Preparation and provision of hydrological forecasting requirements on how to formulate NWP information for Use in flood forecasting to the SWFDP Steering Group

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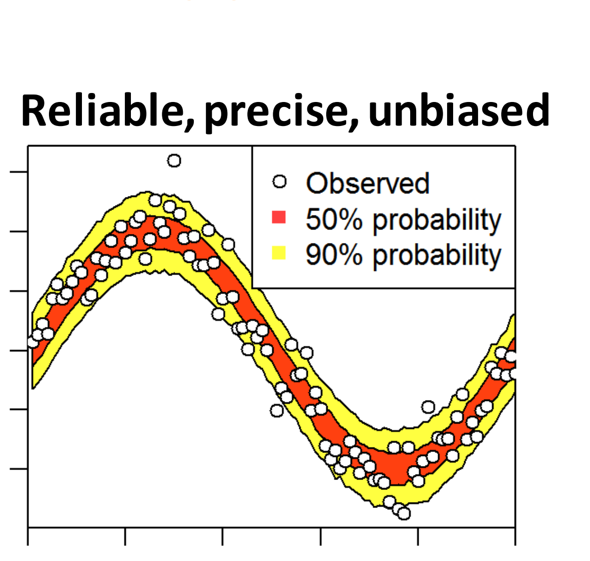
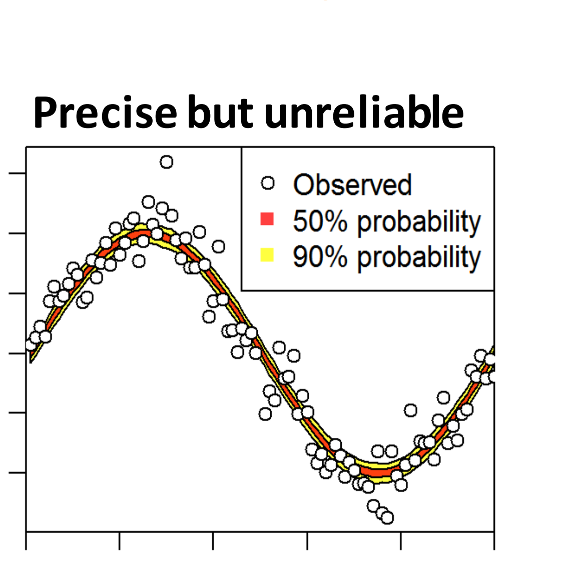
What makes a good probabilistic forecast?

- Water management is about “balancing risks” of extreme events (floods/droughts)
- For accurate risk estimates of extreme events, a good forecast needs to be:
- **Reliable**: Predictions statistically consistent with observed data
- **Precise**: Small uncertainty in predictions (aka forecast “sharpness”)

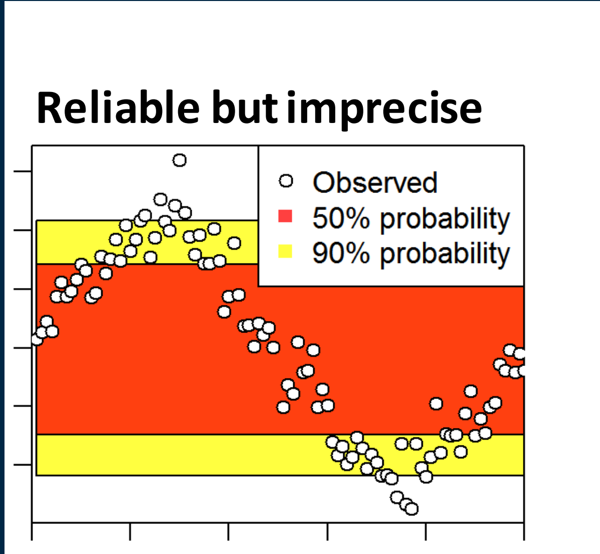
“Sharp & reliable forecasts'': optimum for managing risks and uncertainties



