



Advancing NOAA's Subseasonal and Seasonal Prediction in Support of the Weather Act of 2017 (PL115-25, 201)

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Thanks to Tim Schneider and H. Tolman for support on the presentation.

Thanks to large number of people contributing to the implementation of PL115-25 from CPO, ESRL, GFDL, NWS (STI, CPC, and EMC), OWAQ, and PMEL. Special thanks to Tim Schneider, Jon Gottschalck, Robin Webb, and Karen Keith.

NOAA: NWS, ¹NCEP Climate Prediction Center; ²Office of Science and Technology Integration

Outline

1. Weather Bill Background

- NOAA-Led Efforts to Improve S2S Forecasts:
- Overarching Goals
- Extended-Range Forecast Program
- NGGPS
- Sub-X

2. Recent Science Progress on Improving S2S Predictions

3. S2S Prediction Challenges That Need to Be Addressed

4. Closing Thoughts/Way Forward

Weather Research and Forecasting Innovation Act of 2017

PL 115-25 S2S Provisions: What are they?

Short Title - Weather Research and Forecasting Act of 2017: “Weather Bill”

× TITLE II – Addresses “Sub-seasonal and Seasonal Forecast Innovation”

- Section 201 “Improving Sub-seasonal and Seasonal Forecasts” is the only section in TITLE II
- Section 201 Amends Food Security Act of 1985

× Scope: Defines and authorizes NOAA’s Sub-seasonal and Seasonal (S2S) forecast and coordination responsibilities

× Authorizes \$26M in each of the years 2017 and 2018 for the NWS to meet the provisions of the Act

Weather Bill S2S: Reporting Requirements

By end of October 2018, NOAA shall submit to Congress (relevant House and Senate Committees) a report including:

1. An analysis of how NOAA's S2S forecasts are used for public planning and preparedness,
2. NOAA's specific plans and goals for the continued improvement of an S2S forecasting capability, including products to meet the need described in 1., and
3. An identification of the needed research, monitoring, observing and forecasting requirements for number 2.

The Undersecretary shall consult with relevant Federal, regional, State, tribal, local government agencies, research institutions, and the private sector in the development of this report.

NOAA Goals and Objectives to Meet Weather Bill Mandate

Four major goals and objectives identified:

1. **Advance Prediction Skill:**

- Reduction in number of negative skill events
- Improved impact analyses

2. **Expand Information Content of Forecasts:**

- Better probabilistic/uncertainty info and risk communication
- ** New products for specific types of extreme weather events **

3. **Expanded Service Capacity:**

- **New/tailored products for existing and new customers: including support for National Security Needs**

4. **Improved Scientific and Technical Capabilities:**

- Improved understanding, modeling, post-processing of physical processes
- Diagnosing and exploiting new sources of predictability

NOAA Action on Developing Weather Bill S2S Report to Congress

NWS (DeWitt and Toepfer) is leading a Cross-NOAA Panel to develop plan for S2S program and write draft of required report

Cross-government subject matter experts being consulted for draft.

Other federal agencies consulted on report through Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR)

Public review and comment of draft report via Federal Register

- Targeting early June, 2018
- This opportunity will be announced here:
 - <https://www.federalregister.gov> (updated daily)
 - <http://www.weather.gov/sti/stimodeling>
- **DGD will ensure that WSWC/CDWR and other stakeholders are notified when it will appear.**

NOAA Efforts on Improving S2S Predictions: Extended-Range Prediction Initiative

Overview:

- Five-year program that kicked-off January 2016
- Aimed at improving mid-range weather outlooks
- A joint NWS-OAR initiative
- Includes Extramural grants program



