Combined ENSO, MJO, and trend influences on temperature and precipitation for Weeks 3-4

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[1]NOAA/NWS/NCEP/CPC
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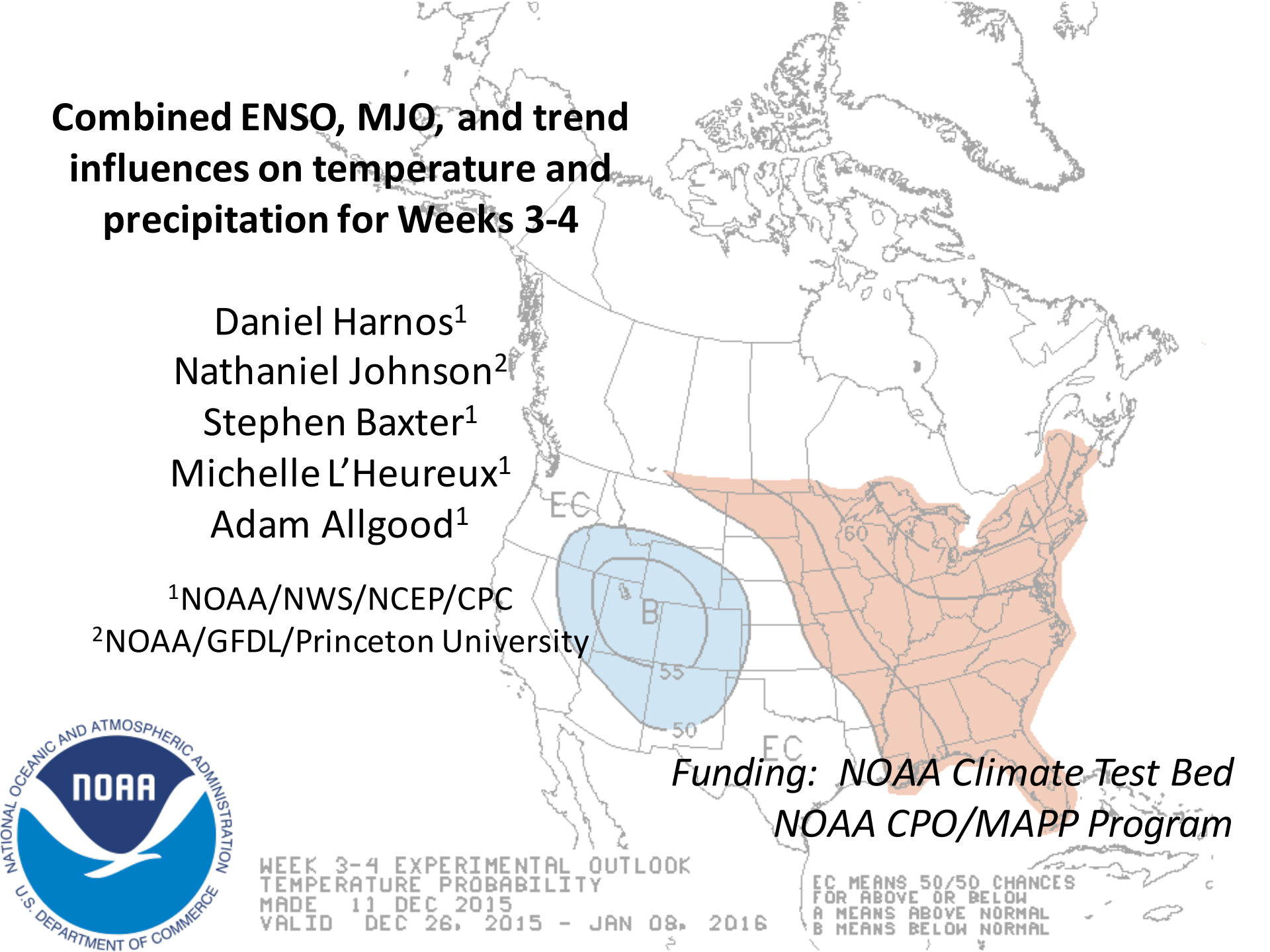

Funding: NOAA Climate Test Bed
NOAA CPO/MAPP Program

OBAMA CALLS ON NOAA TO EXTEND OUTLOOKS 15–30 DAYS

October 7, 2014 | At the United Nations Climate Summit in New York City on September 23, President Obama delivered a major speech with a focus on the impacts of climate change in the United States, progress the nation is making in mitigation, and the importance of building resilience and improving our weather and climate prediction capabilities.

In addition to reiterating consensus scientific views on the nature and causes of climate change, the President made several commitments for new directions and investments in weather and climate prediction at the federal science agencies. Among these commitments is a new focus at the National Oceanic and Atmospheric Administration on subseasonal outlooks for extreme weather in the 15-to-30-day range.

https://president.ucar.edu/government-relations/washington-update/376/obama-calls-noaa-extend-outlooks

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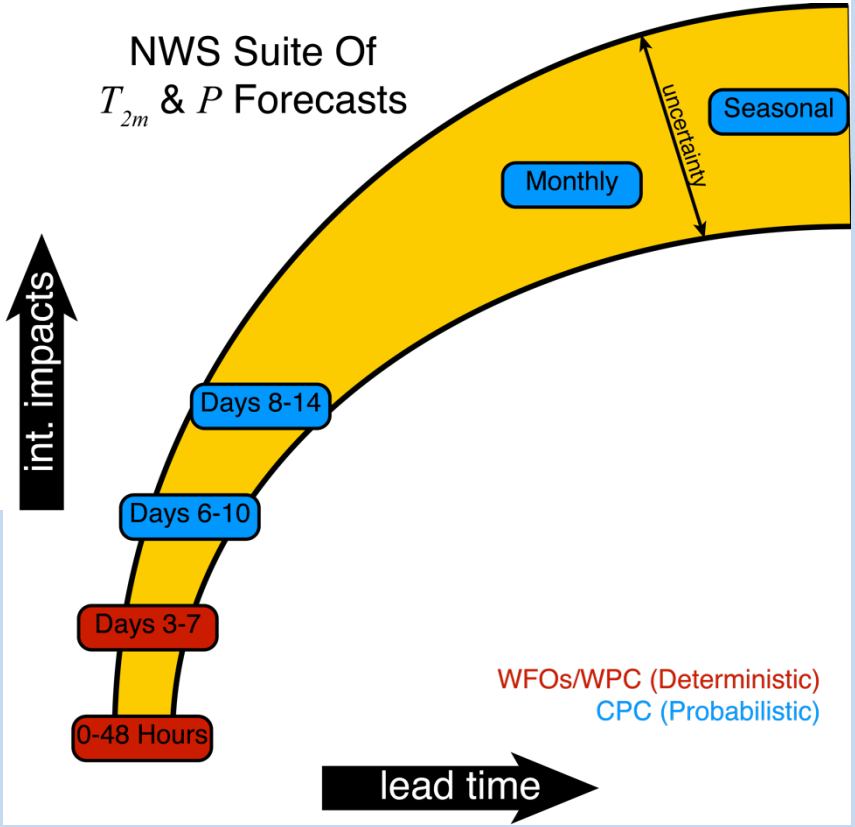

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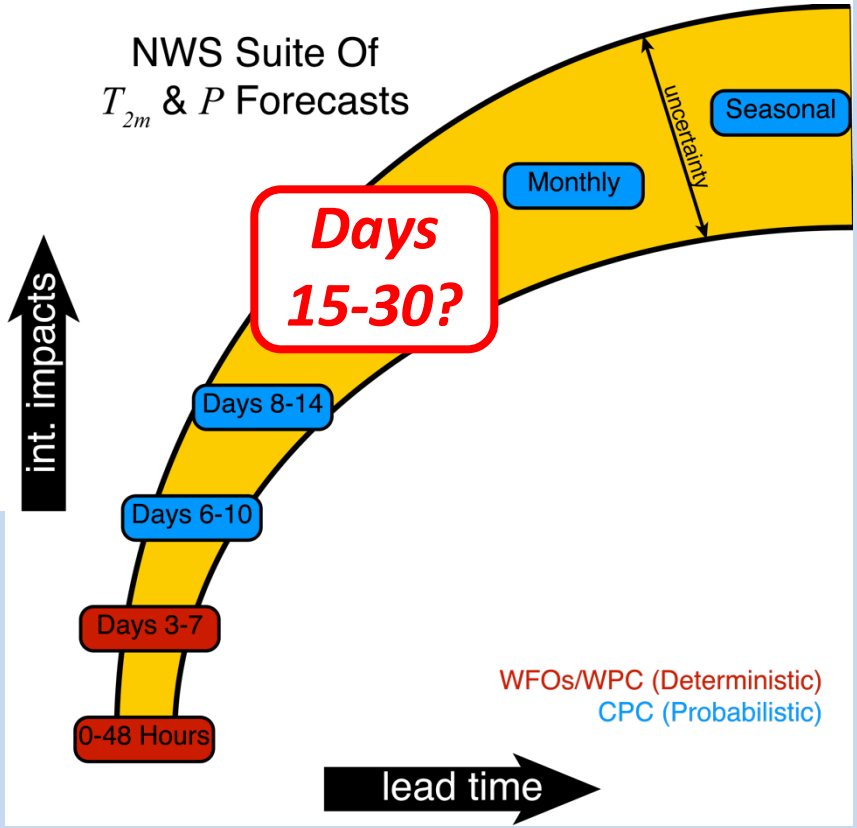
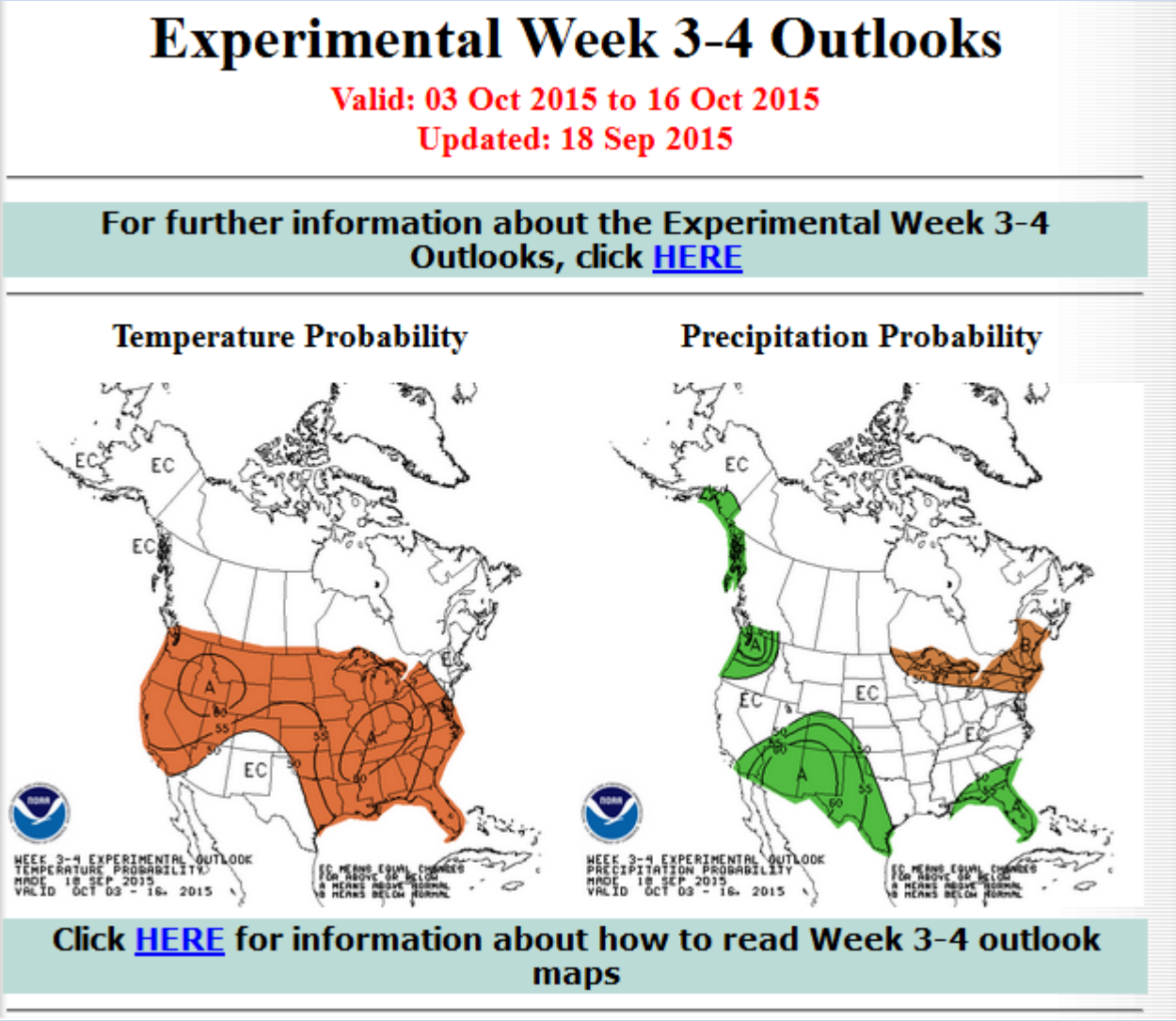


