CPC Unified Precipitation Climatology, Regime-dependant bias-correction and Forecast Verification

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CPC Unified Precipitation dataset application for NAEFS forecasts

- Station-based 0.5x0.5 degree gridded precipitation analysis
  - ¼ degree resolution available over the U.S.
  - Land-only
  - Merging with satellite data expected this year to produce global analysis
- 1979 to 2010 (present)
  - Daily resolution.
- Model bias-correction occurs on 5 and 7 day accumulated precipitation forecasts.

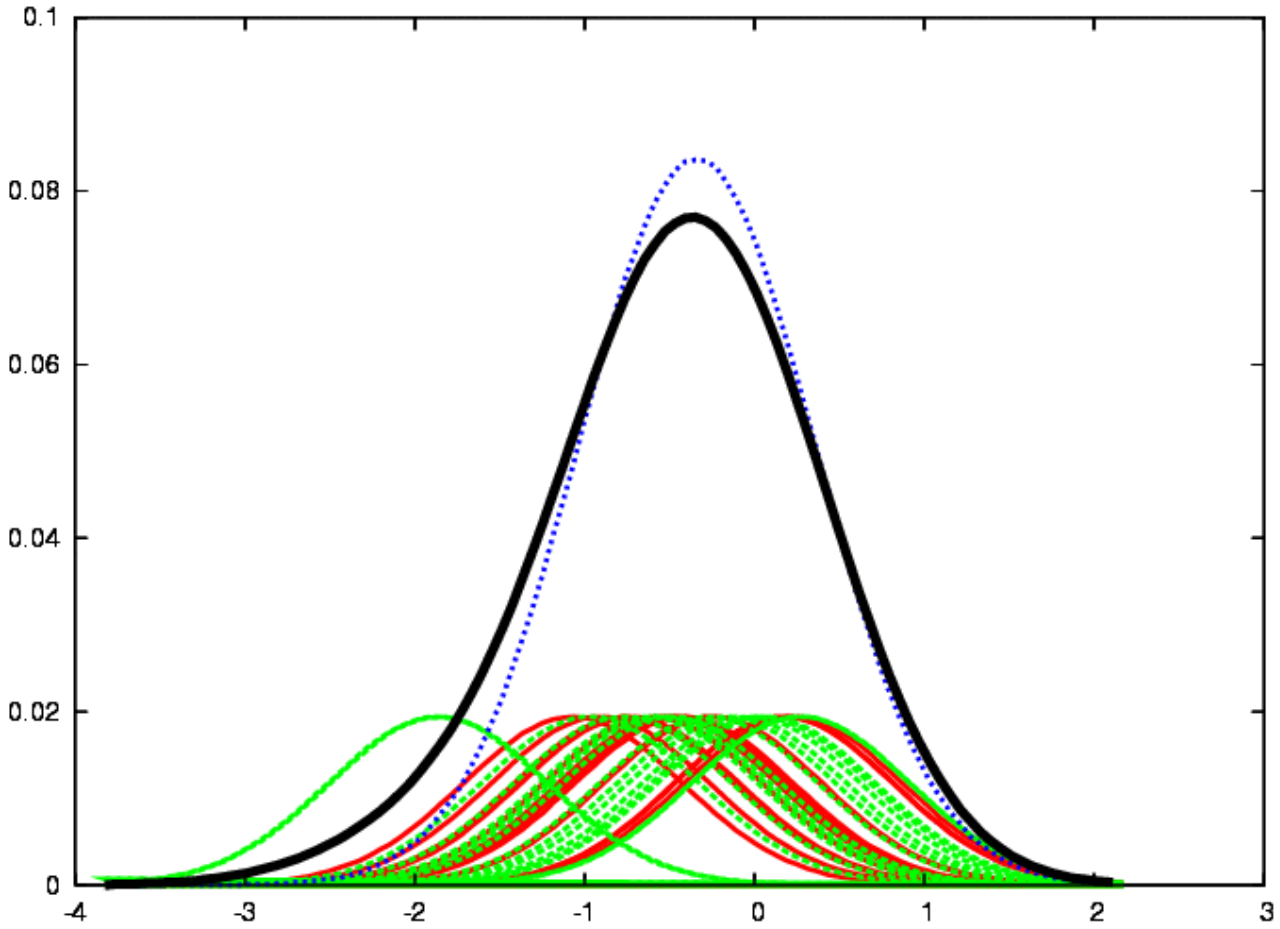
Development of a climatology using *CPC Unified Precipitation* dataset

- Need full distribution climatology as opposed to simply above and below normal category threshold values
  - Allows determination of extremes.
  - Non-normal distribution.
  - Difficult to parameterize the distribution for all locations fitting same type of distribution everywhere

- Obstacles
  - Discontinuous variable with many zeros
  - Some grid points with few positive values at all
  - Limited independent data to sample

- Solution:
  - **Non-parametric distribution**
  - To compensate for sampling errors, distribution is smoothed using kernel distribution function
  - Width of kernel proportional to standard deviation of the observations

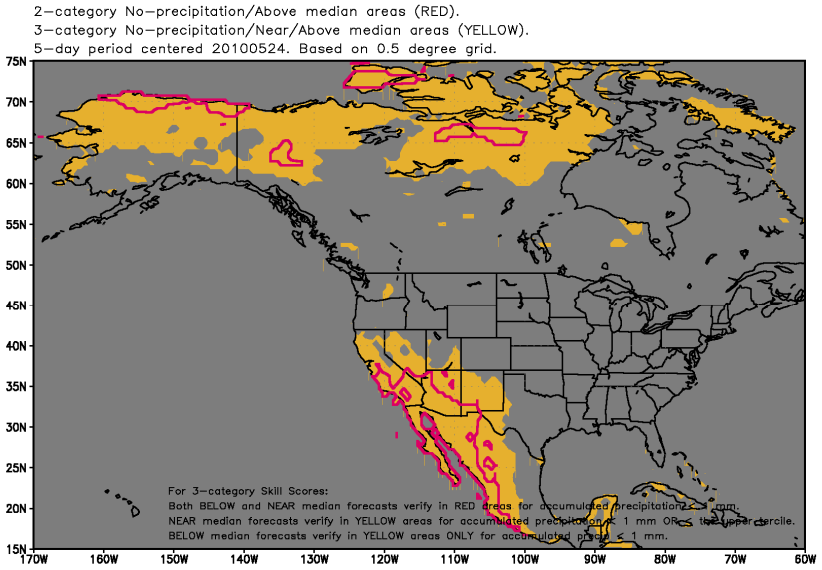
Climatology derived from precipitation observations as sample of true climatology distribution

