



# Subseasonal to Seasonal Outlooks from CPC

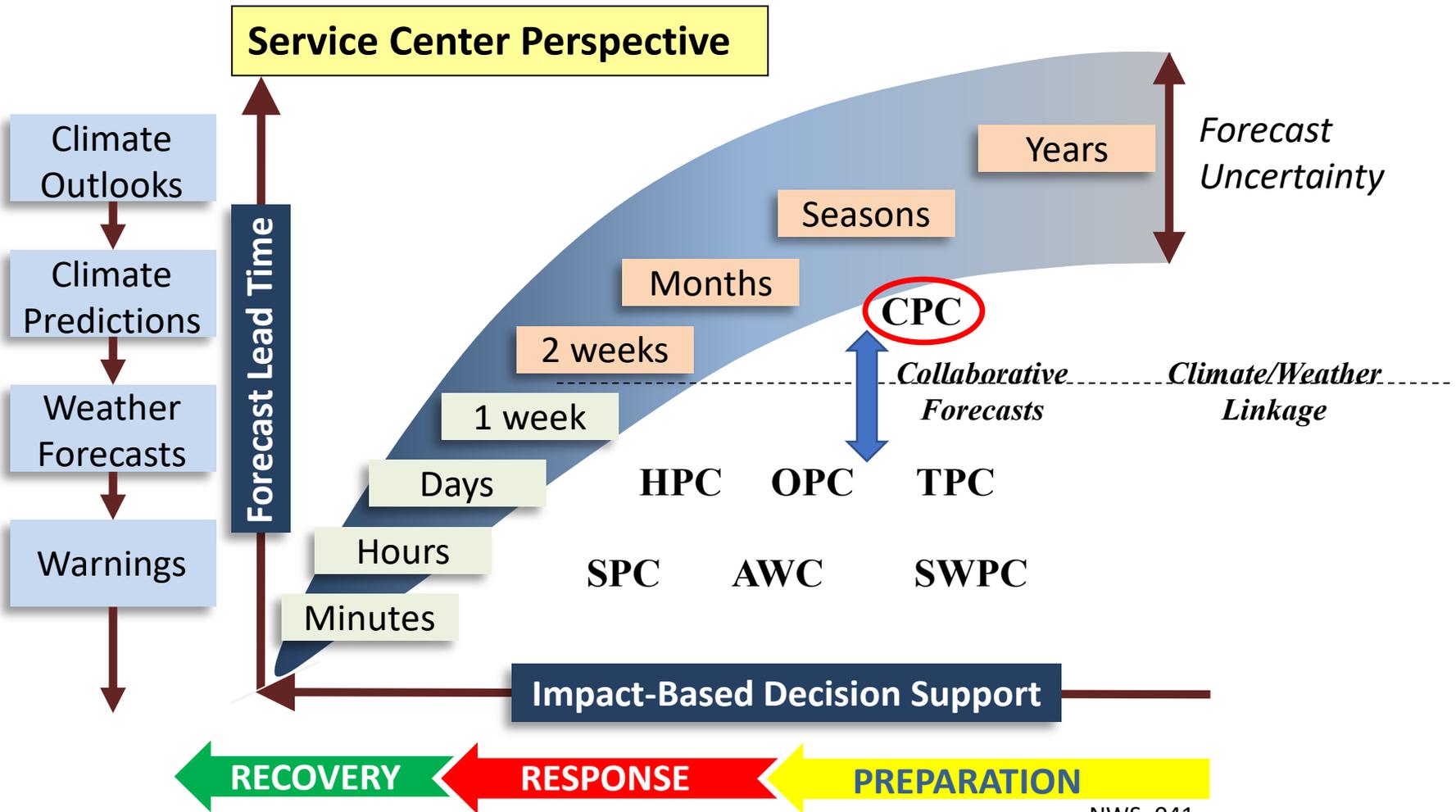
David Miskus / Jon Gottschalck  
CPC/Operational Prediction Branch

*U.S. Drought Monitor Workshop:  
Forecasting, Monitoring, & Responding  
To Drought in the Southeast*

Phillips Market Center,  
SC State Farmers Market,  
West Columbia, SC  
February 4, 2020



# NOAA Seamless Suite of Forecast Products Spanning Climate and Weather



NWS\_041



# Outline



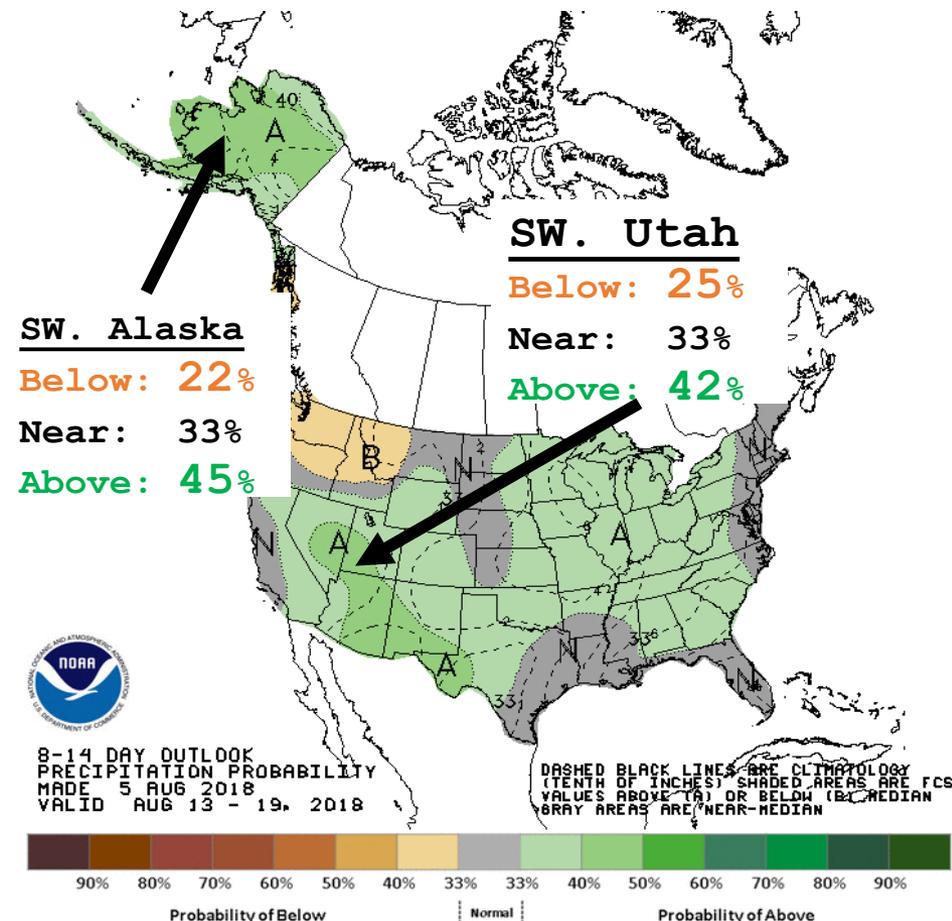
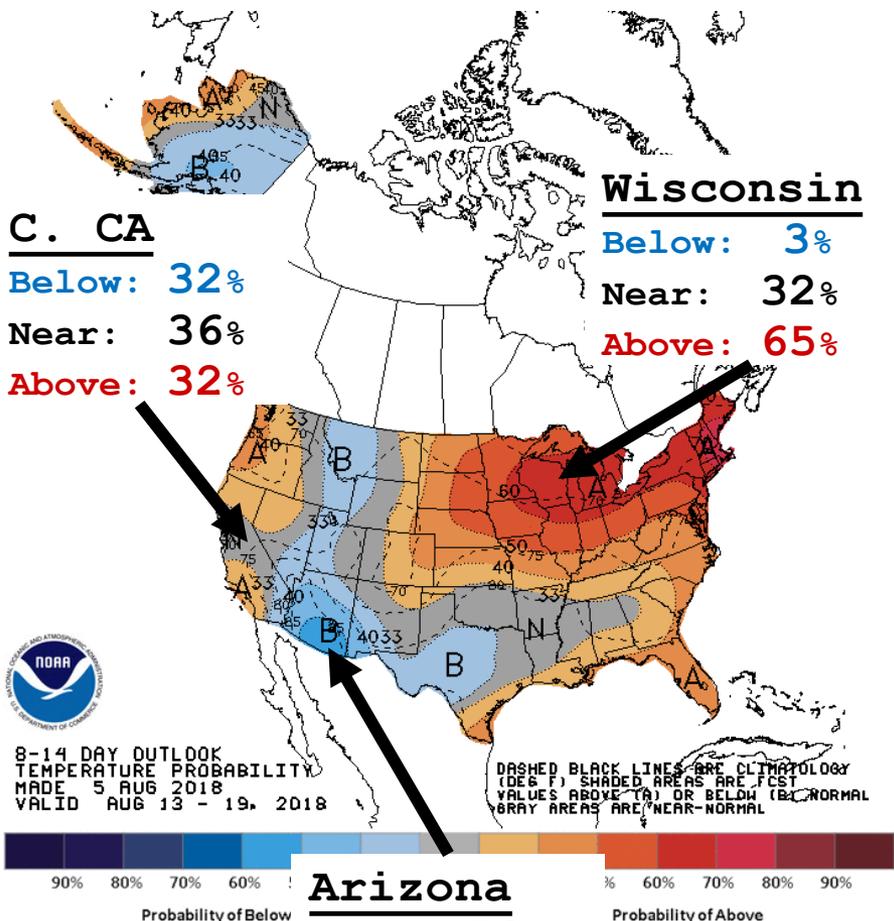
- Overview of CPC Outlooks, Process, Tools, and Services:
  - 1) Week 2 (Days 8-14; *also Days 6-10*)
  - 2) Week 3-4
  - 3) Monthly and Seasonal Outlooks (LLF)
  - 4) Global Tropics Hazards Outlook (GTH)
  - 5) Drought Outlooks (SDO & MDO)
  
- Verification of Outlooks



- Overview of CPC Outlooks, Process, Tools and Services:
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- Verification of Outlooks



# Week 2: Interpretation

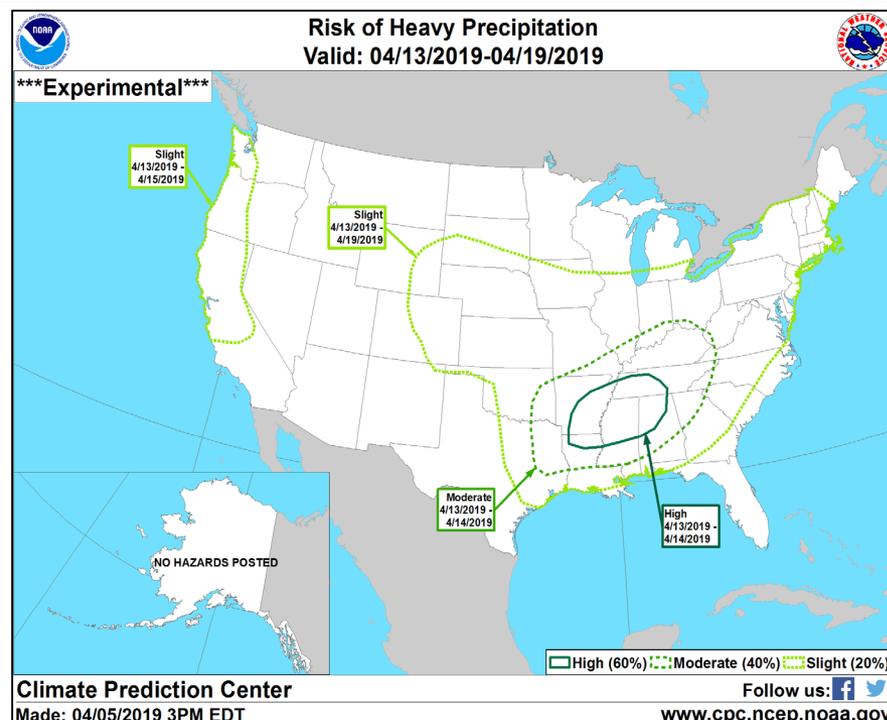
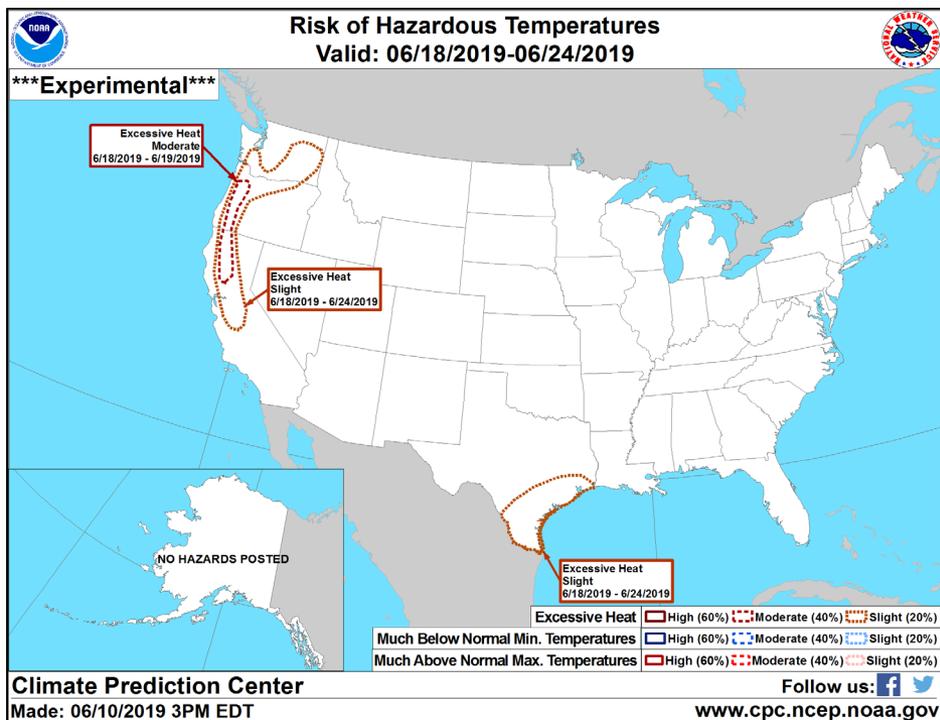




# Week 2 U.S. Hazards



- Targets the Days 8-14 period, probabilistic in nature
- Highlights areas for *slight, moderate or high risk* for hazardous conditions related to temperature, precipitation and winds
- Hazardous conditions are defined based on thresholds or exceeding percentiles or both



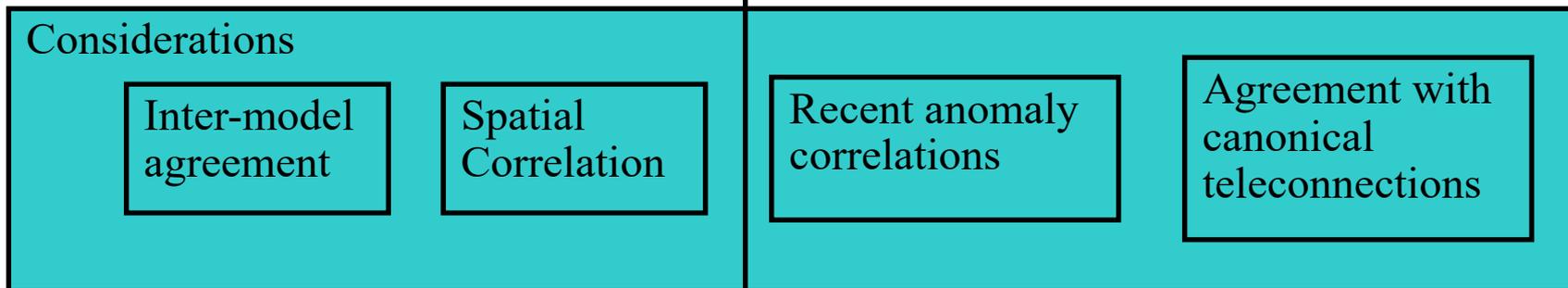


# Week 2: Forecast Process



Upper-Air

**Dynamical model forecasts**



Weighted average 500-hPa height and anomaly forecast (BLEND)

Official height forecast

Analogs

Regression based specifications



# Week 2: Forecast Process



Surface

Dynamical  
model forecasts

Bias Corrections,  
Calibrations,  
Consolidation

Analogs

Regression based  
specifications

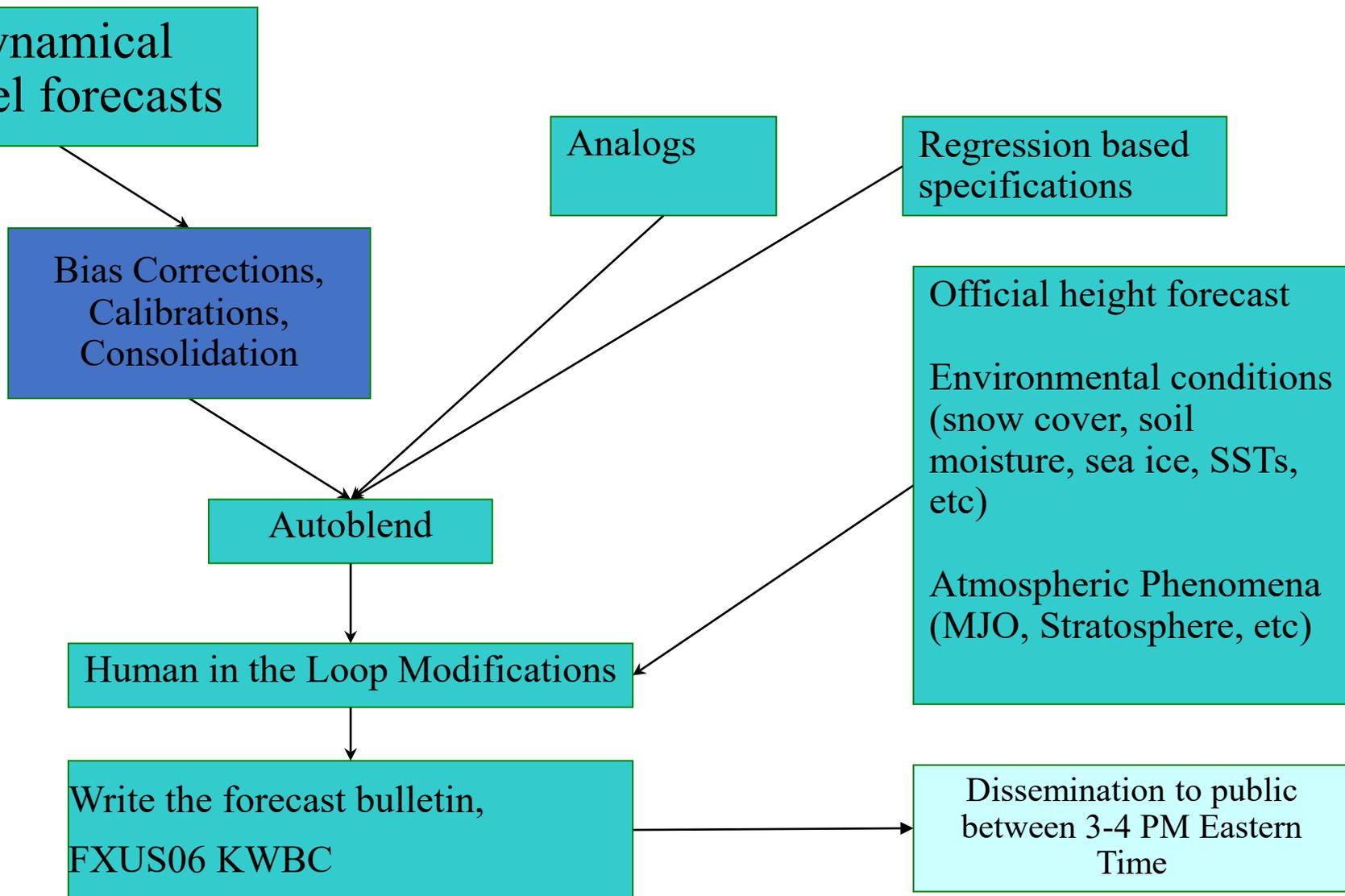
Autoblend

Official height forecast  
Environmental conditions  
(snow cover, soil  
moisture, sea ice, SSTs,  
etc)  
Atmospheric Phenomena  
(MJO, Stratosphere, etc)

Human in the Loop Modifications

Write the forecast bulletin,  
FXUS06 KWBC

Dissemination to public  
between 3-4 PM Eastern  
Time





# Week 2: Forecast Tools



## DYNAMICAL MODELS

- Global Forecast System (GFS) and ensembles
- European Centre for Medium-range Weather Forecasts (ECMWF) ensembles
- Canadian ensembles

## POST-PROCESSING / STATISTICAL TOOLS

- GEFS/ECMWF T, P – bias corrected/calibrated, using reforecasts
- NAEFS – Bias-corrected ensemble forecasts – T, P
- Consolidation – GEFS and ECMWF – Dynamic, skill weighted combination
- GFS P, T – Dynamical model output– calibrated P, T
- Analog composites – Average T, P for the 10 best 500-hPa analogs
- Klein T – Regression
- Teleconnections – Simultaneous, significant temporal correlations for two or more widely separated locations



# Week 2: 500-hPa Height Guidance



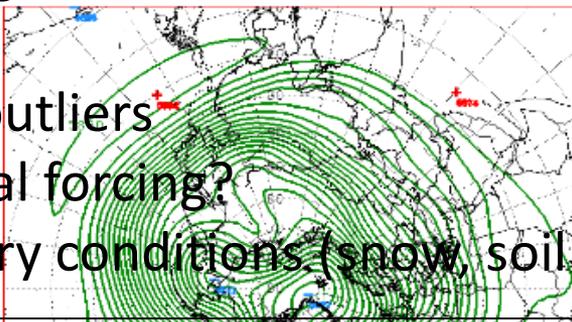
Forecaster considerations: 11/03/2012

- Overall model system agreement
- Ensemble spread
- Run-to-run continuity, outliers
- Consistency with tropical forcing?
- Slowly evolving boundary conditions (snow, soil moisture, local SSTs)

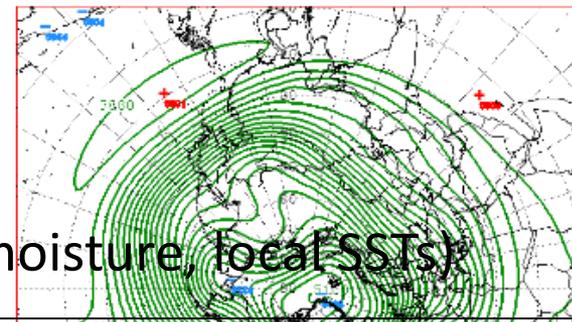
Operational GFS Maps



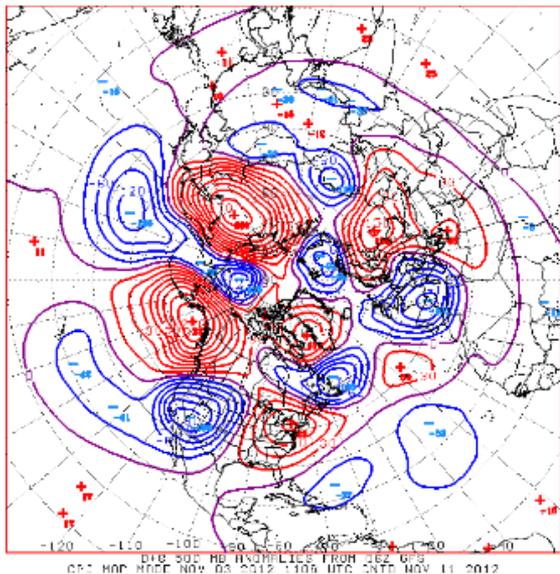
GFS Ensemble Maps



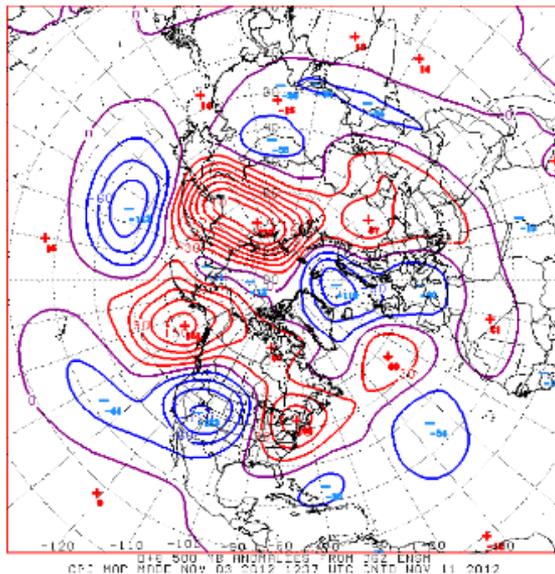
GFS SuperEnsemble



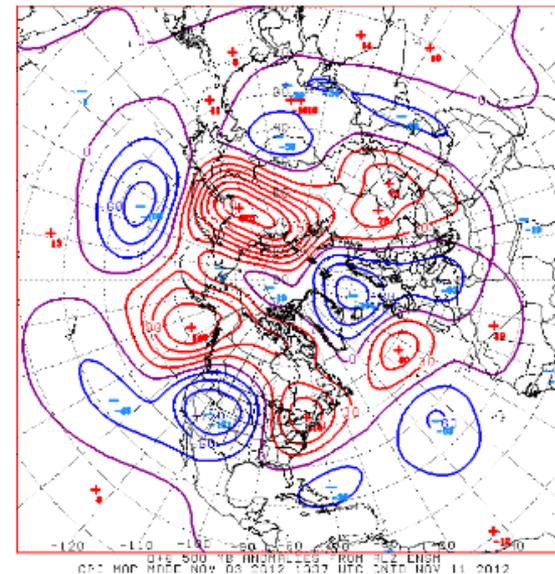
Operational GFS Maps



GFS Ensemble Maps



GFS SuperEnsemble

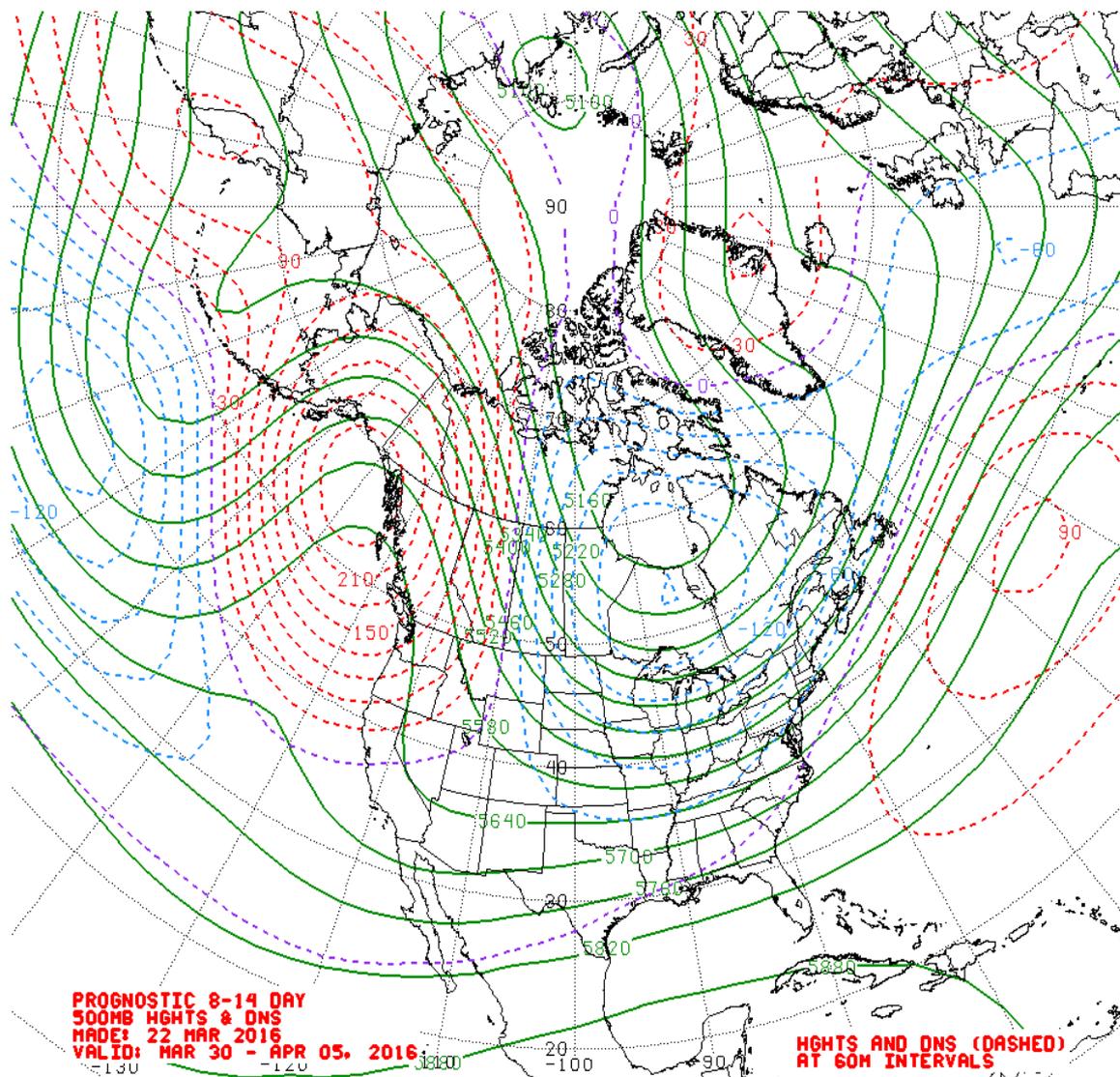


● y12z ● y18z ● 00z ● 06z □ Animate

● y12z ● y18z ● 00z ● 06z □ Animate



# Week 2: 500-hPa Height Outlook



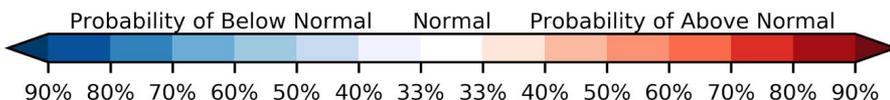
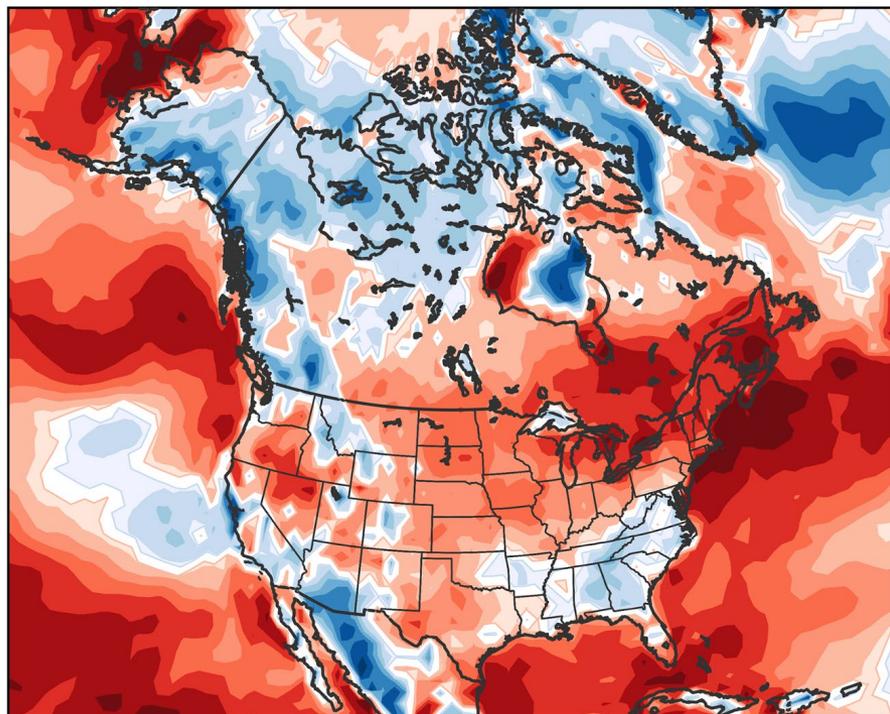
Model	Weight (%)
0Z GEFS Mean	20
6Z GEFS Mean	20
6Z GFS	15
0Z ECMWF Mean	20
y12Z EC Mean	5
0Z CAN Mean	15
y12Z CAN Mean	5



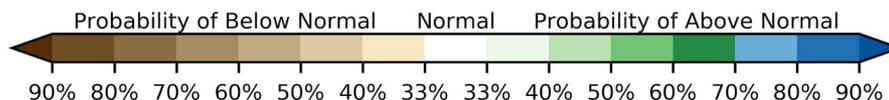
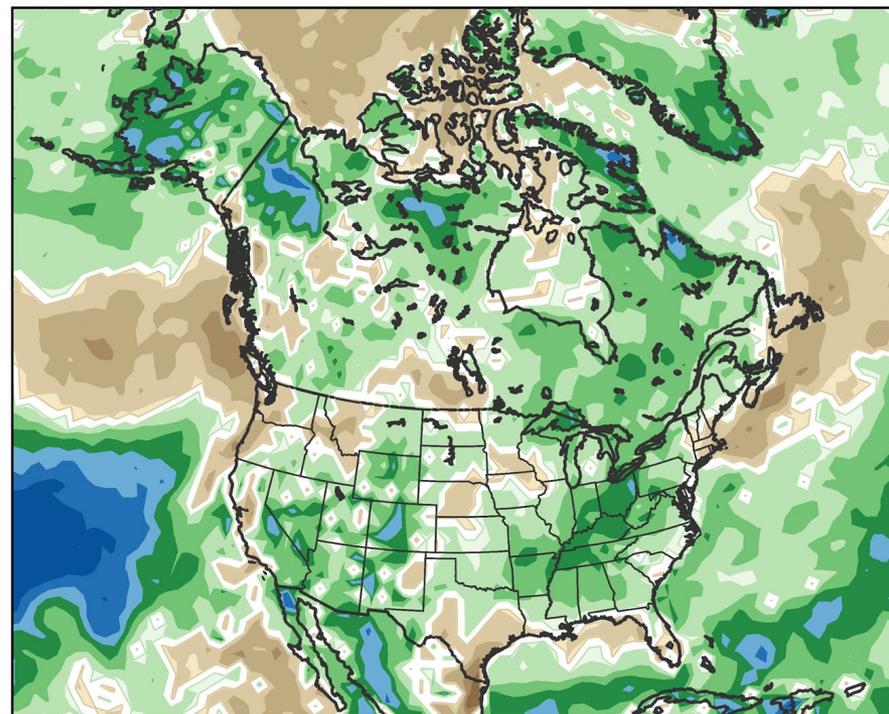
# Week 2: NAEFS



