Seamless subseasonal probabilistic streamflow forecasting

MuTHRE lets you have your cake and eat it too!

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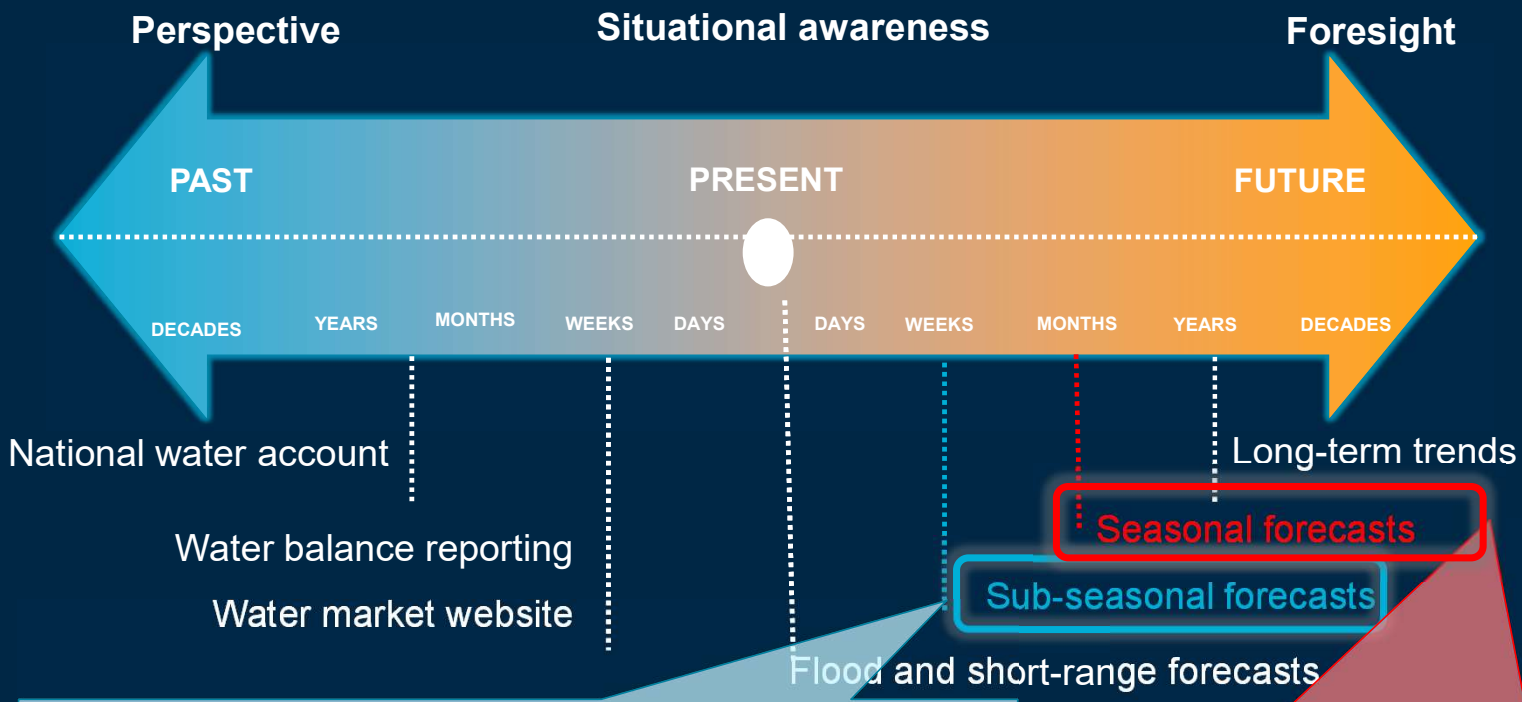
make history.

