

The Real-time NMME Seasonal Prediction System

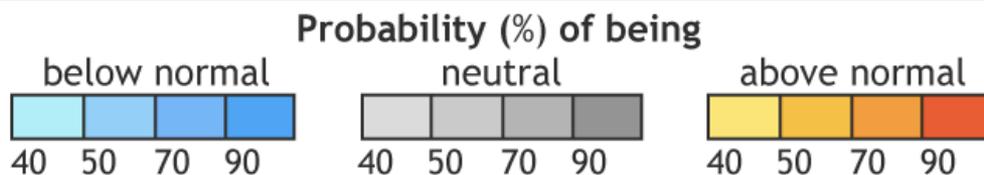
equator

Emily Becker

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MAPP webinar 2 June 2016

Issued April 2016



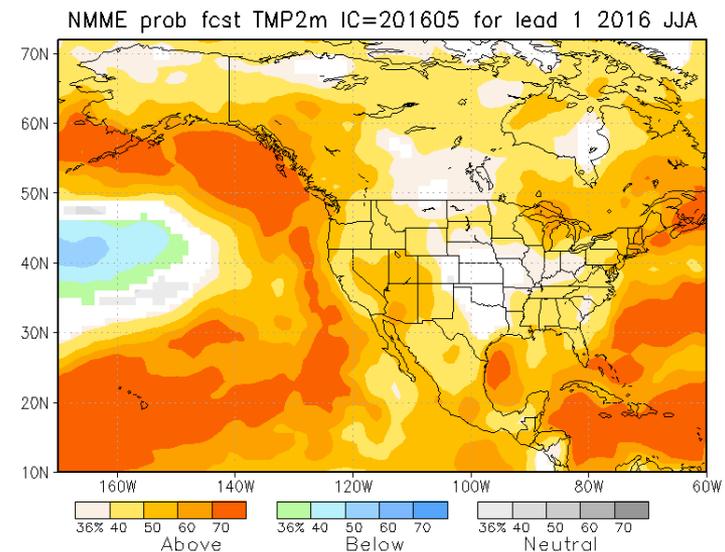
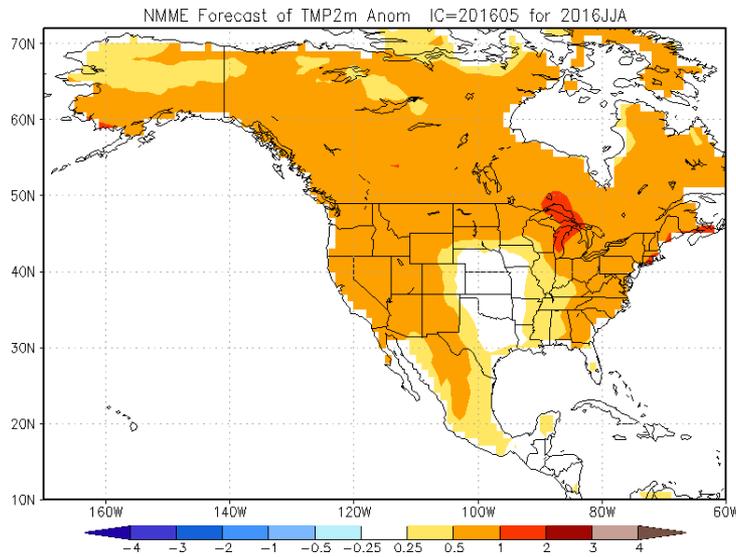
NOAA Climate.gov
Data: CPC

In the beginning...