- **Sources of skill?**
- **How to convey that skill in an operational forecast guidance framework?**

CPC's first experimental Week 3-4 outlook was issued <1 year from Obama's mandate.

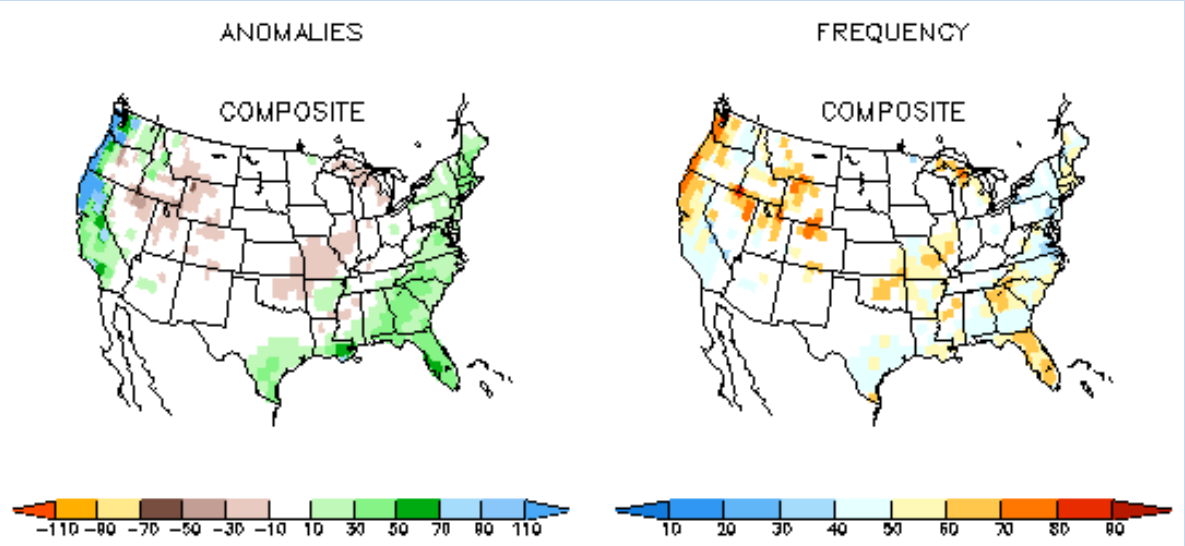
Two-class (above/below normal)

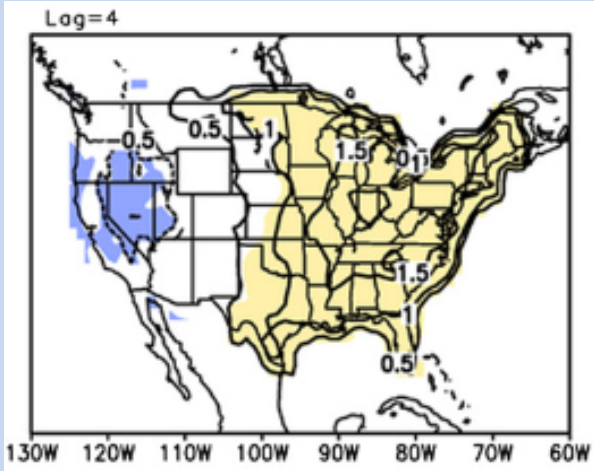
Covers full 2 week period



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

EMPIRICAL GUIDANCE: COMPOSITES





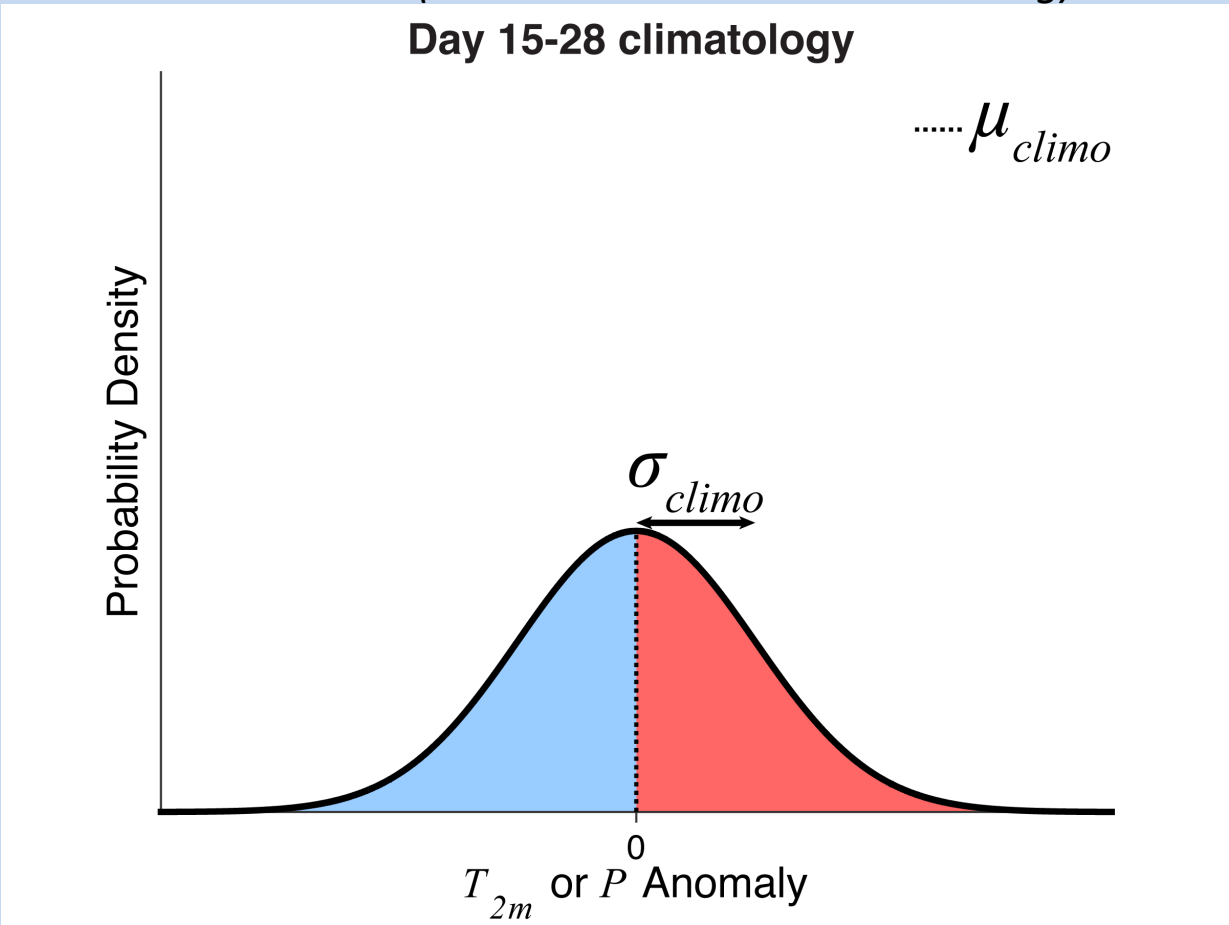
L: DJF precipitation anomalies/frequencies associated with El Niño.
http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/EC_ENP_index.shtml

R: DJF T_{2m} composite 16-20 days after MJO in Phase 3. (*Baxter et al. 2014, J. Clim.*)

- **Composites reveal ENSO and MJO influence at subseasonal timescales.**
- **How to convey composite values in a probabilistic manner?**

PHASE MODEL METHODS

Johnson et al. (2014 – Weather and Forecasting)



