S2S Prediction and Monitoring Success Stories from CPC and S2S Prediction Challenges for the Community

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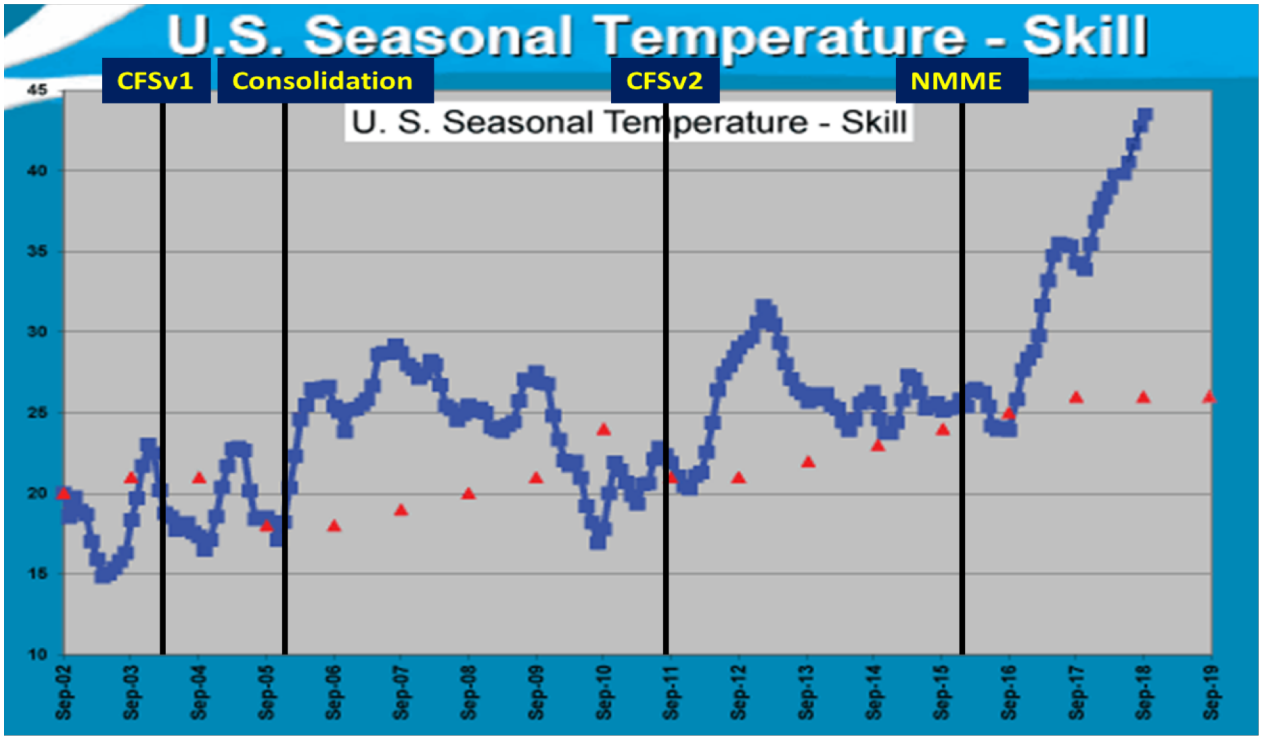
NOAA/NWS

Outline

- CPC Success Stories
  - Seasonal GPRA
  - Aggregate Outlook Skill Metric
  - Week 3-4 Outlooks
  - Arctic Sea Ice
  - Long-Lead Consolidation
  - “Consistency Project” Leveraging Lead-Time Dependent Forecast Skill
  - Hybrid GODAS
  - Probabilistic Forecasts of ENSO Strength
  - CORe Reanalysis
  - High Winds Addition to Week Two Probabilistic Hazards
  - Skill Benefit from Including Research Models in NMME
- Taking Stock of Current Status of S2S Model Skill
  - Is S2S prediction a solved problem or is there room for further improvement?
    - Model Systematic Errors of Relevance (Reducing these errors is an extremely difficult problem but there has also been extremely slow progress since late 1990’s)
    - Examples of focused research efforts that have made significant progress in reducing systematic errors and increasing skill
- Conclusions

CPC Record GPRA for Seasonal Temperature

(Gottschalck, Rosencrans, Unger, Baxter, Artusa, CPC OPB, EMC, CTB, NMME)



CPC Comprehensive Skill Metric (CSM)

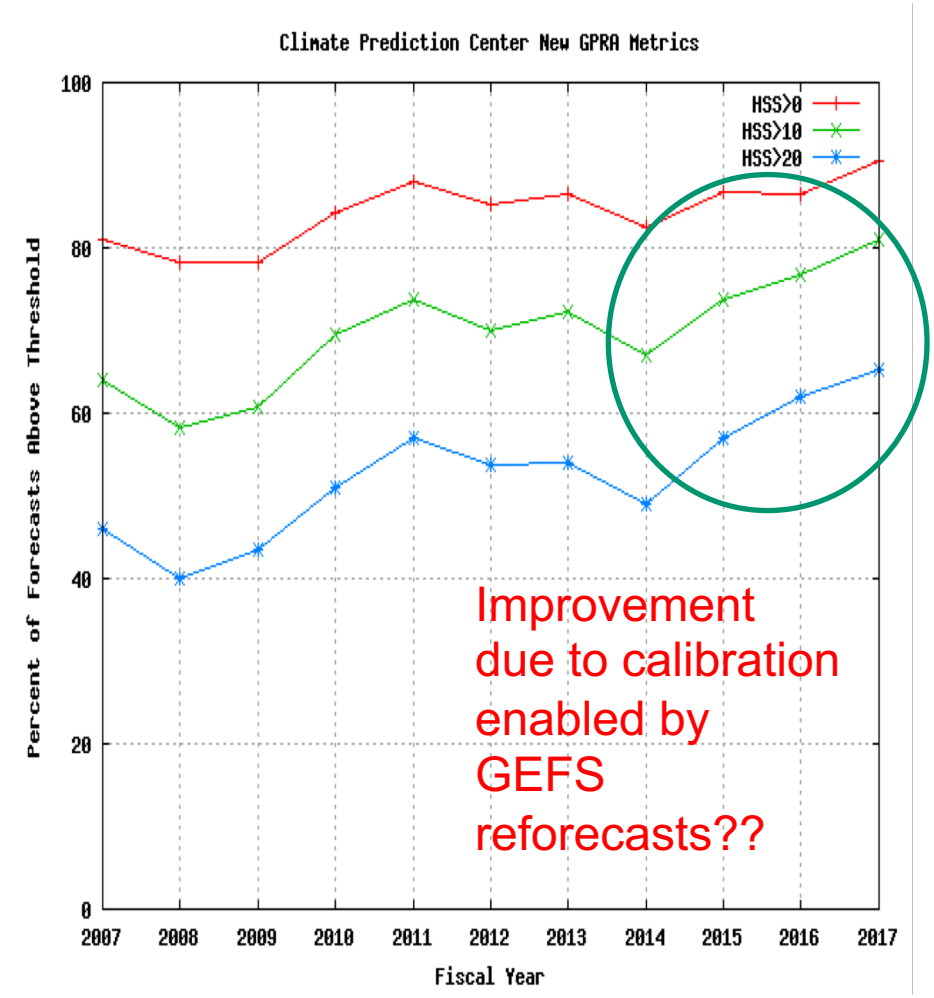
Gottschalck, Rosencrans, Handel, Charles, Ou, CPC OPB)

Comprehensive skill metric (CSM) based on all CPC extended range and long range outlooks.

CSM includes over 1000 product issuances per year.

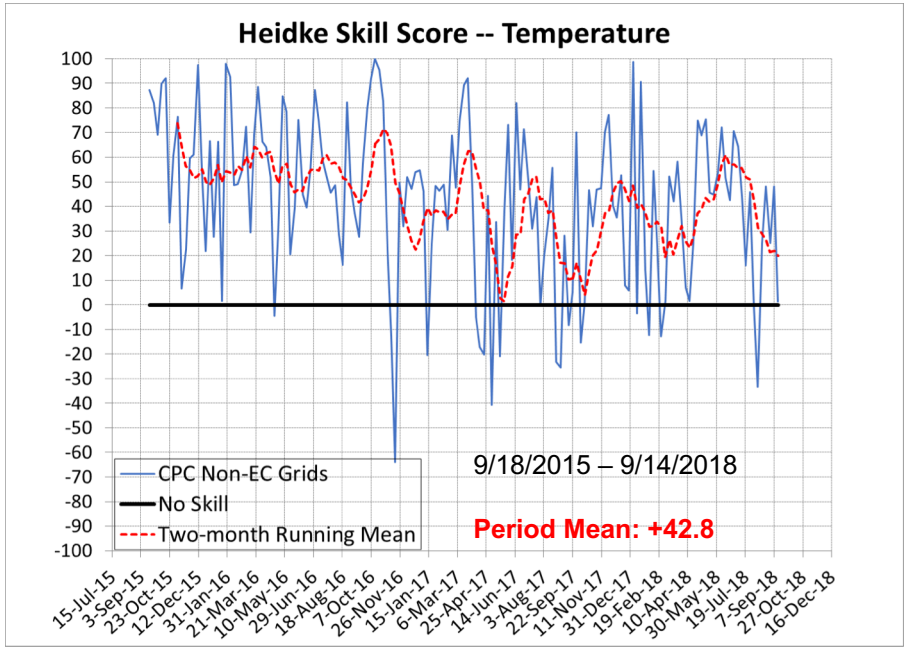
Judged “successful” if its Heidke Skill Score exceeds a particular threshold.

