Streamflow Forecasting without Models

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Abstract

In this study, the authors explore simple concepts of persistence in streamflow forecasting based on the real-time streamflow observations. The authors use 15-minute streamflow observations from the year 2002 to 2018 at 140 U.S. Geological Survey (USGS) streamflow gauges monitoring the streams and rivers over the State of Iowa. The spatial scale of the basins ranges from about 7 km2 to 37,000 km2. Motivated by the need for evaluating the skill of real-time streamflow forecasting systems, the authors perform quantitative skill assessment of different persistence schemes across spatial scales and lead-times. They show that temporal persistence forecasts skill has strong dependence on basin size and weaker, but non-negligible, dependence on geometric properties of the river network of the basin. The authors show that anomaly persistence forecasting can serve as a good reference for the evaluation of real-time streamflow forecasts at scales of order 100 km2. Building on results from this temporal persistence, they extend the streamflow persistence to space through flow-connected river network. It simply assumes that streamflow at a station in space will persist to another station which is flow-connected, and refer to it as pure spatial persistence forecasts (PSPF). The authors show that skill of PSPF derived streamflow forecasts is strongly dependent on basin area-ratio and lead-times, and weakly related to the downstream flow distance between stations. They show that the skill depicted in terms of Kling-Gupta efficiency (KGE) > 0.5 can be achieved for basin area ratio > 0.5 and lead-time up to three days. Adding complexities of hydrologic routing and rainfall QPF to the PSPF further improves the skill. The authors discuss the implications of their findings for improvements of rainfall-runoff models as well as data assimilation schemes.

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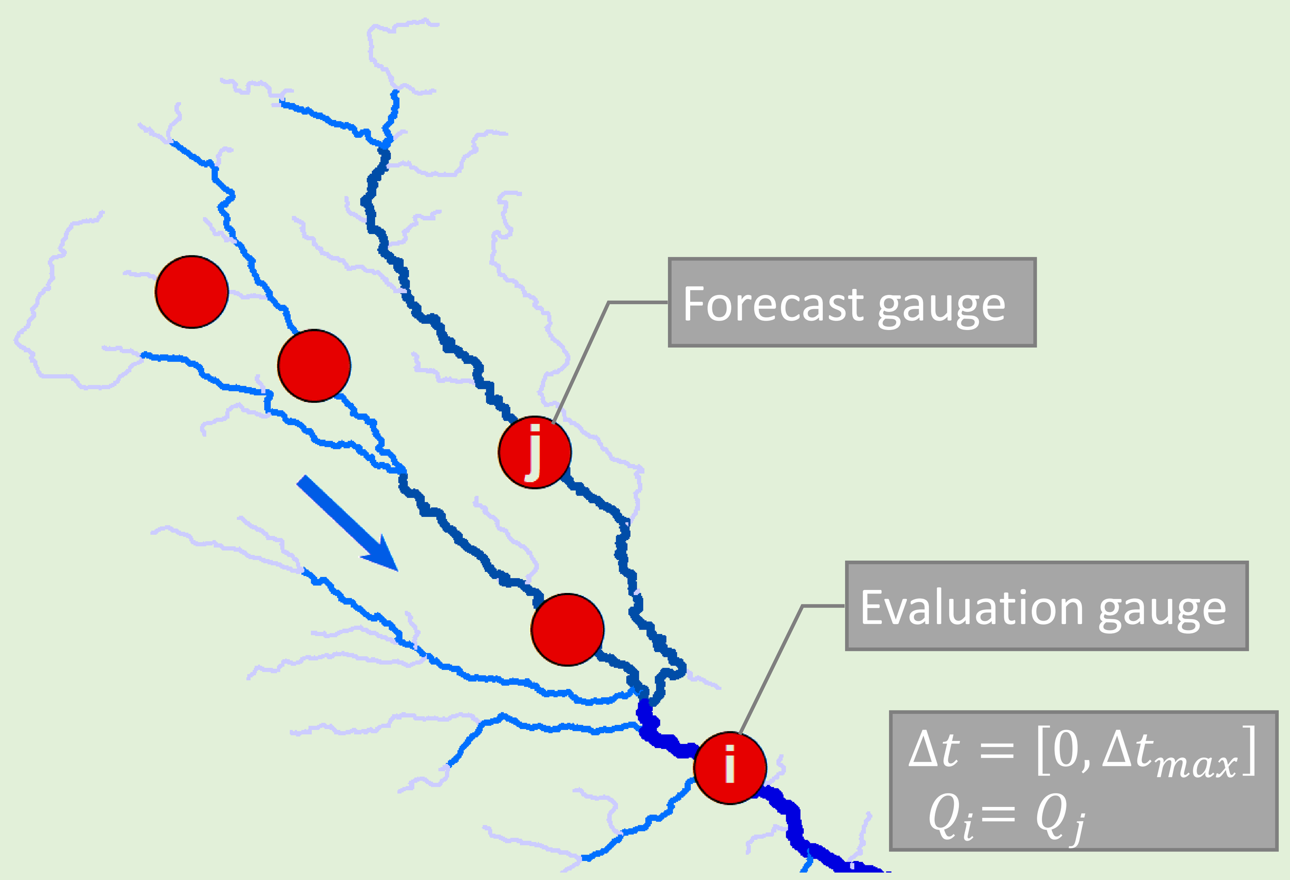
MOTIVATION