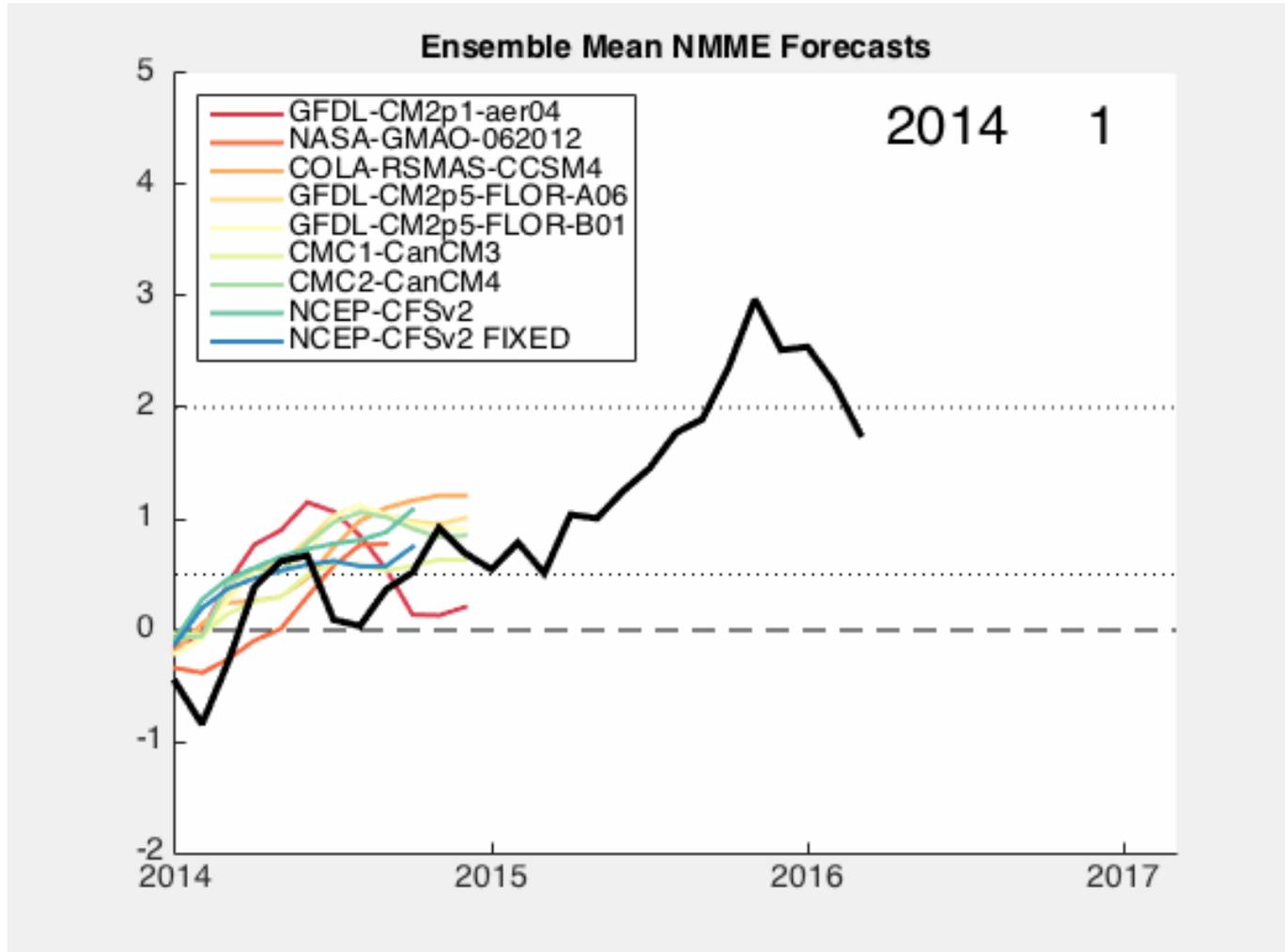
- Initial NMME planning meetings February & April 2011
- Development at CPC Summer 2011
- First real-time forecasts August 2011
- Model suite changed August 2012
- Probabilistic forecasts November 2012
- Real-time verification November 2013
- Model suite changed Spring 2014
- Modeling centers agreed to earlier delivery deadline to accommodate ENSO forecast Summer 2015

Ongoing NMME activities at CPC: Seasonal forecast guidance

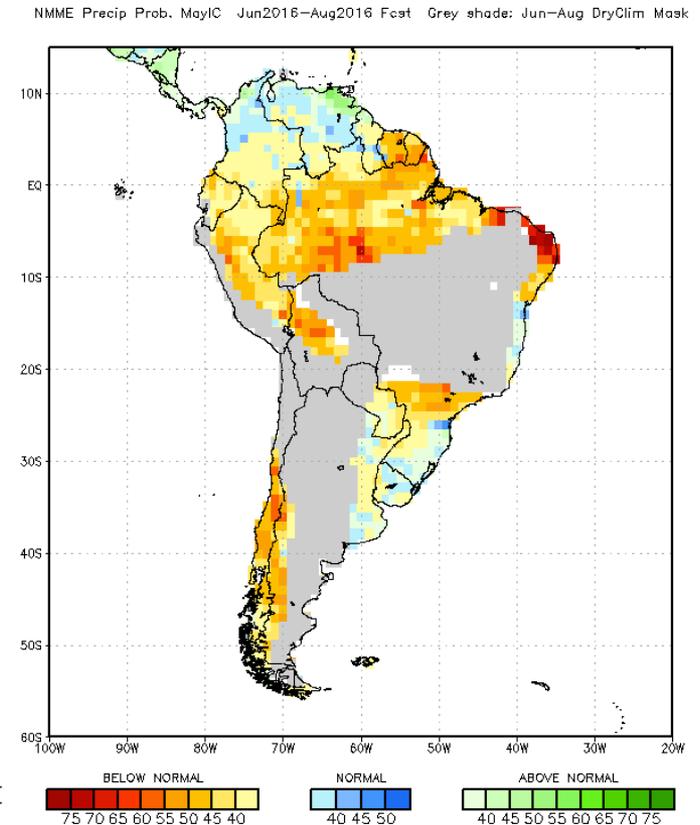
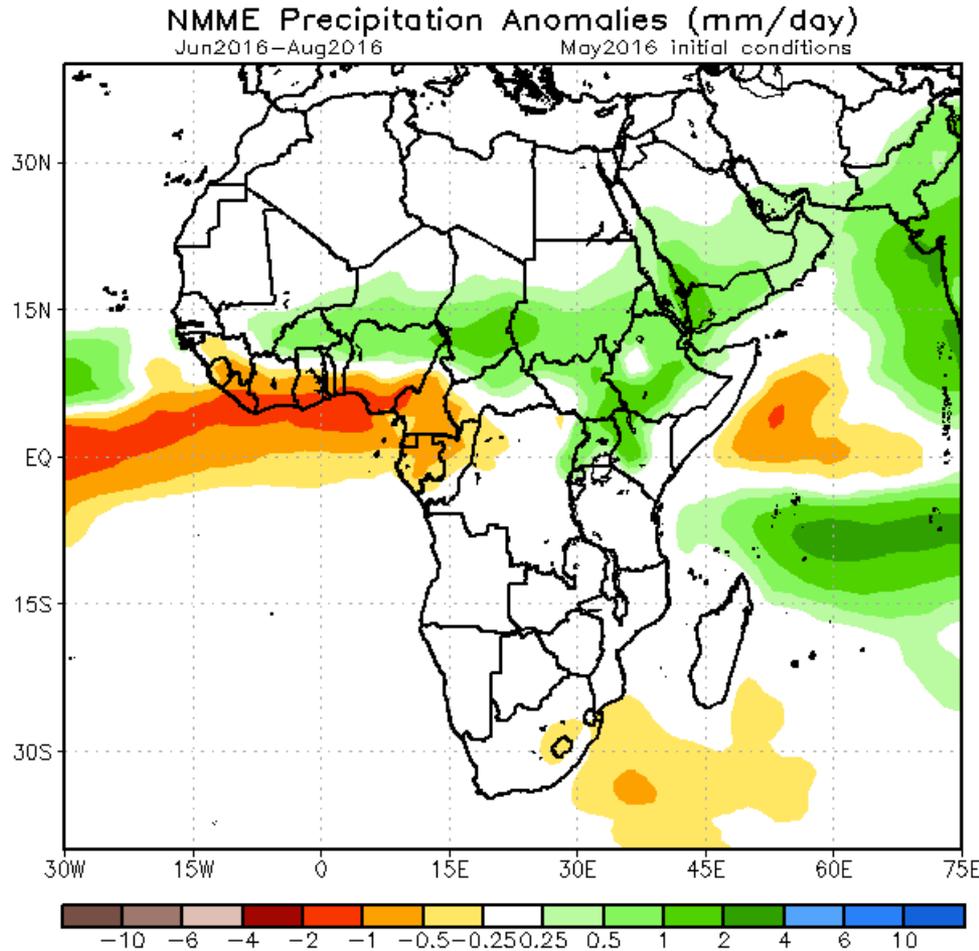
1. Forecasts are due at CPC by 5pm Eastern time on the 6th of the month
2. Forecasts are processed overnight on the 6th
3. Graphics and data are posted on the 7th / 8th



