

Medium-Range GEFS-based Hydrologic Forecasts over Afghanistan

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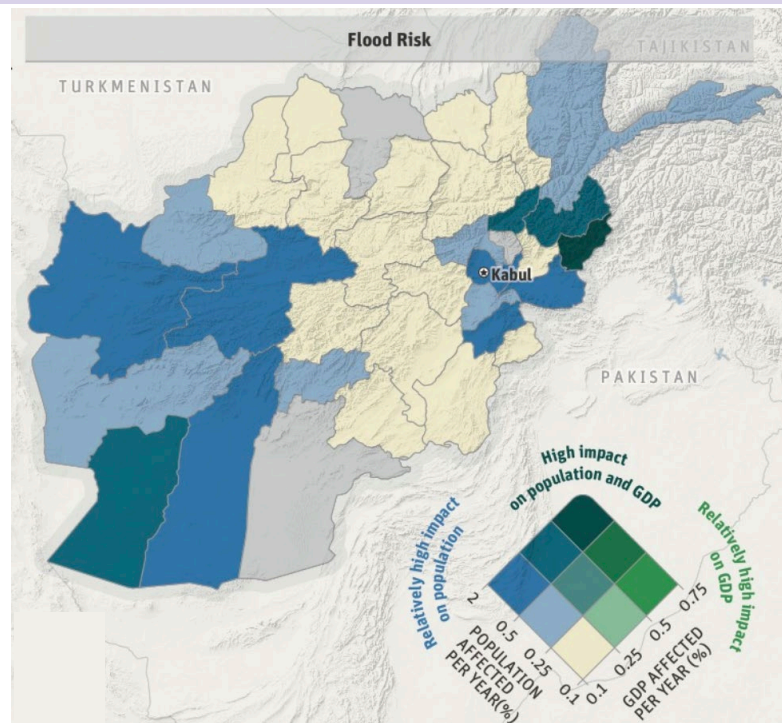


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Introduction

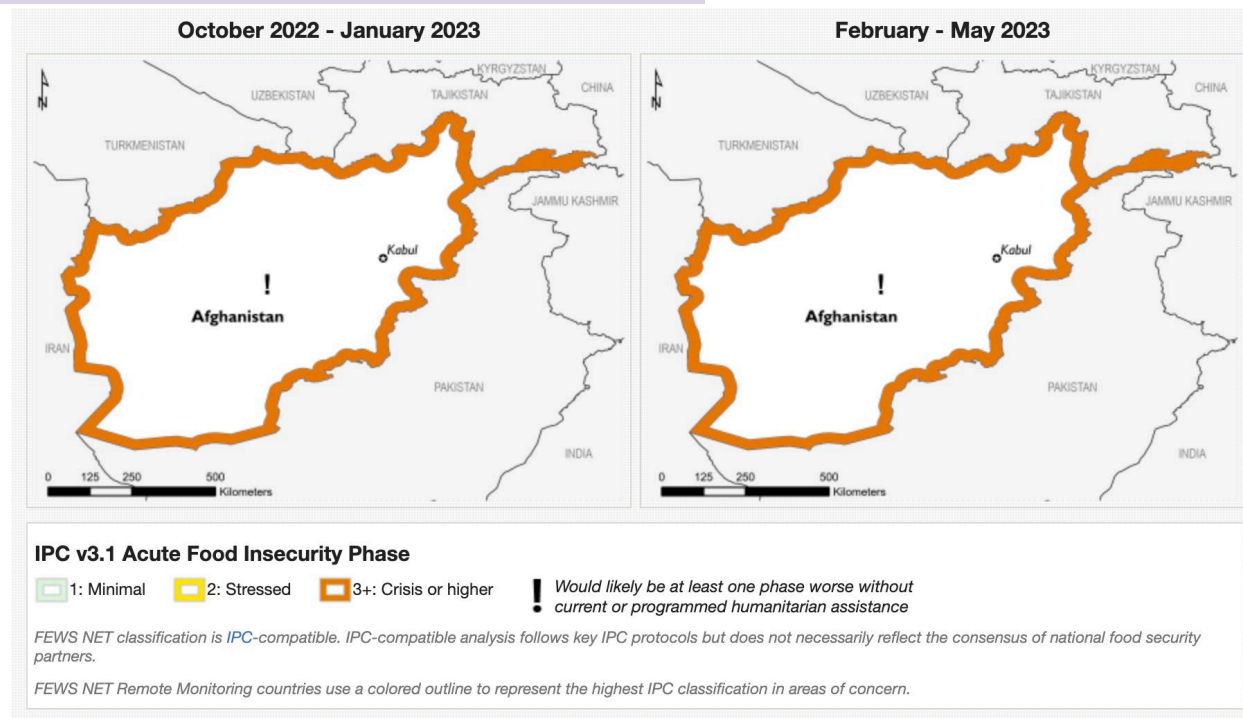


[Global Facility for Disaster Reduction and Recovery](#)

Flooding is the most frequently occurring natural hazard in Afghanistan.

The flooding here usually occurs through river flooding due to steep slopes in headwaters and from heavy rainfall coupled with rapid snowmelt.

The lack of vegetation and denudation of mountain areas also contribute to the occurrence of flooding in Afghanistan.



<https://fews.net/central-asia/afghanistan>

The Famine Early Warnings Systems Network (FEWS NET) outlook above highlight 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.

