Australia's National Science Agency

Hydrological forecasting and verification in Australia

Joint WGNE-JWGFVR meeting workshop

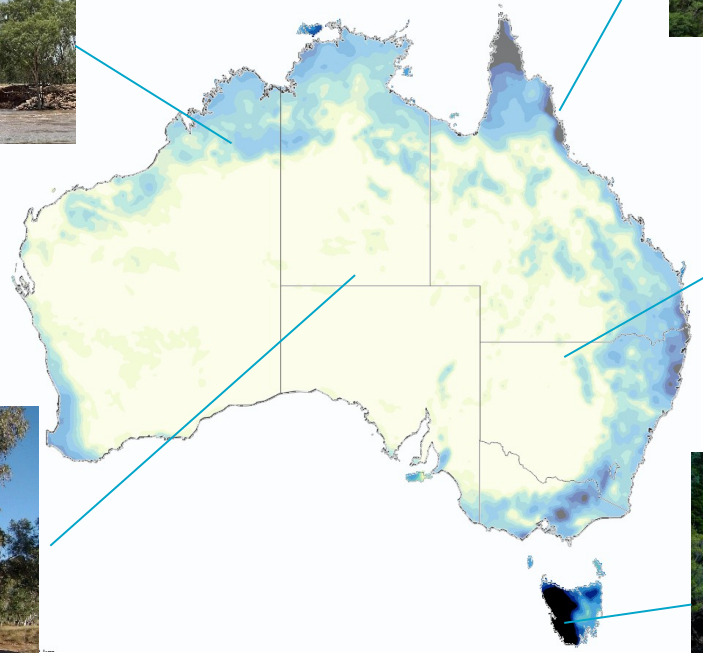
Sao Paulo

James Bennett | 1 Dec

Runoff in Australia

Barron River

Fitzroy River (WA)



