Operational transition of combined ENSO, MJO, and trend influences on temperature and precipitation for Weeks 3-4

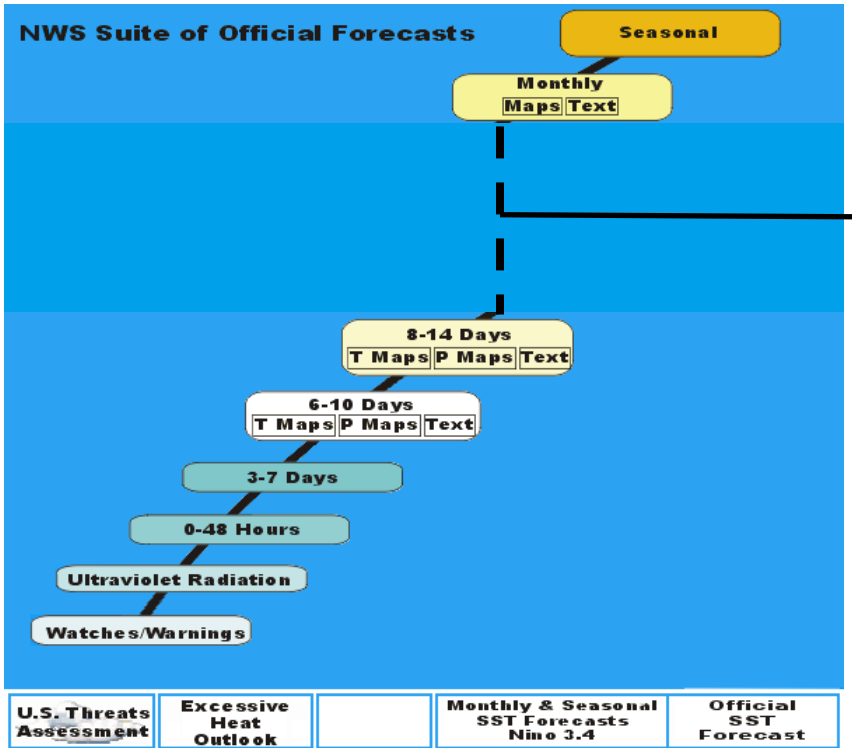
Nat Johnson[1] and Dan Harnos[2]

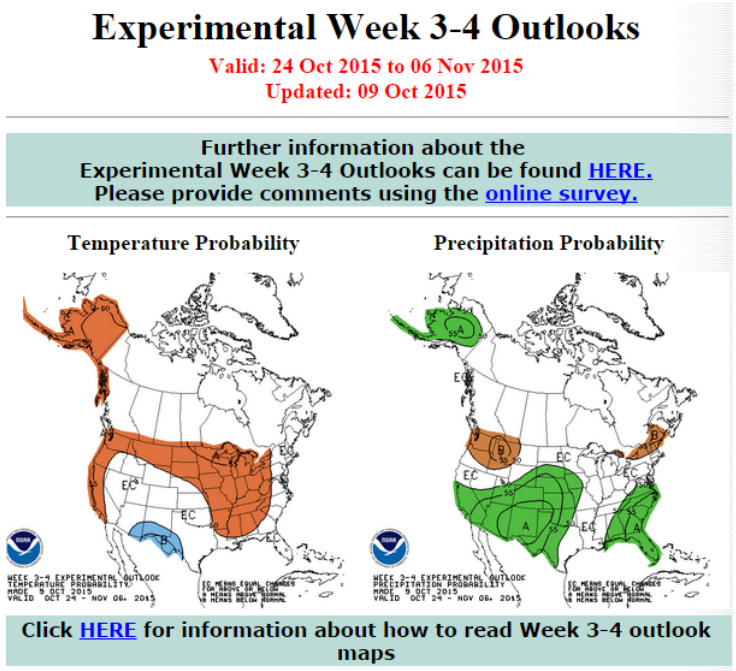
Stephen Baxter[2,3], Steven Feldstein[4], Jiaxin Feng[5,6], Michelle L'Heureux[2], and Shang-Ping Xie[5]

MAPP Webinar: Research Transitions for Predictions

[1]*Cooperative Institute for Climate Science, Princeton University*
[2]*NOAA/NCEP Climate Prediction Center*
[3]*University of Maryland*
[4]*Penn State University*
[5]*Scripps Institution of Oceanography, University of California, San Diego*
[6]*NOAA Geophysical Fluid Dynamics Laboratory*

NOAA CPC is bridging the forecast gap in weeks 3-4





http://www.cpc.ncep.noaa.gov/products/predictions/WK34/

Key Questions:

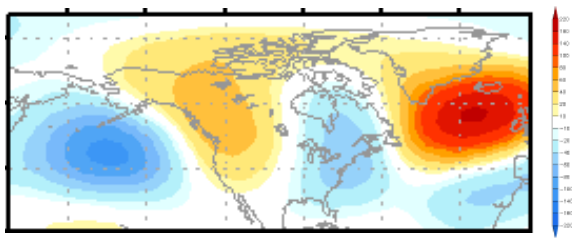
- What are the sources of skill for lead times of 3-4 weeks?
- How do we translate that knowledge into operational forecast guidance?

Many studies indicate that the tropics are a key source of extended-range midlatitude predictability.

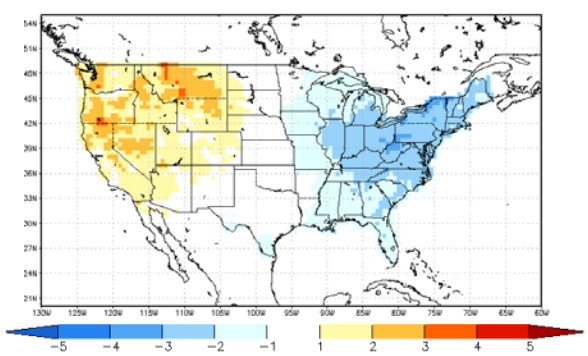
Specifically, relationships with the El Niño/Southern Oscillation (ENSO) and Madden-Julian Oscillation (MJO) hold promise for weeks 3-4.

A weekly cluster pattern

500-hPa height anomalies (m)



Temperature anomalies (°C)

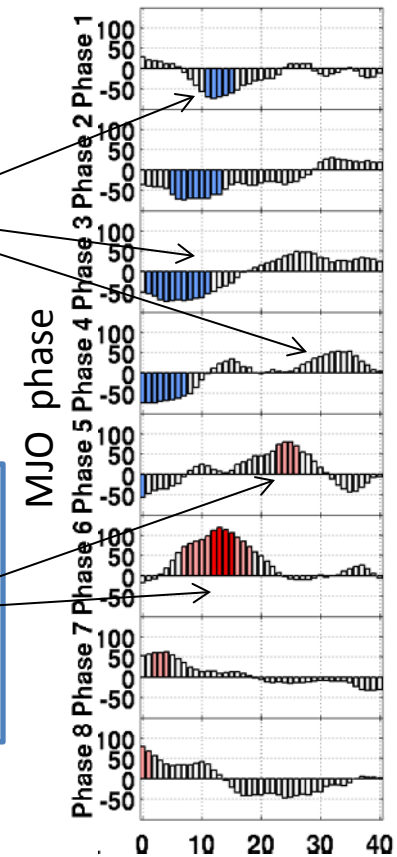


Riddle, Stoner, Johnson, L'Heureux, Collins, and Feldstein (2013, *Climate Dynamics*)

