



THE UNIVERSITY OF  
MELBOURNE



# Trended climatology for seasonal streamflow forecasts

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

# ARC Linkage Project (LP170100922) partners



**Australian Government**  
**Australian Research Council**





# Overview

- Seasonal streamflow forecasts
- Climatology as long-lead forecast
- The problem with climatology
- Proposed solution
- Initial results
- Application
- Conclusion

# Seasonal streamflow forecasts

- Monthly or seasonal total flow
- Several months in advance
- Used for
  - Waterway and reservoir management
  - Water availability
  - Drought and flood risk
- BoM's SSF website



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## Seasonal Streamflow Forecasts

Home | National Summary | Introduction | Skill Score summary | FAQs | Glossary | Publications | Site Information | History | Feedback

### Station Selector

Drainage Division  
Murray-Darling Basin

River Region  
Upper Murray River

Location  
Unregulated inflow to Hume Dam

Nearby stations

- Total flow of Kiewa River to Murray River
- Billabong Creek at Walbundrie (410091)
- Billabong Creek at Aberfeldy (410097)

### Unregulated inflow to Hume Dam

Disable map



Show Legend

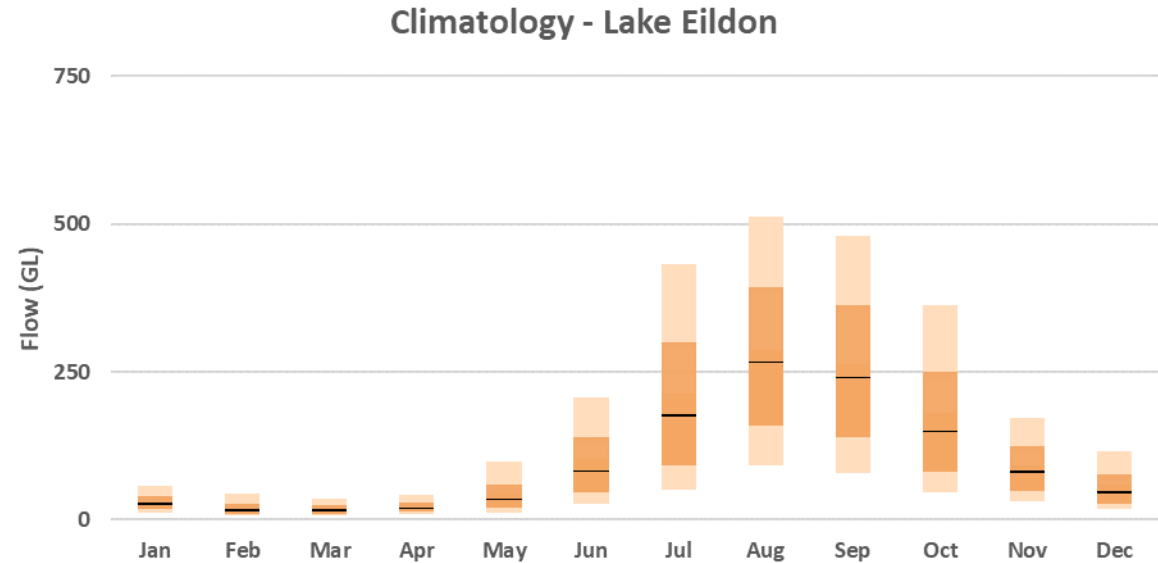
Quick facts	
Catchment area	11754 km <sup>2</sup>
Climate type	Temperate
Annual Rainfall	
Period	1900-2022
Average	1052 mm
Annual Streamflow	
Period	1900-2022
Average	2521 GL
Minimum	205 GL
Maximum	8749 GL

Forecast updated | [View the updated forecast summary for August 2023.](#) | [Learn more about the service upgrade.](#)

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

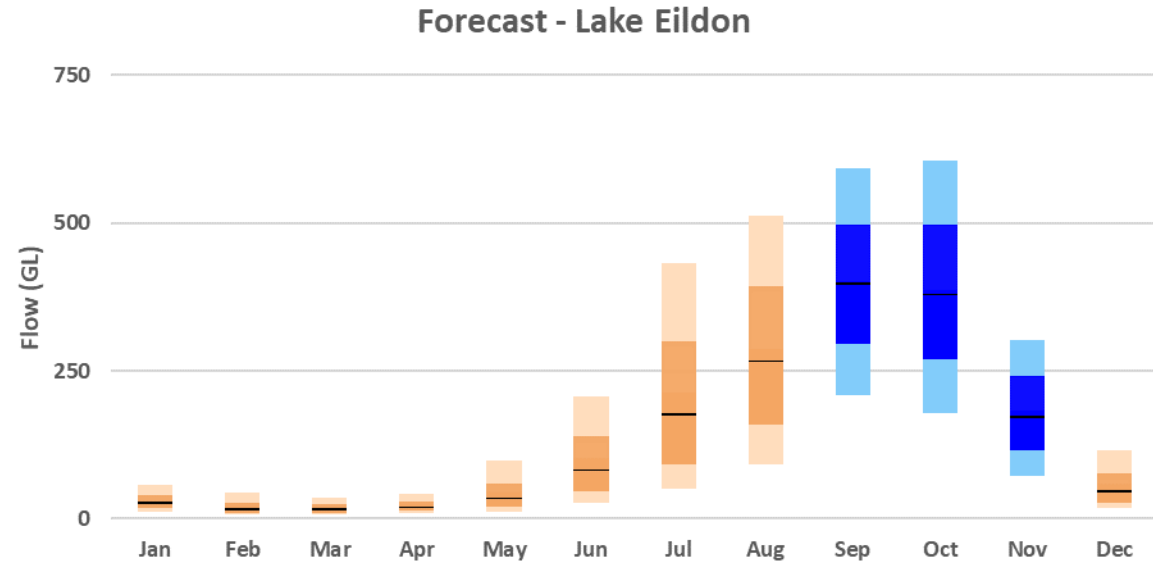
# Climatology as long-lead forecast

- Historical distribution
- Differentiate seasons
- Forecasts differ
- Approach climatology