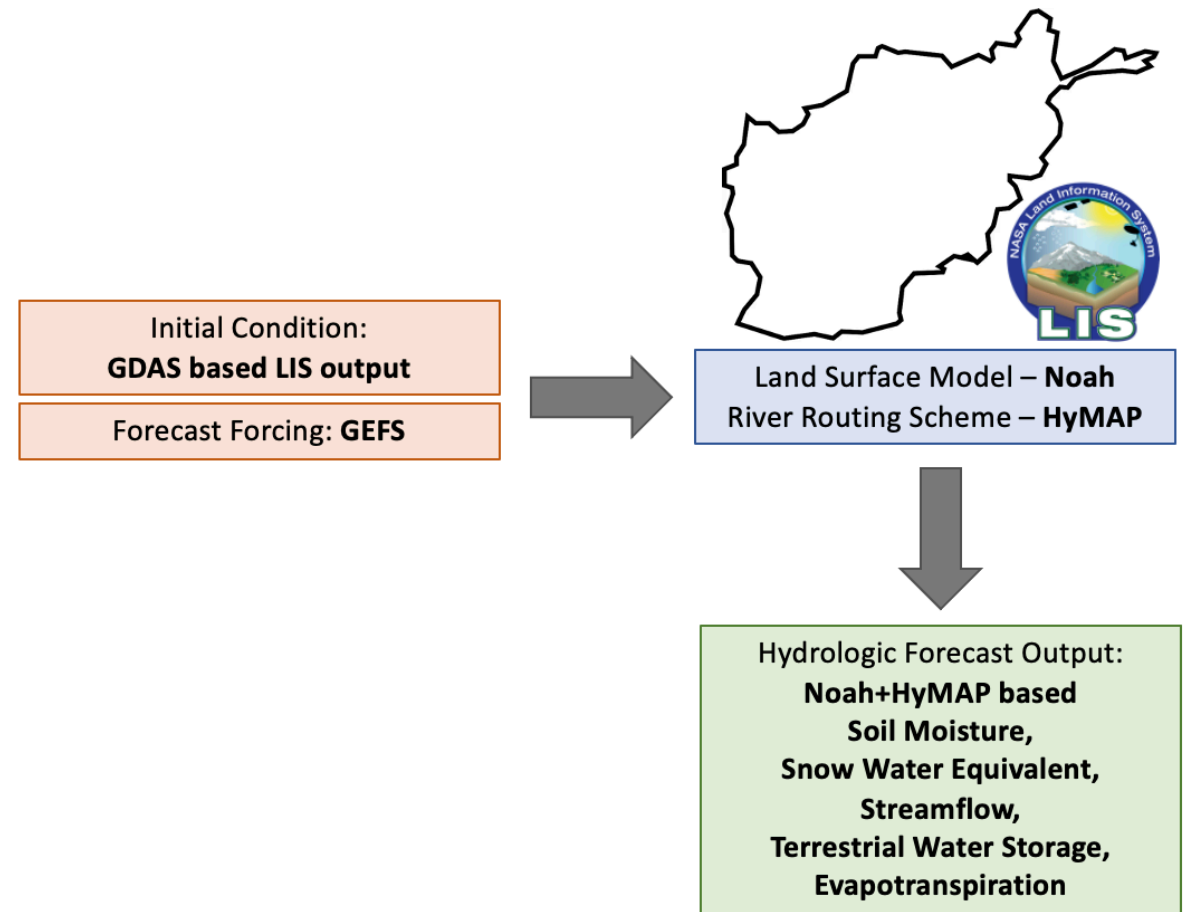
Methodology

FEWS NET provides routine hydrologic monitoring over Afghanistan using Global Data Assimilation System (GDAS) meteorologic forcings with Noah land surface model (LSM).

The FEWS NET team in the Hydrological Science Laboratory at NASA Goddard is working towards providing early warning of potentially flood like conditions over Afghanistan.

A new forecasting system, as a part of FEWS NET Land Data Assimilation System (FLDAS) Forecast, will use Global Ensemble Forecast System (GEFS) meteorologic forecasts to 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.



Schematic of the FLDAS Forecast system over Afghanistan



Results:

