Do more complex hydrological models produce more skilful streamflow forecasts?

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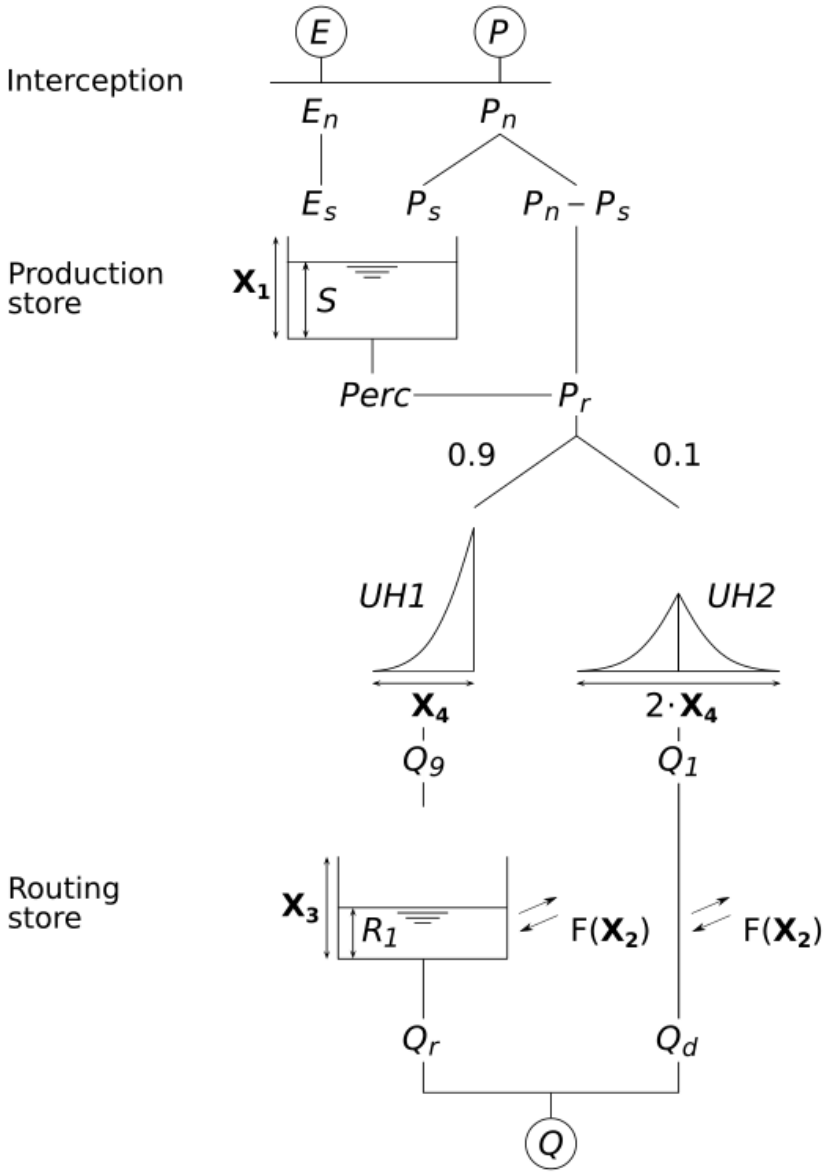
Context

- Work comprises part of a larger project – HydroCast – to establish seasonal hydrological forecasting capabilities for Ireland
- Initial research benchmarked Ensemble Streamflow Prediction (ESP) and showed that skilful forecasts were possible out to a 1-month lead time.
- Can we improve this skill through the use of models with varying parametric and structural complexity?