NAEFS Bias-Corrected Tmean Probabilities  
8-14Day Forecast Issued 2018-08-05  
Valid 2018-08-13 to 2018-08-19



NAEFS Raw Precip Probabilities  
8-14Day Forecast Issued 2018-08-05  
Valid 2018-08-13 to 2018-08-19



Bias corrected using forecasts and observations over the past 120 days using a decaying average mean error

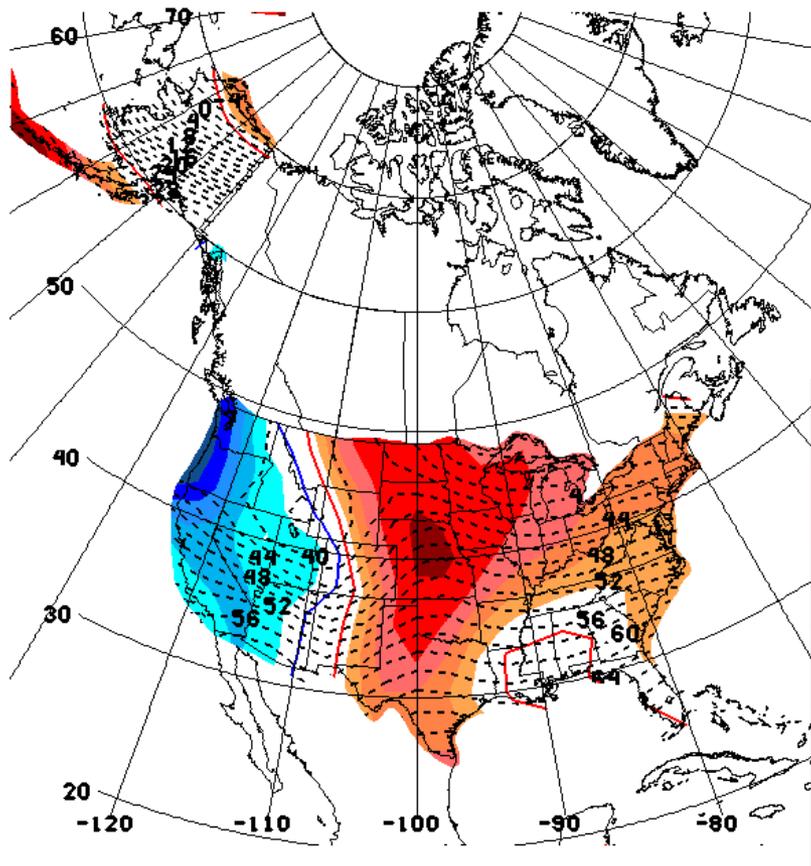


# Week 2: Bias-Correction (short)



## Uncorrected

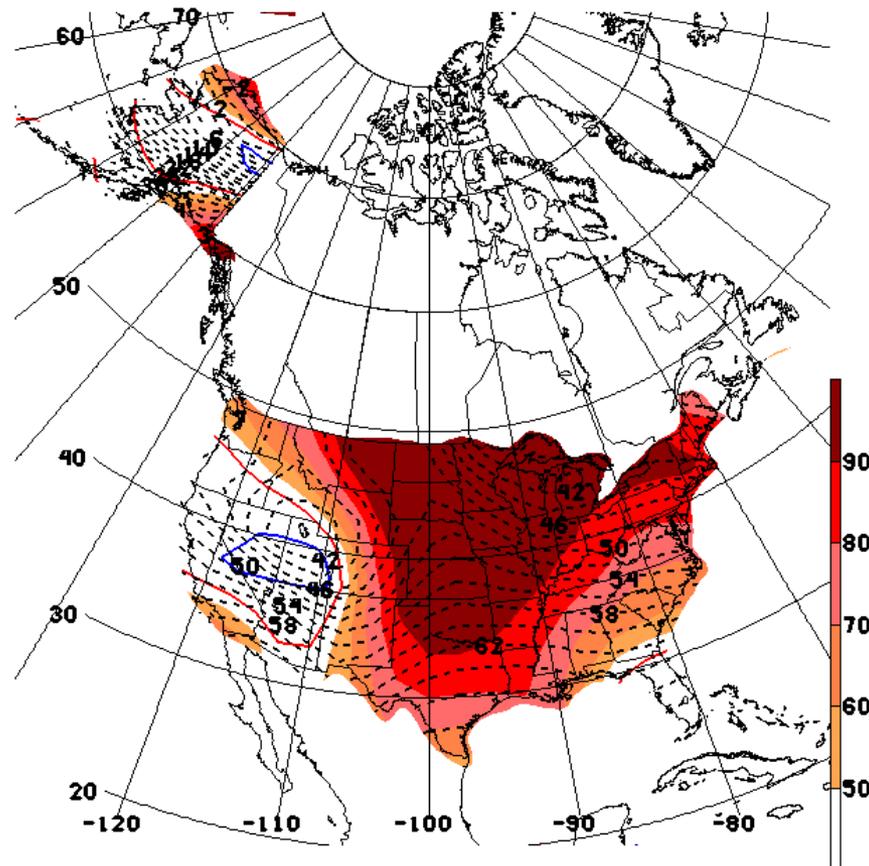
D+11 GFS MEAN 2M UNCALIBRATED TEMPERATURE FORECAST  
FCST 2016/03/11 - 2016/03/17



MAP CREATED 2016 MAR 03

## Bias Corrected

D+11 GFS MEAN 2M CALIBRATED TEMPERATURE FORECAST  
FCST 2016/03/11 - 2016/03/17



MAP CREATED 2016 MAR 03

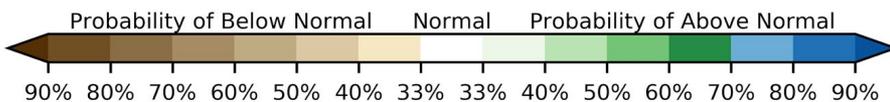
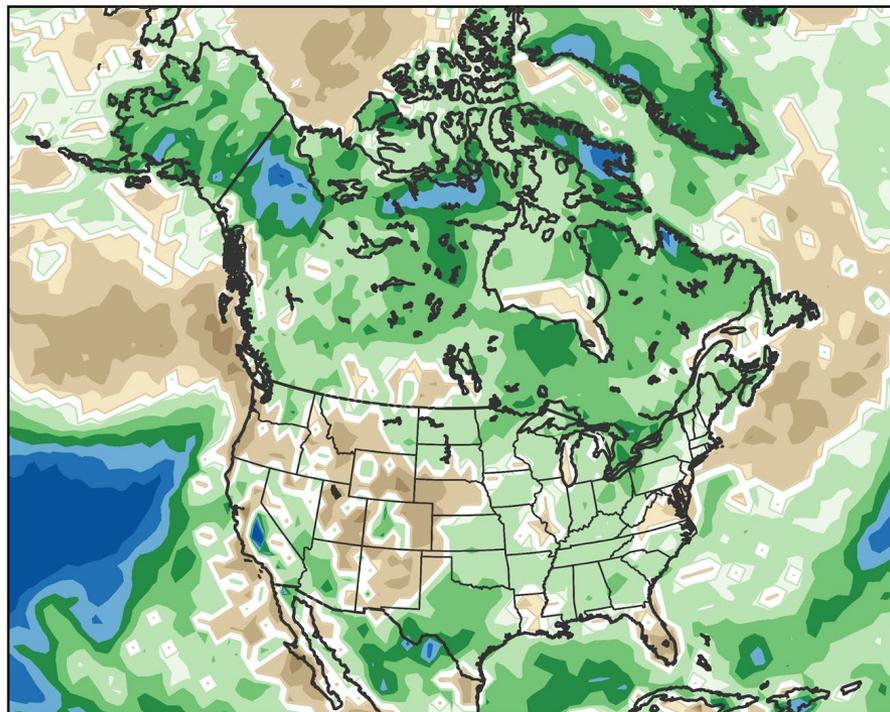
45-day bias removal



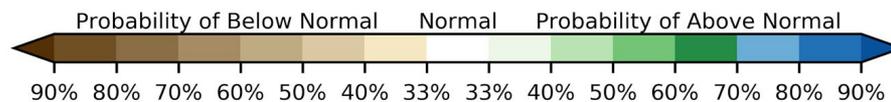
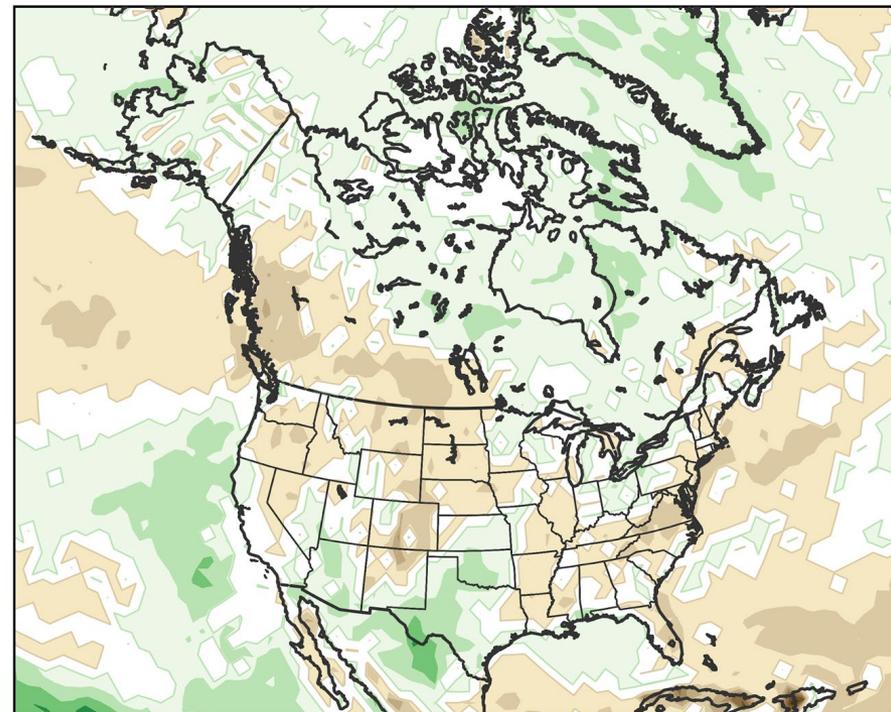
# Week 2: Bias-Correction (reforecast)



ECENS-00Z Raw Precip Probabilities  
8-14Day Forecast Issued 2018-08-05  
Valid 2018-08-13 to 2018-08-19



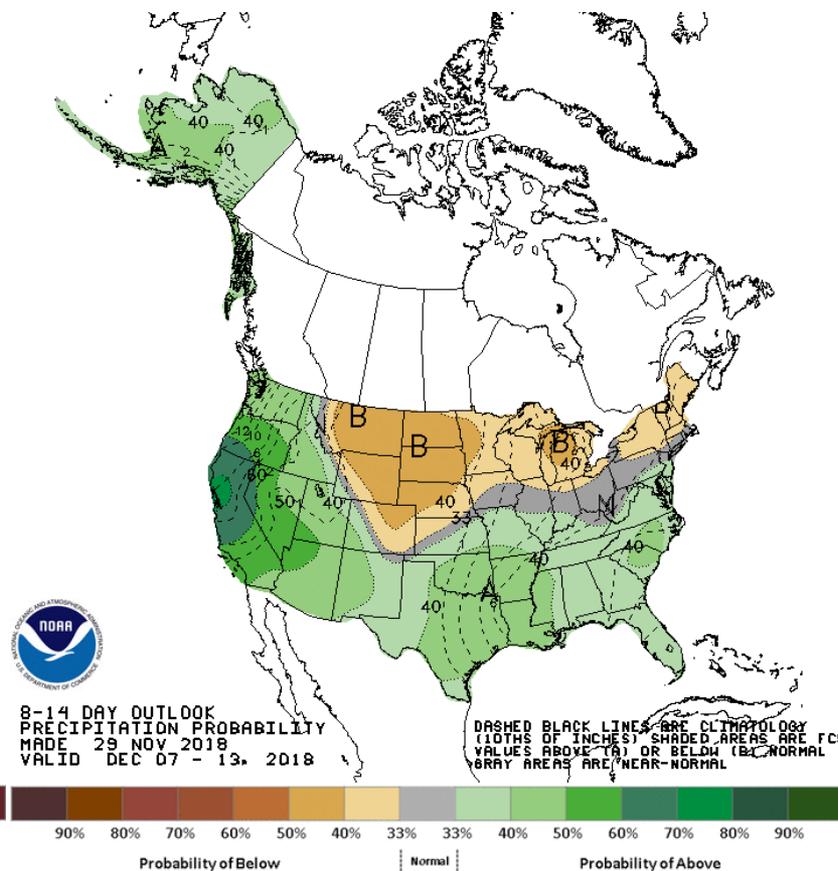
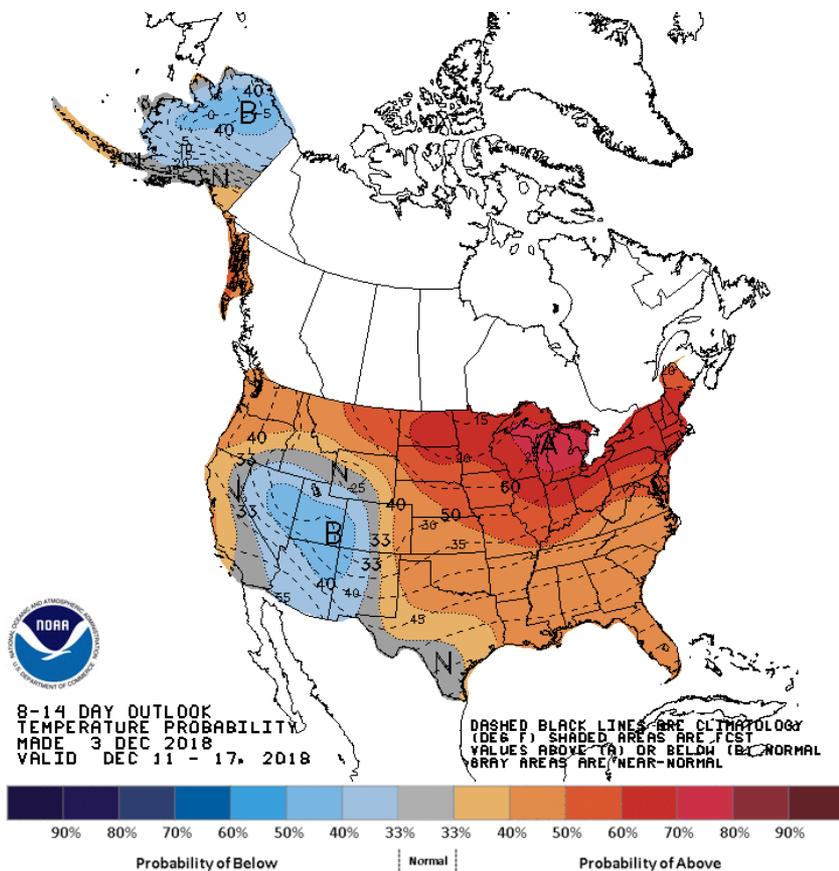
ECENS-00Z Rfcst-Cal Precip Probabilities  
8-14Day Forecast Issued 2018-08-05  
Valid 2018-08-13 to 2018-08-19



Bias correction and calibration using ~20 year reforecast - GEFS and ECMWF (working with Canada to initiate)



# Week 2: Simple "First Guess"



25% NAEFS  
25% GEFS Reforecast  
25% Bias Corrected European  
8.3% Analogs, Kleins, Raw European

20% NAEFS  
40% GEFS Reforecast  
30% ECMWF Reforecast  
10% Analogs from ECMWF



# Week 2: Consolidation "First Guess"



## Skill Weighted Consolidation of Week-2 Forecasts

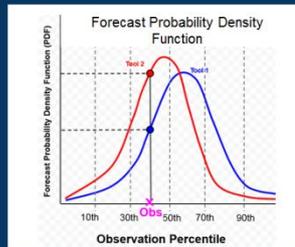
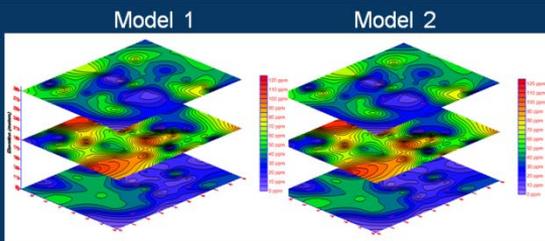
S. Handel, M. Ou, M. Charles, L. He, D. Collins, S. Baxter, D. Unger  
(NOAA/NWS/NCEP/Climate Prediction Center)



Using past forecasts and observations ...

Count the number of times each model "wins"

Calculate weights by summing winning counts over similar type grid points



$$\text{Model weight} = \frac{\# \text{ land point wins}}{(\# \text{ land pts}) * (\# \text{ days w/ no missing data})}$$

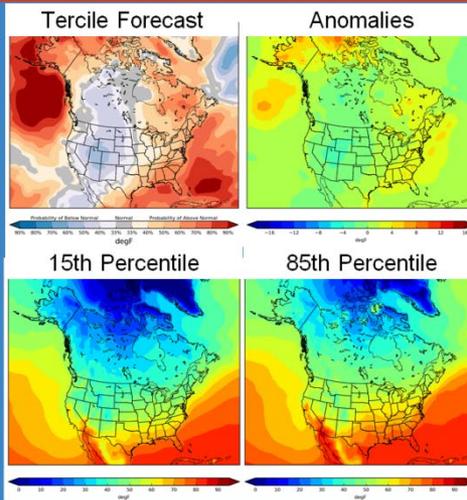
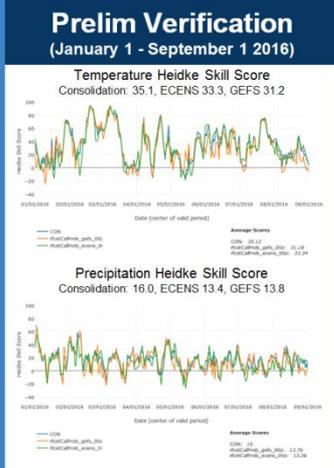
Water	Weights ?	Land

- 1x1 Degree Gridded Reforecast Data
- Ensemble Regression Calibration
- 1985-2010 Reference Period

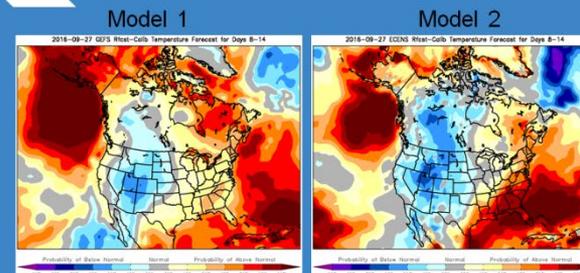
- Observation Sources: Global Telecommunication System (Temperature), CPC Unified Gauge-Based Analysis (Precipitation)

- 9 Point Smoother (1x1 Degree Resolution)

... optimally combine real-time forecasts



$$\text{final probability (prob)} = \text{weight}_{\text{tool1}} * \text{prob}_{\text{tool1}} + \text{weight}_{\text{tool2}} * \text{prob}_{\text{tool2}}$$



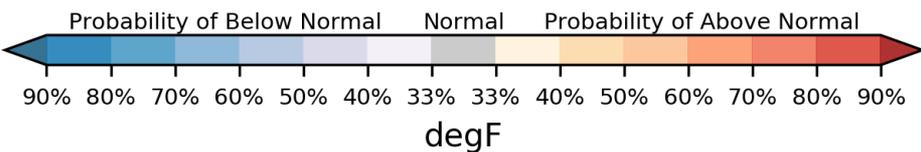
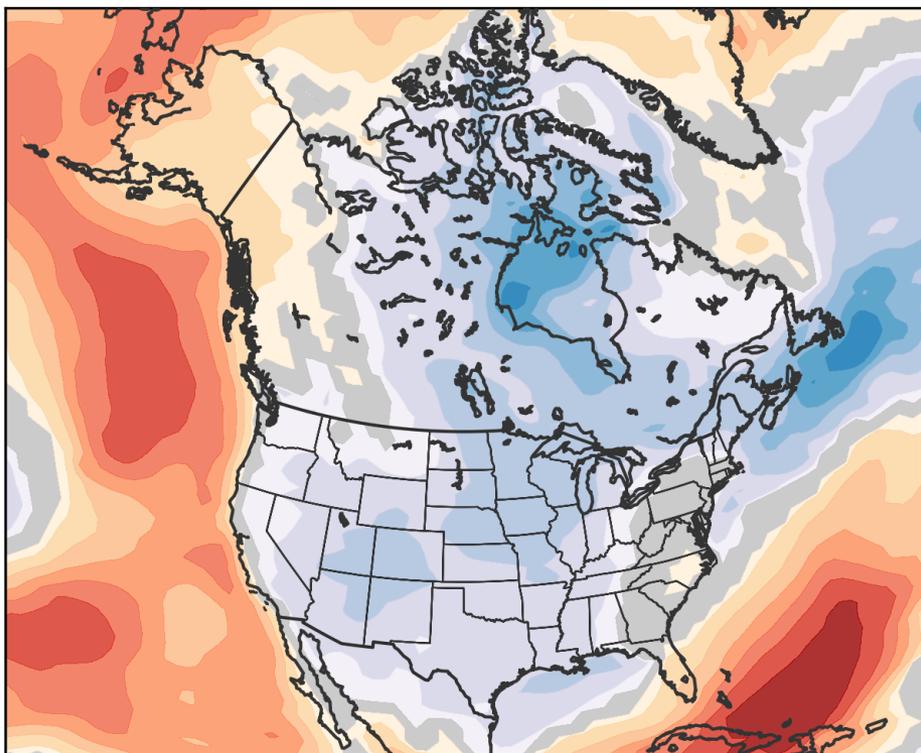
- 135 Day Evaluation Period
- 90 Days from Previous Year (Centered on Forecast Valid Period)
- Last 45 Days from Current Year



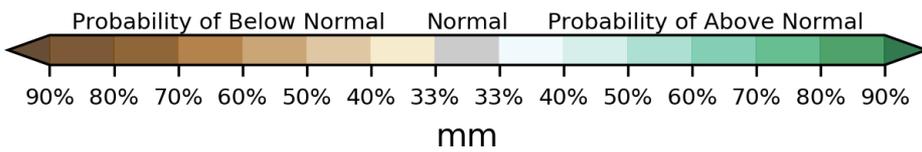
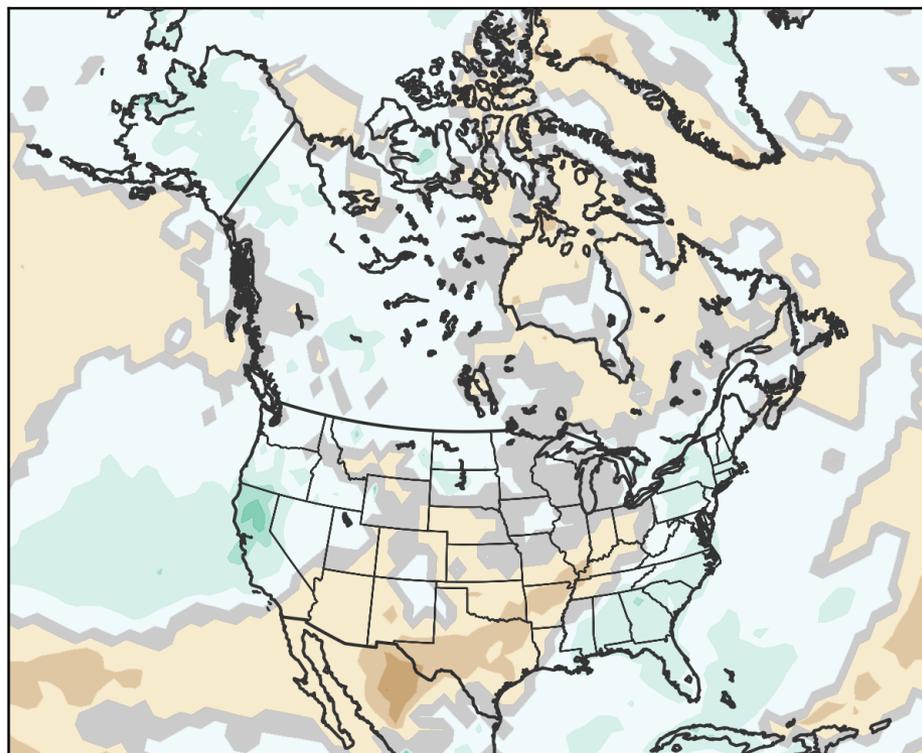
# Week 2: Consolidation "First Guess"



Consolidated 8-14day tmean issued 20181126  
valid 20181204 - 20181210

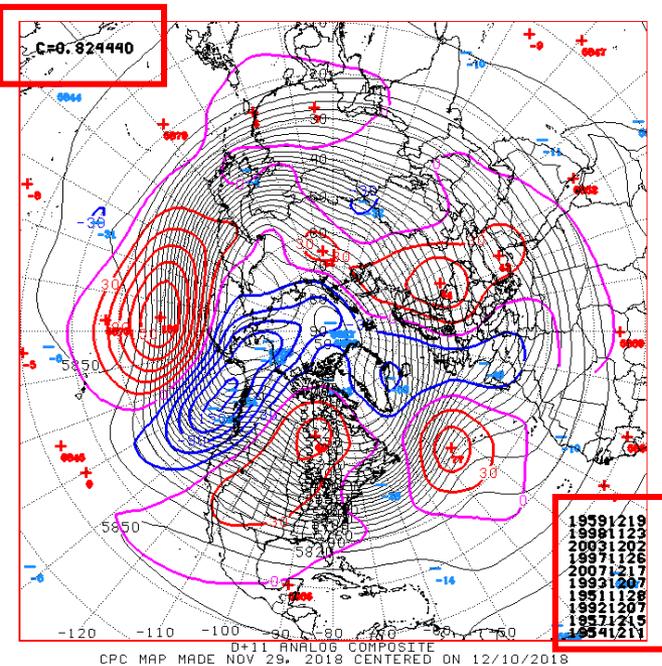


Consolidated 8-14day precip issued 20181126  
valid 20181204 - 20181210

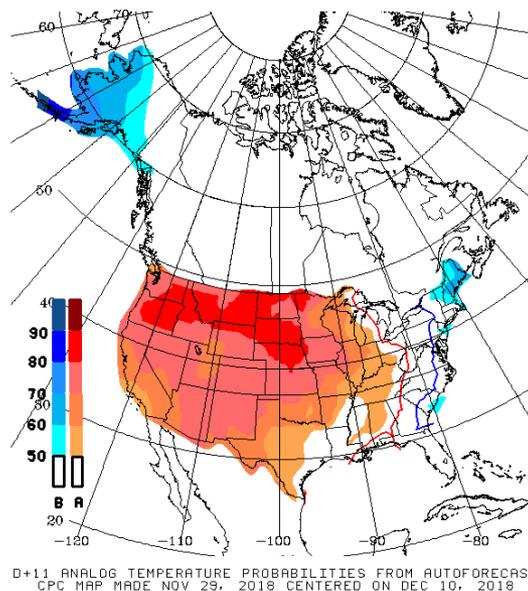




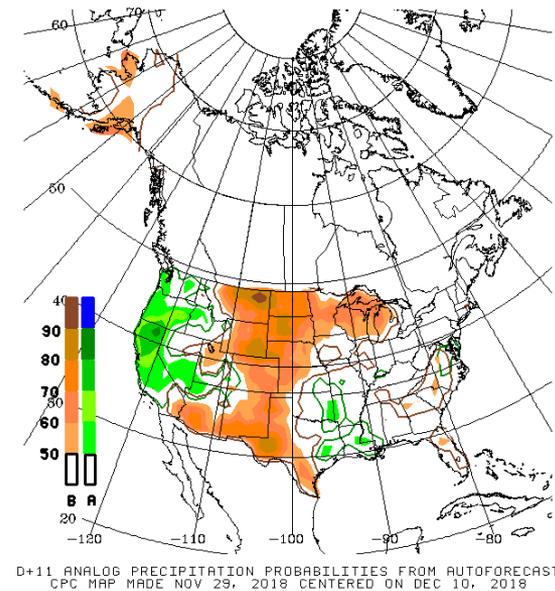
# Week 2: Natural Analogs



500-hPa height



Temperature



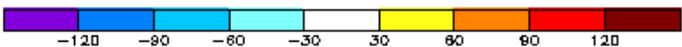
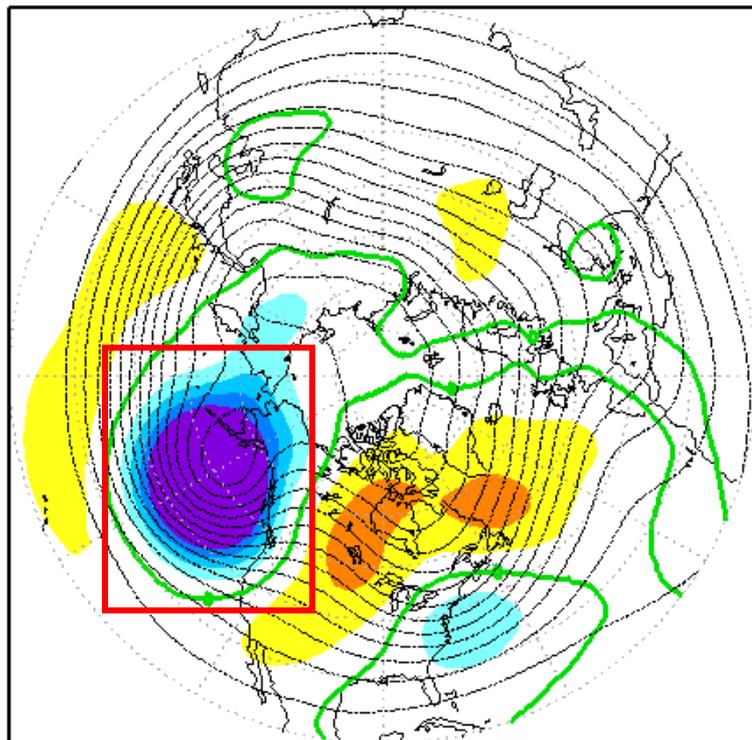
Precipitation



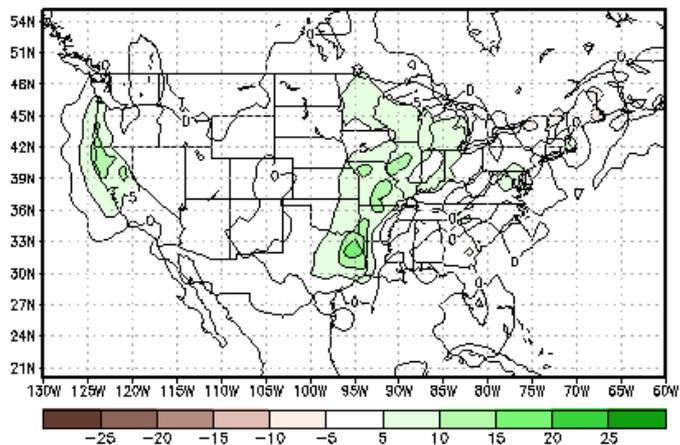
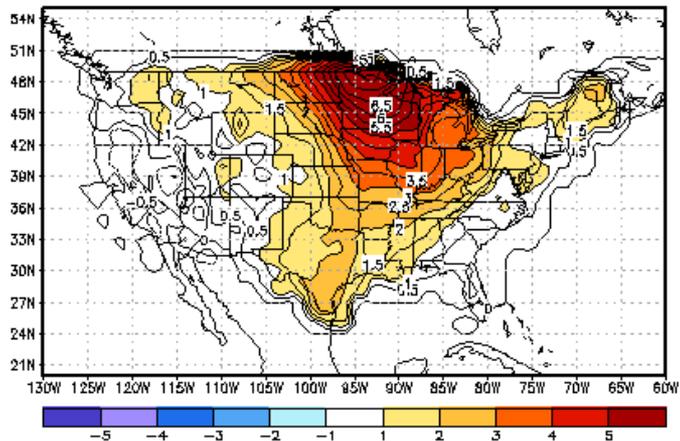
# Week 2: Teleconnections



