

Activities of NOAA's NWS Climate Prediction Center (CPC)

Jon Gottschalck and Dave DeWitt

“Improving Sub-Seasonal and Seasonal Precipitation Forecasting
for Drought Preparedness”

May 27-29, 2015
San Diego, CA

Outline

(1) CPC overview

(2) Monthly and seasonal precipitation

- ➔ Outlooks and historical forecast skill
- ➔ Forecast tools and some associated skill information

(3) Week 3-4 experimental outlooks

- ➔ Overview and plans
- ➔ Statistical and dynamical forecast tools
- ➔ Initial model forecast skill

(4) NIDIS Working Group

CPC Overview

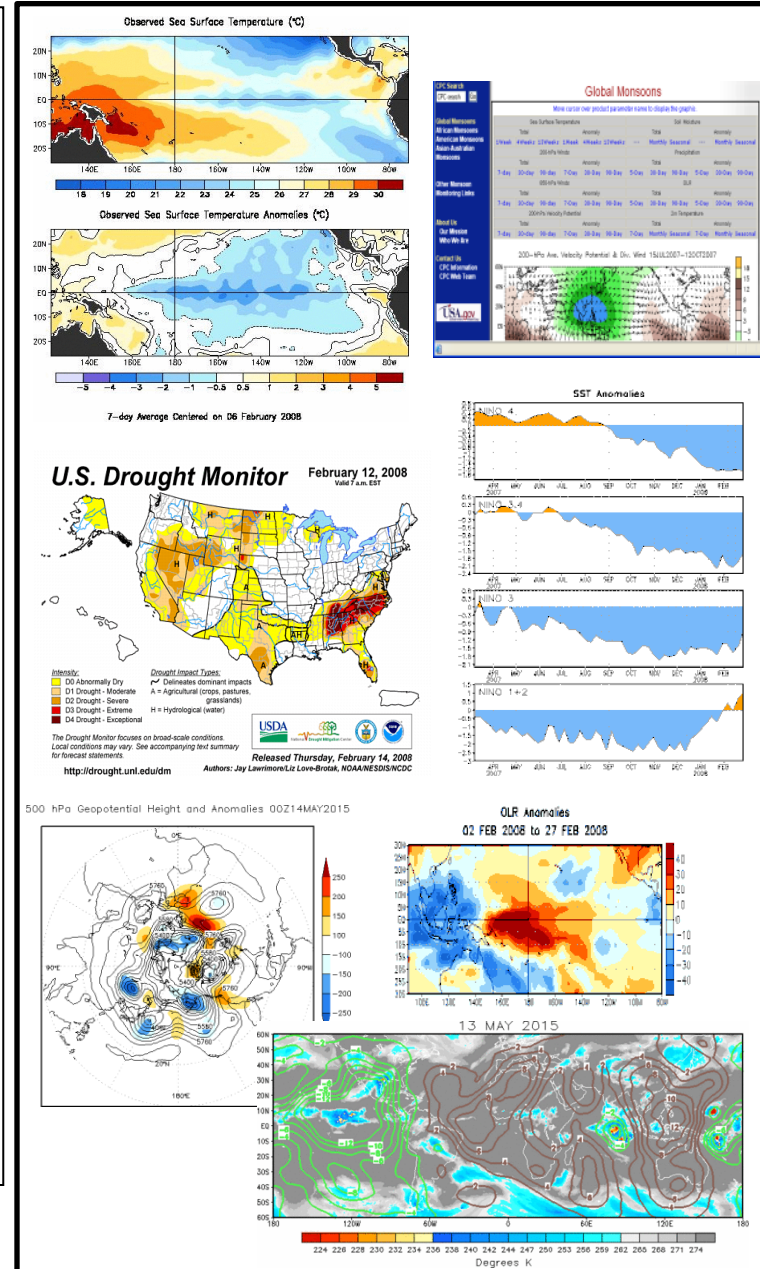
CPC Mission

Deliver real-time products and information that predict and describe climate variations on timescales from weeks to year(s) 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

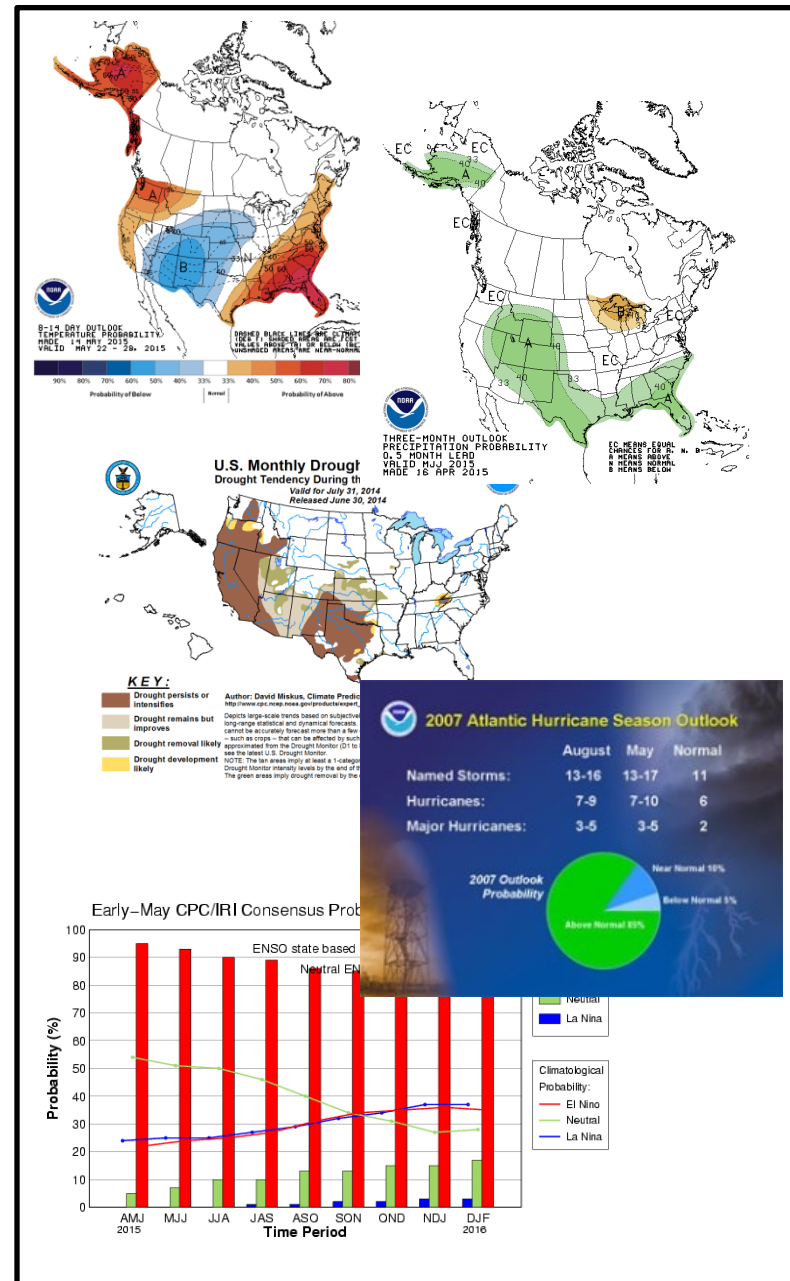
CPC Monitoring Activities

- Daily and monthly data
- Time series and spatial maps for various climate parameters
- Compilation of data on historical and current atmospheric / oceanic conditions
 - Primary modes of climate variability (ENSO, MJO, NAO, PNA, AO,...)
 - Atmospheric Circulation (global troposphere and stratosphere)
 - Blocking
 - Monsoons
 - Oceanic Conditions (global and coastal)
 - Precipitation and Surface Temperature (global and U.S.)
 - Drought (U.S., North America)
 - Climate Reanalysis



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

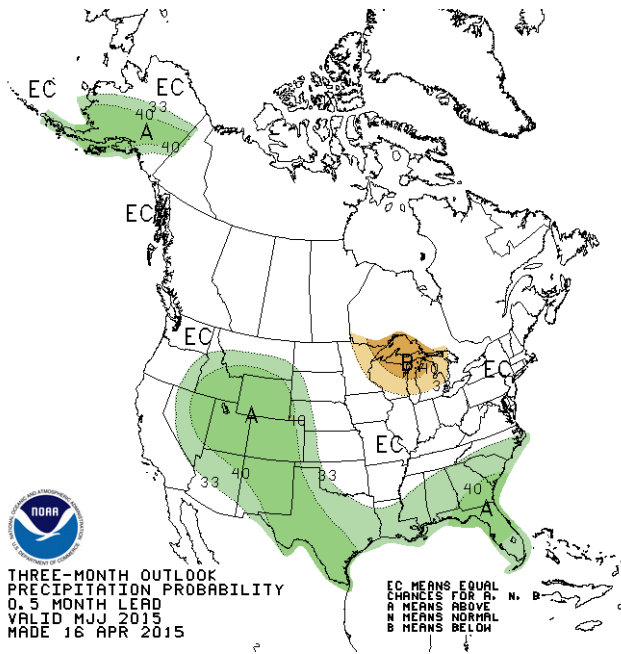


Interaction Between CPC and NWS Regional Offices

- Primary mode of interaction between CPC and the regions is through the Climate Service Program Managers (CSPMs) and Regional Climate Service Directors (RCSDs)
- CSPMs (or their designees) participate in the process of generating CPC outlooks via regular telecons:
 - ✓ **U.S. and Global Tropics Hazards Outlooks**
 - ✓ **Monthly and seasonal T/P outlooks**
 - ✓ **Drought outlooks**
- CPC staff collaborate with CSPMs through telecons listed above, project developmental meetings at times and the Climate Predictions Applications Science Workshop (CPASW) annual meeting organized by the Climate Services Branch (CSB)
- CPC staff conduct special briefings for the NWS Field associated with high-impact climate events [ENSO, winter and spring outlook, hurricane outlook and climate training (i.e. MJO, outlook interpretation)]

CPC Precipitation Outlooks

CPC Monthly and Seasonal Precipitation Prediction

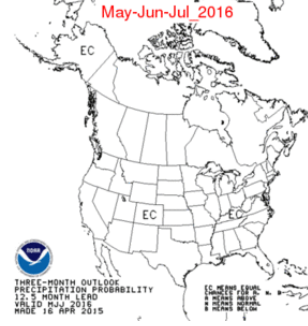
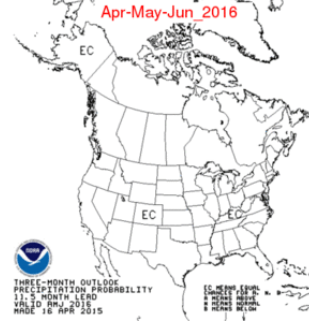
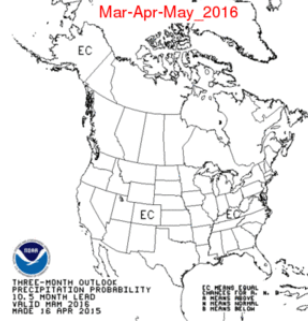
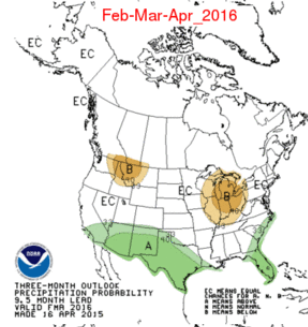
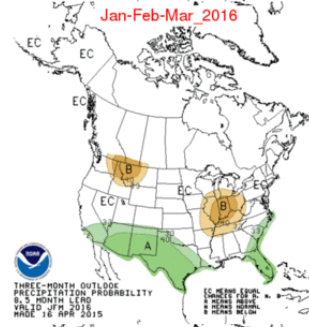
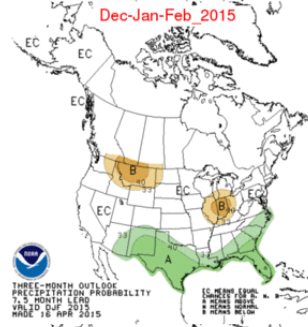
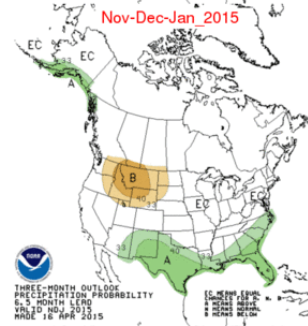
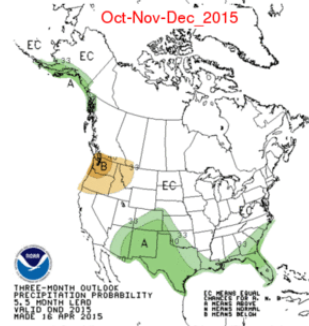
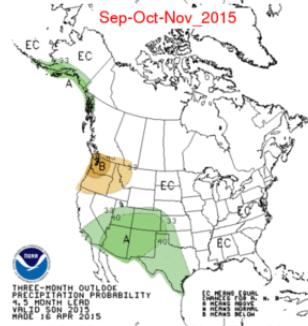
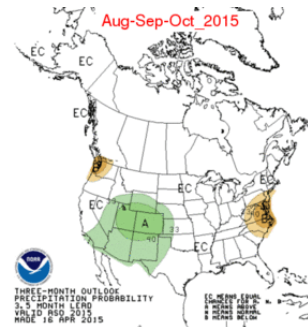
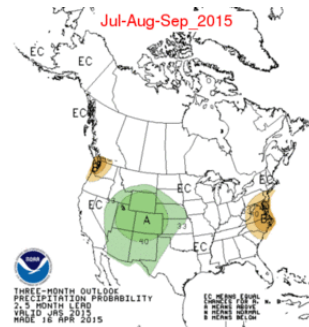
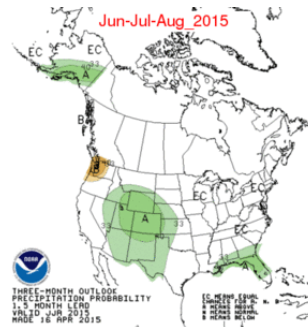


