



Science Planning Perspective

on Improving Regional Climate Prediction for Services

Jiayu Zhou

*Office of Science and Technology
NOAA's National Weather Service*

23 October 2014

Disclaimer

All materials used in this presentation are credited to their original authors indicated under each figure. Deep appreciation goes to outstanding researches that support NWS science and technology strategic planning and development.

“Government of the people, by the people, for the people.”

- Abraham Lincoln, Gettysburg, Pennsylvania, November 19, 1863

Vision:

Weather-Ready and Climate-Smart Nation

- Building community resilience in the face of increasing vulnerability to extreme weather and climate conditions and events.

Requirement:

Skillful and reliable prediction products at local level

S&TI Mission Focus

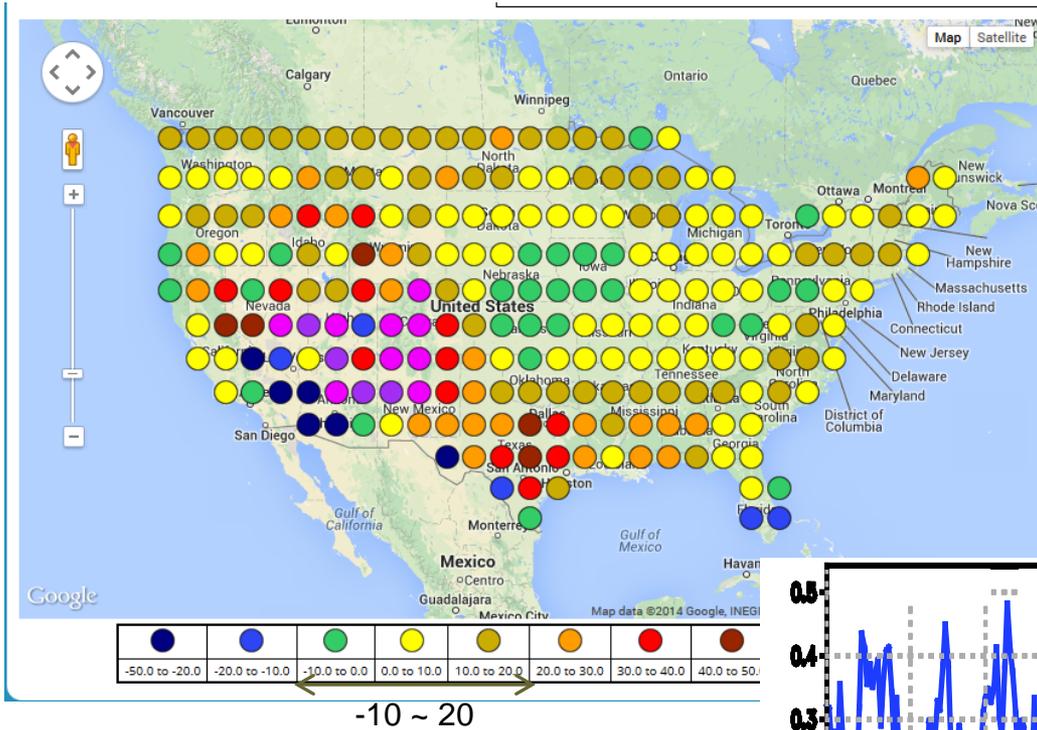
Identify key issues in NWS climate operation and synthesize R&D needs, contributing to NWS S&T strategic plan and roadmap.

Outline

1. Skills - *Service concerns*
2. Puzzles
3. Opportunities
4. Summary

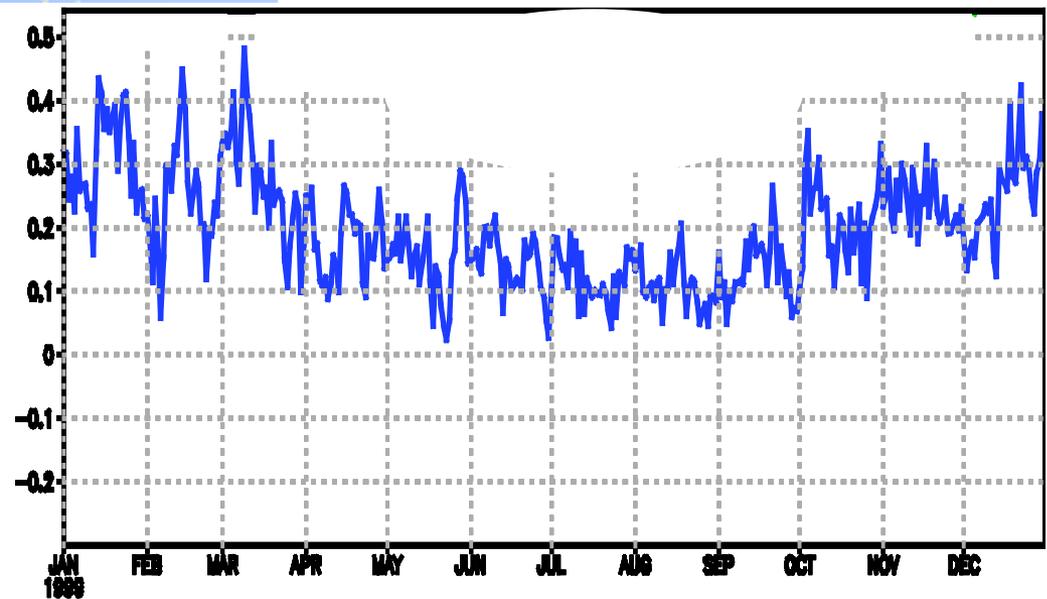
Seasonal (Leas 0.5) Temperature Heidke Skill Score for manual from 200410-201410