Negative Phase at 51N 148W  
for month Dec



Positive Phase at 56N 80W  
for month Dec



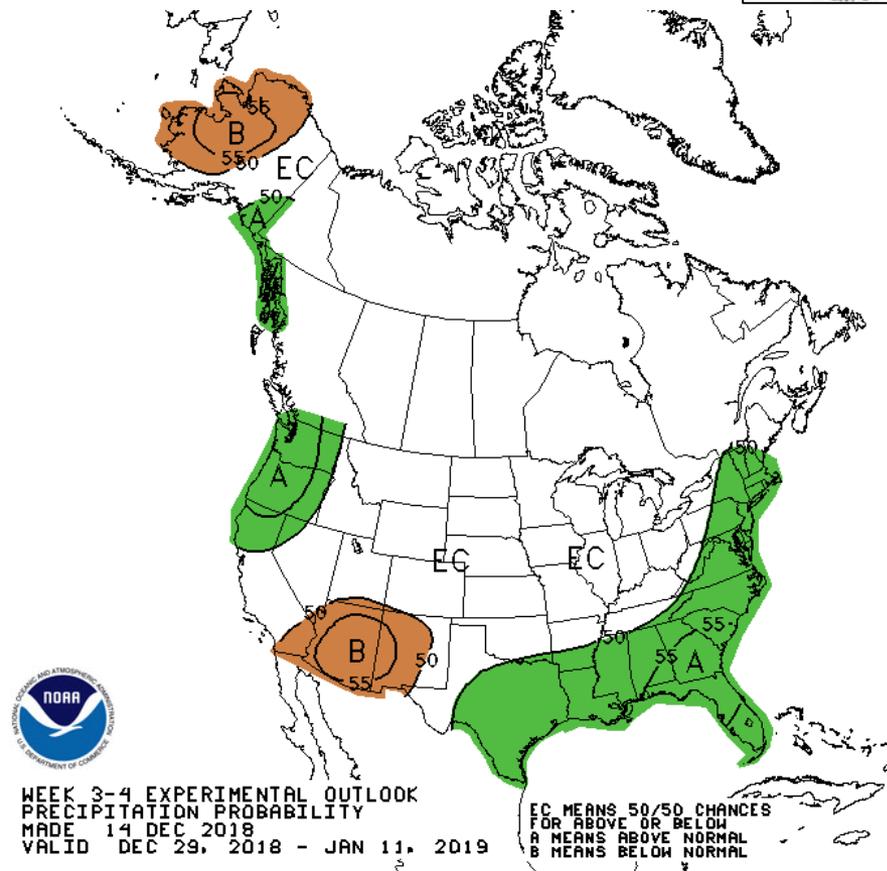
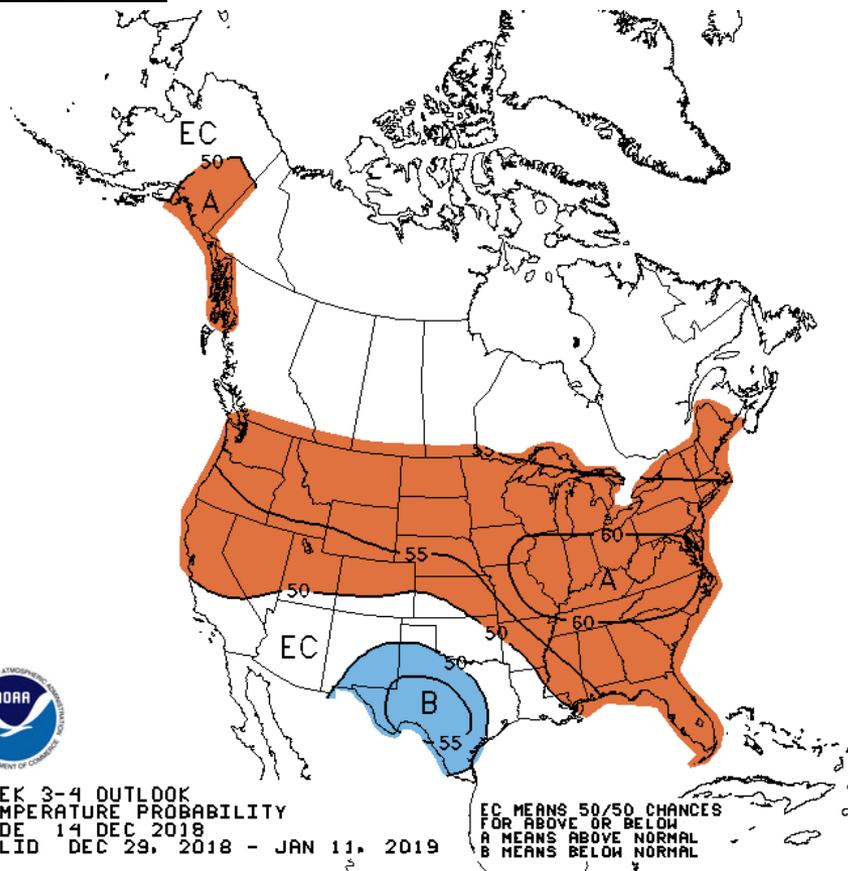
- Inspect data for remote relationships based on phase, location and season of a height anomaly center of action
- Link with observed temperature and precipitation for these respective cases



- Overview of CPC Outlooks, Process, Tools and Services:
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  - 5) Drought Outlooks (SDO & MDO)
  
- Verification of Outlooks



# Week 3-4: Interpretation



- Two category outlook for above- or below-normal 2-week mean temperature and 2-week total precipitation amounts
- “EC” areas indicate 50% probability for each category



# Week 3-4: Process



Surface

Dynamical  
model forecasts

Statistical Tools

Bias Corrections,  
Calibrations,  
Consolidation

Create surface temp/precip outlooks (probabilities, dominant category) using tools  
Write the forecast bulletin

Dissemination to public between 3-4 PM  
Eastern Time  
Weekly - Friday

# Week 3-4: Forecast Tools



## Dynamical Model Guidance

- Climate Forecast System (CFS) lagged ensemble
- European Centre for Medium-range Weather Forecasts (ECMWF) ensembles
- Japan Meteorological Agency (JMA) ensembles
- Environment Canada Climate and Change (ECCC) ensembles
- Experimental Sub-X forecast guidance

## Post processing – Statistical Forecast Guidance

- CFS/ECWFMF/JMA/ECCC T, P – bias corrected/calibrated using reforecasts
- Consolidation products – Equal weighted, correlation weighted combination
- Multiple linear regression (ENSO, MJO, Trend)
- Constructed Analogue (based on 200-hPa streamfunction)
- Subjectively weighted “autoblend” first guess forecast tool



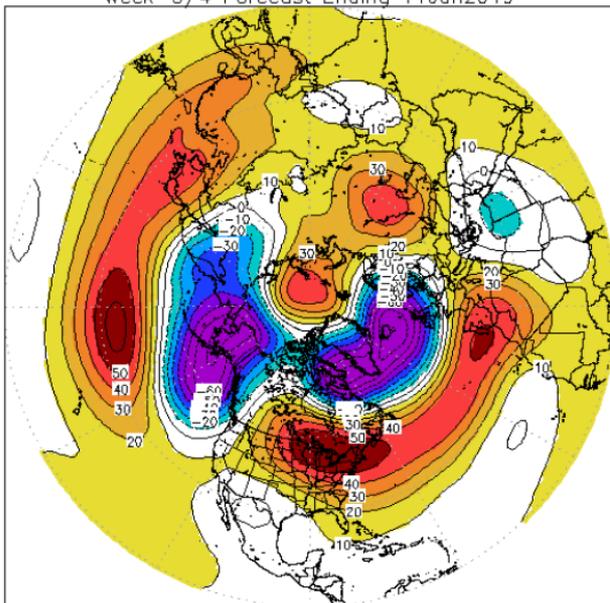
# Week 3-4: 500-hPa Height Guidance



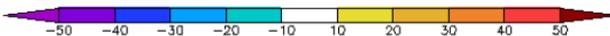
**CFS**

[Product Description](#)

CFS 500hPa Height Anomalies Issued 13Dec2018  
Week-3/4 Forecast Ending 11Jan2019



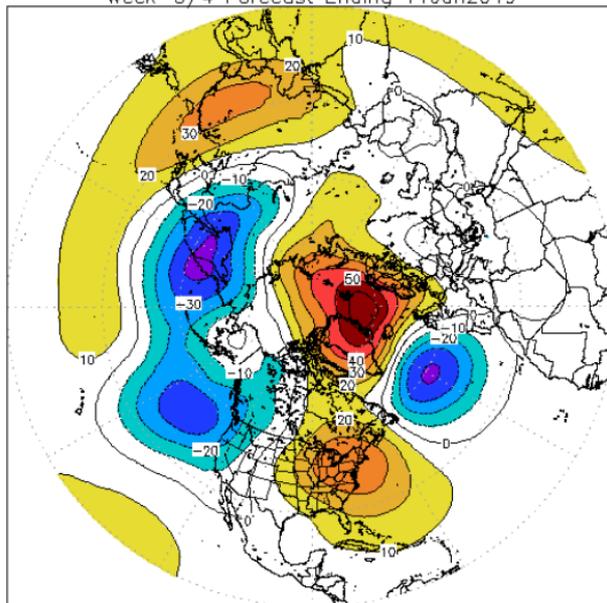
(meters)



**ECMWF**

[Product Description](#)

ECMWF 500hPa Height Anomalies Issued 13Dec2018  
Week-3/4 Forecast Ending 11Jan2019



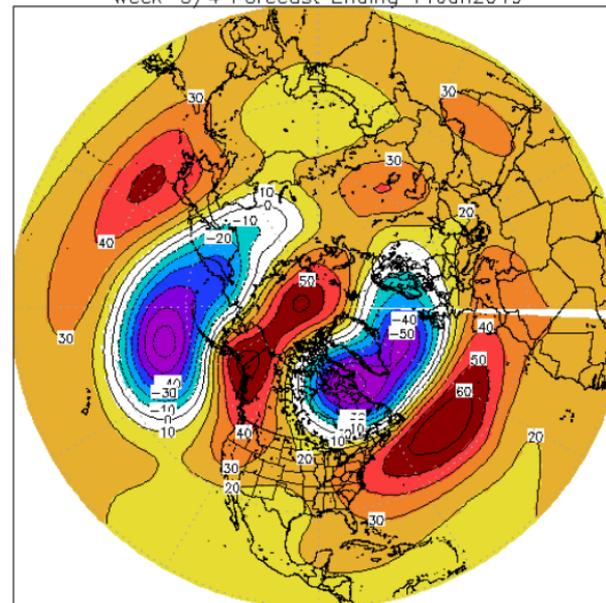
(meters)



**JMA**

[Product Description](#)

JMA 500hPa Height Anomalies Issued 12Dec2018  
Week-3/4 Forecast Ending 11Jan2019

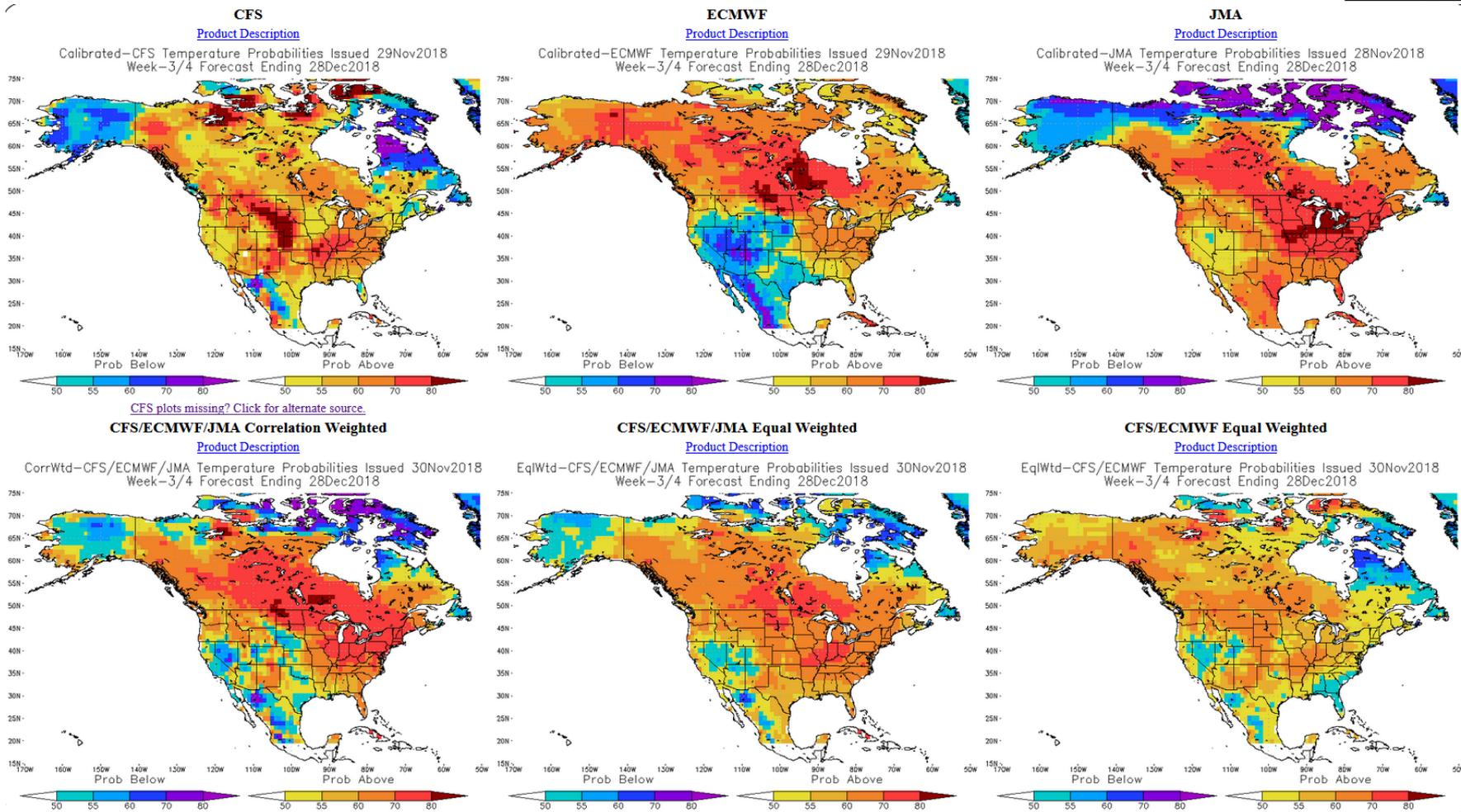


(meters)





# Week 3-4: Temperature Guidance



- Bias-corrected and calibrated probabilistic temperature forecasts
- Objective combinations available



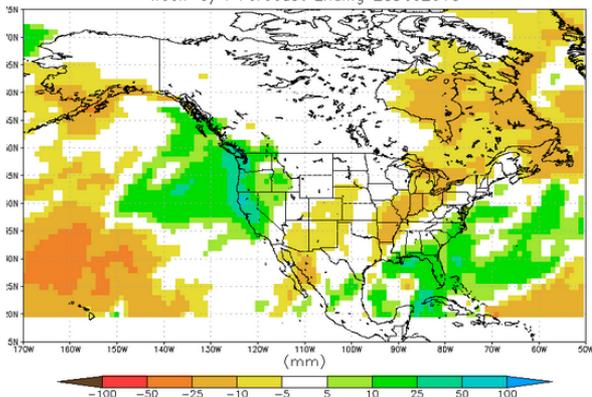
# Week 3-4: Precipitation Guidance



CFS

[Product Description](#)

CFS Precipitation Anomalies Issued 29Nov2018  
Week-3/4 Forecast Ending 28Dec2018

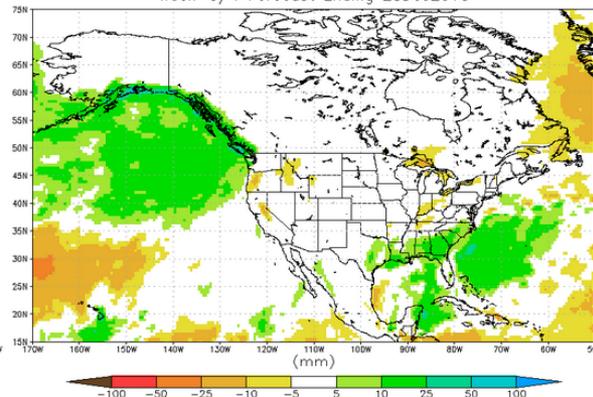


[CFS plots missing? Click for alternate source.](#)

ECMWF

[Product Description](#)

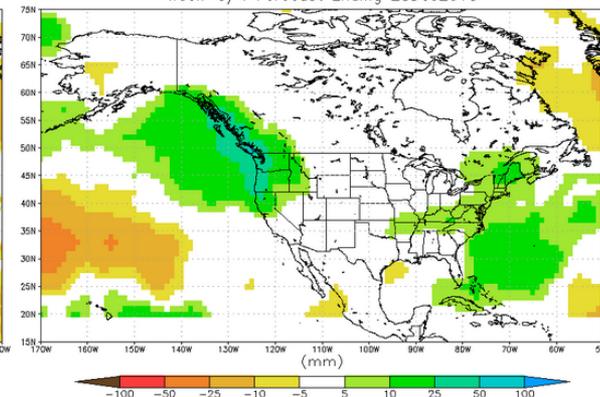
ECMWF Precipitation Anomalies Issued 29Nov2018  
Week-3/4 Forecast Ending 28Dec2018



JMA

[Product Description](#)

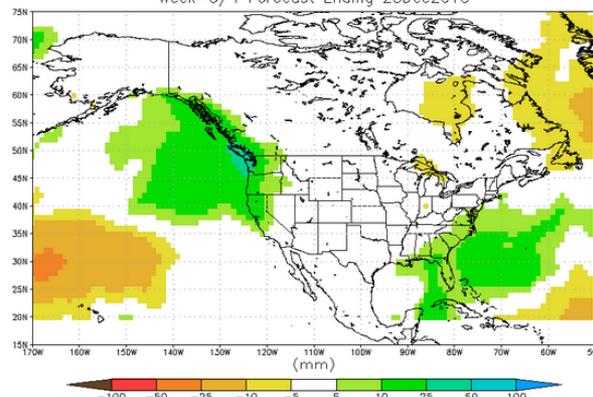
JMA Precipitation Anomalies Issued 28Nov2018  
Week-3/4 Forecast Ending 28Dec2018



CFS/ECMWF/JMA Equal Weighted

[Product Description](#)

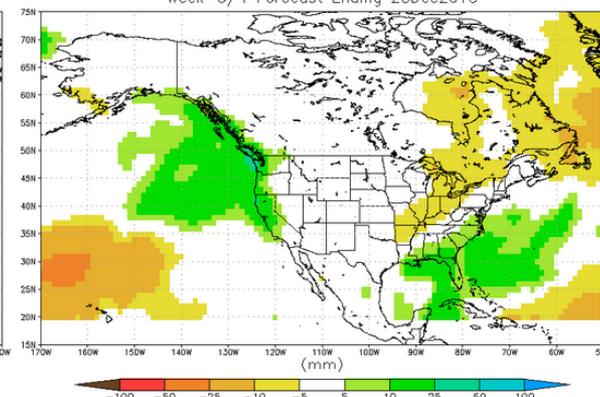
EqWtd-CFS/ECMWF/JMA Precipitation Anomalies Issued 30Nov2018  
Week-3/4 Forecast Ending 28Dec2018



CFS/ECMWF Equal Weighted

[Product Description](#)

EqWtd-CFS/ECMWF Precipitation Anomalies Issued 30Nov2018  
Week-3/4 Forecast Ending 28Dec2018



- Bias-corrected and calibrated precipitation anomaly forecasts
- Objective combinations available

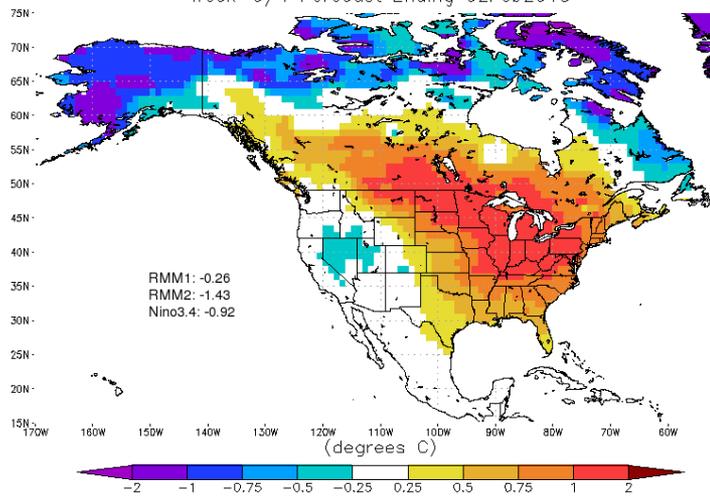


# Week 3-4: Multiple Linear Regression



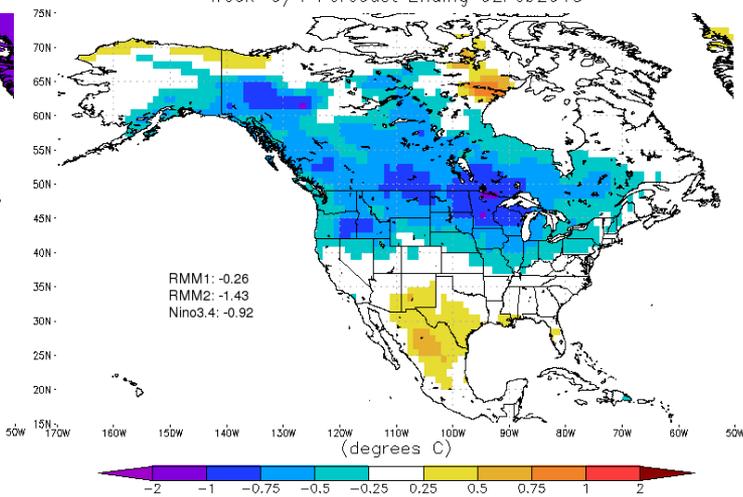
MJO

MLR-MJO Temperature Anomalies Issued 05Jan2018  
Week-3/4 Forecast Ending 02Feb2018



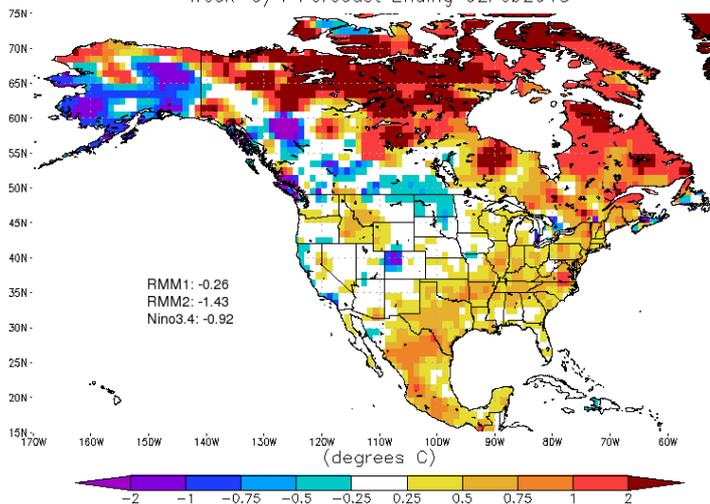
ENSO

MLR-ENSO Temperature Anomalies Issued 05Jan2018  
Week-3/4 Forecast Ending 02Feb2018



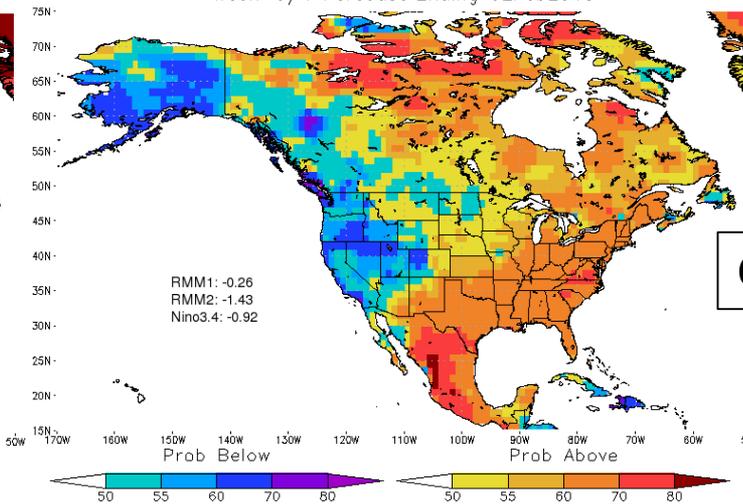
Trend

MLR-Trend Temperature Anomalies Issued 05Jan2018  
Week-3/4 Forecast Ending 02Feb2018



Combined

MLR-Combined Temperature Probabilities Issued 05Jan2018  
Week-3/4 Forecast Ending 02Feb2018



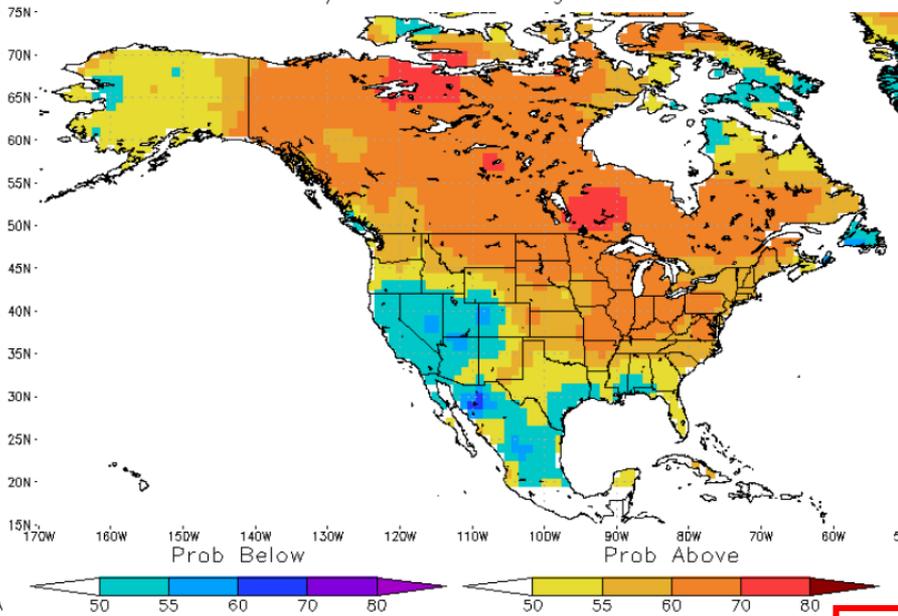


# Week 3-4: Consolidation "First Guess"



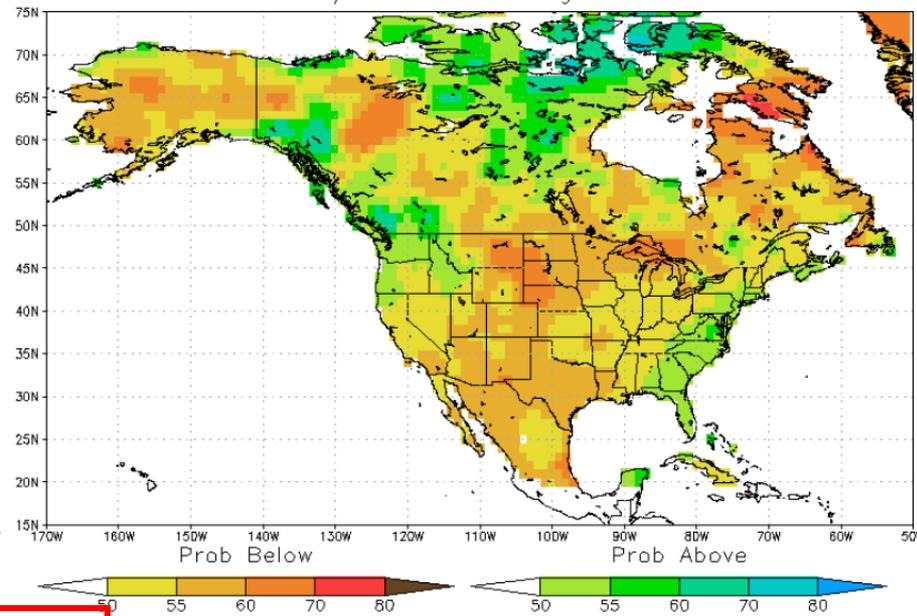
Temperature

Autoblend-Dynamical/MLR Temperature Probabilities Issued 30Nov2018  
Week-3/4 Forecast Ending 28Dec2018



Precipitation

Autoblend-Dynamical/MLR Precipitation Probabilities Issued 30Nov2018  
Week-3/4 Forecast Ending 28Dec2018



MLR Week 3/4: 35%  
ECMWF: 30%  
CFS: 25%  
JMA: 10%

- Autoblend combination of dynamical and statistical guidance
- Weights in this forecast tool are subjectively chosen (red box)



# Outline



- Overview of CPC Outlooks, Process, Tools and Services:
  - 1) Week 2 (Days 8-14)
  - 2) Week 3-4
  - 3) Monthly and Seasonal Outlooks (LLF)**
  - 4) Global Tropics Hazards Outlook (GTH)
  - 5) Drought Outlooks (SDO & MDO)
  
- Verification of Outlooks

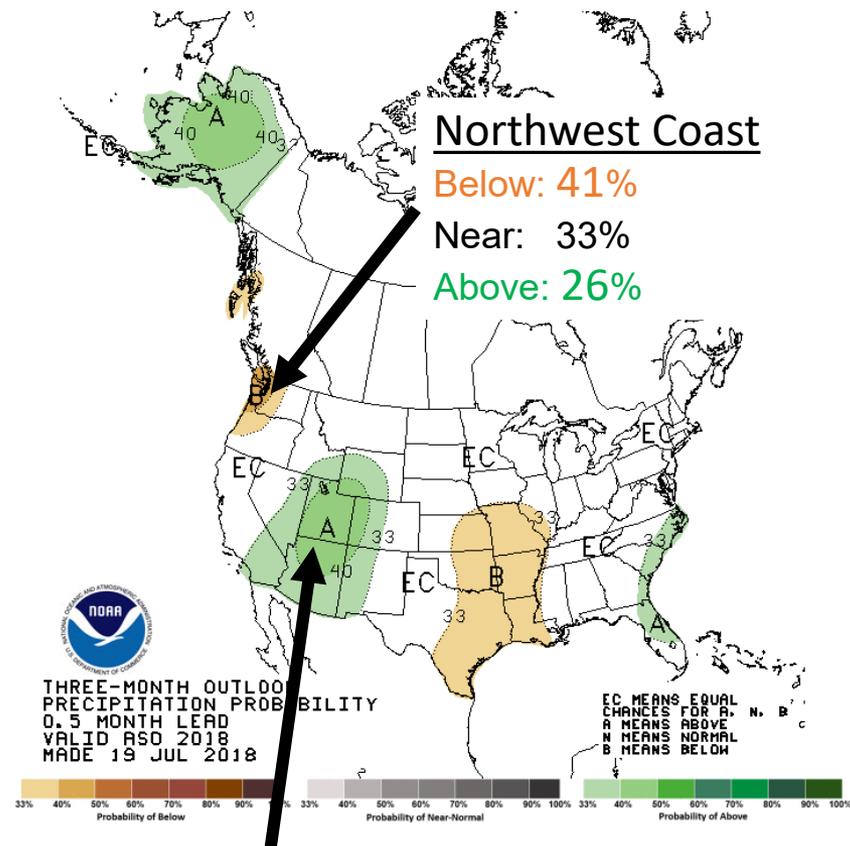
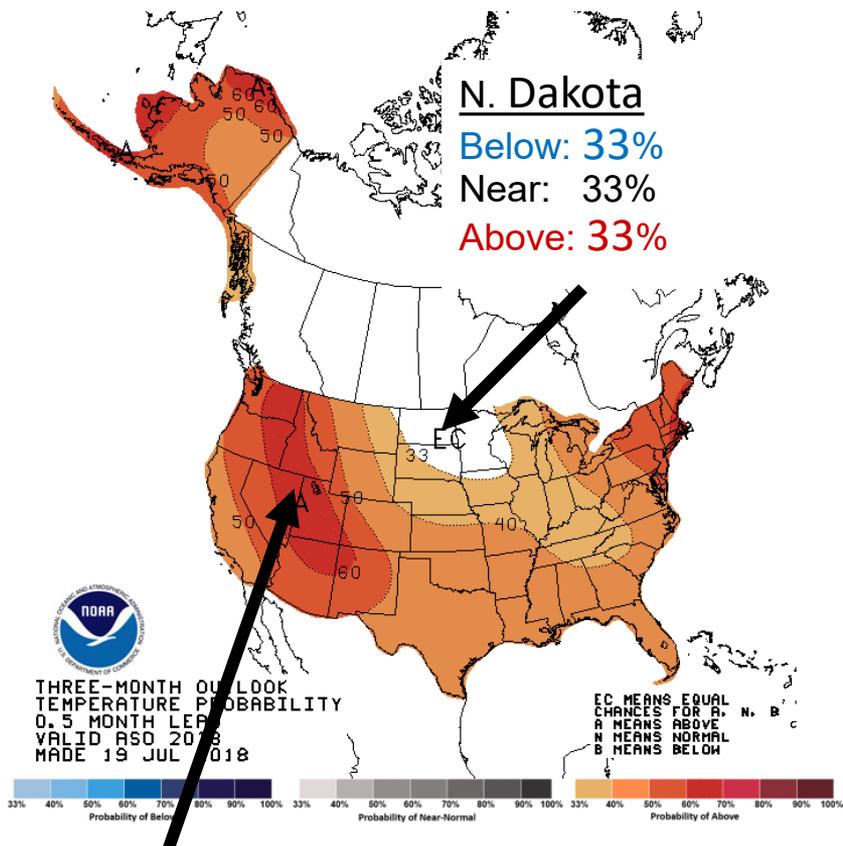


# LLF Outlooks: Interpretation



## Temperature

## Precipitation





# LLF Outlooks: Interpretation



**IMPORTANT:** Static maps (previous slide) can hide the fact that all locations actually relate information about odds for all three categories

INTERACTIVE DISPLAY - UPDATED: 18 APR 2019

Find address or place

[7 Day Forecast for Lander, WY](#)

Three Category Temperature Outlook  
 Normal Maximum Temperature: **64**  
 Normal Minimum Temperature: **36**

