Medium-Range Forecasting over Afghanistan using Noah

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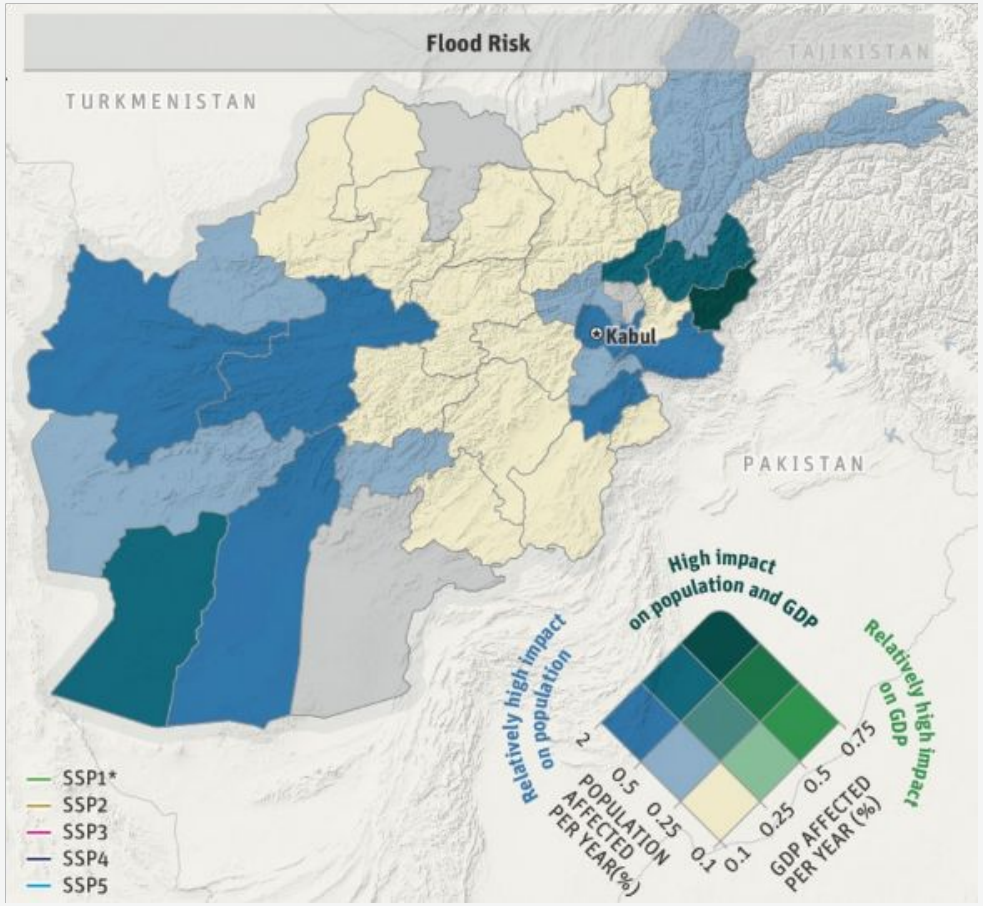
Medium-Range Hydrologic Forecasts over Afghanistan

Flooding impacts population, GDP, and potentially food security



Global Facility for Disaster Reduction and Recovery

- Flooding is the most frequently occurring natural hazard in Afghanistan.
- The flooding usually occurs in the spring due to heavy rainfall coupled with rapid snowmelt.
- The lack of vegetation and denudation, and steep slopes in mountain areas also contribute to the occurrence of flooding in Afghanistan.

