Annual Review of CPC's Operational Products 2005

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Chief, Operations Branch
NOAA-NWS-Climate Prediction Center
December 7, 2005

CPC's Operational Products/Activities

Prediction

- 6-10-/8-14-day T, P forecasts (daily)
- 30-/90-day T, P forecasts (bi-monthly-monthly)
- Seasonal ENSO forecast (nino 3.4 SST, monthly)
- U.S. 3-14-day Hazards Assessment (daily-weekly)
- Probability of Exceedance
- Heating and Cooling Degree Day forecast (weekly and seasonal)
- Global Tropical Hazards and Benefits Assessment (weekly)
- 6-10-/8-14-day Wind Chill (daily)
- 6-10-/8-14-day Heat Index (daily)
- U.S. Seasonal Drought Outlook (monthly)
- Atlantic Hurricane Outlooks (tri-annually)
- Africa Hazards Assessment
- Press and public interviews and questions
- Training courses for NWS Field (several/year)
- Verification – fosters improved forecasts, research, accountability

Monitoring

- U.S. Drought Monitor (weekly)
- ENSO Diagnostic Discussion (monthly, NOAA-wide assessment)
- Atlantic Hurricane Potential Monitoring (6-hourly-weekly)
- Pacific Hurricane Potential Monitoring (6-hourly-weekly)
- Daily Precipitation and Temperature monitoring
- Weekly ENSO Update (CPC assessment)
- Leading Patterns of Climate Variability - ENSO, MJO, Tele-connections, Storm Tracks
- Climate Diagnostics Bulletin (monthly)
- Weekly Weather and Crop Bulletin
- Weekly USDA WWCB Thursday Briefing
- Daily USDA Significant Weather Briefing
- Expert Assessments (seasonally and as required)
- Training of NWS Field (several/year)

Products in white are New in the last 10 years

Top Ten Users of CPC Website
September 2005

Rank	Hostname	Visitor	Hits (Avg.)/Day	% Total Hits
1	68.22.115.82	Ameritech Elec. Commerce	10,690	1.71
2	204.92.50.66	Power Ex	8,453	1.35
3	ws-125-3.startech.net	Startech Environmental Corp.	6,569	1.05
4	h216-165-191-196.216-165.unk.tds.net	TDS Telecom User	3,581	0.57
5	66.112.157.40	Data Transmission Network	3,532	0.57
6	66.249.65.145	Google User	3,186	0.51
7	207.242.93.9	Accuweather	2,889	0.46
8	67-67-5-163.perimtercenter.net	Perimeter Tech Center	2,347	0.38
9	meteorologico.imn.ac.cr	Costa Rica User	2,102	0.34
10	66.9.120.20	Intellispace Inc.	1,212	0.19

Top 10 Products & Pages

October 2005

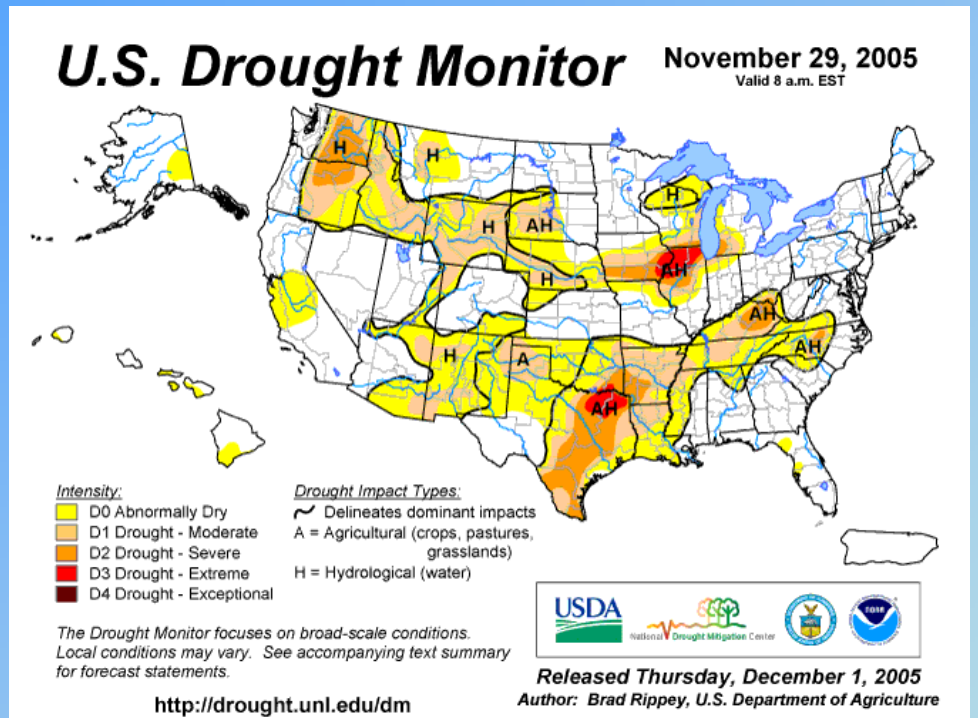
Rank	Product/Page	Hits (Avg.)/Day	% Total Hits
1	CPC Home Page	4,967	1.00
2	6-10 Day Outlook	3,374	0.68
3	8-14 Day Outlook	2,594	0.52
4	Atlantic Hurricane Outlook	1,350	0.27
5	U.S. Daily Data (text file)	1,272	0.26
6	Hazards Assessment	1,219	0.24
7	Winter Outlook	1,113	0.22
8	90-Day Outlook	1,085	0.22
9	30-Day Outlook	981	0.20
10	Outlooks Index	861	0.17

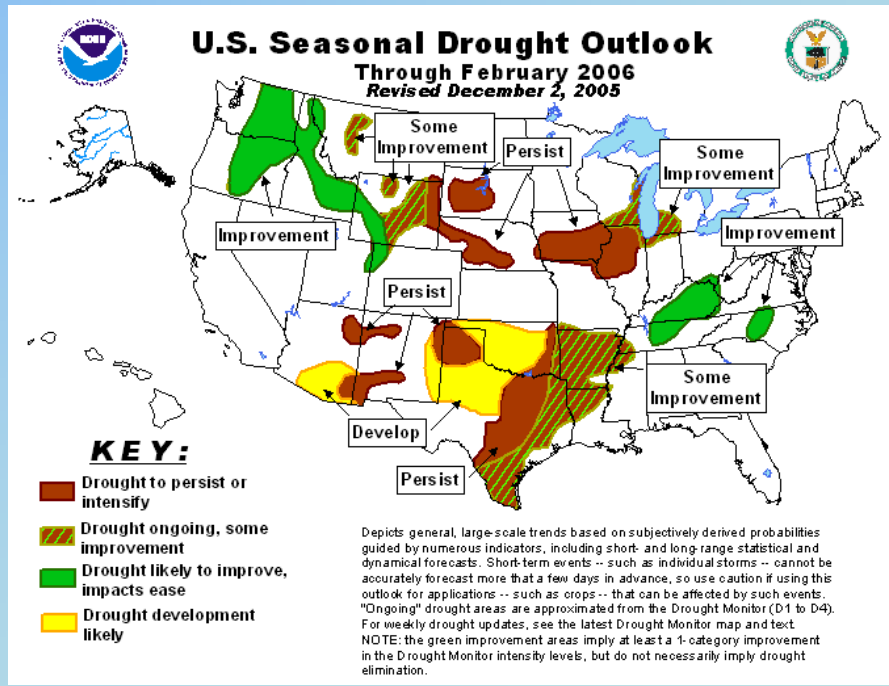
2005 Atlantic Tropical Storm Season

	May 16 Forecast	August 2 Forecast	2005 Actual	Average Season	% of Normal
Tropical Storms	12-15	18-21	26	11	236
Hurricanes	6-8	9-11	14	6	233
Major Hurricanes	2-4	5-7	7	2	350

U.S. Seasonal Drought Outlook

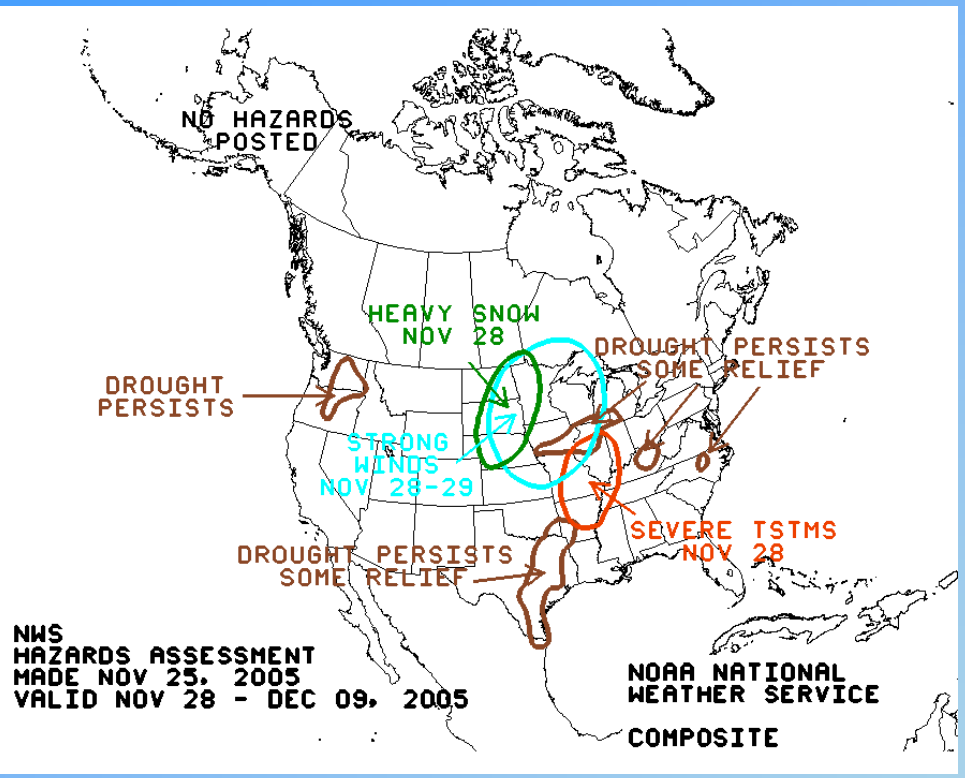
- DM is produced collaboratively each week with USDA, NDMC.
- Seasonal Drought Outlook is produced monthly at CPC.
- Outlook is zero-lead.
- Describes expected changes to the DM, based on CPC's seasonal outlook.
- Uses up-to-the-minute GFS model forecasts, from which much of the skill comes.





U.S. Hazards Assessment

Updated each Tue-Fri, using daily GFS forecasts of extreme events.



Heavy precipitation is defined as the greater of the 95th percentile, or 1 inch per day.

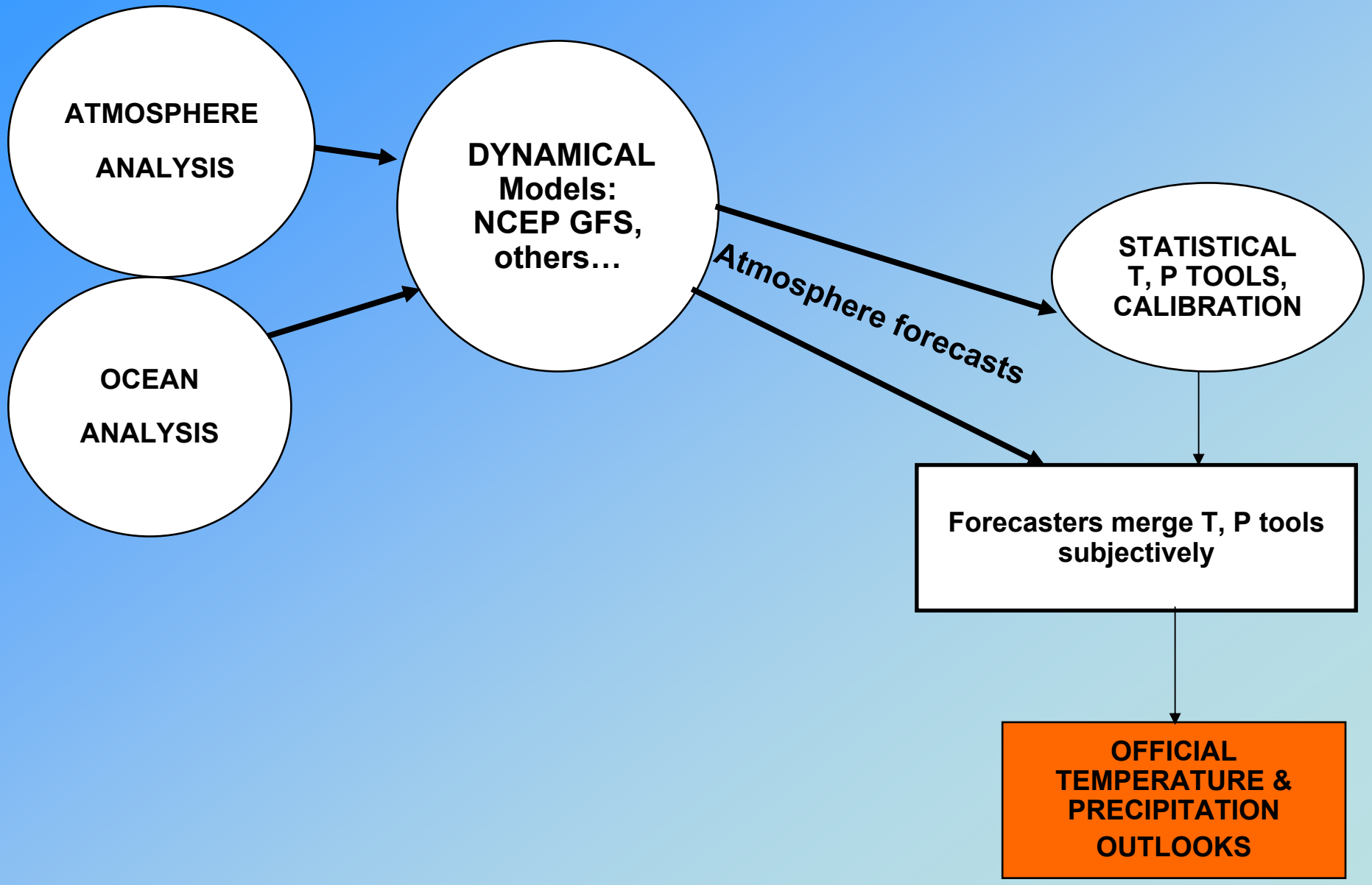
CONTINGENCY TABLE
HEAVY PRECIPITATON HAZARDS

	Observed	Not observed
Forecast	1472 a	4602 b
Not forecast	40457 c	265372 d

Hit rate, heavy Precipitation events = a/(a+b)
=# hits/(# all forecasts)
= 0.24

False Alarm rate, heavy Precipitation events = b/(a+b)
=# miss/(# all forecasts)
= 0.74

NCEP- CPC Extended-Range Forecast Operations



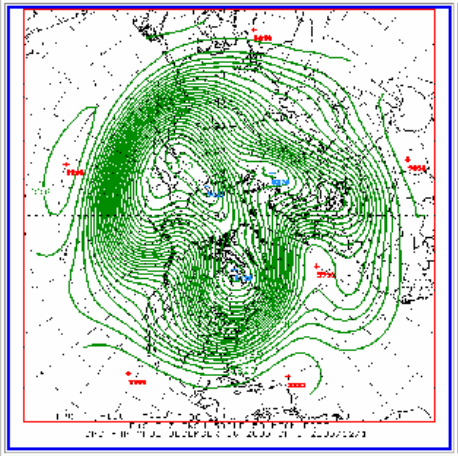
Links D+3 D+4 D+5 D+7 D+11

Please select a field. Images displayed will be of today's.

500 MB Heights

12/6/2005 12/5/2005 12/4/2005 12/3/2005 12/2/2005 12/1/2005 11/30/2005 11/29/2005 11/28/2005 11/27/2005 11/2

GFS Super Ensemble Mean - ETA 9:00 AM



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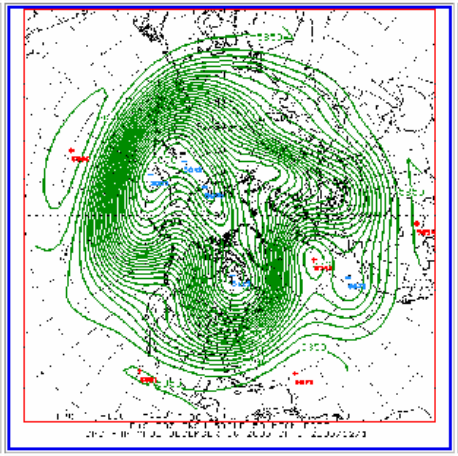
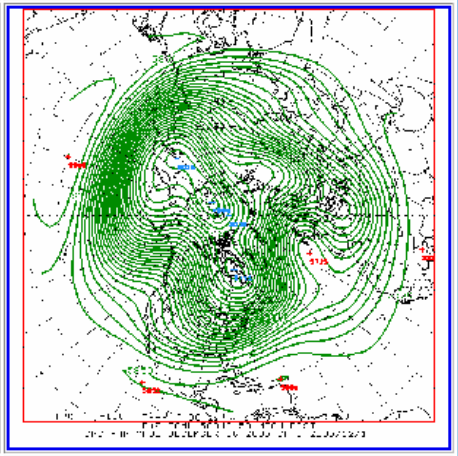
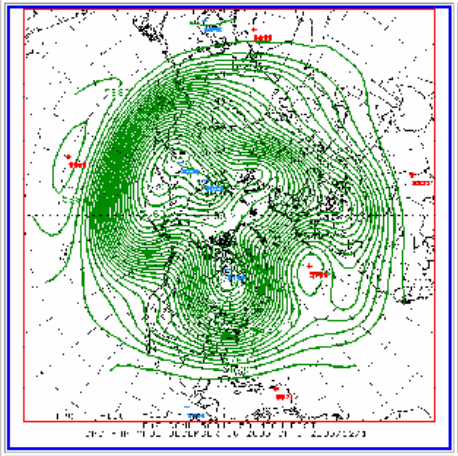


ECMWF Mean - ETA 5:45 AM



CAN Mean - ETA 6:40 AM



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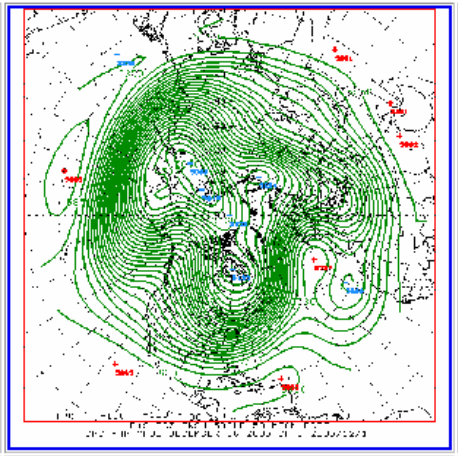

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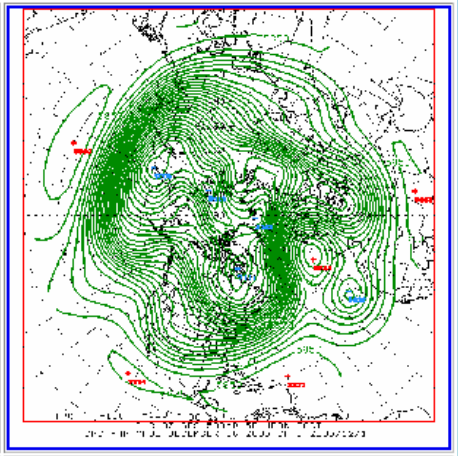

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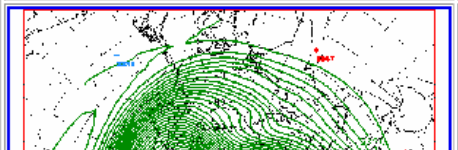
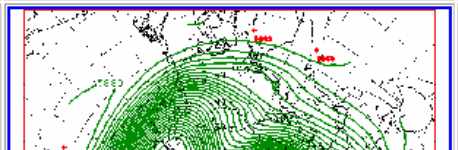
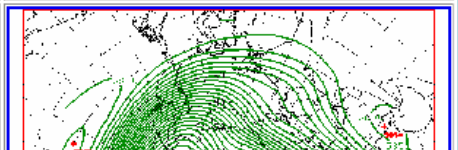


ECMWF - ETA 1:30 AM



DAVA - ETA 6:45 AM



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500 MB Anomalies

12/6/2005 12/5/2005 12/4/2005 12/3/2005 12/2/2005 12/1/2005 11/30/2005 11/29/2005 11/28/2005 11/27/2005 11/2

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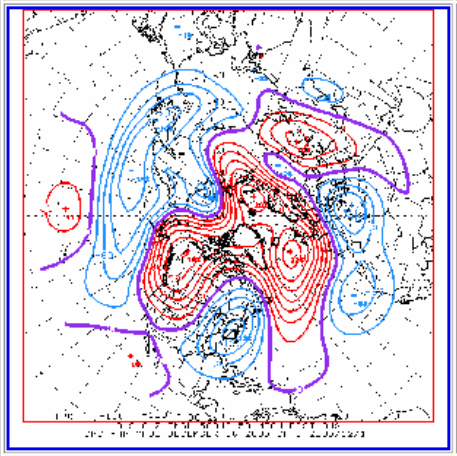

