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High quality probabilistic predictions for existing hydrological models calibrated with common objective functions

Mark Thyer
Jason Hunter
David McInerney
Dmitri Kavetski

School of Civil, Environmental and Mining Engineering

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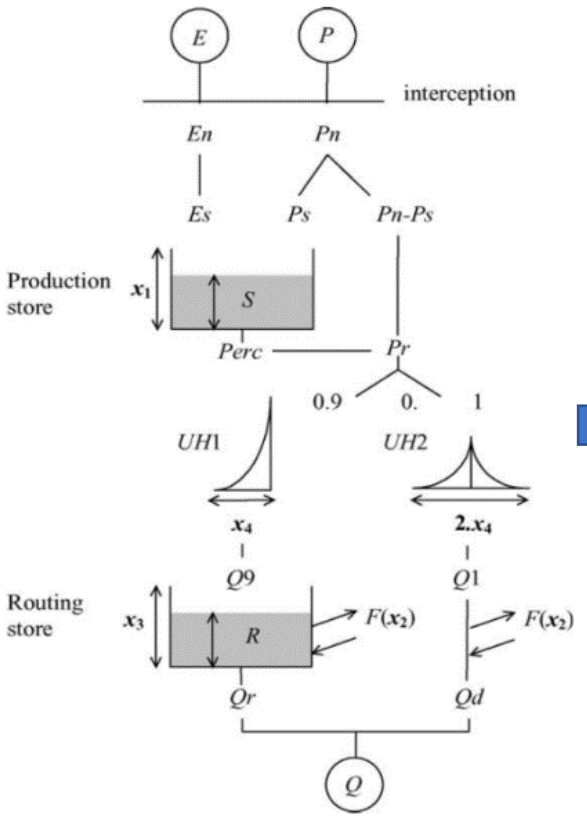
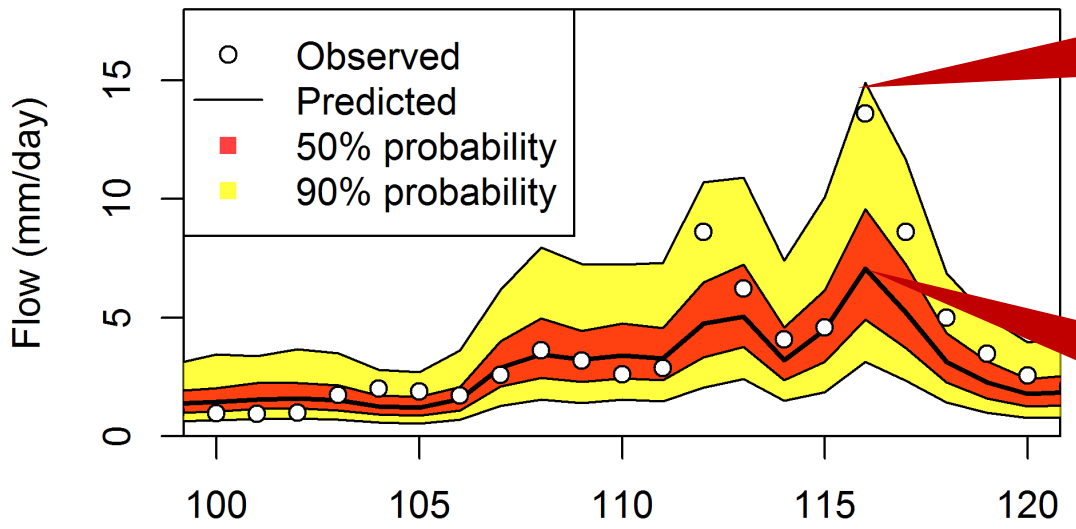
Quantifying uncertainty with high quality probabilistic predictions of streamflow provides more realistic risk estimates





Probabilistic predictions provide realistic risk estimate (~5-10%) of high flow event