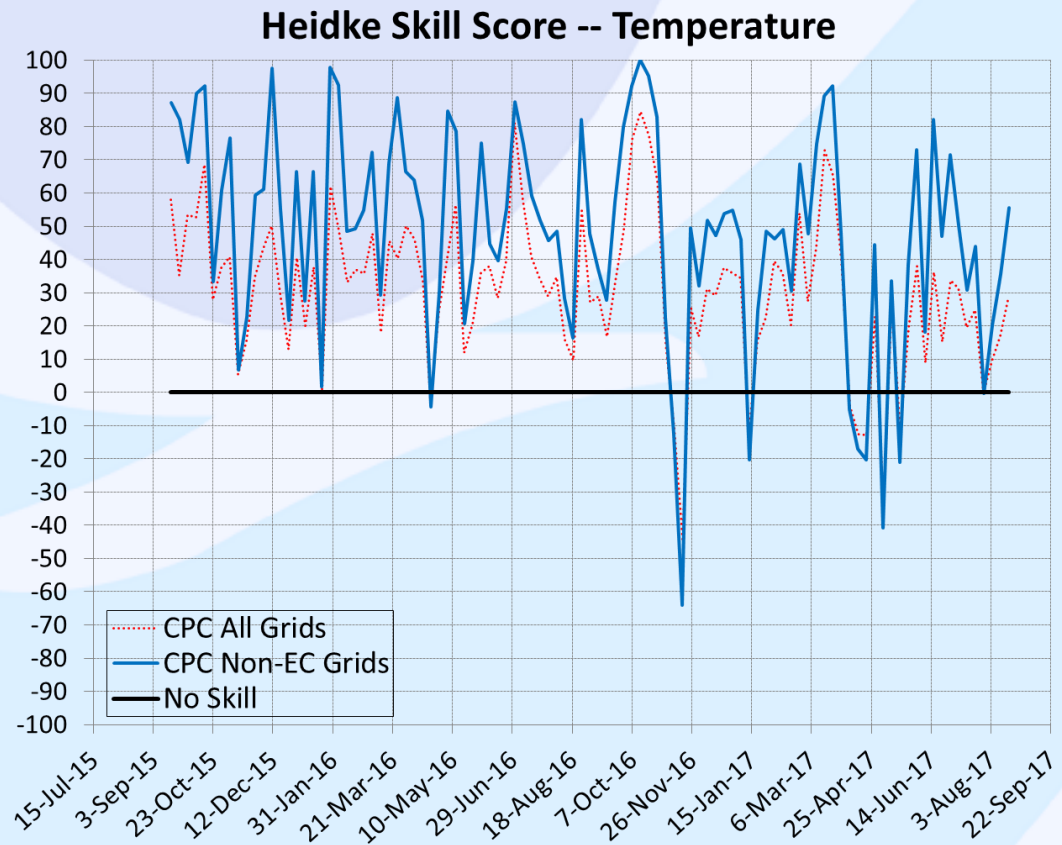
Four major thrusts:

1. Product innovation
2. Extending numerical model guidance out in time
3. Building a reforecast & reanalysis capability
4. Supporting applied research on sub-seasonal forecasts

Weeks 3-4 Program – Select Results

Product Improvements at NWS/NCEP/CPC

- Development, improvement, and operational issuance of Week 3-4 Temperature Outlooks
- Precipitation Outlooks are still experimental and skill is lower due to limited predictability at this time range



Courtesy of Dave DeWitt, CPC

Weeks 3-4 Program – Select Results

Advances on Reforecasts and Reanalyses at OAR/ESRL/PSD

REANALYSIS RUNS Conventional Data Monitoring

CFSR vs FV3

This page presents graphics representing the gsi data assimilation for reanalysis project.

The diagnostics of the GSI data assimilation from the FV3 reanalysis model run are compared to CFSR, based on selections below. The available determined currently by the FV3 run availability, currently 1999 January thru March. More results added as they become available.

We welcome feedback on this product. Email comments to: esrl.psd.reforecast2@noaa.gov.