THE UNIVERSITY of ADELAIDE

Australian Bureau of Meteorology: Water Information Products



New Capability: Seamless Subseasonal Streamflow Daily Forecasts

- Daily forecasts for 0-30 day lead time.
- Seamless forecasts with consistent quality at range of lead times and aggregation time scales (daily/weekly/monthly)

Existing Capability: Non-seamless Seasonal Streamflow Monthly Forecasts

- Available at single time scale/lead time (monthly)
- Cannot be reliably aggregated/disaggregated to longer/shorter lead times

Practical Benefits of Seamless vs Non-Seamless Forecasting

Seamless forecasts can inform decisions at a range of time scales

- Flood warning (up to 1 week)
- Managing hydropower systems (7 and 15 days)
- Managing water supply reservoirs where forecast volumes over lead times of weeks/months
- Non-seamless only works at single time scale

Seamless daily forecasts integrate into real-time decision-making models

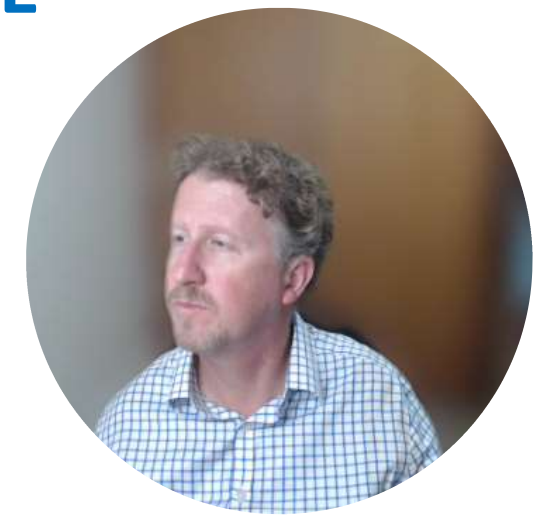
- River system models run at daily time timesteps => Seamless daily forecasts easily used as inputs
- Enables quantify impacts of forecasts
- Non-seamless seasonal models cannot be used as input => only used 'qualitatively'

Seamless forecasts simplify forecasting systems

- A single seamless product can serve a range of forecast requirements at different time scales
- Non-seamless models require multiple forecasting products at different time scales

Key Question: Do seamless forecasts (with all these extra benefits) produce similar performance as non-seamless forecasts at same time scale

Seamless Subseasonal Daily Forecasts: MUTHRE

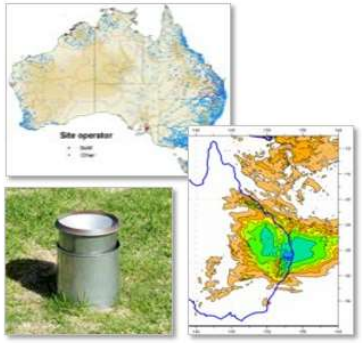


Produce daily subseasonal streamflow forecasts with high quality performance for range of lead times (0-30 day) and time scales (daily to monthly)

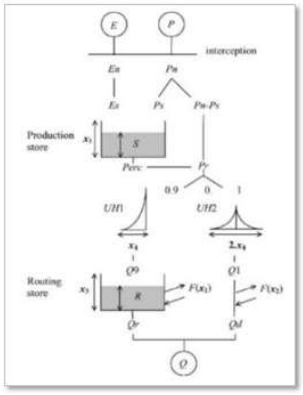
Key innovation

MuTHRE: Multi-temporal hydrological residual error model

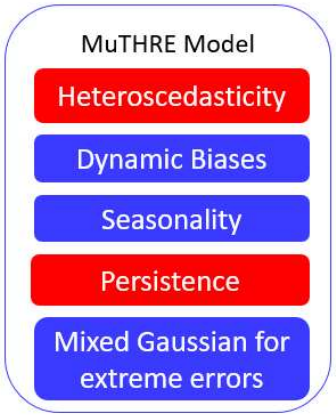
- ***Seasonality:*** Errors vary systematically by month
- ***Dynamic Biases:*** Errors vary yearly, due to non-stationarity
- **Extreme errors:** Occasional very large errors, poorly represented by Gaussian distribution



