Seasonal Climate Prediction at Climate Prediction Center

CPC/NCEP/NWS/NOAA/DoC

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Menu of CPC predictions:

- 6-10 day (daily)
- Week 2 (daily)
- Monthly (monthly + update)
- Seasonal (monthly)
- Other (hazards, drought monitor, drought outlook, MJO, UV-index, degree days, POE, SST) (some are ‘briefings’)
- Informal forecast *tools* (too many to list)

- http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/index.pri.html

Climate??

By example:

A *weather* forecast: Rain in the morning, sun in the afternoon. High in mid-fifties

A *climate* forecast: Temp in DJF 2009/10 will be in upper tercile with a 48% probability

Forecast Maps and Bulletin

•Each month, on the Thursday between the 15th and 21st, CPC, on behalf of NWS, issues a set of 13 seasonal outlooks.

•There are two maps for each of the 13 leads, one for temperature and one for precipitation for a total of 26 maps.

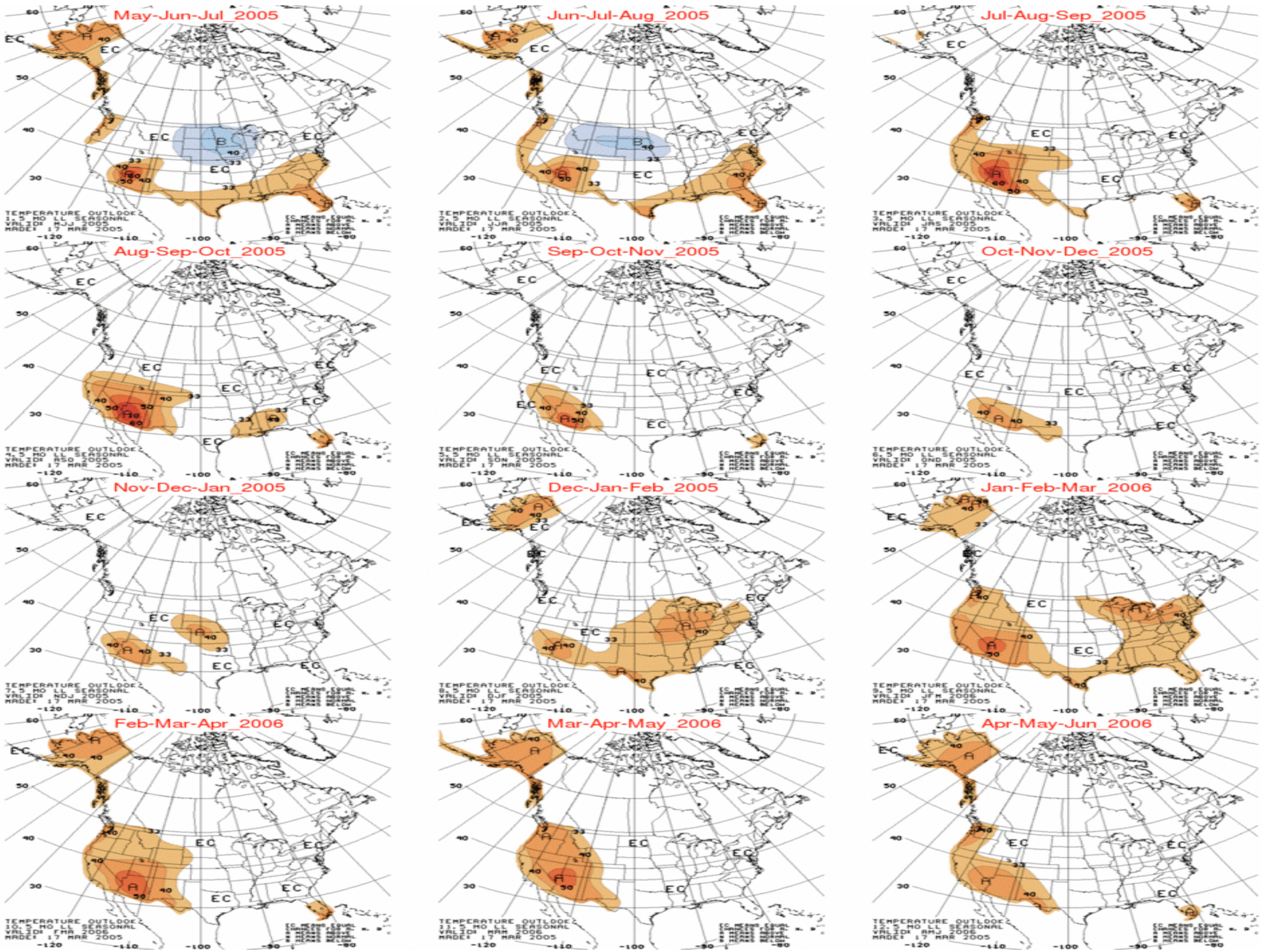
•Each outlook covers a 3-month "season", and each forecast overlaps the next and prior season by 2 months.

•Bulletins include: the prognostic map discussion (PMD) for the seasonal outlook over North America, and, for Hawaii.

•The monthly outlook is issued at the same time as the seasonal outlook. It consists of a temperature and precipitation outlook for a single lead, 0.5 months, and the monthly PMD.

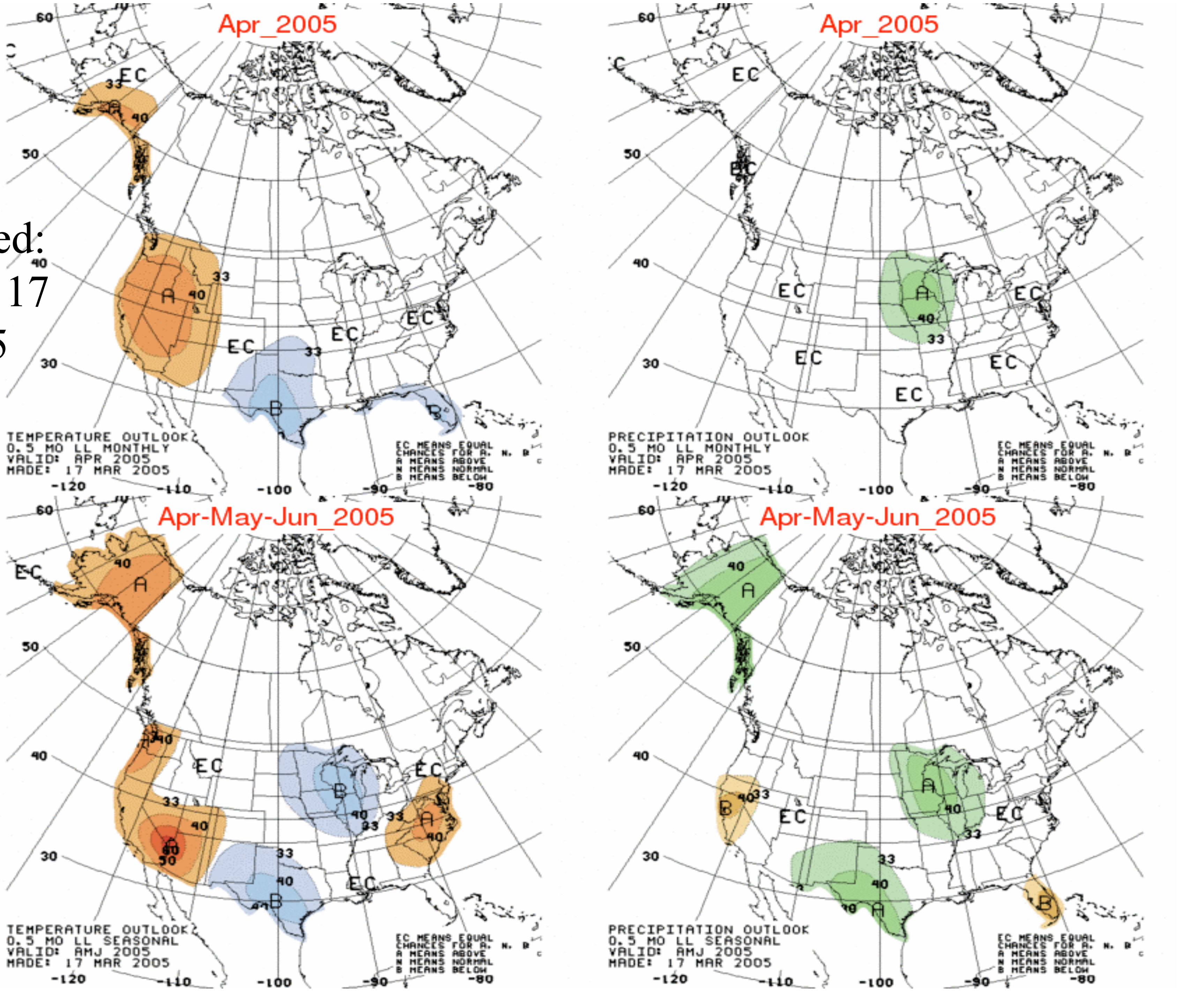
•All maps are sent to AWIPS, Family of Services and internet.

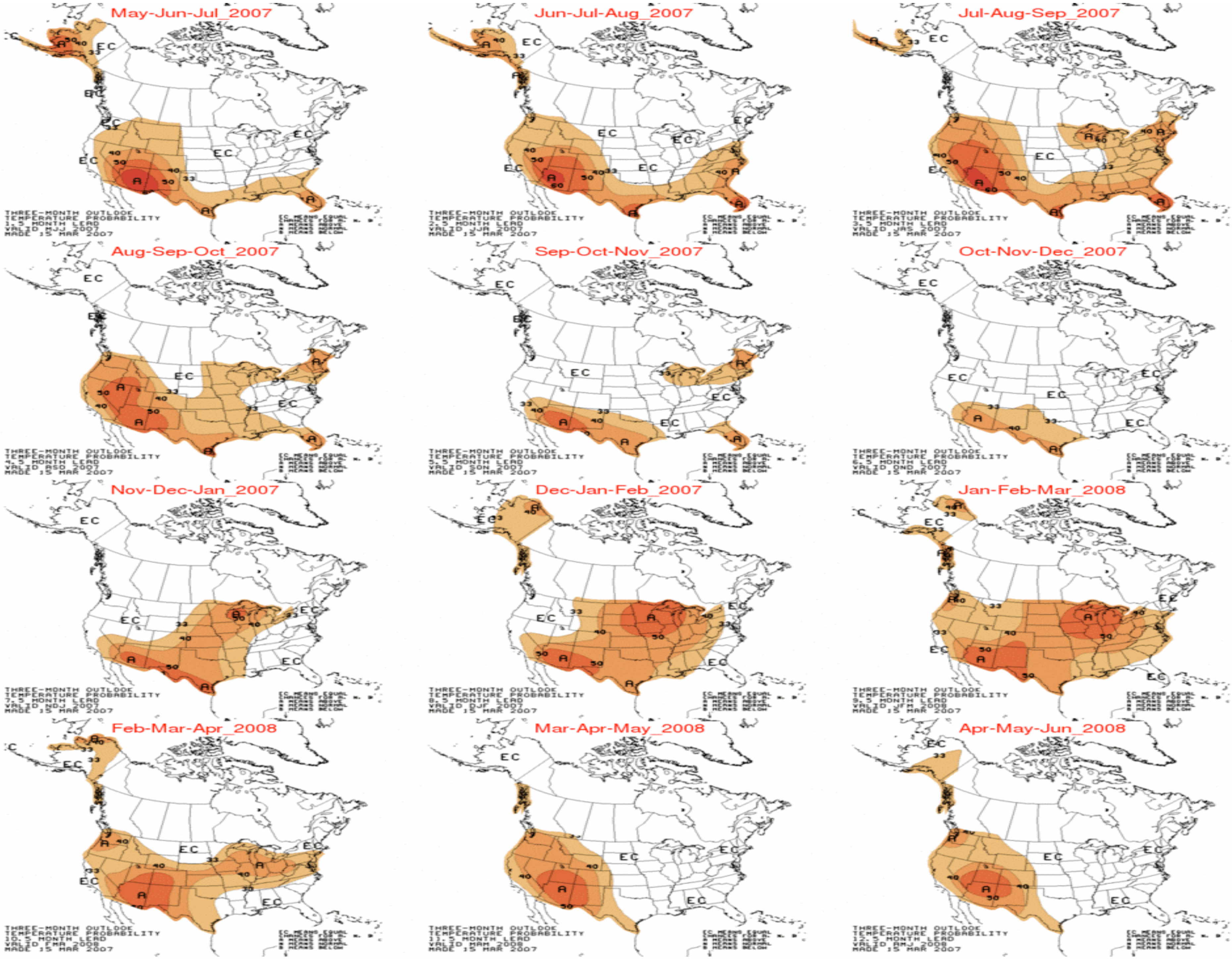
•'Official' SST forecasts

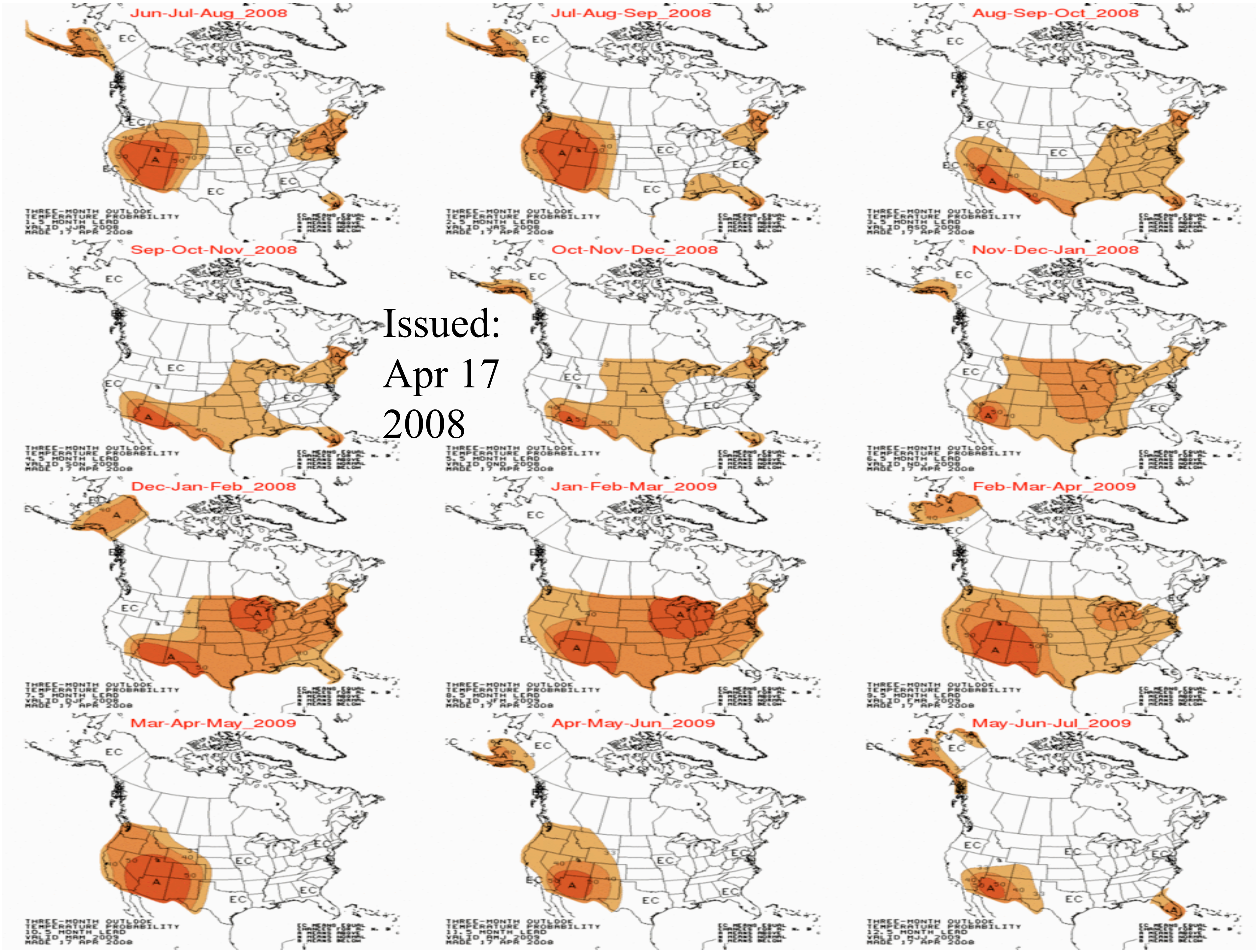


May-Jun-Jul_2005
Jun-Jul-Aug_2005
Jul-Aug-Sep_2005
Aug-Sep-Oct_2005
Sep-Oct-Nov_2005
Oct-Nov-Dec_2005
Nov-Dec-Jan_2005
Dec-Jan-Feb_2005
Jan-Feb-Mar_2006
Feb-Mar-Apr_2006
Mar-Apr-May_2006
Apr-May-Jun_2006
TEMPERATURE OUTLOOK

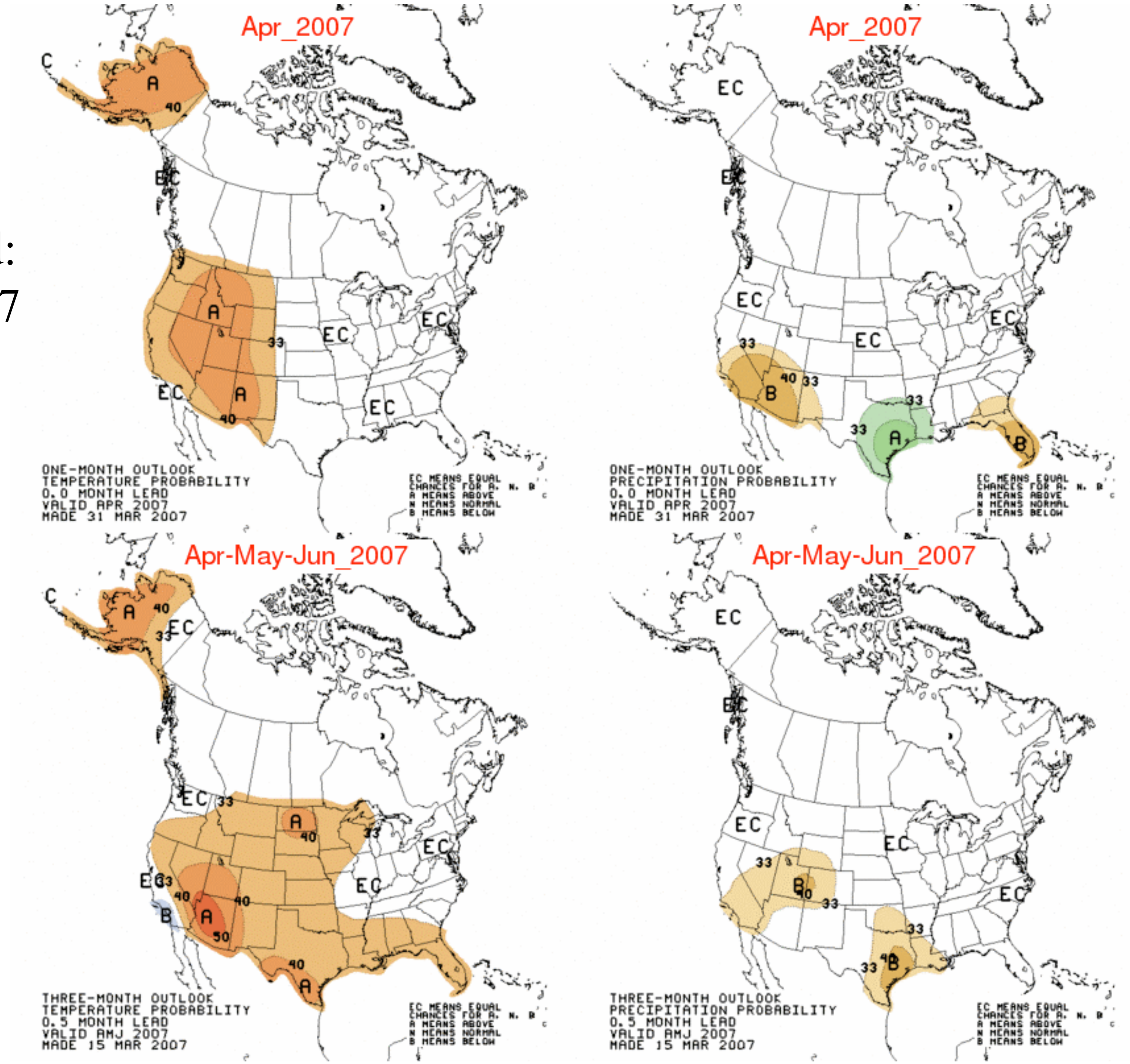
Issued:
Mar 17
2005



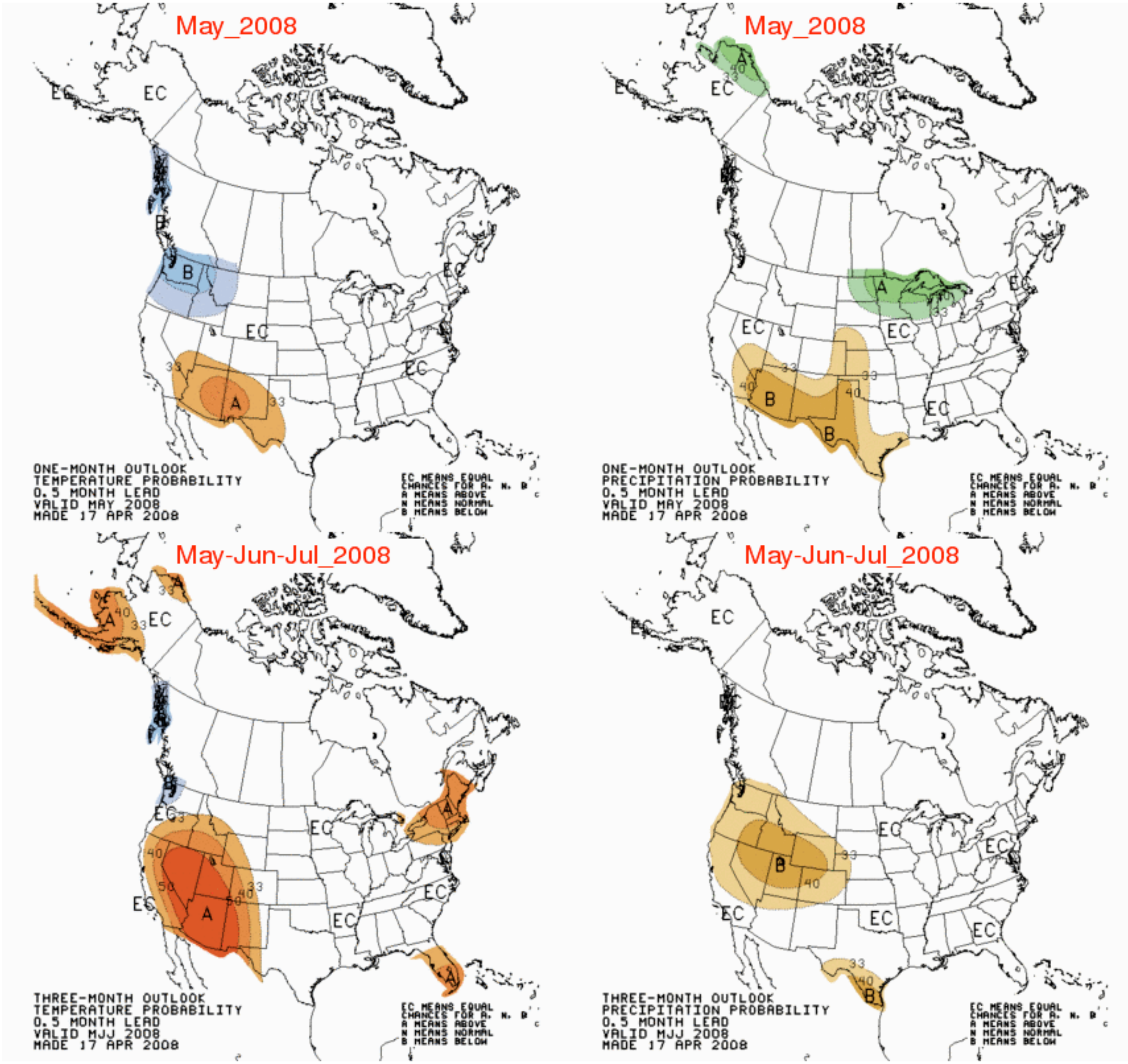

May-Jun-Jul_2007
Jun-Jul-Aug_2007
Jul-Aug-Sep_2007
Aug-Sep-Oct_2007
Sep-Oct-Nov_2007
Oct-Nov-Dec_2007
Nov-Dec-Jan_2007
Dec-Jan-Feb_2007
Jan-Feb-Mar_2008
Feb-Mar-Apr_2008
Mar-Apr-May_2008
Apr-May-Jun_2008
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY


Jun-Jul-Aug_2008
Jul-Aug-Sep_2008
Aug-Sep-Oct_2008
Sep-Oct-Nov_2008
Issued:
Apr 17
2008
Oct-Nov-Dec_2008
Nov-Dec-Jan_2008
Dec-Jan-Feb_2008
Jan-Feb-Mar_2009
Feb-Mar-Apr_2009
Mar-Apr-May_2009
Apr-May-Jun_2009
May-Jun-Jul_2009

Issued:
Mar 17
2007



Issued:
Apr 17
2008



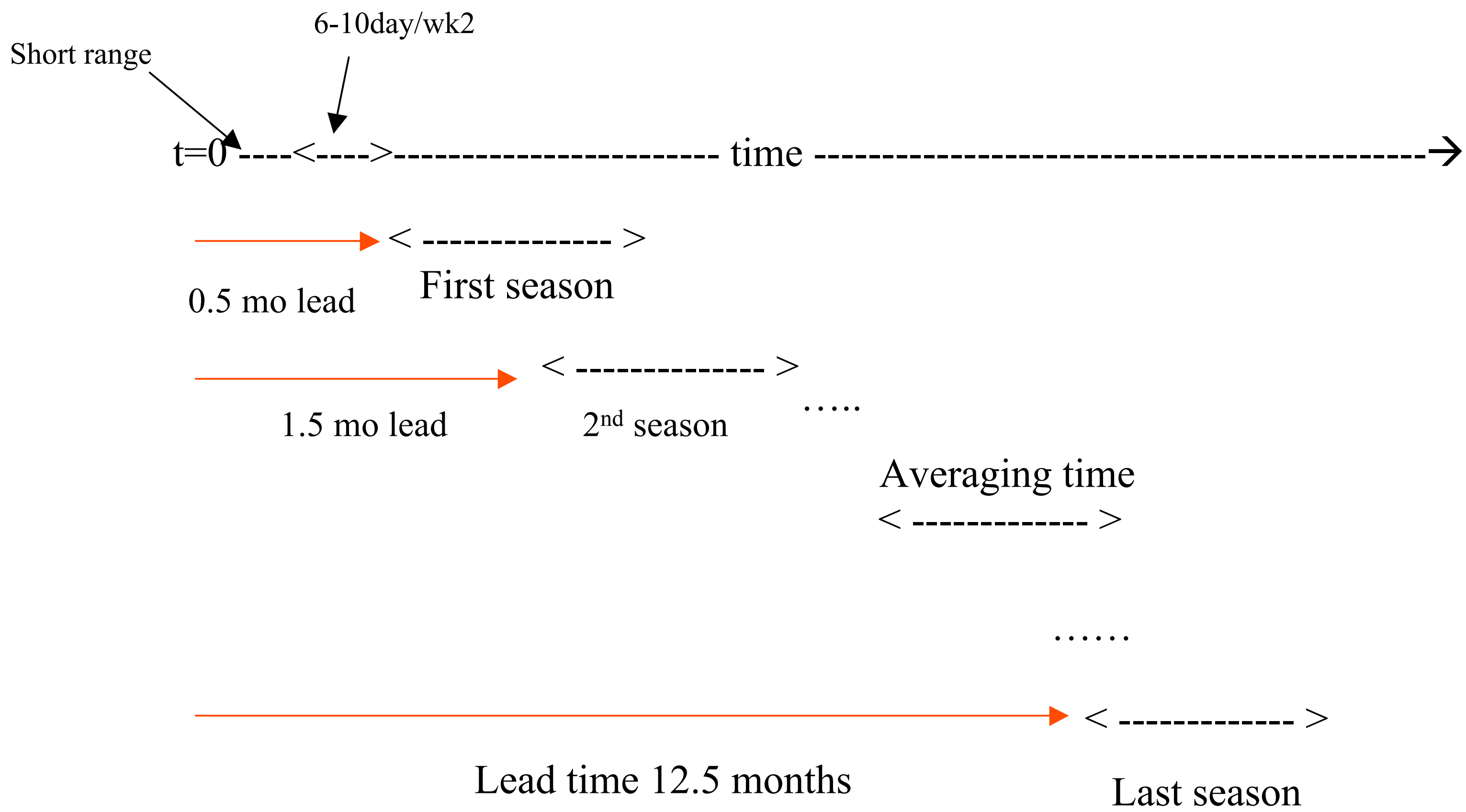


Fig. 9.2 A lay-out of the seasonal forecast, showing the averaging time, and the lead time (in red). Rolling seasonal means at leads of 2 weeks to 12.5 months leads are being forecast.