A look at the Daily Climatology to identify the important periods

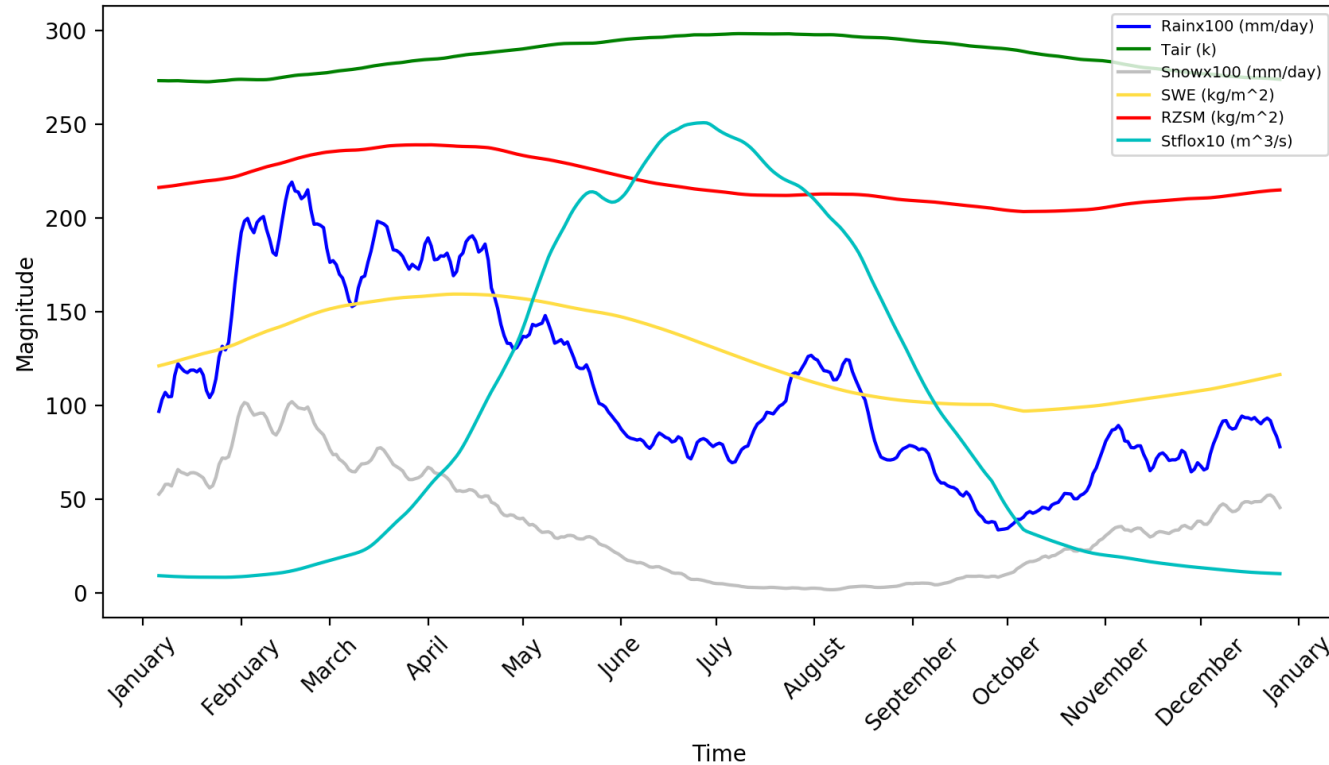


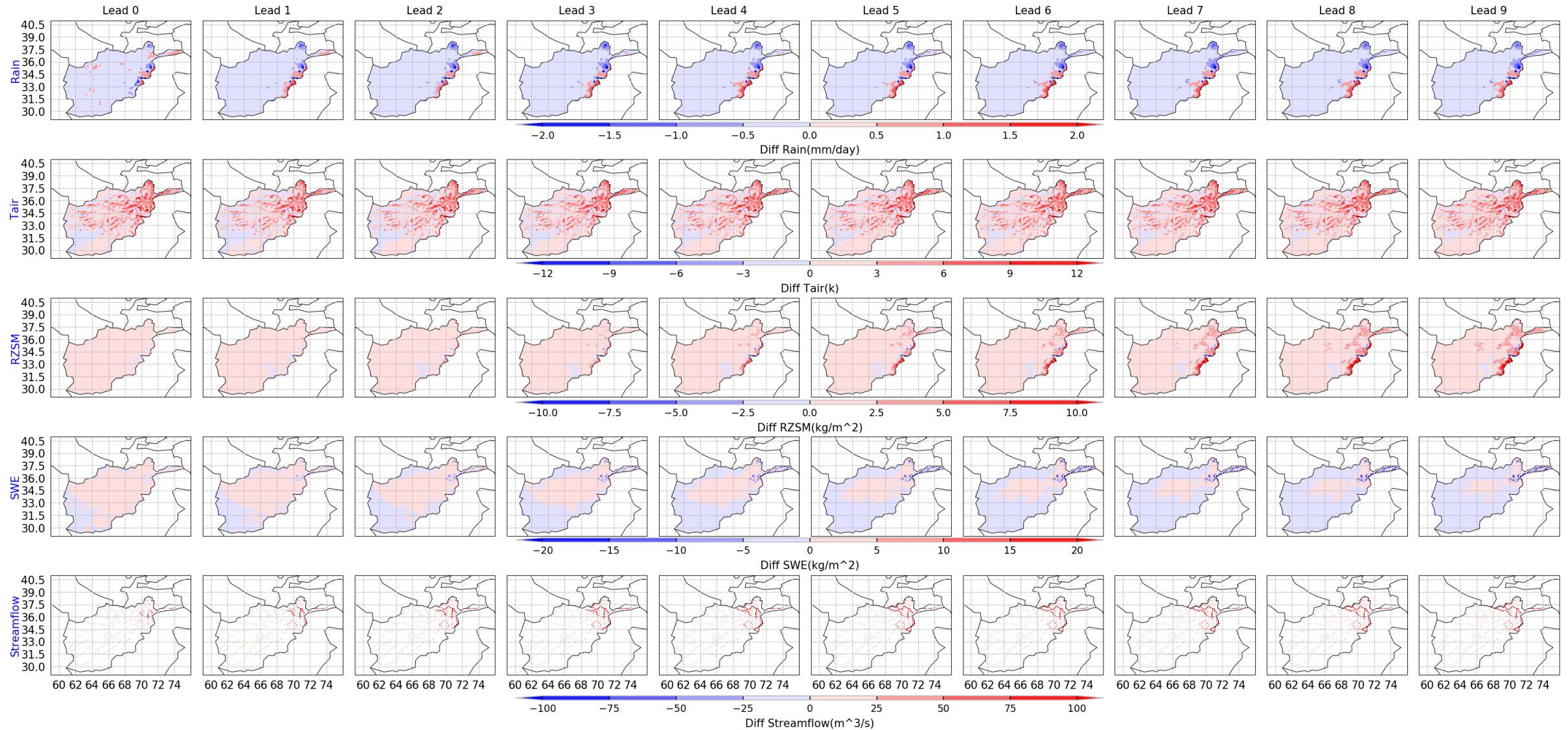
Figure on left uses data produced by GDAS and Noah LSM, which is the open-loop (OL) and the simulated truth for our evaluation.