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# Problem definition

3958

X. S. Zhang et al.: How streamflow has changed across Australia since the 1950s

- Climatology is stationary
- BUT we have observed trends

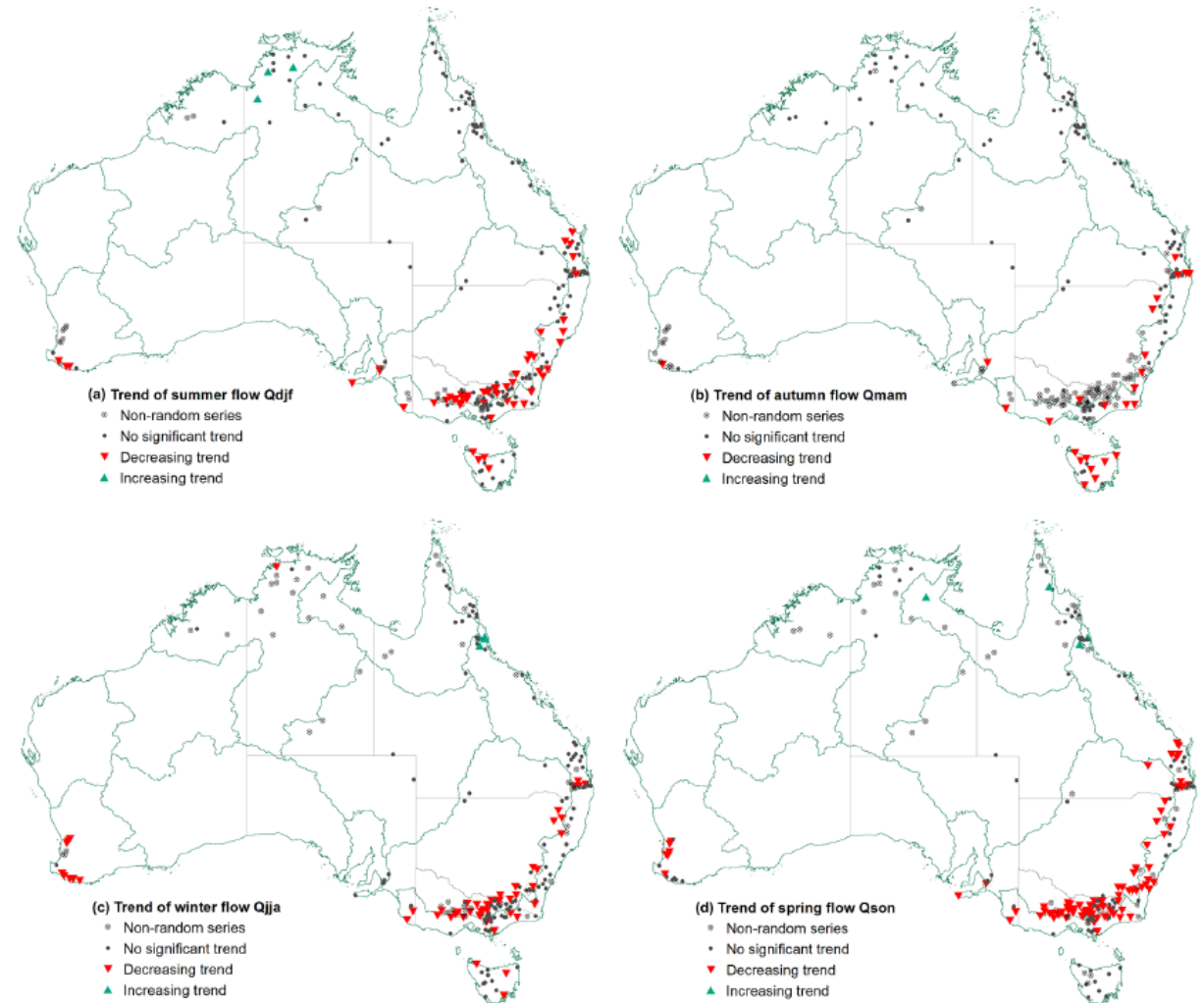
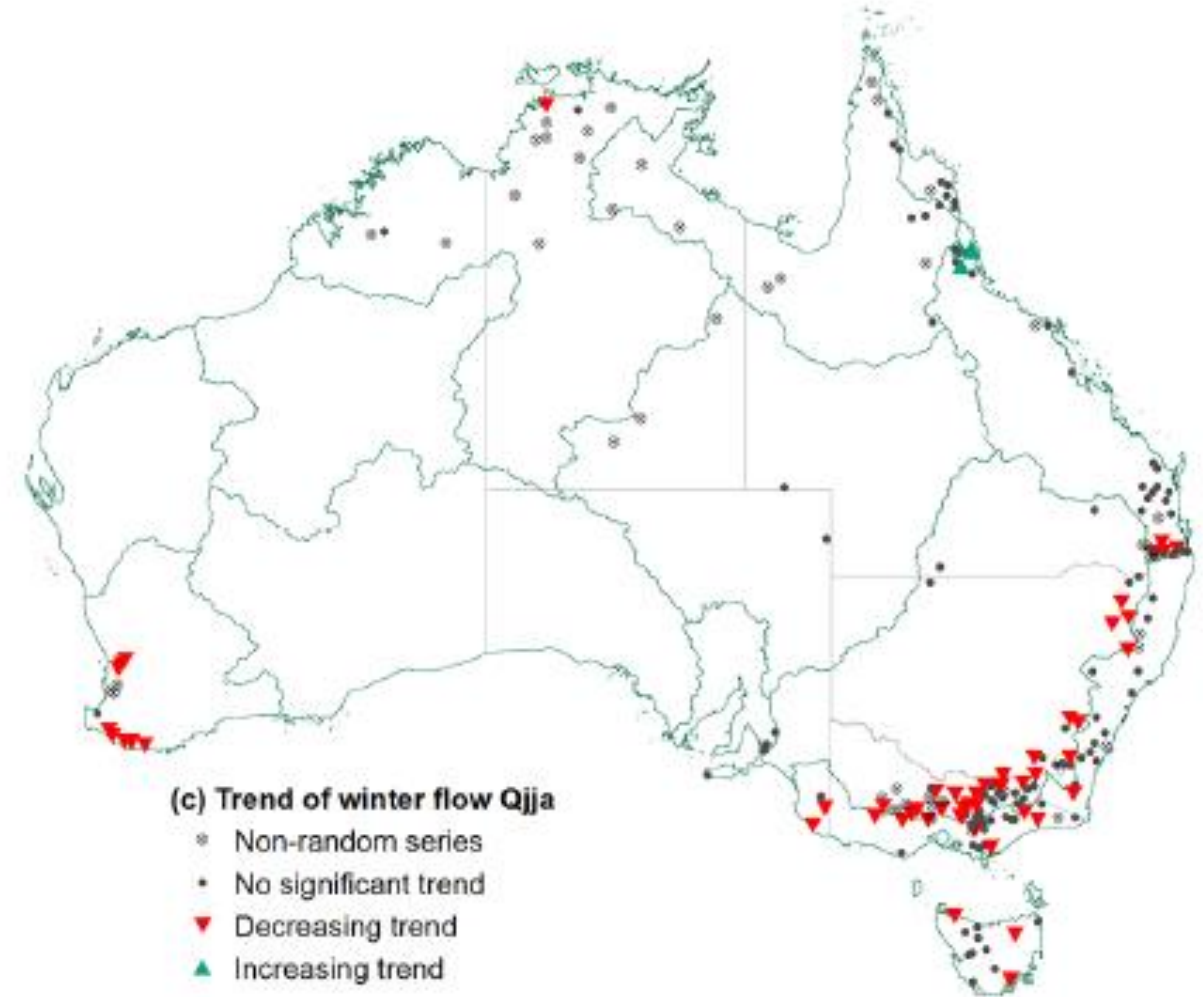


Figure 9. Maps showing trends of seasonal flow in (a)  $Q_{DJF}$  summer flow; (b)  $Q_{MAM}$  autumn flow; (c)  $Q_{JJA}$  winter flow; (d)  $Q_{SON}$  spring flow.

