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**CPC Current Capabilities and Metrics (Part I)  
and  
Key Science Challenges to Improving S2S Forecast  
Skill (Part II)**

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# Outline



- Disclaimer
- CPC Prediction Products Highlighted in S2S Weather Bill:
  - Temperature and Precipitation Outlooks
  - Drought Outlook
  - Extremes (Global Tropical Hazards and Hurricane Seasonal)
  - Arctic Sea Ice
- Key science challenges to improving forecast skill
- Summary



## Disclaimer

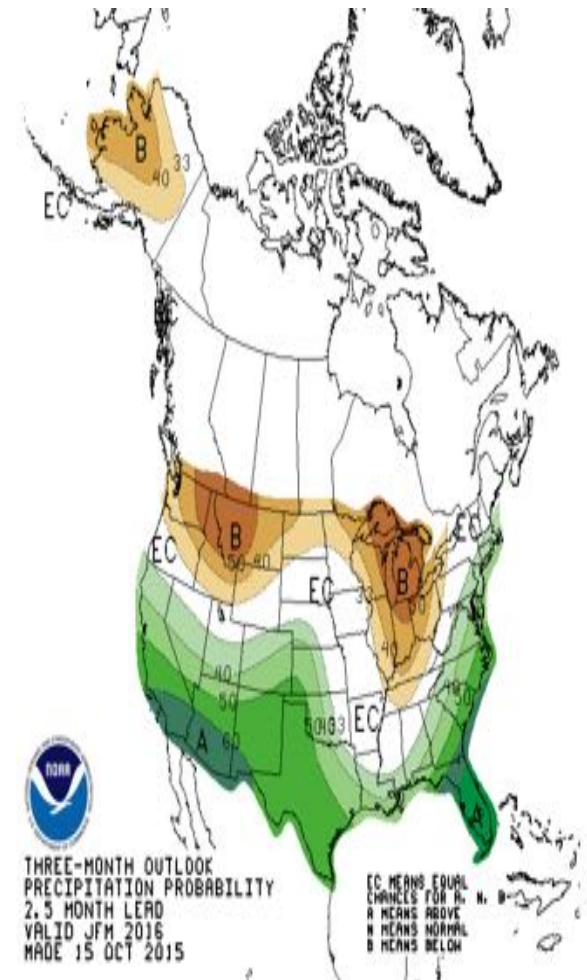


**CPC produces a robust suite of S2S forecast products that have spatially and temporally varying skill. I can't give a comprehensive overview of all of them in 15 minutes. This talk will focus on products highlighted in the S2S Weather Bill. Happy to talk to people offline about these or other parts of our product suite.**

**Utility of any particular forecast product depends on the decision making context and risk tolerance of the stakeholder.**

**CPC uses a variety of dynamical and statistical forecast tools in order to leverage complementary skill from the tools. CPC utilizes state of the art post-processing science to calibrate and combine forecasts from tools.**

**Ultimately, the skill of CPC forecast products depends on the skill of the tools available.**





# Temperature and Precipitation Outlooks



**Timescale:** Week two, Week 3-4, monthly and seasonal.

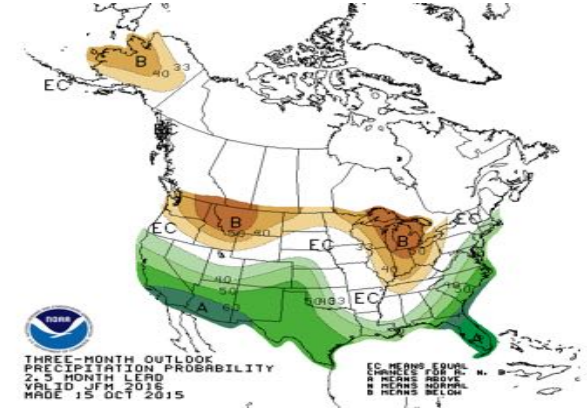
**Format:** Probabilistic forecasts for tercile categories of below, near, or above normal (above or below normal for week 3-4).

