Week-2 NAEFS forecasts at NCEP Climate Prediction Center

Dan Collins

Climate Prediction Center

NCEP/NOAA

Acknowledgements:

Dave Unger, Emily Riddle, Nat Johnson (U. Hawaii)

Products - Outline

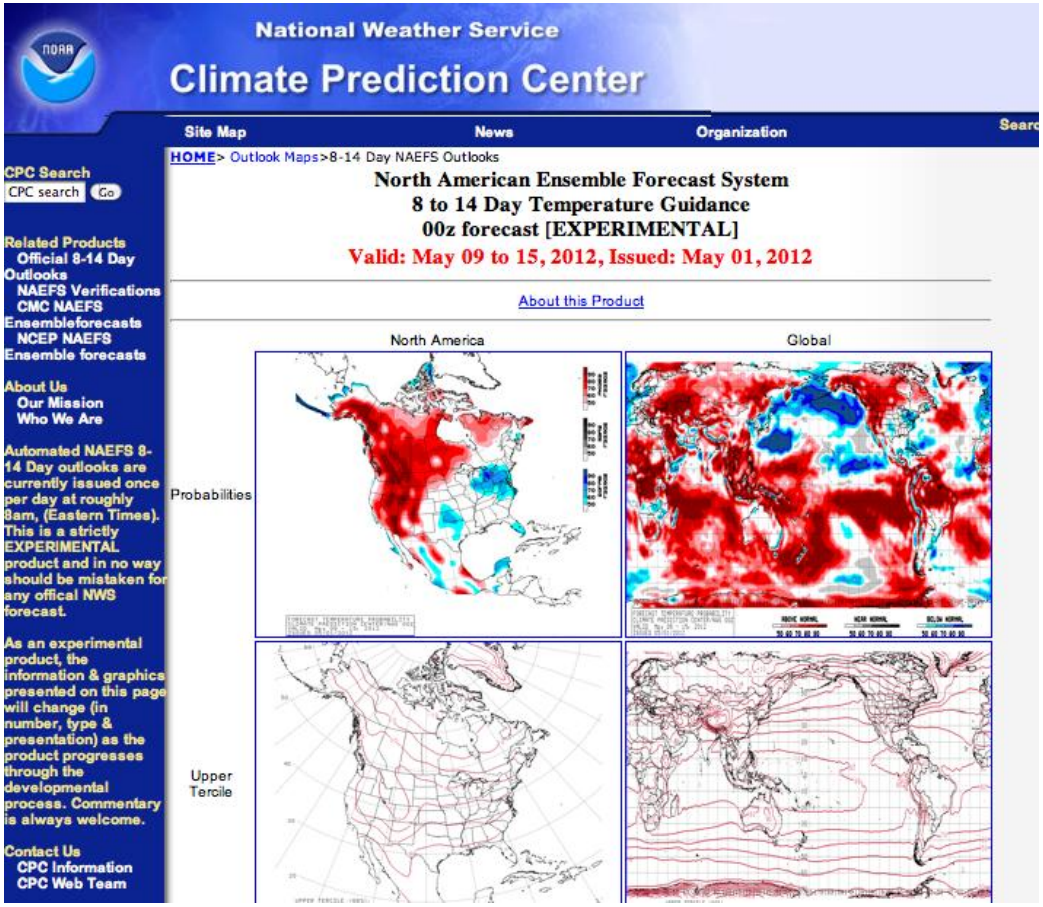
- Bias-corrected products
  1. Temperature using EMC generated corrected ensembles

$$\overline{B}_t = (1 - a)\overline{B}_{t-1} + ab_t$$

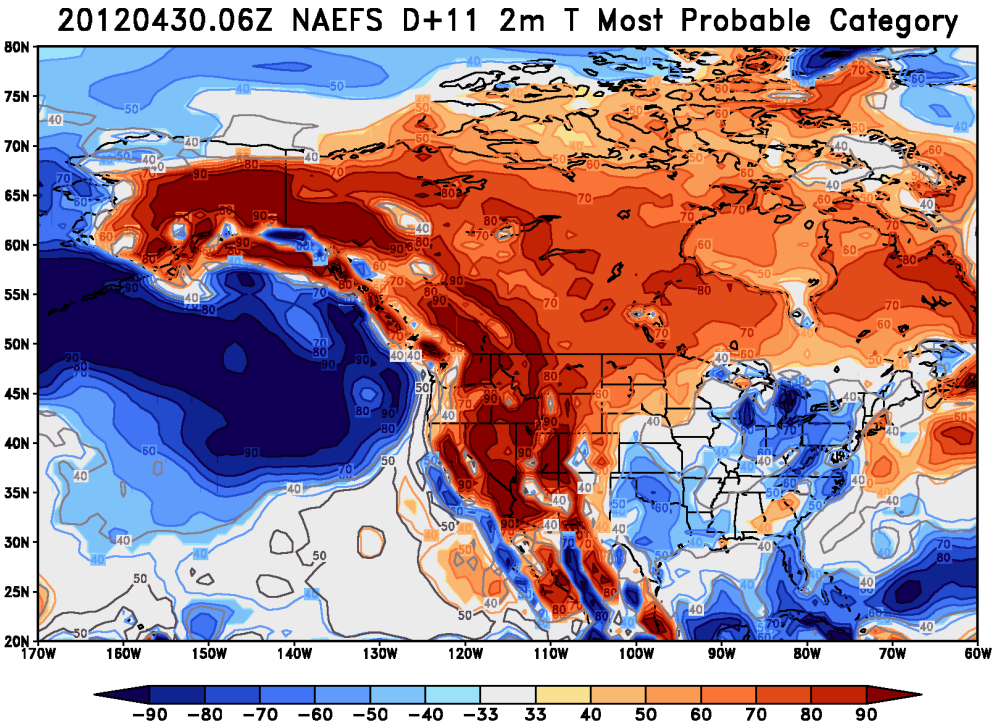
     - 1) Counts and 2) partial calibration using ensemble regression
  2. Internally used full cumulative density function forecast

     (2,5,10, 20, 30, 40, 50, 60, 70, 80, 90, 95, & 98 percentiles)
  3. Precipitation corrected as log(Precip) for 10 thresholds from 1 mm to 6 inches (150 mm)
     1. Above and Below
     2. POP and Probabilistic forecasts of precipitation amount
- Category forecasts correspond to official CPC / National Weather Service forecast product with forecaster input
- Daily P bias information

Ensemble Count-based Un-calibrated Bias-corrected Tercile Probabilities (>50%)