“Over-confident”: under-estimate risks, can’t manage extremes



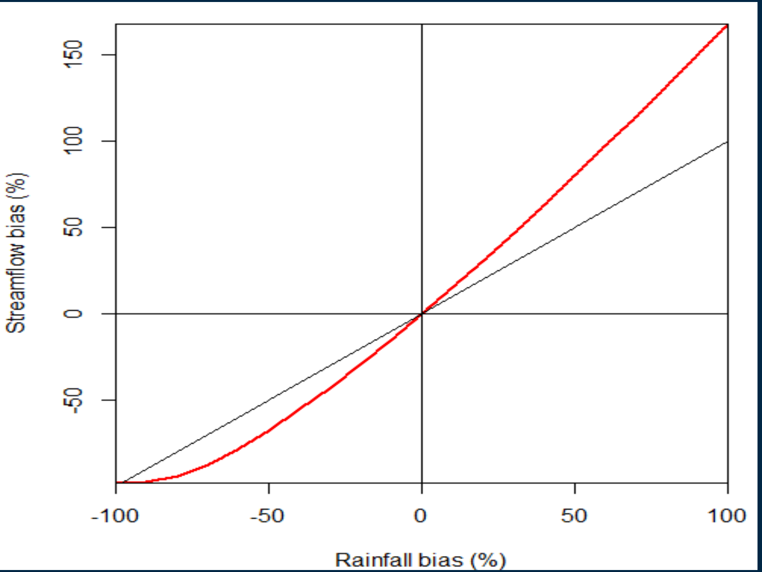
“Too-conservative”: over-estimates risks => missed opportunities



Rainfall forecast requirements for hydrology

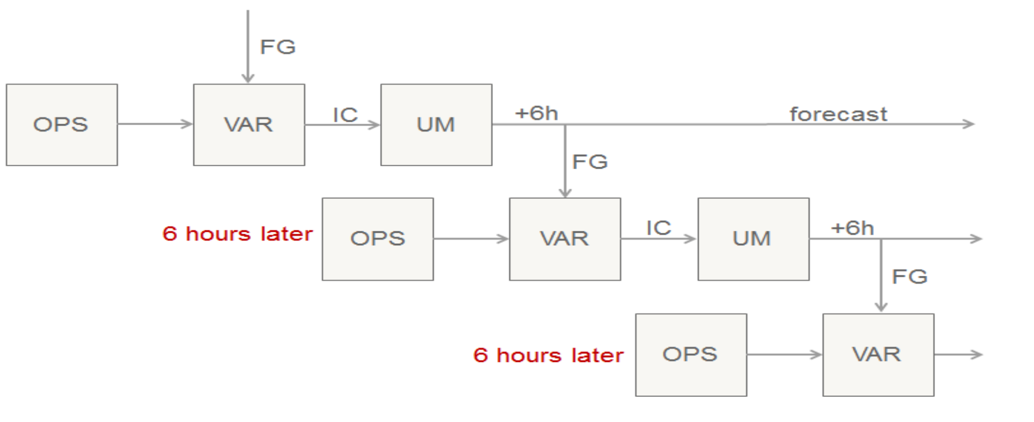
- Minimal bias (mean forecast rainfall is consistent with observations)
- As skilful as possible (errors no worse than naïve forecast)
- Reliable uncertainty (ensemble spread consistent with forecast errors)

- Rainfall-runoff process non-linear
  - Each sub-catchment and lead-time
- Hydrological processes integrate in space and time
  - Appropriate space-time correlations
  - Spatial and temporal totals



Numerical weather predictions

- Atmospheric model ‘dynamics’
- Sub-grid scale processes (e.g. moisture)
- Initial conditions
- Forecast process



- OPS = Obs-processing
- VAR = DA step
- UM = model-forecast
- FG = First-Guess = Background
- *Analysis is now a blend of model and observations*

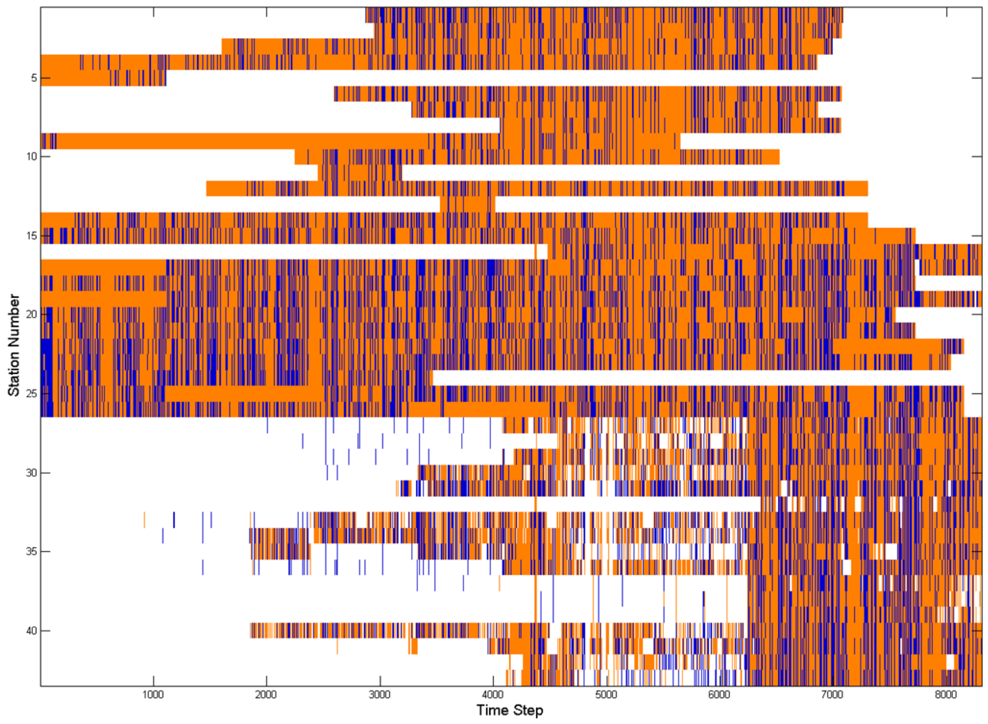
Need to be cognisant of 'real time' gauged rainfall data and its structural spatiotemporal deficiencies

