

# NOAA Sub-seasonal Forecasting, Science and Technology

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With contributions from CPC staff

WSWC Briefing  
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# Outline

- CPC background
- Challenges with forecasting on sub-seasonal time scale (starting with week 3-4)
- Sources of predictability on the week 3-4 timescale
- CPC Experimental Week 3-4 temperature and precipitation outlooks
- Summary

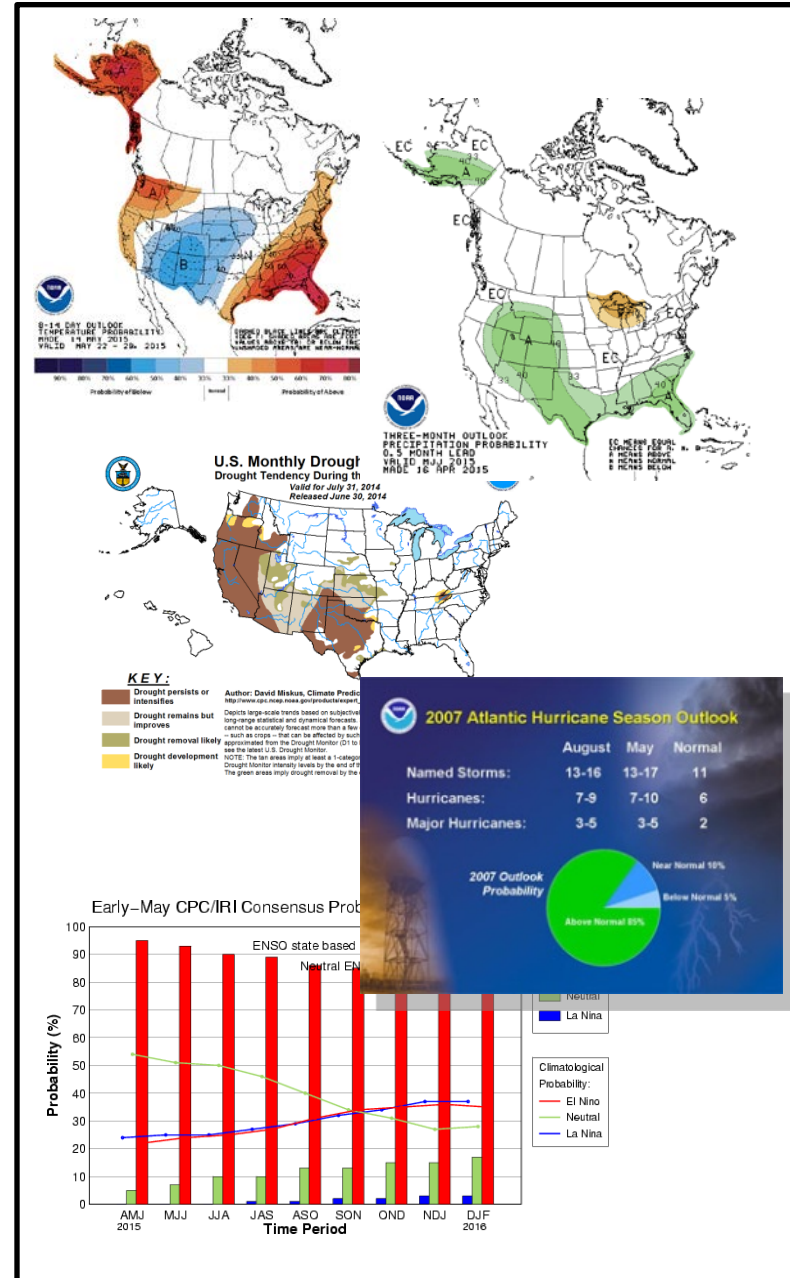
# CPC Mission

***Deliver real-time products and information that predict and describe climate variations on timescales from weeks to year thereby promoting effective management of climate risk and a climate-resilient society.***