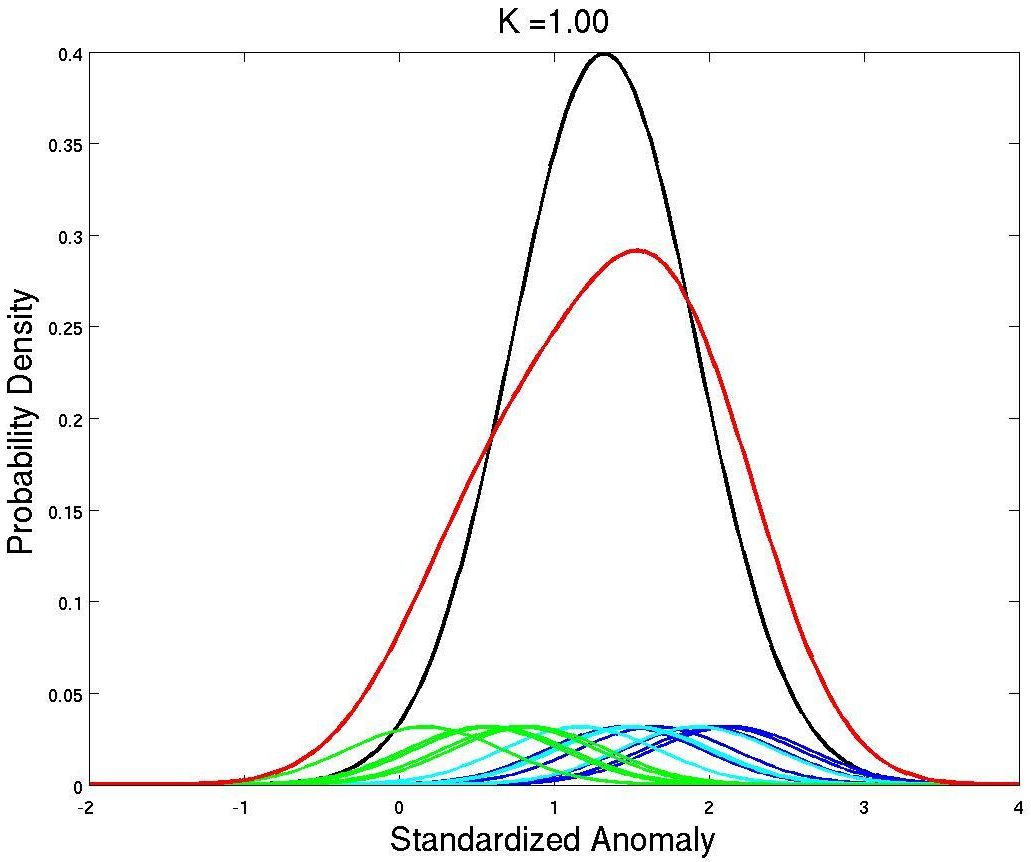
Ensemble Regression-based Calibrated Probability of most likely tercile (>33%)



Used internally by CPC forecasters

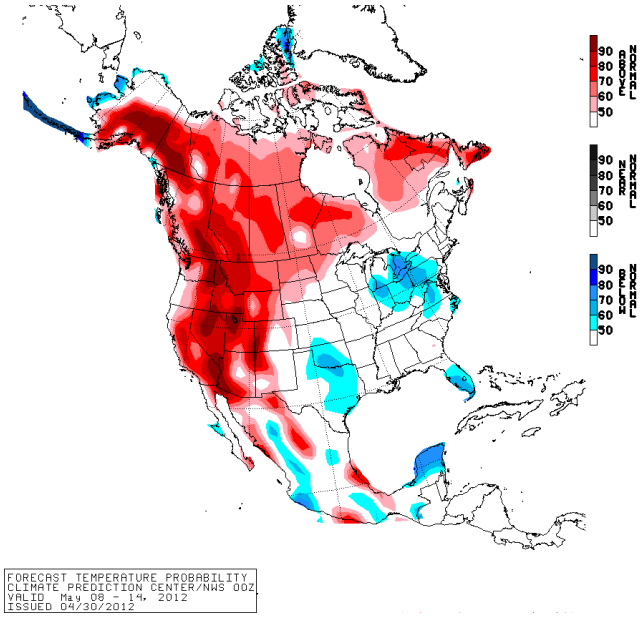
Ensemble Regression (ER) estimates error variance of each member forecast

- Black curve uses only error variance of the mean
- Red curve considers individual member error variance
- As ensemble grows, ER approaches count
- Ensemble assumed to represent PDF shape better for large ensembles, with less sampling error

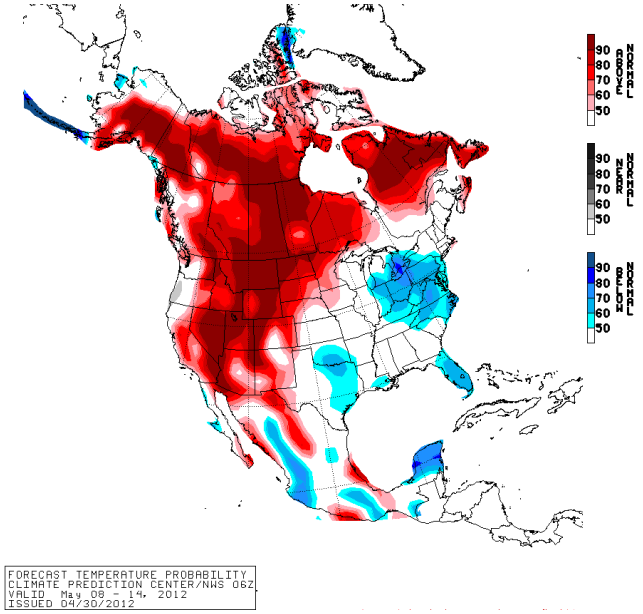


Unger, David A., Huug van den Dool, Edward O'Lenic, Dan Collins, 2009: Ensemble Regression. *Mon. Wea. Rev.*, **137**, 2365–2379.