- Skills
- Puzzles
- Opportunities
- Summary



CPC verification summary

Prate Near US Wk-2 AC

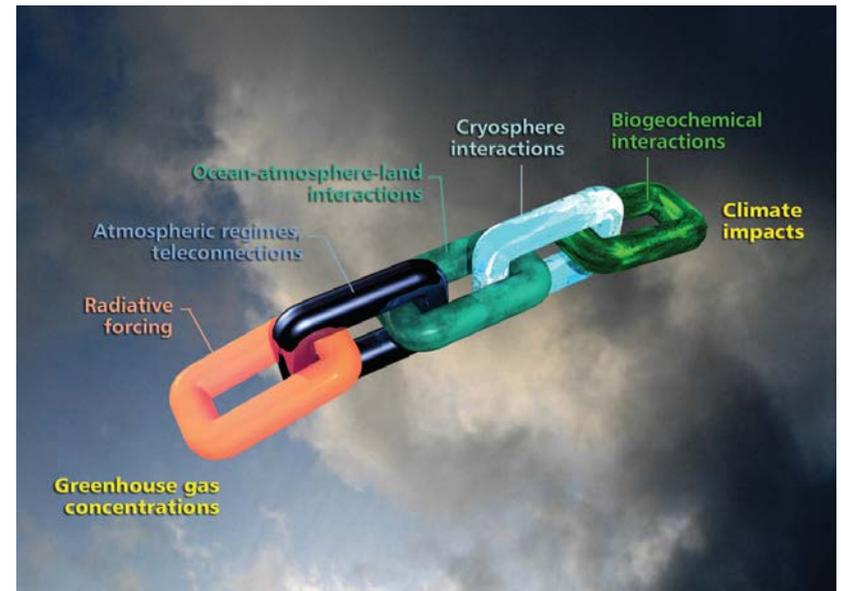


Muthuvel Chelliah

Prediction Skills

The strength of the seamless prediction chain depends on the weakest link.

Where does the weakest link located?



(Palmer et al. 2008)

Outline

1. Skills
2. Puzzles – Find clue from unexpected failure and forecast outliers
3. Opportunities
4. Summary

Case Failure

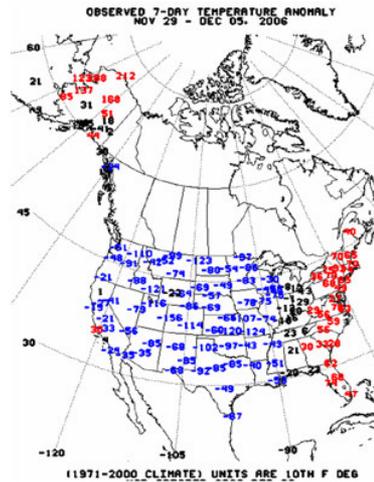
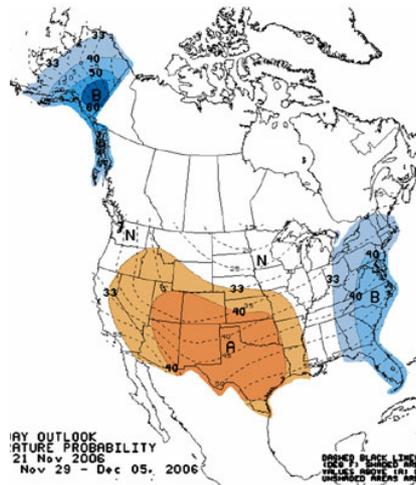


Fig.1 Left: 8-14 day temperature forecast based on GFS ensemble made on 11/21 for 11/29-12/5/2006. Right: The observation for verification in the same period.

*A week-2
forecast running
to the opposite
of the observation*

- From Board of Outstanding Open Problems,
NWS Science & Technology Infusion Climate Bulletin

Skills

Puzzle 2

Opportunities

Summary

What do we need to focus on for improving the week-2 forecast?

- a. Upstream regimes of weather system development
- b. Day-1 forecast
- c. Physical processes and interactions

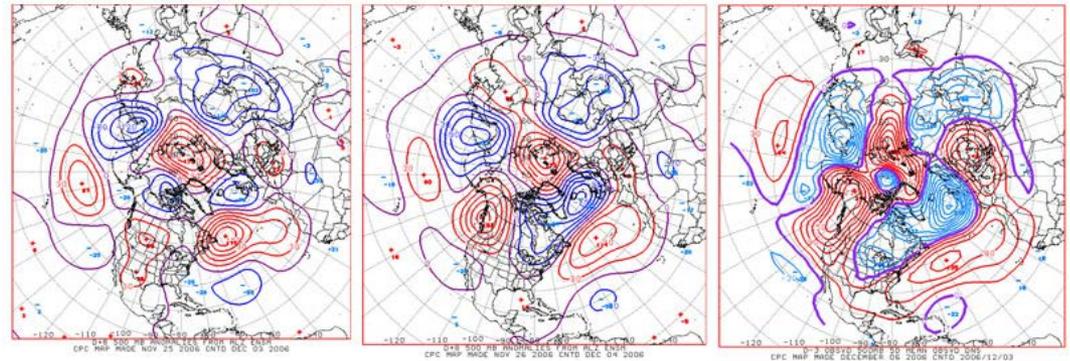


Fig. 2 6-10 day GFS ensemble forecast of 500 hPa height anomalies. Left: The forecast made on 11/25 for Dec 1-5, 2006. Middle: The forecast made on 11/26 for Dec 2-6, 2006. Right: The observation for Dec 1-5, 2006.