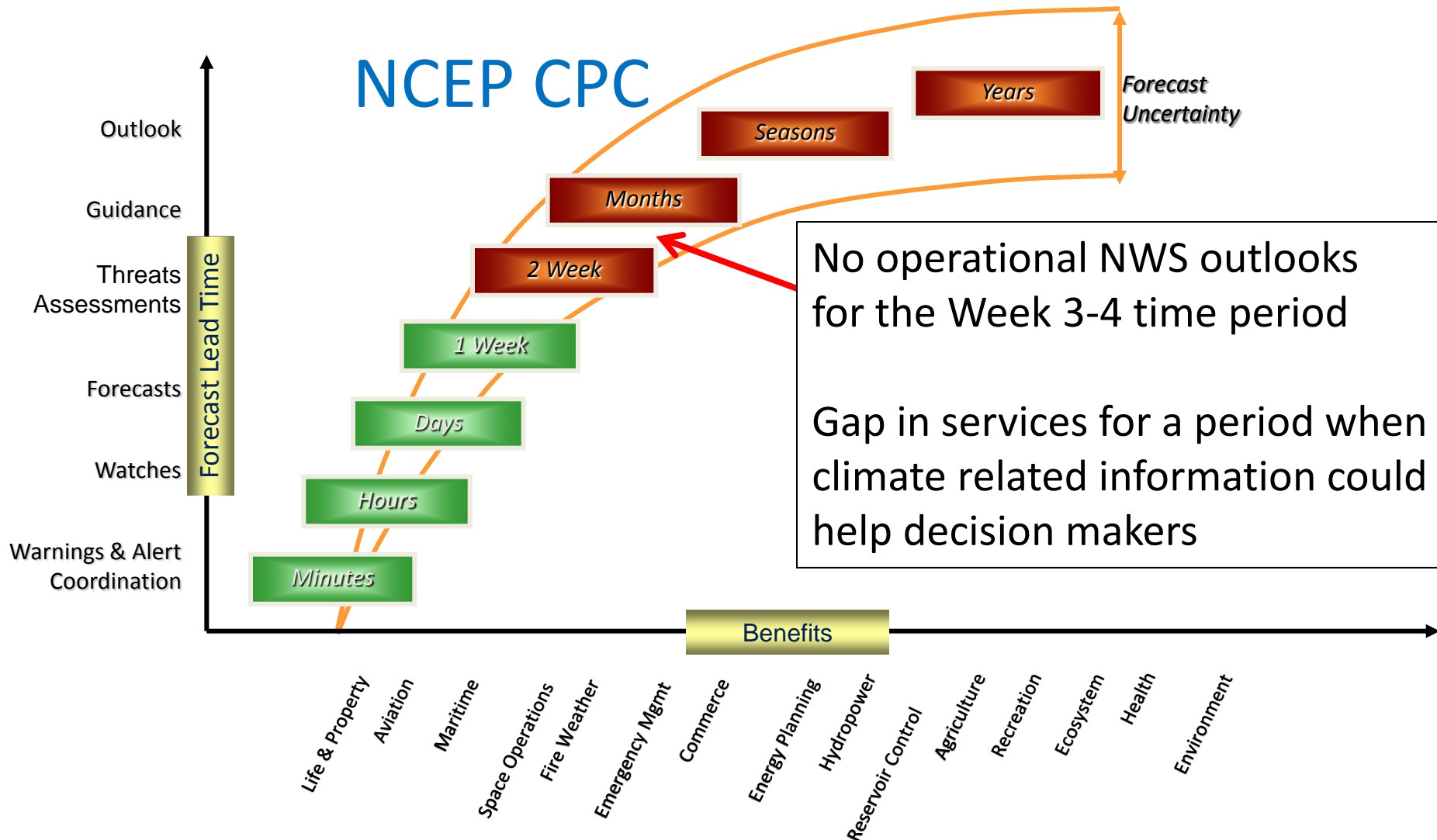
- Short term climate: Weeks, months and seasons
- Longer lead section of the NWS seamless suite of operational products
- Provide monitoring, assessment and prediction products
- Both domestic and international presence

# CPC Prediction Activities

- Extended range (Week-2) temperature and precipitation outlooks
- U.S. and Global Tropics hazards outlooks
- Monthly and seasonal temperature and precipitation outlooks
- Monthly and seasonal drought outlooks
- Seasonal hurricane outlooks
- Monthly ENSO prediction



# NWS Seamless Suite of Forecast Products



# Challenge of Filling the Week 3-4 Gap

The Week 3-4 outlook period is within a time range that:

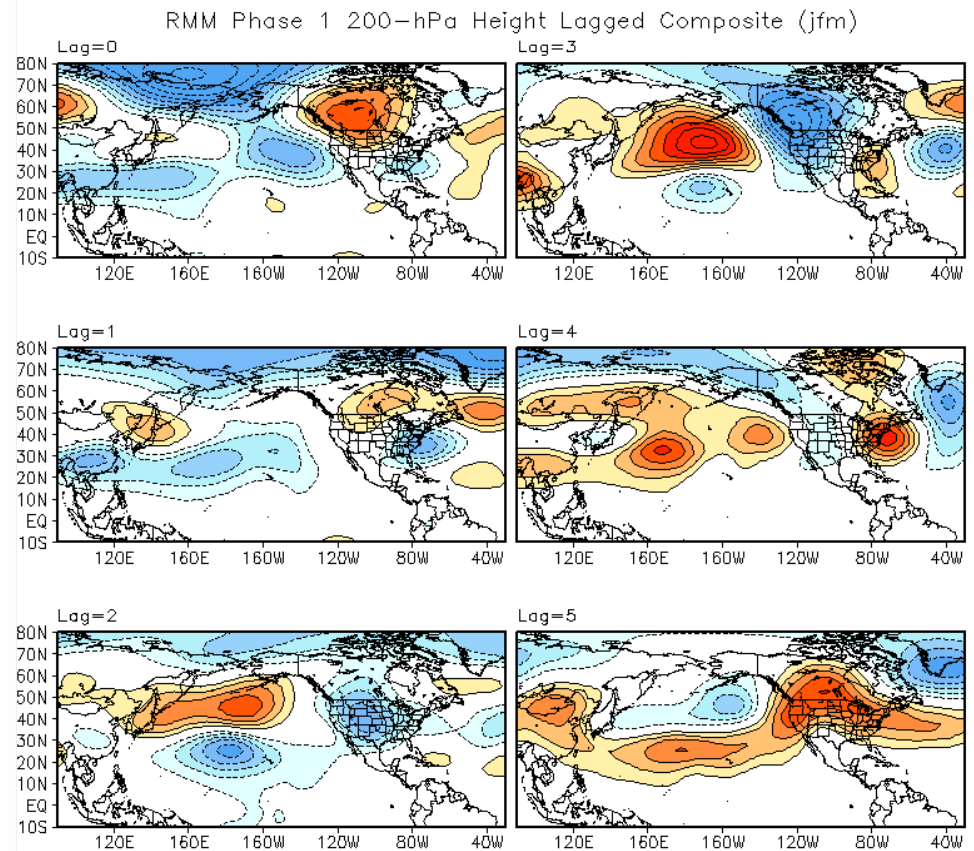
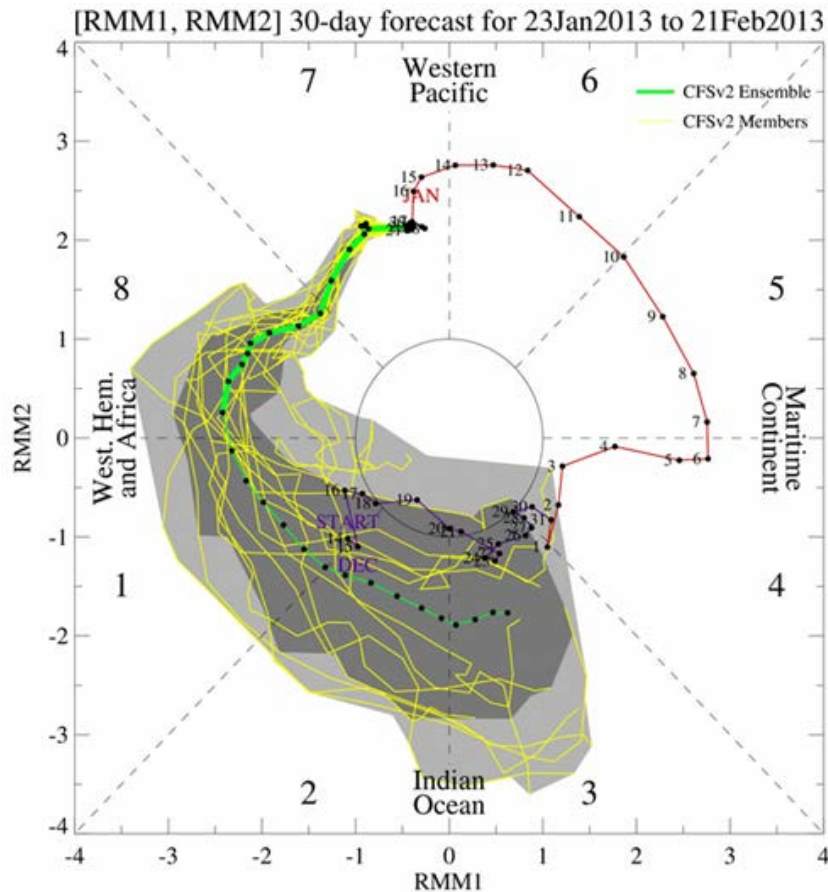
- (1) Primarily no longer benefits from predictability due to atmospheric initial conditions (i.e., Week-2)
  - (2) Is at times in a range too short to reliably benefit from slowly evolving parts of the climate system (ocean, land, etc.) known to aid longer time scale prediction (monthly to seasonal outlooks)
- Consequently, the Week 3-4 time range often suffers from low predictability.
  - Forecasts are frequently forecasts of opportunity which leverage the presence of a large-scale mode of climate variability such as MJO, ENSO, or AO. If no large-scale modes are present forecasts may not be able to be issued.
  - Important to understand these limitations to manage expectations.

