Background And Framework for Establishing a Seasonal Precipitation Forecast Improvement Project (SPFIP)

Outline

- Vision
- Motivation for establishing the program
- State of seasonal forecasting skill including gaps
- Science goals
- Framework for an SPFIP

Vision

Vision: Development of a holistic program to improve seasonal forecast skill through improved understanding of known sources of predictability, exploration of new sources, and improvement of the representation of these processes in our models.

Realizing this vision will require a **substantial and sustained commitment** of resources and need to leverage all members of the short-term climate prediction community including operational centers, federal labs, and academic partners!

Motivation for Improving Seasonal Precipitation Forecasts

The National Climatic Data Center has recorded droughts in the United States having severe economic impacts (more than $1 billion in damages) during 16 of the 21 years from 1980 to 2011, with an estimated annual average direct drought loss of $9.5 billion (adjusted to 2011 dollars; Smith and Katz, 2013)).

Generation of Seasonal Forecasts at CPC

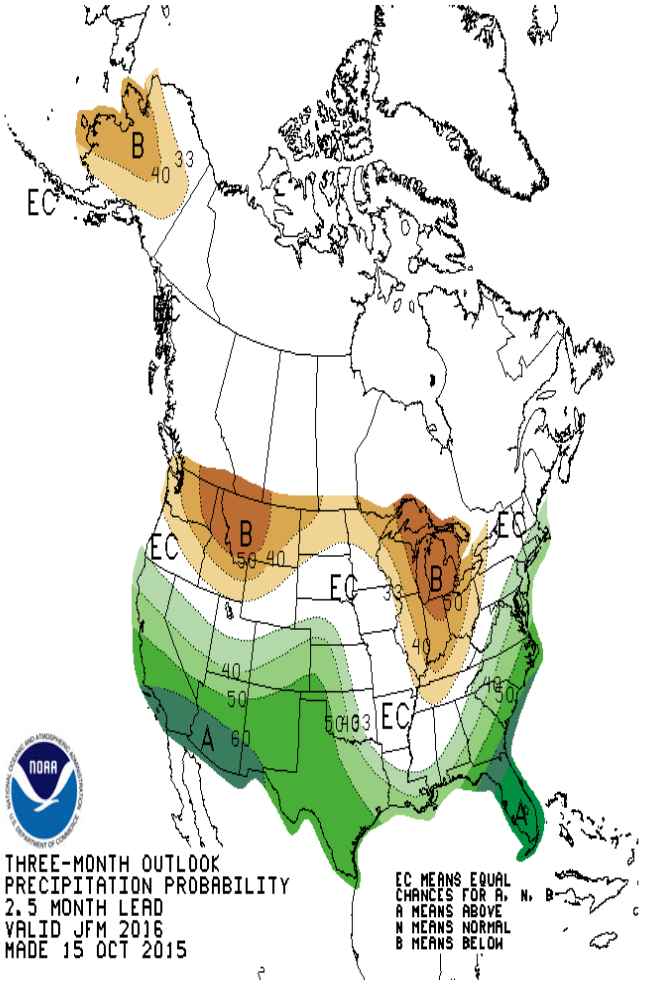
Human Forecasters Use Various Tools To Develop Seasonal Predictions:

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

Goal is to leverage complementary skill between the tools.

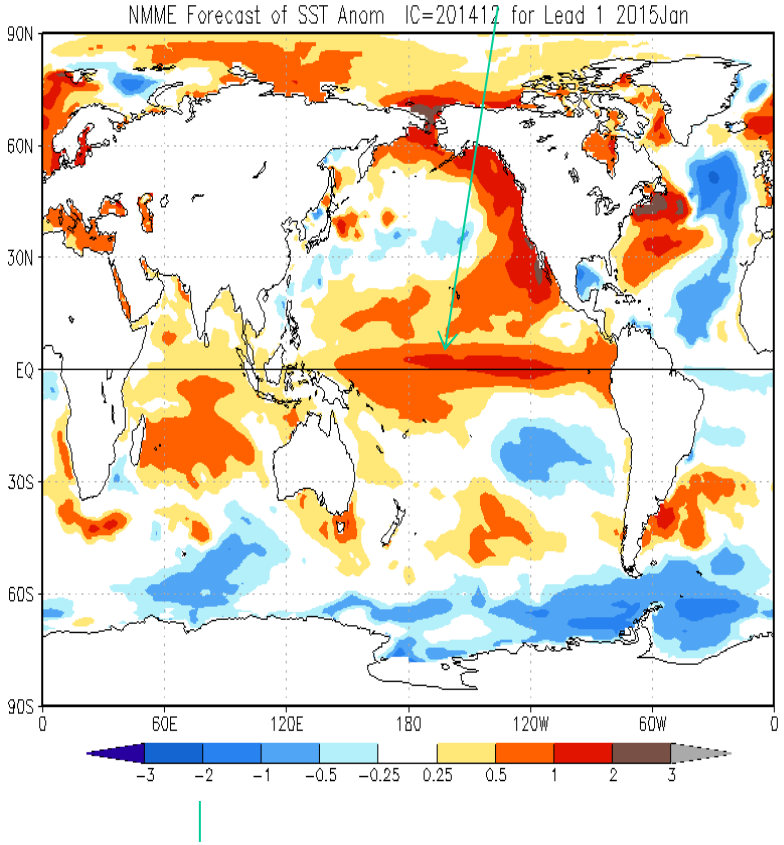
Ultimately, skill of seasonal forecast depends on skill of tools made available to the forecaster.