Daily Rainfall Forecasts



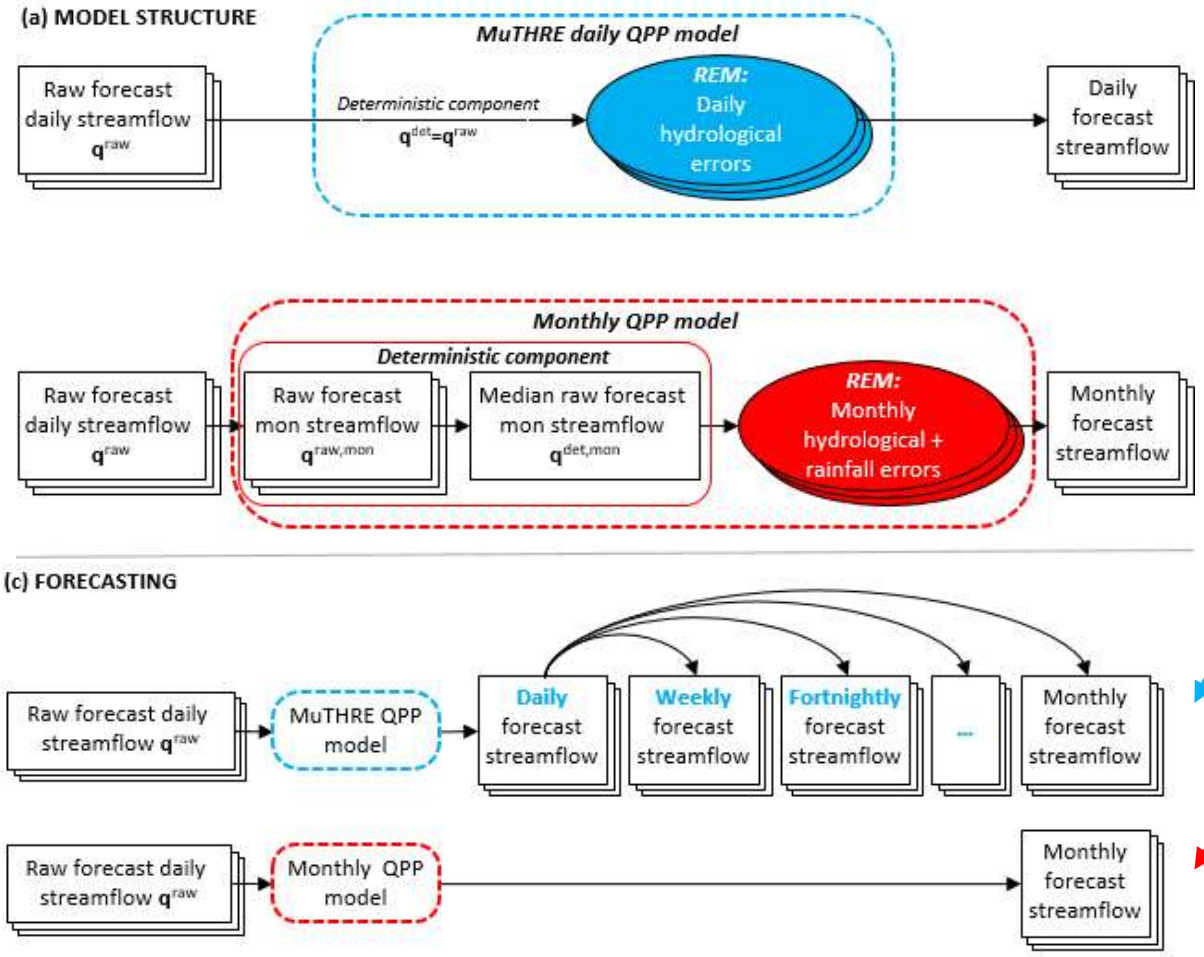
Rainfall-runoff model



Daily streamflow post-processing

- McInerney et al, 2020, WRR: Multi-temporal Hydrological Residual Error Modeling for Seamless Subseasonal Streamflow Forecasting https://doi.org/f8k5
- McInerney et al, 2021, WRR, Improving the Reliability of Sub-Seasonal Forecasts of High and Low Flows by Using a Flow-Dependent Nonparametric Model, https://doi.org/jfz6

Overview of Forecasting Approaches



Seamless Subseasonal Daily Forecasts: MUTHRE

Non-Seamless Seasonal Forecasts: Monthly QPP

Key Question: Do seamless forecasts produce similar performance as non-seamless forecasts at monthly time scale