# Sources of Predictability for Making Week 3-4 Outlooks

- ✓ El Nino-Southern Oscillation (ENSO)
- ✓ Madden-Julian Oscillation (MJO)
- ✓ Atmospheric blocking (NAO and AO)
- ✓ Trends
- ✓ Soil moisture and snow cover anomalies
- ✓ Local sea surface temperature (SST) anomalies

# MJO Activity

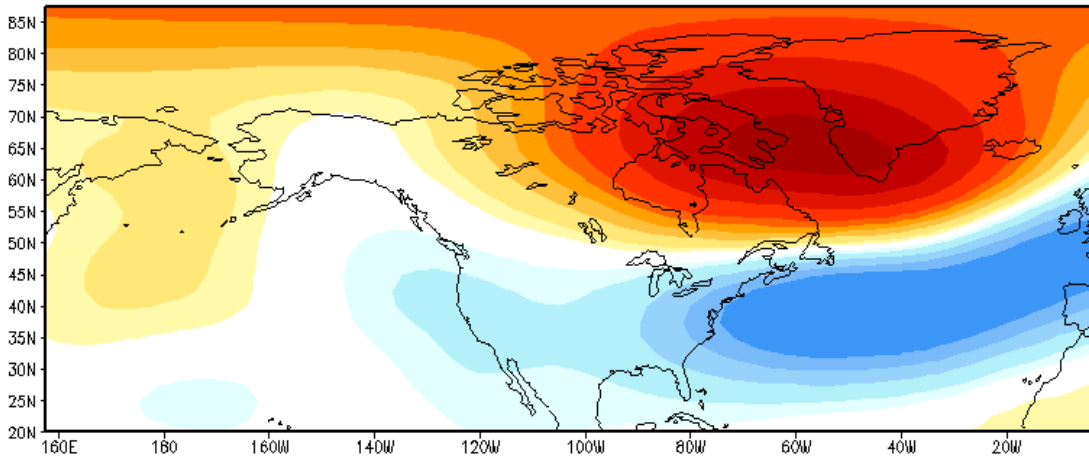
- There are documented relationships between MJO activity (strength and phase) and North America temperature and precipitation patterns



Zhou et al. 2011; Baxter et al. 2014

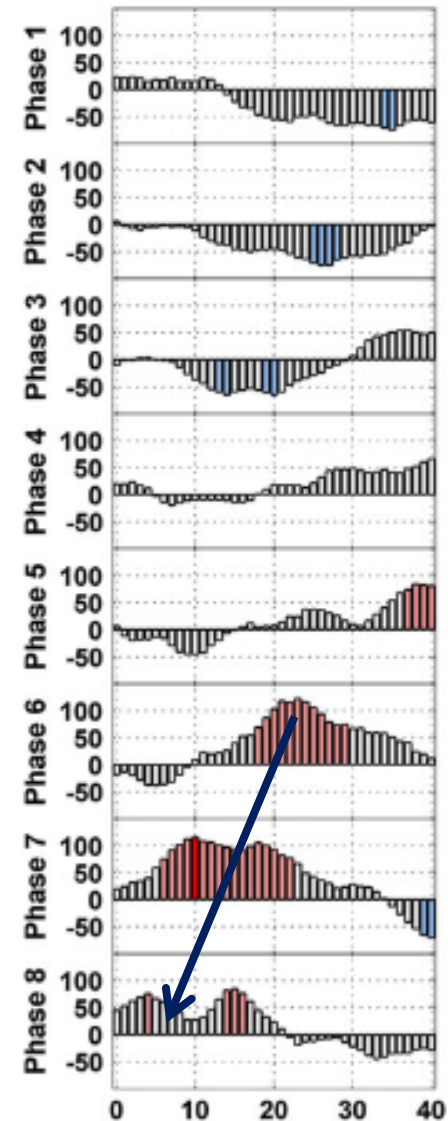


# MJO – NAO/AO Relationships



Cluster analysis on 500-hPa  
geopotential height anomalies

Example cluster resembling –NAO  
pattern found to occur at above  
climatological probabilities 10-30 days  
after MJO phase 6 (right, slanted arrow)