MJO influence on cluster pattern

Anomalous frequency of cluster pattern (top left) occurrence (%)

The MJO gives information on pattern occurrence 10-25 days in advance

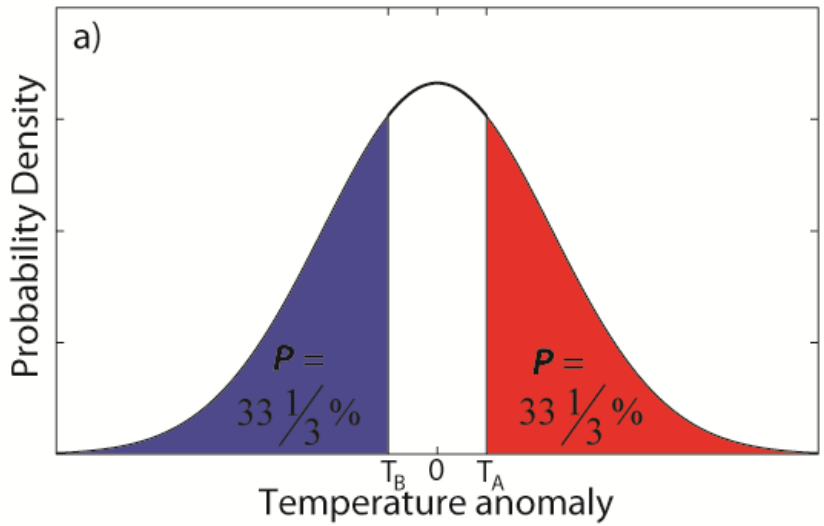


Days that MJO precedes pattern

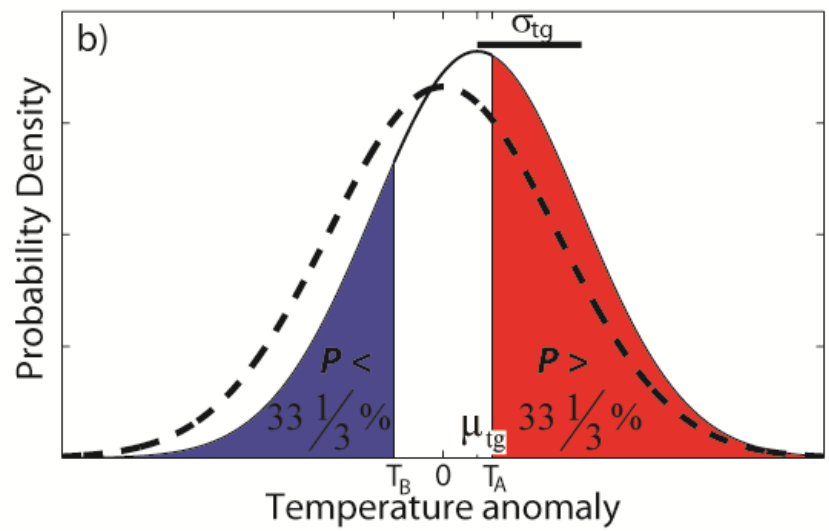
How do we transition the gains from our research into an operational forecast tool?

- We generate winter North American temperature forecasts for weeks 3-4 based on empirical relationships with MJO, ENSO, and the linear trend (Johnson et al. 2014, *Weather and Forecasting*)

Climatology

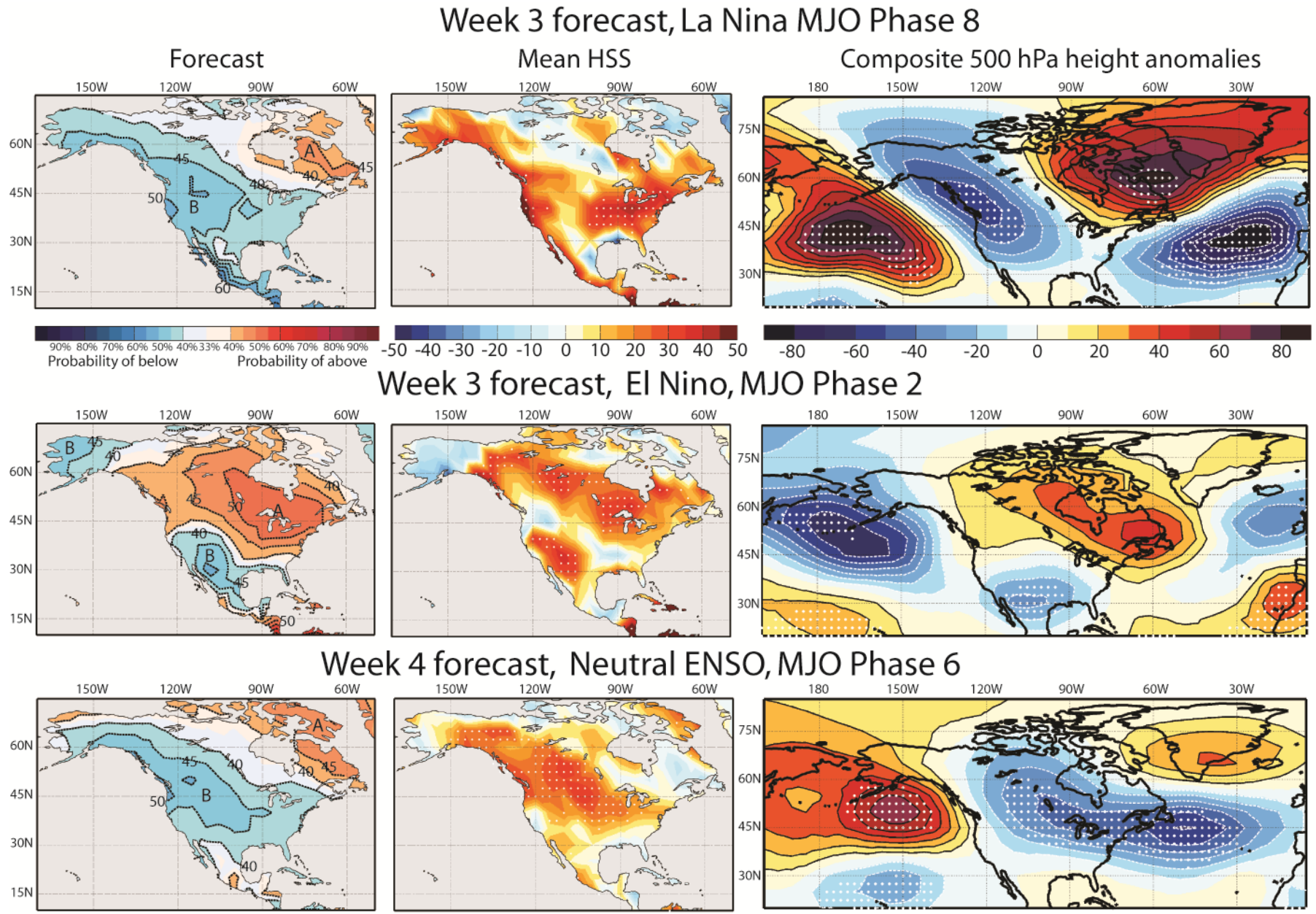


MJO+ENSO+trend forecast



- Simple but transparent
- Translates research into practical guidance for the forecaster
- Produces skillful forecasts

For some initial states of the MJO and ENSO, the skill scores of the weeks 3-4 T2m forecasts from the empirical model are substantially higher than the typical skill scores of dynamical models.