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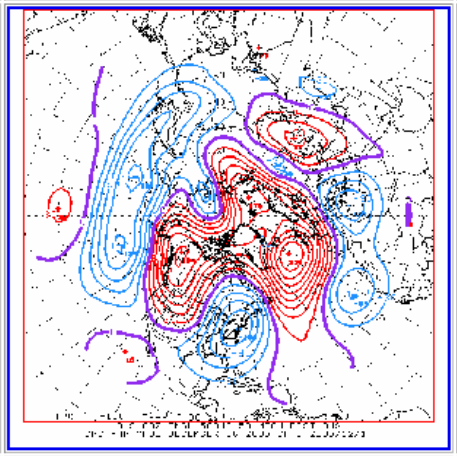
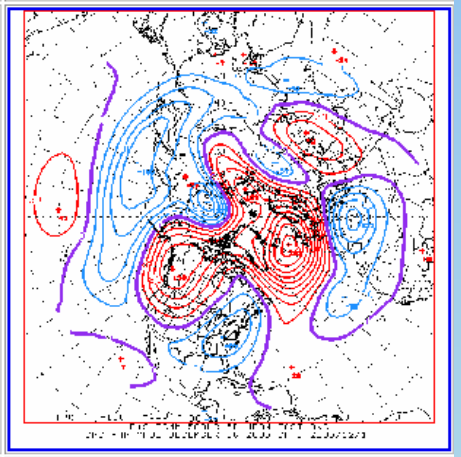
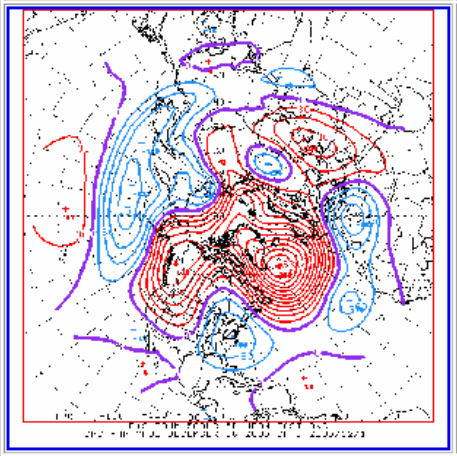


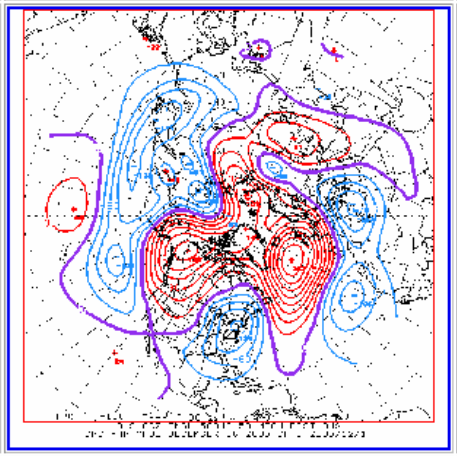
ECMWF Mean - ETA 5:45 AM



CAN Mean - ETA 6:40 AM



6z GFS ENS Mean - ETA 8:30 AM



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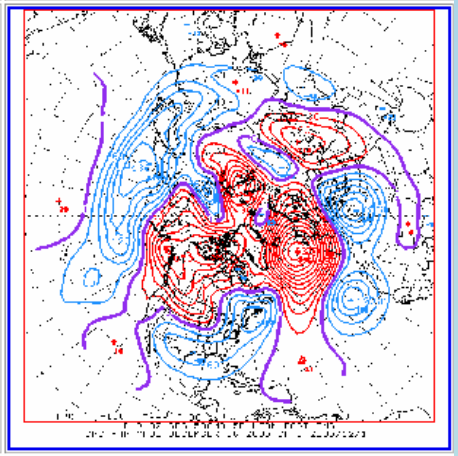

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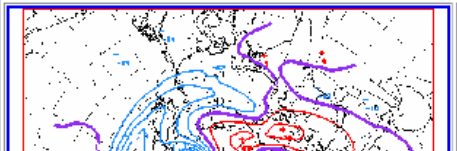
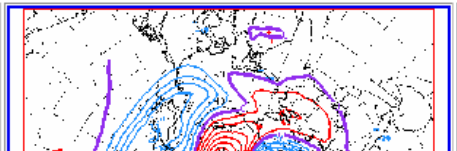
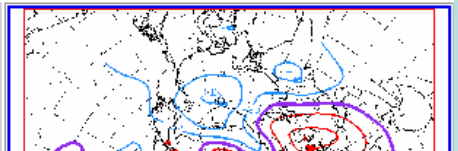


ECMWF - ETA 1:30 AM



DAVA - ETA 6:45 AM



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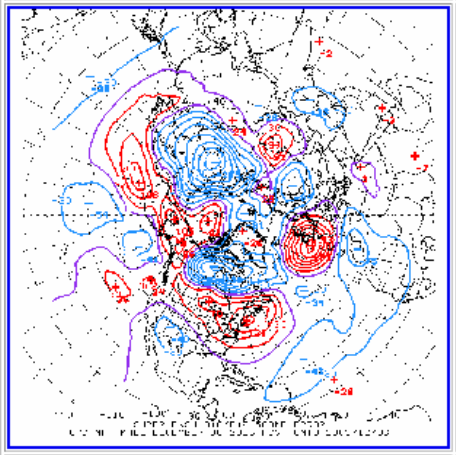
500 MB Height Errors

12/6/2005 12/5/2005 12/4/2005 12/3/2005 12/2/2005 12/1/2005 11/30/2005 11/29/2005 11/28/2005 11/27/2005 11/2

GFS Super Ensemble Mean



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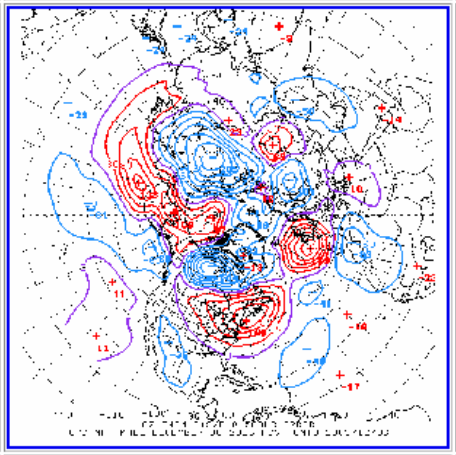

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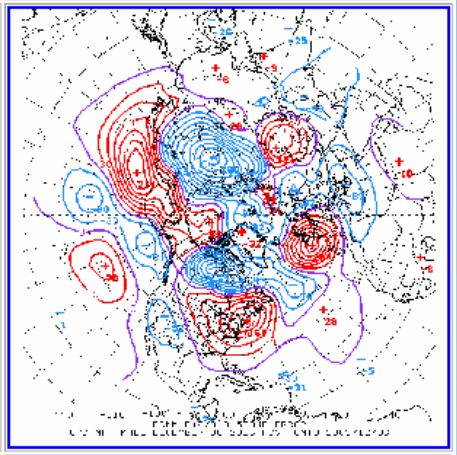
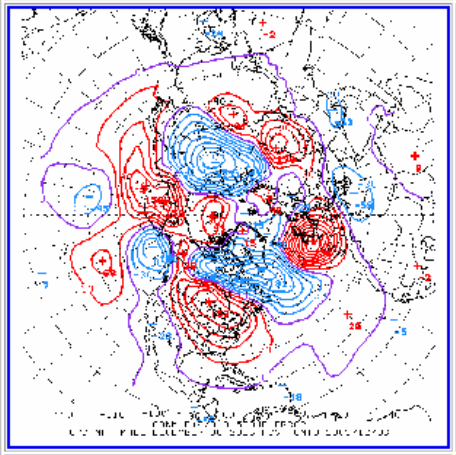


CAN Mean



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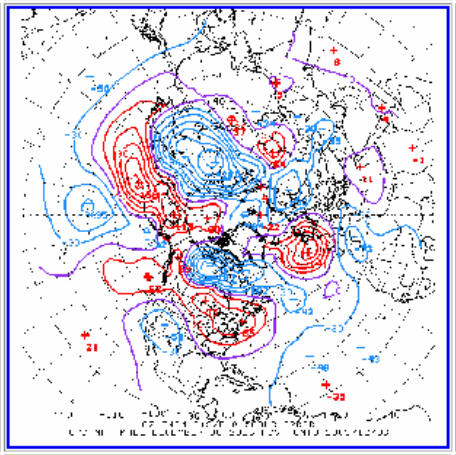

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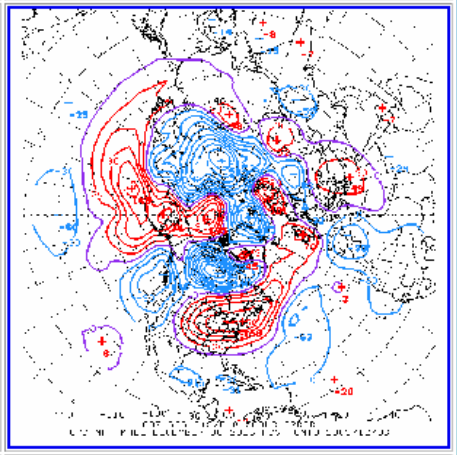

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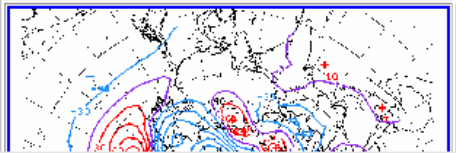

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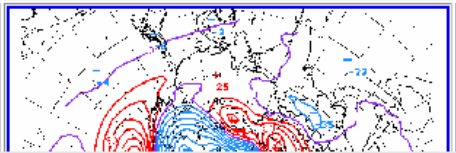

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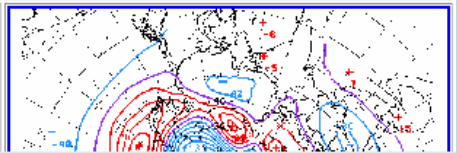
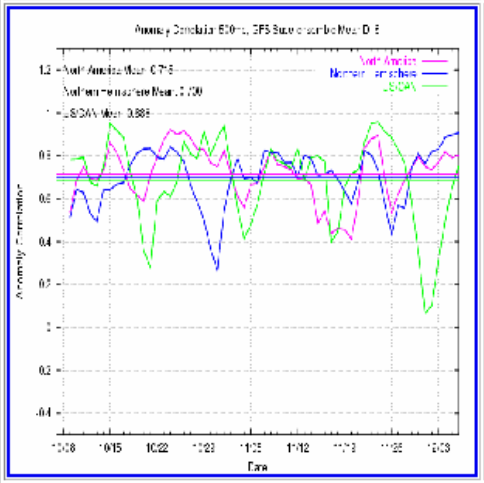


Please select a field. Images displayed will be of today's.

Anomaly Correlations

12/6/2005 12/5/2005 12/4/2005 12/3/2005 12/2/2005 12/1/2005 11/30/2005 11/29/2005 11/28/2005 11/27/2005 11/26

GFS Super Ensemble Mean



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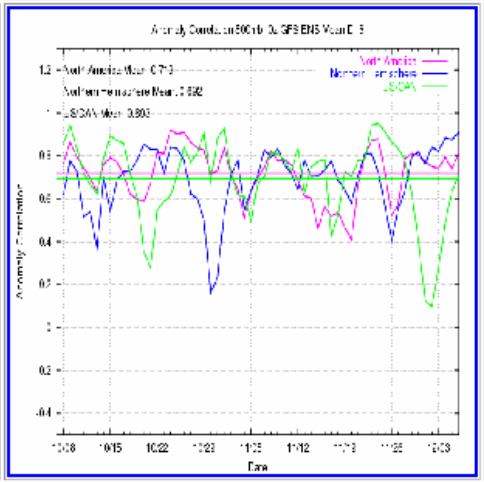

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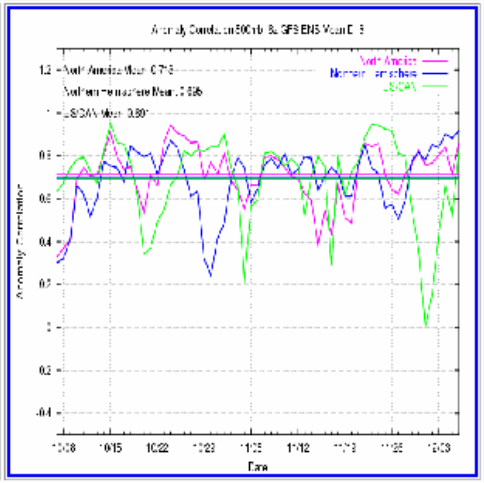
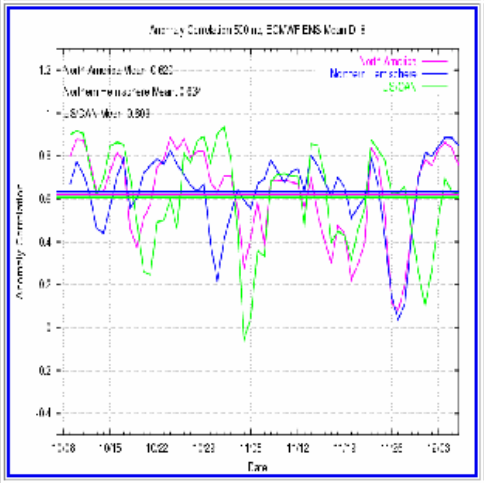
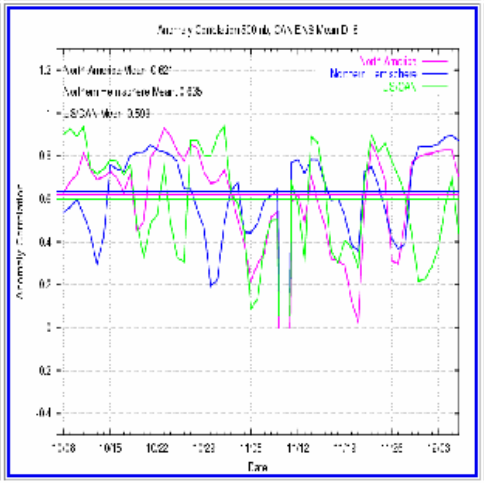


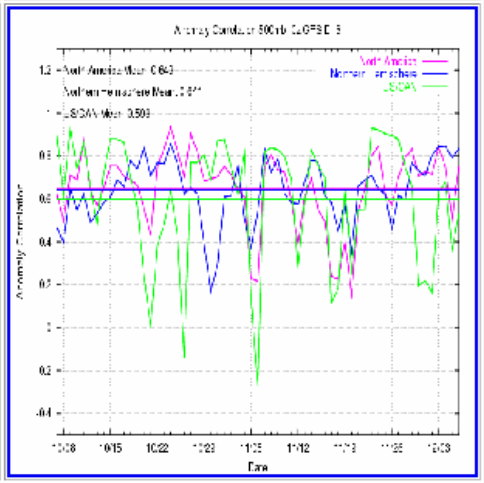
ECMWF Mean



CAN Mean



0z GFS



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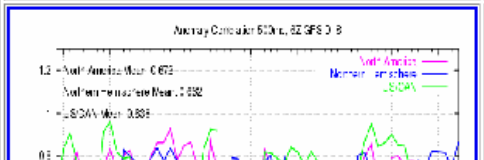

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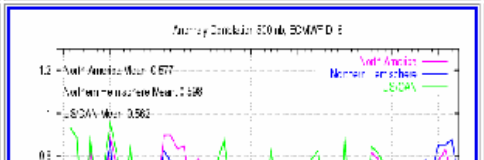

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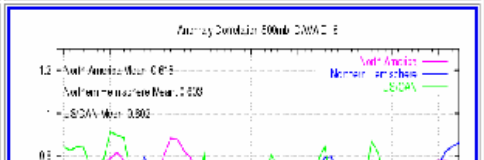
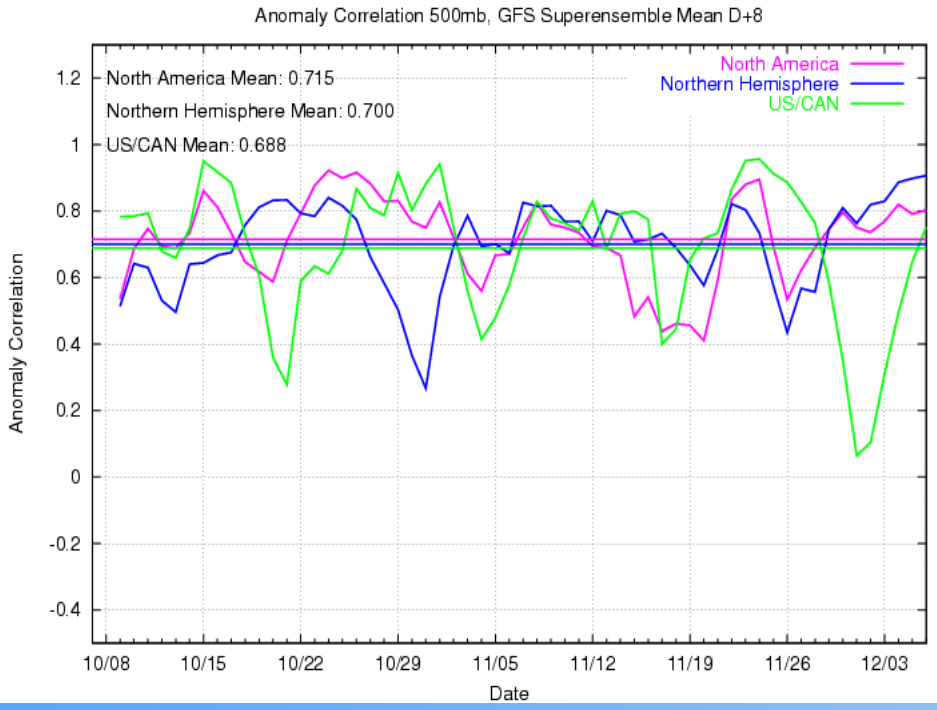
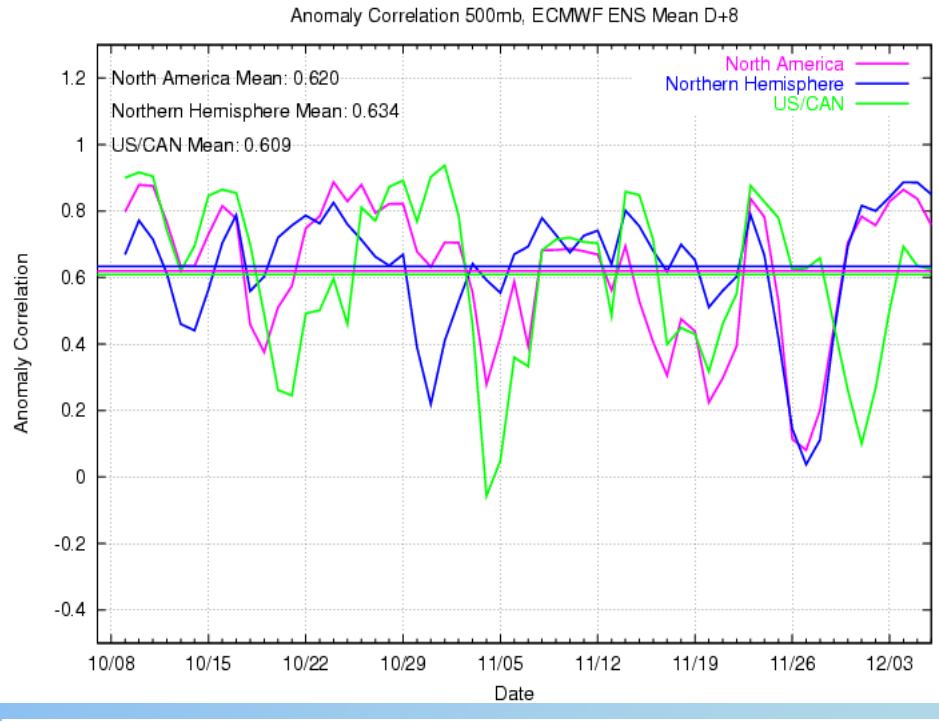



Anomaly Correlation 500mb, GFS Superensemble Mean D+8
North America Mean: 0.715
Northern Hemisphere Mean: 0.700
US/CAN Mean: 0.688
North America
Northern Hemisphere
US/CAN
Anomaly Correlation
Date
10/08
10/15
10/22
10/29
11/05
11/12
11/19
11/26
12/03