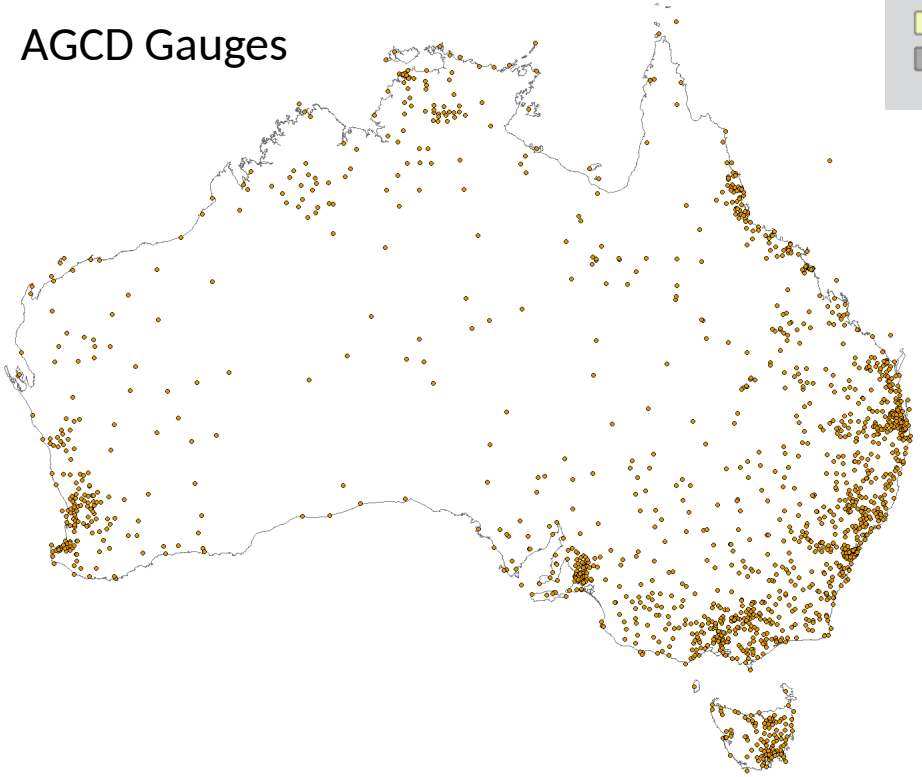
Darling River/Baaka

Todd River

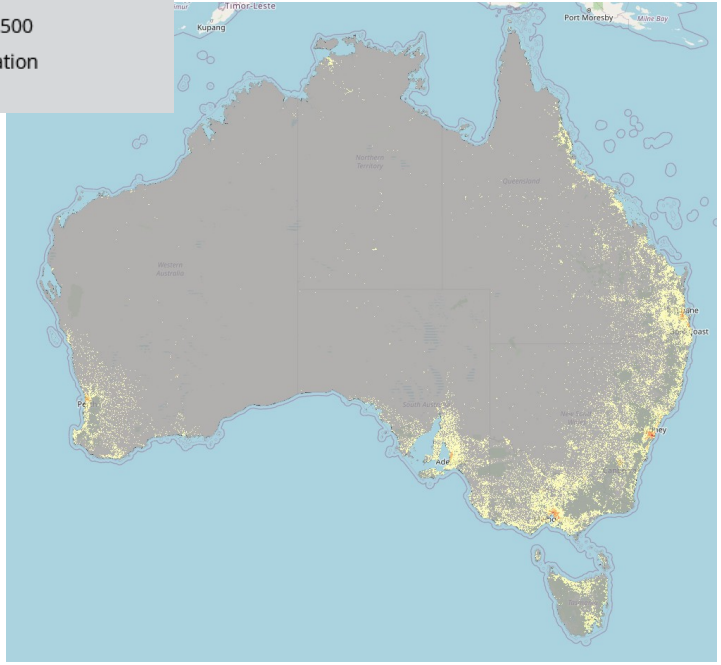
Franklin River

Rain gauges

AGCD Gauges

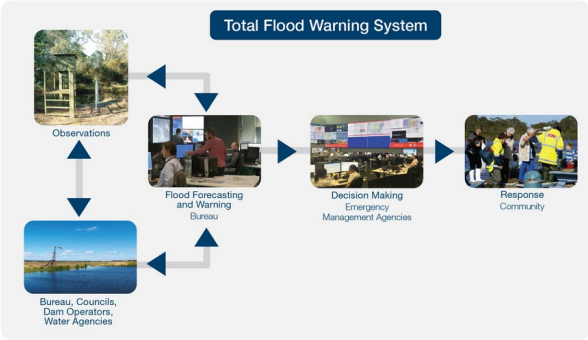


Population

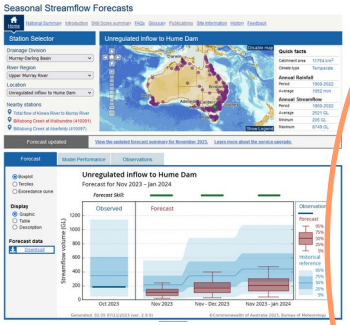


Bureau of Met. hydrological forecasting systems

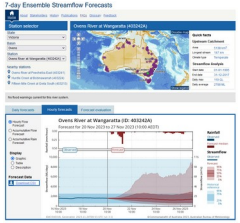
Flood Forecasting and Warning



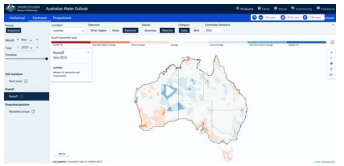
Seasonal streamflow forecasts



7-day ensemble streamflow



AWO



Bureau's first quantitative flood forecasts (Macleay River) — 1962

Funding for National Coverage of FFW — 1987

Water Act — 2007

Seasonal Streamflow Forecasts — 2010

7-Day streamflow forecasts — 2015

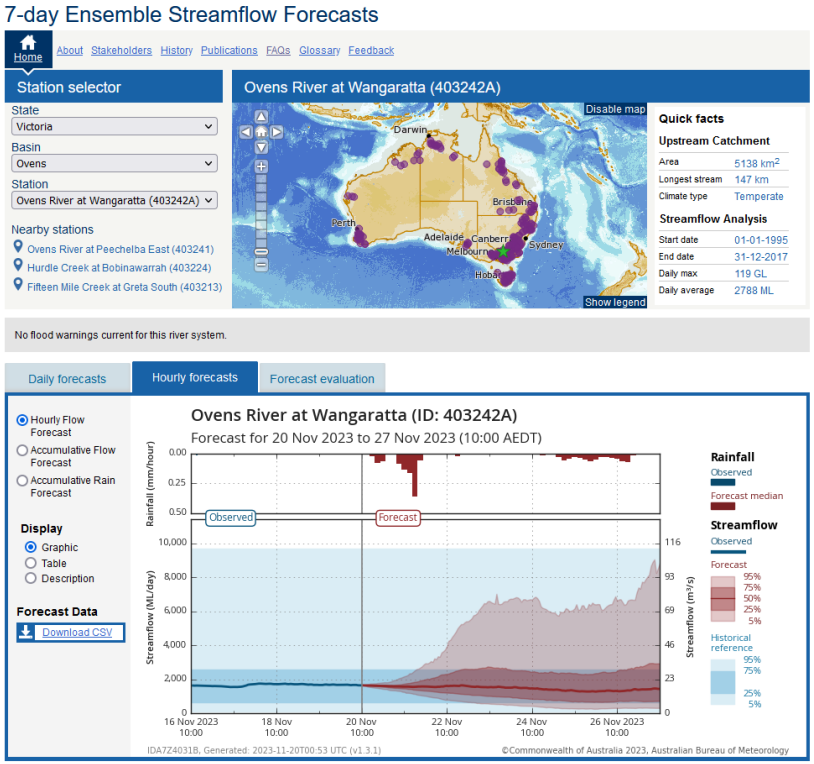
7-Day Ensemble streamflow forecasts — 2020

Australian Water Outlooks — 2021

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

7-day ensemble streamflow forecasts

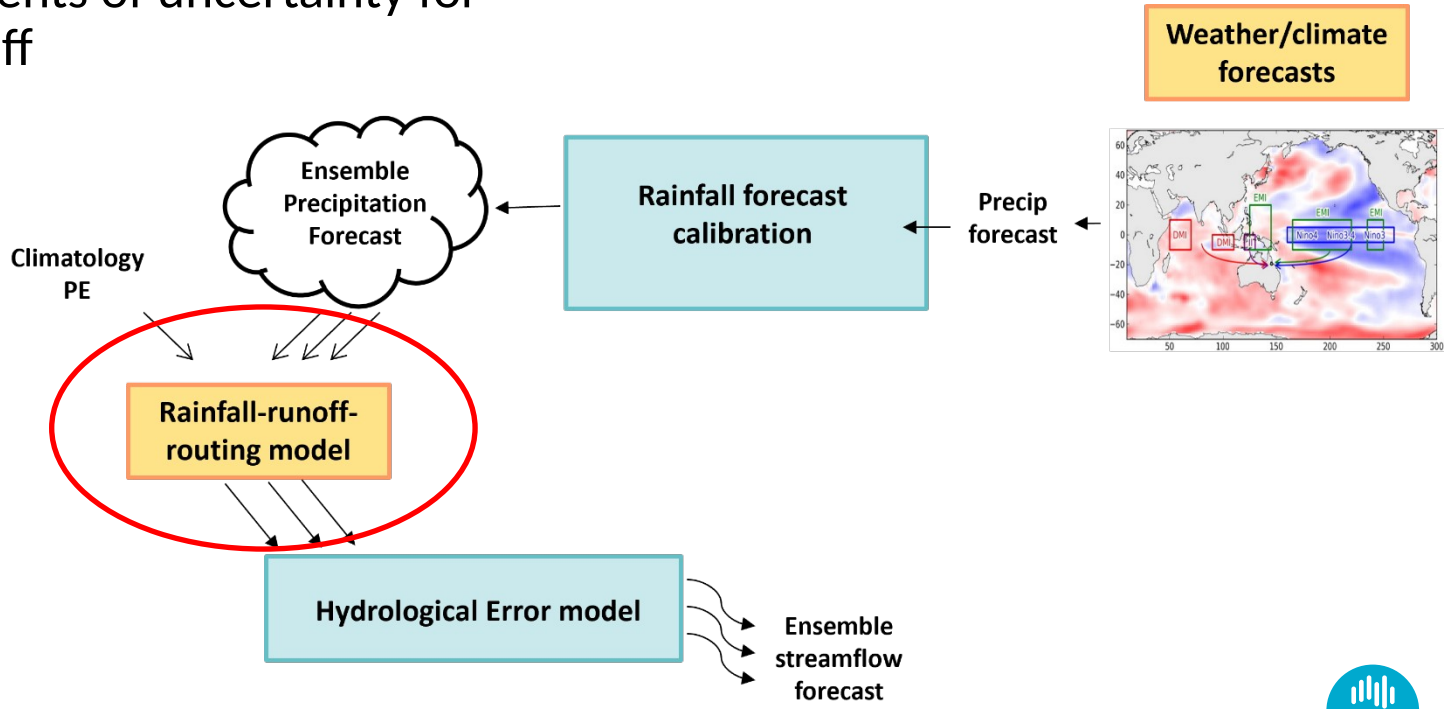
- Discharge (not level/inundation)
- Hourly time step
- Continually available
- Aimed at water/environmental management