Operational Adaptation

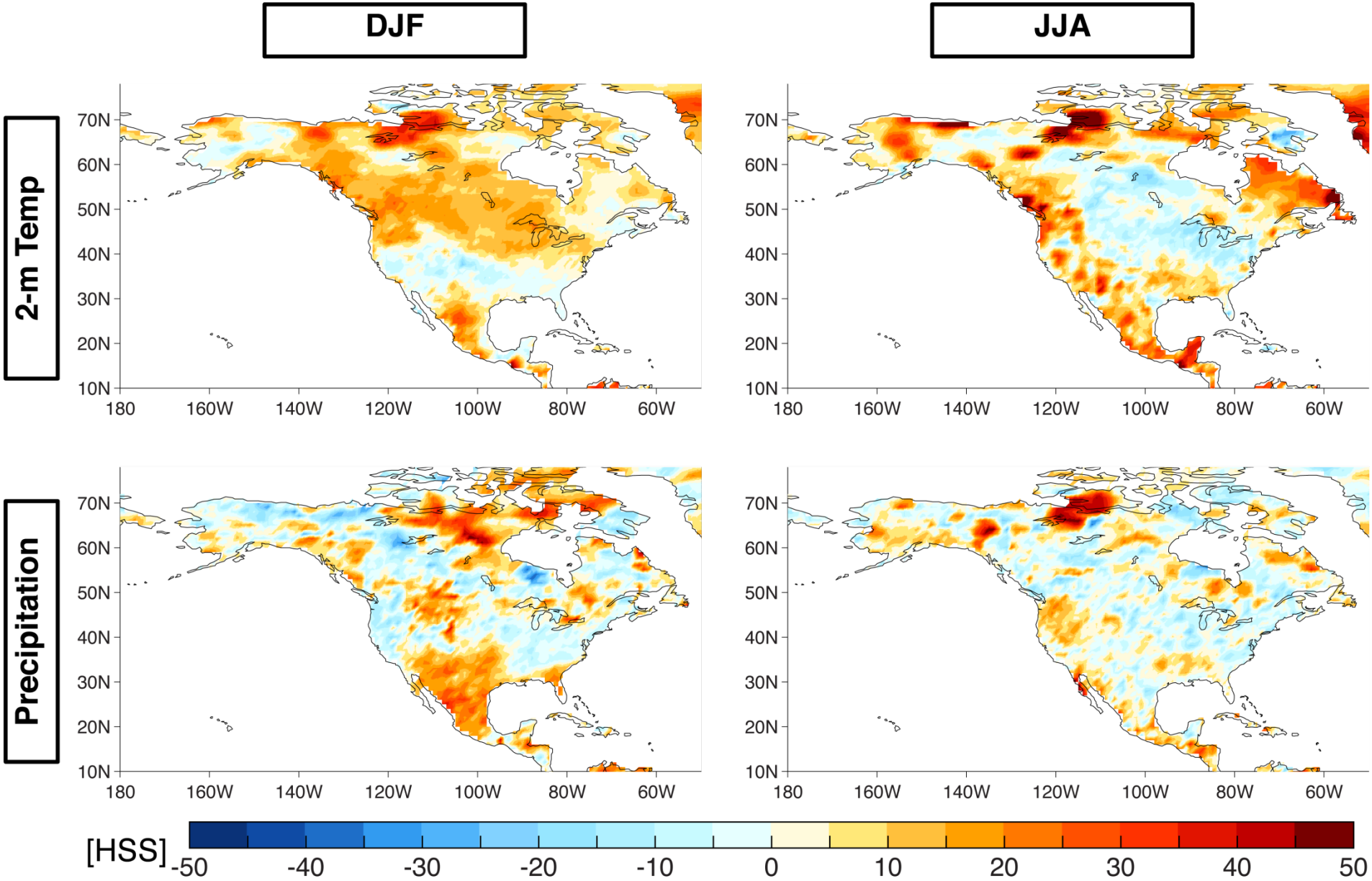
- Extend periods from DJFM to 12 running 3-month periods.

- Shift from ERA-Interim to daily observations:
  - CPC 2-m Temperature (Janowiak, et al. 1999)
  - CPC Unified Gauge-Based Analysis (Xie, et al. 2010)
    - Fourth root taken to increase distribution normality.

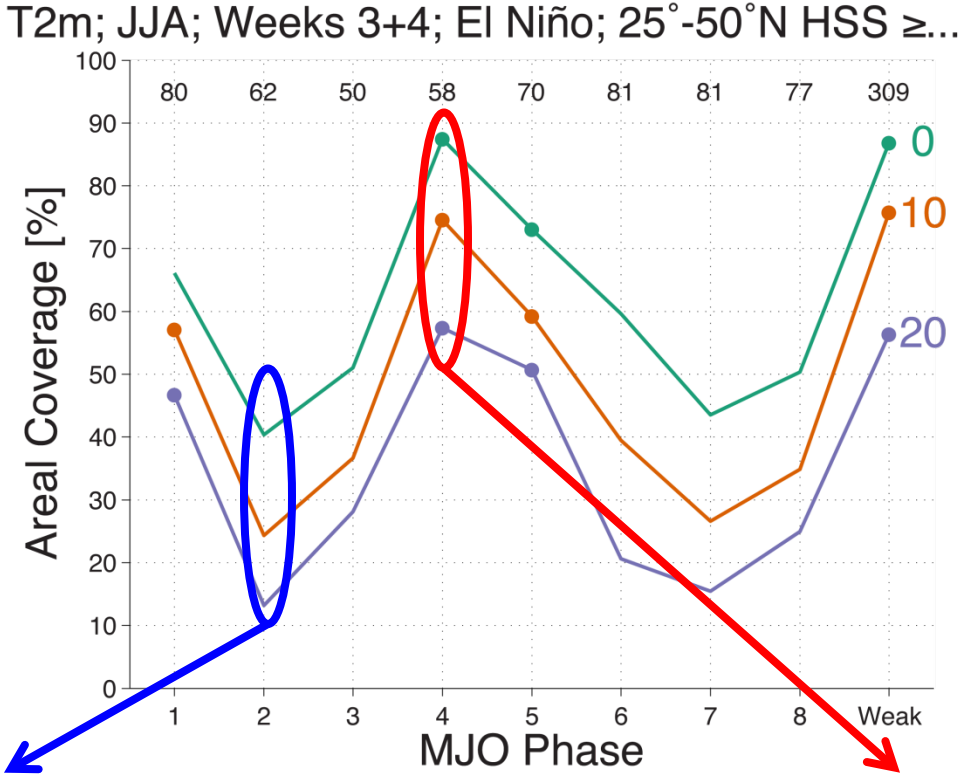
- Shift from three-class to two-class forecast.

- Combined product for Weeks 3 and 4.