Anomaly Correlation 500mb, ECMWF ENS Mean D+8
North America Mean: 0.620
Northern Hemisphere Mean: 0.634
US/CAN Mean: 0.609
North America
Northern Hemisphere
US/CAN
Anomaly Correlation
Date
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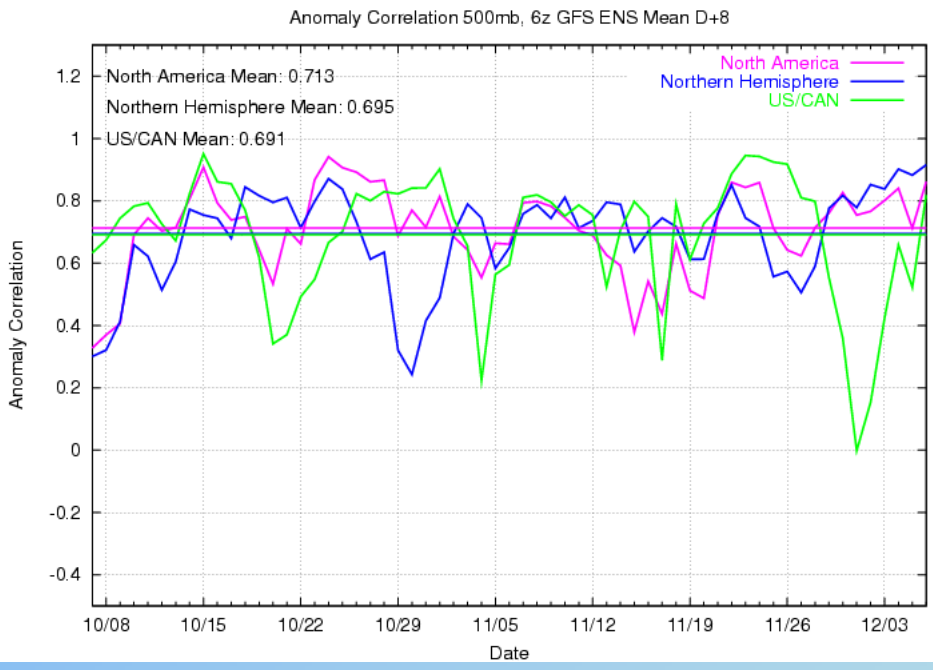
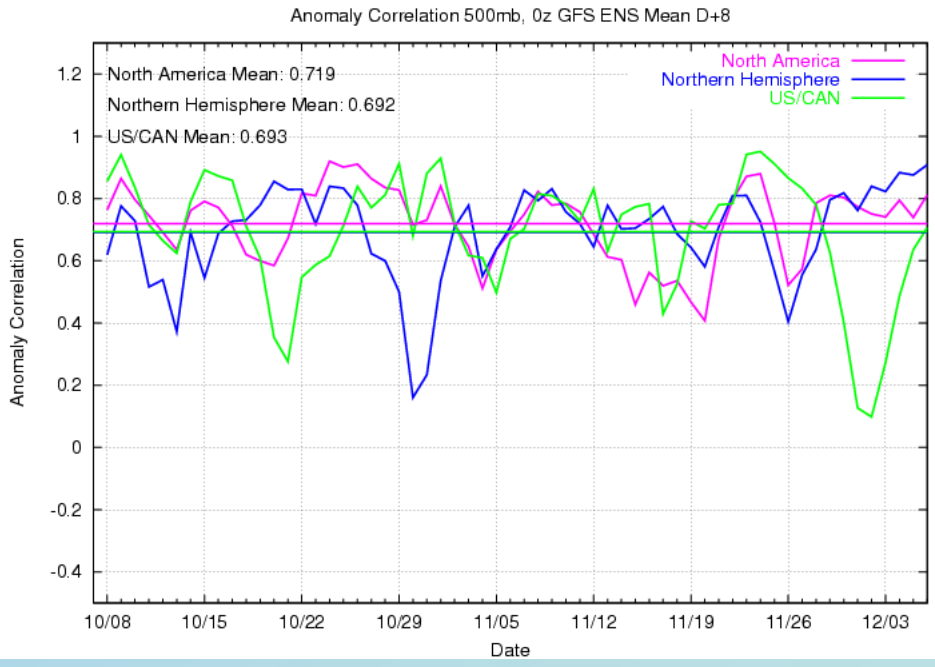
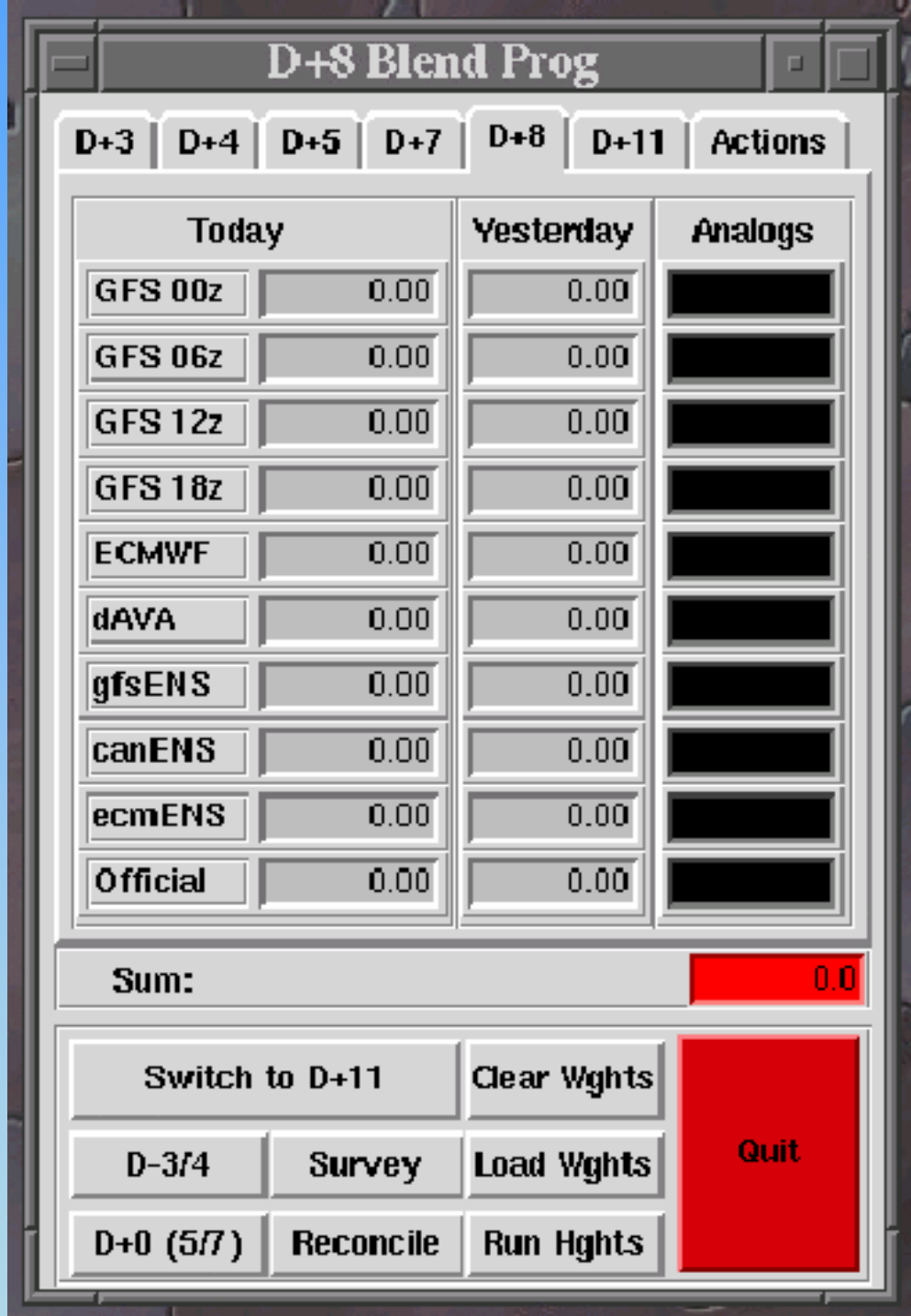
11/05
11/12
11/19
11/26
12/03

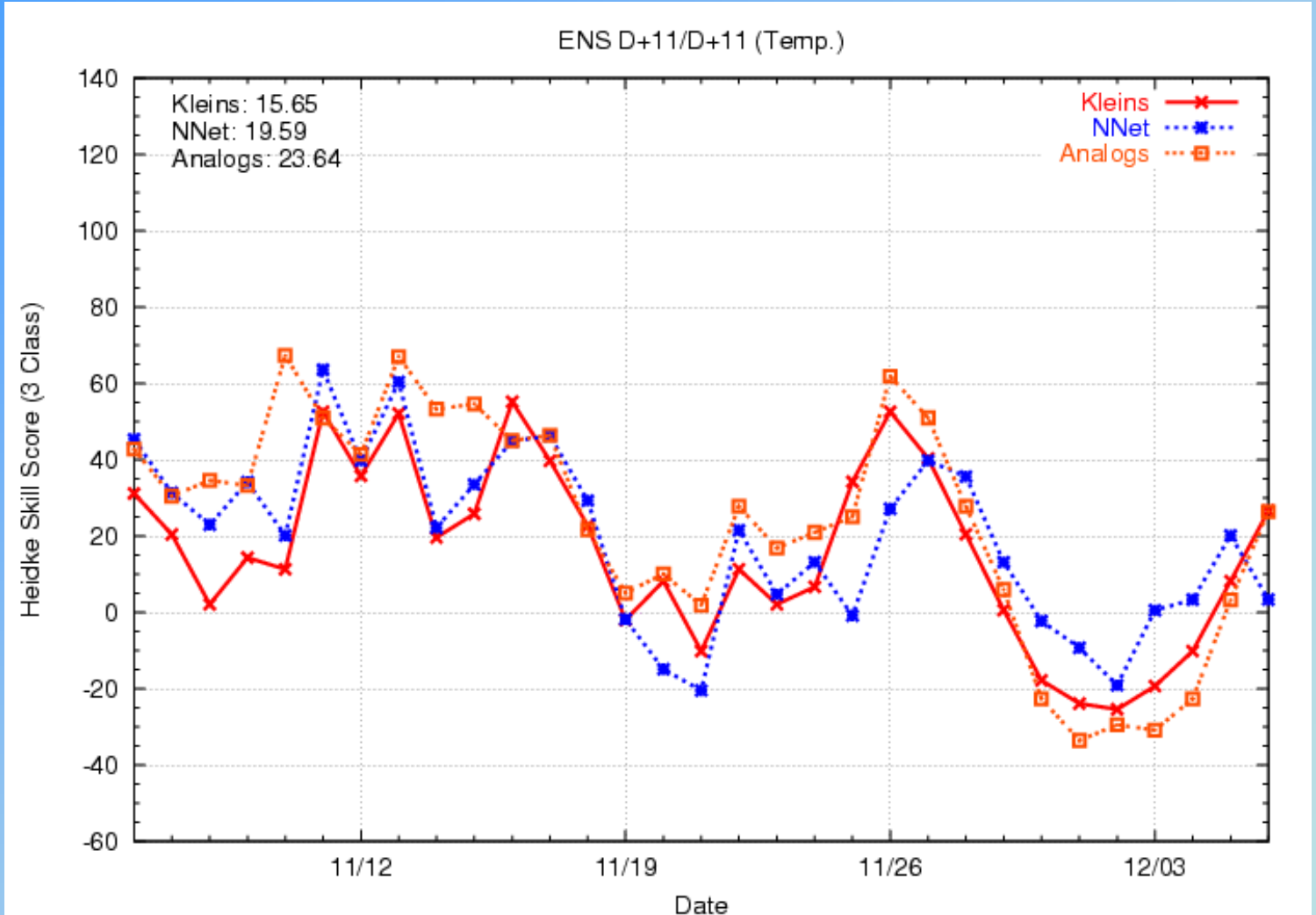

Anomaly Correlation 500mb, 6z GFS ENS Mean D+8
North America Mean: 0.713
Northern Hemisphere Mean: 0.695
US/CAN Mean: 0.691
North America
Northern Hemisphere
US/CAN
Anomaly Correlation
Date
10/08
10/15
10/22
10/29
11/05
11/12
11/19
11/26
12/03


Anomaly Correlation 500mb, 0z GFS ENS Mean D+8
North America Mean: 0.719
Northern Hemisphere Mean: 0.692
US/CAN Mean: 0.693
North America
Northern Hemisphere
US/CAN
Anomaly Correlation
Date
10/08
10/15
10/22
10/29
11/05
11/12
11/19
11/26
12/03

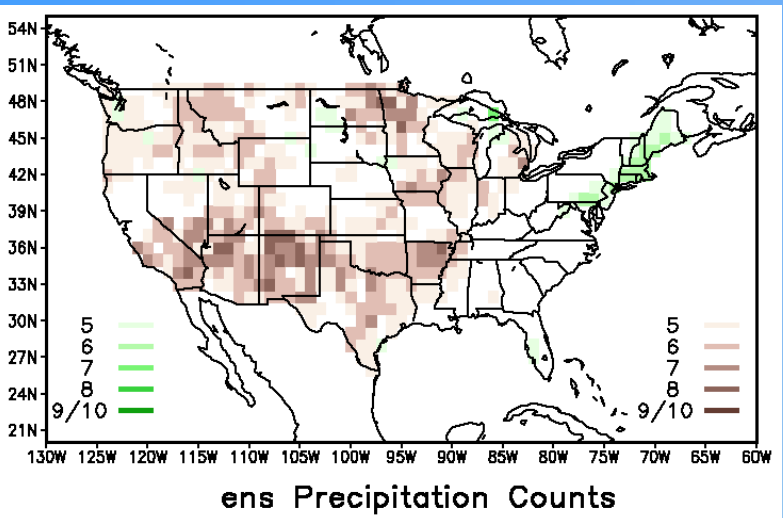
Almost since its inception in 1978, the 6-10 day and later, the 8-14-day, forecast used a weighted average of available forecast models. A GUI is currently used to create a weighted average of 500-hPa height forecasts

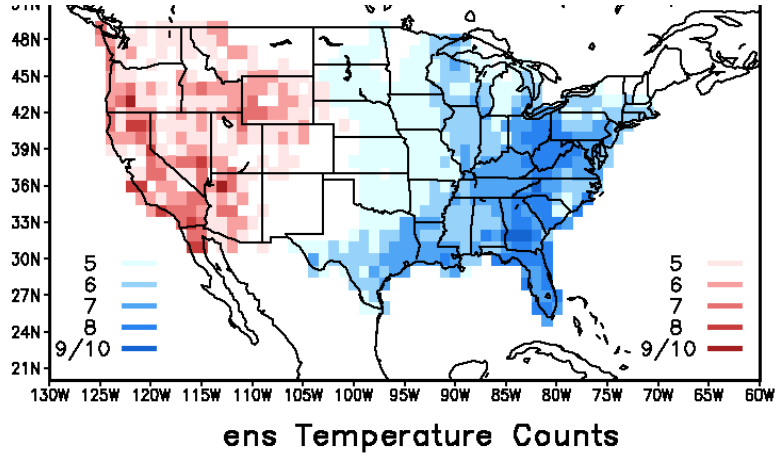


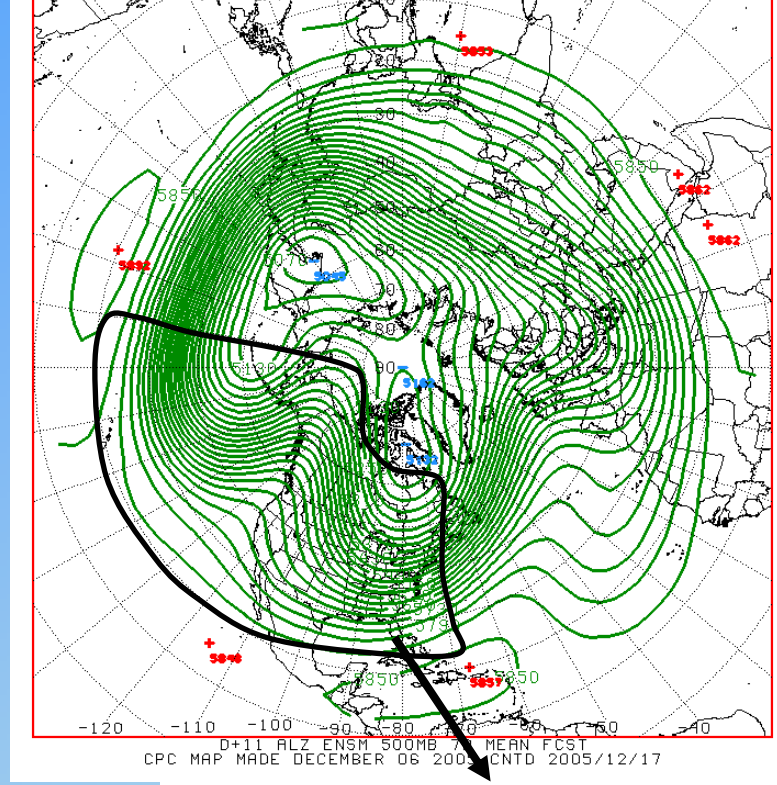
A Combination of Downscaling and Calibrated GFS Output Are Used to Forecast 2-m T and P

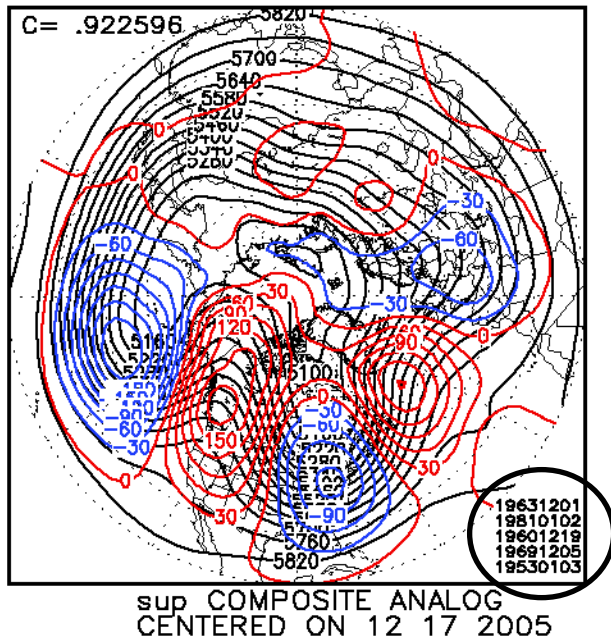


Natural Analogs Are Used to Downscale and for Calibration









Calibration

Systematic errors in models cause their probability forecasts for wet or dry, warm or cold, to differ from what is observed in nature. Calibration greatly reduces this problem.

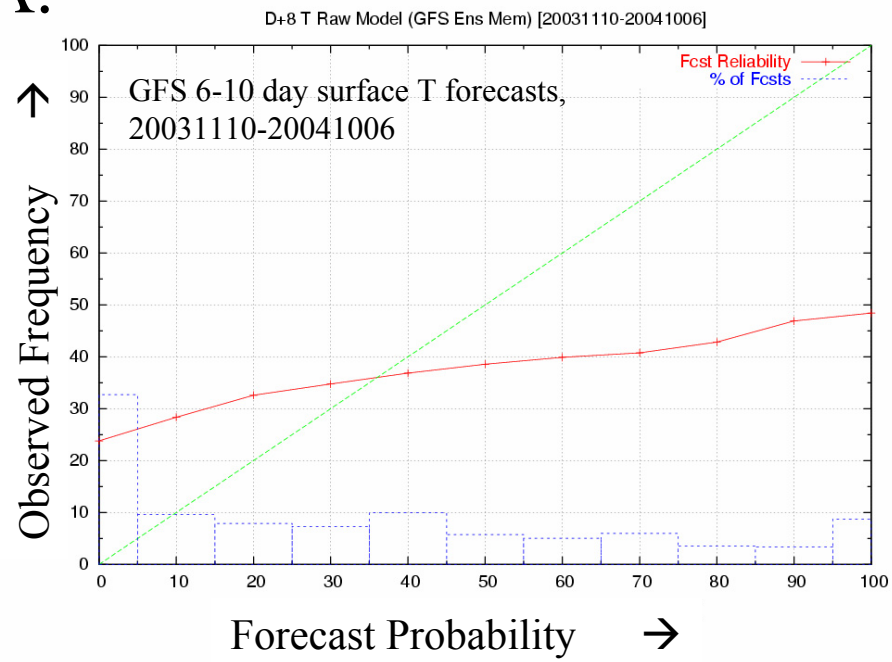
A. Example of poor calibration

B. Example of better calibration.

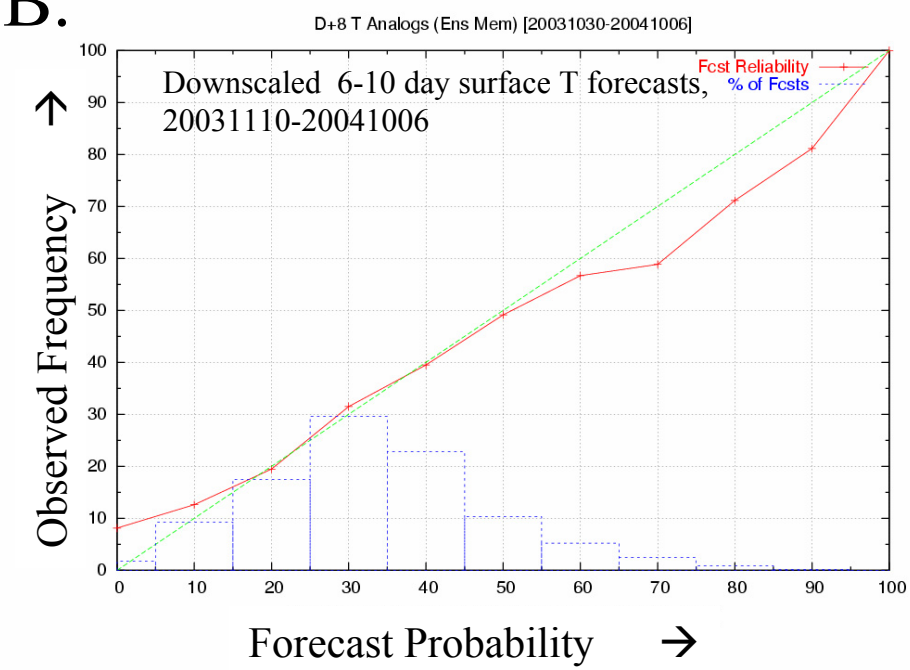
Climate model forecasts are calibrated.