Week 2 Temperature
Probability of Above, Near and Below Normal

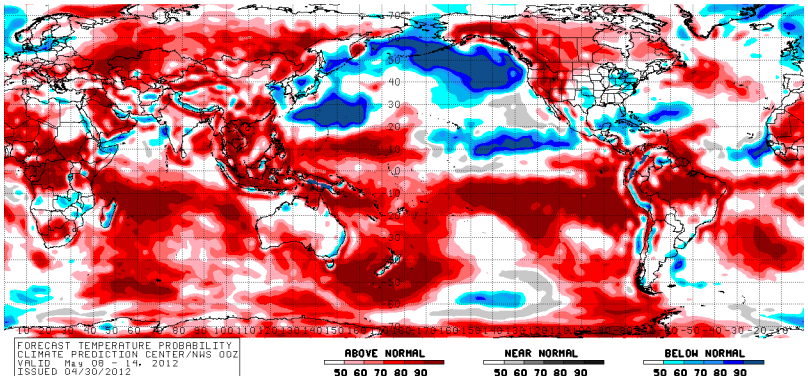


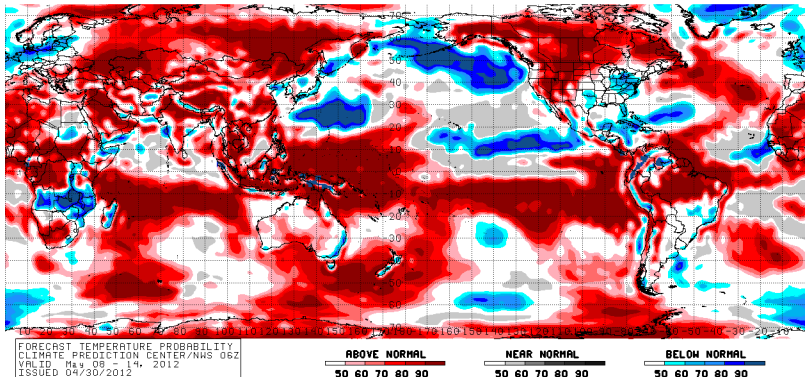
00Z NCEP + Environment Canada



06Z NCEP Only

Week 2 Temperature
Probability of Above, Near and Below Normal

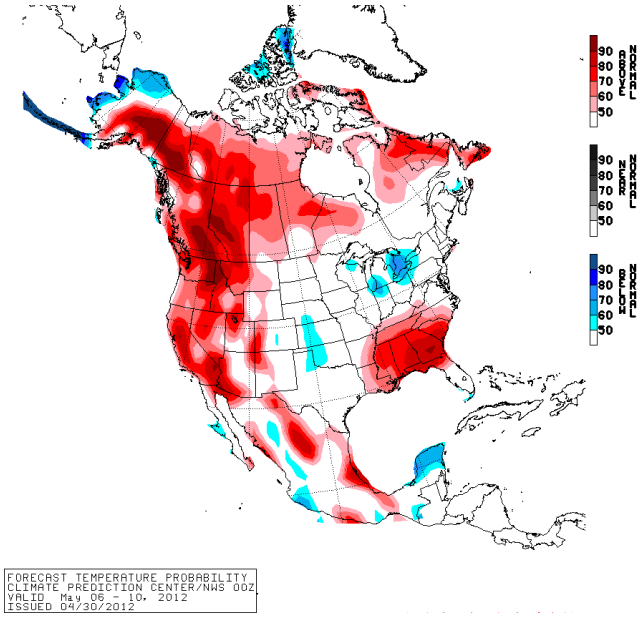




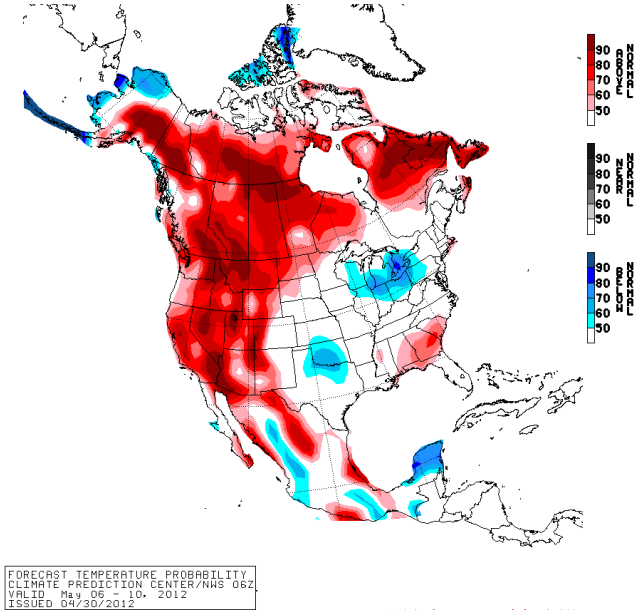
00Z NCEP + Environment Canada

06Z NCEP Only

6-10 day Temperature
Probability of Above, Near and Below Normal



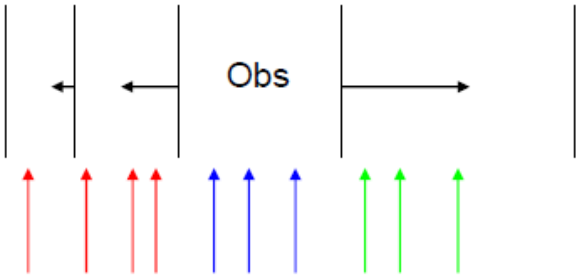
00Z NCEP + Environment Canada

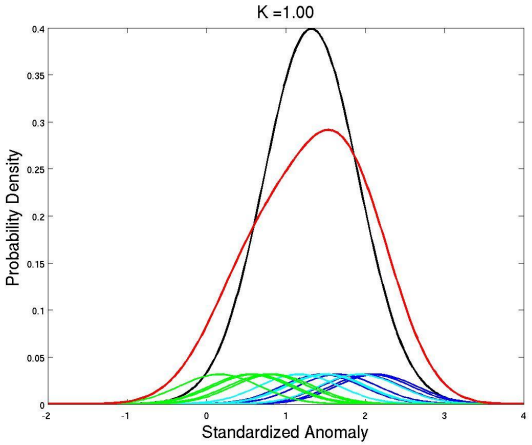


06Z NCEP Only

Adaptive Precipitation PDF Bias Correction

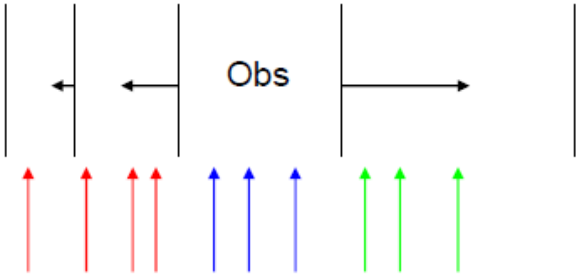
- Correction is made at several thresholds or precipitation amounts, including the no-precipitation/precipitation 1 mm threshold.
- PDF is smoothed and variance adjusted using Gaussian kernels
- The probability of exceeding (POE) each threshold determined by the ensemble forecasts is used as the measure of the bias of ensemble.