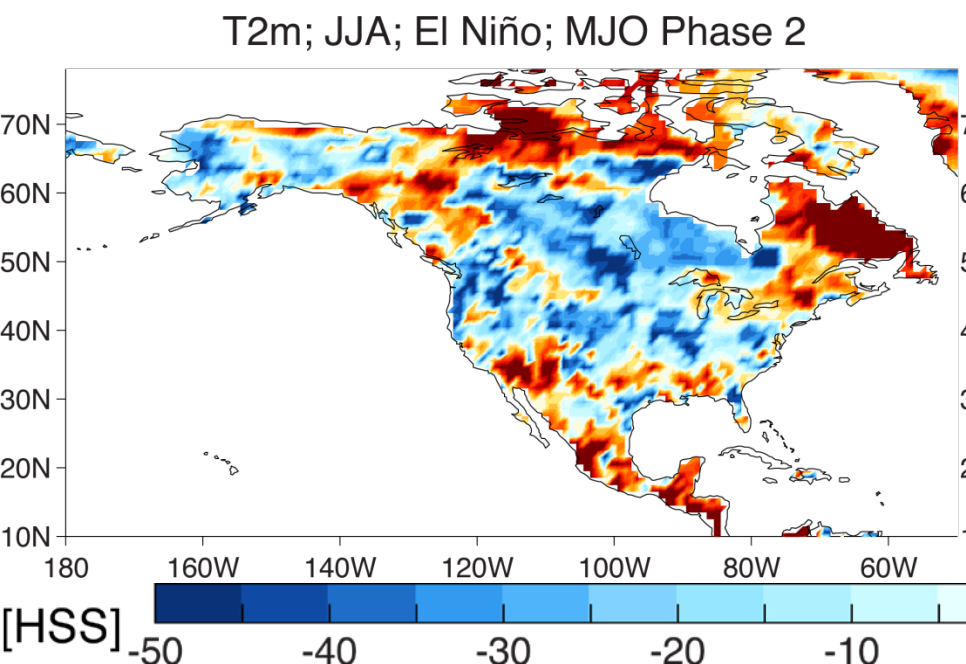
Weeks 3+4 Heidke Skill Score from combined effects of ENSO+MJO+Trend

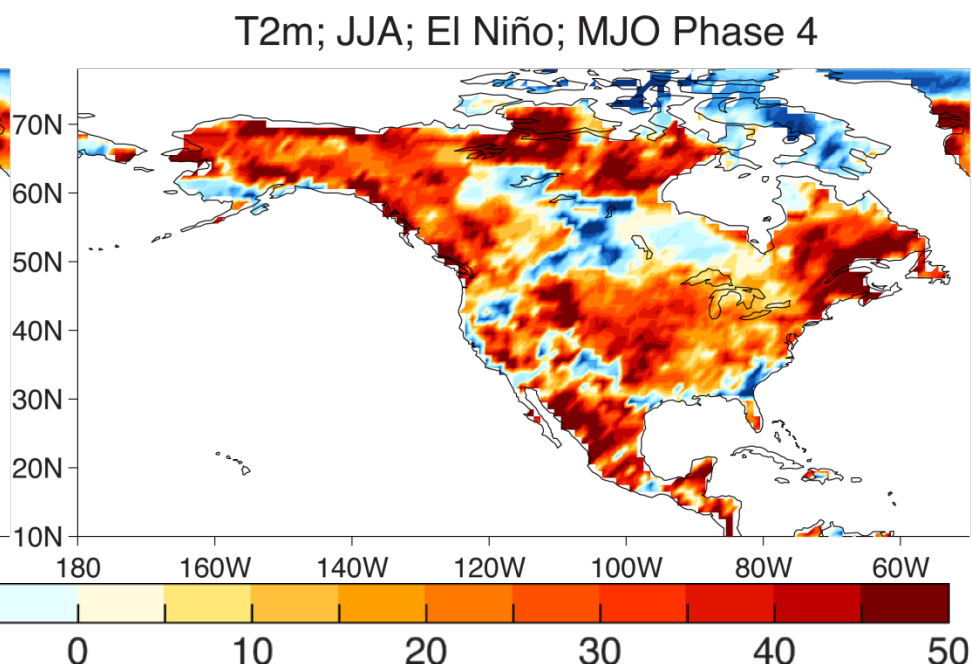


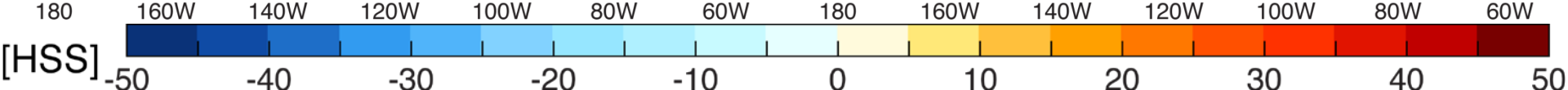
Embedded periods of lower/higher skill dependent upon background climate state.

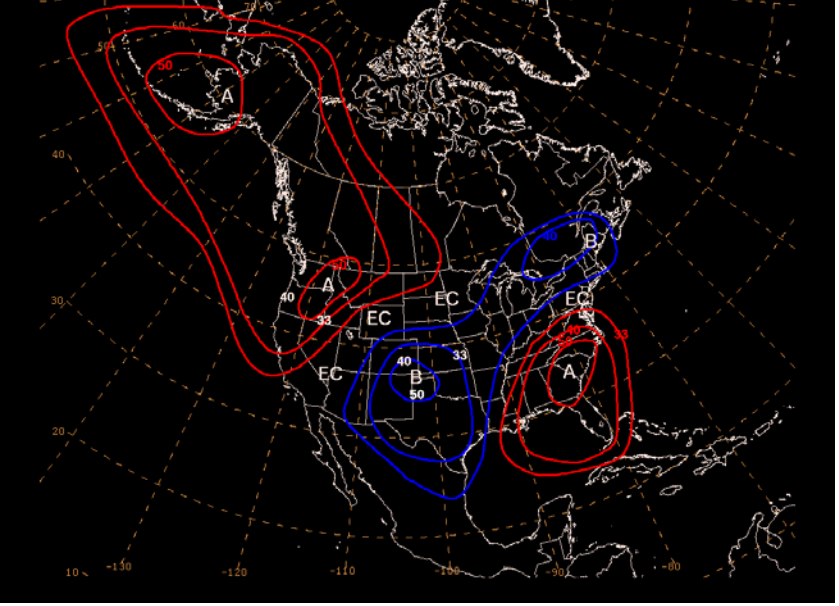


Note even with a weak MJO, skill is present. Active background state not necessary for a skillful forecast (due to trend and nonlinearity of ENSO).





