Initial Assessment of the National Multi-Model Ensemble System for the Prediction of Drought over the NIDIS Test-beds

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Introduction

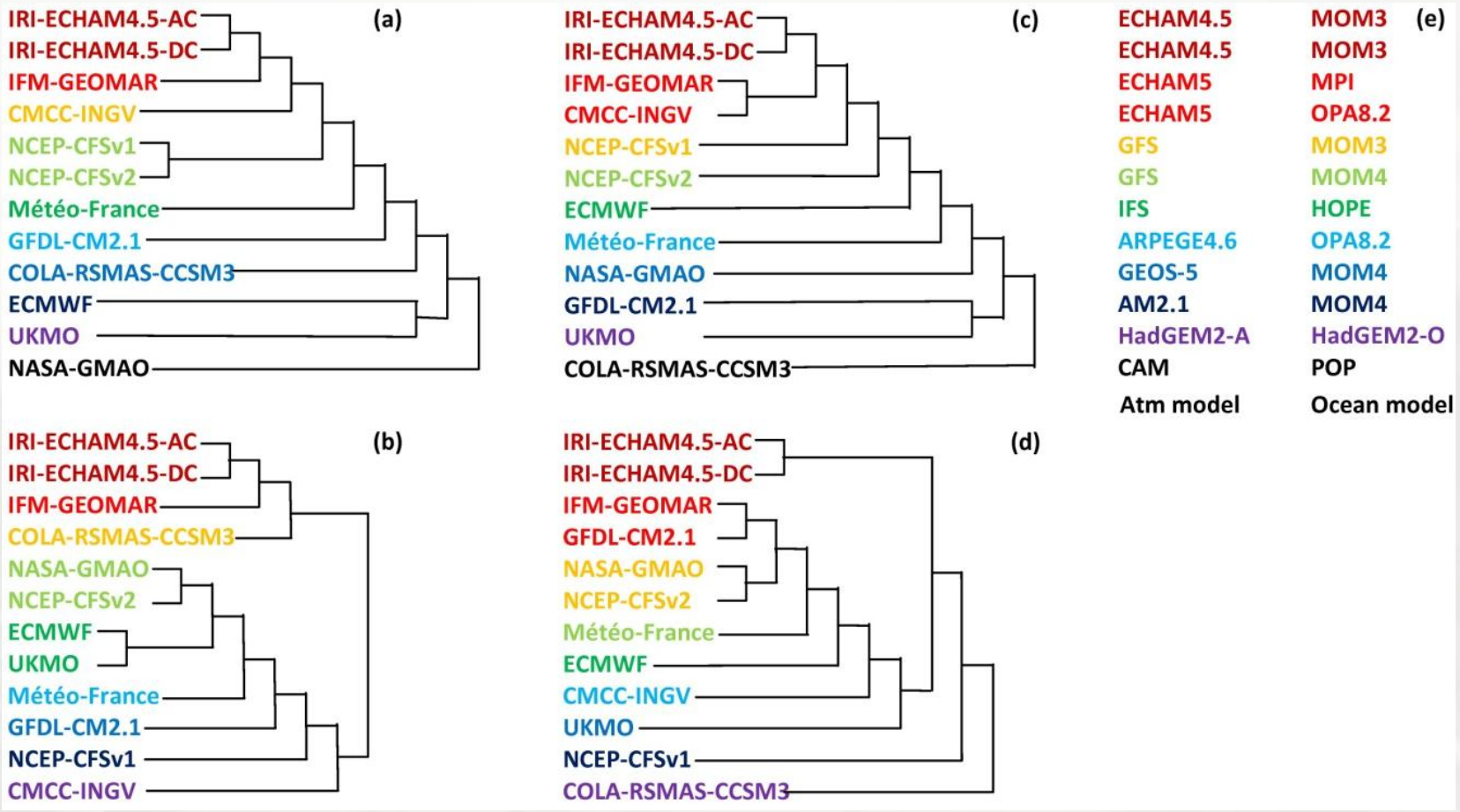
Our task within the NMME project is to

1. Assess the NMME hindcasts to determine their skill over land for precipitation and temperature, which are the main drivers of hydrological forecasts;
2. Analyze MME hindcasts for their skill for drought forecasting and seasonal hydrological forecasts.

Research questions of interest:

- Does utilizing the multi-model ensemble increase the skill of predicting drought?
- Does an increase in skill in the precipitation forecast propagate to soil moisture forecasts?

On the clustering of climate models in ensemble seasonal forecasting (Yuan and Wood, GRL, 2012)



- To quantify the distance between two models, we use inverse trigonometric cosine function of the anomaly correlation ($\cos^{-1}AC$)
- We applied the same clustering method to CONUS region for 7 NMME models, and got COLA, GFDL, ECHAMF, GMAO, CFSv2 for our downscaling study.