Data availability and quality assurance

- Rainfall forecast distributions need to capture attributes of the imperfect real time rainfall observations

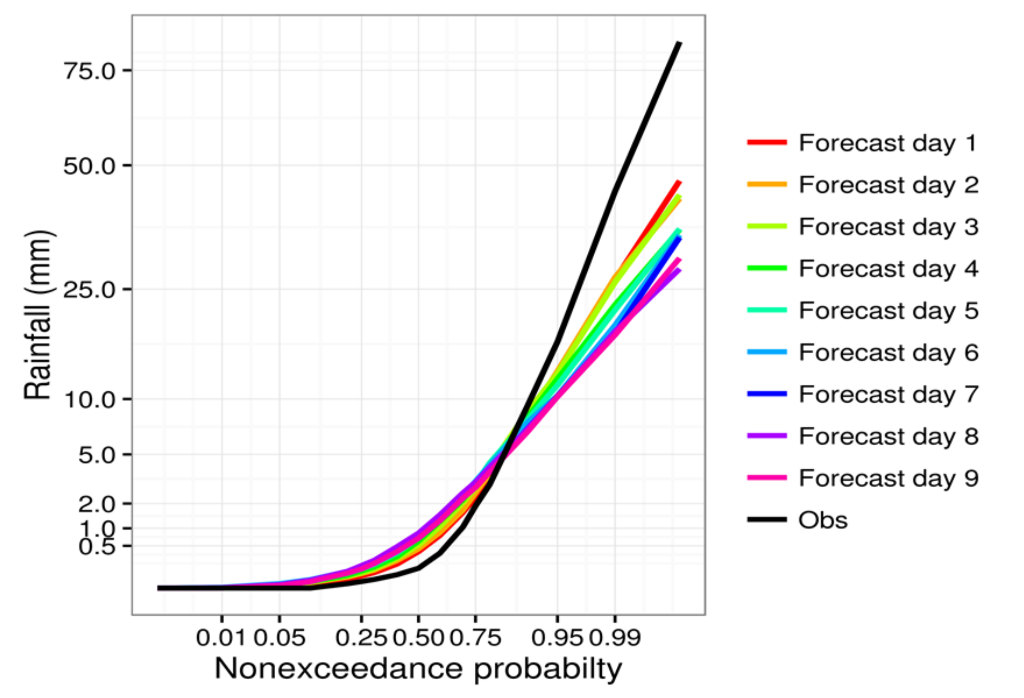
- Real time rainfall data deficiencies:
  - Missing values (white space)
  - Zero values (orange)
  - Non zero values (blue)

- Quality assurance:
  - Data and modelling system must be able to handle inconsistencies in real time data



What limits forecast performance – rainfall distribution

- Magnitude of large rainfall events too small
- Light rainfall too frequent
- Forecast performance degrades with lead time



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Need rainfall post processing methods