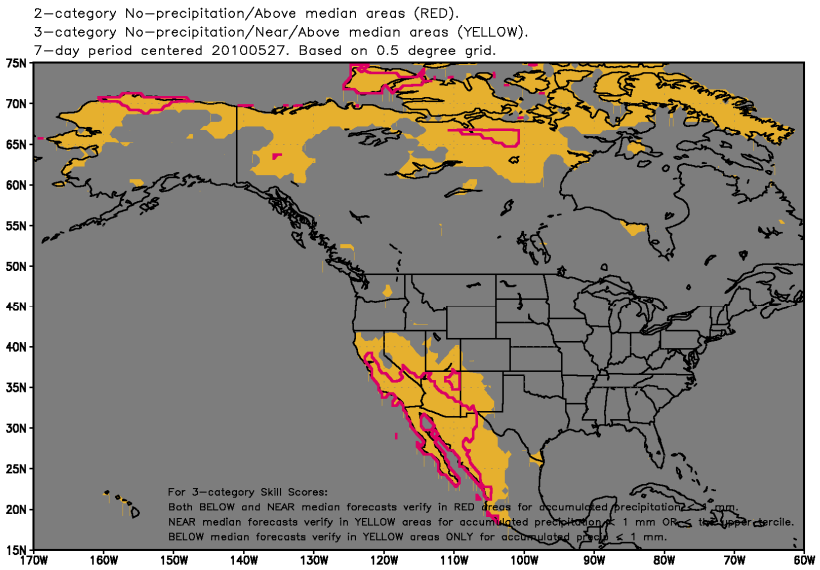


Climatology probability of precipitation used to determine locations that are dry normally

Climatologically dry areas are only forecast to be near-normal or above-normal;

Never should be below-normal





Discontinuity at zero precipitation

- Minimum accurately measurable and predictable precipitation chosen.
  - Using 1 mm as minimum measurable precipitation, but model may have little or no skill below 2-3 mm
  - Log(P) < 0 are separated for distribution
- Remaining measurable amounts used to create conditional distribution for measurable precipitation forecast and observation.
- Log precipitation used for both observational analysis and model data.
  - Decreases skewness; often too much
  - Errors are considered proportional to precipitation amount

Regime-dependent Bias-correction

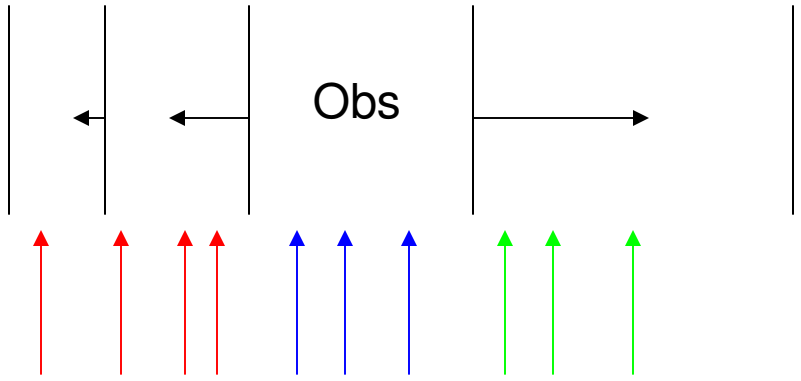
- Bias correction on log (precipitation) at multiple threshold values from 1 mm to ~150 mm (6 inches)

- **Bias is dependent on precipitation amount**

  – *Allows bias correction of **probability of precipitation** at the 1 mm threshold; however, model representation of low precipitation amounts lack skill.*

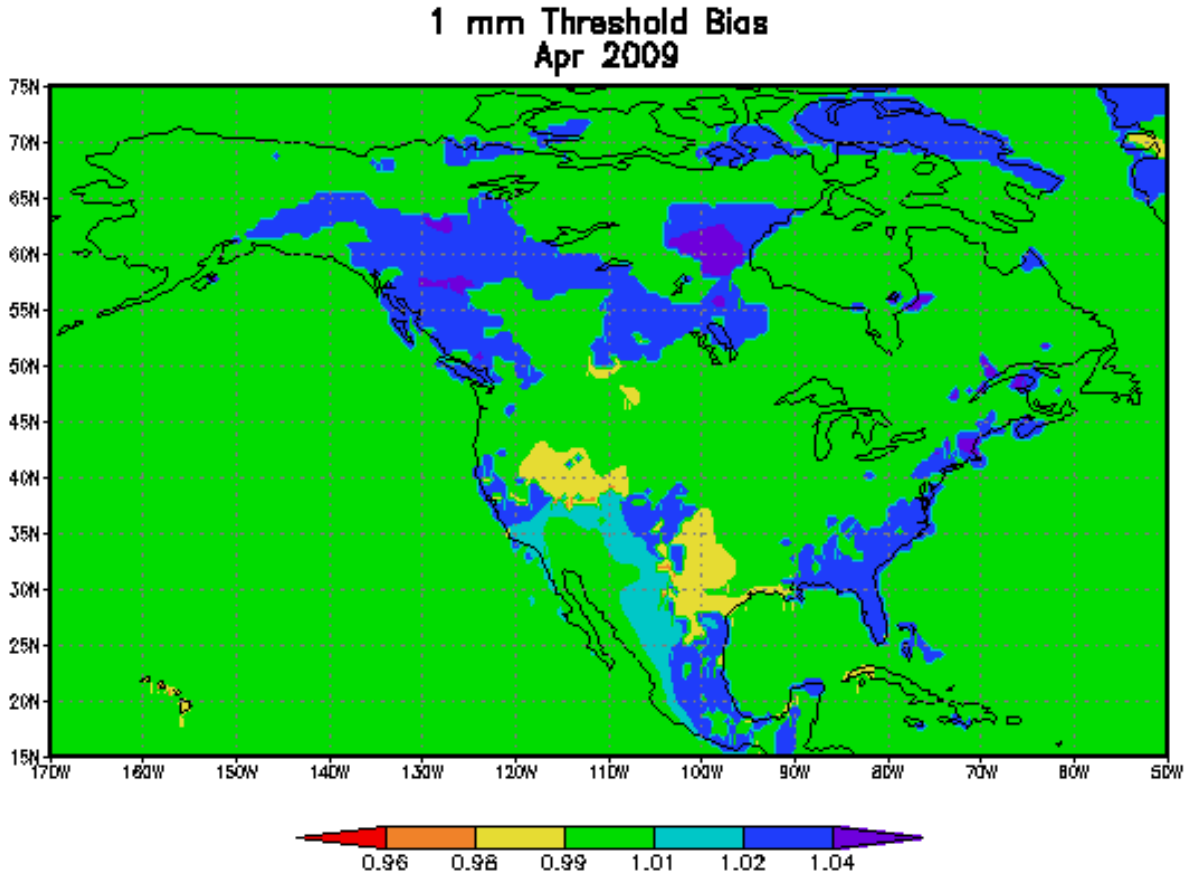
Regime-dependent Bias-correction

- Each precipitation event affects nearest thresholds
  - Threshold values are pushed towards neighboring values.
  - Change is related to closeness of next threshold creating a rippling or slinky effect when a thresholds move
  - Green forecast move thresholds up, Red moves them down, Blue members have no effect