Released third Thursday of the month

Seasonal: 13, 3-month overlapping seasons

Monthly: Twice per month (i.e., update released on last day of month)

Probabilities of favored category

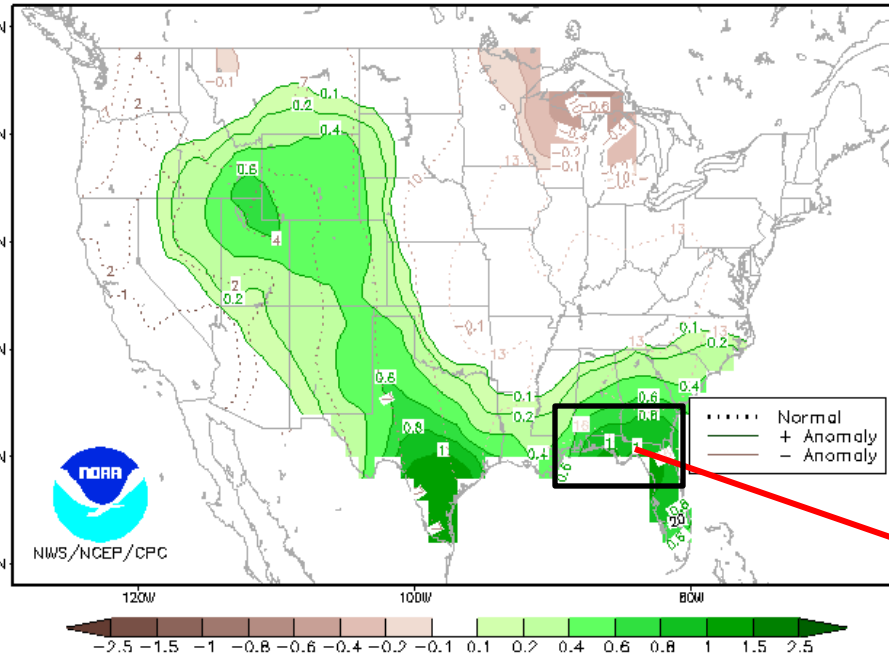


Additional Seasonal Precipitation Information

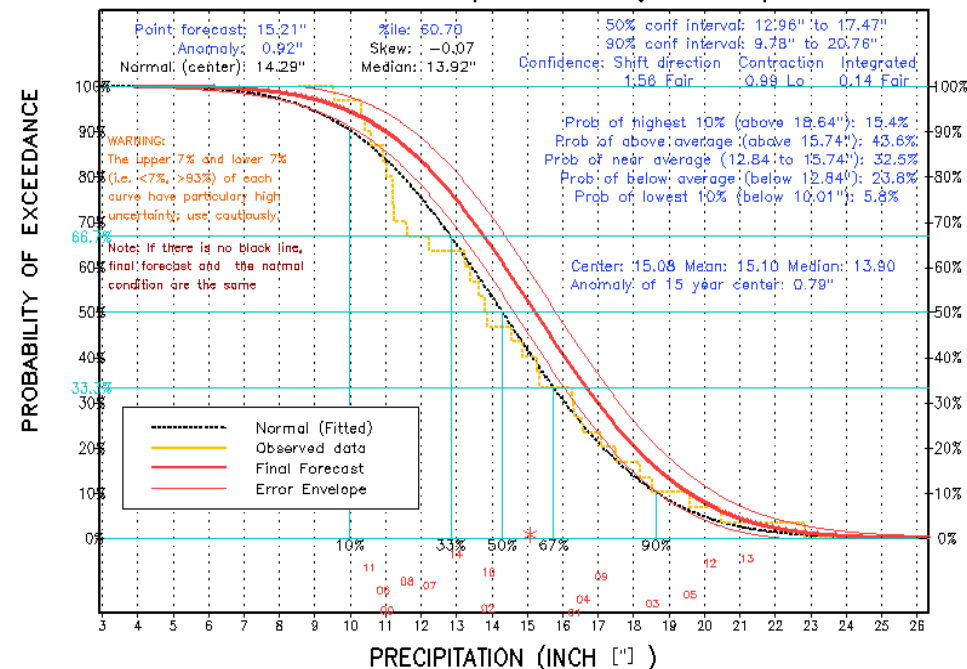
Northern Florida Climate Division

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

CPC Interactive Display of Climate Outlooks

INTERACTIVE DISPLAY - UPDATED: 24 MAY 2015

[580 Allatoona Dam Road, Cartersville, GA 30120, USA](#)

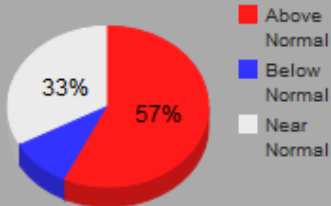
Enter Location

Enter

Three Category Temperature Outlook

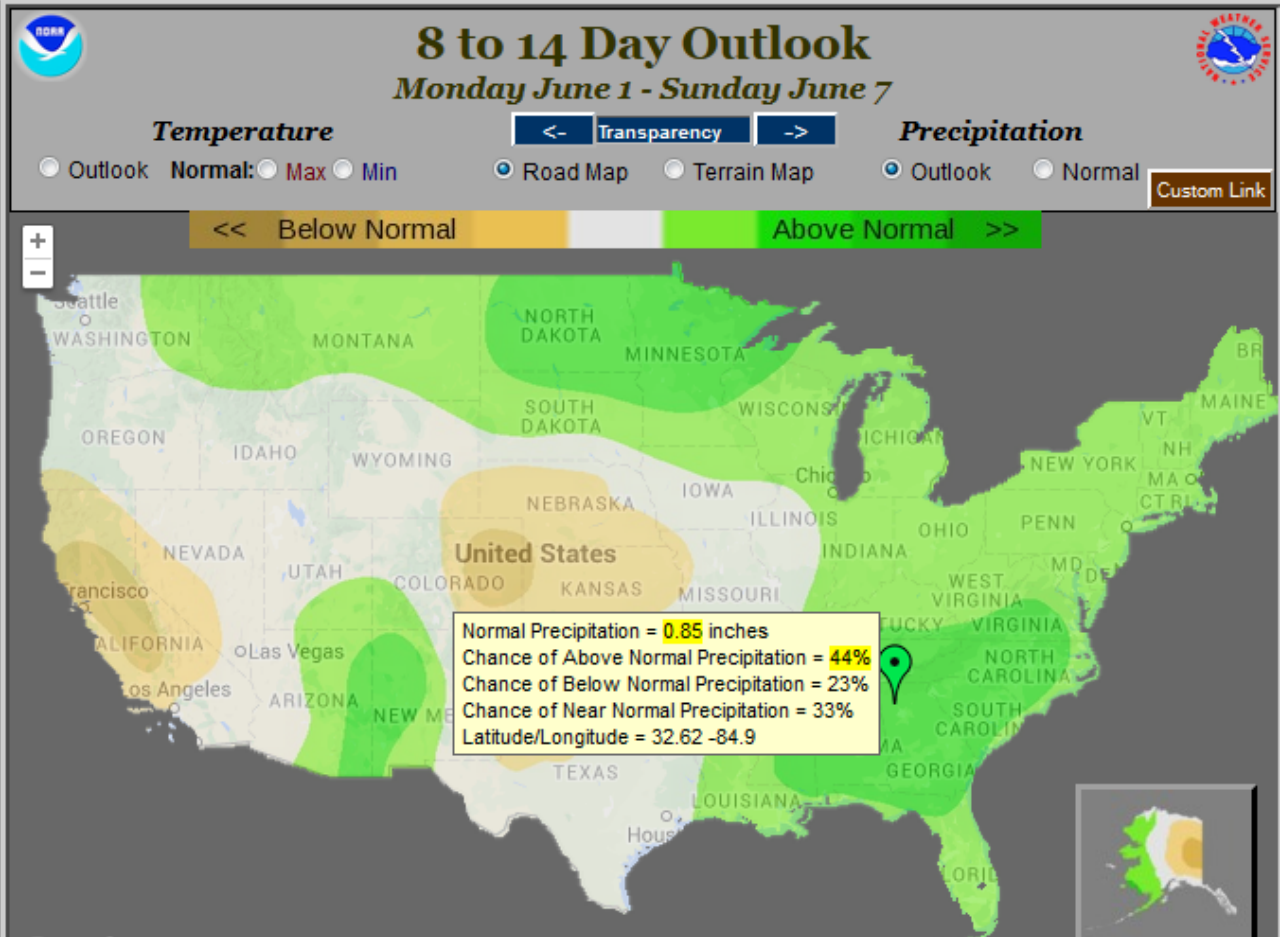
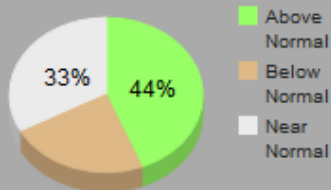
Normal Maximum Temperature: **84**

Normal Minimum Temperature: **62**



Three Category Precipitation Outlook

Normal Precipitation: **0.79**



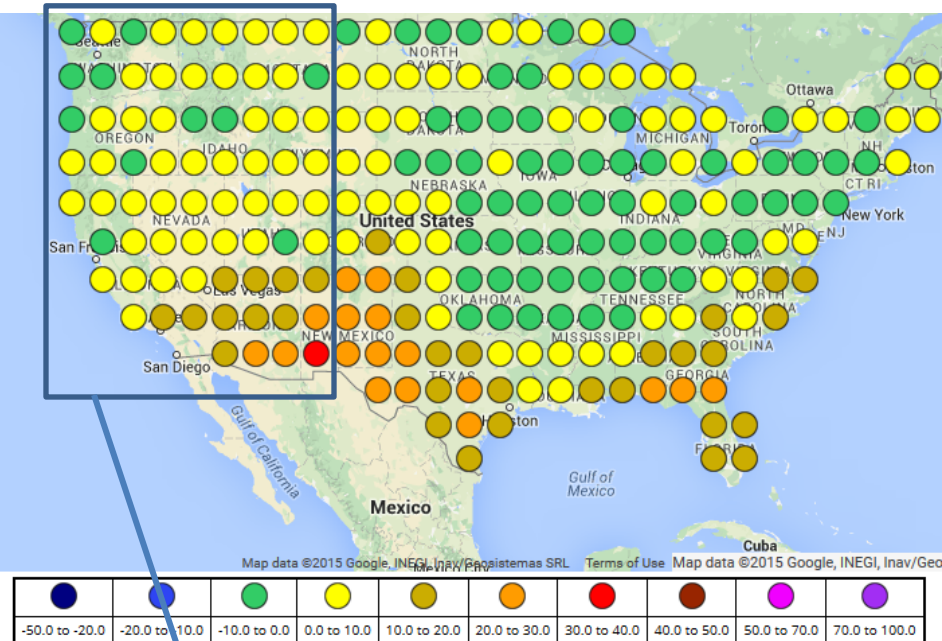
- Example is from CPCs extended range outlooks
- Planned to be implemented for the monthly and seasonal outlooks sometime during FY16