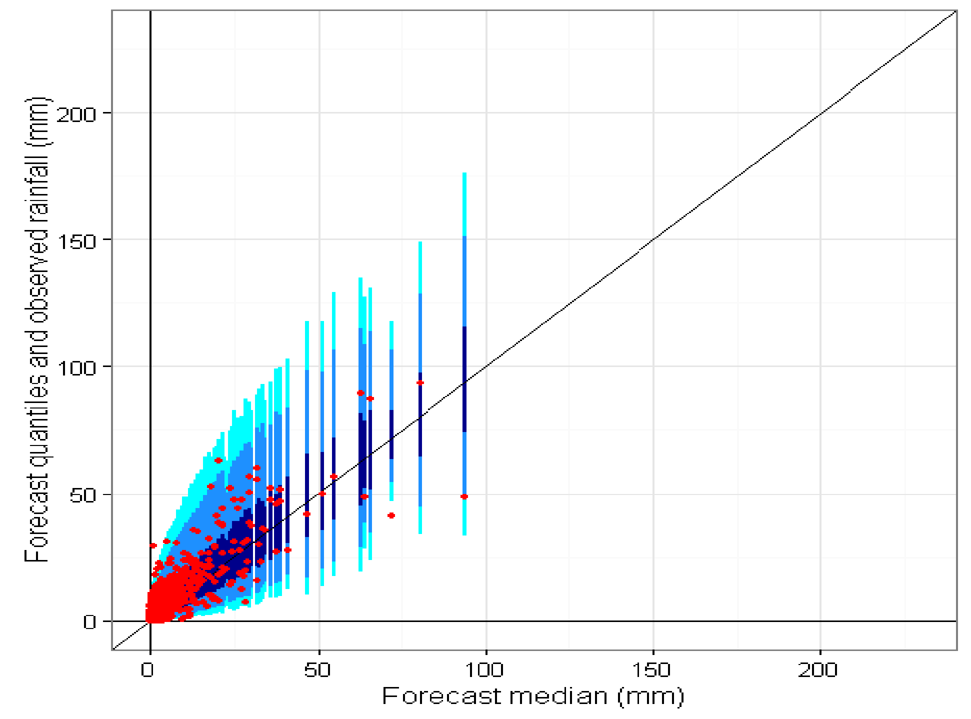
Forecast rainfall uncertainty

Post-processing
- Reduces errors
- Quantifies uncertainty

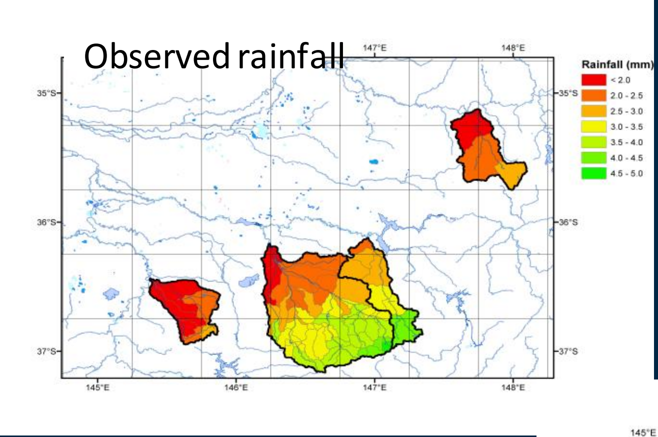
Forecast rainfall is uncertain

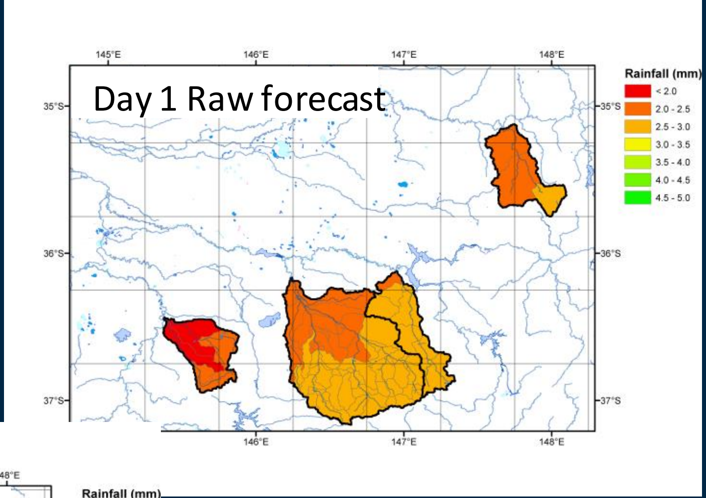
Forecast uncertainty increases with event size

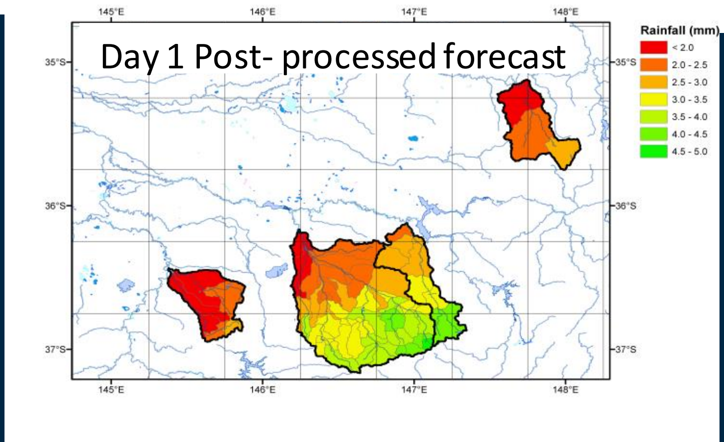
For 50 mm median forecast
- 50% CI ~ 30 mm
- 80% CI ~ 70 mm
- 90% CI ~ 100+ mm