- Correction is made in log(precipitation): Greater for larger amounts
- Weights of 0.04 used with CPC NAEFS precipitation forecasts

Adaptive Precipitation Correction (2)

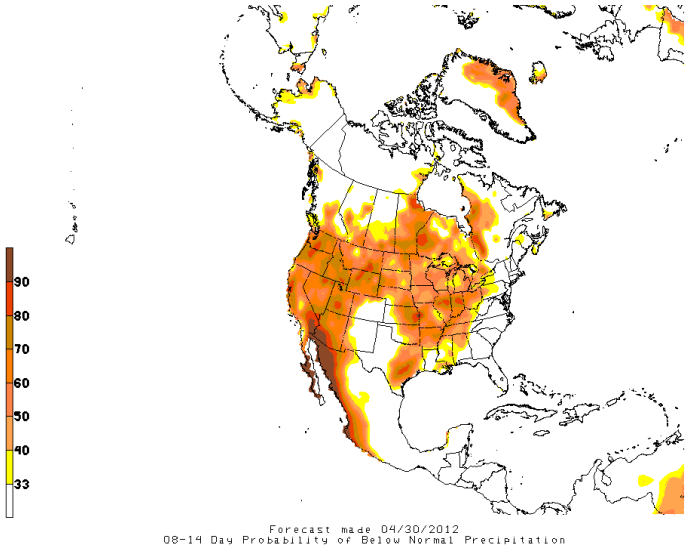


- Positive tendency of thresholds = a * POE * Δ
- Negative tendency of thresholds = a * (1-POE) * Δ

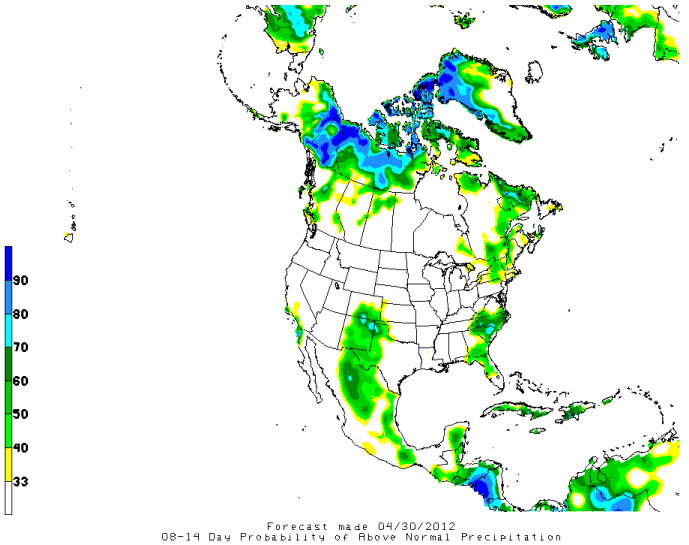
    - Where Δ is the difference from the neighboring precipitation threshold

- **Parts of the distribution that are not near the observation would generally be unaffected (small or no adaption)**