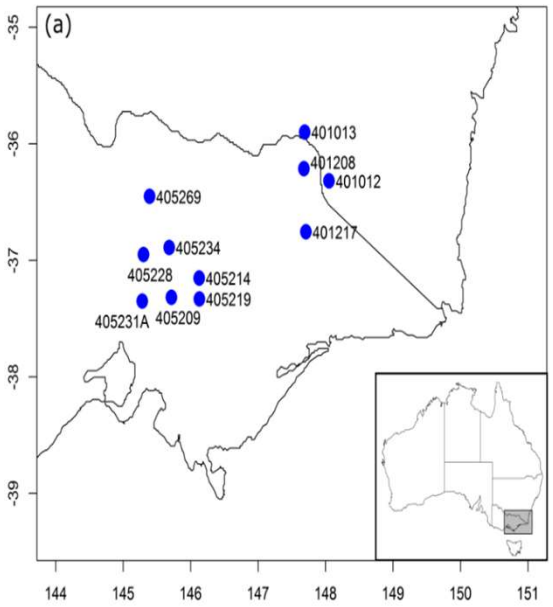
Expectation:

Non-seamless Forecasts would perform better as they only have on 'job' to do: produce forecasts at monthly time scale used for calibration

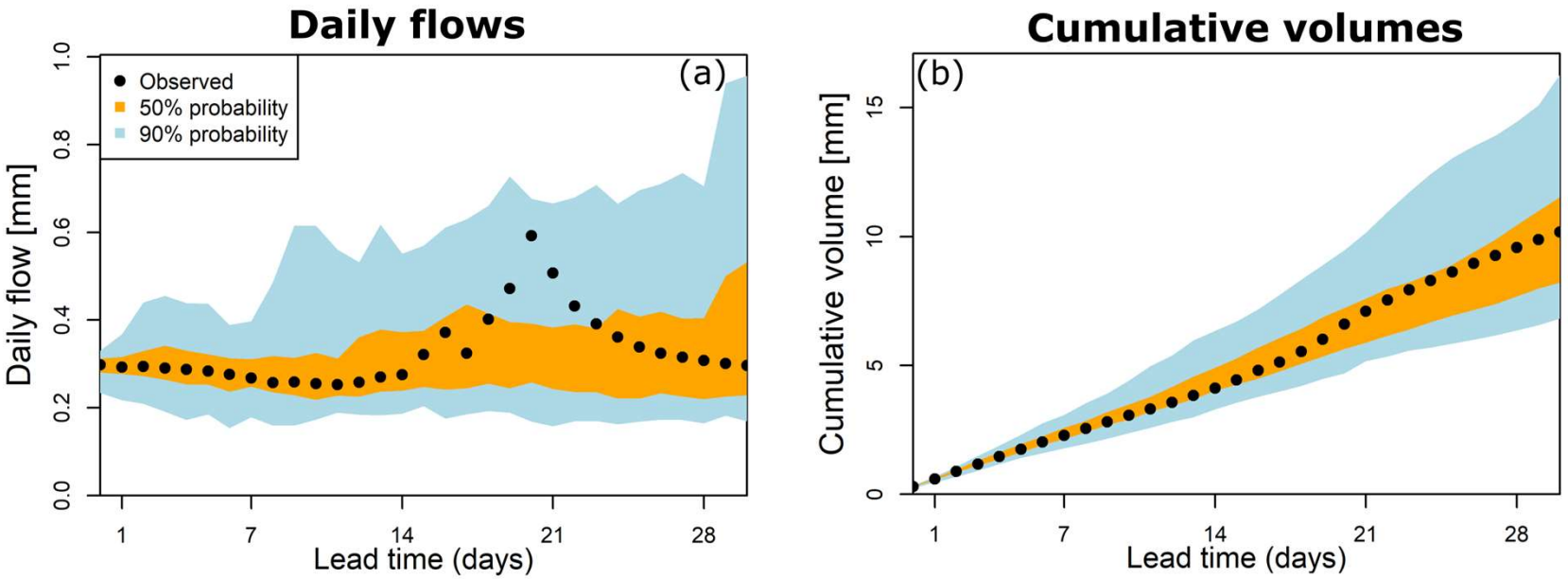
Seamless Subseasonal: Produce forecast at range of lead times and aggregation times scales