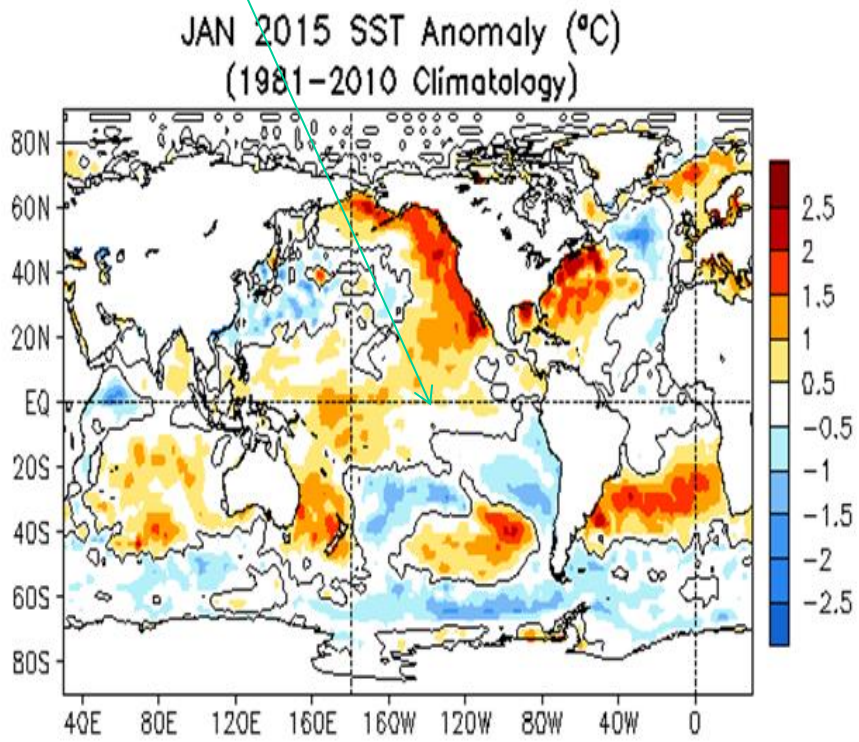
In the 2014-2016 period forecast tool performance has not been good. This has also been true for international models as well.



Lead 1 NMME SST Forecast for January 2015

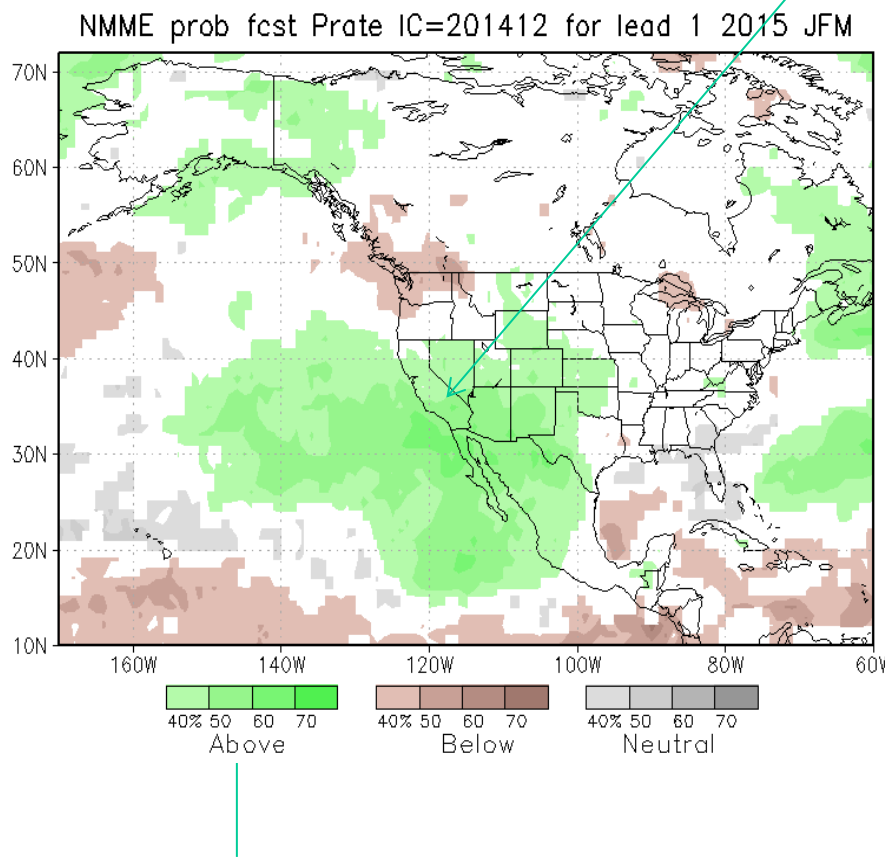
1 month lead NMME forecast calls for moderate cannonical El-Nino while observed anomalies were confined to western Pacific