Medium-Range Hydrologic Forecasts over Afghanistan

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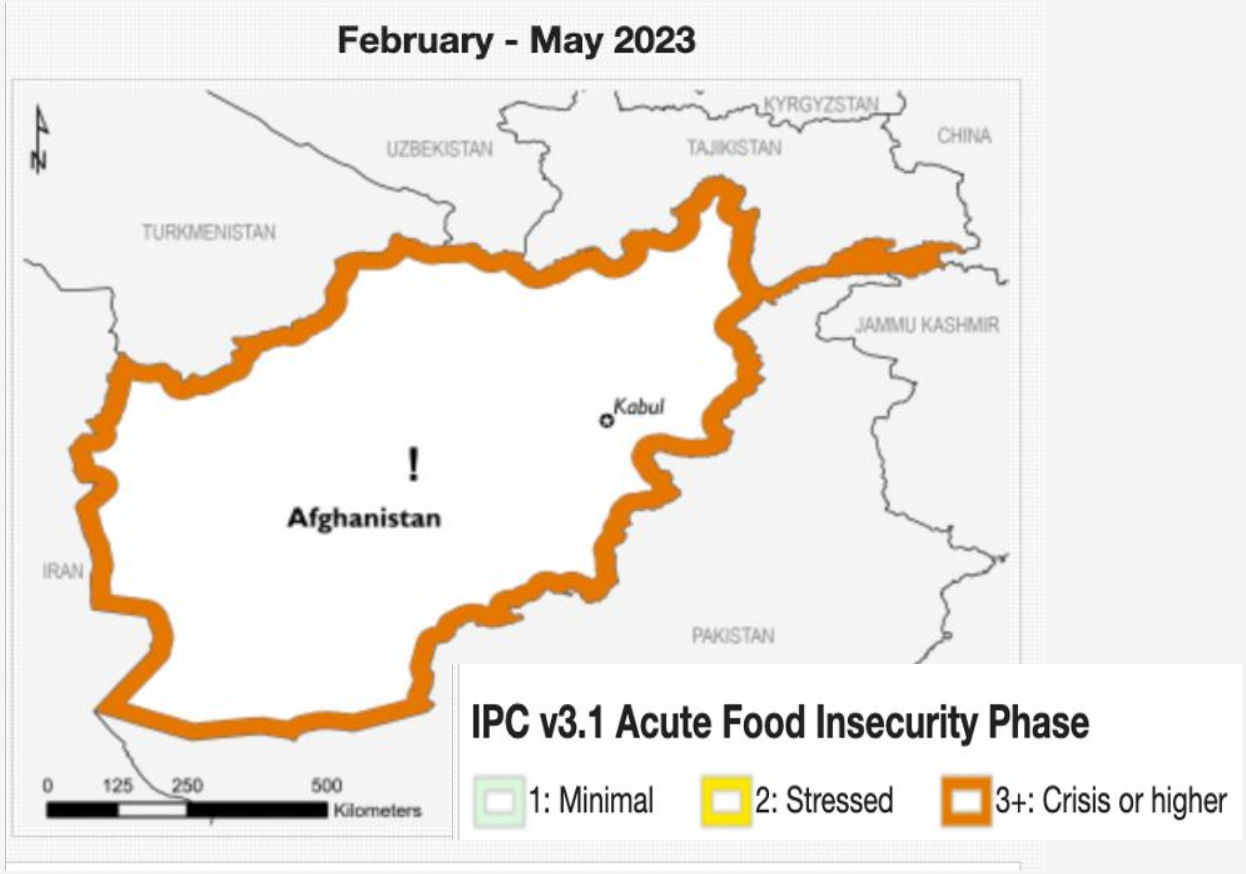
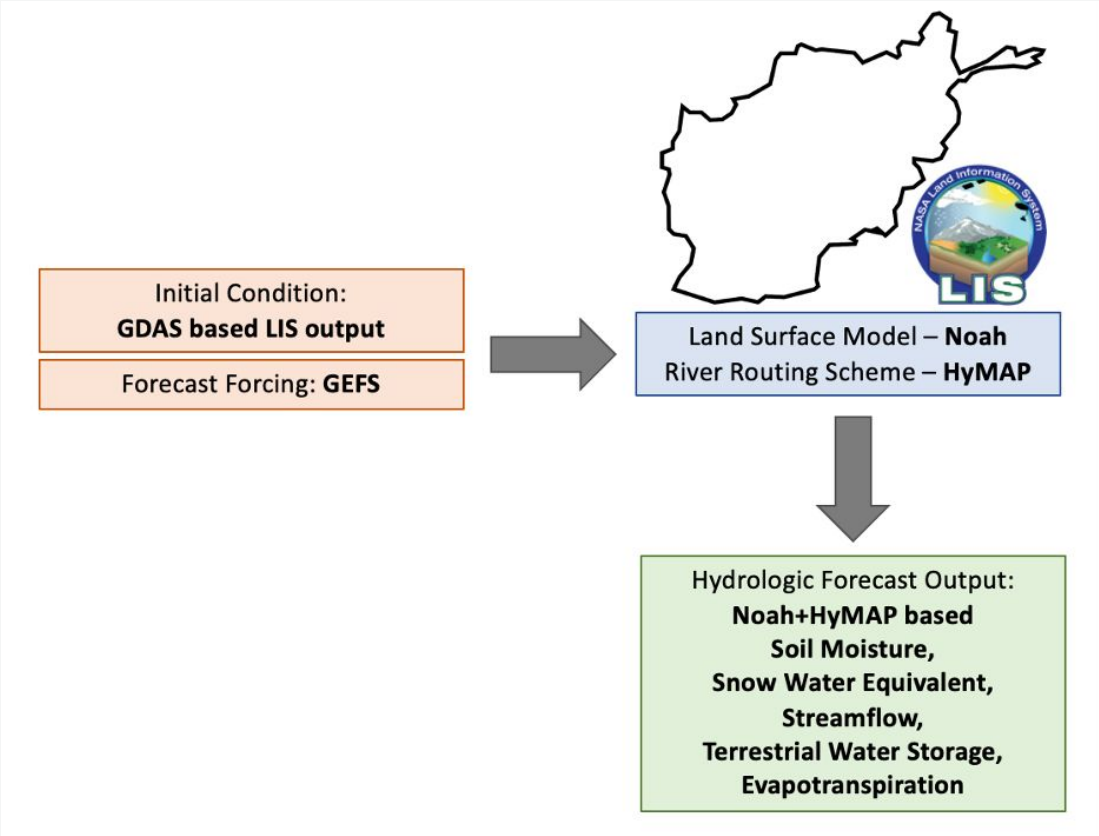


https://fews.net/central-asia/afghanistan (accessed December 2022)

- The Famine Early Warning Systems Network (FEWS NET) indicates that drought and poor economy will drive the high assistance needs in the 2022/23 lean season.
- Over 110,600 people have already been affected by floods in 2022 across Afghanistan.

Medium-Range Hydrologic Forecasts over Afghanistan

Satellites and Numerical Models are essential for monitoring and forecasting due to lack of available in situ data