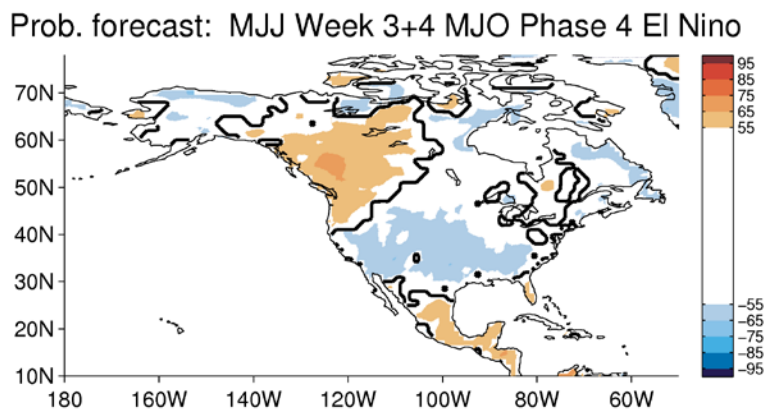


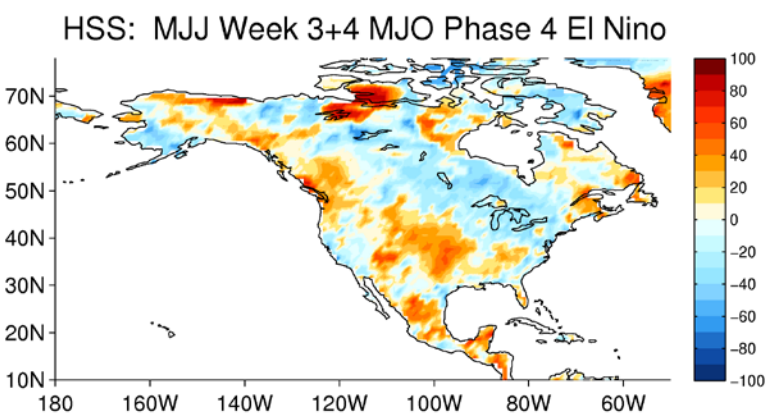


Temperature

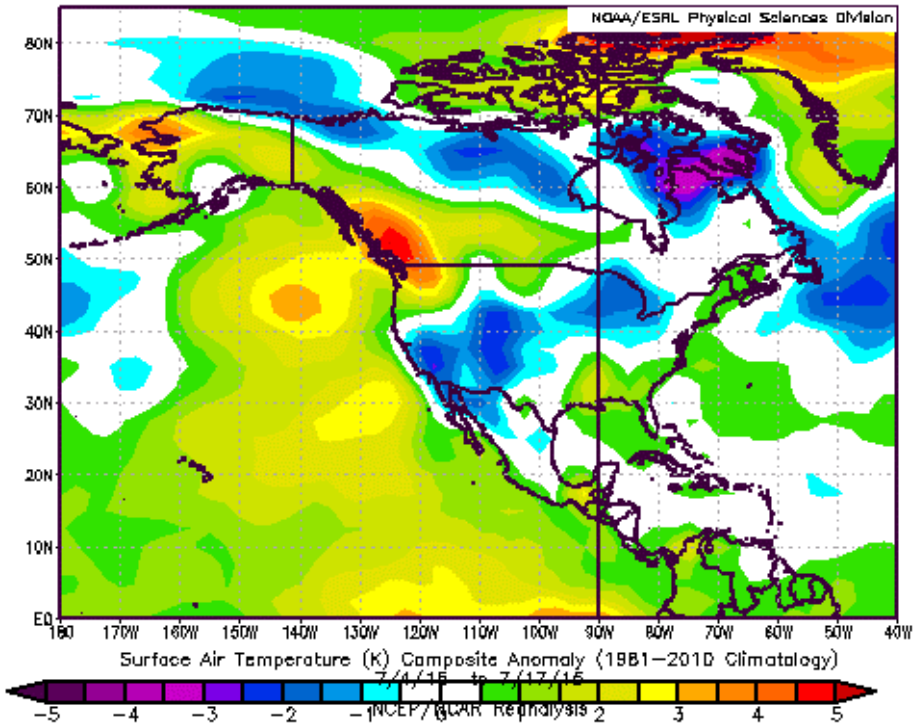
- Top left: Forecast (from 6/19)
- Mid/Bot left: Forecast tool output
- Bot right: Observations (7/4-17)

Coherence between statistical tool and forecast, despite tool being unavailable to forecasters.





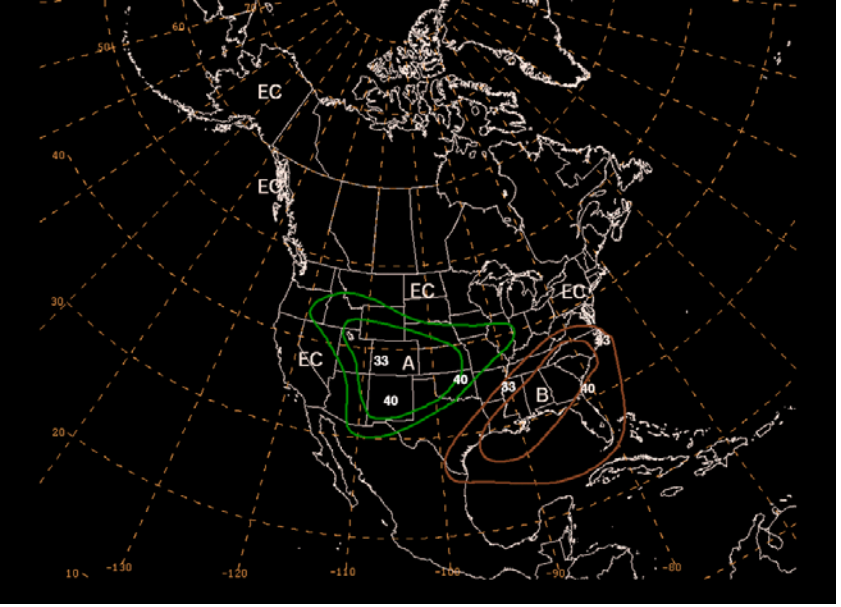
Forecast and tool verified well.

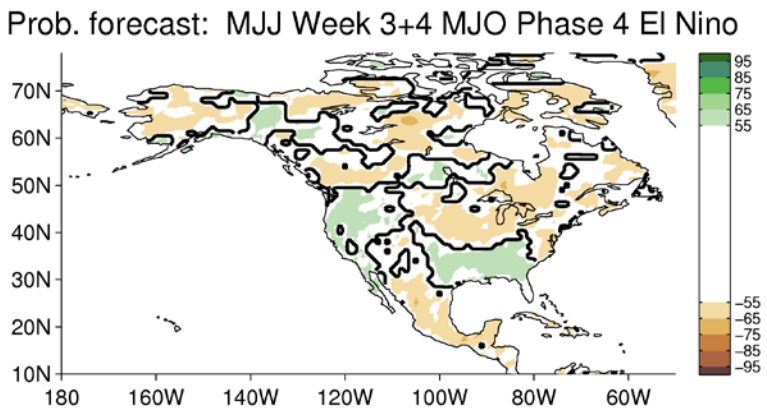


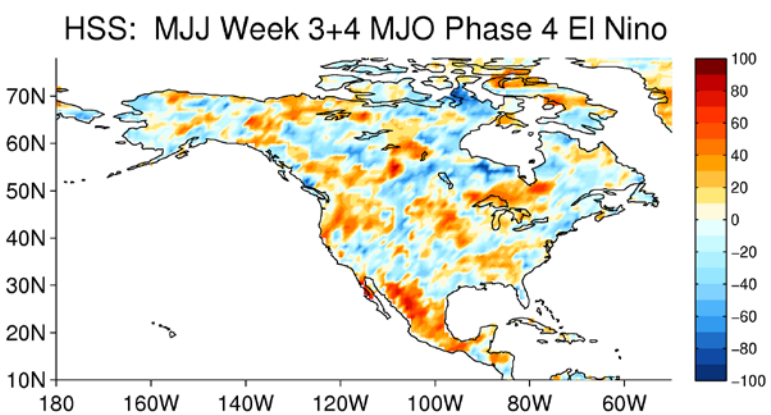
Precipitation

- Top left: Forecast (from 6/19)
- Mid/Bot left: Forecast tool output
- Bot right: Observations (7/4-17)