- Days 15-28 forecasts of T_{2m}, P generated empirically
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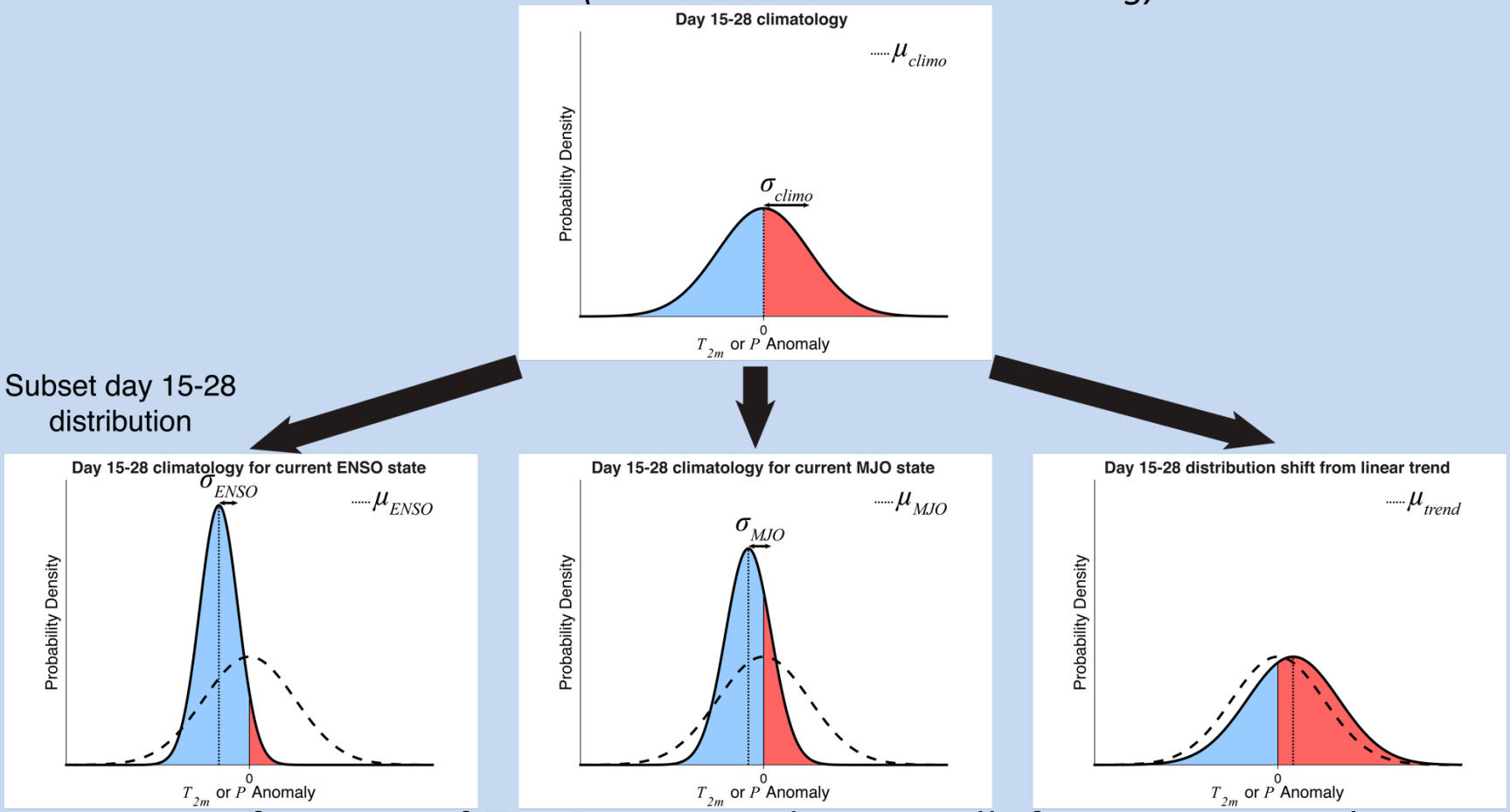
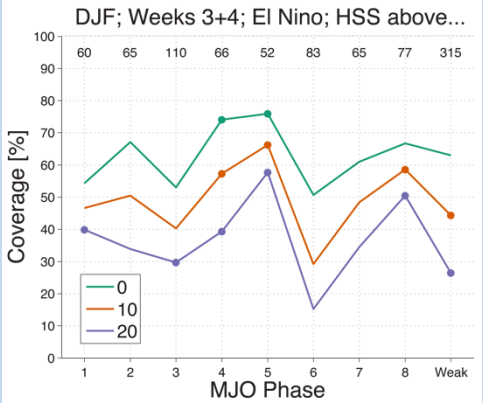


- Days 15-28 forecasts of T_{2m}, P generated empirically from ENSO, MJO base states.
  - T_{2m}: Janowiak et al. (1999); $P^{1/4}$ (Xie et al. 2010); both 1°
  - ENSO: ONI (3-month mean Niño 3.4); MJO: *Wheeler and Hendon (2004)*

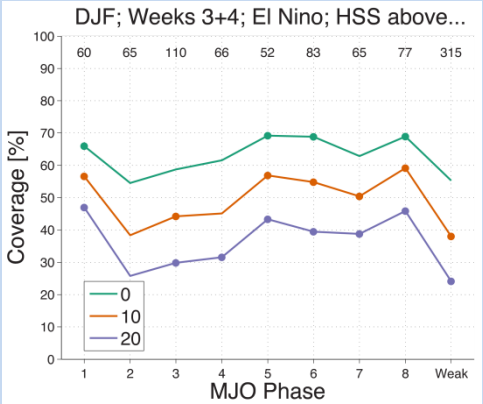
1/1/16: MJO PHASE 6 (2.4 AMP); ONI: 2.0

US Heidke Coverage

T_{2m}



P



+HSS: Forecast superior to random chance

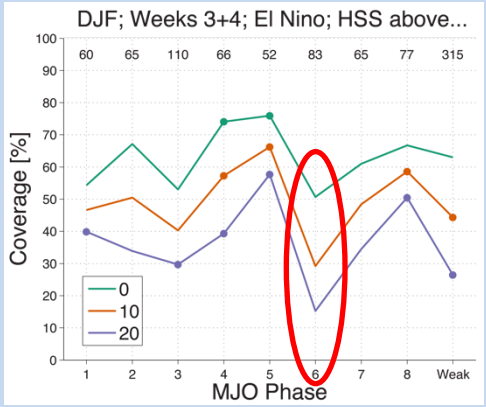
HSS Cross validation uses leave-one-out methodology

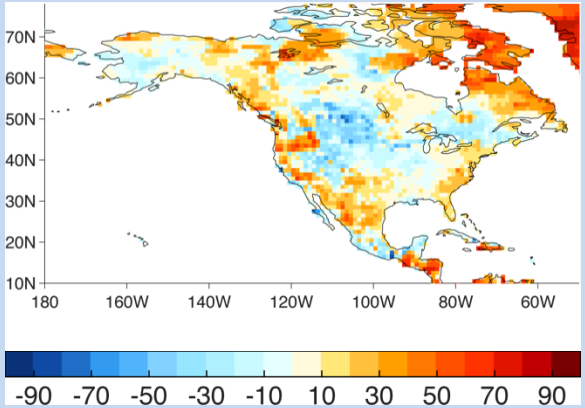
DJF; El Niño

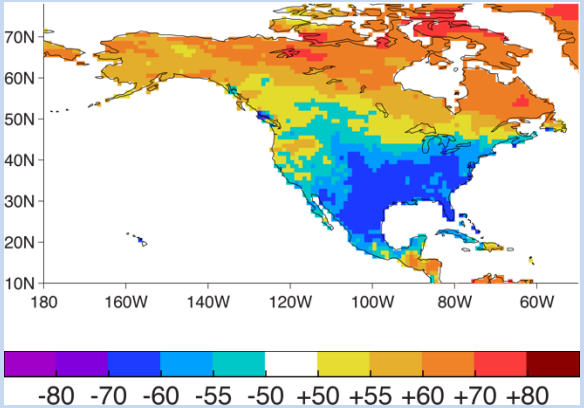
1/1/16: MJO PHASE 6 (2.4 AMP); ONI: 2.0

US Heidke Coverage | **Heidke Skill Score** | **Mean Prob. Forecast**

T_{2m}







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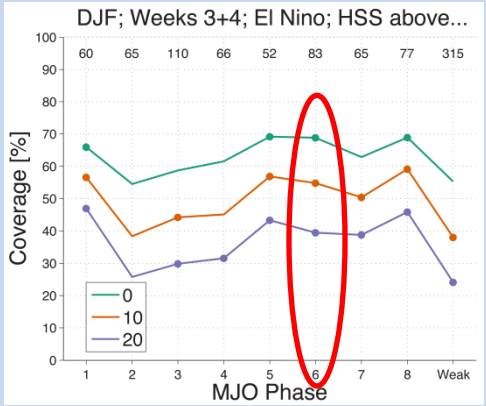
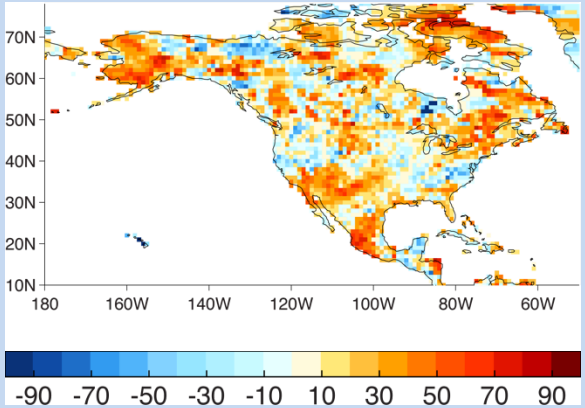
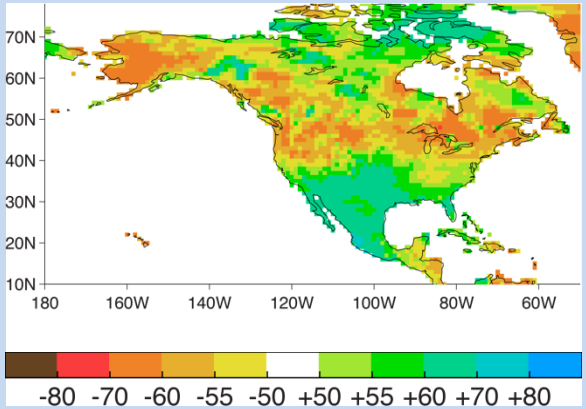






+HSS: Forecast superior to random chance

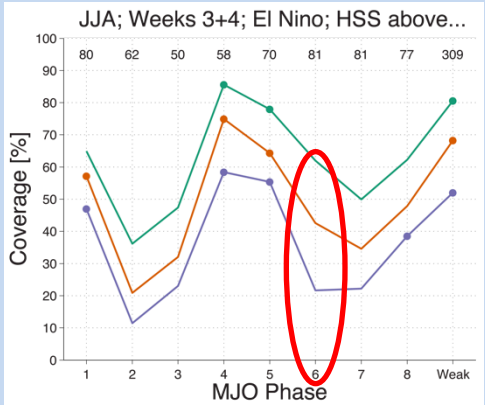
(Valid January 16-29)

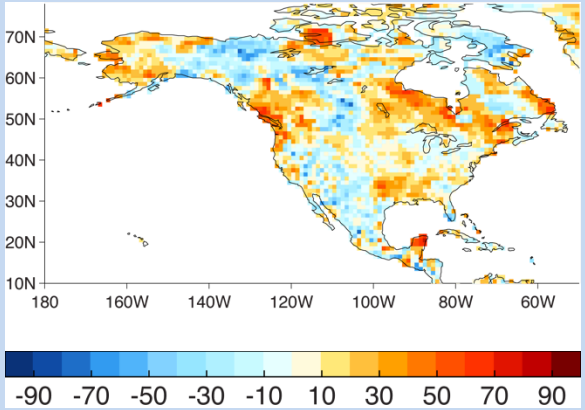
DJF; El Niño; MJO Phase 6

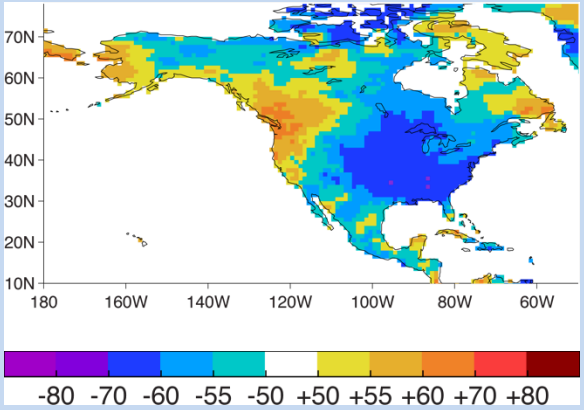
WHAT IF IT WERE 6 MONTHS FROM NOW?