- ❑ Establish a benchmark for model-based forecasting
- ❑ Explore streamflow forecasting by persistence

APPROACH

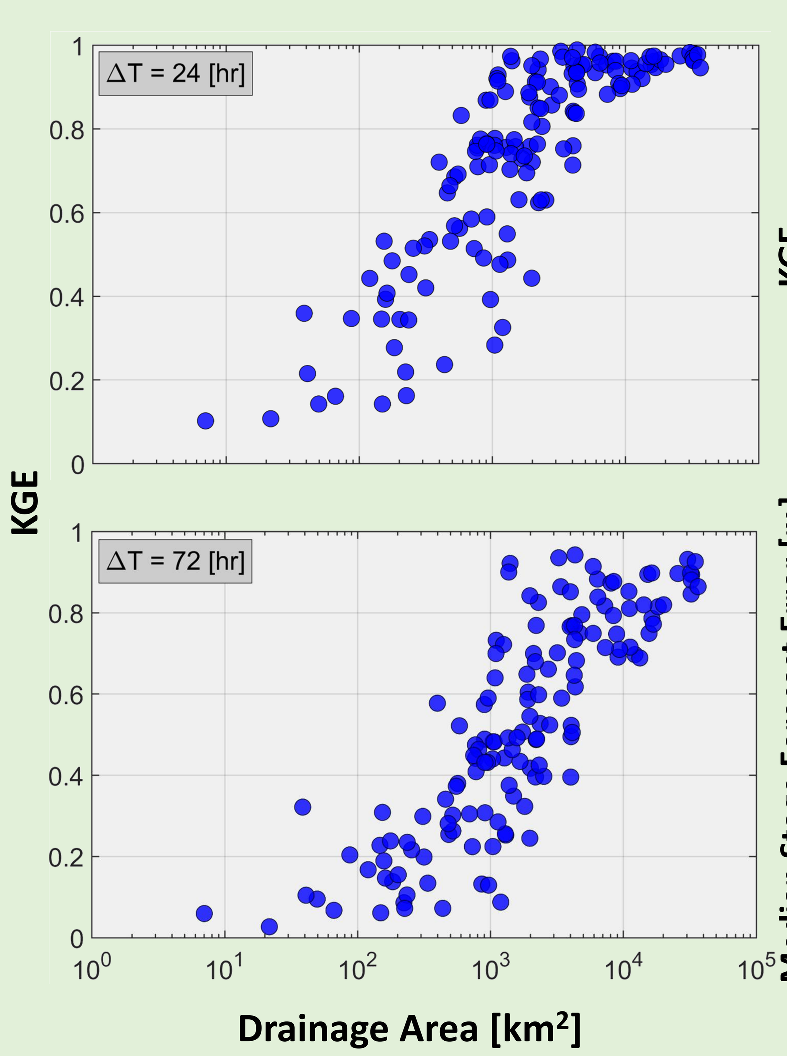