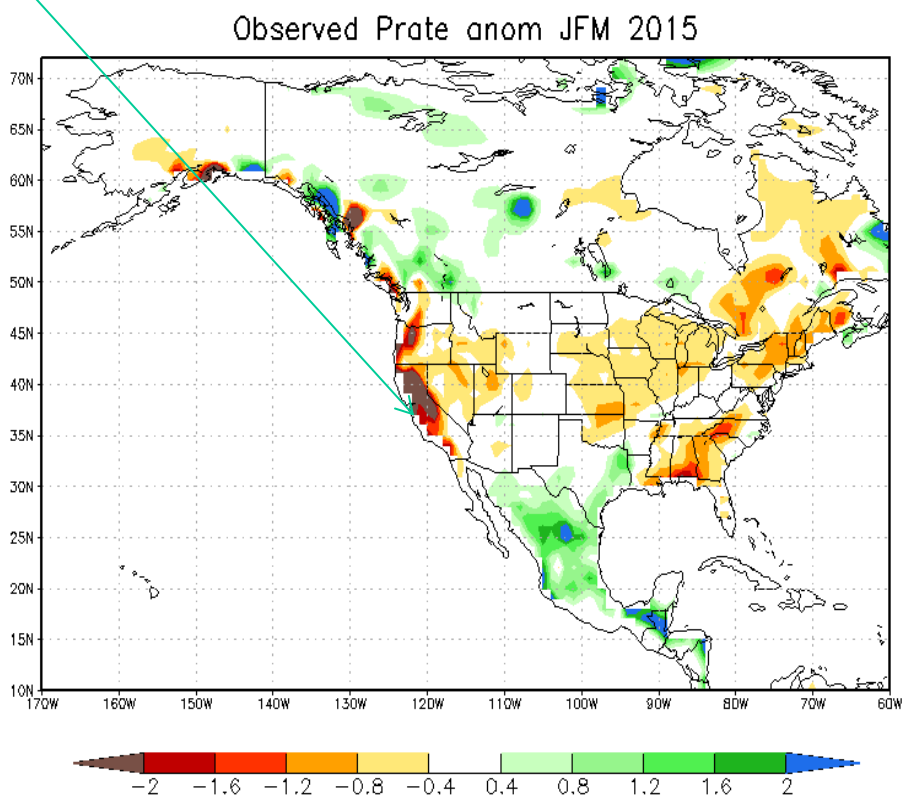




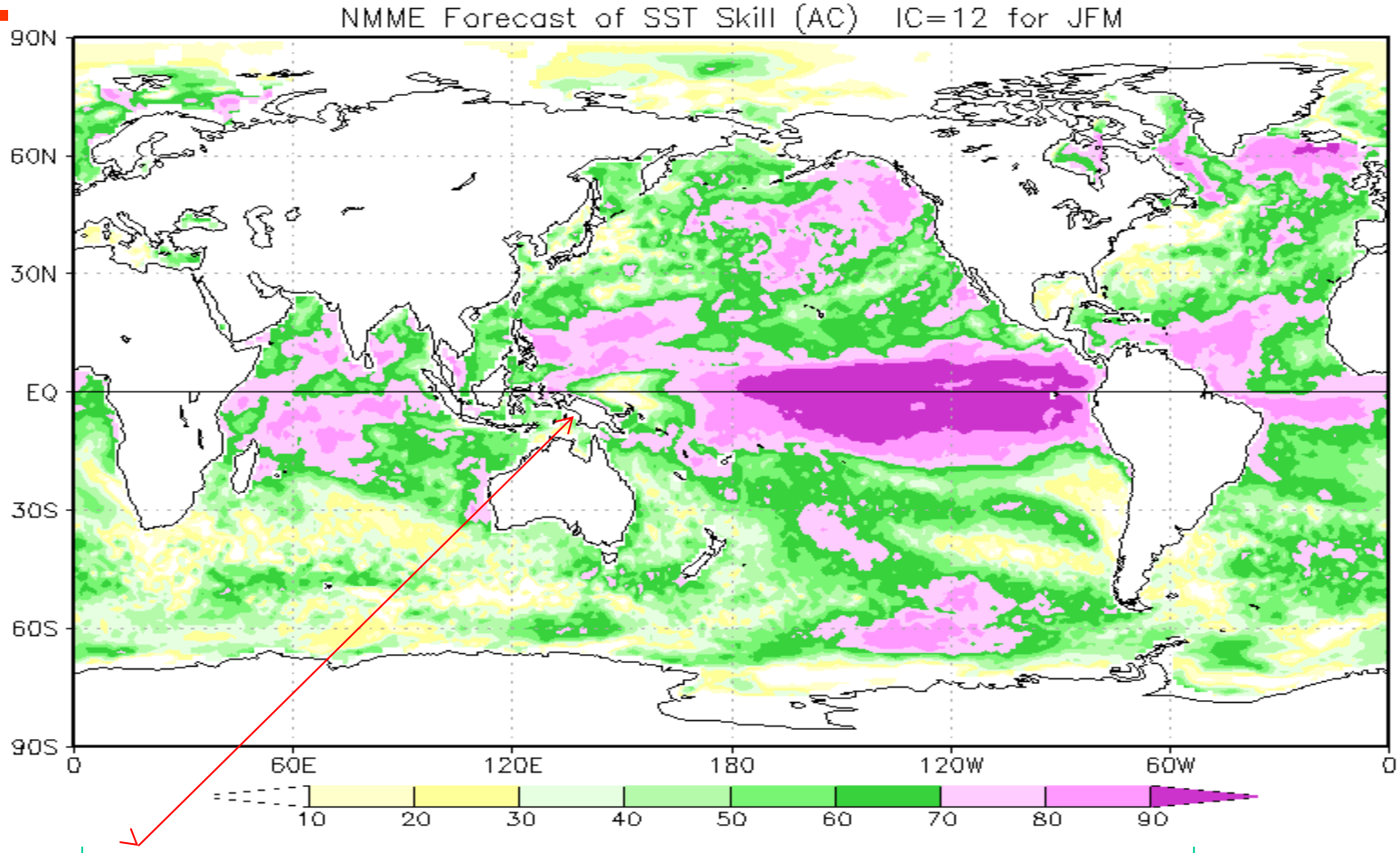
Lead 1 NMME Precipitation Forecast for JFM 2015

