Seasonal streamflow forecast using Long Short-Term Memory (LSTM) networks
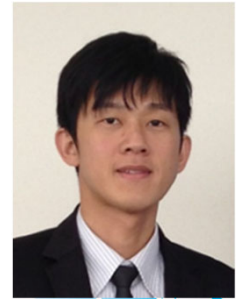
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Motivation:
1. Monthly streamflow outlook is one of the frequently requested results from HyperFacets stakeholders.
2. The outlook has practice significance for water use planning. It is relevant for flood protection, reservoir operation, and water use permitting
3. Consistent with the Northeast drought storyline.

Typical workflow:
1. Regional climate modeling + bias correction + hydrologic models.
   → bias correction is tricky
   → Information loss from both climate and hydrologic models
2. Statistical modeling.
   → unsure it is exhaustively extracting the information content from climate simulations and basin attributes
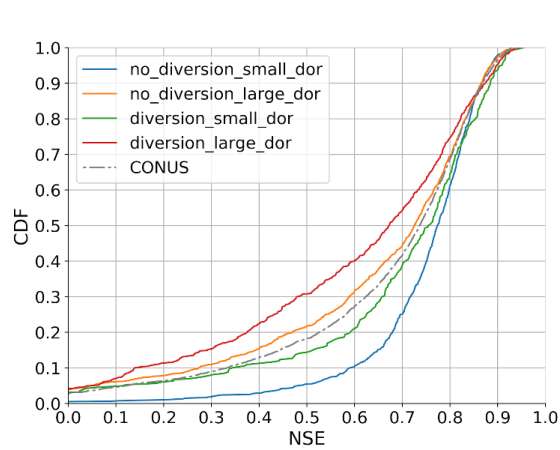
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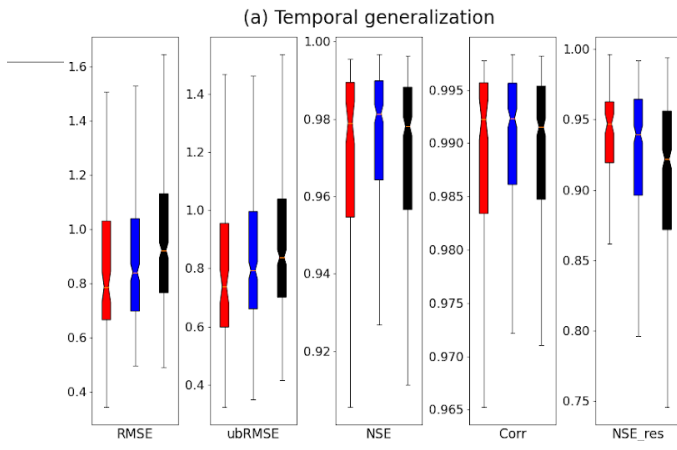
HYPERFACETS

