum_{t=1} \left| p(t) - p_U(t) \right|$$

(Renard et al. 2010)

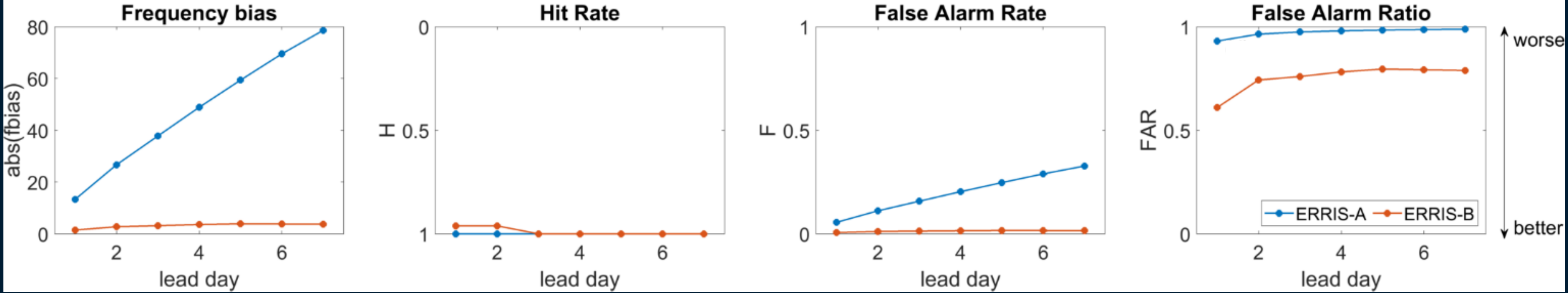
Also need

- Sharpness (AWPI)
- Accuracy (CRPS)

Case study: 2 forecasting methods



Verifying forecast selection



$$\left|\frac{no.\ forecasted\ \ floods - no.\ observed\ \ floods}{no.\ observed\ \ floods}\right|$$

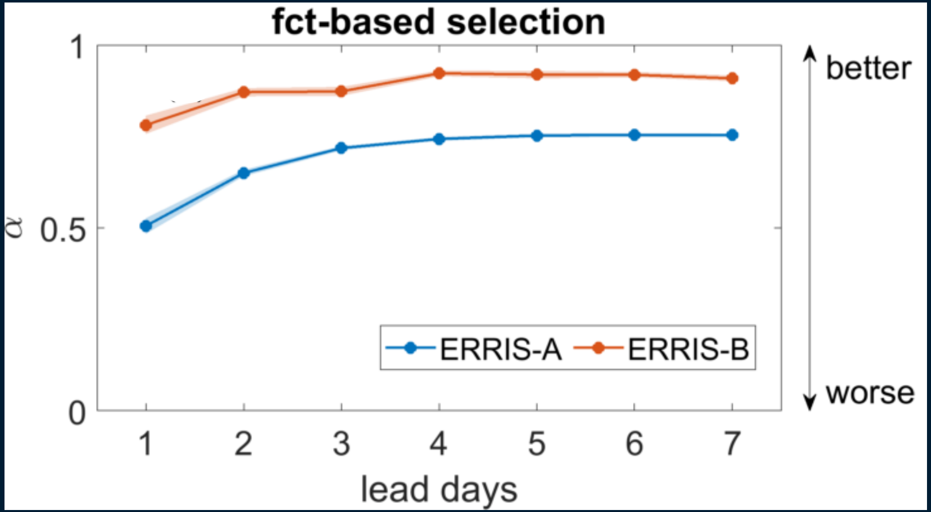
$$\frac{hits}{no.\ observed\ \ floods}$$