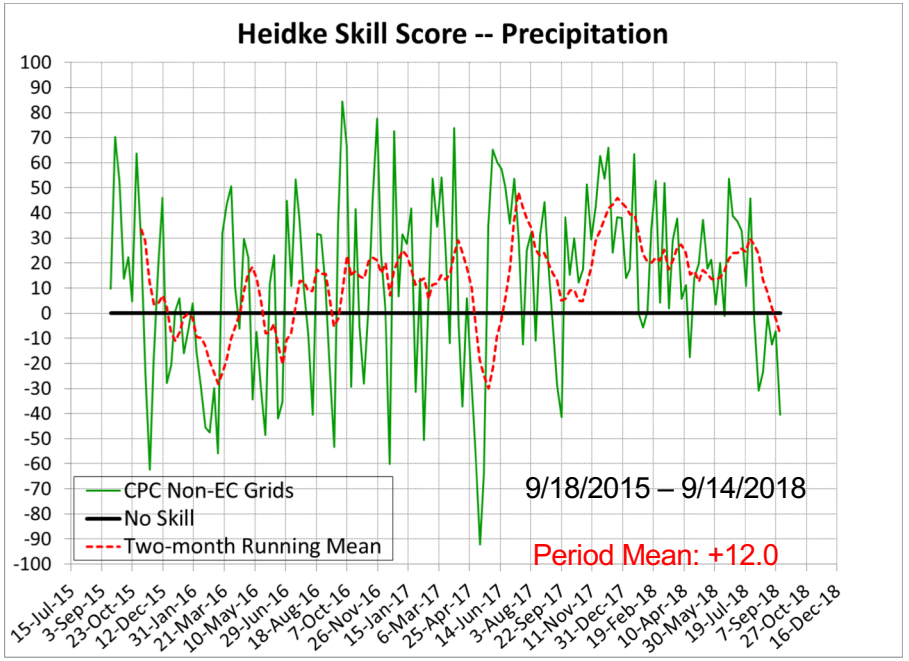
CSM shows continuous, improvement of CPC products.



Week Three-Four Temperature and Precipitation Outlook Skill

(Gottschalck, Allgood, Harnos, L'Heureux, Collins, Baxter, CPC OPB)





CPC Week 3-4 Arctic Sea Ice Prediction System

(Wang, Liu, Collow, and Kumar)

1. Forecast Model

CFSm5: GFS (T126,L64)
MOM5 (0.5x0.5, L40)

2. Initialization

Sea ice: CSIS (CPC Sea ice Initialization System)
Ocean: CSIS
Atmos.: CFSR

3. Forecast

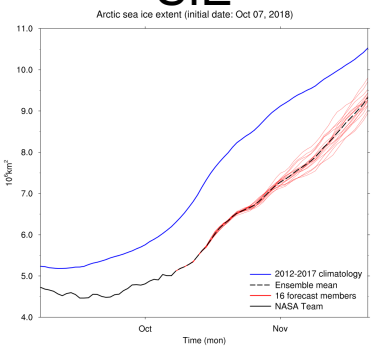
Target: Weeks 1-6 target
Update: weekly

4. Products

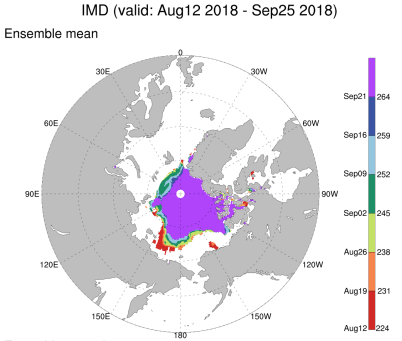
SIE: Sea ice extent
SIC: Sea ice concentration
IMD: Sea ice melt date
IFD: Sea ice freeze-up date

http://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_wk34

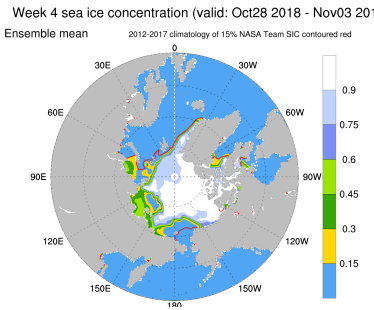
SIE



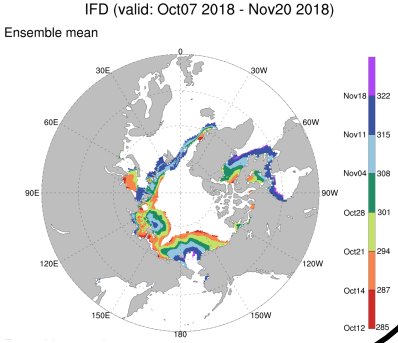
IMD



SIC

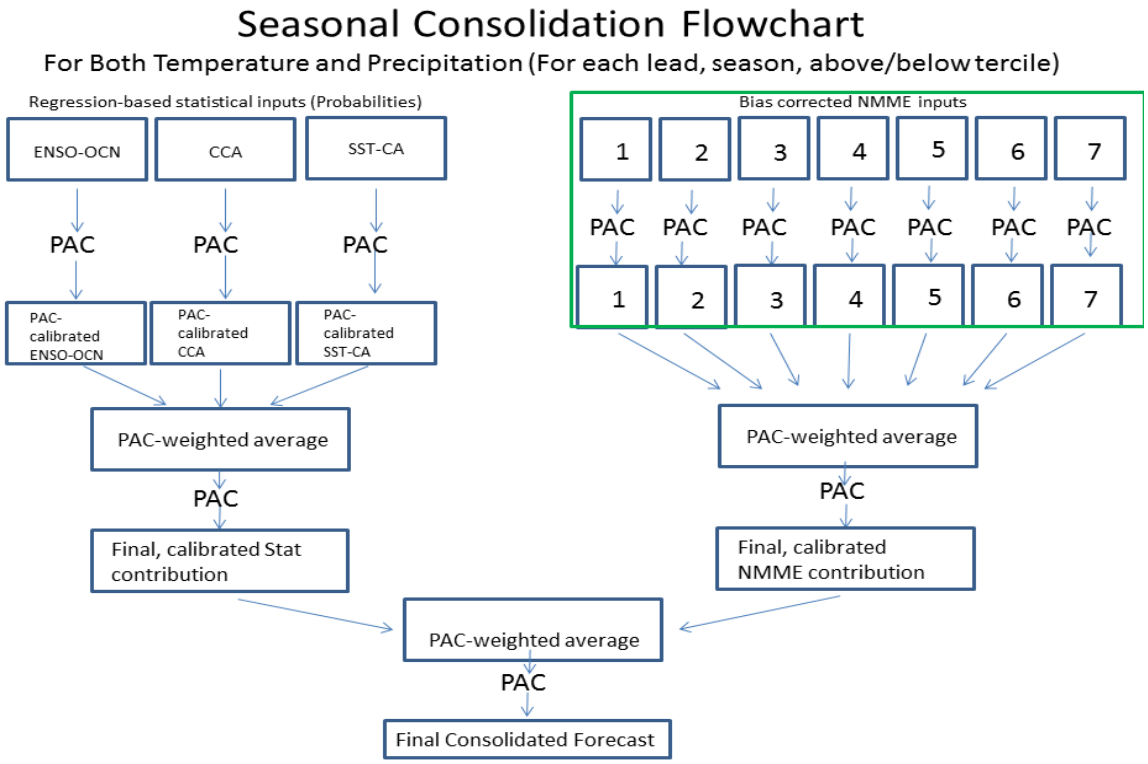


IFD



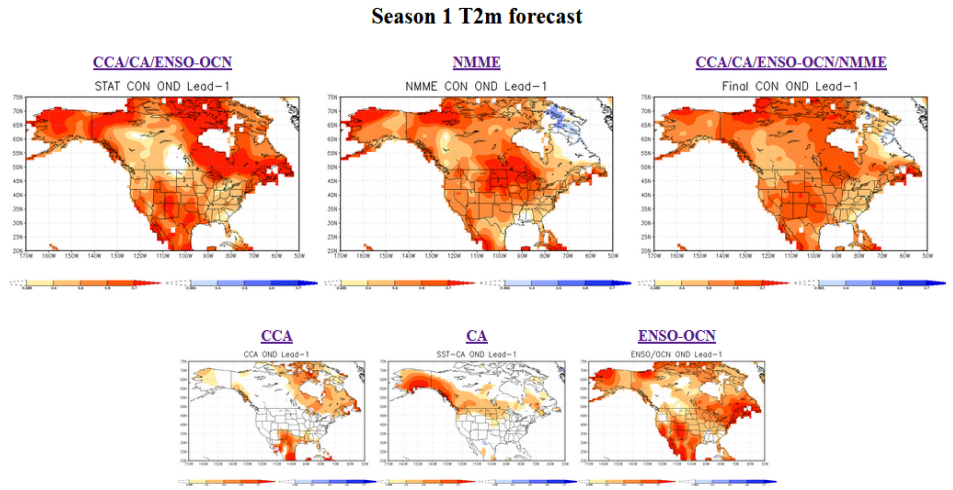
For more details see Yanyun Liu's poster: (16) Overview of the Climate Prediction Center Weekly Experimental Sea Ice Prediction System