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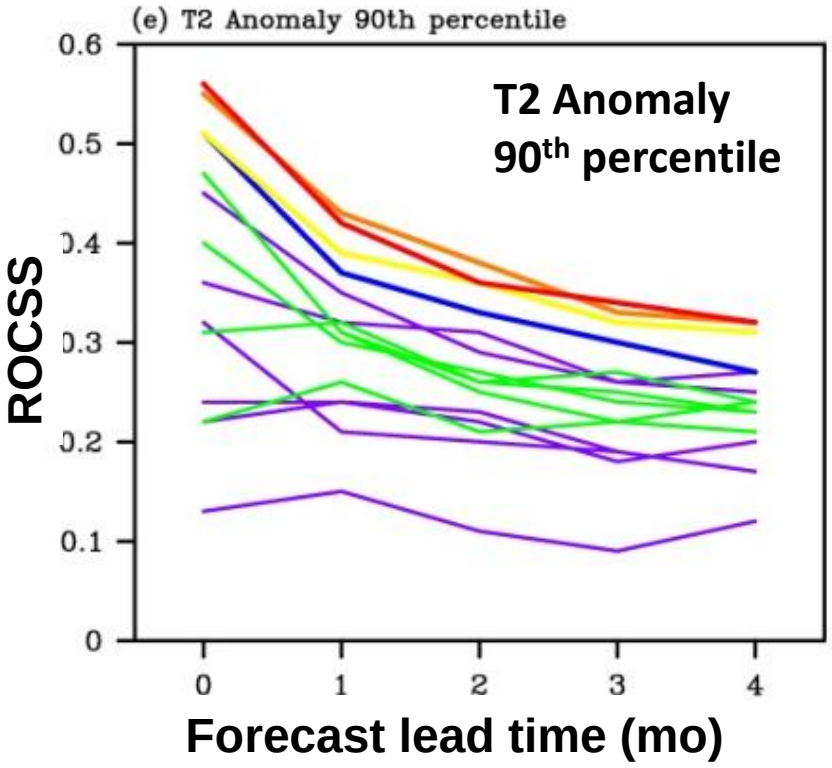
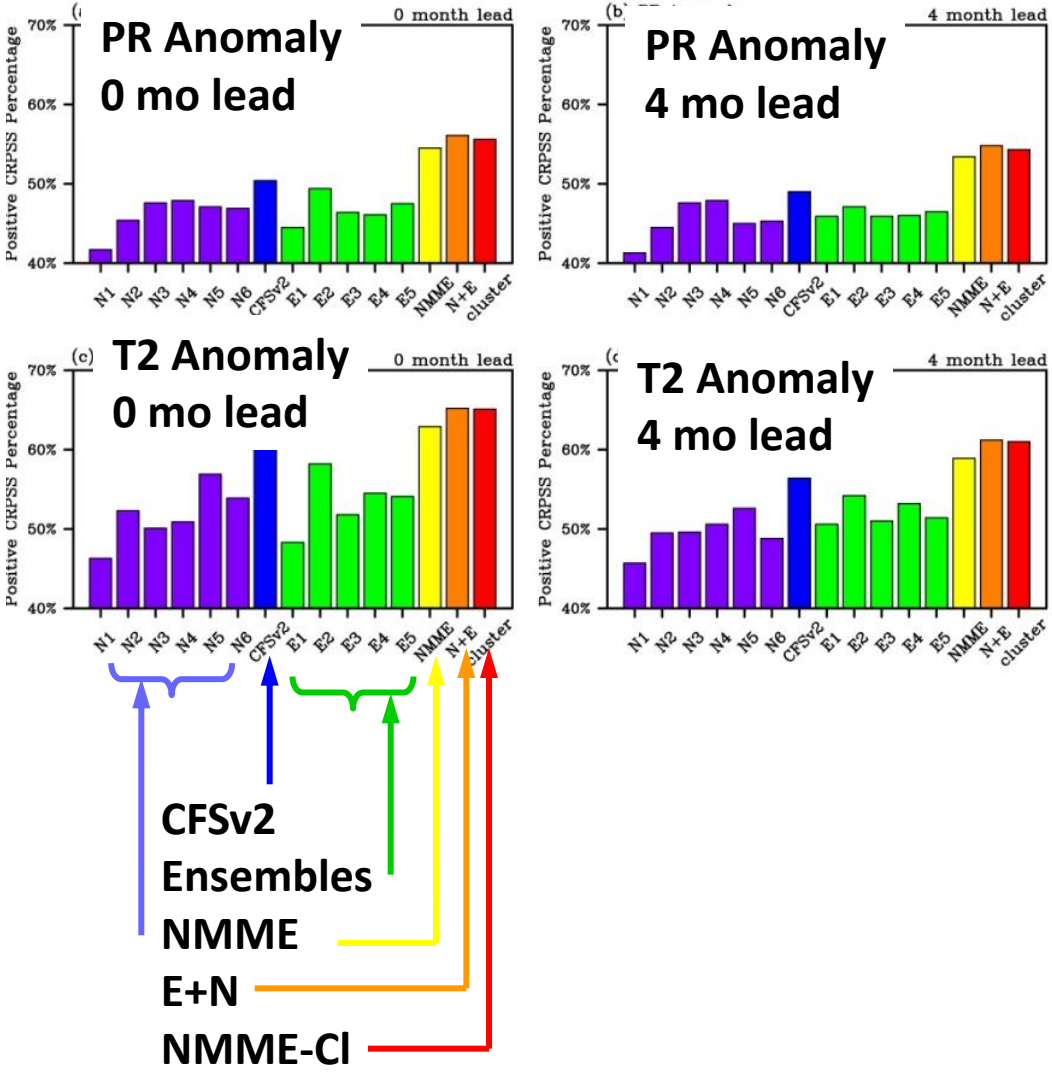
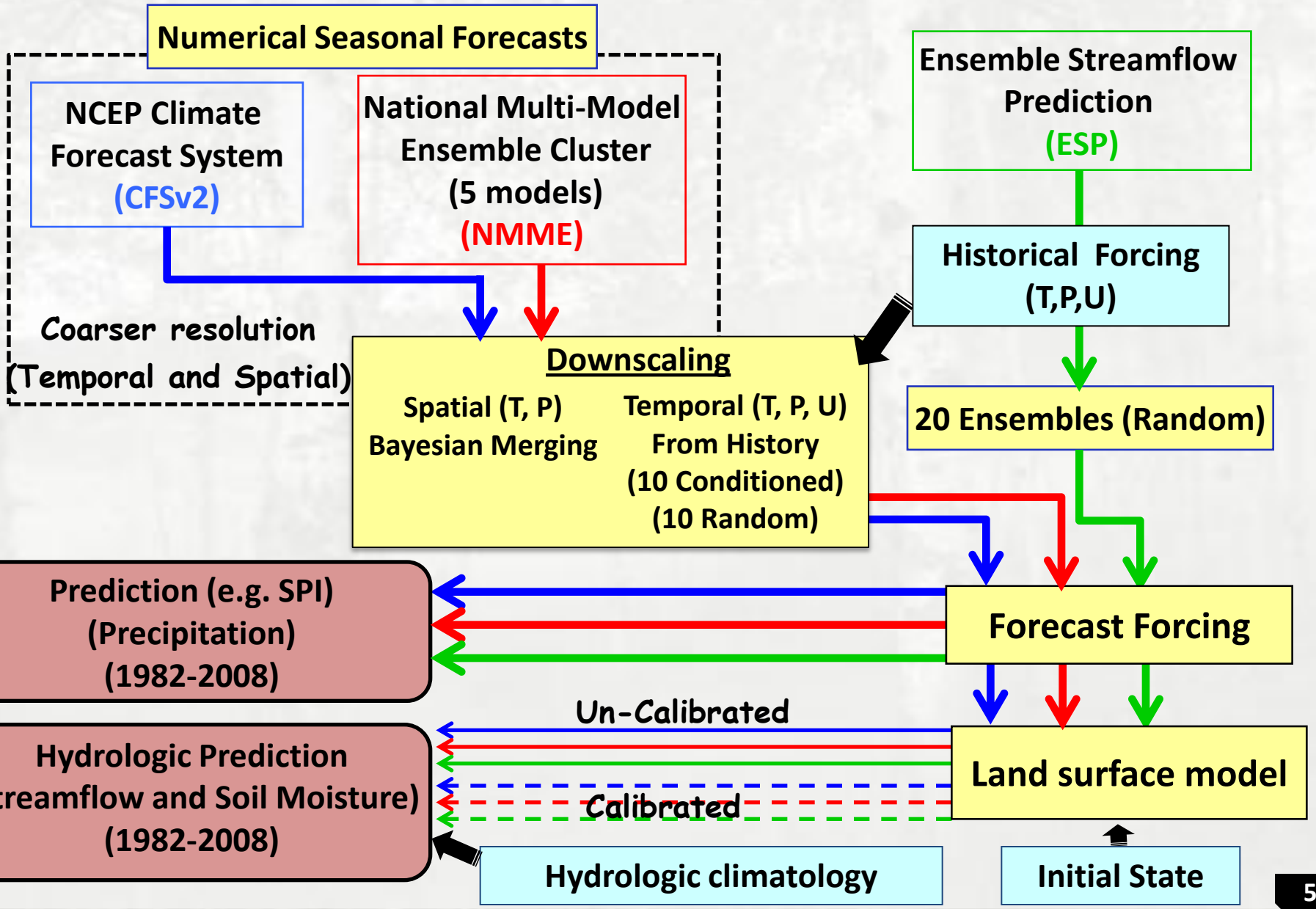