**Verification:** Heidke Skill Score (categorical measure) and Ranked Probability Skill Score (RPSS).

Interactive verification tool available that lets users tailor verification by period, metric, location: [www.vwt.ncep.noaa.gov](http://www.vwt.ncep.noaa.gov)

**Information available beyond static maps:**

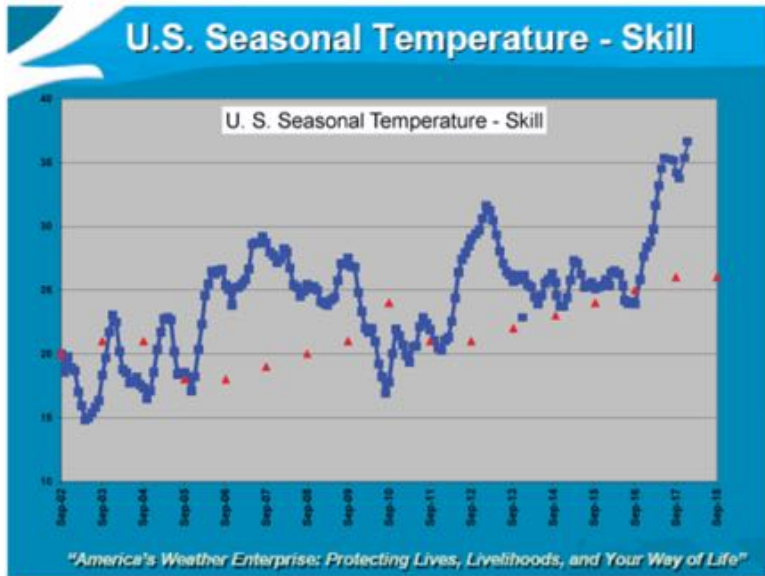
Interactive probability of exceedance tool that lets users choose their own risk tolerance (seasonal for now. Working on tool shorter timescale).



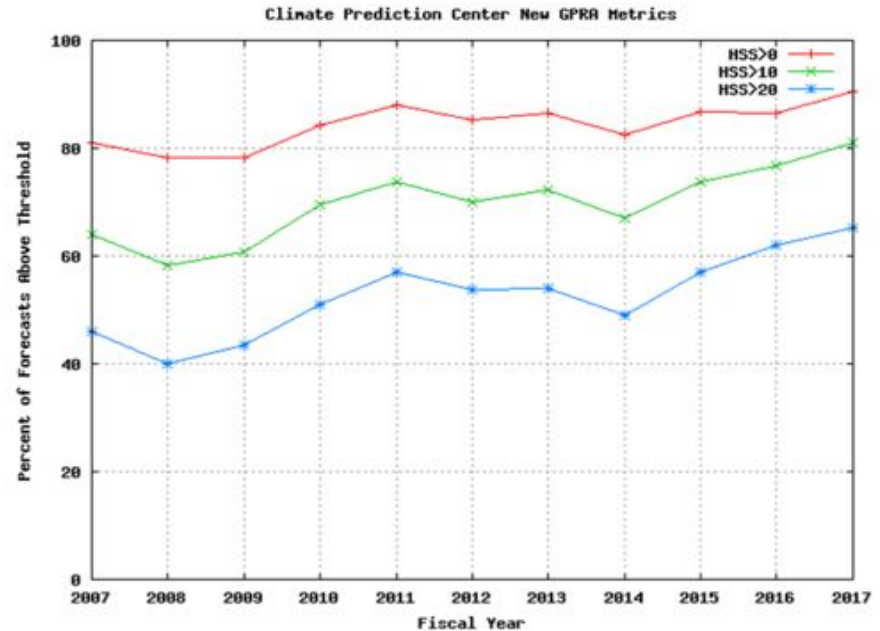
Interactive POE Tool



# Temperature and Precipitation Outlook Verification



CPC GPRA Metric: Running 48 month mean US Seasonal Temperature Forecast Skill  
January 2018 GPRA is 36.9: FY18 Goal is 26.



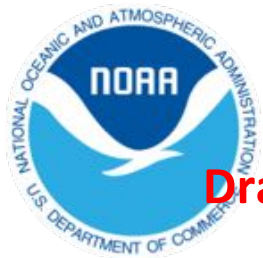
CPC Comprehensive T&P Outlooks Skill Measure: based on all CPC extended range and long range outlooks.

CSM includes over 1000 product issuances per year.

Judged "successful" if its Heidke Skill Score exceeds a particular threshold.

CSM shows continuous, improvement of CPC products.



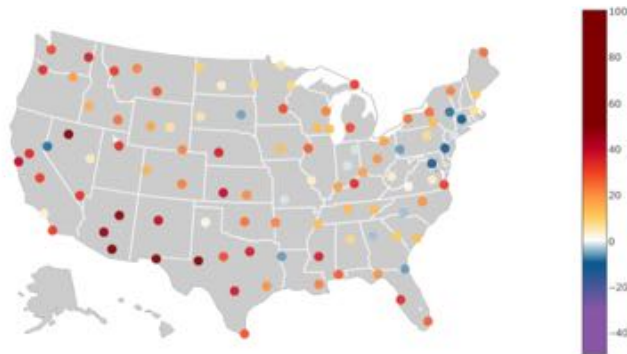


# Comparison of Week-2 and One-Month CPC Official Precipitation Forecast Skill for JFM 2016 and 2017



**Dramatic Decrease in Skill from Week 2 Compared to One Month**

8-14day Precipitation Heidke Skill Score (Combined Categories)