A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales
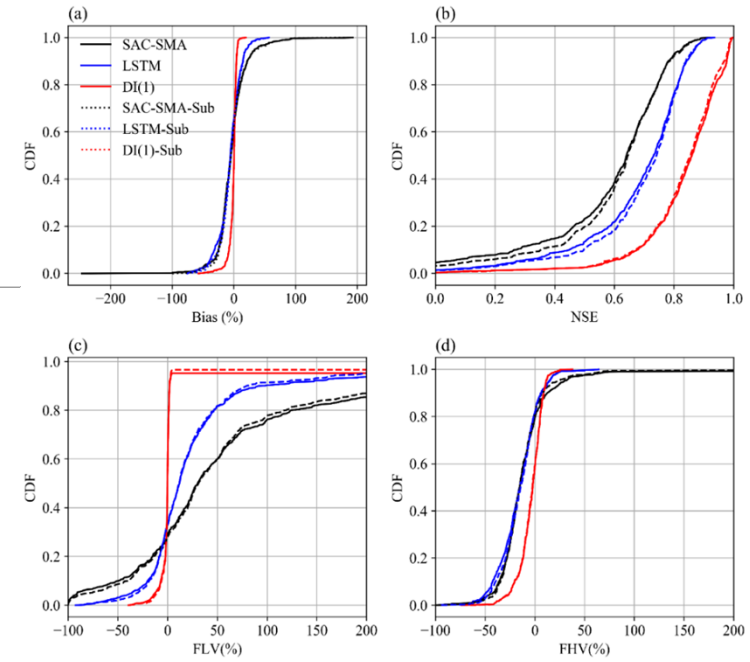
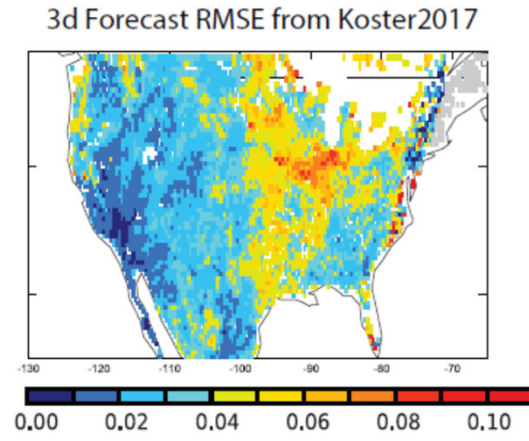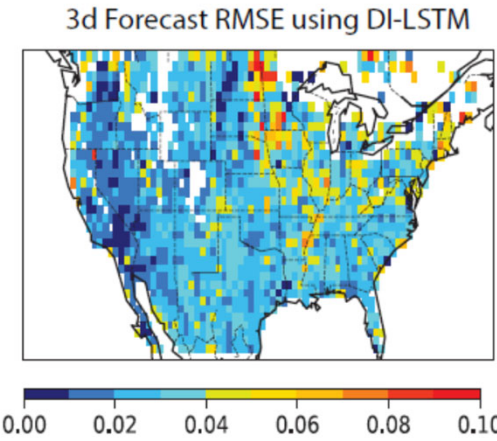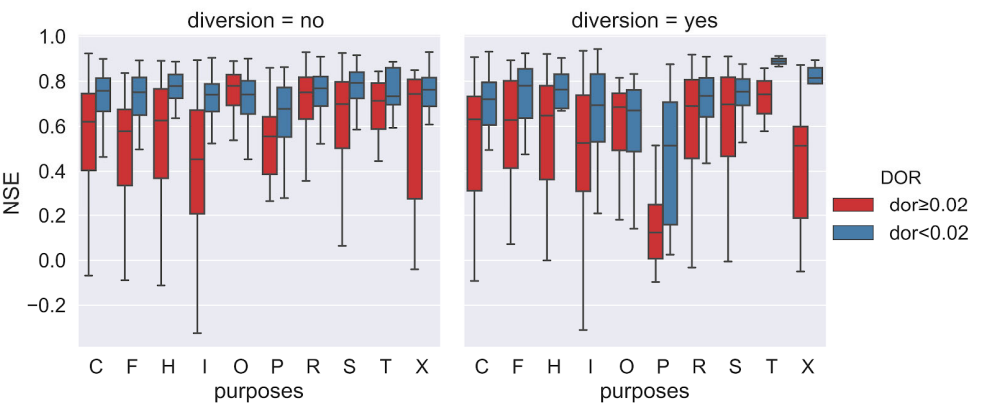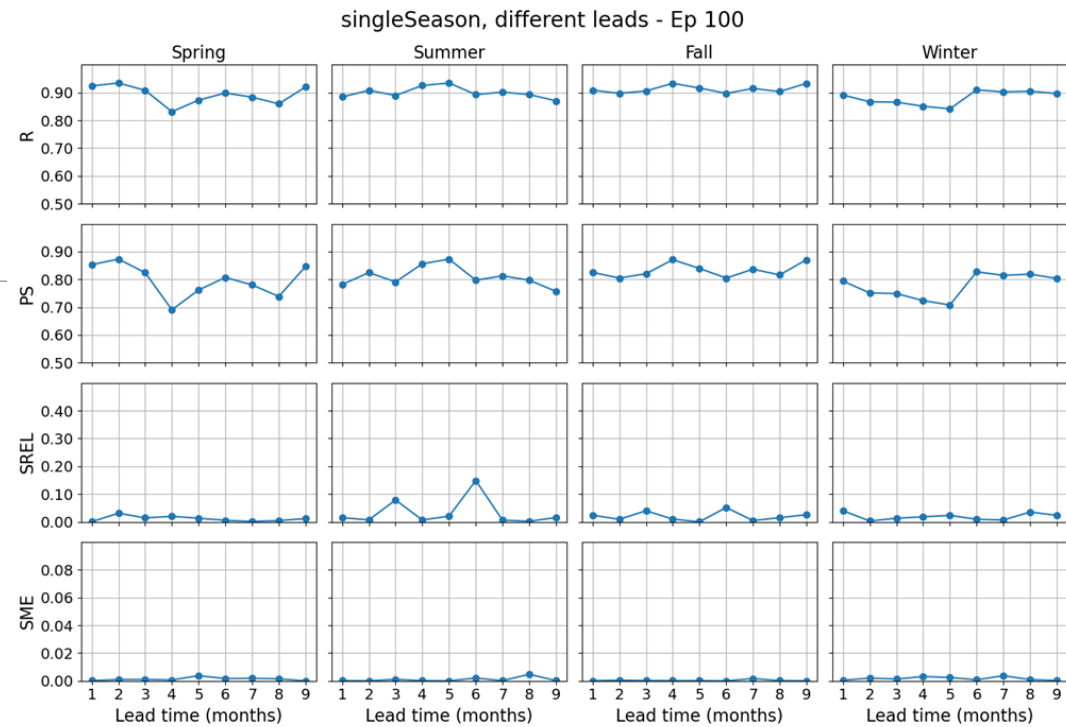# Previously we know the power of LSTM for dynamical prediction