Improvements from rainfall post processing at river basin scale is necessary pre-requisite







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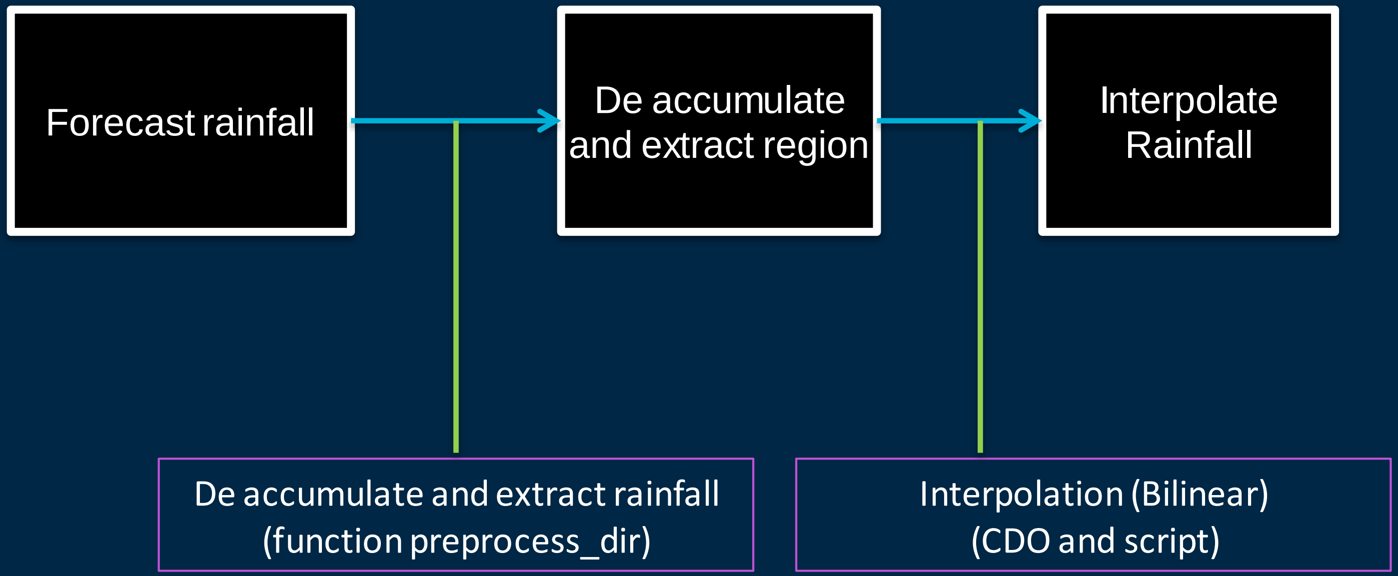
May need to interpolate coarse scale ensemble NWP forecasts to fine scale for hydrologic applications

Forecast rainfall interpolation issues for river basin applications

Fine scale gridded hydrologic models may require use of interpolation methods on coarse scale ensemble NWPs