(Helpert 2006)

Outliers

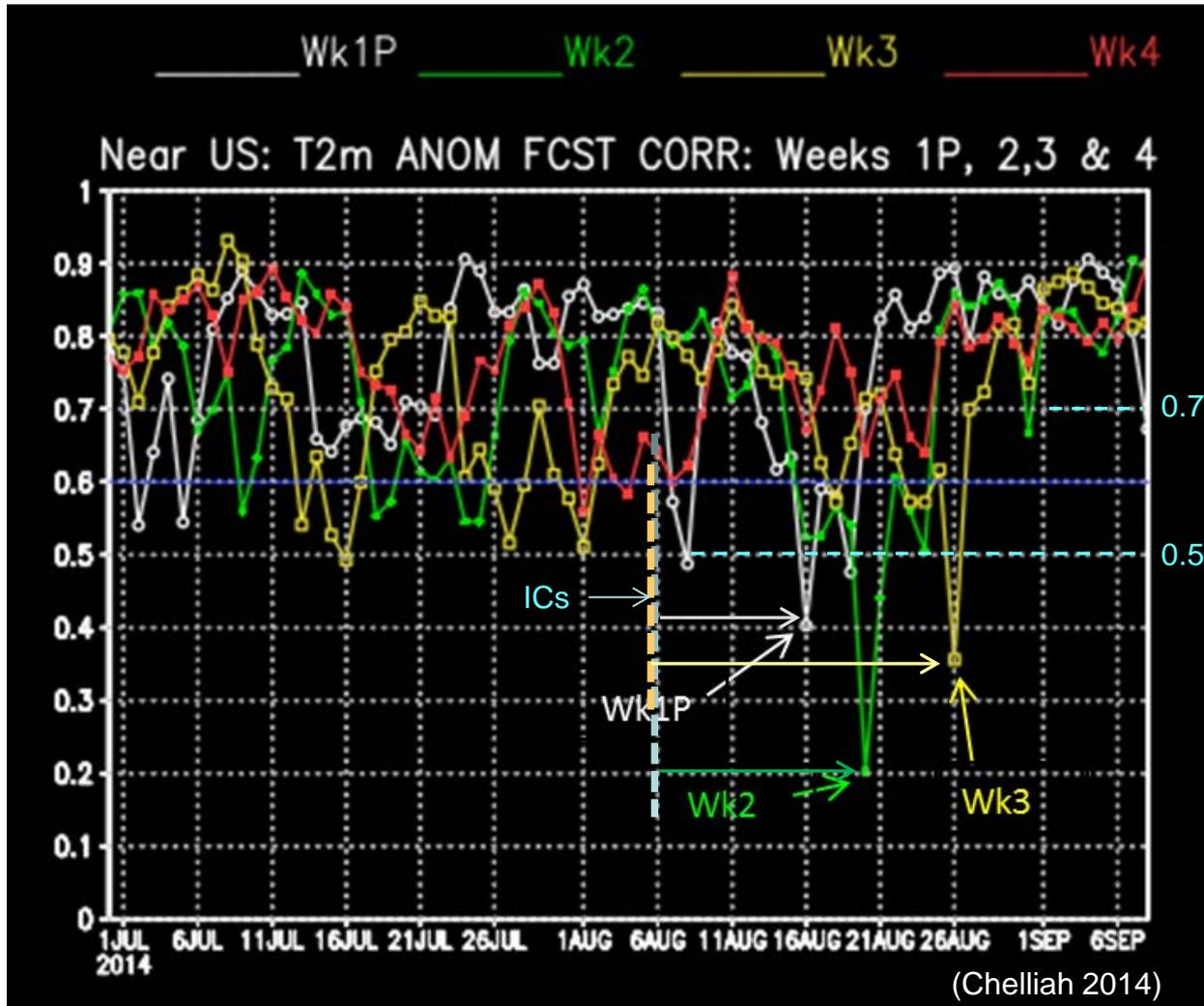
Tendency Forecast

Skills

Puzzle 3

Opportunities

Summary



Key Predictor

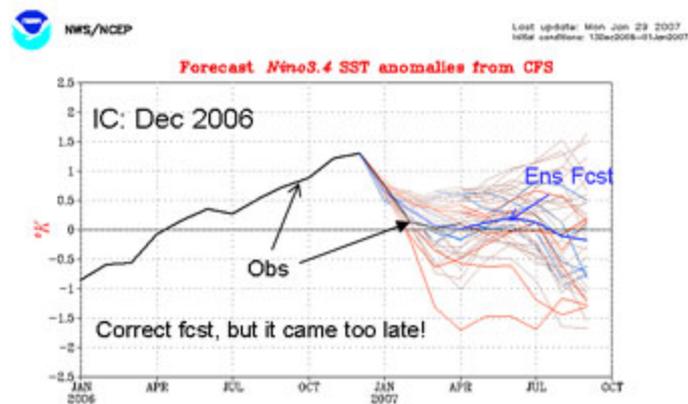
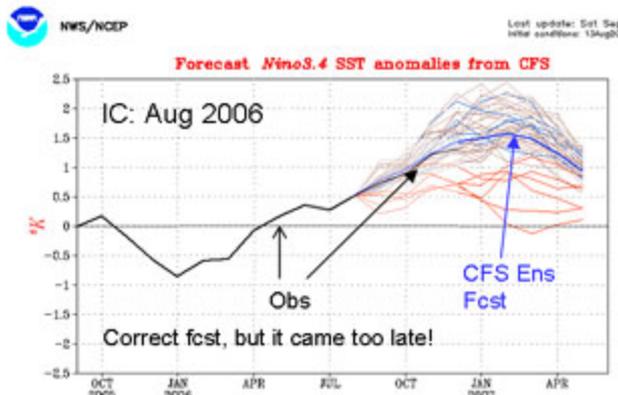
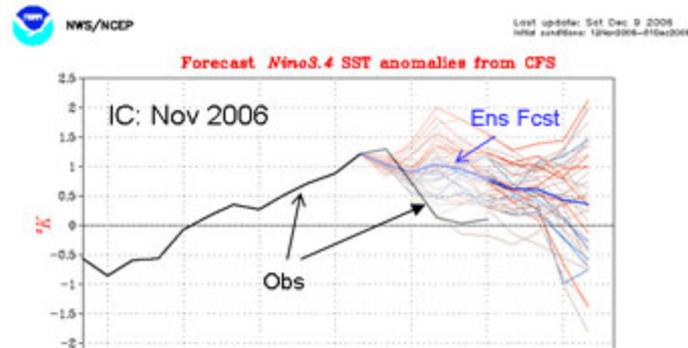