CRPSS for models and ensemble

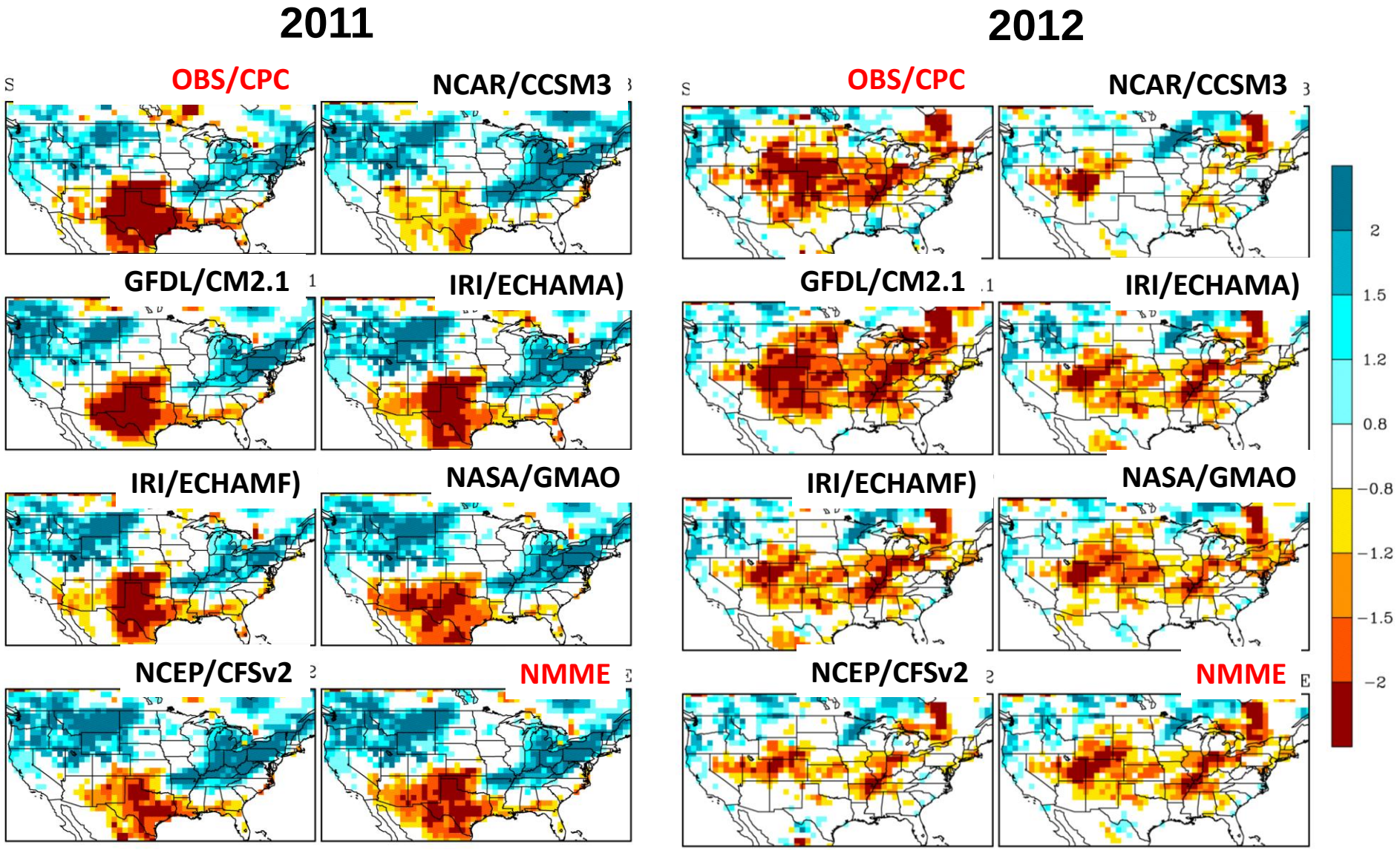


Hydrologic Forecast Methodology



SPI6 for MAMJJA, 2011 & 2012

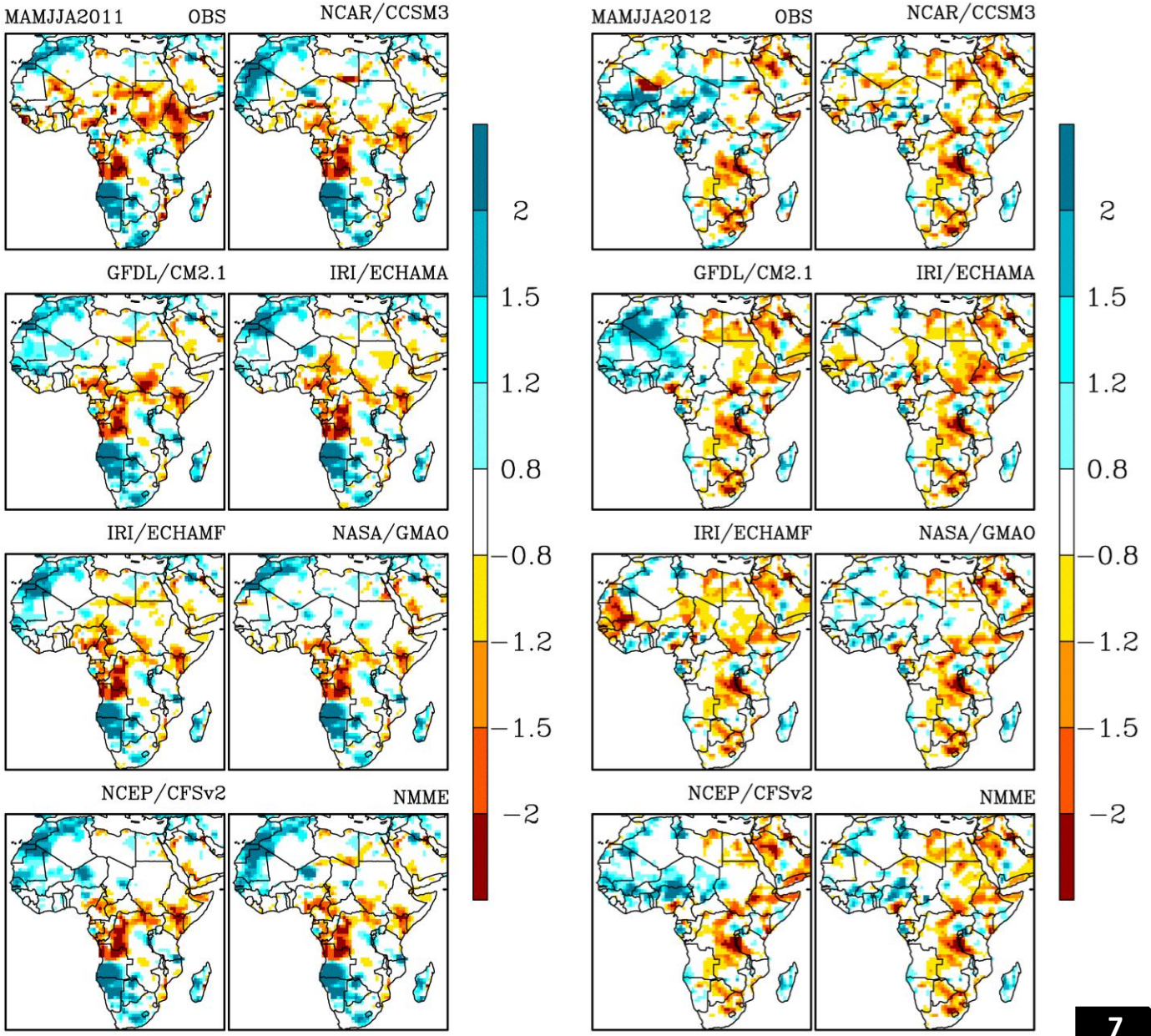
SPI6: Prior 3-month (MAM) observation with the current (JJA) 3-month forecast



SPI6 for MAMJJA, 2011 & 2012

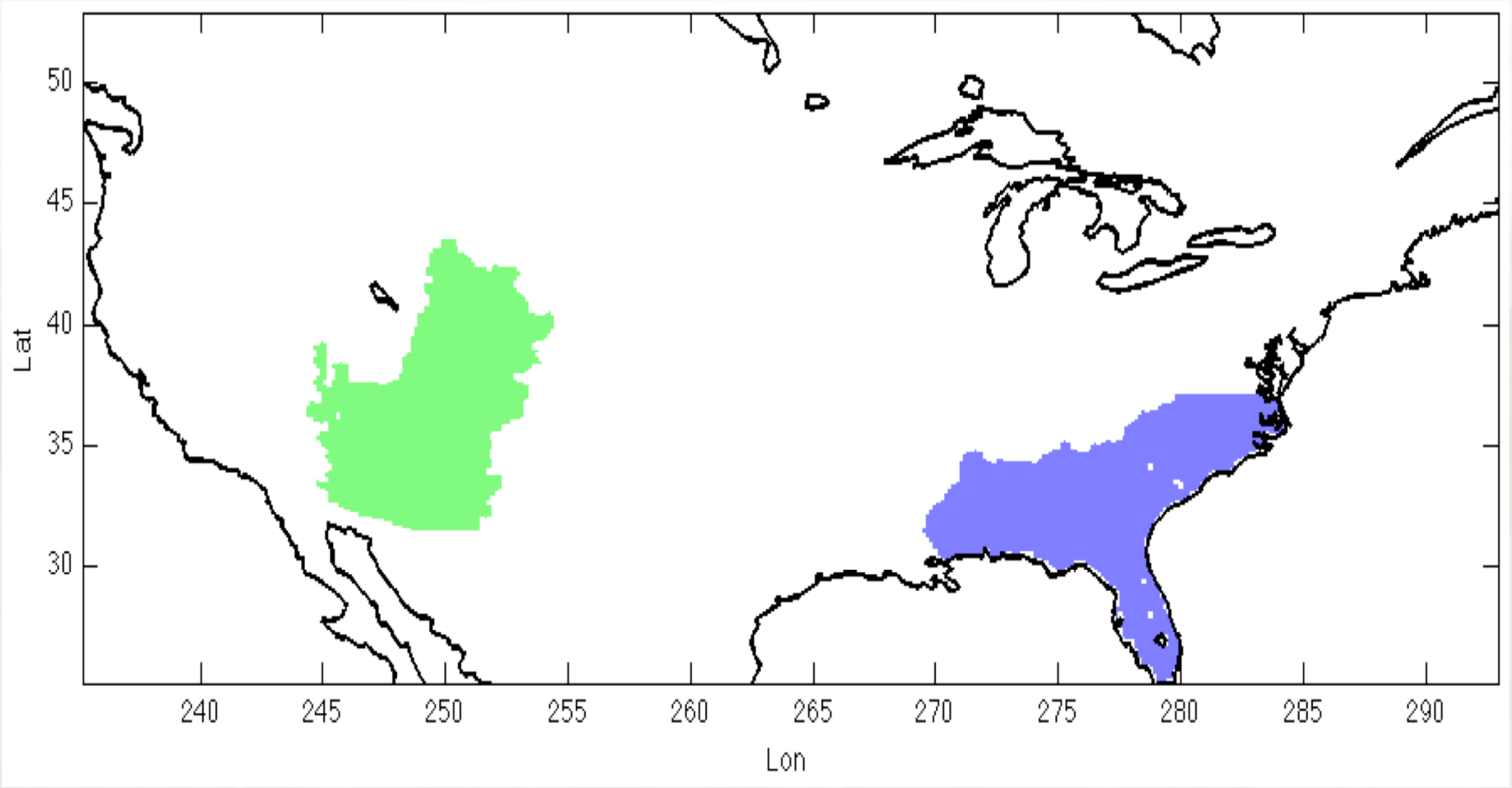
SPI6: Prior 3-month (MAM) observation with the current (JJA) 3-month forecast