Streamflow with reservoir

(a) Temporal generalization

Stream temperature

Streamflow forecast 10.1029/2019WR026793

diversion = no   diversion = yes

DOR
dor≥0.02
dor<0.02

3d Forecast RMSE using DI-LSTM   3d Forecast RMSE from Koster2017

Workflow

$$Q_q^{t_1:t_1+3} = LSTM_{D2}^{t_1}(F^{t_1:t_1+3}, A), \quad t_1 = 3, 6, 9, 12$$

NMME GCM Forcings
(daily) 1991-2010

- Downloading
- Extraction
- Interpolation (IDW)
- Normalization

Pooling
- Initializations
- Seasons

Other Inputs
- Static Attributes (30)
- *Static FDCs*
- *Climate Indices*

Observed streamflow
- Normalization (basin area and precipitation)

Compute Seasonal Quantiles

hydroDL
LSTM Model
(training/testing)

ny = 13 quantiles

Seasonal Streamflow Forecasts
(up to 9 months lead time)
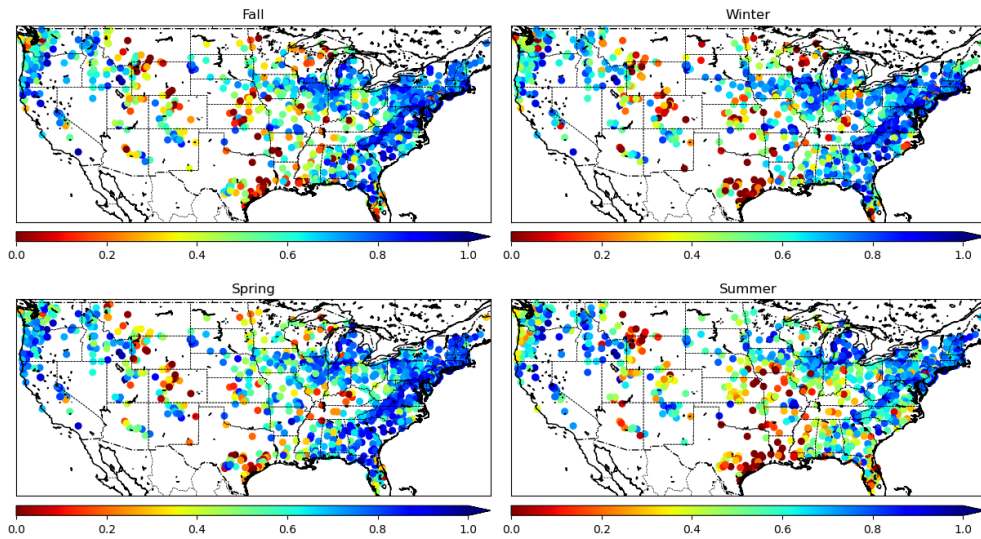

singleSeason, different leads - Ep 100

R is the Pearson's correlation coefficient.