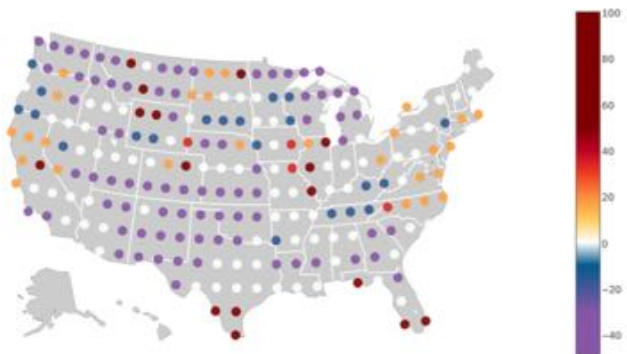
Week-2:  
2016

8-14day Precipitation Heidke Skill Score (Combined Categories)



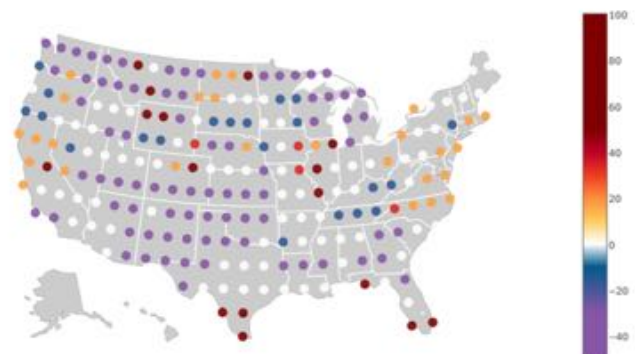
Week-2:  
2017

monthly Precipitation Heidke Skill Score (Combined Categories)



Month 1:  
2016

monthly Precipitation Heidke Skill Score (Combined Categories)



Month 1:  
2017

**But what was the skill of the models that the forecasters had available?**



# Monthly and Seasonal Drought Outlooks



**Timescale: Month One, Season One.**

**Format: Categorical with 4 categories:**

**Drought persists**

**Drought remains but improves**

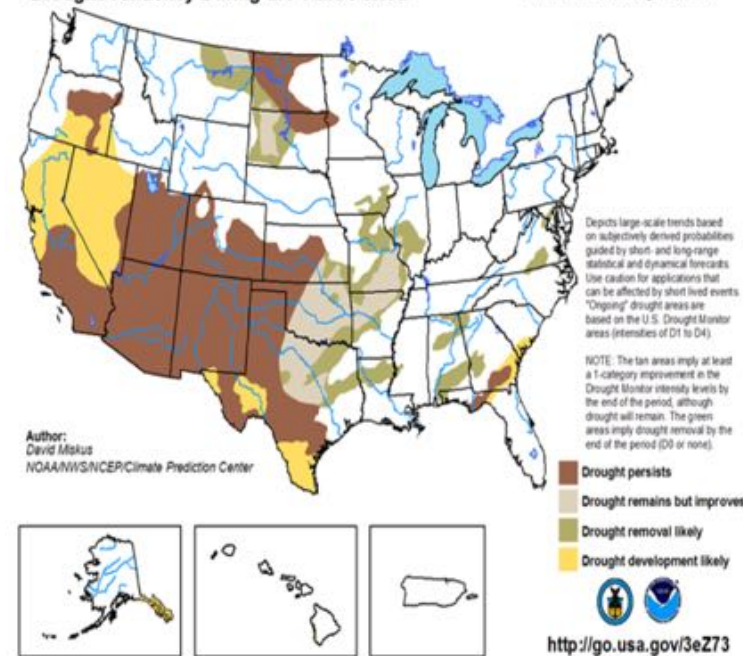
**Drought removal likely**

**Drought development likely**

**Verification: Hit/Miss for 4 categories.**

**Uses Drought Monitor as verification.**

**U.S. Seasonal Drought Outlook**  
Drought Tendency During the Valid Period  
Valid for February 15 - May 31, 2018  
Released February 15, 2018