The period of highest streamflow is evaluated next between years 2001 to 2019.

Daily Climatological Timeseries between 2001-2019 over Afghanistan

Results:

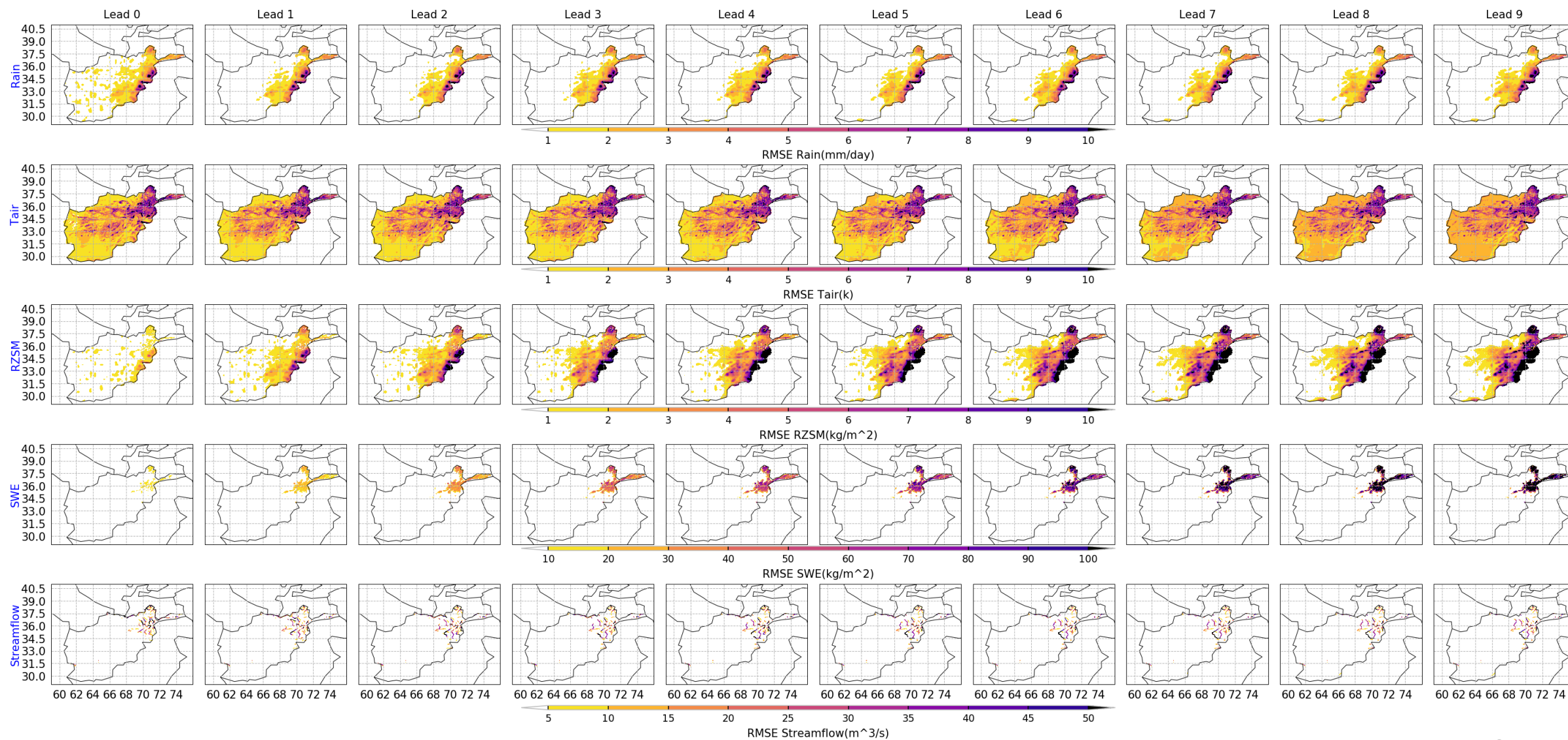
Difference between mean forecasts and mean OL for all July start dates between 2001-2019