Temporal: $Q_i(i, t_0 + \Delta t) = Q_i(i, t_0)$

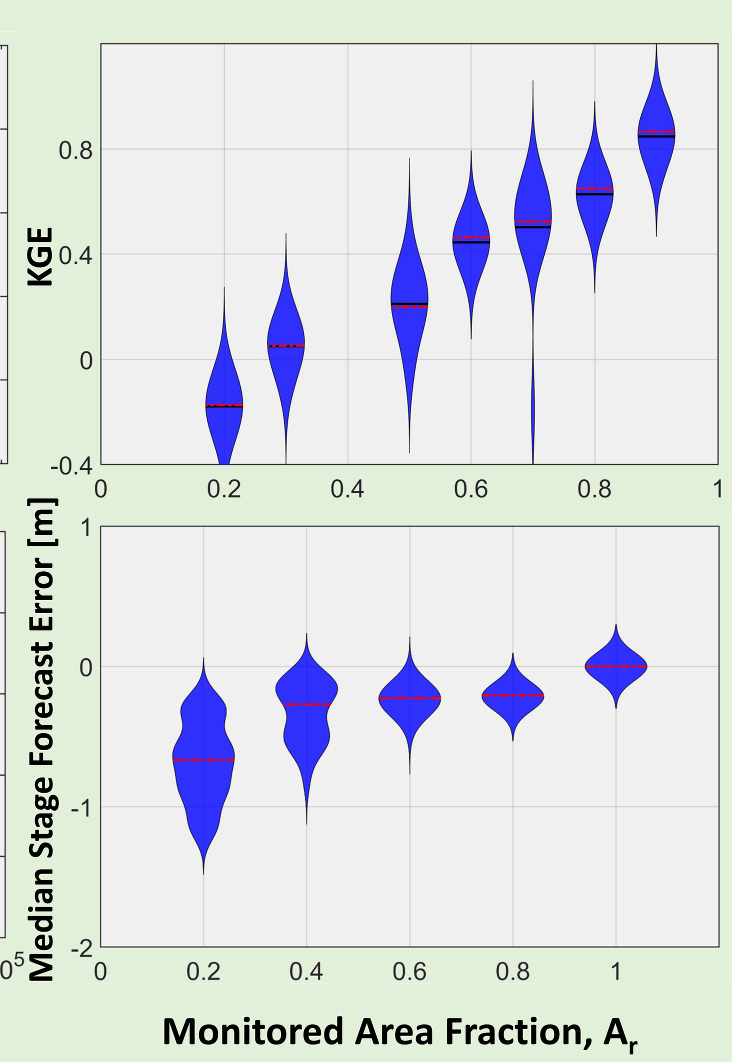
Spatial: $Q_i(i, t_0 + \Delta t) = Q_j(i, t_0)$