Ongoing NMME activities at CPC: ENSO forecast guidance



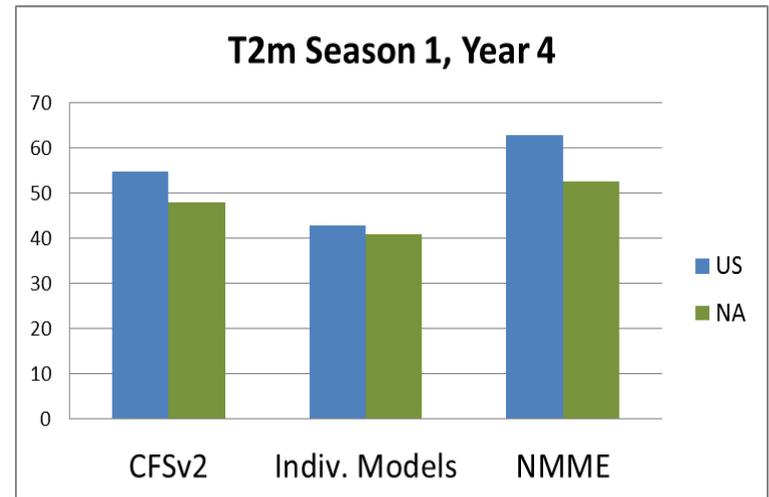
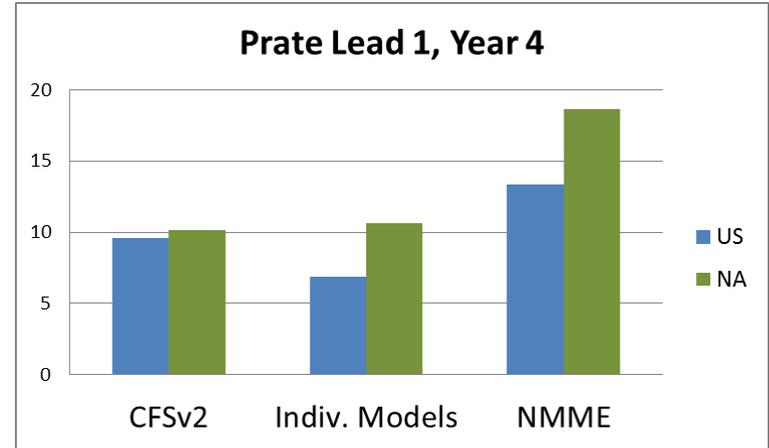
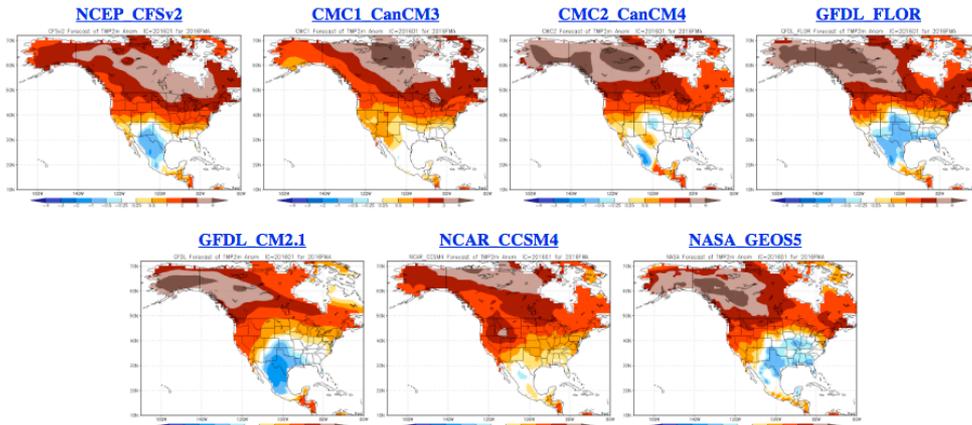
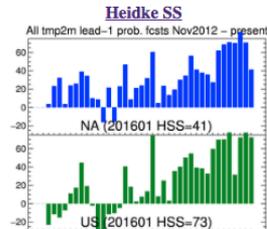
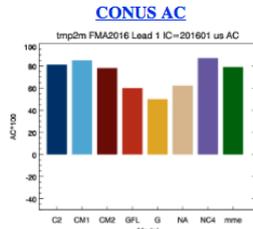
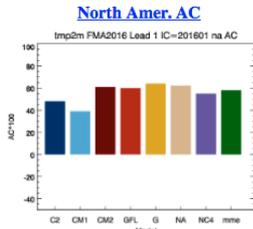
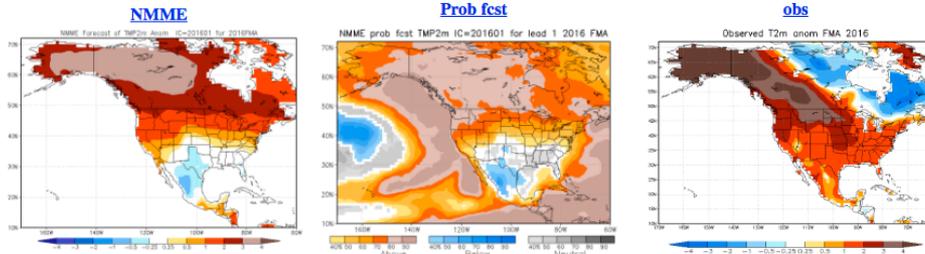
Ongoing NMME activities at CPC: International Desk