10 member ensemble forecasts

Week-2 Precip
1 mm threshold bias estimate for April 2009

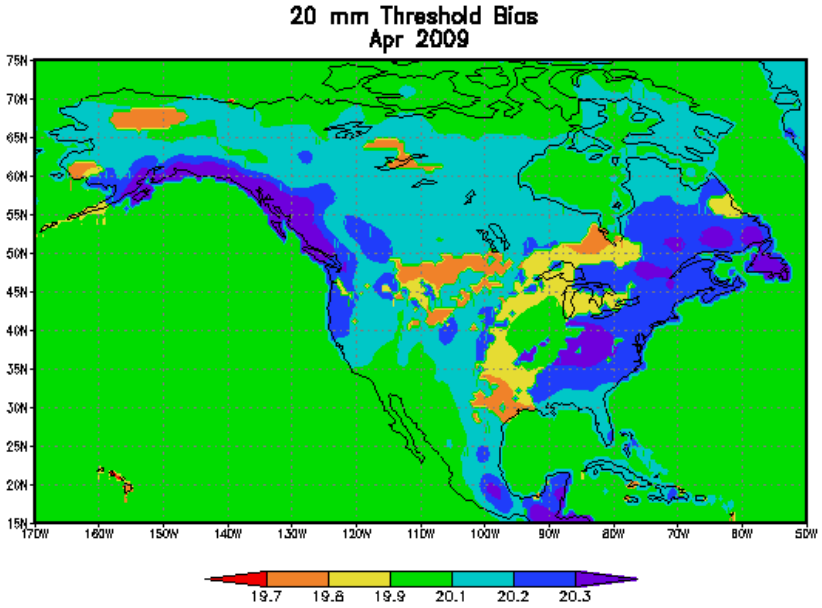


Wet bias over relatively dry, high latitude regions

1 mm used as “zero” threshold in forecasts

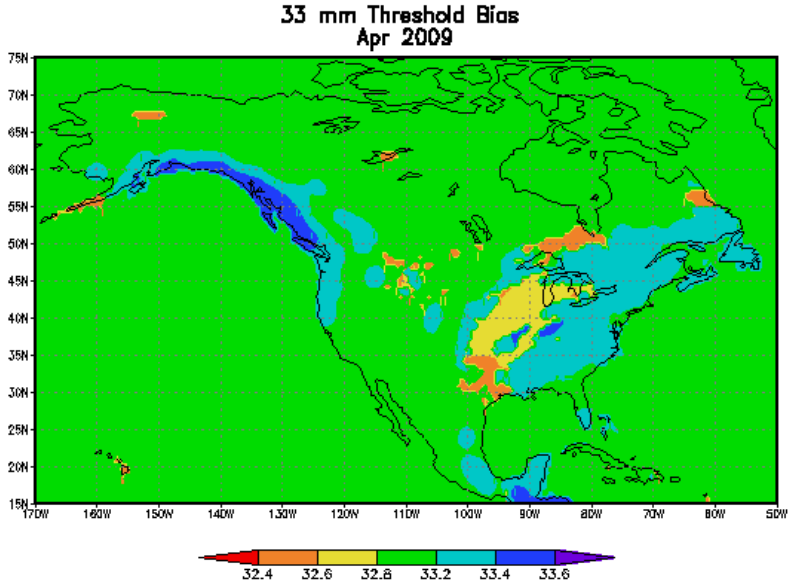
Limited ability to bias correct due to zero measurable precipitation discontinuity & poor model representation

Week-2 Precip
20 & 33 mm threshold bias estimate for April



Wet bias widespread but especially along Pacific & Atlantic Coasts and much of Eastern N. America

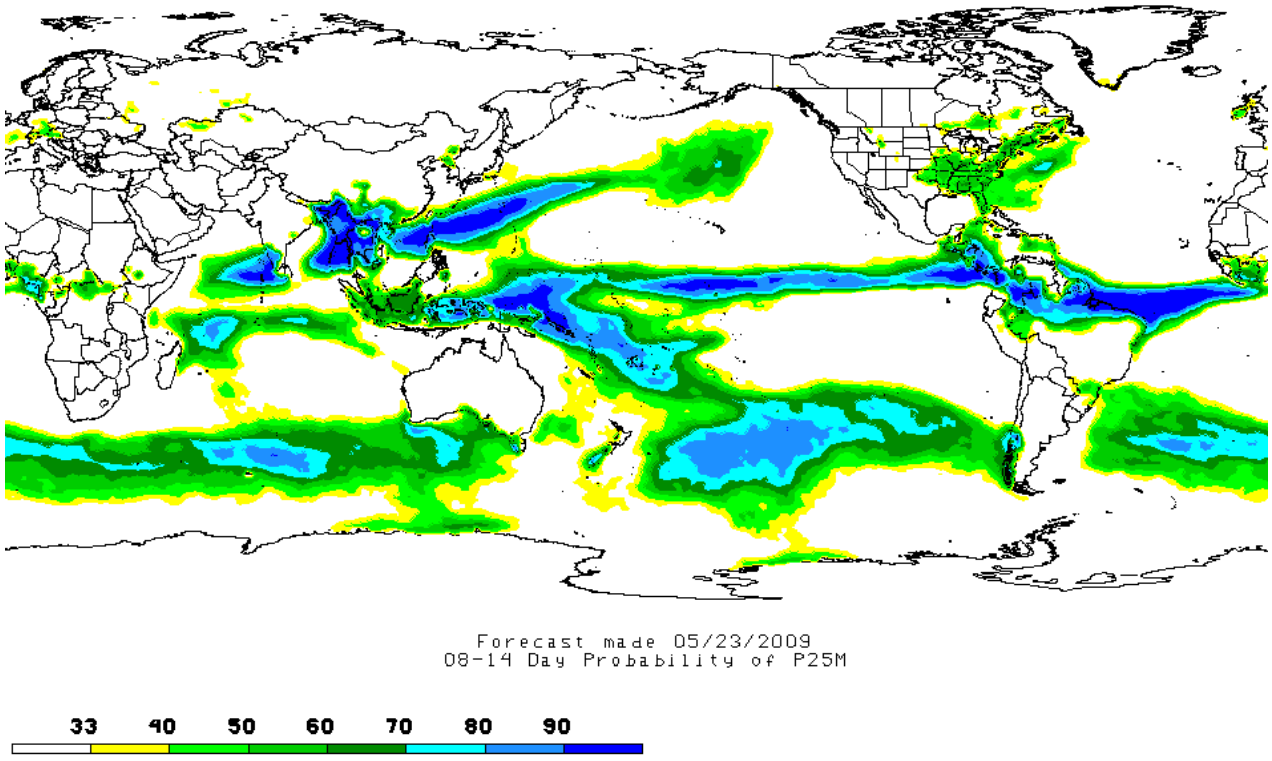
Dry biases appear related to individual extreme wet events