http://www.bom.gov.au/water/7daystreamflow/

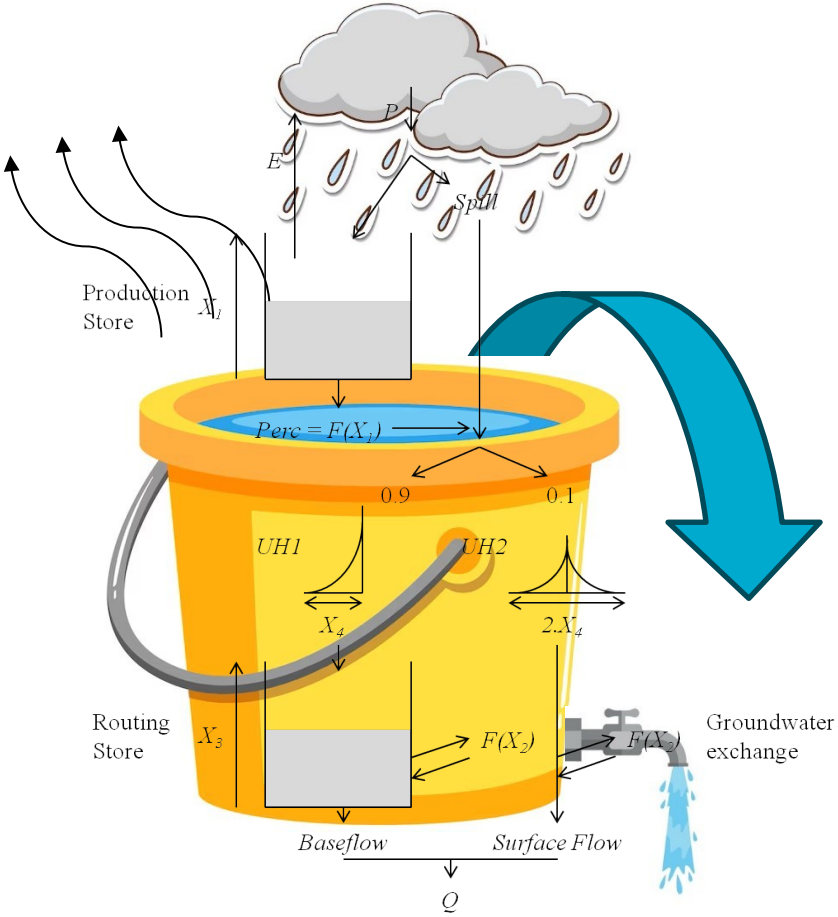
7-day ensemble streamflow forecast model chain

- Hybrid statistical-dynamical system
- Separate treatments of uncertainty for rainfall and runoff



Hydrological modelling

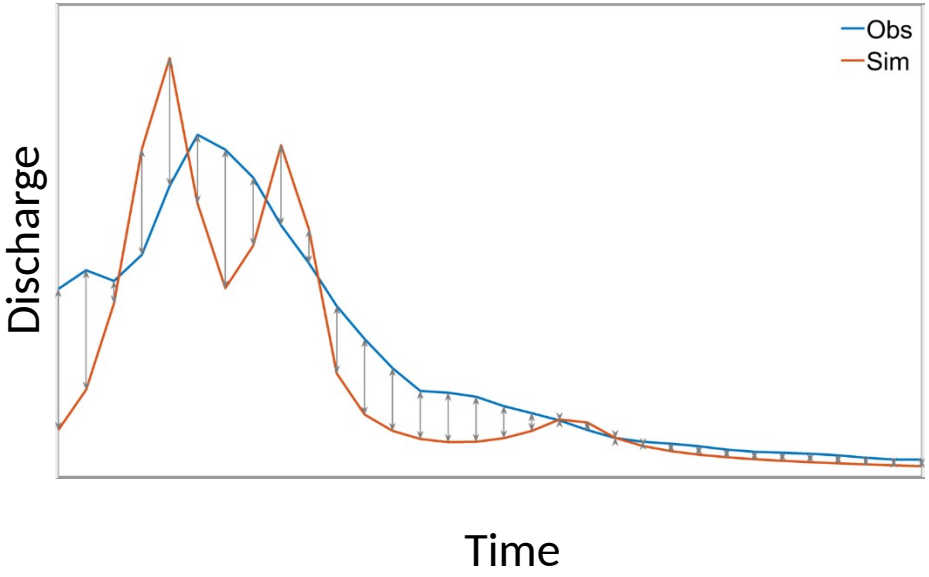
- Divide catchment into irregular ‘subareas’
- Rainfall-runoff modelling
- Routing between subareas
- Models are simple by design (for automated optimisation)



Perrin et al. 2003

Verification – hydrological models

- Commonly used scores:
  - Nash-Sutcliffe Efficiency (NSE)
  - Kling-Gupta Efficiency (KGE)
  - NSE of log-transformed flow
  - bias

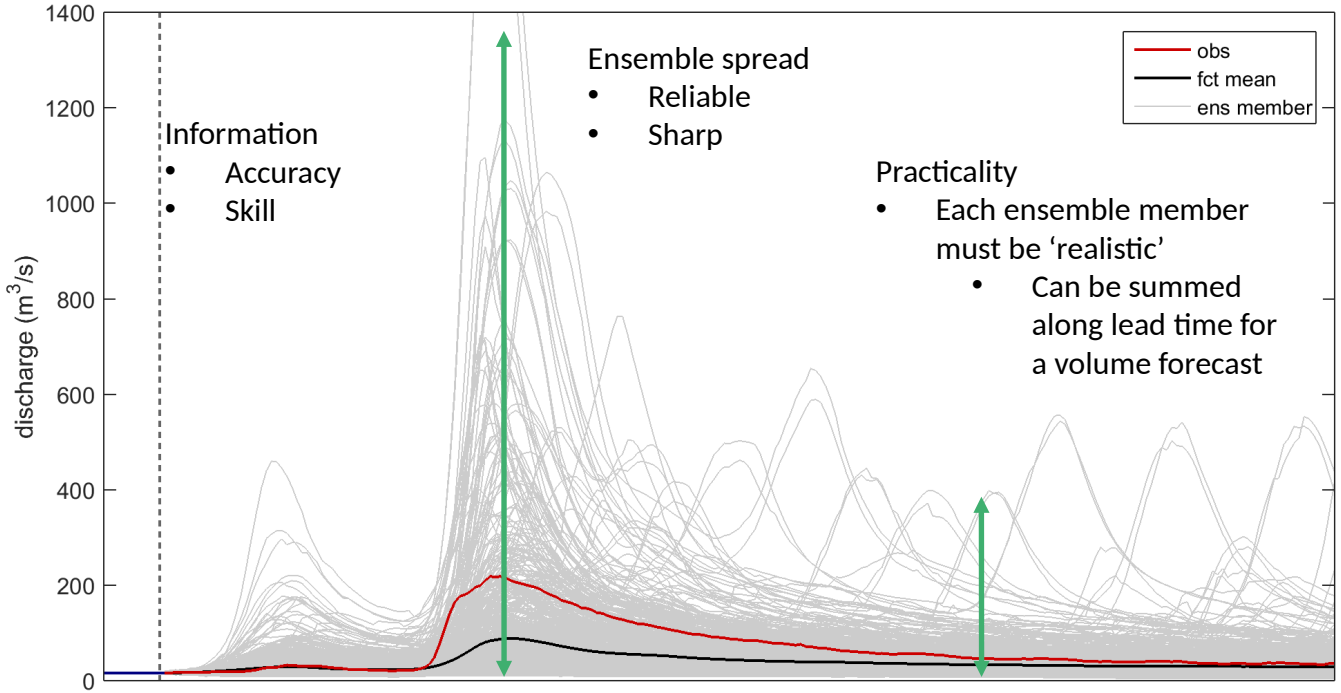


$$NSE = 1 - \frac{\sum_{t=1}^{T} (q_{obs}(t) - q_{sim}(t))^2}{\sum_{t=1}^{T} (q_{obs}(t) - \overline{q_{obs}})^2}$$