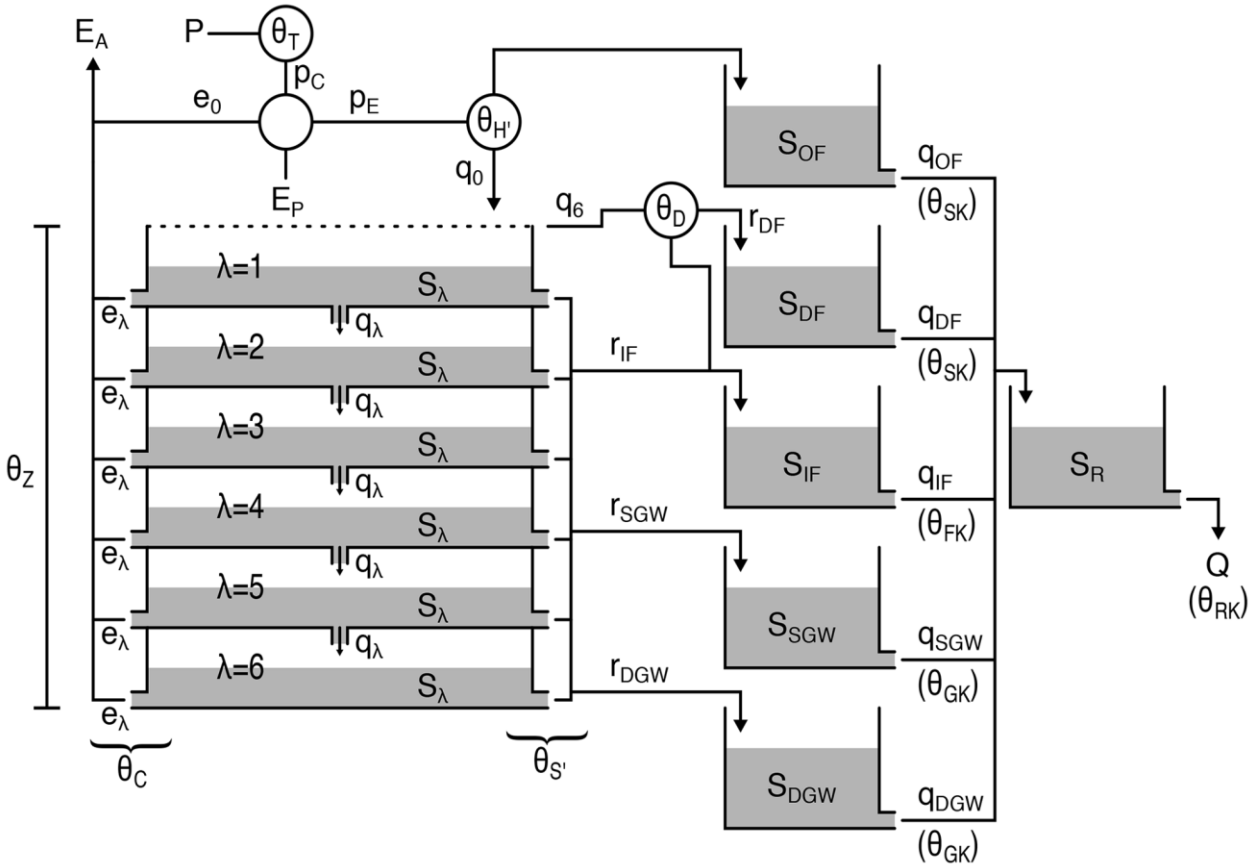
Simple Model: GR4J



Parameter	Description	Unit
x_1	Production store capacity	mm
x_2	Groundwater exchange coefficient	mm
x_3	One day ahead maximum routing store capacity	mm
x_4	Time base of unit hydrograph UH1	d

- Reliable.
- Successfully applied to Irish conditions.
- Produced skilful ESP forecasts so ideal benchmark.

Complex Model: SMART



Parameter	Description	Unit
T	Rainfall aerial correction factor	–
C	Evaporation decay coefficient	–
H	Quick runoff ratio	–
D	Drain flow ratio	–
S	Soil outflow coefficient	–
Z	Effective soil depth	mm
SK	Surface reservoir residence time	d
FK	Interflow reservoir residence time	d
GK	Groundwater reservoir residence time	d
RK	Channel reservoir residence time	d

- Developed for water quality modelling in Ireland.
- Explicitly separates key flow pathways in a catchment.