Forecast Evaluation Approach: Comprehensive and Systematic

- Eleven key unregulated catchments in Murray-Darling Basin
  - >60% inflow to major storages
- Range of commonly used metrics to capture key aspects of forecast performance
  - Reliability, Sharpness, Volumetric Bias, CRPS
- Range of time scales/stratified evaluations to assess performance consistency
  - Daily and Monthly Time Scales
  - Stratified by Lead Time/Months/Years
- Leave-one-out Cross Validation Procedure

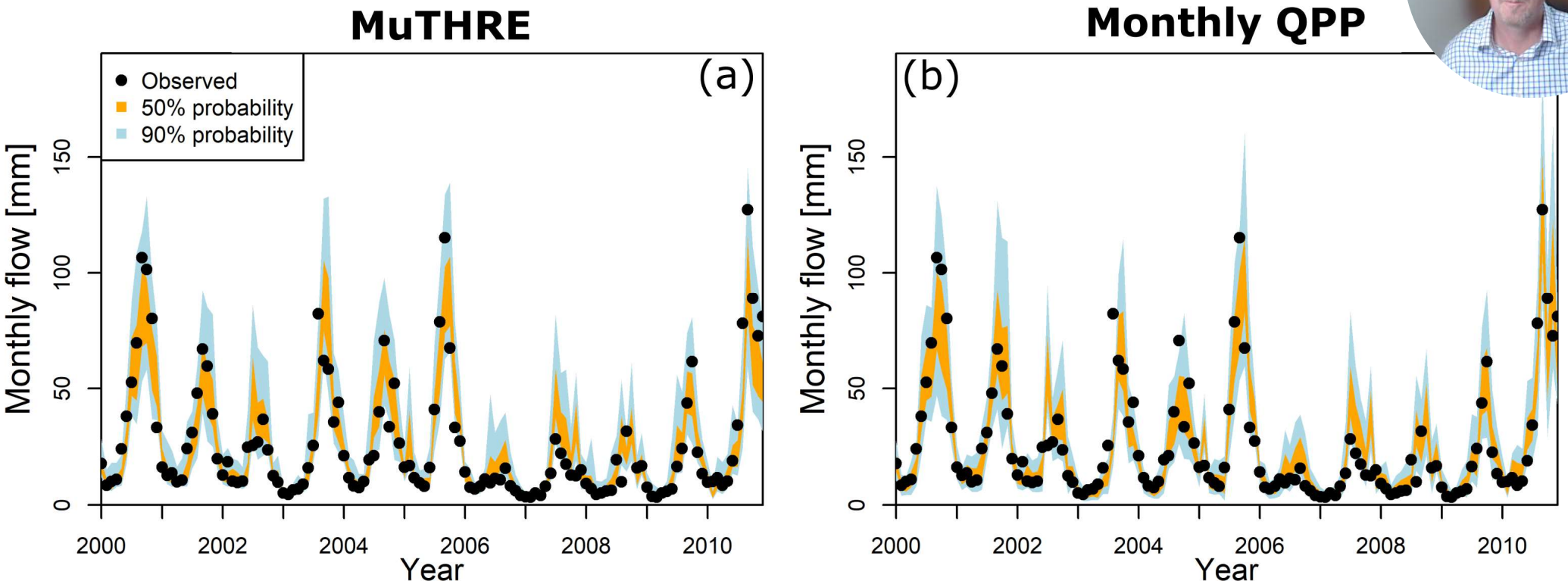


Key Outcomes: Daily Forecasts (MUTHRE)