Seasonal Precipitation Forecast Skill

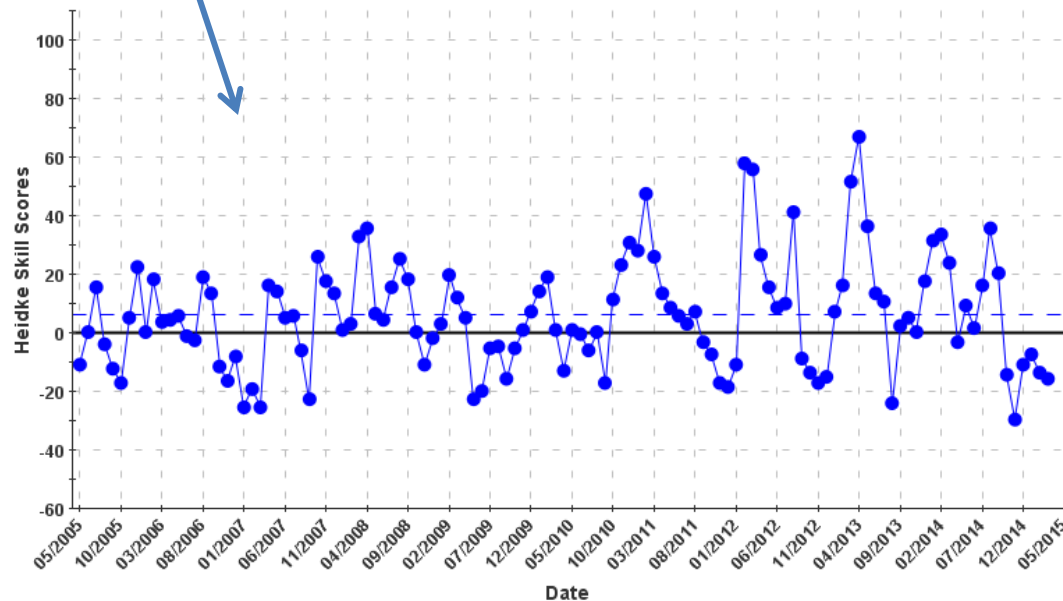
Heidke Skill Score

1995-2015

Sep-Oct-Nov → Mar-Apr-May



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

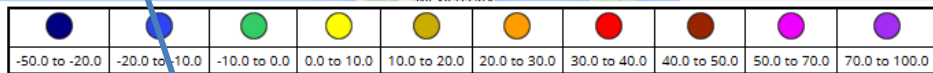
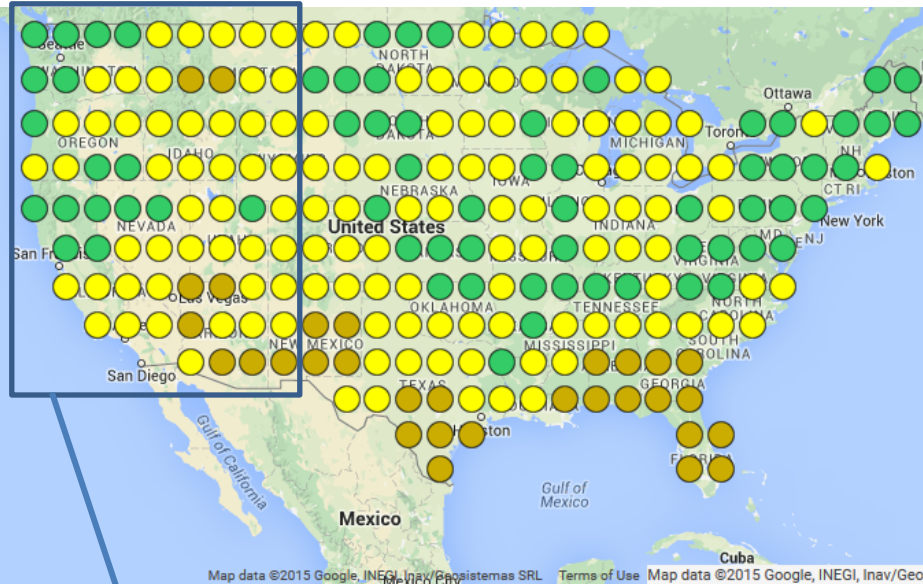


Heidke Skill Score

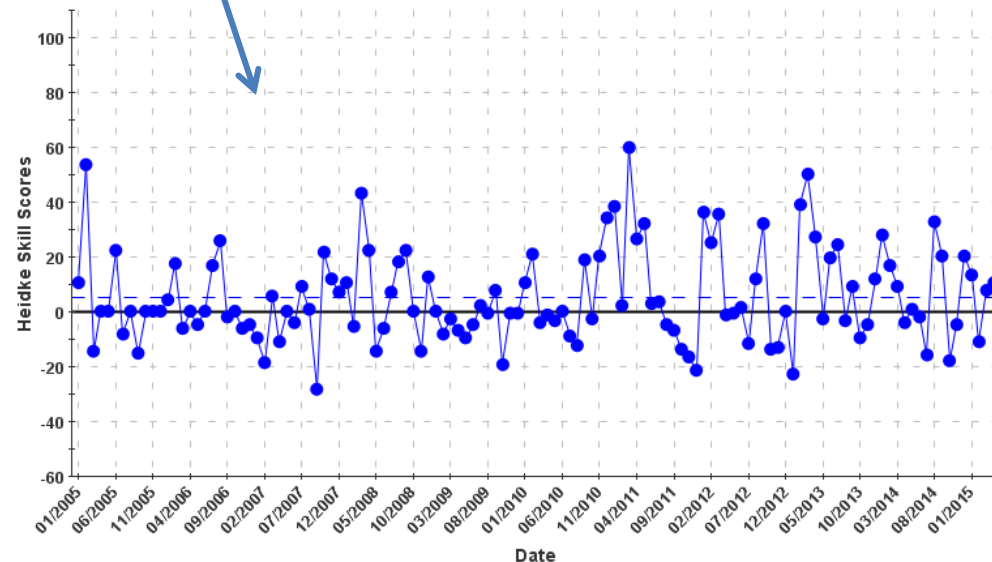
2005-2015, all seasons

Mean: +6.7

Monthly Precipitation Forecast Skill



Monthly (Lead 0.5) Precipitation Heidke Skill Scores (Combined Categories)



Heidke Skill Score

1995-2015

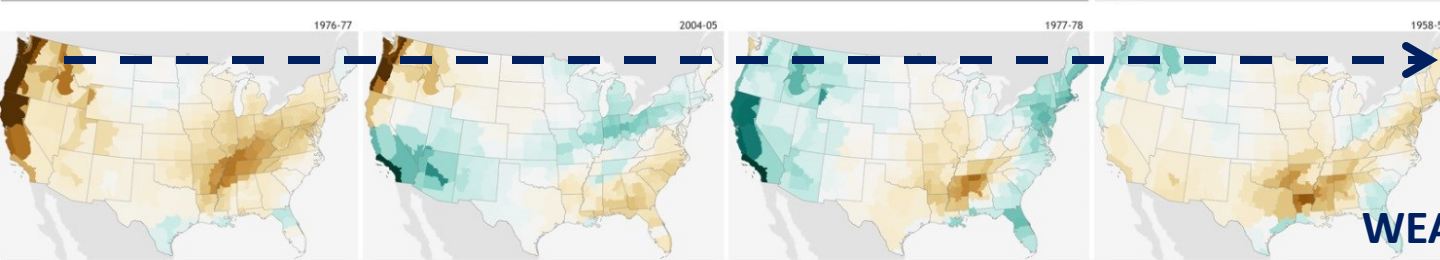
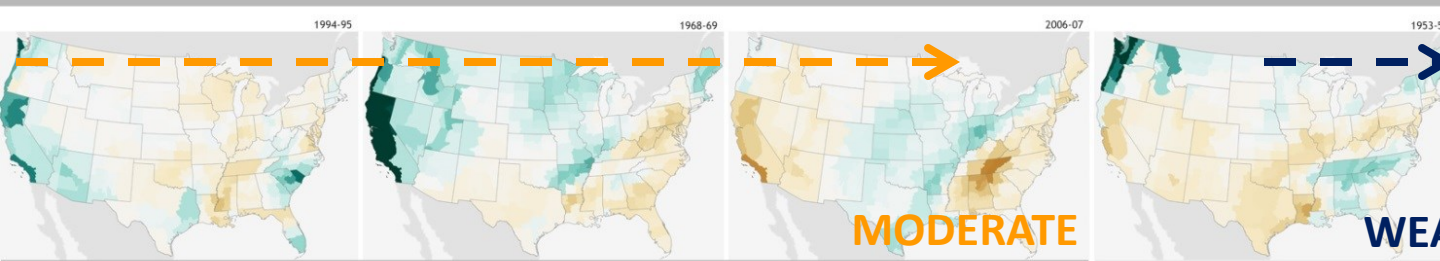
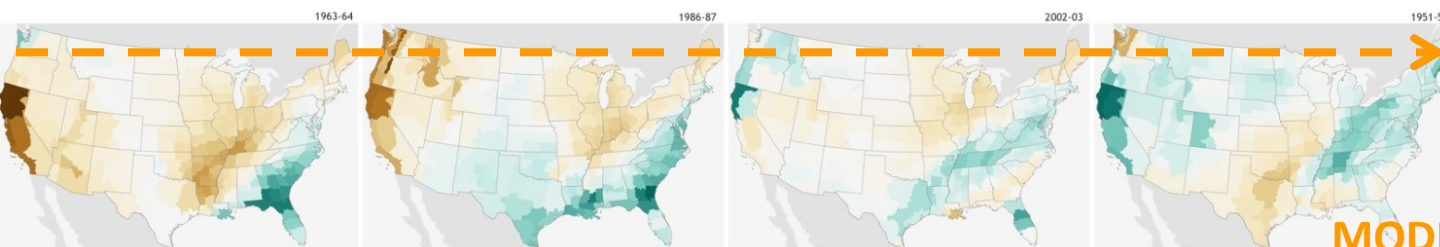
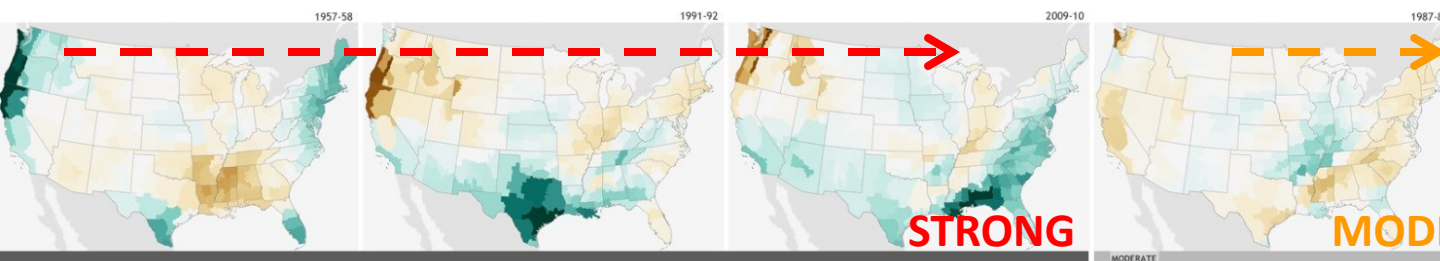
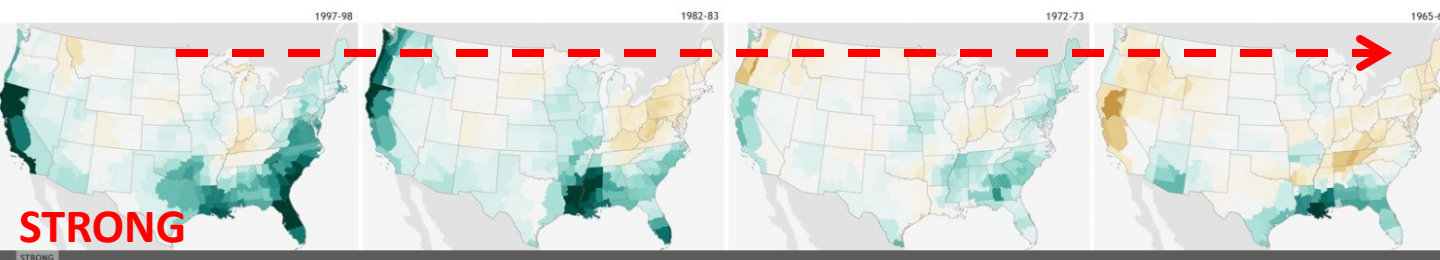
October through April

Heidke Skill Score

2005-2015, all months

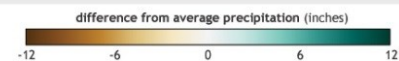
Mean: +5.1

Winter (December-February) precipitation patterns during strong, moderate, and weak El Niño events since 1950



ENSO

Dec-Jan-Feb



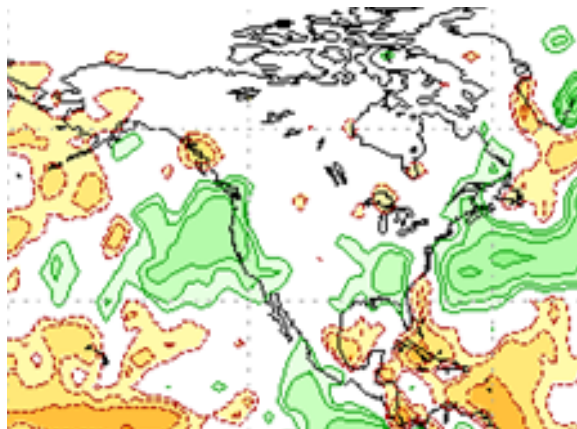
Operational Statistical Forecast Tools

Canonical Correlation Analysis (CCA):