New Objective Seasonal Consolidation For NMME and Statistical Models (Baxter and Barandiaran)



Seasonal consolidation flowchart. The green box indicates process that currently executes operationally upstream of the consolidation. All other processes are included as part of this experimental consolidation process.

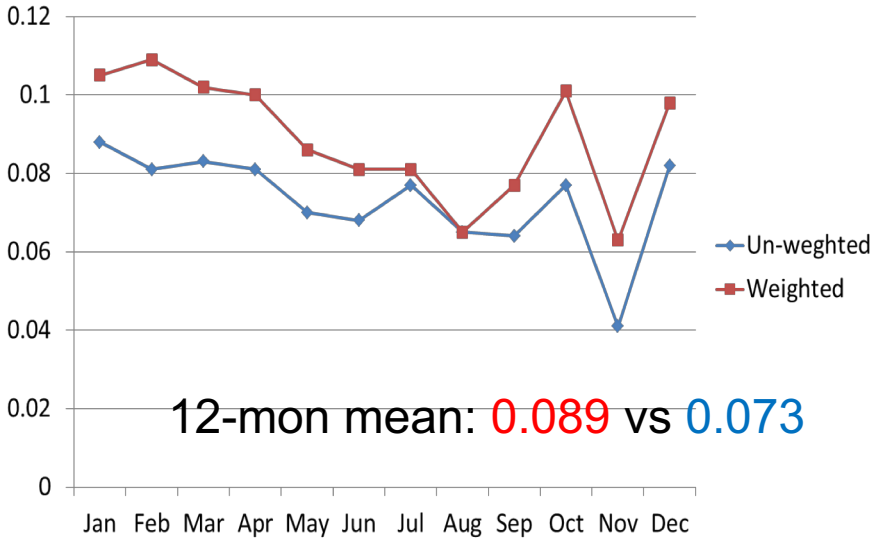
Sample output graphics available to forecasters for the Lead-1 temperature forecast (OND 2018).



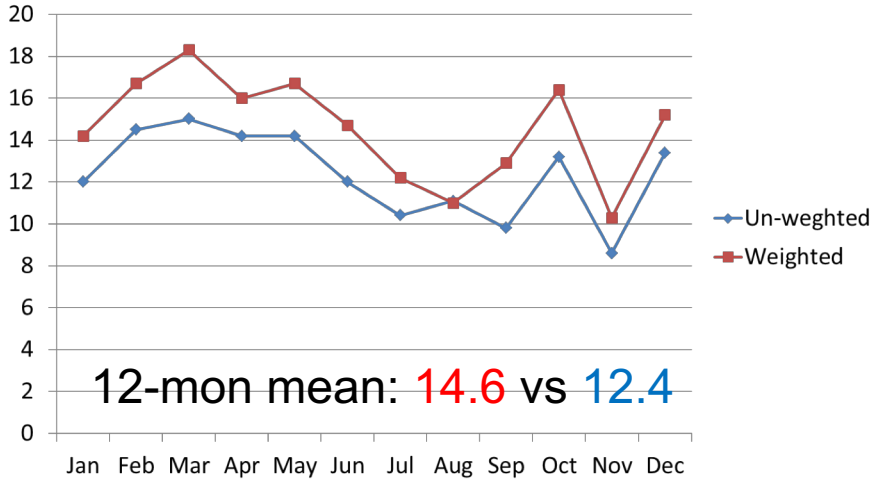
Consistency Project to Leverage Increased Skill from Shorter Lead Forecasts

(Baxter, Peng, Halpert, and Charles)

RPSS of Prec Days1-30 Forecast over CONUS

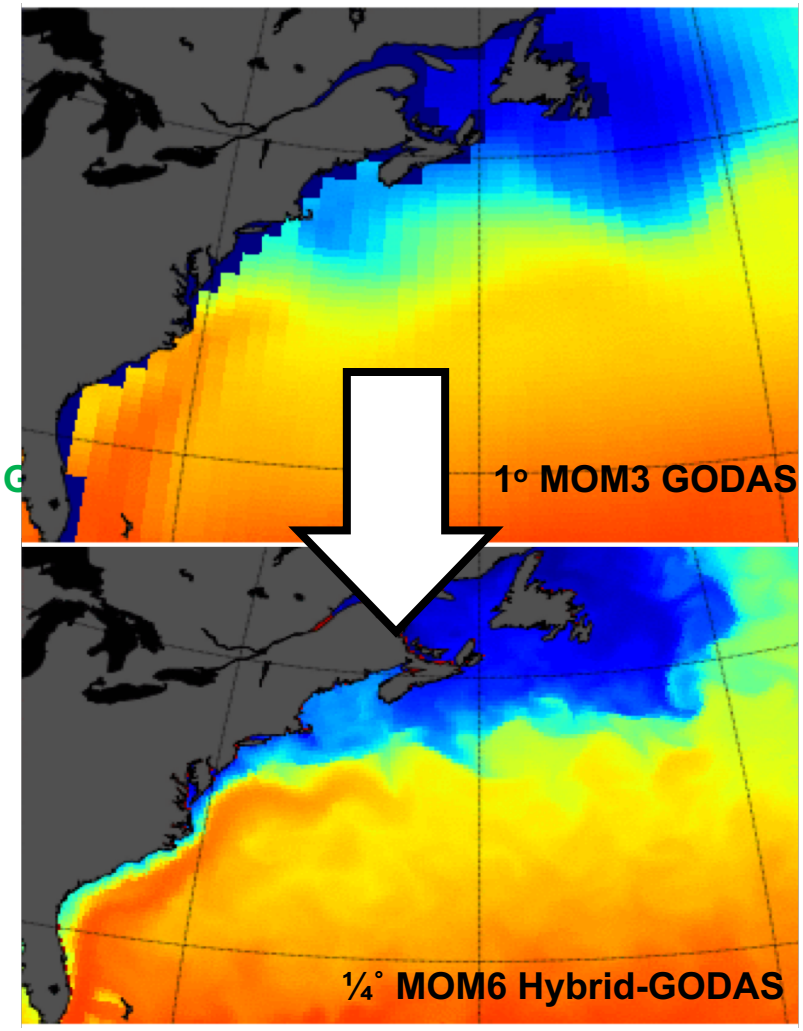


HSS of Prec Days1-30 Forecast over CONUS



Upgrade 1° MOM3 GODAS to ¼° MOM6 Hybrid-GODAS in Support of Ocean/ENSO Monitoring at CPC (Xue and Sluka)

- **Upgrade of ocean model**: from 1 degree MOM3 to ¼ degree MOM6 with sea ice model
- **Upgrade of data assimilation scheme**: from univariate 3DVar to Hybrid LETKF/3DVar
- **Upgrade of observations:** from in situ temperature profiles only to in situ temperature and salinity profiles, altimetry SSH, and satellite SST (NESDIS ACSPO)

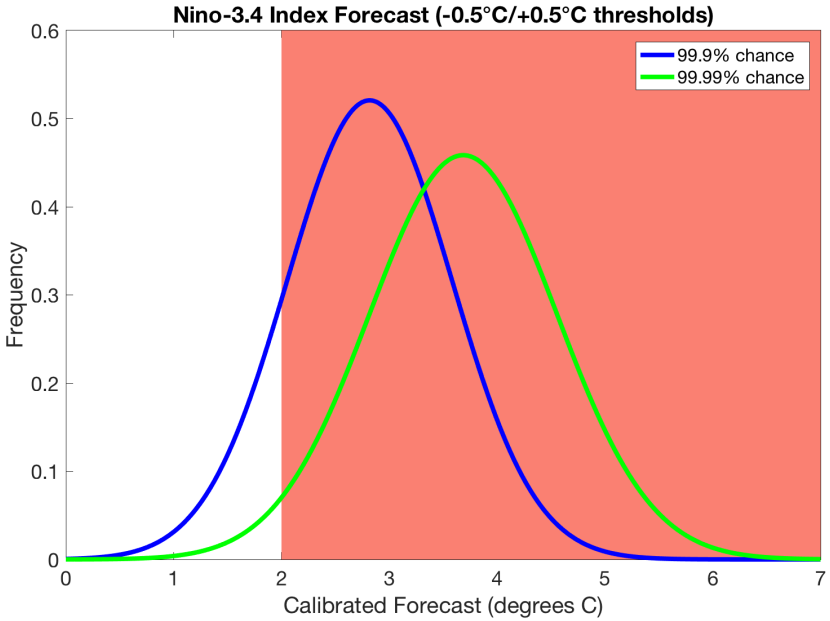


CTB Project: Yan Xue (NCEP-CPC), Travis Sluka (NCEP-CPC), Steve Penny (UMD), James Carton (UMD), EMC Partners (H.-C. Lee, ...)