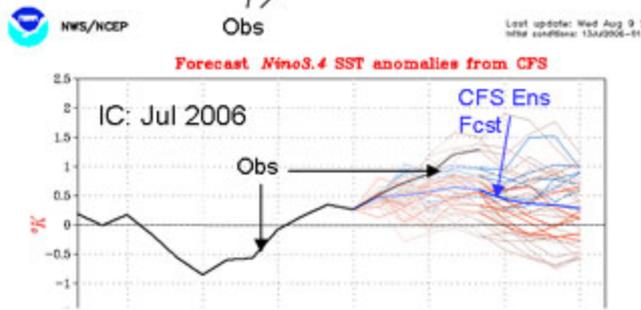
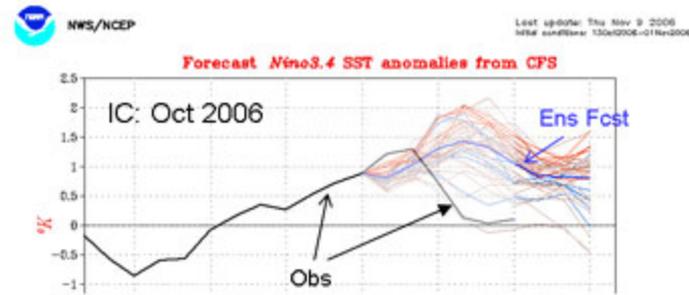
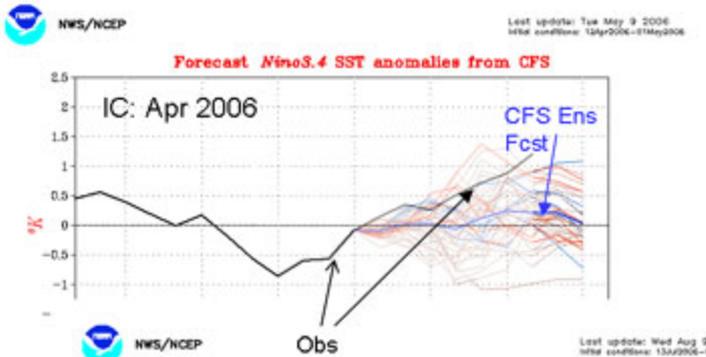
Skills

Puzzle 4

Opportunities

Summary

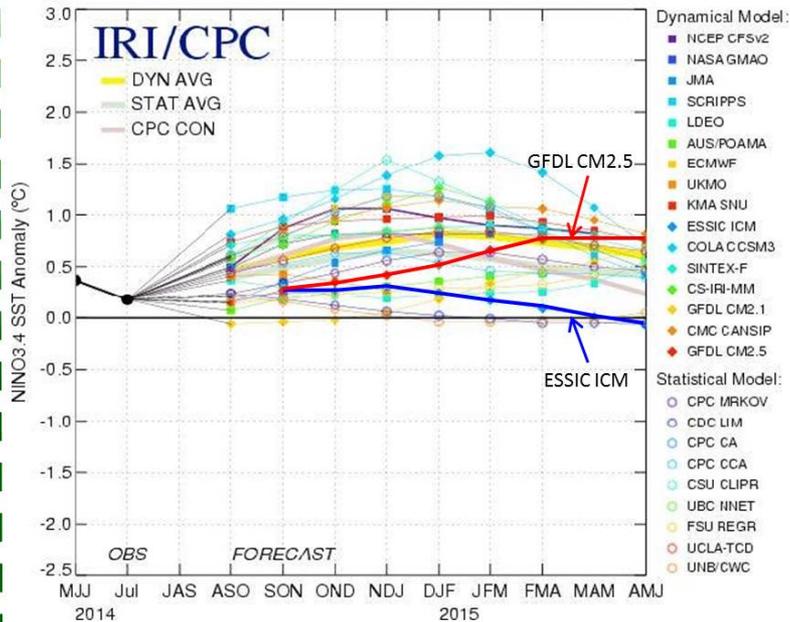
Prediction
of 2006 &
2007
ENSO
Phase
Changes