US Heidke Coverage | **Heidke Skill Score** | **Mean Prob. Forecast**

T_{2m}







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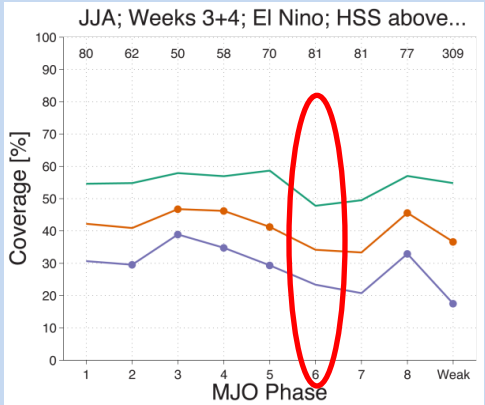

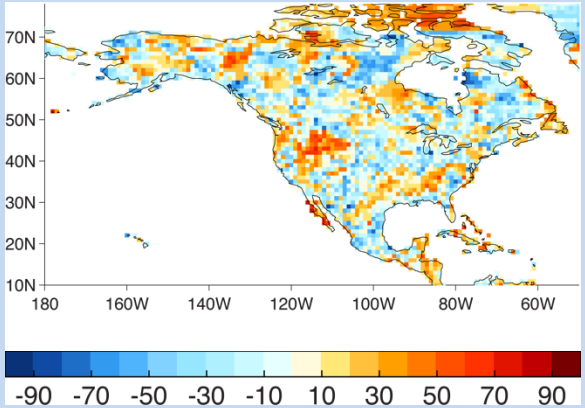

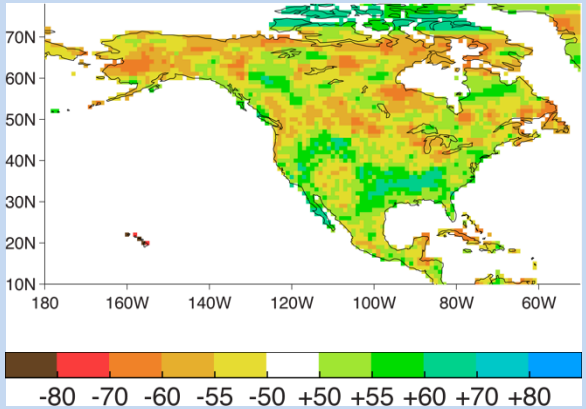

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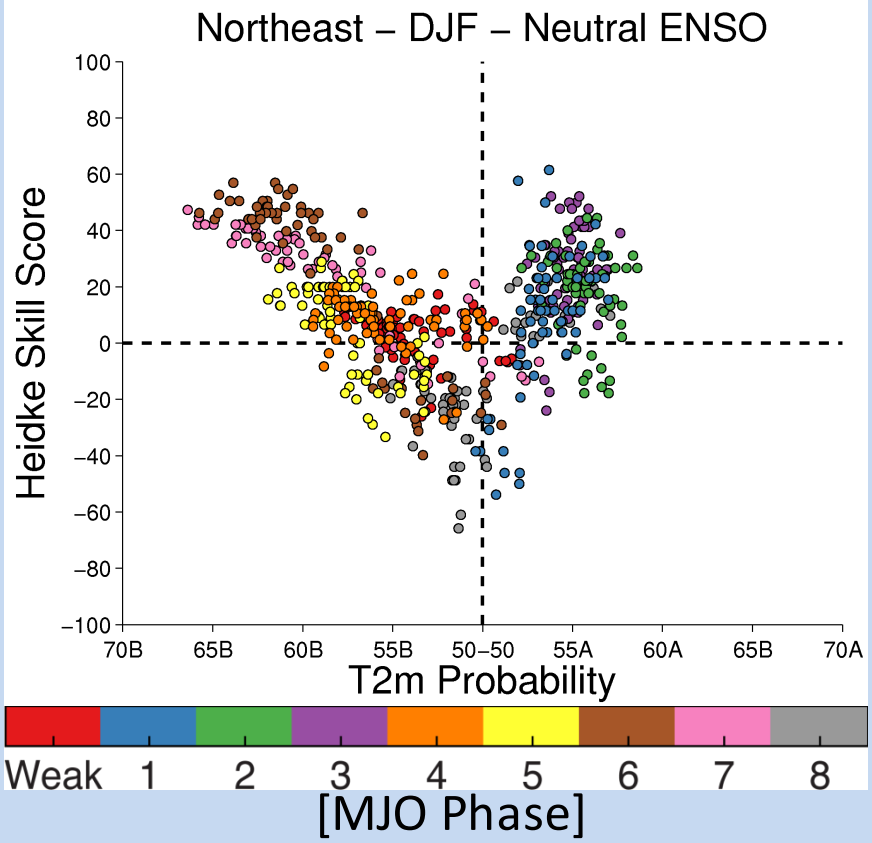
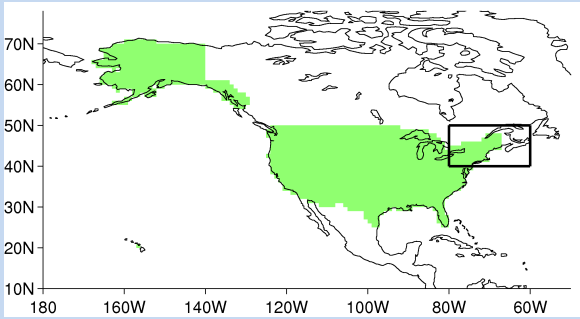
JJA; El Niño; MJO Phase 6

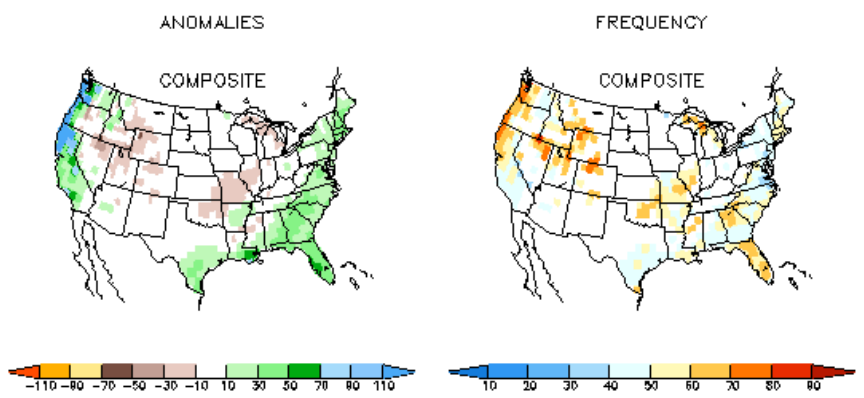
T_{2m} MJO Regional Influences





- Higher skill, more confident forecasts:
  - Cold: 5, 6, 7
  - Warm: 1, 2, 3
- Lesser skill, less confident forecasts:
  - Weak MJO (reduced forcing)
  - Phases 4, 8 (transitional)

COMPOSITE SHORTCOMINGS



http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/EC_ENP_index.shtml

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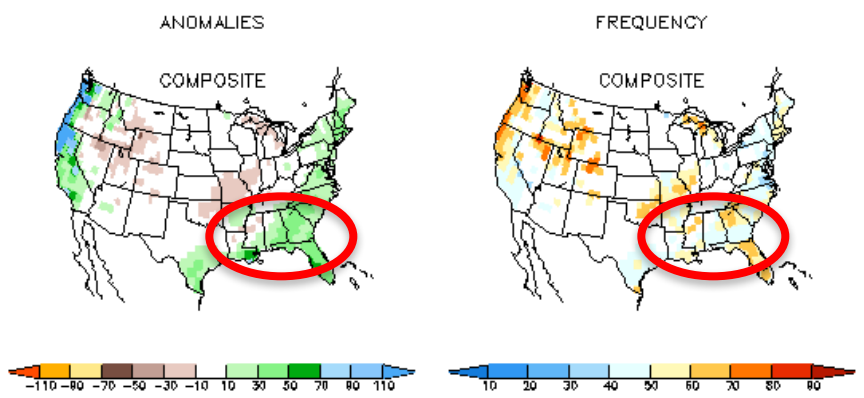

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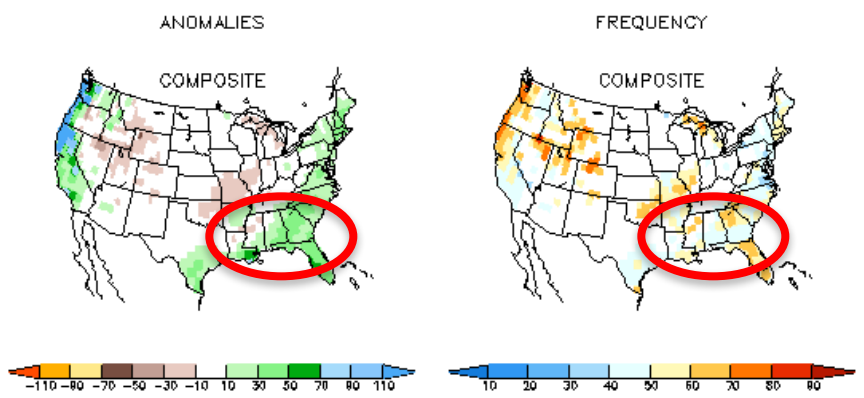