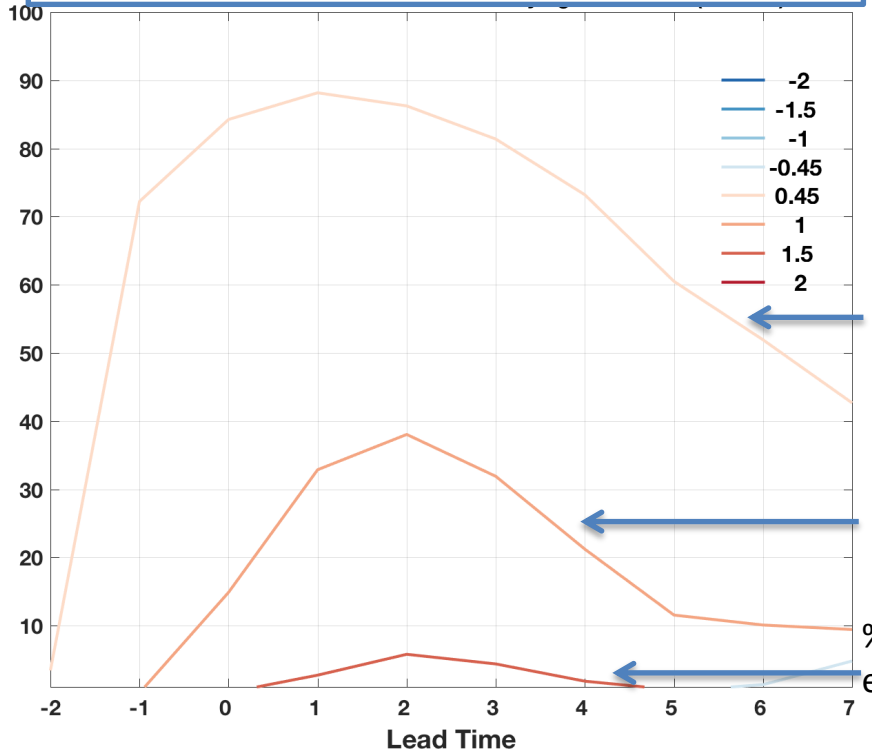
ENSO Strength Outlooks

(L'Heureux, Barnston, Takahashi, Tippett and CPC/IRI ENSO Team)

Goal: To provide the *full* distribution (POE) based on CPC's official ENSO outlooks.



Chance (%) that Niño-3.4 index exceeds various thresholds
(based on Oct. 2018 start)



% chance in excess of +0.5C

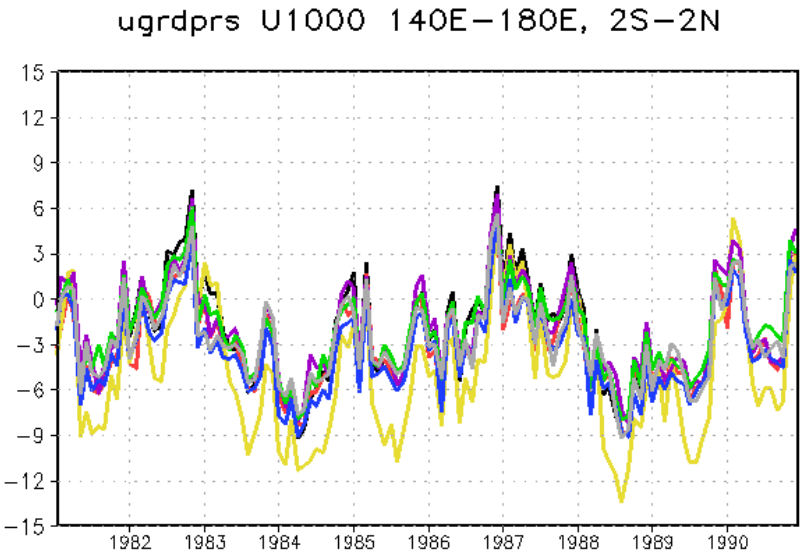
% chance in excess of +1C

% chance in excess of +1.5C

Conventional Observation Reanalysis (CORe) to Replace R1

(Ebisuzaki, Kumar, Compo, Privette, and Whitaker)

- A collaborative CPC-ESRL-NCEI project supported by CPO's MAPP program
- Goal – Replace R1 (also known as CDAS, Kalnay et al. product).
- Period will be 1950 to present. Resolution is one quarter of R1.
- Based on the FV3-GFS and using an Ensemble Kalman Filter Assimilation

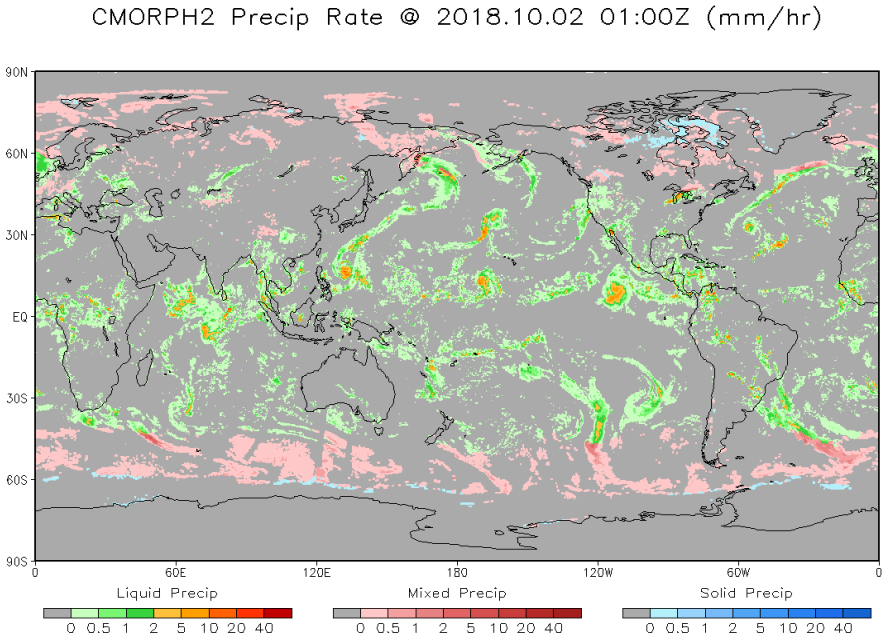


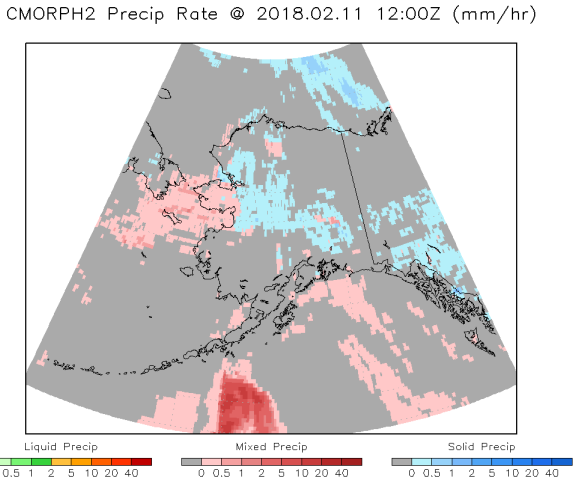
1000 hPa Zonal Wind

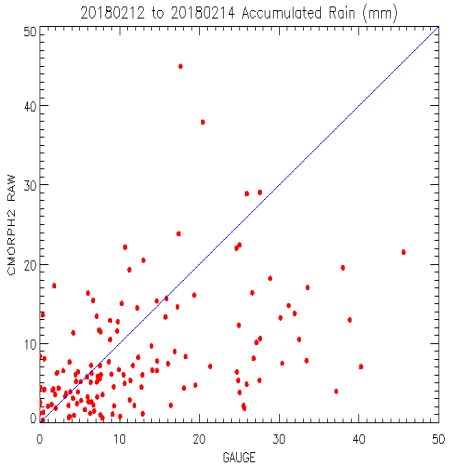
Yellow – CFSR (Outlier)
Black – EnKF
Others – ERA I; JRA 55…