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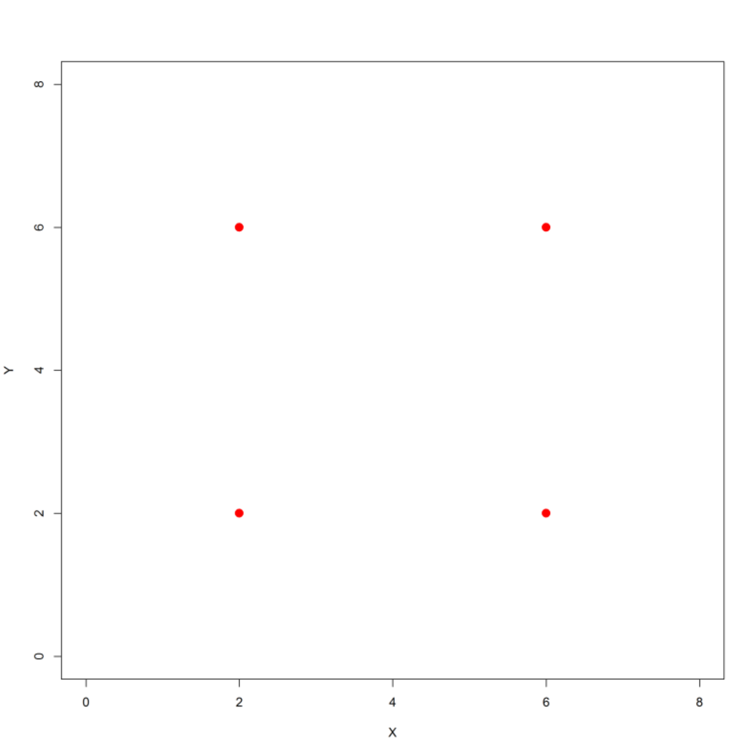
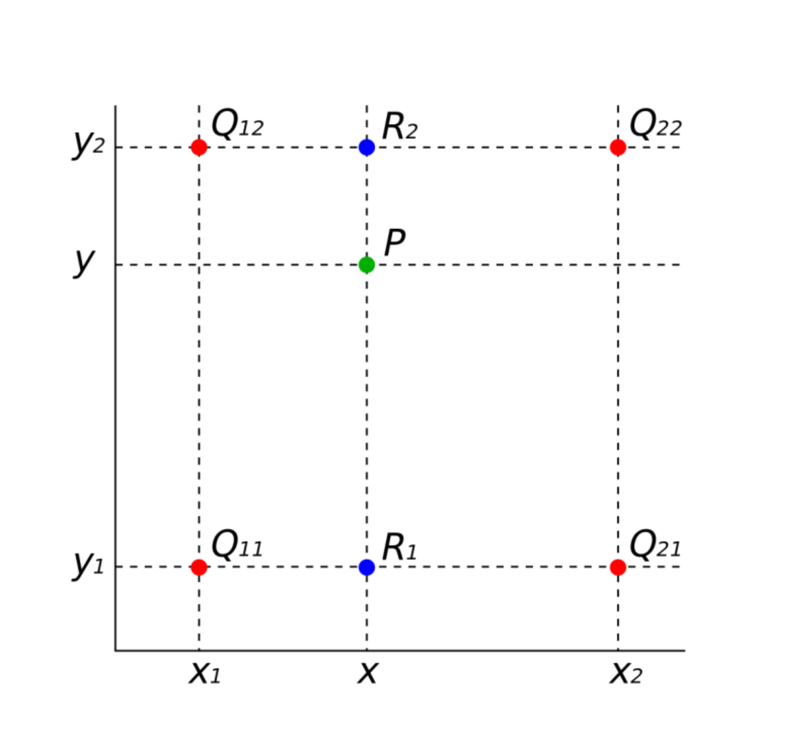
Bilinear Interpolation (Coarse scale forecast rainfall)

Coarse scale to fine scale interpolation methods need to be robust





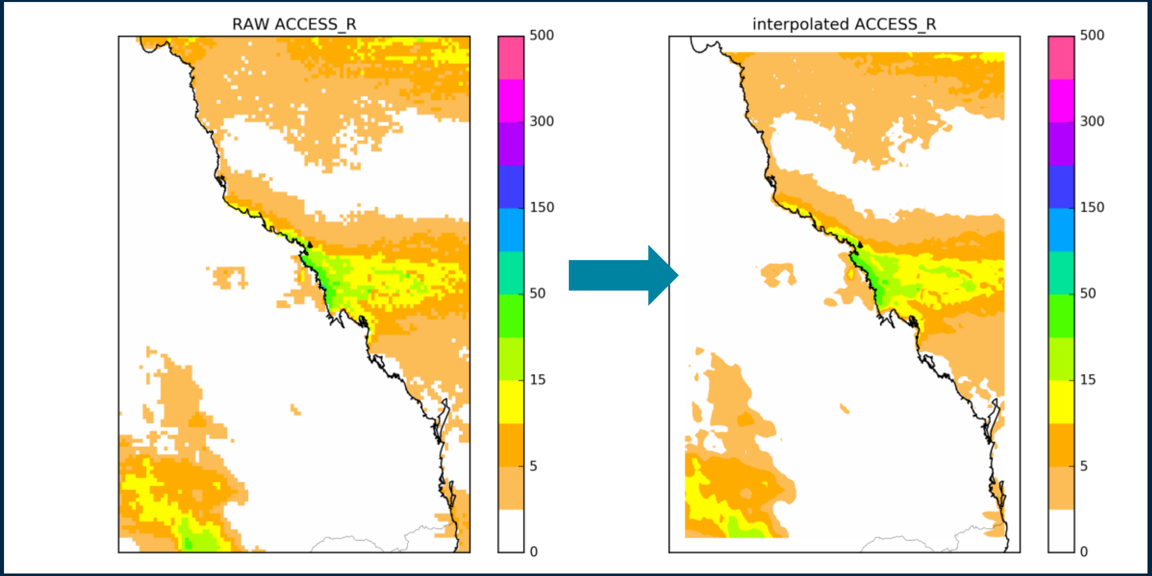
ACCESS-R Forecast Rainfall

- Disaggregated to hourly time step
- Interpolated to 1km grid centroids

12x12km²
3 hourly data

2014/01/09 12:00

1x1km²
hourly data



Need to standardise NWP forecast quality for hydrologic applications

Assessment of forecast quality

Definitions

- Climatology: Distribution of observed flow data for a given period over a long period of time (typically 1970-2010)