2011 left 2012 right	
OBS (CPC)	NCAR (CCSM3)
GFDL (CM2.1)	IRI (ECHAMA)
IRI (ECHAMF)	NASA (GMAO)
NCEP (CFSv2)	NMME



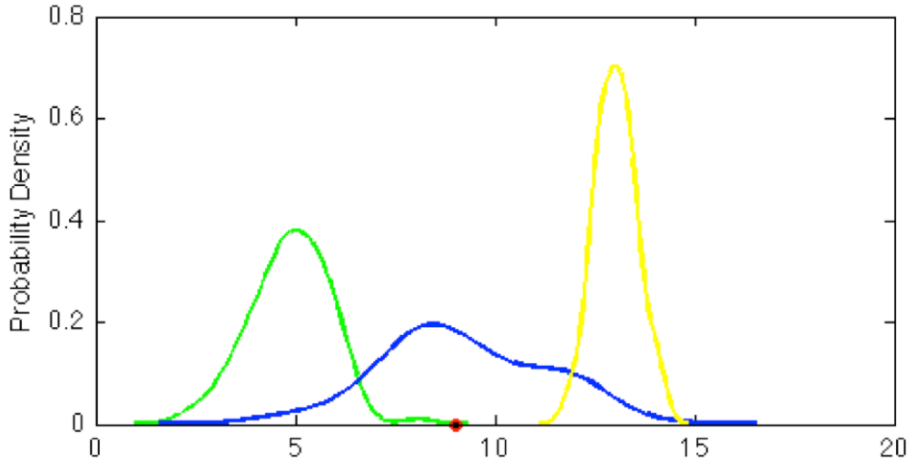
NIDIS Study Basins

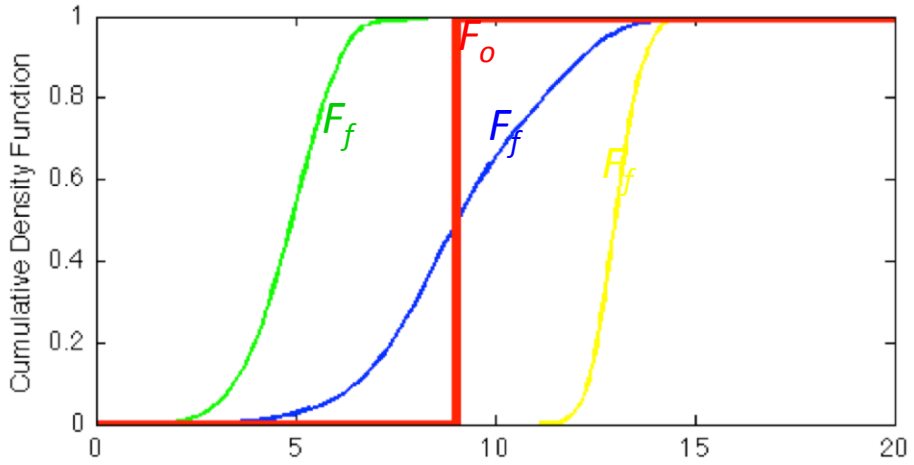
- Colorado (COL)
- Southeast (SE)



Skill Metric

- Continuous Ranked Probability Skill Score (CRPSS)

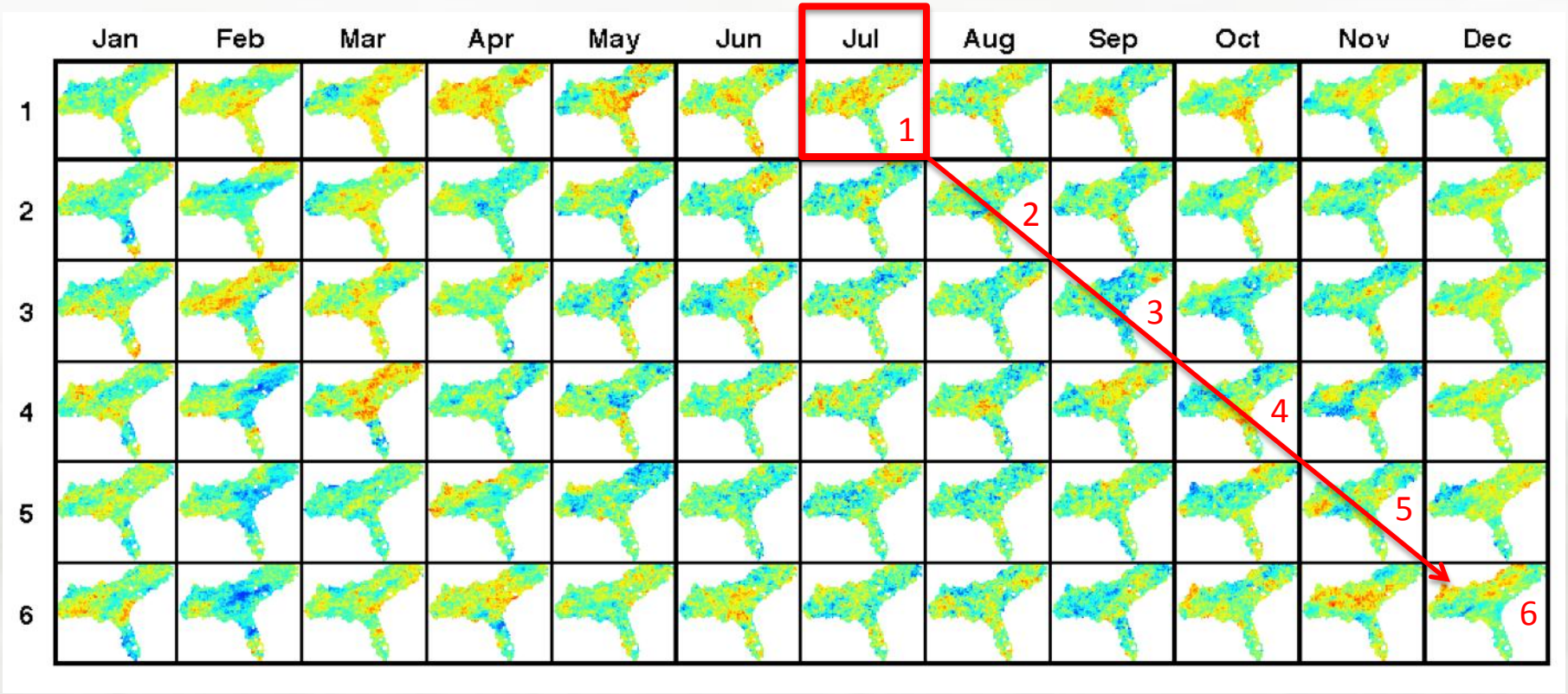




$$\boldsymbol{CRPSS} = \int_{-\infty}^{\infty} [F_y(y) - F_o(y)]^2 dy$$

- Evaluate the % of forecasts that are more skillful than the reference forecast (ESP or random selection from climatology)
  - Tercile (Lower – Middle – Upper)