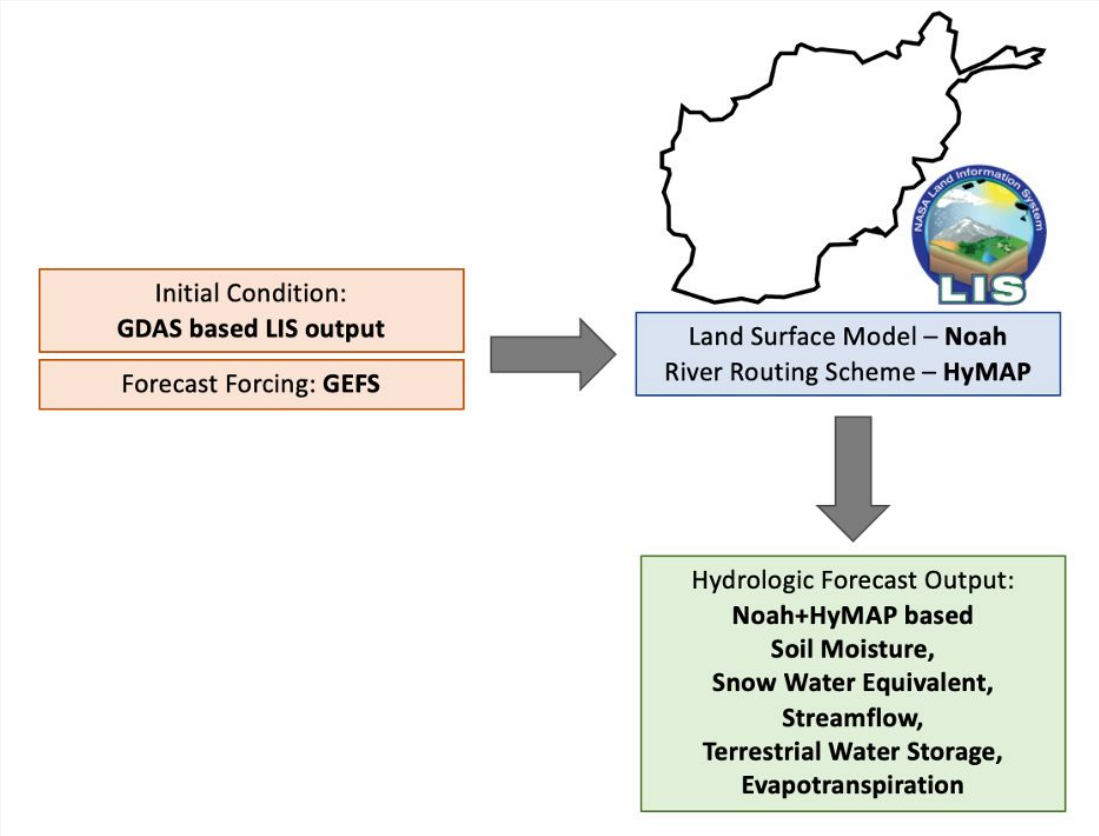


Schematic of the Experimental FLDAS-Forecast system over Afghanistan

- FEWS NET provides routine hydrologic monitoring over Afghanistan (McNally et al. 2022).
- A new forecasting system, as a part of FEWS NET Land Data Assimilation System (FLDAS) Forecast, will produce medium-range (10 days) hydrologic forecasts at a spatial resolution of 1km over Afghanistan.
- We provide preliminary results of evaluating this new forecast system.

Medium-Range Hydrologic Forecasts over Afghanistan

Satellites and Numerical Models are essential for monitoring and forecasting due to lack of available in situ data

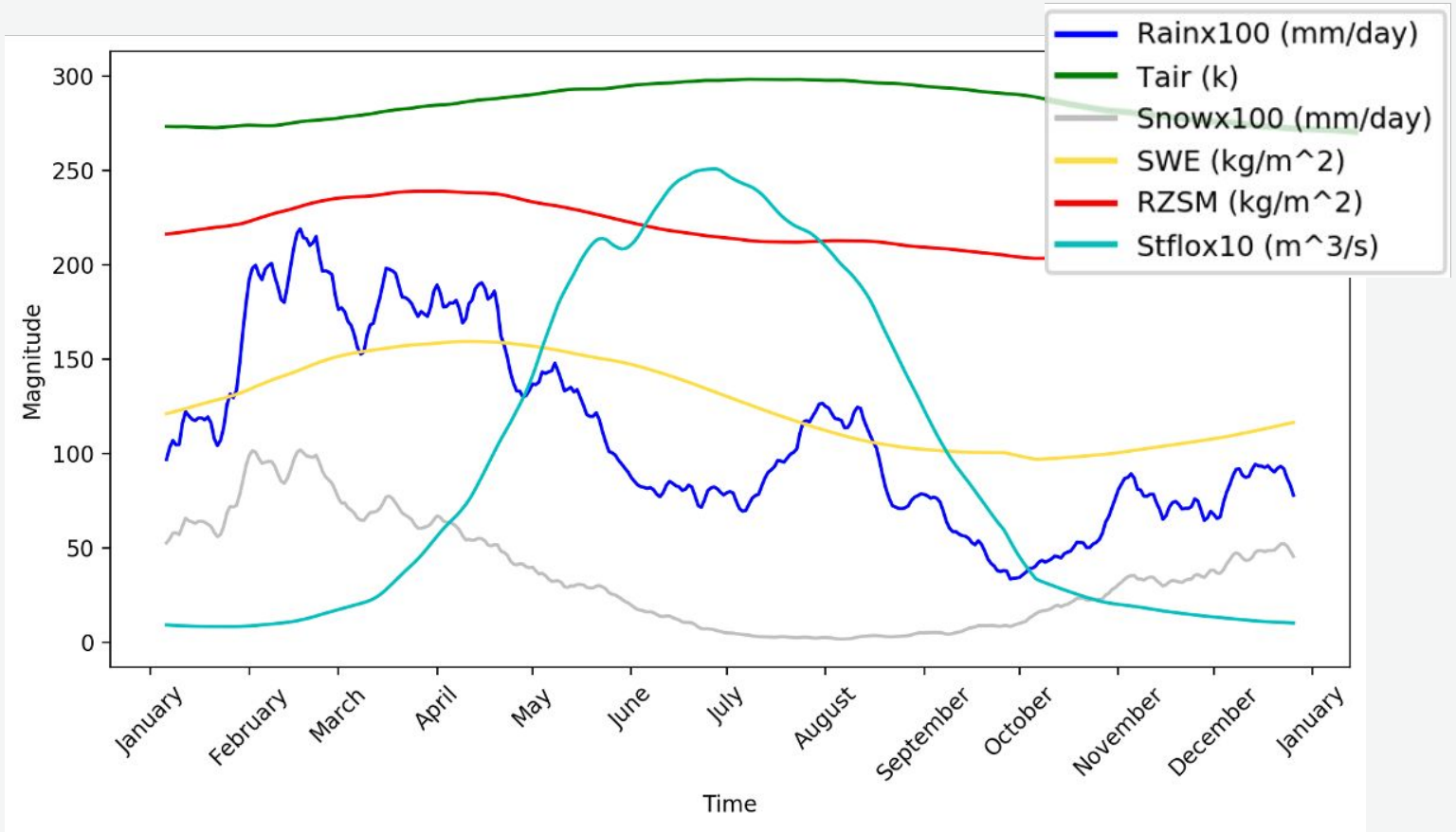


Schematic of the Experimental FLDAS-Forecast system over Afghanistan

- This system uses Noah as it depends for initial conditions on the FEWS NET routine hydrologic monitoring over Afghanistan (McNally et al. 2022), which was based on Noah initially.
- An update of this experimental forecast system using Noah-MP is underway.