- [Select Conventional Data Dates](#)
- [Compare overlap time in model streams](#)
- [Return to Main Page](#)

Choose a Plot Below:

Plot Field: T-Temperature

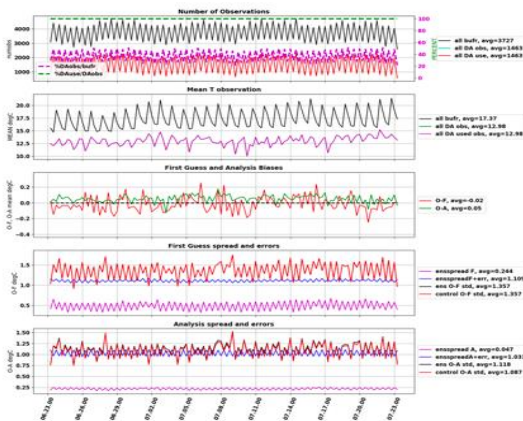
Level: 800mb-900mb

Region: GLOBAL

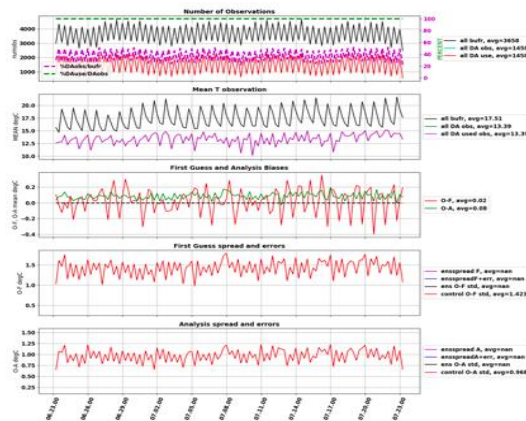
FV3 stream: FV3 stream #1: 1999->

Get Plots

FV3s1 CONVENTIONAL OBS T Global 800_mb to 900_mb



CFSR CONVENTIONAL OBS T Global 800_mb to 900_mb



Courtesy of Tom Hamill, PSD

- Conducting “scout runs” for the new Reanalyses
- Using the ‘new’ FV3 -GFS model
- Diagnostic tool shown

The Subseasonal Experiment (SubX) *Funded Through Climate Testbed*

Objectives:

- Collecting and serving data both internally at CPC for use by operational forecasters and for the external community via the IRI data library
- Providing a baseline verification particularly for the weeks 3-4 temperature and precipitation probability forecasts
- Evaluating the skill of individual model systems
- Investigating multi-model combinations including selecting suitable models, optimizing the design of the system, and evaluation of the prediction products
- Enhancing communications between operational forecasts and the model forecast producers