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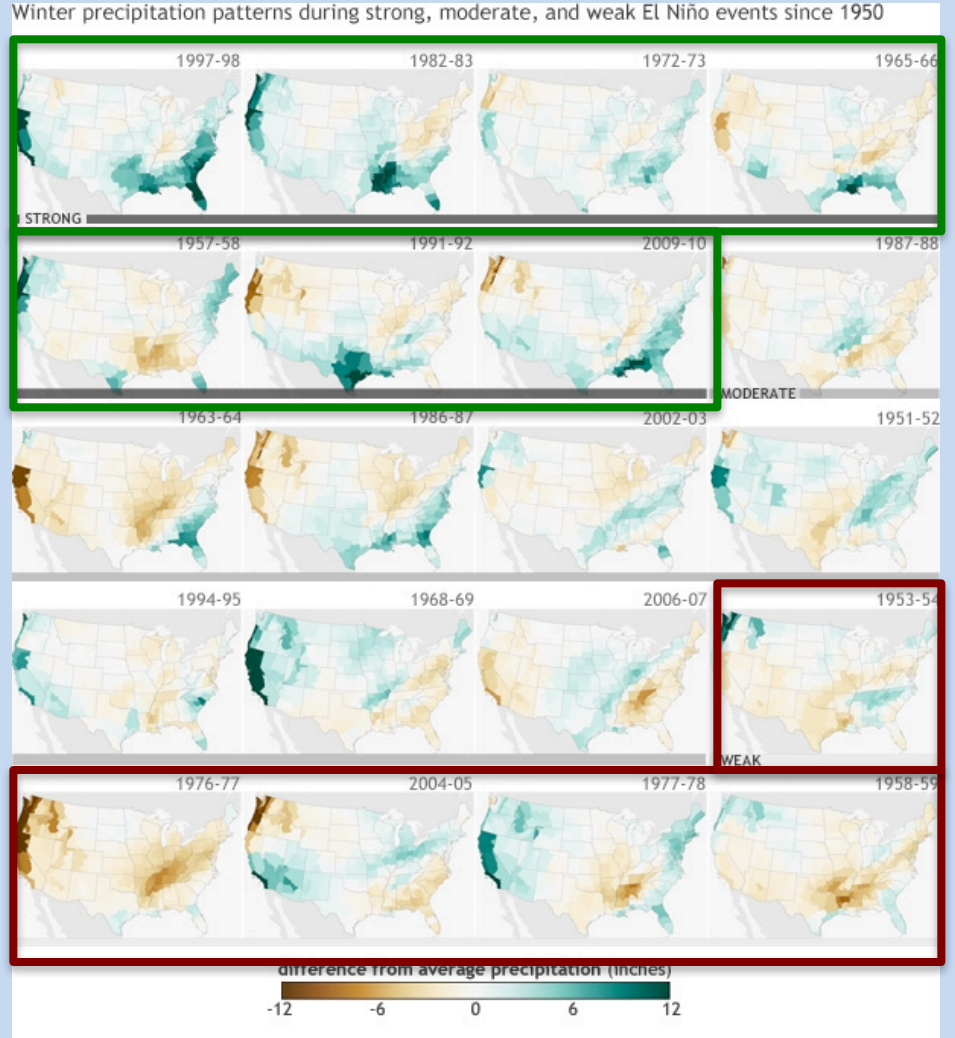
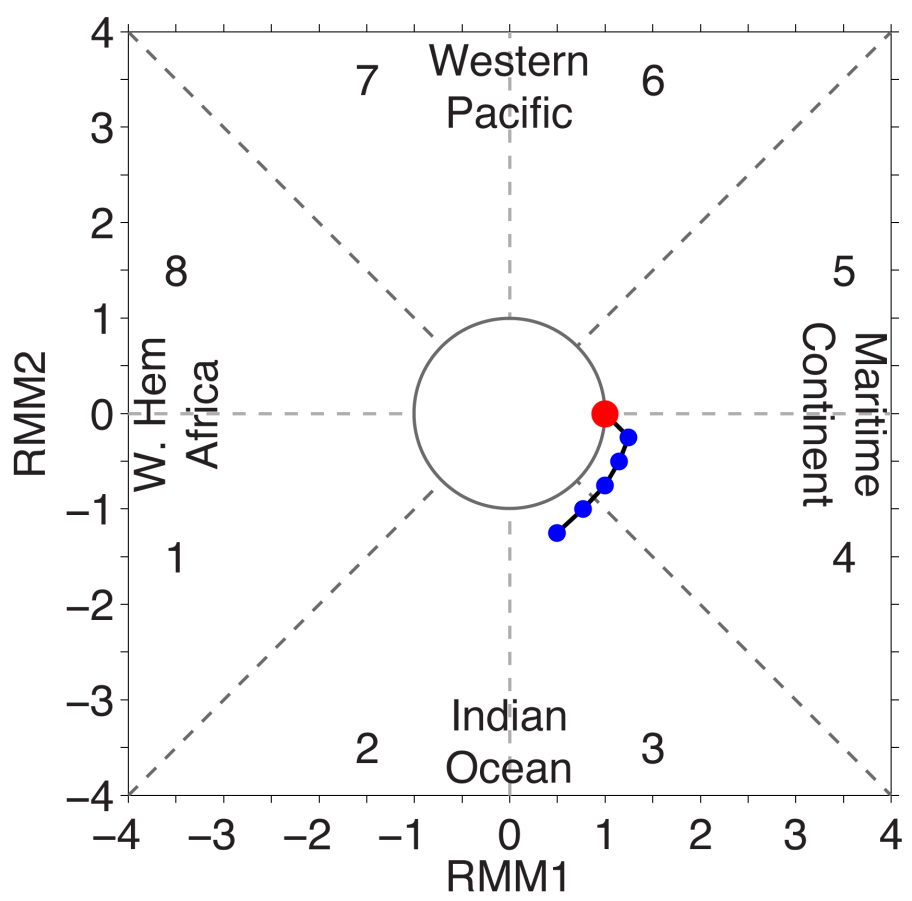
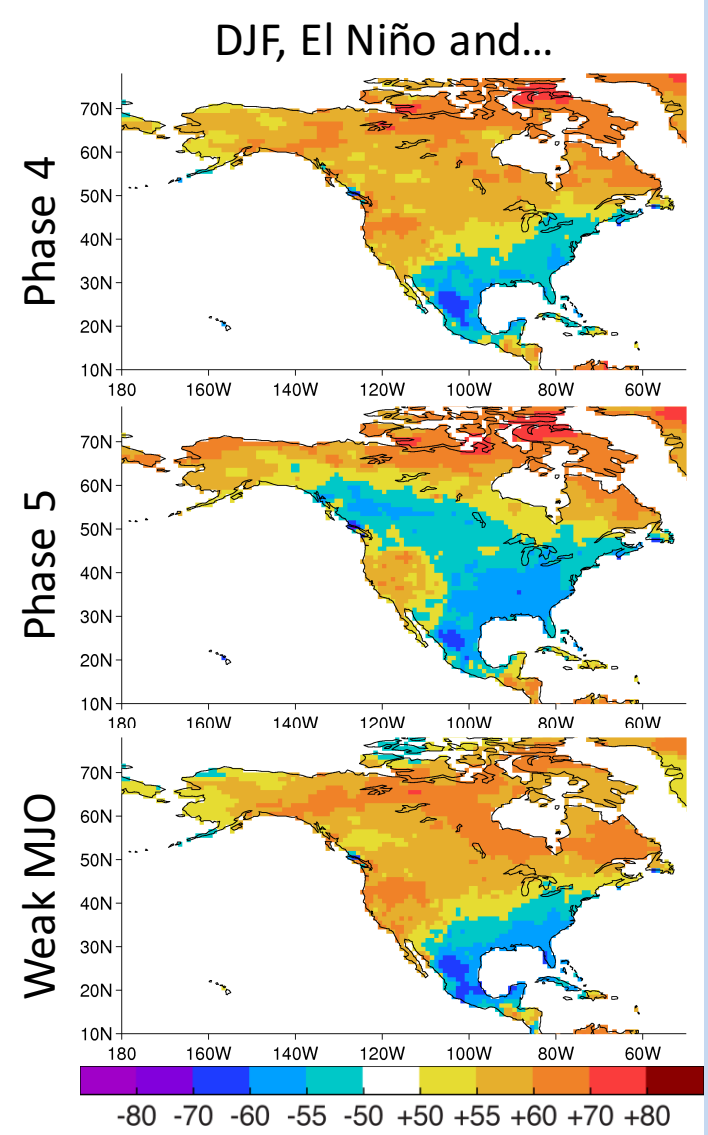


https://www.climate.gov/news-features/blogs/enso/united-states-el-ni%C3%B1o-impacts-0

- **No scaling by amplitude of event!**
- **Can be addressed through a regression framework.**

COMPOSITE SHORTCOMINGS





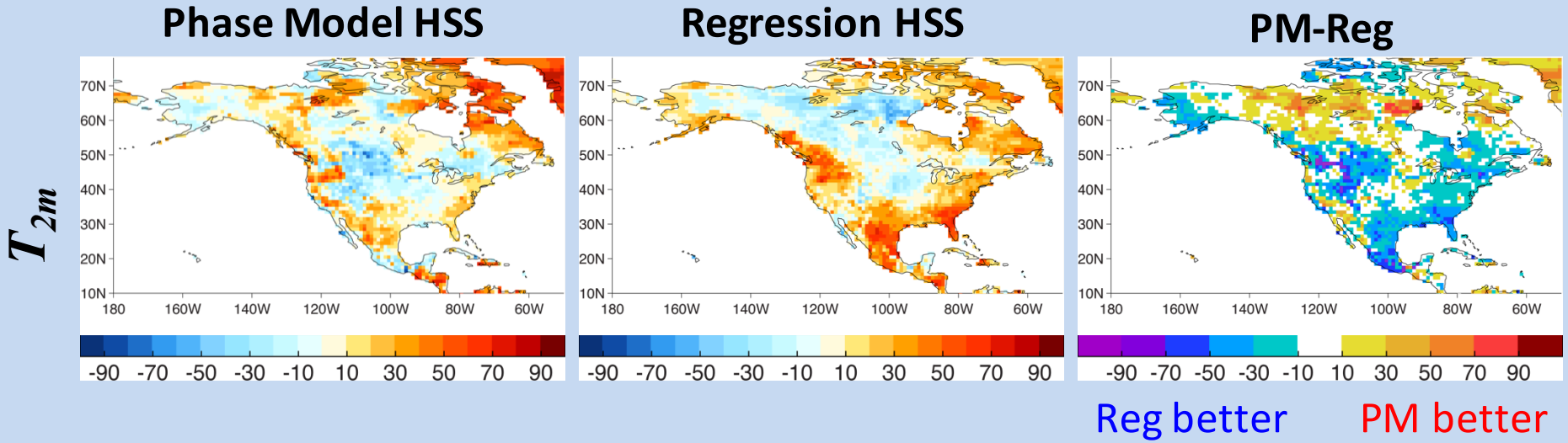
- **Abrupt forecast transitions for slight MJO adjustment!**
- **Can be addressed through a regression framework.**

MULTIPLE LINEAR REGRESSION METHODS

- Predictors: All standardized (1982-2013 base) over running 3-month period
  - Daily Niño 3.4 index (OISSTv2)
  - Daily Wheeler-Hendon (04) RMM1, RMM2
  - Linear trend
- Predictand: T_{2m} or P anomaly
  - Gaussian PDF then constructed using adjusted climatological variance:

$$\sigma_{adj} = \sigma_{c\lim o}\sqrt{1-R^2}$$

DJF; EL NIÑO; MJO PHASE 6



Reg. coefficients from all ENSO/MJO combinations, verified during El Niño & Phase 6.