Medium-Range Hydrologic Forecasts over Afghanistan

Seasonal Signals over Afghanistan

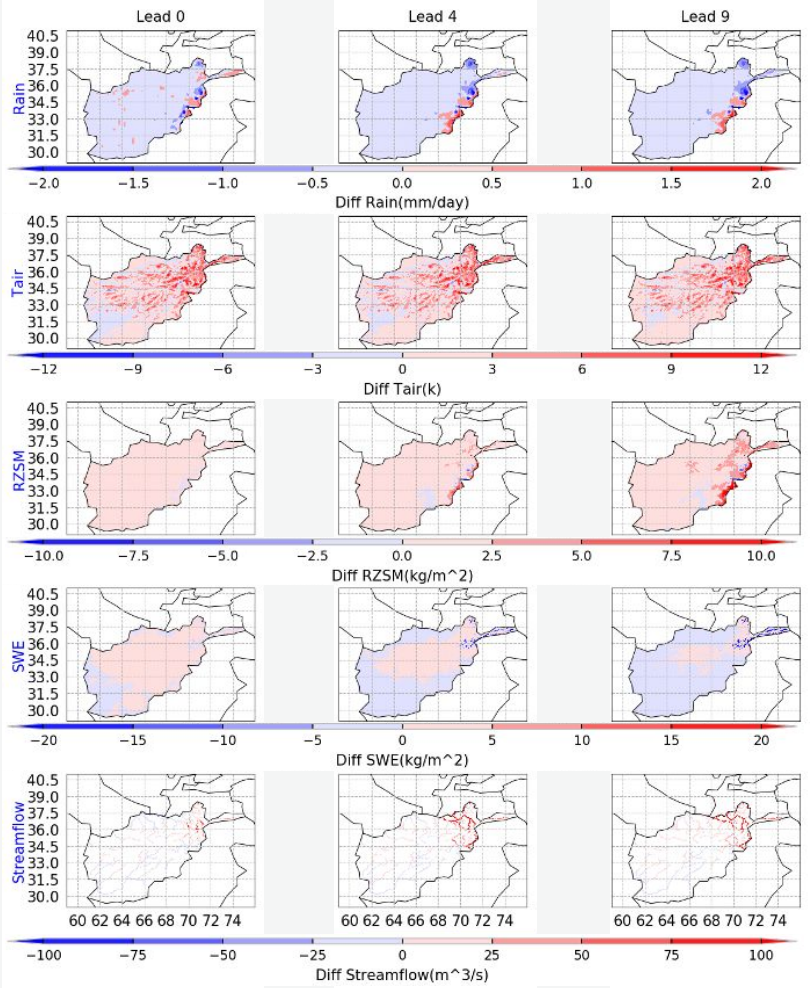


Daily Climatological Time Series between 2001-2019 over Afghanistan from Open-Loop simulation (GDAS)

- Figure on left uses data produced by GDAS and Noah LSM, which is the open-loop (OL) and the simulated truth for our evaluation.
- Peak precipitation between November to May and peak streamflow in July
- The period of highest streamflow is evaluated next between years 2001 to 2019.

Medium-Range Hydrologic Forecasts over Afghanistan

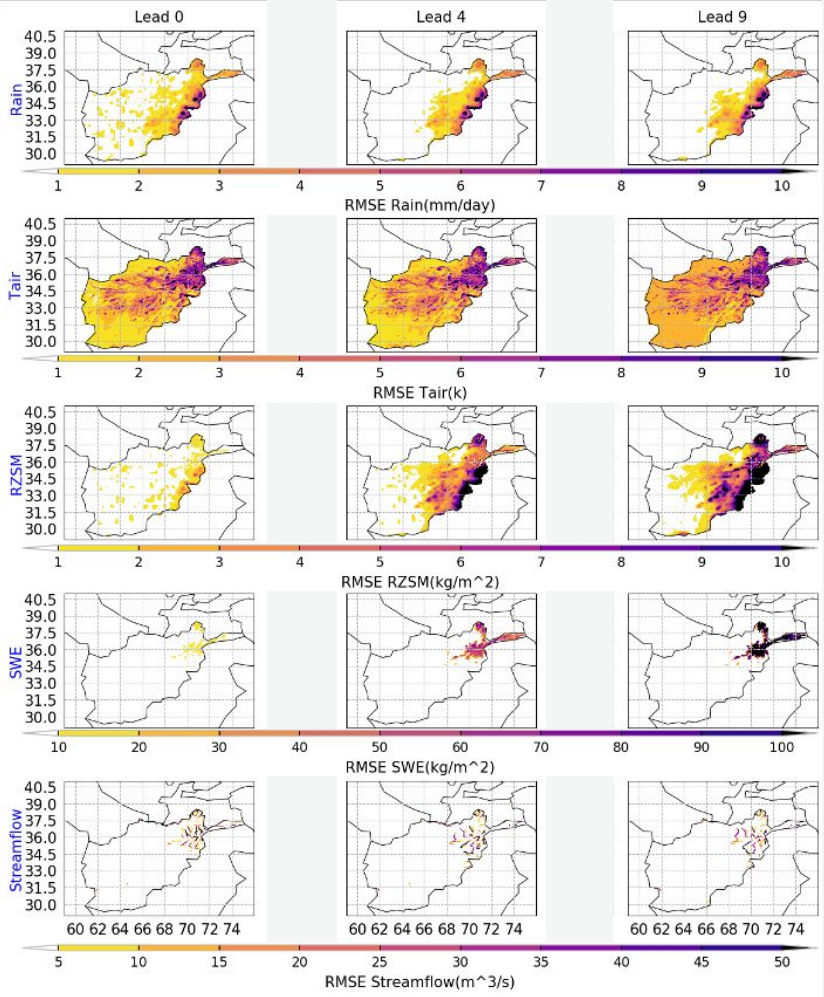
Difference between mean forecasts and mean OL for all July start dates between 2001-2019:



- **Reds**: Forecasts> OL
  Blues: OL>Forecasts
- Forecasts initialized in July estimate higher Air Temperature, Soil Moisture and Streamflow than OL at all leads.