- Ensemble forecasts: Forecast made of several replicates randomly generated

- Skill: Forecast performance compared to a benchmark (e.g. climatology)

- Score: Performance metric (e.g. bias)

Assessment of forecast quality

A two step process:

1. Cross validation
2. Computation of skill scores

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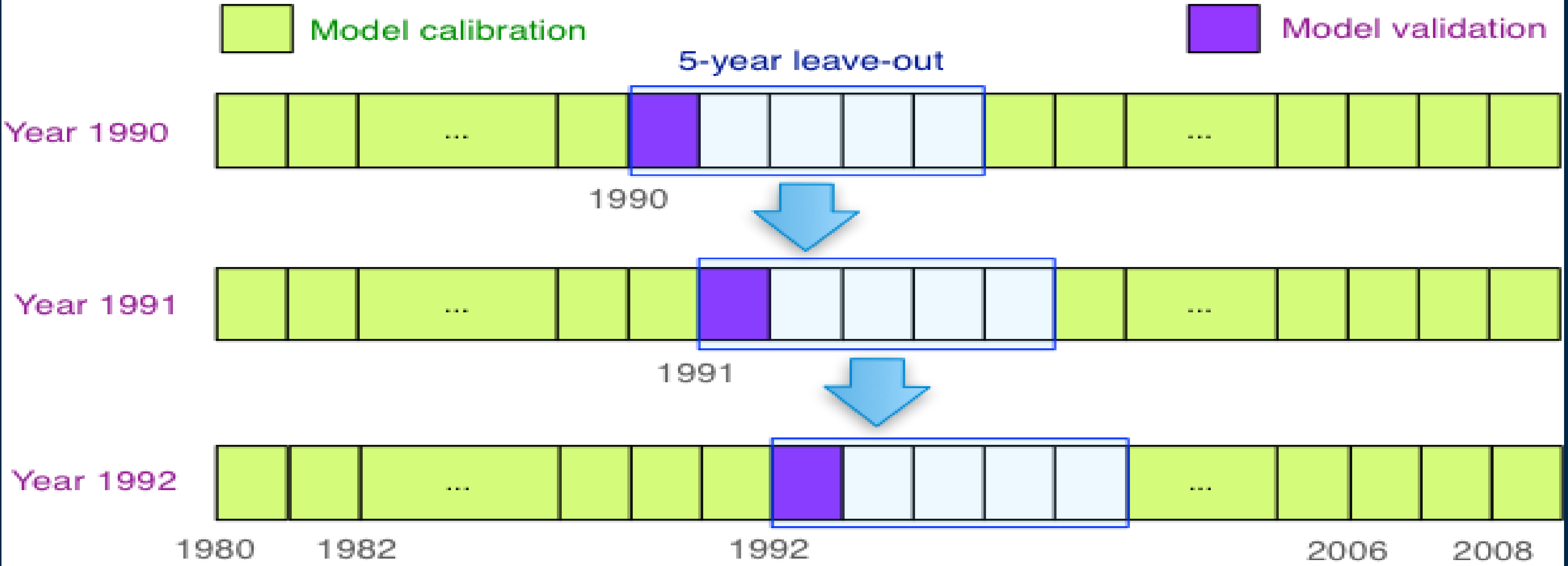

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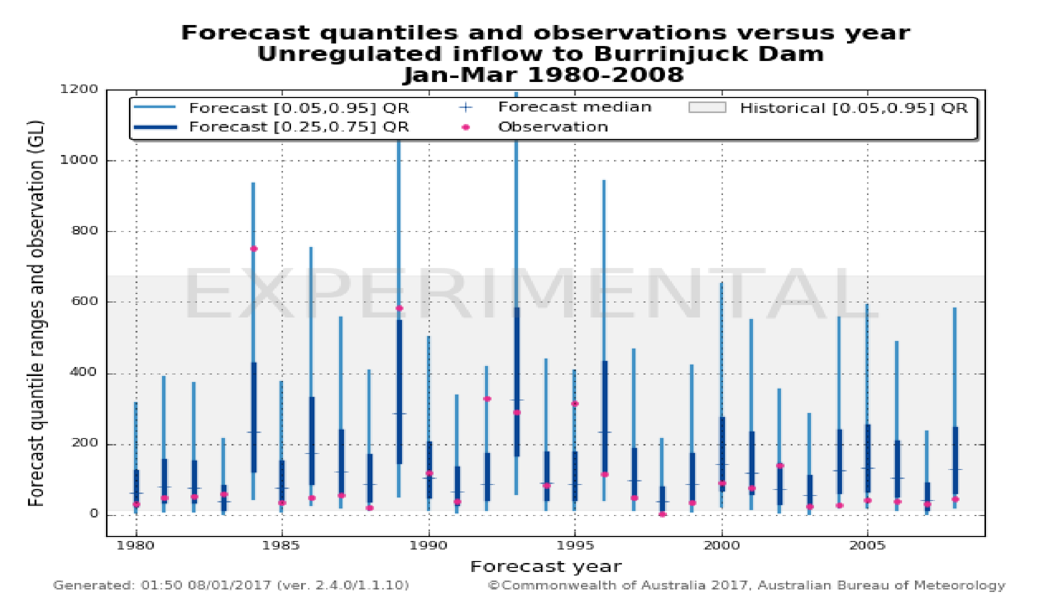