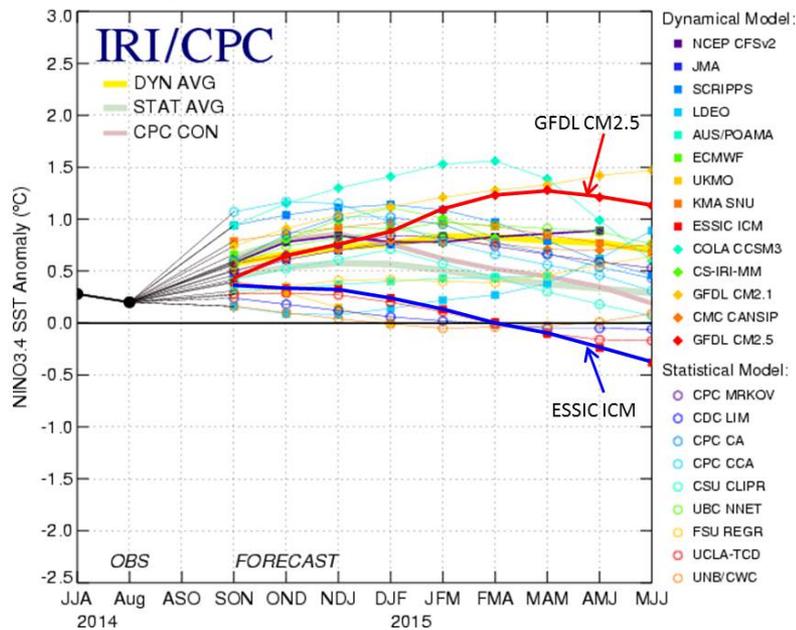
— CFS Forecast Ensemble Mean
— Olv2 Observation

- From Board of Outstanding Open Problems,
NWS Science & Technology Infusion Climate Bulletin

Mid-Aug 2014 Plume of Model ENSO Predictions



Mid-Sep 2014 Plume of Model ENSO Predictions



Key Predictor

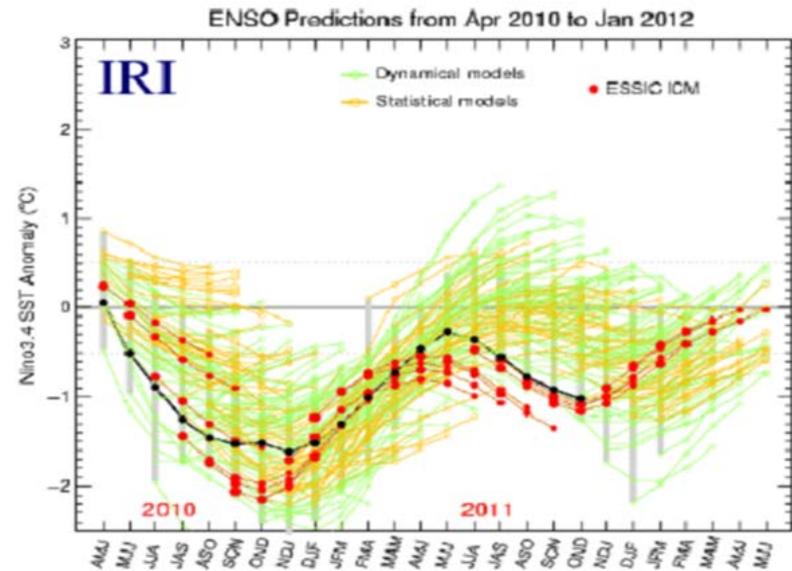
ENSO Early Warning

Skills

Puzzle 4

Opportunities

Summary



One of ICM unique feature is an empirical parameterization of the temperature of subsurface water entrained into the mixed layer.

(Zhang *et al.*, *Scientific Reports, Nature*, 2013)

Key Predictor

Skills

Puzzle 5

Opportunities

Summary

Warming Trend

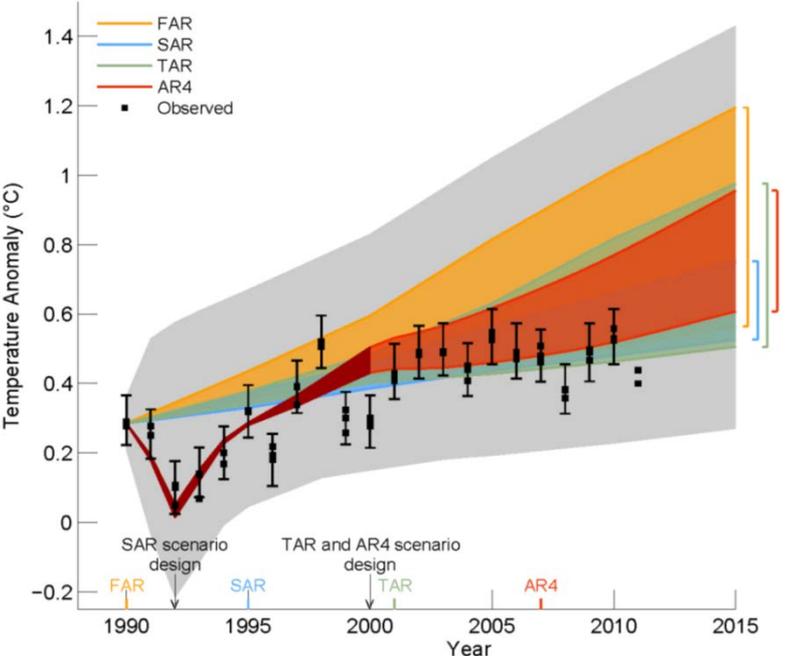
- 1. Underestimation of internal natural climate variability on decadal and longer time scales
- 2. Influence of unaccounted external forcing factors
- 3. Overestimation of the model sensitivity to elevated greenhouse gas concentrations
- 4. Role of ocean