- Relates tropical Pacific Ocean sea-surface temperatures (SSTs), 700-hPa heights to U.S. surface temperatures (T) and precipitation (P)

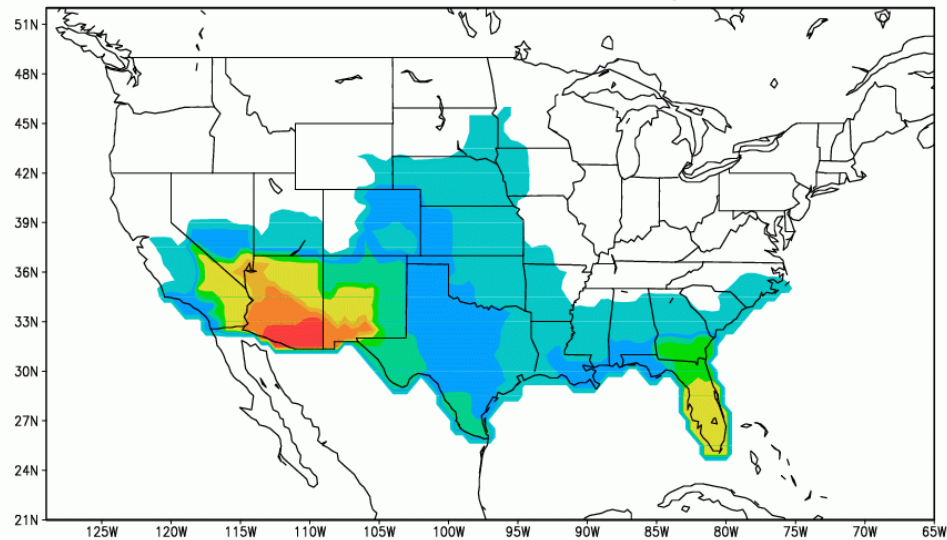
Constructed Analogue (CA):

- Linear combination of past observed anomaly patterns close to the initial state
- Forecast obtained by persisting the weights assigned to each year in the historical record and linearly combining the future states following the initial time in the historical years
- Both soil moisture and SST based applications used in operations

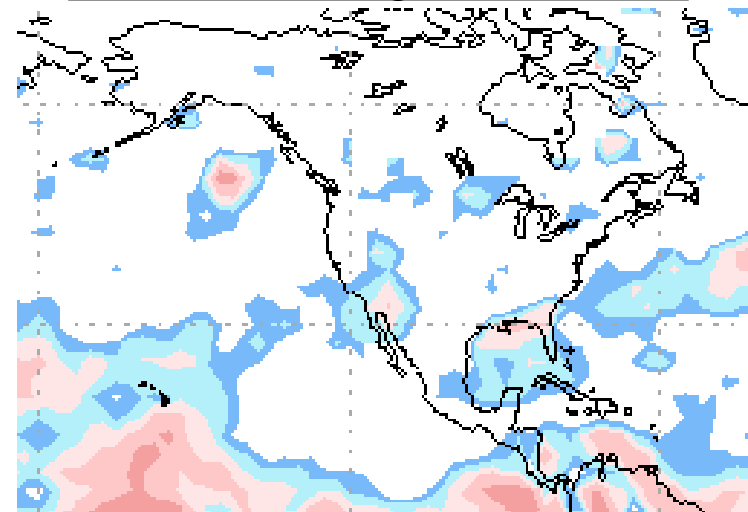


Historical Forecast Skill

CCA p skill Lead 1 JFM Target

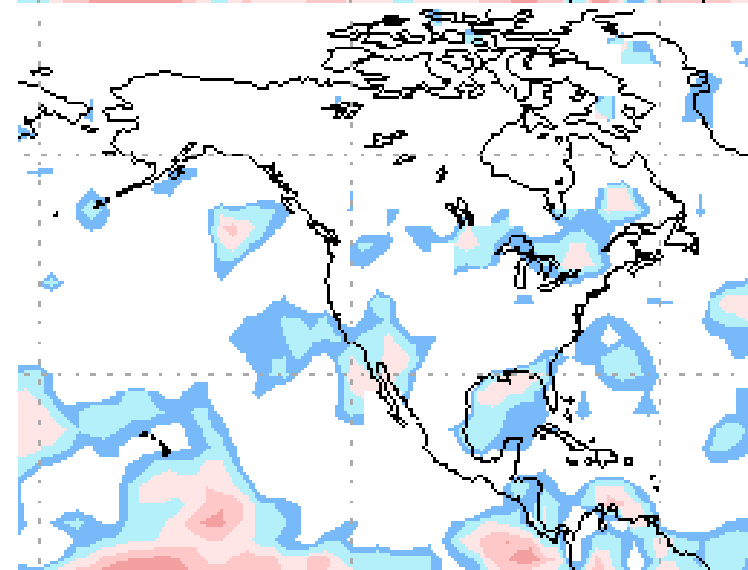
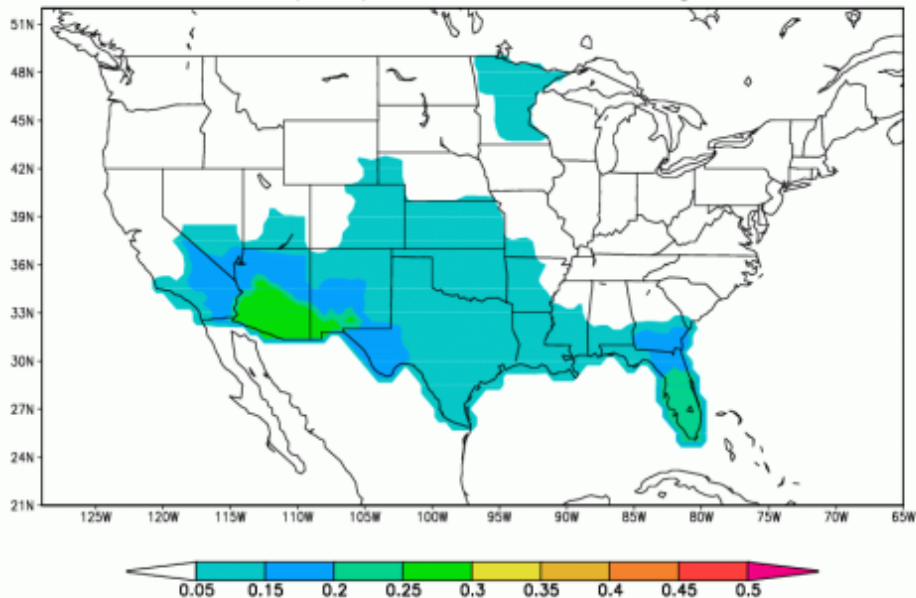


Constructed Analogue based on SST

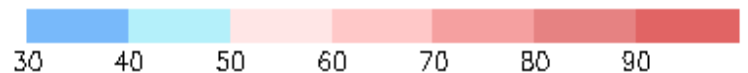


Lead 1

CCA precip skill Lead 6 JFM Target

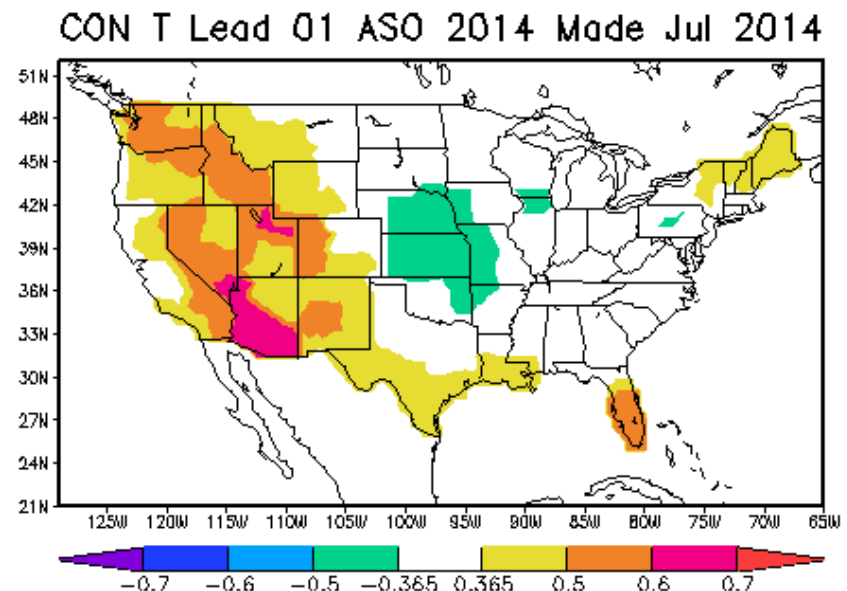


Lead 6



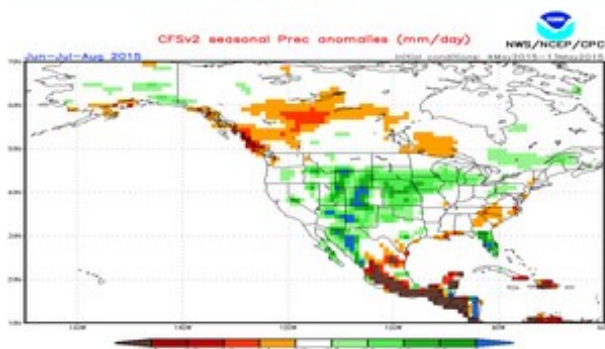
Statistical Forecast Tools

- These forecast tools were developed a considerable time ago
- Other than objectively combining these tools into a combined forecast, termed the “consolidation”, CPC has not invested much into statistical methods in recent years
- CPC efforts (and NOAA priorities) have primarily invested in work related to dynamical model development and multi-model ensembles of these inputs

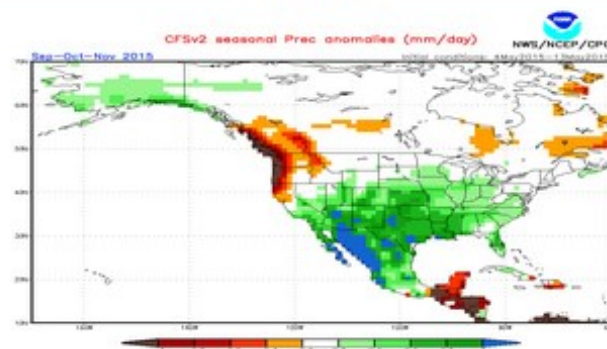


Climate Forecast System (CFS)