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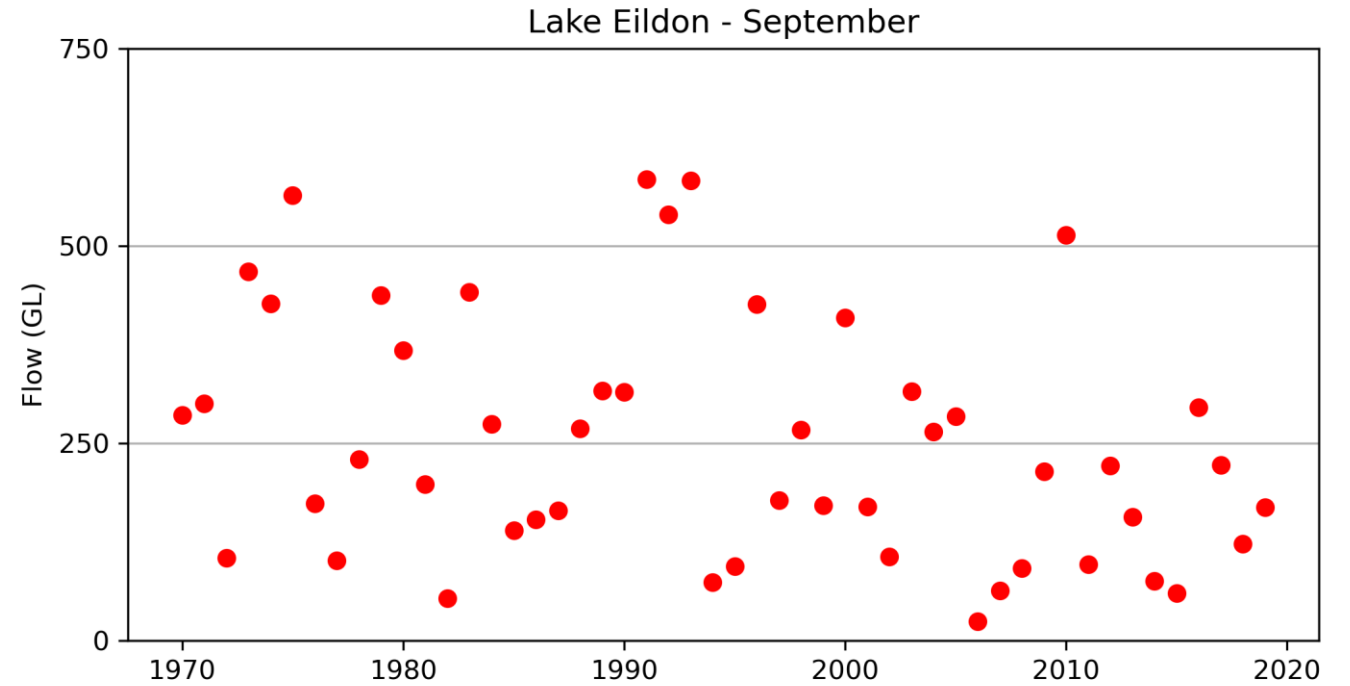
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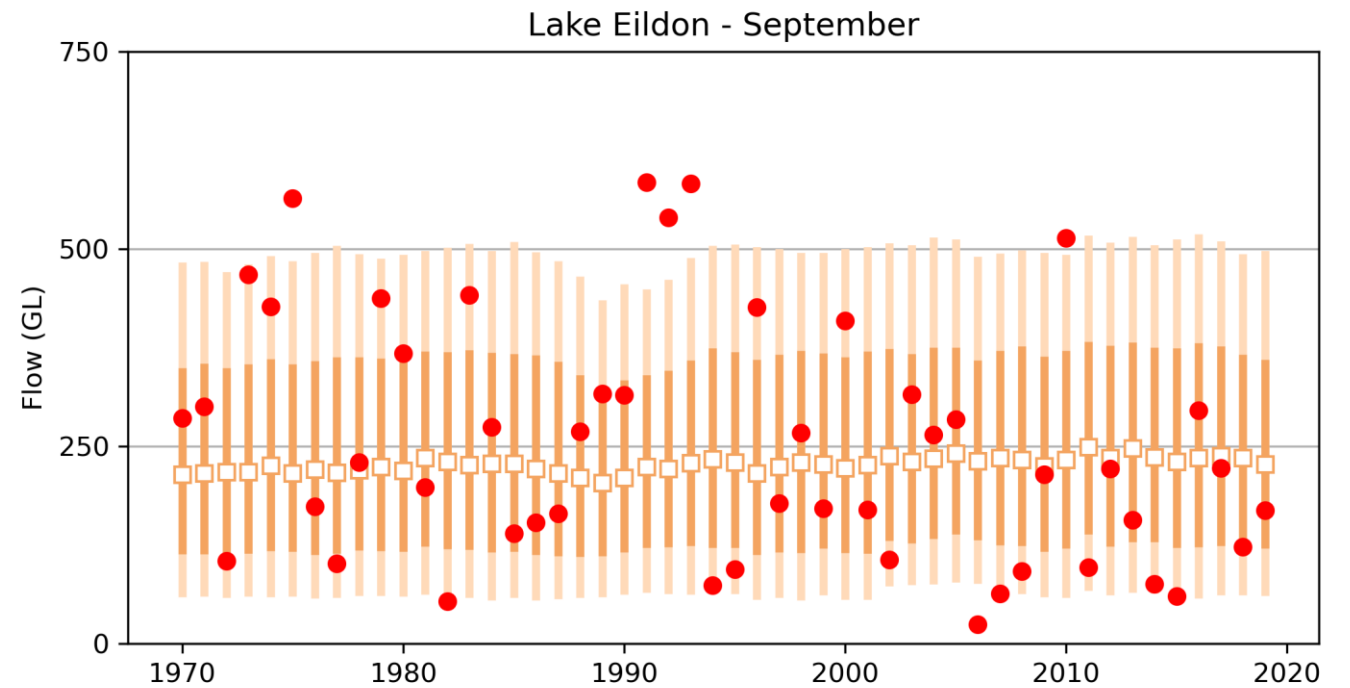
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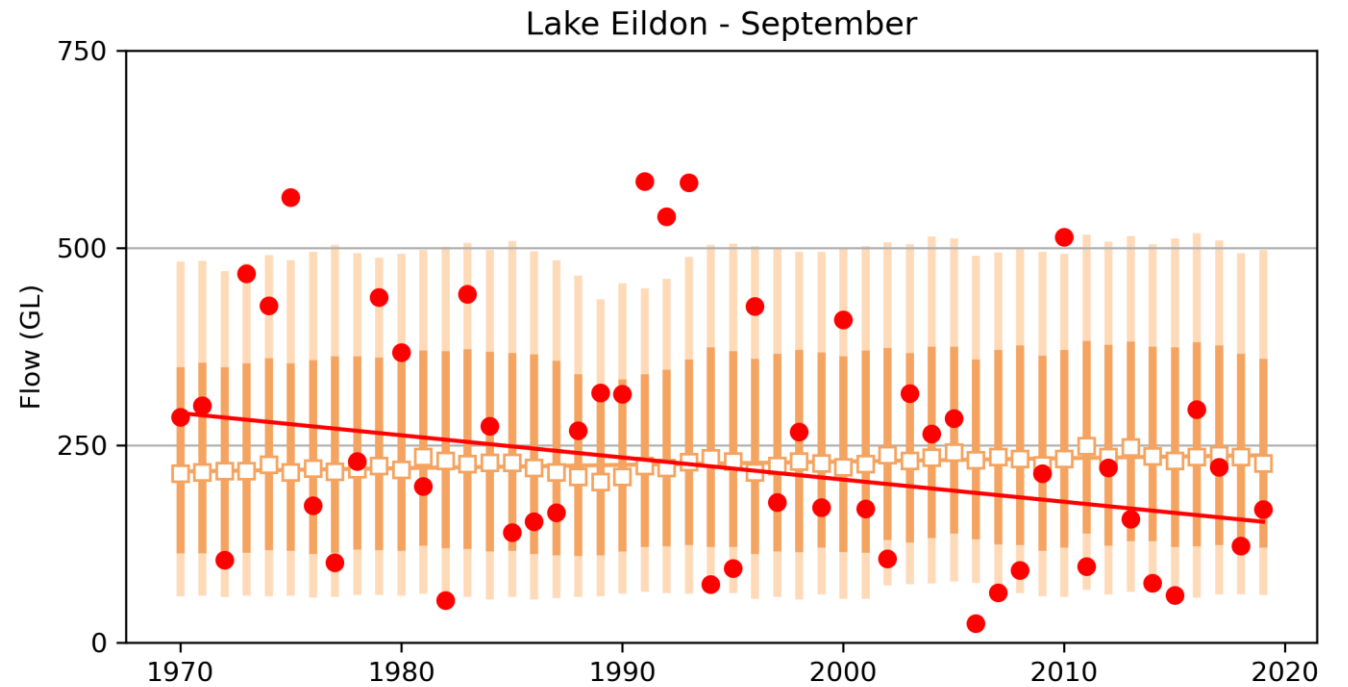