Second Generation CMORPH
(Xie, Joyce, and Wu)

- 2nd Generation CMORPH Satellite Precipitation Estimates are under test mode real-time production being produced on a CPC server
  - *Pole-to-Pole Complete Global Coverage*
  - *Explicit snowfall representation*
- Work on the way
  - *Fine-tuning for improved performance*
  - *Thorough examination of quality*
  - *Reducing the production latency to 2 hours*
  - *Pushing the product into AWIPS II*
- *(Right Figure) Sample 2nd generation pole-to-pole CMORPH for 01:00Z, 2 Oct., 2018.*



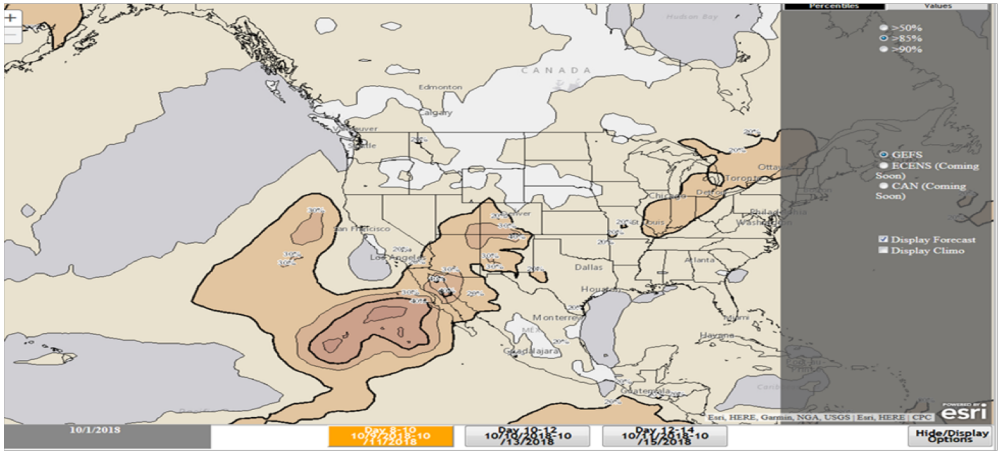


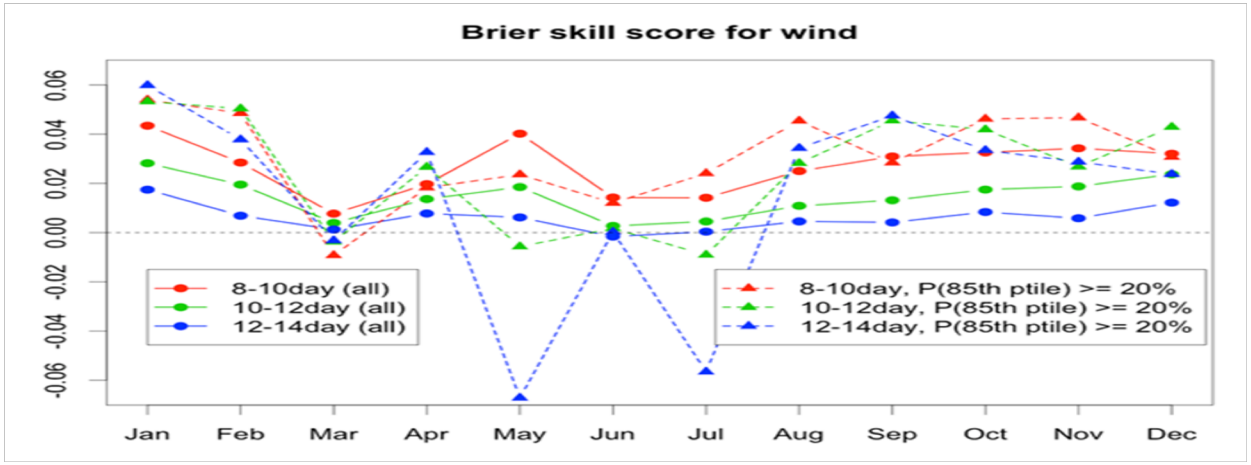


- (left) Animation of 2nd generation CMORPH for 11-13 feb., 2018
- (right) Scatter plots of 11-13 Feb, 2018 3-day accumulated precipitation from gauge (X-axis) and CMORPH (Y-Axis)
- ➔
  - *2nd generation CMORPH captures snowfall storm over Alaska quite well*
  - *Fine-tuning is needed to improve the smoothness / continuity of spatial patterns*

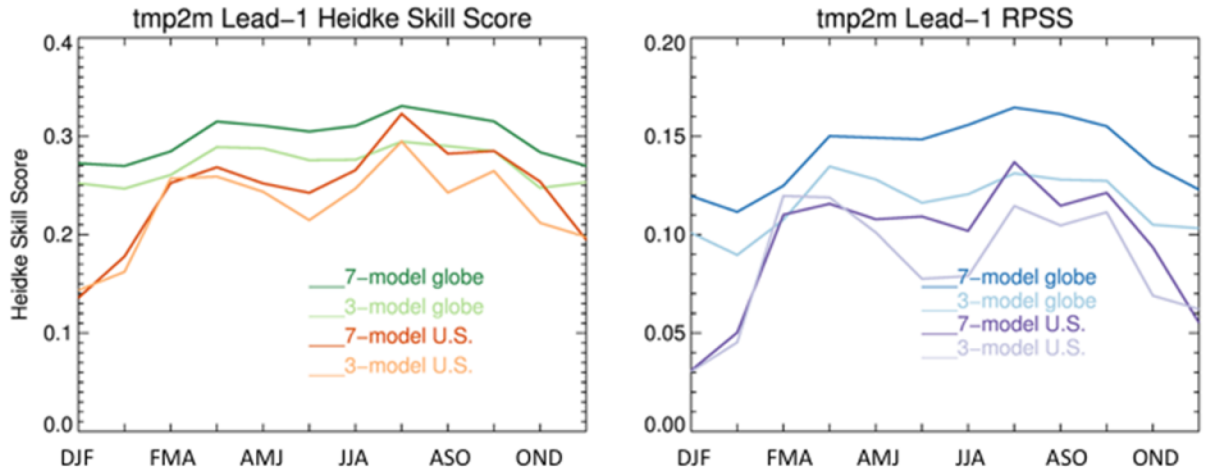
Development of High-Winds Tool for Week Two Probabilistic Extremes Outlook

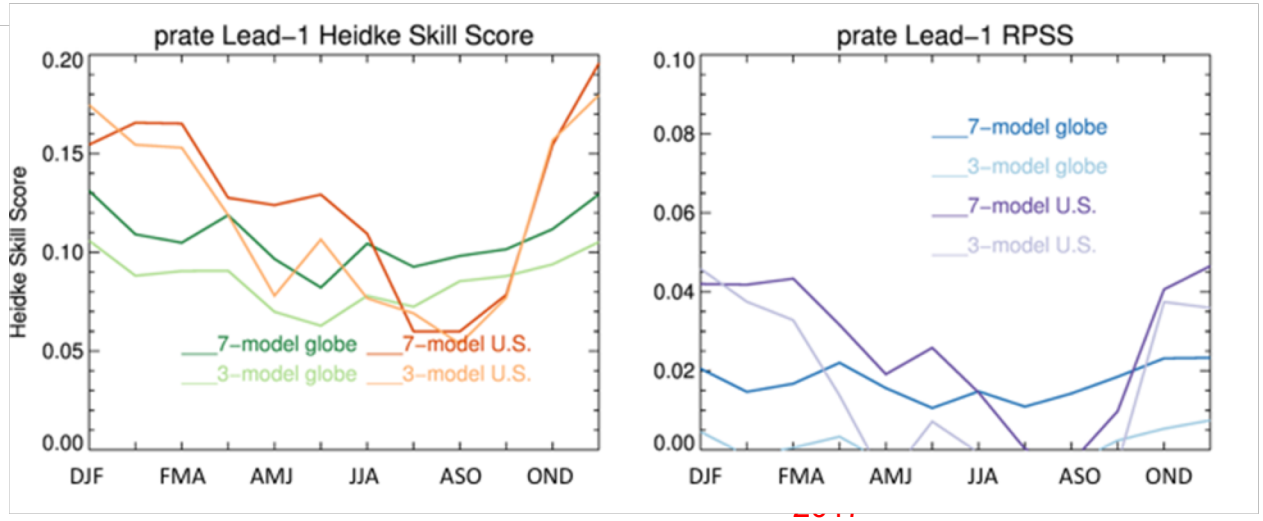
(Ou, Gottschalck, Scheurer, Rosencrans, and Franks)