<http://www.cpc.ncep.noaa.gov/products/international/nmme/nmme.shtml>
Created and maintained by V. Kumar⁵CPC

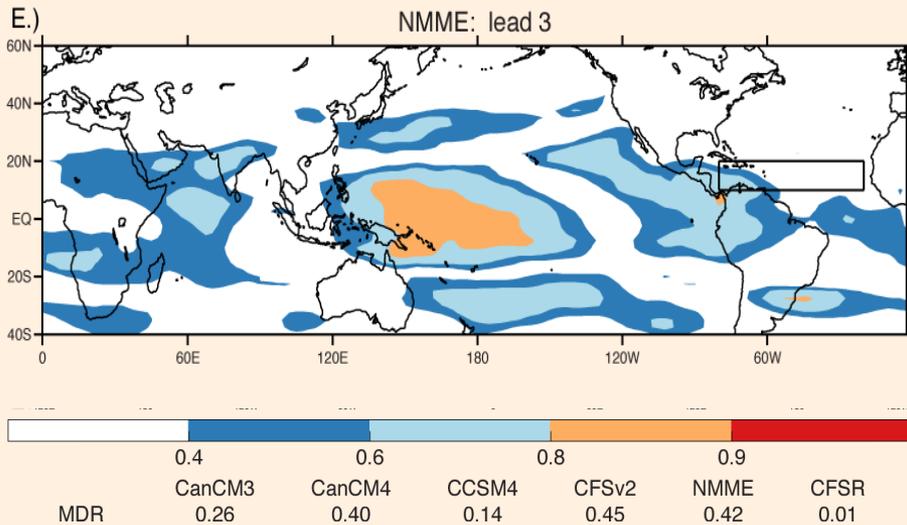
Ongoing NMME activities at CPC: real-time verification

Anomaly correlation for deterministic forecasts

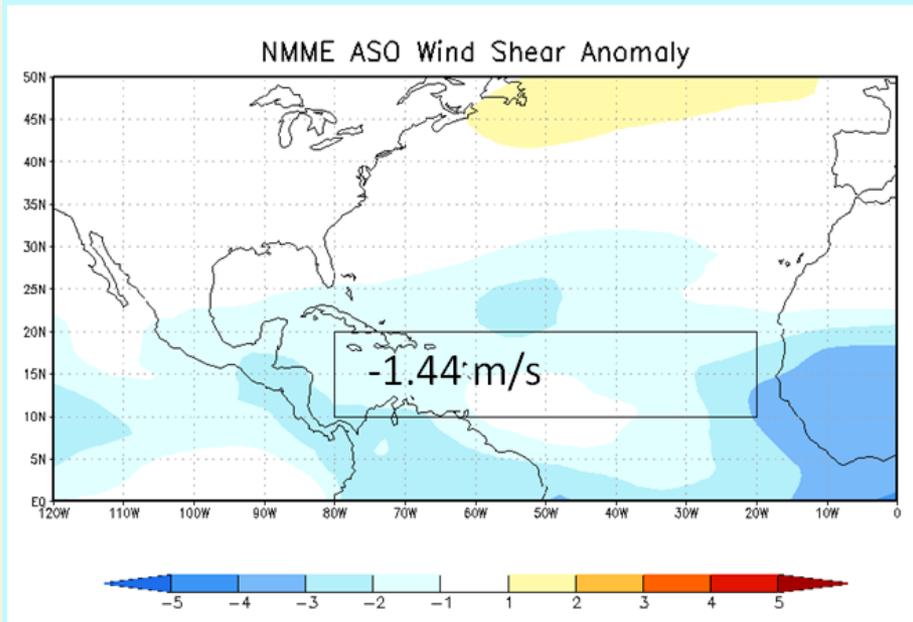


Ongoing NMME activities at CPC: Hurricane forecasting

Hindcast anomaly correlations of ASO vertical wind shear ($u_{850}-u_{200}$) with April initial conditions