Medium-Range Hydrologic Forecasts over Afghanistan

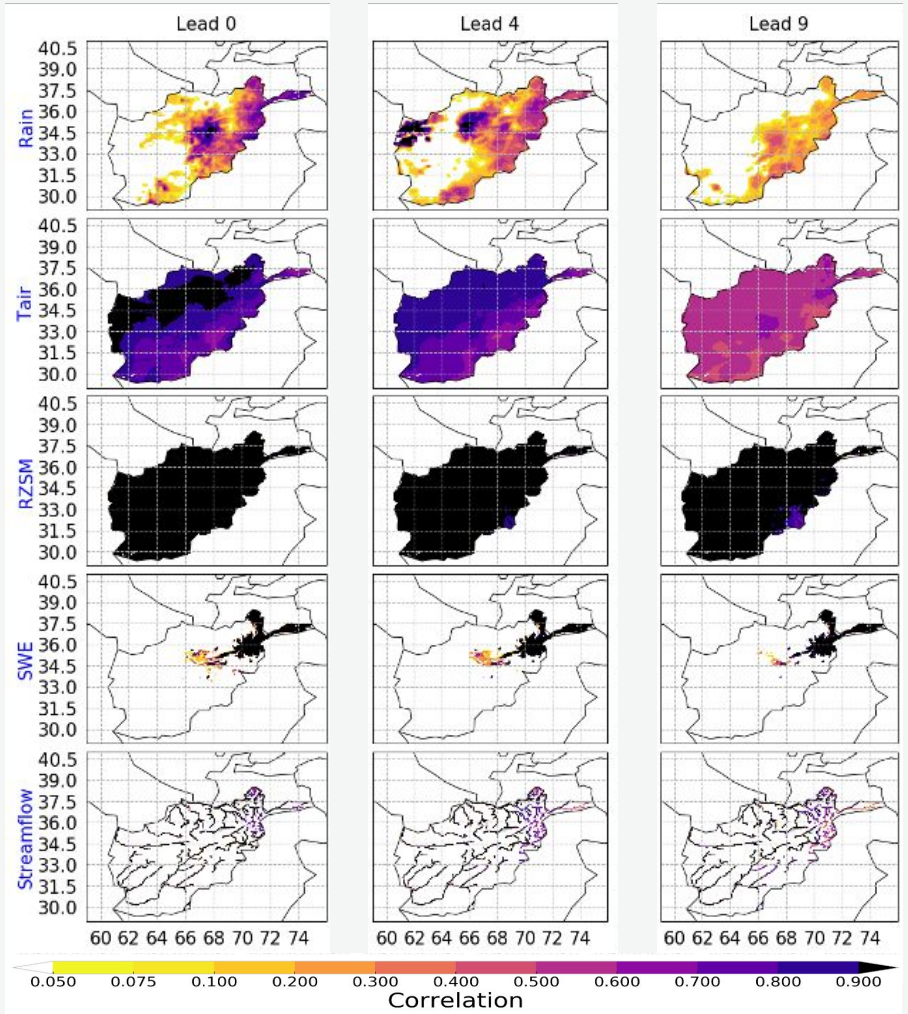
RMSE between forecasts and OL for all July start dates between 2001-2019:



- RMSE is highest in areas with high elevation.

Medium-Range Hydrologic Forecasts over Afghanistan

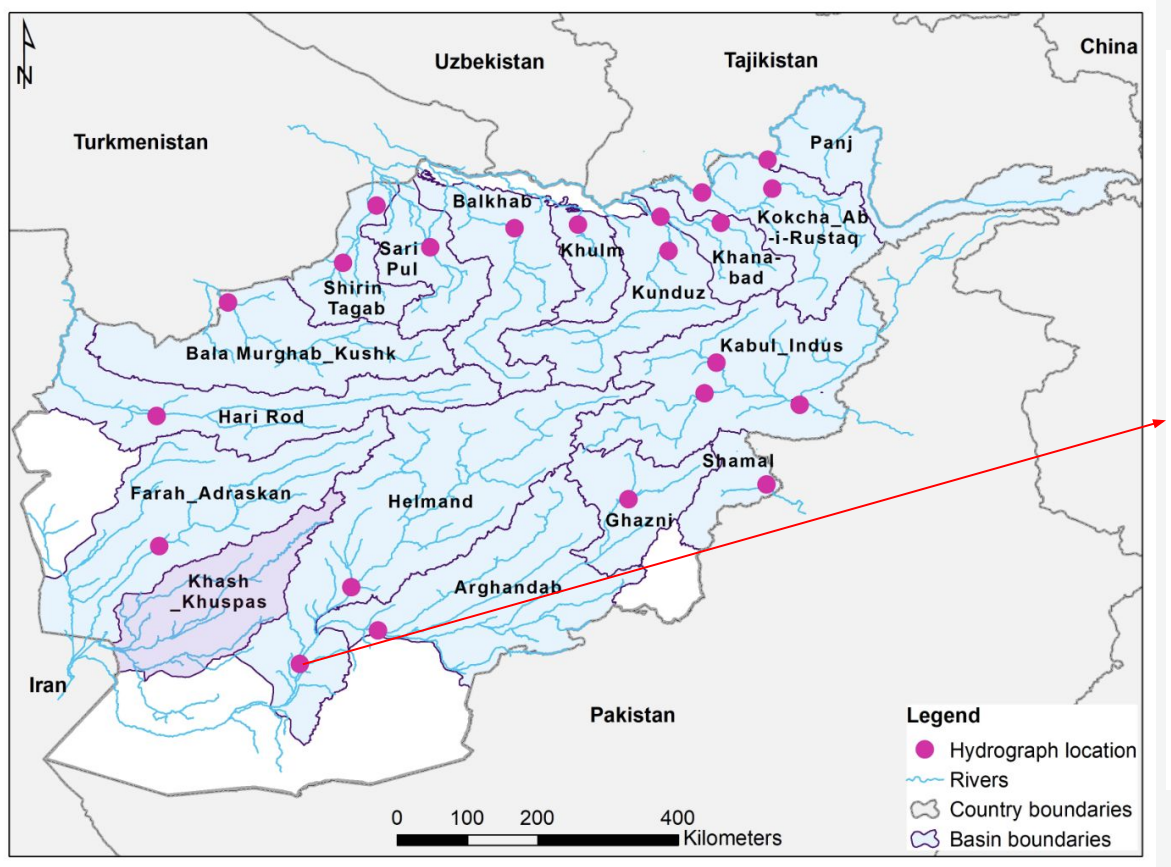
Anomaly Correlation between forecasts and OL for all July start dates between 2001-2019:

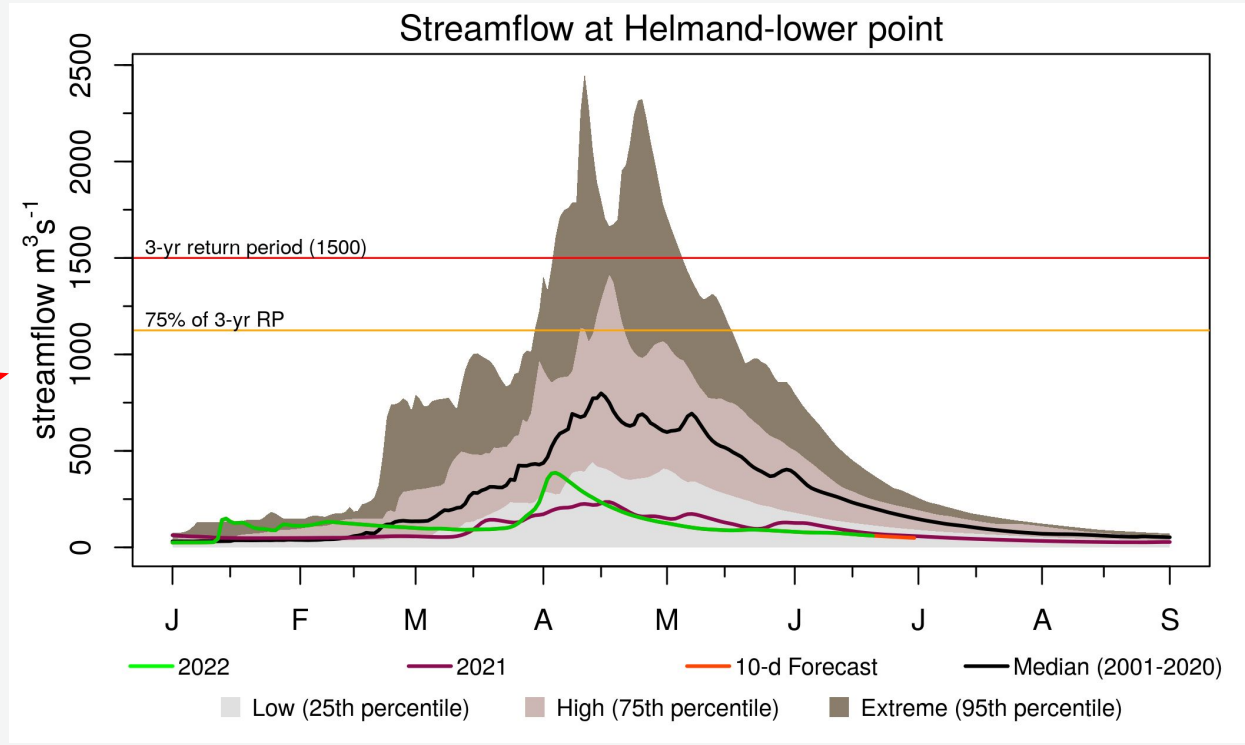


- Anomaly correlations are generally good showing the forecasts capture variability

Medium-Range Hydrologic Forecasts over Afghanistan

Streamflow Monitoring and Forecast at Specific Points:

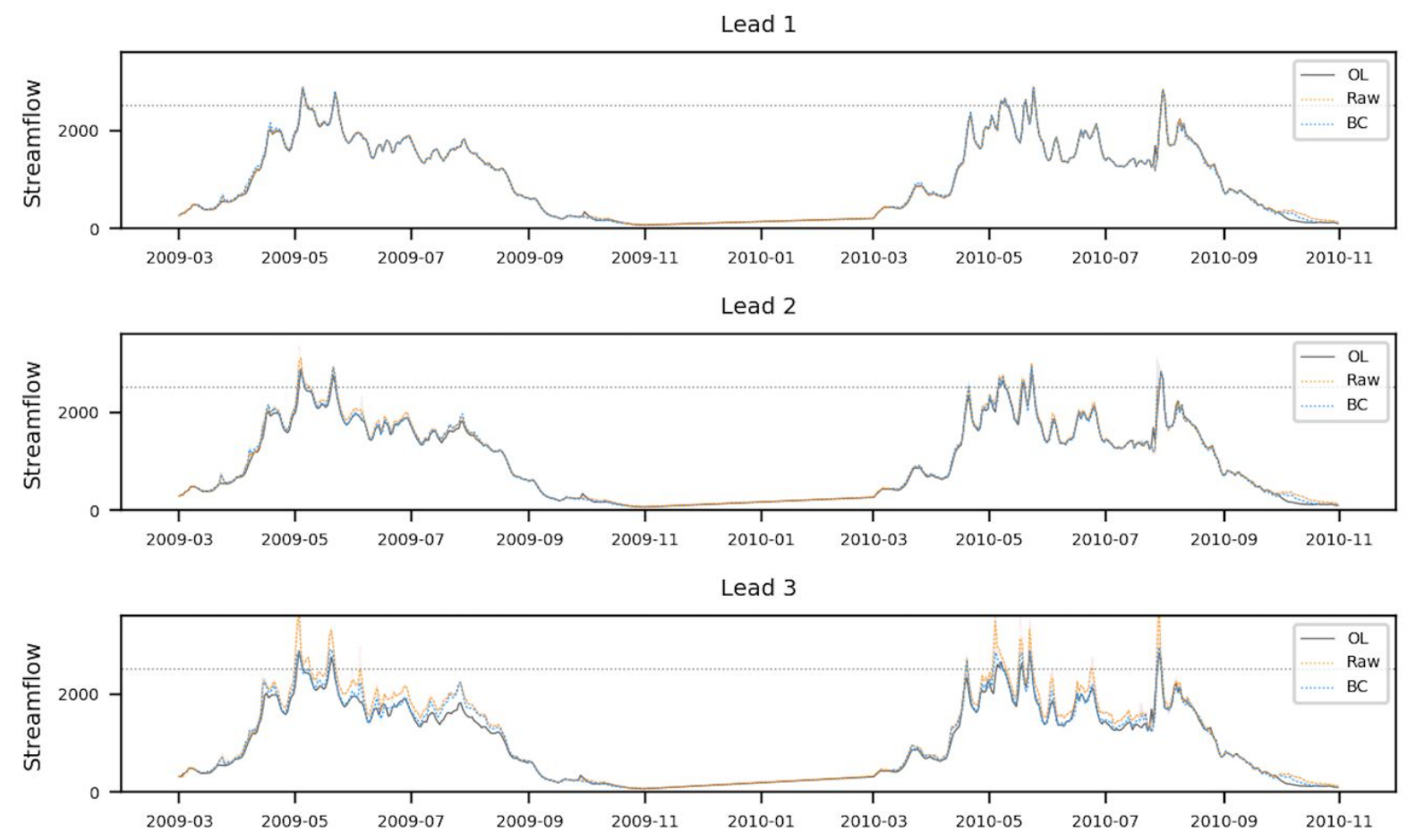




https://earlywarning.usgs.gov/fews/GDAS

Medium-Range Hydrologic Forecasts over Afghanistan

An example of streamflow monitoring point:

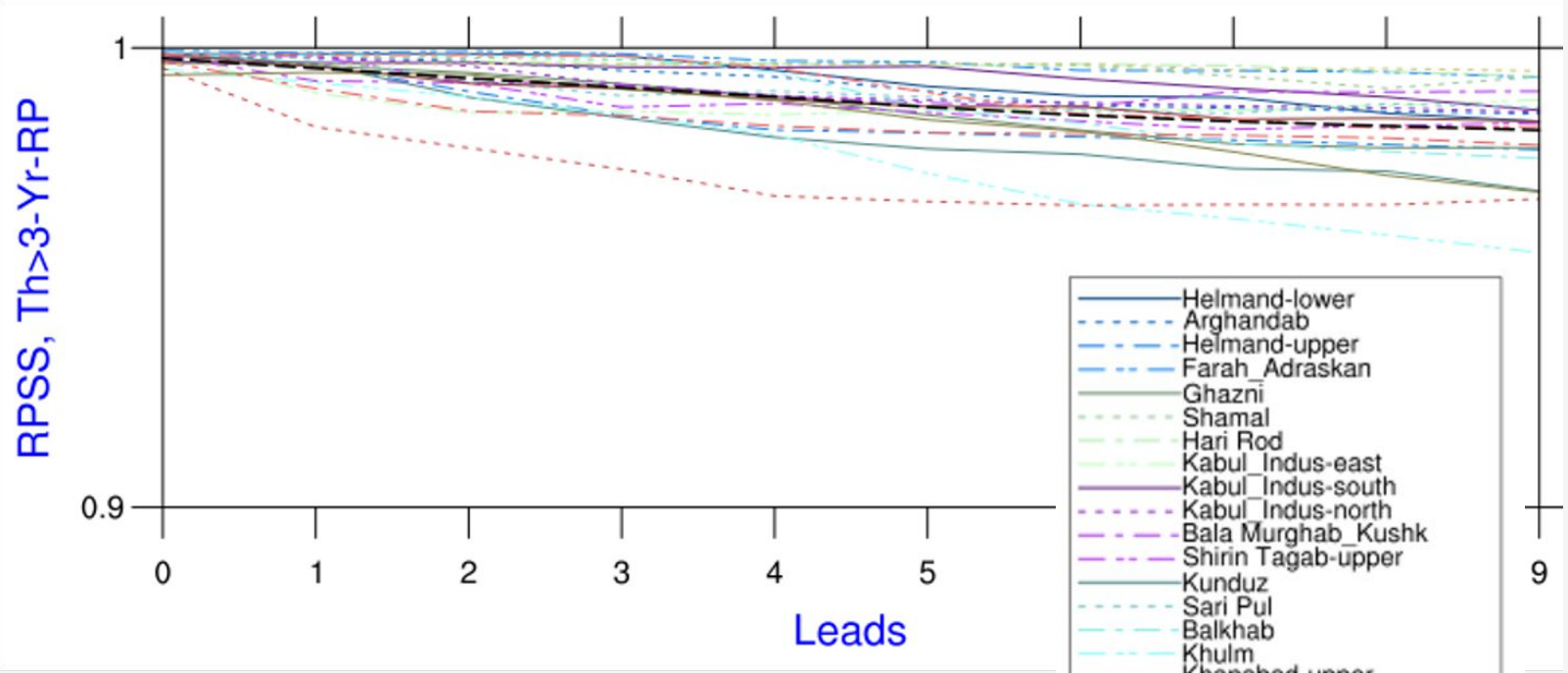


Kabul Indus East (grey dotted line parallel to x-axis - 3-year return period threshold)

- The top panel show the raw streamflow forecast (orange) follows the open-loop (dark grey) very closely in the first few forecast leads.
- The bottom panel shows that at higher leads, the forecasts have much higher values than open-loop, especially around the high flow period.
- Bias-correction using CDF-matching (blue) shows that the bias-corrected forecasts follow the open-loop much more closely.