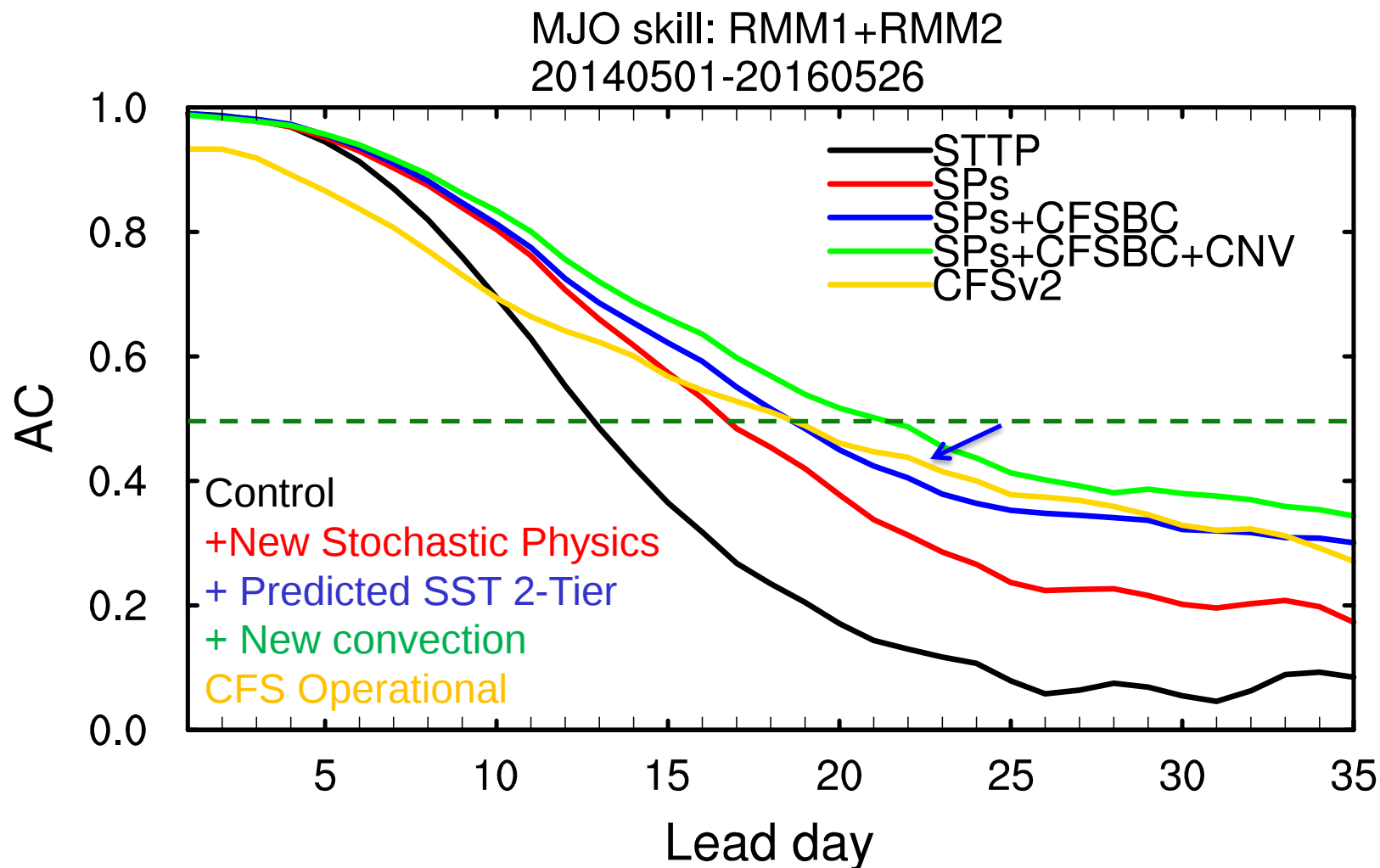
Subseasonal to Seasonal Modeling Strategy

Coupled Model Development

FY17				FY18				FY19				FY20				FY21				FY22		
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1		
Bench mark testing GSM+MOM5+CICE5																						
		Replace MOM5 with MOM6 & Couple to FV3																				
				Physics Testing of Coupled system (deterministic) FV3+MOM6+CICE5																		
		Developing MOM6 DA capability																				
				Adding GOCART (Aerosol) and Aerosol DA in GSI																		
			Add WW3 (model + DA) to coupled system and improve ocean-wave physics																			
			Adding Sea Ice (CICE5) DA capability																			
			Observation Processing of New data sets (additional atmospheric + Marine + land) for coupled DA																			
				Testing with NOAA-MP + Land DA																		
						Testing of coupled system (FV3+MOM6+CICE5+GOCART+WW3+NOAH-MP) with fully coupled DA																
											Reanalysis & Reforecast Phase											
																	Evaluation + Validation + Transition to operations/implementation					

Recent Progress on Subseasonal to Seasonal Prediction

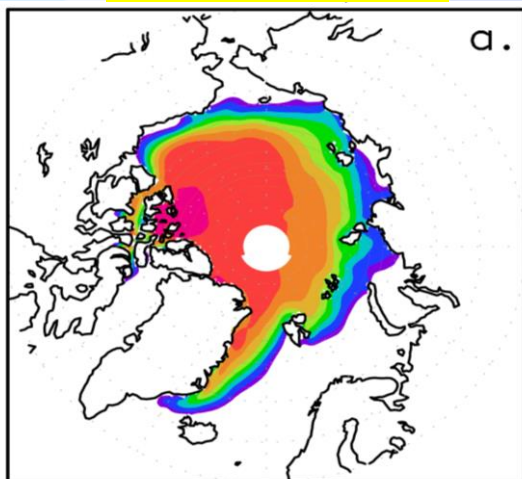
GEFS week 3&4 forecasts (May 2014-May 2016) (Zhu et al.)