Short and extended-range model forecasts are generally NOT calibrated.

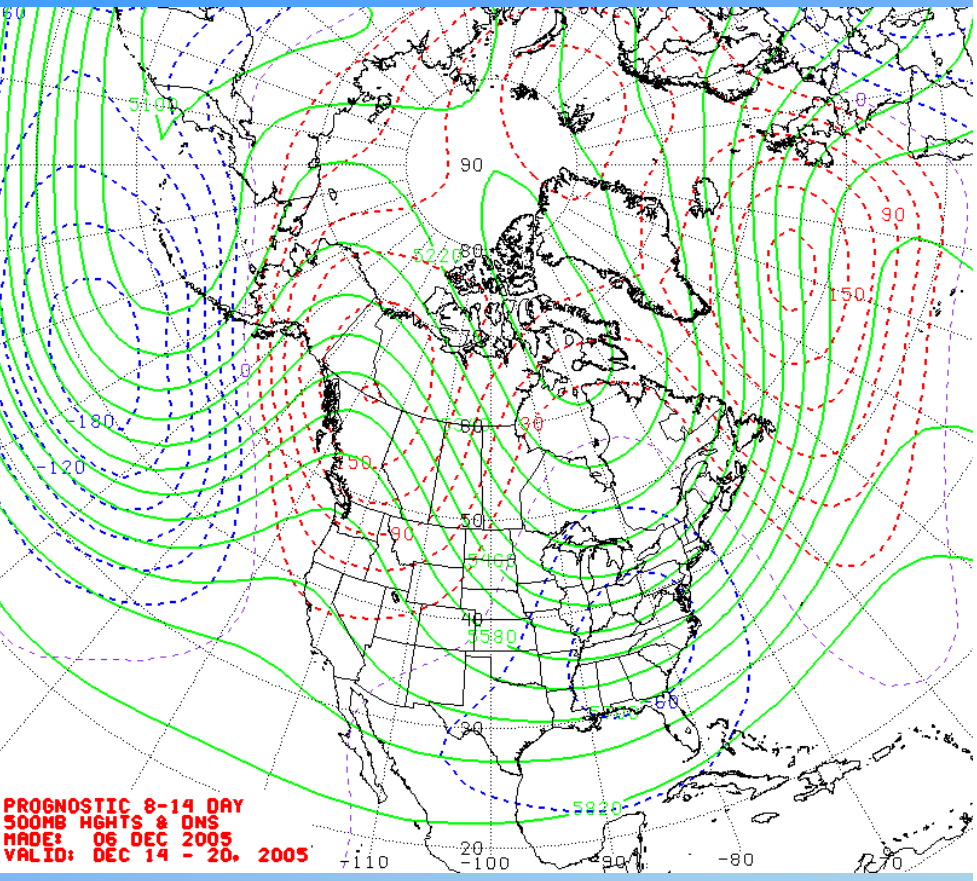
A.

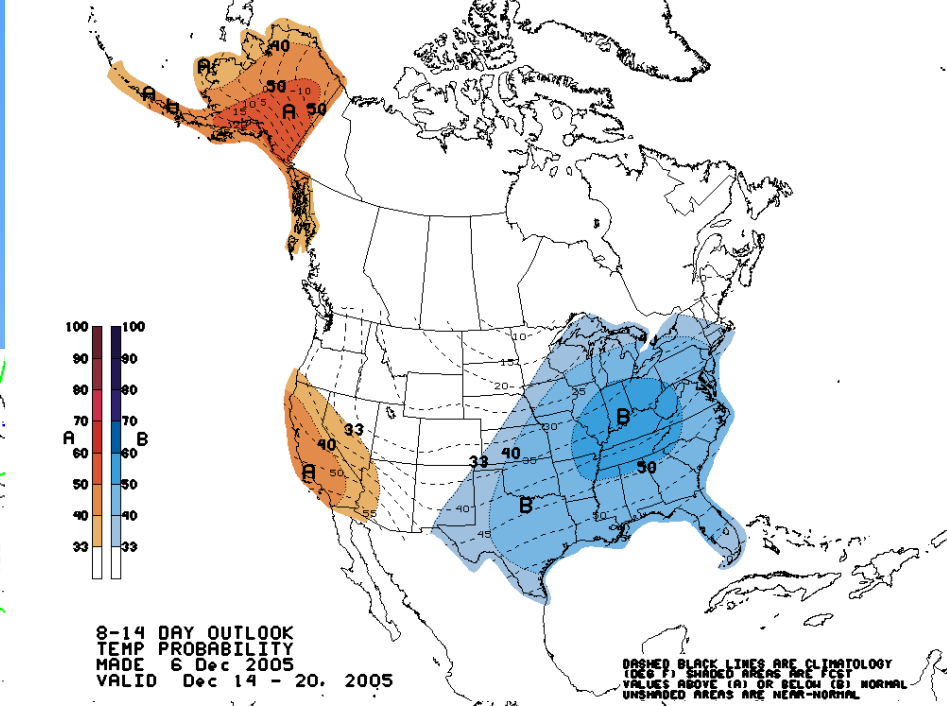


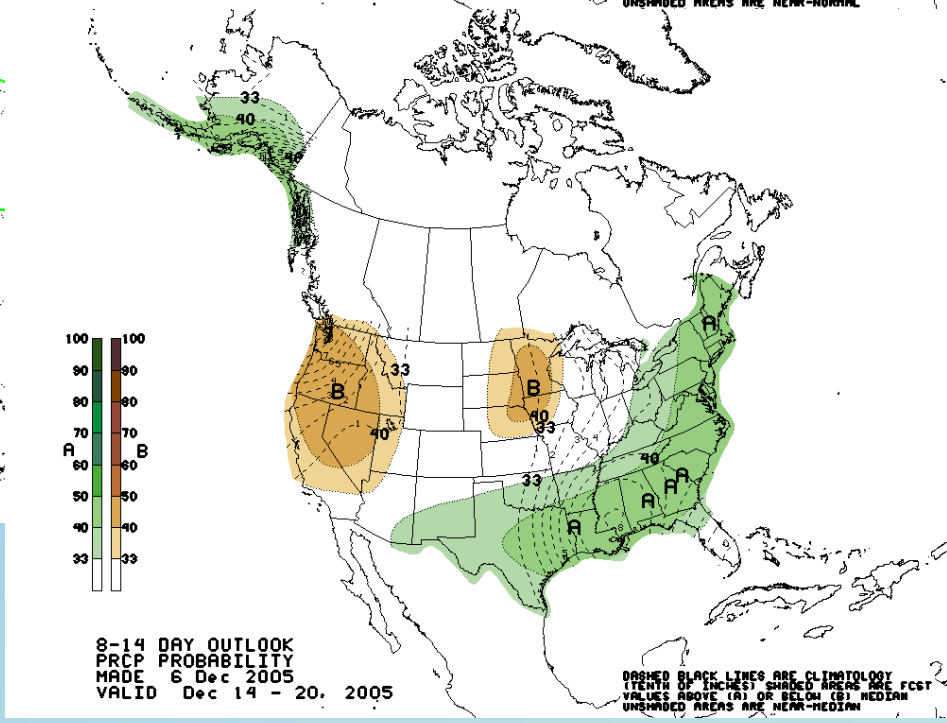
B.

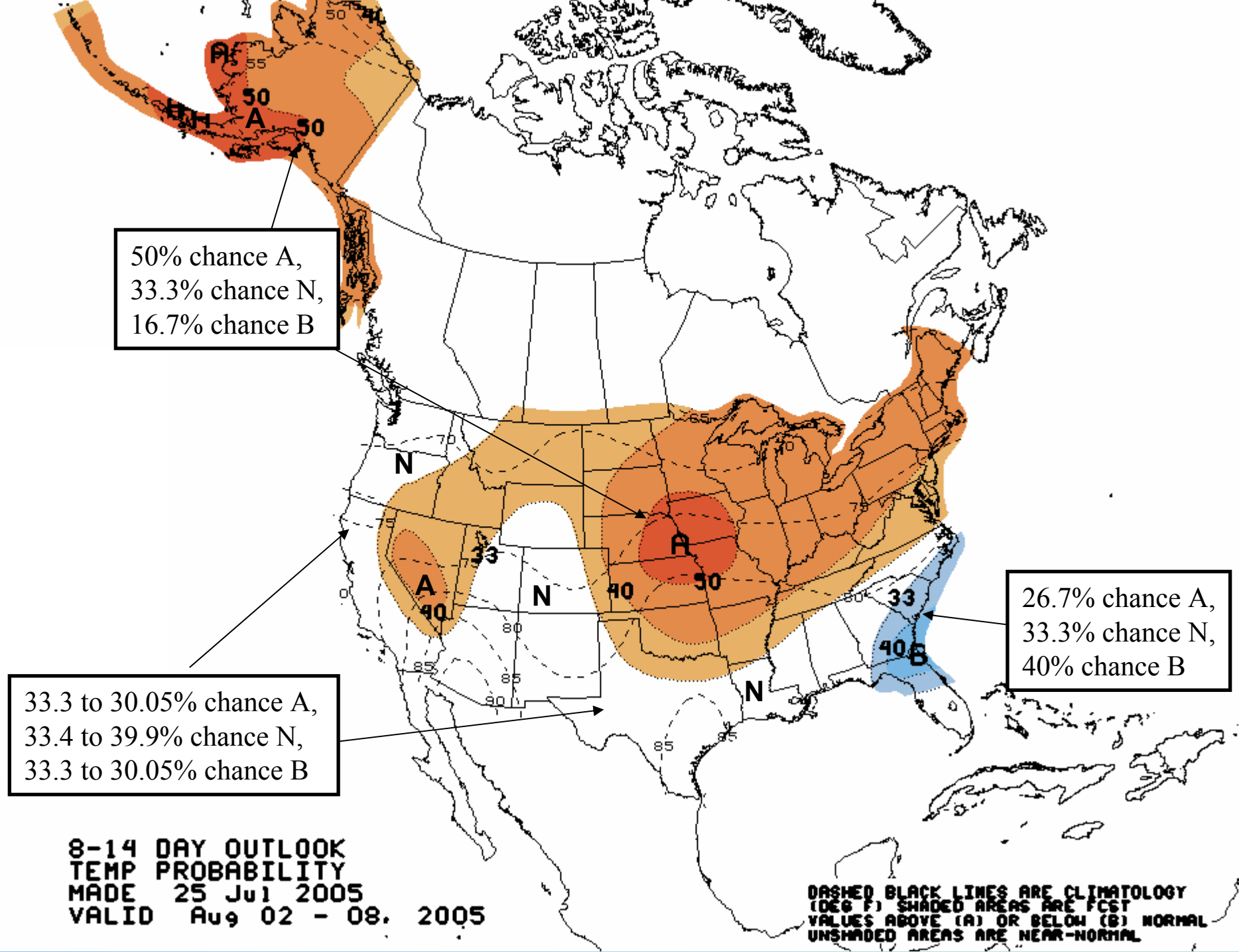


8-14-day (D+11) Forecast for Dec 14-20








50% chance A,
33.3% chance N,
16.7% chance B
26.7% chance A,
33.3% chance N,
40% chance B
33.3 to 30.05% chance A,
33.4 to 39.9% chance N,
33.3 to 30.05% chance B
8-14 DAY OUTLOOK
TEMP PROBABILITY
MADE 25 Jul 2005
VALID Aug 02 - 08. 2005
DASHED BLACK LINES ARE CLIMATOLOGY
(DEG F) SHADED AREAS ARE FCST
VALUES ABOVE (A) OR BELOW (B) NORMAL
UNSHADED AREAS ARE NEAR-NORMAL

Heidke Skill Score: % Improvement over Random Forecasts

$$s = \frac{c - e}{t - e} * 100$$

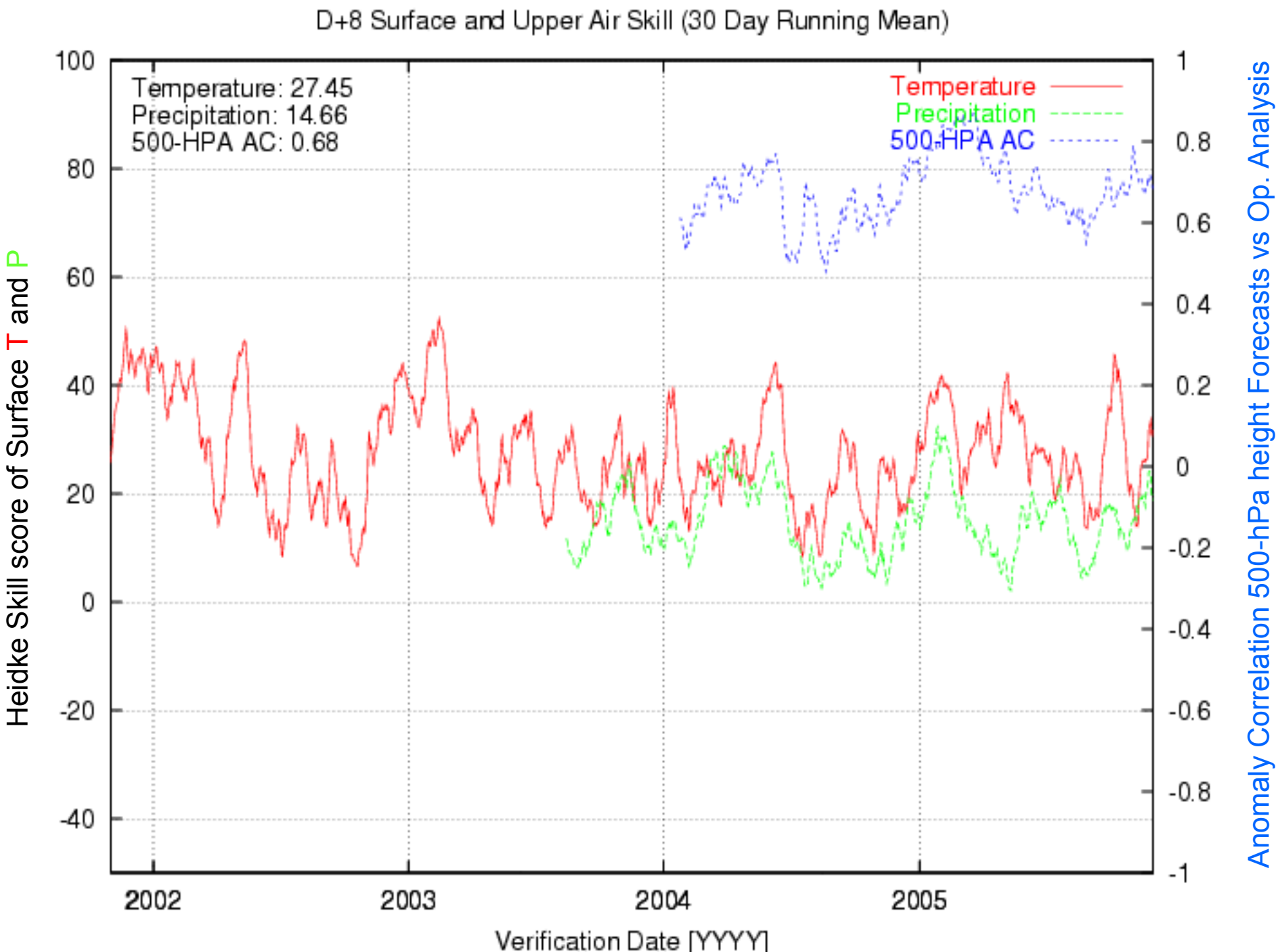
c = # correct forecasts
t = # total forecasts
e = # correct randomly (climatology)

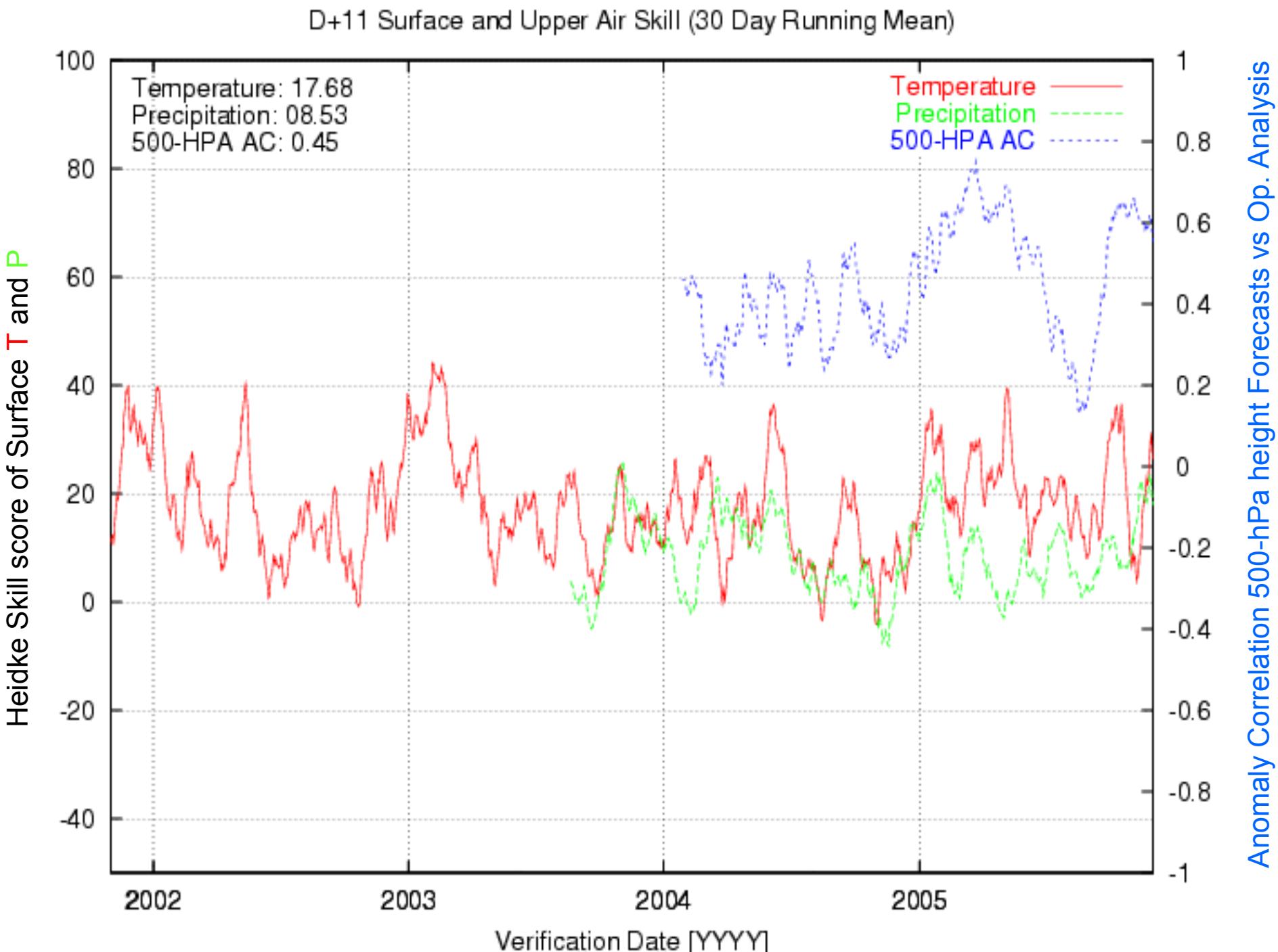
Brier Skill Score: Fractional Improvement in the MSE Over Random Forecasts

$$bs = \frac{1}{n} \sum_{k=1}^{n} (y_k - o_k)^2$$

$$bss = \frac{bs_f - bs_e}{bs_p - bs_e} = 1 - \frac{bs_f}{bs_e}$$

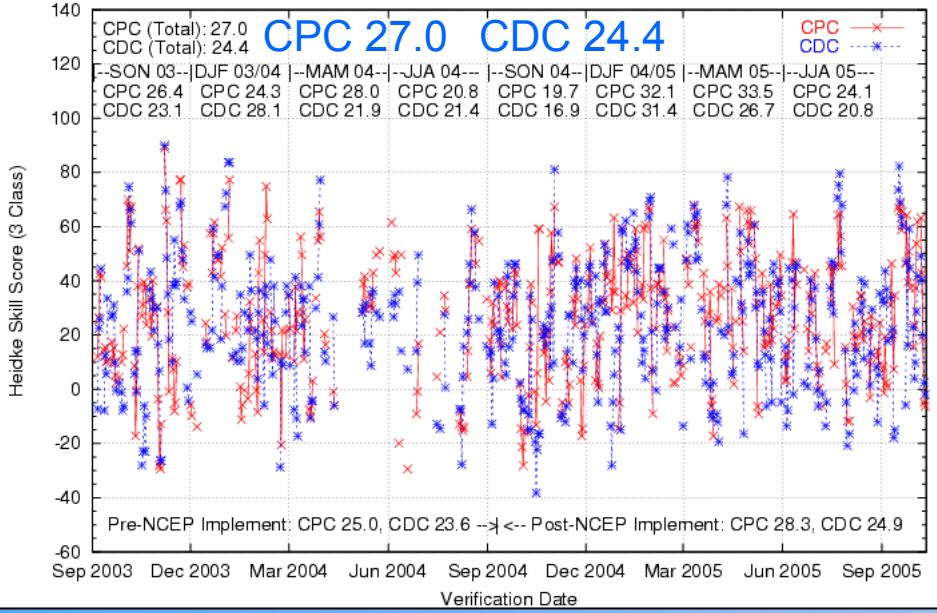
bs = Brier score
y_k = event forecast probability
o_k = event observation, 1 or zero
bs_f = bs of the forecast
bs_p = bs of perfect forecast = 0
bs_e = bs of climatology/random forecasts