Week 2 Precipitation
Probability of Above and Below Normal

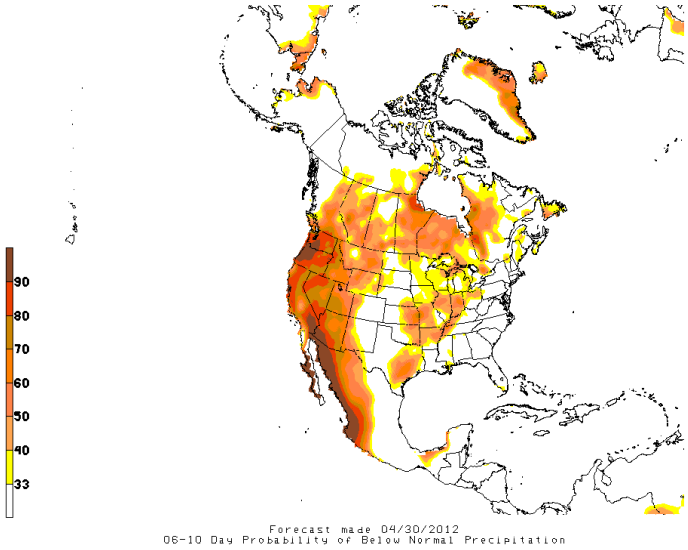


00Z NCEP +
Environment Canada

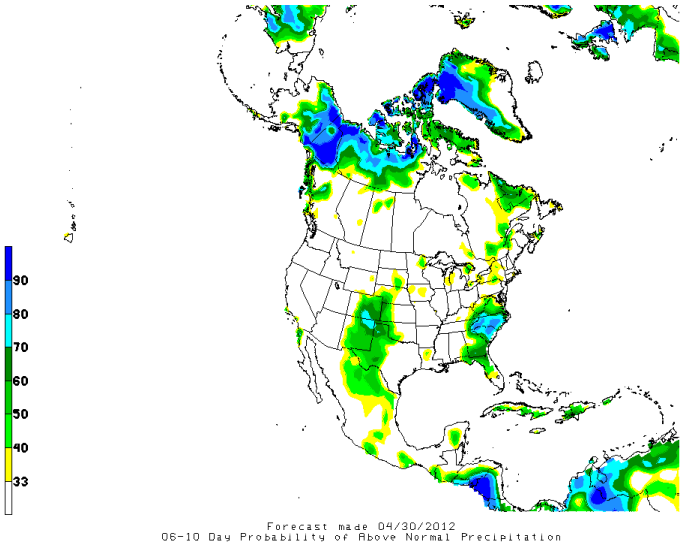


06Z NCEP
Only

6-10 day Precipitation
Probability of Above and Below Normal

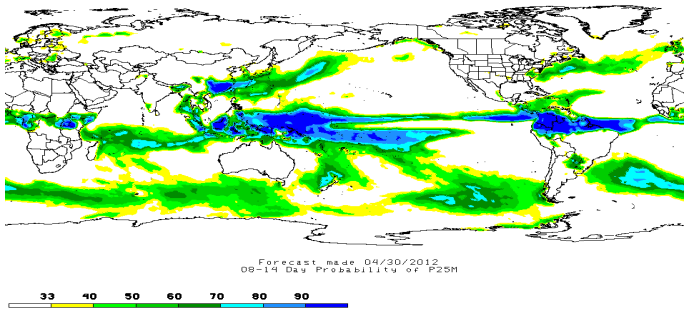


00Z NCEP +
Environment Canada

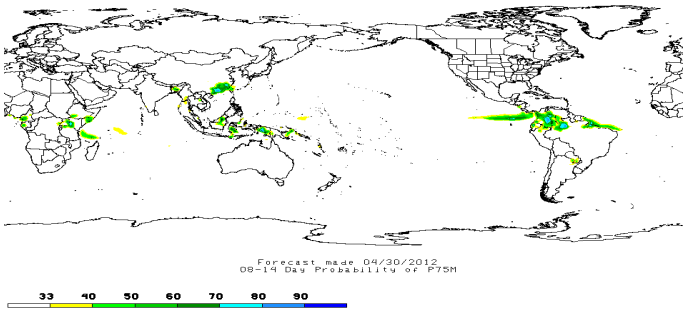


06Z NCEP
Only

Week 2 Precipitation
Probability of precipitation quantity

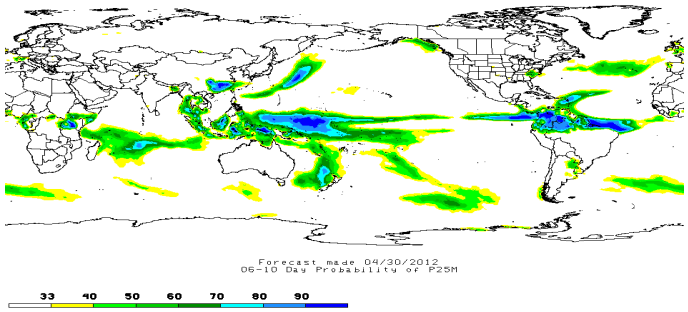


Probability of 1 inch precipitation in week-2 period

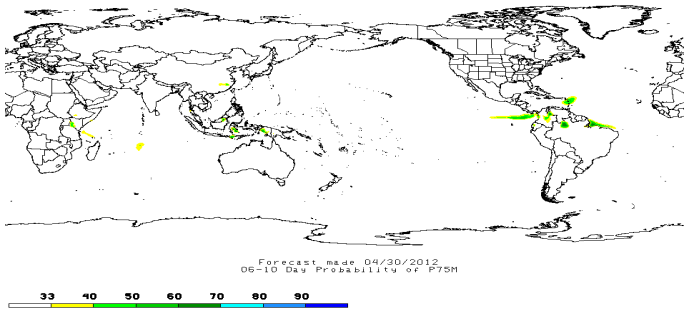


Probability of 3 inches precipitation in week-2 period

6-10 day Precipitation
Probability of precipitation quantity



Probability of 1 inch precipitation in week-2 period



Probability of 3 inches precipitation in week-2 period

Some tests using reforecasts (CFSv2 1999-2010, 45-day runs)

- Longer reforecast data record should allow longer period for exponential mean, i.e. a smaller weighting, a, of the latest bias value, b_t

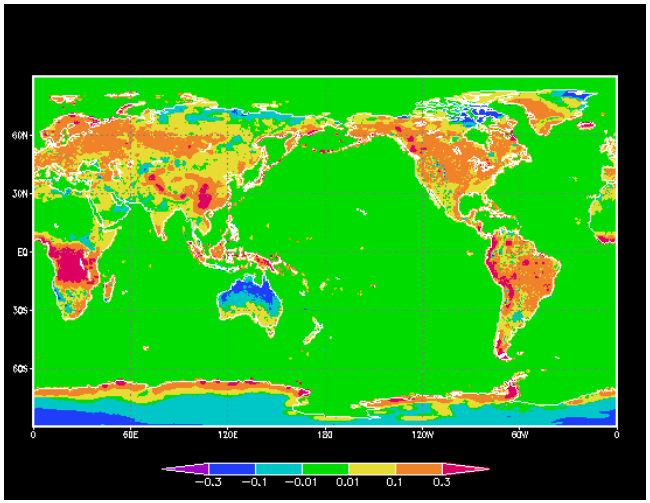
$$\overline{B}_t = (1 - a)\overline{B}_{t-1} + ab_t$$

- Bias correction should be more robust with more cases
- Greater capacity to correct full CDF

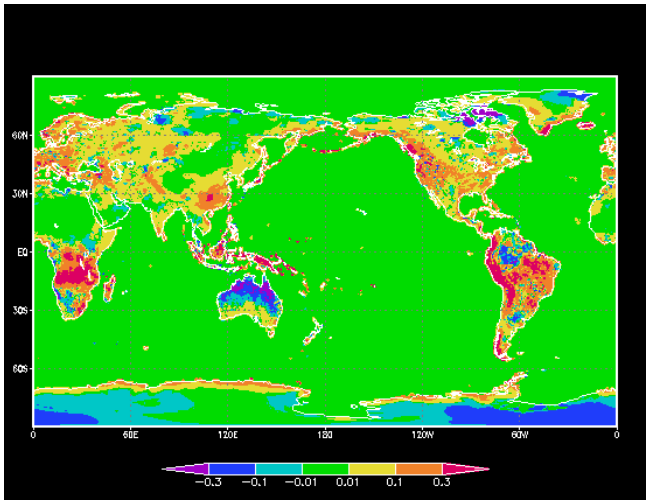
- Using CFSv2 and a = 0.01

- January - February 1999-2007 to spin up and calculating bias over 3 months, February, 2008-2010

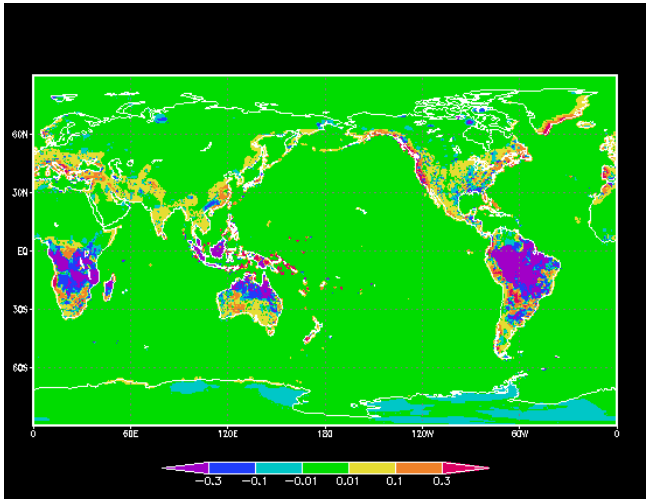
CFSv2 1999-2010 Spatial Variations in Mean Bias by precipitation amount for 6-10 days lead-time