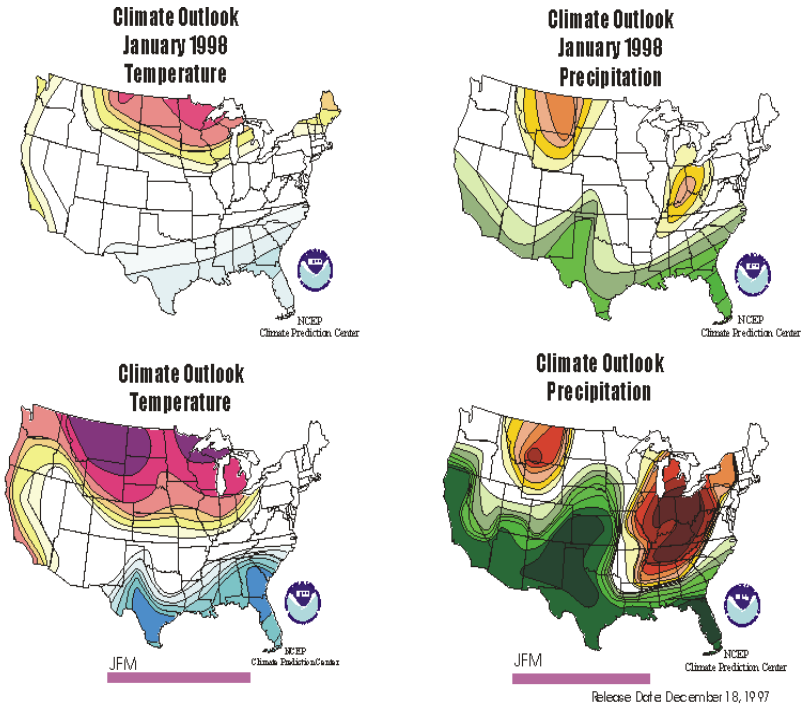


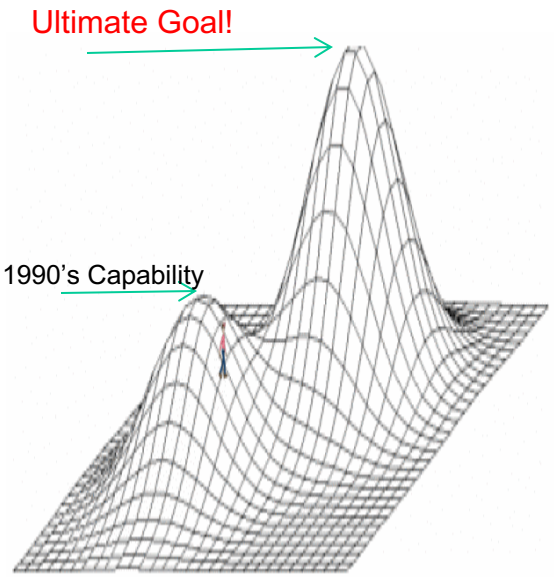
Skill Enhancement from Including Research Models in the NMME
(Becker and van den Dool)





View on Seasonal Forecasting: Is it a solved problem or was late 1990s Success a False Summit and we have more work to do to?

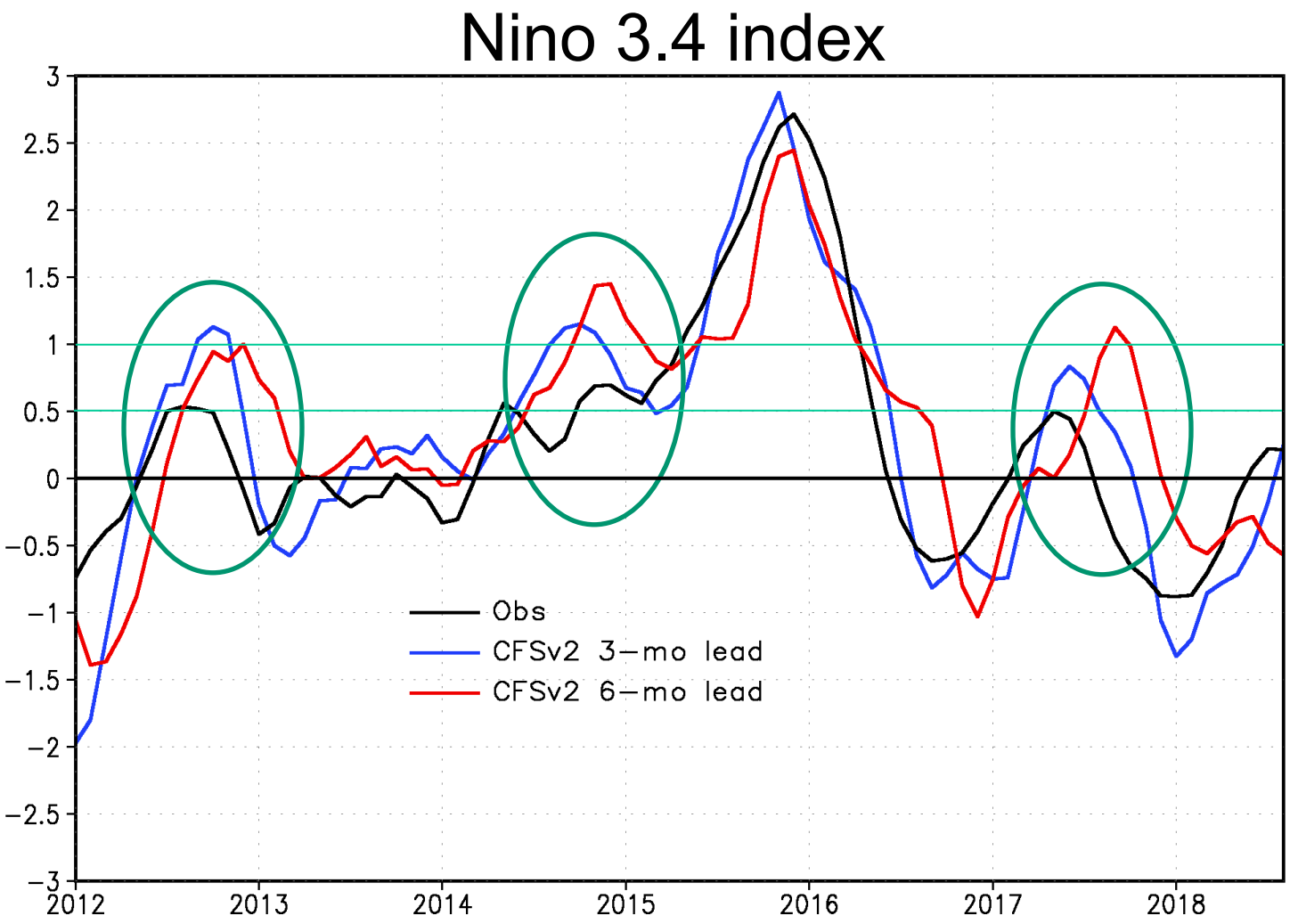




Hard work and higher-risk research by the S2S enterprise in the late 1980s through the 1990's led to tremendous success in forecasting the 1997-98 El Nino and 1998-99 La Nina. That led some to conclude that this was a solved problem. I (DGD) believe that shaped our research investment decisions and our focus.