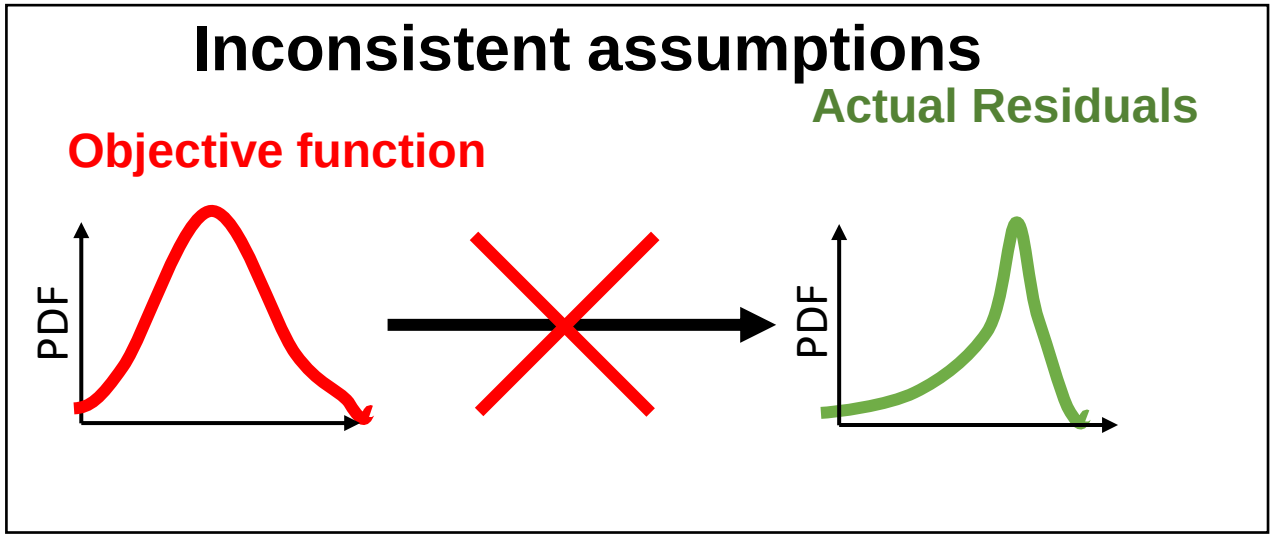
Deterministic predictions under-estimate high flow event by 50%

How do we get high quality probabilistic predictions from deterministic predictions of existing hydrological models?

Challenge: Existing hydrological models are often pre-calibrated using common objective functions

- Nash-Sutcliffe Efficiency (NSE), Kling-Gupta Efficiency (KGE) and others

Common objective functions have assumptions that are inconsistent with actual residuals



- Nash-Sutcliffe Efficiency (NSE)

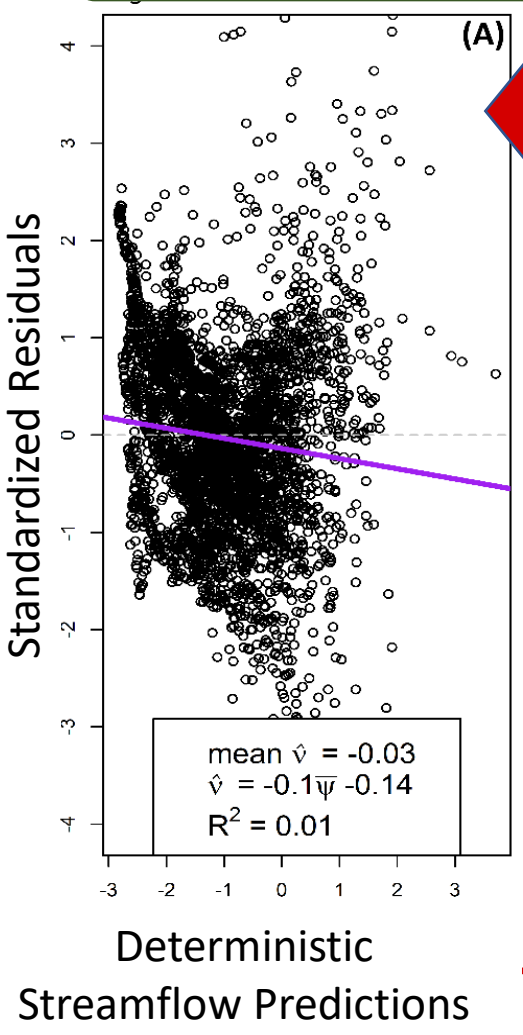
  => assumes residuals are normally distributed: homoscedastic, no skew
- Actual Residuals

  => heteroscedastic/skewed/persistence
- Same applies to range of other common objective functions (KGE, NSE+BIAS)

How do we get high quality probabilistic predictions from deterministic predictions using objective functions that have “inconsistent” assumptions?