Above Normal  
 Below Normal  
 Near Normal

Three Category Precipitation Outlook  
 Normal Precipitation: **6.22**

Above Normal  
 Below Normal  
 Near Normal

**Select Lead**

**Seasonal Outlook**  
 May 2019-July 2019 (Lead 1)

**Temperature**  Outlook  
**Precipitation**  Outlook

Opacity: 70%

<< Below Normal Above Normal >>

POWERED BY **esri**  
 Esri. FAO. NOAA



# LLF Outlooks: Forecast Basis



- Persistent or recurring atmospheric circulation patterns associated with anomalies in:
  - ✓ the initial state of the climate system, or
  - ✓ boundary conditions
- El Niño and La Niña: anomalous climate states whose development, persistence and evolution are somewhat understood
- Potentially persistent or recurring atmospheric circulation patterns that are less well understood: AO, NAO, PNA
- Unidentified persistent atmospheric patterns may arise from the initial state of the climate system or from boundary forcing
- Decadal variability or trends



# LLF Outlooks: Process



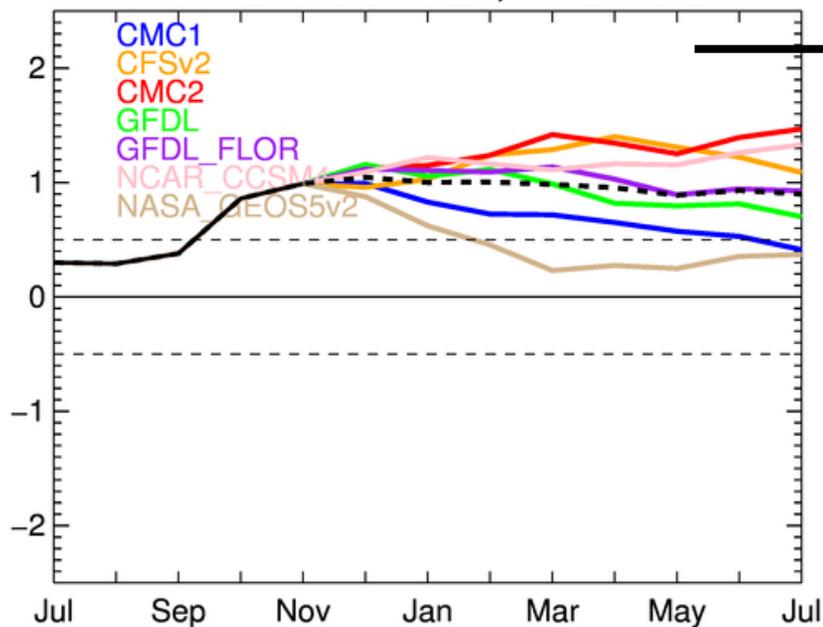
- Seasonal temperature and precipitation forecasts are based on a combination of *statistical* and *dynamical* forecasts
- An objective *consolidation* of forecast information often provides the starting point for the outlook map
- Model forecasts (specifically the NMME) now play a large role
- A forecaster subjectively adjusts the forecast
- A team of seasonal forecasters reviews the forecasts with input from across NOAA and other agencies
  - Internally, forecasters gather Friday before release date to review the current climate state, previous forecasts and draw preliminary maps
  - Call on Tuesday before release date to review the forecaster's preliminary maps is open to entire NWS
- Release date every third Thursday of the month
- **Monthly ENSO forecast is always updated prior to the start of the seasonal forecast process (2<sup>nd</sup> Thursday)**



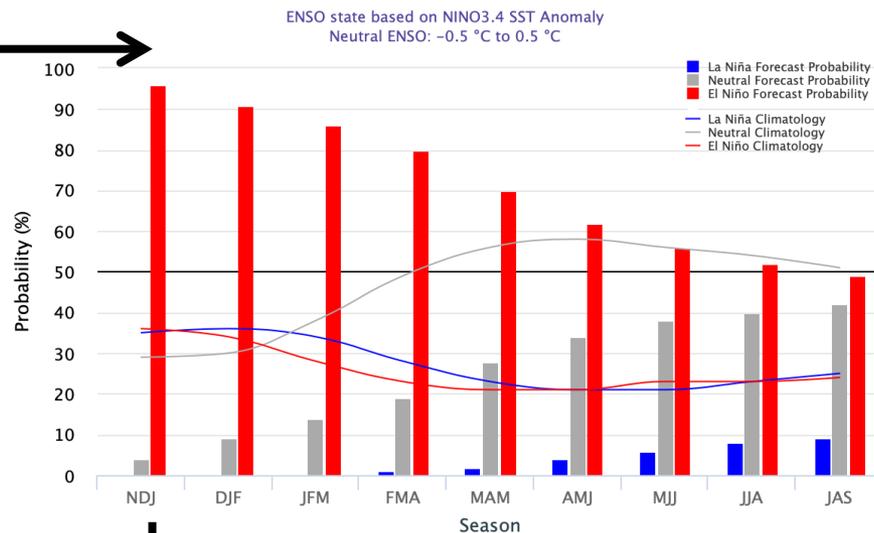
# LLF Outlooks: ENSO



### NMME Nino3.4 Fcst, IC=201812

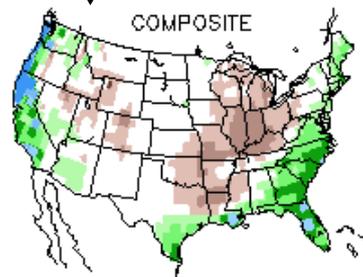


### Early-December 2018 CPC/IRI Official Probabilistic ENSO Forecasts

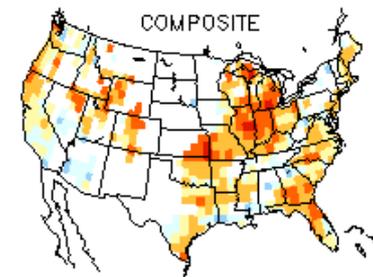


### JFM EL NINO PRECIPITATION ANOMALIES (MM) AND FREQUENCY OF OCCURRENCE (%)

#### ANOMALIES



#### FREQUENCY





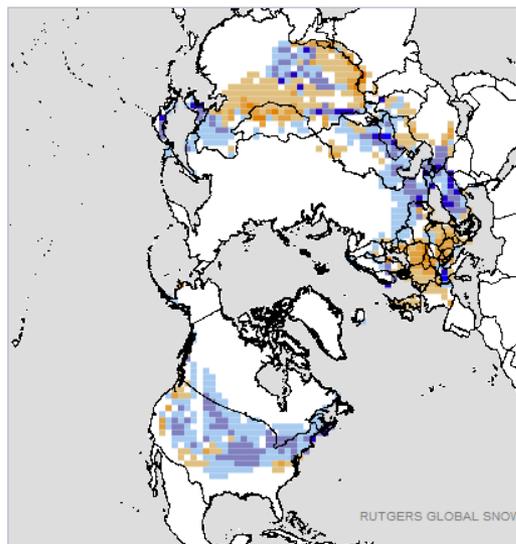
# LLF Outlooks: Boundary Conditions



## Snow cover



Departure from Normal - December 2013

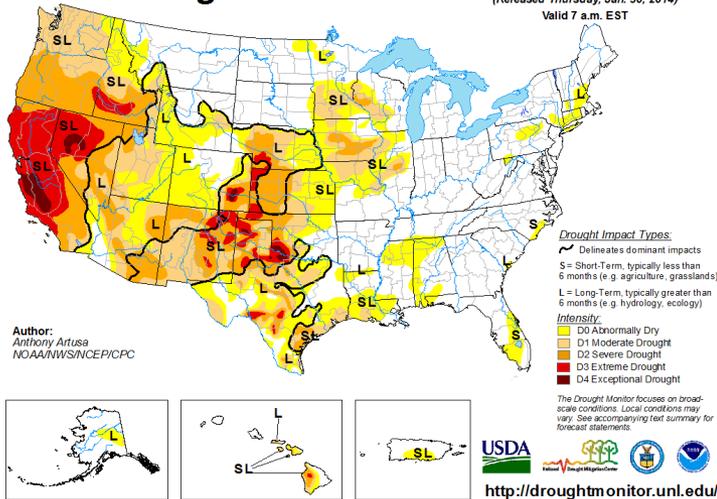


Legend: -100 -70 -75 -61 -50 -20 -25 -0 -6 -5 0 -25 20 -50 51 -75 75 -100

## Soil moisture

### U.S. Drought Monitor

January 28, 2014  
(Released Thursday, Jan. 30, 2014)  
Valid 7 a.m. EST

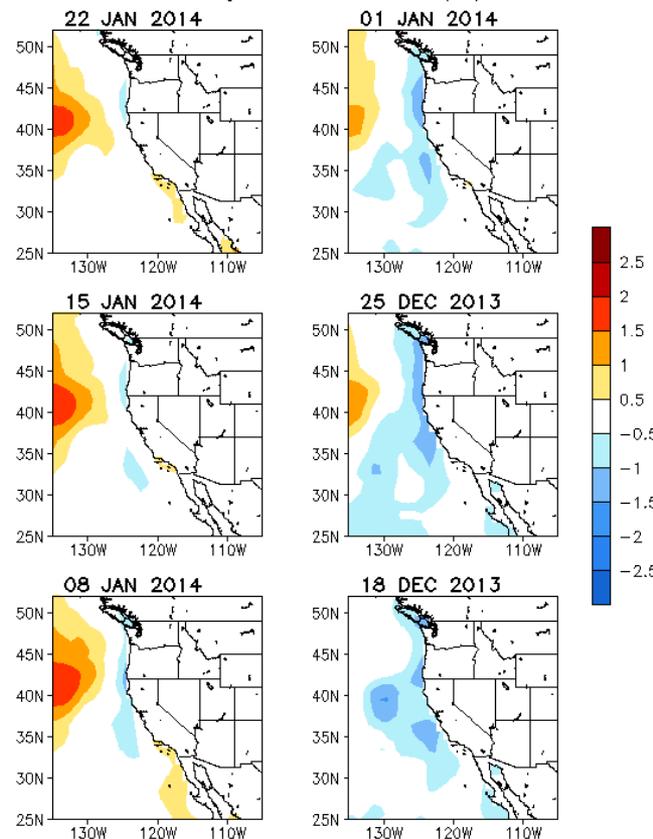


Author:  
Anthony Artusa  
NOAA/NWS/NCEP/CPC

USDA  
<http://droughtmonitor.unl.edu/>

## Local SSTs

Weekly OI SST Anom. (°C)



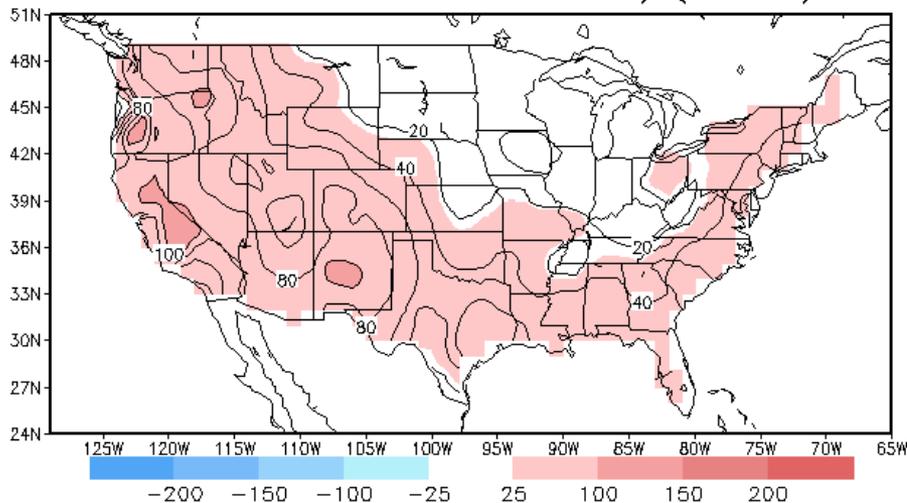
2.5  
2  
1.5  
1  
0.5  
-0.5  
-1  
-1.5  
-2  
-2.5



# LLF Outlooks: Long Term Trends

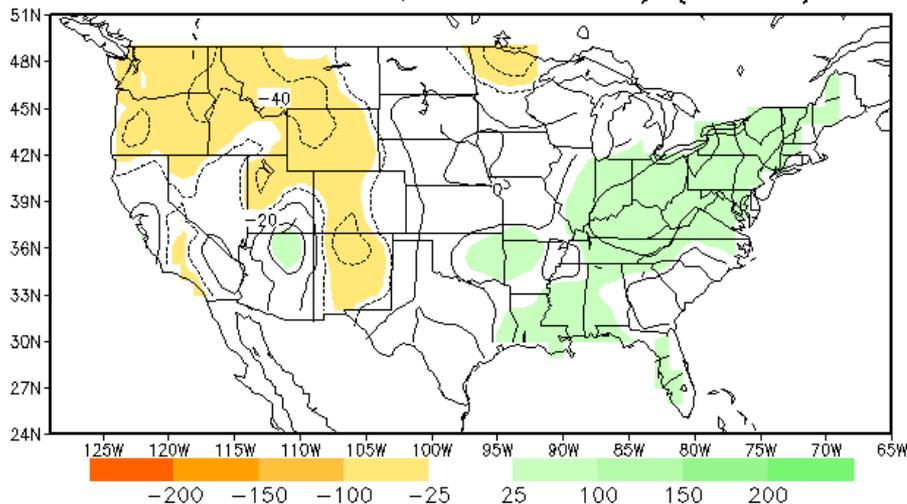


hmgz temperature OCN (15 year) forecast for JJA  
base 1981-2010; units: anomaly (sdX100)



Huuq van den Doel, CPC/NCEP/NWS/NOAA; untampered OCN; data thru Aug 2017

hmgz precipitation OCN (15 year) forecast for JJA  
base 1981-2010; units: anomaly (sdX100)



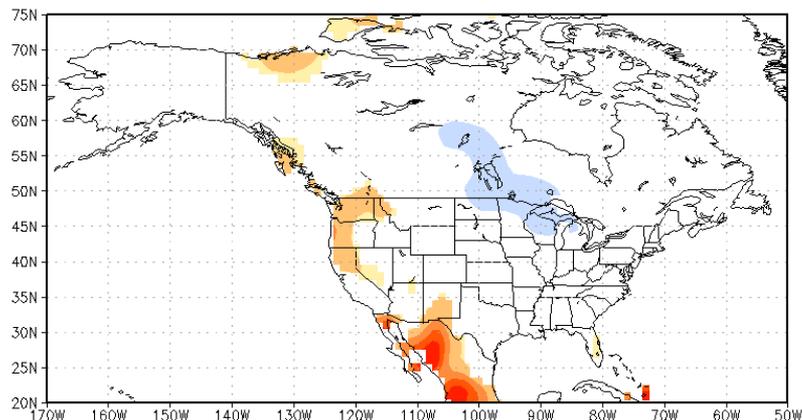
- Optimal Climate Normal (OCN)
- Difference between some pre-determined averaging period and the standard 1981-2010 normal
- CPC uses 15 years for this period at the current time
- Both temperature and precipitation



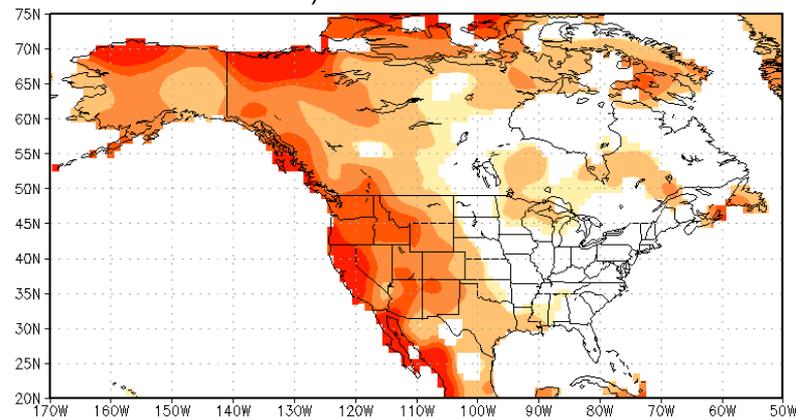
# LLF Outlooks: Statistical Tools



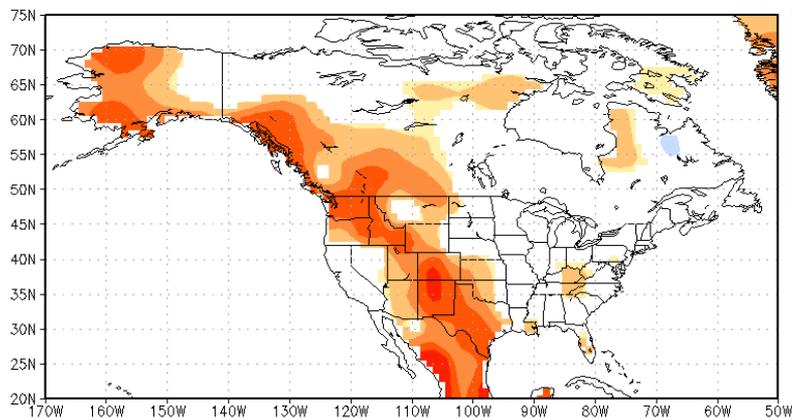
CCA JFM Lead-1



ENSO/OCN JFM Lead-1



SST-CA JFM Lead-1



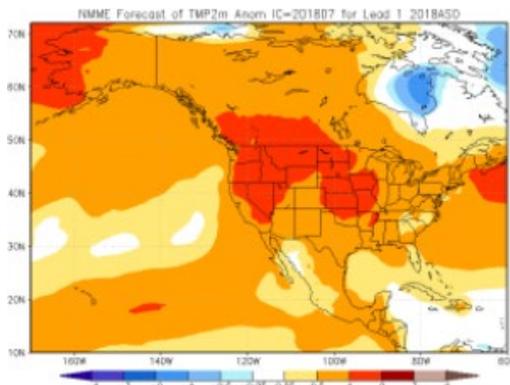
1. Canonical Correlation Analysis (CCA) (top left)
2. Constructed Analogue (CA) (bottom left)
3. ENSO-Trend combination (ENSO/OCN) (top right)



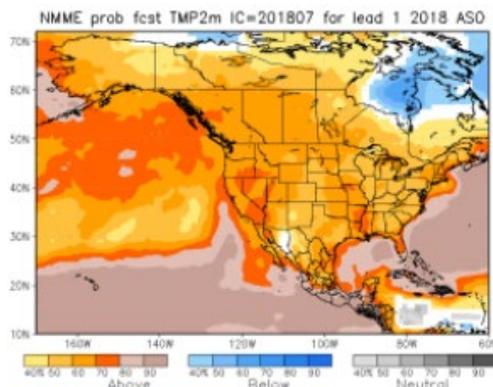
# LLF Outlooks: Dynamical Model Guidance



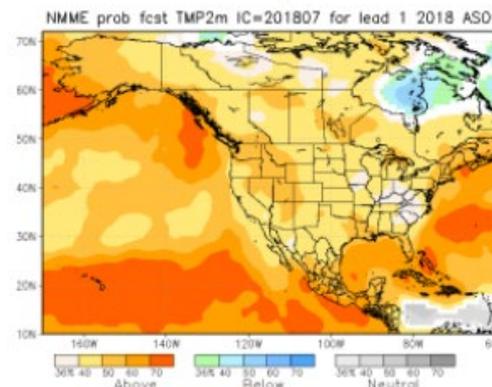
### NMME



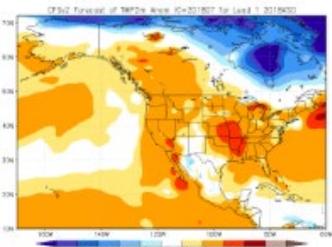
### Prob fcst



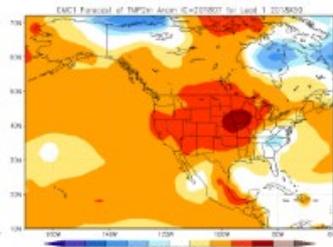
### PAC calib. prob fcst



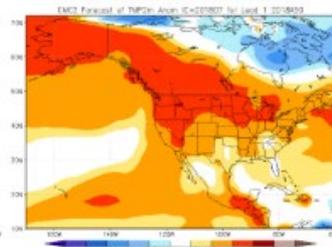
### NCEP\_CFSv2



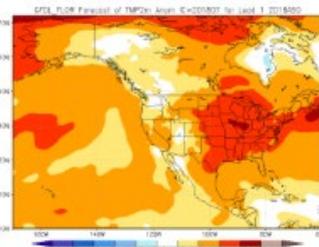
### CMC1\_CanCM3



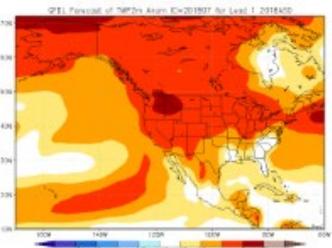
### CMC2\_CanCM4



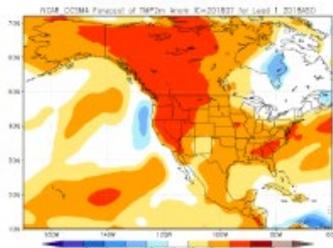
### GFDL\_FLOR



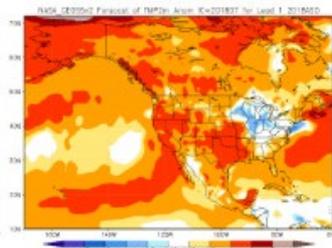
### GFDL\_CM2.1



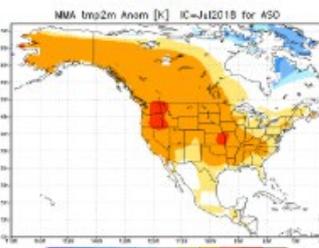
### NCAR\_CCSM4



### NASA\_GEOS5v2



### IMME

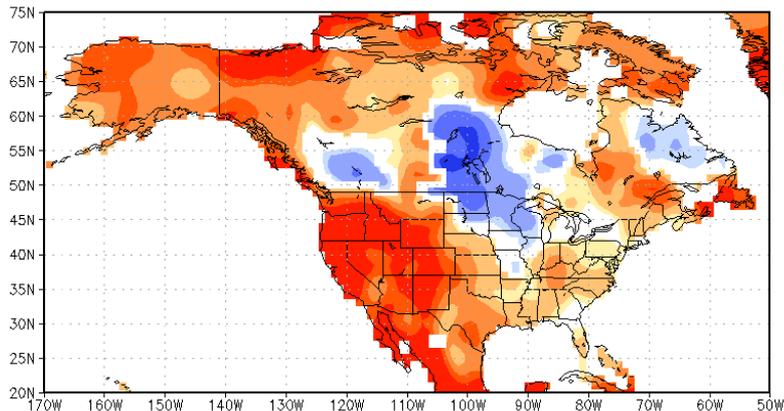




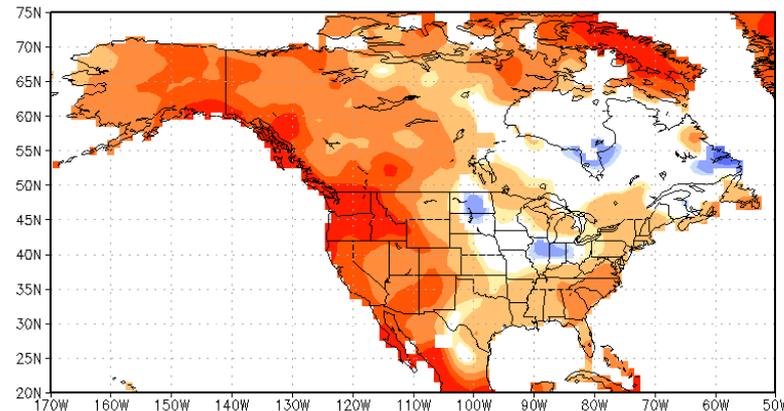
# LLF Outlooks: Consolidation "First Guess"



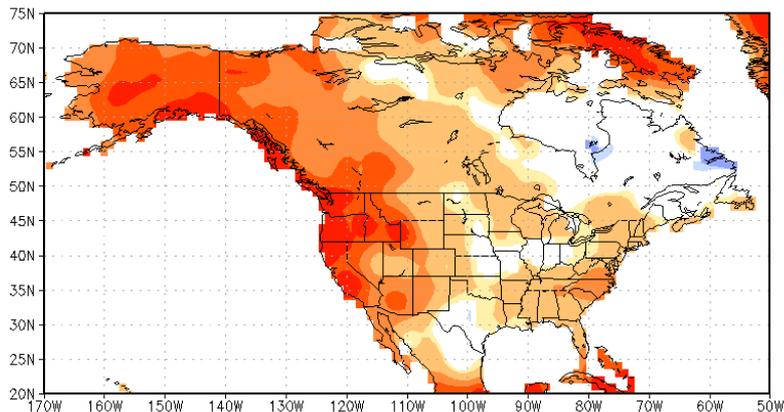
STAT CON JFM Lead-1 Scaled



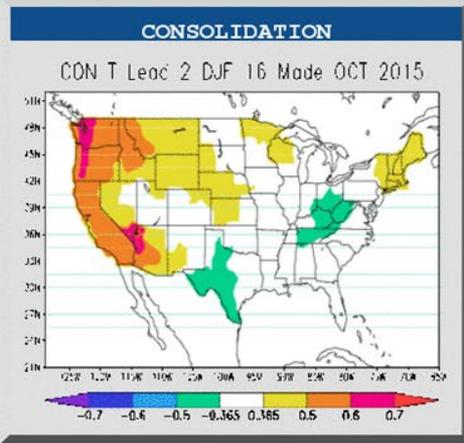
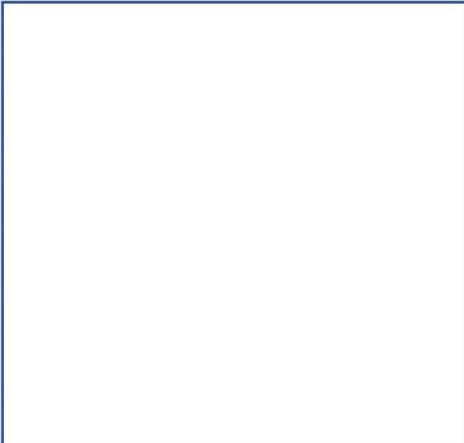
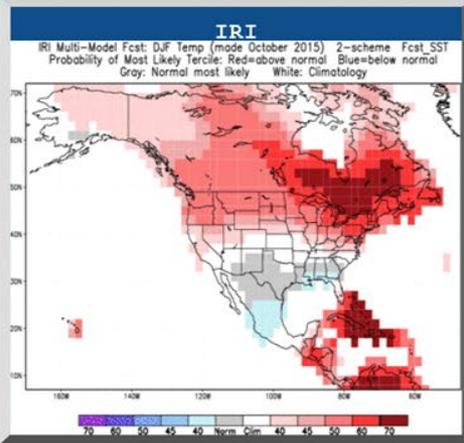
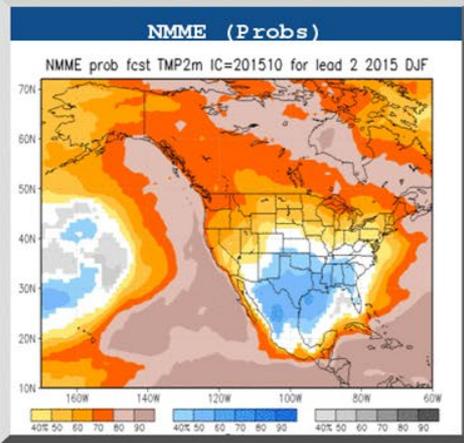
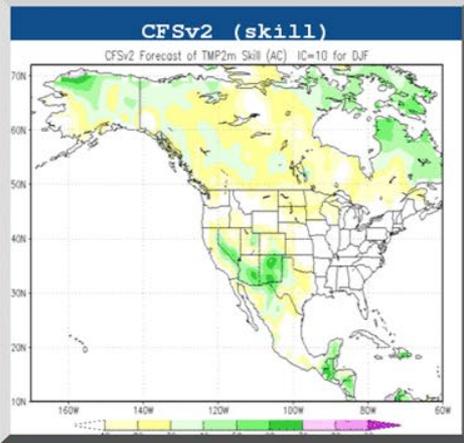
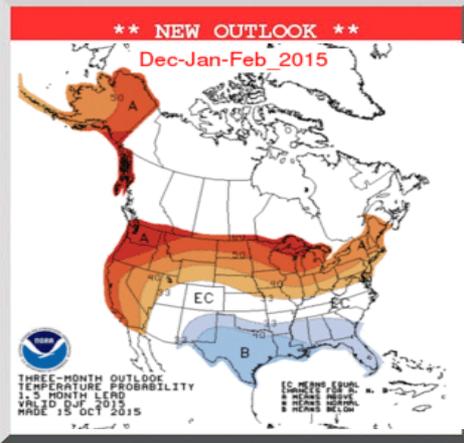
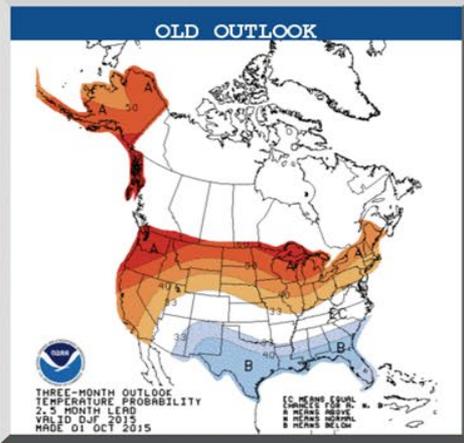
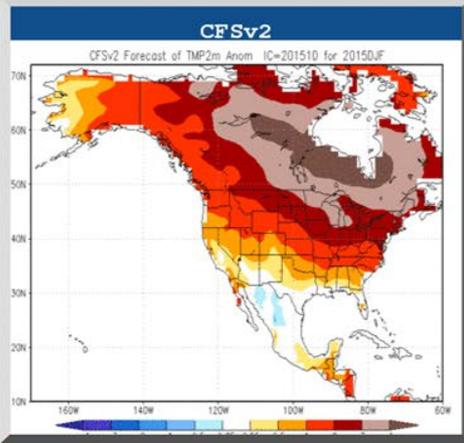
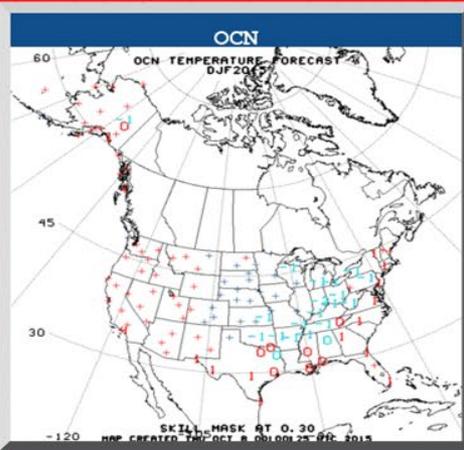
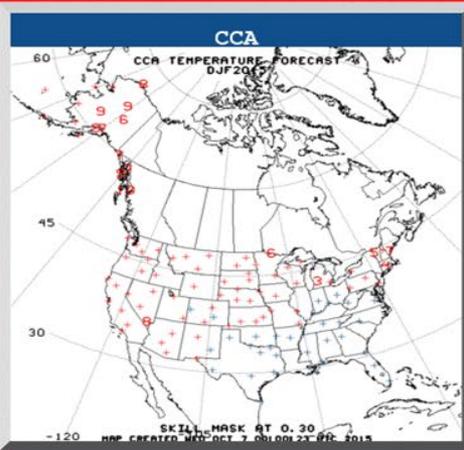
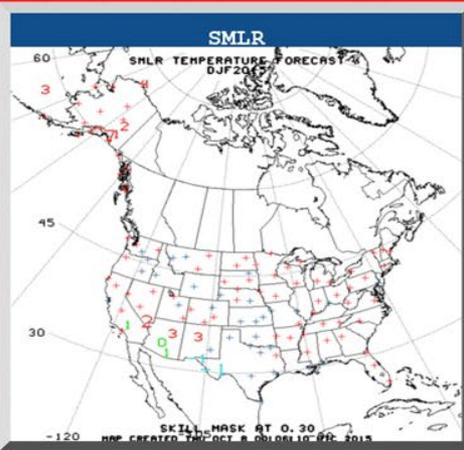
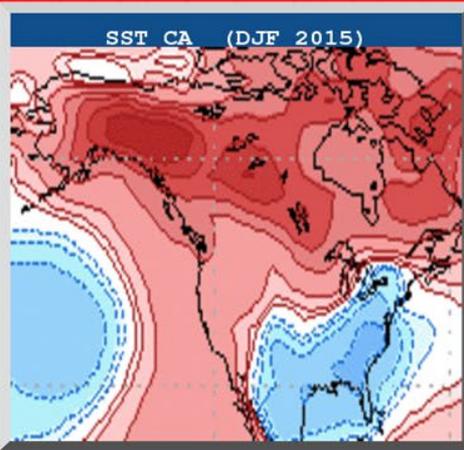
Final CON JFM Lead-1 Scaled



NMME CON JFM Lead-1 Scaled



1. Statistical consolidation (STAT) (top left)
2. NMME consolidation (NMME) (bottom left)
3. Final consolidation (Final) (top right)