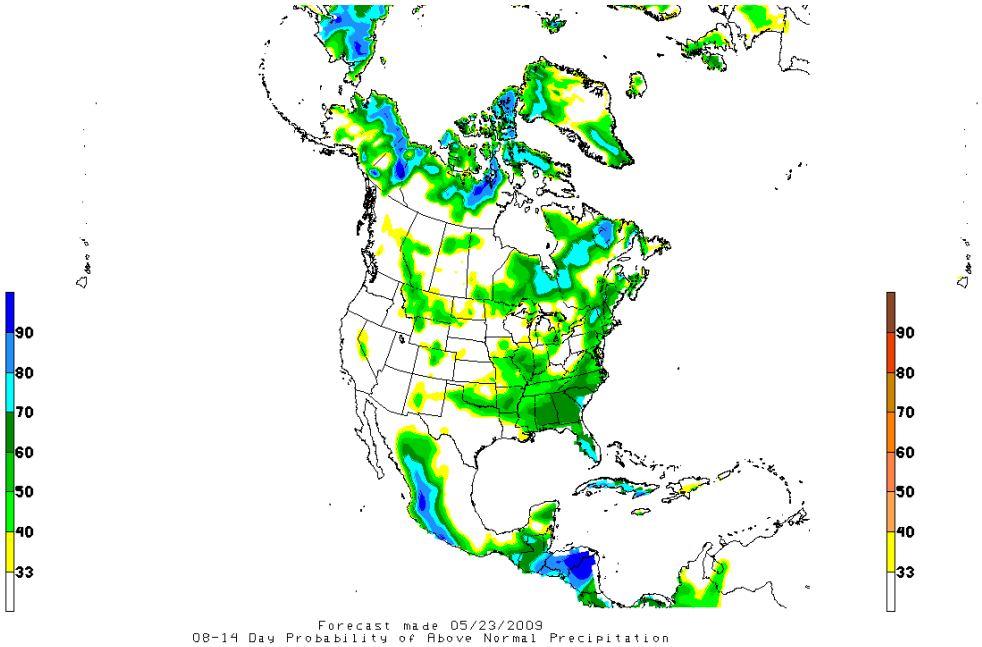
6-10 day and Week-2 CPC Precipitation Forecasts

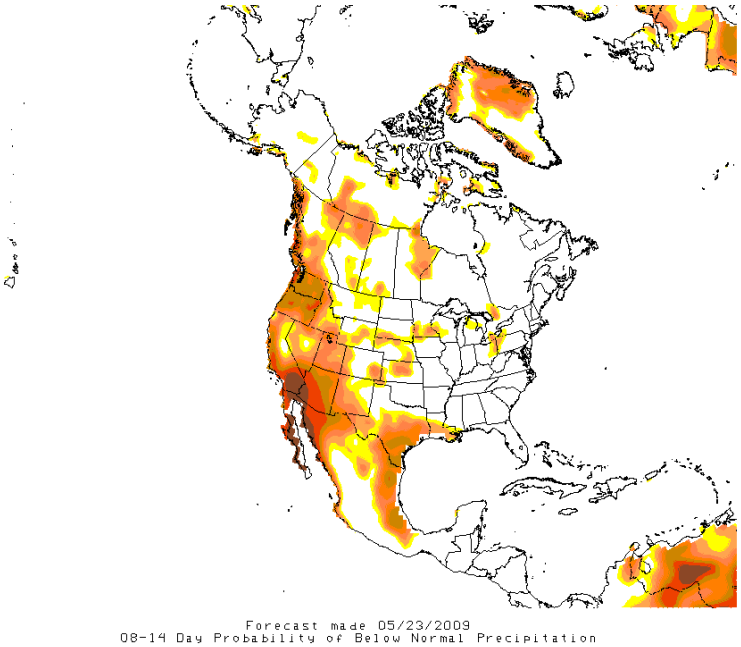
- Because CPC Unified precipitation analysis is currently higher resolution (½ degree) than model data (1 degree)
  - Model forecasts are *"downscaled"* by the bias-correction process.
- Appears to be one of more skillful forecast tools, especially for week-2, when skill is low.

25 mm or 1 inch threshold probability of exceedence



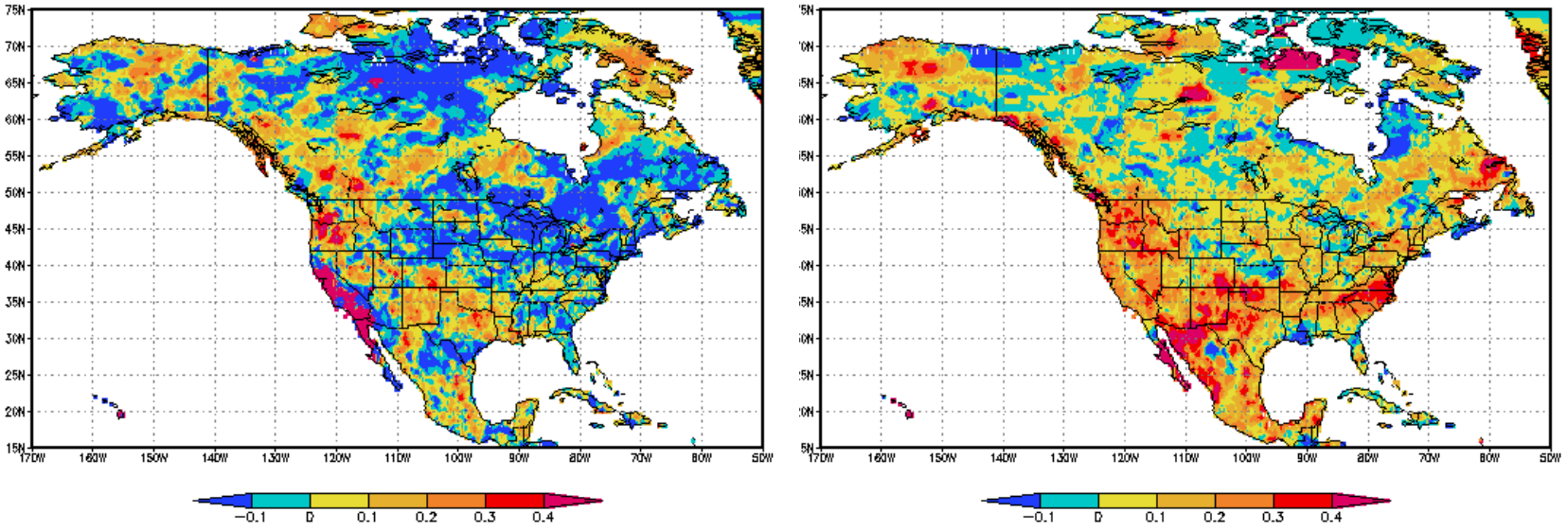
3-Category forecasts for above (left) and below (right) normal week-2 precipitation