Impact of Objective Function on Residuals

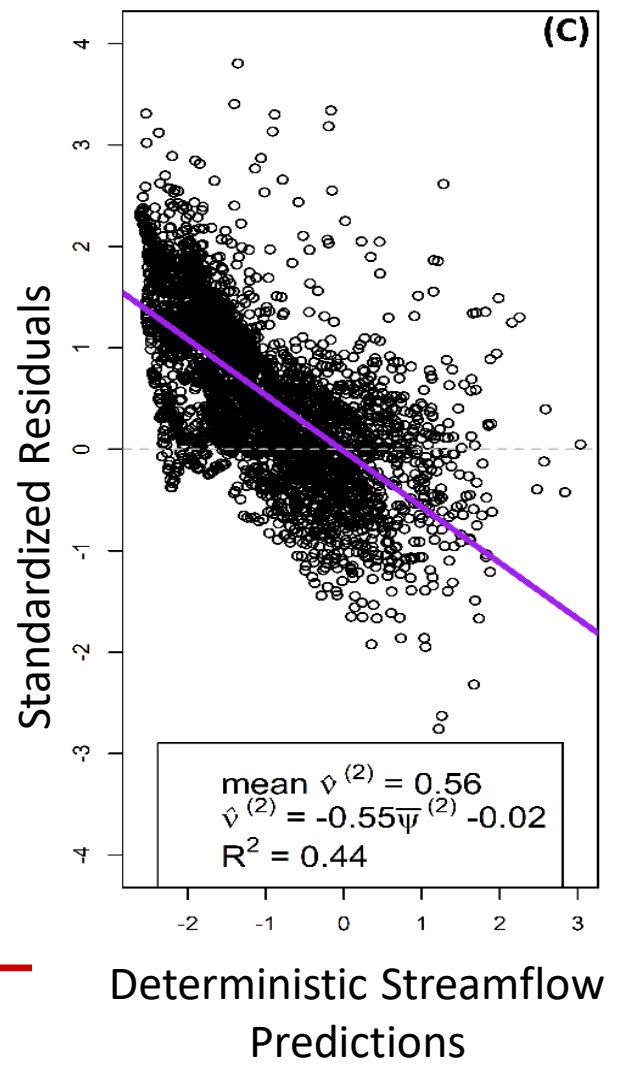
"Consistent" Objective Function



Consistent assumptions => no flow dependence in residuals (zero mean)