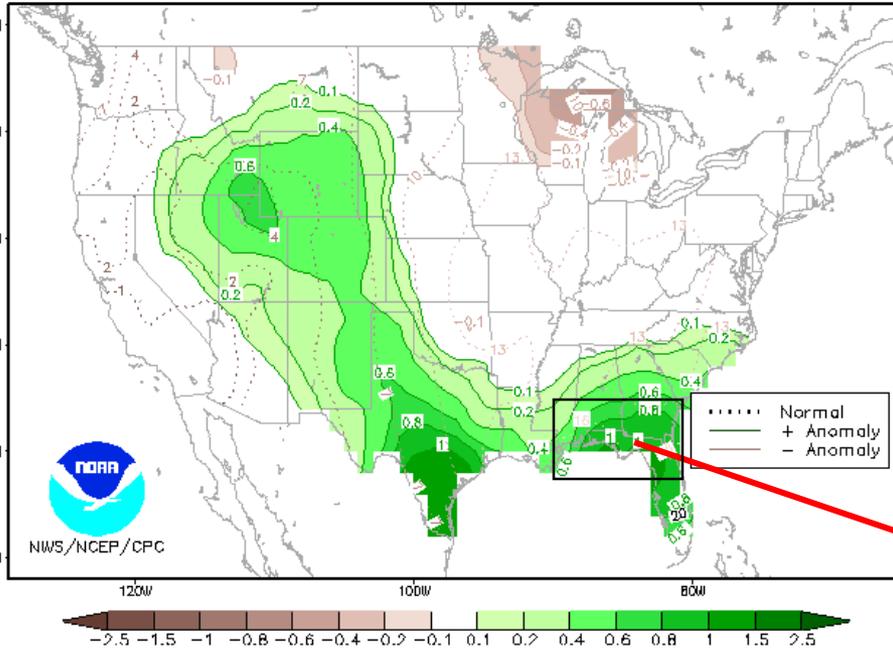


# Additional Seasonal Precipitation Information

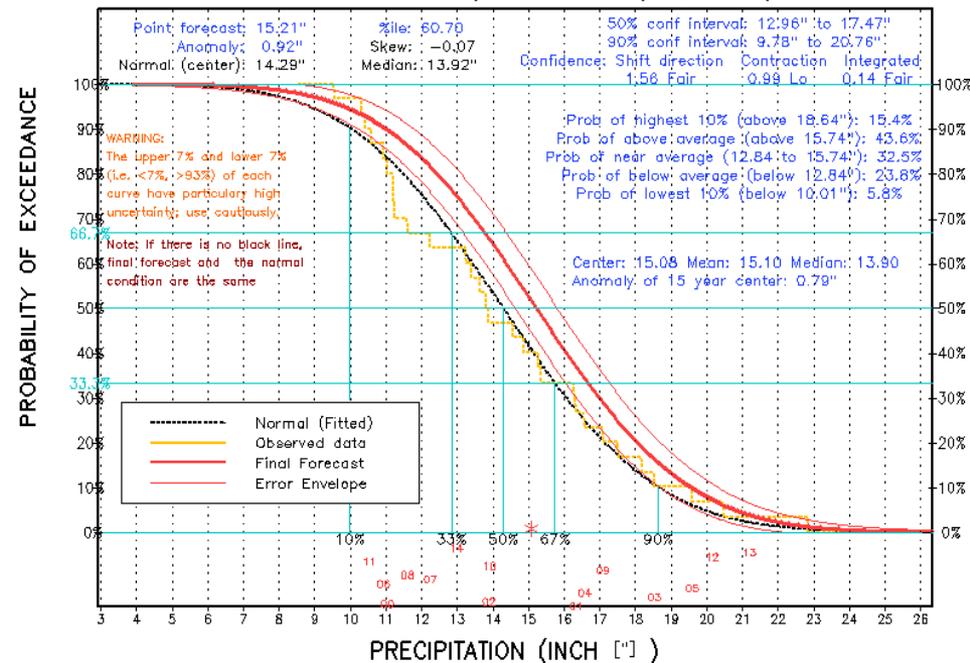
## Northern Florida Climate Division

### Probability of Exceedance Graph

Illustrates the shift in the distribution



### PRECIPITATION OUTLOOK FOR MJJ 2015 0.5 MONTH LEAD OUTLOOK - MADE Apr 16 2015 Climate Division 66 (Jacksonville Region, Florida)



Anomaly (inches) of the median value of the outlook distribution

Dashed lines are the 1981-2010 median value

Shading are anomalies



- Overview of CPC Outlooks, Process, Tools and Services:
  - 1) Week 2 (Days 8-14)
  - 2) Week 3-4
  - 3) Monthly and Seasonal Outlooks (LLF)
  - 4) Global Tropics Hazards Outlook (GTH)**
  - 5) Drought Outlooks (SDO & MDO)
  
- Verification of Outlooks



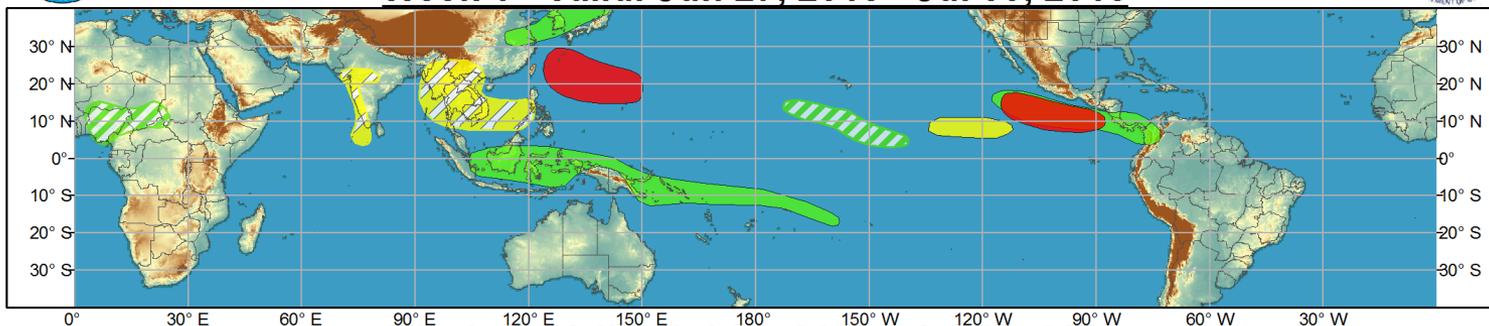
# GTH Outlook: Interpretation



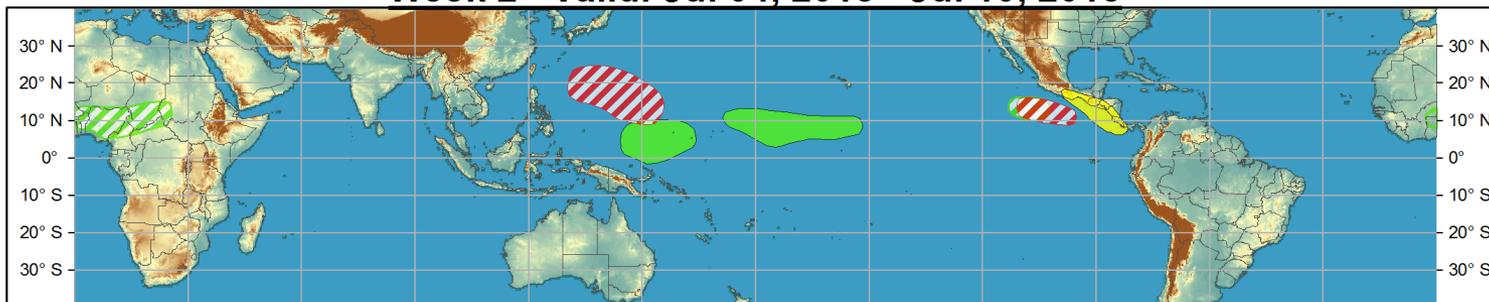
Global Tropics Hazards and Benefits Outlook - Climate Prediction Center



**Week 1 - Valid: Jun 27, 2018 - Jul 03, 2018**



**Week 2 - Valid: Jul 04, 2018 - Jul 10, 2018**



Produced: 06/26/2018

Forecaster: Allgood

Confidence		
High	Moderate	
		Tropical Cyclone Formation Development of a tropical cyclone (tropical depression - TD, or greater strength).
		Above-average rainfall Weekly total rainfall in the upper third of the historical range.
		Below-average rainfall Weekly total rainfall in the lower third of the historical range.
		Above-normal temperatures 7-day mean temperatures in the upper third of the historical range.
		Below-normal temperatures 7-day mean temperatures in the lower third of the historical range.

Product is updated once per week, except from 6/1 - 11/30 for the region from 120E to 0, 0 to 40N. The product targets broad scale conditions integrated over a 7-day period for US interests only. Consult your local responsible forecast agency.





# GTH Outlook: Interpretation



## Global Tropics Hazards and Benefits Outlook Discussion

Last Updated: 06.26.18

Valid: 06.27.18 - 07.10.18

There is a weak MJO signal apparent in both the RMM-based and CPC velocity potential-based indices, with the enhanced (suppressed) phase over Africa and the far western Indian Ocean (western and central Pacific). The presence of an intraseasonal signal is more apparent in the wind field than the convective anomalies, and other modes continue to interfere with the overall picture. The suppressed phase of an equatorial Rossby wave over the west Pacific appears to be constructively interfering with the suppressed phase of the MJO, but Kelvin wave activity over the East Pacific is restricting the eastern extent of the signal. There is considerable uncertainty among the dynamical model RMM-index forecasts, with the ECMWF generally supporting weak MJO activity that strengthens by the end of Week-2 over the Maritime Continent, and the GFS depicting no eastward propagation and instead bringing the index outside of the circle back in Phase-1. It is possible that model forecasted tropical cyclone activity over the East Pacific is interfering with the RMM-index forecasts, acting to pull the index back towards the Western Hemisphere, especially given the lack of a robust intraseasonal convective signal. Therefore, the MJO may be active during the next two weeks, but there is too much uncertainty to project potential impacts of this signal on the global tropical convective pattern.

Tropical Storm Daniel formed over the East Pacific on June 24, and remained well out to sea before becoming post-tropical. No additional tropical cyclone development occurred across the global basins during the past week. During Week-1, the East Pacific is anticipated to become extremely active, partly due to the aforementioned recent Kelvin wave activity. The National Hurricane Center (NHC) is currently monitoring a broad area of disturbed weather approximately 600 miles south of Acapulco, Mexico, and forecasts a 90 percent chance of tropical cyclone formation over the next 5 days. Additionally, a tropical wave currently over Central America has a 90 percent chance of development per NHC during the next 5 days after emerging over the East Pacific and moving westward to the south of El Salvador, Guatemala, and Mexico. The GFS forecasts both of these systems to become intense hurricanes, and also shows a third tropical cyclone formation during late Week-1 or early Week-2. Based on these forecasts, a broad high confidence tropical cyclone formation area is depicted on the outlook during Week-1. A smaller moderate confidence region is maintained during Week-2, in case the potential third system develops at the beginning of that period. Over the West Pacific, the GFS ensembles show potential development early in the period east of the Philippines, with a second potential tropical cyclone forming near or north of Guam. Both of these potential formation regions were covered with a single high confidence shape during Week-1 of the outlook period. For Week-2, additional tropical cyclone development is possible once again in the vicinity of Guam, with the threat extending northwestward well east of the Philippines. No tropical cyclone formation is anticipated over the Atlantic basin, but NHC is monitoring a non-tropical low pressure system anticipated to move offshore of the Carolinas along a frontal boundary, with a low potential existing for tropical or subtropical development.

In the absence of robust MJO-related convective anomalies in the recent observations, the forecasts for enhanced or suppressed rainfall rely primarily on a consensus of dynamical model forecasts and anticipated tropical cyclone activity. The CFS and ECMWF both depict a continued reduction in monsoon precipitation over South and Southeast Asia, which is fairly consistent with the low-level zonal flow anomalies associated with potential MJO activity over the western Indian Ocean. Enhanced convection is forecast over the equatorial Maritime Continent, extending south-southeastward to the central Pacific near 10S. An active ITCZ is anticipated south of Hawaii, with a small area of suppressed convection between this region and the potential East Pacific tropical cyclones due to subsidence. During Week-2, enhanced precipitation is favored across parts of the West Pacific, with potential ongoing tropical cyclone activity generating enhanced convection to the south and southwest of Mexico. Broad suppressed rainfall is favored to overspread southern Mexico and parts of Central America later in Week-2, due in part to subsidence and reduced SSTs in the wake of the earlier tropical cyclone activity. There is too much uncertainty in both model guidance and MJO forecasts to depict regions of enhanced or suppressed rainfall over the Indian Ocean basin or Maritime Continent for Week-2.

## GIS Ready Formats

	Week 1	Week 2
Tropical Cyclone Formation	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>
Upper Tercile Precipitation	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>
Lower Tercile Precipitation	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>
Above Average Temperatures	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>
Below Average Temperatures	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>	<a href="#">KMZ</a> / <a href="#">KML</a> / <a href="#">SHP</a>



# GTH Outlook: Release Schedule



## Product released weekly according to the following steps:

**MONDAY:** Forecaster updates the MJO weekly update PPT/PDF and prepares draft GTH outlook maps and posts to preliminary page

**MONDAY:** Forecaster sends out message to collaborators for feedback announcing technical call

**MONDAY:** Conduct 2:30 PM ET conference call with available partners/contributors

**MONDAY:** Finalize MJO weekly update PPT/PDF and post to web by 4 PM ET

**TUESDAY:** Forecaster updates outlook maps based on feedback and latest forecast information

**TUESDAY:** Forecaster writes PMD, performs last round of coordination with NHC by 1 PM ET

**TUESDAY:** Forecaster posts final outlook maps and PMD to web and confirms release

**TUESDAY:** Forecaster conducts Global Tropics Briefing at 2:30 PM ET

**FRIDAY:** An update is prepared during the Atlantic hurricane season 6/1-11/30, reduced region (120 E to 0, 0 to 40 N)

**Product released at 2:30 PM ET Tuesday, update on Friday**

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghazards/index.php>

### Global Tropics Hazards and Benefits Briefing

Tuesday, March 5, 2013 11:30 AM - 11:50 AM EST - [Show in my Time Zone](#)

#### Webinar Registration

The GTH briefing is a review of recent conditions across the Tropics during the past week and a review of the latest GTH outlook. Potential impacts across both the Tropics and Extratropics are discussed when appropriate.

\* First Name:  \* Last Name:   
\* Email Address:



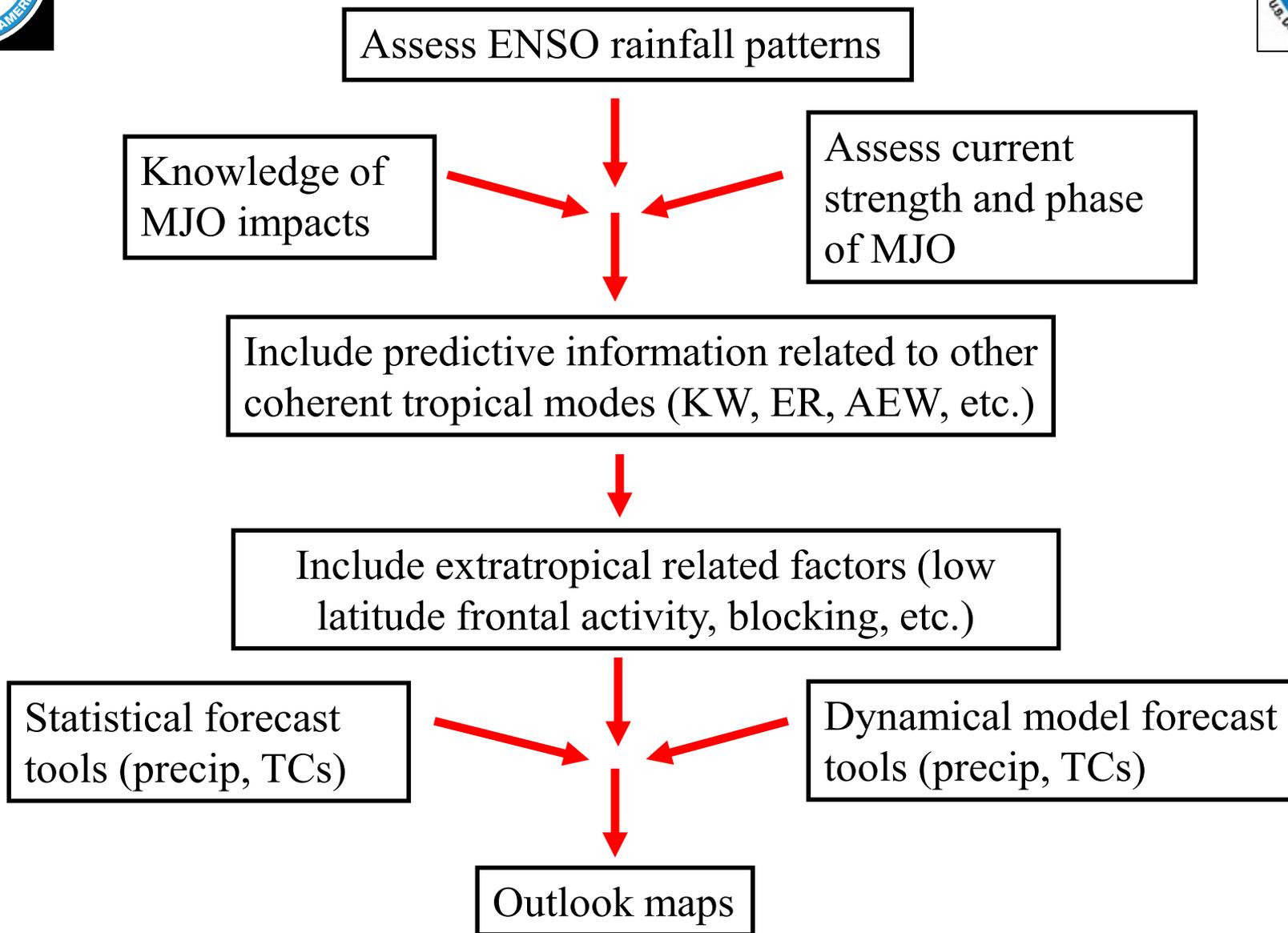
\* Indicates a required field

By clicking the "Register Now" button you submit your information to the Webinar organizer, who will use it to communicate with you regarding this event and their other services.

[Register Now](#) [View system requirements](#)

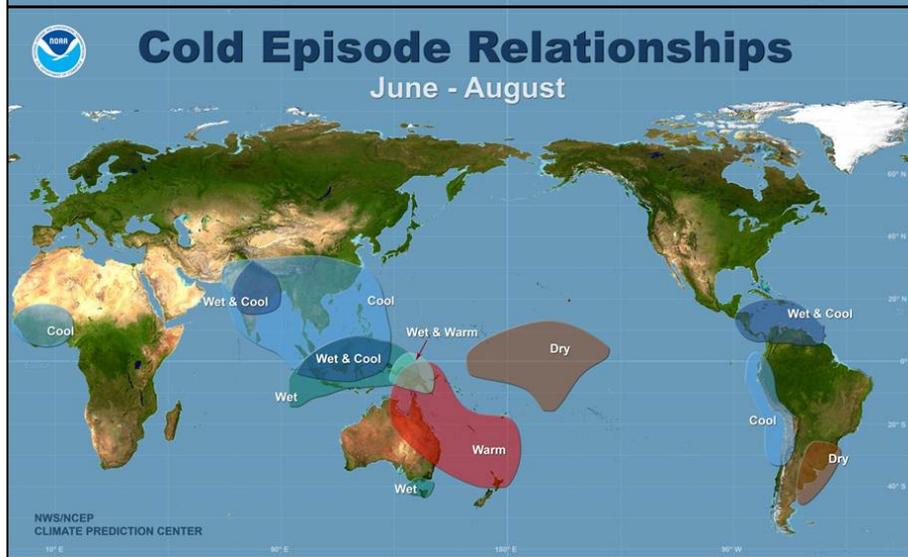


# GTH Outlook: Process

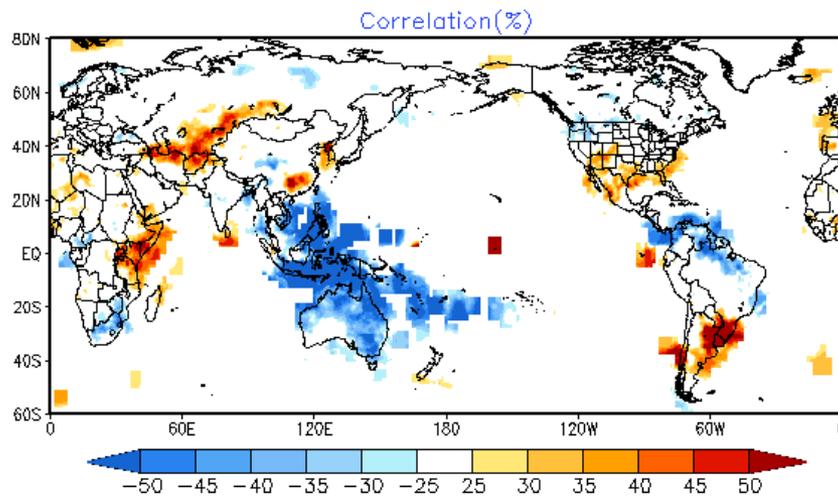
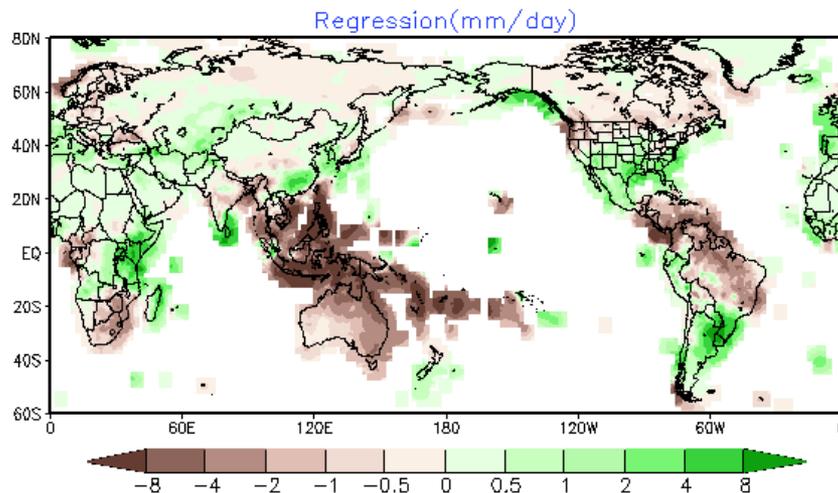




# GTH Outlook: Forecast Tools



ENSO Teleconnection: OND Precip



High Resolution Images can be found at:

<http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/ENSO-Global-Impacts/>

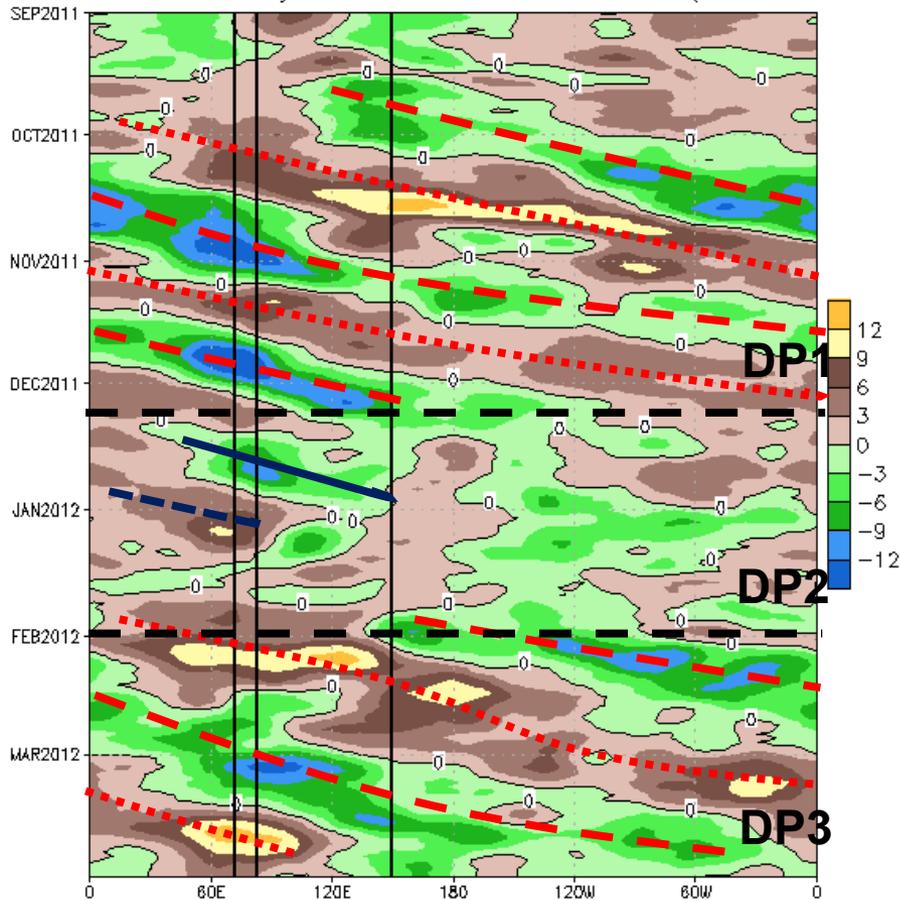


# GTH Outlook: Forecast Tools

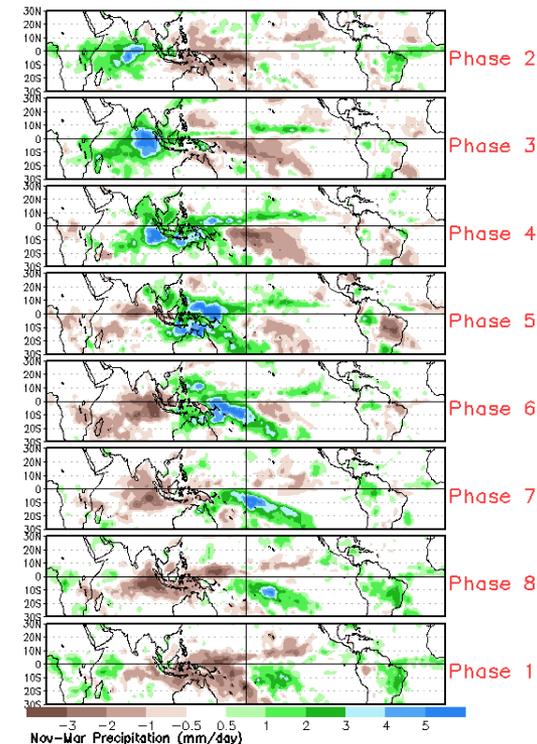
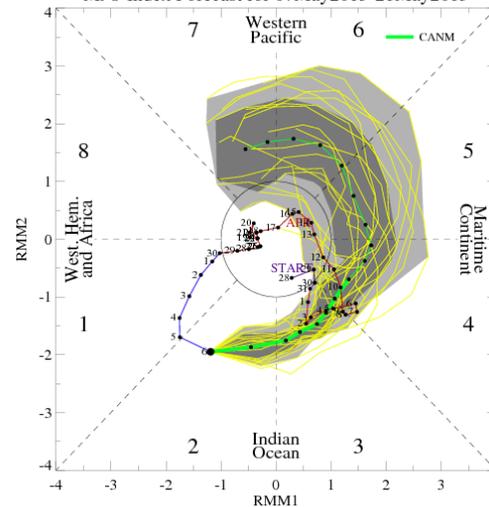


## Madden-Julian Oscillation (MJO)

### 200-hPa Velocity Potential Anomalies (10N - 10S)



MJO Index Forecast for 07May2013-21May2013



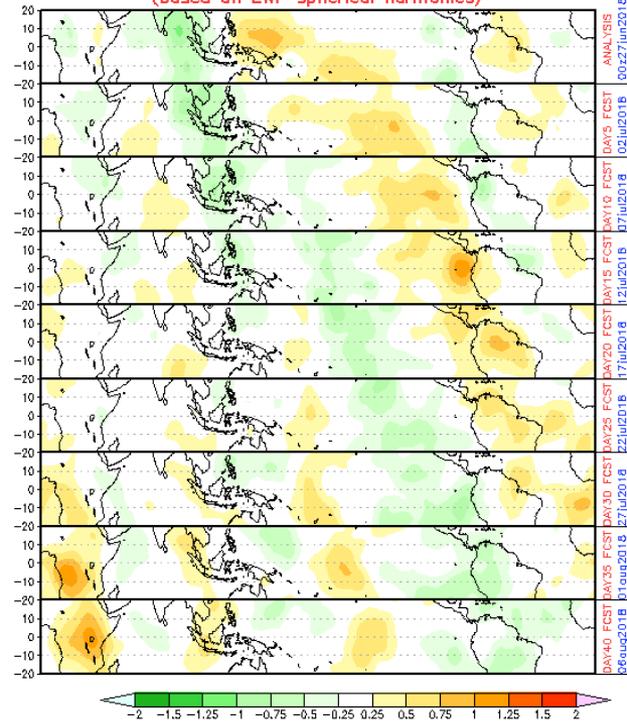


# GTH Outlook: Forecast Tools



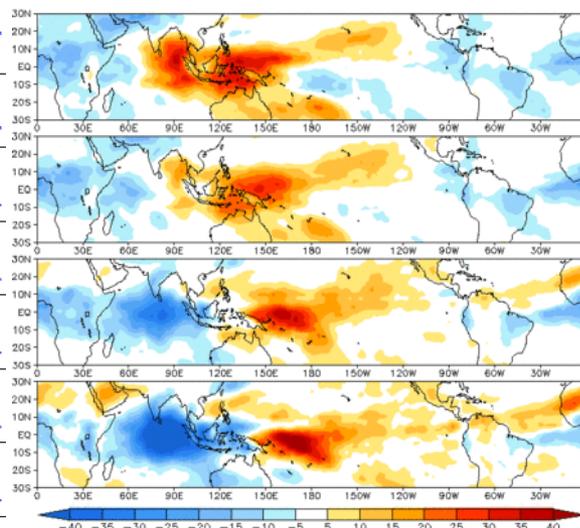
## EWP

CHI 200 hPa 40-DAY forecast (00z27jun2018-06aug2018)  
(based on EWP spherical harmonics)



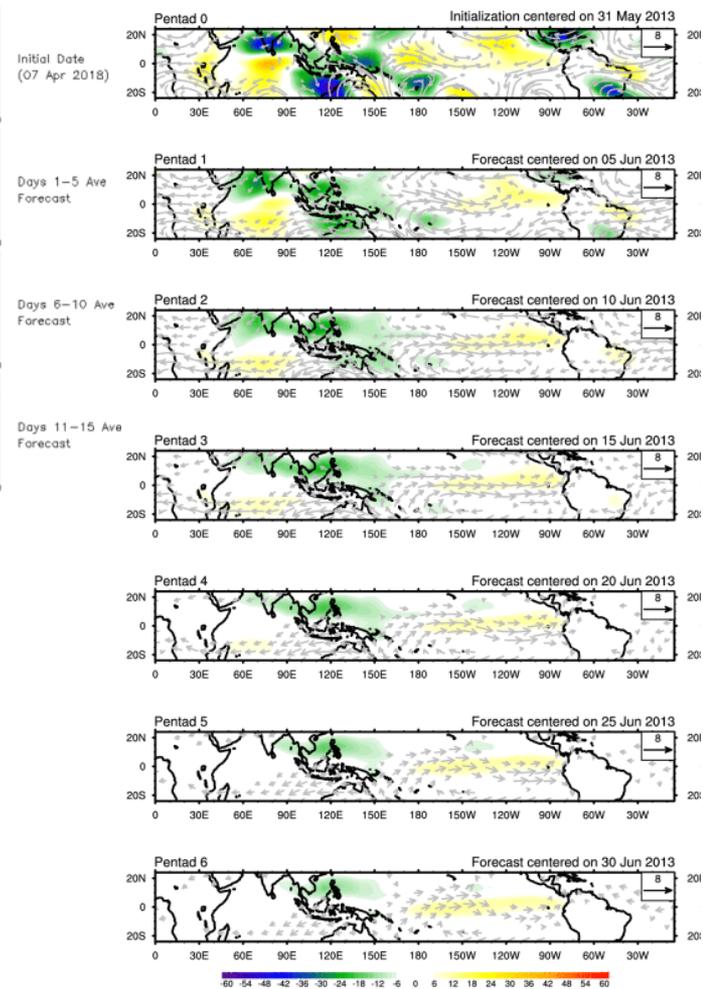
## CA

OLR prediction of MJO-related anomalies using CA model reconstruction by RMM1 & RMM2 (07 Apr 2018)