Improved groundwater representation

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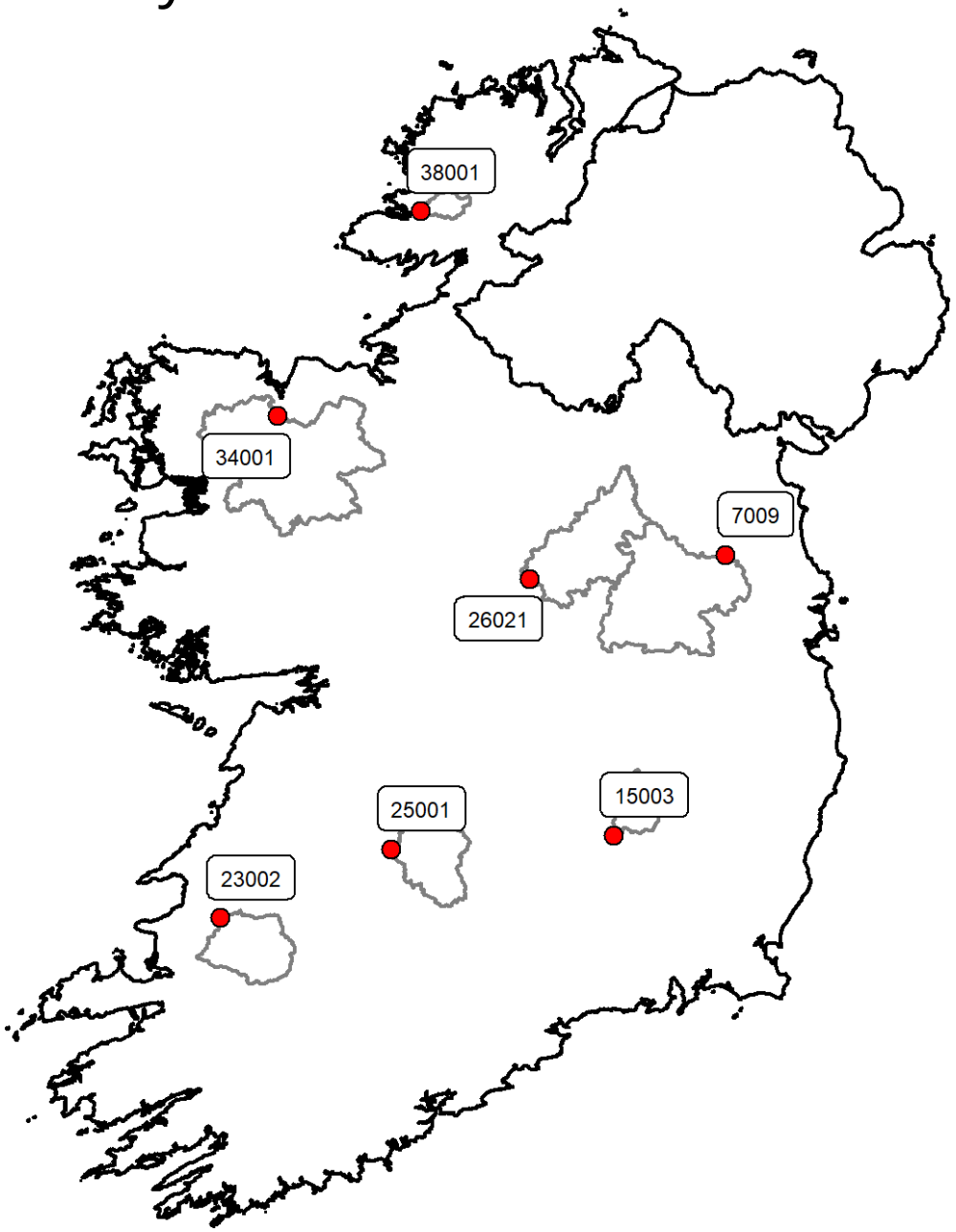
Improved forecast skill?