NMME Precipitation All Terciles



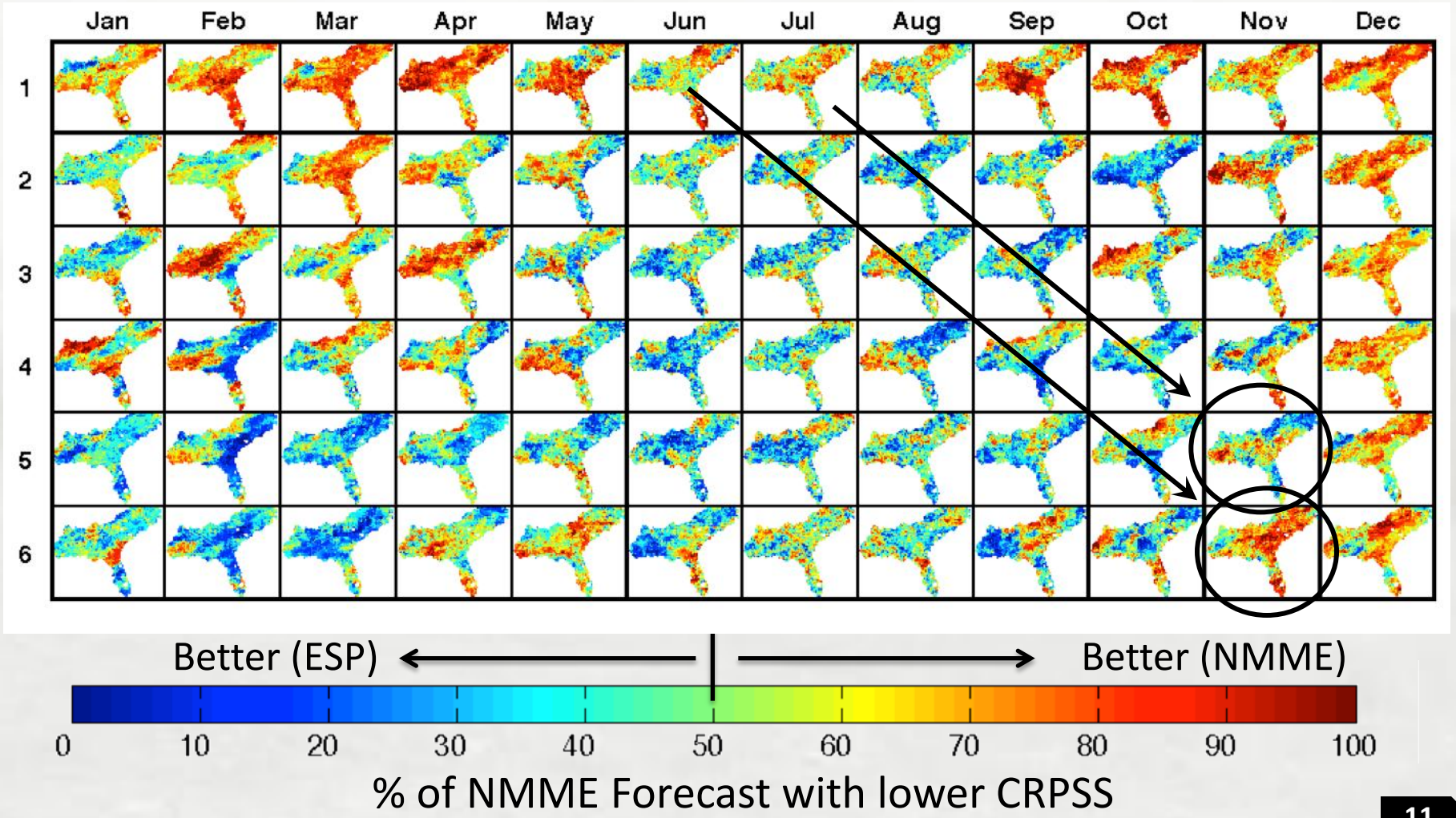
Better (ESP) ← → Better (NMME)