Distinguish 3 time scales:

- 1) Averaging time
- 2) Lead time
- 3) Time scale of physical process we try to predict

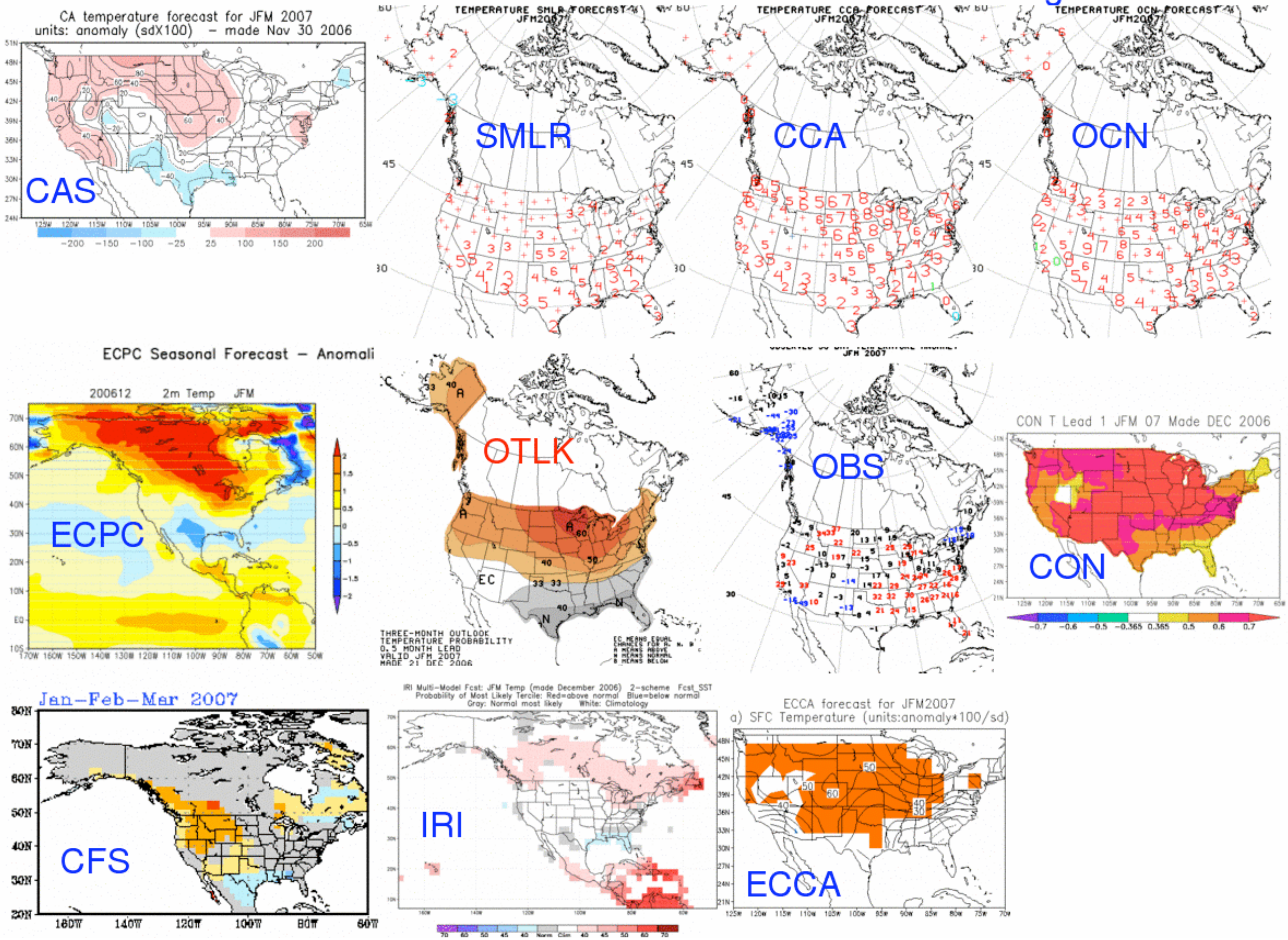
- Examples of 3rd point:
- -) ENSO (a few years)
- -) Inter-decadal (no name, trend, global change
- Reflect on definition of time scale.
- What is time scale of seasonal forecast? Fourier

Element →

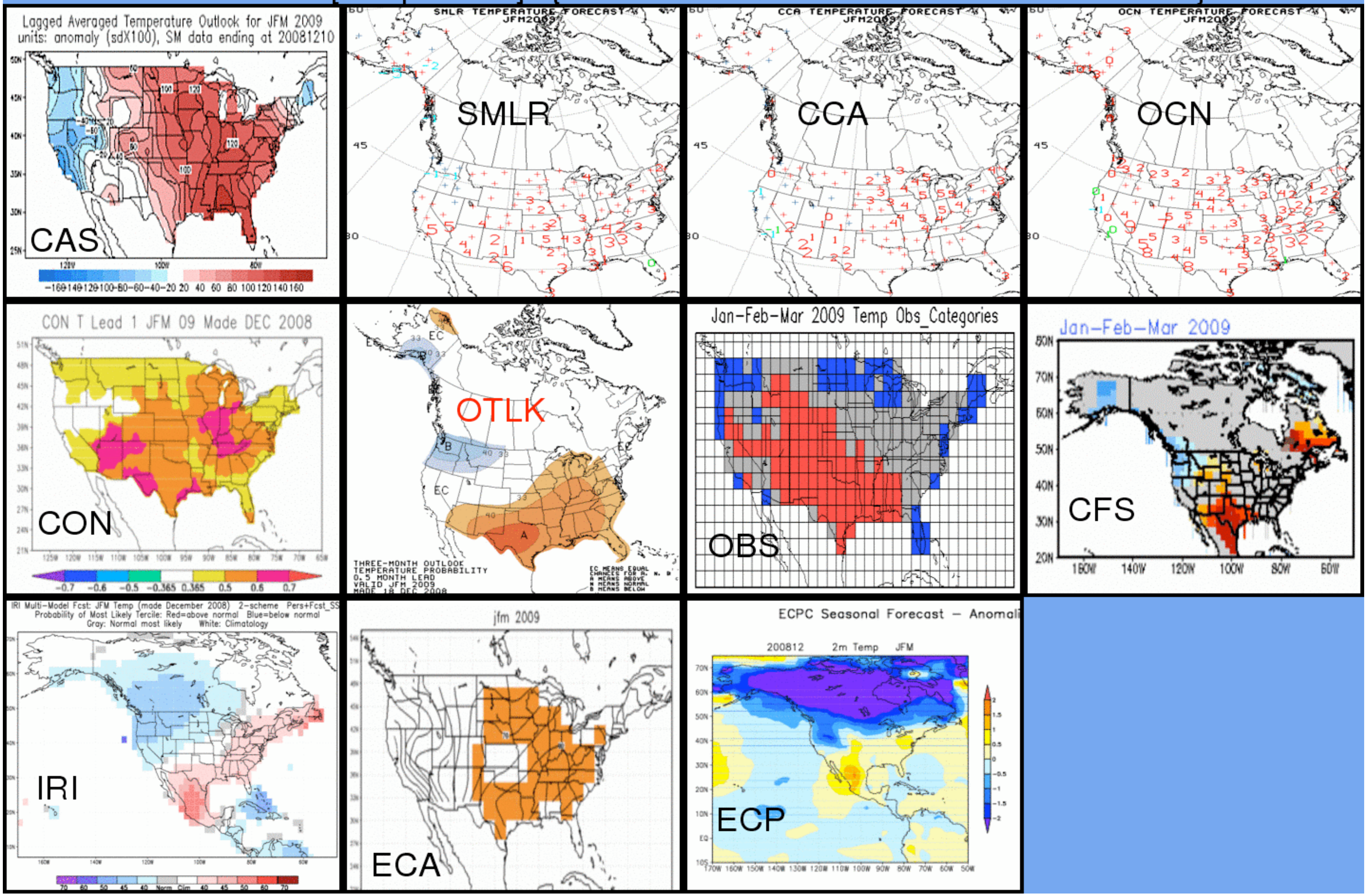
Method:	US-T	US-P	SST	US-soil moisture
CCA	X	X	X	
OCN	X	X		
CFS	X	X	X	
Constructed Analog	X	X	X	X
Markov			X	
ENSO Composite	X	X		
Other (GCM) models (IRI, ECHAM, NCAR, CDC etc):	X	X		
Cane&Zebiak			X	
Multiple Lin Reg	X	X		
Consolidation	X	X	X	

CCA = Canonical Correlation Analysis
OCN = Optimal Climate Normals
CFS = Climate Forecast System (Coupled Ocean-Atmosphere Model)

JFM Season: All-Stns: +9.7 / Non-EC: +10.8 / %-Covg: 89.8



JFM Season [Temperature] {ALL: +10.1 / NON-EC: +16.6 / %-COVG: 61.2}



Coupled Forecast System at NCEP

History:

- MRF-b9x, CMP12/14 1995 onward (Leetmaa, Ji, etc
- SFM 2000 onward (Kanamitsu et al
- CFS, the 1st truly coupled global system at NCEP (aug 2004)
- Next CFS: Jan 2010

CFS Reference: Saha, S. Nadiga, C. Thiaw, J. Wang, W. Wang, Q. Zhang, H. M. van den Dool, H.-L. Pan, S. Moorthi, D. Behringer, D. Stokes, M.Pena, G. White, S. Lord, W. Ebisuzaki, P. Peng, P. Xie, 2006: The NCEP Climate Forecast System. J. of Climate, 19, 3483-3517.

All CFS info is at http://cfs.ncep.noaa.gov/

Long Lead Predictions of US Surface Temperature using *Canonical Correlation Analysis*. Barnston(J.Climate, 1994, 1513)

Predictor - Predictand Configuration

Predictors	Predictand
* Near-global SSTA	
* N.H. 700mb Z	* US sfc T
* US sfc T	
four predictor "stacked" fields	one predictand period
4X652=2608 predictors	102 locations

Data Period 1955 - last month

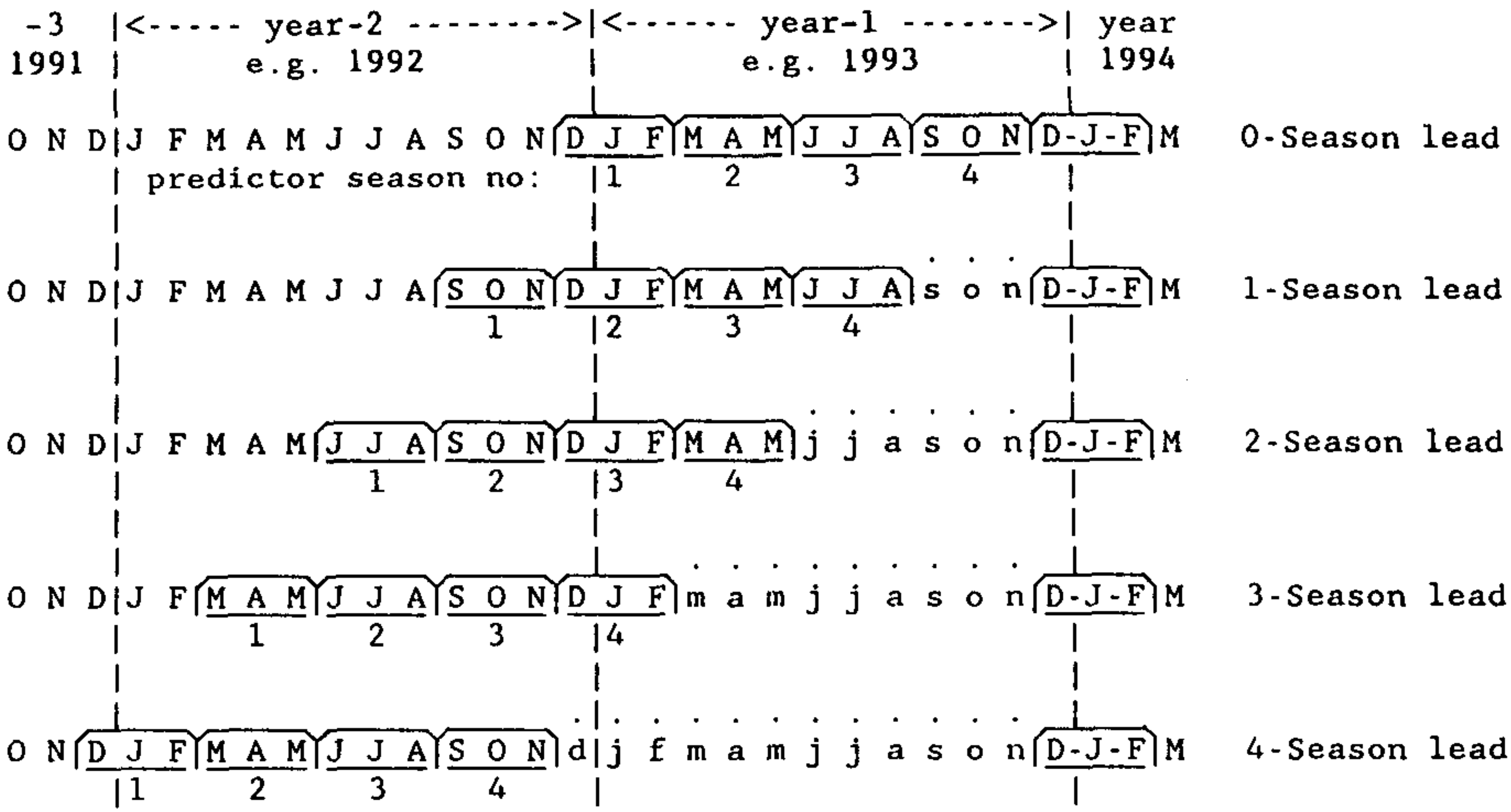


FIG. 3. Schematic of the timing of the predictor and predictand periods for the five lead times used in the study, for the example of forecasting Dec–Jan–Feb 1993/94. Each row illustrates a progressively larger lead time, with the four predictor periods (numbered beneath the month abbreviations) retreating farther into the past with increasing lead. The lead period is represented by lowercase month abbreviations with dots above them. A similar diagram could be drawn for other target seasons, or for fixed predictor periods and a variable target period as in real-time forecasting using the most recent 12 months of predictor data.

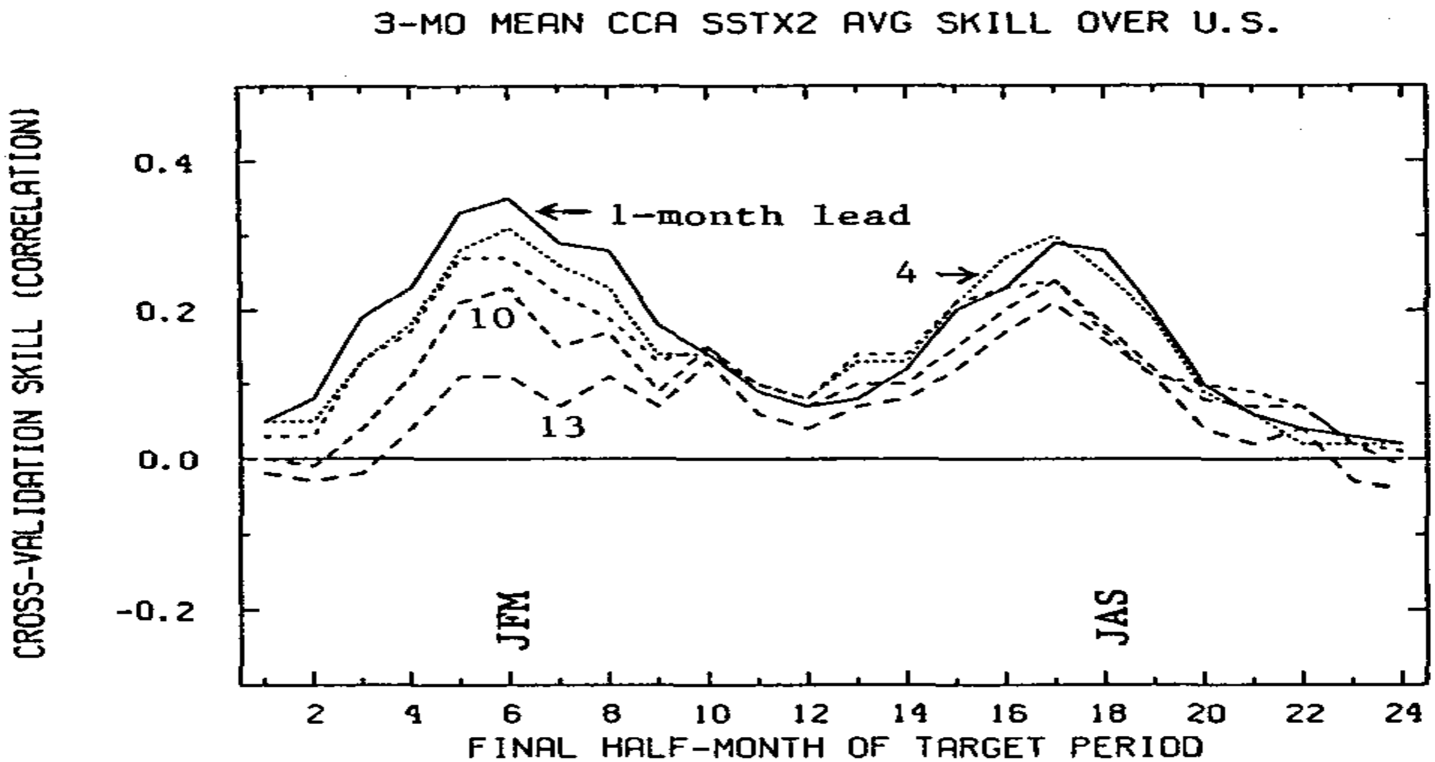


FIG. 6. CCA forecast skill averaged over the United States for 3-month mean temperature (as in Fig. 4a) except the SST field is weighted double its natural value.

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About *OCN*. Two contrasting views:

- Climate = average weather in the past
- Climate is the 'expectation' of the future

30 year WMO normals: 1961-1990; 1971-2000 etc

OCN = Optimal Climate Normals: Last K year average. All seasons/locations pooled: K=10 is optimal (for US T).

Forecast for Jan 2010

= (Jan00+Jan01+... Jan09)/10. – WMO-normal

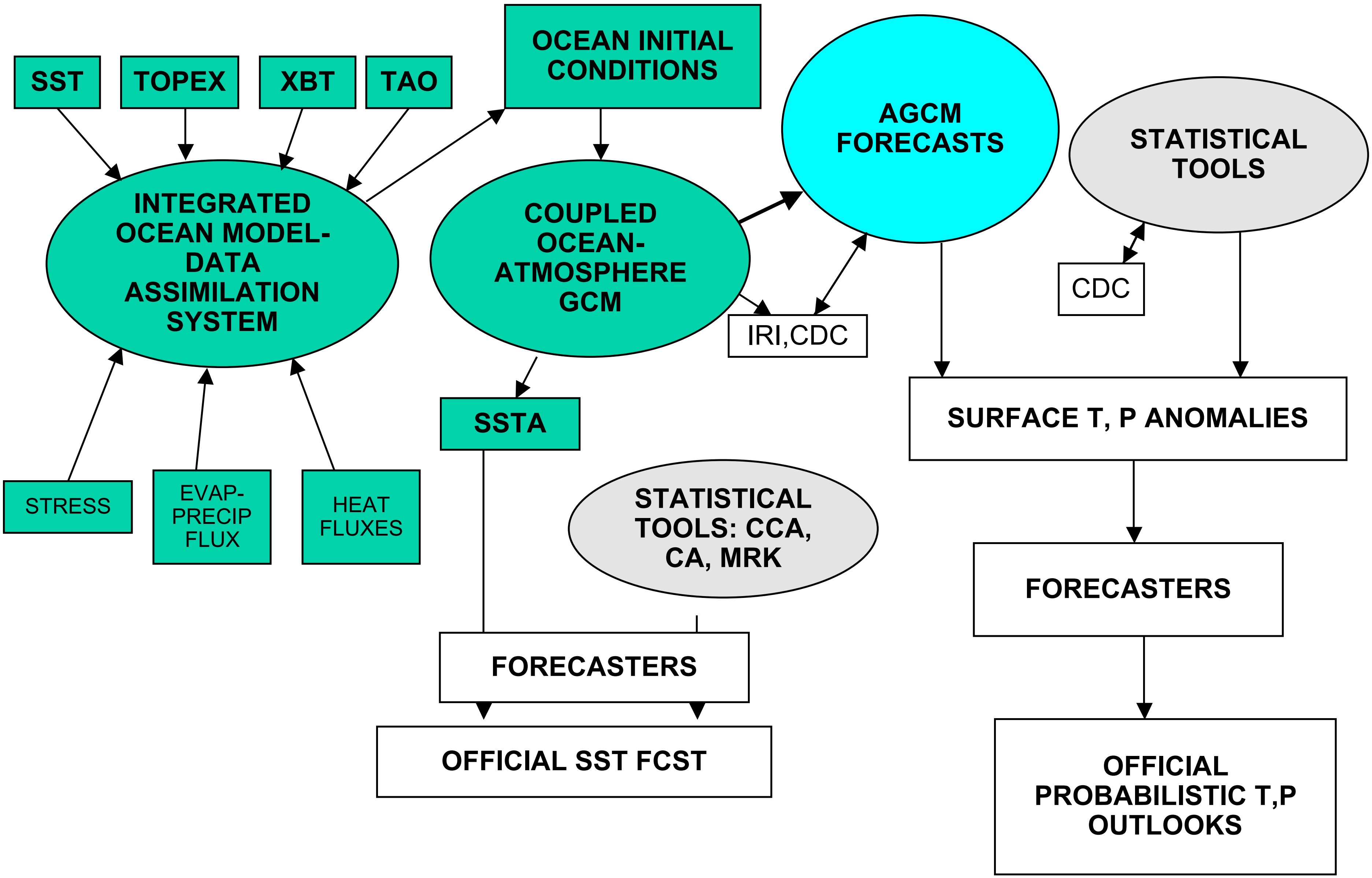
plus a skill evaluation for some 50 years.

Why does OCN work?

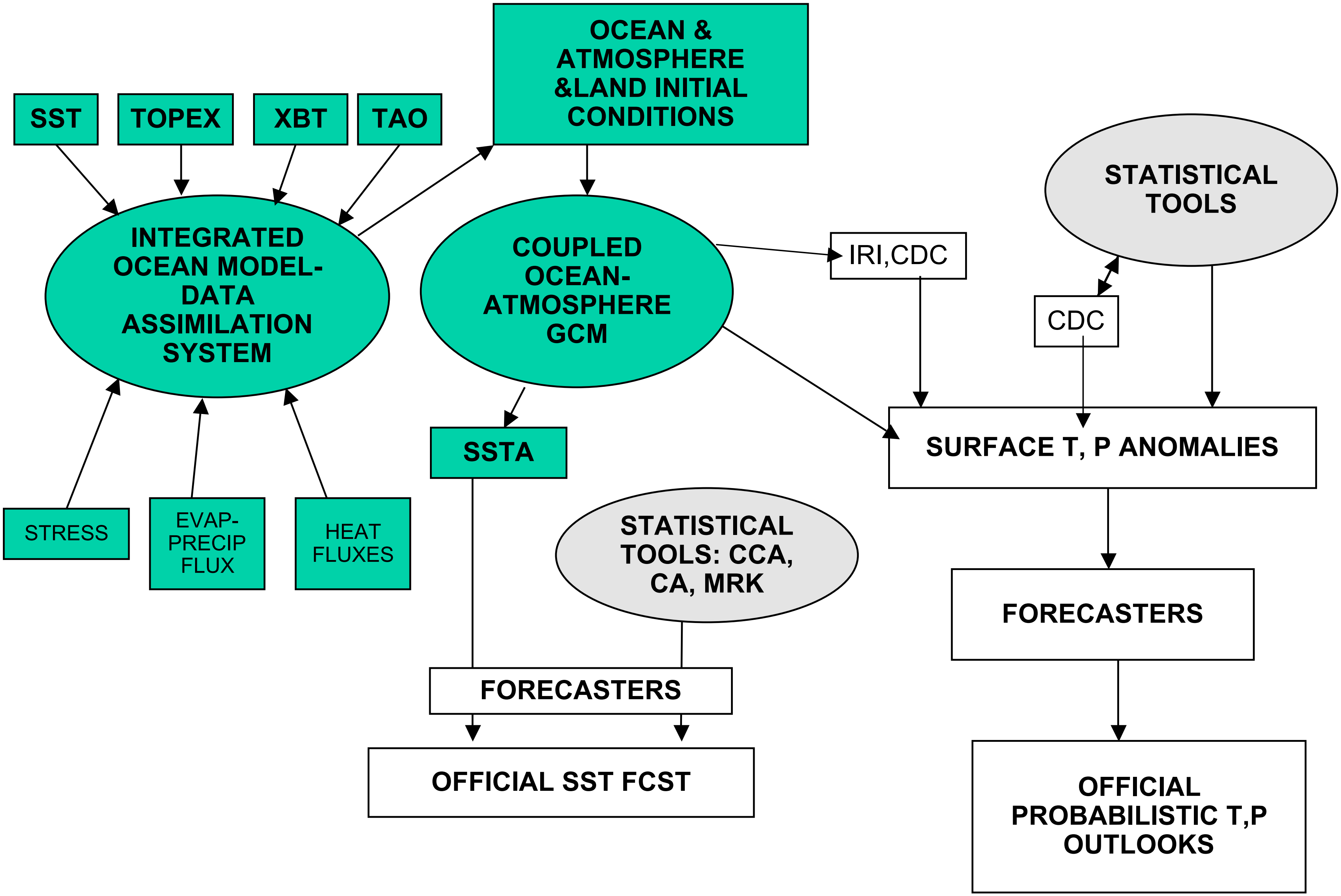
1) climate is not constant (K would be infinity for constant climate)
2) recent averages are better
3) somewhat shorter averages are better (for T)

→see Huang et al 1996. J.Climate. 9, 809-817.

NCEP's old (Two-Tier) Coupled Model Forecast



NCEP (One-Tier) Coupled Model Forecast



Major Verification Issues

- ‘a-priori’ verification (used to be rare)
- After the fact (fairly normal)

(Seasonal) Forecasts are useless unless accompanied by a reliable a-priori skill estimate.

Solution: develop a 50+ year track record for each tool. 1950-present.