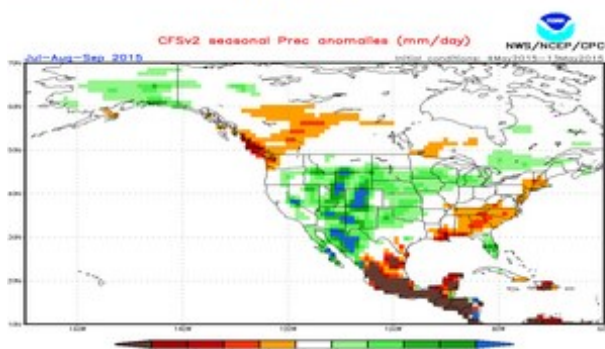
JJA 2015



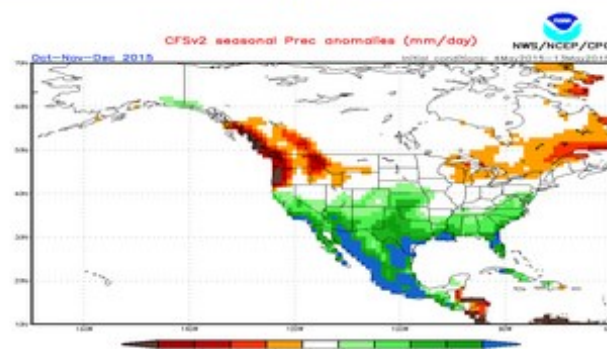
SON 2015



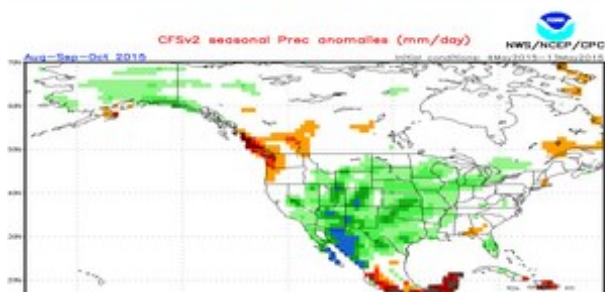
JAS 2015



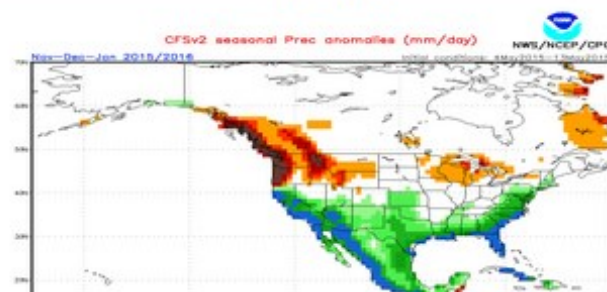
OND 2015



ASO 2015



NDJ 2015

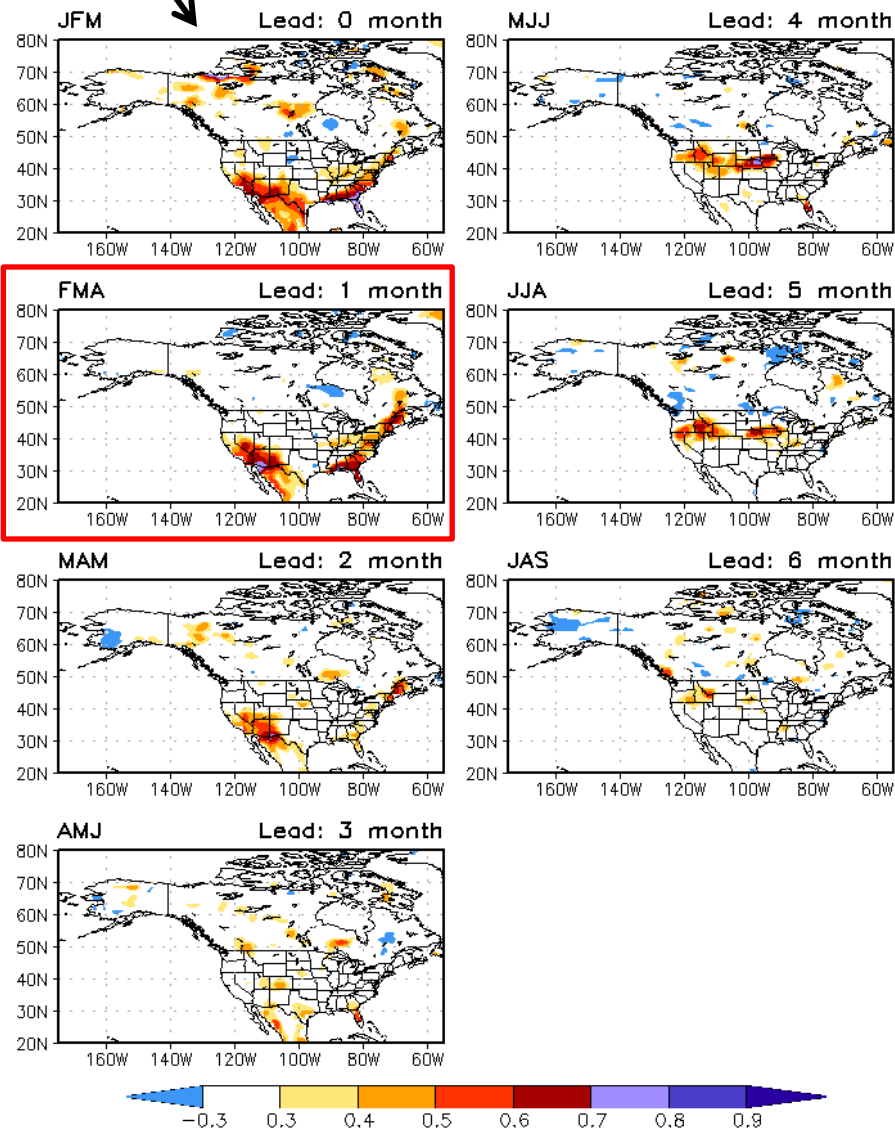


Forecasts made in Dec

CFS Forecast Skill

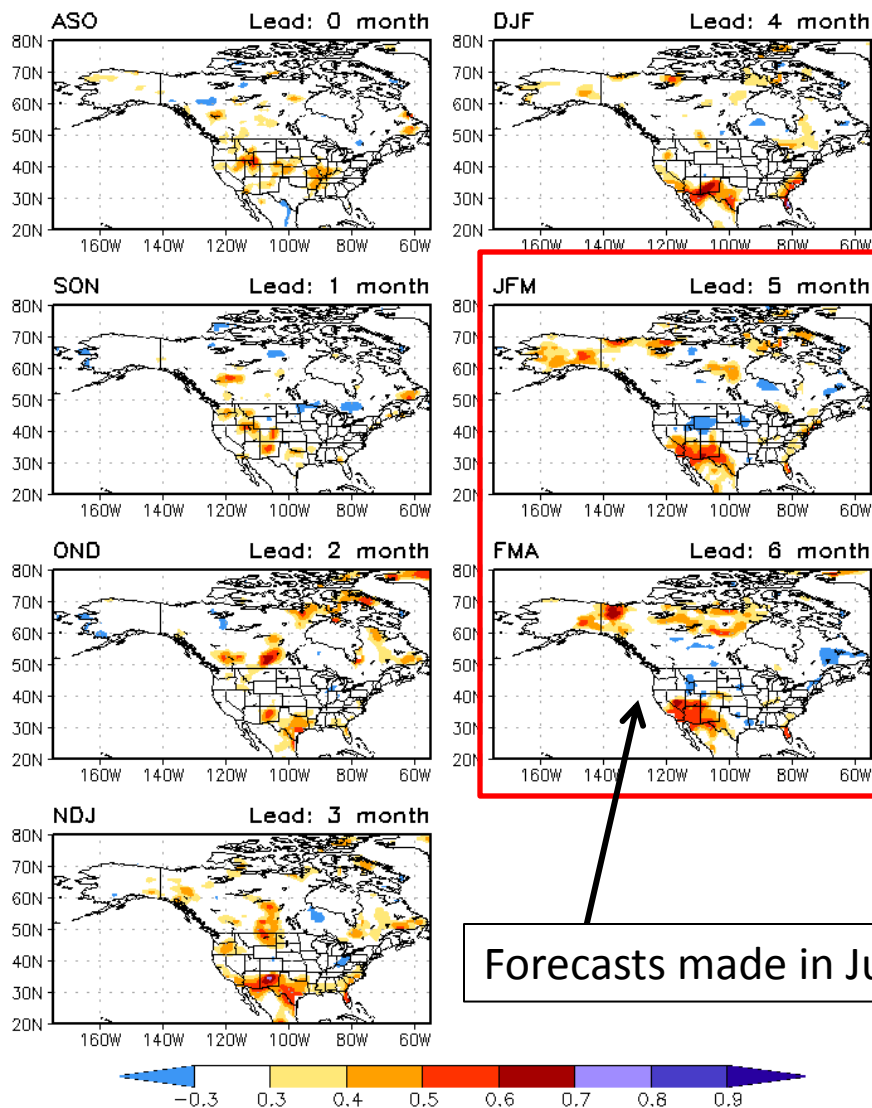
CFSv2 Correlation Precipitation

Initial month: Dec 1982–2009



CFSv2 Correlation Precipitation

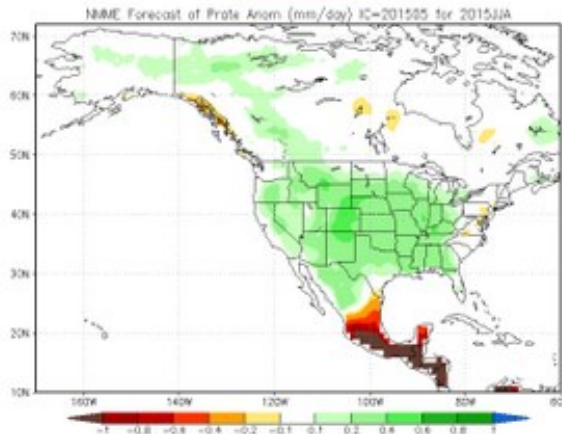
Initial month: Jul 1982–2009



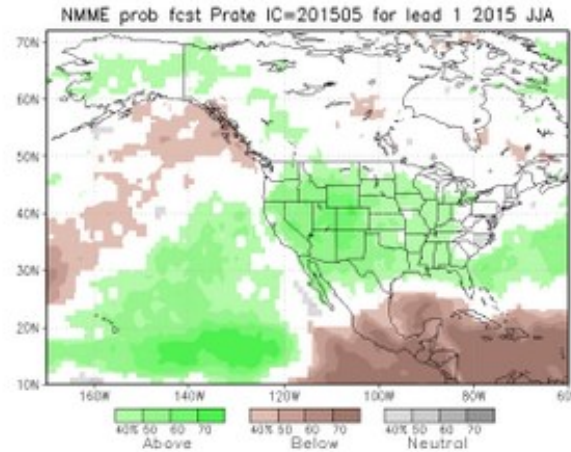
Forecasts made in July

North American Multi Model Ensemble

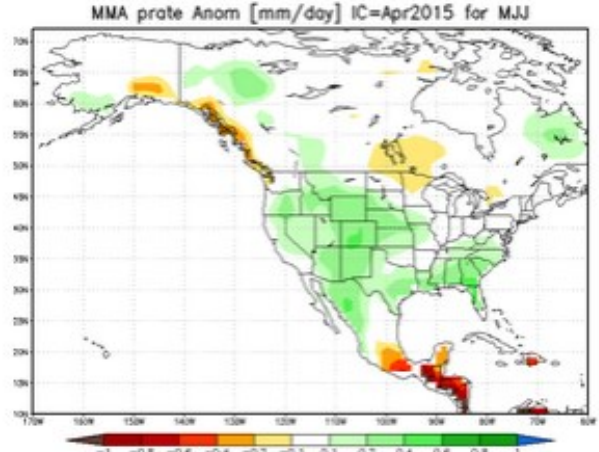
NMME



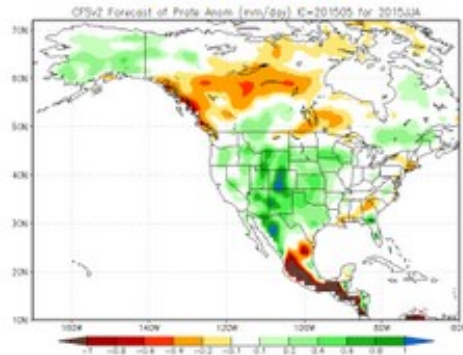
Prob fcst



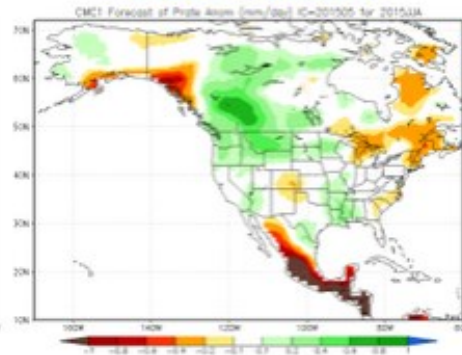
IMME



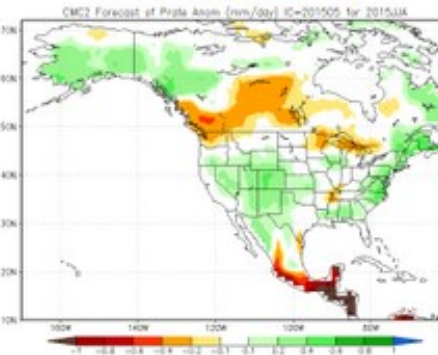
NCEP CFSv2



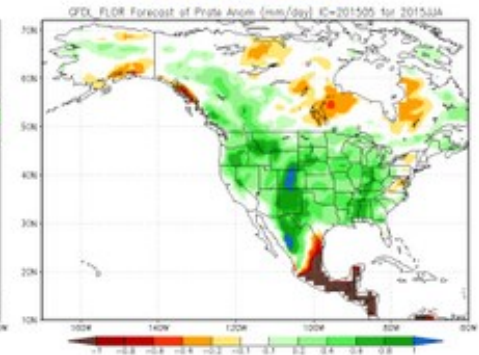
CMC1 CanCM3



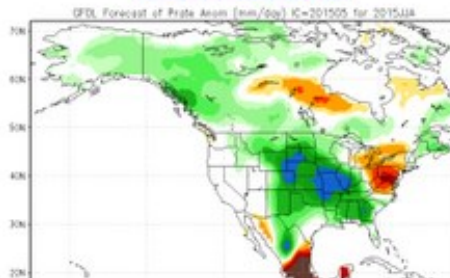
CMC2 CanCM4



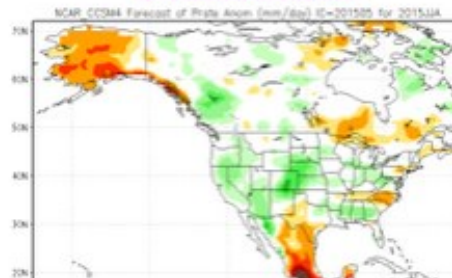
GFDL FLOR



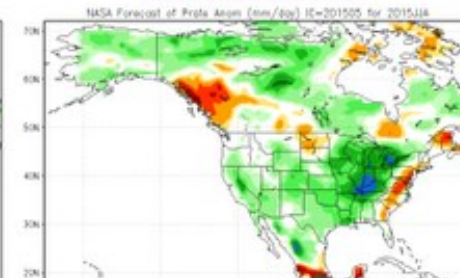
GFDL CM2.1



NCAR CCSM4



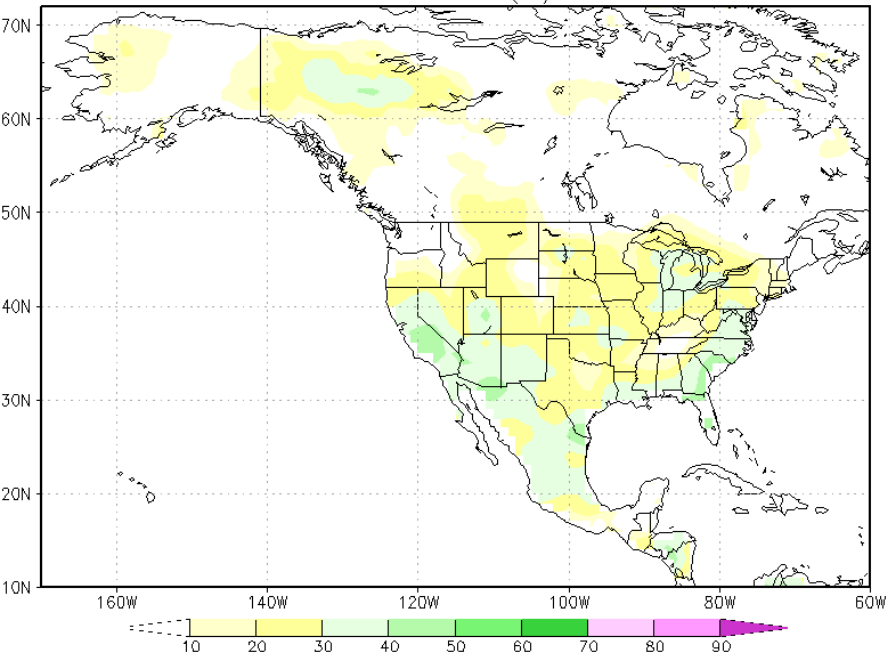
NASA GEOS5



NMME Forecast Skill

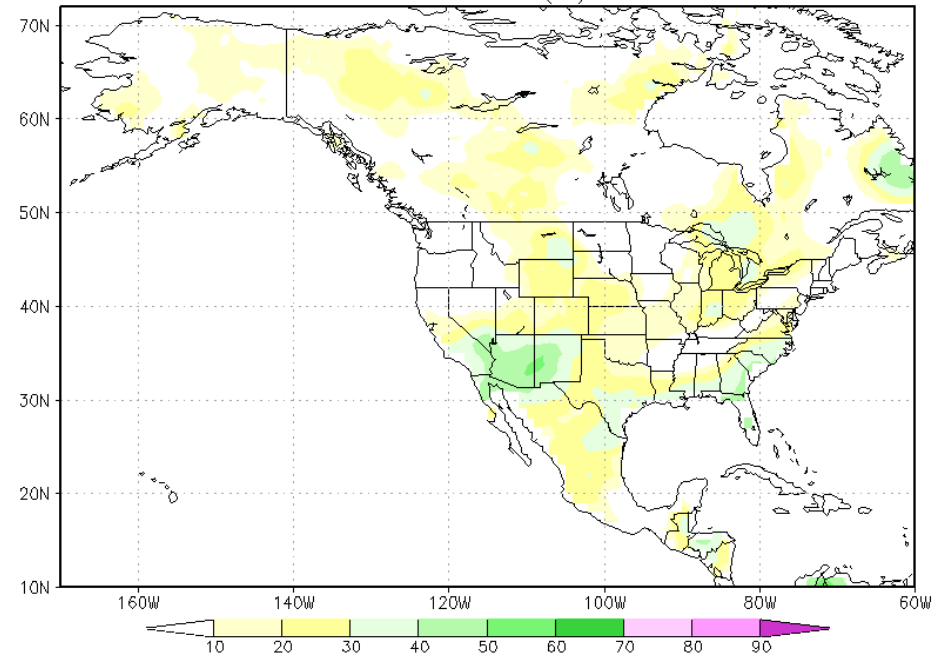
Lead 1 for DJF

NMME Forecast of Prate Skill (AC) IC=11 for DJF



Lead 5 for DJF

NMME Forecast of Prate Skill (AC) IC=07 for DJF



Some thoughts

- Situational awareness can be aided by keeping tabs on monitoring and prediction resources at CPC
- For good or bad, less of an emphasis has been placed on developing or improving statistical methodologies in recent years

CPC staff discussion:

- (1) It may be worthwhile to invest some time in re-evaluating predictors and updating datasets for CCA and CA tools, but other statistical tools may be discontinued.
- (2) Time likely better spent continuing efforts for statistical post-processing of model data, whether it be direct sensible weather variables or large scale circulation features and downscaling
- (3) Strong emphasis, however, will continue to be placed within NOAA for model evaluation and development (higher resolution, physics, MME, etc.).

For Example

Statistical-dynamical methods to improve precipitation forecasts:

- Develop statistical error correction on precipitation from the NMME forecasts
- CCA methods to correct precipitation and T2m
- Bayesian correction: Models have higher skill in predicting SST and large scale patterns than precipitation. Using Bayesian correction to improve precipitation forecasts

CPC Week 3-4 Outlooks

Toward Week 3-4 Experimental Outlooks

- A major goal in the CPC 5-year strategic plan is to develop official Week 3-4 operational outlooks. An initiative to work in this direction was started in late FY14.
- Many challenges to overcome over the next few years to meet this objective
 - ➔ Assessing the scientific basis for this type of outlook?
 - ➔ Documenting forecast skill? Can they be reliable?
 - ➔ What would be the frequency and format of this type of product?
- CPC team has determined an initial inventory of information to be targeted in a Phase 1 project during FY15 with outlined requirements, deliverables, project plan and timeline.
- The initial experimental product is to be a combined Week 3-4 probabilistic temperature and precipitation outlook released once per week, using a two class system with the inclusion of equal chances (EC)

Toward Week 3-4 Experimental Outlooks

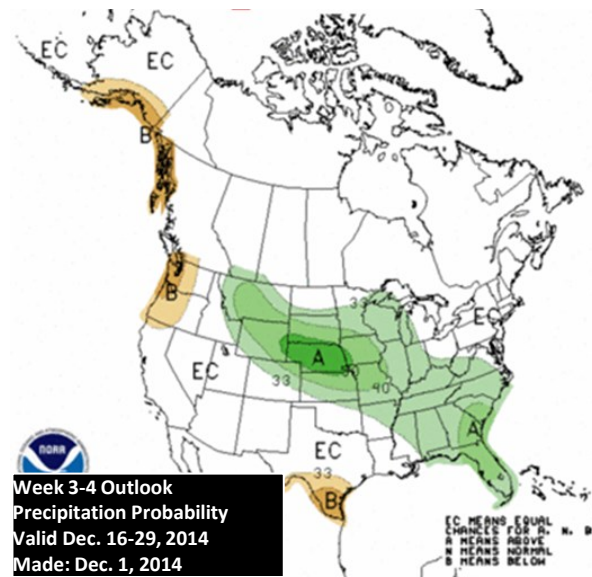
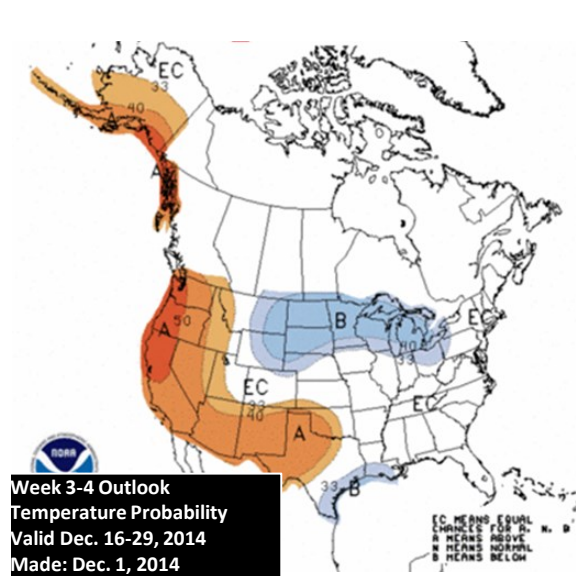
- Work is currently ongoing in areas listed below:

(1) Modification, enhancement and new development related to empirical techniques (i.e., constructed analogue, regression, etc.) whose methodologies target MJO/ENSO, etc.

(2) Analysis of dynamical model guidance from a number of operational centers including NCEP, ECMWF, JMA and Environment Canada

(3) Operational implementation at CPC of Coupled Linear Inverse Modeling (C-LIM) techniques from ESRL for the Tropics

- Outlooks will need to capitalize on forecasts of opportunity



Week 3-4 Project Status

- Realtime forecast graphics being created for:

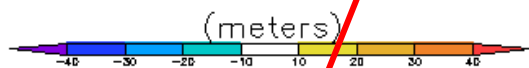
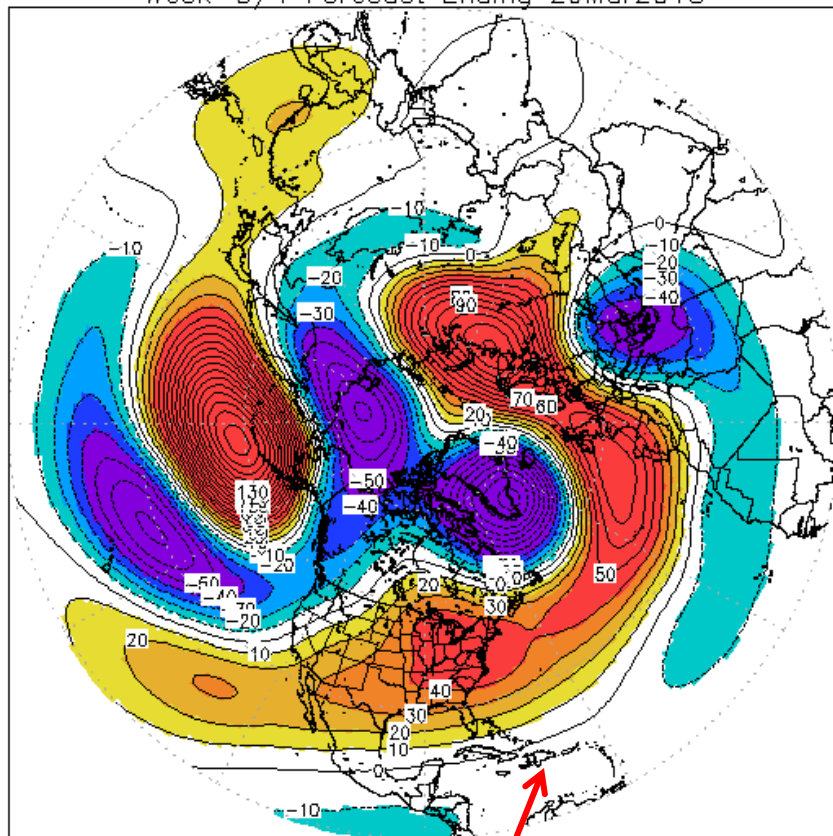
- (1) Mean, anomalous and standardized 500-hPa height
- (2) 500-hPa forecast spread
- (3) Temperature and precipitation anomalies
- (4) Temperature and precipitation probabilities

from the CFS and ECMWF for Week 3, Week 4 and Week 3-4.