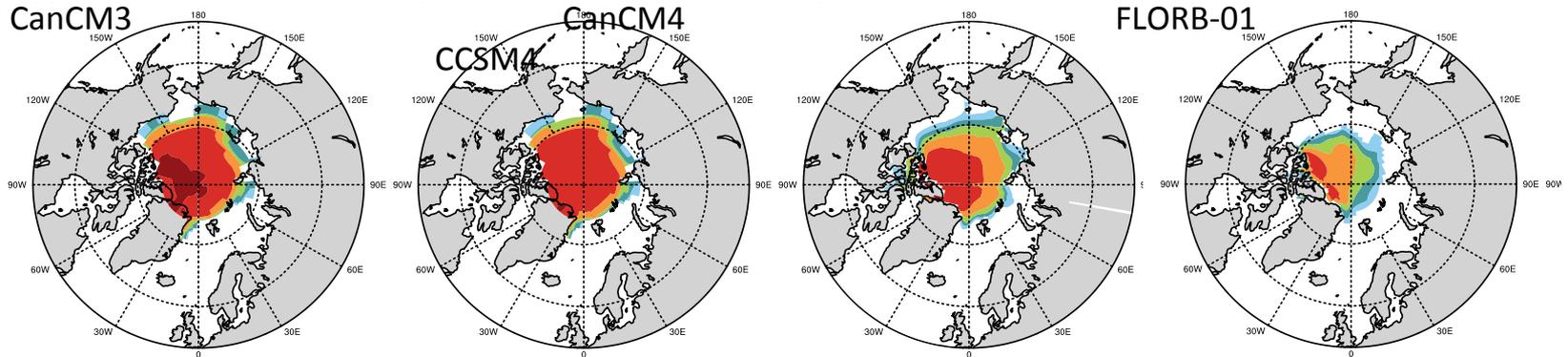
April 2016 vertical wind shear forecast for ASO



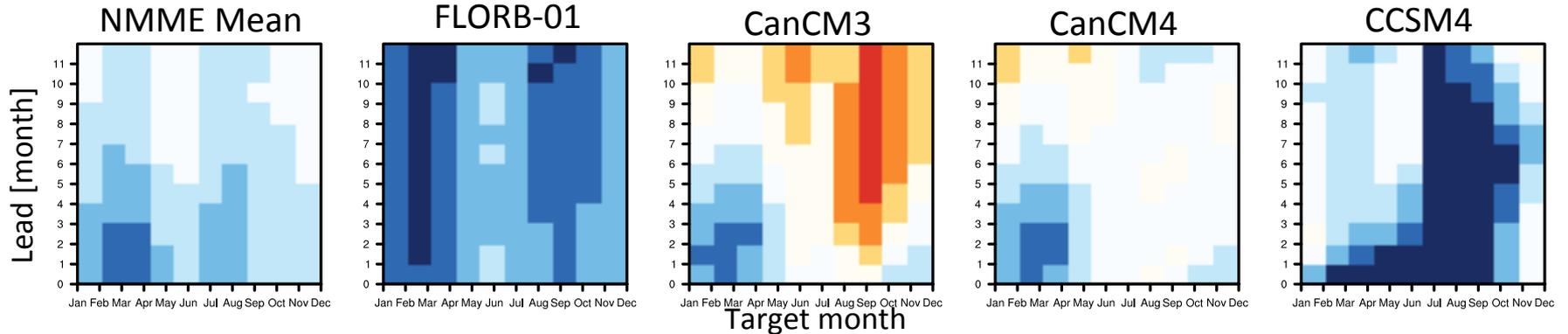
Ongoing NMME activities at CPC:

Sea ice research

September Sea Ice Concentration [%]



Sea Ice Extent difference (Model – Observations) [10^6 km^2]



Current events:

Cooperation arrangement

A cooperation arrangement for NMME-Phase II Seasonal System (hereafter, the NMME system) has been signed by

- NOAA NWS/National Centers for Environmental Prediction (NCEP)
- NOAA OAR/Climate Program Office
- NOAA OAR/Geophysical Fluid Dynamics Laboratory (GFDL)
- Environment Canada (EC)
- NASA Goddard Space Flight Center
- UCAR (on behalf of NCAR)
- University of Miami

Current events:

Cooperation arrangement

Establish terms of operation to:

- 1) Enhance operational seasonal forecasts at NCEP and EC
 - 2) Enable research on prediction and modeling based on NMME data
- Covers the period August 1, 2015, through July 31, 2018
 - Co-sponsored by operational and research institutions
 - Includes metrics to ensure both operational and research needs are met

Current events:

Cooperation arrangement

7 Prediction systems:

- CFSv2 (NCEP operational system)
- CMC prediction systems (2 models; EC operational system)
- GEOS5 (NASA GMAO research system)
- FLOR (NOAA/GFDL research system)
- CESM1 (NCAR research system)
- CCSM4 (Operated by U of Miami/CIMAS; research system)

These are operated according to a common protocol available at http://cpo.noaa.gov/sites/cpo/MAPP/pdf/NMME_Prediction_Protocol.pdf