0 10 20 30 40 50 60 70 80 90 100

% of NMME Forecast with lower CRPSS

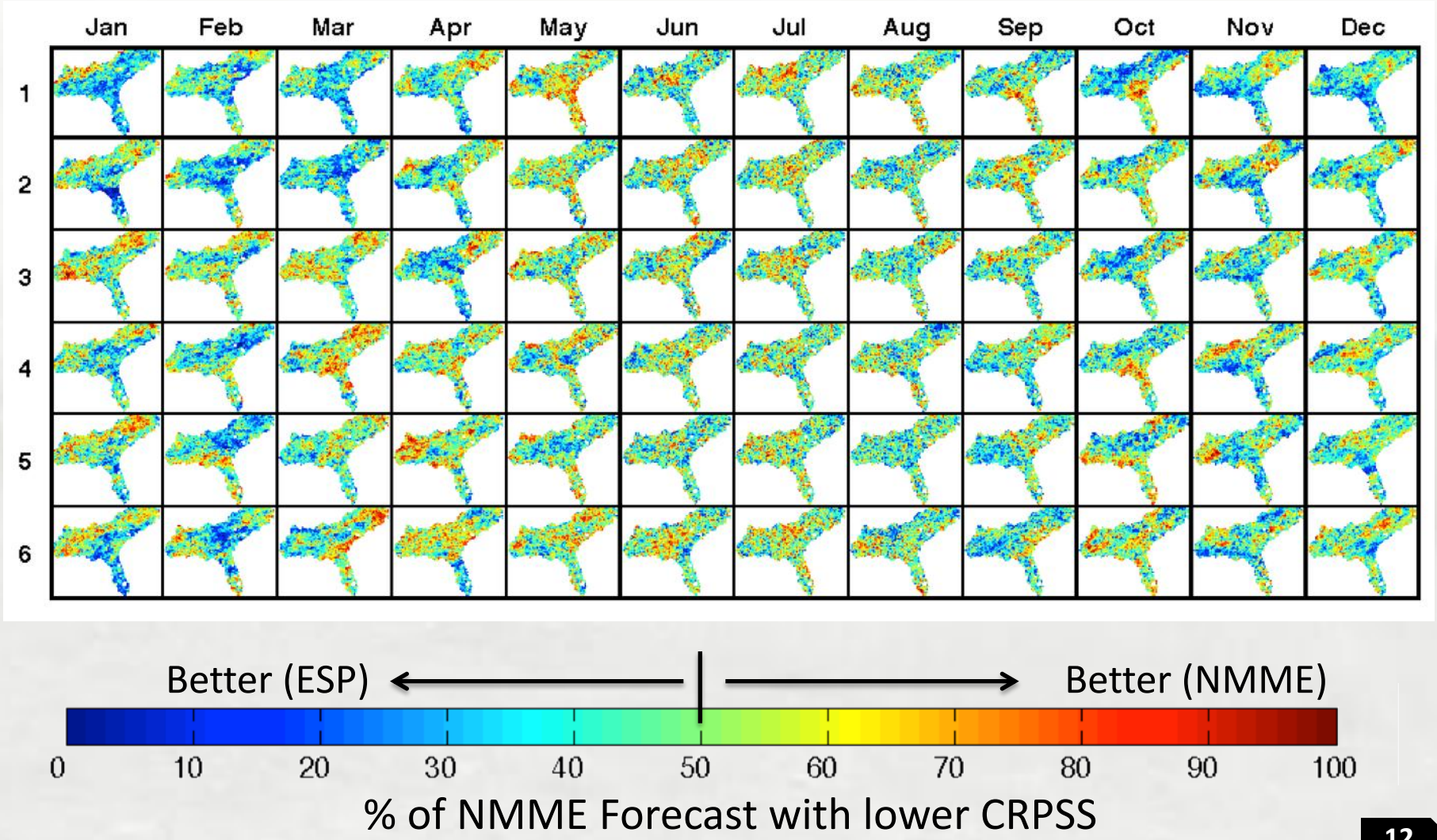
NMME Precipitation Lower Tercile

First Month shows the greatest improvement over ESP



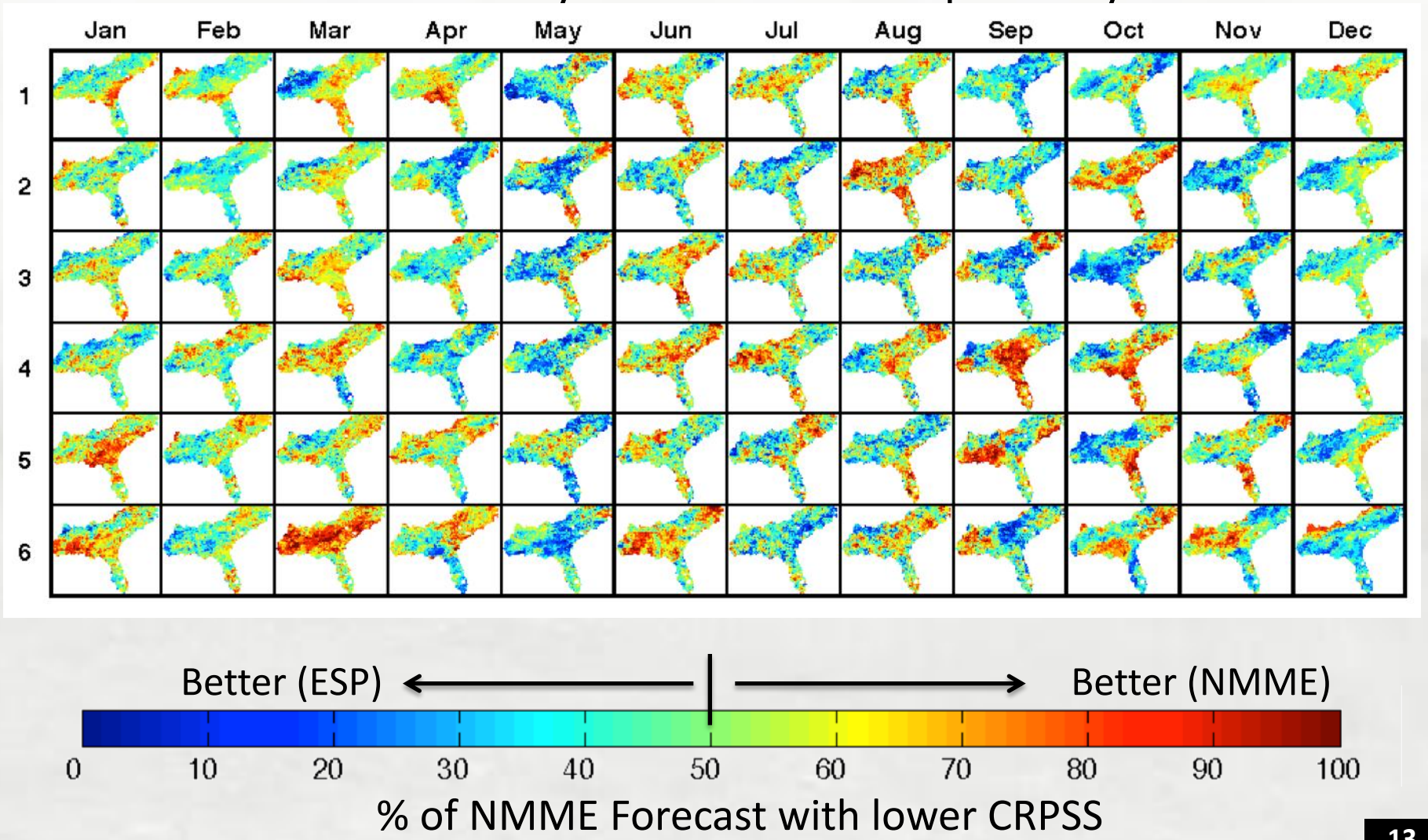
NMME Precipitation Middle Tercile

Not much difference, but over all NMME is does worse

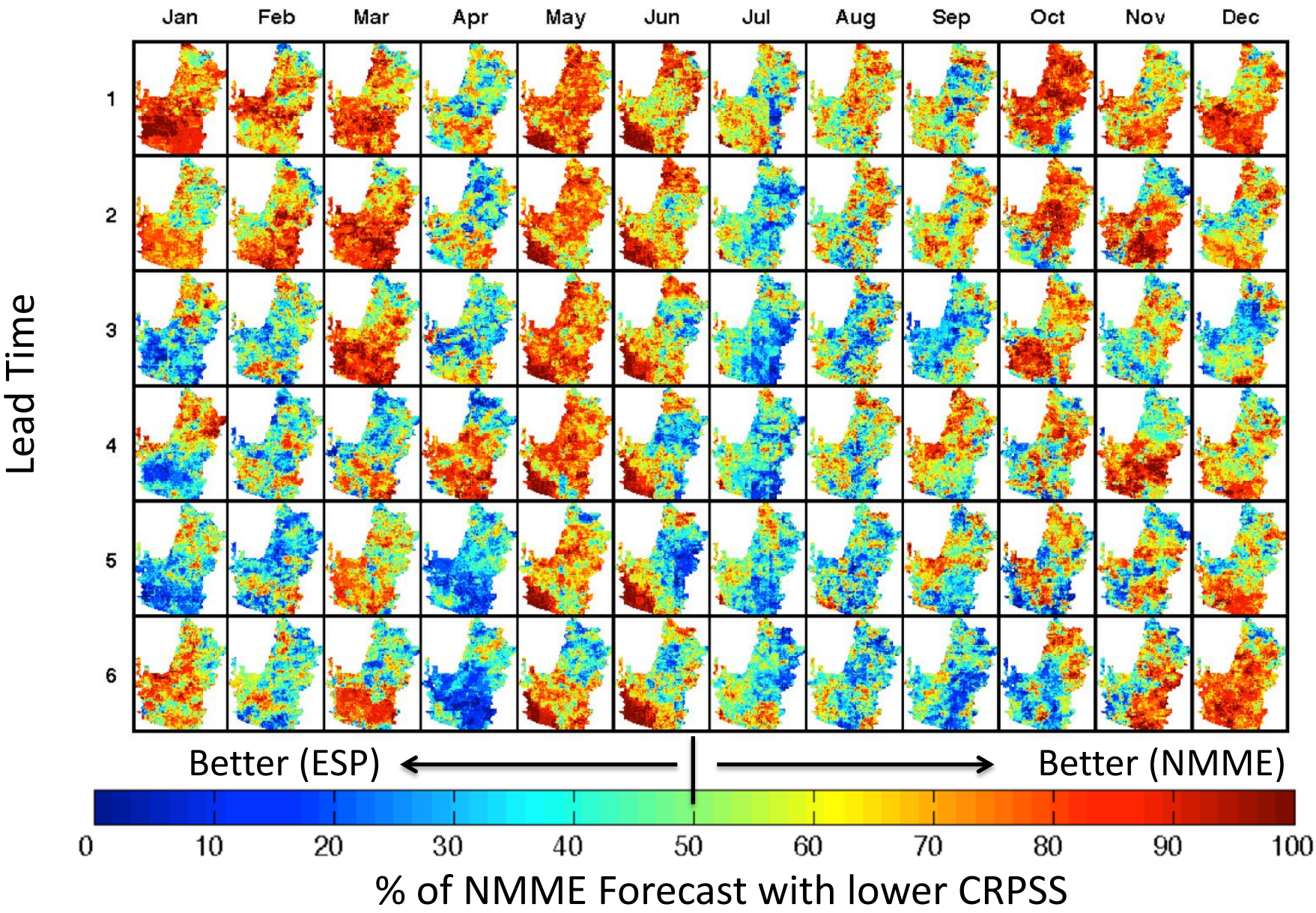


NMME Precipitation Upper Tercile

Not much improvement, except random lead times and months.
Lack of statistical stability? Reforecasts are probably too short.