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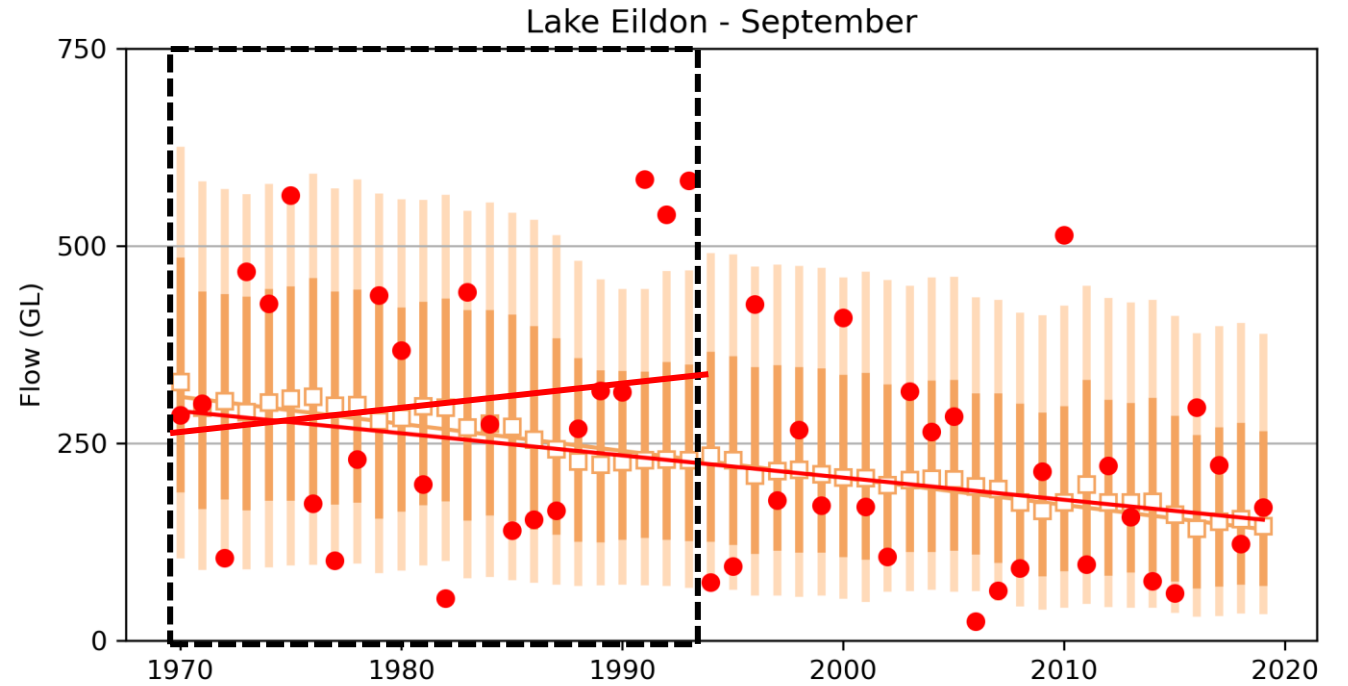
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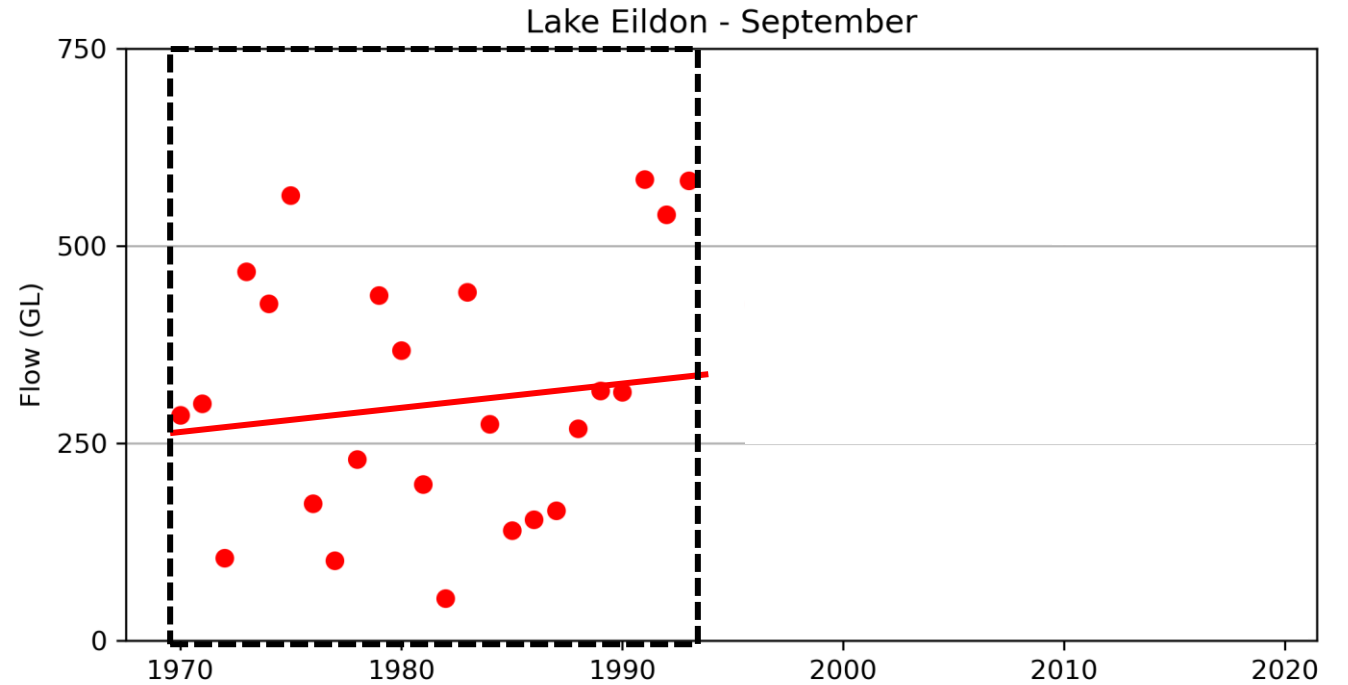
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- Climatology is stationary
- BUT we have observed trends
- We can't use all the data