KEY RESULTS

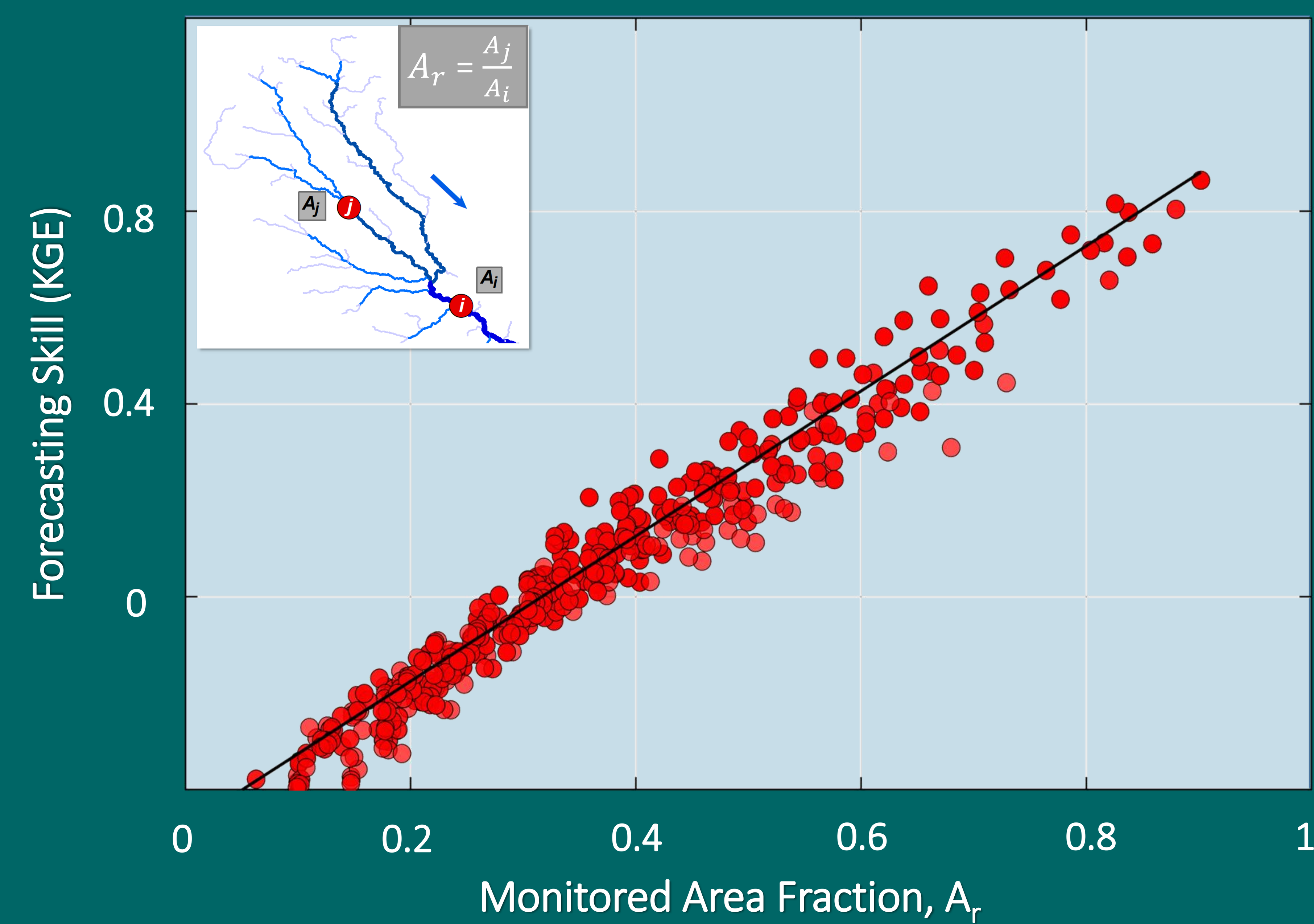
Temporal persistence forecast skill shows strong spatial scale dependence.



Spatial persistence forecast skill shows dependence on monitored area fraction.



Monitored area fraction explains the skill of streamflow forecasting by persistence.