Deep-ocean contribution to sea level and energy budget not detectable over the past decade

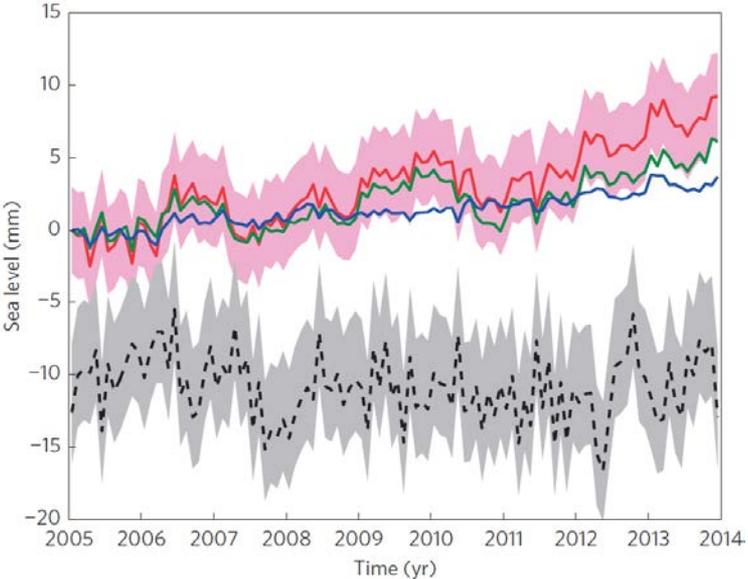
(Llovel *et al.*, *Nature Climate Change*, *Nature*, 2014)

Figure Caption: Global mean steric sea-level change contributions from different layers of the ocean.

0–2,000m (red), 0–700m (green), 700–2,000m (blue). The dashed black curve shows an estimate for the remainder of the ocean below 2,000m computed by removing the 0–2,000m estimate from the GRACE-corrected observed mean sea-level time series. Seasonal signals have been removed from all curves. Curves are offset for clarity. Shading, where shown, denotes 1- uncertainty of the respective estimates.

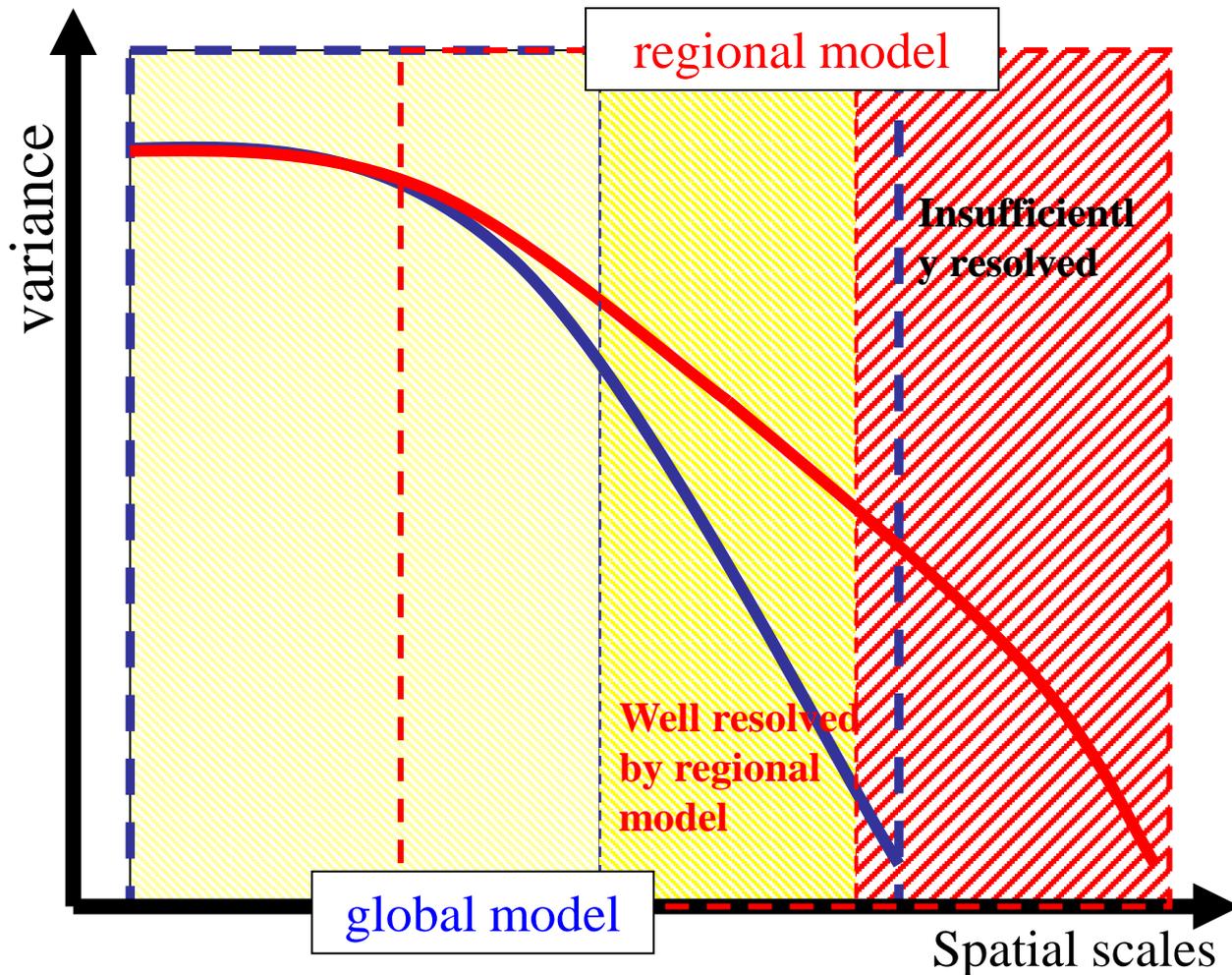


(IPCC WG1 AR5 SOD 2013)