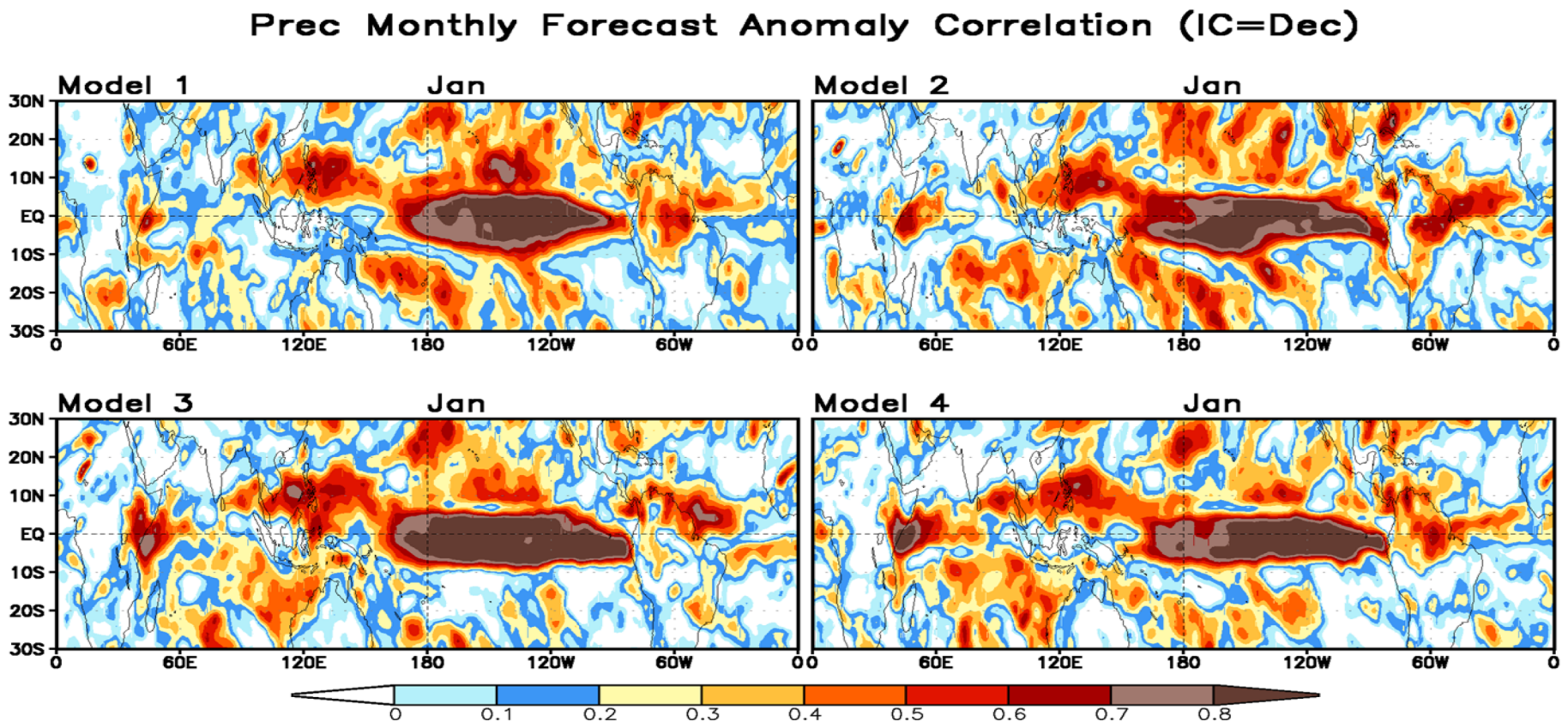
El Nino False alarms in CFSv2

(Wang)



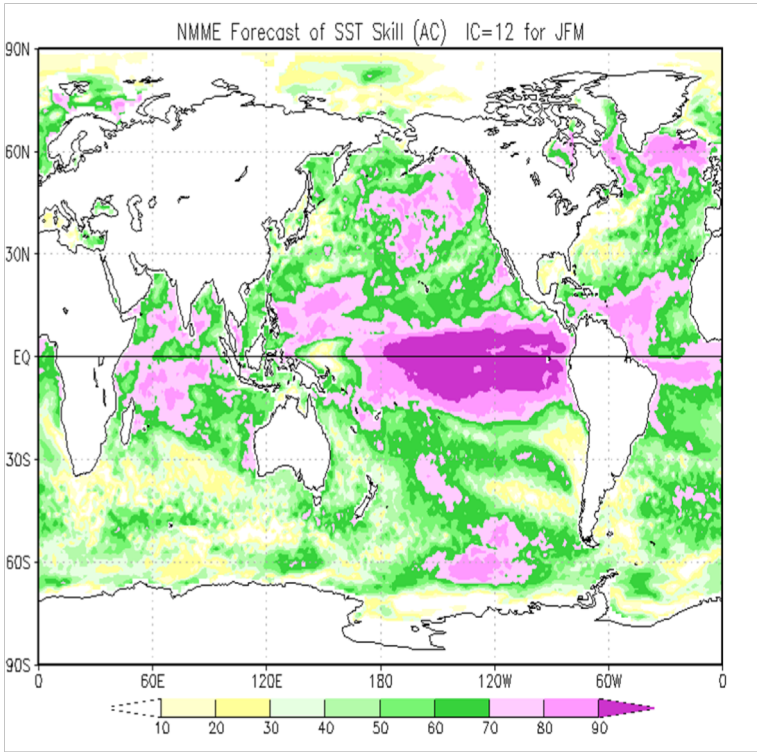
False alarms occurred in 2012, 2014, and 2017 in CFSv2 real-time forecasts.

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

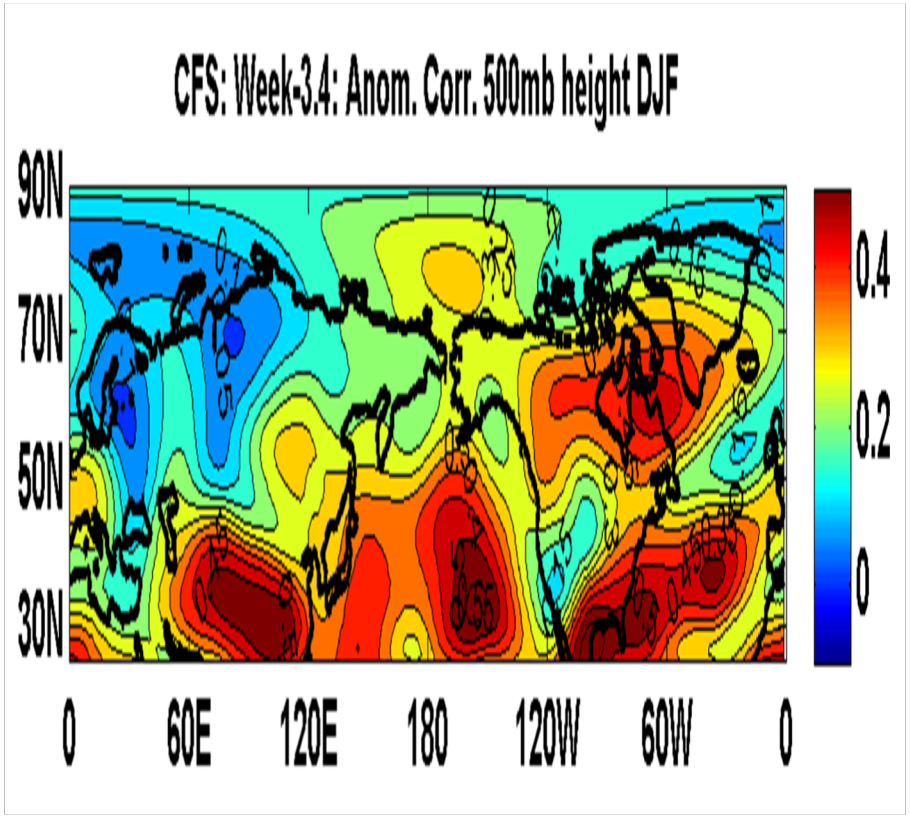


State of the art coupled models from NMME have very little skill in predicting tropical precipitation outside of near-equatorial central and eastern Pacific.