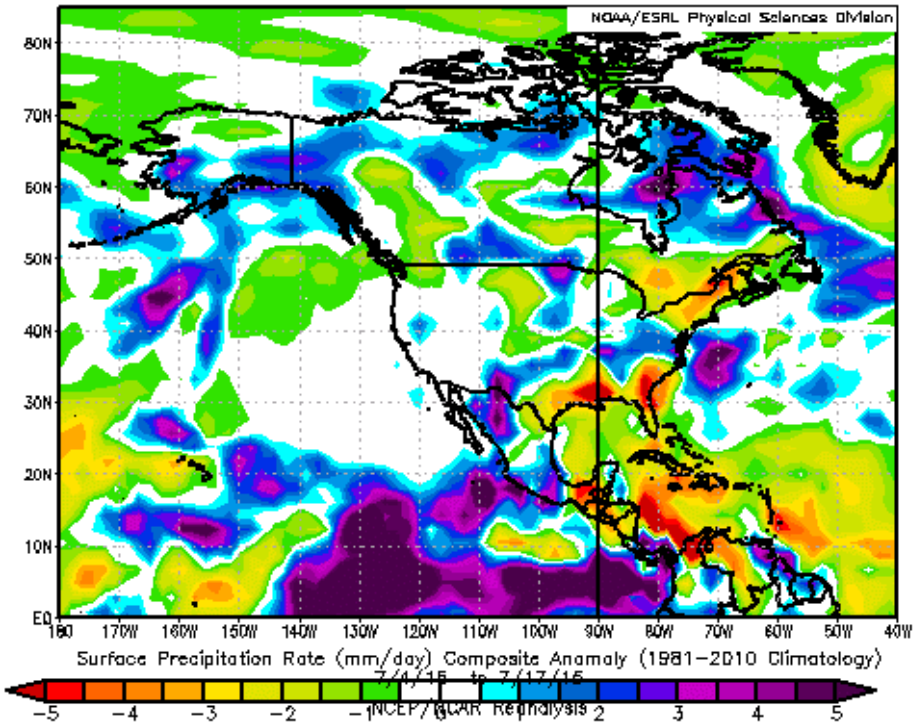
Less agreement between tool and forecast made without it.





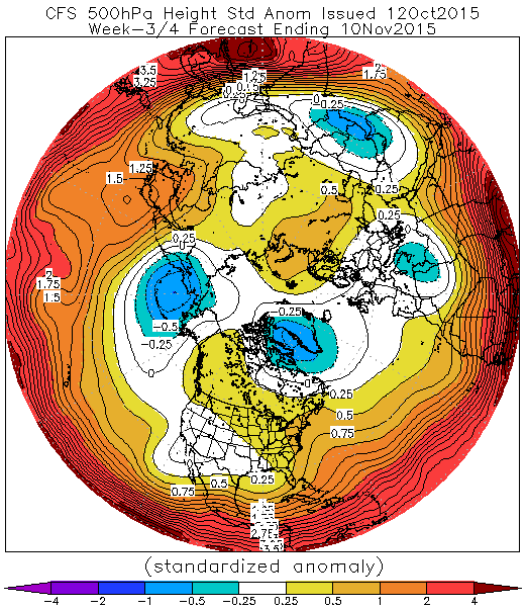


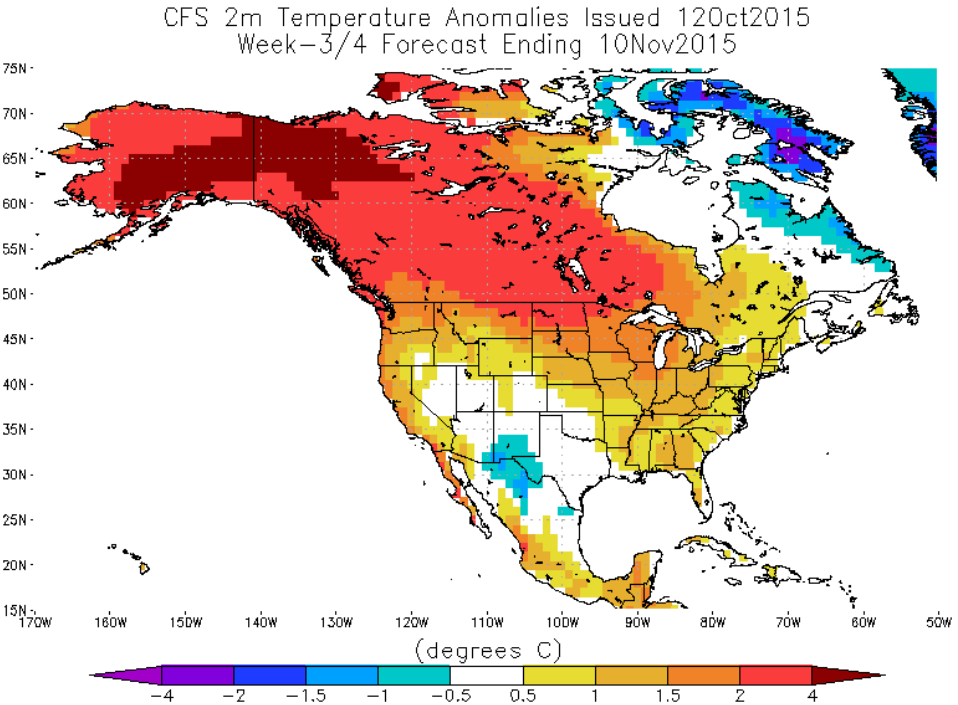
Forecast and tool performance comparable.