Reds: Forecasts > OL, Blues: Forecasts < OL

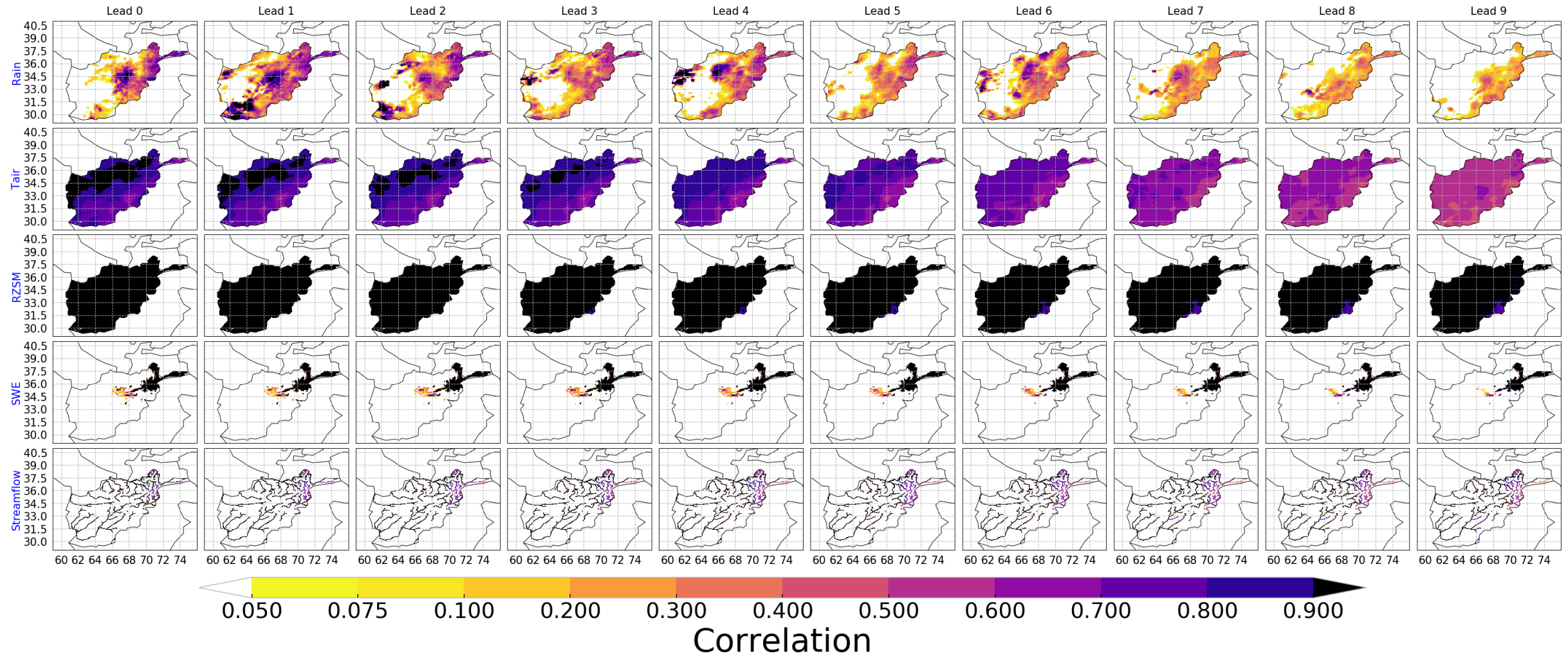
Results:

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



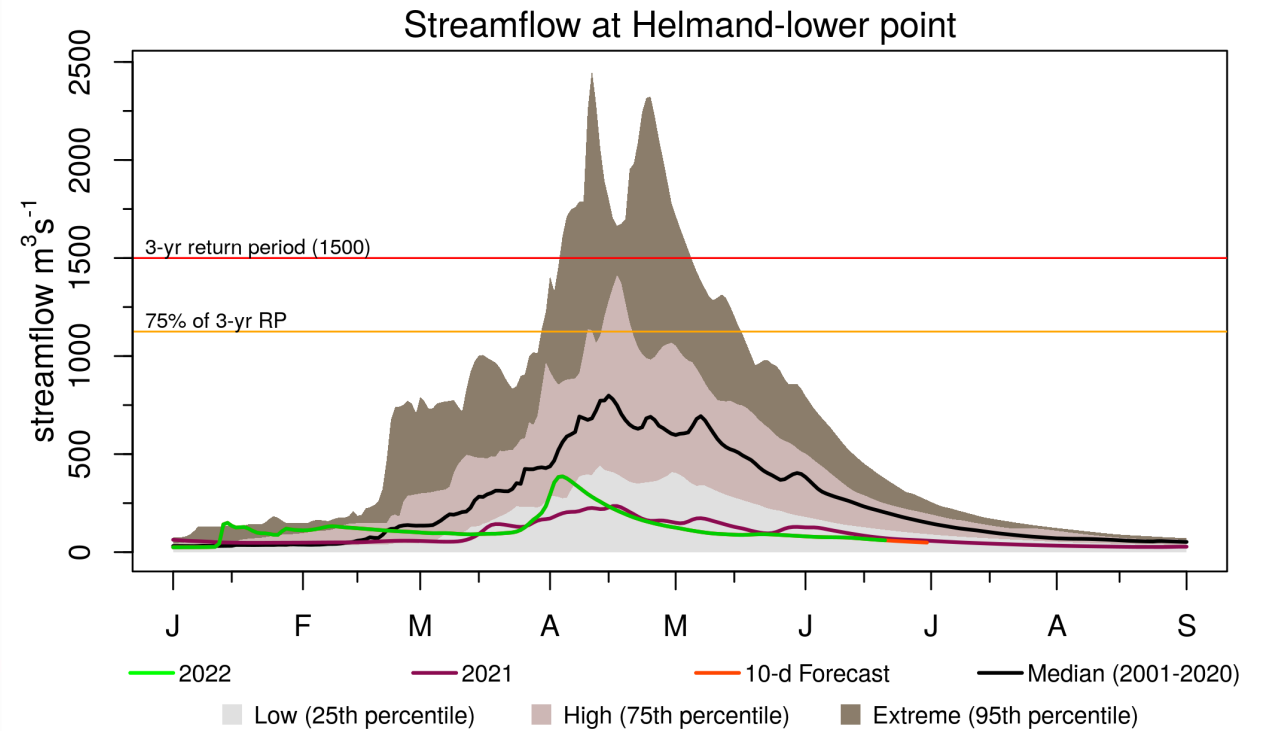
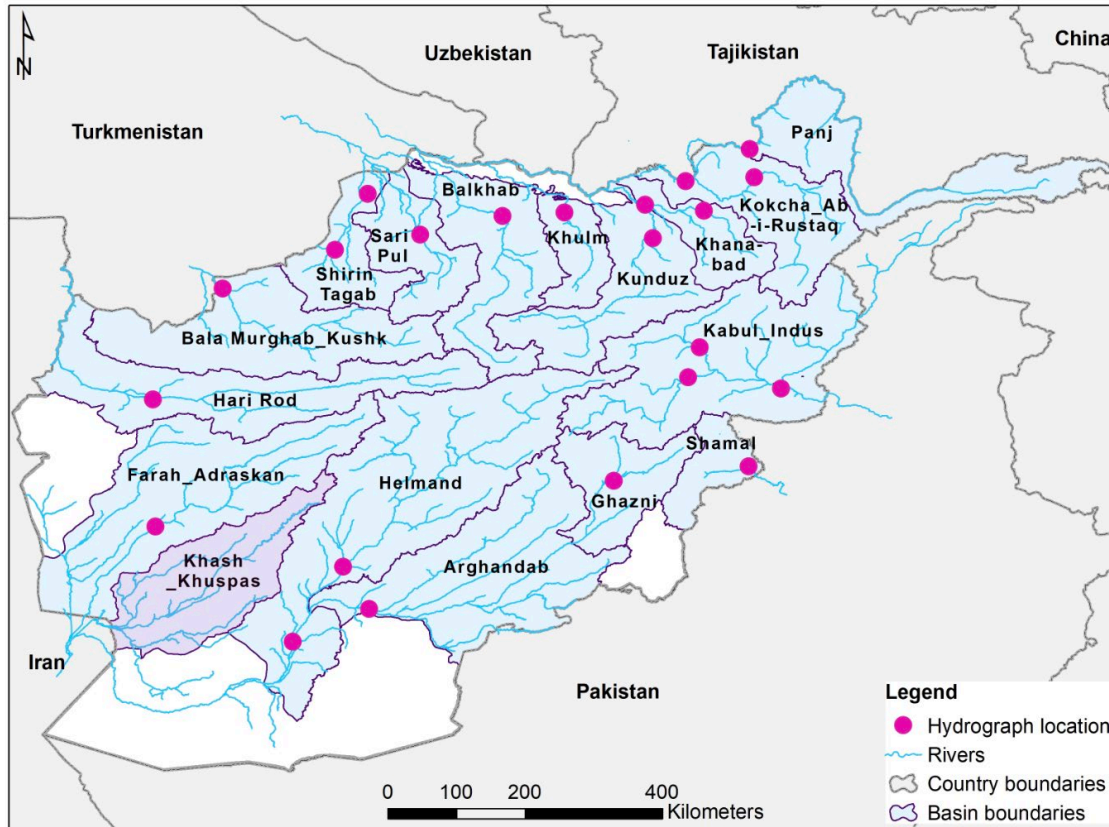
Results:

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



Results:

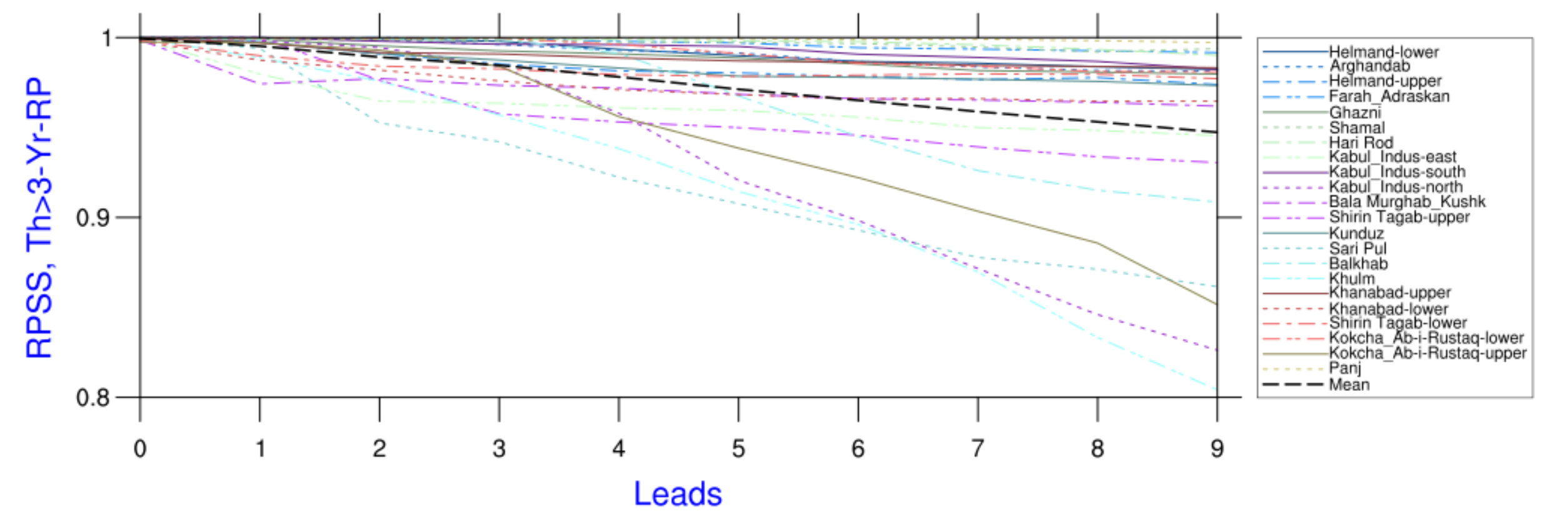
Probabilistic forecast analysis of the streamflow over the following monitoring points:



Afghanistan Streamflow available from: <https://earlywarning.usgs.gov/fews/GDAS>

Results:

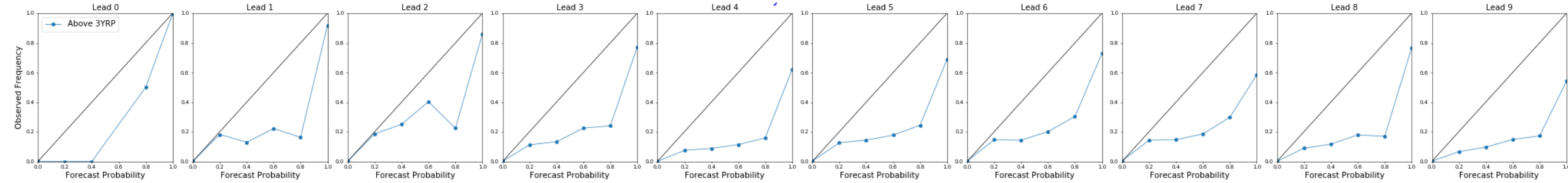
Rank Probability Skill Score for all start dates for March–October between 2001-2019, for threshold of above the 3-year return period (A return period is known as a recurrence interval or repeat interval, it is the average time or an estimated average time between recurrence of floods and is used as measure of flood potential):



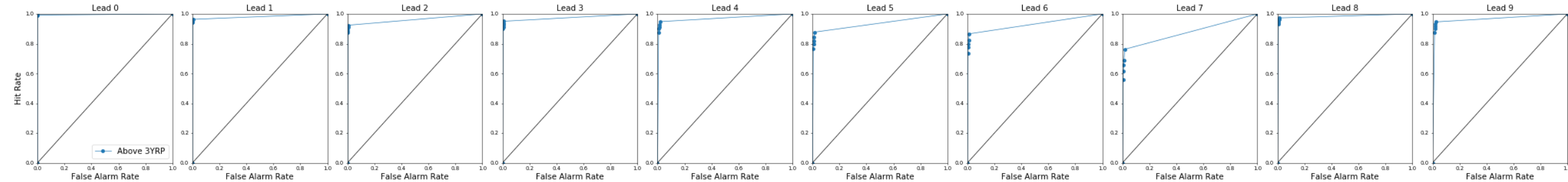
Results:

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

RELIABILITY



ROC



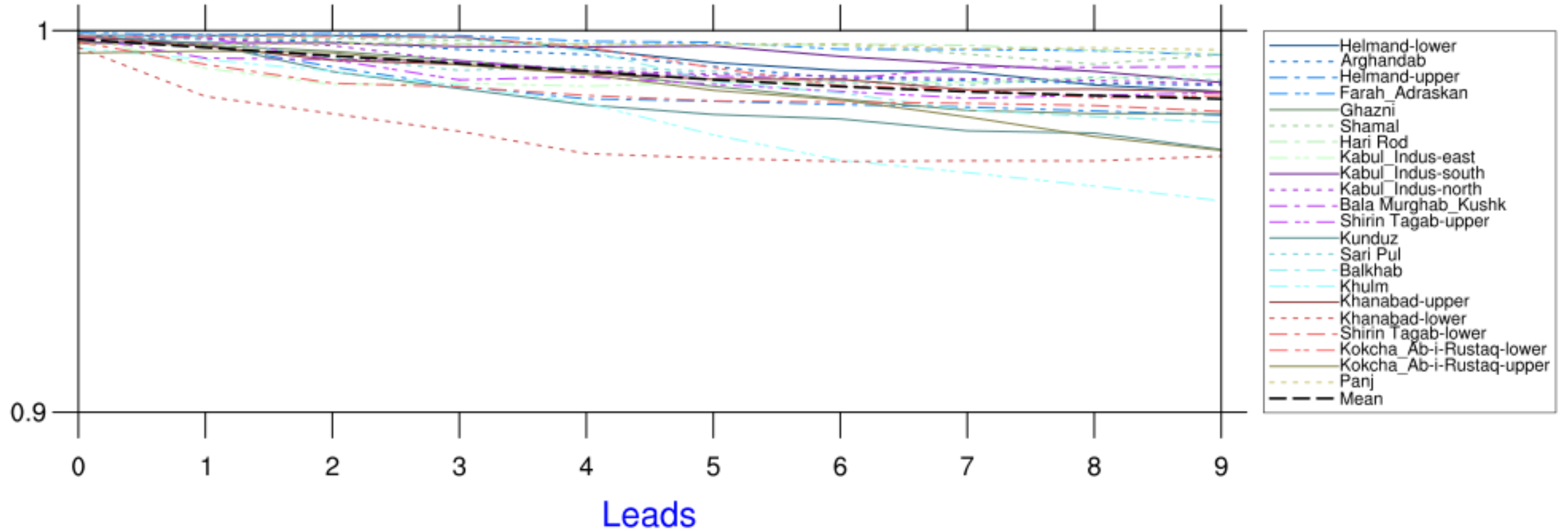


Results:

Evaluation of Bias Corrected forecast data:

The bias-correction is done by CDF matching of the forecasts to OL
Shows near perfect RPSS for all headwater points.