- Reforecast skill evaluation of ECMWF, CFS and JMA models is ongoing as is realtime verification
- Initial work on constructed analogue based forecast for Week 3-4 CONUS temperature developed and being evaluated
- ESRL C-LIM tropical convection forecast code ported to CPC internal servers, benchmarking underway

Realttime Week 3-4 Plots

CFSv2 500hPa Height Anomalies Issued 19Feb2015
Week-3/4 Forecast Ending 20Mar2015

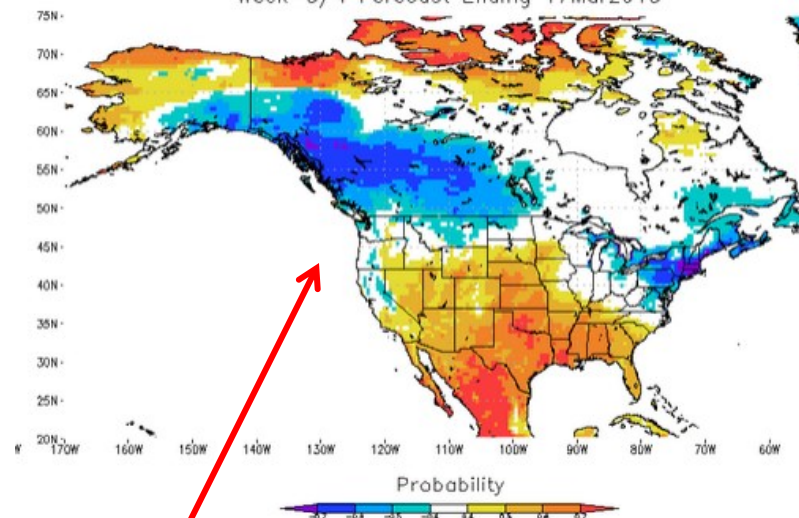


500 height anomalies
Tercile temp probabilities
Percent of Normal Precipitation

ECMWF

Updates Tuesdays and Fridays

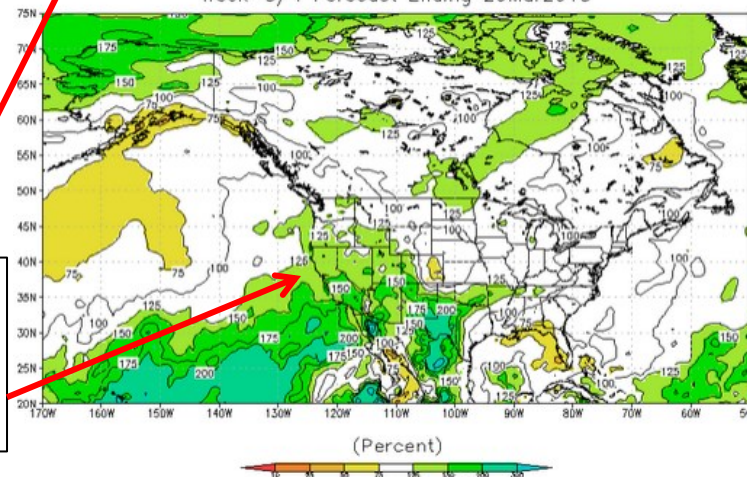
ECMWF 2m Temperature Probabilities Issued 16Feb2015
Week-3/4 Forecast Ending 17Mar2015



ECMWF

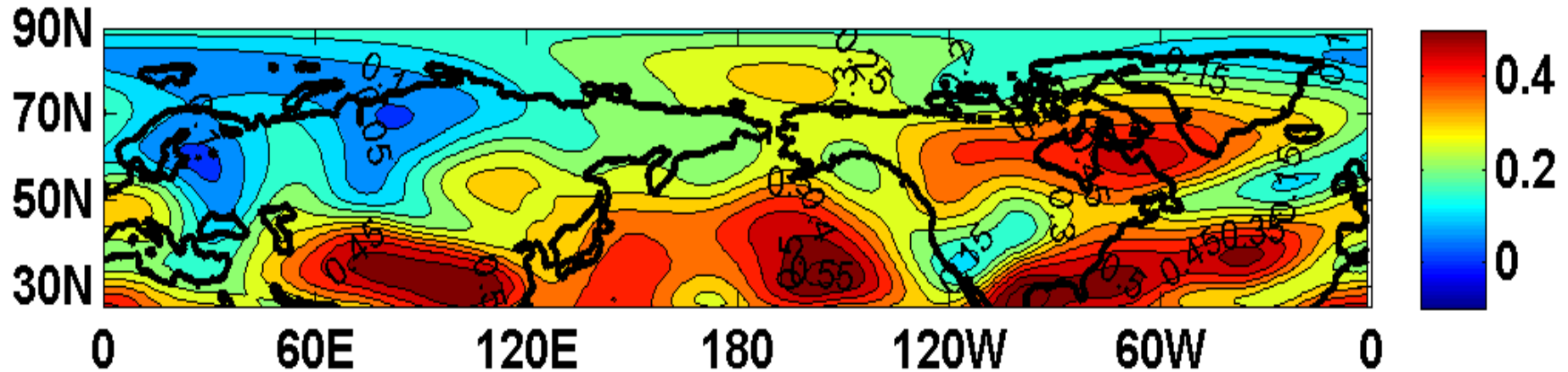
Updates Tuesdays and Fridays

ECMWF Precip Pct of Normal Issued 19Feb2015
Week-3/4 Forecast Ending 20Mar2015



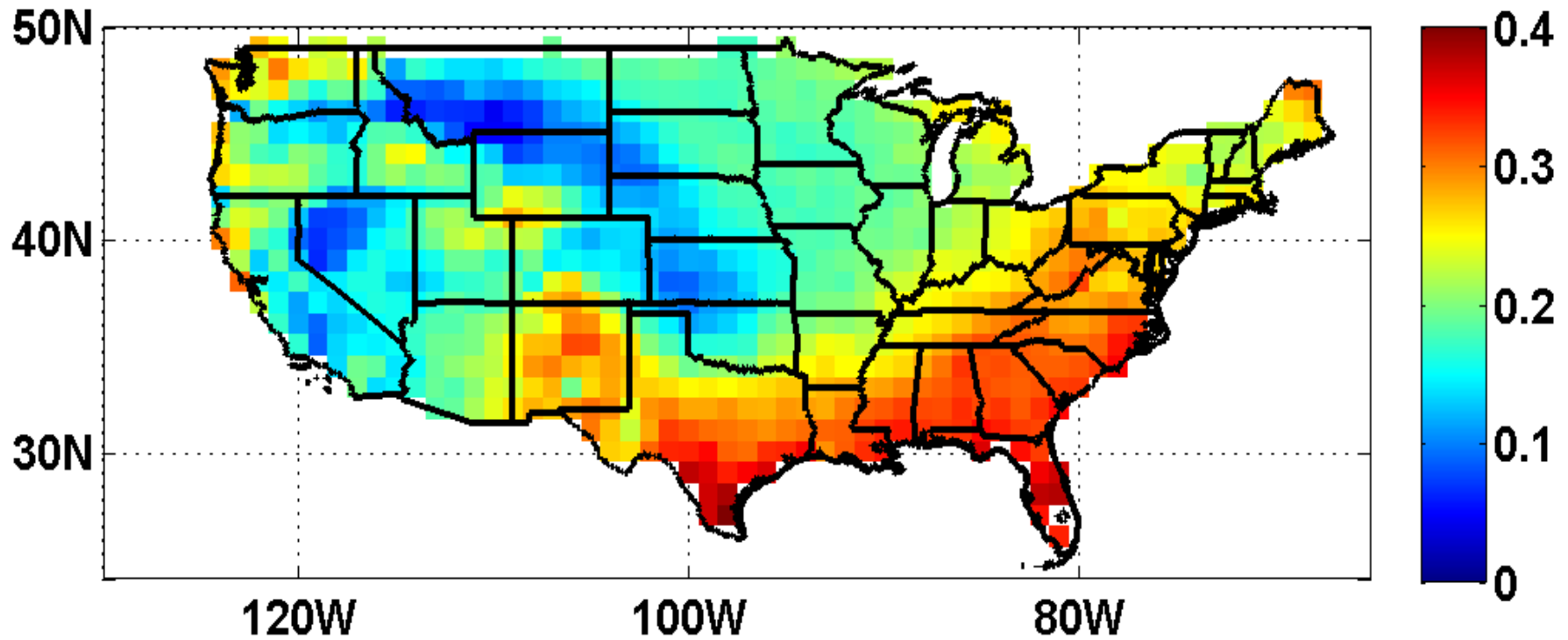
CFS 500-hPa Height Reforecast Skill

CFS: Week-3.4: Anom. Corr. 500mb height DJF



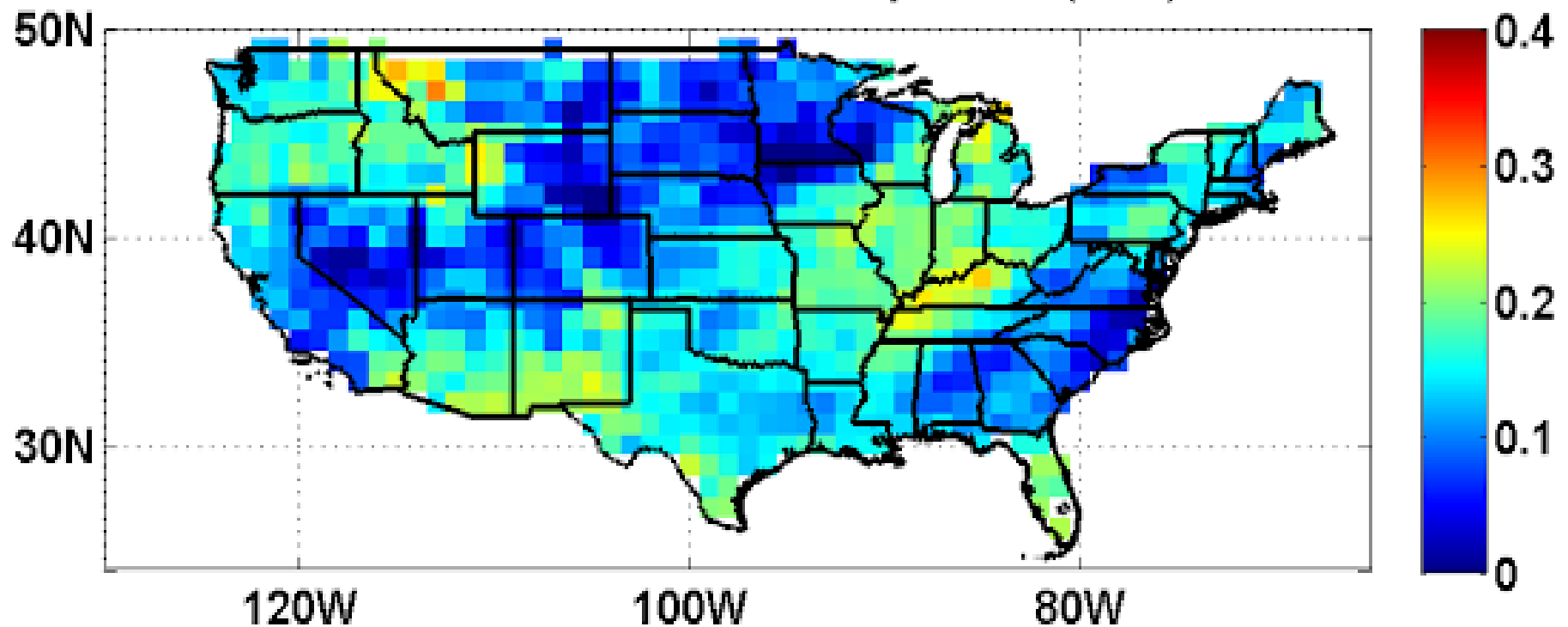
CFS 2 m Temperature Reforecast Skill

2-meter Temp. anom. corr. Week-3.4 DJF



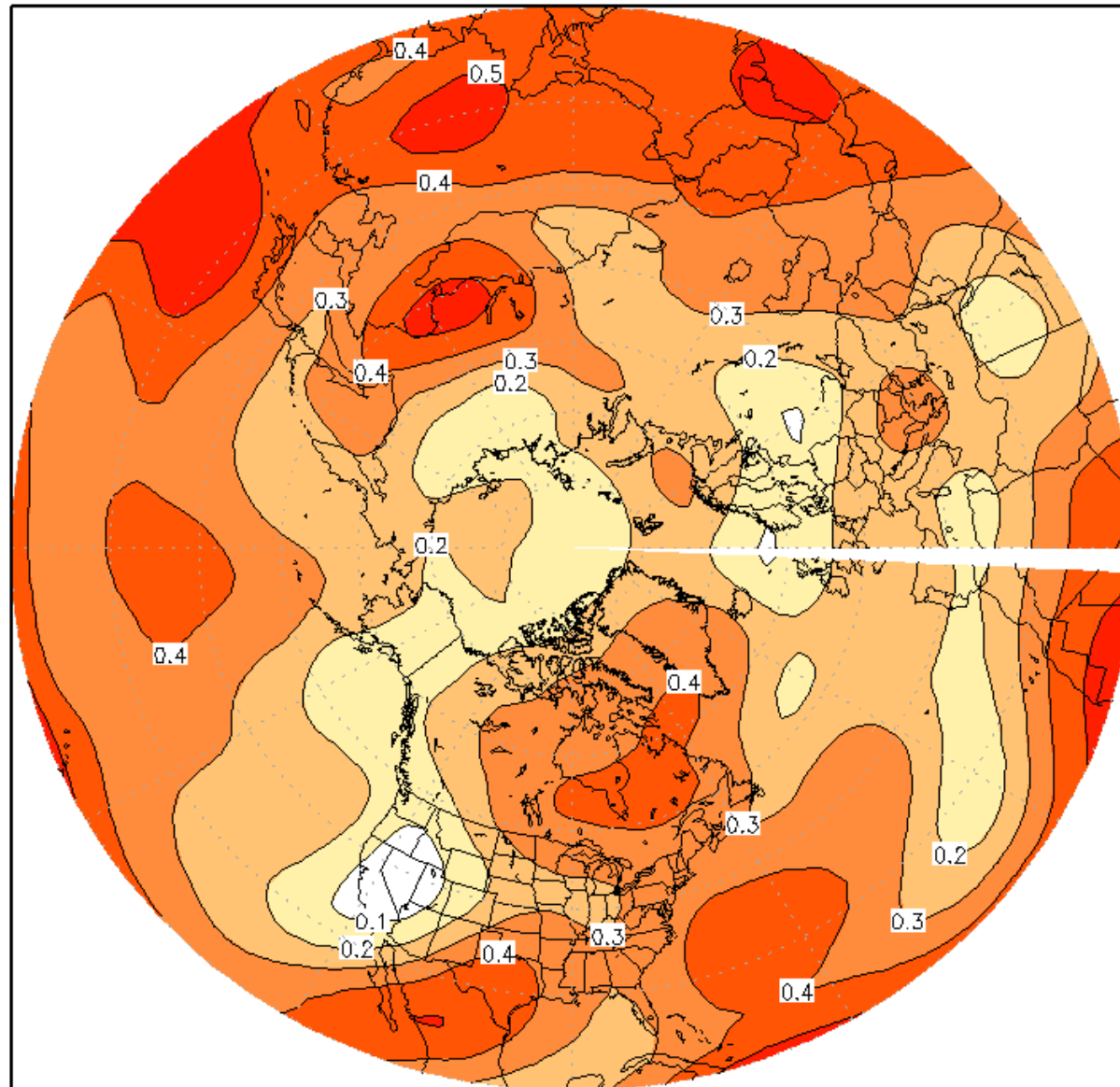
CFS Precipitation Reforecast Skill

CFSv2 Lead=Week-3&4 Precipitation (DJF)