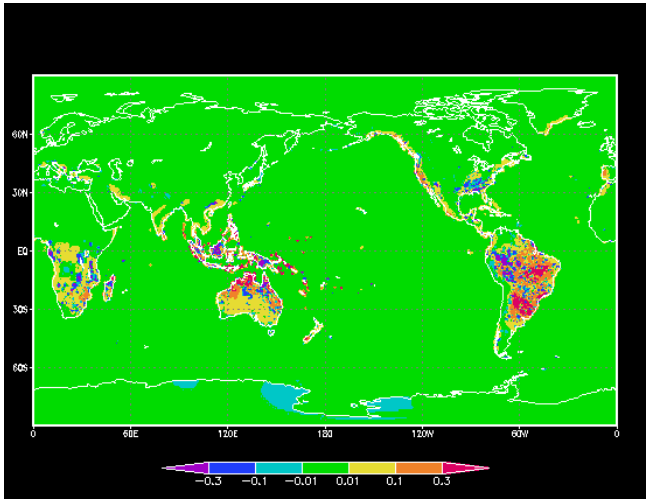
1 mm



0.25 inch

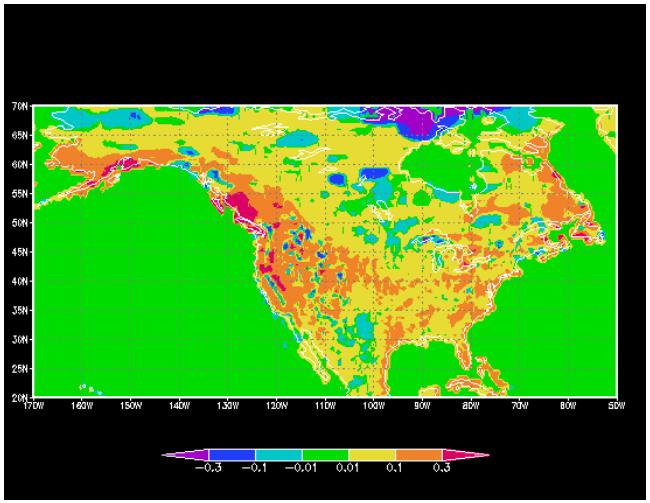


1 inch

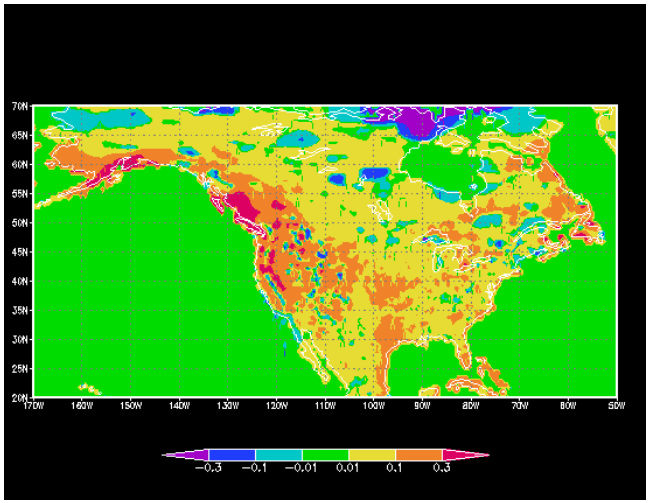


2 inches

CFSv2 1999-2010 Lead-time Variation in Mean Bias for ¼ inch accumulated **precipitation**

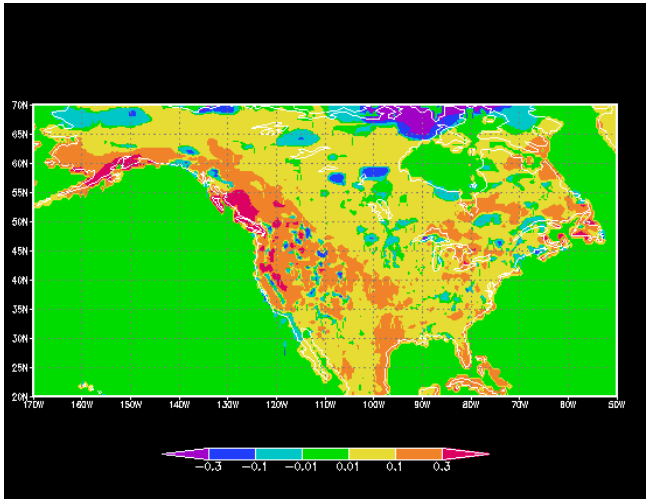


6-10 days



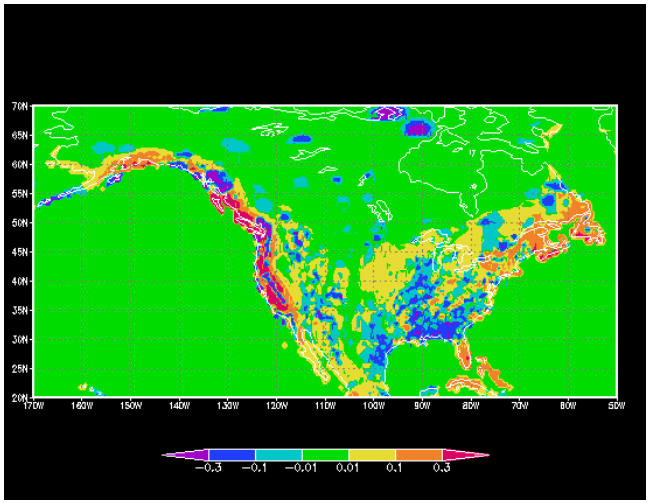
11-15 days

Out to 3 weeks or more the smaller precipitation amounts have widespread positive bias