(Admittedly we need 5000 years)

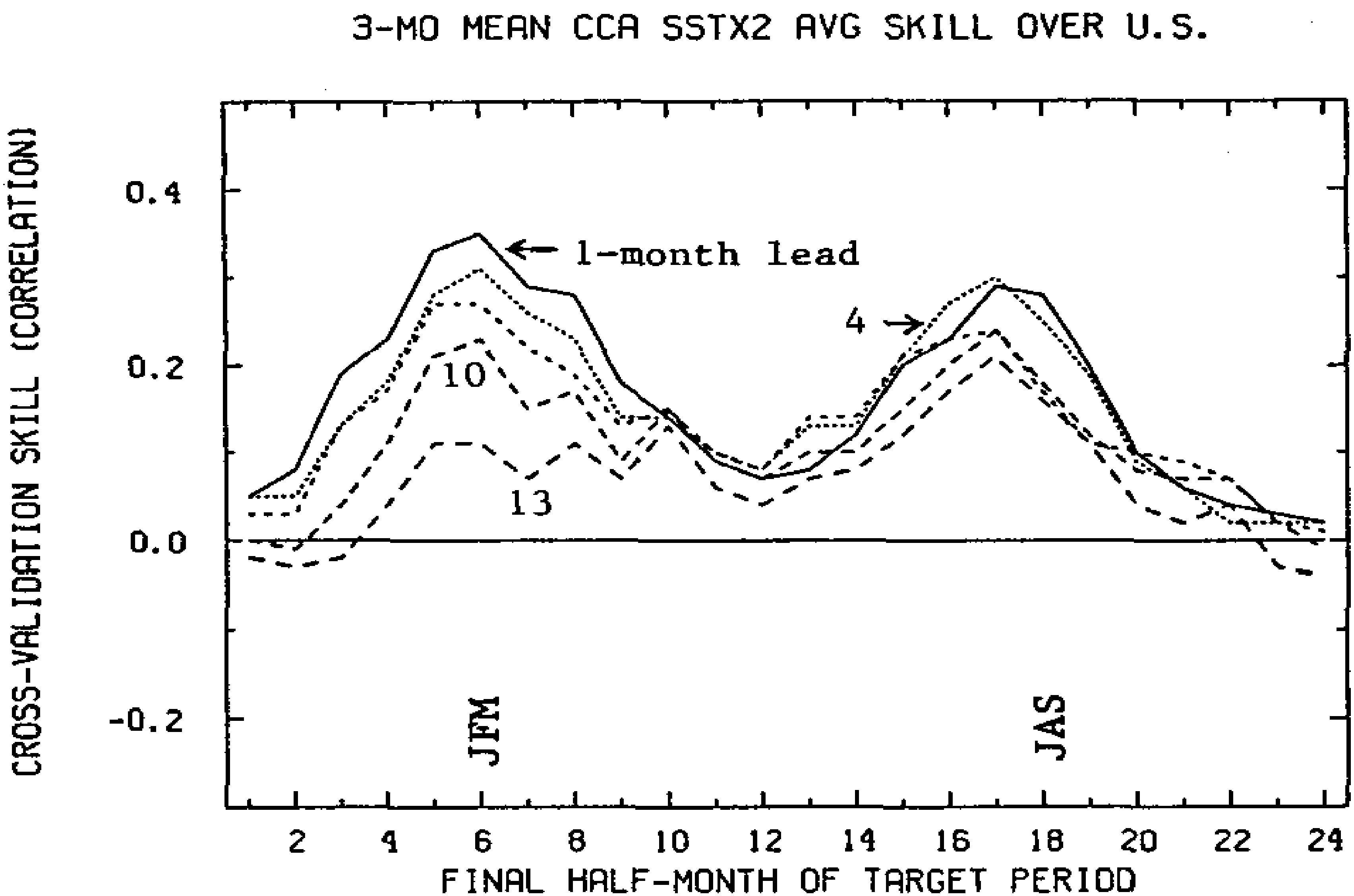
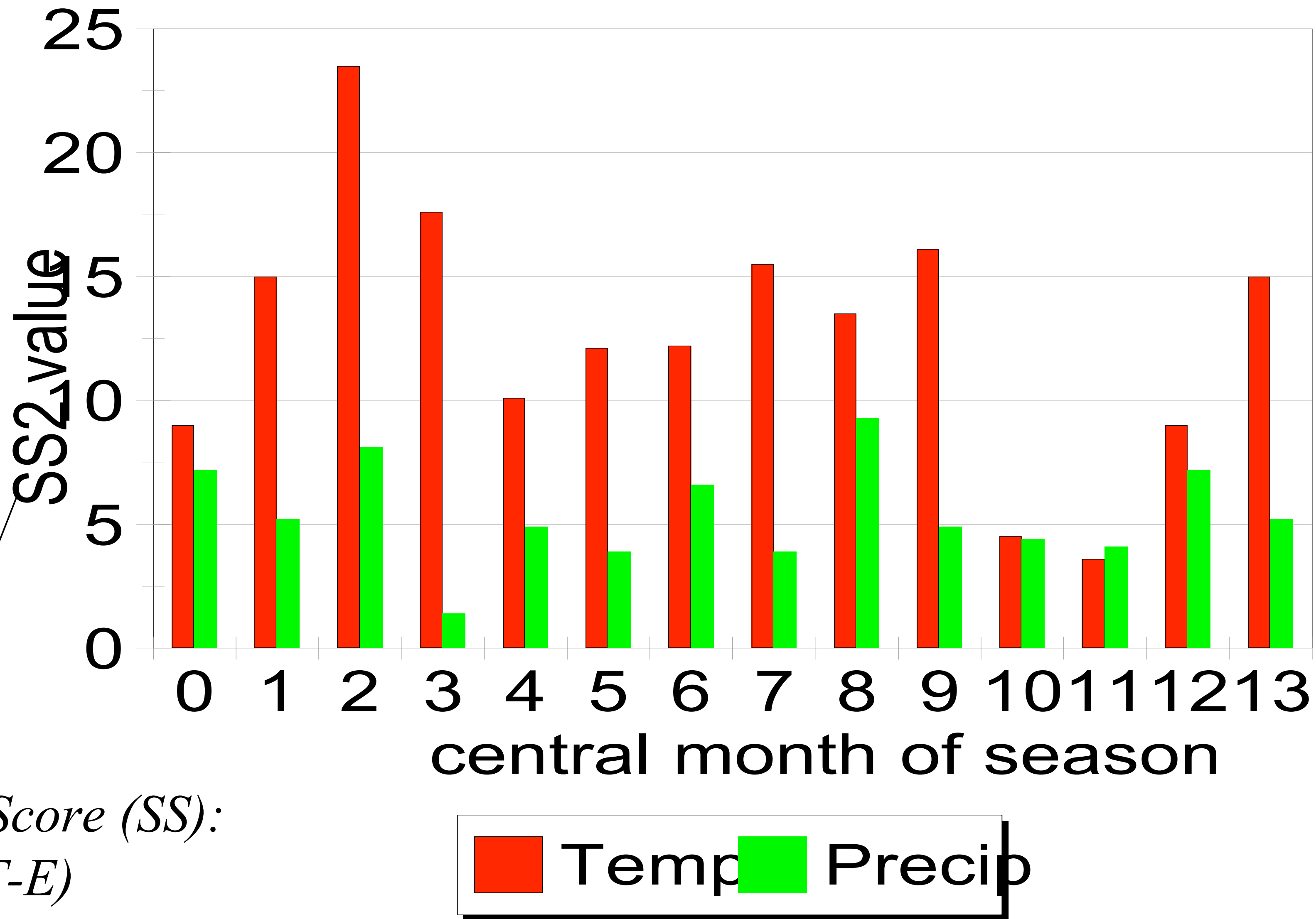


FIG. 6. CCA forecast skill averaged over the United States for 3-month mean temperature (as in Fig. 4a) except the SST field is weighted double its natural value.

Seasonality SS2 OCN seasonal fr

1962 - July 2000 T(12.8) & P(5



Heidke Score (SS):
(H-E)/(T-E)
2 SS~=correlation*

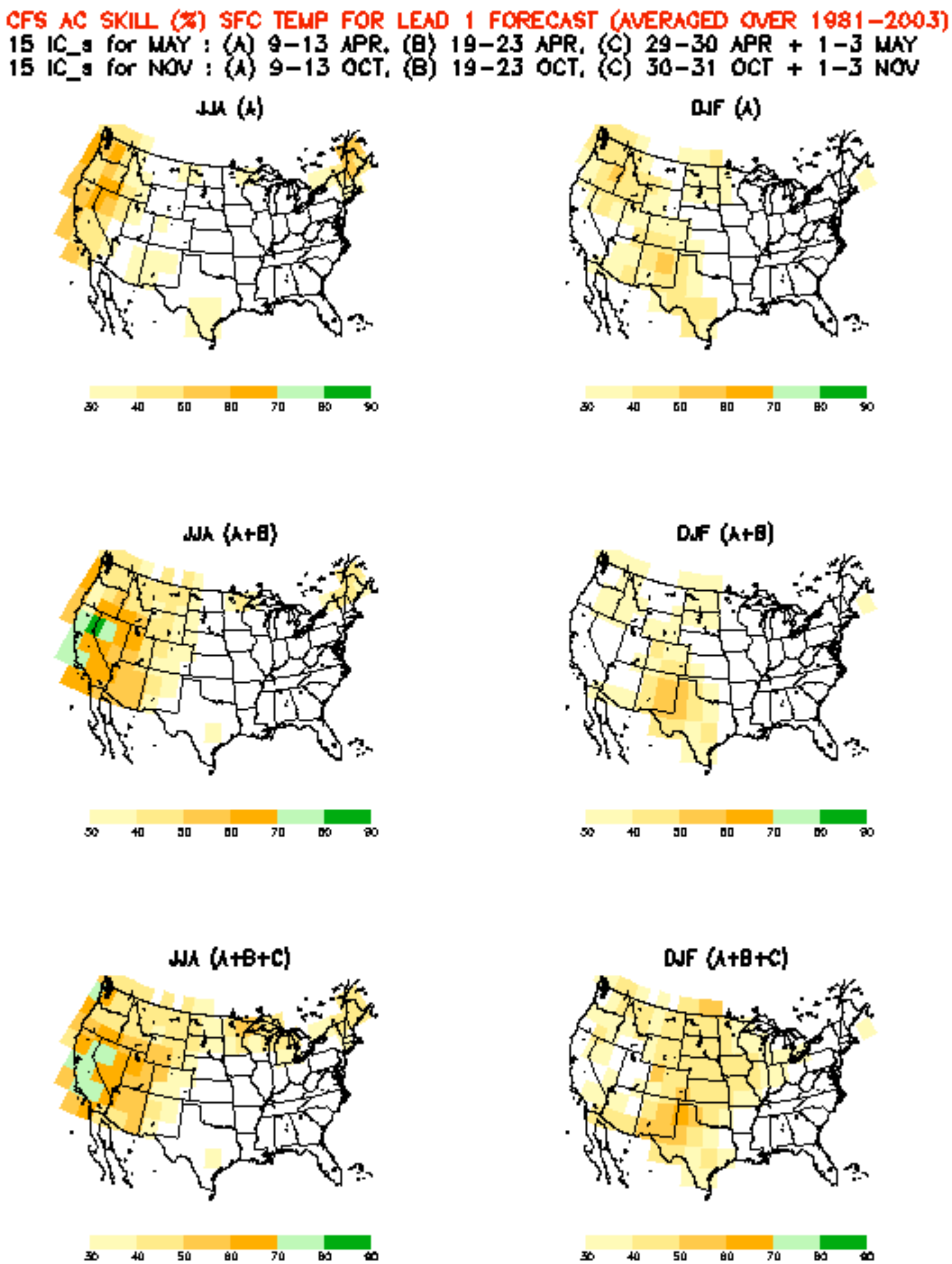
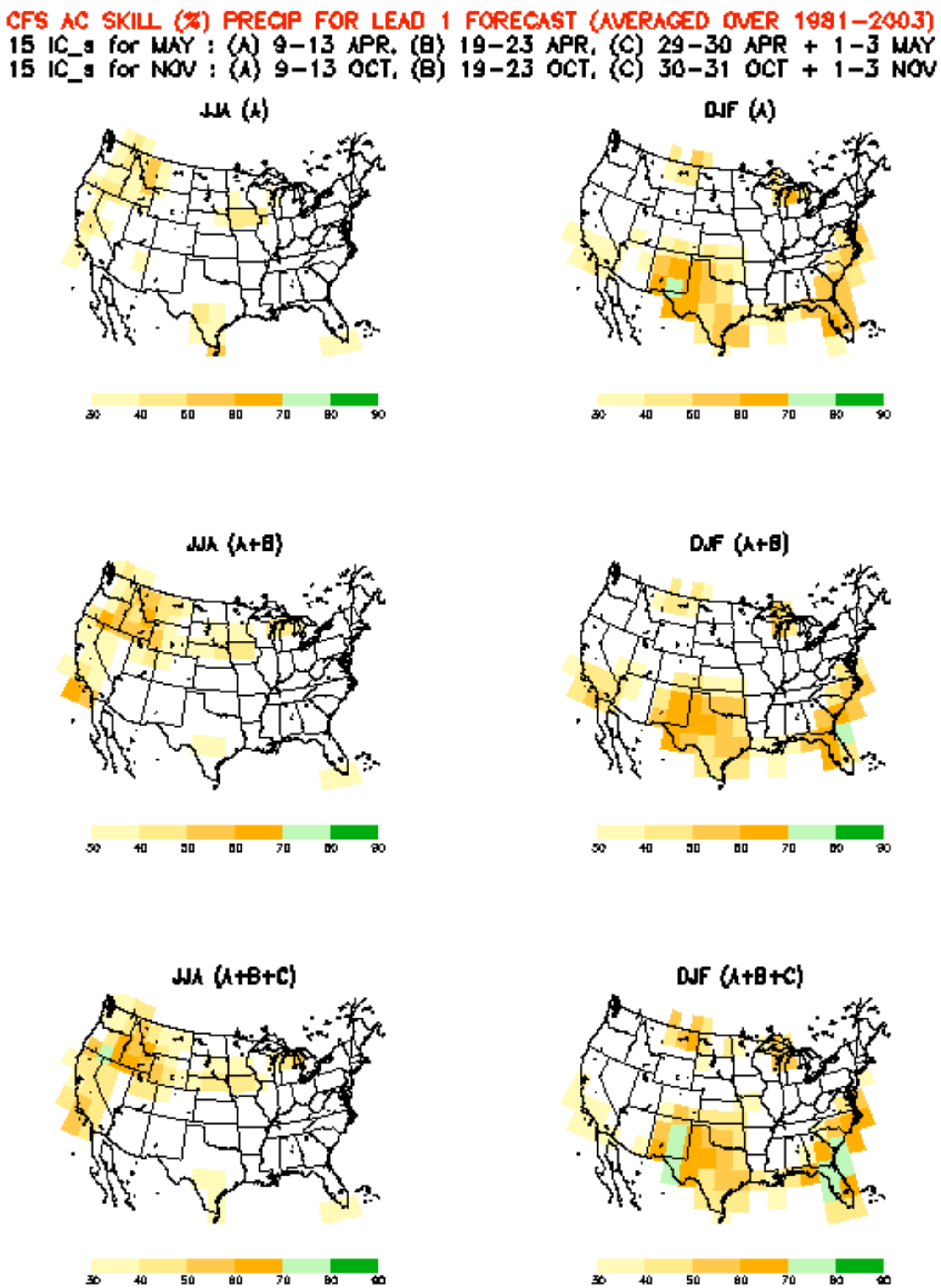


Fig. 9 Spatial distribution of retrospective (1981-2003) forecast skill (anomaly correlation in %) over the United States for lead 1 seasonal mean JJA temperature (left panel) and DJF temperature (right panel).

From top to bottom, the number of members in the CFS ensemble mean increases from 5 to 15. Values less than 0.3 (deemed insignificant) are not shown. The period is 1981-2003

1981-2003 (now 2006) is not much! if 5000 years is needed. Main limitation: ocean analysis



As in Fig.9, but now for Precipitation.

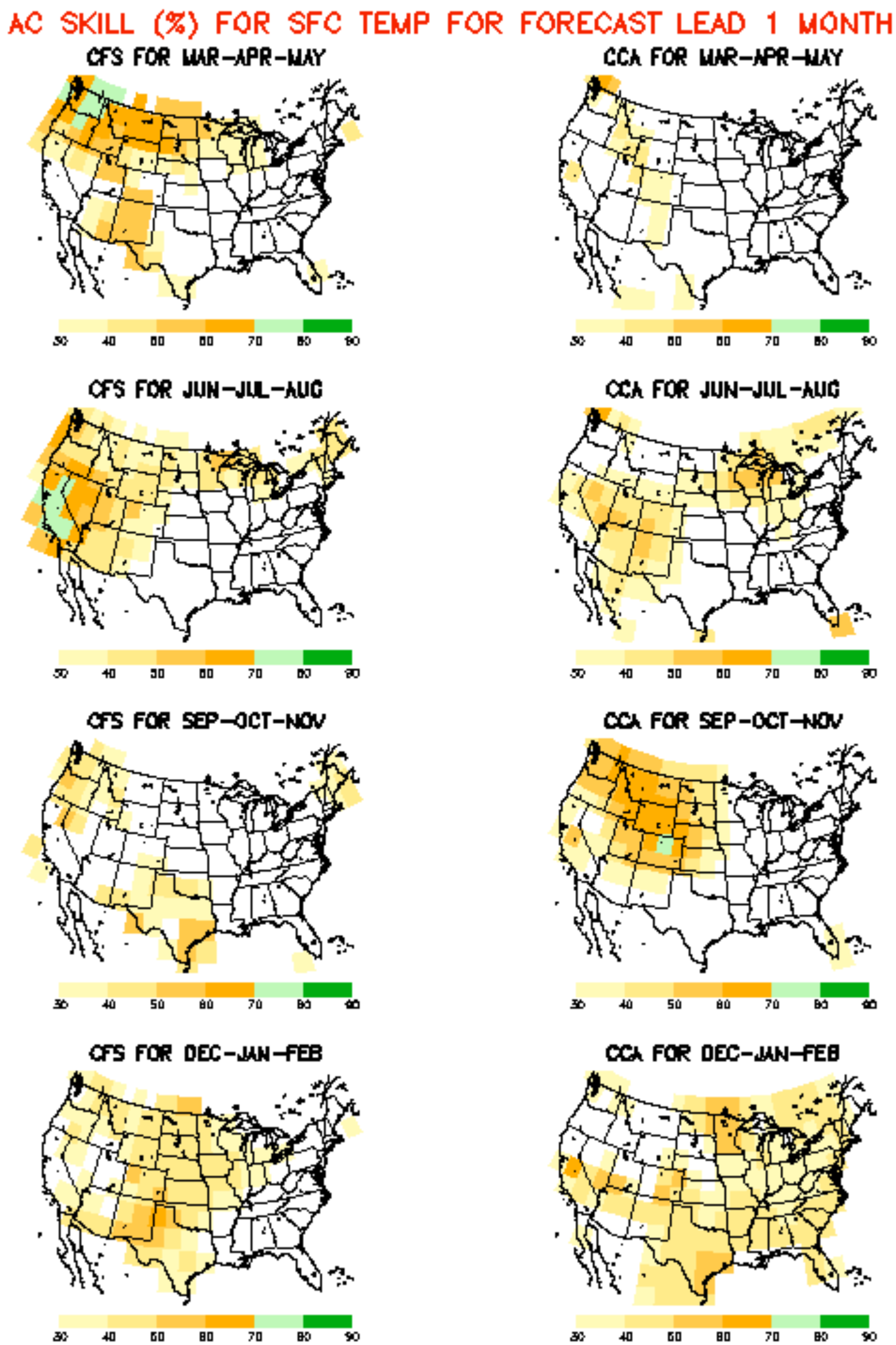
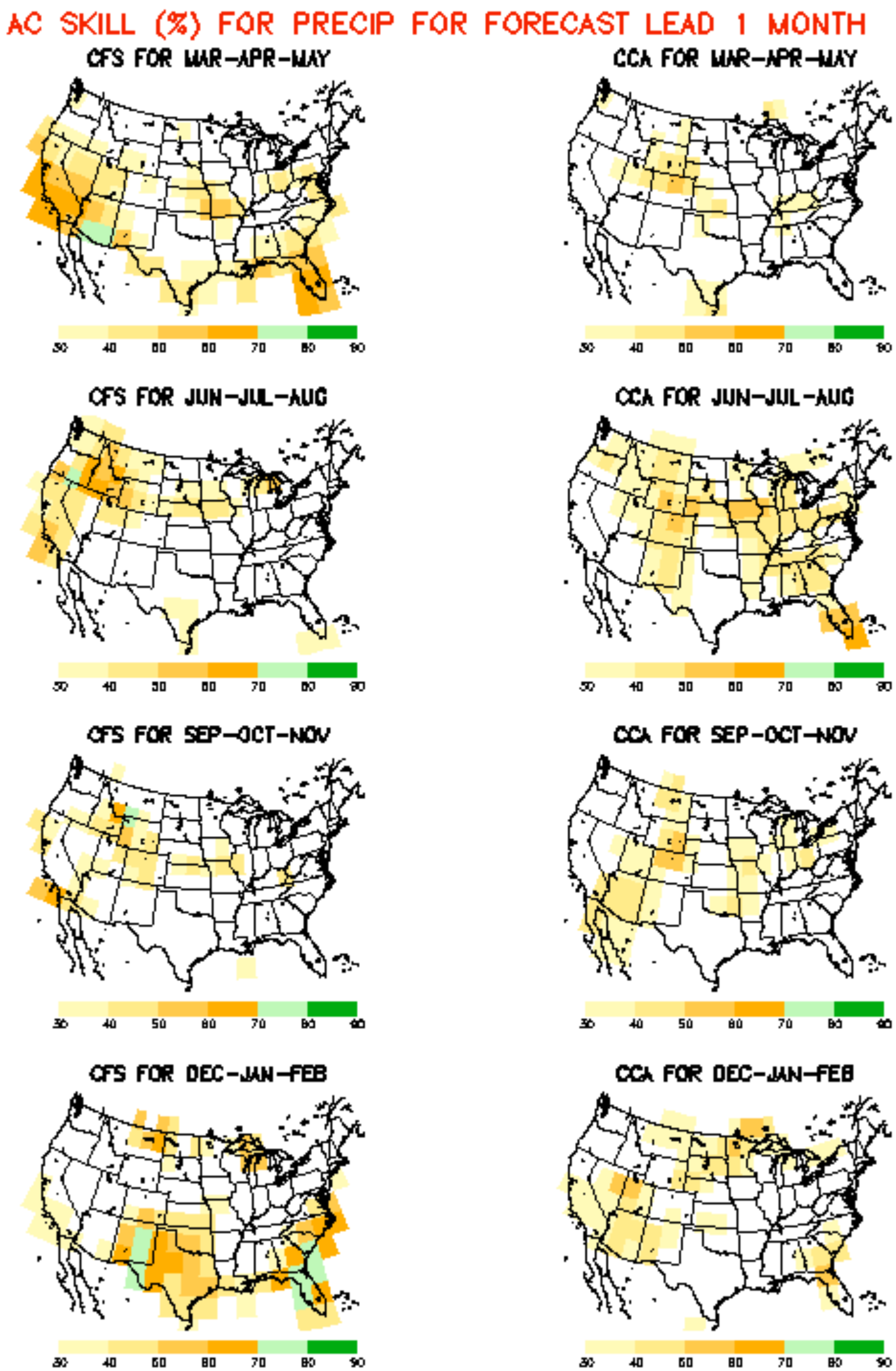
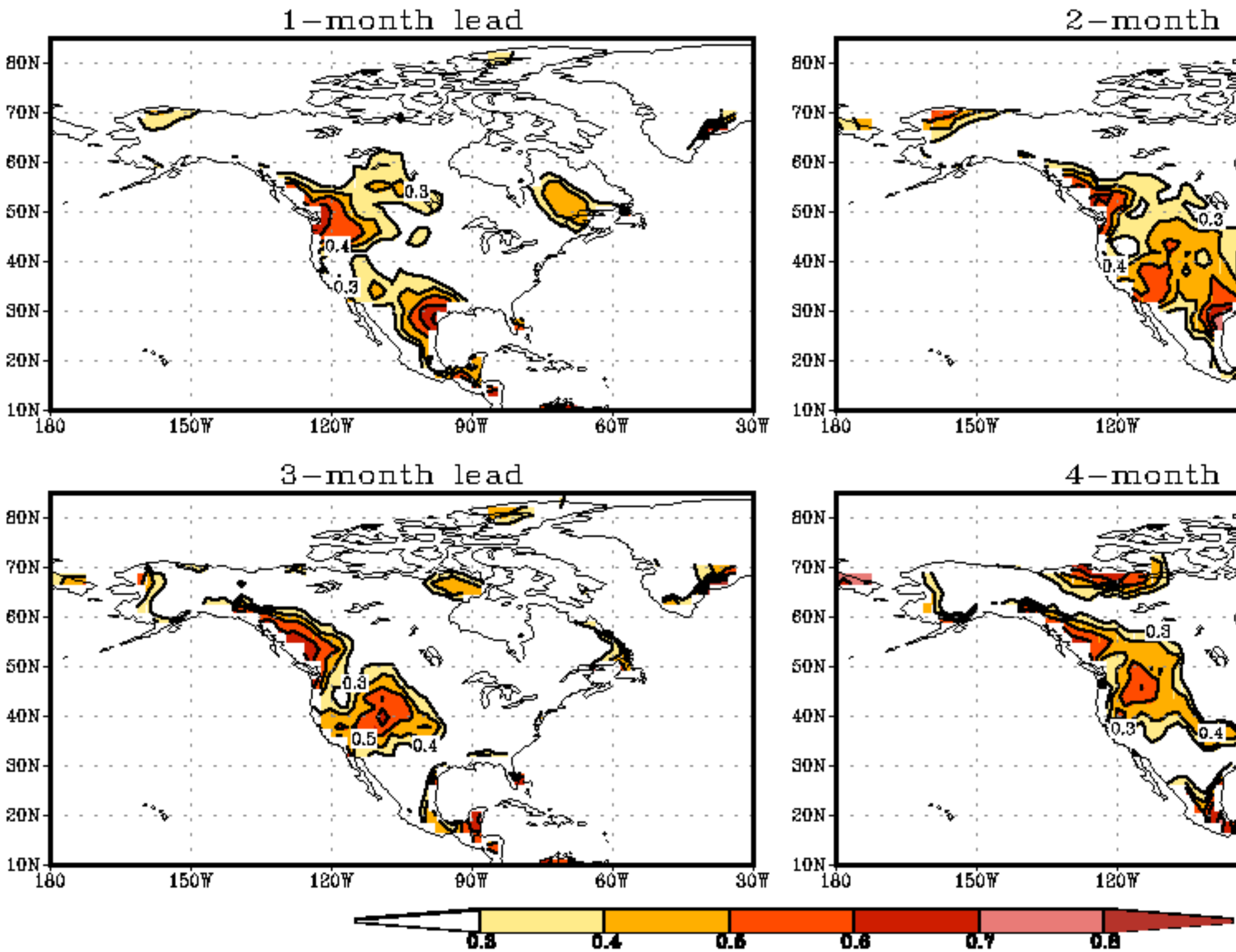


Fig. 11 Left column: Spatial distribution of retrospective ensemble mean CFS forecast skill (anomaly correlation in %) for lead 1 seasonal mean temperature over the United States. The target seasons are, from top to bottom, MAM, JJA, SON and DJF. The CFS (left) is compared to CCA, in the right column. Note that CCA is based on a longer period, 1948-2003. Correlation less than 0.3 are not shown

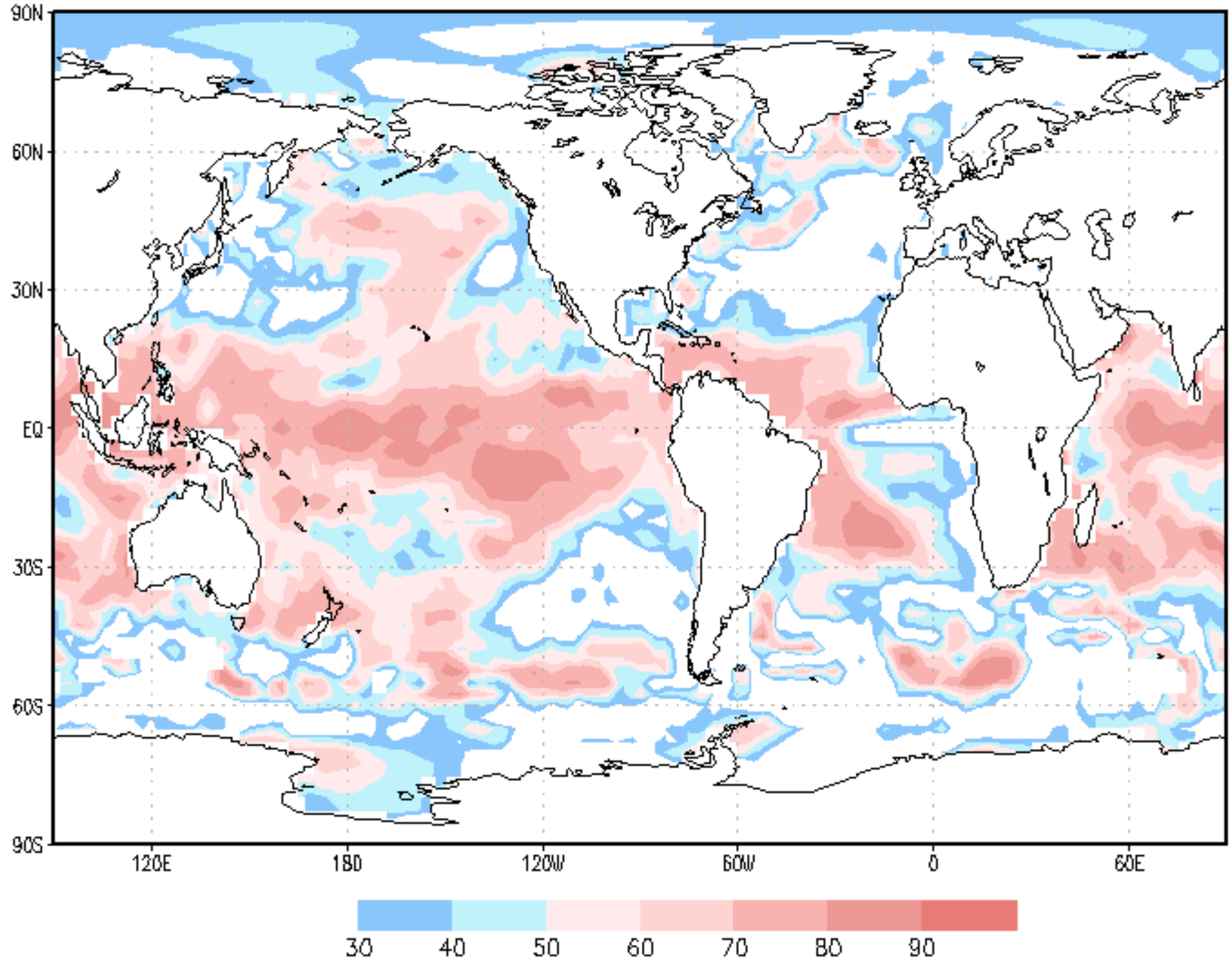


As in Fig.11, but now for precipitation.