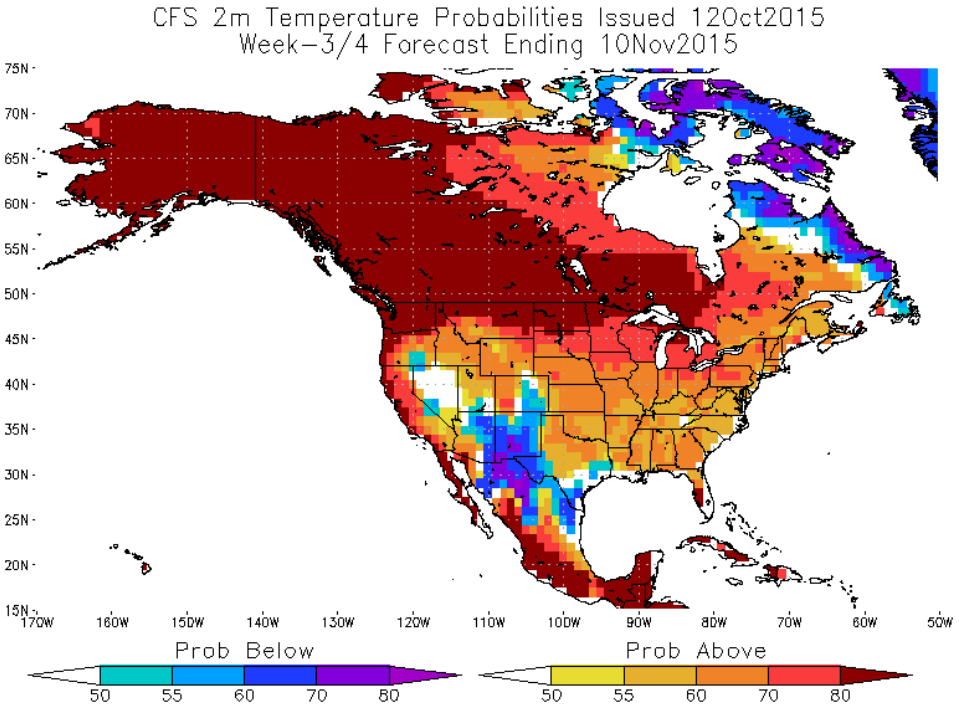


Week 3-4 Forecast Guidance

- Dynamical: CFSv2, ECMWF, JMA
  - Geopotential heights
  - T2m & Precipitation anomalies
  - T2m & Precipitation probabilities







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- Dynamical: CFSv2, ECMWF, JMA
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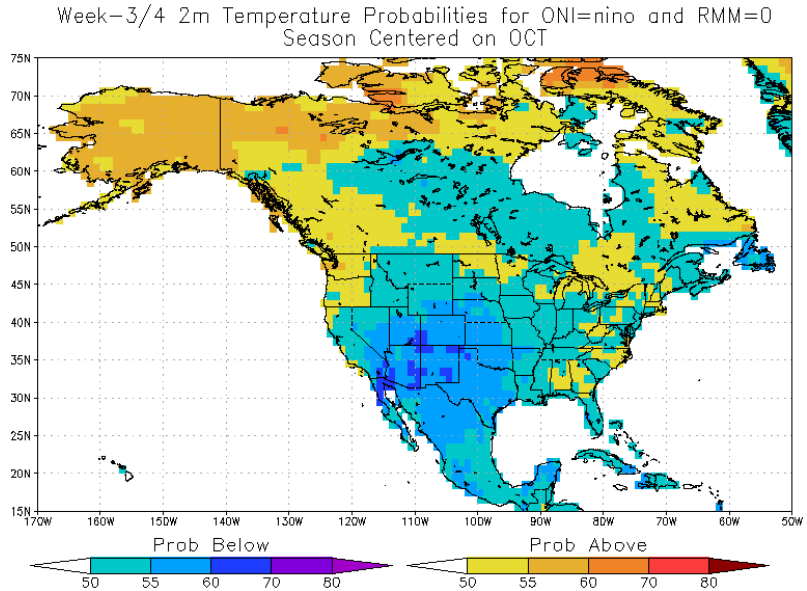
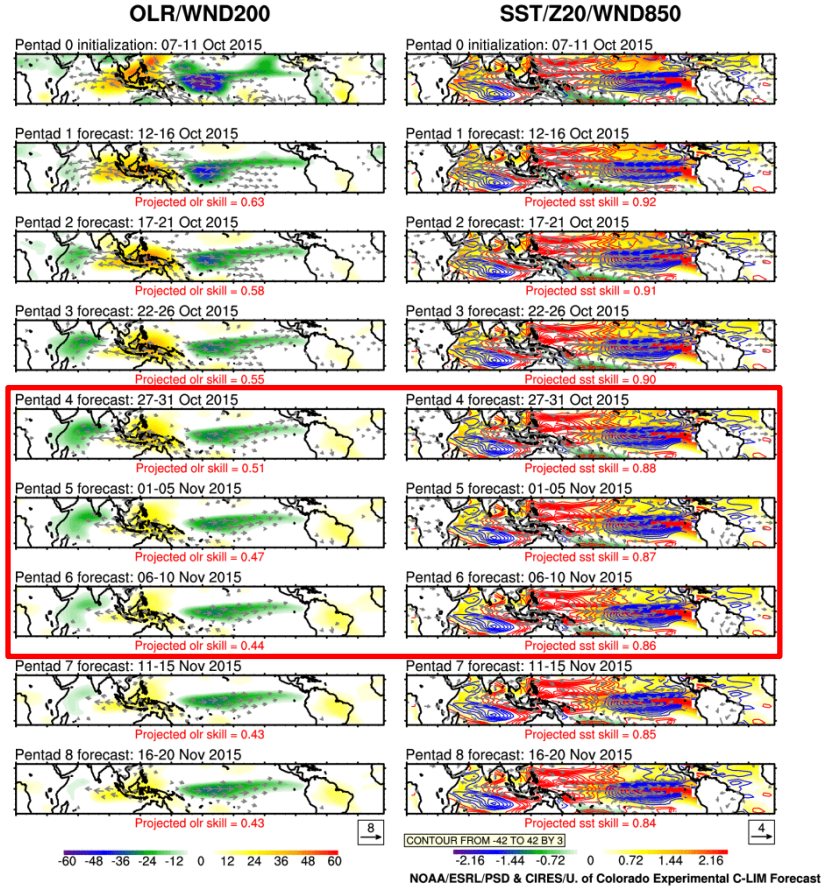
- Statistical:
  - ENSO/MJO phase model
  - Constructed analog
  - Coupled linear-inverse model