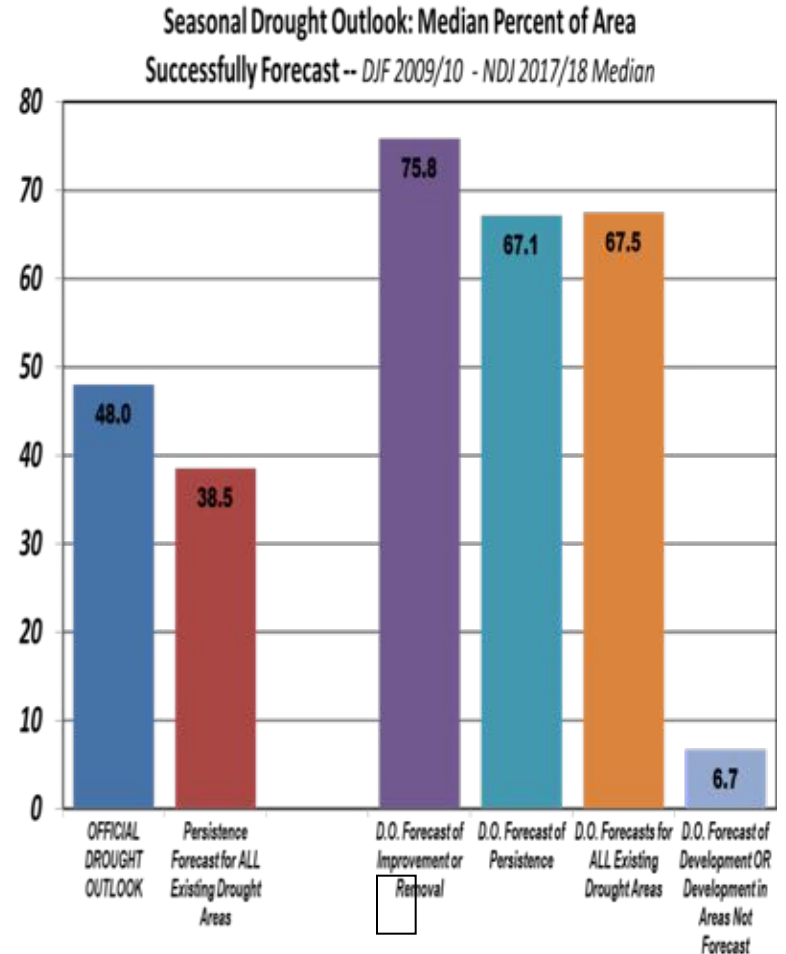


# Drought Outlook Verification



Drought Outlook forecast skill is strongly variable with lowest (marginal) skill for development of drought.

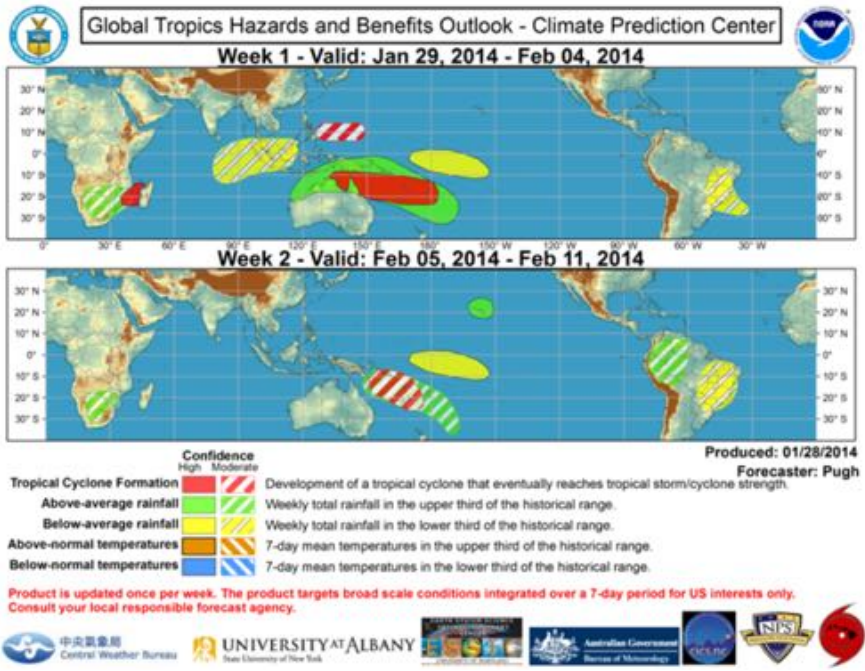
Forecasting drought development is difficult due to low skill in forecasting precipitation beyond week two in our current generation of tools.







# Outlook of Extremes



Global Tropical Hazards Outlook:  
 Tropical cyclone formation, Above or below normal temperature and precipitation. Verified with Heidke.



NOAA's 2013 Atlantic and Eastern Pacific hurricane season outlooks indicate t likely ranges (each with a 70% chance) of Named Storms (NS), Hurricanes (H), Major Hurricanes (MH), and percentage of the median Accumulated Cycloni Energy (ACE).

NOAA's 2013 Central Pacific hurricane season outlook indicates the likely nurt of tropical cyclones, which include tropical depressions, tropical storms and hurricanes.