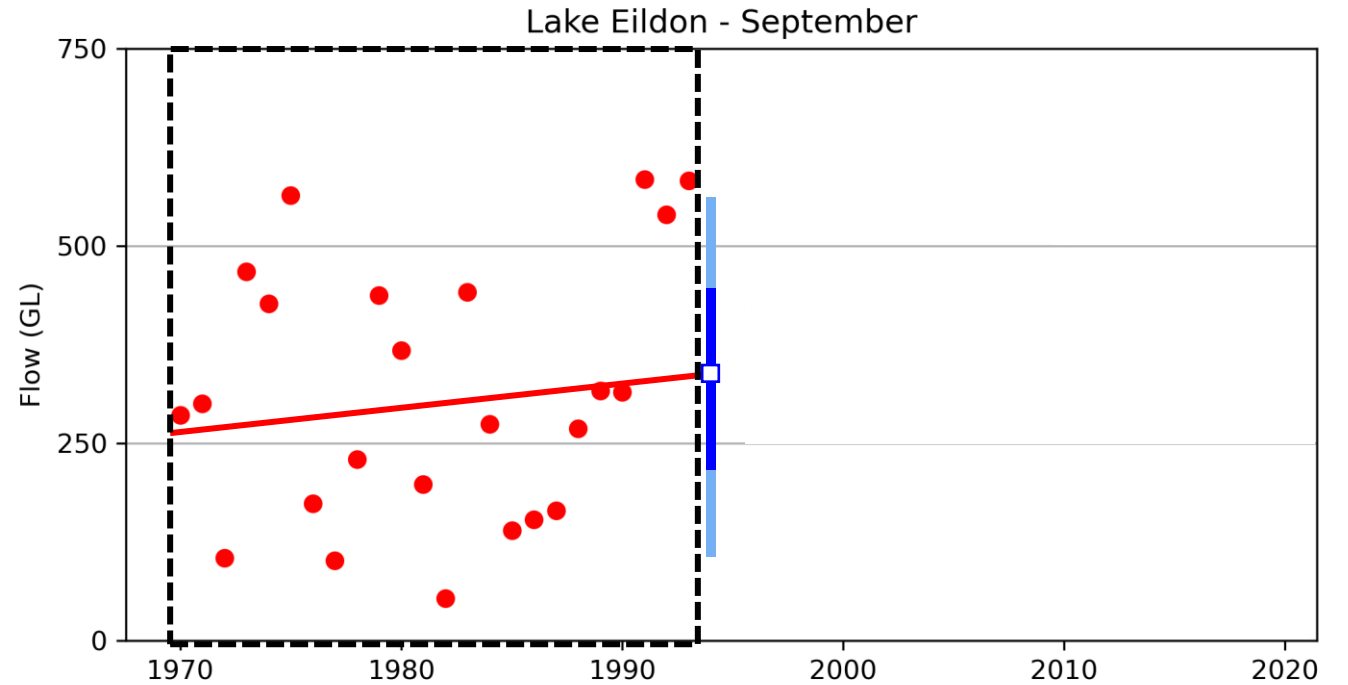
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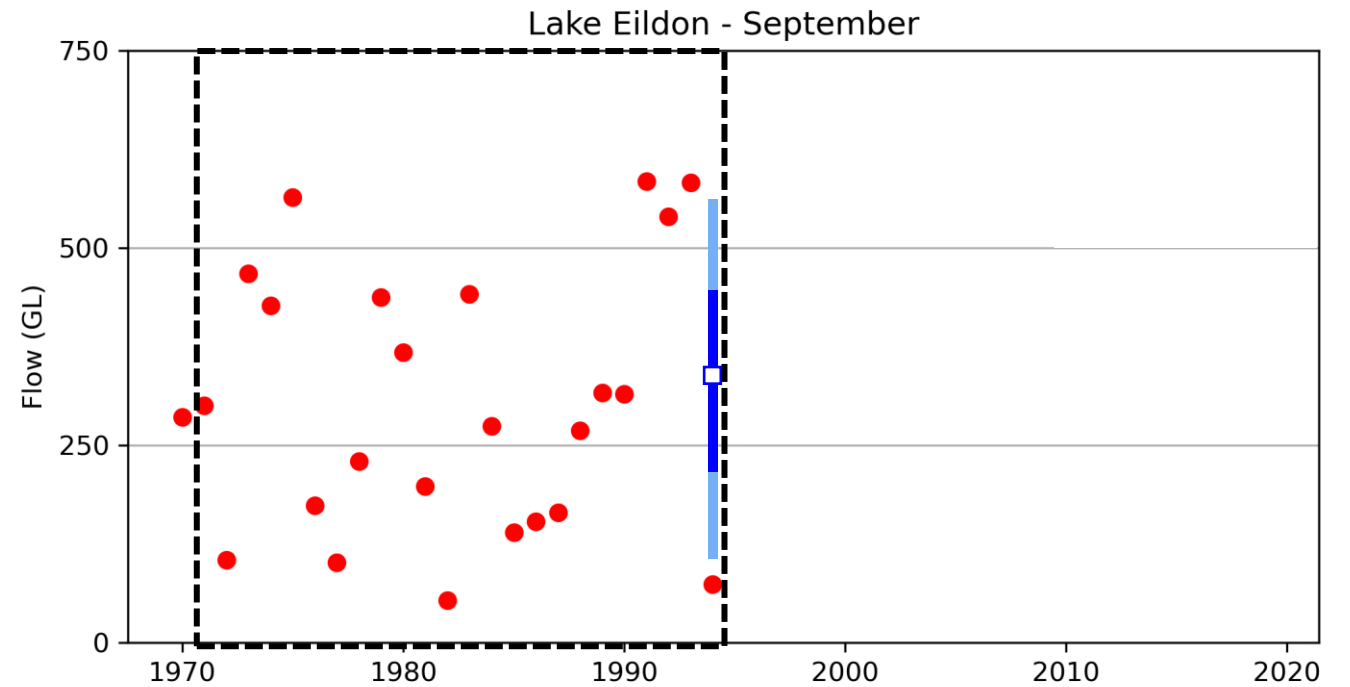
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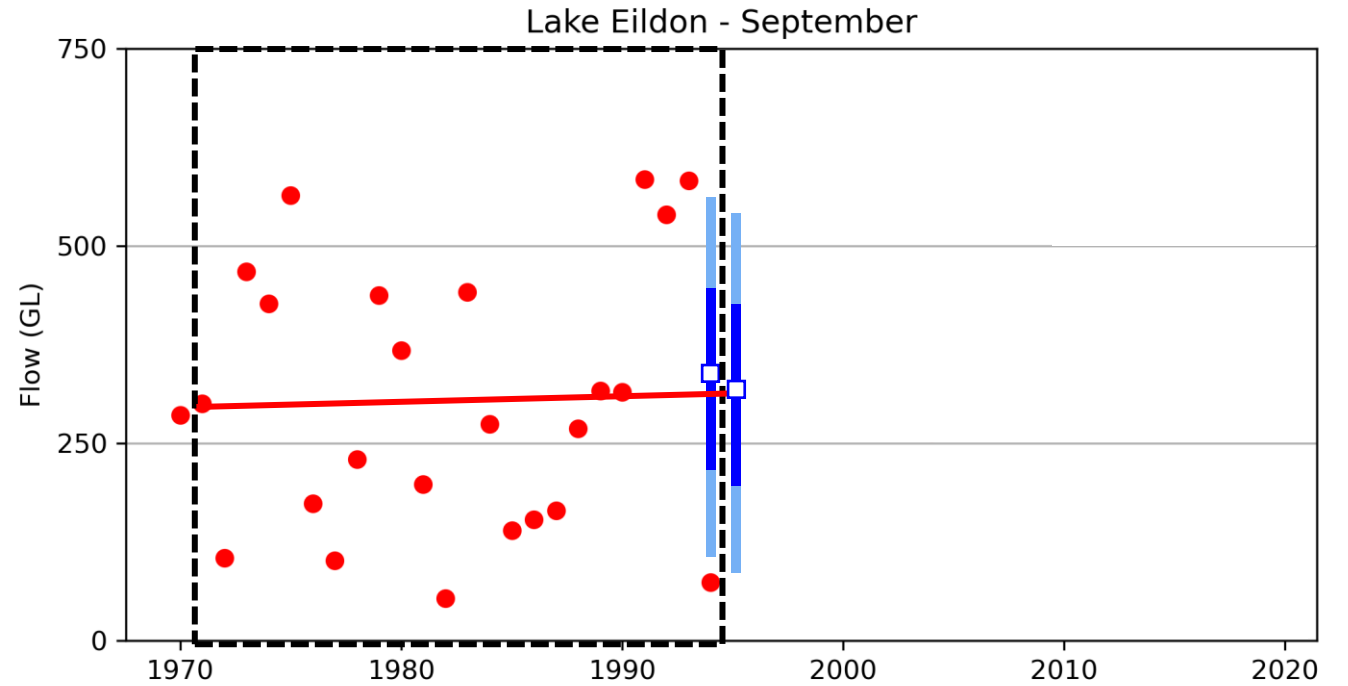