Outline

1. Skills
2. Puzzles
3. Opportunities - *Get the most from current model outputs*
2. Summary



(von Storch 2014)

↑
Added value

Down-scaling by a good regional model, which resolves smaller scale variances that the global model can't resolve, does provide more useful information for service. But the large scale dynamics could be altered due to the domain constrain.

Spectral nudging was used to prevent large and unrealistic departures between the GCM driving fields and the RCM fields at the GCM spatial scales

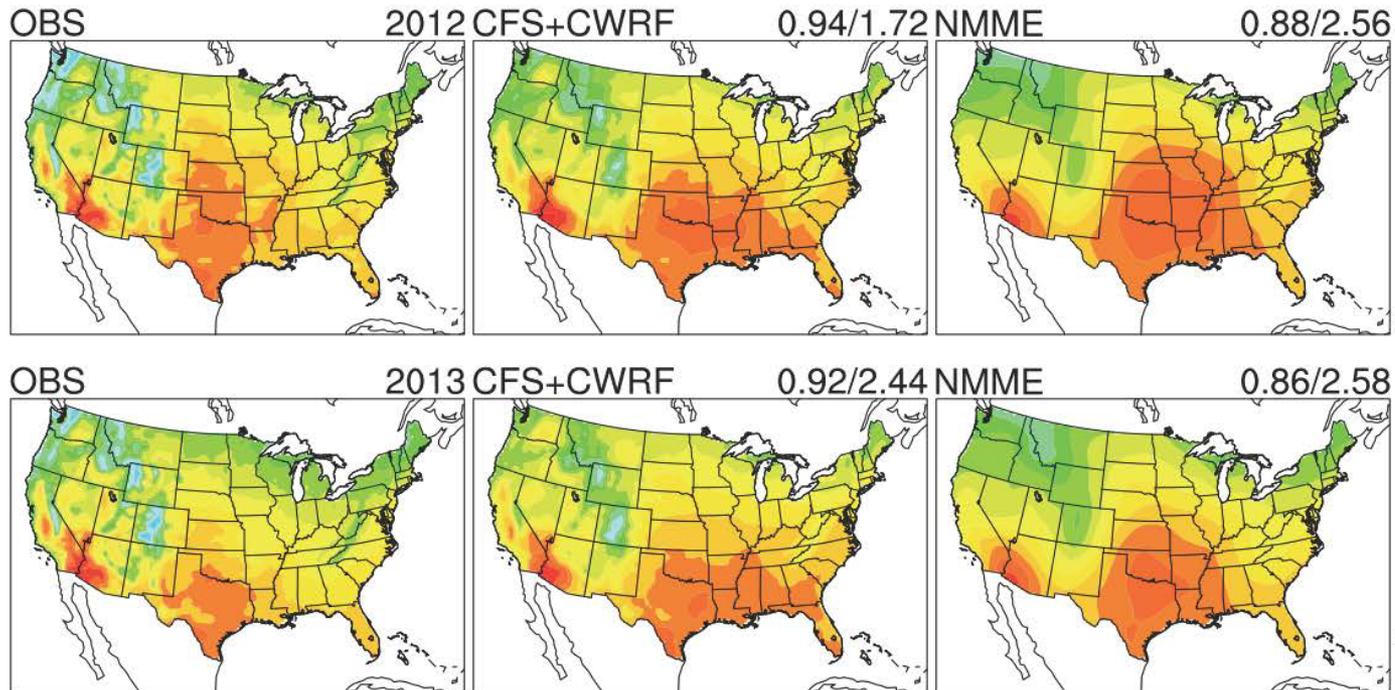
CFS-CWRF Hybrid

Skills

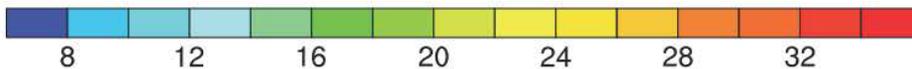
Puzzles

Opportunity 1

Summary



Spatial correlation coefficient/
root mean square error of model simulations with observational analysis (OBS, GDAS)



Superensemble of CFS multi realizations driving CWRF multi physics runs has the potential to further enhance the skill (the result shown each has a single member).