Study Area

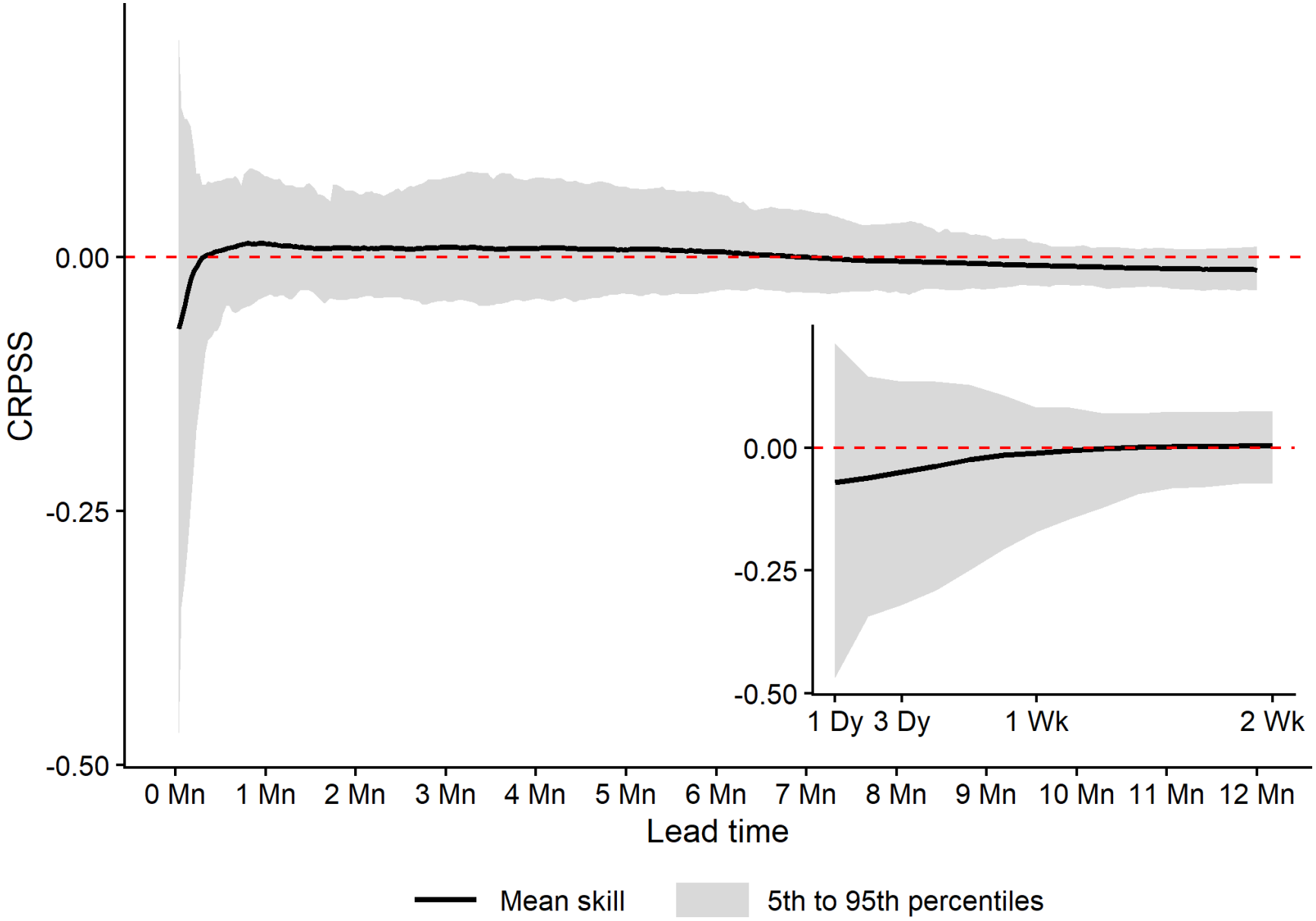


ID	Waterbody / Station	Baseflow Index
26021	Inny at Ballymahon	0.82
34001	Moy at Rahans	0.76
07009	Boyne at Navan Weir	0.70
25001	Mulkear at Annacotty	0.52
15003	Dinin at Dinin Bridge	0.39
23002	Feale at Listowel	0.33
38001	Owenea at Clonconwal Ford	0.27