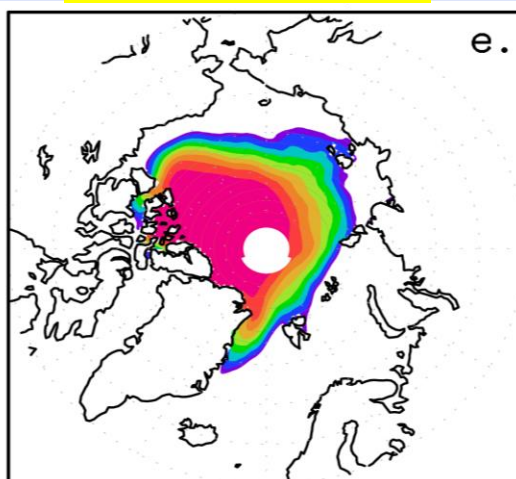
Dramatically increased skill of MJO from improved physics! Need to continue to improve teleconnections from MJO, i.e. precipitation forecast skill over California.

Forecast mean September sea ice concentration from March (2009-2013)

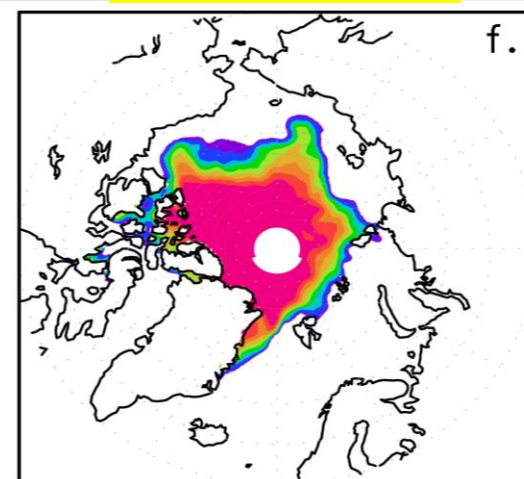
CFSv2/CFSR



CFSv2p/PIOMAS



NASA Bootstrap



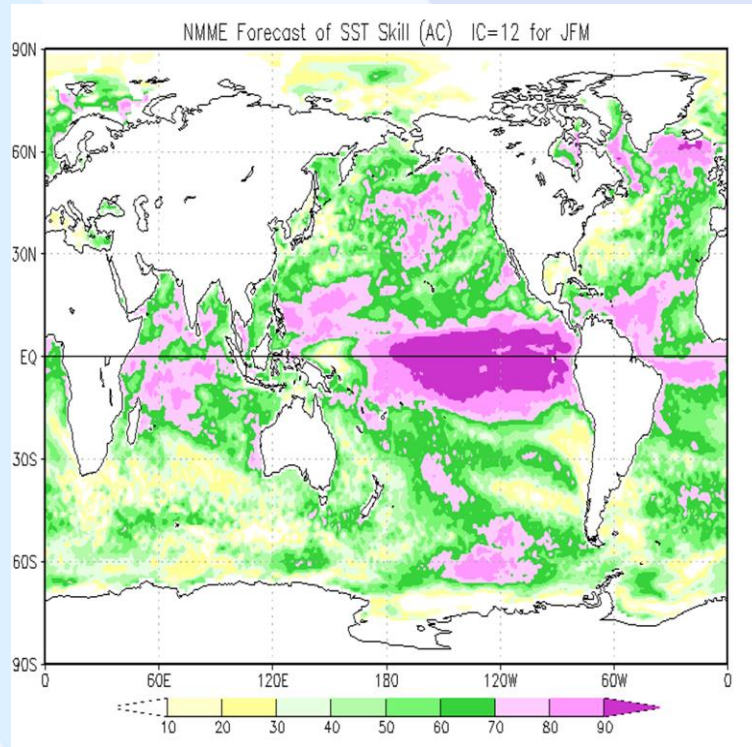
Stakeholder requests for sea-ice forecasts for mineral extraction, tourism, national security, and environmental stewardship.