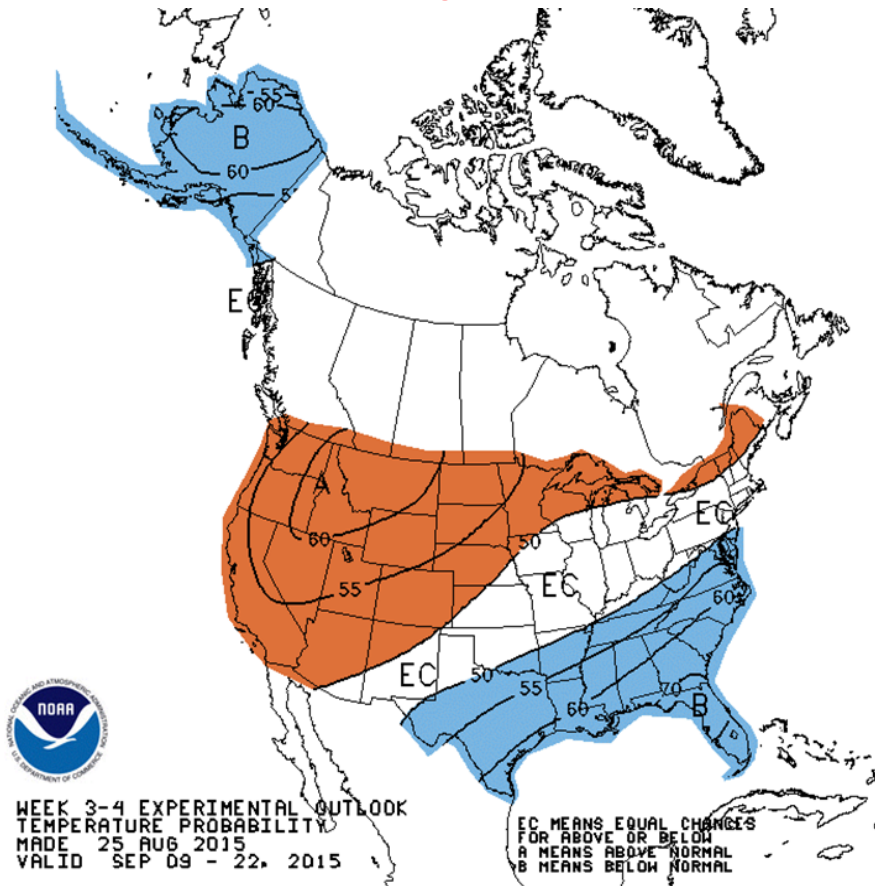
# CPC Experimental Week 3-4 Temperature and Precipitation Outlooks

- The experimental product is 2-class (above or below-average) temperature and precipitation outlook maps for the favored category of ***two-week*** mean temperature and ***two-week*** total accumulated precipitation
- The target is a combined two week outlook for Weeks 3-4 in the future
- Outlook maps depict probabilities for the favored category
- The experimental product is released once per week every Friday at approximately 3 PM ET
- First experimental outlook was released on September 18, 2015
- Users are encouraged to provide feedback on product through webform available here: <http://www.cpc.ncep.noaa.gov/products/predictions/WK34/>

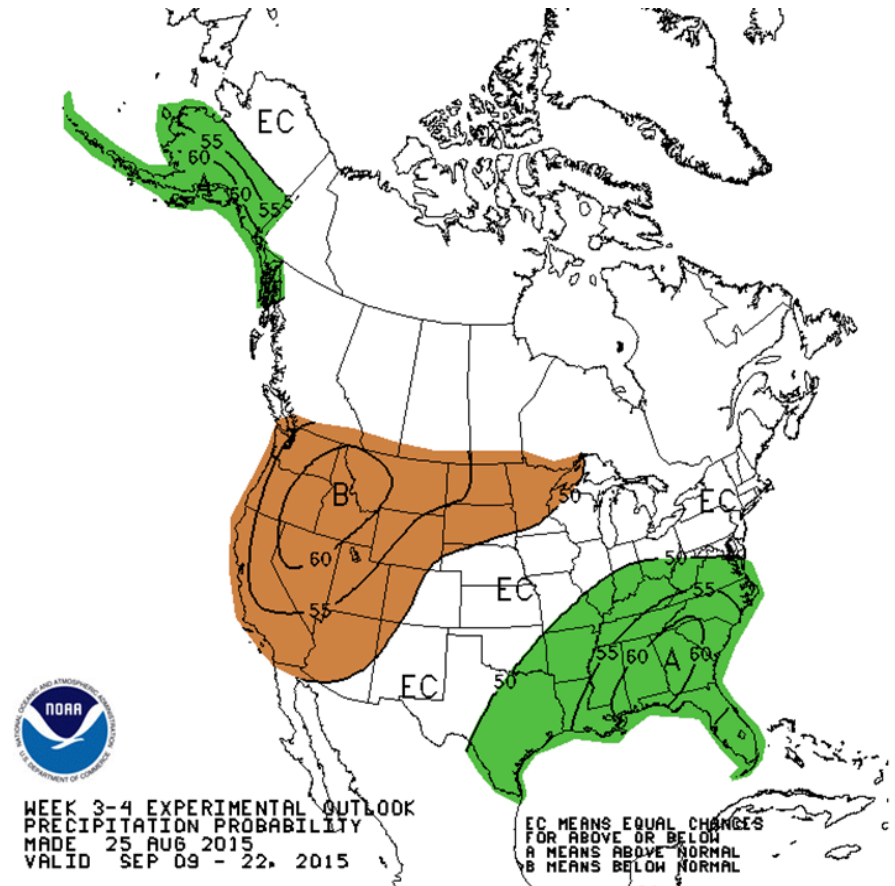
# Experimental Week 3-4 Temperature and Precipitation