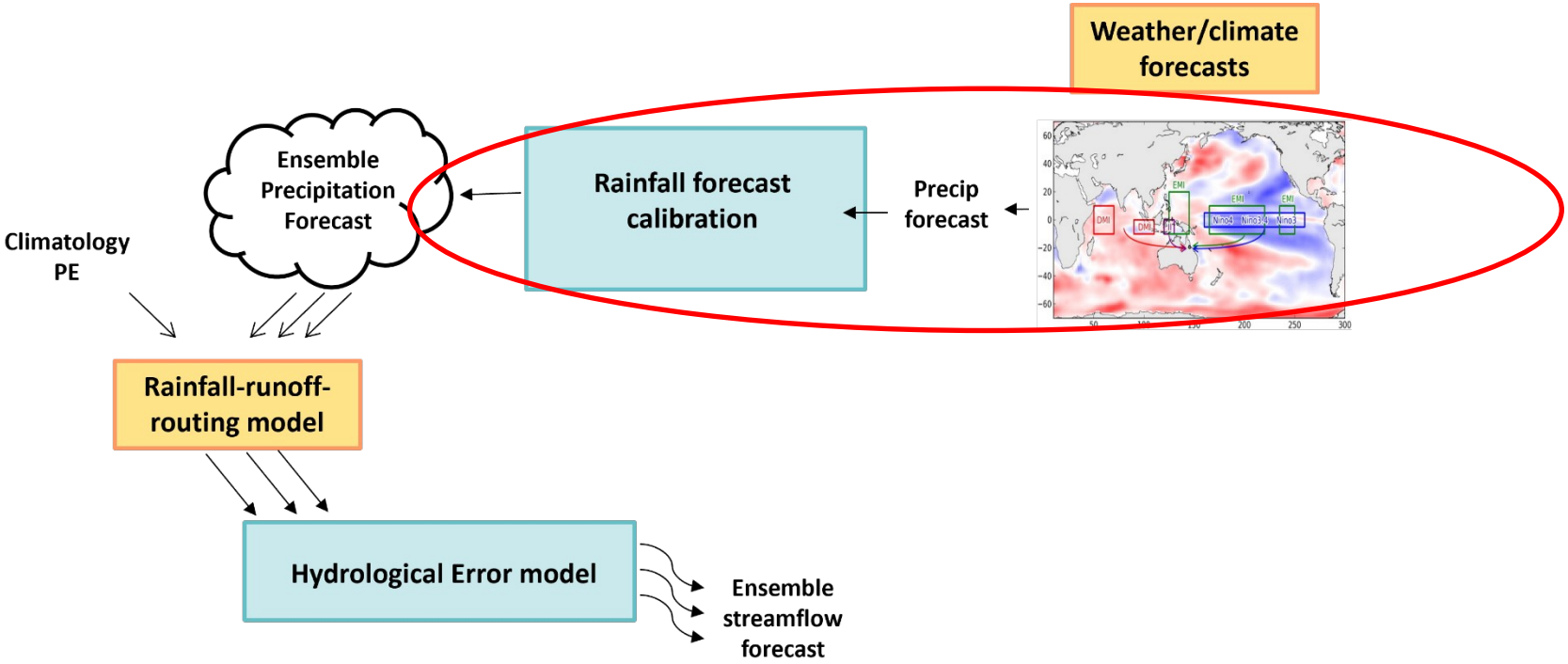
$$KGE = 1 - \sqrt{(r-1)^2 + \left(\frac{\sigma_{sim}}{\sigma_{obs}} - 1\right)^2 + \left(\frac{\overline{q_{sim}}}{\overline{q_{obs}}} - 1\right)^2}$$

Forecast verification

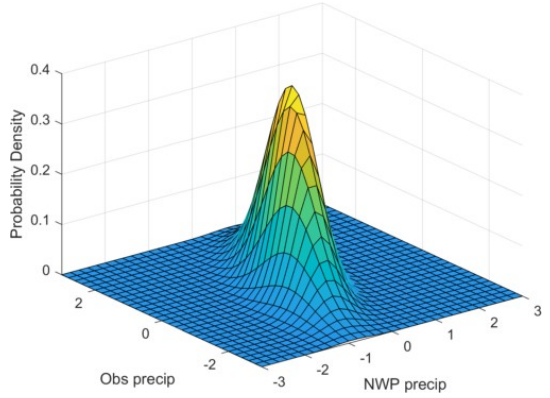
"maximise sharpness, subject to **calibration**" Gneiting & Katzfuss 2014



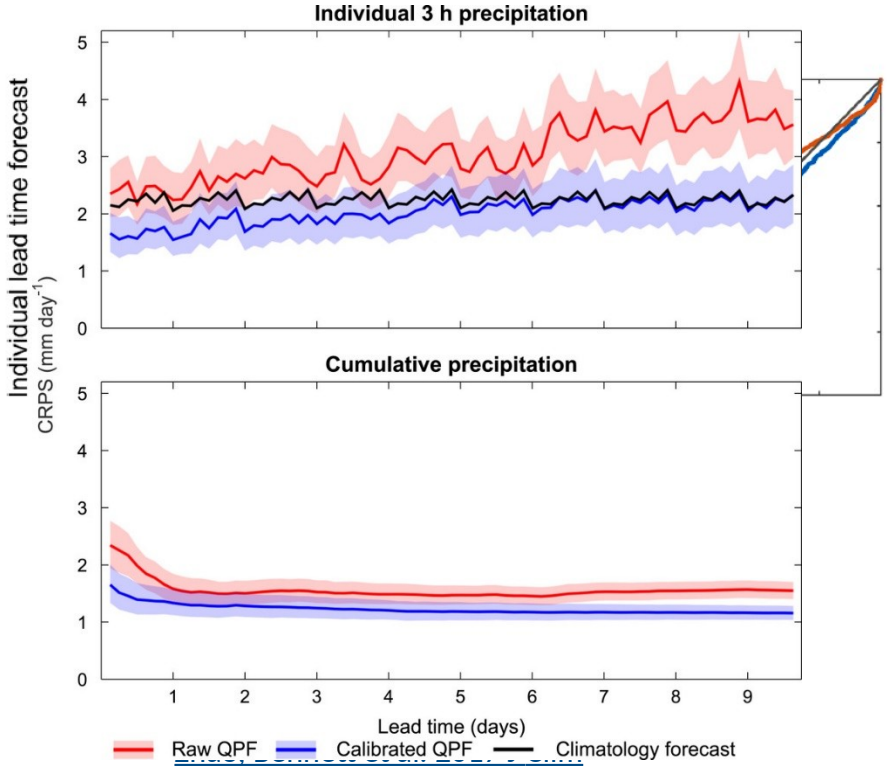
7-day ensemble streamflow forecast model chain