Prediction Challenges on the Subseasonal to Seasonal Timescale

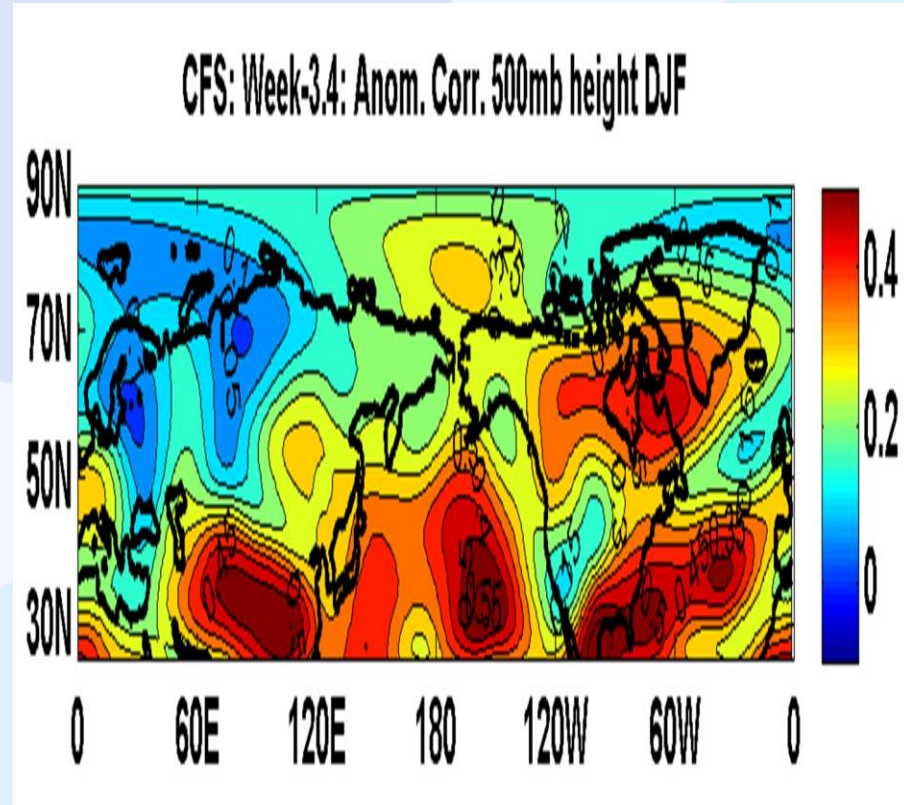
S2S Science Challenges (Focus of Future Research to Meet Goals of Weather Bill)

- Inability to accurately predict Tropical SST outside of the central and eastern Pacific
- Inability to accurately predict tropical precipitation beyond a few weeks outside of the central and eastern Pacific
- Skill minima in upper level steering flow over the western US
- Need to better understand why models did not perform well in predicting precipitation in the western US for the winters of 2014-2017.