## Outlooks

### Temperature



### Precipitation



Orange: Above average temperatures favored  
Blue: Below average temperatures favored  
Equal Chances (EC): Equal odds for  
above/below

Green: Above average precipitation favored  
Brown: Below average precipitation favored  
Equal Chances (EC): Equal odds for  
above/below



# Generation of Climate Forecasts at CPC

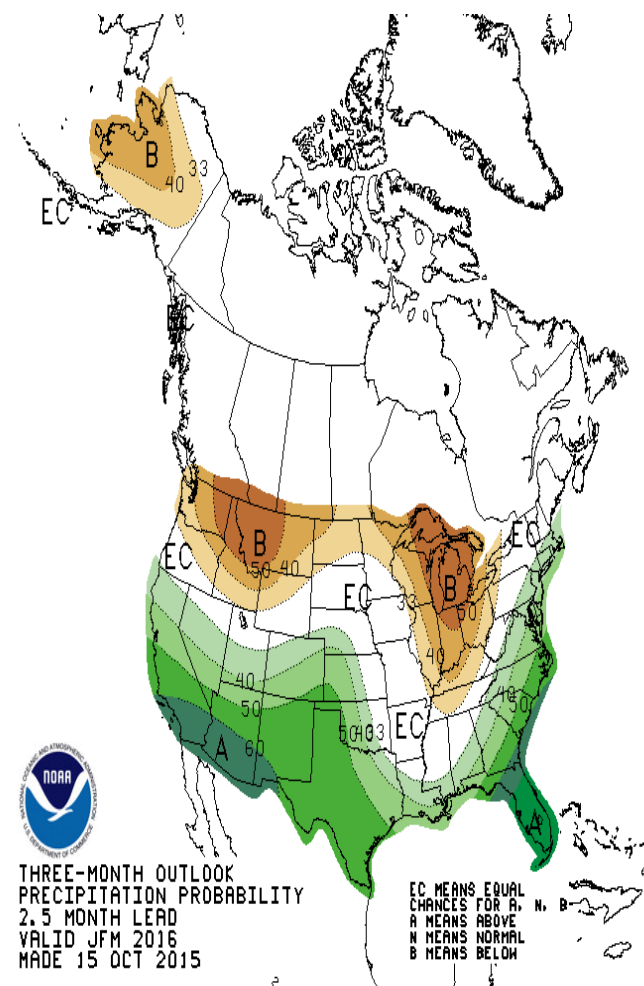


## Human Forecasters Use Various Tools To Develop Seasonal Predictions:

- ⌘ Dynamical Models
- ⌘ Statistical Models
- ⌘ Historical Analogs
- ⌘ Historical Composites

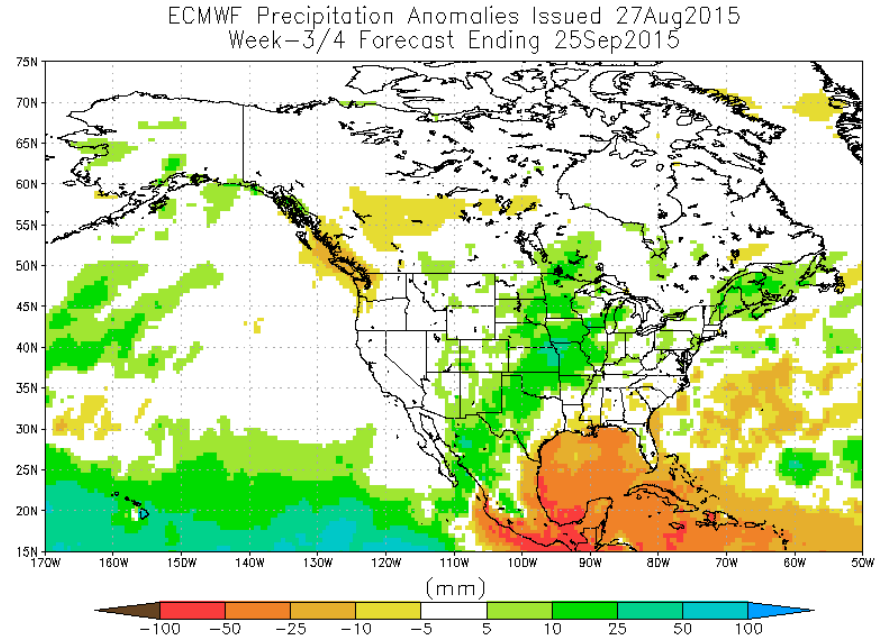
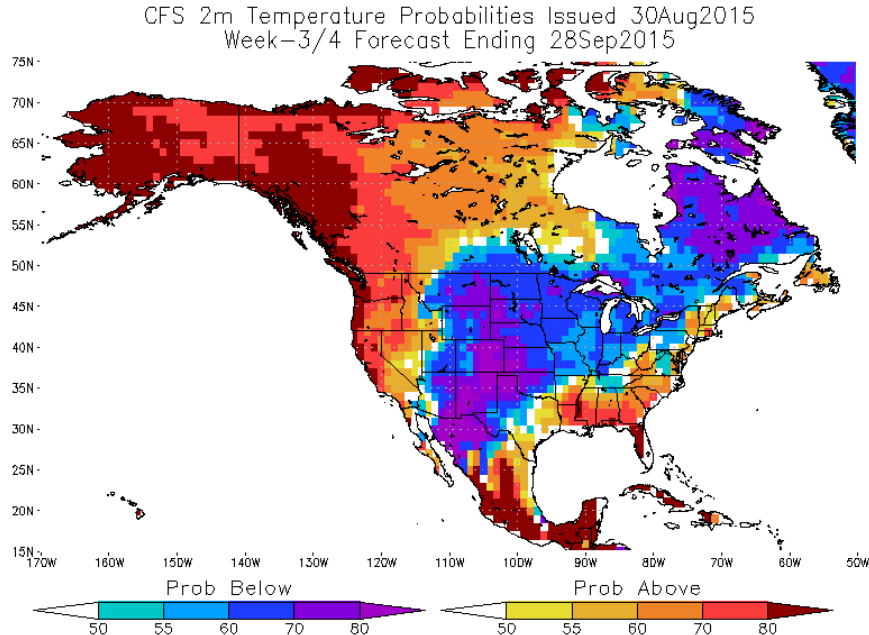
Goal is to leverage complementary skill between the tools.