PS is the potential skill of the forecasts (i.e., the skill if there were no biases).
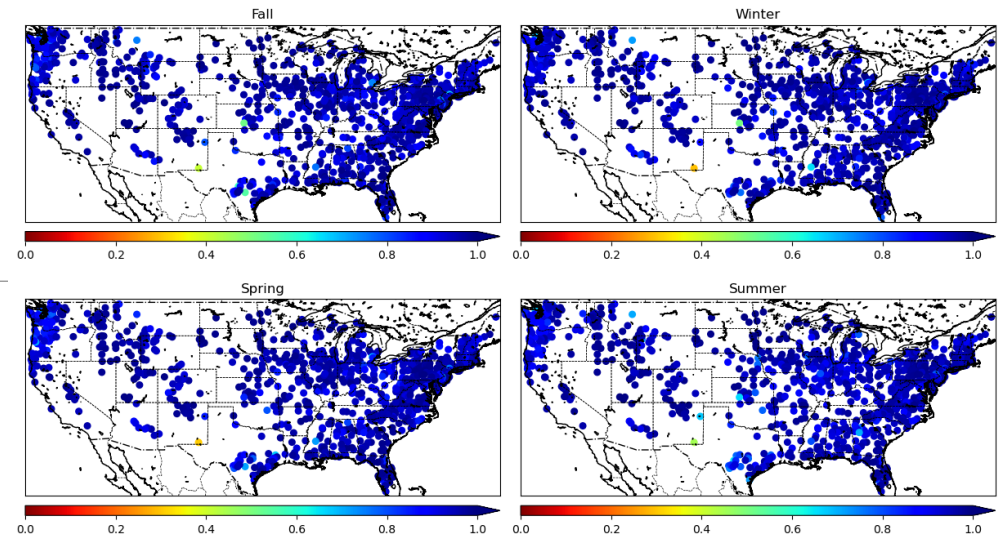
SREL (slope reliability) is a measure of the conditional bias.

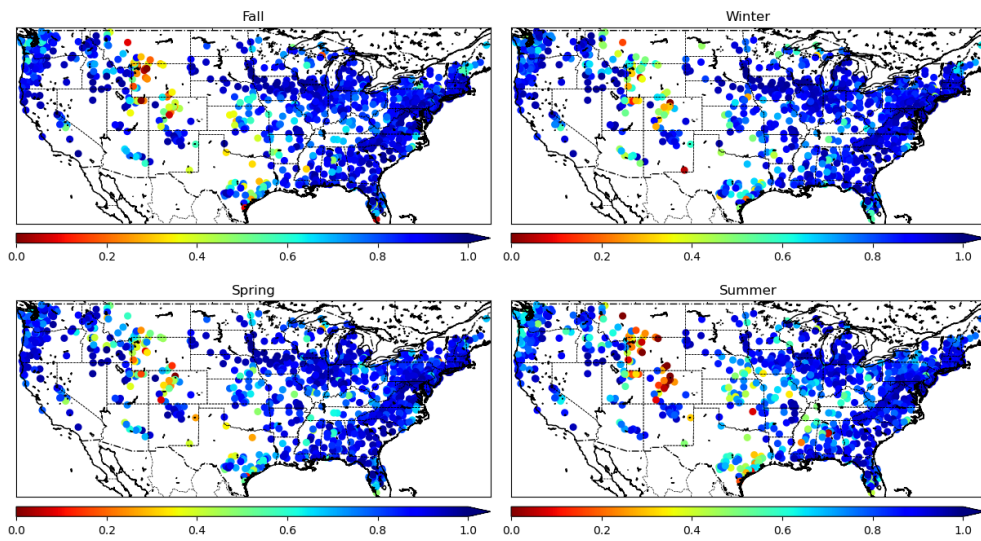SME is standardized mean error, a measure of the unconditional bias

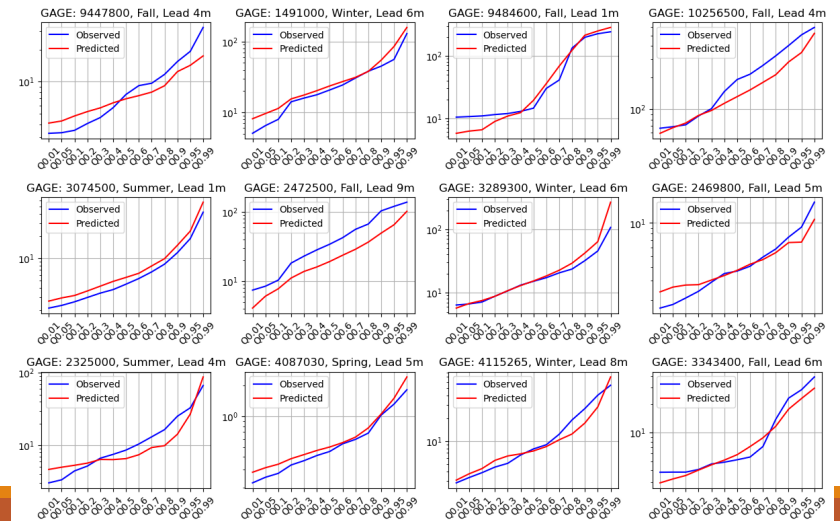Correlation between observed and predicted Q0.05

Correlation between observed and predicted Q0.95

Correlation between observed and predicted Q0.5 (median) streamflow

FDCs for randomly selected Gages

DL-based Parameter estimation talk tomorrow!