Hindcast skill of US temperature by SFM for February ICs



Verification (AC X 100) SST CA Forecast : Lead 1 :
MJJ (last data used thru Mar) Period IC in 1956-2007



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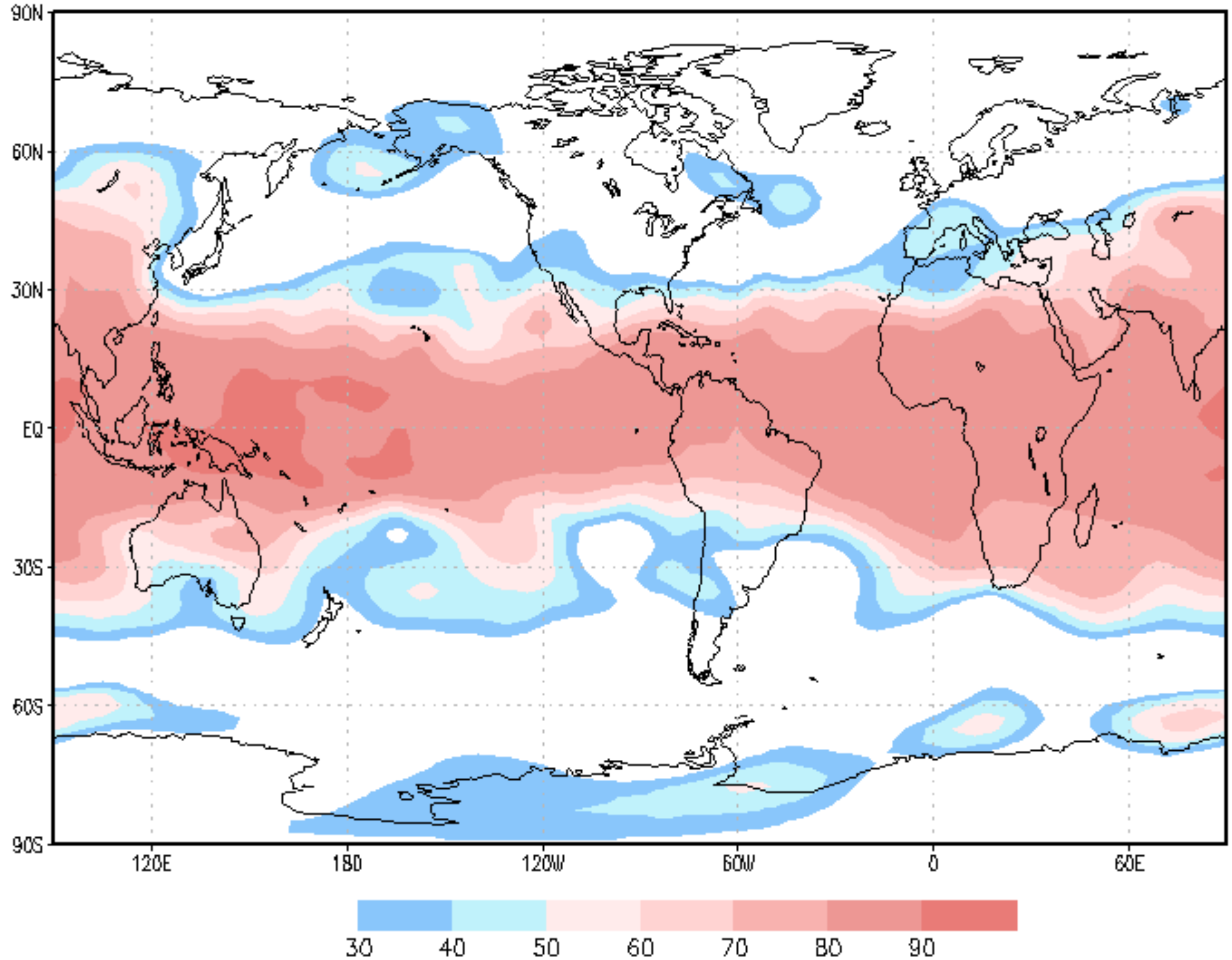
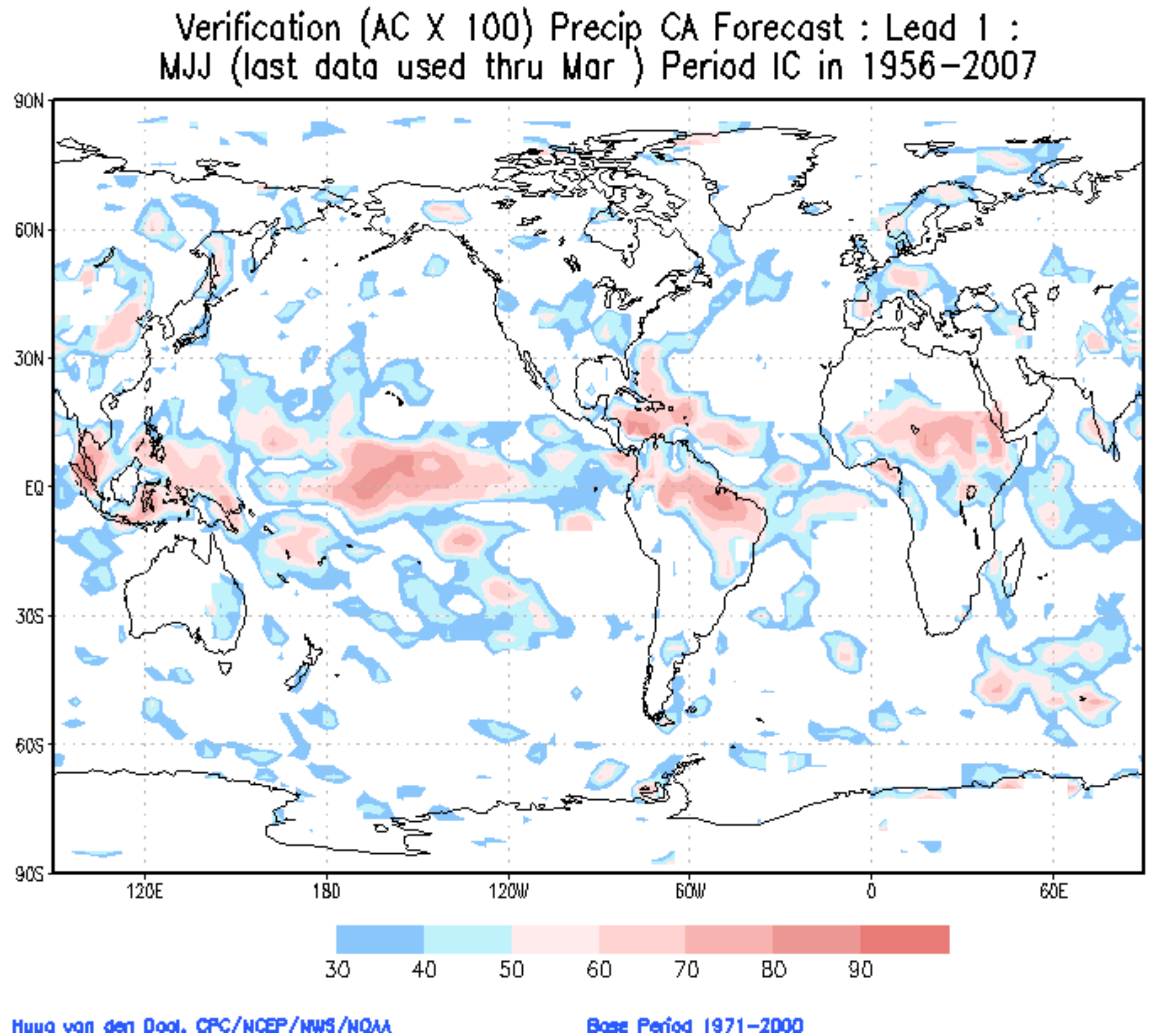
Base Period 1971-2000

Verification (AC X 100) Height CA Forecast : Lead 1 :
MJJ (last data used thru Mar) Period IC in 1956-2007



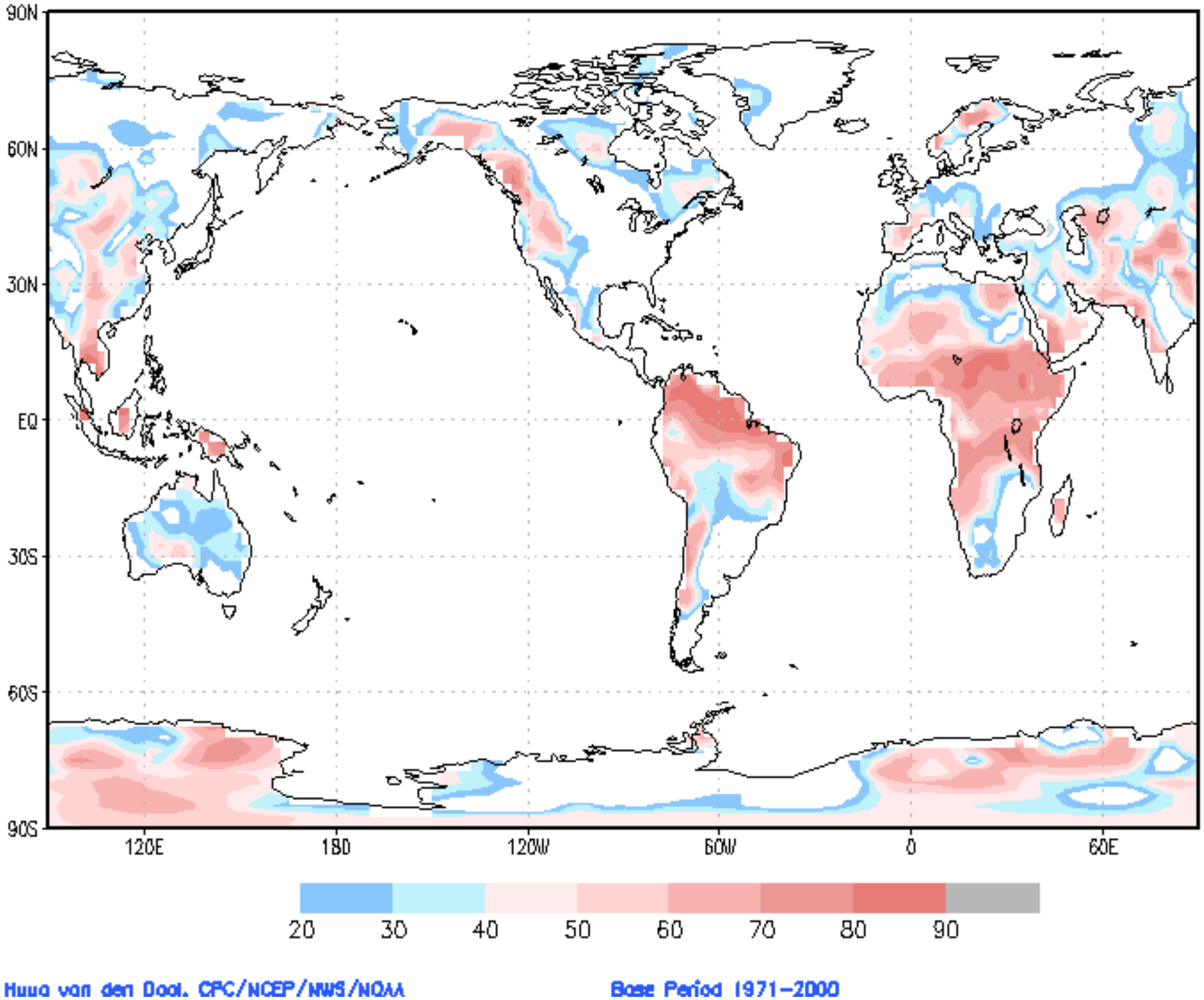
Huug van den Dool. CPC/NCEP/NWS/NOAA

Base Period 1971-2000



Verification (AC X 100) Precip CA Forecast : Lead 1 :
MJJ (last data used thru Mar) Period IC in 1956-2007
90N
60N
30N
EQ
30S
60S
90S
120E
180
120W
60W
0
60E
30
40
50
60
70
80
90
Huug van den Dool. CPC/NCEP/NWS/NOAA
Base Period 1971-2000

Verification (AC X 100) T2m CA Forecast : Lead 1 :
MJJ (last data used thru Mar) Period IC in 1956-2007



OFFicial Forecast(element, lead, location, initial month) =

a * A +

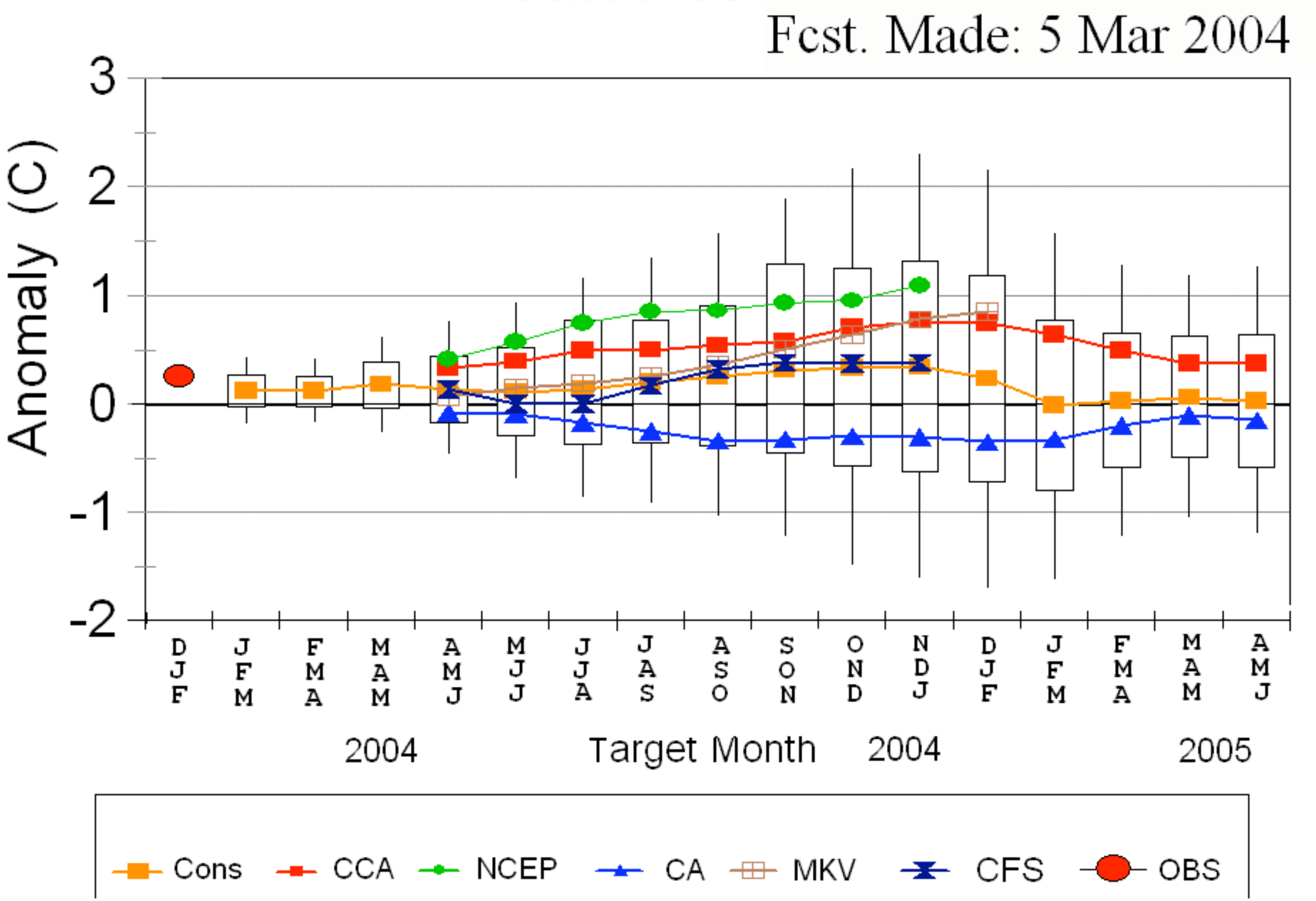
b * B +

c * C +

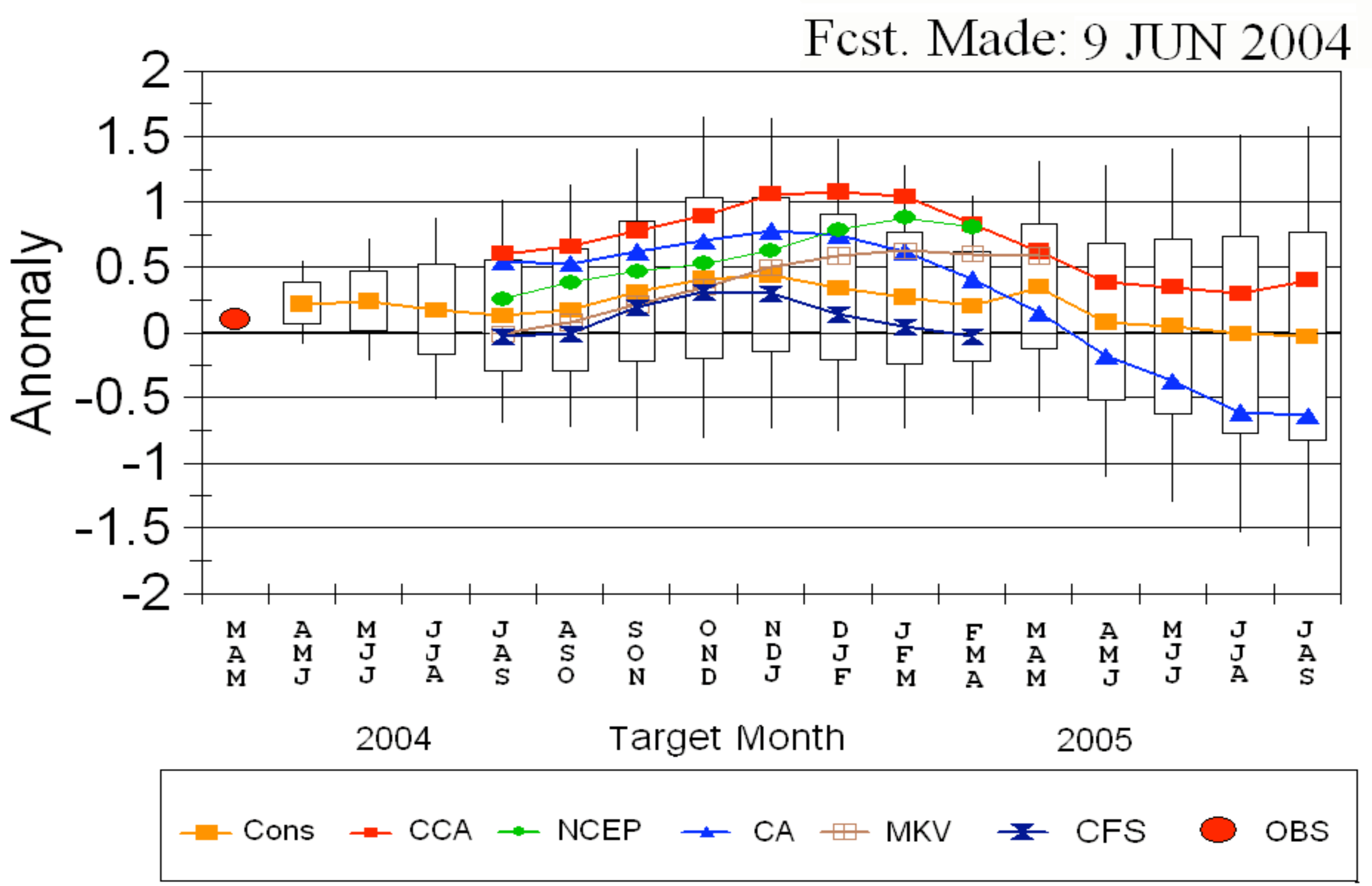
…

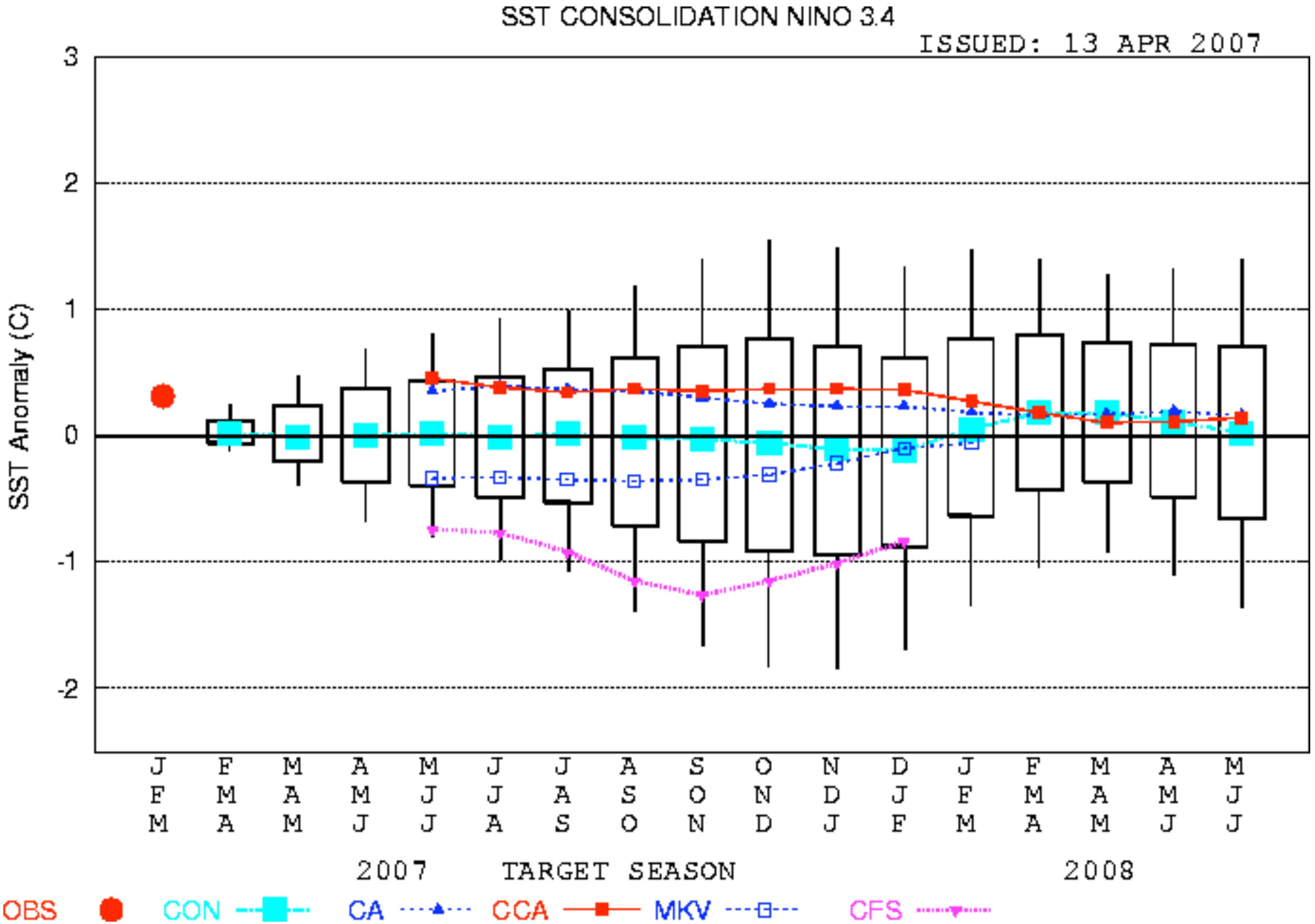
Honest hindcast required 1950-present.
Covariance (A,B), (A,C), (B,C), (A, obs), (B, obs), (C, obs) allows solution for a, b, c (element, lead, location, initial month)