$$\frac{false\ \ alarms}{no.\ observed\ \ no\ \ floods}$$

$$\frac{false\ \ alarms}{no.\ forecasted\ \ floods}$$

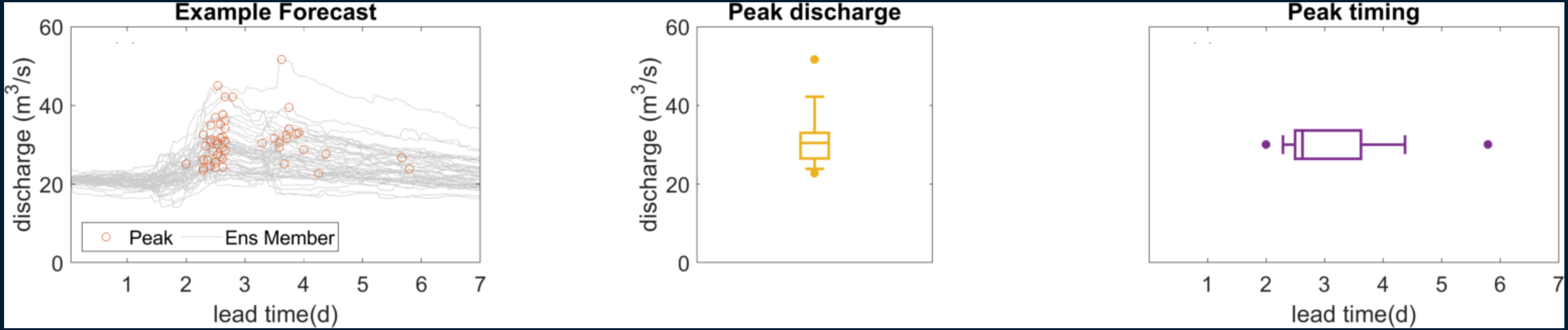
- Flood threshold exceeded in 26 forecasts
- ERRIS-A up to ~2000 forecasts selected
- ERRIS-B up to ~120 forecasts selected

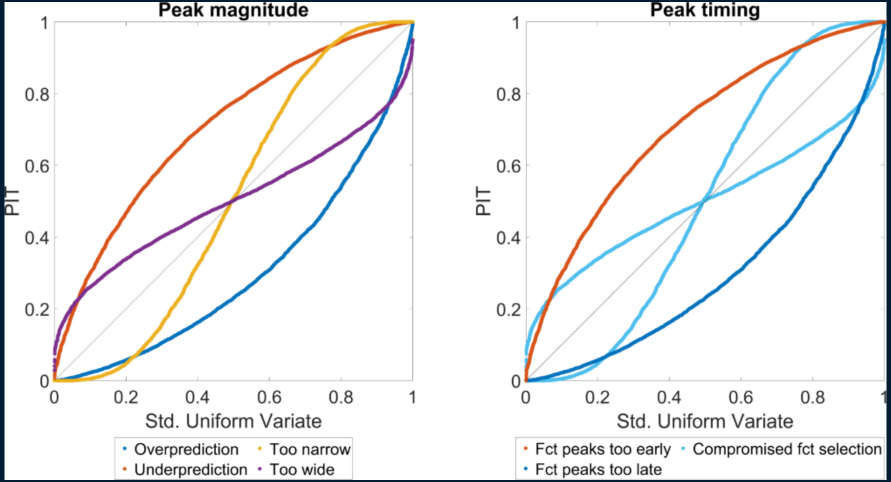
Reliability of flood forecasts



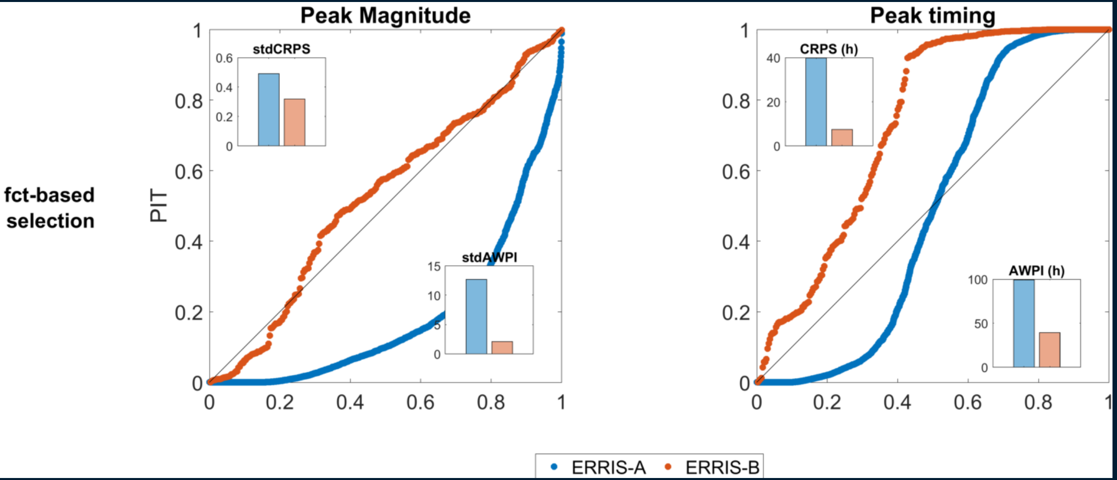
Accuracy and sharpness of flood forecasts