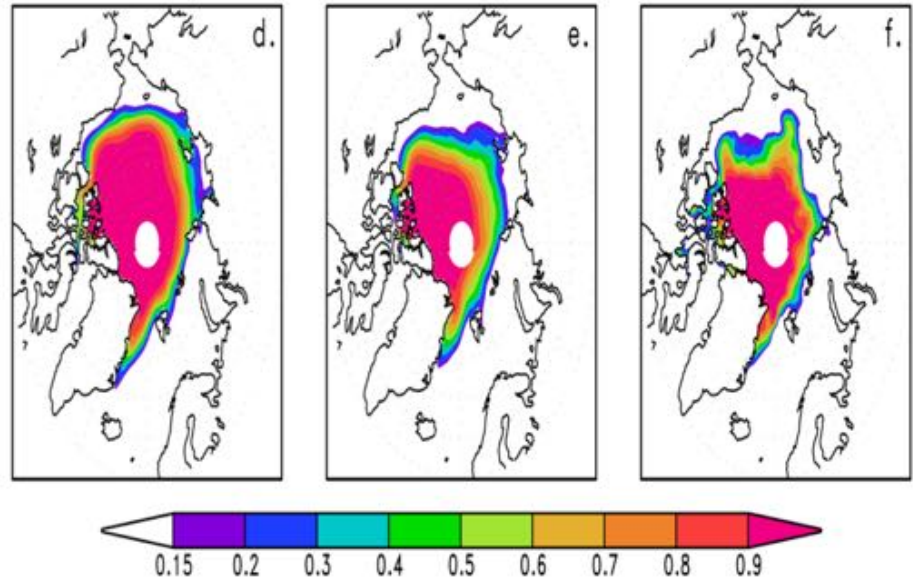
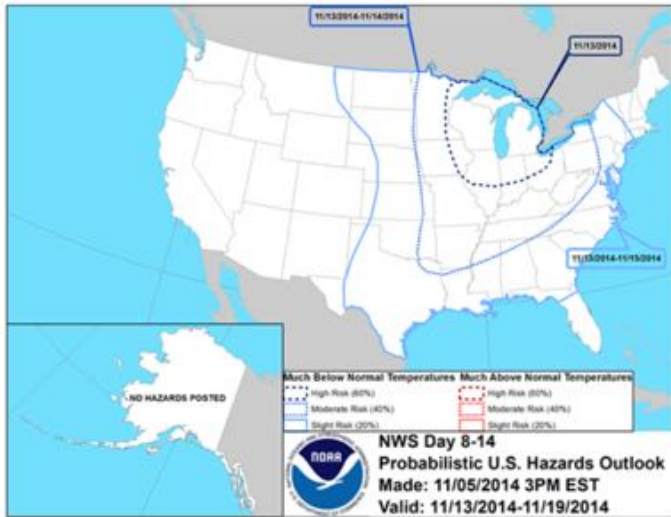
For 2013 the probabilities of each season type are:

	Atlantic	Eastern Pacific	Central Pacific
Above Normal	70%	10%	5%
Near Normal	25%	35%	25%
Below Normal	5%	55%	70%

Hurricane Seasonal Outlook:  
 Verified using range comparison.



# Additional Outlooks



Probabilistic Hazards Outlook for Temperature and Precipitation

Seasonal Arctic Sea Ice Outlook. Verified with anomaly correlation and RMSE.





## Summary



- **CPC is the civilian operational agency for S2S forecasts in the US.**
  - We currently produce products from week two to 13 months.
  - Skill of products is variable and depends on season, lead time, location, and variable.
  - Generally speaking temperature forecasts have much higher skill than precipitation forecasts. Many stakeholders would like to see improved skill for precipitation forecasts over the US.



## Closing Thoughts/Way Forward



Improved S2S precipitation forecasts will require improved skill from dynamical and statistical models.

Two stream approach to providing improved support to water resource managers:

- **“Do what you can, with what you have, where you are” (Teddy Roosevelt)**
  - We need to explore/exploit use of currently skillful week two precipitation forecasts for various applications. CPC will be exploring these in next year or so. Still seeking out interested operational organizations to test utility of week two forecasts/tools.
- **“Improvise, overcome, adapt” (Clint Eastwood)**
  - Need to focus on reduction/improvement of systematic errors in S2S Tropical SST and precipitation forecasts.
  - Need to do deep-dive diagnostics to understand what led to limited predictive skill for 2015-2017 period and use that information to improve models.
  - Need to continue to investigate new sources of S2S predictability.