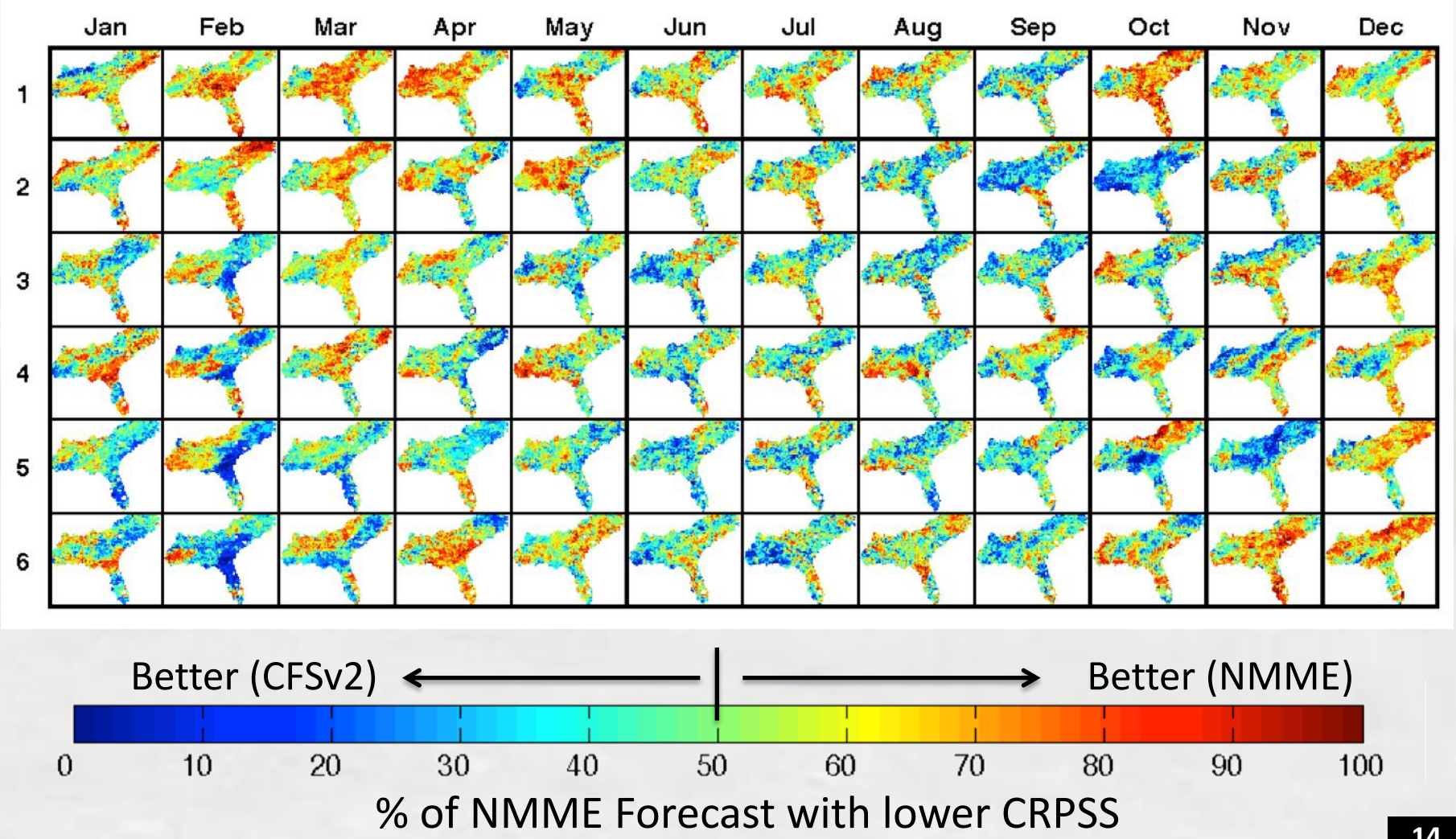


NMME Precipitation Lower Tercile

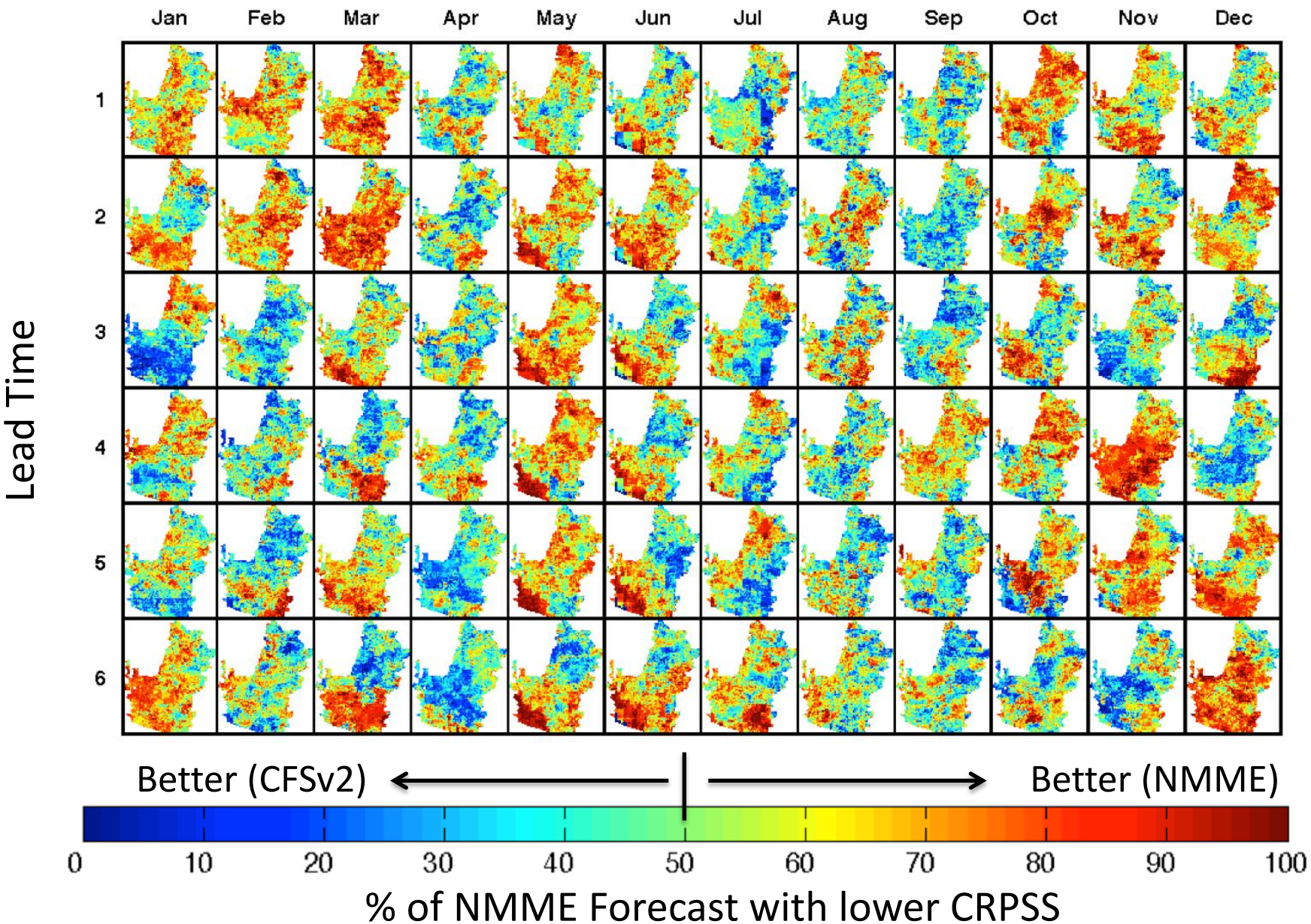


NMME Precipitation Lower Tercile

NMME shows some improvement over CFS, mainly in the first month, does worse in February with long lead times.