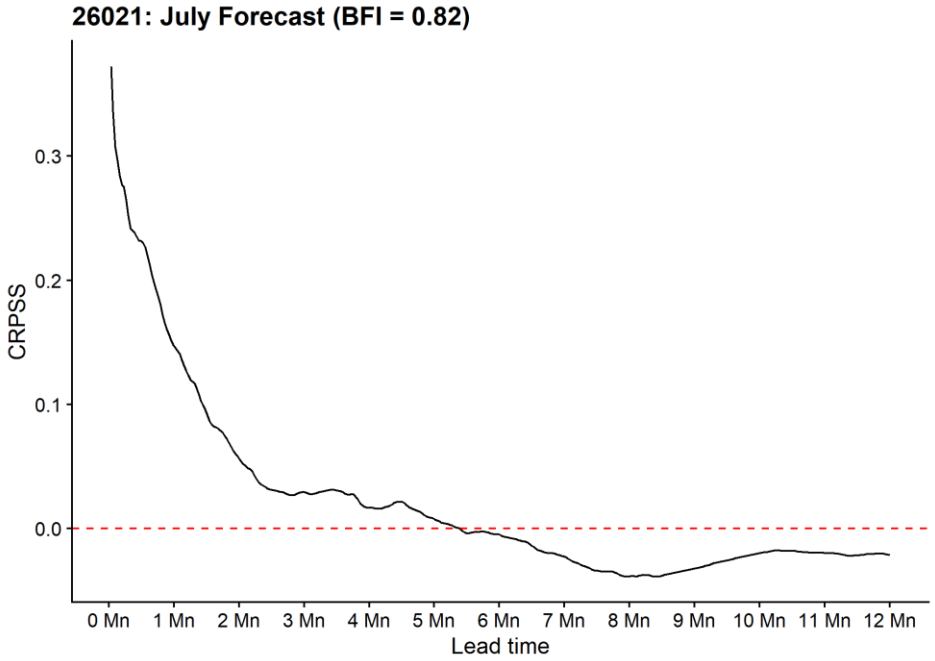
Hindcast Experiment

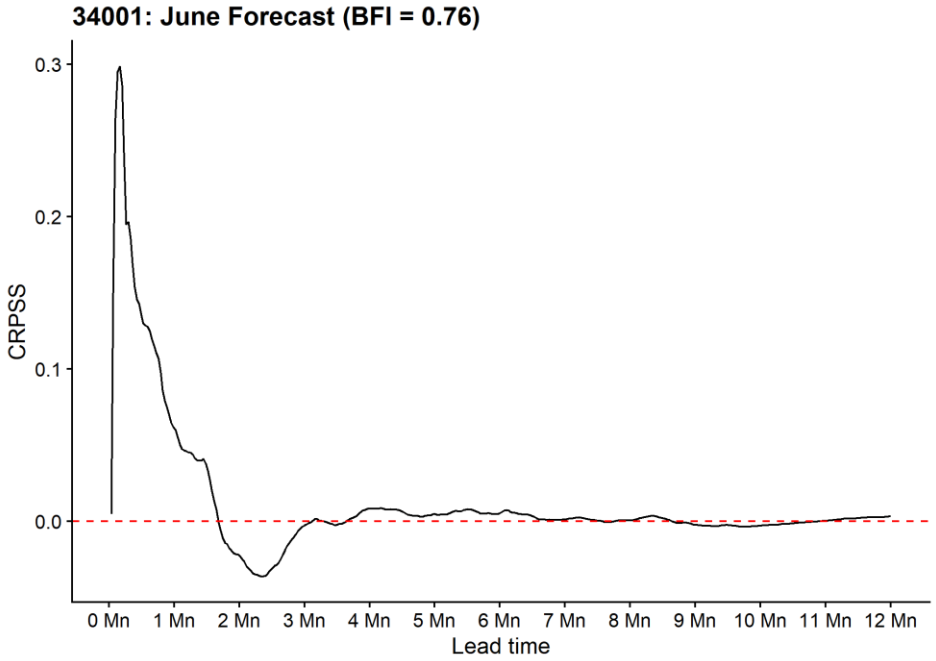
Hindcast years: 24 (1993–2016)
Ensemble members: 55 (1961–2016)
Initialisation: 1st of each month
Lead time: 365 days
Evaluation: CRPSS