Associated precipitation forecast calls for modest probability of above normal precipitation, while record breaking drought was observed.





Retrospective Forecast Skill of Lead 1 NMME SST Forecast for JFM from NMME



State of the Art MME Dynamical Forecast System has Low Skill in Predicting Near-Equatorial Western Pacific SST. If SST in this region drove the large-scale pattern in 2014-2015 there is an issue.

SPFIP Science Goal : Improved Seasonal Prediction Tools

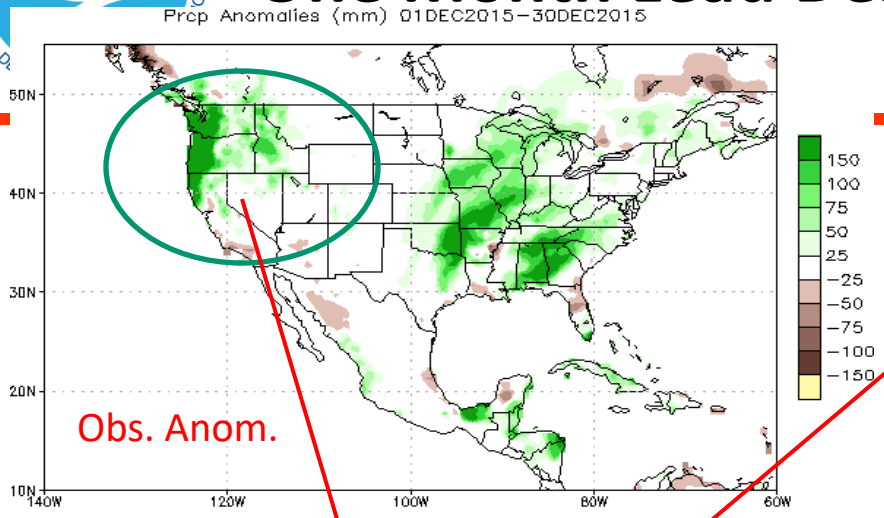
Dramatic failure of state of the art dynamical models (including NMME) in predicting the precipitation anomalies in the western and central US during the record 2015-2016 El-Nino suggests that:

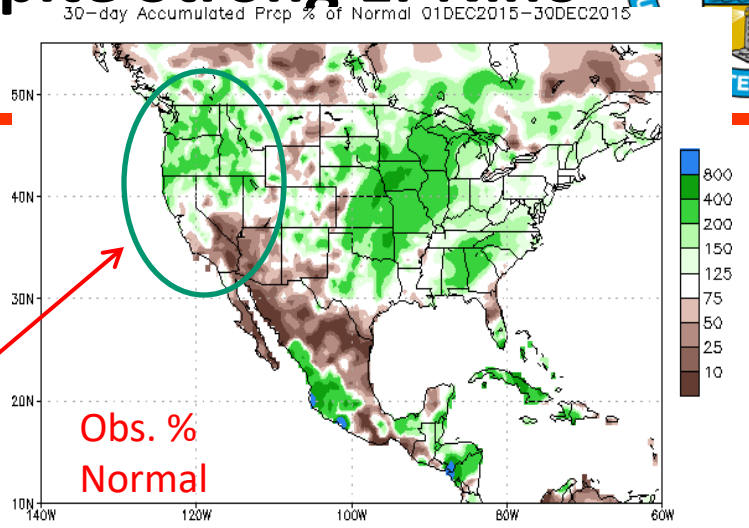
Either there is less predictability in the system then we previously believed or