Ultimately, skill of seasonal forecast depends on skill of tools made available to the forecaster.



# Dynamical Model Forecast Guidance

- Product currently utilizes output from the CFS, ECMWF and JMA
- Model data is bias corrected based on available reforecasts
- A suite of model based forecast tools (500 and 200-hPa height, temperature, precipitation, etc.) is available for the forecaster



# Empirical / Statistical Forecast Guidance

MJO-ENSO phase model: Empirical tool that incorporates information about the current strength and phase of ENSO and MJO to produce a forecast anchored to historical observations (Johnson et al. 2014)

Multiple Linear Regression model: Statistical tool that uses daily Nino3.4 index, MJO indices (RMM1 and RMM2) and linear trends as predictors for predictands that are Week 3-4 temperature and precipitation.

Constructed analogue tool: Statistical tool based on 200-hPa streamfunction to construct a forecast based on closely matching analogues of the past to the current conditions. Past cases are objectively weighted.

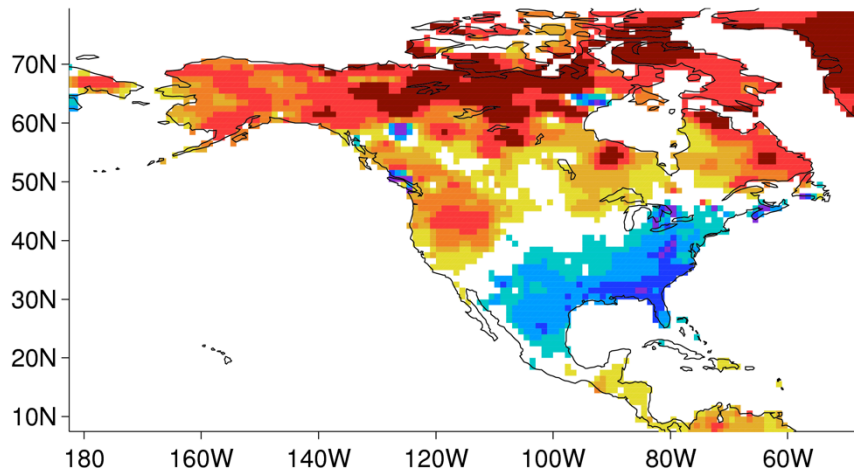
Coupled Linear Inverse Model (C-LIM): Created at the Earth System Research Laboratory (ESRL) and migrated to also run operationally at CPC. Forecasts of tropical rainfall and winds that serve as a statistical counterpart to dynamical model tropical rainfall forecasts (Newman et al. 2009)