SST Consolidation Forecast
Nino 3.4

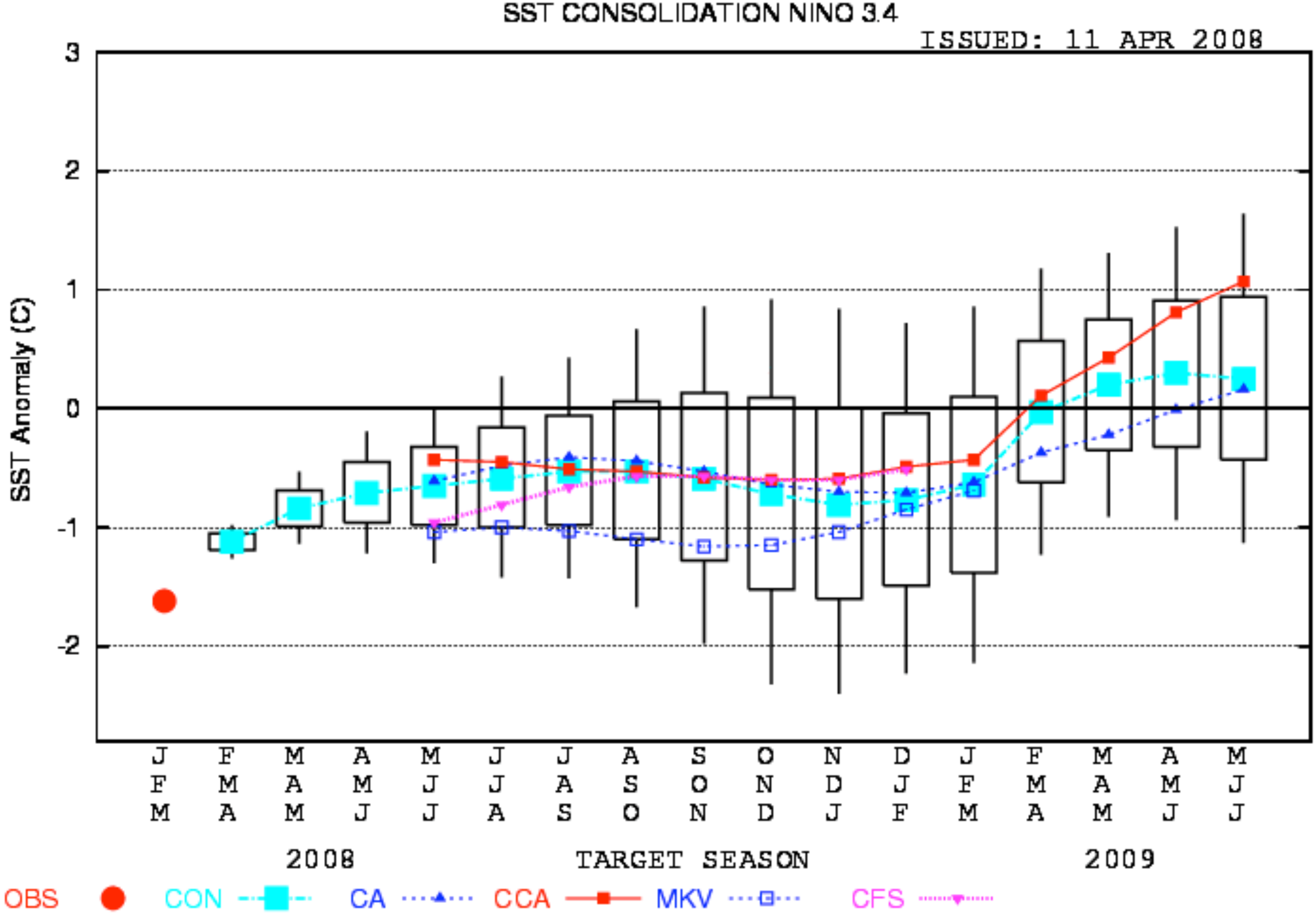


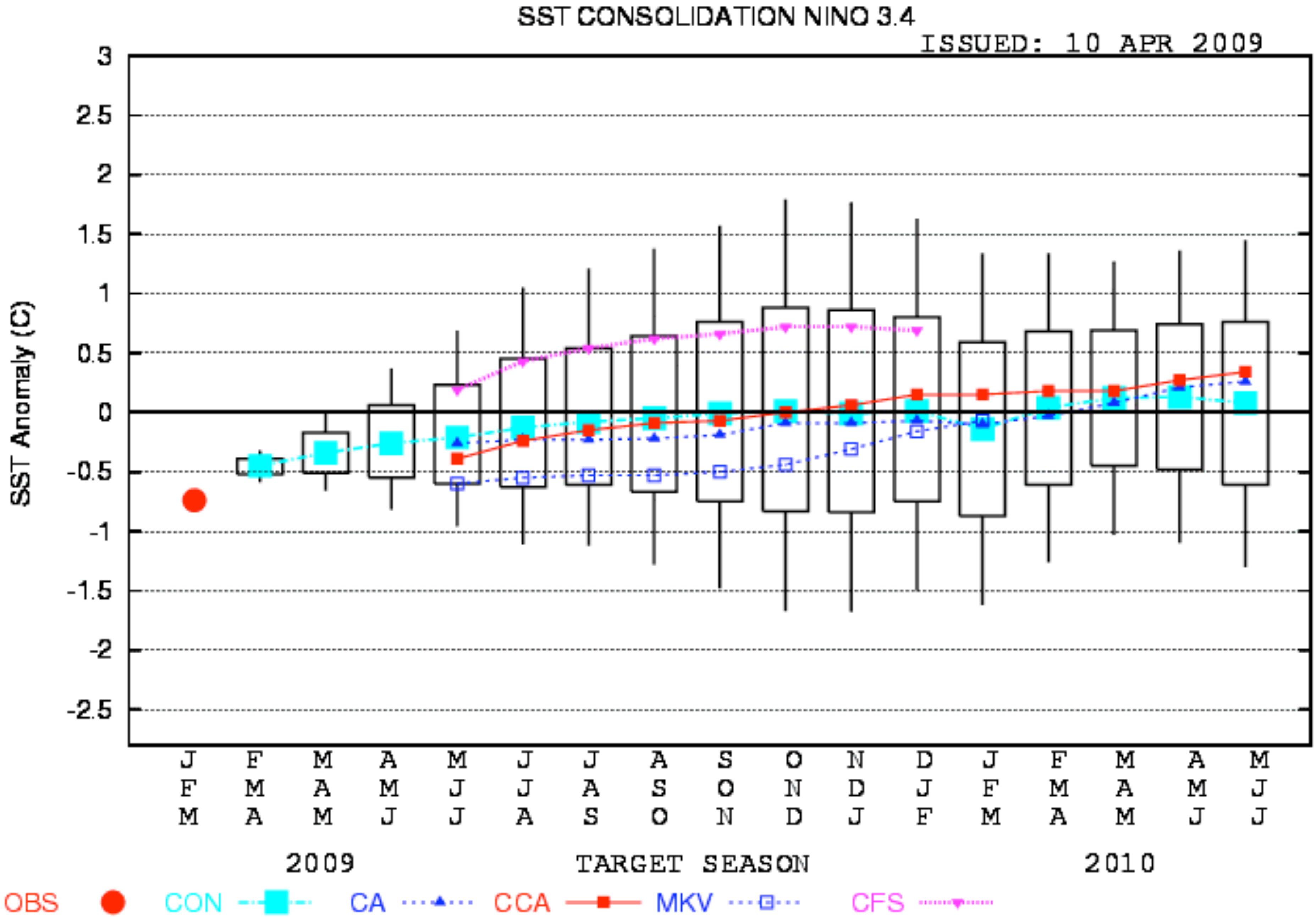
SST Consolidation Forecast
Nino 3.4

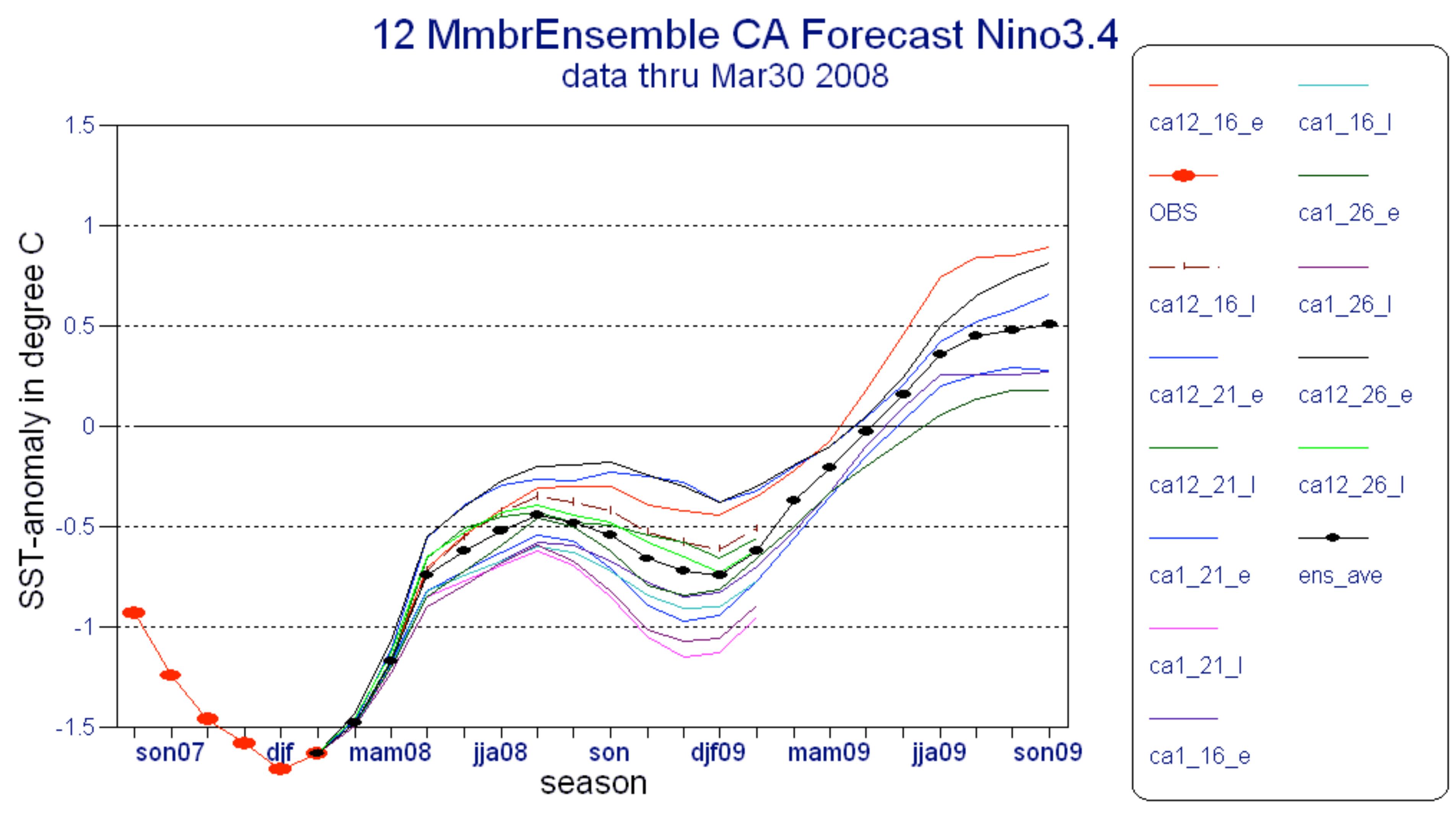




SST CONSOLIDATION NINO 3.4
ISSUED: 13 APR 2007
SST Anomaly (C)
3
2
1
0
-1
-2
J F M
F M A
M A M
A M J
M J J
J J A
J A S
A S O
S O N
O N D
N D J
D J F
J F M
F M A
M A M
A M J
M J J
2007 TARGET SEASON 2008
OBS
CON
CA
CCA
MKV
CFS


SST CONSOLIDATION NINO 3.4
ISSUED: 11 APR 2008
SST Anomaly (C)
3
2
1
0
-1
-2
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
2008
TARGET SEASON
2009
OBS
CON
CA
CCA
MKV
CFS


SST CONSOLIDATION NINO 3.4
ISSUED: 10 APR 2009
SST Anomaly (C)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
2009
TARGET SEASON
2010
OBS
CON
CA
CCA
MKV
CFS


12 MmbrEnsemble CA Forecast Nino3.4
data thru Mar30 2008
SST-anomaly in degree C
1.5
1
0.5
0
-0.5
-1
-1.5
son07
djf
mam08
jja08
son
djf09
mam09
jja09
son09
season
ca12_16_e
OBS
ca12_16_l
ca12_21_e
ca12_21_l
ca1_21_e
ca1_21_l
ca1_16_e
ca1_16_l
ca1_26_e
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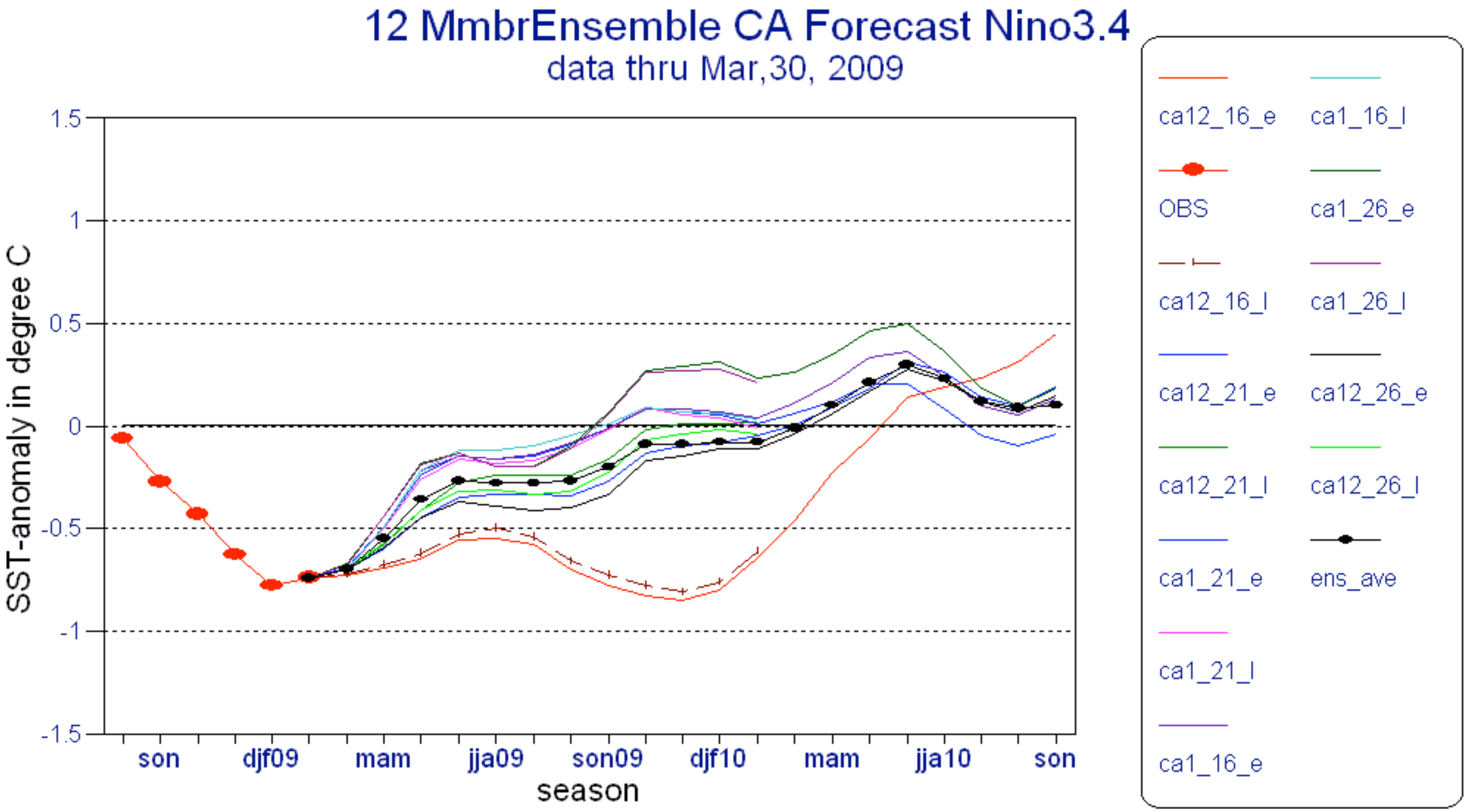
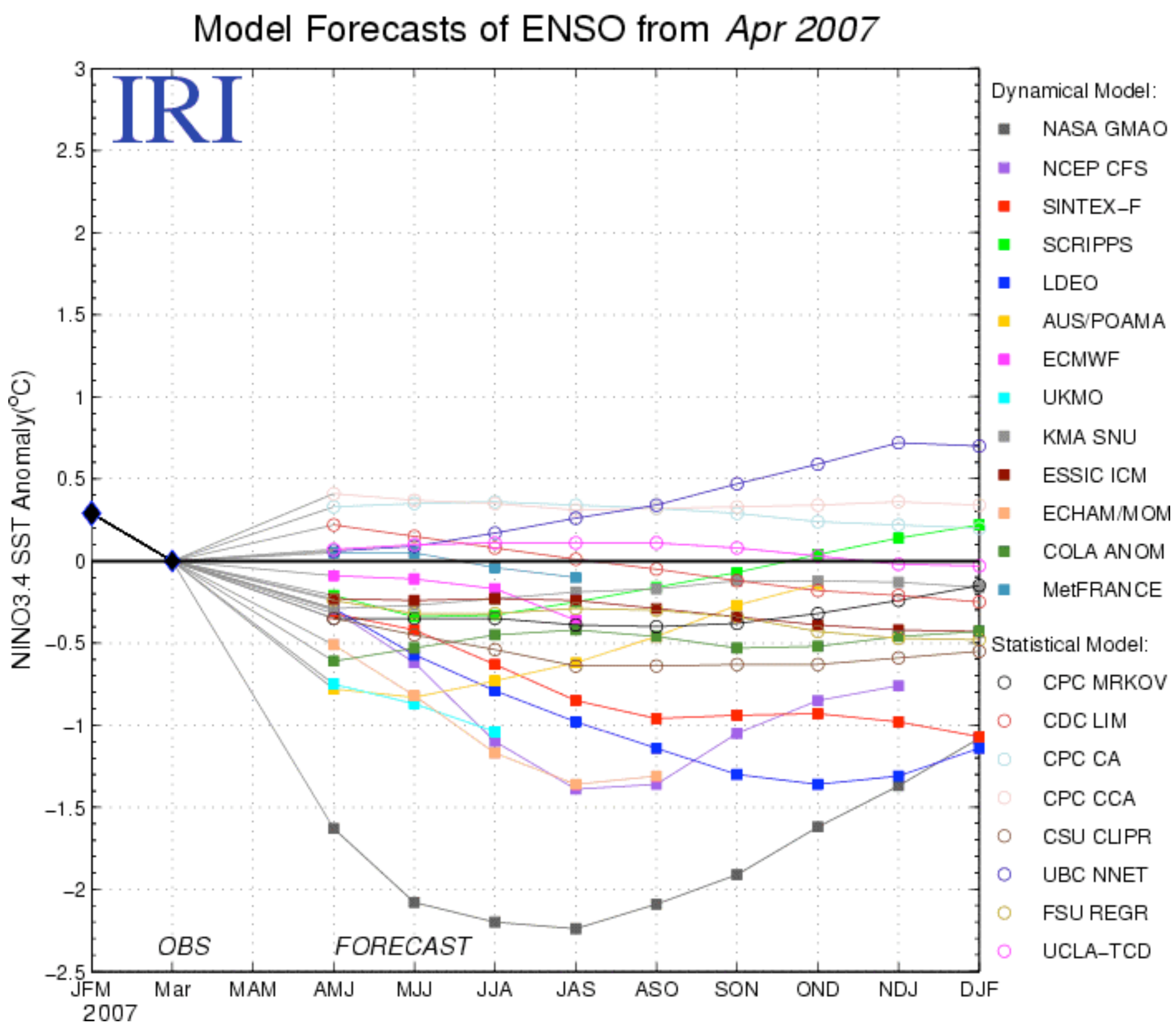
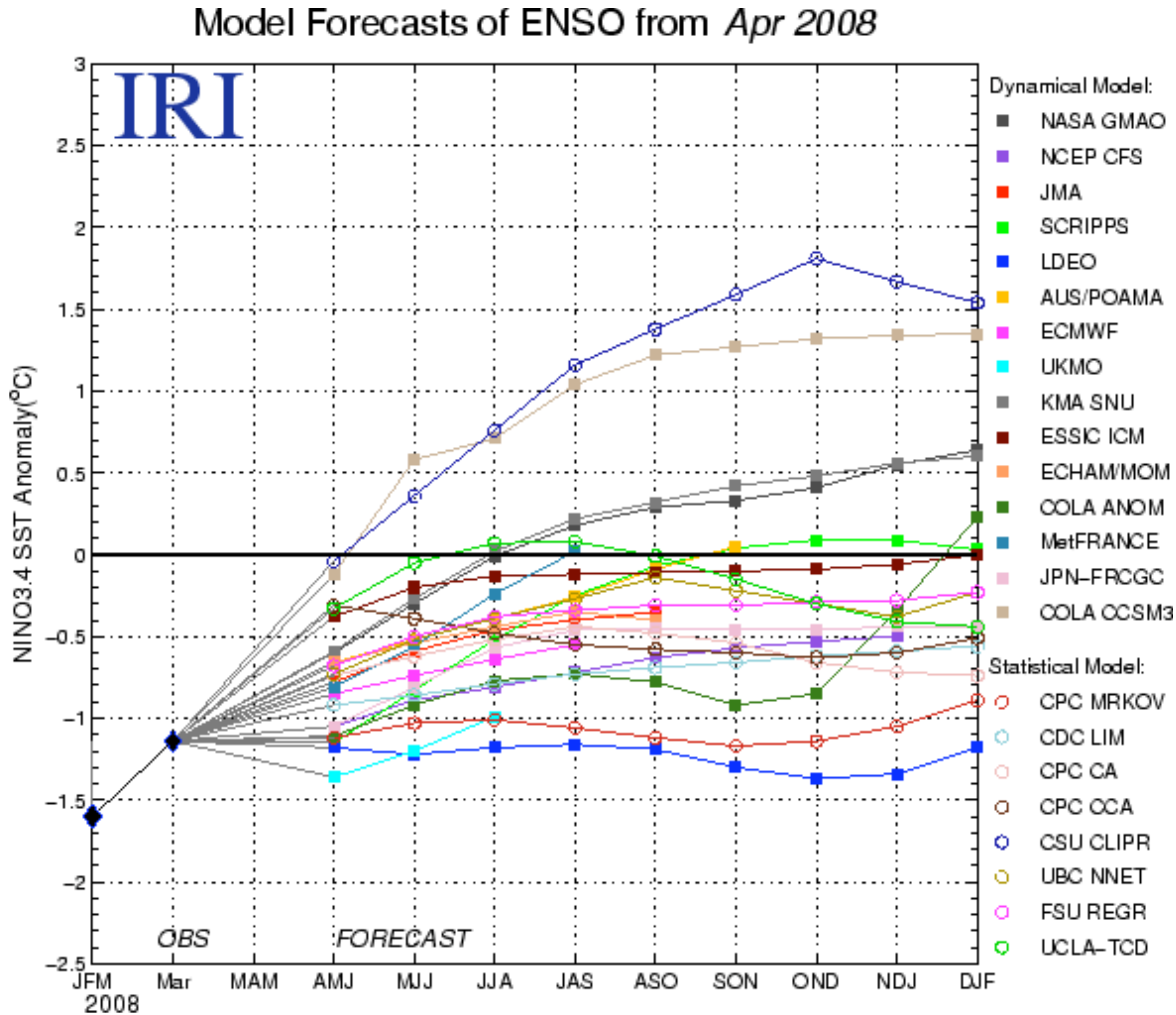
ca12_26_e
ca12_26_l
ens_ave

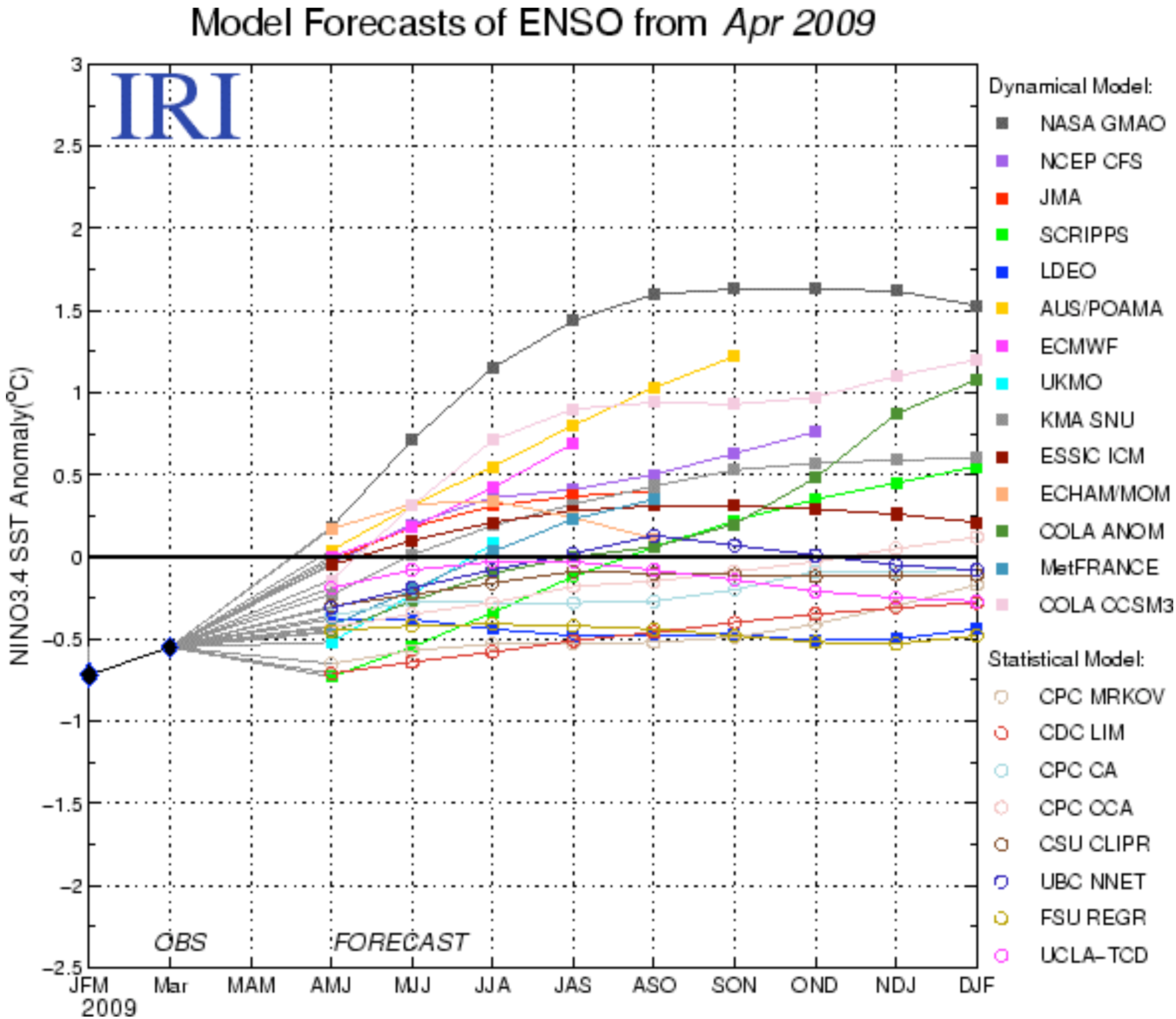


12 MmbrEnsemble CA Forecast Nino3.4
data thru Mar,30, 2009
SST-anomaly in degree C
1.5
1
0.5
0
-0.5
-1
-1.5
son
djf09
mam
jja09
son09
djf10
mam
jja10
son
season
ca12_16_e
ca1_16_l
OBS
ca1_26_e
ca12_16_l
ca1_26_l
ca12_21_e
ca12_26_e
ca12_21_l
ca12_26_l
ca1_21_e
ens_ave
ca1_21_l
ca1_16_e

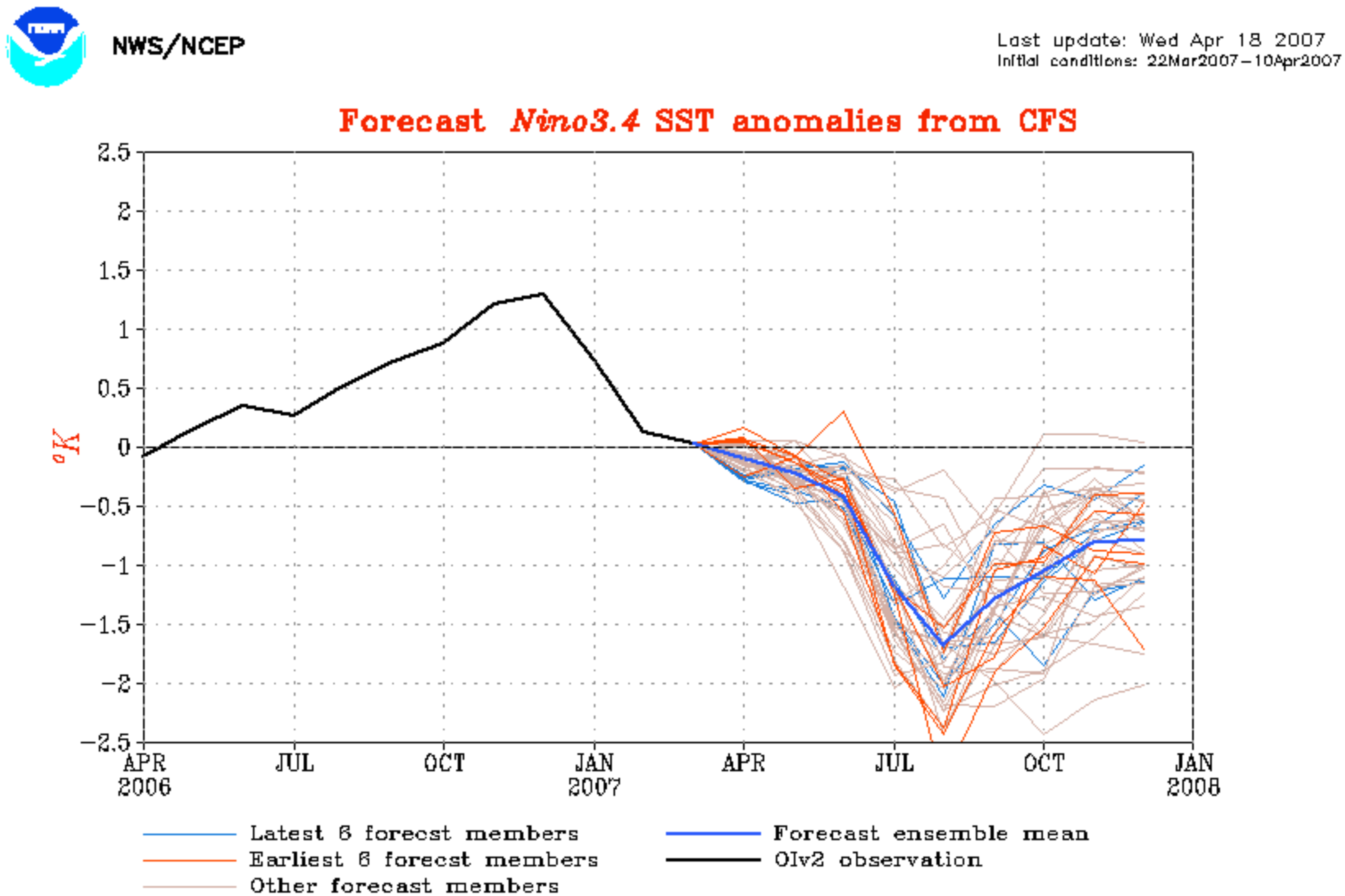

Model Forecasts of ENSO from Apr 2007
IRI
NINO3.4 SST Anomaly(°C)
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
OBS
FORECAST
JFM
2007
Mar
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
Dynamical Model:
NASA GMAO
NCEP CFS
SINTEX−F
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
ESSIC ICM
ECHAM/MOM
COLA ANOM
MetFRANCE
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA−TCD