DJF; El Niño; MJO Phase 6

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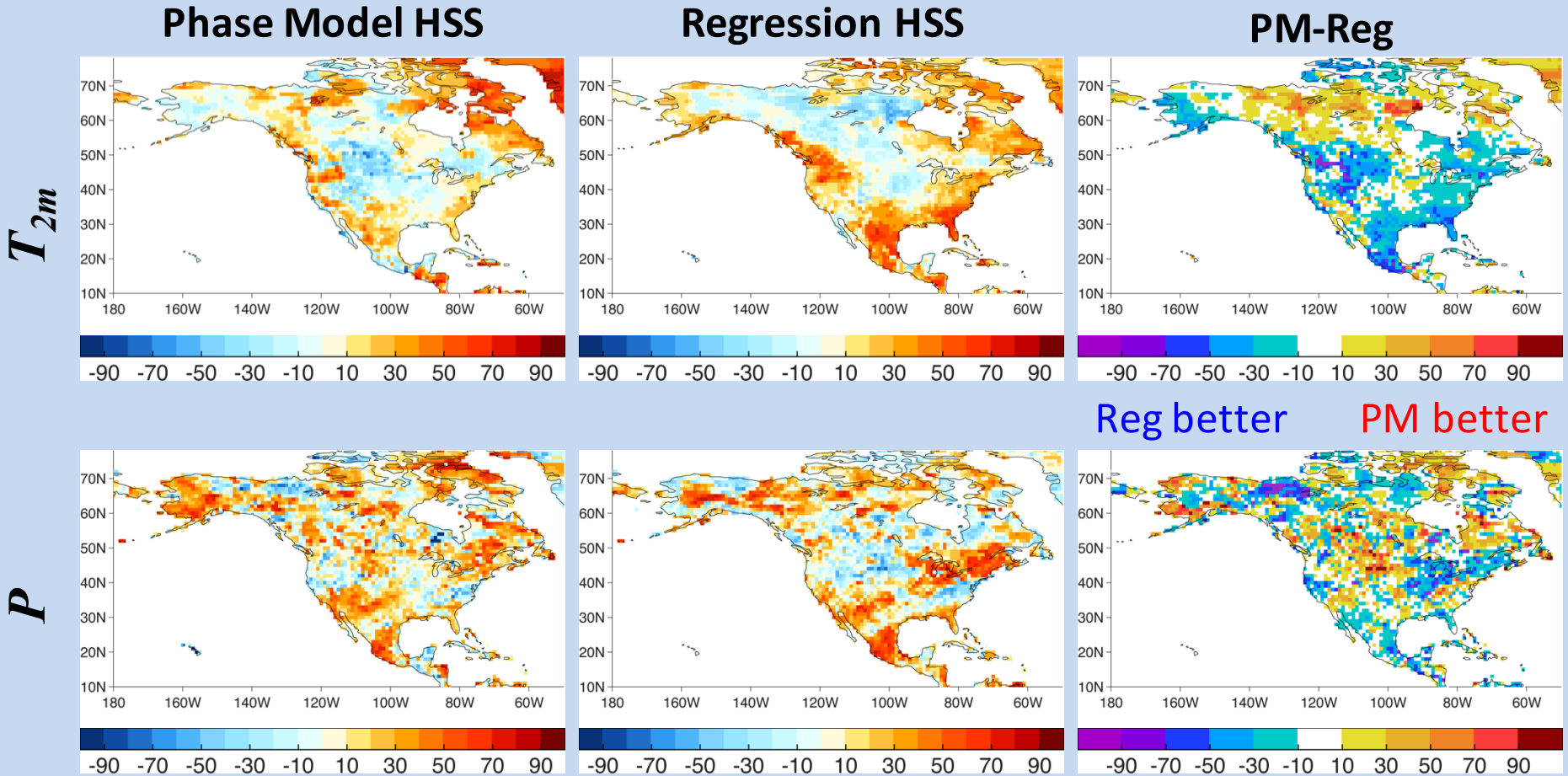

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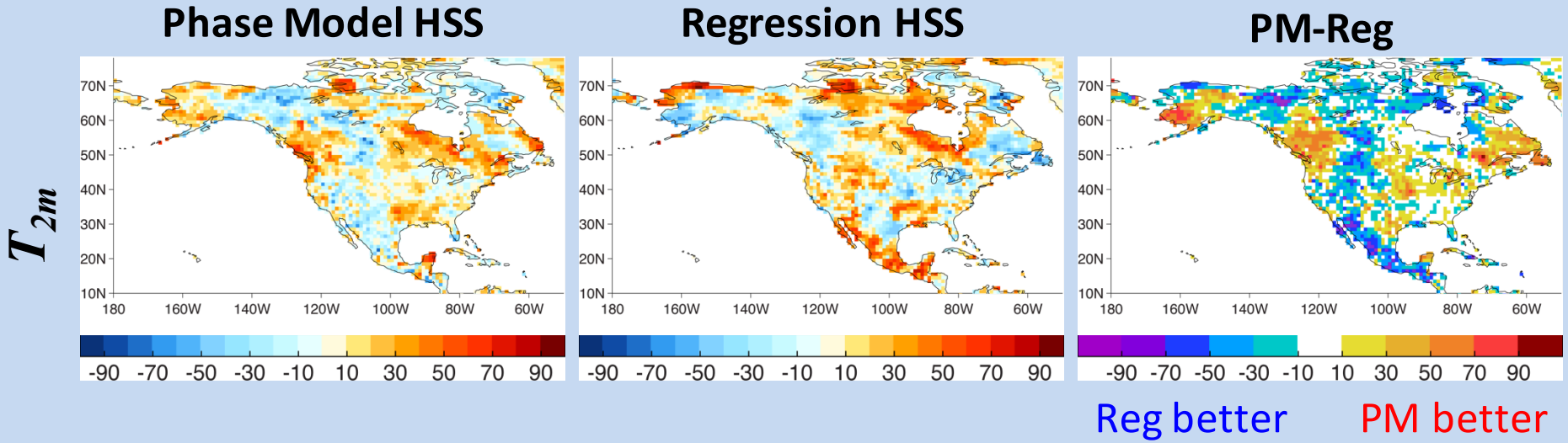

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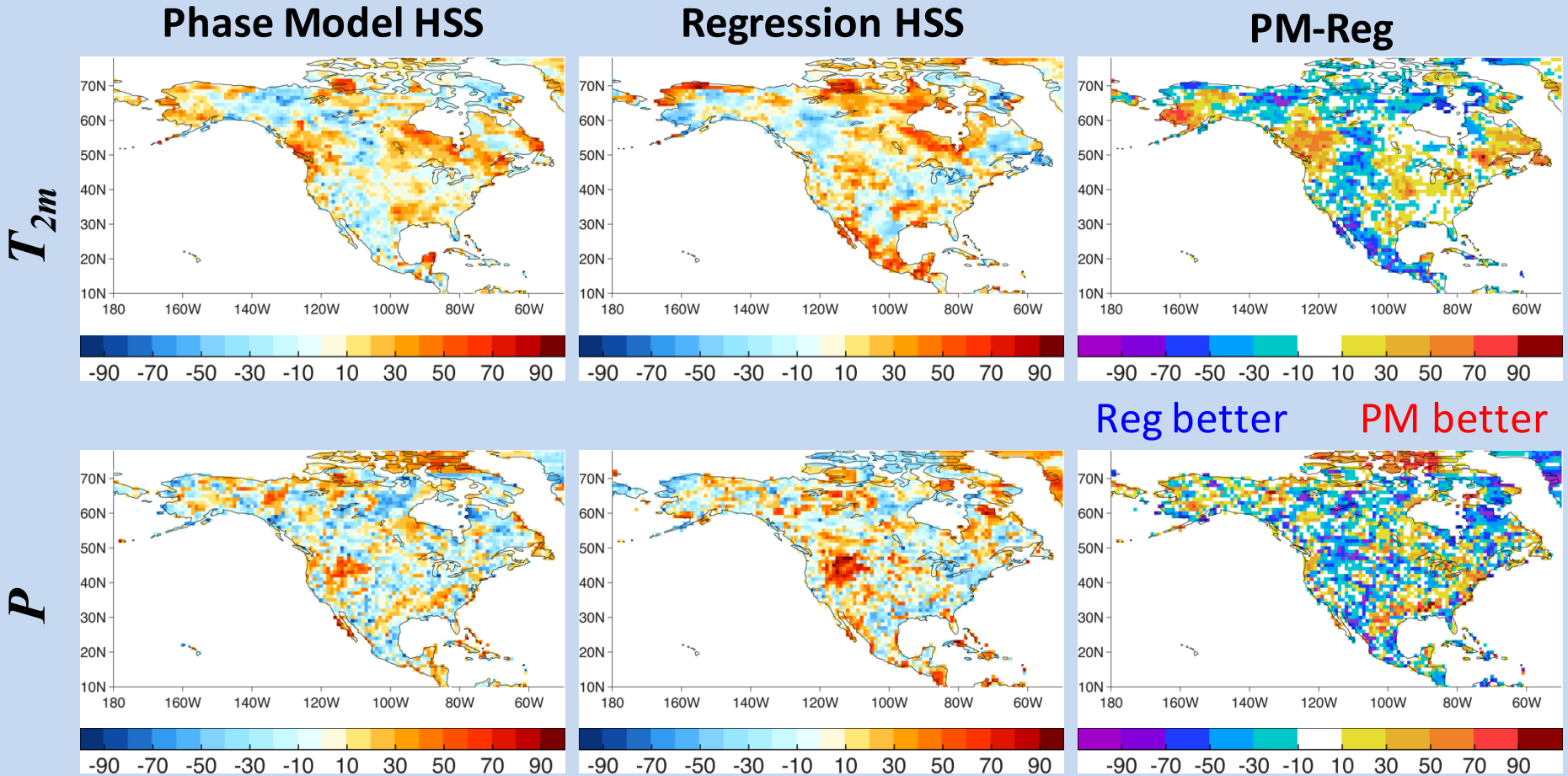