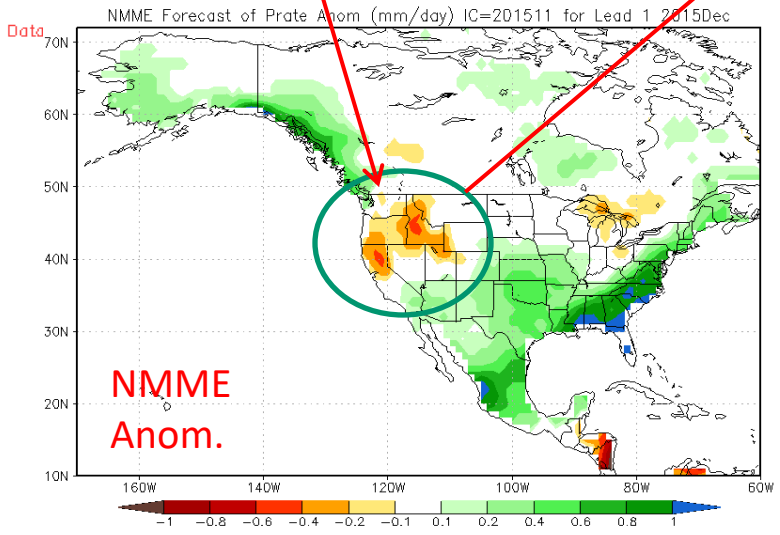
The current generation of models misrepresent or don't represent at all key processes

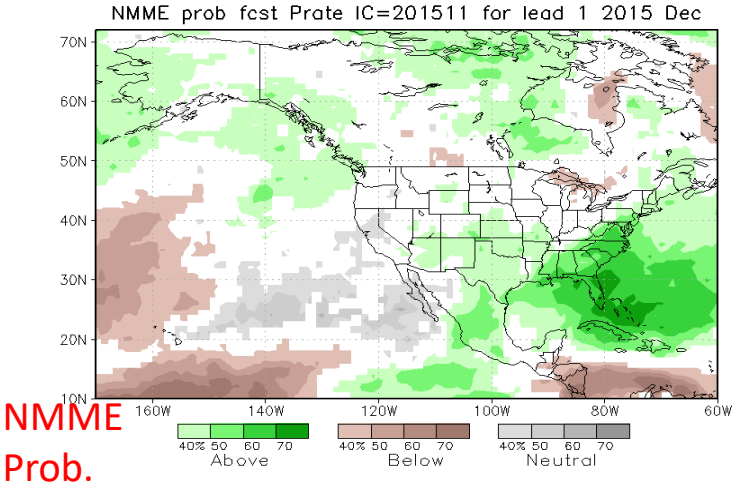
Tremendous opportunity for the short-term climate community to conduct targeted experiments to try to determine which of these is true.

NMME Precipitation Forecast for December 2015 at One Month Lead Despite Strong El-Nino



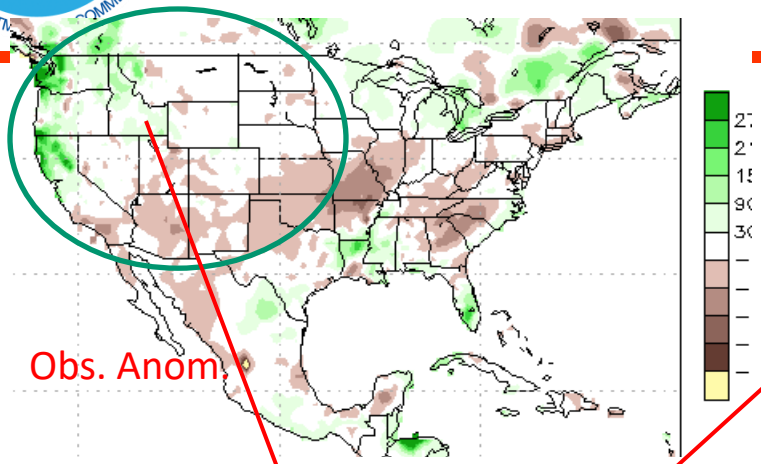




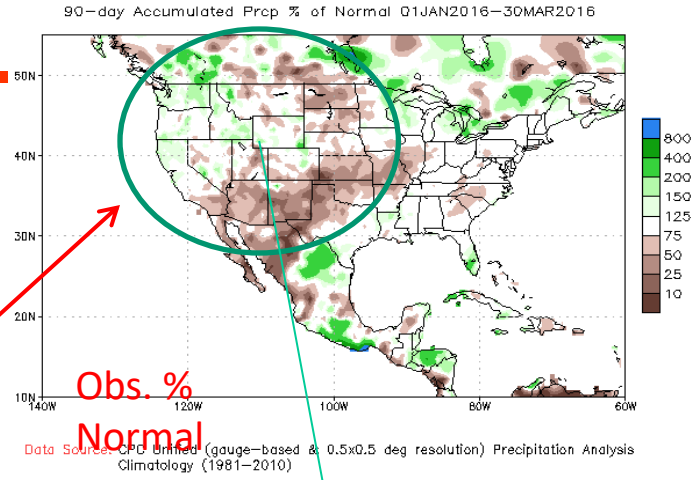


State of the art NMME misses major precipitation anomalies in Western US despite Strong El-Nino.