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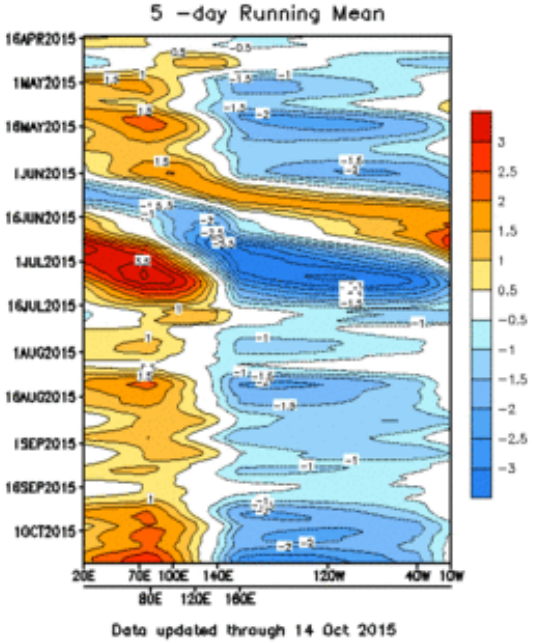
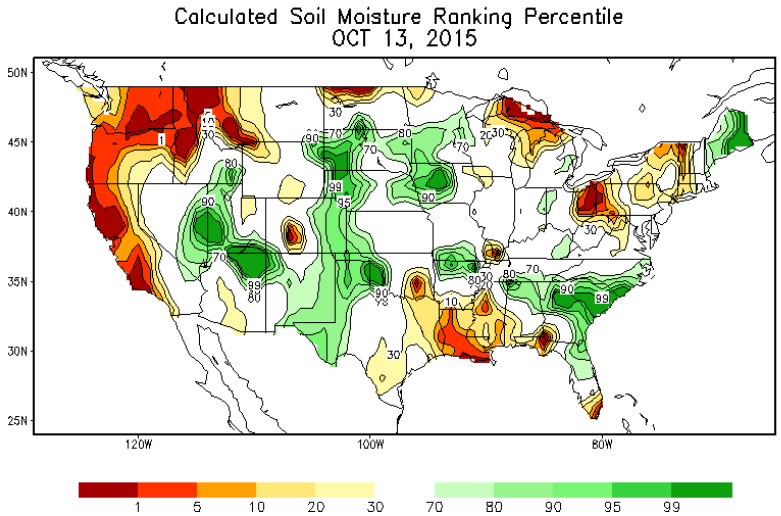
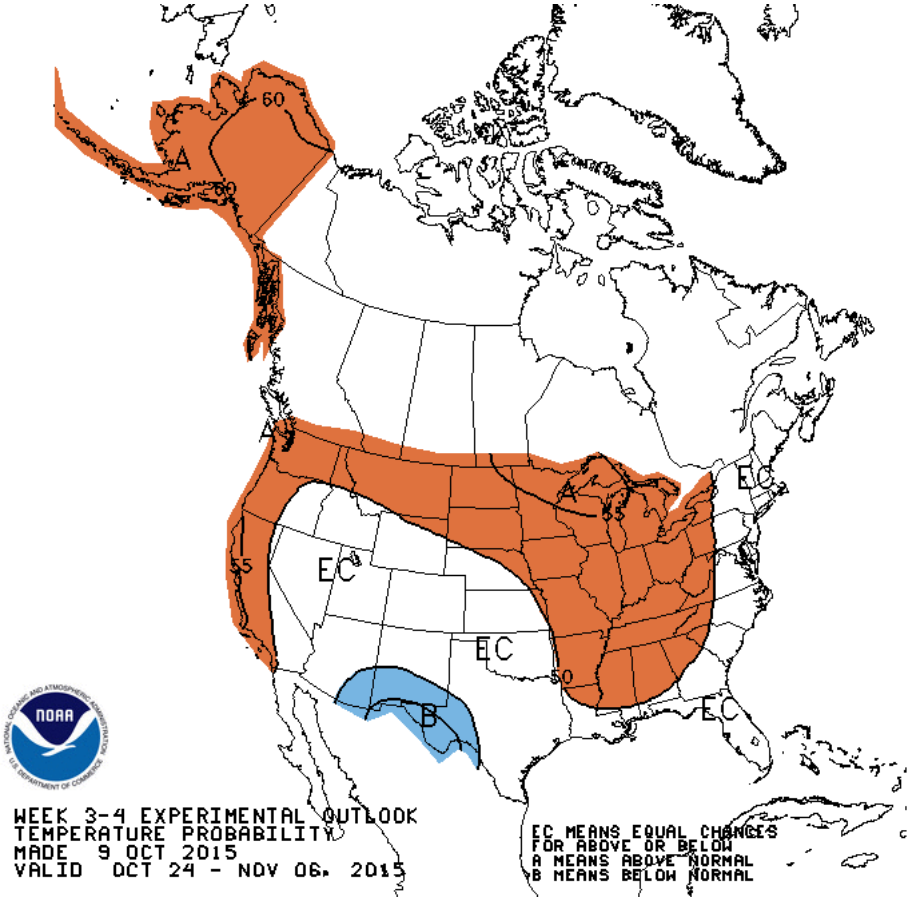
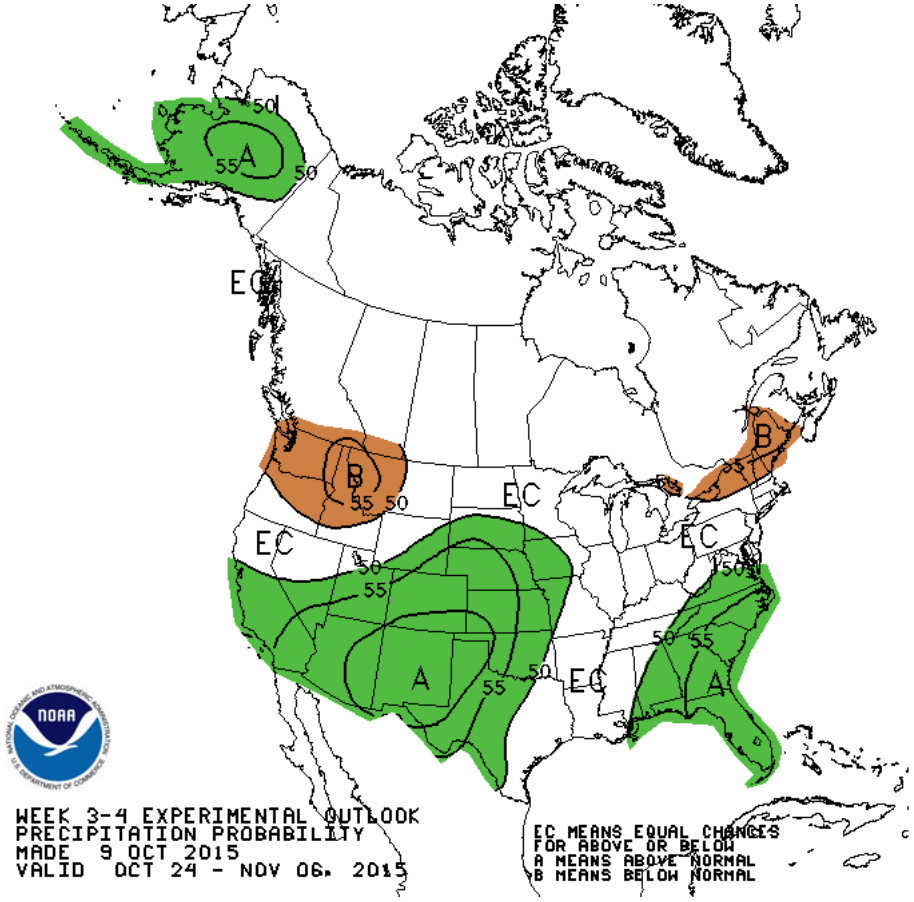
- Statistical:
  - ENSO/MJO phase model
  - Constructed analog
  - Coupled linear-inverse model
- Observations:
  - ENSO & MJO
  - Sea ice
  - Soil moisture
  - Tropical cyclones









Statistical guidance emphasizing the subseasonal ENSO footprint was strongly utilized. This guidance, along with the dynamical consensus leads to a more confident precipitation outlook relative to temperature. Above-median precipitation is favored

Conclusions

- A simple empirical model for probabilistic T2m and precipitation forecasts based on the initial state of the MJO and ENSO produces skillful Week 3-4 forecasts over North America across various seasons and climate states.

- This empirical model has been undergone successful R2O prior to CPC's experimental Week 3-4 forecast product going live, and has become a key component of the forecasting process.

- Research team member participation in the Week 3-4 forecasting process has aided statistical tool interpretation by forecasters, and led to feedback for subsequent product development in an O2R sense.