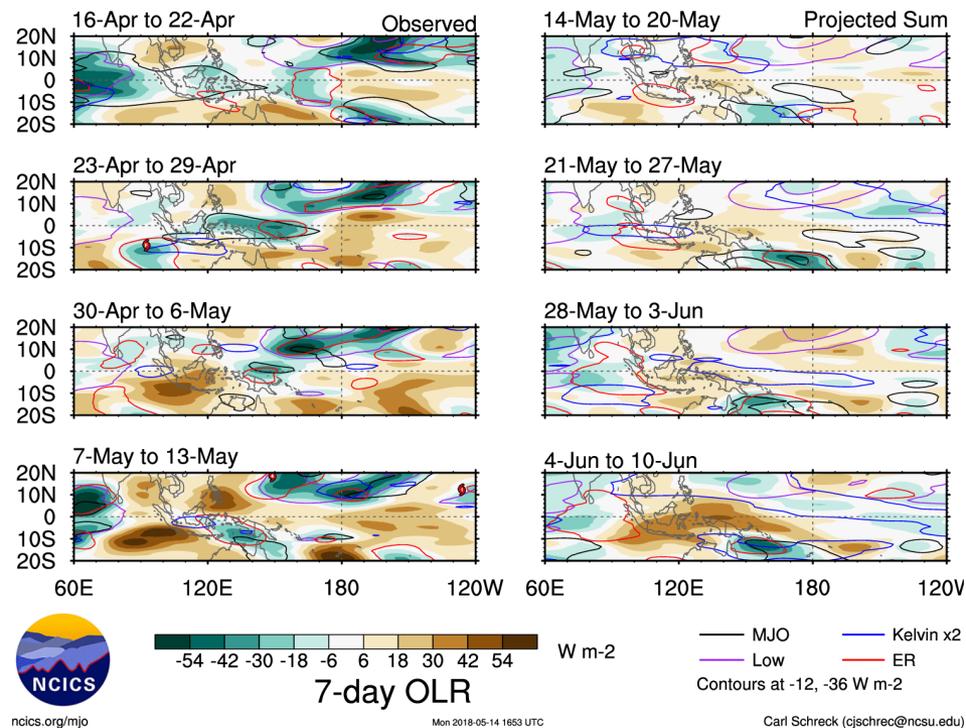
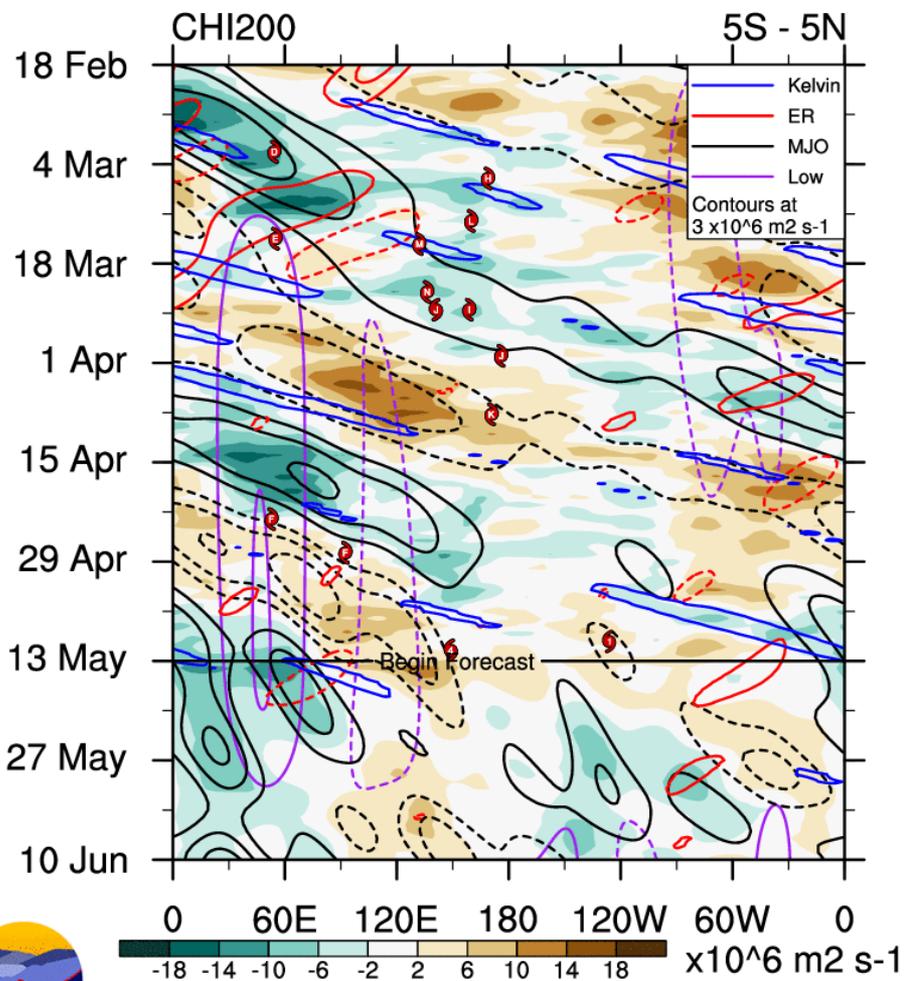
## C-LIM

OLR/WND200





# GTH Outlook: Forecast Tools



ncics.org/mjo

Mon 2018-05-14 1021 UTC

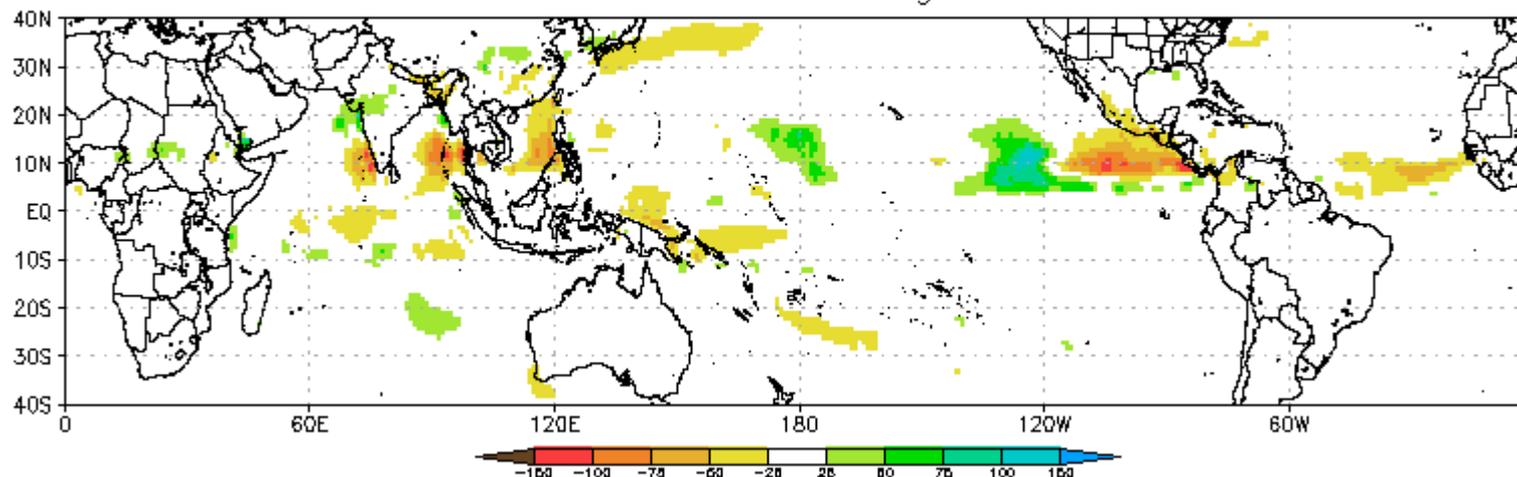
Carl Schreck (cjschrec@ncsu.edu)



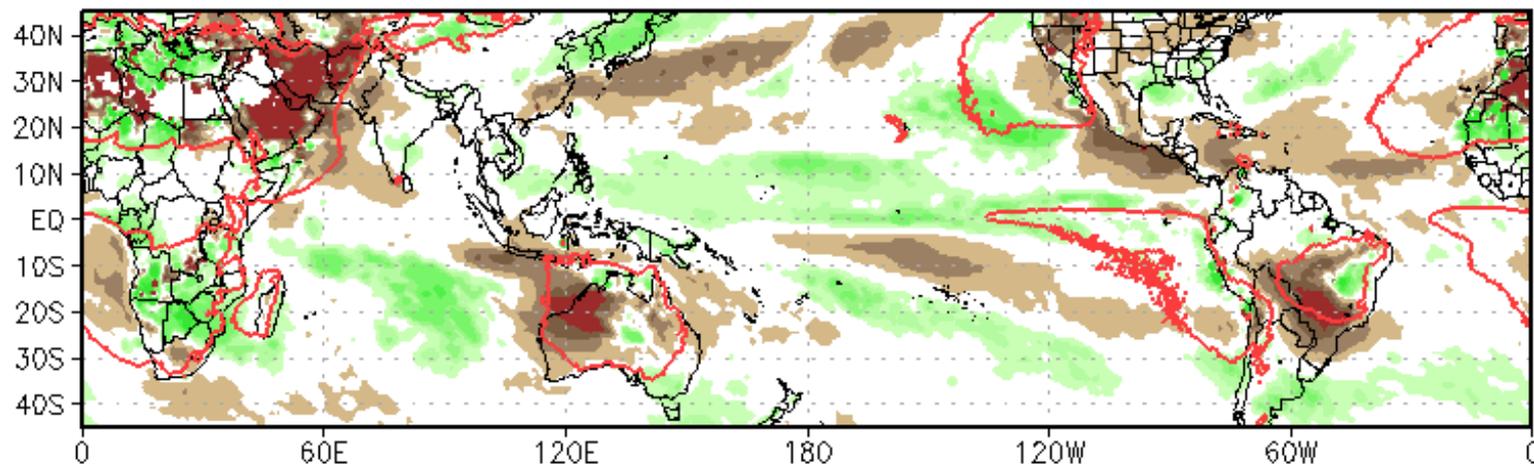
# GTH Outlook: Forecast Tools



CFS Precipitation Anomalies (mm) Issued 27Jun2018  
Week-2 Forecast Ending 12Jul2018



Week-2 ECMWF Prec % of Normal

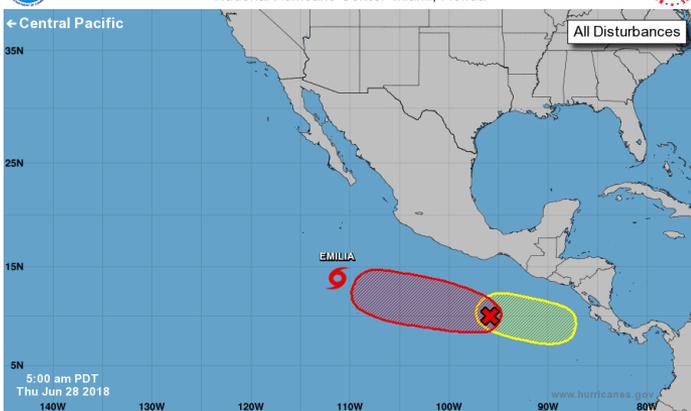




# GTH Outlook: Forecast Tools



**Five-Day Graphical Tropical Weather Outlook**  
National Hurricane Center Miami, Florida

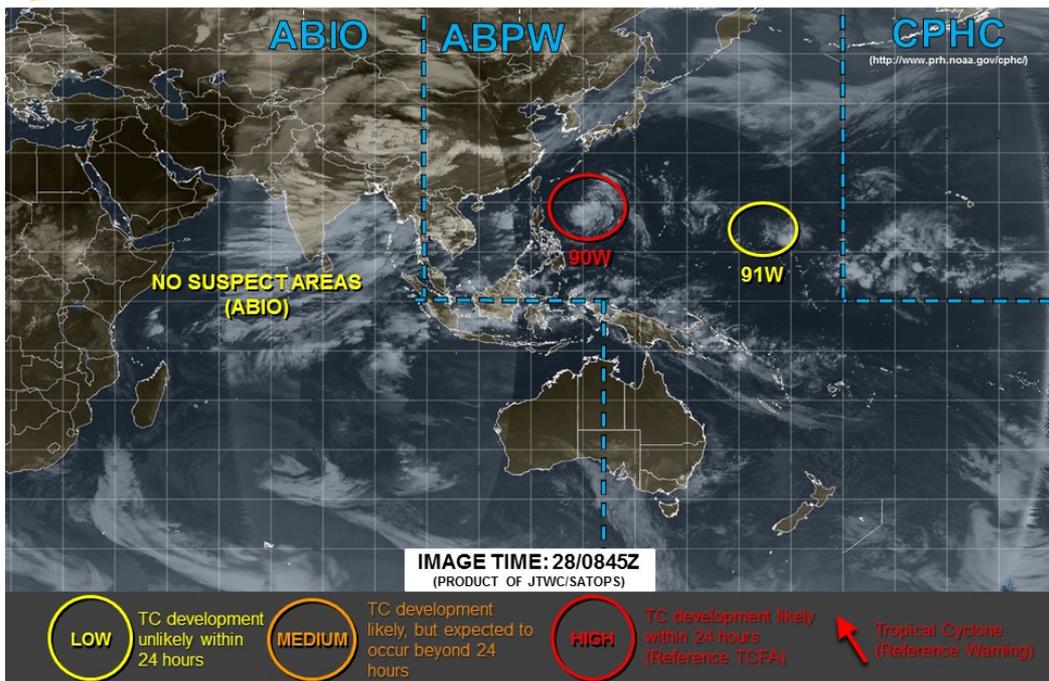
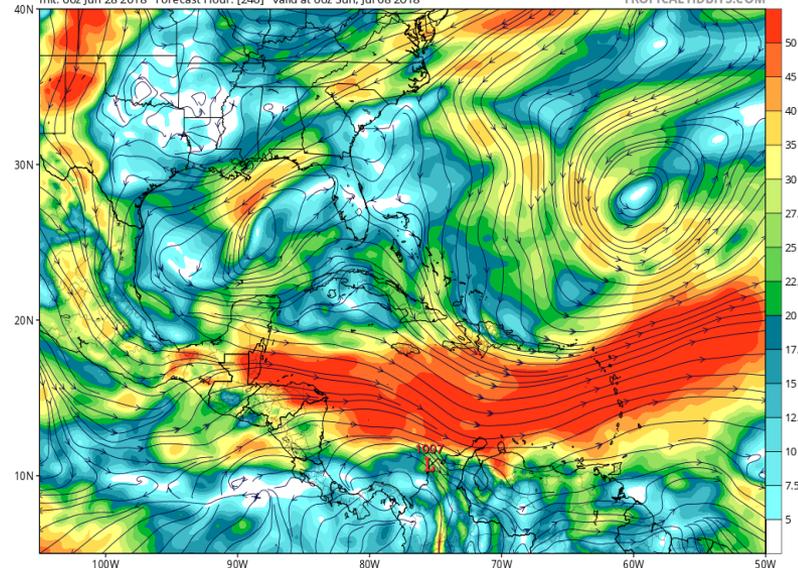


## JOINT TYPHOON WARNING CENTER



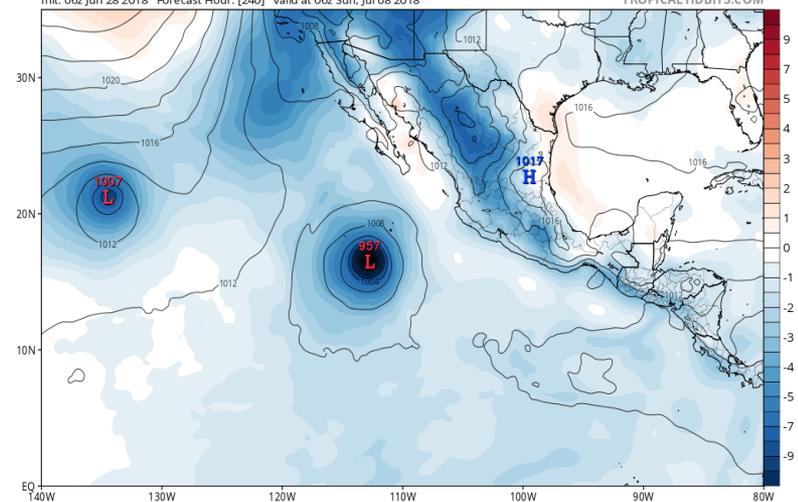
**GFS 200mb-850mb Wind Shear (knots) & Low Centers (mb)**  
Init: 06z Jun 28 2018 Forecast Hour: [240] valid at 06z Sun, Jul 08 2018

TROPICALTIDBITS.COM



**GFS MSLP and Anomaly (hPa) (based on CFSR 1981-2010 Climatology)**  
Init: 06z Jun 28 2018 Forecast Hour: [240] valid at 06z Sun, Jul 08 2018

TROPICALTIDBITS.COM





# GTH Outlook: Forecast Tools



## Tropical Cyclone Storm Tracks

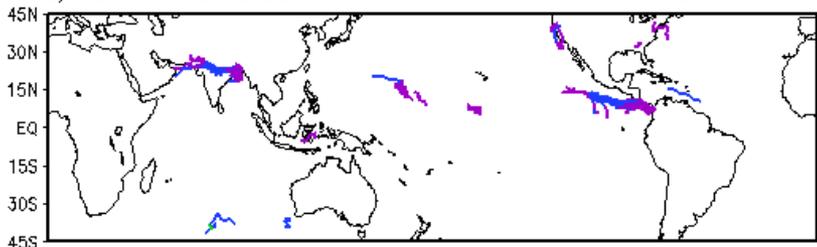
CFSv2 45-Day Forecasts

CFSv2 45-Day Forecasts

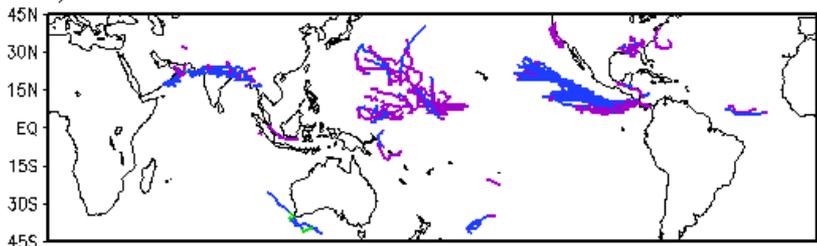
Week 2: 0703-0709

- Cat 3
- TD
- Cat 1
- Cat 2
- Cat 4
- Cat 5

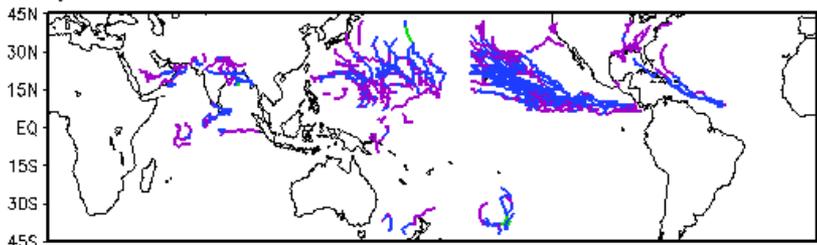
a) Week 1: 0626-0702



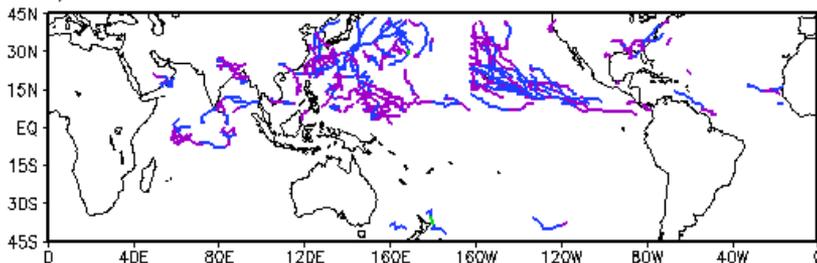
b) Week 2: 0703-0709



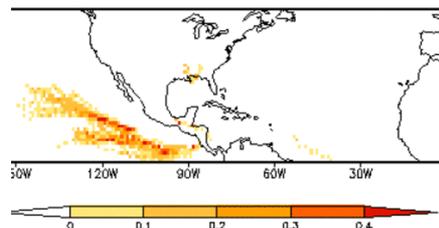
c) Week 3: 0710-0716



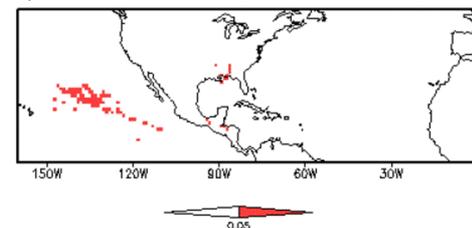
d) Week 4: 0717-0723



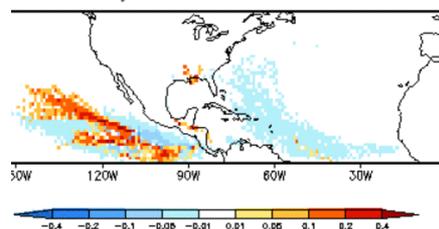
Forecast Tracks



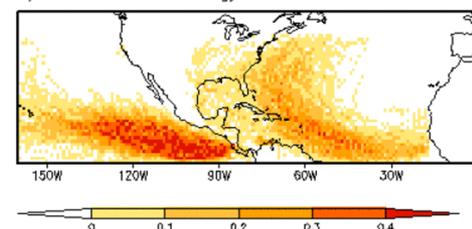
b) Filtered Tracks



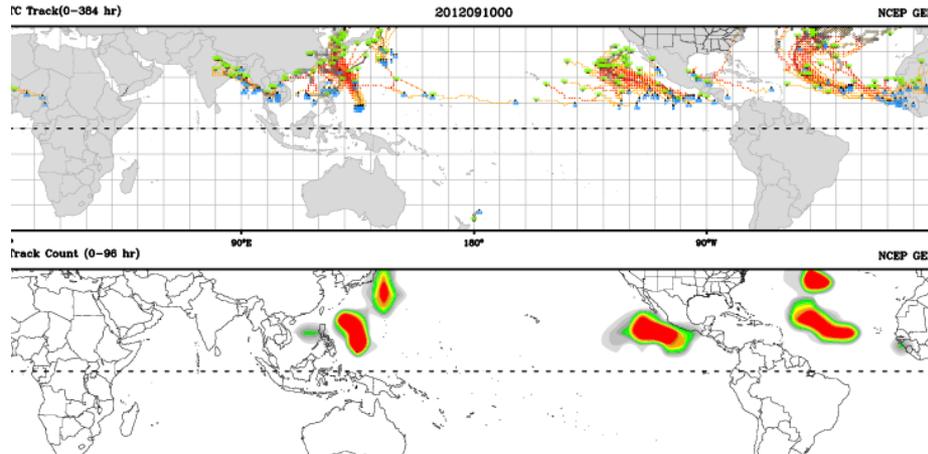
Track Anomaly



d) False Alarm Climatology



### CWB TC Tracker for NCEP GEFS (AllCriteria)





# GTH Outlook: Product Purpose



1. Commerce is Global: Support sectors of U.S. economy (financial, energy, agriculture, water resource management, aid organizations, *etc.*) that have international interests

- ✓ Advance notice of hazards and benefits in the Tropics
- ✓ Assessment of weather / climate pattern changes

2. Support NOAA: Support the National Weather Service (NWS) field, among other U.S. government agencies, by:

- ✓ Assessing and forecasting the distribution of large scale tropical convection
- ✓ Providing advance notice for potential pattern changes across the U.S.
- ✓ Providing subseasonal tropical cyclone forecasts for U.S. government agencies

3. Additional resource for international met organizations



# GTH Outlook: Partners, Applications



## Partners:

### NOAA National Centers:

- ➔ National Hurricane Center
- ➔ Central Pacific Hurricane Center

### Dept. Of Defense:

- ➔ Joint Typhoon Warning Center
- ➔ Naval Postgraduate School

### International Agencies:

- ➔ Australian Bureau of Meteorology
- ➔ Taiwan Central Weather Bureau

### Academia:

- ➔ SUNY, NC-CICS

## Stakeholders:

NWS: NCEP, WFOs, RFCs, Regional HQs

NOAA agencies: National Marine Fisheries Service

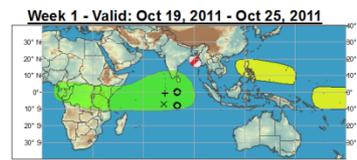
Aid Organizations: U.S. and International Red Cross, USAID

Private Sector: Energy, agriculture, financial, and water resources sectors

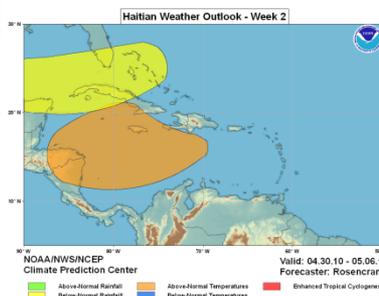
Others: Other U.S. Agencies, International weather agencies, TV mets

## Example Applications:

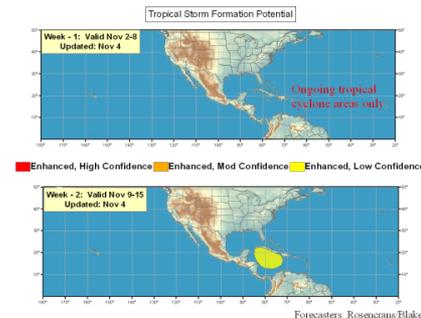
### Field Campaigns



### Haiti Relief



### Oil Spill





- Overview of CPC Outlooks, Process, Tools and Services:
  - 1) Week 2 (Days 8-14)
  - 2) Week 3-4
  - 3) Monthly and Seasonal Outlooks (LLF)
  - 4) Global Tropics Hazards Outlook (GTH)
  - 5) Drought Outlooks (SDO & MDO)**
  
- Verification of Outlooks

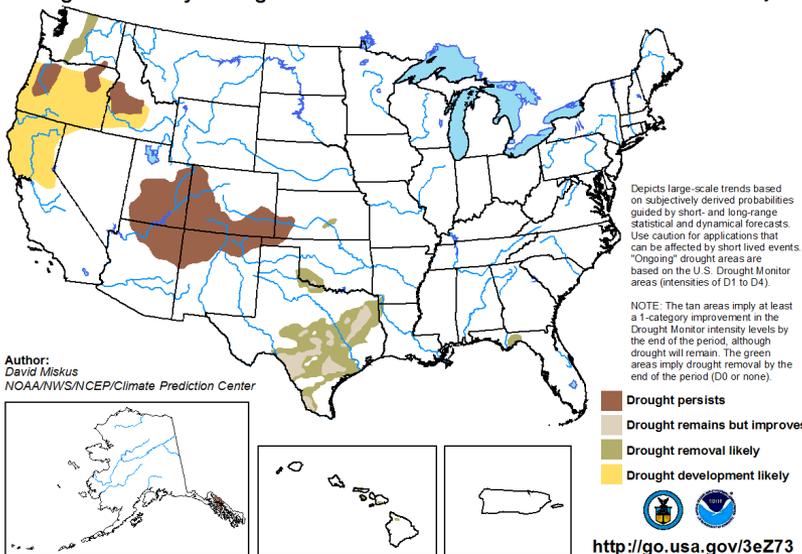


# Drought: CPC U.S. Drought Outlooks



## U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

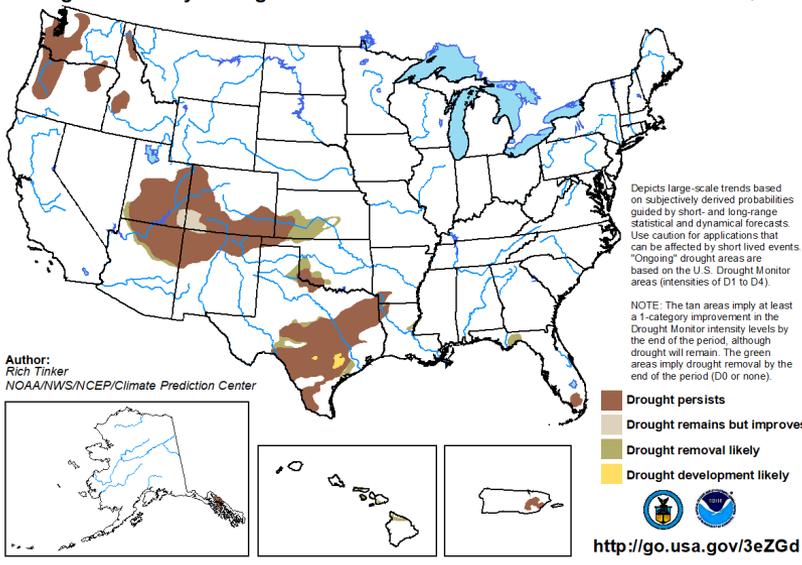
Valid for January 16 - April 30, 2020  
Released January 16



- Produced in conjunction with monthly and seasonal T/P outlooks
- Drought Monitor is starting point for outlooks
- Forecaster consults with extended-range, subseasonal and seasonal forecasters / guidance for consistency
- Forecaster sends draft outlook to stakeholders for feedback. Typically, several dozen stakeholders will request changes to the forecast over 2-3 days.

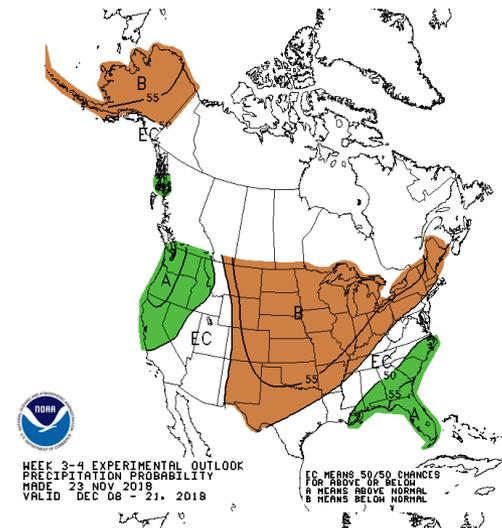
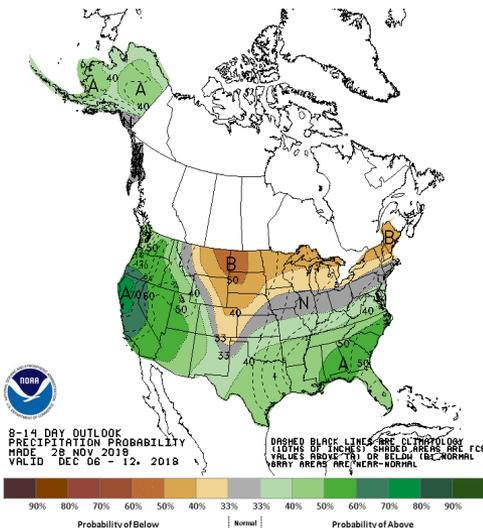
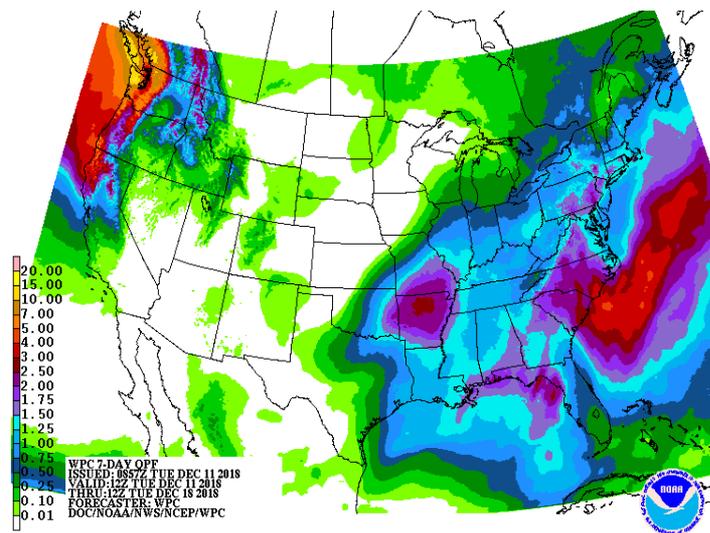
## U.S. Monthly Drought Outlook Drought Tendency During the Valid Period

Valid for January 2020  
Released December 31, 2019

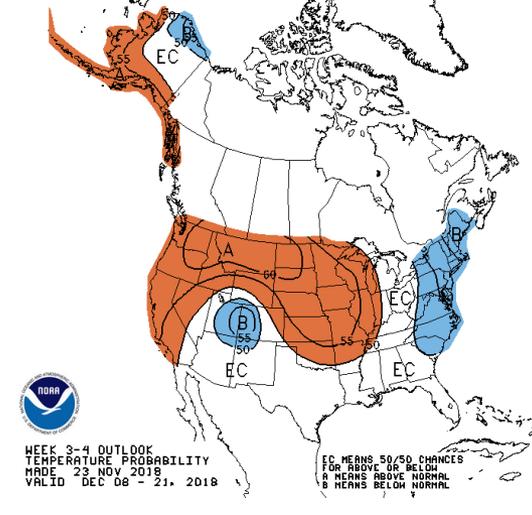
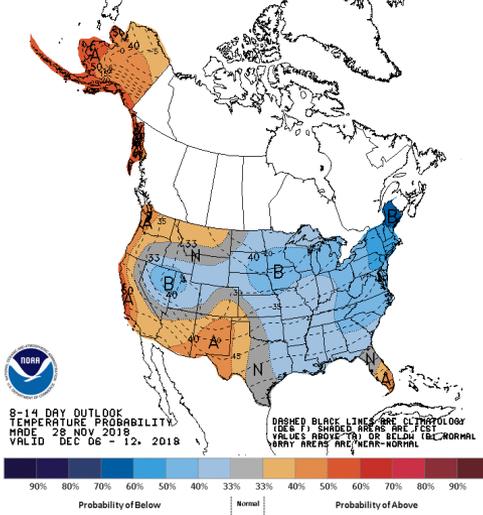
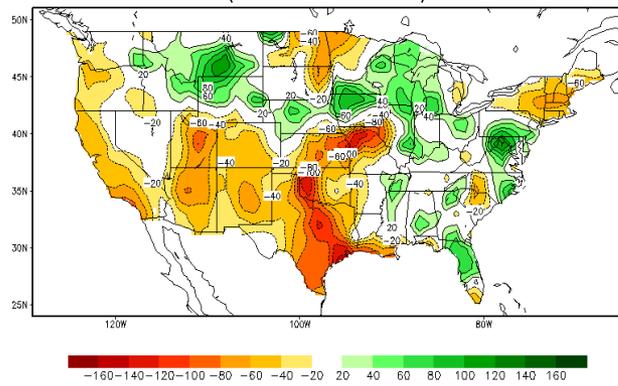




# Drought: DO Short Term Tools



Predicted Soil Moisture Anomaly (mm)  
(20Jun2018-04Jul2018)