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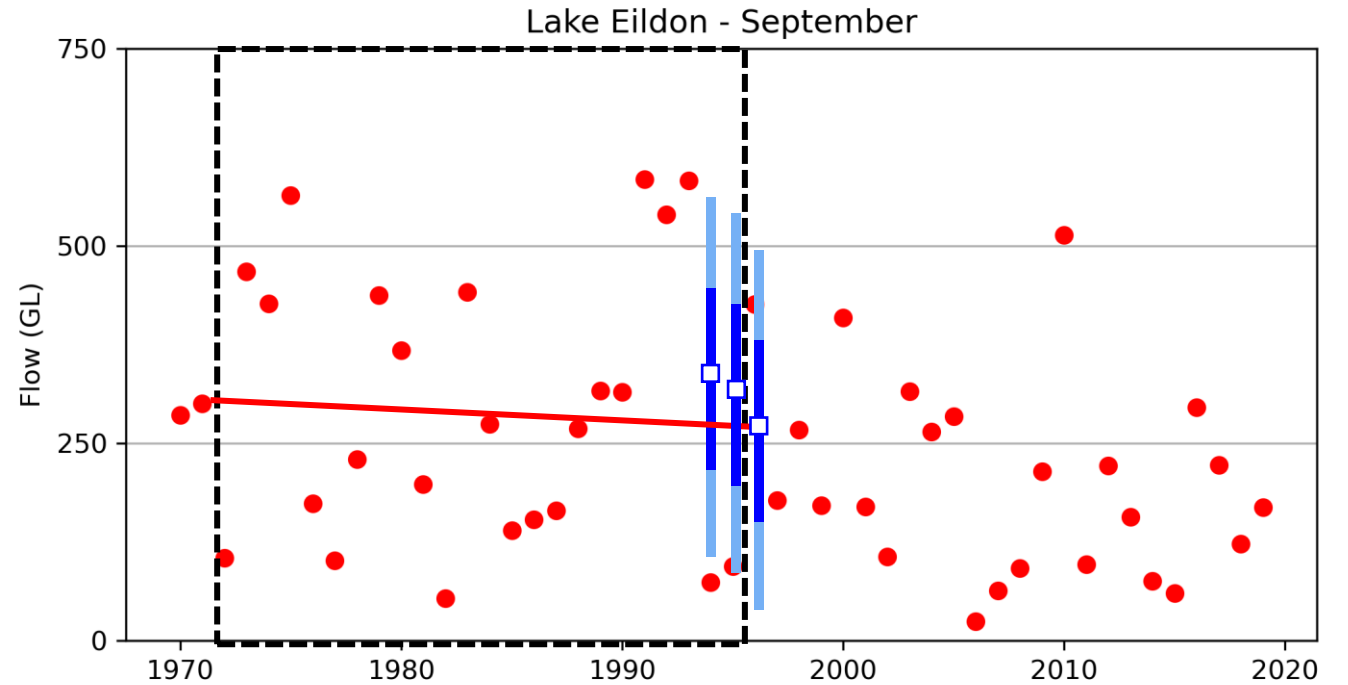
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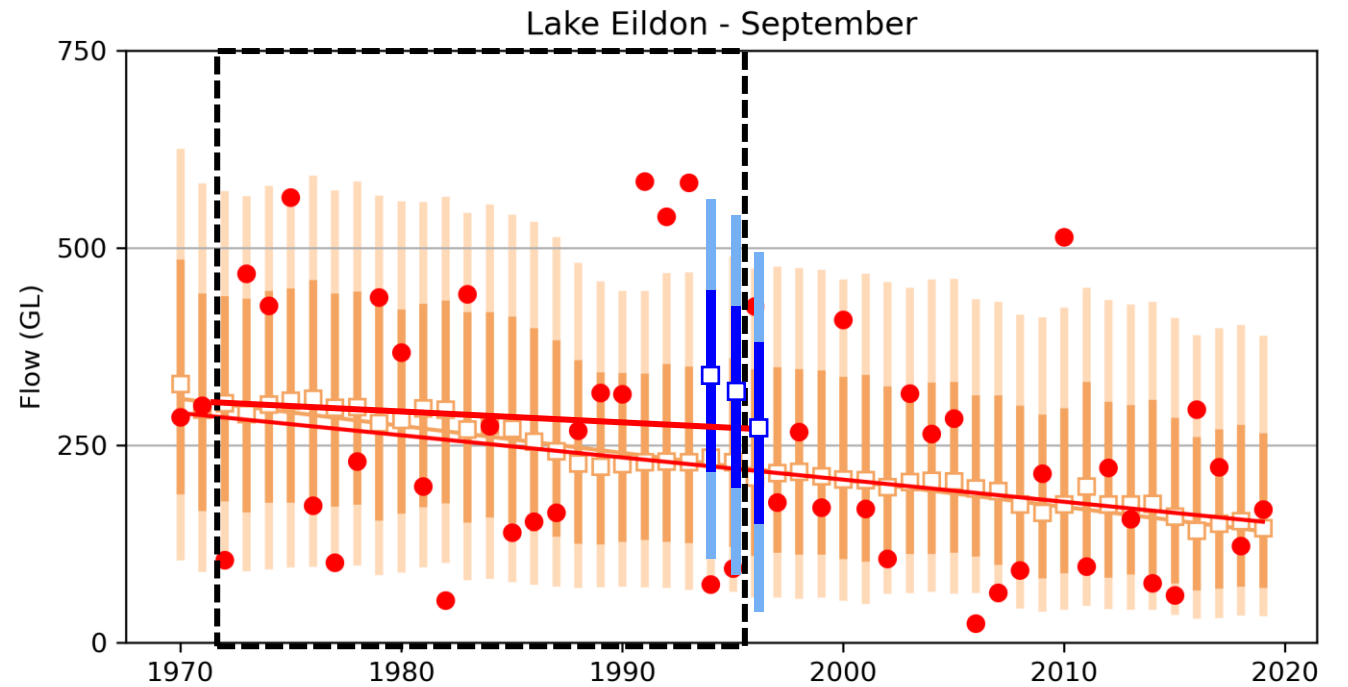
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# Proposed solution