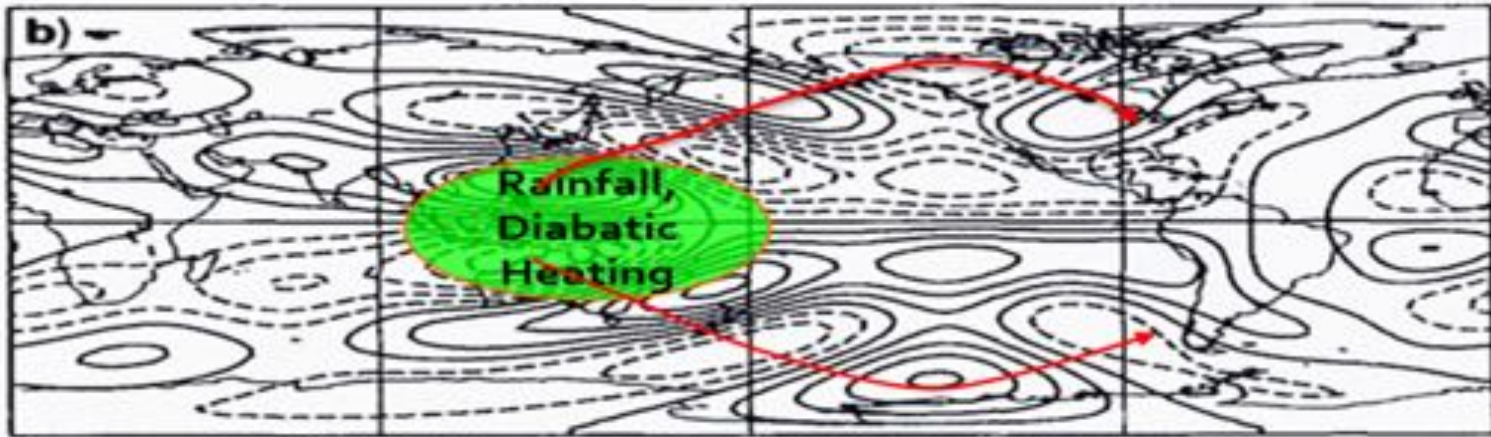
# Extra Slides







# Key Driver of S2S Variability over US: Tropical Convection

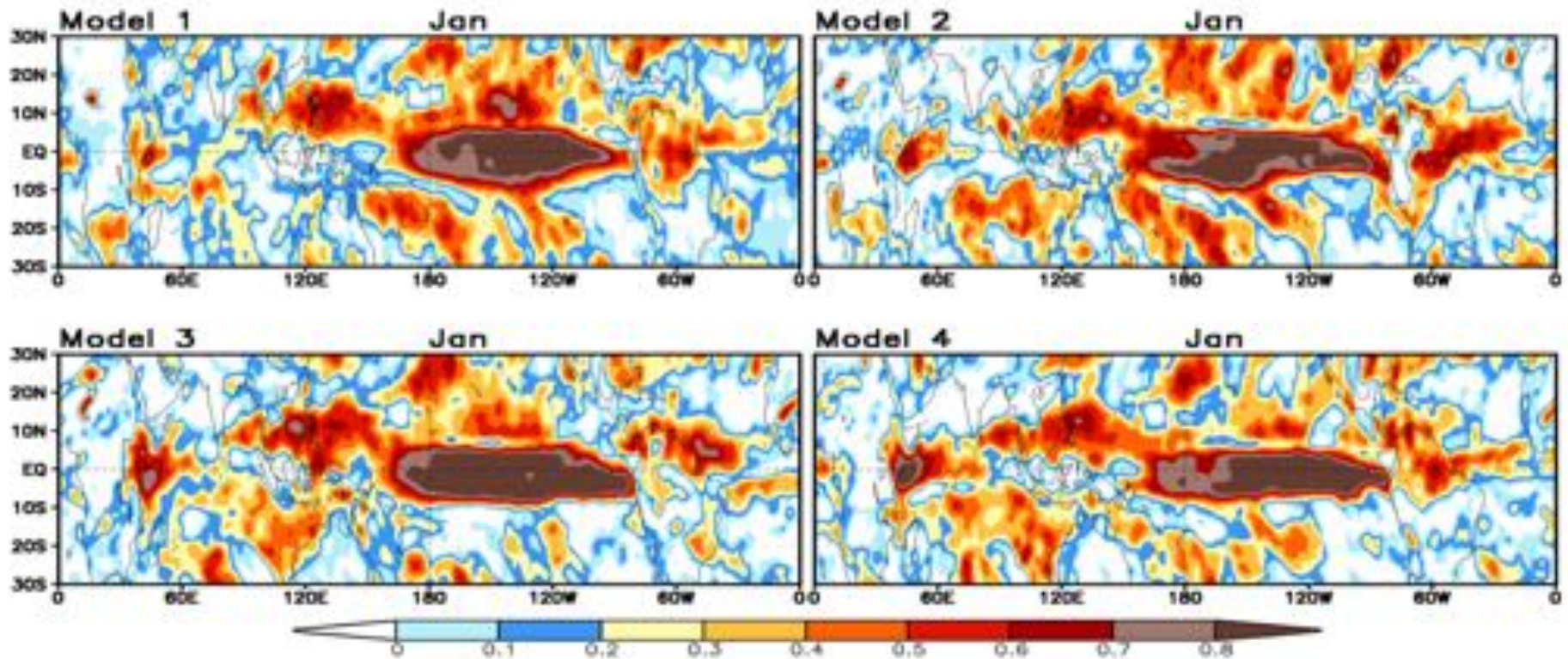




## Large Scale Model Errors Leading To Limited Precipitation Forecast Skill for US Beyond Week Two



Prec Monthly Forecast Anomaly Correlation (IC=Dec)