Verification – calibrated rainfall

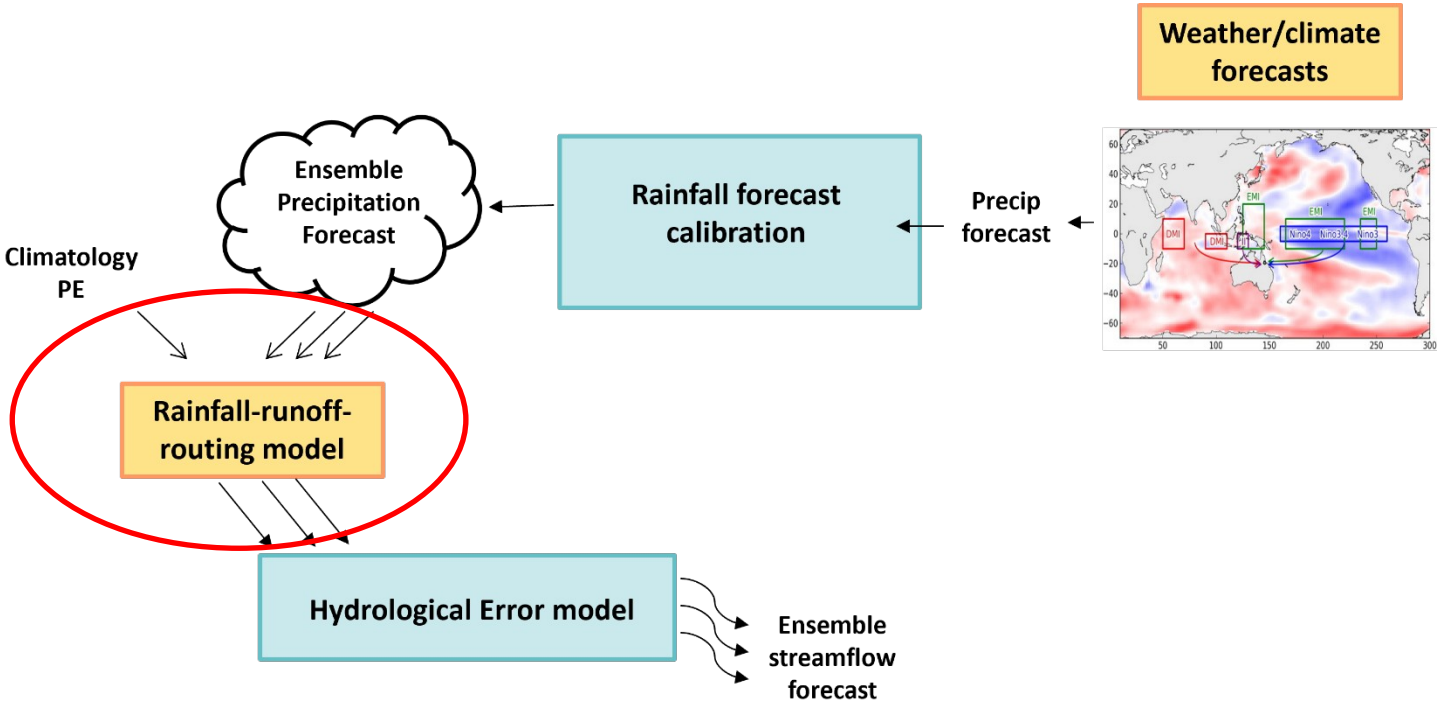


- Calibration with Bayesian joint probability model + Schaake Shuffle
- ‘Coherence’ (Krzysztofowicz 1999)
- Reliability, esp. of accumulations in space and time
- Bias (v important for inputs to tuned models)