Inconsistent assumptions => Linear trend in residuals

"Inconsistent" Objective Function



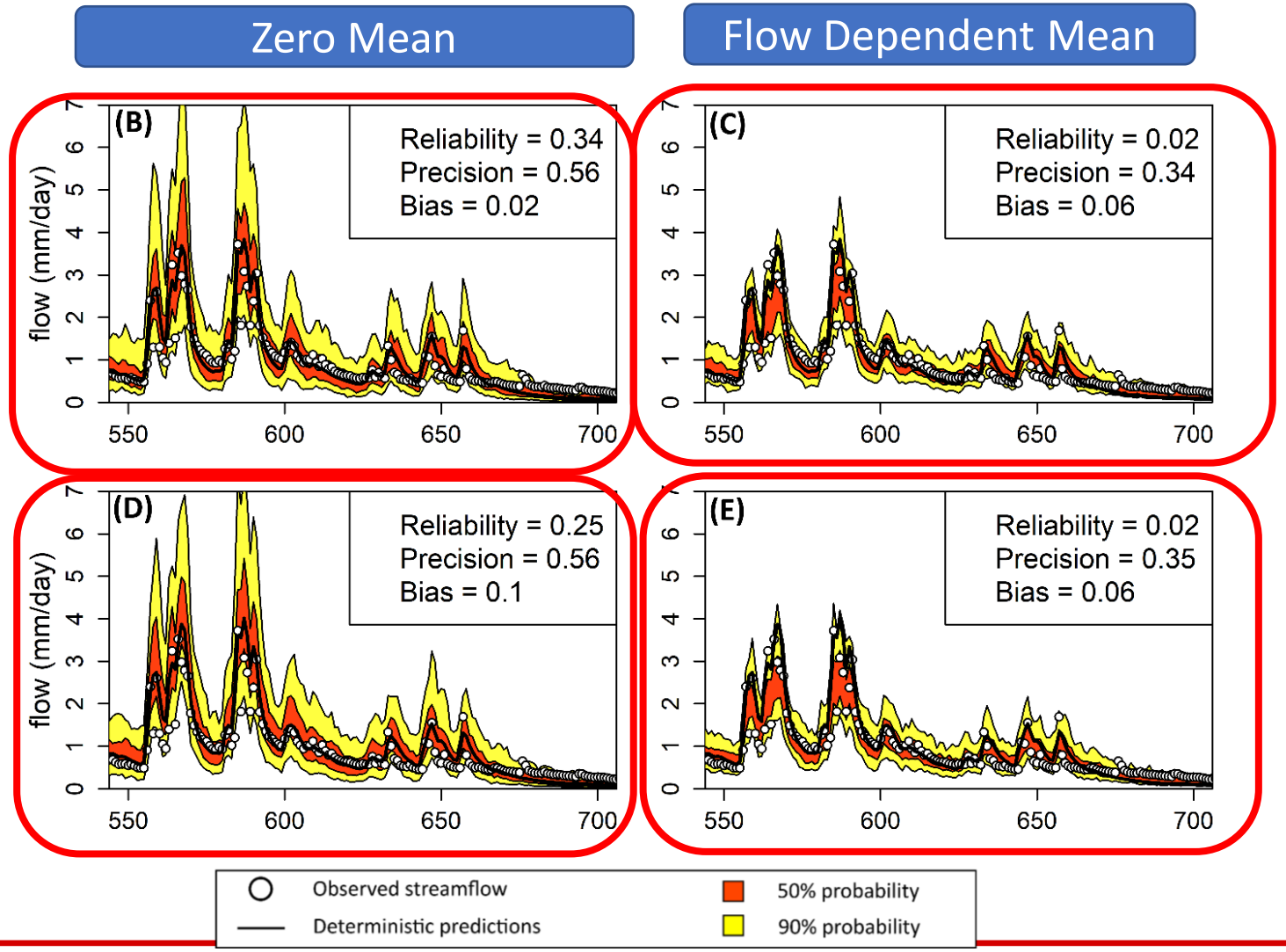
Suggest flow-dependent mean in residuals could help overcome inconsistentcy

Incorporating flow dependent mean provides more reliable and precise probabilistic predictions

Lower is better for all metrics

Objective Function: Nash-Sutcliffe Efficiency

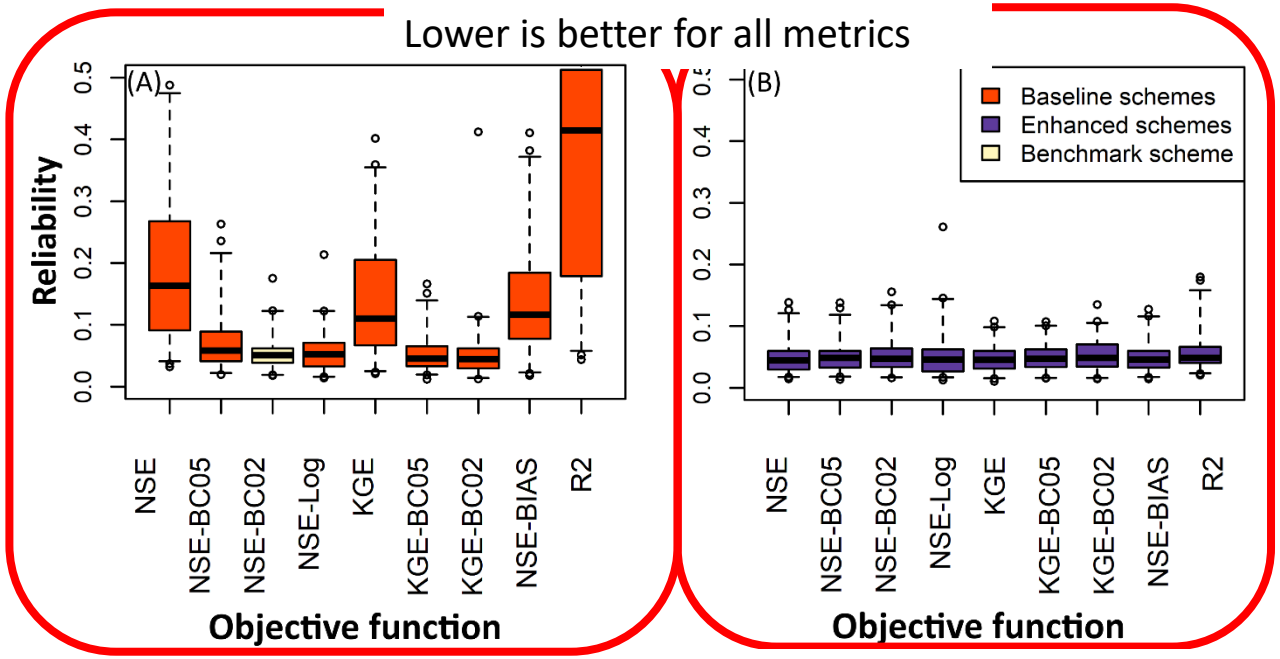
Objective Function: Kling Gupta Efficiency