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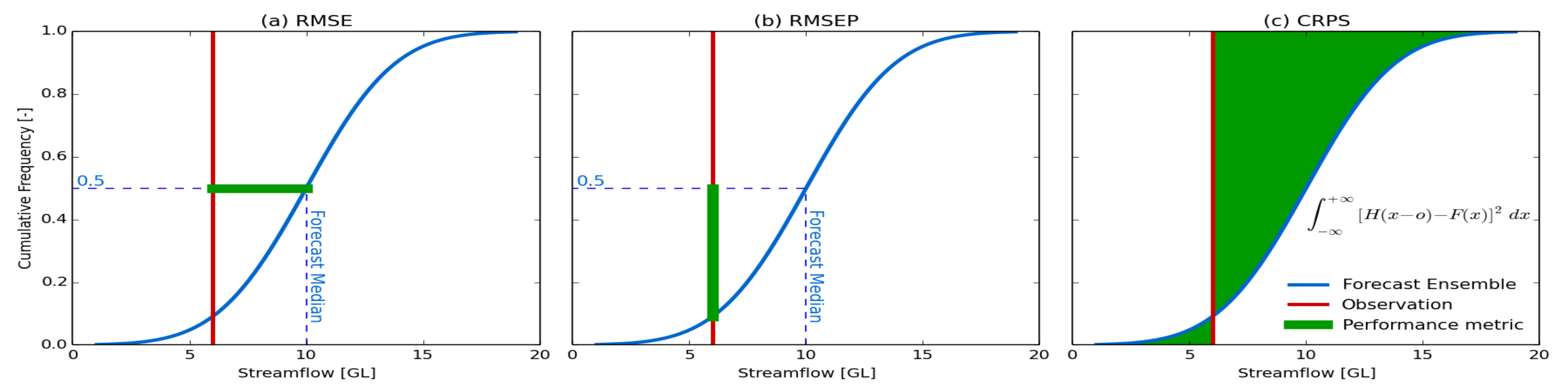

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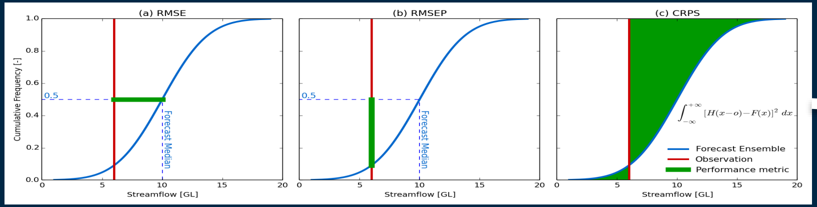
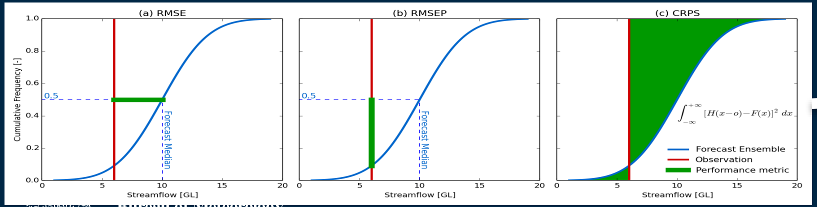


Forecast (F)

Skill = 100 x (C-F)/C



Climatology (C)

Need to tabulate ensemble NWPs available from different global centres with a focus on operational access

Need to standardise hindcast and forecast strategies to balance the need for robust forecast performance assessment vis-à-vis computational and network storage costs

Need to compile case studies in various hydro-climate regions on how and when NWPs are helpful in managing risks to public safety

Follow up work needed to review relevant literature with a team from OPACHE experts