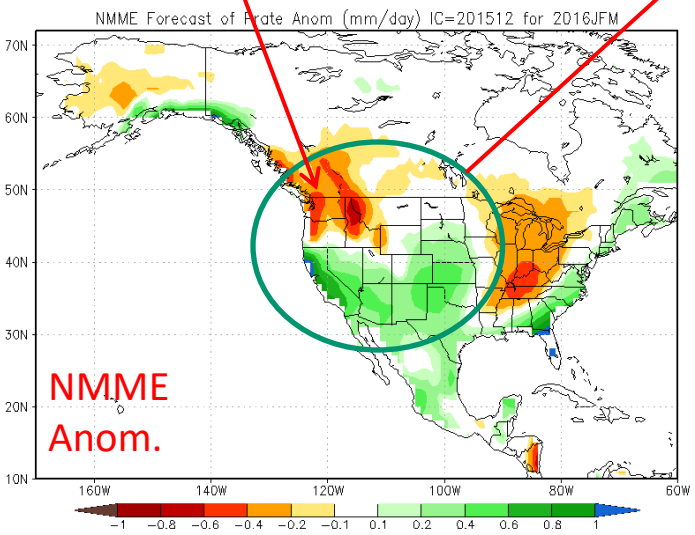
NMME Precipitation Forecast for JFM 2015-16
One Month Lead Despite Strong El-Nino



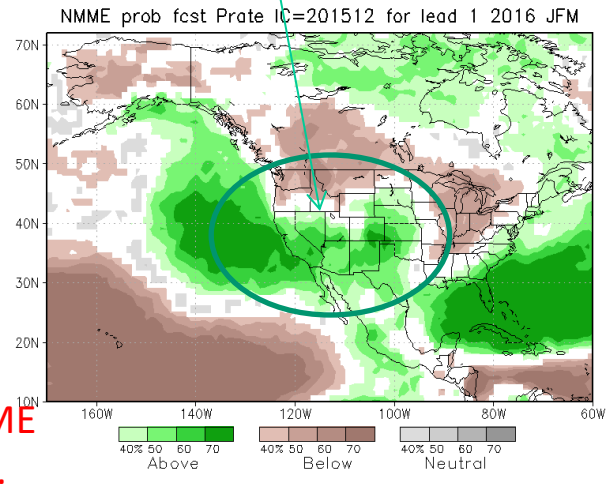
Obs. Anom.



Obs. % Normal



NMME Anom.



NMME Prob.

State of the art NMME misses major precipitation anomalies in Western/Central US despite record El-Nino.

National Academy Assessment of State of Interaseasonal to Interannual Climate Prediction and Predictability (2010)

Main Conclusions:

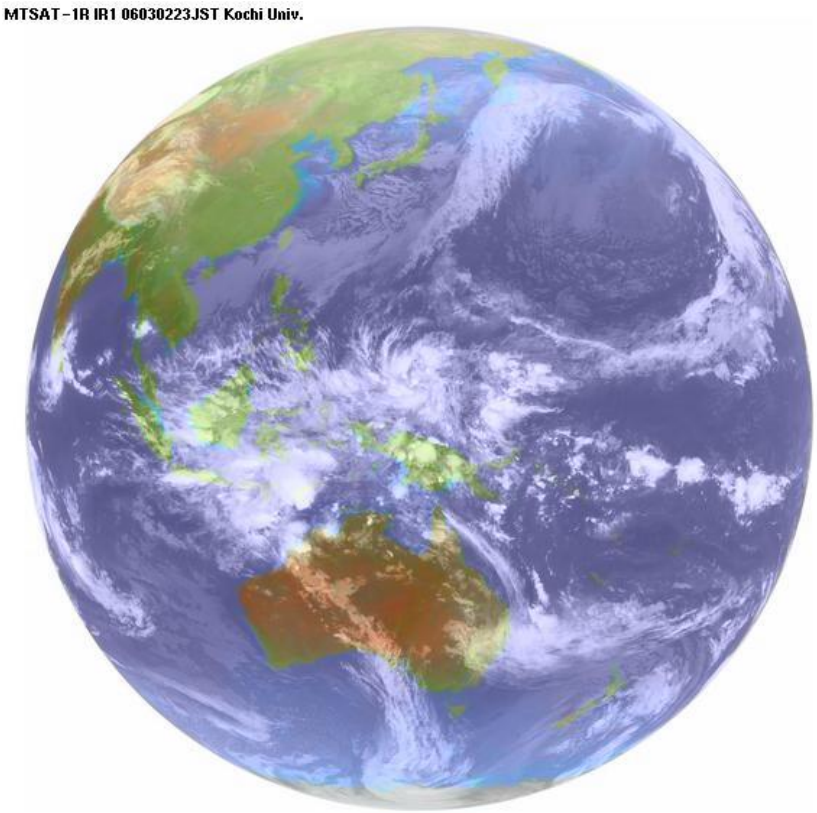
- There are no “silver bullets;” there is no single action that will lead to a revolutionary leap forward in instraseasonal to interannual (ISI) predictions.
- Incremental increases in ISI forecasting quality are to be expected as the building blocks of ISI forecasts are improved and we increase knowledge of sources of predictability.