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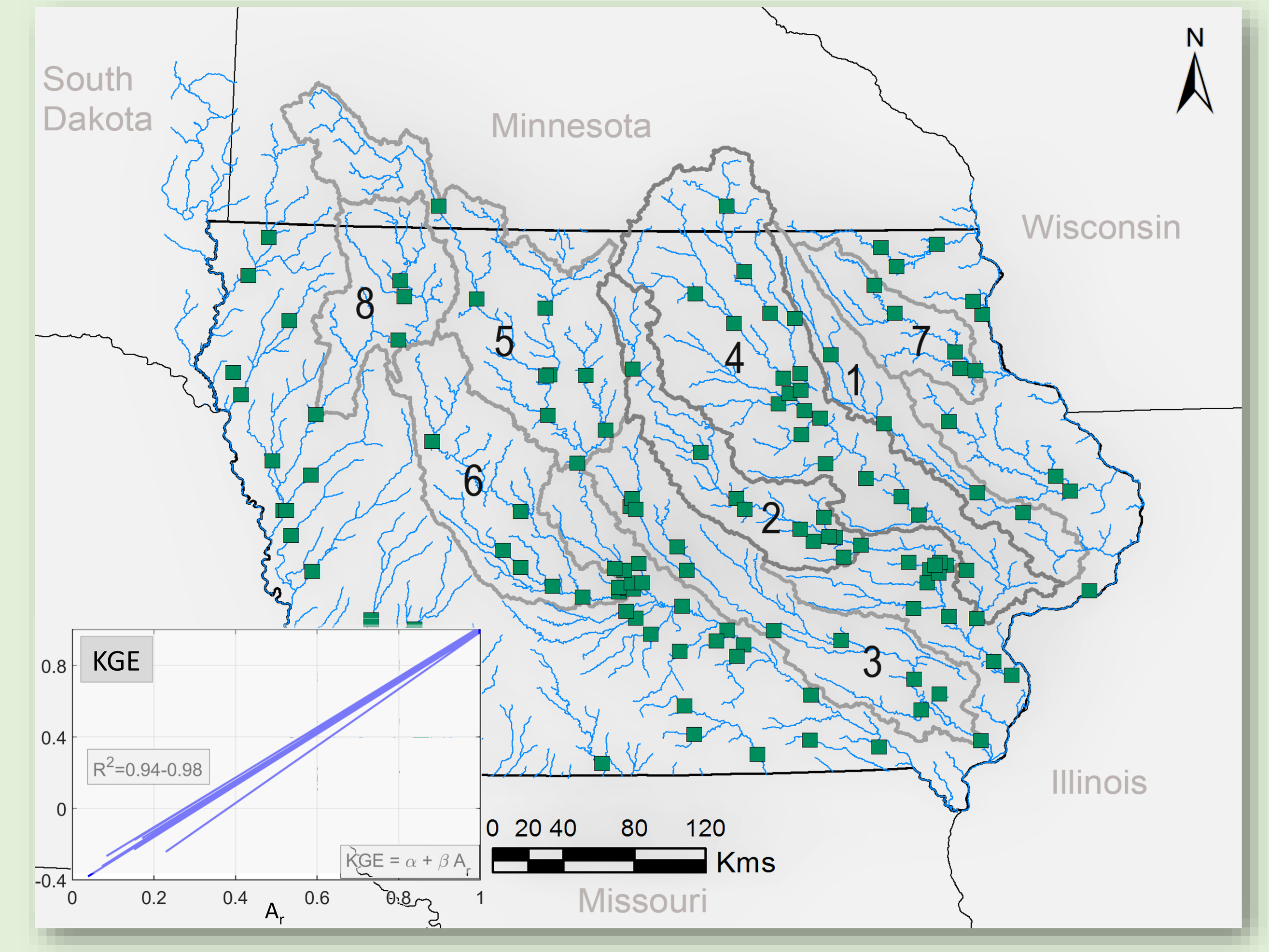
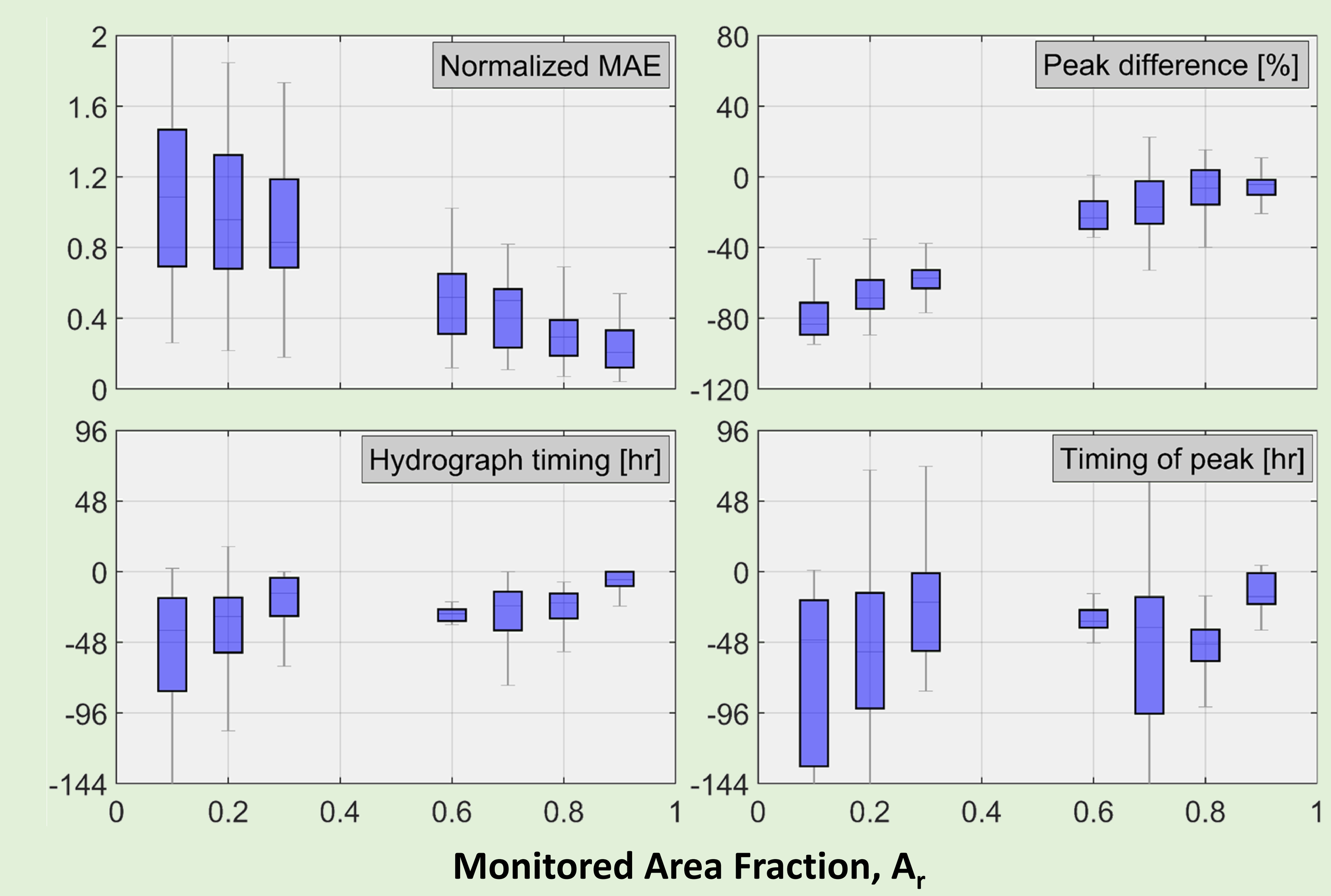
Forecast skill (KGE) shows universal linear relationship with monitored area fraction for all basins.



Inter-annual (2002-2018) variability of skill measures show dependence on monitored area fraction.



Forecast skill (KGE) shows low sensitivity with respect to forecast lead time.