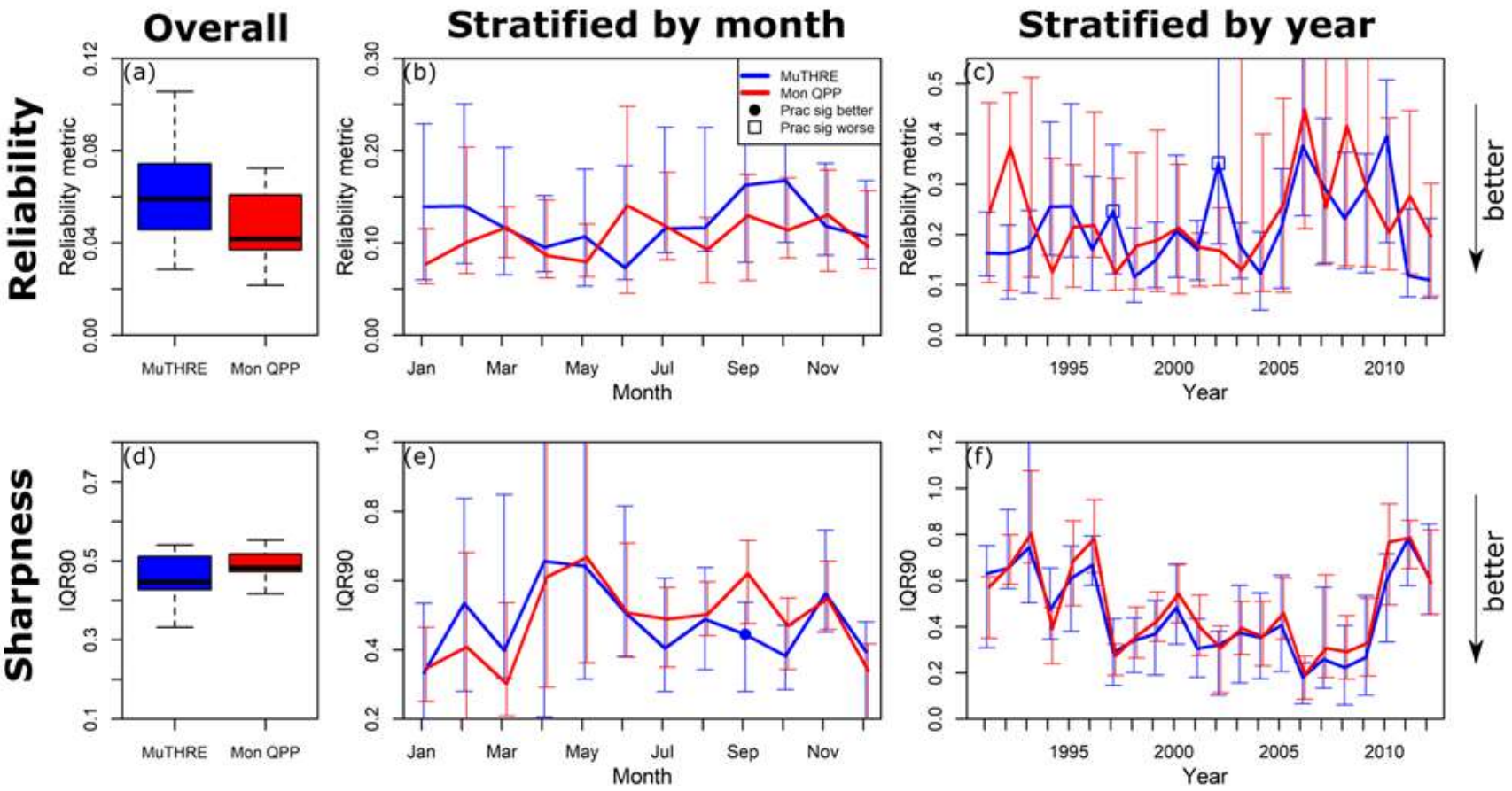
- Reliable and sharp forecasts across a range of lead times and aggregation time scales (daily/monthly) and stratifications (month/year)
- Monthly QPP **cannot produce** daily forecasts

Key Outcomes:
Monthly Forecast Time Series



- Seamless daily forecasts from MUTHRE aggregated to monthly time scales produce similar results to non-seamless Monthly QPP

Key Outcomes: Monthly Forecasts Metrics



- Seamless daily forecasts from MUTHRE aggregated to monthly time scales produce similar results to non-seamless Monthly QPP

Summary

- Daily seamless subseasonal forecasts from MUTHRE provide essentially the same performance as the non-seamless Monthly QPP
- Seamless forecasts provides a wide range of practical benefits over non-seamless forecasts
- Modeller can proverbially ‘have their cake and eat it too”
- Key finding: Seamless forecasting is not only viable but a preferred choice for future research development and practical adoption in streamflow forecasting
- Any question: email **mark.thyer@adelaide.edu.au**
- See further details in journal paper:

McInerney et al, 2022, HESS, Seamless streamflow forecasting at daily to monthly scales: MuTHRE lets you have your cake and eat it too, https://doi.org/j68c