Challenge 1: Understanding Processes Controlling Organization of Tropical Convection

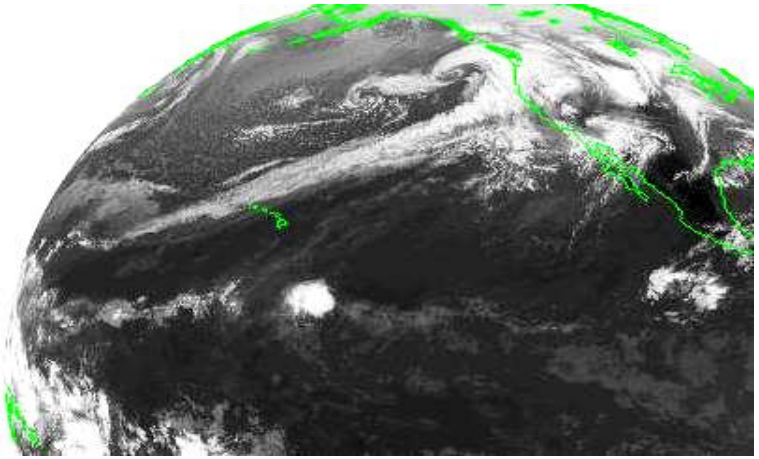
- **A pervasive weakness of weather and climate models.**

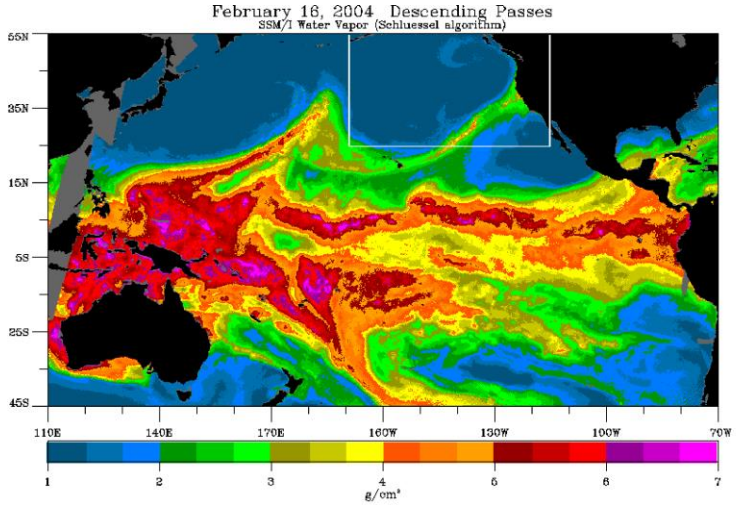
- **Studies suggest that beyond 10 days, variations in tropical heating are a (the) major source of predictability, including weather events.**

- **Tropical climate biases often appear very early in model integrations.**



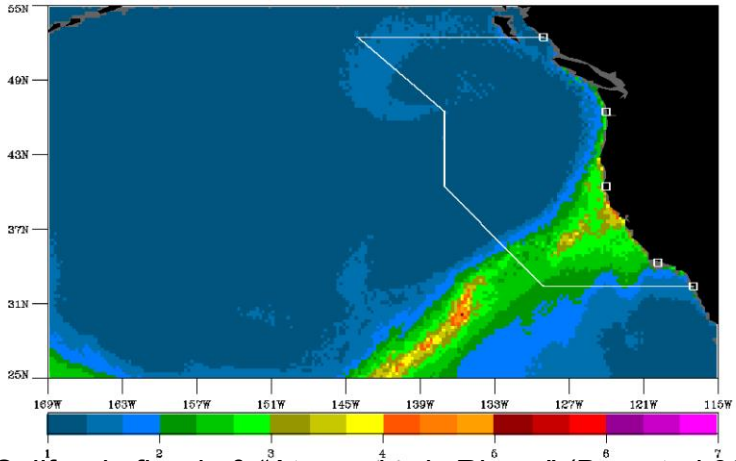
Challenge 2:
Improve Understanding and Prediction
Tropical – Extratropical Interactions





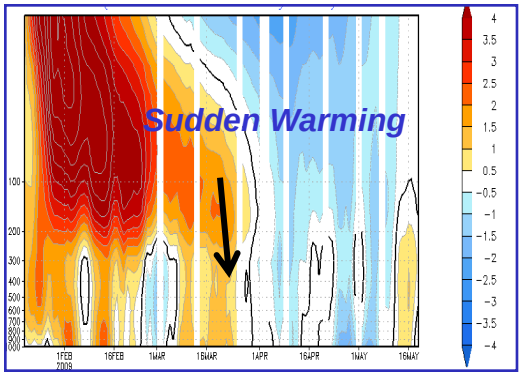
Improve understanding and prediction of:

- Madden-Julian Oscillation
- “Atmospheric Rivers”
- “Pineapple Express” events
- Blocking and Storm Tracks
- Impacts: West Coast floods