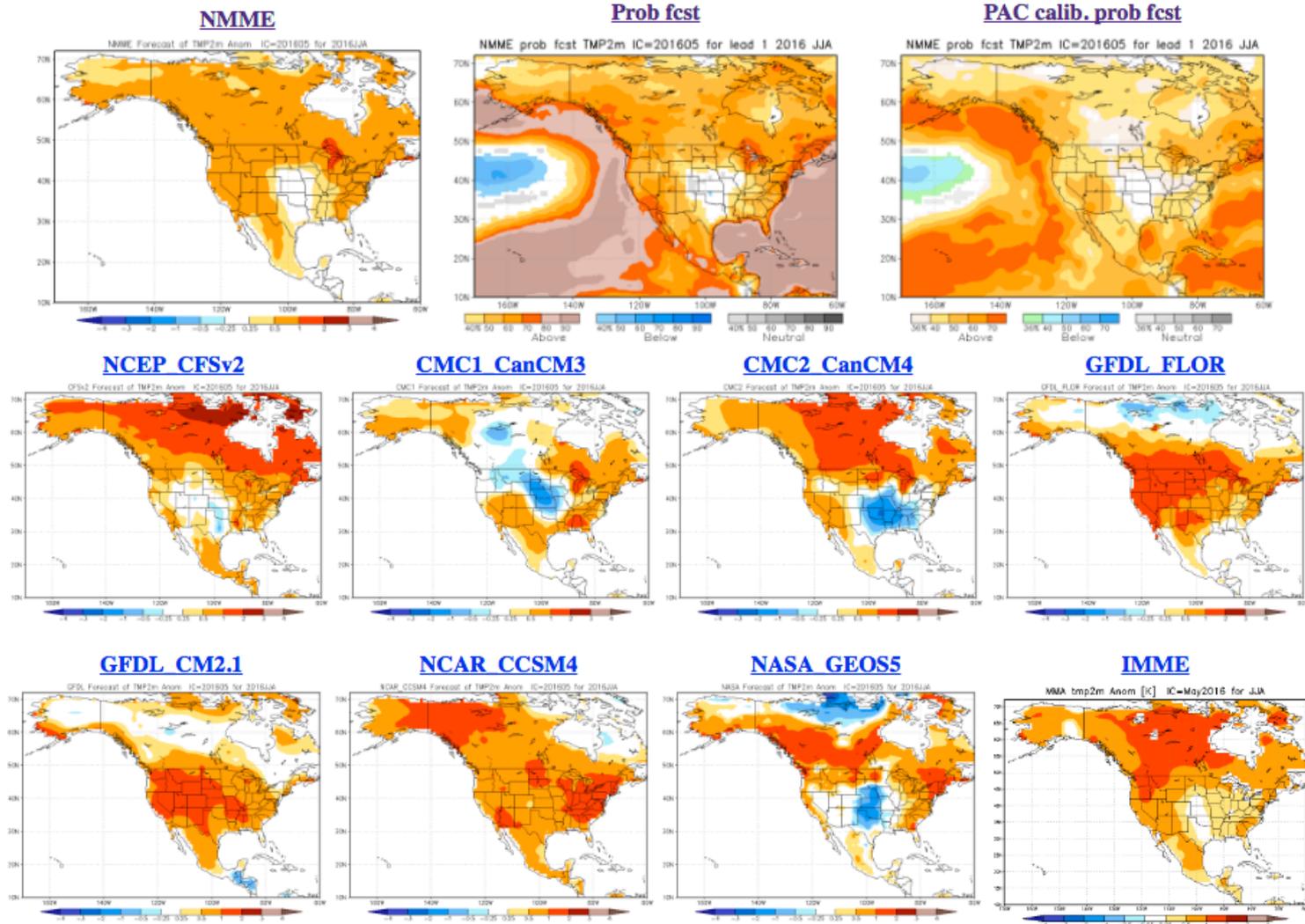
Current events:

Operational service requirements

CPC evaluates whether NMME system is meeting its operational service requirements by assessing:

- **Timeliness:** Baseline is NWS's 99% on-time product delivery requirement
- **Seasonal forecast skill:** Skill of NMME-derived products, physical variables (e.g., SST), and major climate phenomena (e.g., Madden-Julian Oscillation) is evaluated based on standard NCEP skill metrics as a function of:
 - lead time
 - number of models, and
 - ensemble members

Current events: Calibrated probability forecasts

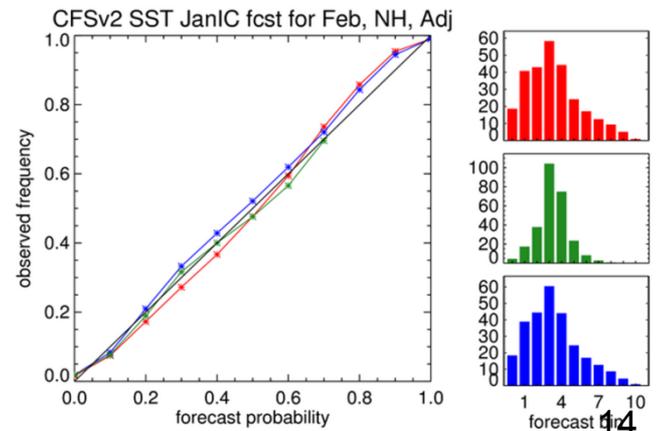
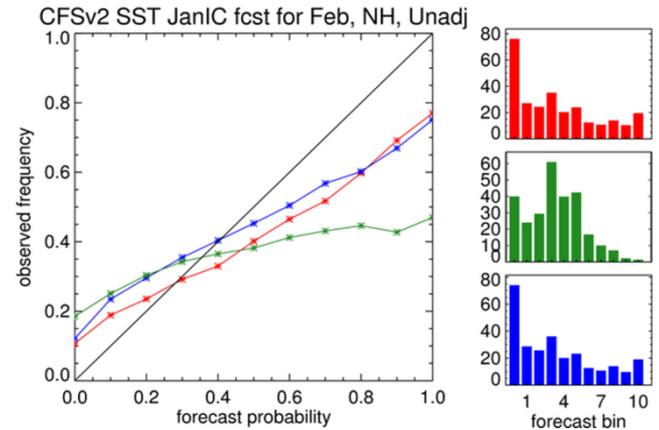