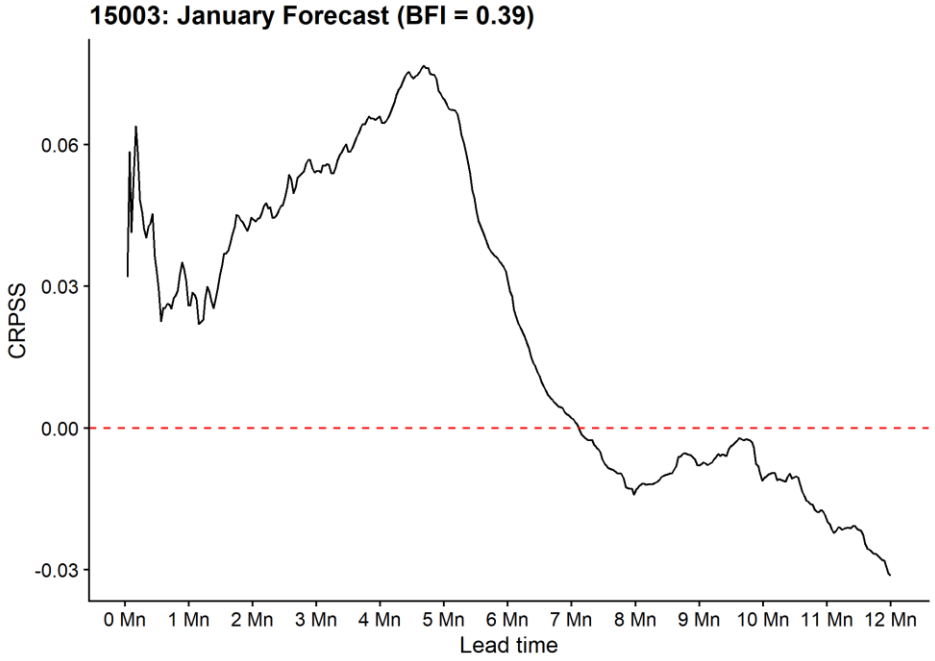
Results: Average Skill

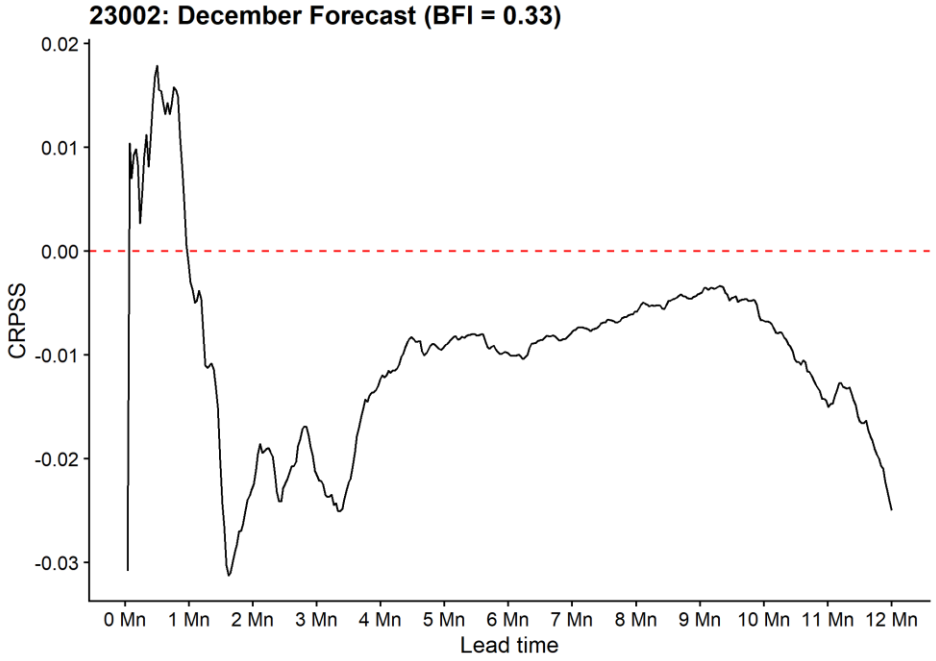


Results: Catchment/Initialisation Month









Conclusions

- The contribution of hydrological model complexity to forecast skill is not straightforward.
- Improvements in skill depend on a combination of factors such as lead time, initialisation month, and critically local hydrological context
- In Ireland, model complexity can contribute forecast skill through improved groundwater representation.
- Highlights the need for models to capture key flow pathways in catchments.

Thank You!

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