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CONCLUSIONS

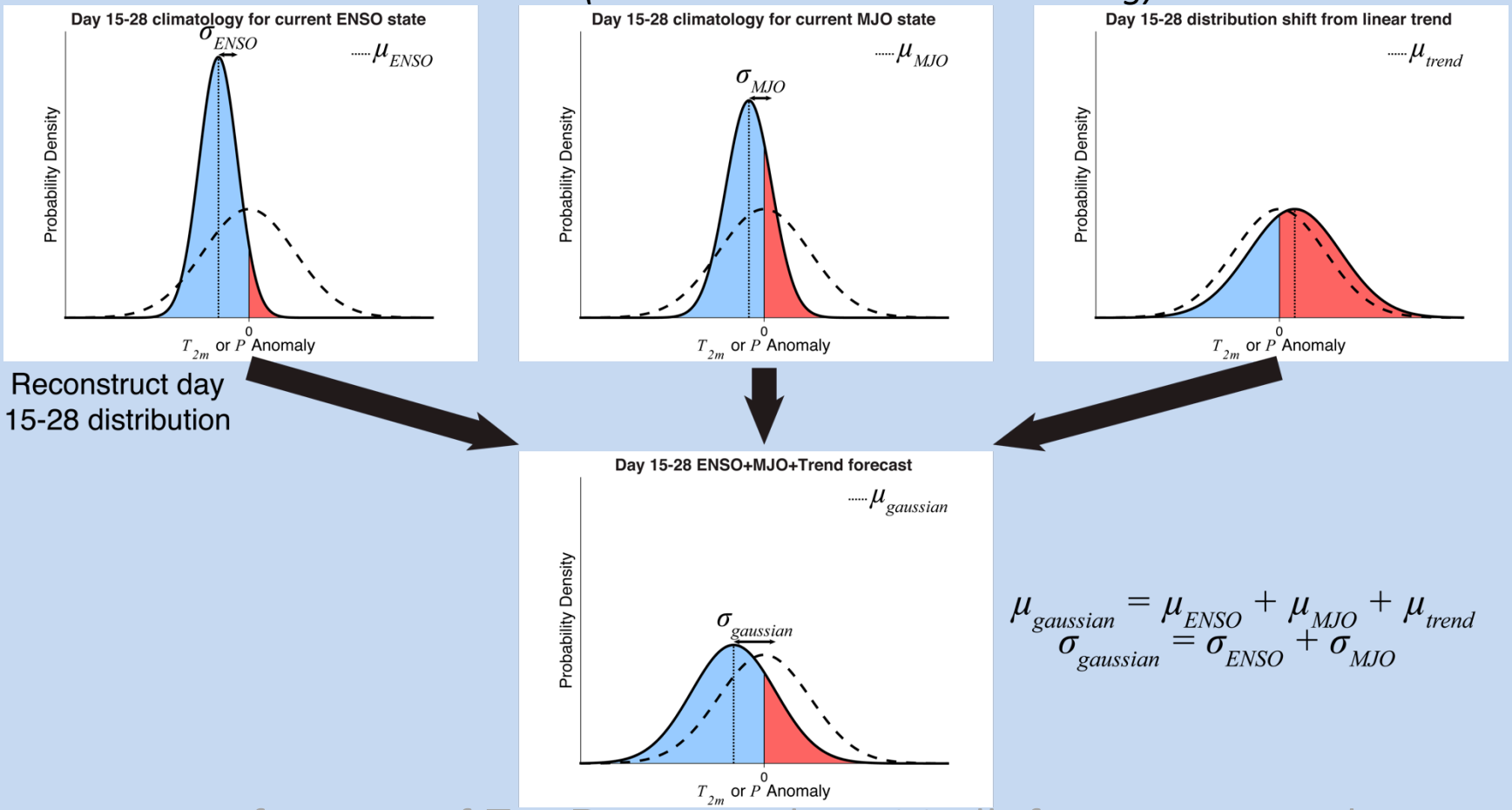
- Both the phase model and multiple linear regression at CPC show promise as complimentary, skillful probabilistic T_{2m} and P guidance for Weeks 3&4 for many base states of ENSO and the MJO.

- Forecasts of opportunity provide periods of consistently skillful forecasts despite modest predictability expectations at Weeks 3&4.

Questions/Comments: Daniel.Harnos@noaa.gov

PHASE MODEL METHODS

Johnson et al. (2014 – Weather and Forecasting)



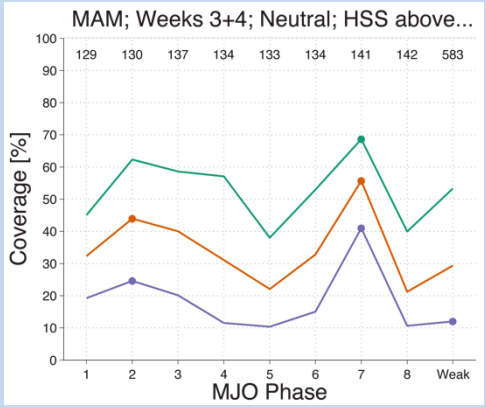
$$\mu_{gaussian} = \mu_{ENSO} + \mu_{MJO} + \mu_{trend}$$
$$\sigma_{gaussian} = \sigma_{ENSO} + \sigma_{MJO}$$

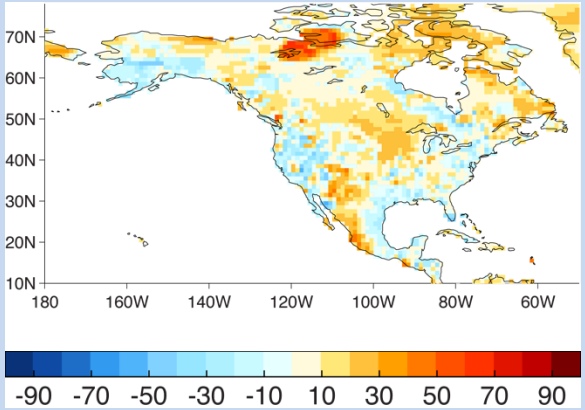
- Days 15-28 forecasts of T_{2m}, P generated empirically from ENSO, MJO base states.
  - T_{2m}: Janowiak et al. (1999); $P^{1/4}$ (Xie et al. 2010); both 1°
  - ENSO: ONI (3-month mean Niño 3.4); MJO: *Wheeler and Hendon (2004)*
- Cross-validation results use leave-one-out methodology.