D+8 Surface and Upper Air Skill (30 Day Running Mean)
Temperature: 27.45
Precipitation: 14.66
500-HPA AC: 0.68
Temperature
Precipitation
500-HPA AC
Heidke Skill score of Surface T and P
Anomaly Correlation 500-hPa height Forecasts vs Op. Analysis
Verification Date [YYYY]
100
80
60
40
20
0
-20
-40
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
2002
2003
2004
2005

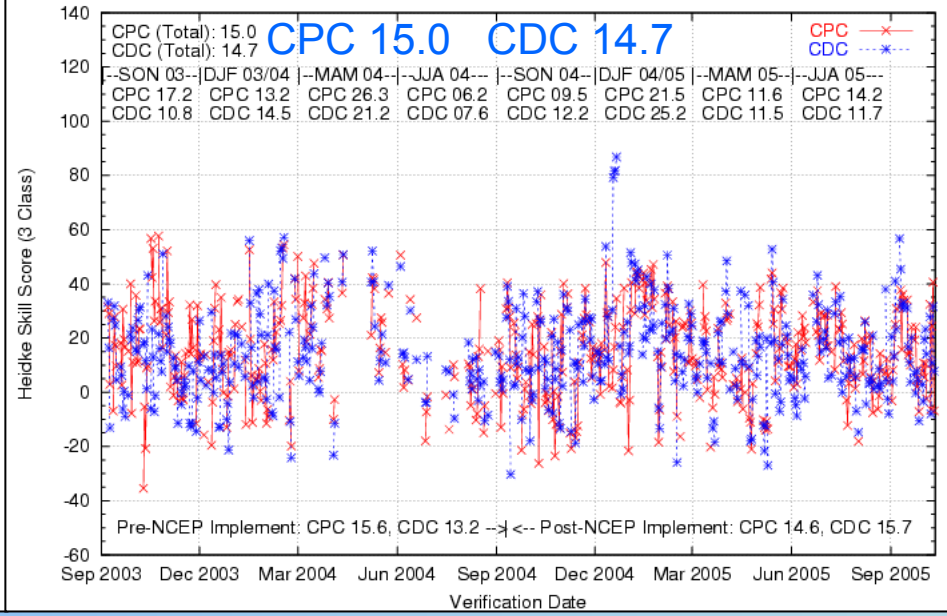

D+11 Surface and Upper Air Skill (30 Day Running Mean)
Temperature: 17.68
Precipitation: 08.53
500-HPA AC: 0.45
Temperature
Precipitation
500-HPA AC
Heidke Skill score of Surface T and P
Anomaly Correlation 500-hPa height Forecasts vs Op. Analysis
Verification Date [YYYY]
100
80
60
40
20
0
-20
-40
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
2002
2003
2004
2005

Skill Comparison: CPC Official and CDC Calibrated MRF98 T, P Forecasts

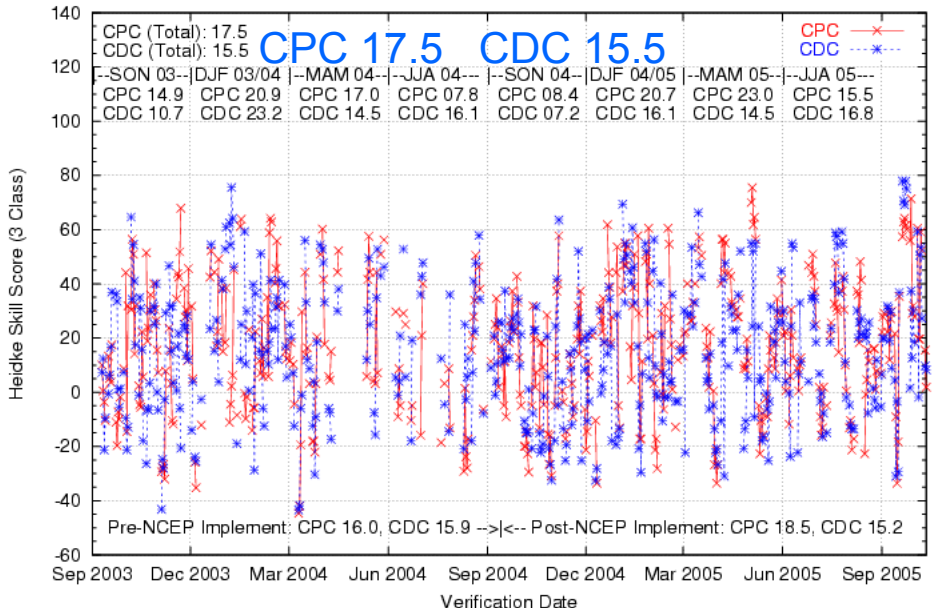
6-10-DAY TEMPERATURE



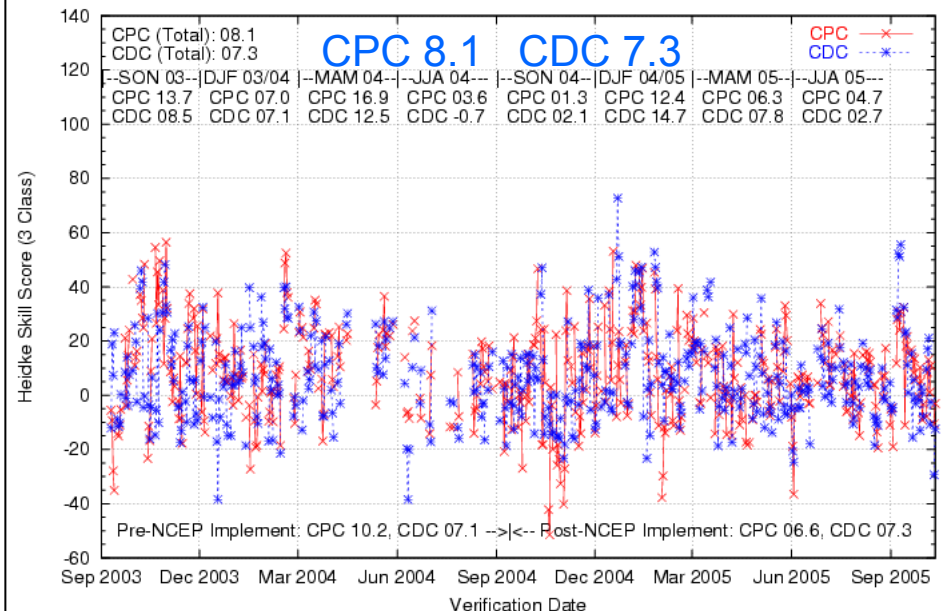
6-10-DAY PRECIPITATION

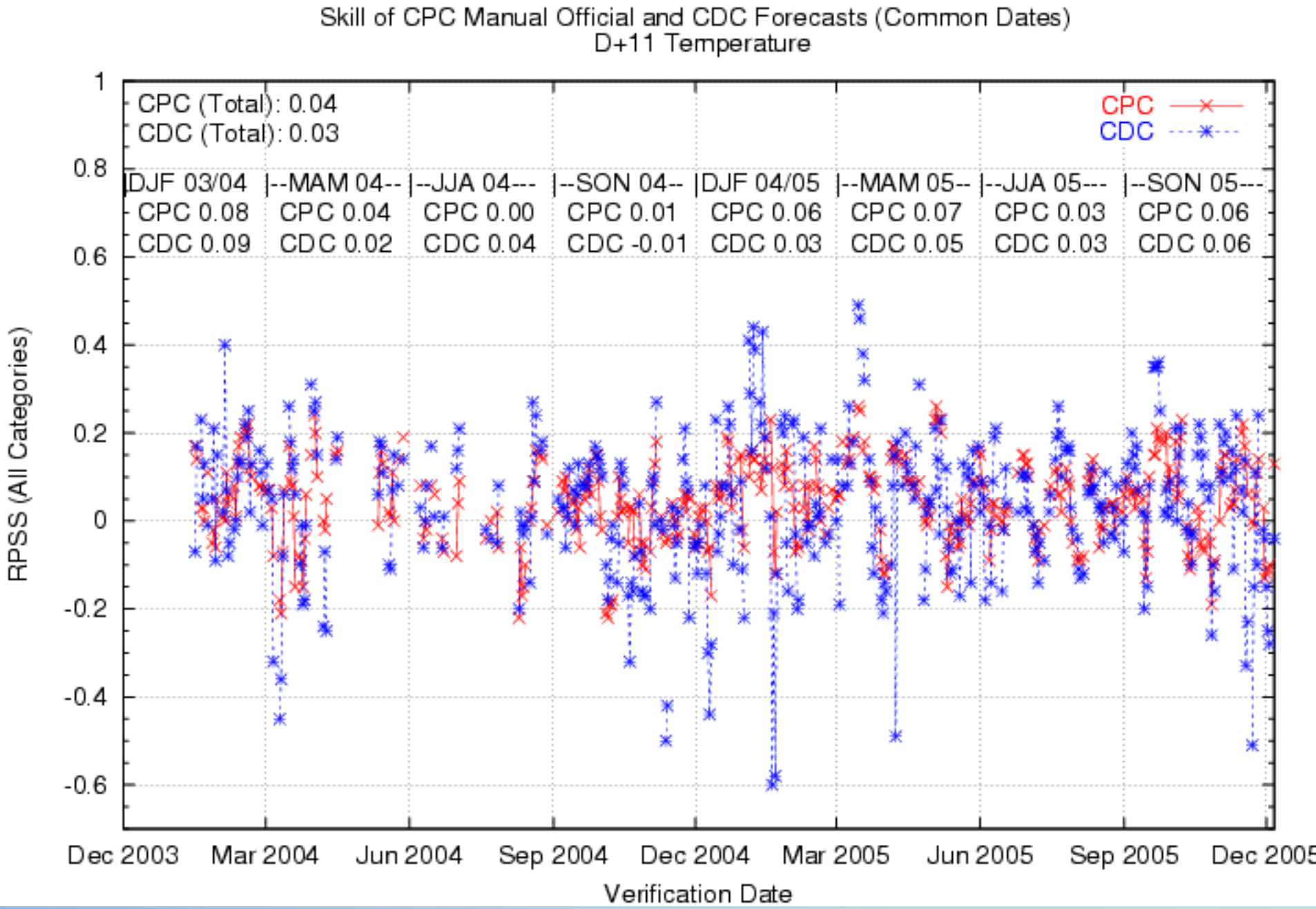


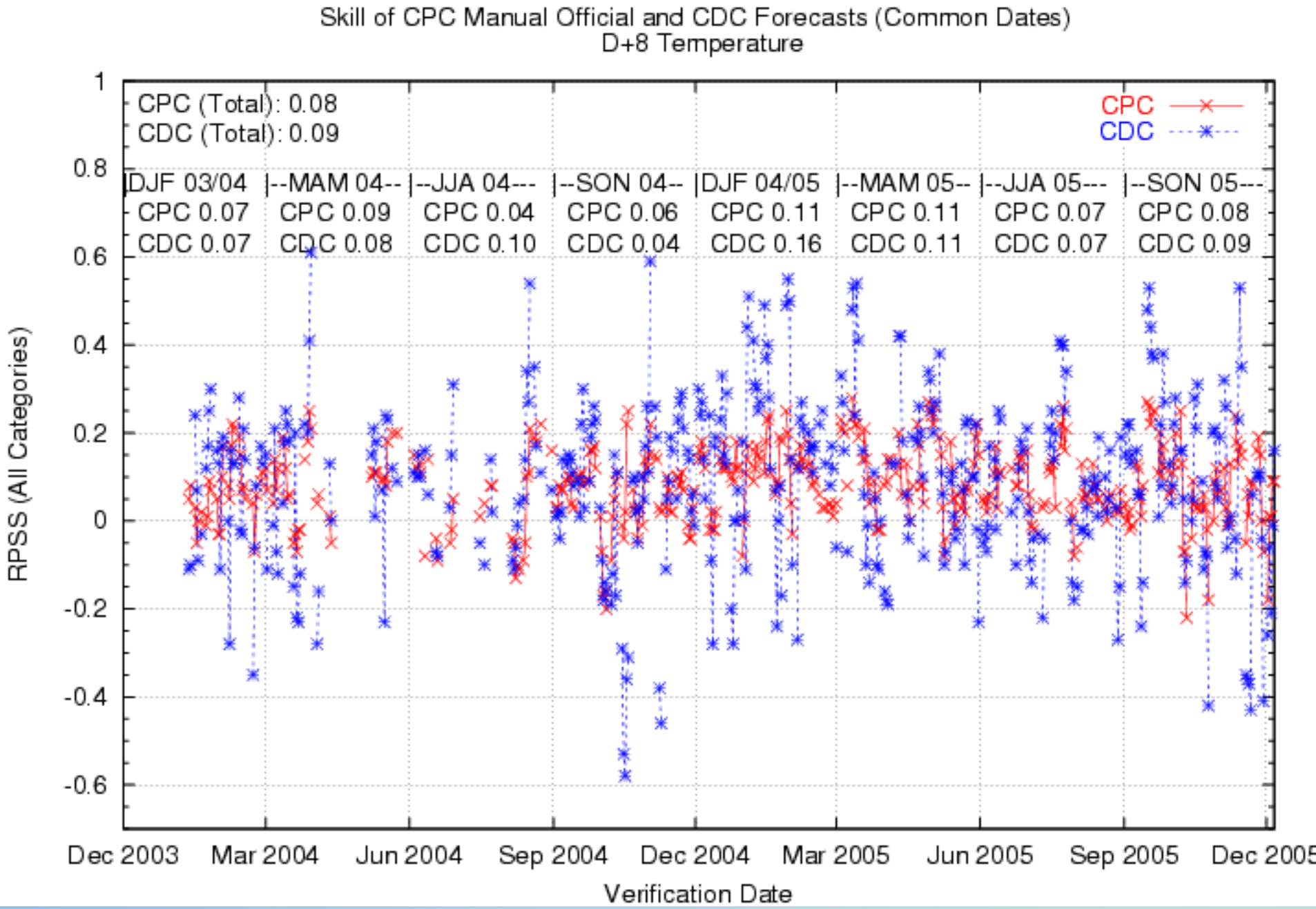
8-14-DAY TEMPERATURE



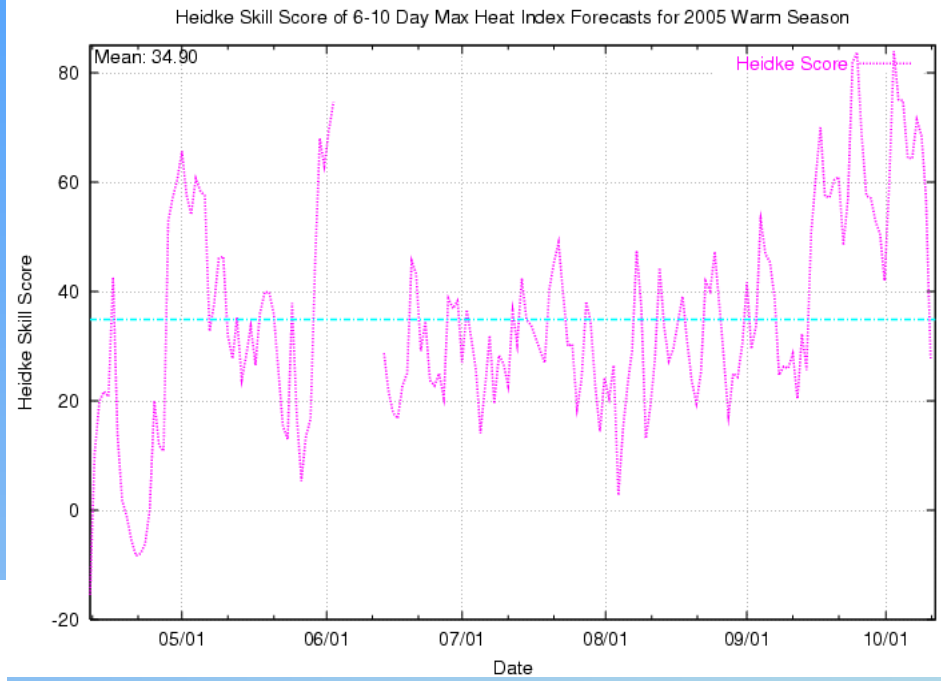
8-14-DAY PRECIPITATION



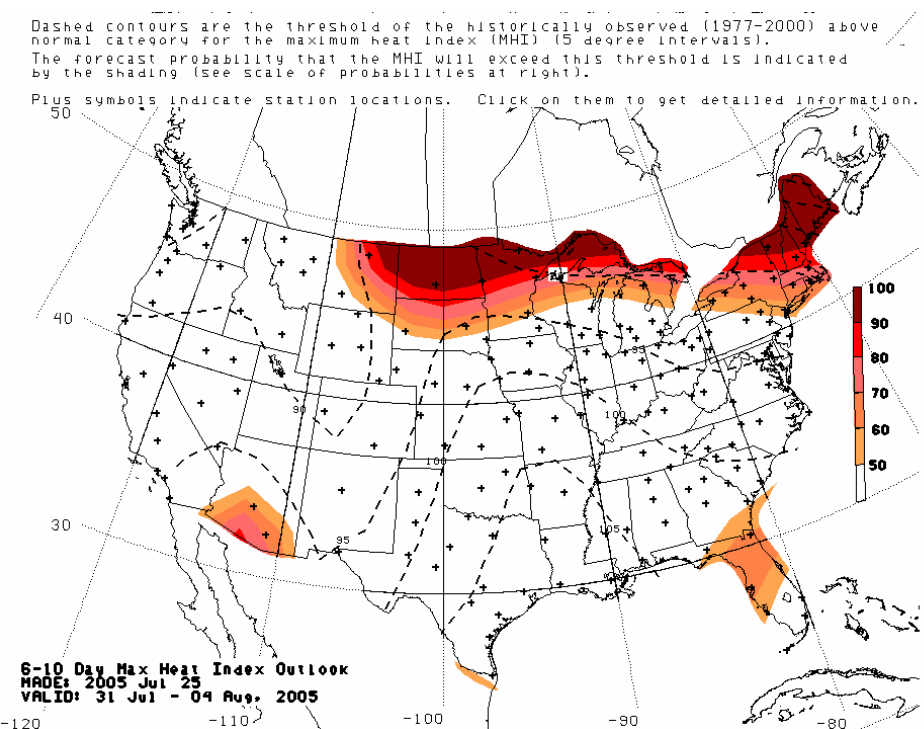

Skill of CPC Manual Official and CDC Forecasts (Common Dates)
D+11 Temperature
CPC (Total): 0.04
CDC (Total): 0.03
CPC
CDC
DJF 03/04
CPC 0.08
CDC 0.09
MAM 04
CPC 0.04
CDC 0.02
JJA 04
CPC 0.00
CDC 0.04
SON 04
CPC 0.01
CDC -0.01
DJF 04/05
CPC 0.06
CDC 0.03
MAM 05
CPC 0.07
CDC 0.05
JJA 05
CPC 0.03
CDC 0.03
SON 05
CPC 0.06
CDC 0.06
RPSS (All Categories)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Dec 2003
Mar 2004
Jun 2004
Sep 2004
Dec 2004
Mar 2005
Jun 2005
Sep 2005
Dec 2005
Verification Date

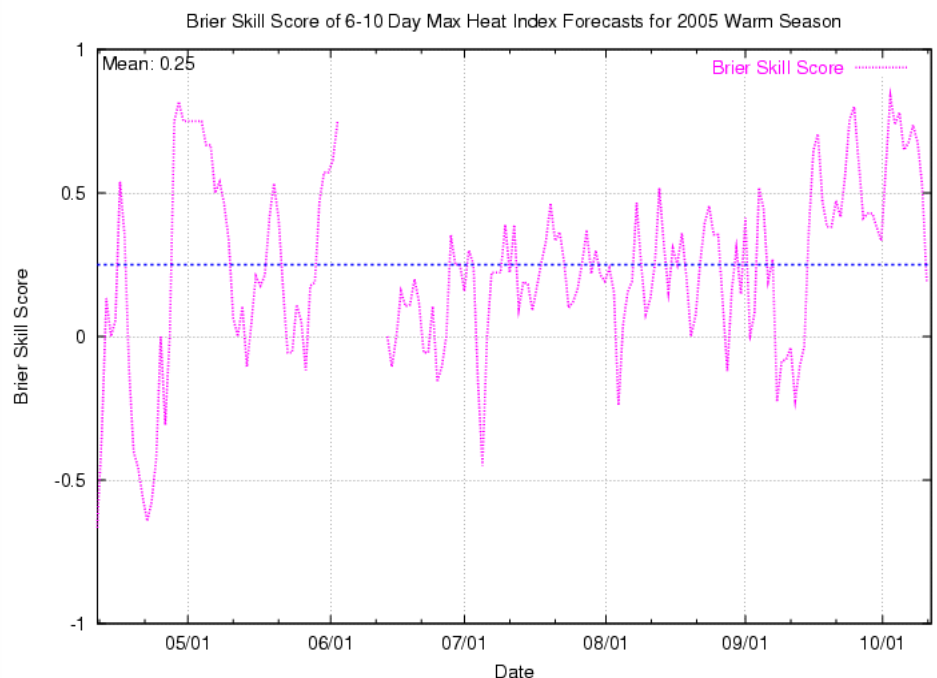

Skill of CPC Manual Official and CDC Forecasts (Common Dates)
D+8 Temperature
CPC (Total): 0.08
CDC (Total): 0.09
CPC
CDC
DJF 03/04
CPC 0.07
CDC 0.07
MAM 04
CPC 0.09
CDC 0.08
JJA 04
CPC 0.04
CDC 0.10
SON 04
CPC 0.06
CDC 0.04
DJF 04/05
CPC 0.11
CDC 0.16
MAM 05
CPC 0.11
CDC 0.11
JJA 05
CPC 0.07
CDC 0.07
SON 05
CPC 0.08
CDC 0.09
RPSS (All Categories)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Dec 2003
Mar 2004
Jun 2004
Sep 2004
Dec 2004
Mar 2005
Jun 2005
Sep 2005
Dec 2005
Verification Date

Daily 6-10- and 8-14-day Heat Index Outlooks are prepared by calculating the heat index from GFS 2-meter T, RH and then calibrating the forecasts using 45 days of observed heat index and GFS forecasts. The success of simple calibration methods warrants considering more elaborate ones.