Model Forecasts of ENSO from Apr 2008
IRI
NINO3.4 SST Anomaly(°C)
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
OBS
FORECAST
JFM
2008
Mar
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
Dynamical Model:
NASA GMAO
NCEP CFS
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
ESSIC ICM
ECHAM/MOM
COLA ANOM
MetFRANCE
JPN−FRCGC
COLA CCSM3
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA−TCD



Model Forecasts of ENSO from Apr 2009
IRI
NINO3.4 SST Anomaly(°C)
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
OBS
FORECAST
JFM 2009
Mar
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
Dynamical Model:
NASA GMAO
NCEP CFS
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
ESSIC ICM
ECHAM/MOM
COLA ANOM
MetFRANCE
COLA CCSM3
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA-TCD

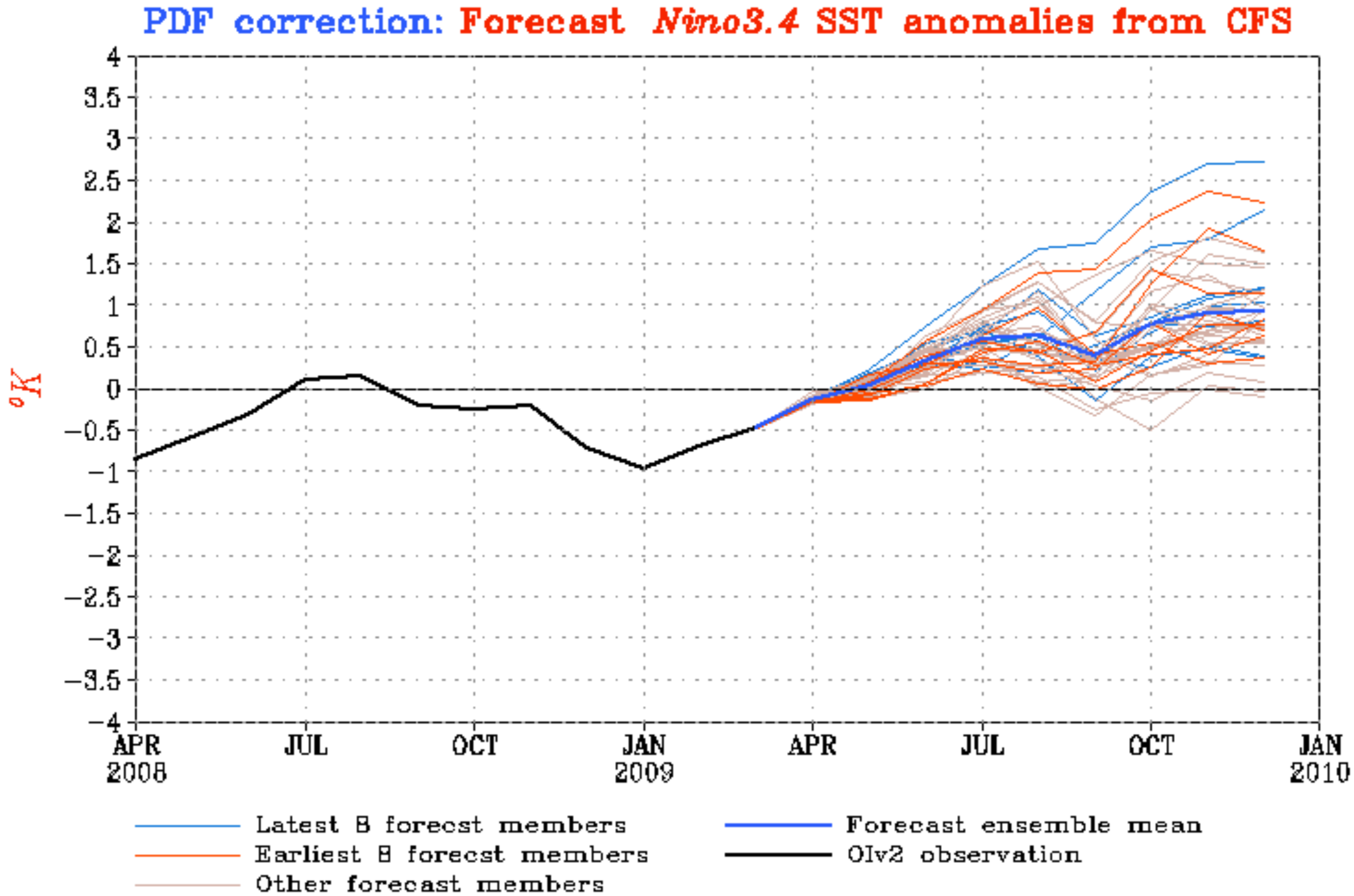


Forecast initial conditions: 22Mar2007 to 10Apr2007.

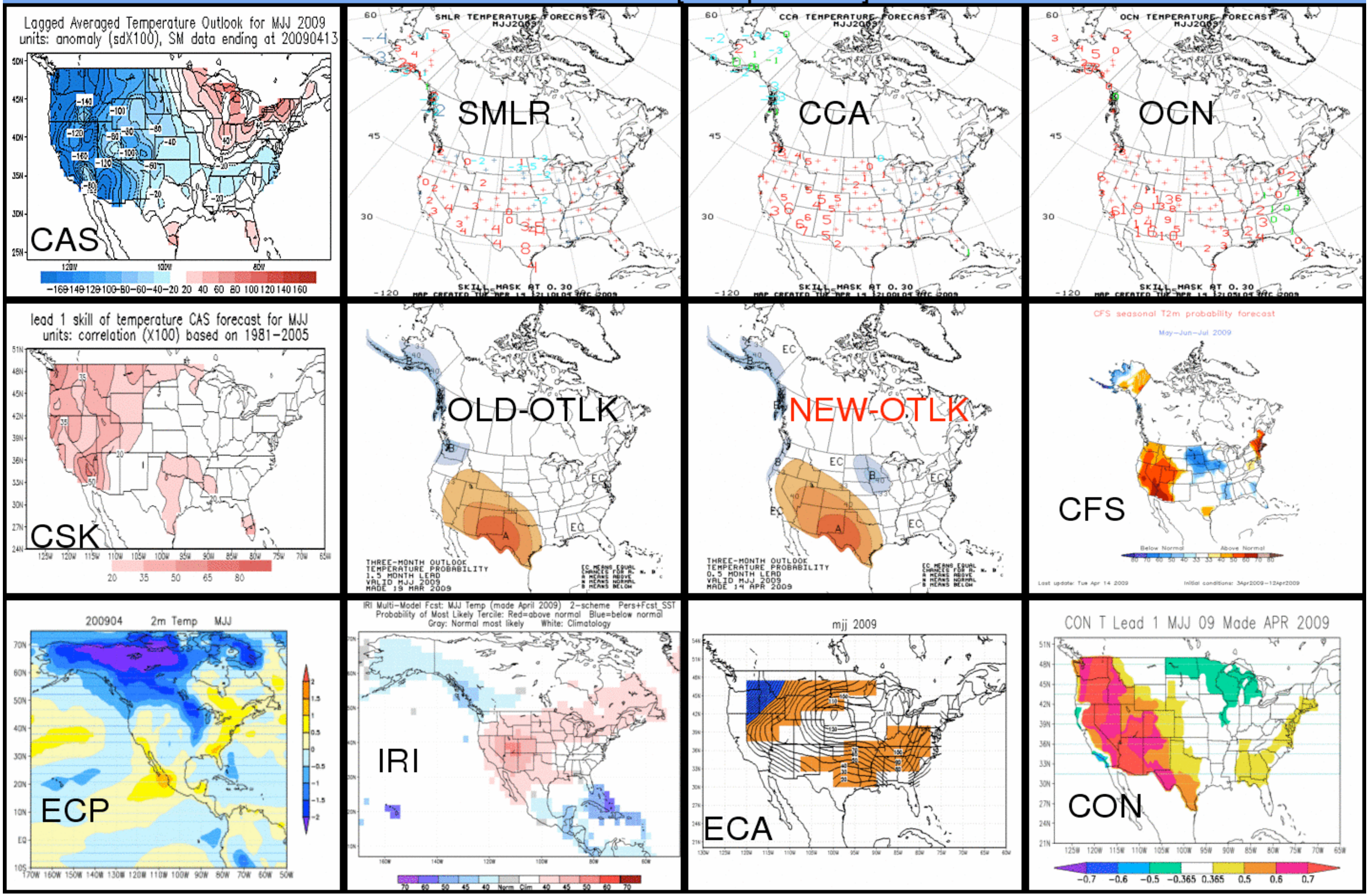
Base period for climatology is 1971–2000. Base period for bias correction is 1982–2003.

NWS/NCEP

Last update: Tue Apr 21 2009
Initial conditions: 10Apr2009–19Apr2009



MJJ Season [Temperature]



Assume a method in the madness:

OFF(icial) = CON(solidation) =

α * Tool A +

β * Tool B +

γ * Tool C + etc

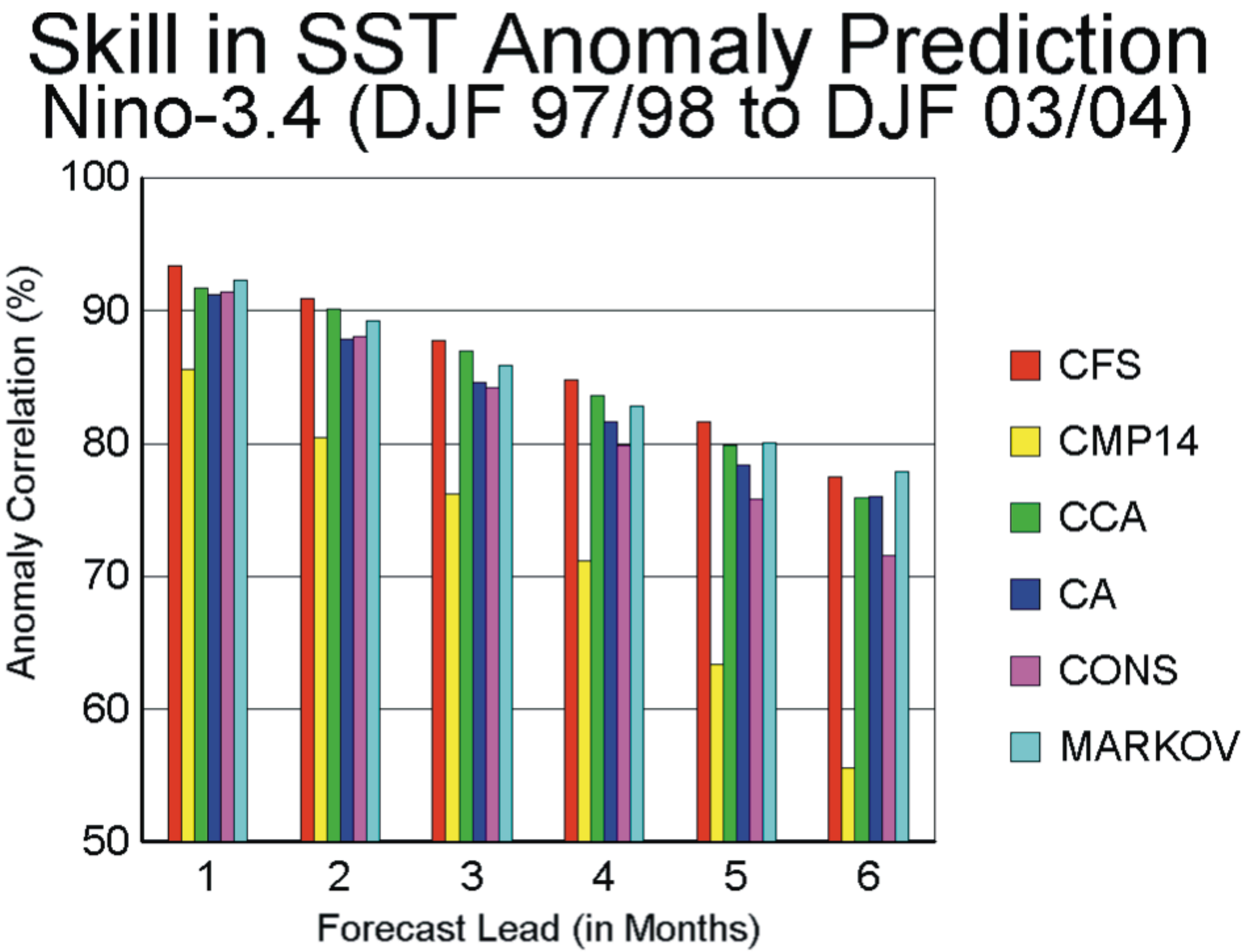
where the coefficients are determined (each month again) from a track record for each tool, 1981-present for Nino3.4, and 1955-present for US T&P.

A-posteriori verification:

The bottom line (all leads/all seasons); JFM95-FMA2002, Skill of CPC TEMPERATURE Forecasts:

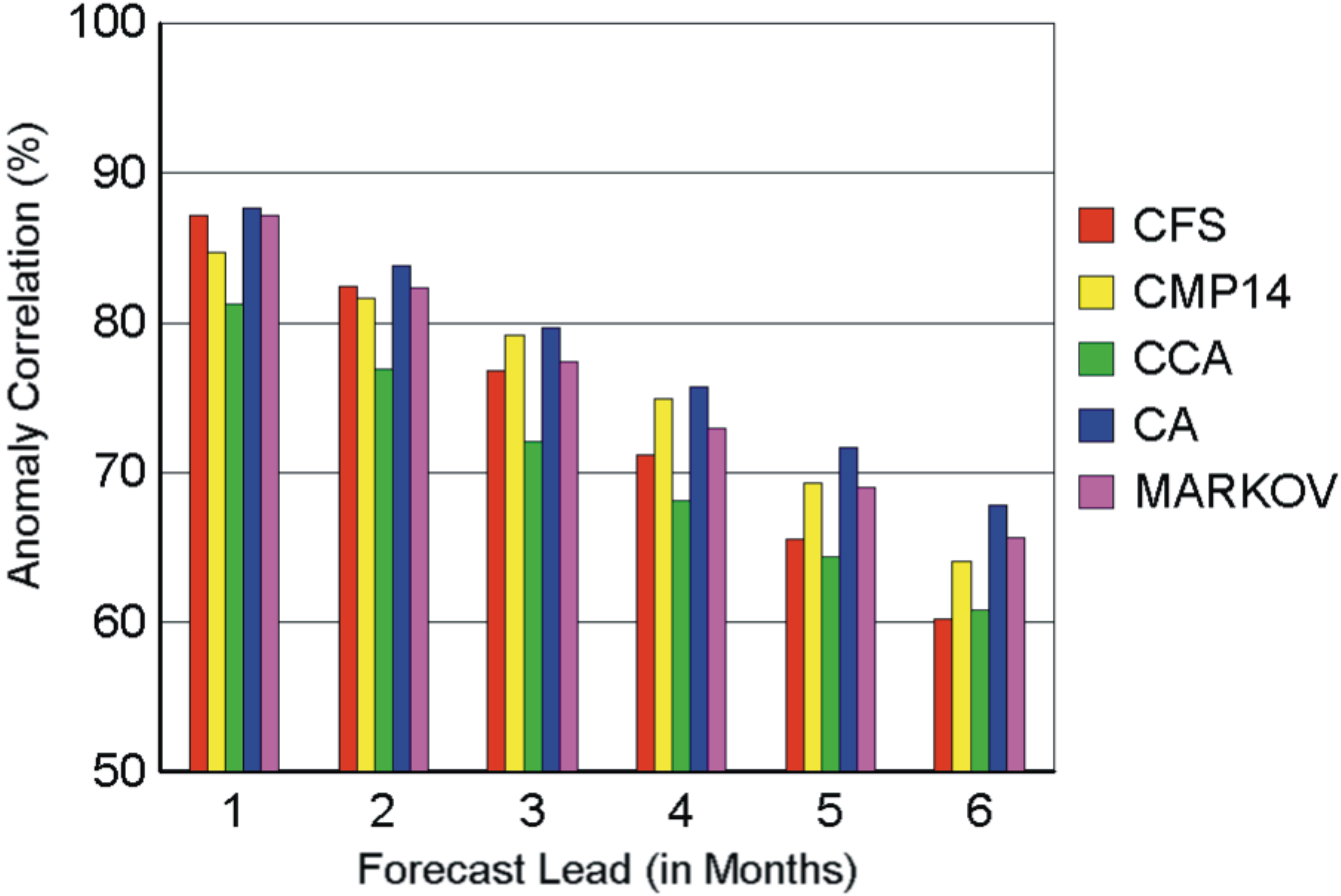
	SS1	SS2	Coverage
OFF	22.7	9.4	41.4%
CCA	25.1	6.4	25.5
OCN	22.2	8.3	37.4
CMF (now old)	7.6	2.5	32.7 (1st 4 leads only)

SS2=SS1*coverage (for 3 equal class system



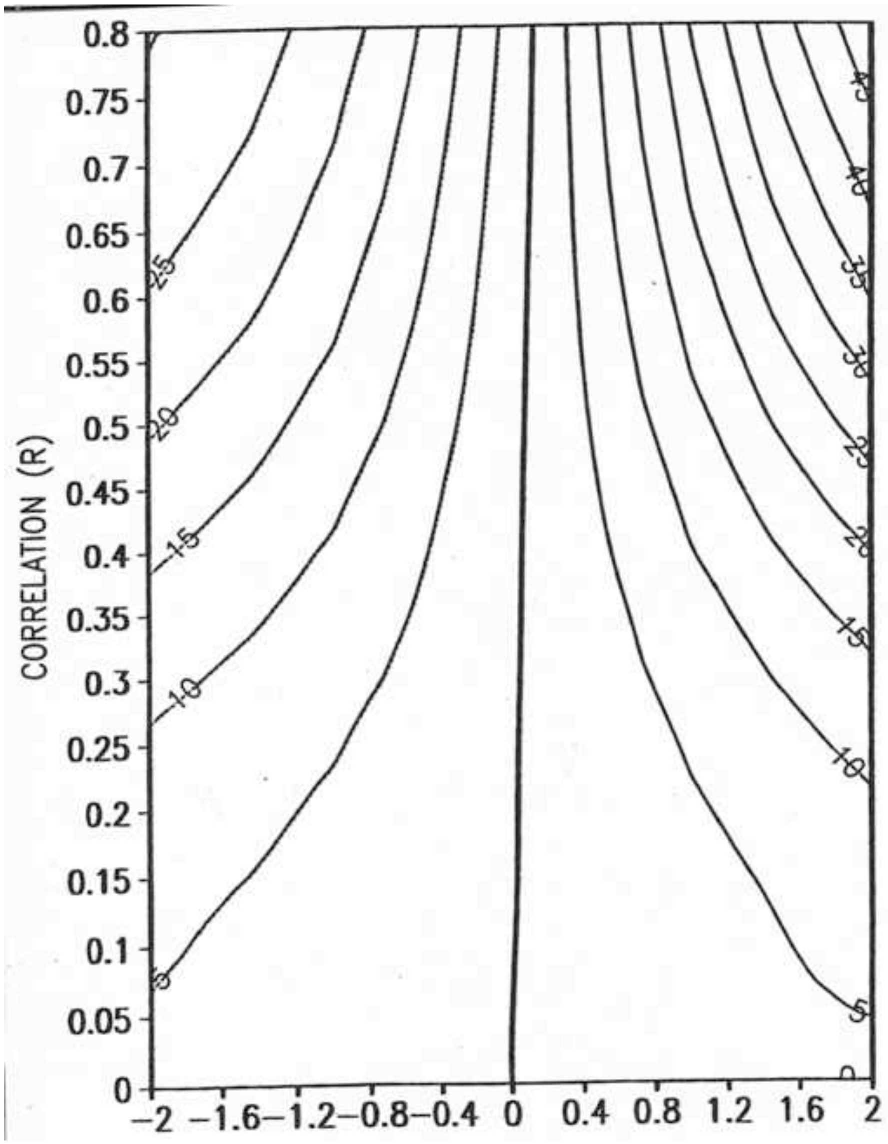
Skill in SST Anomaly Prediction
Nino-3.4 (DJF 97/98 to DJF 03/04)
Anomaly Correlation (%)
100
90
80
70
60
50
1
2
3
4
5
6
Forecast Lead (in Months)
CFS
CMP14
CCA
CA
CONS
MARKOV

Skill in SST Anomaly Prediction
Nino-3.4 (DJF 81/82 to DJF 03/04)



Issues of ‘format’ and protocol

- Article of faith: uncertainty shall be conveyed by a probability format
- Except for a few specialized users we cannot provide a full prob.density function.
- Protocol to make a pdf palatable (on a map)
- Three classes (B, N, A); equal classes
- Absolute probability, probability anomaly
- CL-option (I, CP, CL, EC)



F →

Source: Dave Unger. This figure shows the probability shift (contours), relative to 100*1/3rd, in the above normal class as a function of a-priori correlation (R , y-axis) and the standardized forecast of the predictand (F, x-axis). The prob.shifts increase with both F and R. The R is based on a sample of 30, using a Gaussian model to handle its uncertainty.

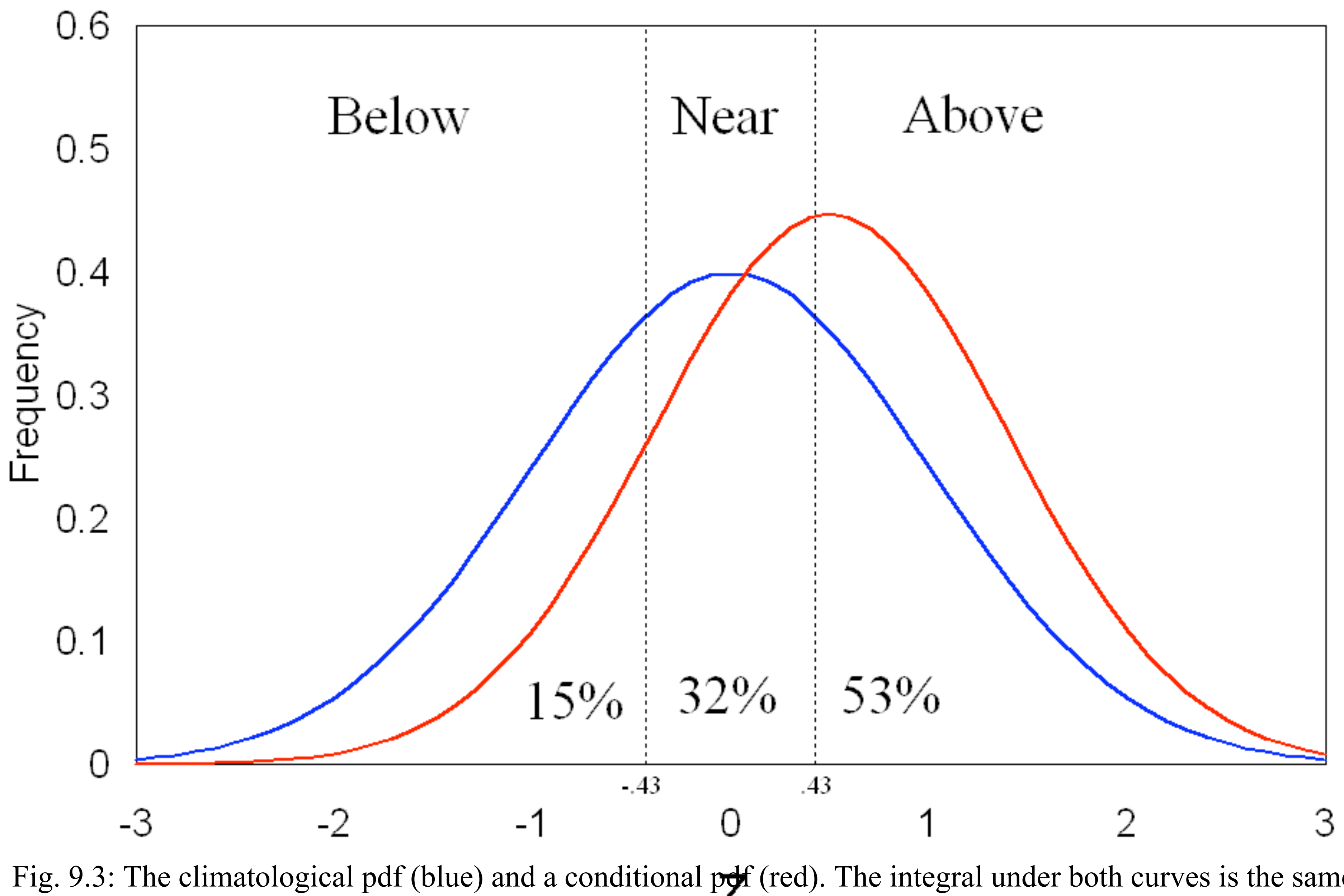
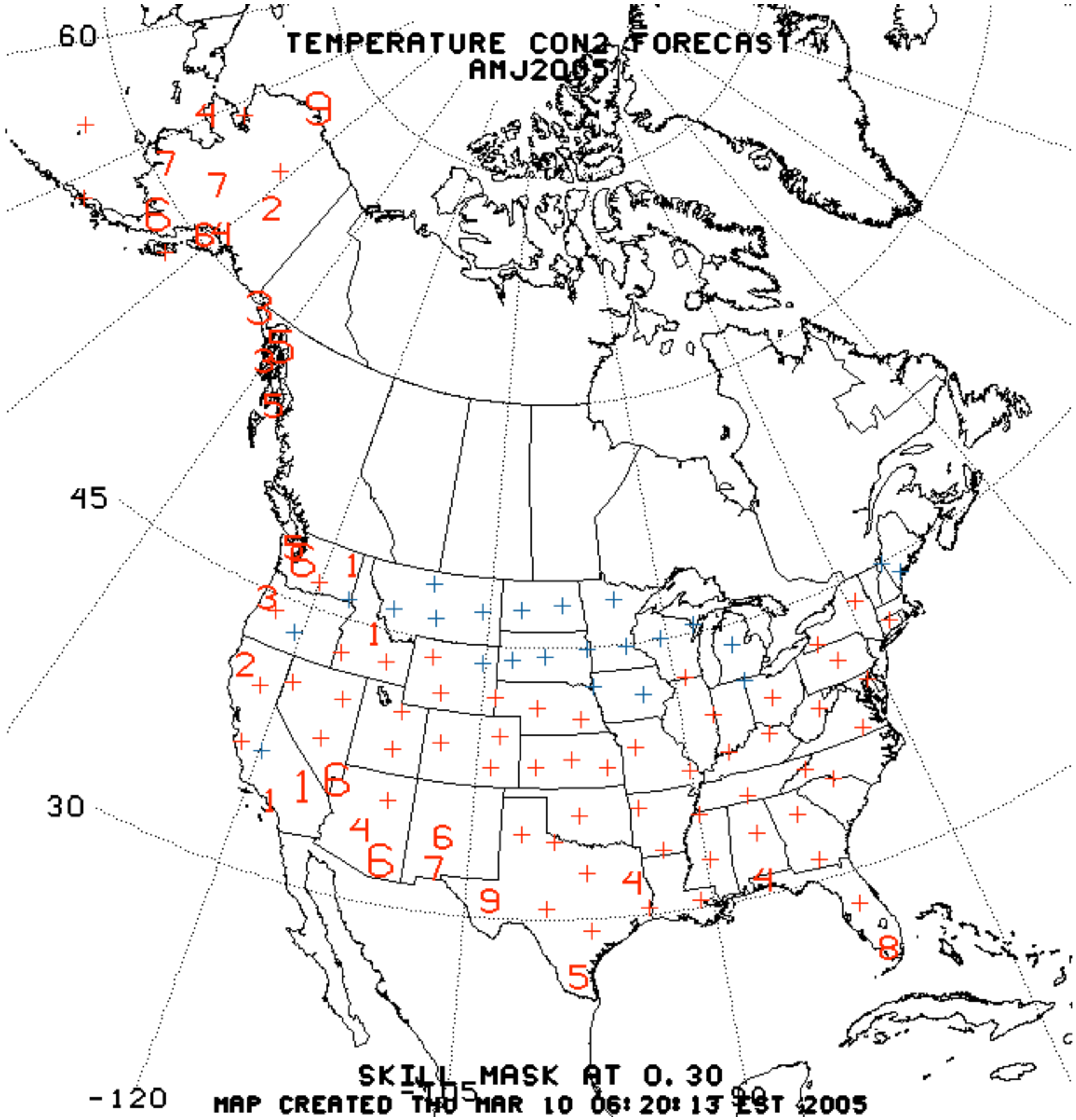
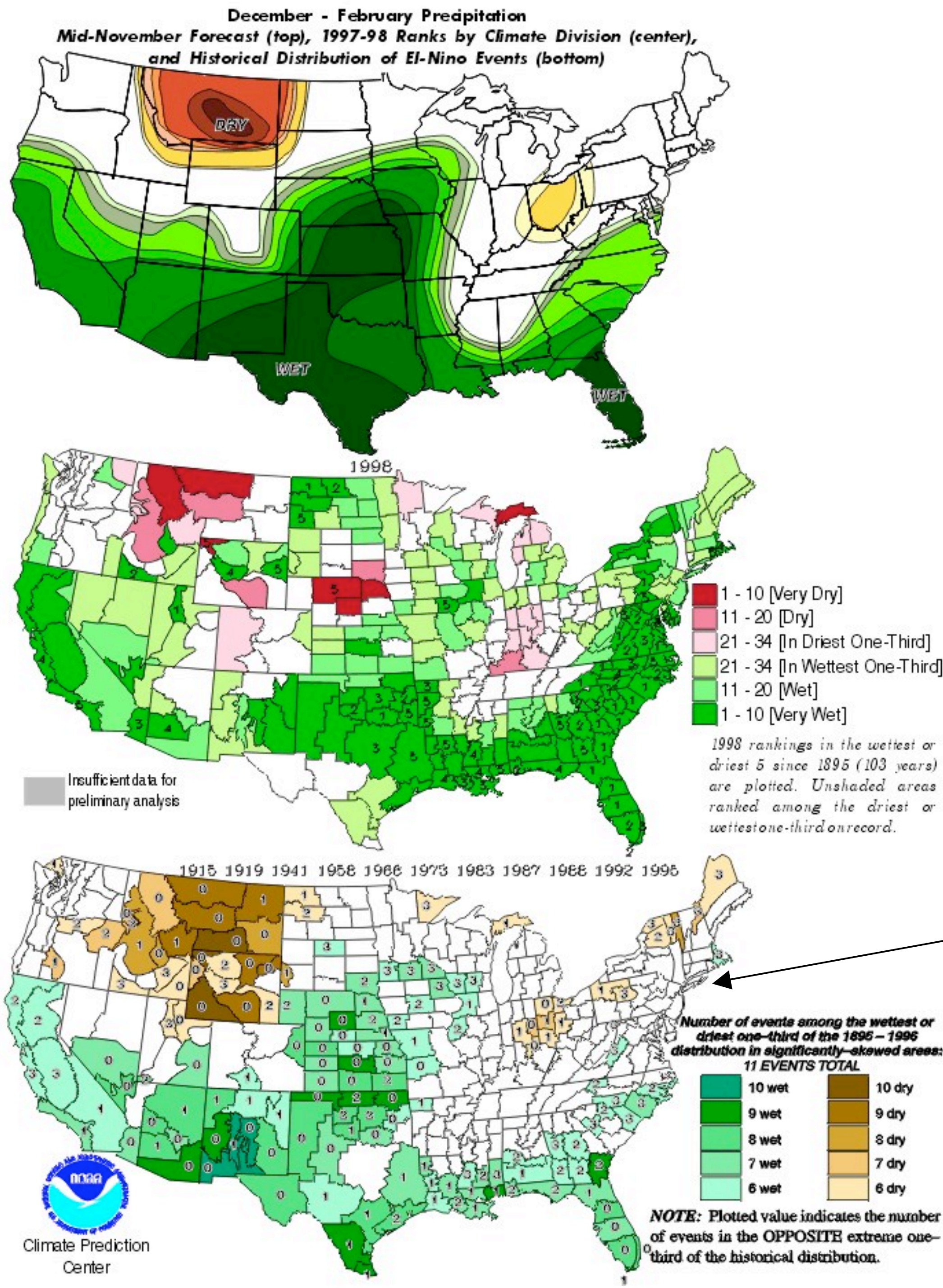