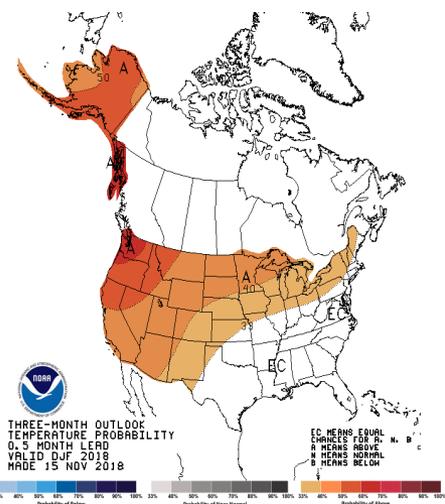
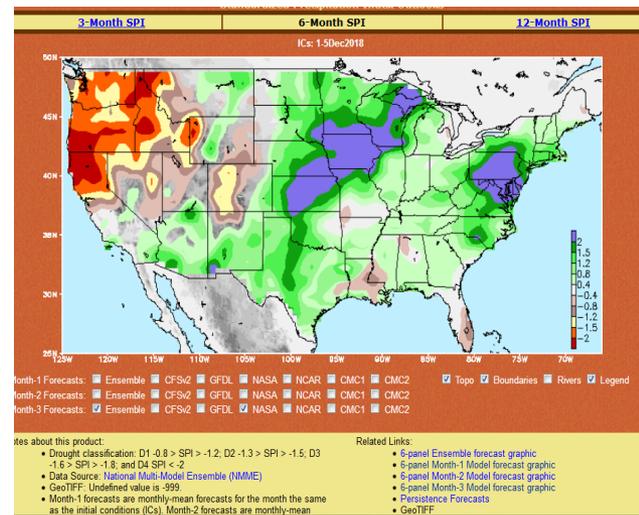
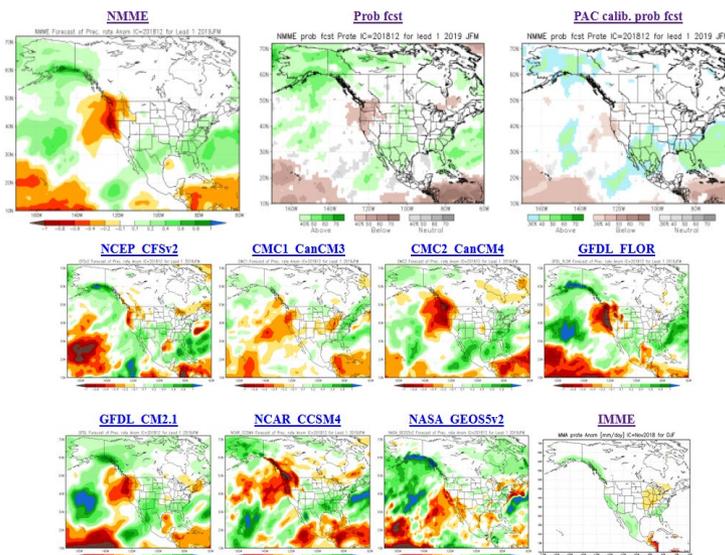
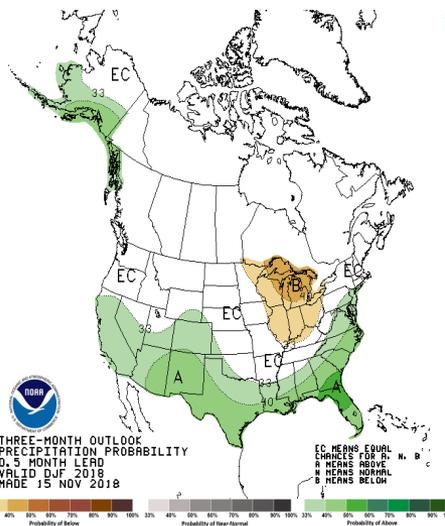




# Drought: DO Long Term Tools

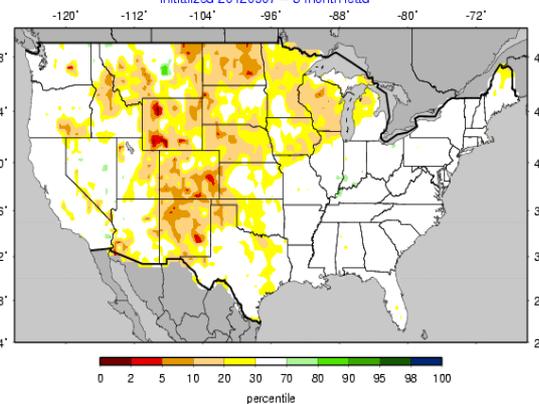


## Season 1 prate forecast



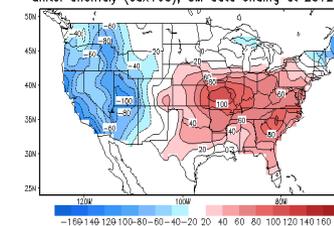
## VIC Predicted Soil Moisture Percentiles

based on ranking of ESP ENSO-Subset median  
Initialized 20120907 - 3 month lead



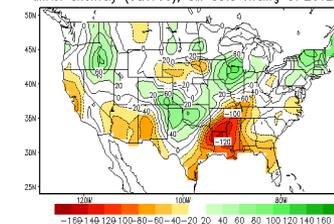
## Lagged Averaged Temperature Outlook for NDJ 2012/2013

units: anomaly (sdX100), SM data ending at 20121008



## Lagged Averaged Precipitation Outlook for NDJ 2012/2013

units: anomaly (sdX100), SM data ending at 20121008





# Drought: DO Outlook Discussions



## Discussion for the Seasonal Drought Outlook

Tools used in the U.S. Seasonal Drought Outlook (SDO) included the official Climate Prediction Center (CPC) [temperature and precipitation outlooks](#) for December 2017 through February 2018 (DJF 2017-18), various [short- and medium-range forecasts](#) and models such as the 7-day quantitative precipitation forecast (QPF) totals from the Weather Prediction Center (WPC), the 6-10 day and 8-14 day CPC extended-range forecasts (ERFS), Weeks 3-4, dynamical models at the seasonal time scale, 384-hour total precipitation forecasts from several runs of the GFS, 240-hour total precipitation forecasts from the ECMWF, climatology for the DJF season including median soil moisture changes, and initial conditions (the U.S. Drought Monitor valid on November 14, 2017). La Niña conditions are predicted to continue (~65-75% chance) at least through boreal winter 2017-18.

Across the Northeast during the past 30-days, the Departure from Normal Precipitation (DNP) map depicts wetter-than-normal conditions across approximately the western and eastern thirds of this region, with intervening near- to drier-than-normal conditions for the central third. A few areas, such as near and along the New Hampshire-Maine border, and northern New York's Tug Hill Plateau area, report precipitation surpluses of at least 4 inches during the past 30 days. Looking back over the past 121 years of record, the Northeast typically receives 20-30 percent of its annual precipitation during this three-month period. Though there are a few widely scattered areas of abnormal dryness (DO) on the U.S. Drought Monitor in the Northeast, there is no drought at this time. It is unlikely that drought will redevelop across this region during the winter.

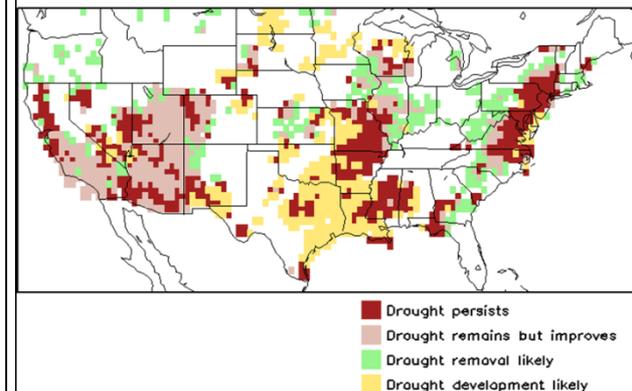
*Confidence for the Northeast is moderate to high.*

Thirty-day precipitation anomalies in the Southeast indicate mostly below- to near-normal precipitation, with the exception of far western sections of Virginia and the Carolinas, and over southern Florida, where above-normal precipitation fell. Typically during the DJF season, most of this region receives 20-30 percent of its annual precipitation. The exception is the Florida Peninsula, where the historical record reveals a gradation of values ranging from 15-20 percent in the north to 5-10 percent in the south. Existing moderate drought (D1) from the Carolina Piedmont region into southern Virginia (and over a localized area along the southern border of Alabama/Georgia) is expected to persist and/or intensify during the DJF period, as precipitation predictions at nearly all time-scales out to one season in advance support below normal precipitation. Drought development is also anticipated across portions of the Southeast region. This is a common (though not guaranteed) occurrence during La Niña winters. Across most of peninsular Florida, drought development is considered much less likely, as it received copious rainfall from both Hurricane Irma earlier in the season and from a record wet season this year.

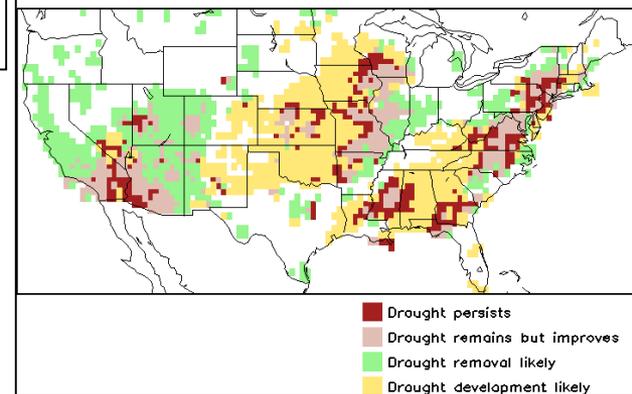
*Confidence for the Southeast is moderate to high.*

- Future plans include a Probabilistic DO (consistent with other CPC outlooks)

Drought outlook for Feb2018  
NMMR initial 01Jan2018



Drought outlook for Feb2018-Apr2018  
NMMR initial 01Jan2018



■ Drought persists  
■ Drought remains but improves  
■ Drought removal likely  
■ Drought development likely

## Discussion – Detailed narrative by region that includes reasoning and confidence

**Latest Monthly Assessment** - The Monthly Drought Outlook (MDO) for December 2017 is primarily based on official precipitation forecasts from both the Weather Prediction Center (WPC, Week-1), and the Climate Prediction Center (Week 2, Week 3/4, and the 30-day precipitation update for December). Dynamical model precipitation guidance from the CFS, GFS, and ECMWF was also used. The overall picture that emerges is one that is "front loaded"; that is, significant precipitation is predicted to fall during the early stages of the outlook period, in this case Week-1. Beyond this time, a succession of polar air masses and northwesterly flow are expected to dominate the Nation east of the Rockies, which is typically associated with a much drier pattern. Should enhanced convection associated with the tropics-based Madden-Julian Oscillation (MJO) emerge over the West Pacific early in the period as dynamical model forecasts suggest, it may also play a role in the mid-latitude North American circulation pattern by prolonging the duration of colder, drier weather across the United States, compared to what would normally be expected by extratropical influences alone. Precipitation patterns typically associated with cold season La Niñas favor drier conditions across the southern tier of states, and wetter conditions across the northern tier of states (the latter being associated with a poleward-displaced jet stream and main storm track). However, this climate signal is often more robust after the month of December, and the utility of this signal for this MDO is therefore limited.

The factors noted above, as well as climatology based on a long historical record (121 years) favor the maintenance of drought conditions across a significant portion of the contiguous United States during December 2017. Several areas of new drought development are anticipated as well. These potential development regions are indicated over the southern CONUS, and are loosely associated with abnormally dry (DO) regions depicted on the latest U.S. Drought Monitor (valid 28 November). Though some of the tools used favor precipitation across portions of the South and Southeast during Week-1, it does not look like the forecasted amounts will warrant drought improvement or removal. The normally wet winter season in California is off to a slow start this year, and with the possible exception of the end of December, the next few weeks look relatively dry as well. With the approach of Hawaii's core rainy season, most of the islands are expected to see drought improvement and/or removal. One exception may be along and near the leeward slopes of western Maui, which has received well below-normal rainfall during November. The persistent trade wind pattern that has dominated the Hawaiian Islands is forecast to continue in December. There is no drought in Alaska or Puerto Rico at this time.

Forecaster: Anthony Artusa

Next Monthly Outlook issued: December 31, 2017 at 3 PM EST

## Summary - Short overall narrative



- Overview of CPC Outlooks, Process, Tools and Services:
  - 1) Week 2 (Days 8-14)
  - 2) Week 3-4
  - 3) Monthly and Seasonal Outlooks (LLF)
  - 4) Global Tropics Hazards Outlook (GTH)
  - 5) Drought Outlooks (SDO & MDO)
  
- **Verification of Outlooks**



# Verification: Modified HSS Metric



Modified Heidke Skill Score (HSS):  
% Improvement over Random Forecasts

$$\text{HSS (\%)} = 100 * \frac{(H - E)}{(T - E)}$$

H = Number of correct forecasts

E = Expected number of correct forecasts (1/3 of total)

T = Total number of valid forecast-observation pairs

$$\text{HSS (\%)} = 100 * \frac{(\text{Hits} - \text{Expected})}{(\text{Total} - \text{Expected})}$$

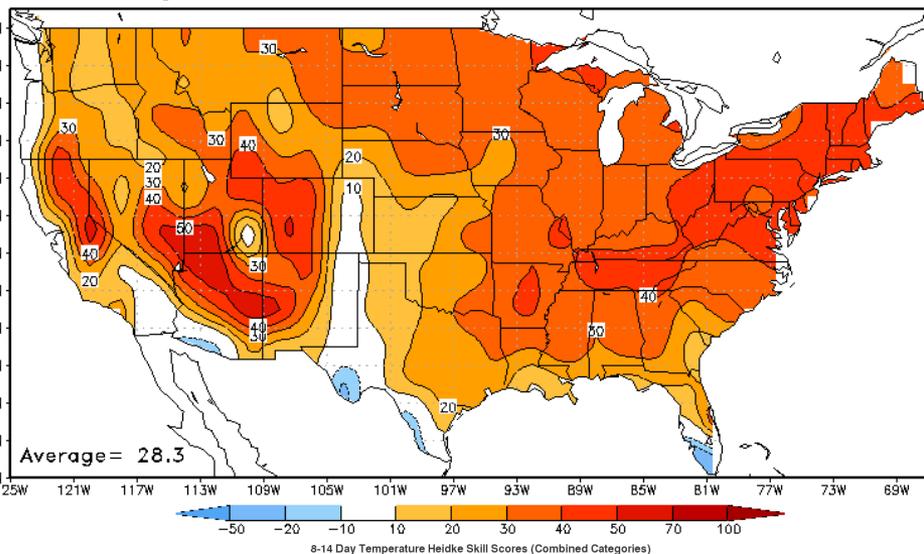


# Verification: Week-2



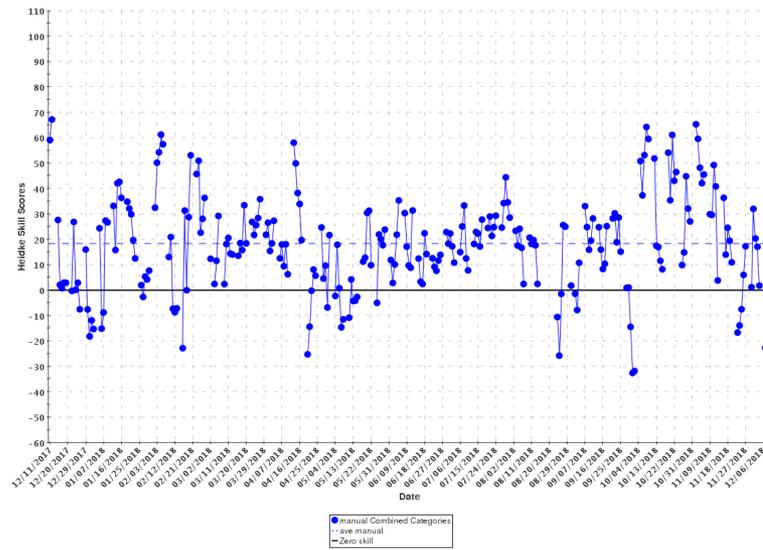
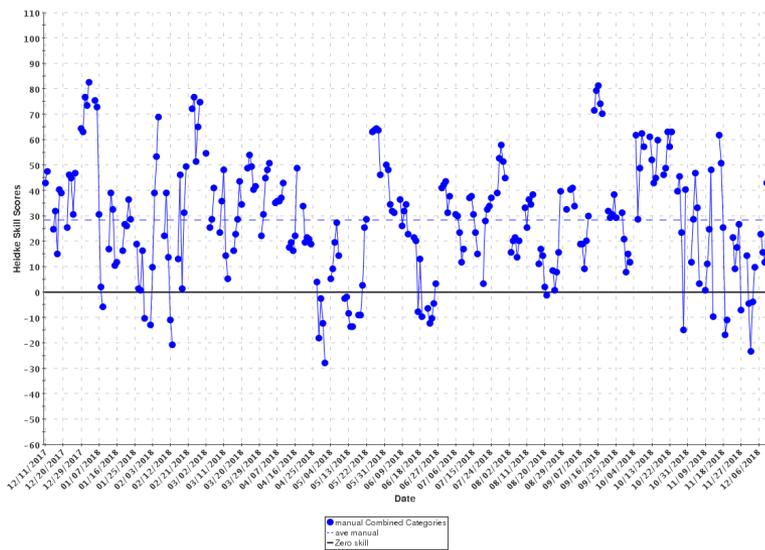
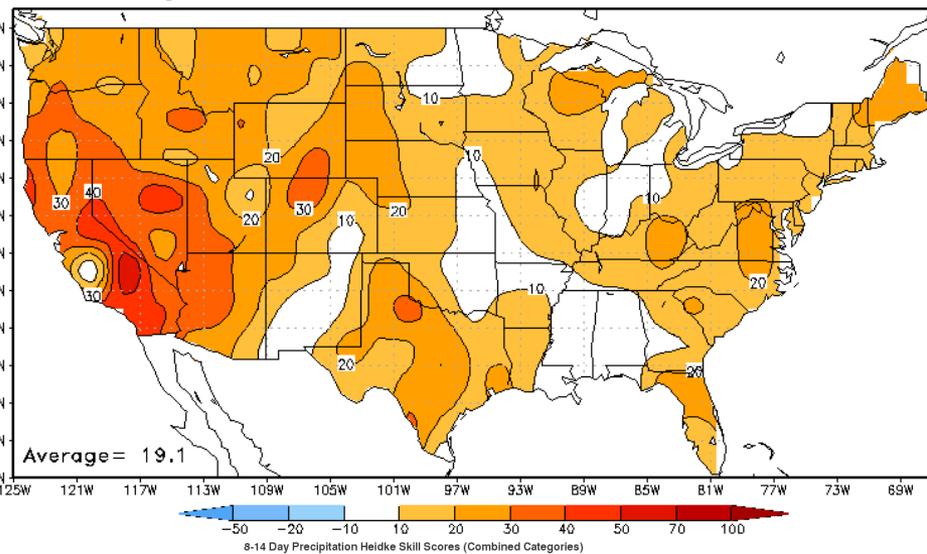
## Temperature

8 to 14 Day Temperature Heidke Skill Score  
365 Days of Manual Forecasts From 20171211 to 20181210

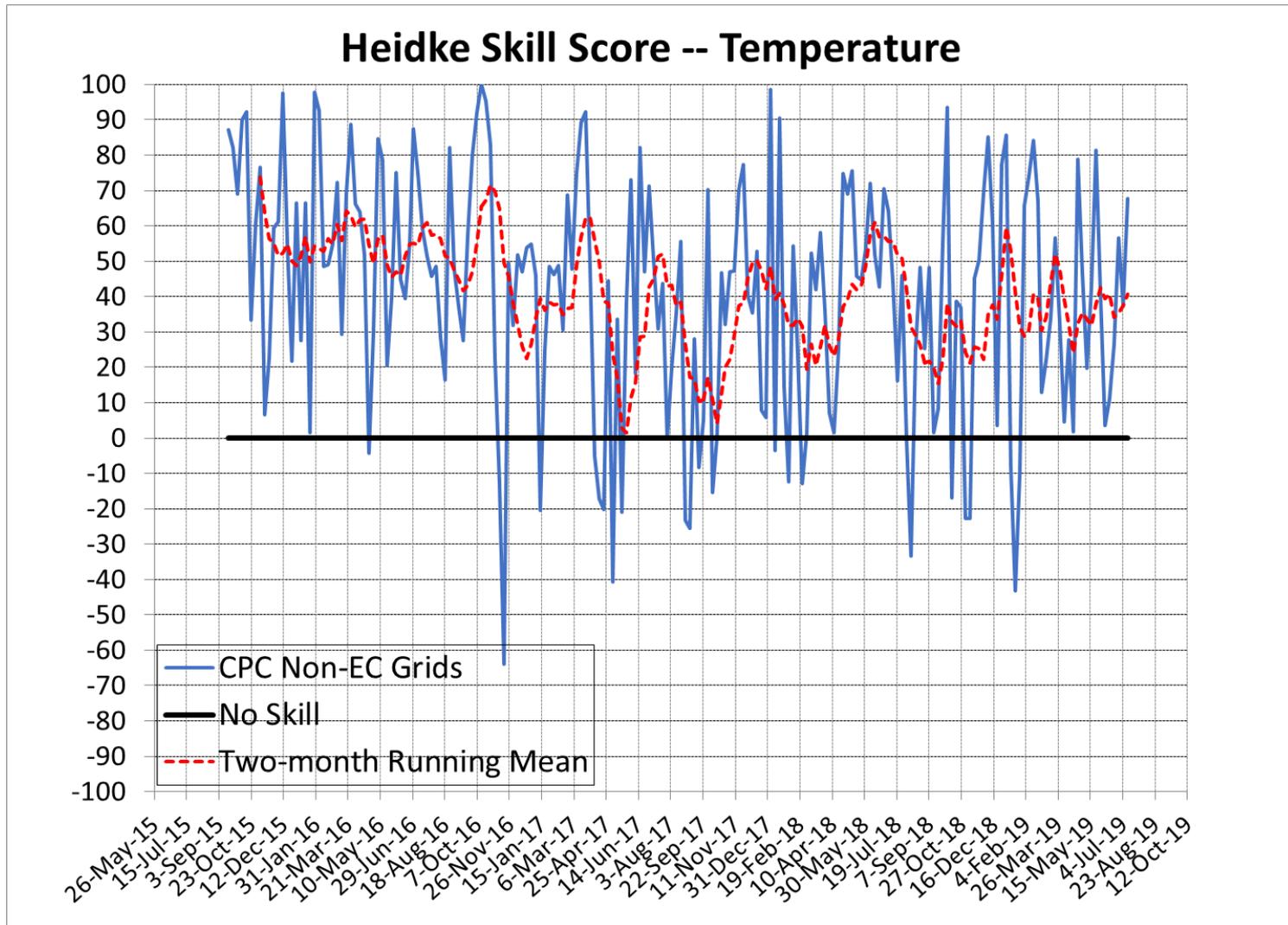


## Precipitation

8 to 14 Day Precipitation Heidke Skill Score  
365 Days of Manual Forecasts From 20171211 to 20181210



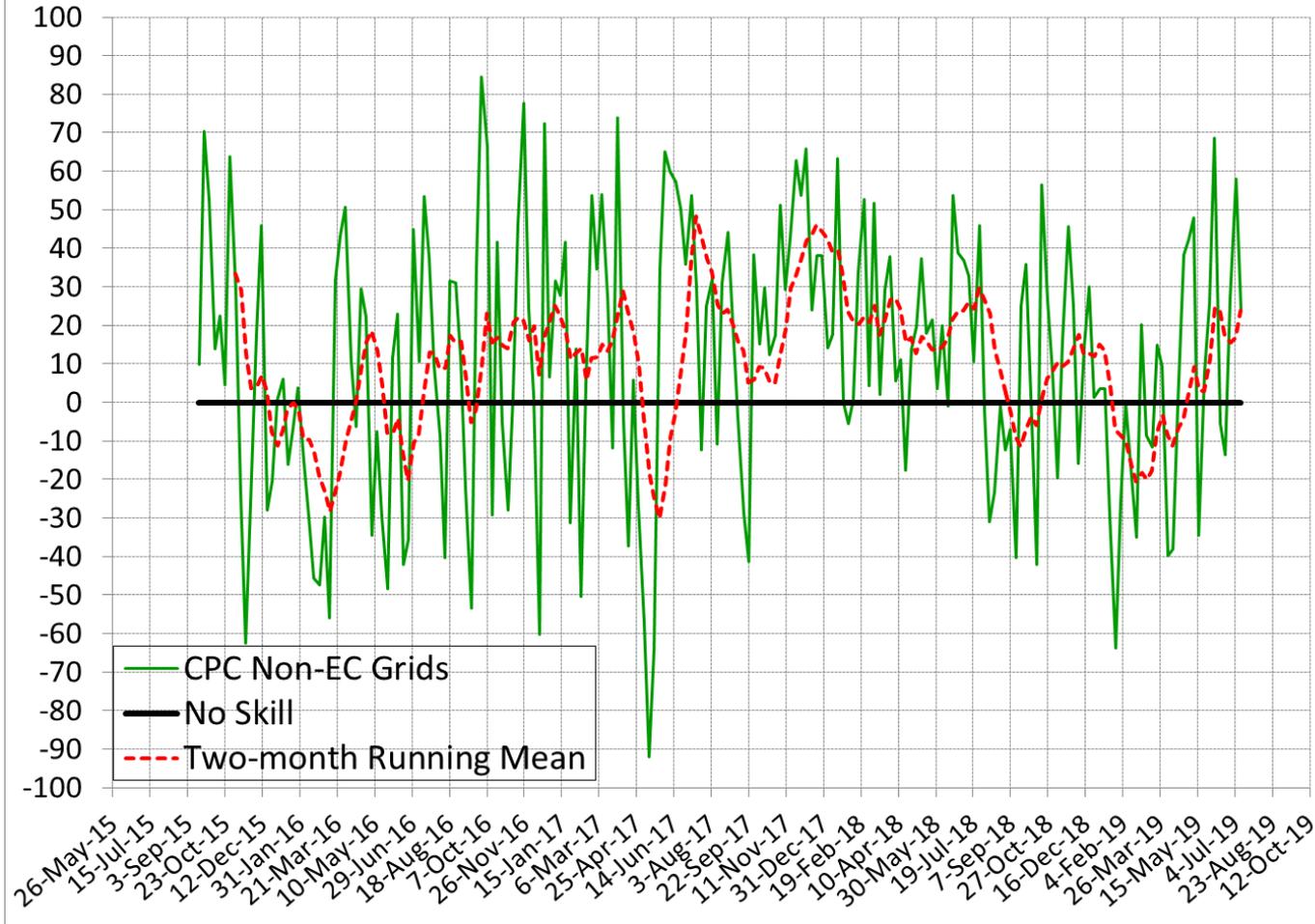
# Verification: Week 3-4



# Verification: Week 3-4



## Heidke Skill Score -- Precipitation



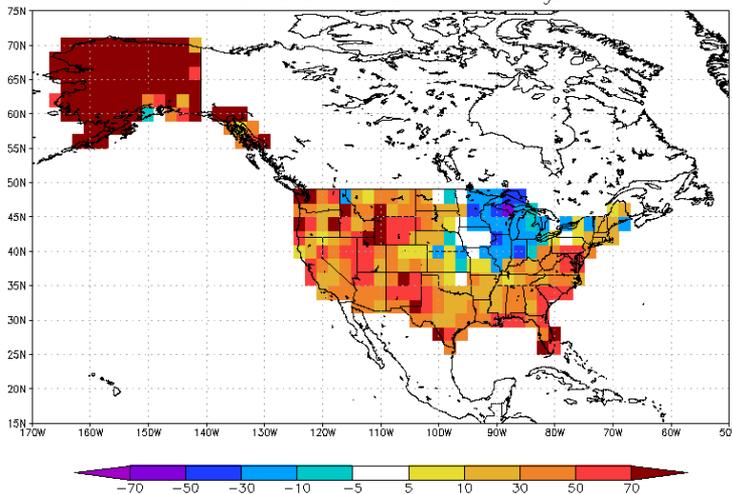
# Verification: Week 3-4



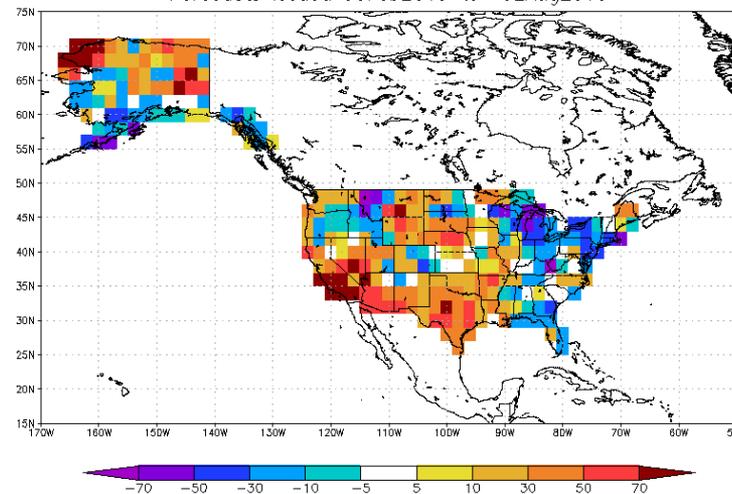
## Temperature

## Precipitation

Official Week-3/4 Temperature Heidke Skill Scores  
Forecasts issued 03Feb2019 to 02Aug2019

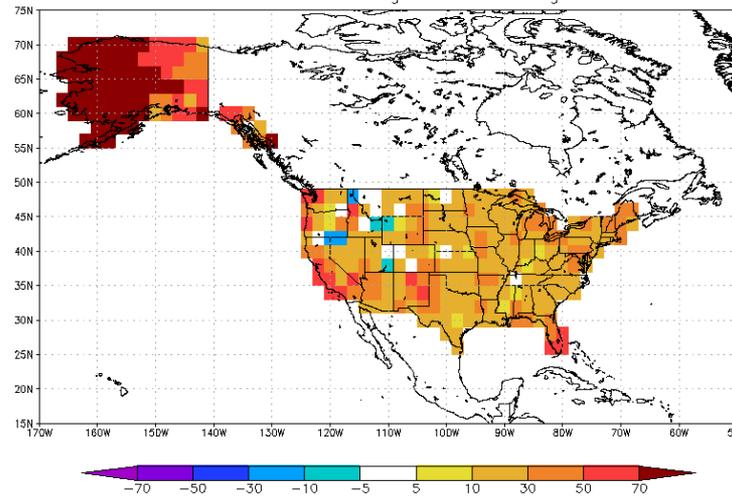


Official Week-3/4 Precipitation Heidke Skill Scores  
Forecasts issued 03Feb2019 to 02Aug2019

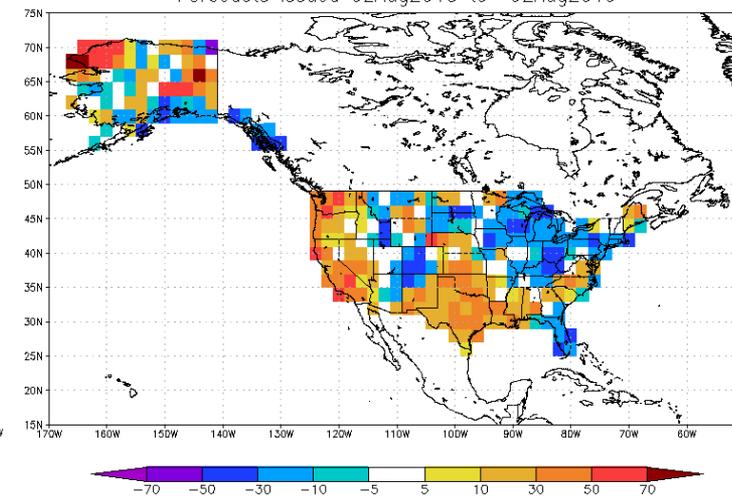


Last 180 days

Official Week-3/4 Temperature Heidke Skill Scores  
Forecasts issued 02Aug2018 to 02Aug2019



Official Week-3/4 Precipitation Heidke Skill Scores  
Forecasts issued 02Aug2018 to 02Aug2019



Last 365 days

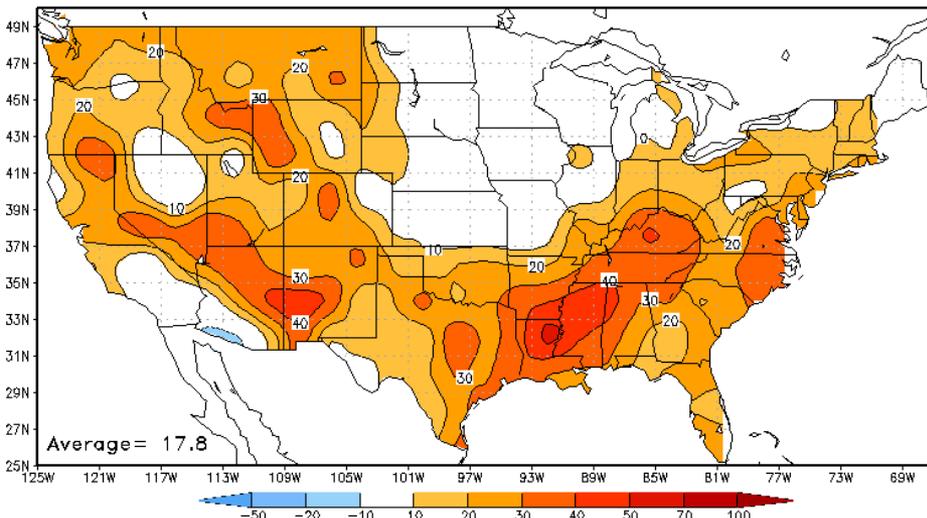


# Verification: Seasonal Outlook

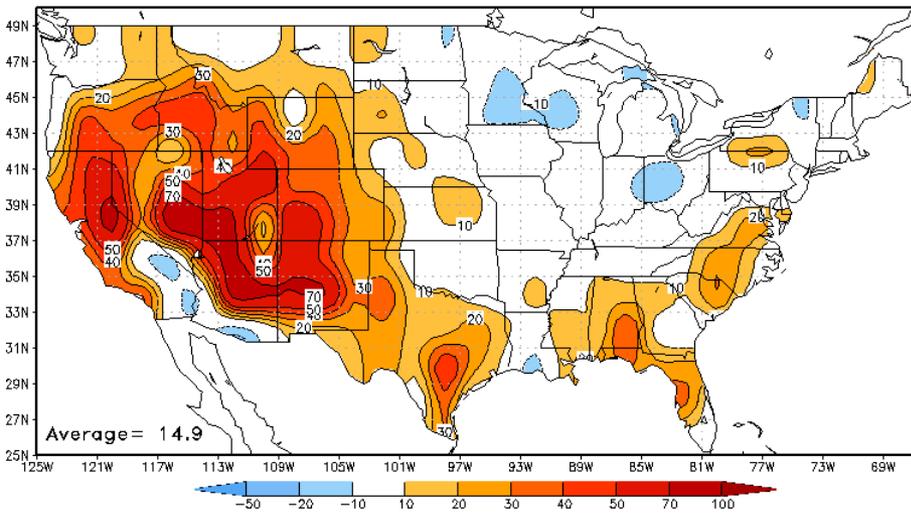


## Temperature

Seasonal (Lead 0.5 Months) Temperature Heidke Skill Score  
DJF Manual Forecasts From 1995 to 2018