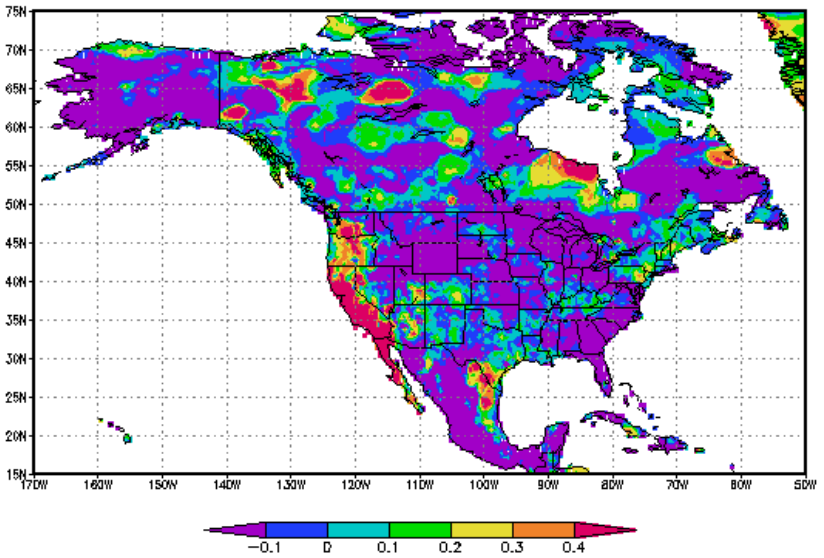


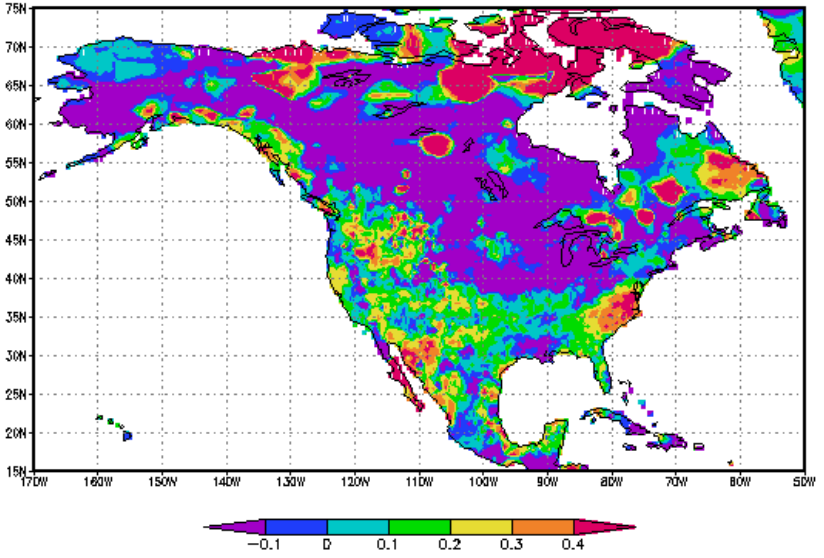
Week-2 Precipitation Heidke SS
DJF 2009-2010 & JJA 2009

0.17 HSS over Mexico during this winter

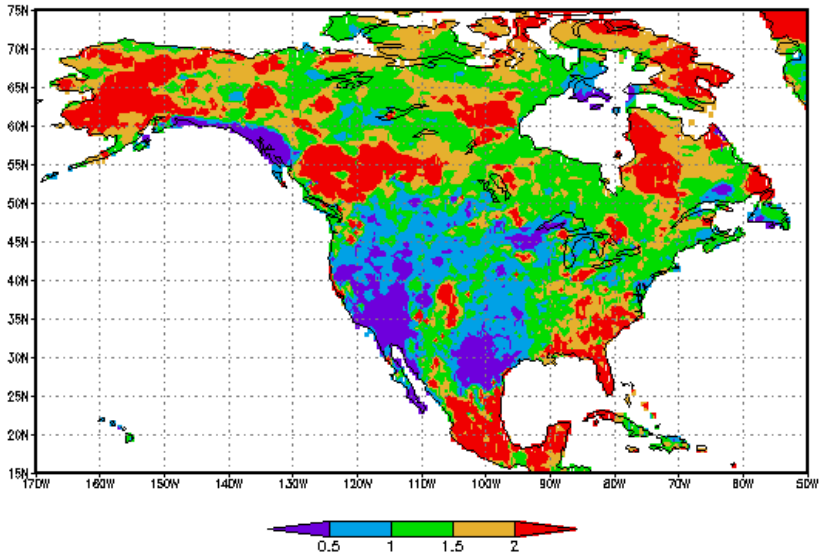


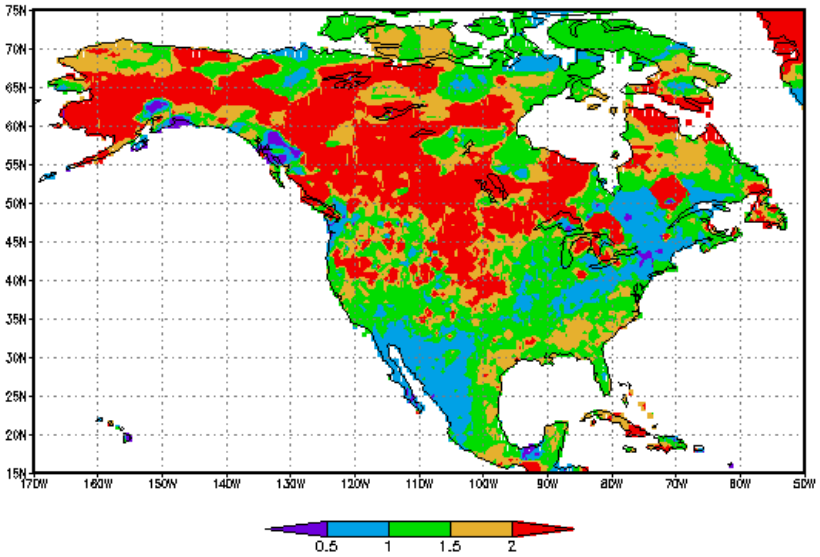
3-Category (Above, Below and Near-Normal) Rank Probability Skill Score