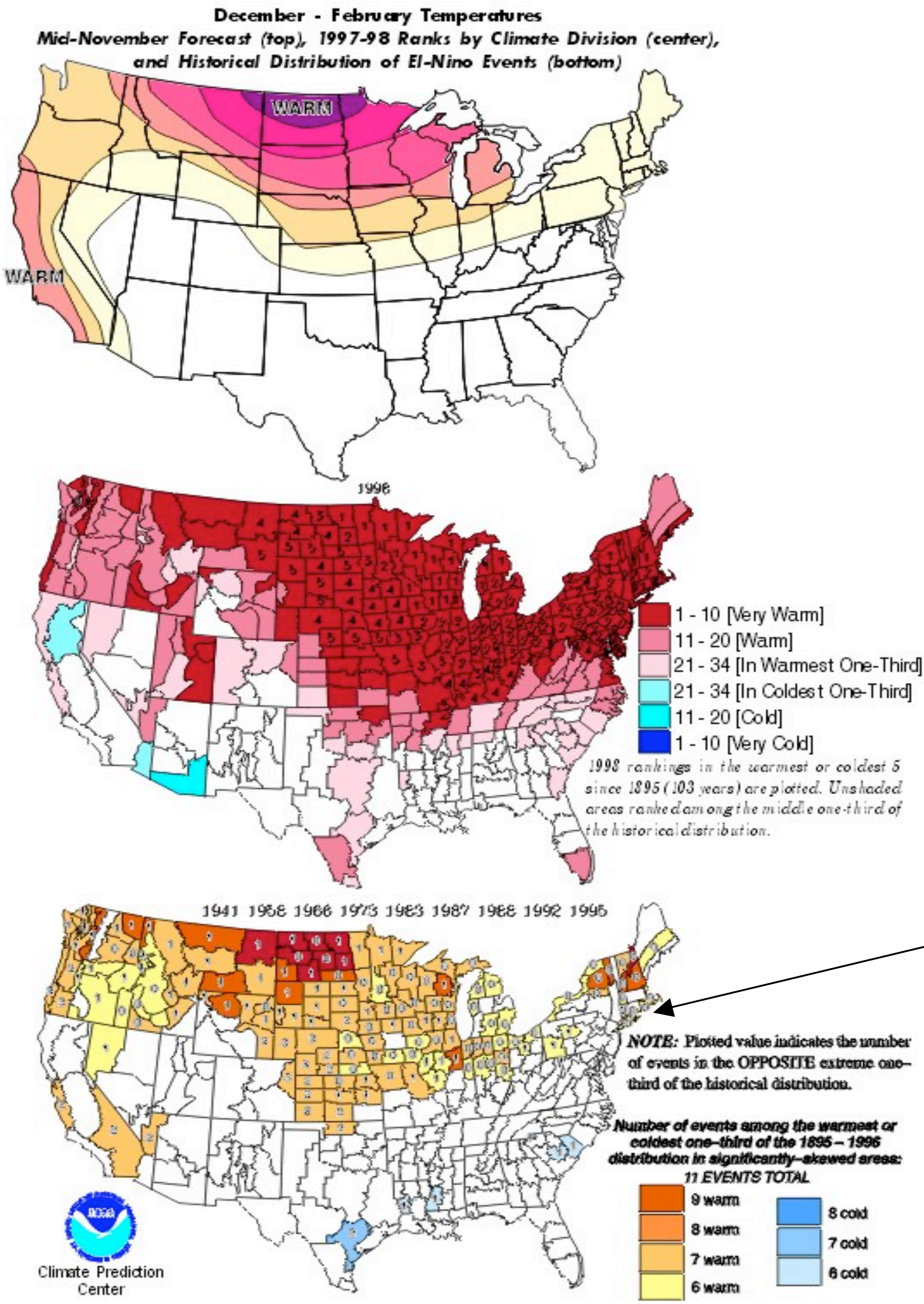
Fig. 9.3: The climatological pdf (blue) and a conditional pdf (red). The integral under both curves is the same, but due to a predictable signal the red curve is both shifted and narrowed. In the example the predictor-predictand correlation is 0.5 and the predictor value is +1. This gives a shift in the mean of +0.5, and the standard deviation of the conditional distribution is reduced to 0.866. Units are in standard deviations (x-axis)


TEMPERATURE CON2 FORECAST
AMJ2005
SKILL MASK AT 0.30
MAP CREATED THU MAR 10 06:20:13 EST 2005
60
45
30
-120
-105
-90

Glorious moments



ENSO composite



glorious moments

(not unique for T)

ENSO composite

Trends revisited

B	N	A	at 102 US locations
(assumed to be 1/3rd, 1/3rd, 1/3rd, based on 30 year normals period)			
26	28	46	1995
36	34	30	1996
27	32	41	1997
08	17	75	1998
13	24	63	1999
22	20	58	2000
15	32	53	2001 (Normals changed!)
19	36	46	2002
15	38	47	2003
20	33	47	2004
07	34	59	2005
11	34	55	2006
10	34	56	2007
19	30	50%	1995-2007
B	N	A	at 102 US locations
-14	-3	+17	('Probability anomalies' ; SS2=~26)

Distribution of B, N and A in the last 14 years:

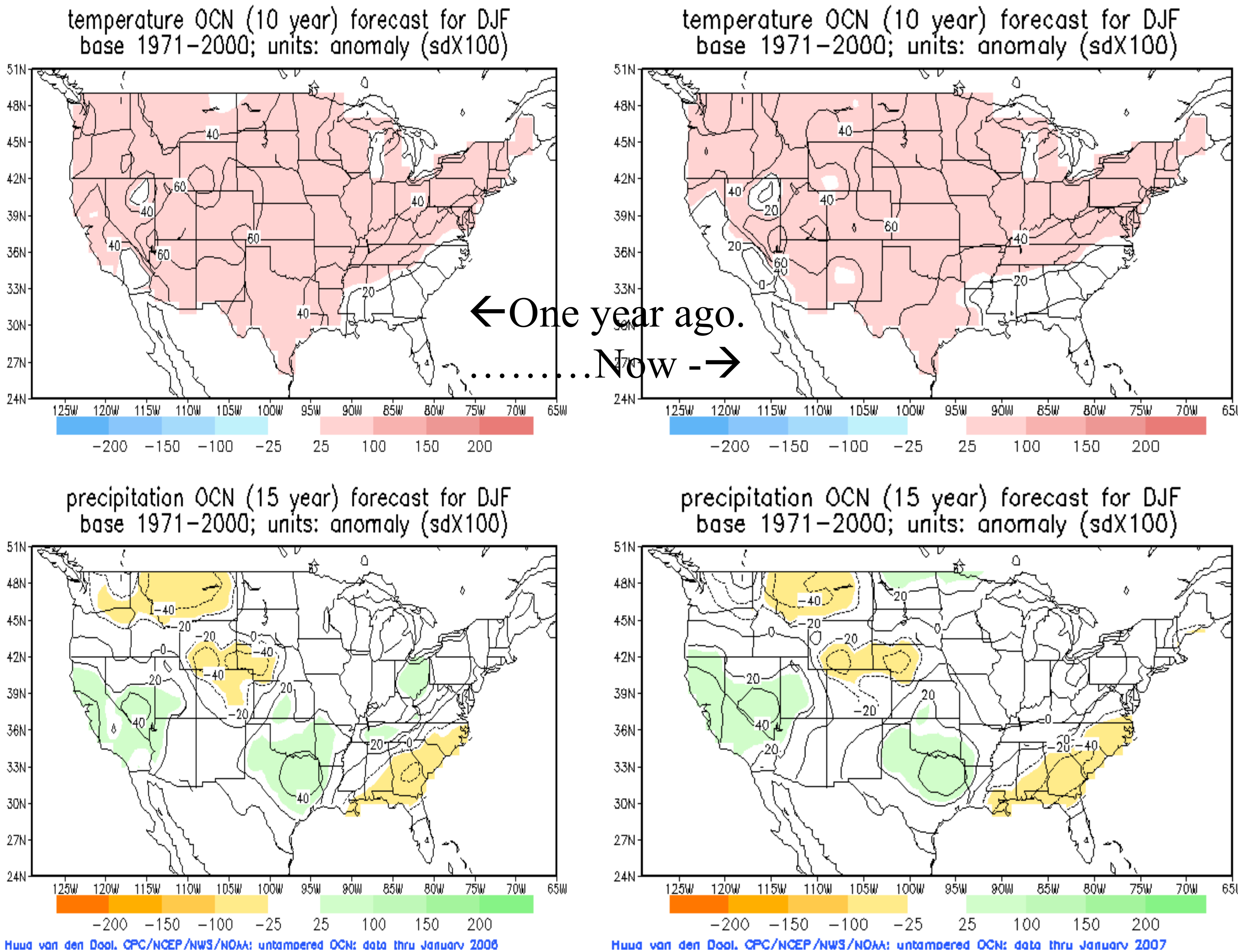
B N A at 102 US locations (assumed to be 1/3rd, 1/3rd, 1/3rd, based on 30 year normals period)

26 28 46% 1995
36 34 30 1996 These three years were not very biased
27 32 41 1997

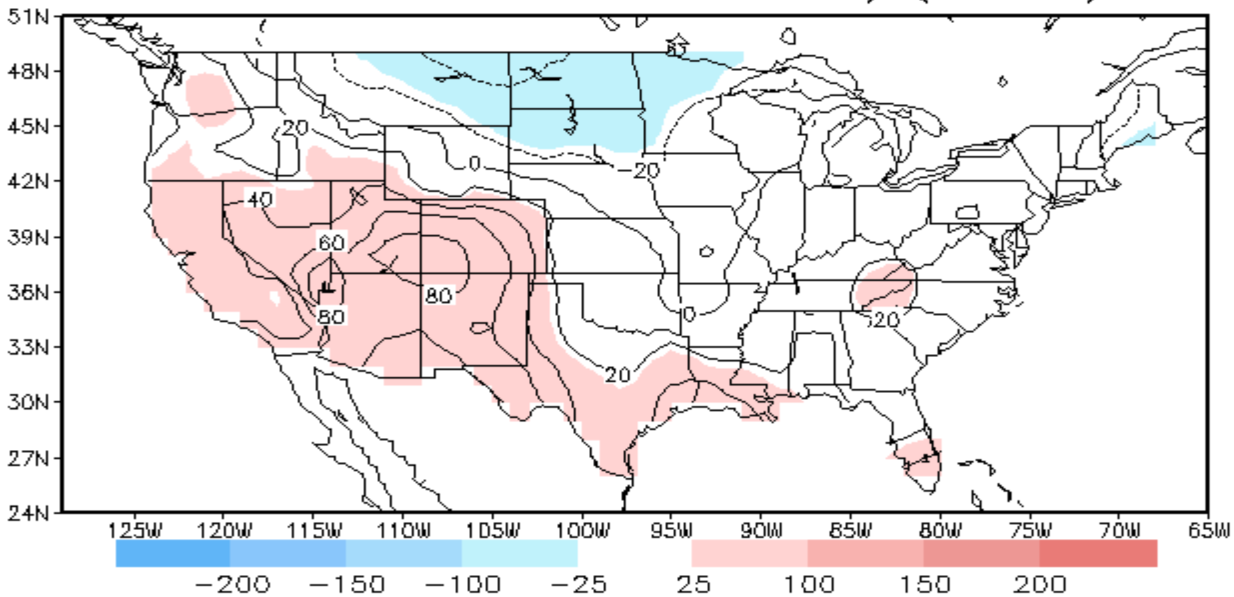
08 17 75 1998 suddenly strongly A, Kicked off by ENSO???
13 24 63 1999
22 20 58 2000

15 32 53 2001 (Normals changed!, but not much relief)
19 36 46 2002
15 38 47 2003 Bias only mild for these three years. Official gipper came down because trend wasn't that strong!!!

20 33 47 2004
07 34 59 2005 accelerating warming????
10 28 62 2006
10 34 56 2007
31 41 27 2008 B N A at 102 US locations (assumed to be 1/3rd,

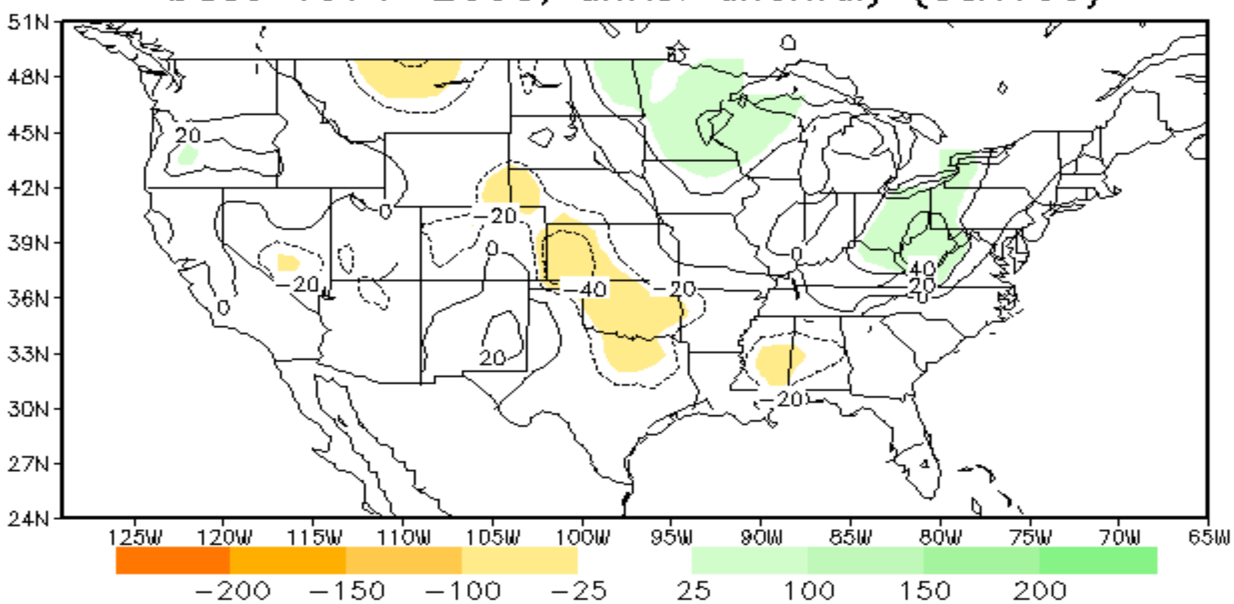

temperature OCN (10 year) forecast for DJF
base 1971-2000; units: anomaly (sdX100)
precipitation OCN (15 year) forecast for DJF
base 1971-2000; units: anomaly (sdX100)
←One year ago.
………Now -→
-200 -150 -100 -25 25 100 150 200
Huug van den Dool, CPC/NCEP/NWS/NOAA: untampered OCN: data thru January 2006
Huug van den Dool, CPC/NCEP/NWS/NOAA: untampered OCN: data thru January 2007

temperature OCN (10 year) forecast for MAM
base 1971-2000; units: anomaly (sdX100)

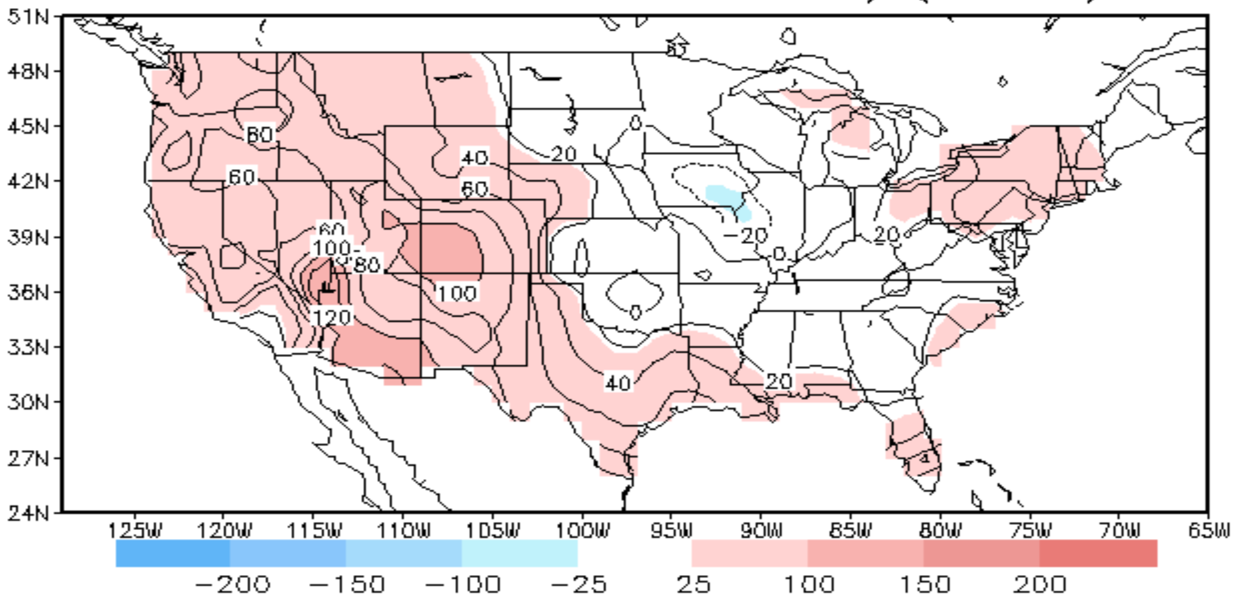


Huug van den Dool, CPC/NCEP/NWS/NOAA; untampered OCN; data thru January 2006

precipitation OCN (15 year) forecast for MAM
base 1971-2000; units: anomaly (sdX100)

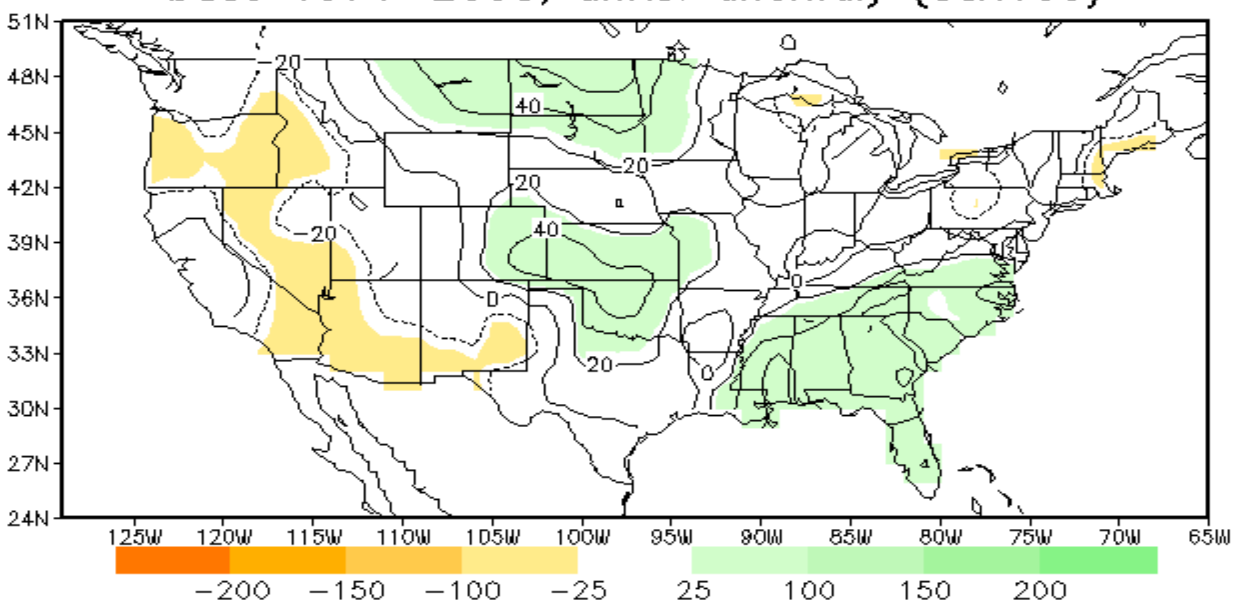


temperature OCN (10 year) forecast for JJA
base 1971-2000; units: anomaly (sdX100)

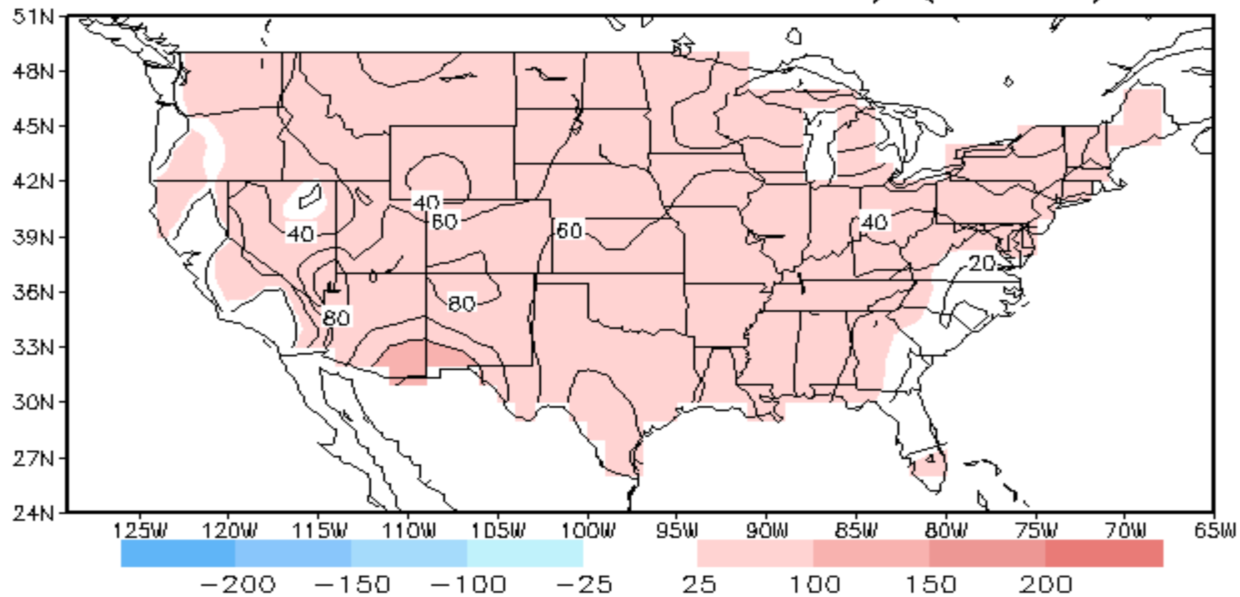


Huug van den Dool, CPC/NCEP/NWS/NOAA; untampered OCN; data thru January 2008

precipitation OCN (15 year) forecast for JJA
base 1971-2000; units: anomaly (sdX100)