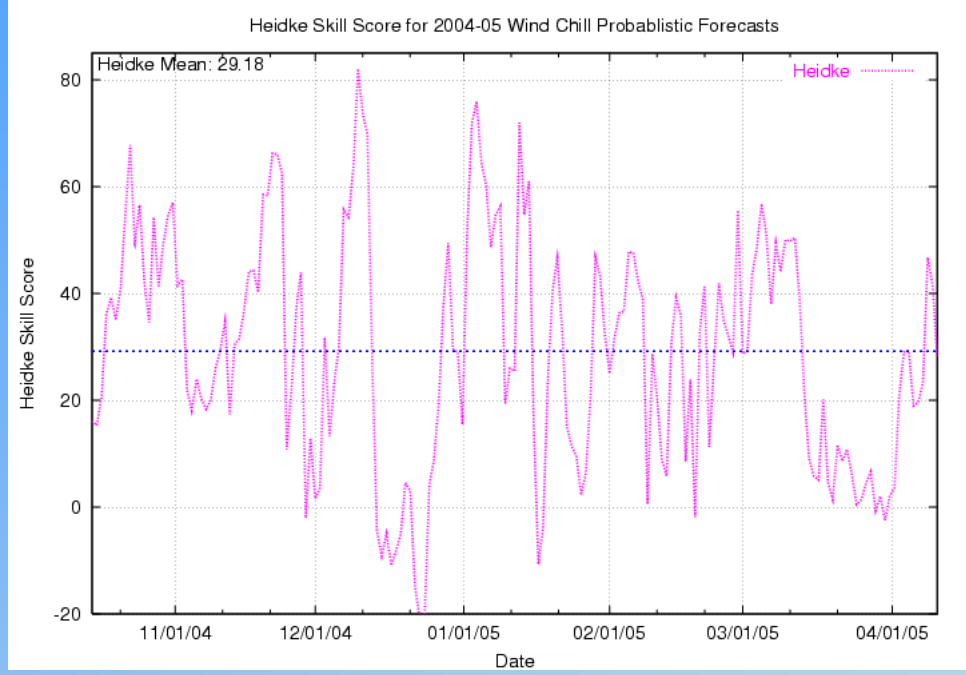


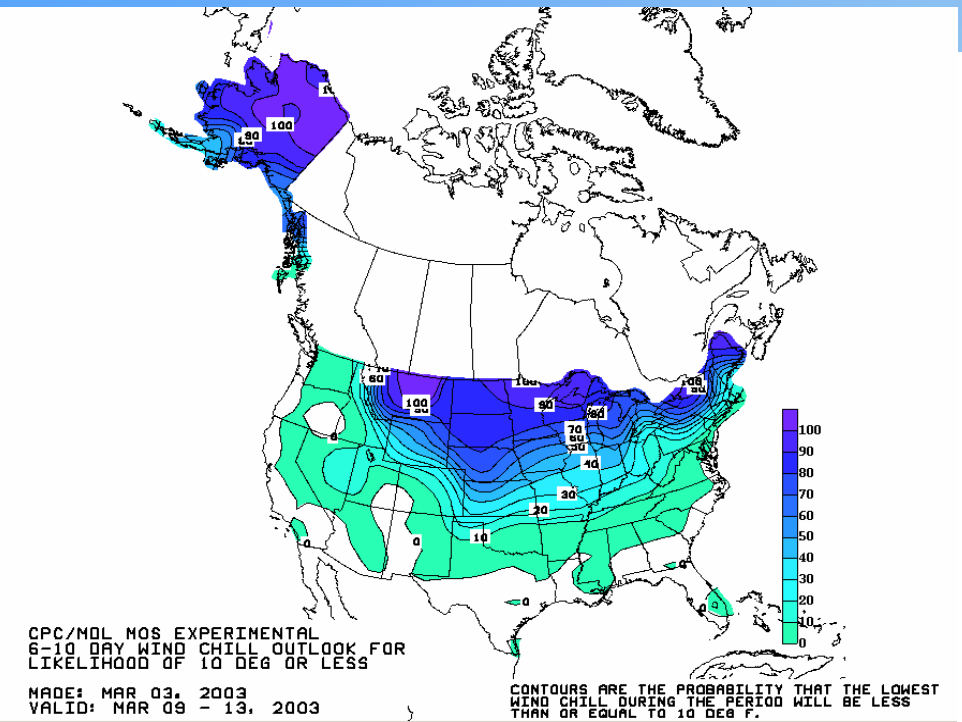
Probability the maximum heat index will be in the ABOVE normal category

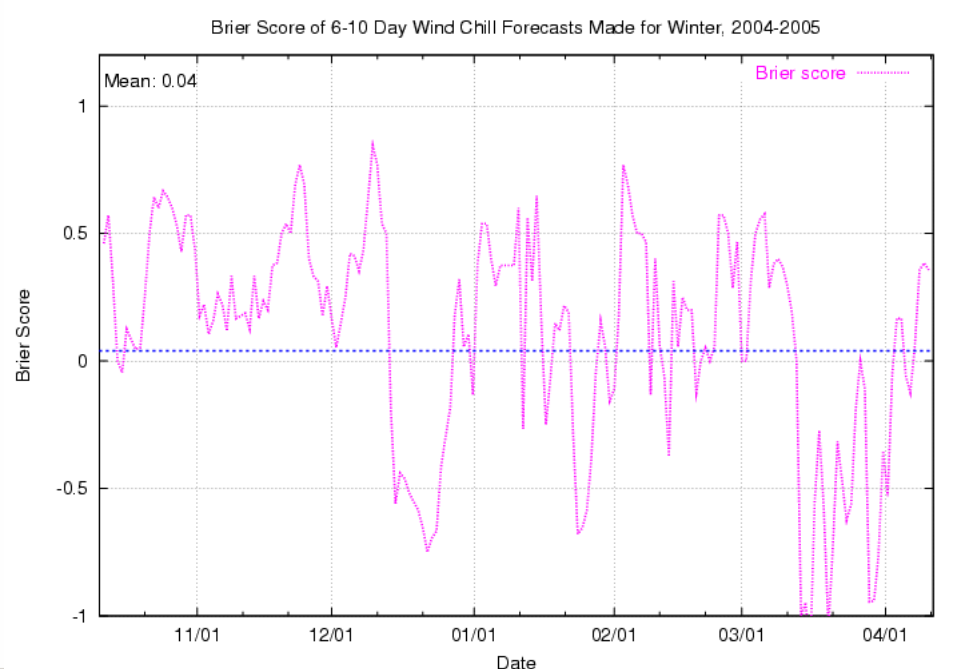




Daily 6-10- and 8-14-day Wind Chill Outlooks are prepared by calculating the wind chill from GFS 2-meter T, 10-meter wind and then calibrating the forecasts using 45 days of observed wind chill and GFS forecasts. The success of simple calibration methods warrants considering more elaborate ones.



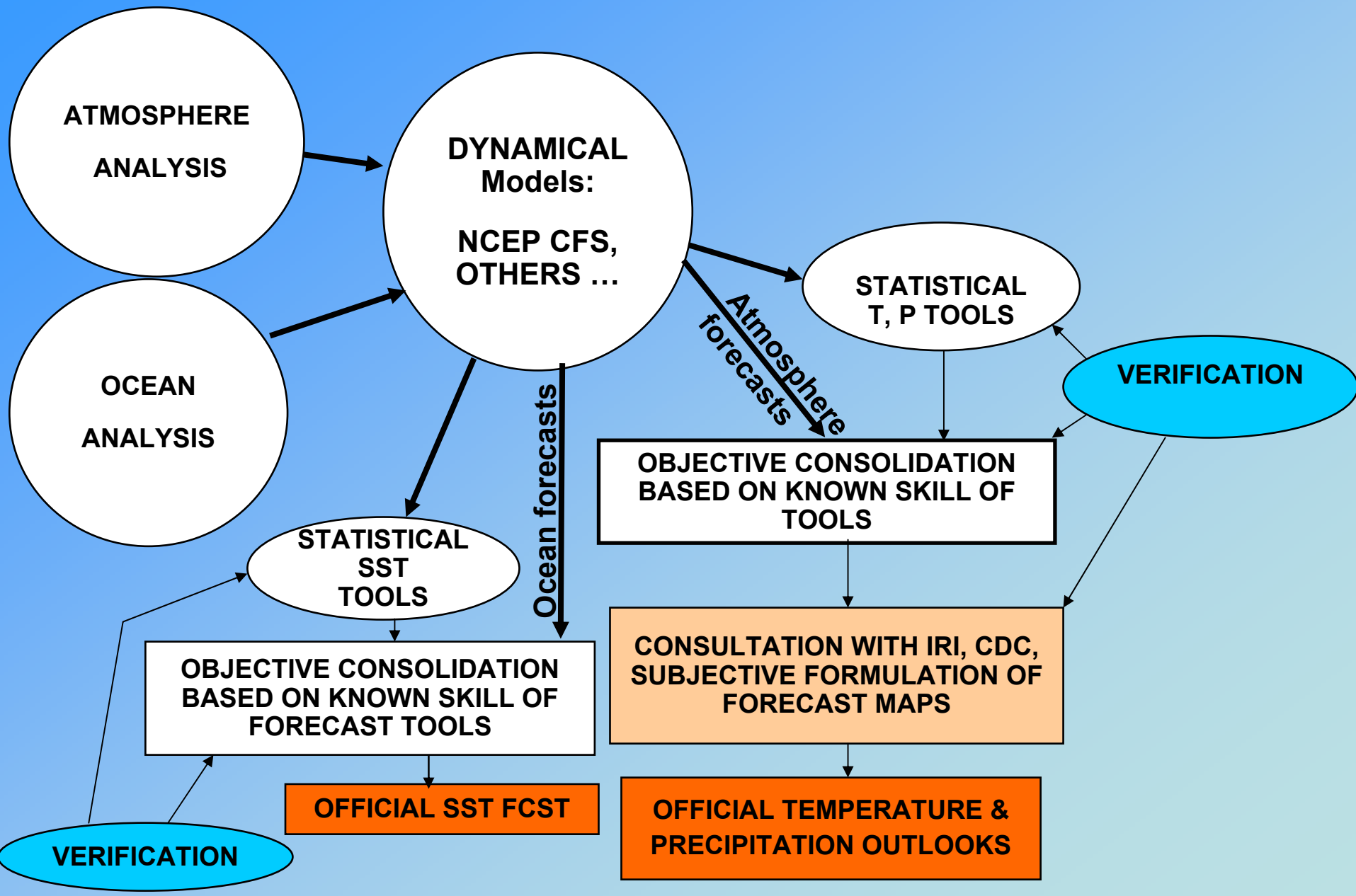




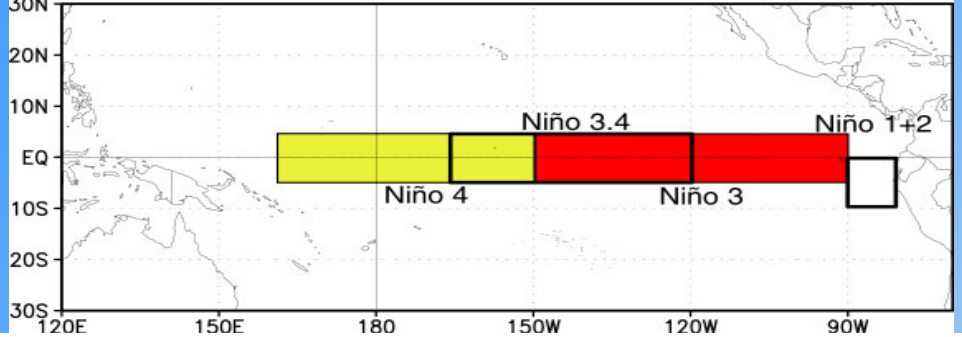
What can lead to improvements in ER Forecasts?

- Improved dynamical prediction models
- Enhanced use of ensemble information from a single model through calibration
- Multi-model ensembles, from calibrated models
- Improved downscaling techniques
- Forecast tool consolidation procedures
- Predictability from ENSO-related extreme events, monsoon-related summer precipitation, annular mode, land-atmosphere interactions and the MJO

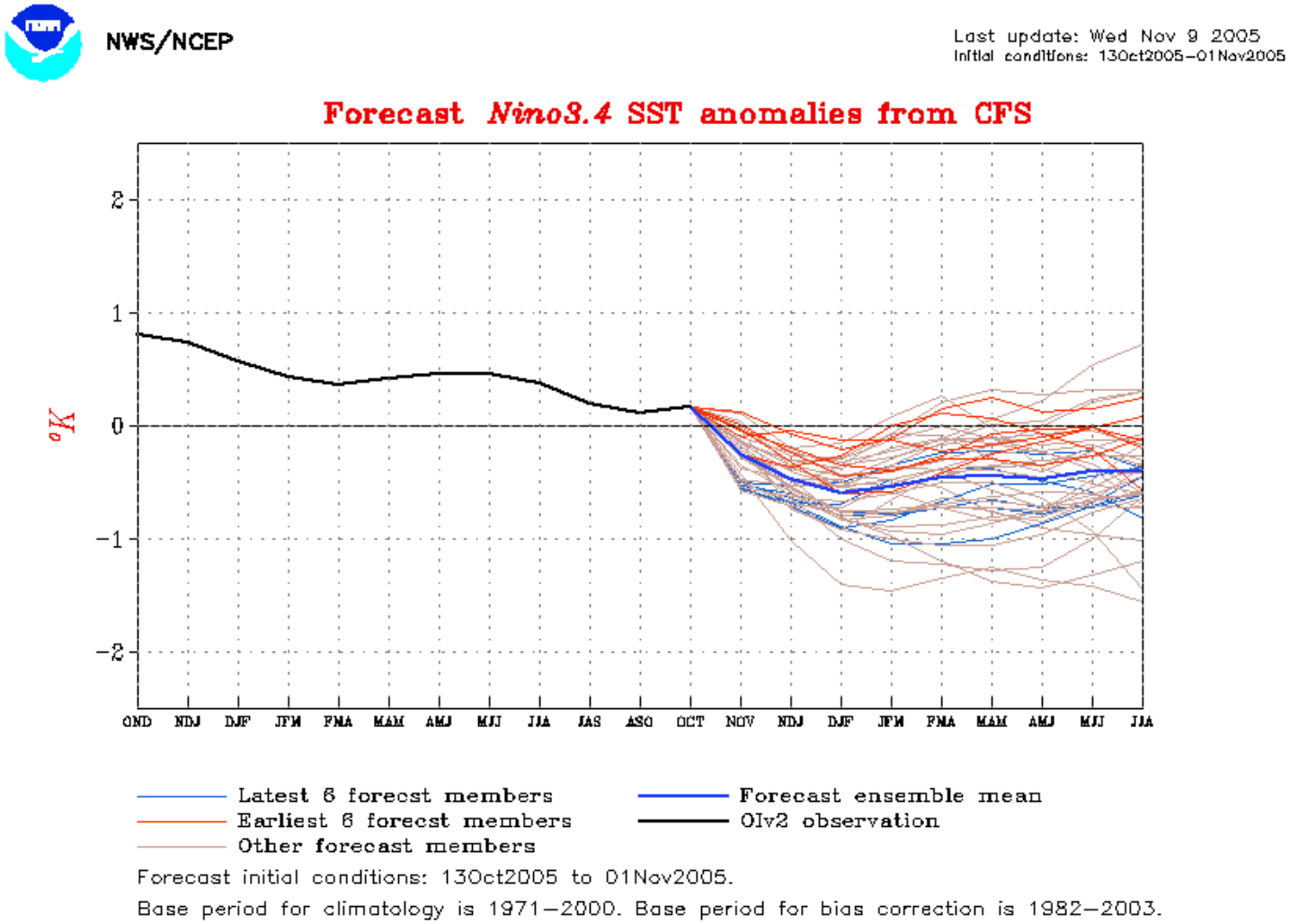
NCEP- CPC Seasonal Forecast Operations



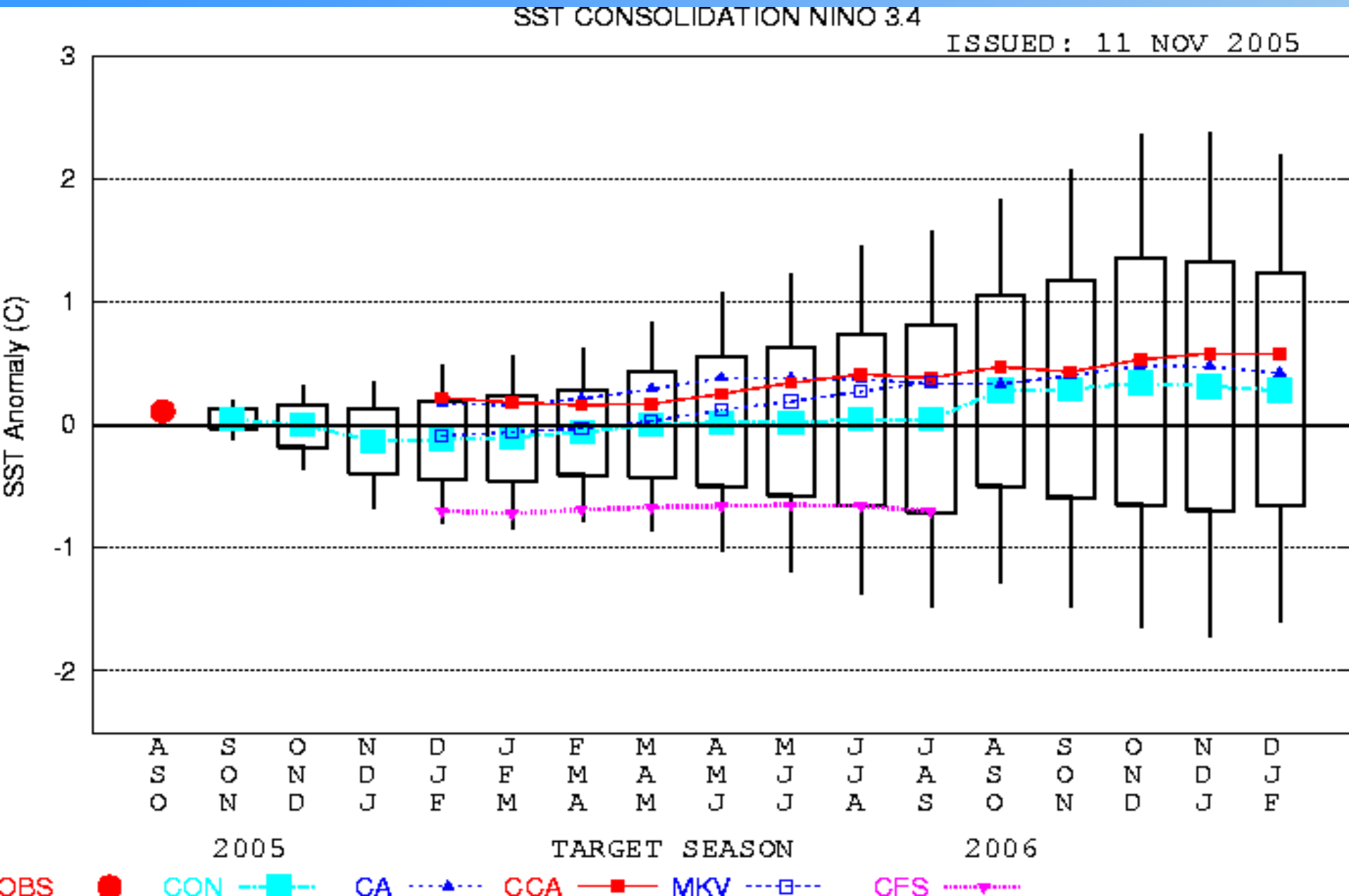
CFS SST Forecast

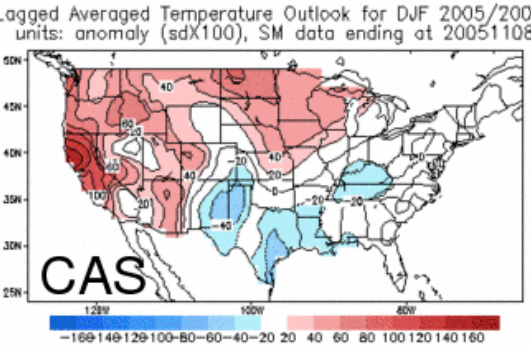


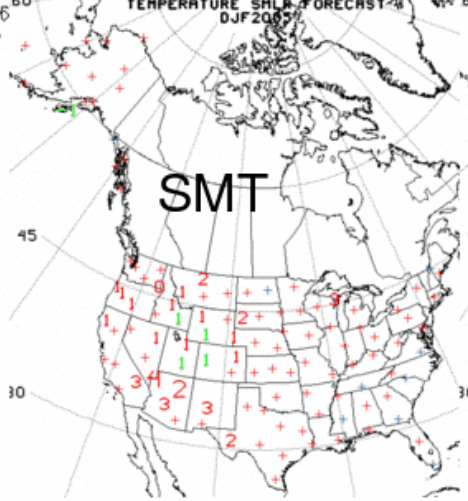
CFS SST Forecasts Set the Standard for ENSO Prediction