- Modify forecast methodology
- Bayesian Joint Probability
- Bayesian inference
- Note: Additional uncertainty

$$\theta = \{\mu, \Sigma\}$$

$$y' \sim N(\mu, \Sigma)$$

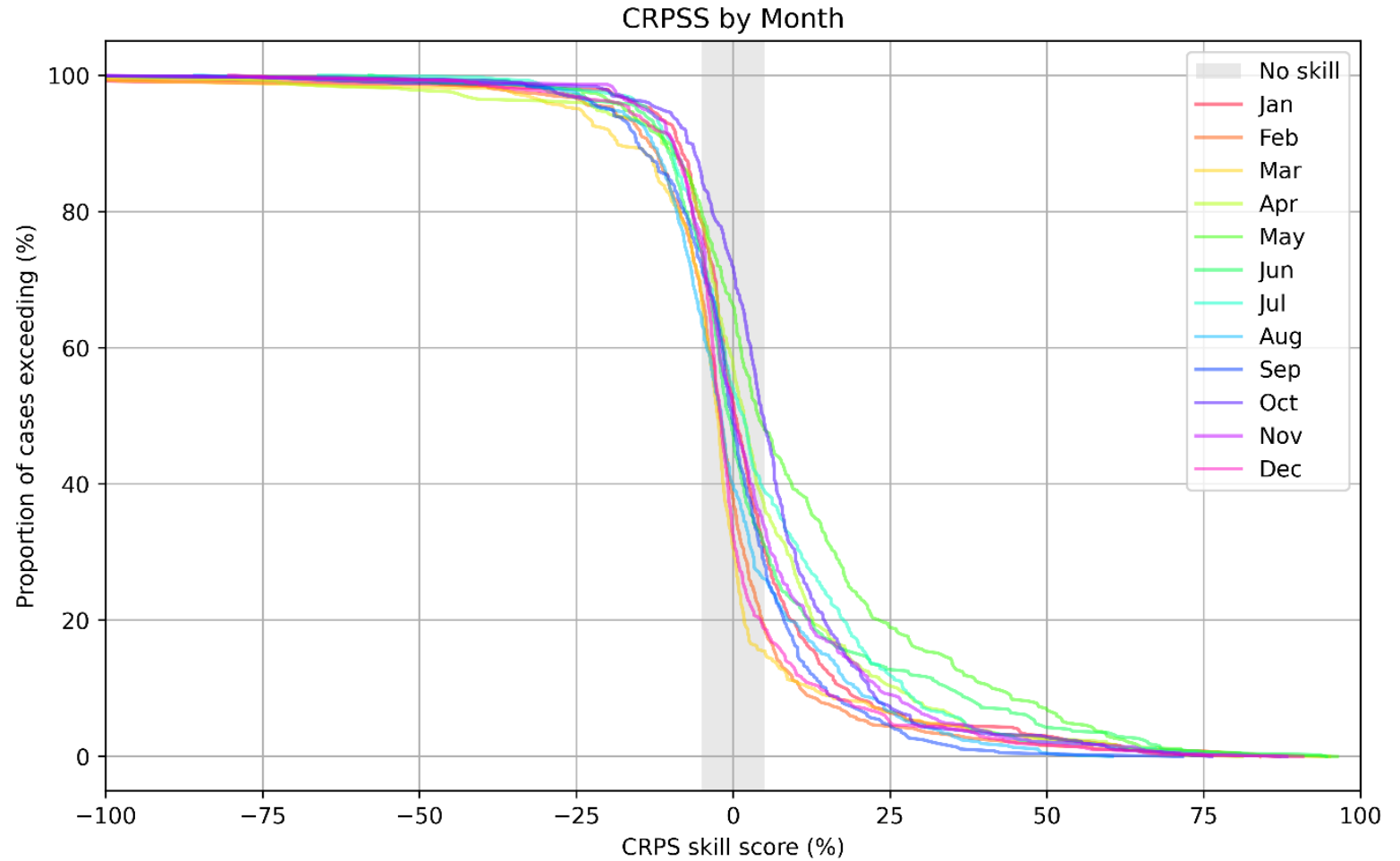
$$p(\theta|D) \propto p(\theta)p(D|\theta) = p(\theta) \prod_{t=1}^n p(D_t|\theta)$$

$$\theta = \{\mu, \sigma^2, \alpha\}$$

$$y'(t) \sim N(\mu + \alpha(t - t_m), \sigma^2)$$

# Initial results

- Average skill of 3%
- Median skill of 0%
- Varies by month
  - Mar: -1%
  - May: = +14%





# Application

- When should we apply non-stationary climatology?
- What predictors can we use?
  - Climate region?
  - Water year?
  - Catchment area?
  - Mean or CV?
  - ...
- When there is a significant trend?

	Include	Exclude
Better	True positive	False negative
Worse	False positive	True negative