Current events:

Calibrated probability forecasts

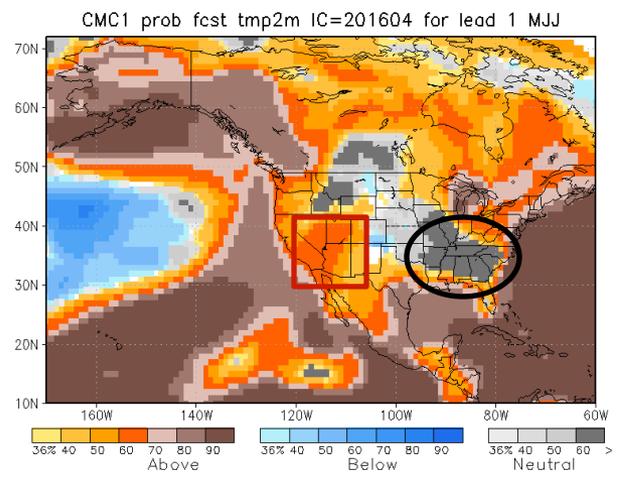
What's the Probability Anomaly Correlation (PAC?)

- Historical correlation between forecast probability anomaly and observed probability anomaly
- Probability anomaly = difference between forecast or obs and 1/3, the presumptive climatological frequency in the case of equally-likely terciles
- E.g.: forecast for A= 0.5: prob anom = 0.17 Observed A = 1: prob anom = 0.66
- Adjustment factor = $\text{PAC} * (\text{sdobs}/\text{sdmod})$ used to damp forecast probability anomalies
- Higher PAC = less damping, lower PAC = more damping.
- Each model forecast is calibrated based individually based on its own adjustment factor from 1982-2010 hindcasts

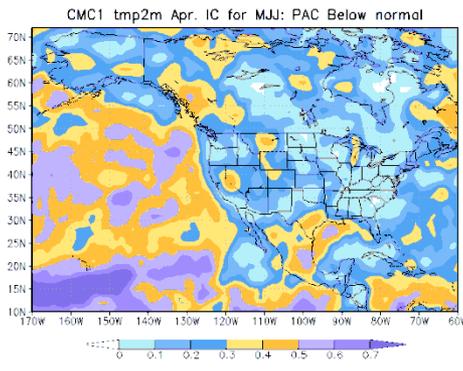
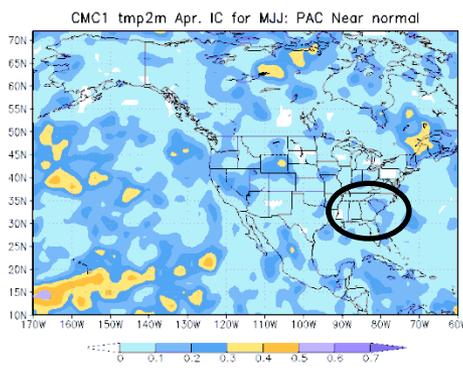
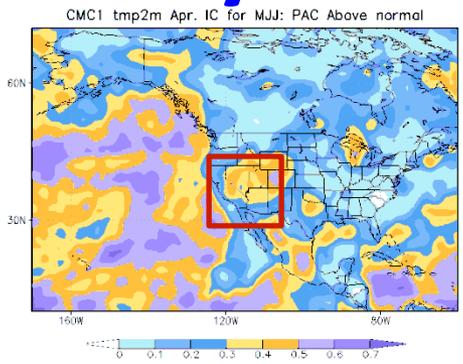
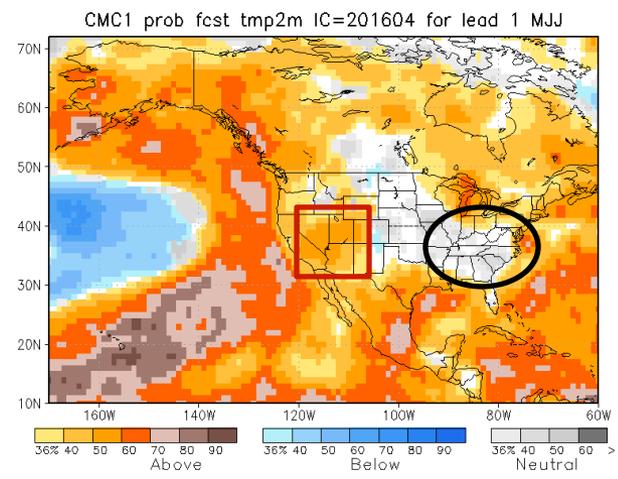