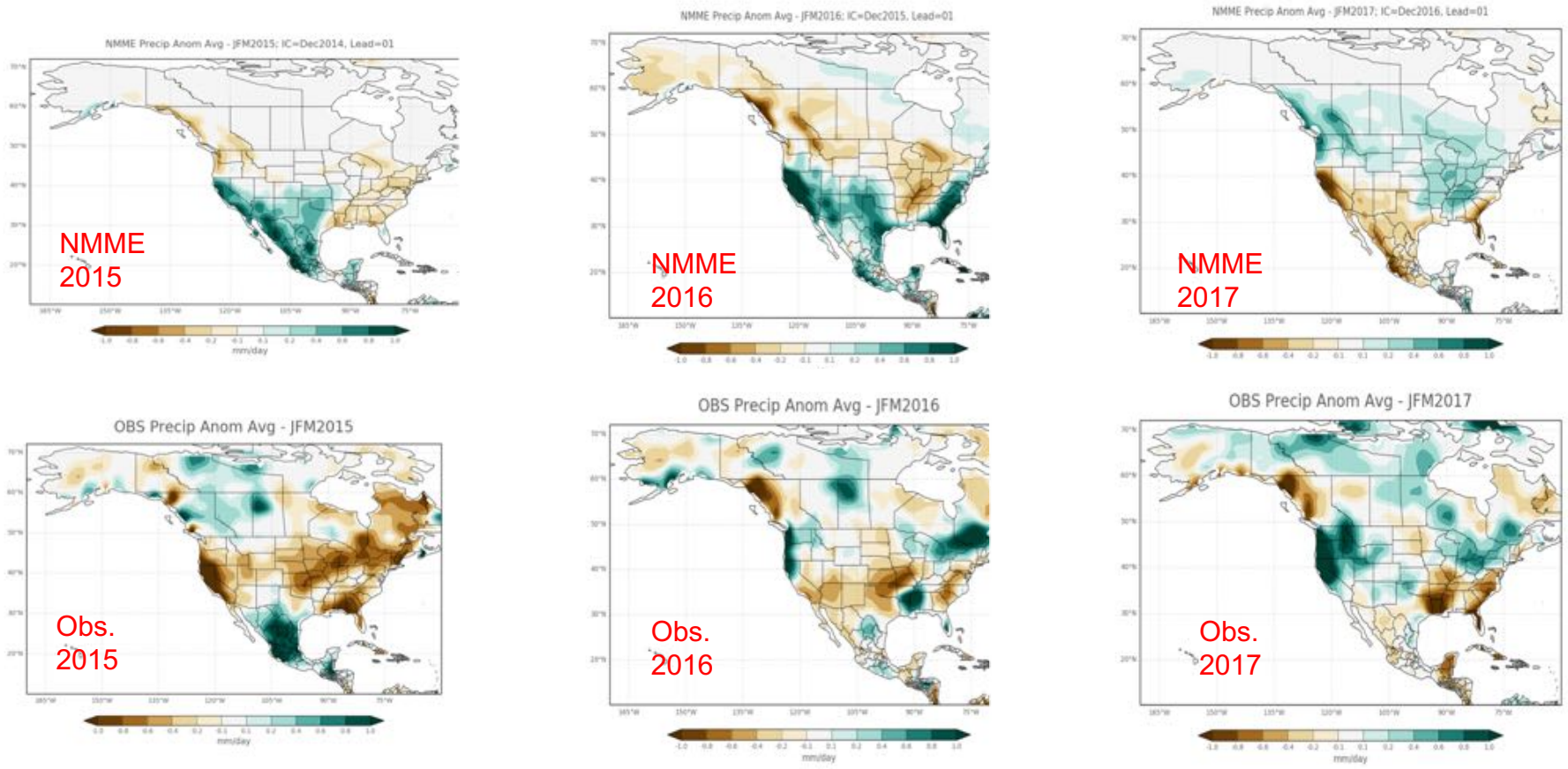


State of the art coupled models from NMME have very little skill in predicting tropical precipitation outside of near-equatorial central and eastern Pacific. That means that we can't predict tropical forcing for 2/3 of the forcing region.