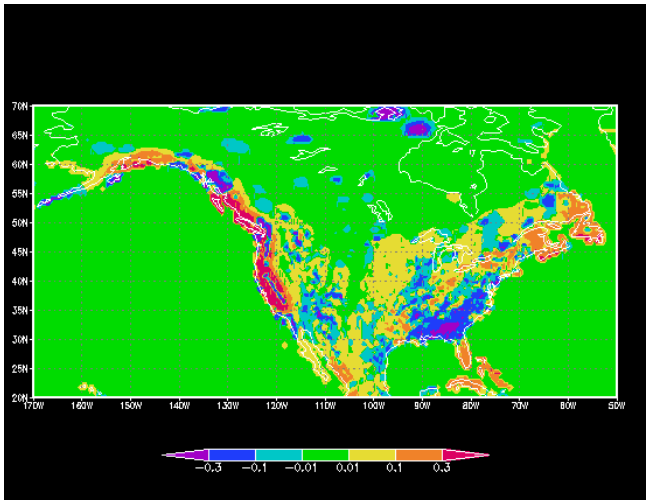


16-20 days

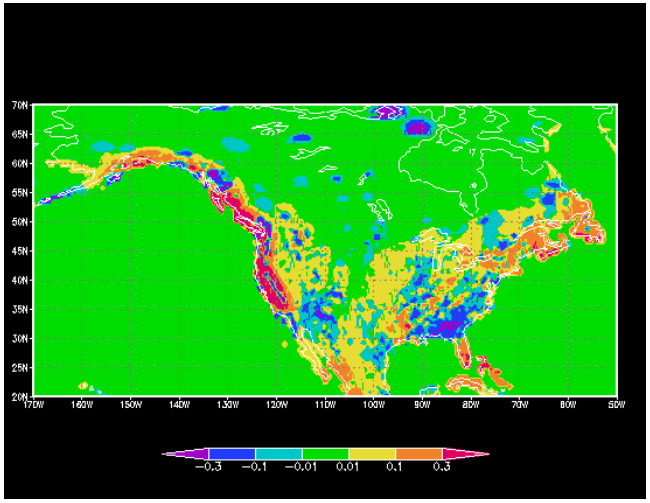
CFSv2 1999-2010 bias-correction using weight of 0.01
Lead-time Variations in Mean Bias for 1 inch accumulated **precipitation**



6-10 days



11-15 days



16-20 days

1) As precipitation amount increases, the number of events decreases and estimates of bias are less reliable.
2) Bias relatively constant at longer leads could allow smoothing over multiple lead times.
3) NAEFS correction using only one year expected to be less reliable

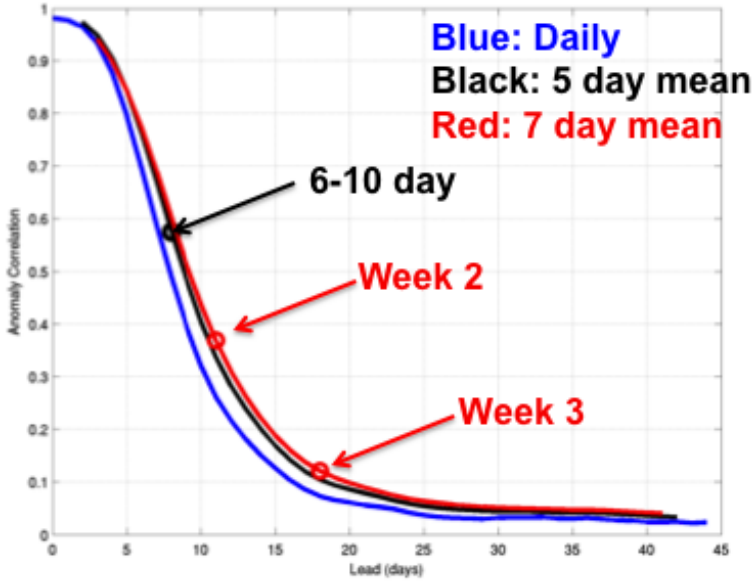
Summary of precipitation correction

- Bias correction that differentiates bias by precipitation amount appears well determined by using frequency of precipitation but poorly estimated for more rare larger events
- Bias varies across the entire distribution, **however** bias does **not** have large changes from 1 day to the next as lead time is extended.
  - For small precipitation amounts bias is nearly constant across lead-times out to several weeks.
- Lead times within a few days of each other can be combined to produce more robust bias estimates

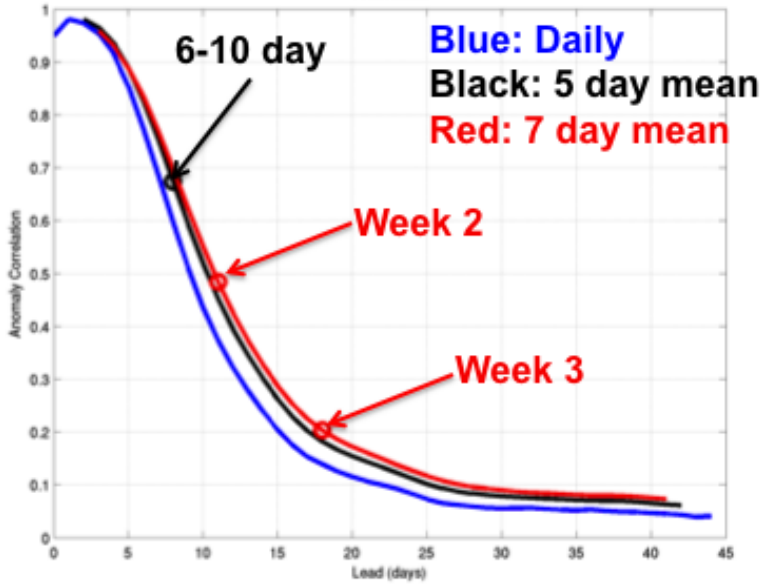
$$\overline{B}_t = (1 - a)\overline{B}_{t-1} + ab_t$$

- While bias in larger precipitation amounts (> 1-2 inches per day) may be less reliable because of a smaller sample size, lower amounts may be used as prior information.

500 hPa height anomaly correlations for week-3 and week-4 over North American region (CFSv2, 1999-2010)