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



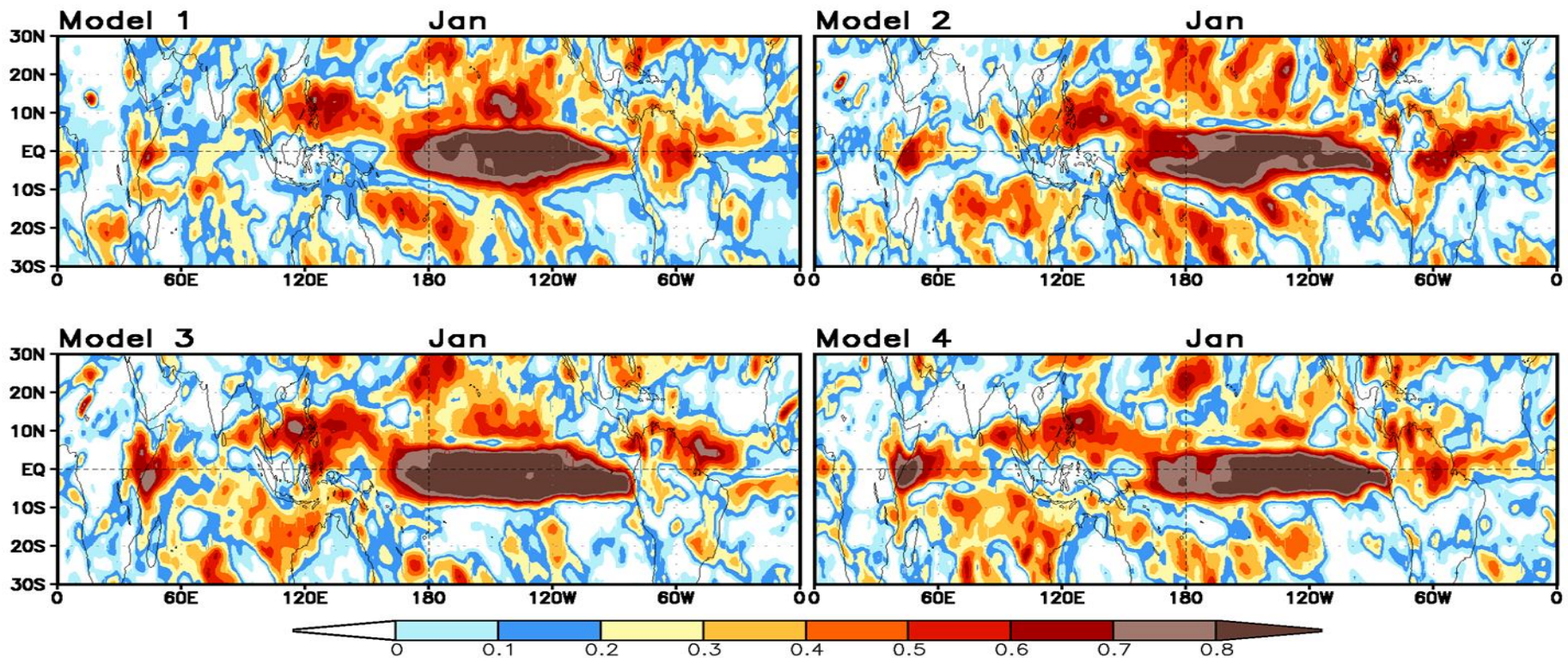
Inability of dynamical models to
predict tropical SST variability
beyond a few weeks outside
central/eastern Pacific



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

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

Prec Monthly Forecast Anomaly Correlation (IC=Dec)

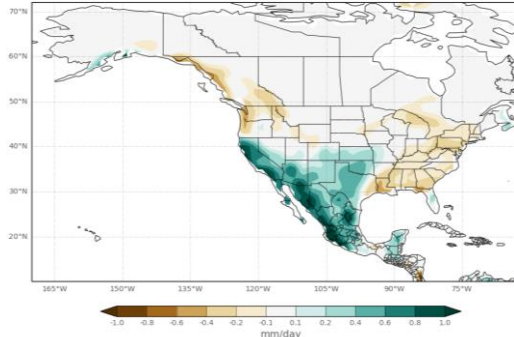


State of the art coupled models from NMME have very little skill in predicting tropical precipitation outside of near-equatorial central and eastern Pacific.