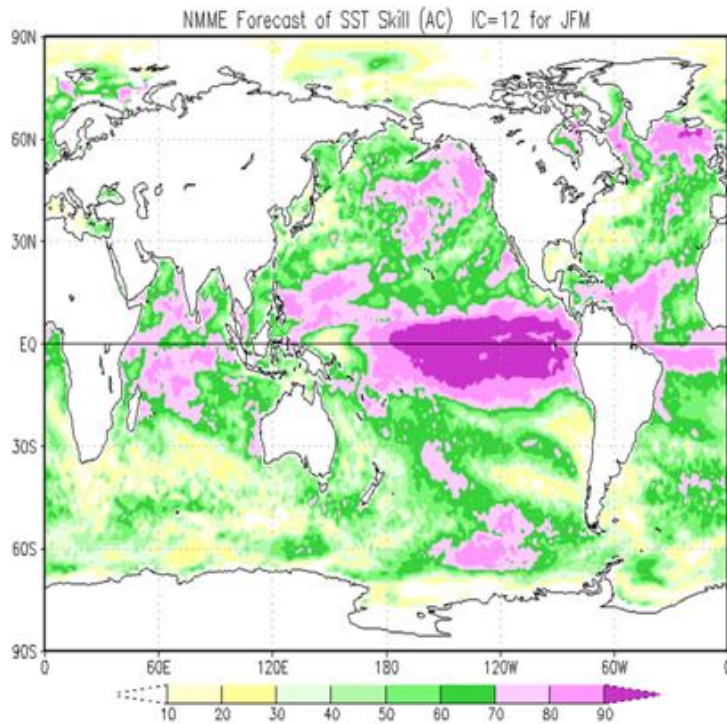
# NMME Precipitation Forecast One Month Lead for Jan.-Feb.-Mar. (JFM)



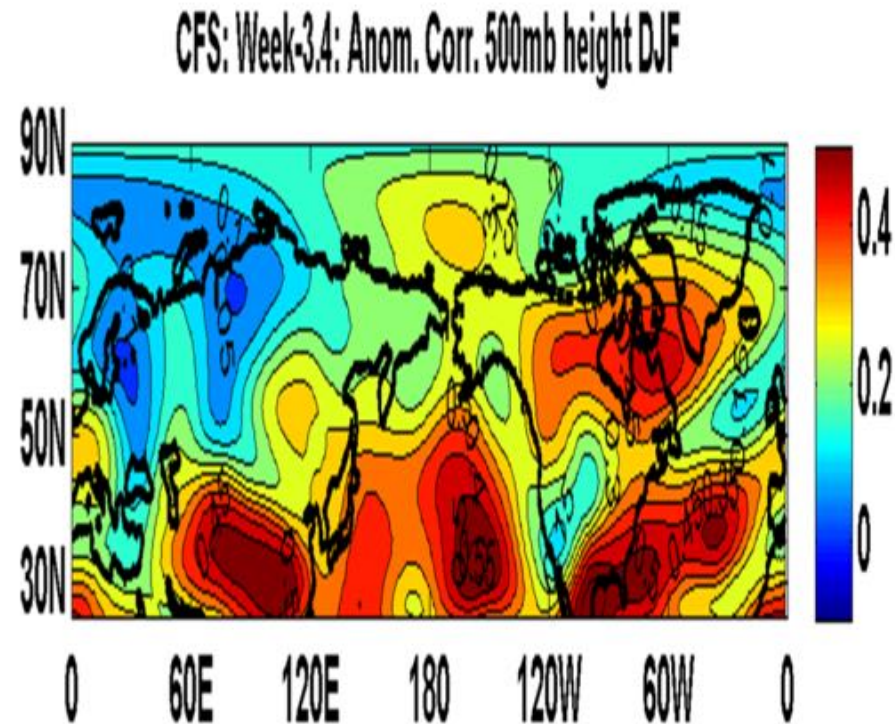
State of the art NMME first season precipitation forecasts for winters of 2015-2017 were consistently of wrong sign over California and most of the west. Forecasters add value to model forecasts but it is hard to overcome really bad model forecasts.



# Large Scale Model Errors Leading To Limited Precipitation Forecast Skill for US Beyond Week Two



Inability of dynamical models to predict tropical SST variability beyond a few weeks outside central/eastern Pacific



Inability of dynamical models to predict upper-level flow for western half of the US.