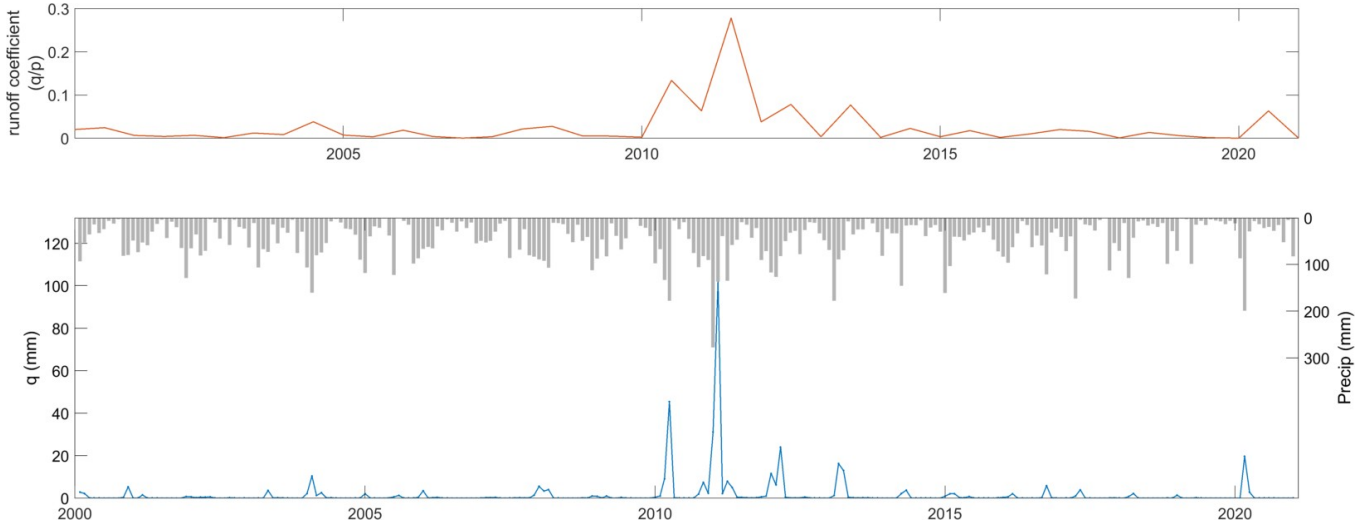


Shrestha, Robertson, Bennett, Wang 2015 MWR

7-day ensemble streamflow forecast model chain

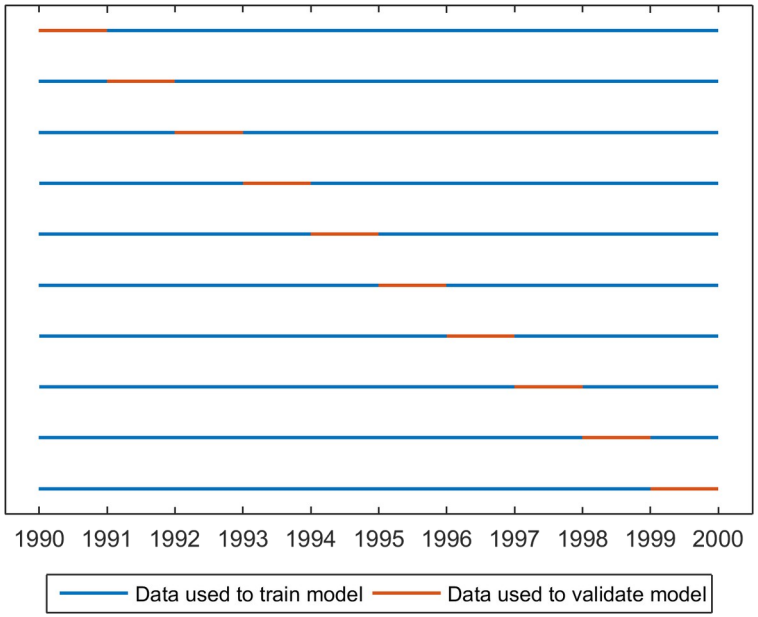


Temporal cross-validation

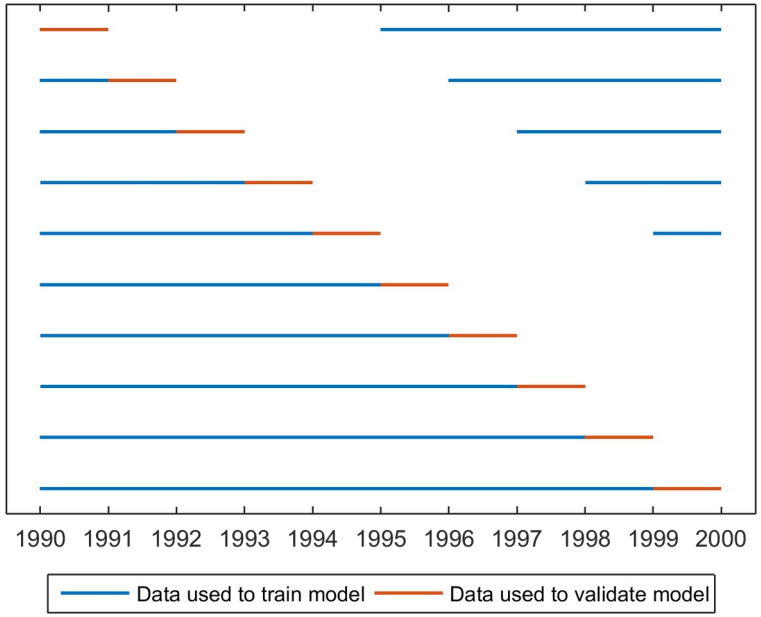


Cross-validation

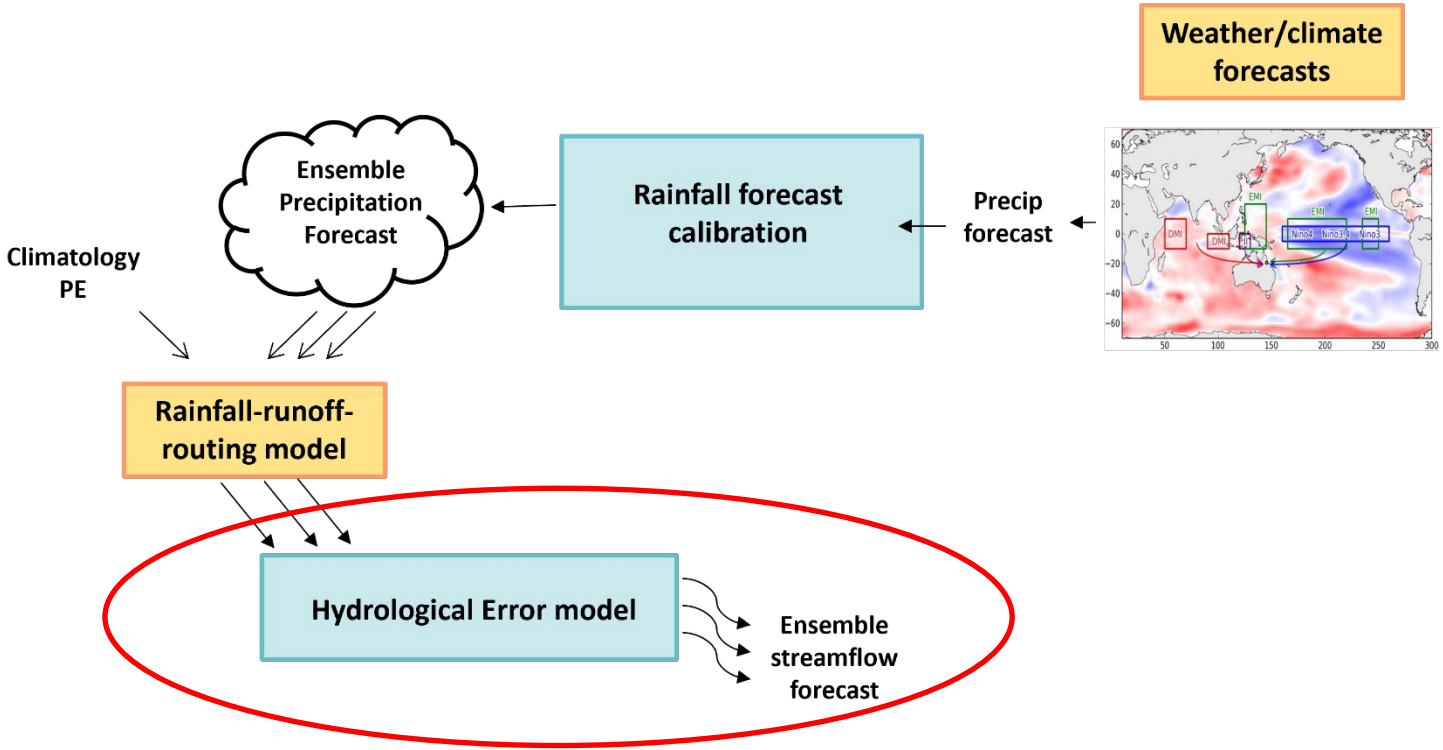
Leave 1-year out



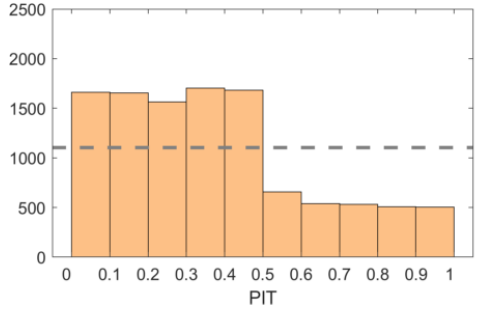
Buffered leave 1-year out (+X)