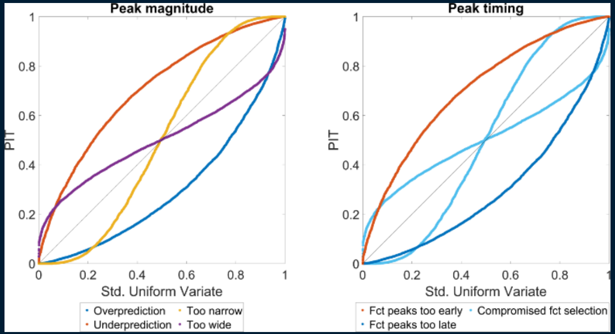
Reliability of flood peak magnitude and timing





Reliability of flood peak magnitude and timing





Recommendations

- Forecast-based selection crucial to measure reliability
  - (and false alarms!)
  - But… forecast-based selection means comparing different numbers of forecasts of different events
- Obs-based selection still useful for communicating performance

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7-day ensemble streamflow forecasting service

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Thank you

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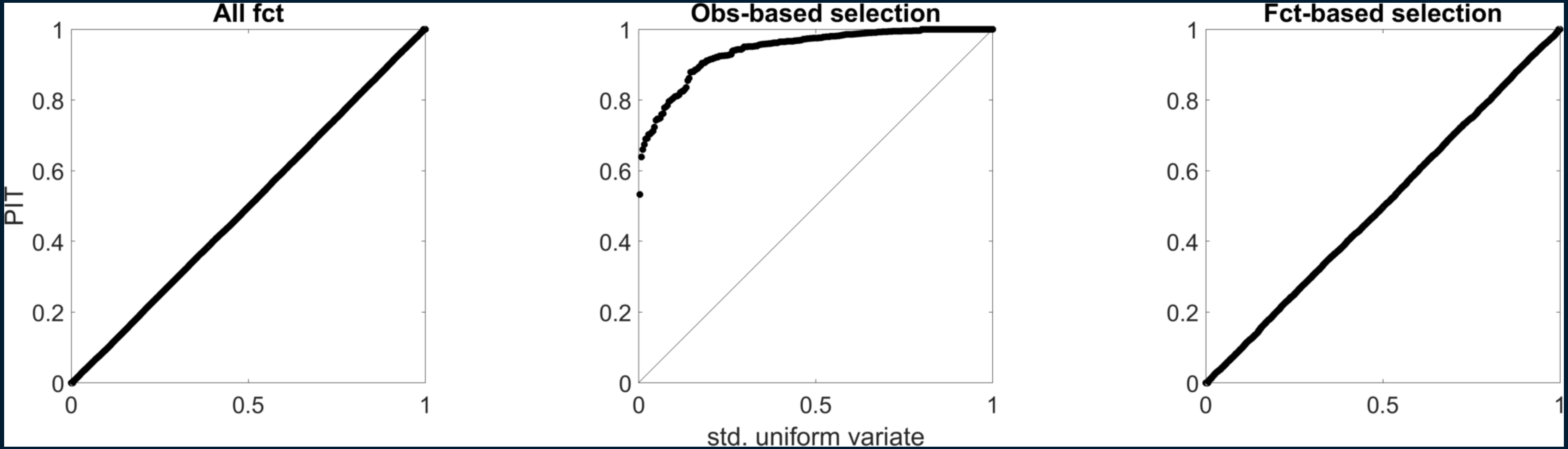
Reliability and forecast selection



Synthetic example

- Obs and forecasts drawn from the same normal distributions
- ‘Flood threshold’ based on 99.5% quantile of ‘observations’

Some context: Aus forecasting services