Current events: Calibrated probability forecasts

Before



After



CanCM3 T2m for MJJ

- Model has 10 members
- Land T2m obs = GHCN+CAMS
- Ocean obs = Reynolds OI SST

- ⊙ Near-Normal PAC is near zero: prob. reduced to ~EC
- ◻ Above PAC is 0.3-0.5: prob. reduced from 60% to 50%

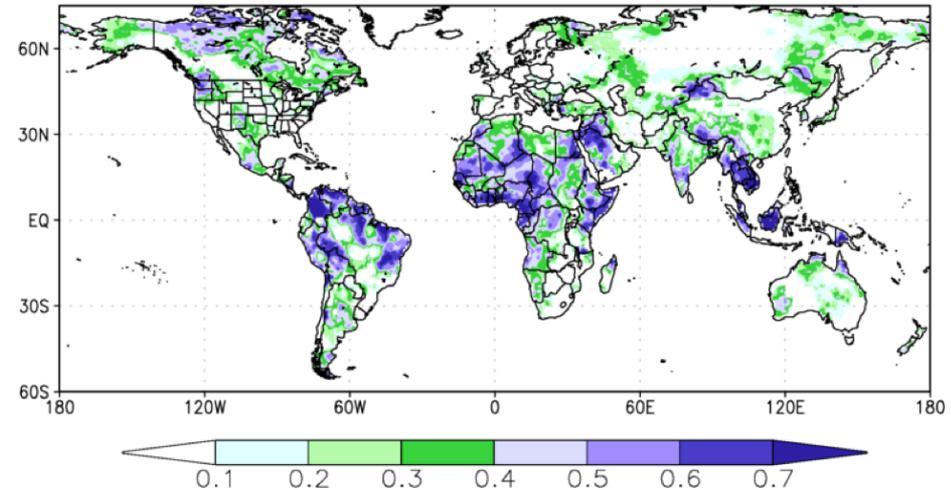
Looking forward

1. NMME Working Group project to determine best model weighting method for probabilistic forecasts

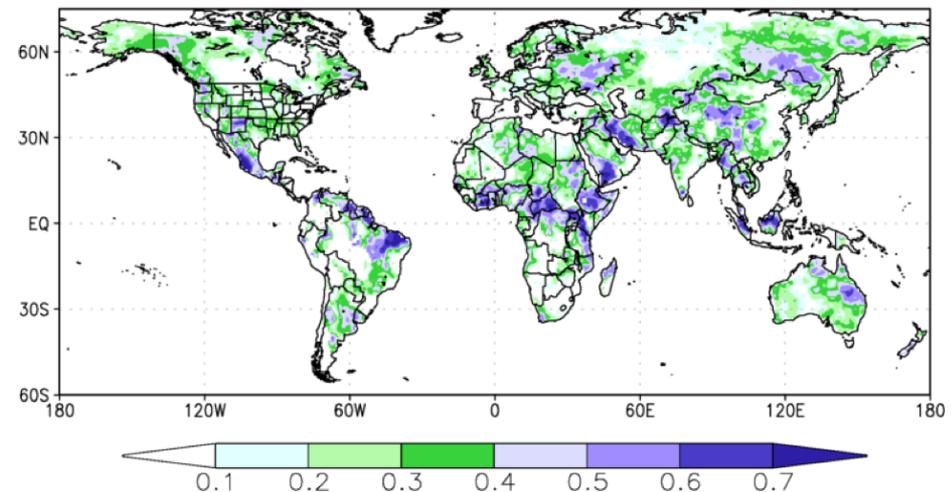
Current method is equal weights for each model ensemble member; one potential (likely?) outcome is that no other method can be shown to produce higher skill forecasts

2. FY17 milestone to develop probabilistic extremes forecasts

T2m SEDI, 95th percentile



T2m SEDI, 5th percentile



Data and product archiving and access

8 real-time monthly fields available at CPC, with supporting monthly hindcasts available at IRI

- ftp://ftp.cpc.ncep.noaa.gov/NMME/realtime_anom/
- <http://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/>

Real-time NMME forecast and verification products for SST, 2-m temperature, and precipitation available at CPC NMME website

- <http://www.cpc.ncep.noaa.gov/products/NMME/>

Data and product archiving and access

Daily hindcast data⁺⁺ available at NCAR⁺⁺⁺ including:

- 22 daily surface fields (atmospheric and land)
- 5 daily atmospheric fields provided at 850, 500, 200, 100, and 50 hPa (i.e., geopotential, temperature, zonal and meridional winds, specific humidity)
- 2 monthly sea-ice fields (i.e., sea-ice concentration and thickness)
- 7 monthly ocean fields at 13 depth levels
- 6-hourly data from CFSv2 during 1999-2012

<http://www.cpc.ncep.noaa.gov/products/ctb/nmme/NMME-PhaseII-DataPlan-27May.pdf>

<https://www.earthsystemgrid.org/search.html?Project=NMME>

Publishing NMME-related research

NMME data terms of use:

Users of NMME data are expected to acknowledge NMME data and participating modeling groups. See <http://cpo.noaa.gov/mapp/NMME> for details on how to properly acknowledge the NMME in publications and presentations.

An NMME Special Issue is now open:

- Accepting manuscript submissions to *Climate Dynamics* through Sep. 2016
- Intended to document use of NMME data for research ranging from predictability studies, to multi-model prediction evaluation and diagnostics, to emerging applications of climate predictability for subseasonal to seasonal predictions