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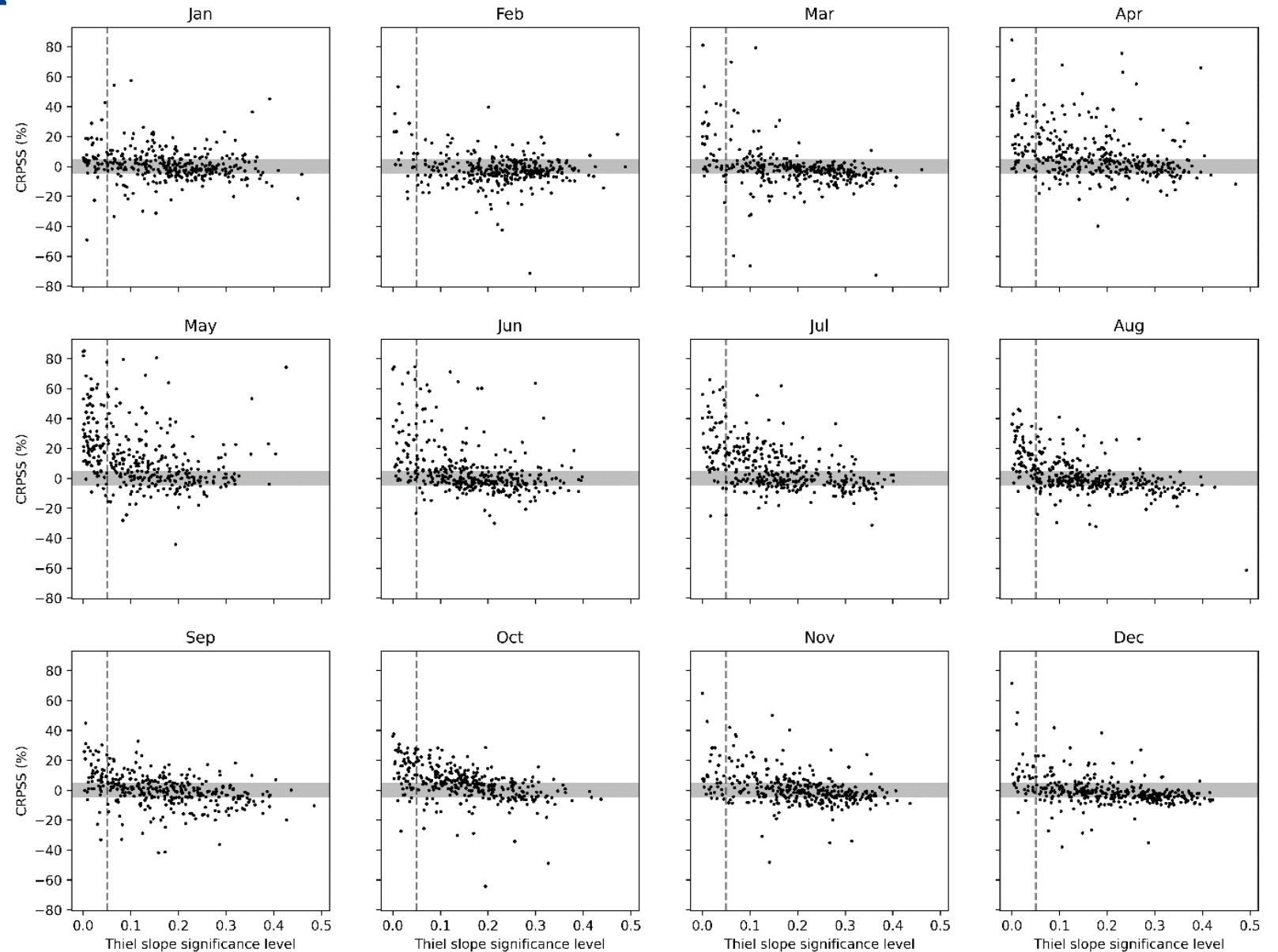
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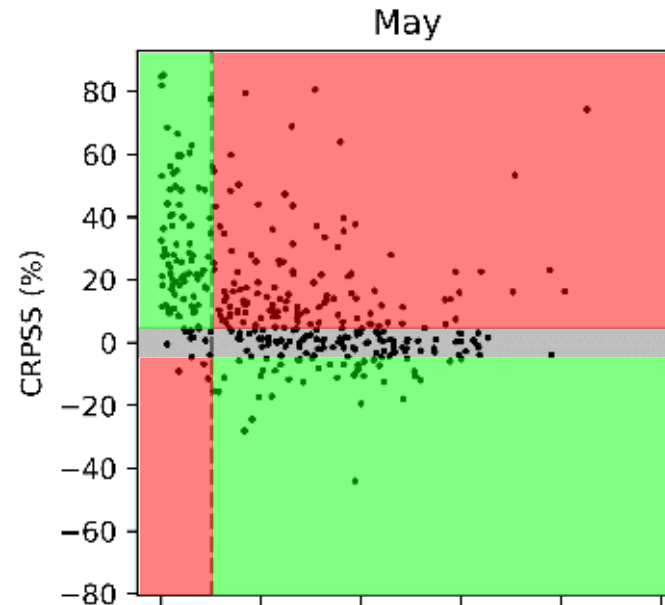
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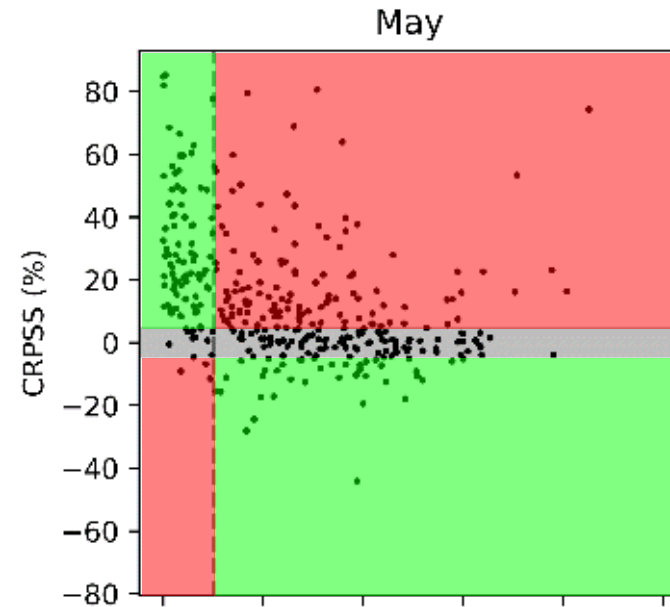
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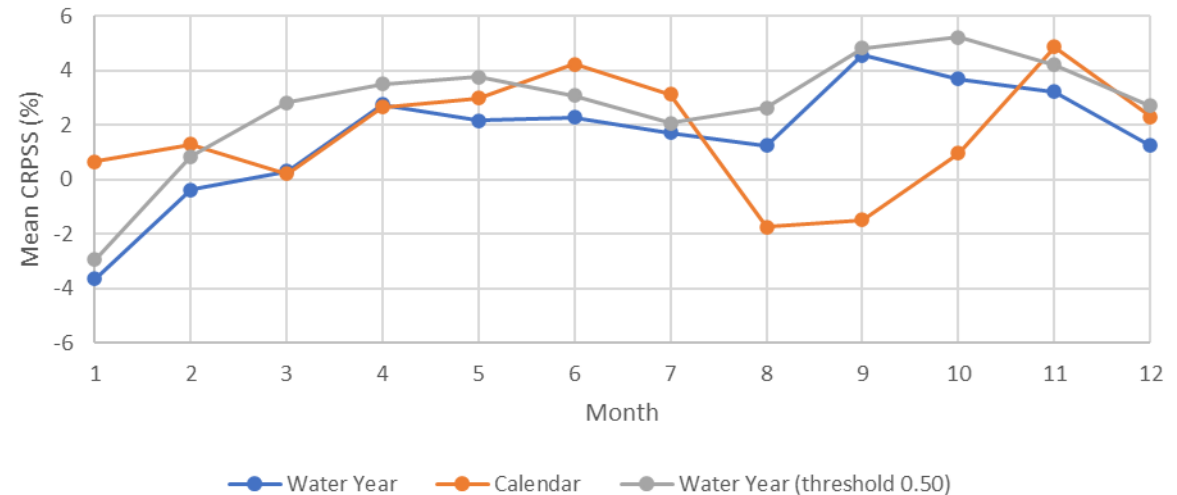
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CRPSS where at least one year had trend







# Conclusion

- Long-term trends can lead to large skill in some cases.
- Is important to identify when to apply the method.
- Don't use for wettest months.
- Use for significant trends ( $\alpha = 0.50$ )



**Thankyou**



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