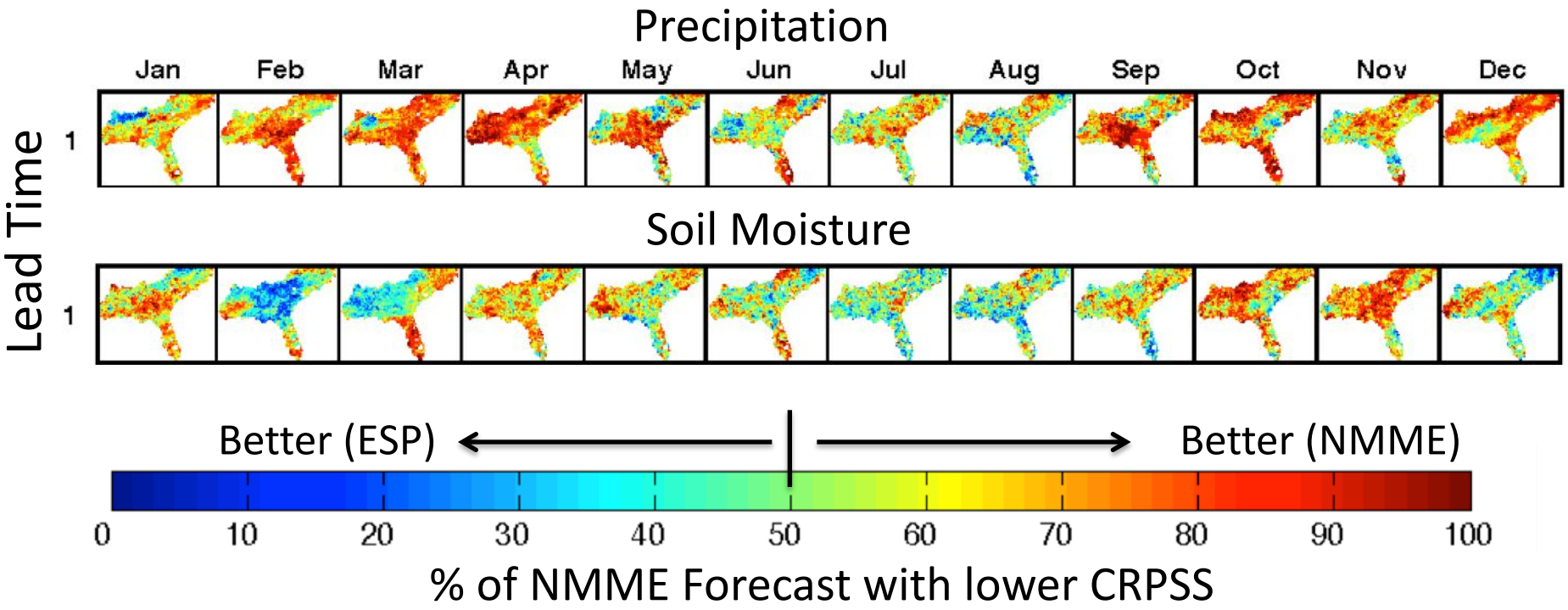


NMME Precipitation Lower Tercile



NMME Soil Moisture Skill

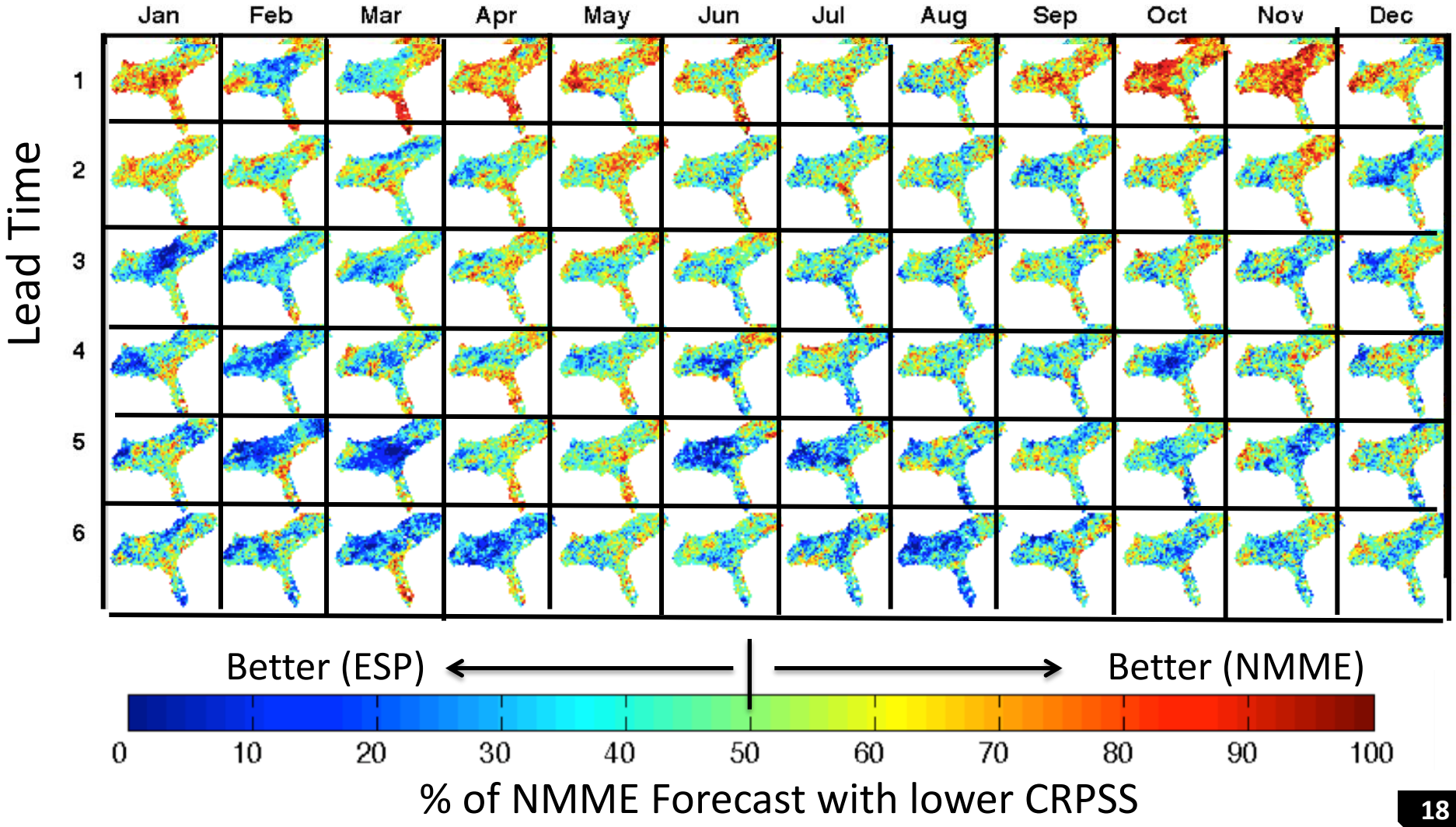
- **How does the precipitation skill propagate to soil moisture forecast skill?**



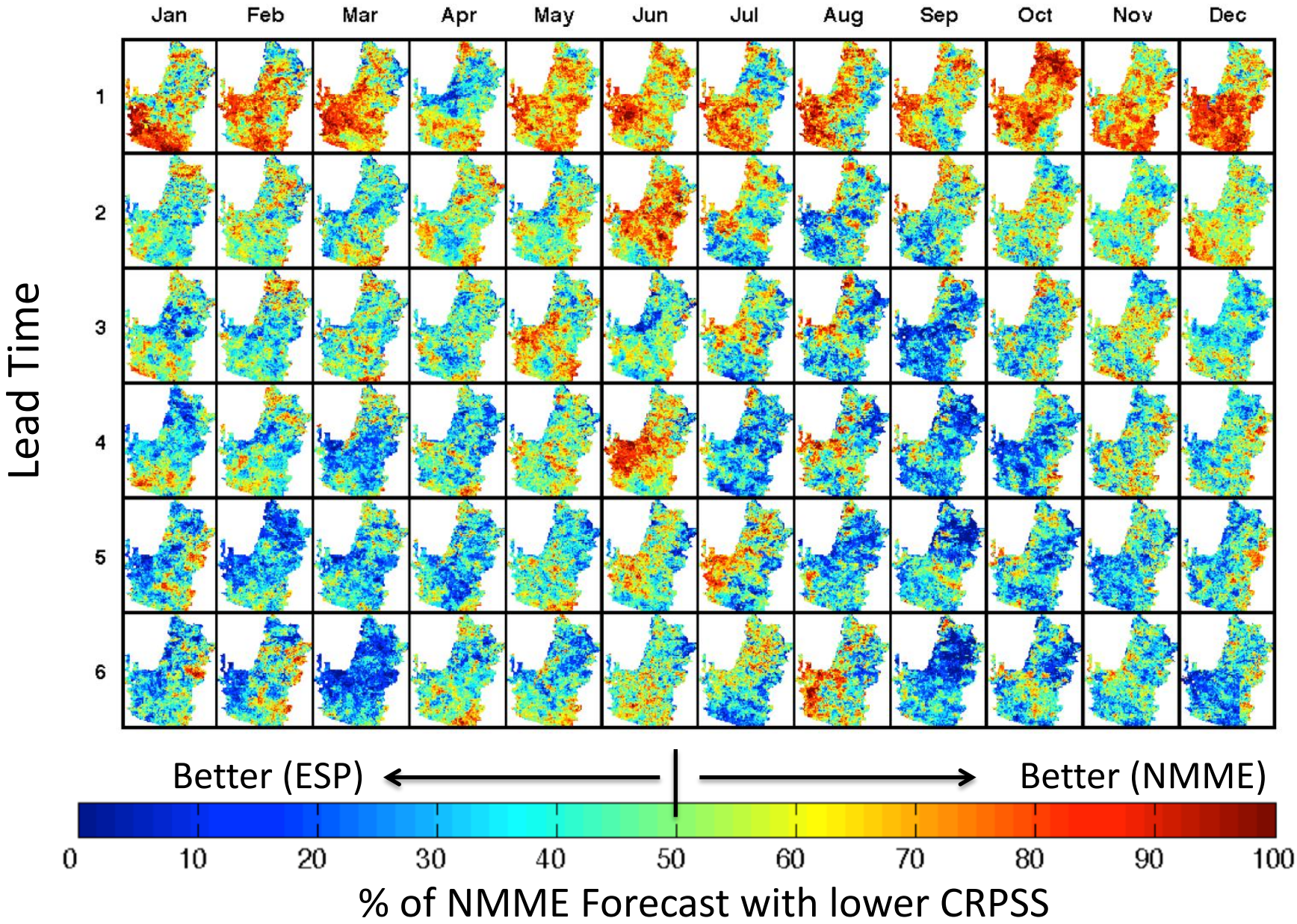
- **Some months show consistent skill (Oct and Nov)**
- **Some months are inconsistent (Feb and Mar)**

NMME Soil Moisture Lower Terciles

NMME shows some improvement over ESP, mainly in the first month (Spring/Fall), does worse at long leads times.



NMME Soil Moisture Lower Terciles



Conclusions

- NMME generally shows higher skill than CFSv2 alone, but is complicated by ensemble size;
- Real issues of statistical stability of the derived skill maps, with suggestions that the reforecast period is too short.
- Resampling from climatology (ESP) has competitive skill measures
- Over the Southeast the NMME shows an increase in skill for month-1 forecasts in the lower tercile.
  - -- The skill is not always propagated to forecasts of soil moisture, which depends on initial conditions as well.
  - -- Does SPI provide a better drought forecast?
- Over the Colorado the NMME shows an increase in skill in the precipitation forecasts for the lower tercile.
  - -- However during the summer the increase in skill is attributed to over-forecasting of lower tercile events.