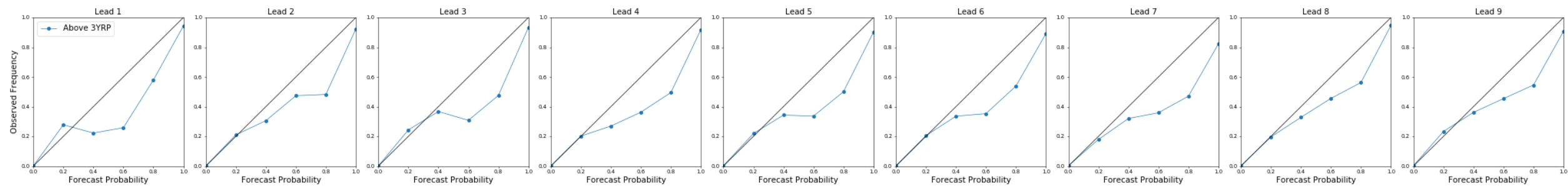
RPSS, Th>3-Yr-RP



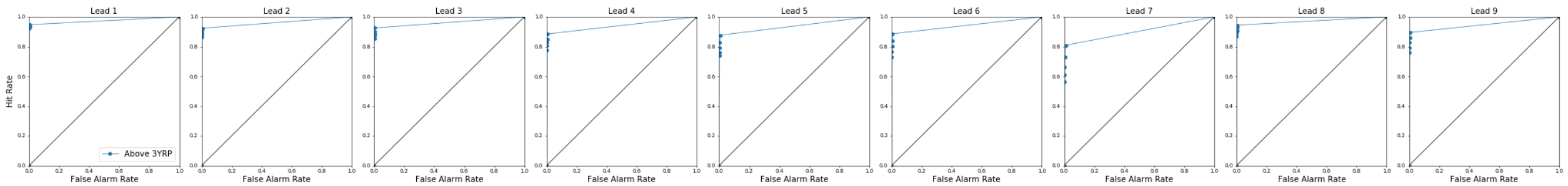
Results:

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

RELIABILITY



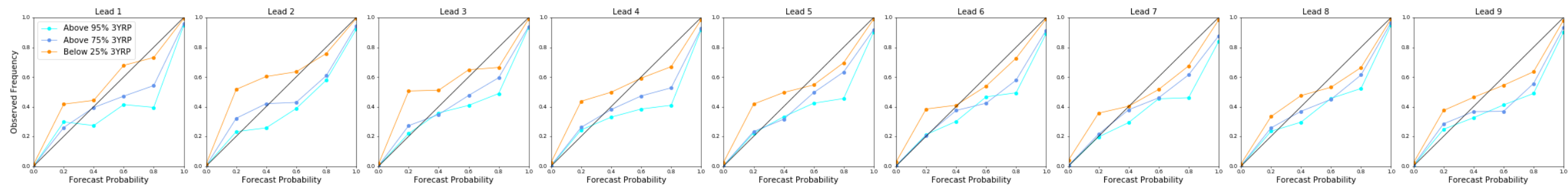
ROC



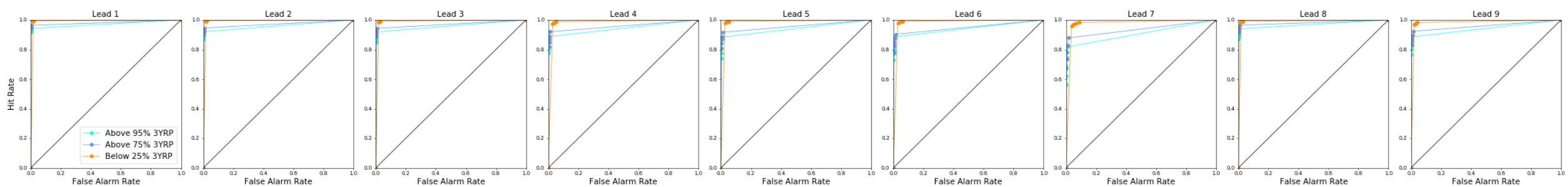
Results:

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

RELIABILITY



ROC



Summary:

- Hydrologic forecasts of rootzone soil moisture and streamflow show consistent positive bias in forecasts, while SWE shows mixed biases.
 - The deterministic skill of hydrologic forecasts are found to be have high anomaly correlation spatially during this period.
- Although the forecast RPSS and ROC of the streamflow in the headwater points are very high, the forecast reliability is found to be very poor for the above 3-year return period threshold. That is, the predicted probabilities of the event do not correspond well to their observed frequencies.
- Bias correcting the streamflow using CDF matching produces better RPSS and ROC and the reliability curve is also greatly improved, although some over-forecasting are still seen at the above 3-year return period threshold.
- Further, evaluating the thresholds of above 95% and 75% and below 25% of the 3-year return period, shows much better reliability and ROC, with the above 95% and 75% conditionalities showing some over-forecasting and below 25% conditionality showing under-forecasting.
 - These metrics show below 25% conditionality performing better than above 75% conditionality better than the above 95% conditionality, implying low flows have better forecasts than the high flows, however, the difference in the skill of these three conditionalities are not significantly large.