(Liu, Wang, Liang *et al.* 2014)

Potential Usefulness

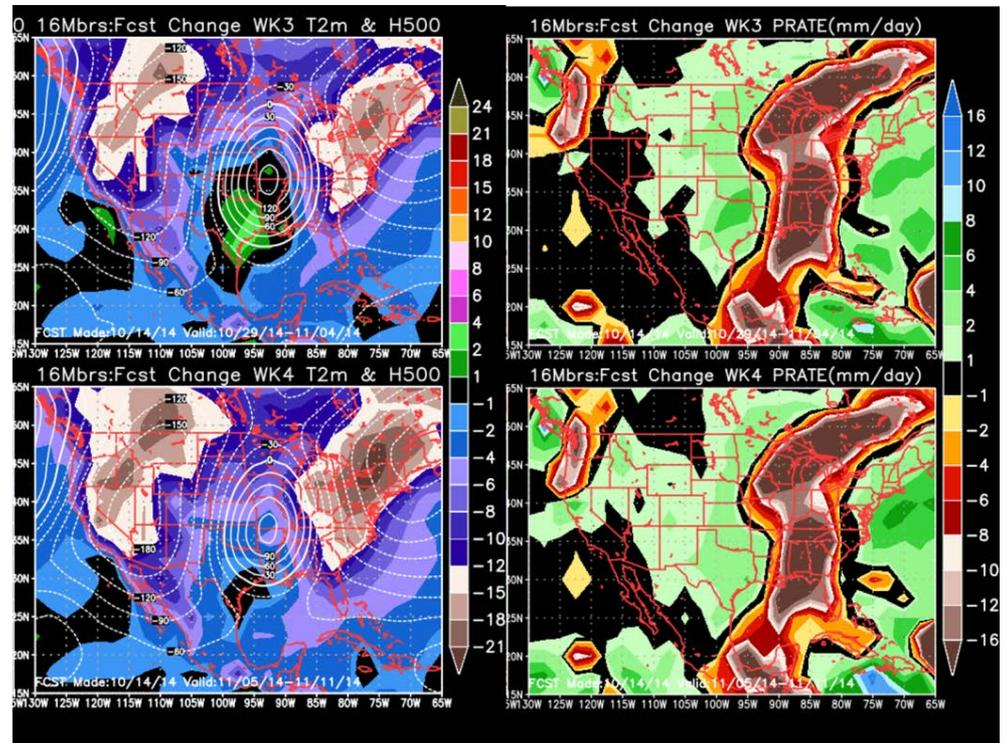
NWS/CR Weeks 3-4 Discussion (10/14/2014)

“For October 29- November 11 continued warmer than mean temperatures, slowing any kill-off from frost/freeze across southern areas of Central Region.

Precipitation chances lean to the drier than average and then return to average as we move as we move towards mid November.”

Tendency Forecast Supplementary:

1. Geographical temperature drop along with seasonal march
2. Height increase with warmer/no change in temperature centered around southern Missouri.
3. Expect more precip in the west and less in the east of CR than the condition on 10/14



Skills

Puzzles

Opportunities

Summary

Summary

Science planning has to be ahead of the operational development, which requires sensitiveness to research advancement for stepping over existing barriers.

A challenging issue on effective climate service is to provide users skillful and reliable prediction information at the local level.

To move our service beyond obstacles, we need research support and advocate collaboration and mutual development.



Local forecast by "City, St" or ZIP code

[Location Help](#)

Science and Technology Infusion Climate Bulletin

[Weather.gov](#) > [Office of Science and Technology](#) > [S&TI Climate Bulletin](#) > R20 & O2R

[MAIN](#) [NEWS](#) [CLIMATE TESTBED](#) [R20 & O2R](#) [MEETINGS & SEMINARS](#) [FEATURED COLLECTIONS](#)

Office of Science and Technology

National Weather Service Headquarters

- Foreword
- Diagnostics and Prediction
- Climate Modeling
- Regional Service and Decision Support
- Climate Data
- Climate and Weather Connection
- Link Climate and Water
- Technology Share
- Opportunities

Operation to Research

Board of Outstanding Open Problems

1. Predicting 2011/12 La Nina onset by models — Where was the early warning?
2. Skill disparity between temperature and precipitation in 2010-2011 seasonal forecasts
3. Difficulties in prediction of ENSO phase changes and impact on outlooks of 2006 North Atlantic hurricane season & 2006/07 DJF US drought
4. A case of week-2 forecast running to the opposite of the observation

Thank you!

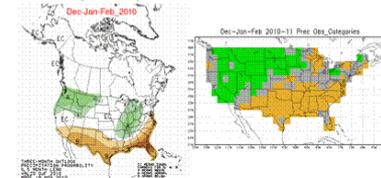
Board of Outstanding Open Problems

Skill disparity between temperature and precipitation in 2010-2011 seasonal forecasts

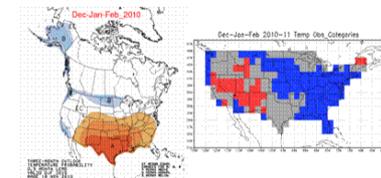
The fall, winter and spring of late 2010 and 2011 were characterized by a moderate to strong La Niña across the tropical Pacific Ocean, which shaped CPC's seasonal outlooks for those seasons.

Problems:

- i) Precipitation forecasts for September – November 2010 through April – June 2011 scored at least 30% better than a climatological forecast, the longest streak (eight) of successful forecasts since CPC began issuing seasonal forecasts in 1955.



- ii) In contrast, the temperature forecasts during the heart of the winter (November – January, December – February, and January – March) were not as successful, with Heidke skill scores near or below zero. What caused the disparity in skill between the temperature and precipitation forecasts? The answer could be the seasonally dependent influence of unpredictable factors, i.e. AO, PNA *et al.*



See discussions by Mike Halpert of CPC/CEP --> ["The Climate Prediction Center's 2010-11 Seasonal Forecasts and a Look Ahead to 2011-12"](#)

To Shoot Arrows at the Target!

<http://nws.noaa.gov/ost/climate/STIP/r2o+o2r.htm>