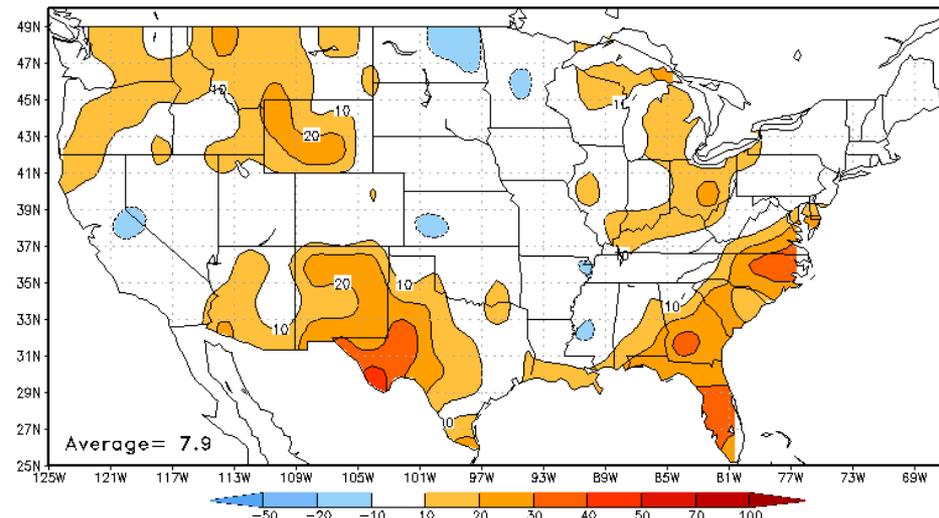


Seasonal (Lead 0.5 Months) Temperature Heidke Skill Score  
JJA Manual Forecasts From 1995 to 2018

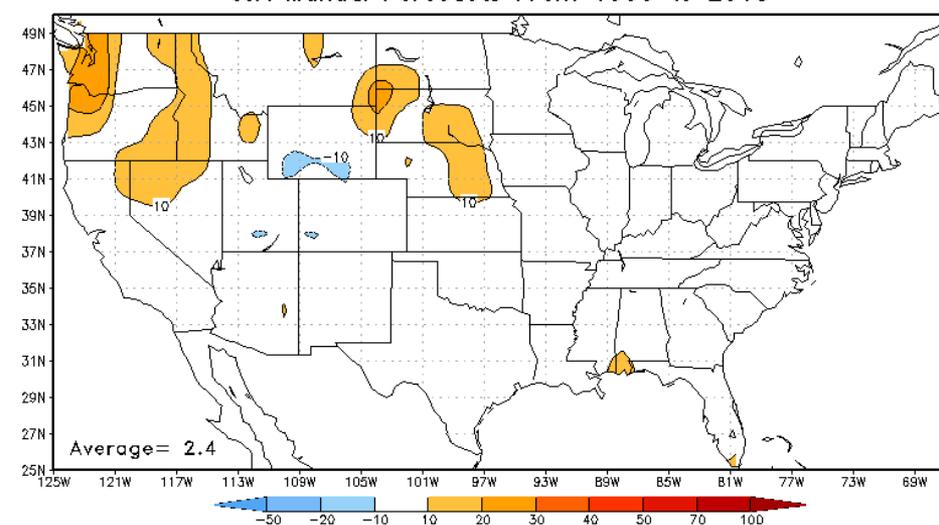


## Precipitation

Seasonal (Lead 0.5 Months) Precipitation Heidke Skill Score  
DJF Manual Forecasts From 1995 to 2018



Seasonal (Lead 0.5 Months) Precipitation Heidke Skill Score  
JJA Manual Forecasts From 1995 to 2018



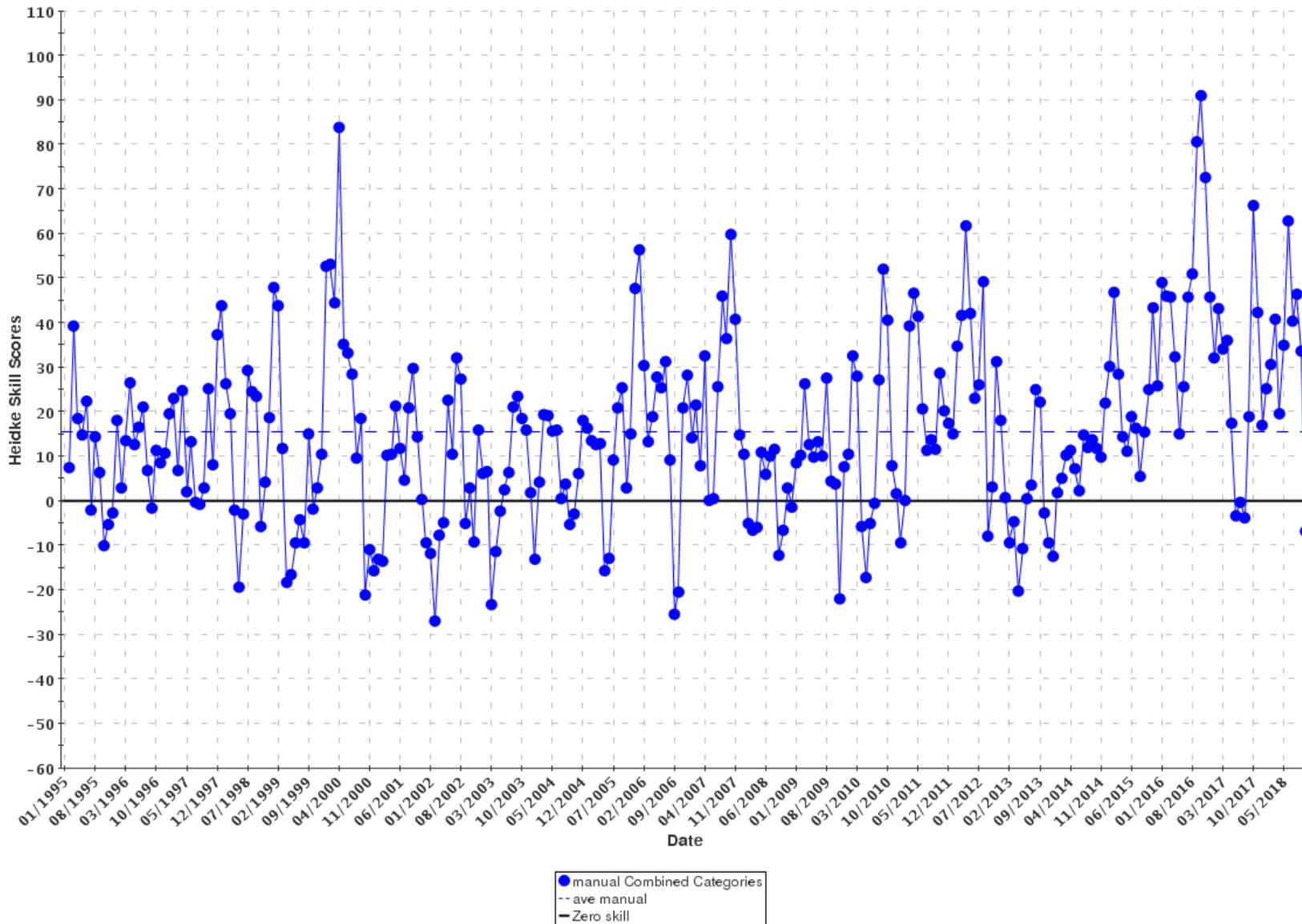


# Verification: Seasonal Outlook



## Temperature

Seasonal (Lead 0.5 months) Temperature Heidke Skill Scores (Combined Categories)



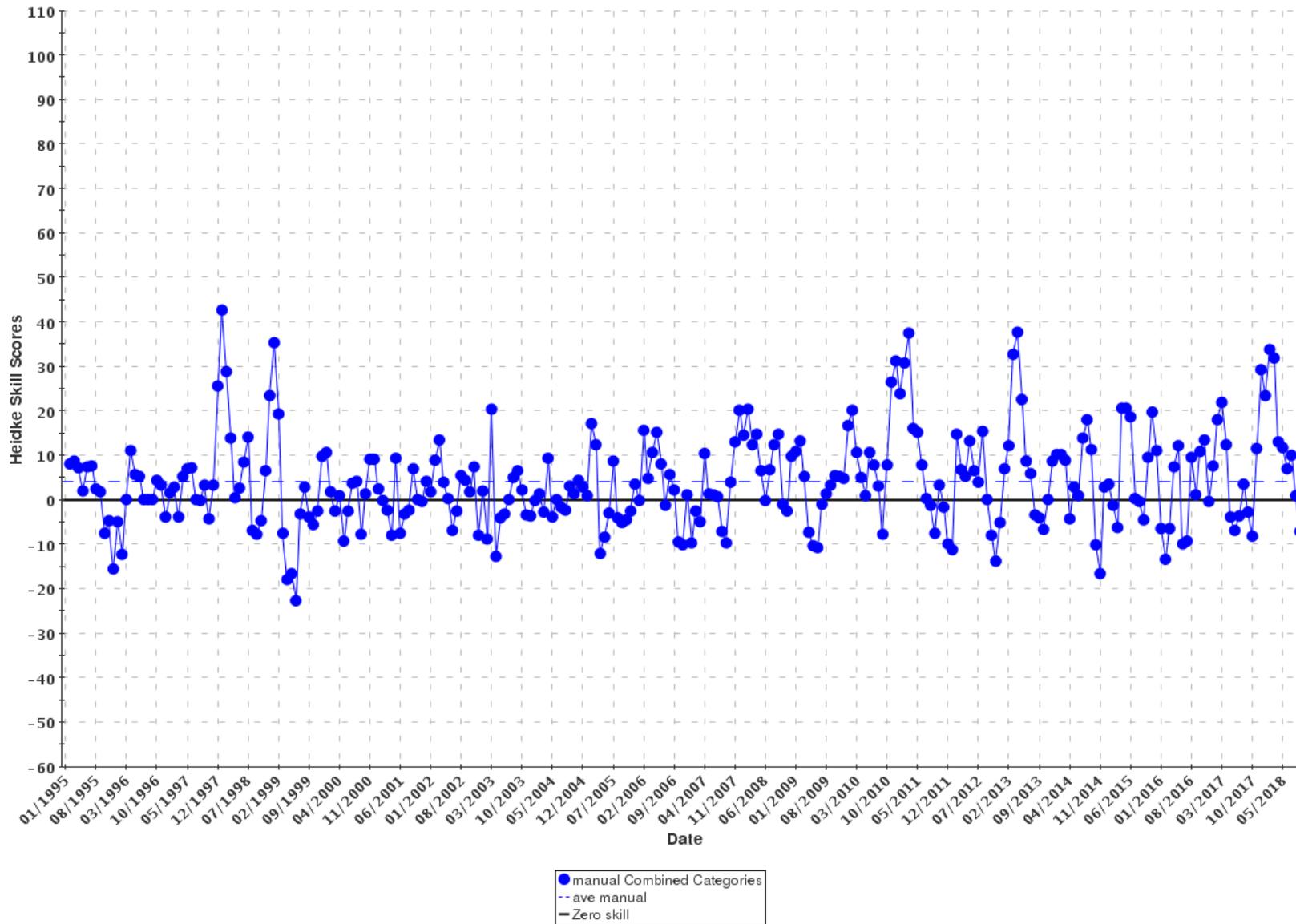


# Verification: Seasonal Outlook



## Precipitation

Seasonal (Lead 0.5 months) Precipitation Heidke Skill Scores (Combined Categories)





# Verification: GPRA Metric



## Verification: Seasonal Outlook

### Gridded Seasonal Verifications

Forecast Valid: Jan-Feb-Mar 2018

To view another forecast/observation pair, please select the valid season and year using the menu below and press the "Submit" button. (Note that the year corresponds to the center month of the valid period)

season  year  submit

### Download Skill Score Archive

[Temperature](#) [Precipitation](#)

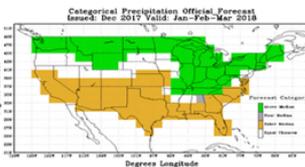
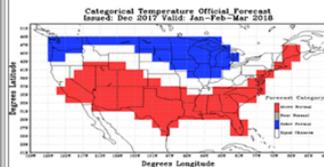
[Click here for skill score explanation](#)

Temperature Forecast Heidke Skill Scores :  
Non-Equal Chance(non EC) forecasts: 40.70  
All forecasts: 30.17  
% coverage not Equal Chance forecasts : 74.14

Precipitation Forecast Heidke Skill Scores :  
Non-Equal Chance(non EC) forecasts: 40.79  
All forecasts: 33.41  
% coverage not Equal Chance forecasts : 81.90

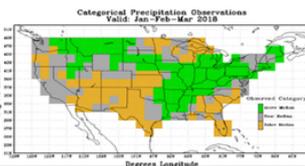
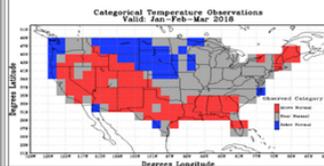
Temperature (Forecast)  
Download Forecast Data Archive  
(CAT PROB ABOVE PROB BELOW)  
[How To Read Temperature Forecasts](#)

Precipitation (Forecast)  
Download Forecast Data Archive  
(CAT PROB ABOVE PROB BELOW)  
[How To Read Precipitation Forecasts](#)

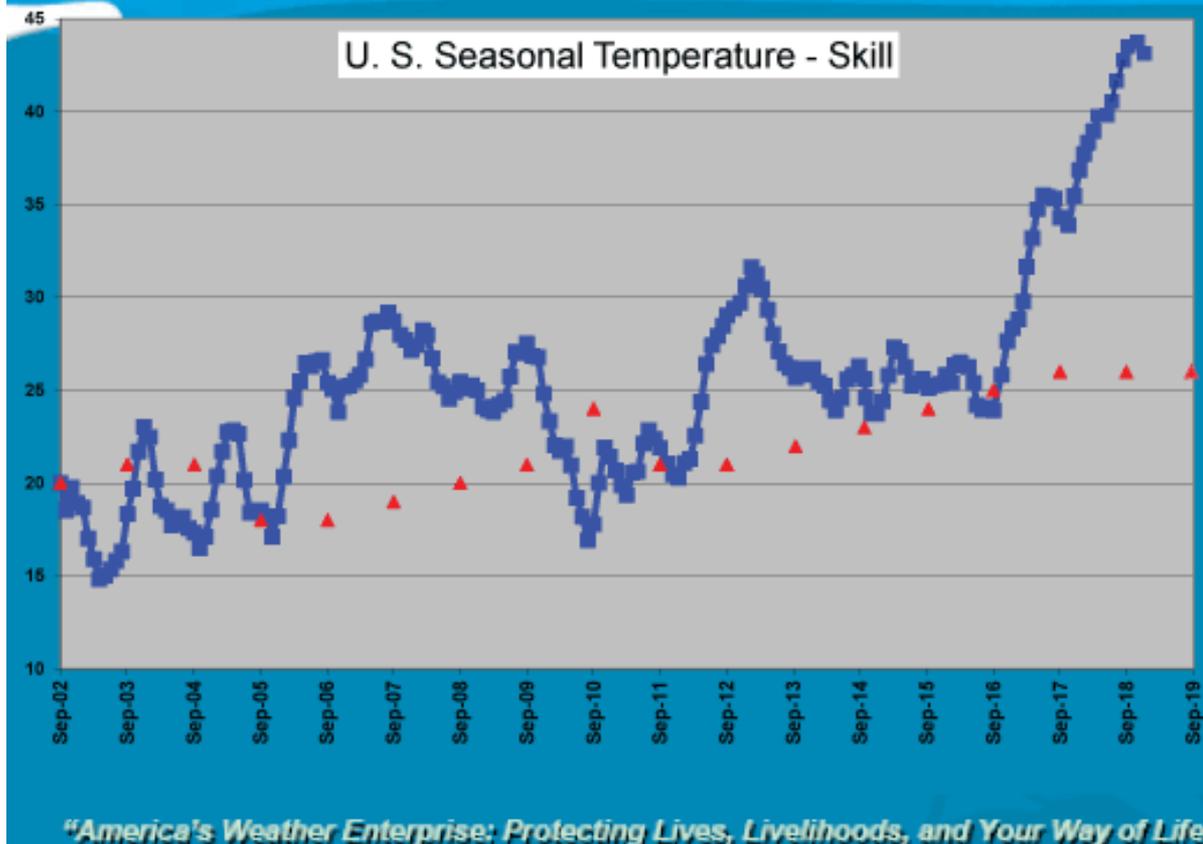


Temperature (Observations)  
Download Observational Data Archive  
(Temperature Observations)  
[How To Read Observations](#)

Precipitation (Observations)  
Download Observational Data Archive  
(Precipitation Observations)  
[How To Read Observations](#)



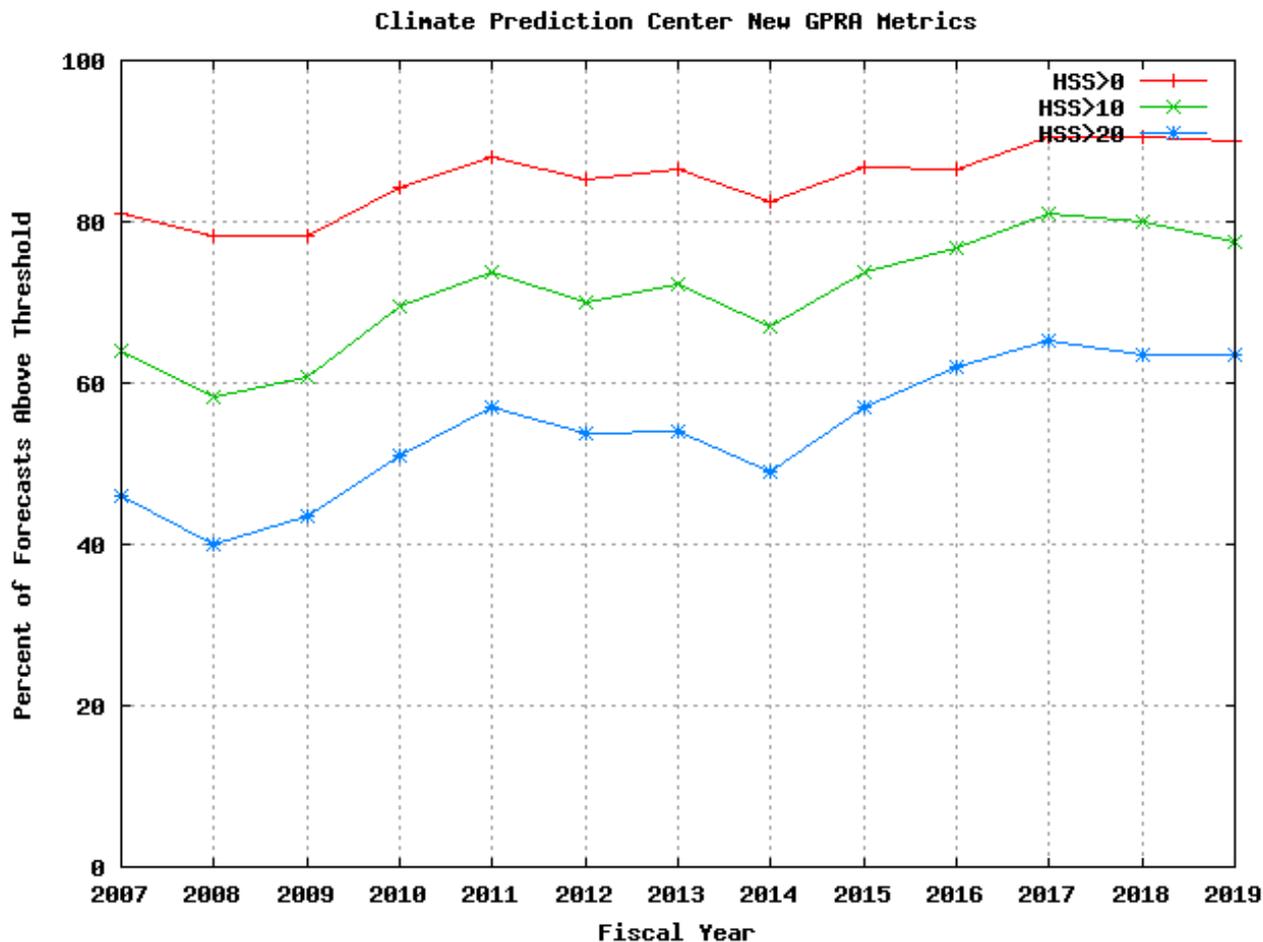
## U.S. Seasonal Temperature - Skill



- Running 48 month average score for Lead 1 seasonal temperature outlooks (blue)
- NWS HQ FY goal (red triangles)



# Verification: Comprehensive Metric



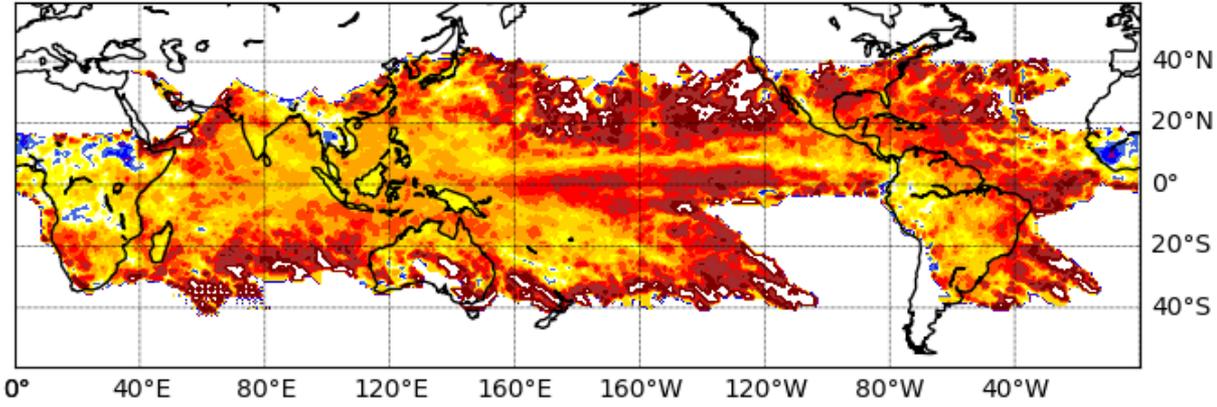
- Most CPC T/P outlooks from Days 6-10 through seasonal
- More heavily weights Week-2 outlooks



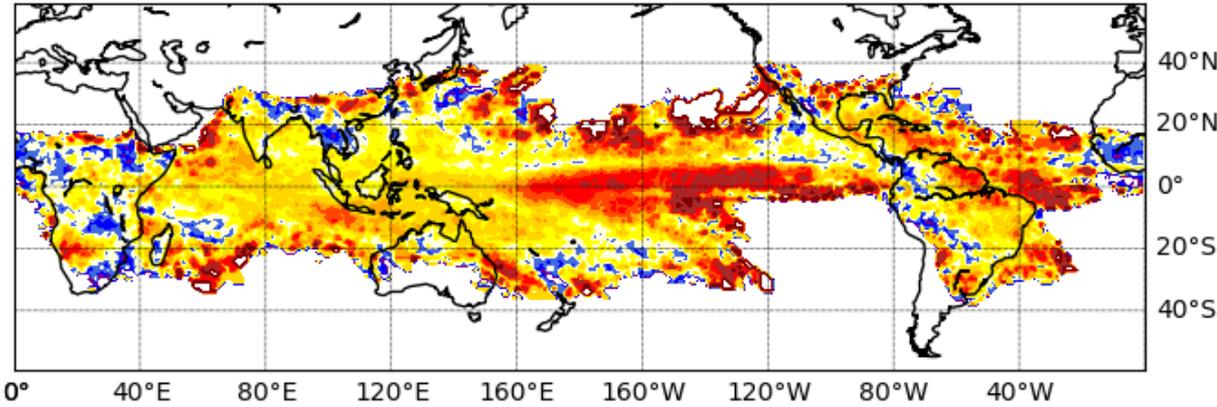
# Verification - GTH



HSS Week 1



HSS Week 2



Official GTH Outlooks

Forecast Precipitation Areas  
(both above- and below-normal areas)

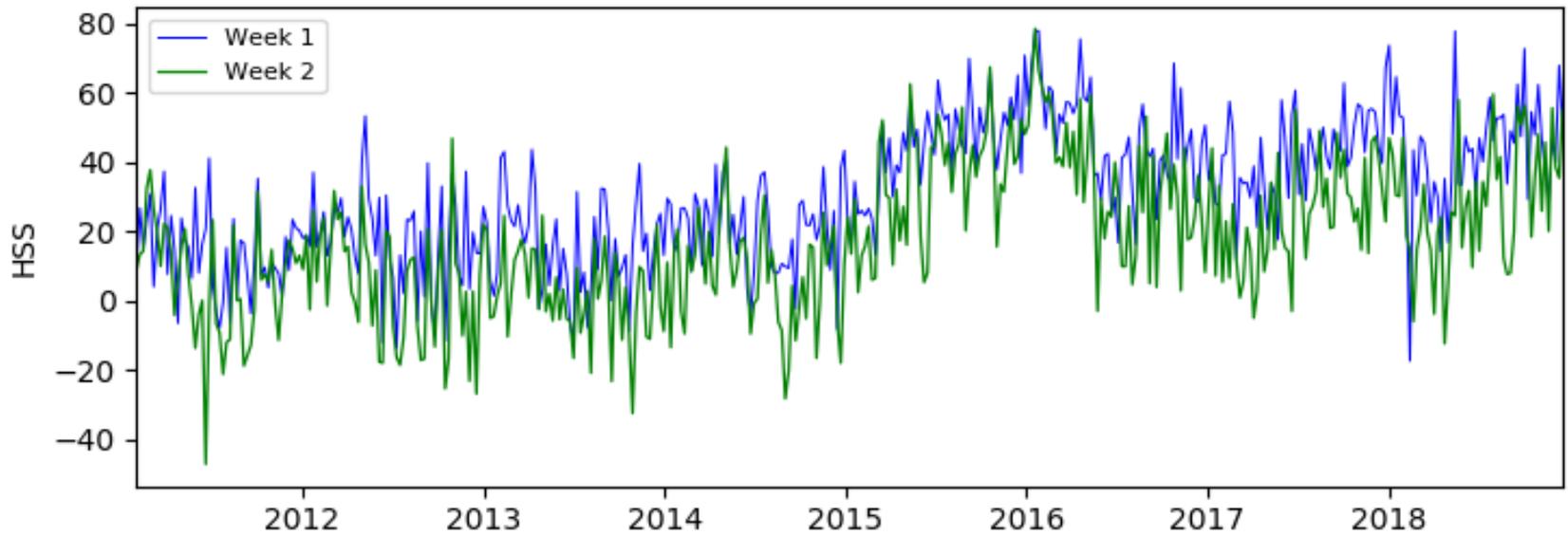
2011-2019 Period



# Verification - GTH



### Heidke Skill Score for GTH Forecasts



## Official GTH Outlooks

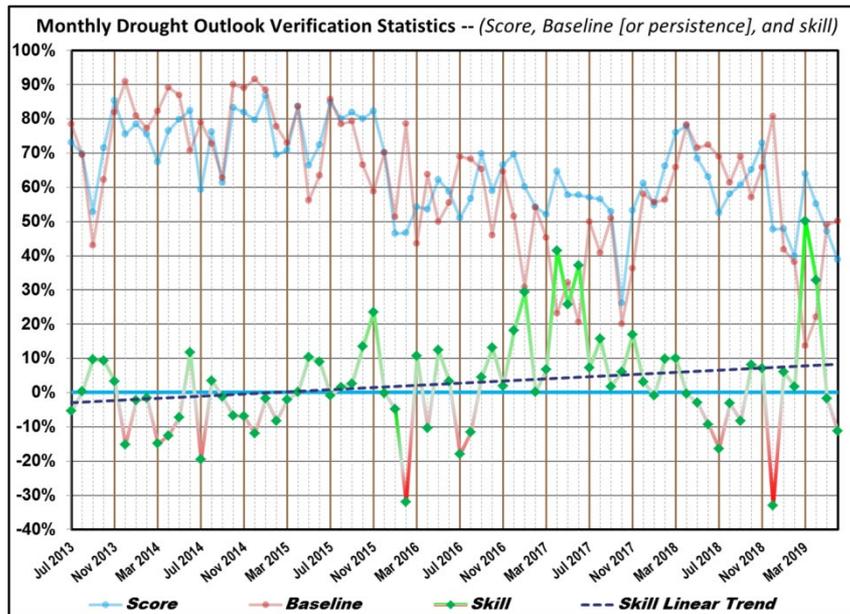
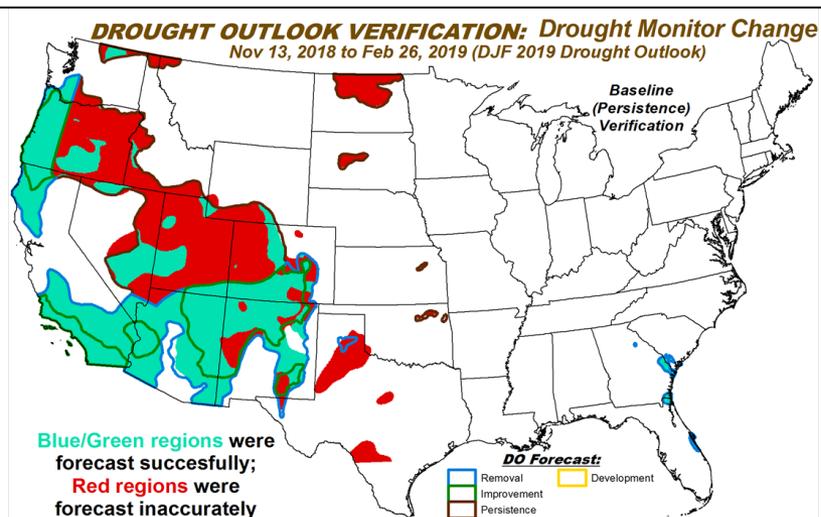
Forecast Precipitation Areas  
(both above- and below-normal areas)

2011-2019 Period

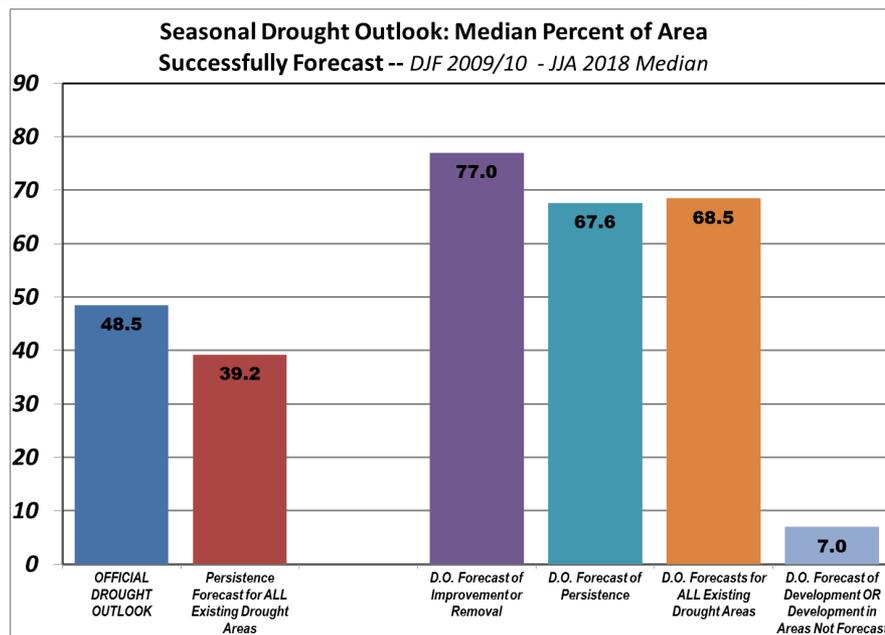
From 2007-2012, HSS were calculated for Weeks 1 & 2 in individual ocean basins where tropical cyclone favored development areas occurred (Atlantic, Pacific, Indian).



# Verification: Drought Outlooks



FORECAST	HIT	MISS
Improvement/Removal	46,794	5,221
Persistence	10,208	38,090
Development	0	6,232
<b>TOTAL</b>	<b>57,002</b>	<b>49,543</b>
<b>SCORE</b>	<b>53.5%</b>	
PERSISTENCE FORECAST BASELINE	15,429	91,116
<b>PERSISTENCE FORECAST SCORE</b>	<b>14.5%</b>	
<b>"SKILL"</b> (forecast score) minus (persistence score)	<b>+39.0</b>	



Thanks for your attention and time.

Any comments, questions, or suggestions?

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