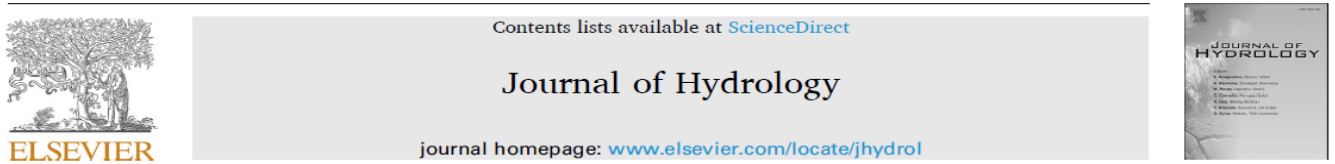
Flow dependent mean achieves high quality probabilistic predictions for wide range of objective functions & catchments

Zero Mean | Flow Dependent Mean

Lower is better for all metrics



Similar trends for range of performance metrics => See paper for more details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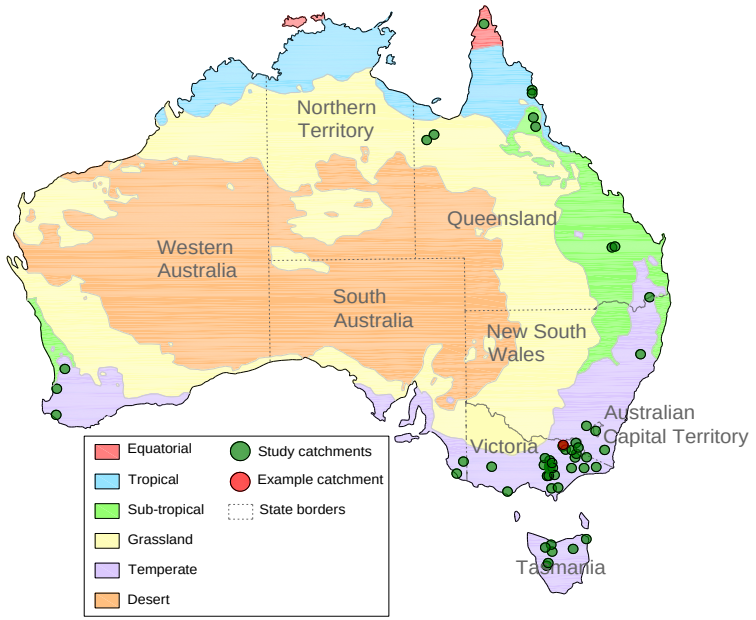
Achieving high-quality probabilistic predictions from hydrological models calibrated with a wide range of objective functions

Jason Hunter *, Mark Thyer, David McInerney, Dmitri Kavetski

School of Civil, Environmental and Mining Engineering, University of Adelaide, Adelaide 5005, SA, Australia



High quality probabilistic predictions are now easily achievable

Developing a open-source R code/webapp
email mark.thyer@adelaide.edu.au if interested