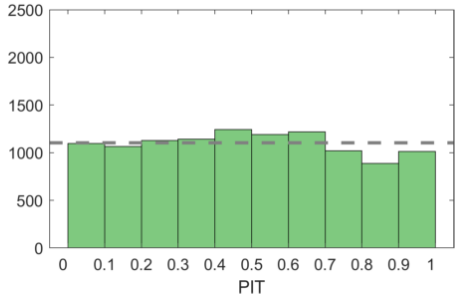


7-day ensemble streamflow forecast model chain

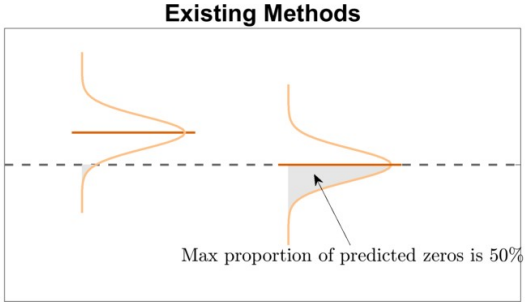


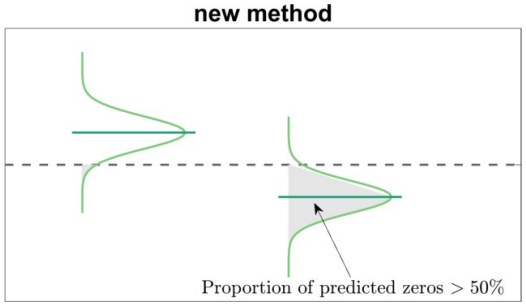
Error modelling with many zeros





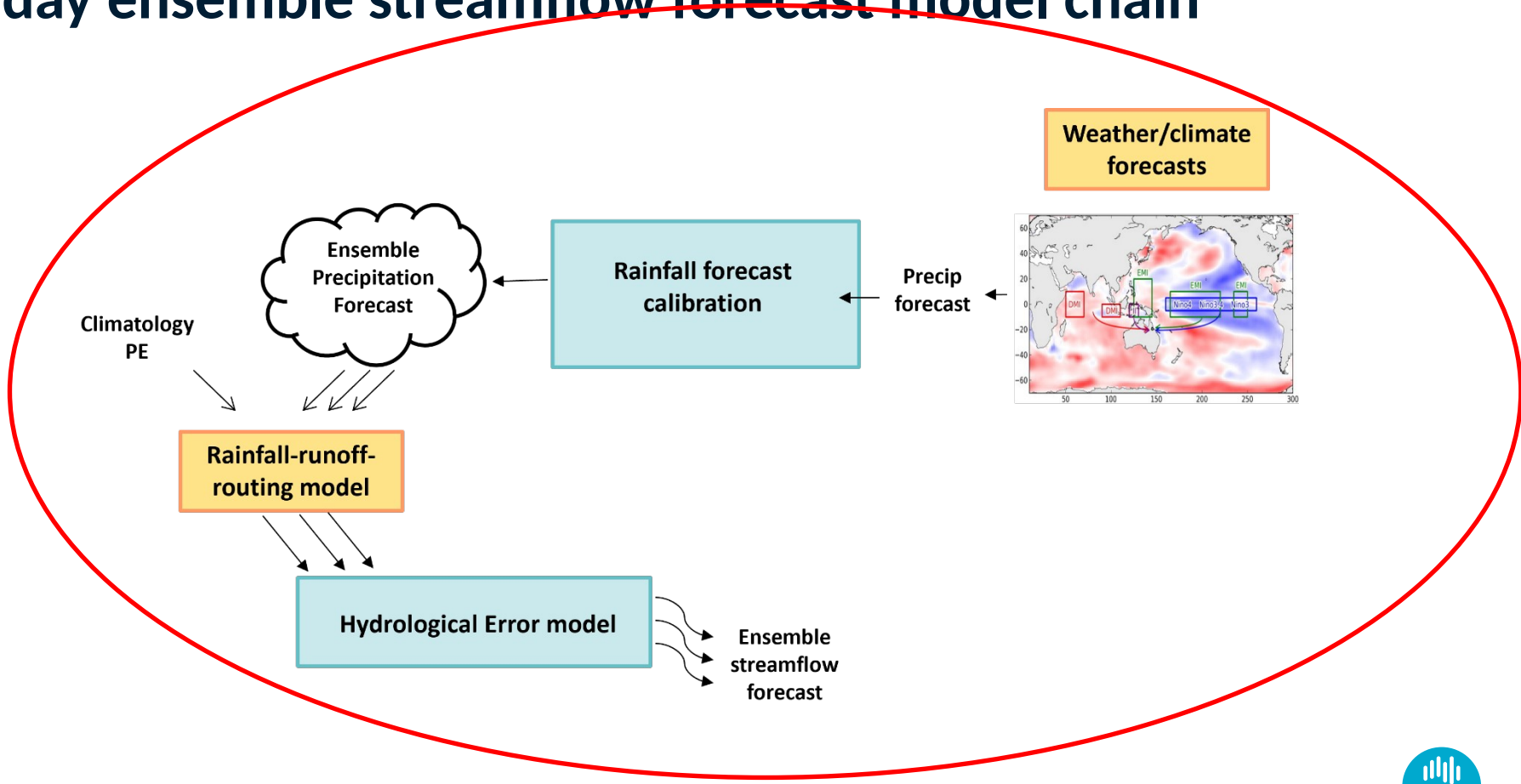
Ord River





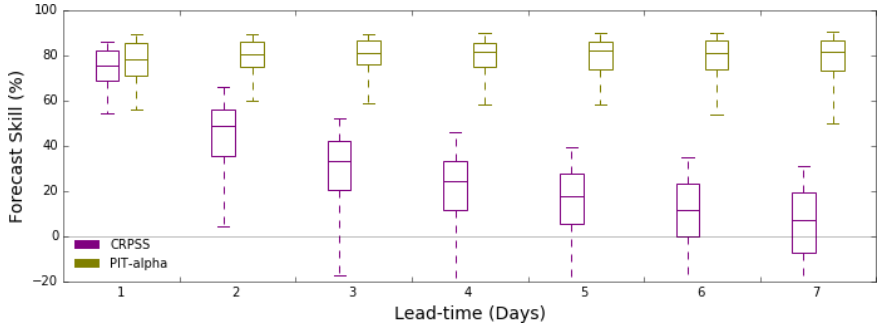
Wang, Bennett, Robertson, Li 2020 WRR

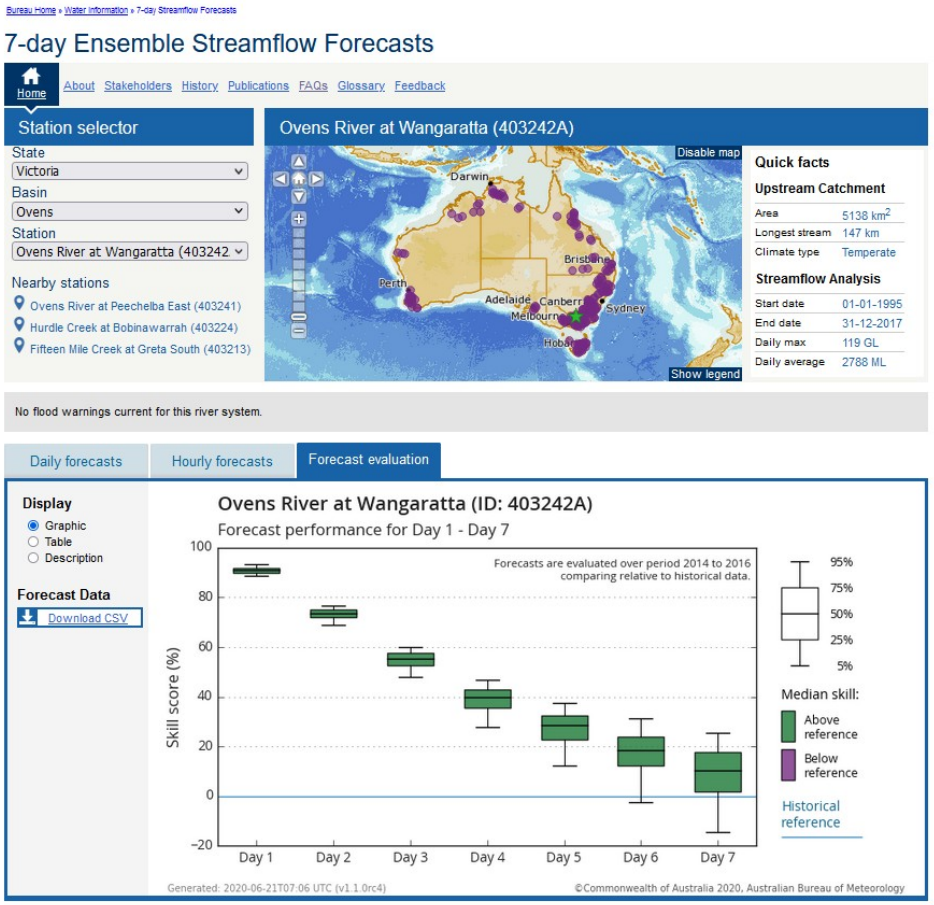