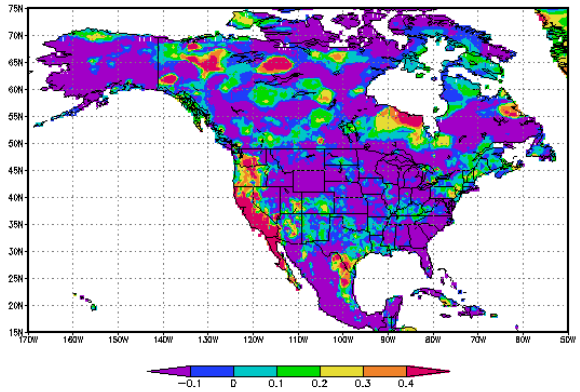


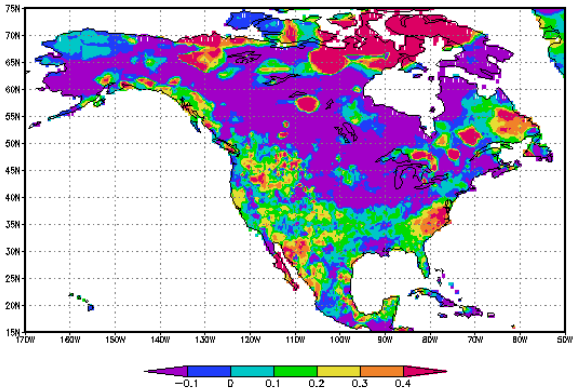
Above-Normal bias ratio

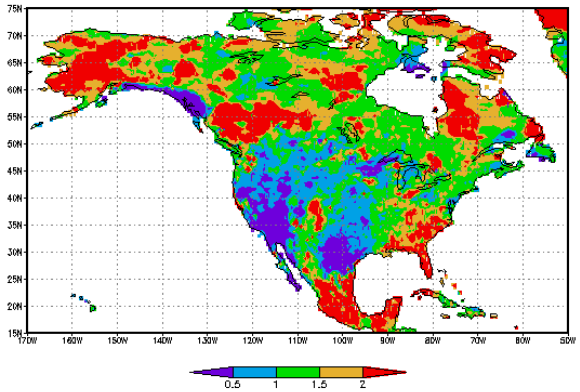


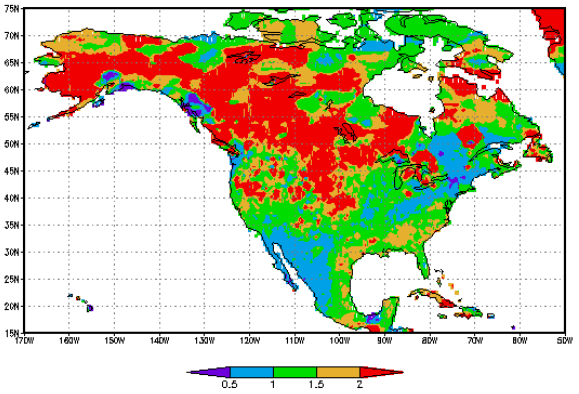


3-Category (Above, Below and Near-Normal) Rank Probability Skill Score (Top) & Bias in above-normal forecast frequency