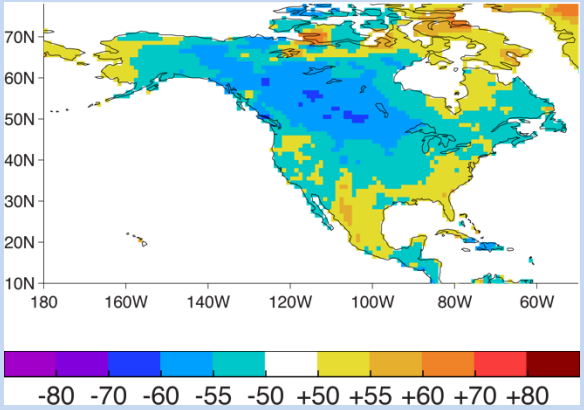
TRANSITION SEASON & WEAK FORCING

US Heidke Coverage | **Heidke Skill Score** | **Mean Prob. Forecast**

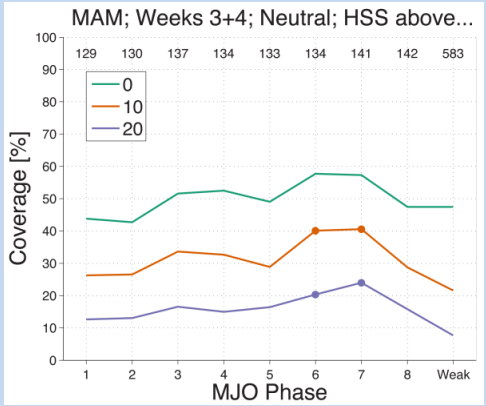
T_{2m}

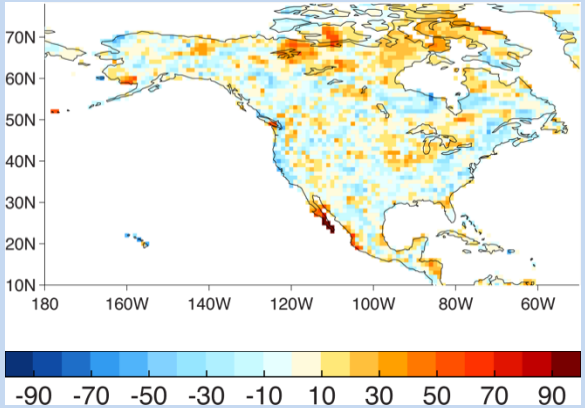


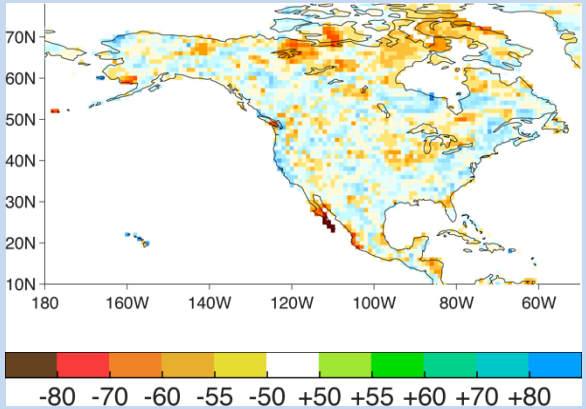




P

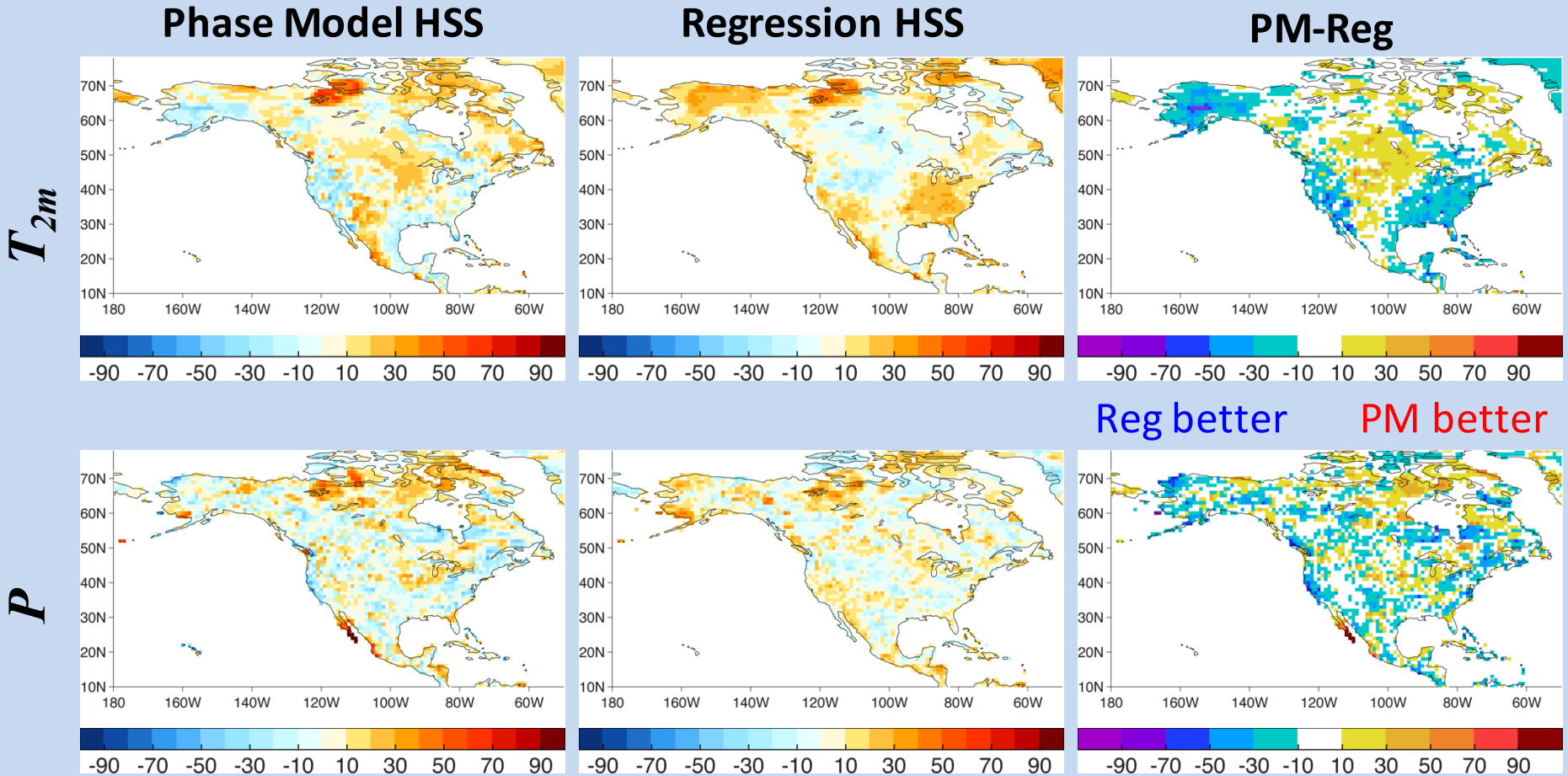






MAM; Neutral ENSO; Weak MJO

MAM; NEUTRAL; WEAK MJO



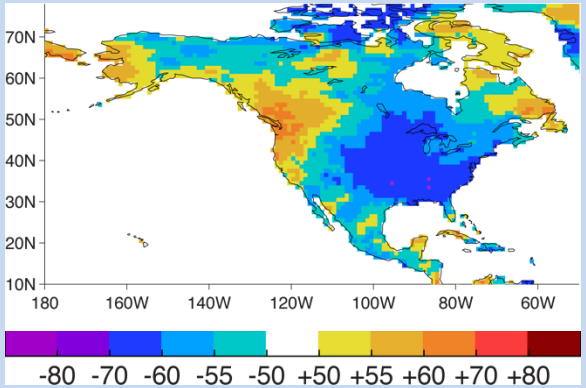
Reg. coefficients from all ENSO/MJO combos, verified during Neutral ENSO/Weak MJO

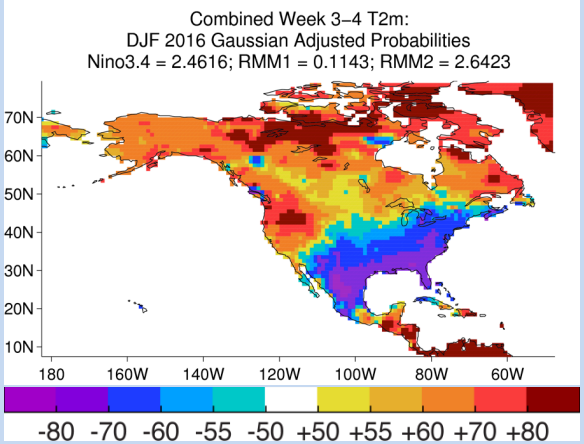
MAM; Neutral ENSO; Weak MJO

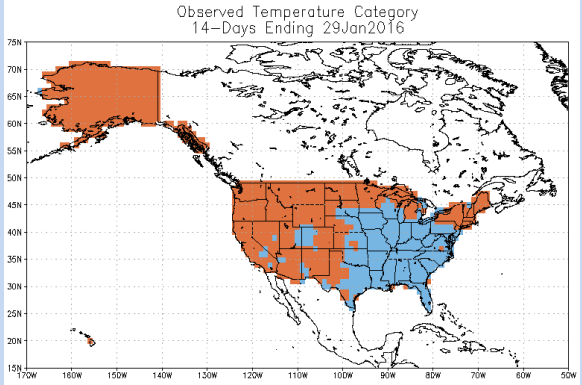
JANUARY 15-29, 2016 VERIFICATION

Phase Model | **Regression** | **Verification**

T_{2m}







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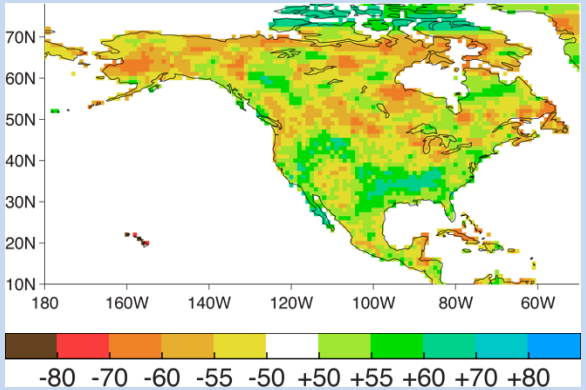
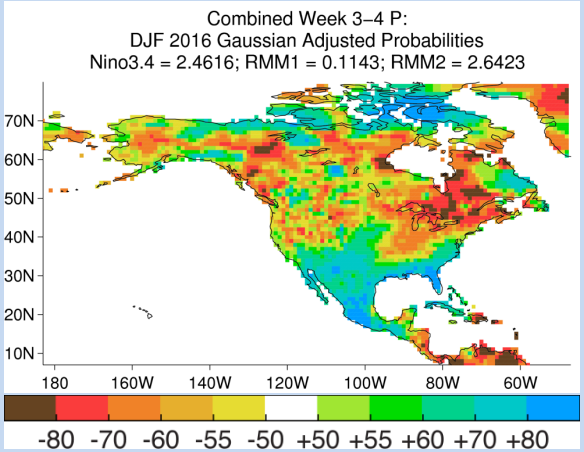
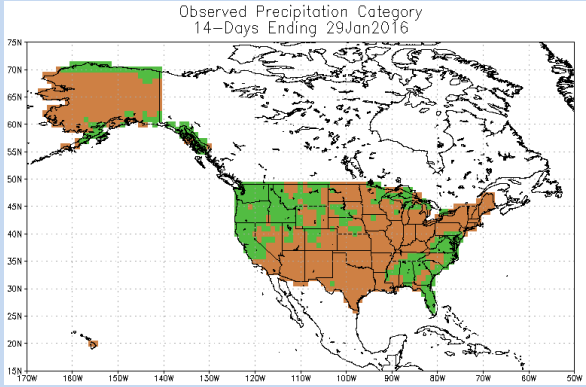
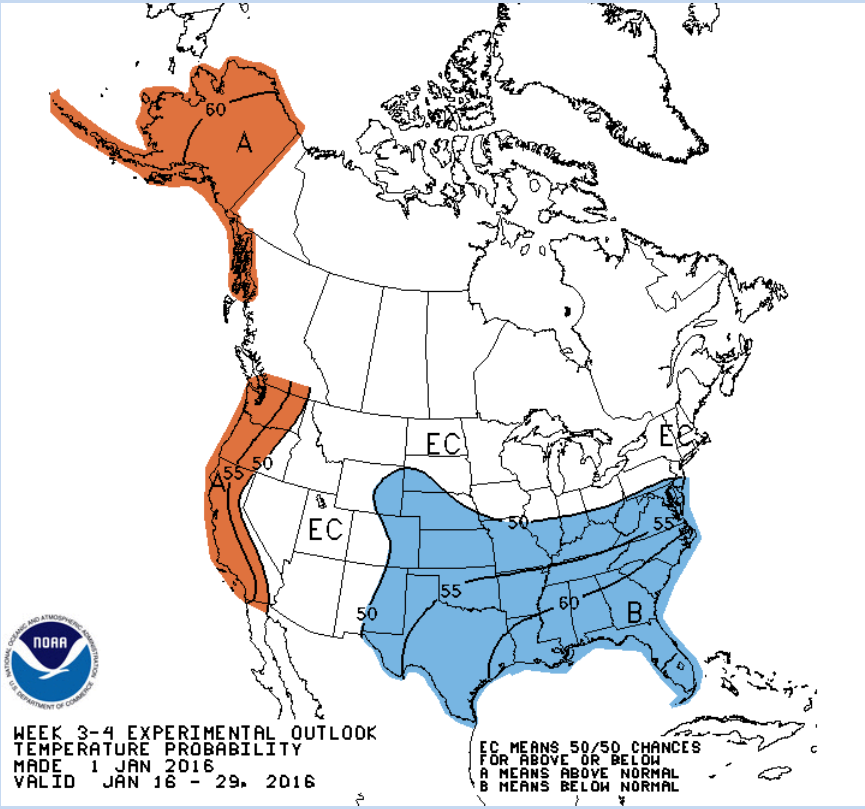




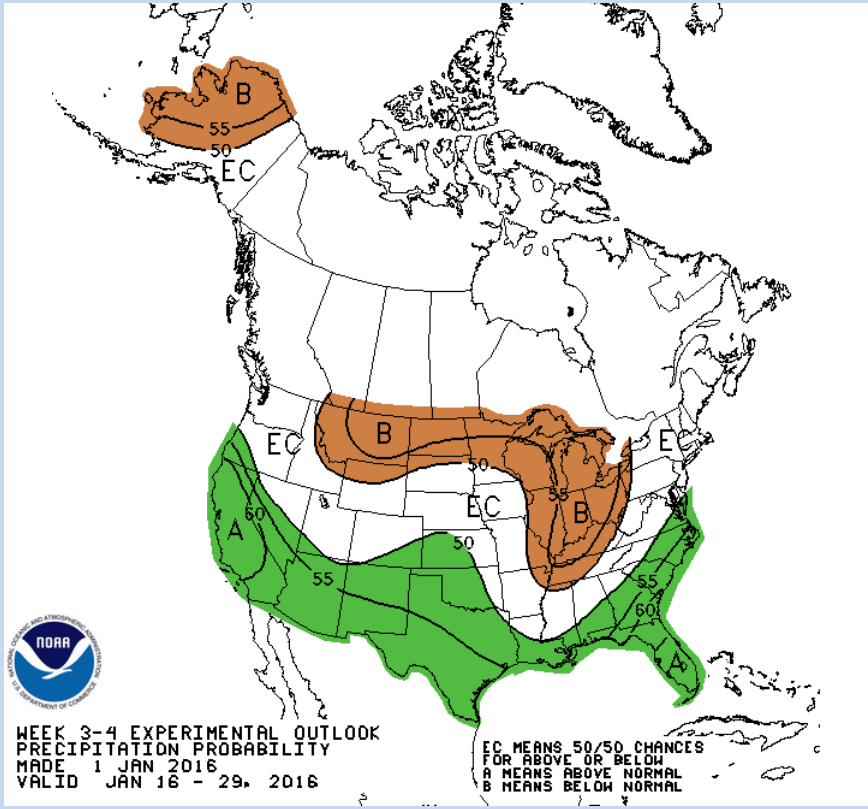


JANUARY 15-29, 2016 VERIFICATION

Official Forecast



Heidke Skill Score: 72.5



Heidke Skill Score: 12.0