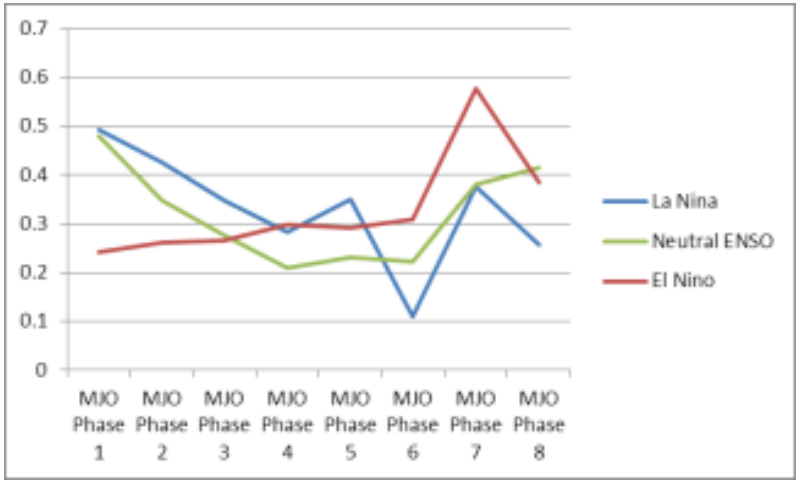
Single ensemble member

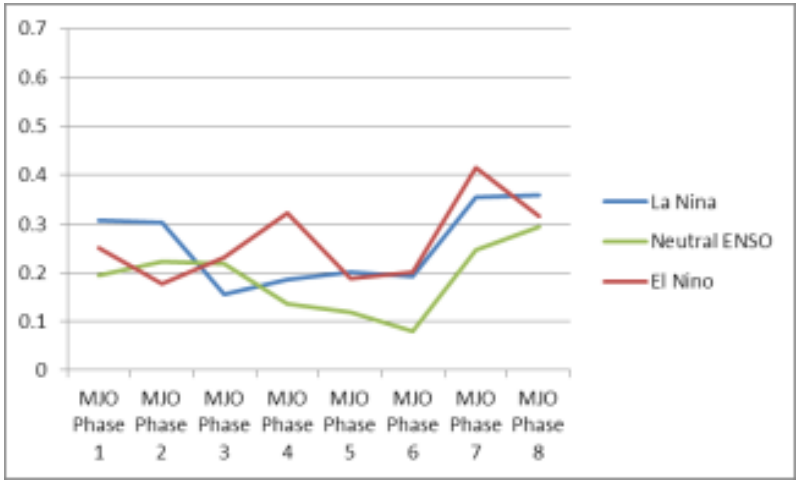


4-member ensemble mean

Anomaly correlations around 0.20 at week-3 (7-day mean)

500 hPa height anomaly correlations dependence on MJO and ENSO (CFSv2, 1999-2010)

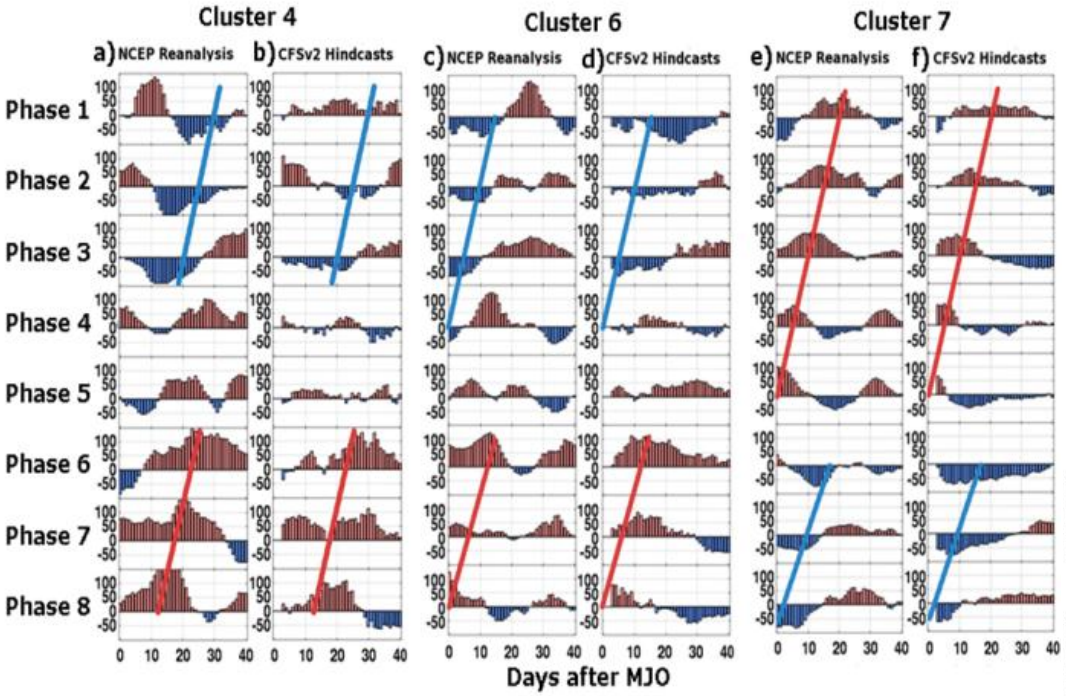


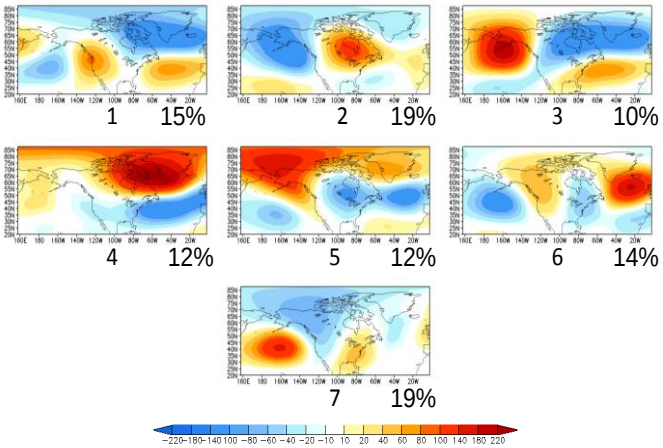


Week-3 **Week-4**

1) Skill can be several times greater during ENSO and MJO activity than for all cases
2) Week-3 and week-4 forecast anomaly correlations are low overall (but usable?)

500 hPa height anomaly dependence on MJO and ENSO compared to CFSv2, (1999-2010)





NAEFS used in monthly forecast update

30-DAY OUTLOOK DISCUSSION FOR MAY 2012

THE UPDATE OF THE MAY TEMPERATURE AND PRECIPITATION OUTLOOK IS MADE AT THE END OF THE MONTH USING THE LATEST GUIDANCE FROM NUMERICAL WEATHER AND CLIMATE MODELS INCLUDING FORECASTS FROM VERSION 2 OF THE CLIMATE FORECAST SYSTEM (CFSV2) AND, FOR THE FIRST TWO WEEKS OF THE MONTH, FROM THE NORTH AMERICAN ENSEMBLE FORECAST SYSTEM (NAEFS), A BIAS-CORRECTED, MULTI-MODEL ENSEMBLE OF THE NCEP GLOBAL ENSEMBLE FORECAST SYSTEM AND ENVIRONMENT CANADA ENSEMBLE MODELS.