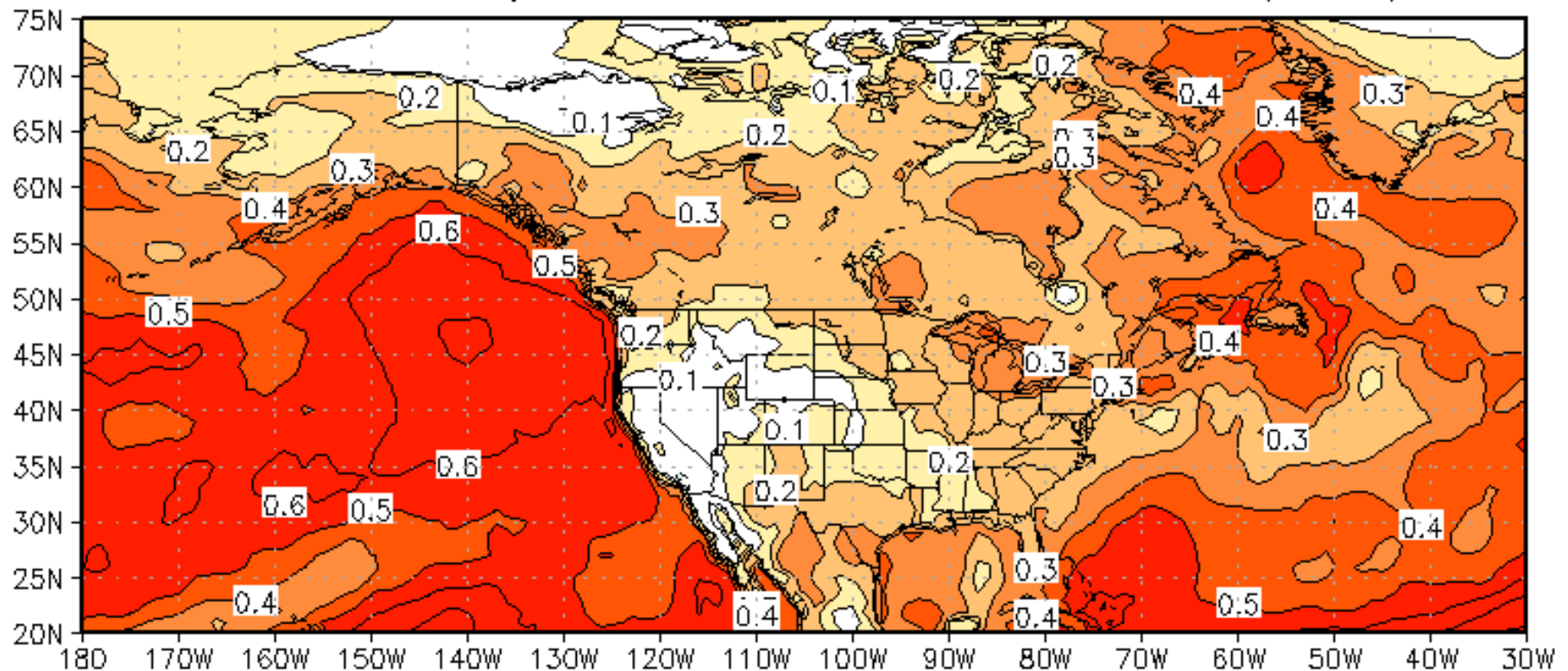
ECMWF 500-hPa Height Reforecast Skill

Z500 Wk 3/4 AnomCorr Hindcast (JFM)



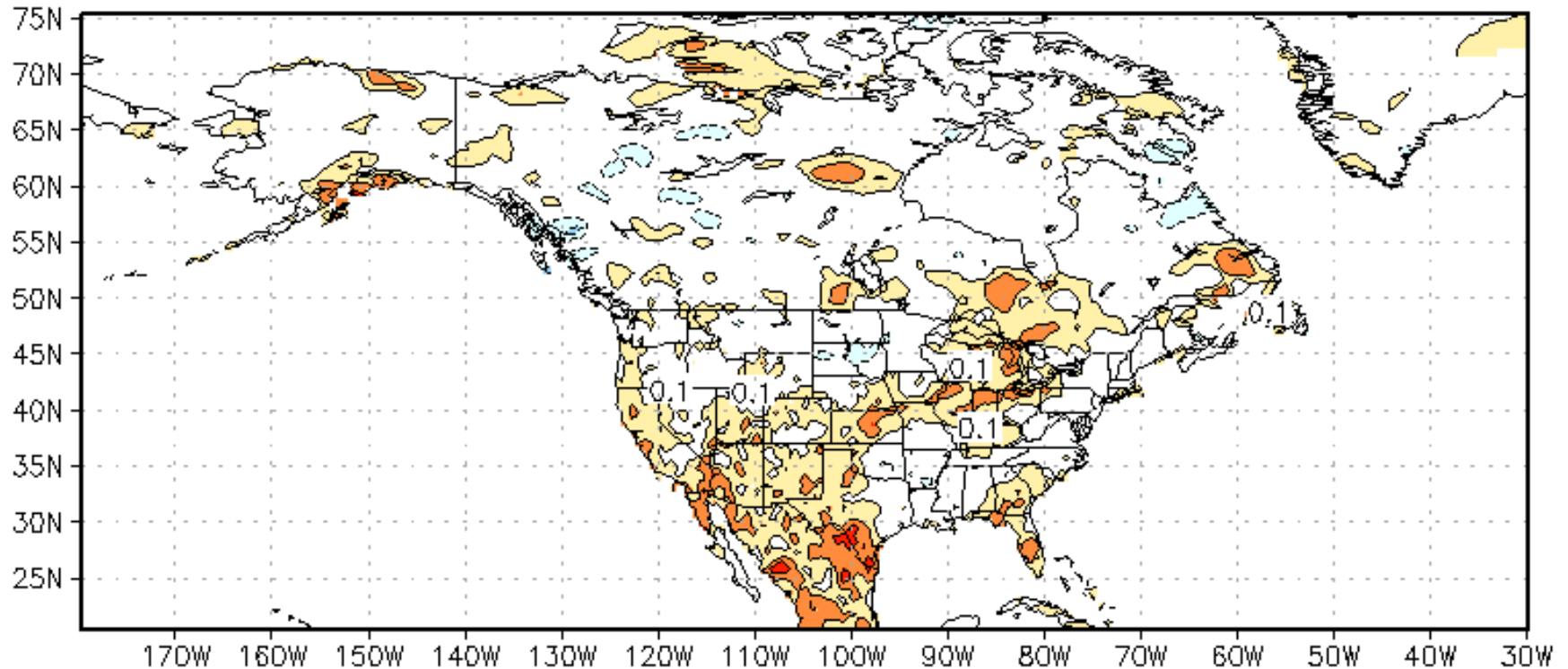
ECMWF 2 m Temperature Reforecast Skill

T2m Wk 3/4 AnomCorr Hindcast (JFM)



ECMWF Precipitation Reforecast Skill

PREC Wk 3/4 AnomCorr Hindcast (JFM)



Links with External Activities



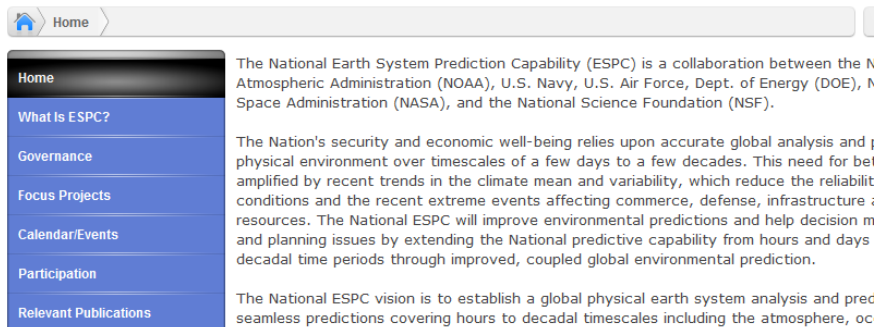
- Links with broader initiatives are critical for CPC to deliver these services by leveraging advances in:

(1) Understanding and Predictability Research

(2) Modeling capacity



- ➔ S2S Prediction Project
- ➔ Earth System Prediction Capability
- ➔ NMME subseasonal database



NIDIS Working Group

Working Group Specifics

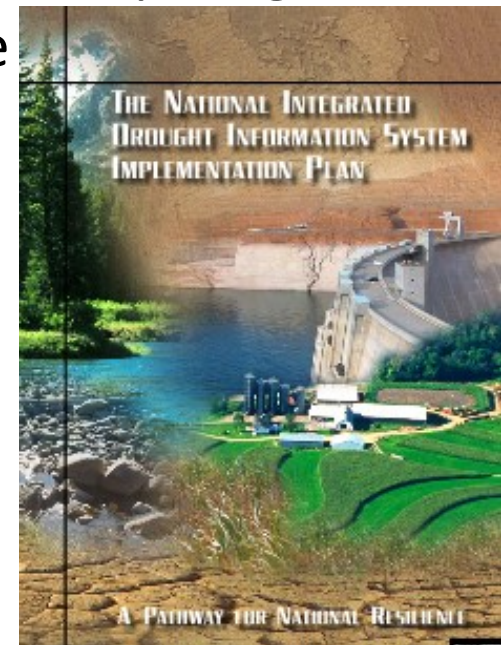
- NIDIS Predictions and Forecasts Working Group (WG)
- Chaired by Jon Gottschalck (NOAA) and Hailan Wang (NASA)
- Currently 18 member team that spans both operational and research institutions
- Expertise in operational drought forecasting, drought prediction research, subseasonal and seasonal variability and hydrometeorological modeling

Working Group Role

- Act as a broker in the transition zone between drought and precipitation prediction research and authoritative official operational outlooks to ensure:
 - ➔ Proper coordination is performed to make these linkages, and
 - ➔ Immature products not rushed into operational services
- Coordinate across agencies on Drought Task Force Reports and Global Drought Information System research needs

Near Term WG Tasks

- Assess, organize and document the latest drought related research, in the context of predictions, of WG members, their colleagues and overall drought community
- Outline recommendations and a path forward to best utilize the most mature drought prediction related research
- Inform the 2016 NIDIS implementation plan to encompass goals of the WG through 2019 based on (1) and (2) above
- Collaborators from private sector needed on WG



Summary

- CPC has numerous monitoring and prediction resources available to aid in situational awareness including precipitation outlooks
- Precipitation outlook material includes forecast maps, but also additional quantitative information that may help decision making
- Precipitation forecast skill across California is only marginally positive and strongly dependent on a case by case basis
- CPC utilizes both statistical and dynamical forecast tools, although most recent work has been related to short term climate models
- Ongoing studies focus on hybrid type methods where statistical post processing is used to correct patterns in dynamical model output

Summary

- CPC set in motion an initiative that aims to work towards experimental Week 3-4 products for temperature and precipitation in FY15
- Dynamical and statistical tools expected to play a role, important to manage expectations as these are forecasts of opportunity
- NIDIS Predictions and Forecasts WG formed to coordinate various research activities across agencies with the objective of improving operational drought outlooks