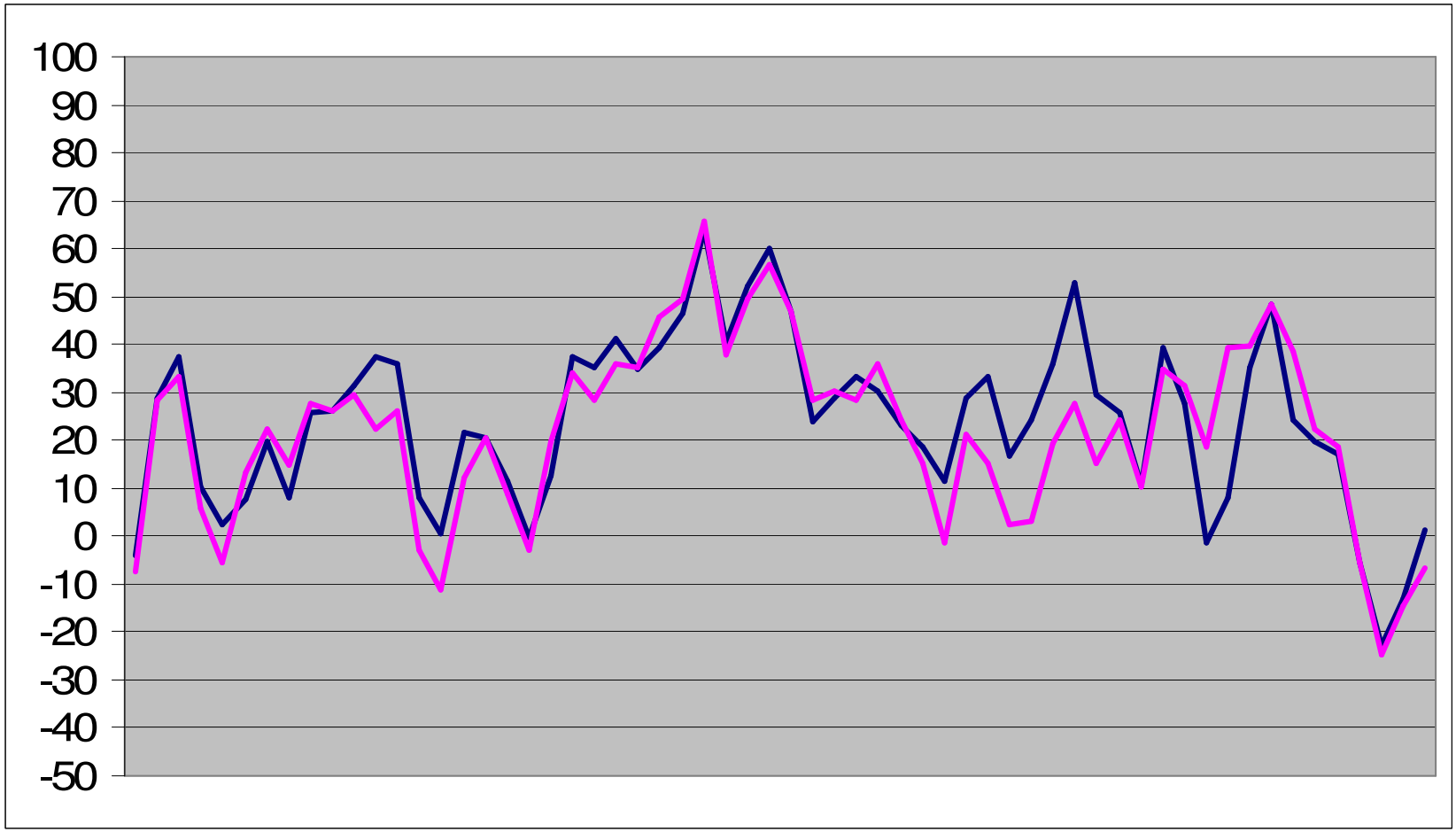




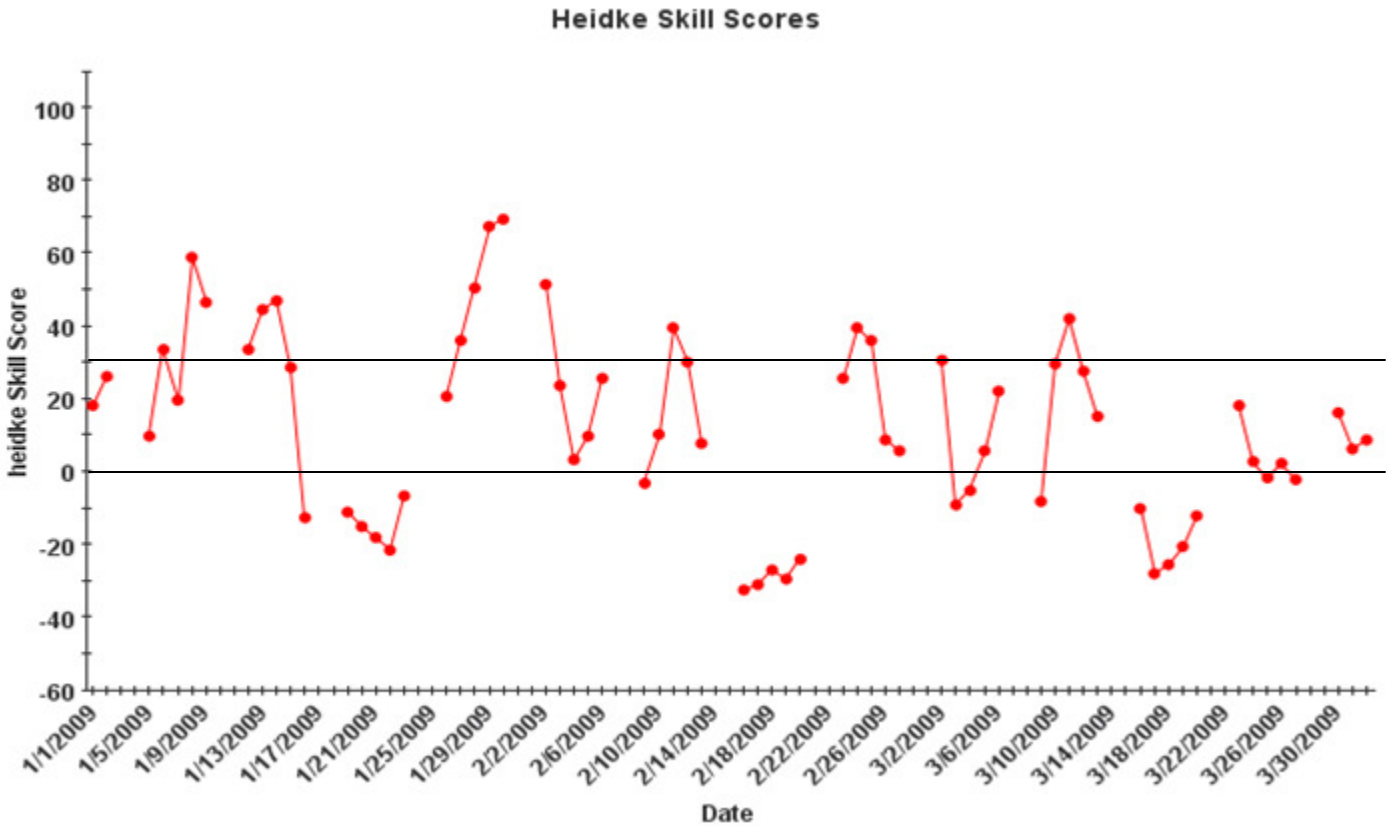




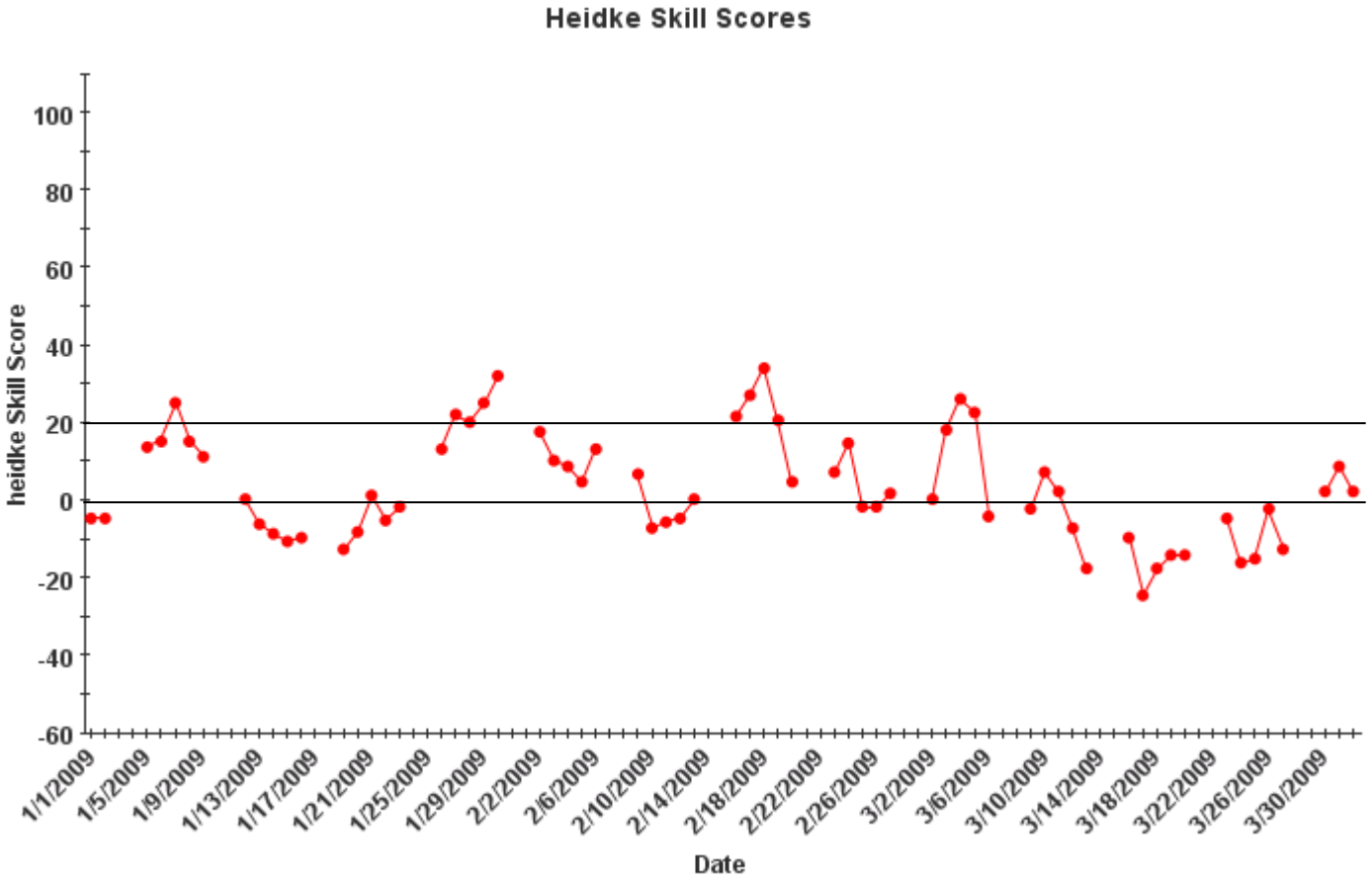
CPC Week-2 NAEFS Temperature: Winter Verification Heidke Skill Score