# Statistical Forecast Guidance

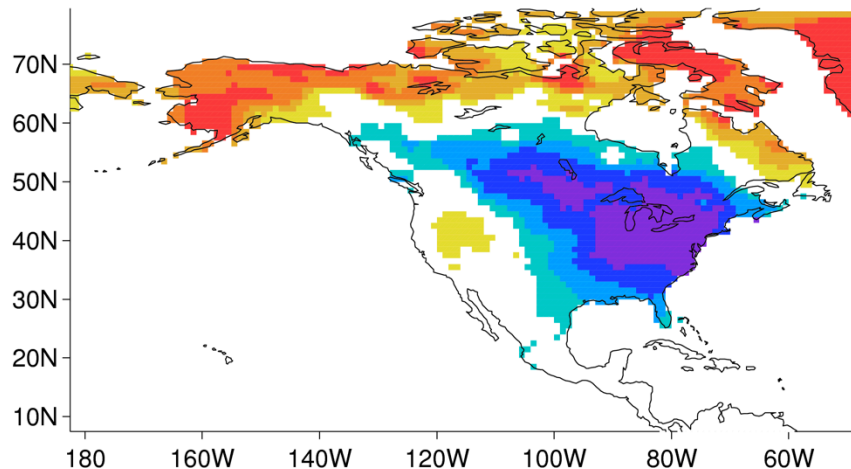
Combined Week 3–4 T2m:  
DJF 2016 Anomalies

Nino3.4 = 2.4616; RMM1 = 0.1143; RMM2 = 2.6423



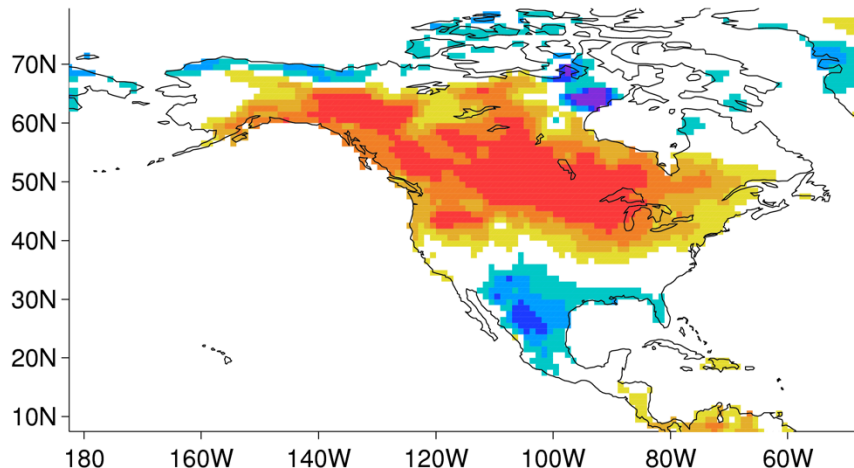
Combined Week 3–4 T2m:  
DJF 2016 Anomalies from MJO

Nino3.4 = 2.4616; RMM1 = 0.1143; RMM2 = 2.6423



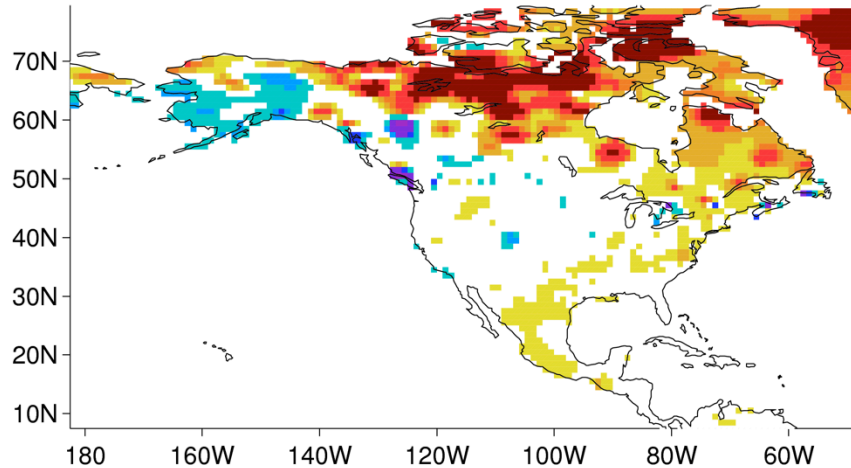
Combined Week 3–4 T2m:  
DJF 2016 Anomalies from ENSO

Nino3.4 = 2.4616; RMM1 = 0.1143; RMM2 = 2.6423



Combined Week 3–4 T2m:  
DJF 2016 Anomalies from trend

Nino3.4 = 2.4616; RMM1 = 0.1143; RMM2 = 2.6423



-4 -2 -1.5 -1 -0.5 0.5 1 1.5 2 4 [°C]

# Summary



## Summary

- Current scientific understanding indicates limited predictability at the Week 3-4 time range. Forecasts at this time range will need to capitalize on forecasts of opportunity which may not be available every week.
- As with all timescales, forecast skill for precipitation forecasts is considerably lower than that for temperature.
- Increasing skill of precipitation forecasts on timescales from week 2 to first season is high priority for a variety of stakeholders. This is an extremely difficult scientific problem but one that would have tremendous societal benefit.
- Increasing precipitation skill for this time range will require a large-scale coordinated program that leverages the contributions of the operational agency, federal labs, and the research community.