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



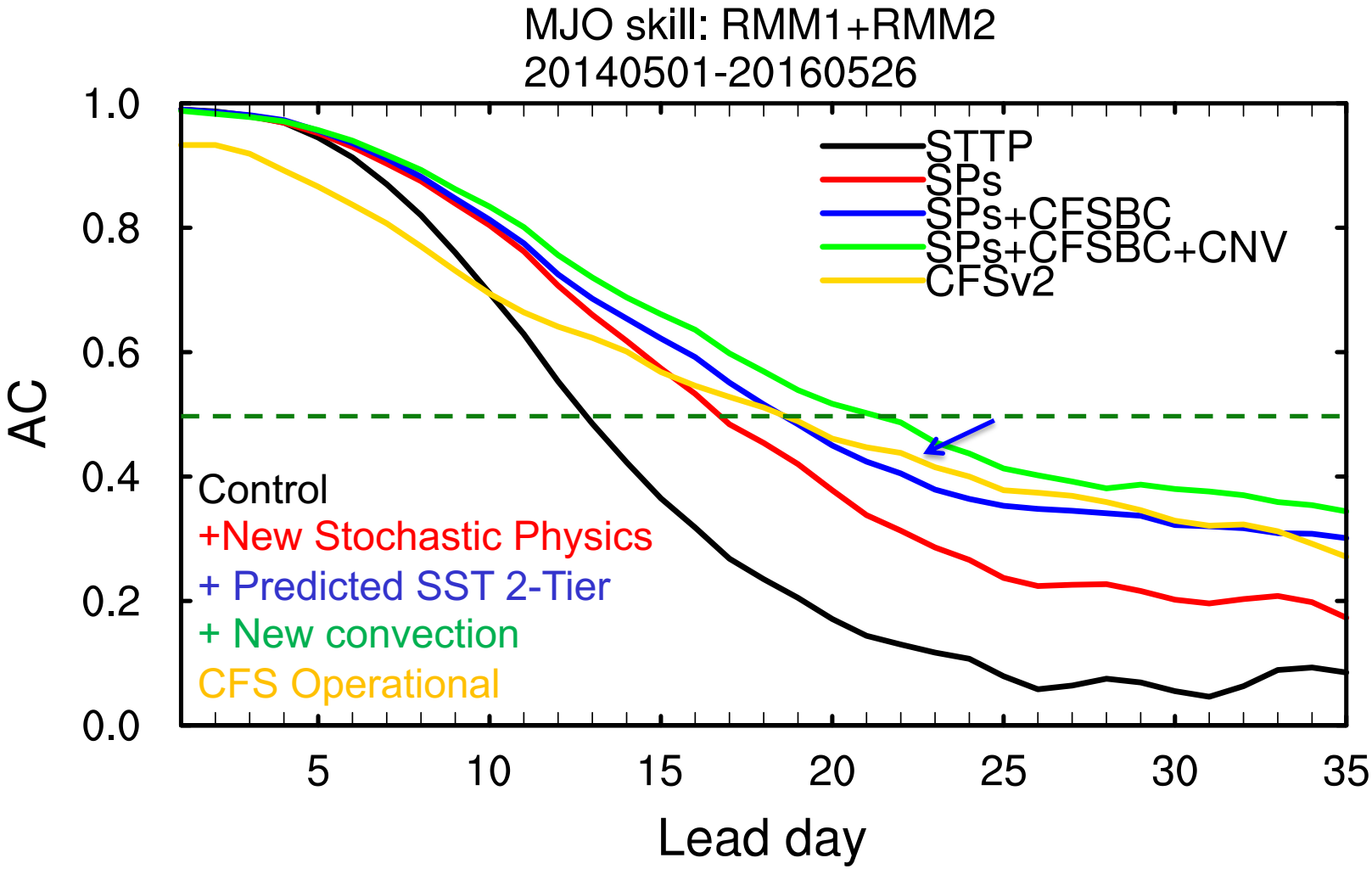
Inability of dynamical models to predict tropical SST variability beyond a few weeks outside central/eastern Pacific



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

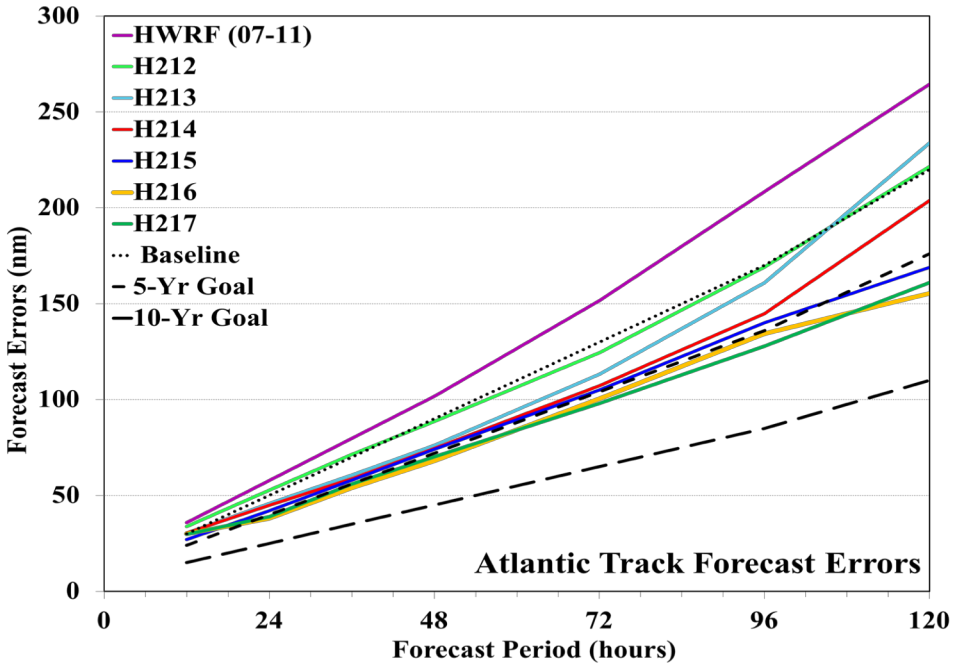
Increased MJO Forecast Skill from Focused Model Development

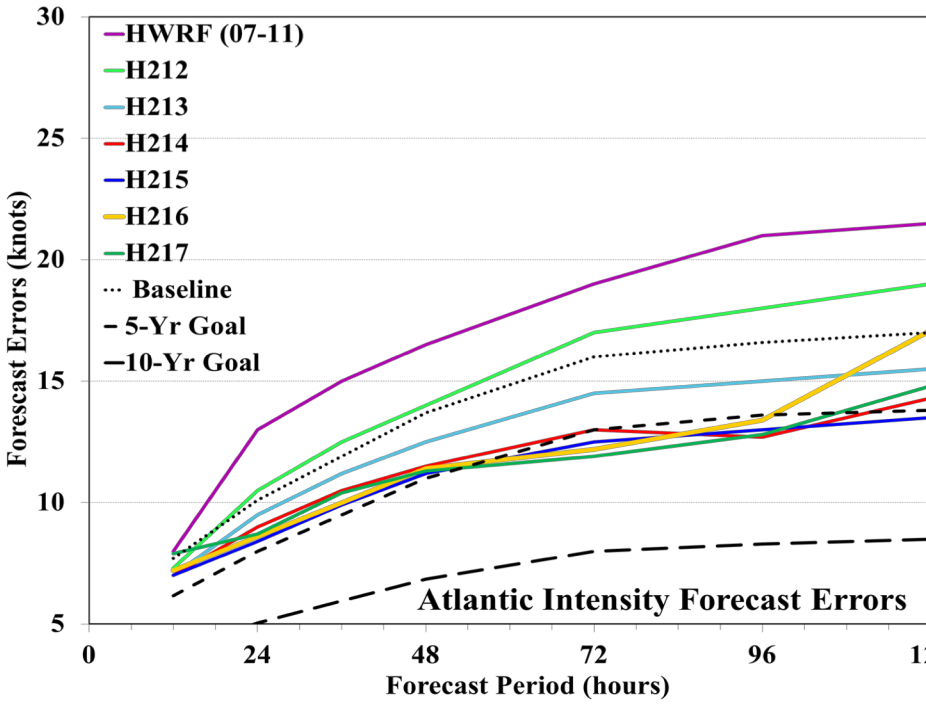
(Zhu and Tallapragada)



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

HFIP as a Successful Paradigm to Improve Forecast Skill Through Targeted Research





Characteristics of HFIP that led to its success with aggressive goals despite much slower progress before its inception and skepticism from some that it could succeed:

Focus on operational outcomes, well-defined targets/metrics, recognition of the difficulty of the problem and realization that there was no single silver bullet that would meet these goals, leveraging the talents of all parts of the weather enterprise, and sufficient and sustained investment to enable progress.

Conclusions

- There has been some great progress at CPC (and with collaborators) on improving S2S prediction and monitoring products and services. I encourage you to talk to the people I have highlighted as leading that work, many of whom are here
- I (DGD) believe that we haven't reached the upper limit of S2S forecast skill and improving forecasts will require us to solve some extremely difficult problems including:
  - Improving forecast skill for tropical SST beyond the current ability to forecast large SST anomalies in the central and eastern Pacific.
  - Improving forecast skill for tropical precipitation beyond the current ability to forecast local precipitation anomalies associated with large SST anomalies in the central and eastern Pacific.
  - Improving modeling of coupled atmosphere-ocean interactions in order to simulate the coupling strength with fidelity in the tropics.
  - Understanding why there is a predictive skill minima in upper level flow over the western US on S2S timescales.
- I (DGD) also believe that we have really smart people in our field and with considerable effort, and sufficient and sustained investment we can make progress on these problems. If you are one of those people and want to work with us on trying to solve these problems let me know.

The 43rd NOAA Annual Climate Diagnostics and Prediction Workshop Digest

Solicitation of Extended Summaries

Objective: Promote full scope S&T exchanges between research and operation to benefit the entire climate community

Invitees: All 43rd CDPW presenters (**both oral and poster**)

Format: MS Word document, high quality figures, flexible length (preferably 1-4 pages). Reference to past volumes for examples.

The CDPW Digest (2009-) and previous Proceedings (1976-2000) are available via NOAA Library online catalogue, or at NWS STI Climate Bulletin
http://www.nws.noaa.gov/ost/STIClimateBulletin/Collections.htm
DOI number has been assigned since 39th CDPW Digest.

Submission due: **February 31, 2019**

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