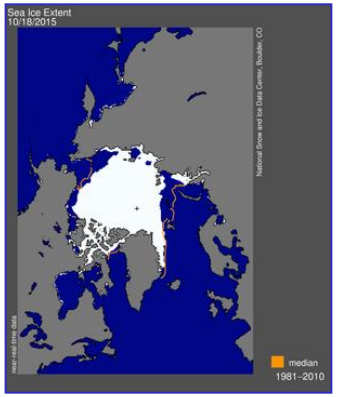
California floods & “Atmospheric Rivers” (Bao et al 06)

Challenge 3: Increase Understanding and Exploit Sources of Predictability

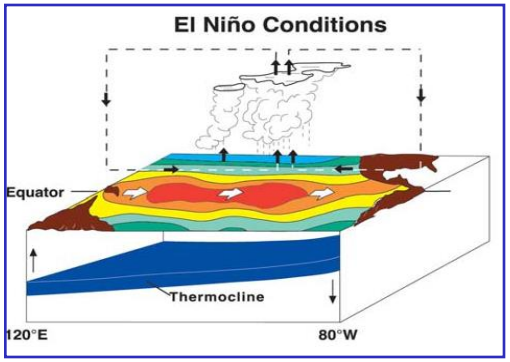


Stratosphere – Troposphere Interactions

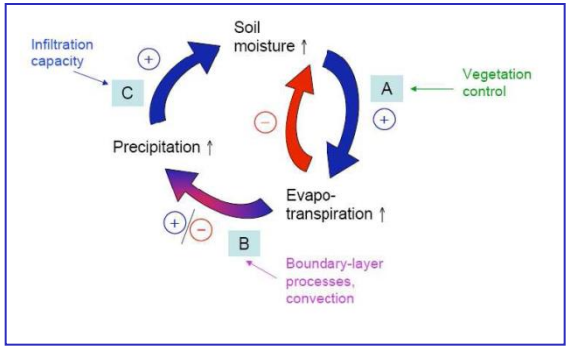
Key sources that link climate to weather:



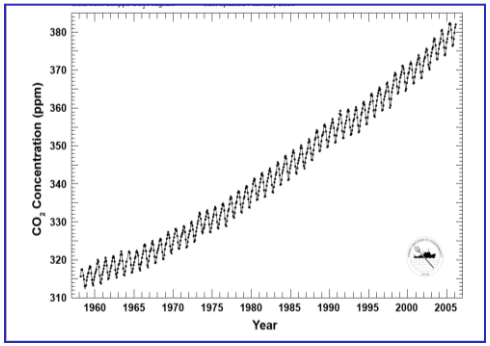
Arctic Sea ice



Ocean-Atmosphere Interactions; Role of sea-surface temperature



Land -Atmosphere Interactions; Role of soil moisture & land processes

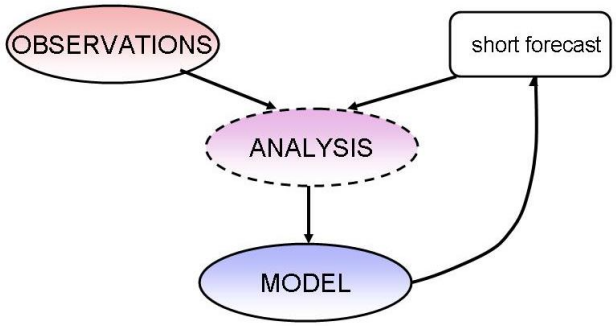


Long-term Trends and Climate Variability

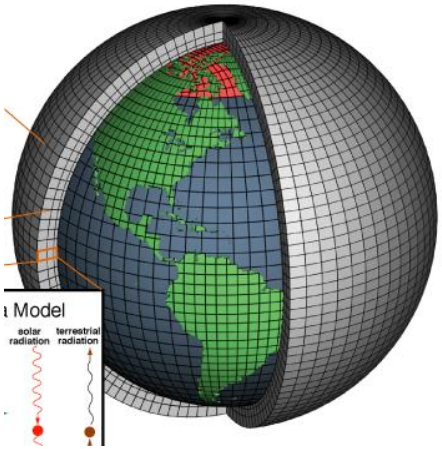
THE NATIONAL ACADEMIES:
http://www.nap.edu/catalog/12878.html

Challenge 4:
Improve the "Building Blocks"

Upgrade Data Assimilation Systems



Identify / correct model errors



Enhance Observational Networks

Improvements in models, observational networks, and data assimilation systems lead to improved understanding and more realistic prediction over time.

THE NATIONAL ACADEMIES:
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Framework for an SPFIP

1. Need to recognize the difficulty of the problem and ensure sufficient and stable resources are obtained. Uncertain funding levels make it difficult to plan and make progress.
2. Essential components:
   - Grants program supporting mission-driven research on understanding sources of predictability
   - Support to modeling centers for model improvements
   - Grants program on tailoring products for end users
   - Support infrastructure for testing new tools and transitioning to operations
   - High-performance computing augmentation
3. Key partners:
   - Academic community
   - Within NOAA: NWS (NCEP, NWC), OAR (GFDL, ESRL, CPO); NESDIS (NCEI)
   - Other willing federal agencies