NMME Precipitation Forecast

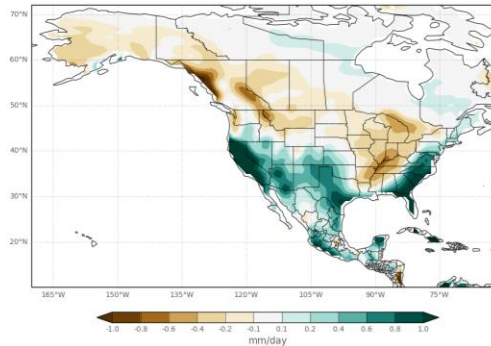
One Month Lead for Jan.-Feb.-Mar. (JFM)

NMME Precip Anom Avg - JFM2015; IC=Dec2014, Lead=01



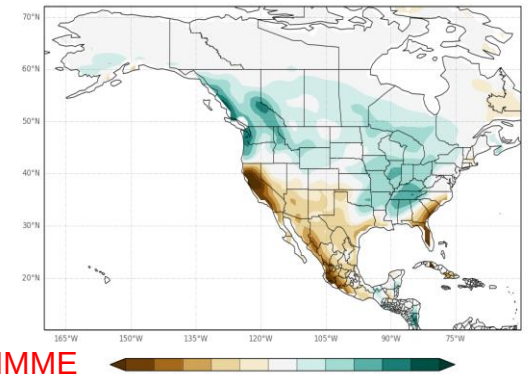
NMME
2015

NMME Precip Anom Avg - JFM2016; IC=Dec2015, Lead=01



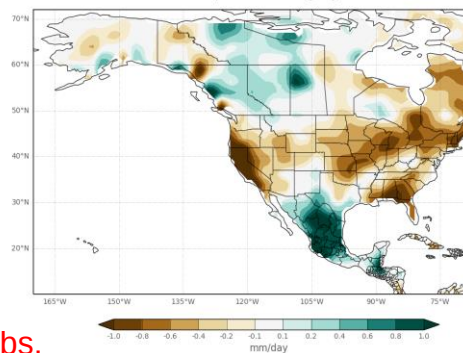
NMME
2016

NMME Precip Anom Avg - JFM2017; IC=Dec2016, Lead=01



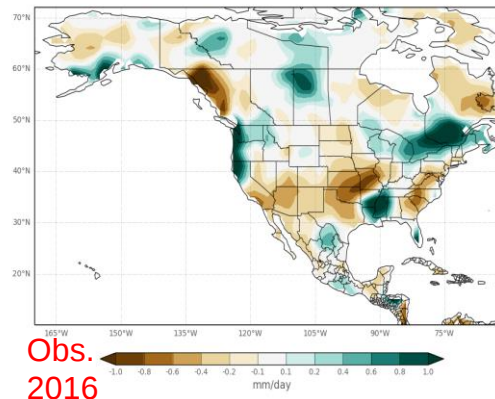
NMME
2017

OBS Precip Anom Avg - JFM2015



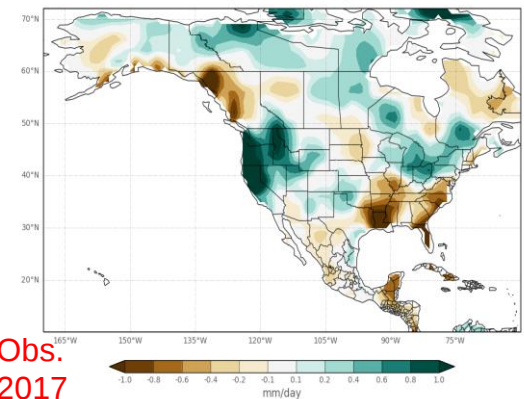
Obs.
2015

OBS Precip Anom Avg - JFM2016



Obs.
2016

OBS Precip Anom Avg - JFM2017



Obs.
2017

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.

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 water resource 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.