7-day ensemble streamflow forecast model chain



End-to-end Verification

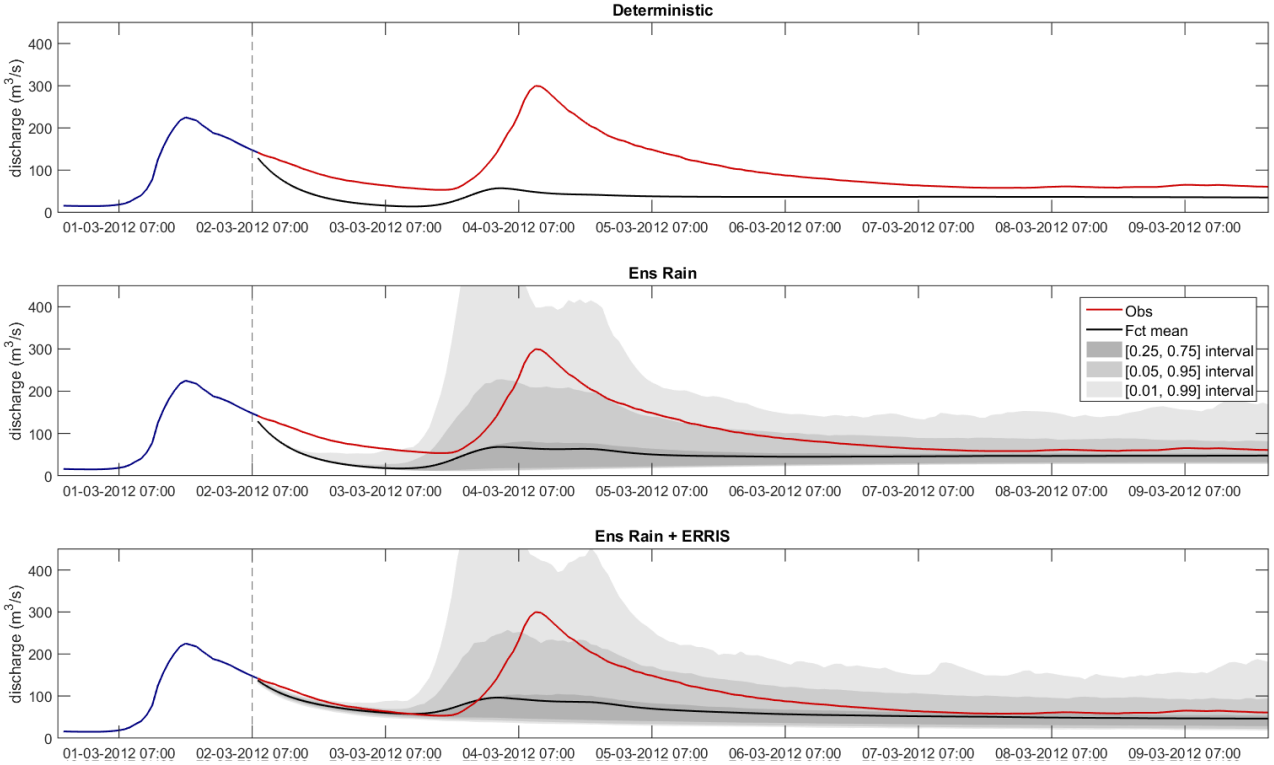
- Acceptance criteria
  - Hydrological model NSE>0.6
  - Positive skill (CRPSS) > 3 days lead time





Hapuarachchi et al. 2022 HESS

Verification vs communication?



Murray River at Biggara

Thank you

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https://people.csiro.au/B/J/James-Bennett