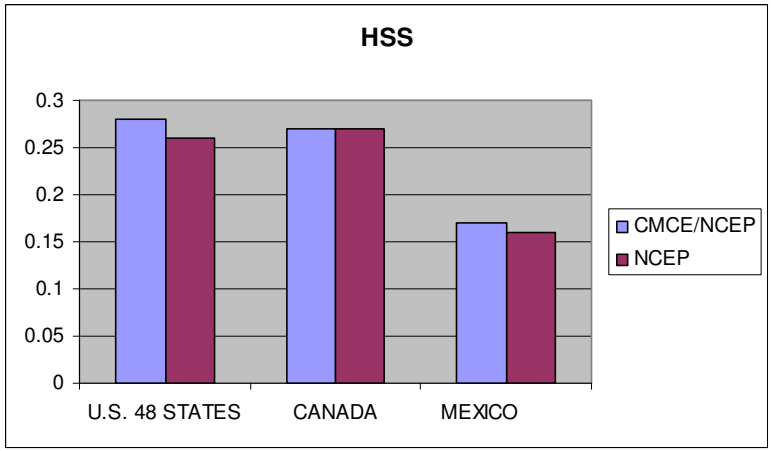
Official temperature forecast verification, Heidke Skill Score



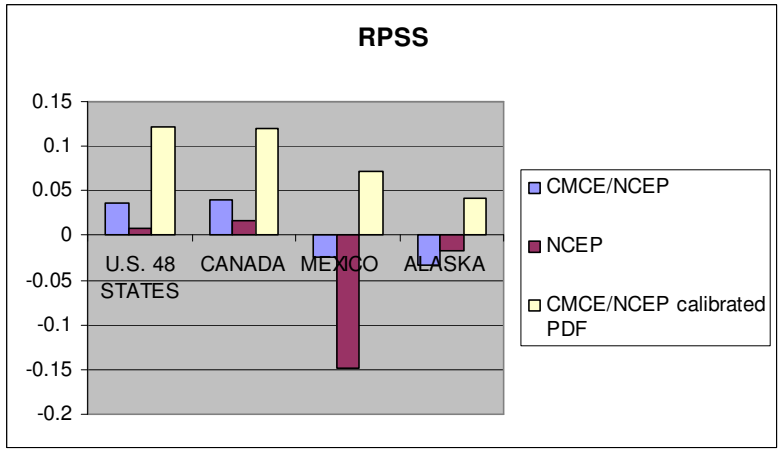
Official Week-2 precipitation forecast verification, Heidke Skill Score

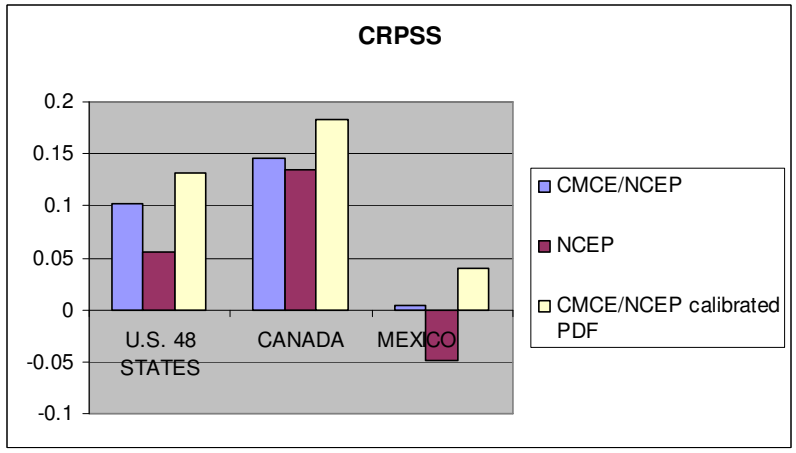


Week-2 Temp Verification: Tercile skill scores

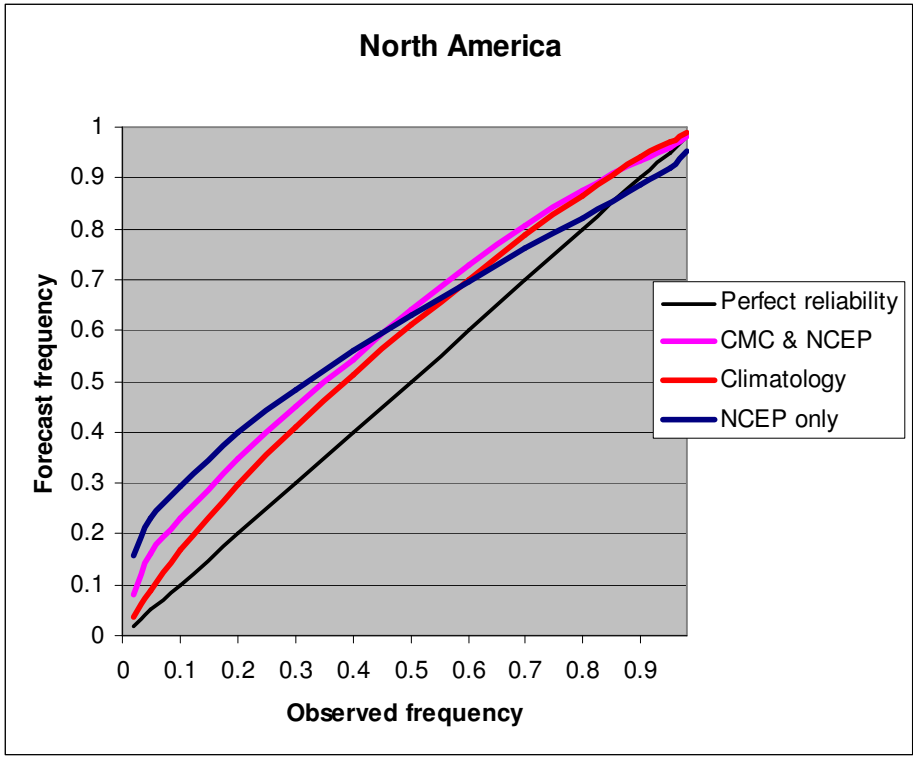


- No appreciable change in the Heidke skill score (HSS) with the addition of CMC ensemble to the NCEP ensemble
- Significant improvement in the probabilistic skill determined by a 3-category rank probability skill score (RPSS) and continuous RPSS.
- PDF calibration increases probabilistic skill





Week-2 Temperature: Reliability of Probabilities



- Reliability improves with addition of CMC ensemble to NCEP alone
- Reliability closer to climatology
- Climatology forecast reliability indicates November through April colder than climatology

The North American Ensemble Forecast System (NAEFS)