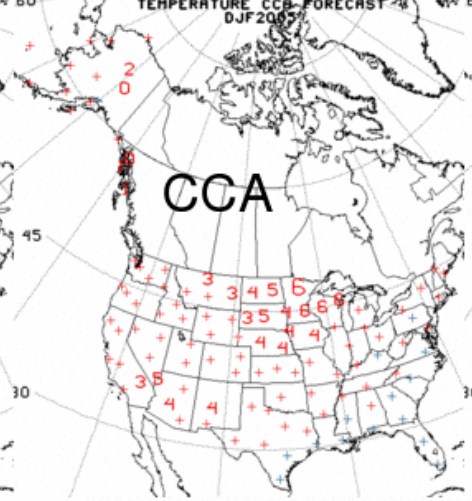


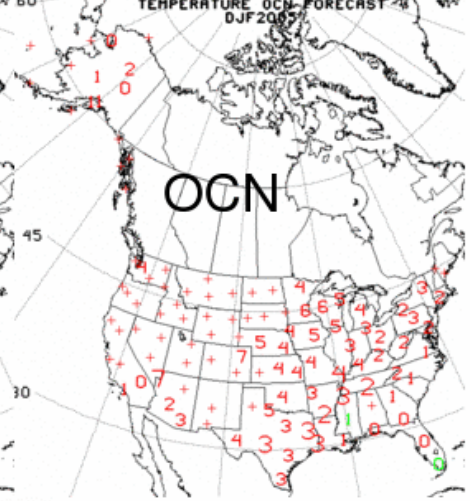
CPC Official SST Forecast

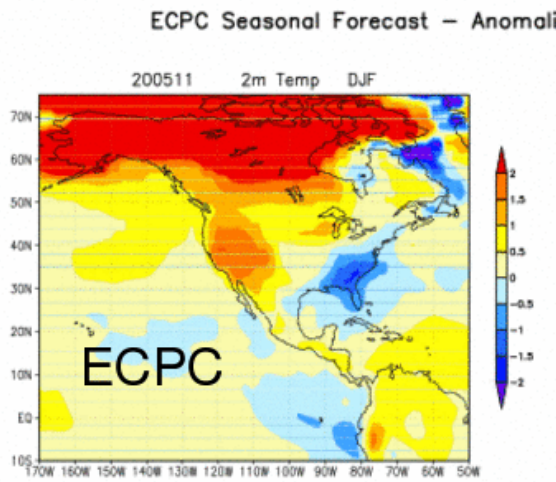


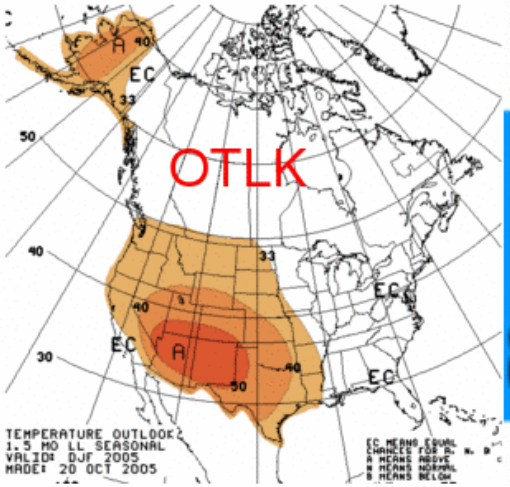

Lagged Averaged Temperature Outlook for DJF 2005/2006
units: anomaly (sdX100), SM data ending at 20051108
CAS


TEMPERATURE SMT FORECAST
DJF2005
SMT

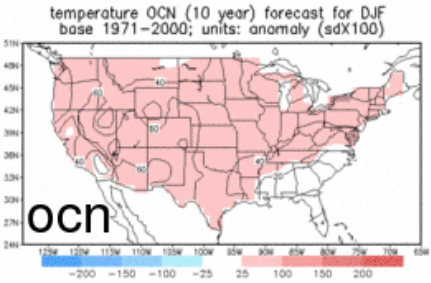

TEMPERATURE CCA FORECAST
DJF2005
CCA

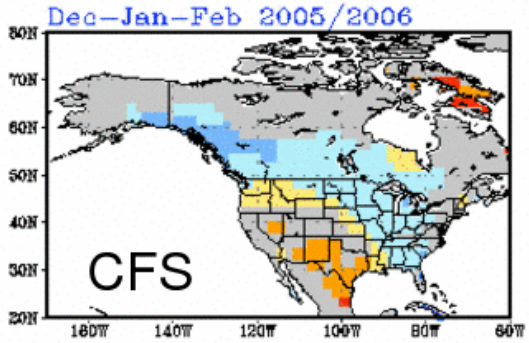

TEMPERATURE OCN FORECAST
DJF2005
OCN

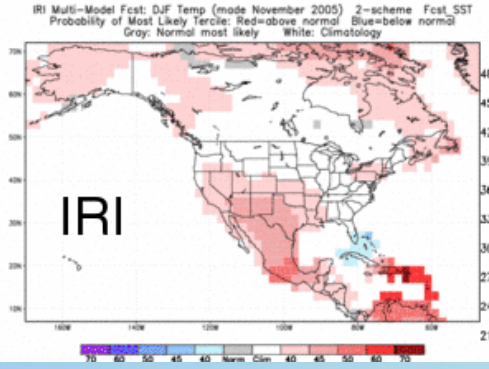

ECPC Seasonal Forecast – Anomali
200511 2m Temp DJF
ECPC

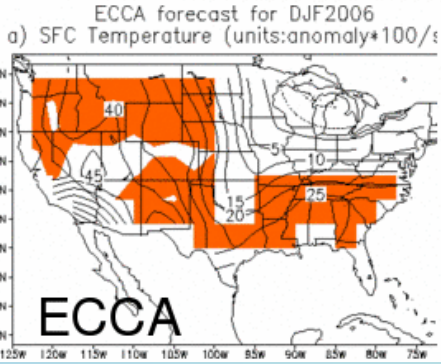

OTLK
TEMPERATURE OUTLOOK
1.5 MO LL SEASONAL
VALID: DJF 2005
MADE: 20 OCT 2005

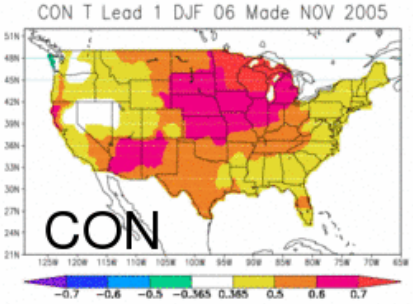
DJF Season


temperature OCN (10 year) forecast for DJF
base 1971–2000; units: anomaly (sdX100)
ocn

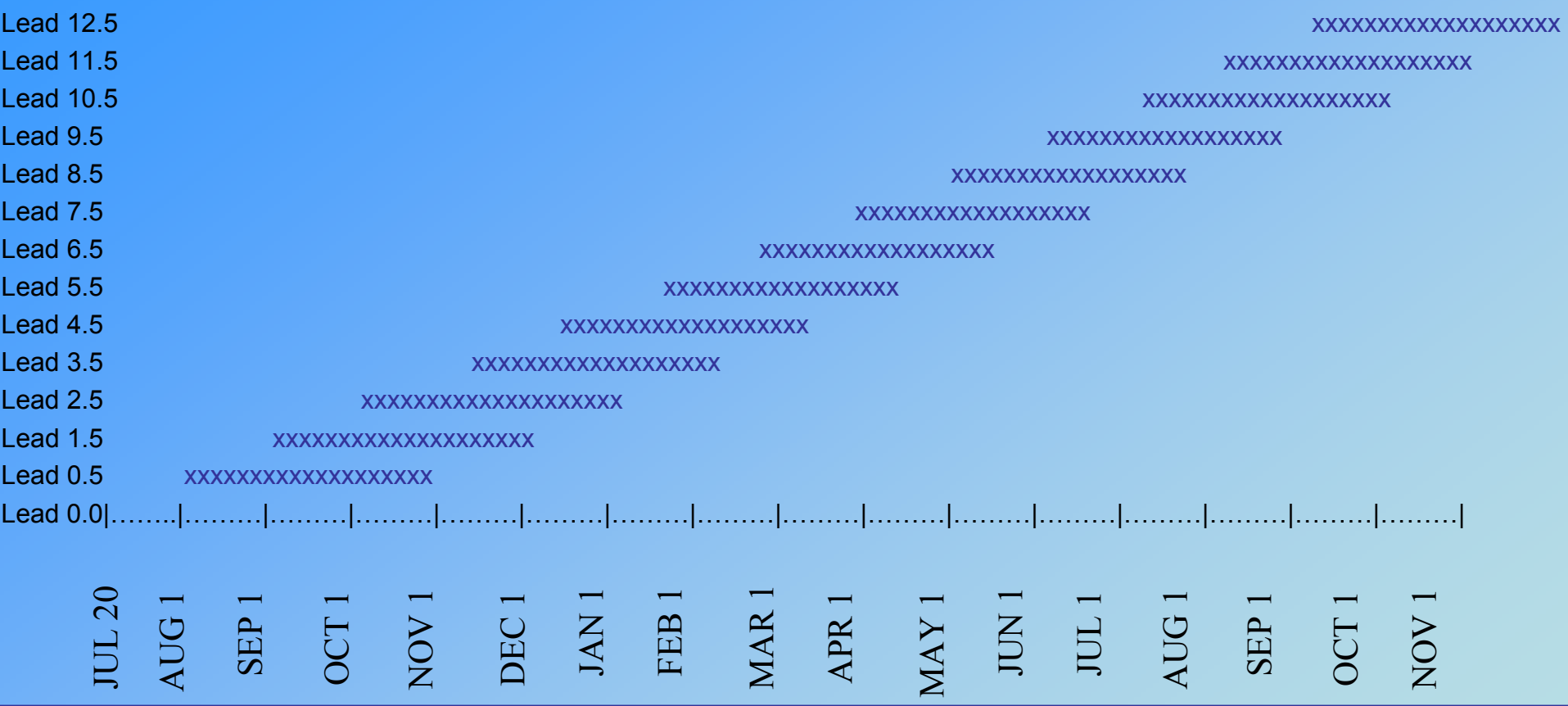

Dec–Jan–Feb 2005/2006
CFS


IRI Multi-Model Fcst: DJF Temp (made November 2005) 2-scheme Fcst_SST
Probability of Most Likely Tercile: Red=above normal Blue=below normal
Gray: Normal most likely White: Climatology
IRI

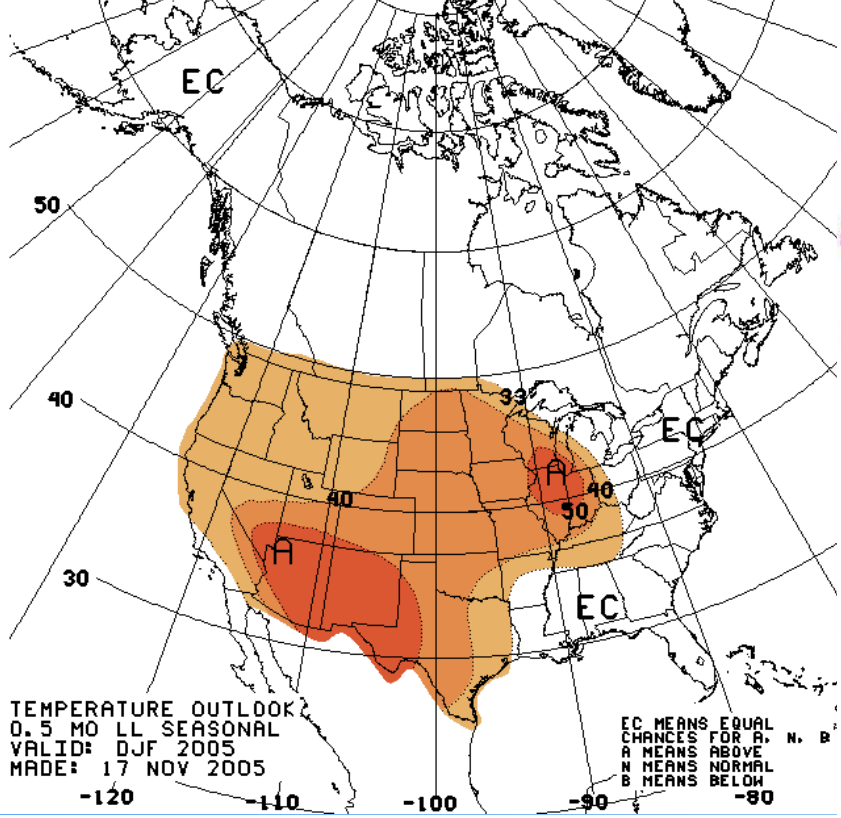

ECCA forecast for DJF2006
a) SFC Temperature (units:anomaly*100/s
ECCA

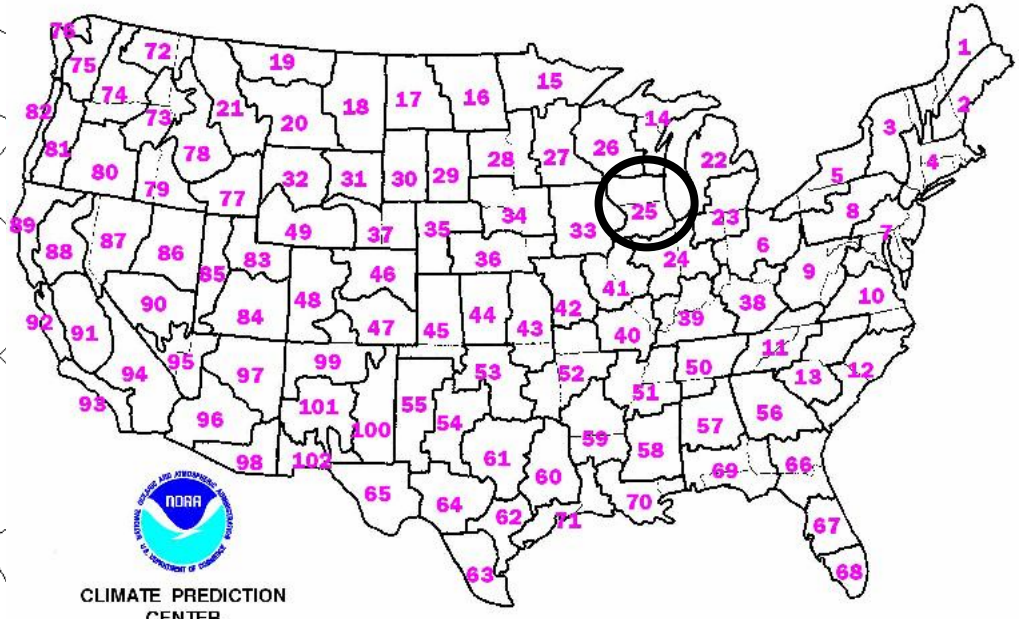

CON T Lead 1 DJF 06 Made NOV 2005
CON

CPC Seasonal Forecast Products and Leads Released July 20, 2005

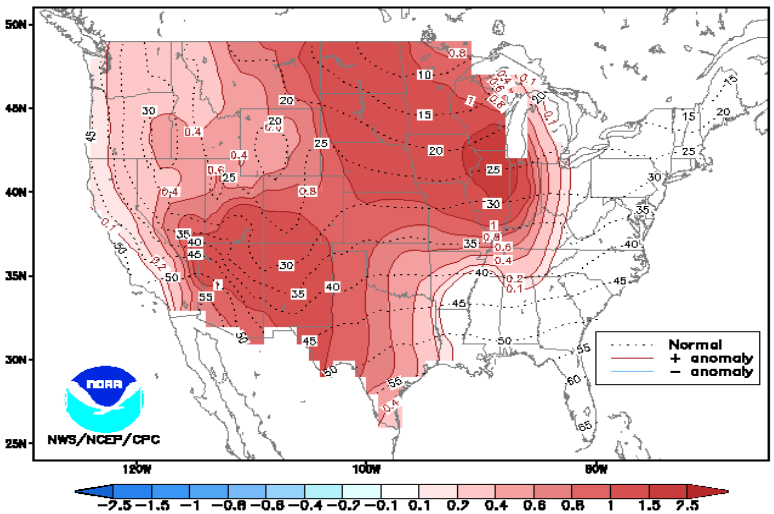


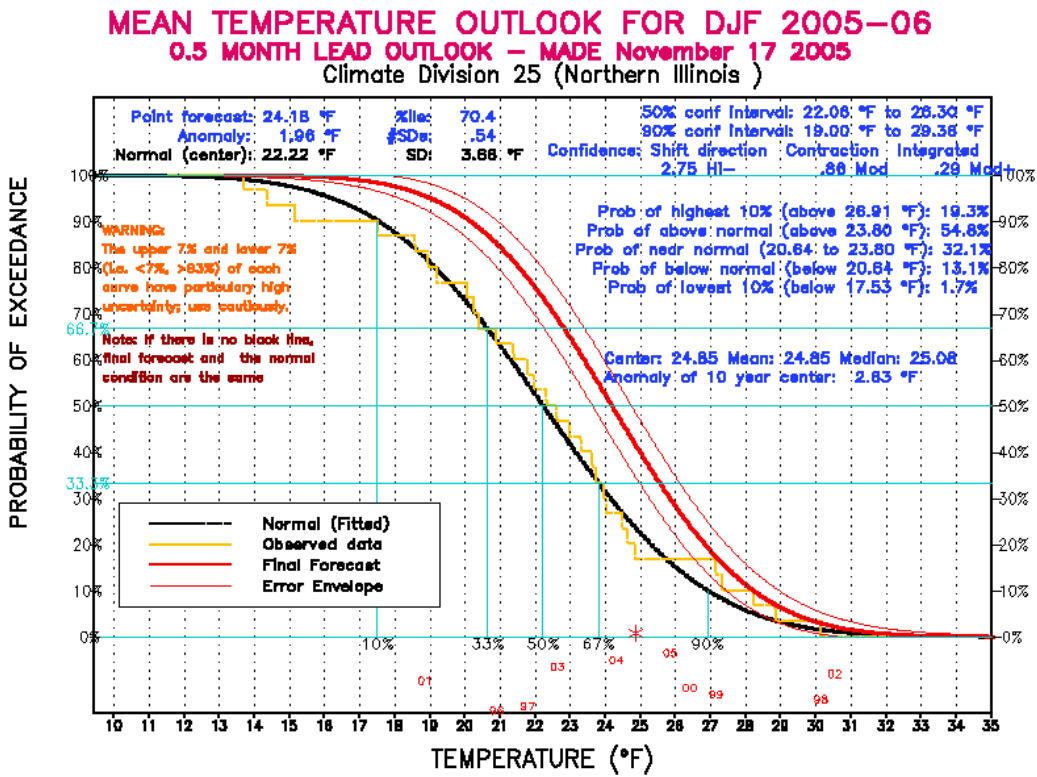
- Once each month, near mid-month
- 13 maps each for U.S. T and P
- Leads from 2 weeks to 12 ½ months
- Adjacent maps overlap each other by 2 months