Evaluation of the Bias-Corrected Forecast

How well does Bias-Corrected forecast ensembles represent flows greater than 3-yr return period?

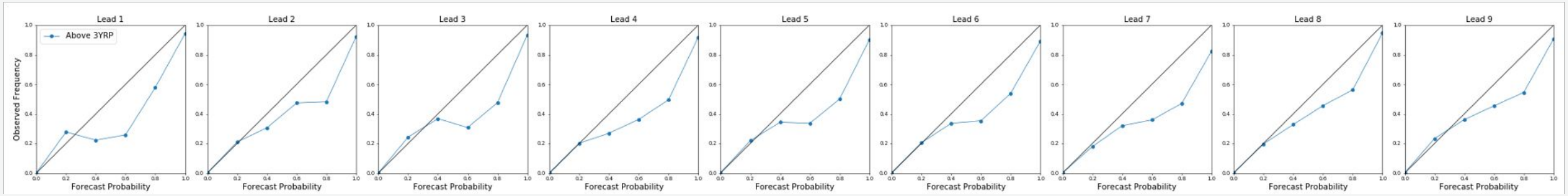


- Rank Probability Skill Score for all start dates for March–October between 2001-2019 for threshold of above the 3-year return period show near perfect scores.
- These RPSS scores tell us that the bias-corrected ensemble forecasts for all the streamflow monitoring points are significantly more skillful than using a climatology-based forecast.

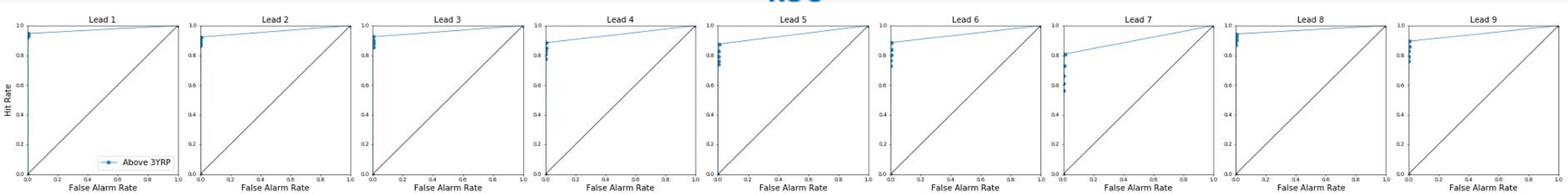
Evaluation of the Bias-Corrected Forecast

Reliability and Relative Operating Characteristic (ROC) for all start dates for March–October between 2001-2019, for threshold above the 3-year return period after bias-correction:

RELIABILITY



ROC

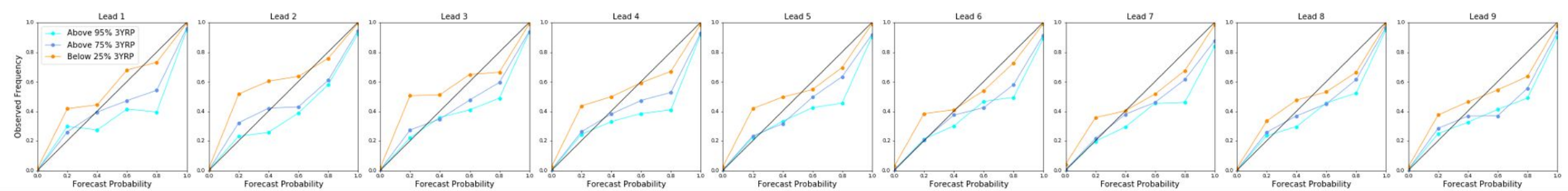


- The reliability curve plots the forecast probability relative to observed frequency.
- The ROC curve plots the Hit Rate relative to the False Alarm Rate.

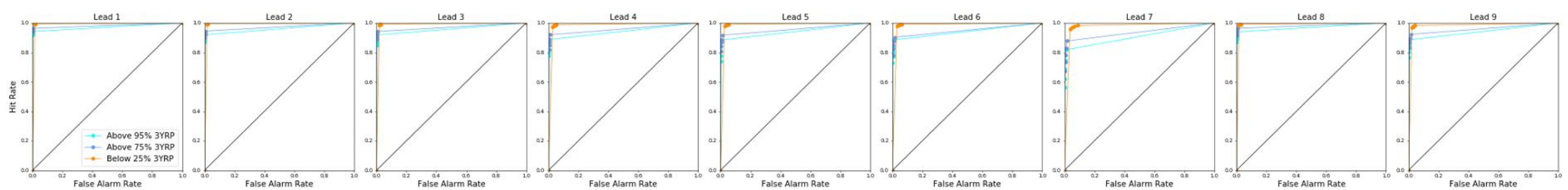
Evaluation of the Bias-Corrected Forecast

Reliability and ROC for all start dates for March–October between 2001-2019, for thresholds above 95%, 75% and below 25% of the 3-year return period

RELIABILITY



ROC



- All three conditions show good reliability and ROC curves for the bias-corrected forecast.
- Below 25% scores > above 75% scores > above 95% scores.
- Low flow conditionality has better score than the high flow conditionalities.
- However, the difference in the skill of these three conditions are not very large.

Conclusion

- The deterministic skill of hydrologic forecasts show high anomaly correlation spatially during the high-flow period.
- The bias-corrected streamflow forecasts RPSS.
- ROC and the reliability curve also show good scores, although the reliability curve shows some over-forecasting at the above 3-year return period threshold.
- Evaluation of thresholds of above 95% and 75% and below 25% of the 3-year return period, show slightly better reliability and ROC, with the above 95% and 75% conditionalities showing some over-forecasting and below 25% conditionality showing under-forecasting.

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