Most Likely Temperature Anomaly (deg F) Outlook, 0.5 Month Lead for DJF 200

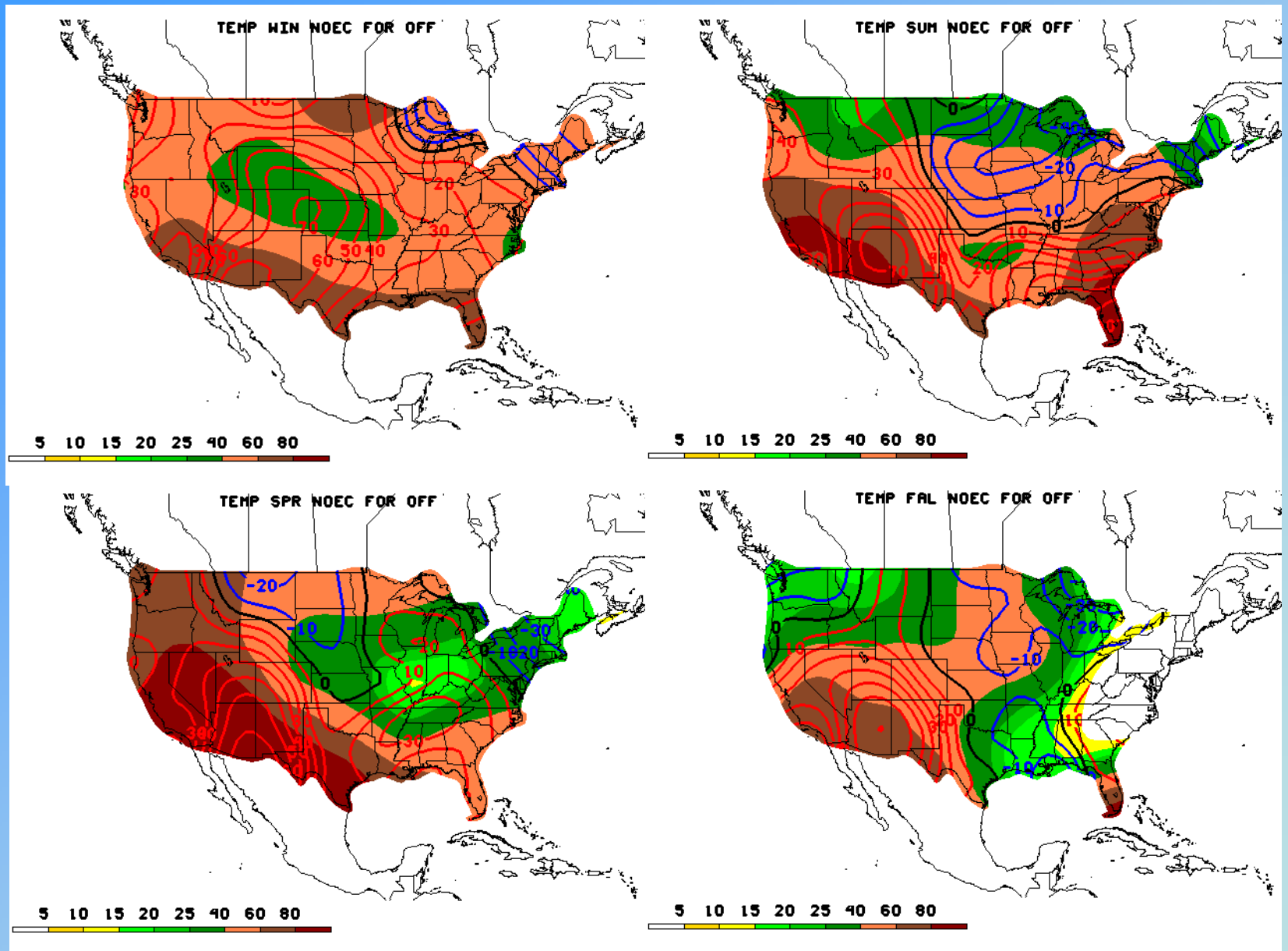




Operational Temperature Forecast Skill – By Season

s = ((c-e)/(t-e)) x 100 (contours)

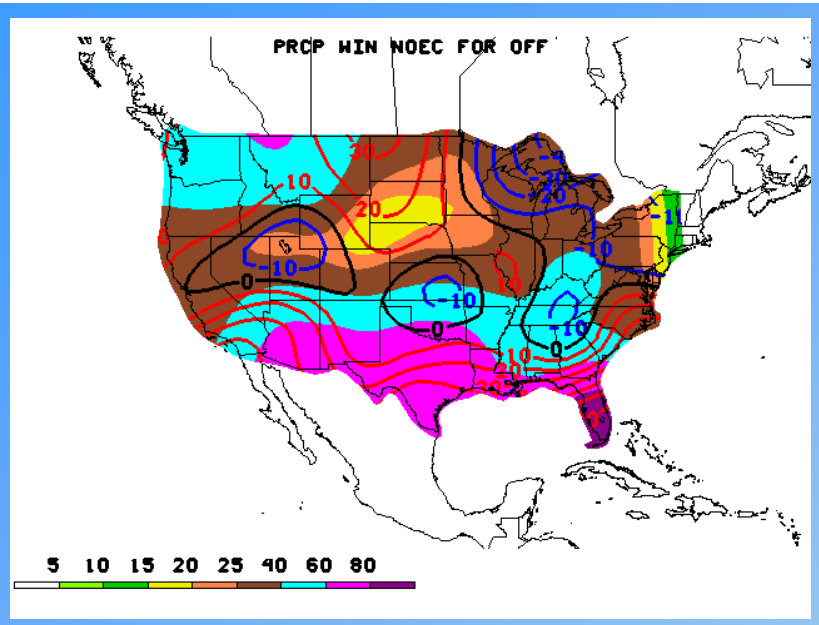
Shading = % of forecasts

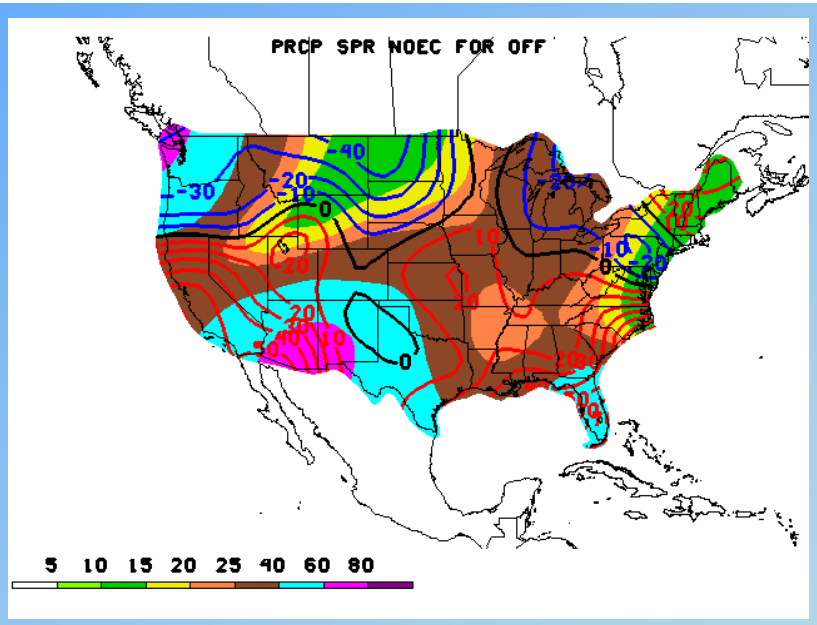


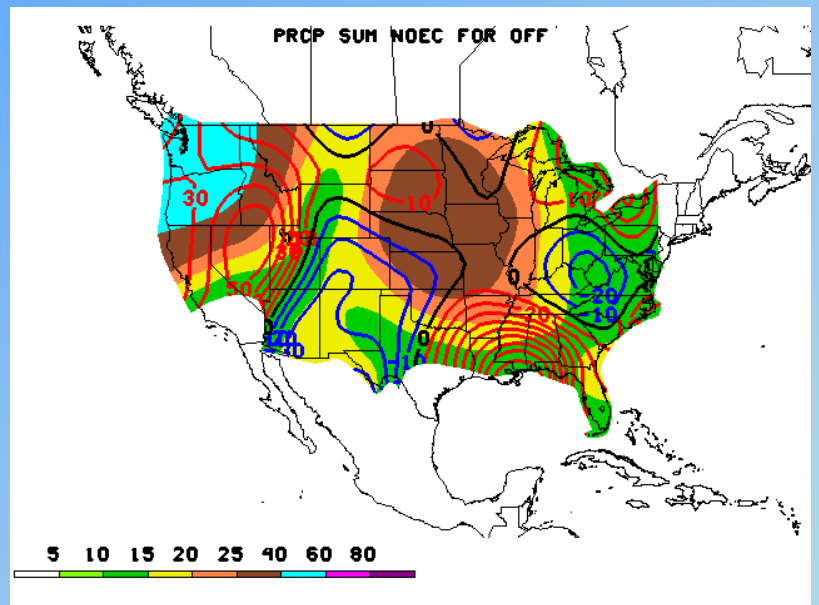
Operational Precipitation Forecast Skill – By Season

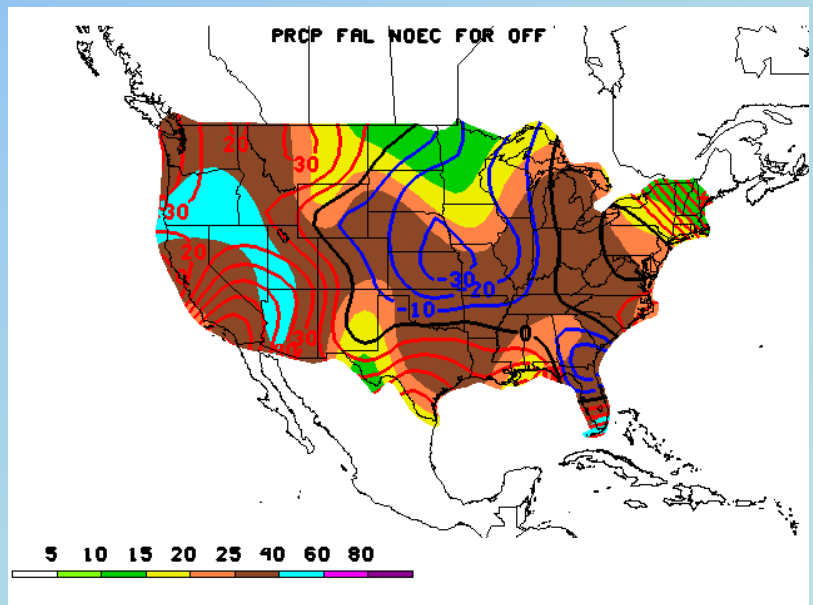
s = ((c-e)/(t-e)) x 100 (contours)

Shading = % of forecasts









What can lead to improvements in SI Forecasts?

- Improved dynamical prediction models – diurnal cycle of convection, for example.
- Enhanced use of ensemble information from a single model.
- Multi-model ensembles.
- Improved empirical prediction tools.
- Improvements in consolidation procedures.
- Improved SST predictions.
- Predictability beyond ENSO SSTs – NAO.

90-DAY FORECAST TOOLS CONSOLIDATION BASED ON SKILL

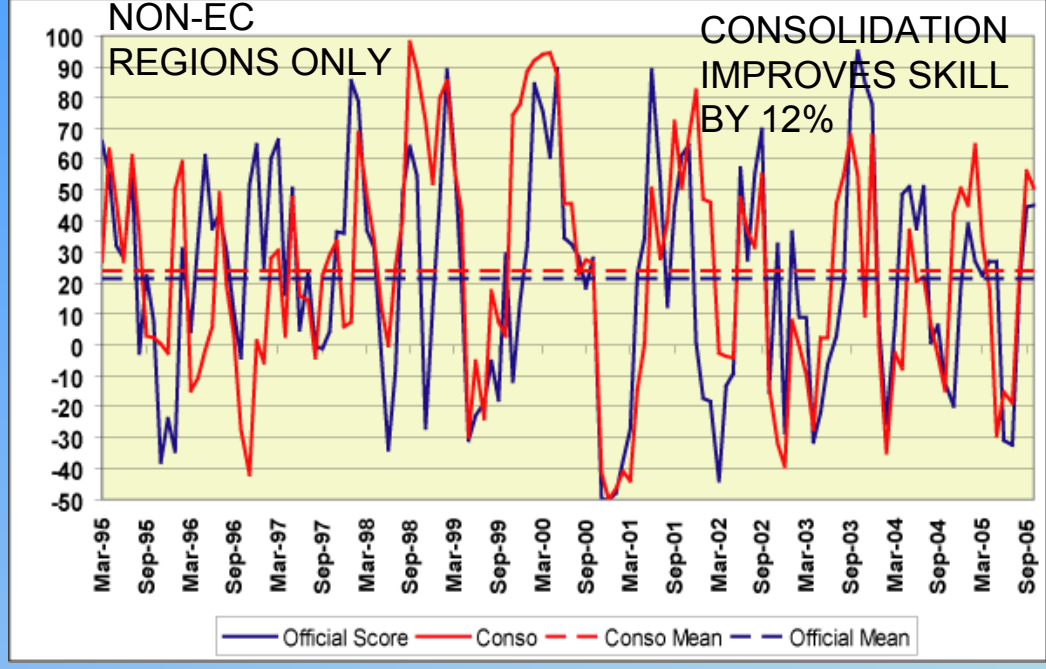
A comparison of skill of U.S. seasonal surface temperature predictions from 1995-present.

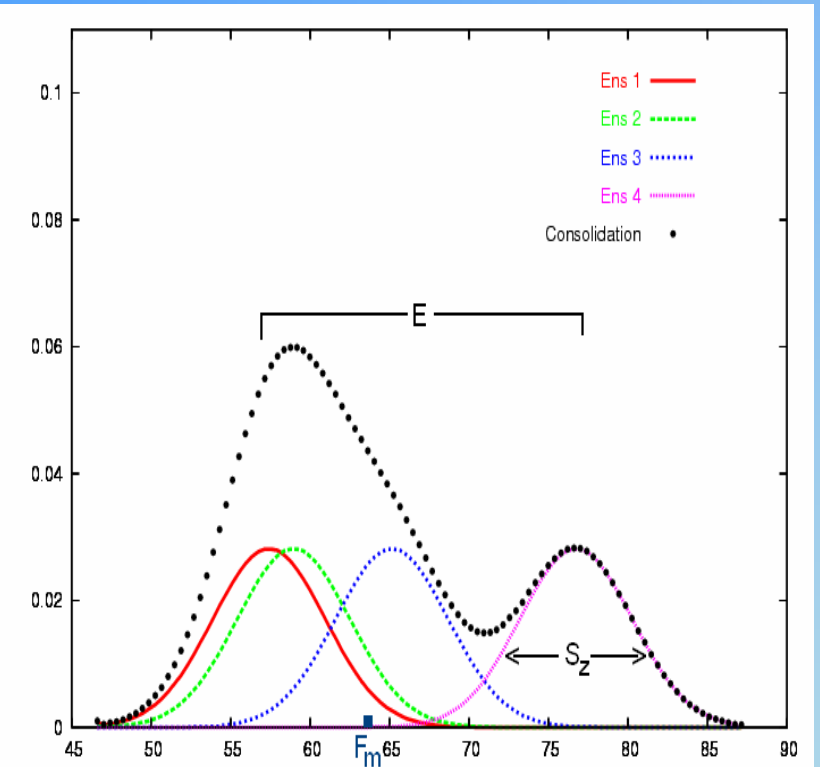
Blue = CPC Official

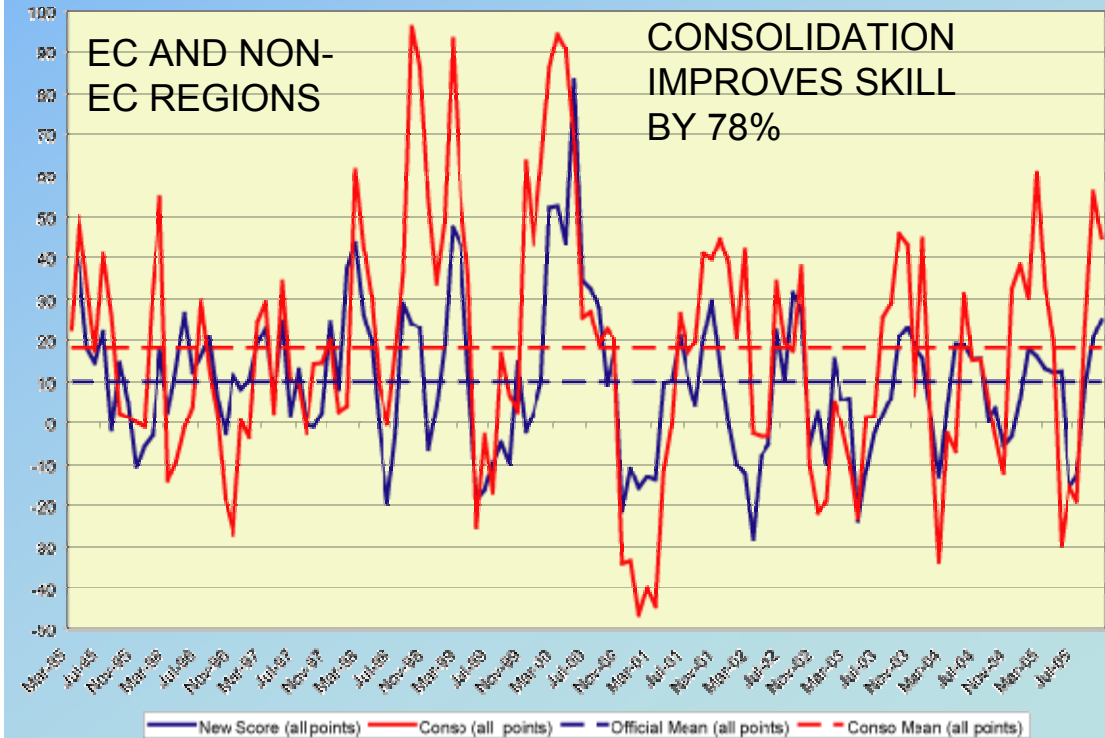
Red = Consolidation of CFS, CCA, OCN, SMLR

Top: Non-EC regions, 12% improvement

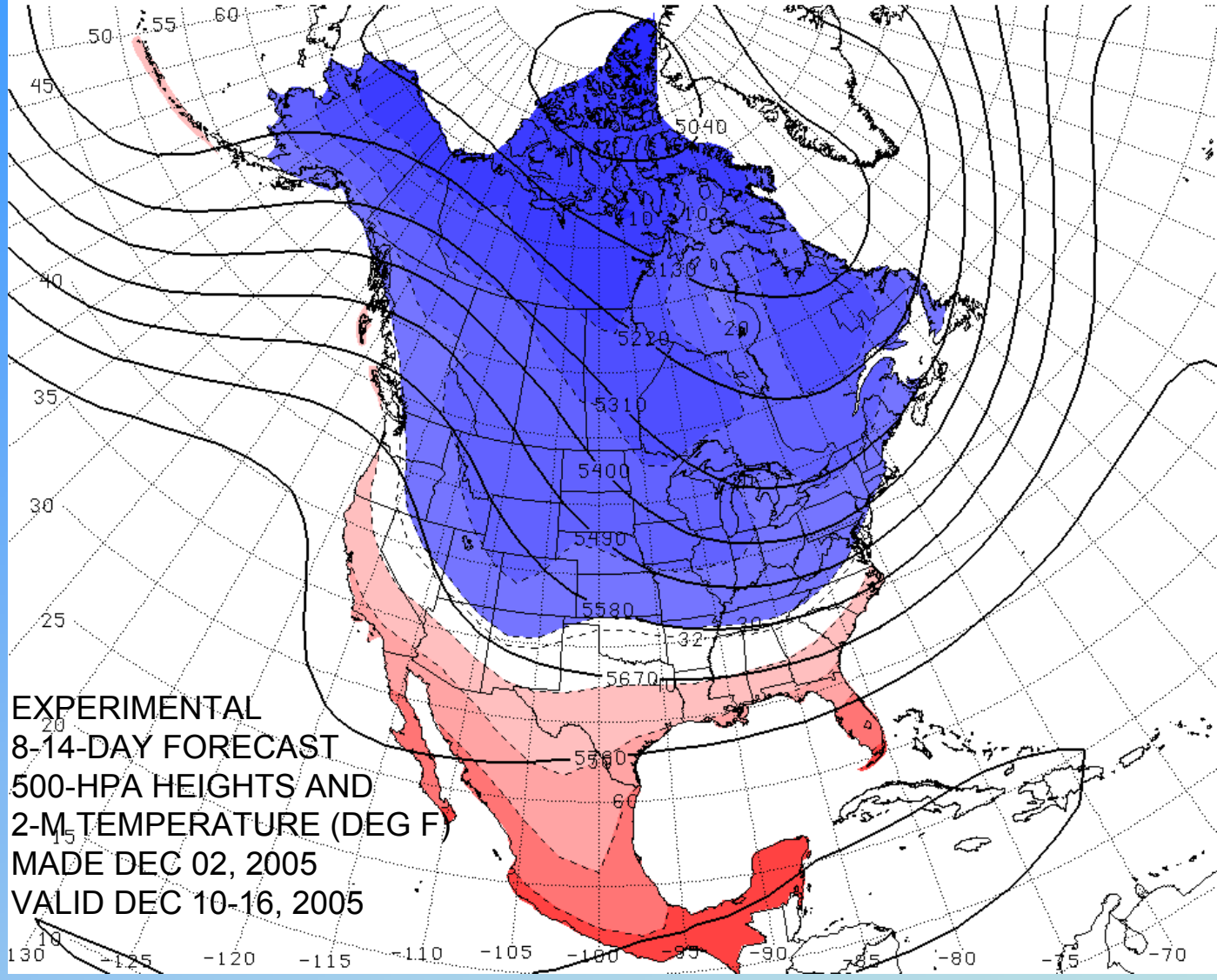
Bottom: All areas, 78% improvement







Prototype 8-14-day Forecast from The North American Ensemble Forecast System (NAEFS)



The U.S., Canada and Mexico, through NAEFS, will develop a standard set of *basic products* from calibrated models. *End products* derived from basic products will be developed to suit each country's requirements. A very early version of one such end product, developed at CPC, is shown above.