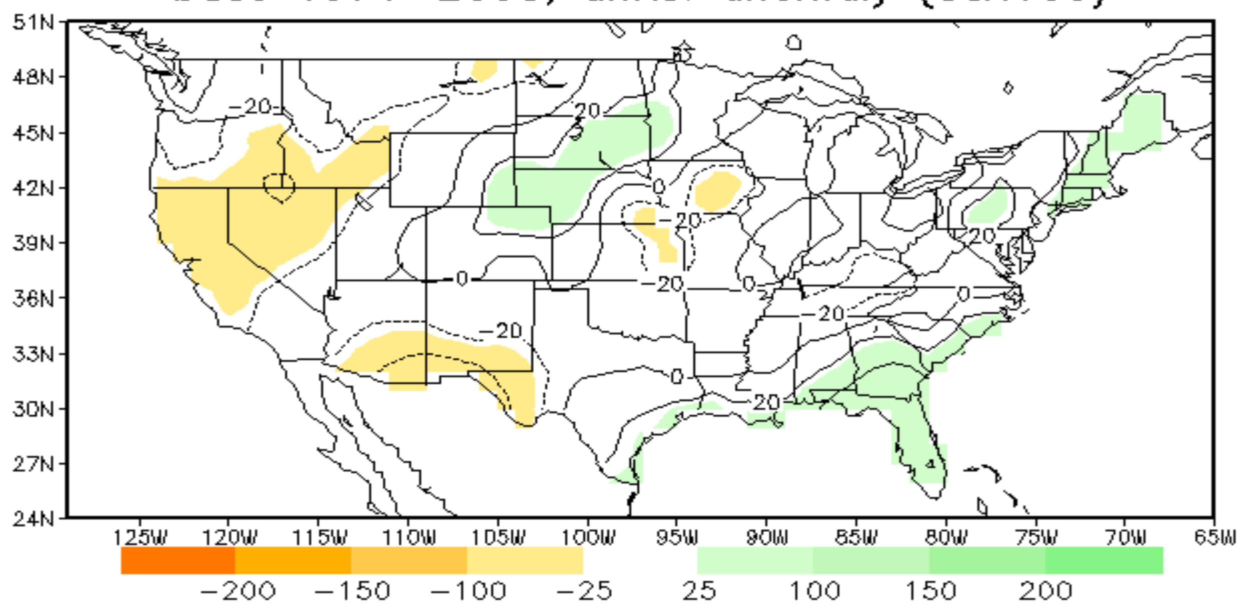


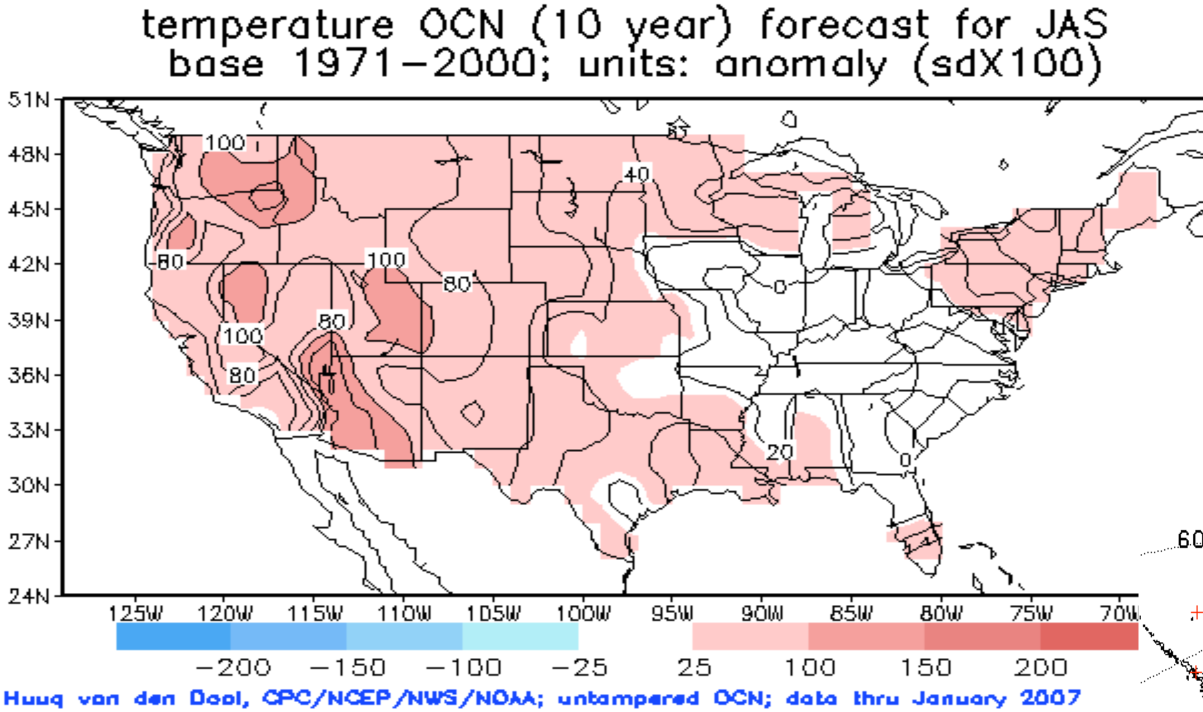
temperature OCN (10 year) forecast for SON
base 1971-2000; units: anomaly (sdX100)

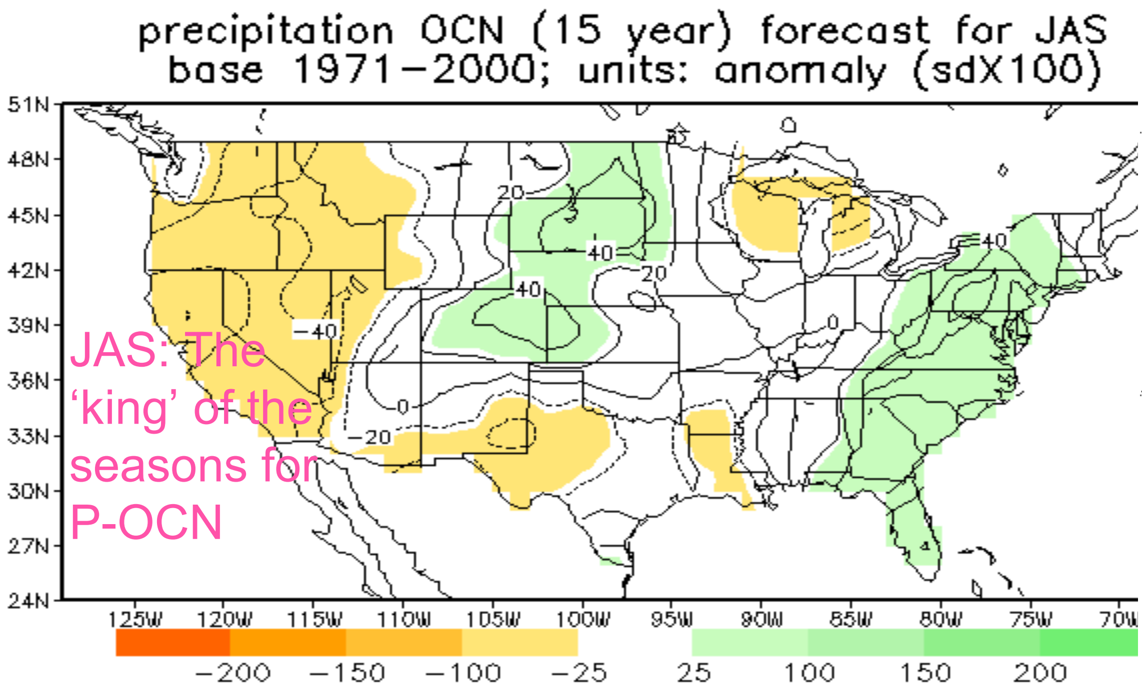


Huug van den Dool, CPC/NCEP/NWS/NOAA; untampered OCN; data thru January 2006

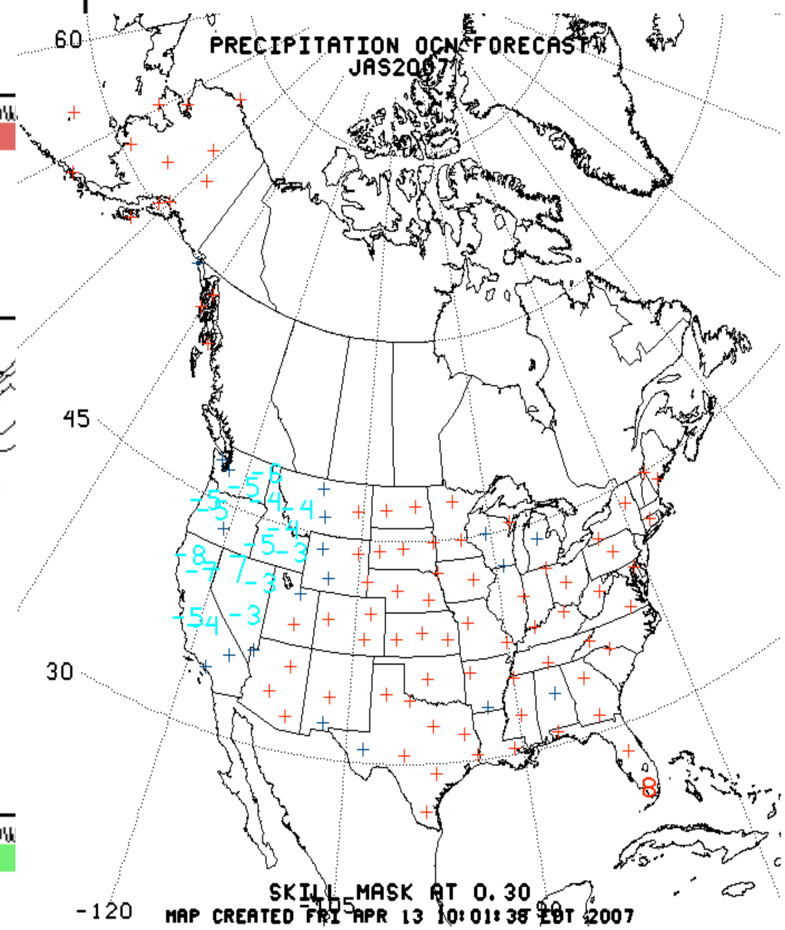
precipitation OCN (15 year) forecast for SON
base 1971-2000; units: anomaly (sdX100)

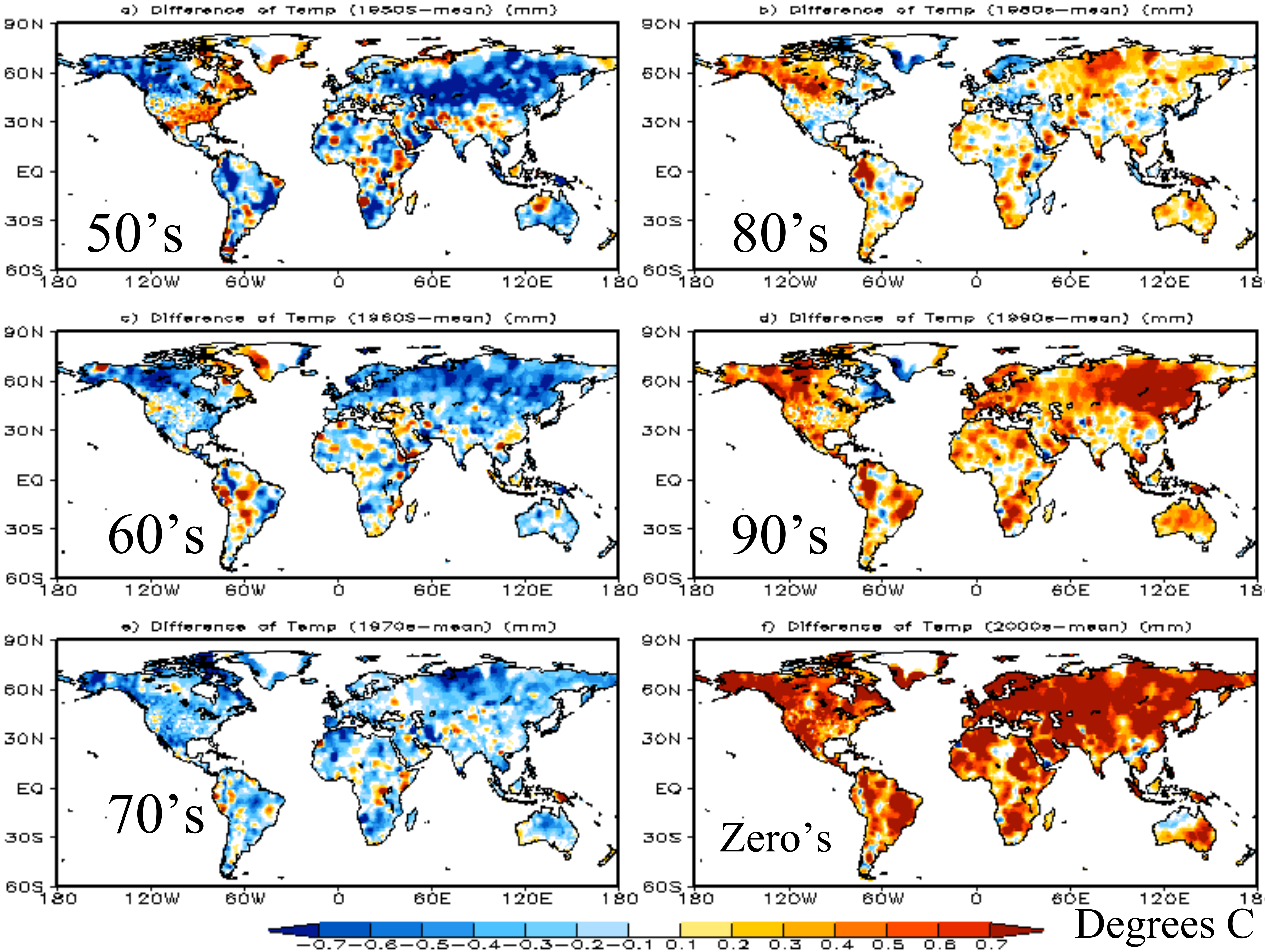




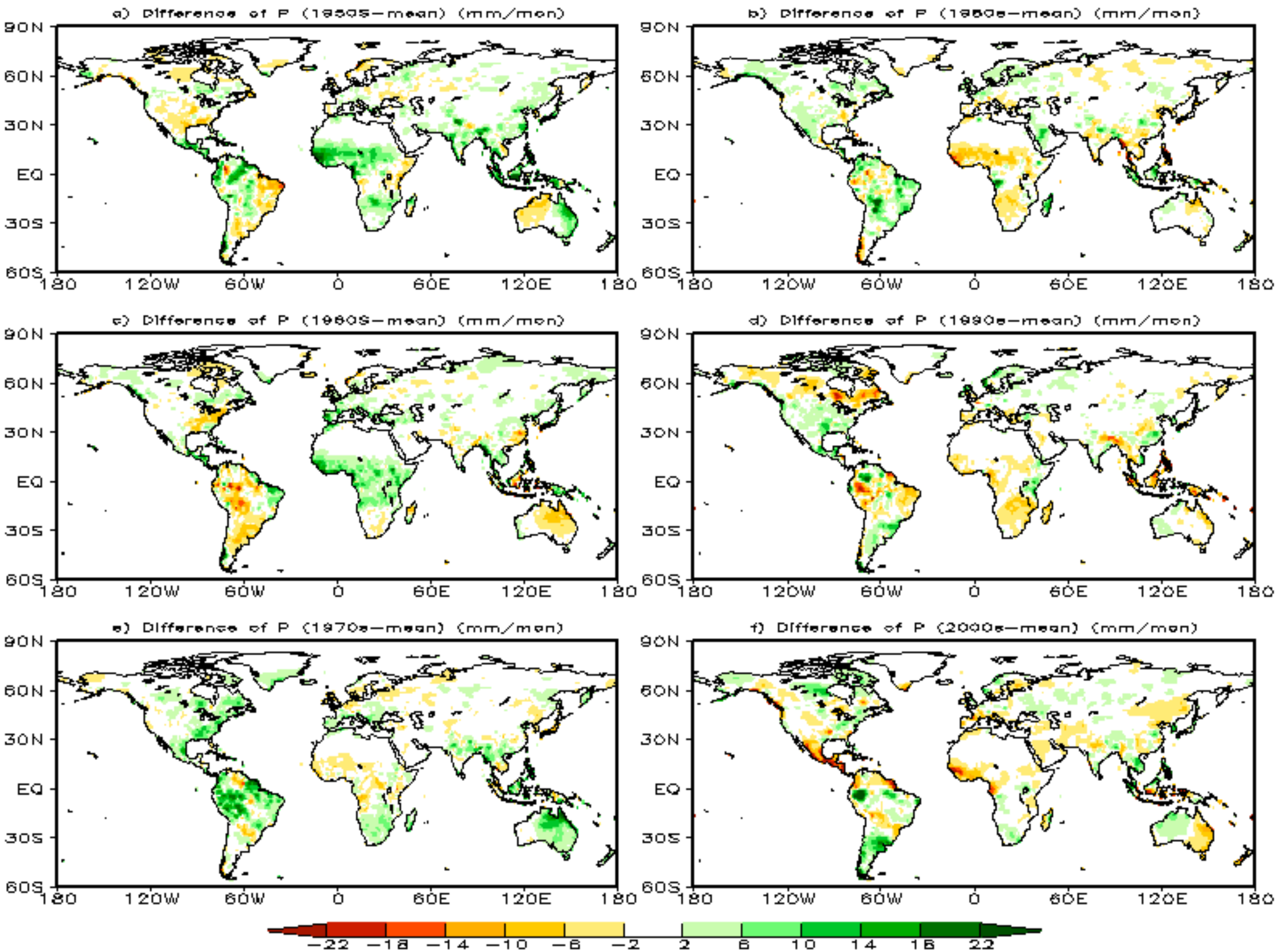


JAS: The 'king' of the seasons for P-OCN





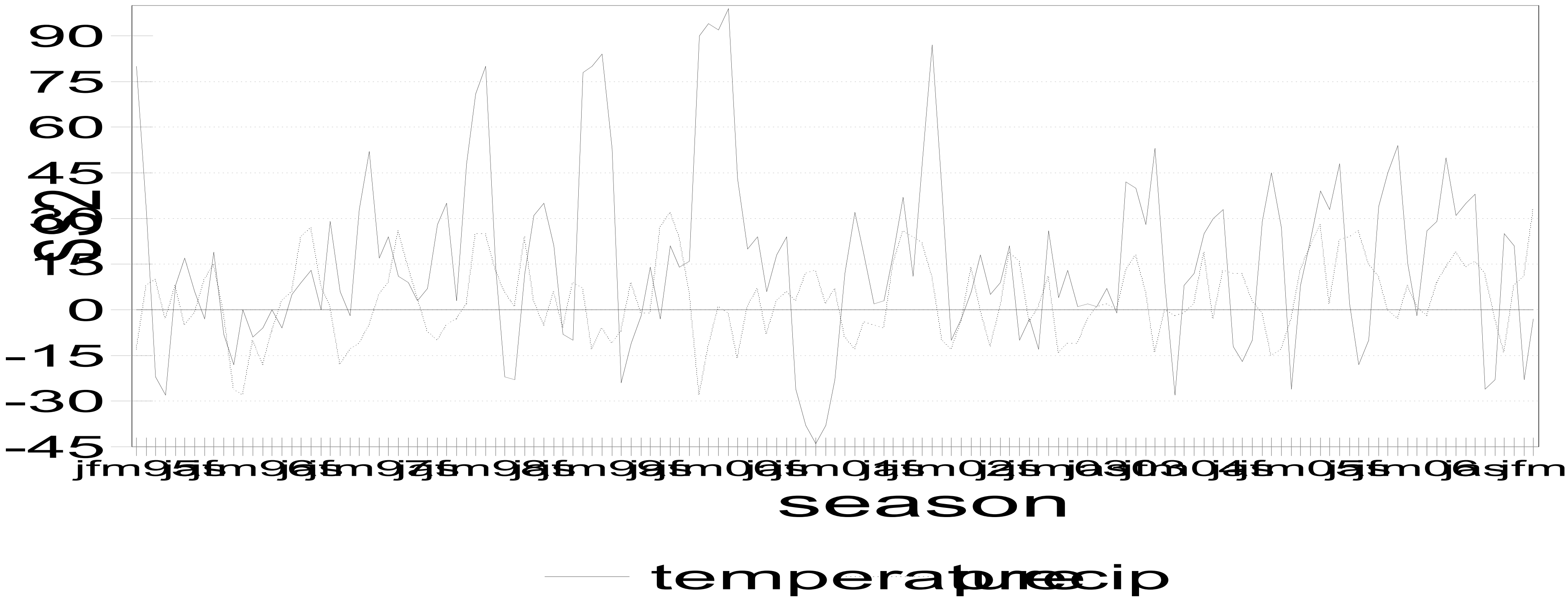
a) Difference of Temp (1950S–mean) (mm)
50's
b) Difference of Temp (1980s–mean) (mm)
80's
c) Difference of Temp (1960S–mean) (mm)
60's
d) Difference of Temp (1990s–mean) (mm)
90's
e) Difference of Temp (1970s–mean) (mm)
70's
f) Difference of Temp (2000s–mean) (mm)
Zero's
90N 60N 30N EQ 30S 60S
180 120W 60W 0 60E 120E 180
−0.7 −0.6 −0.5 −0.4 −0.3 −0.2 −0.1 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Degrees C



a) Difference of P (1950S−mean) (mm/mon)
b) Difference of P (1960s−mean) (mm/mon)
c) Difference of P (1980S−mean) (mm/mon)
d) Difference of P (1990s−mean) (mm/mon)
e) Difference of P (1970s−mean) (mm/mon)
f) Difference of P (2000s−mean) (mm/mon)
90N
60N
30N
EQ
30S
60S
180
120W
60W
0
60E
120E
180
−22 −18 −14 −10 −6 −2 2 6 10 14 18 22

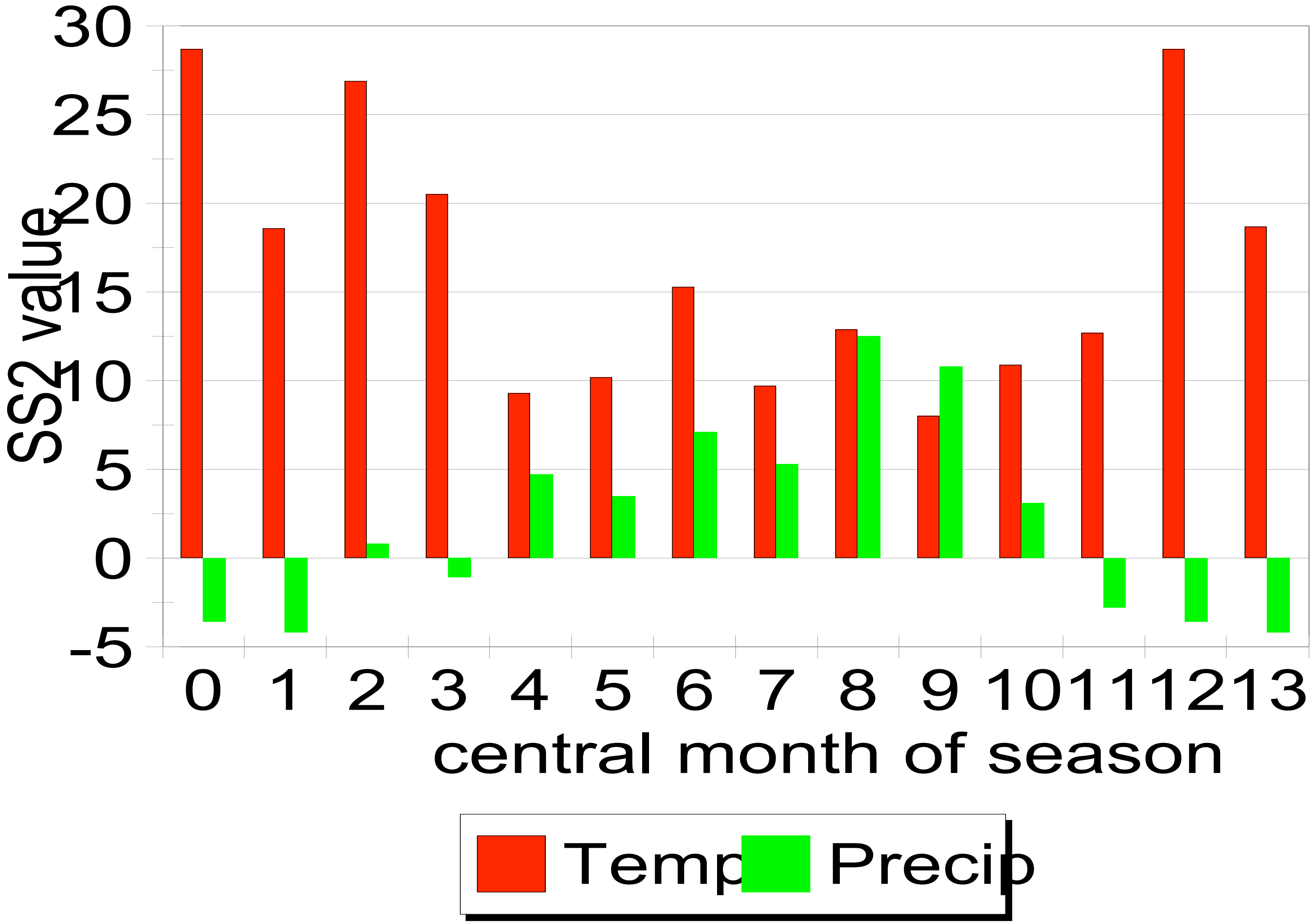
SS2 of retro-OCN JFM

OVERALL: Temp SS2=15.4



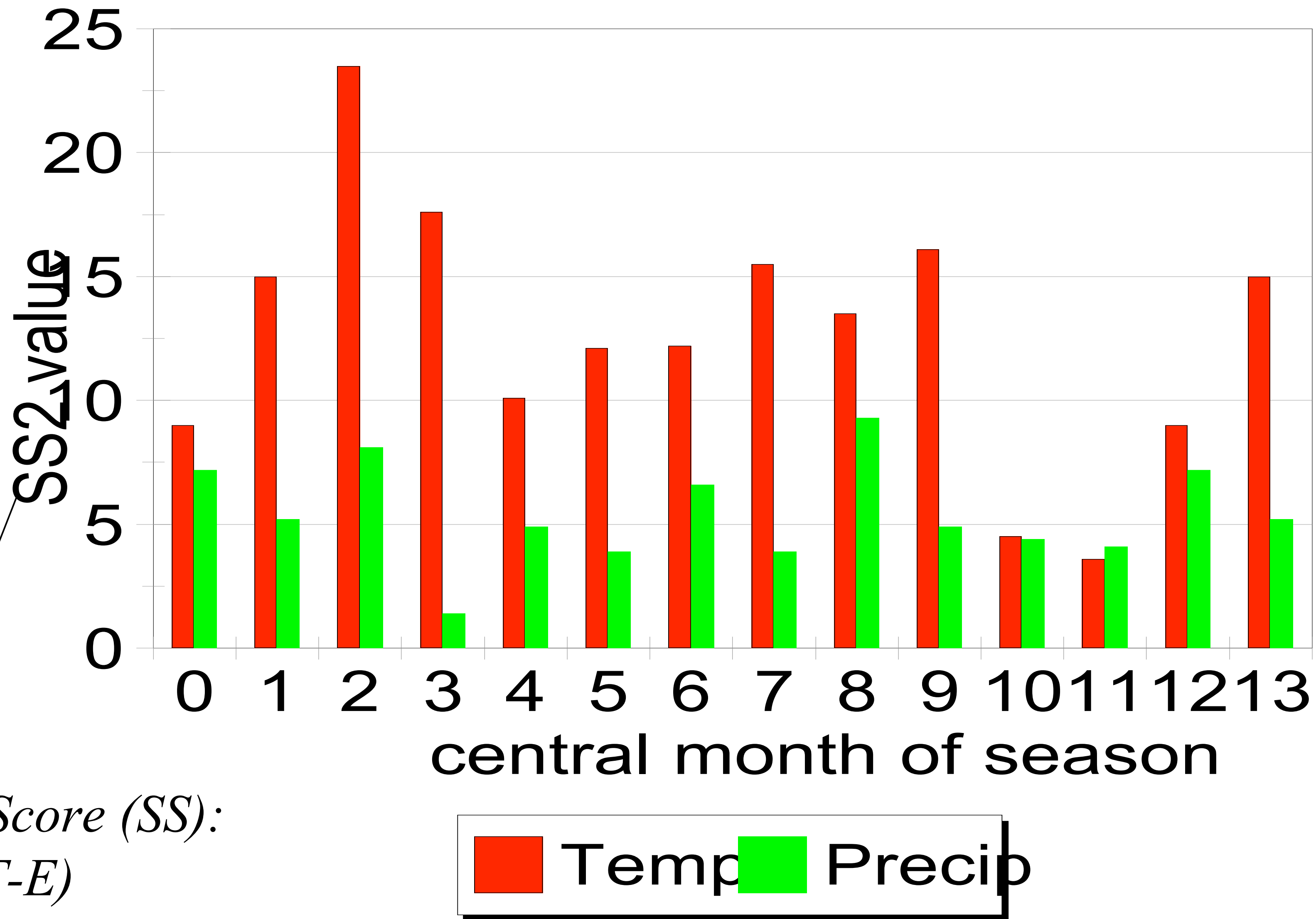
Seasonality SS2 OCN seasonal fro

1995 - 2 - Mar 2007 T(12.5) & P(3



Seasonality SS2 OCN seasonal fro

1962 - July 2000 T(12.8) & P(5



Heidke Score (SS):
(H-E)/(T-E)
2 SS~=correlation*

SS2 of OCN 1962-2006 year b

overall: Temp SS2=12.5 Precip SS2=5.1

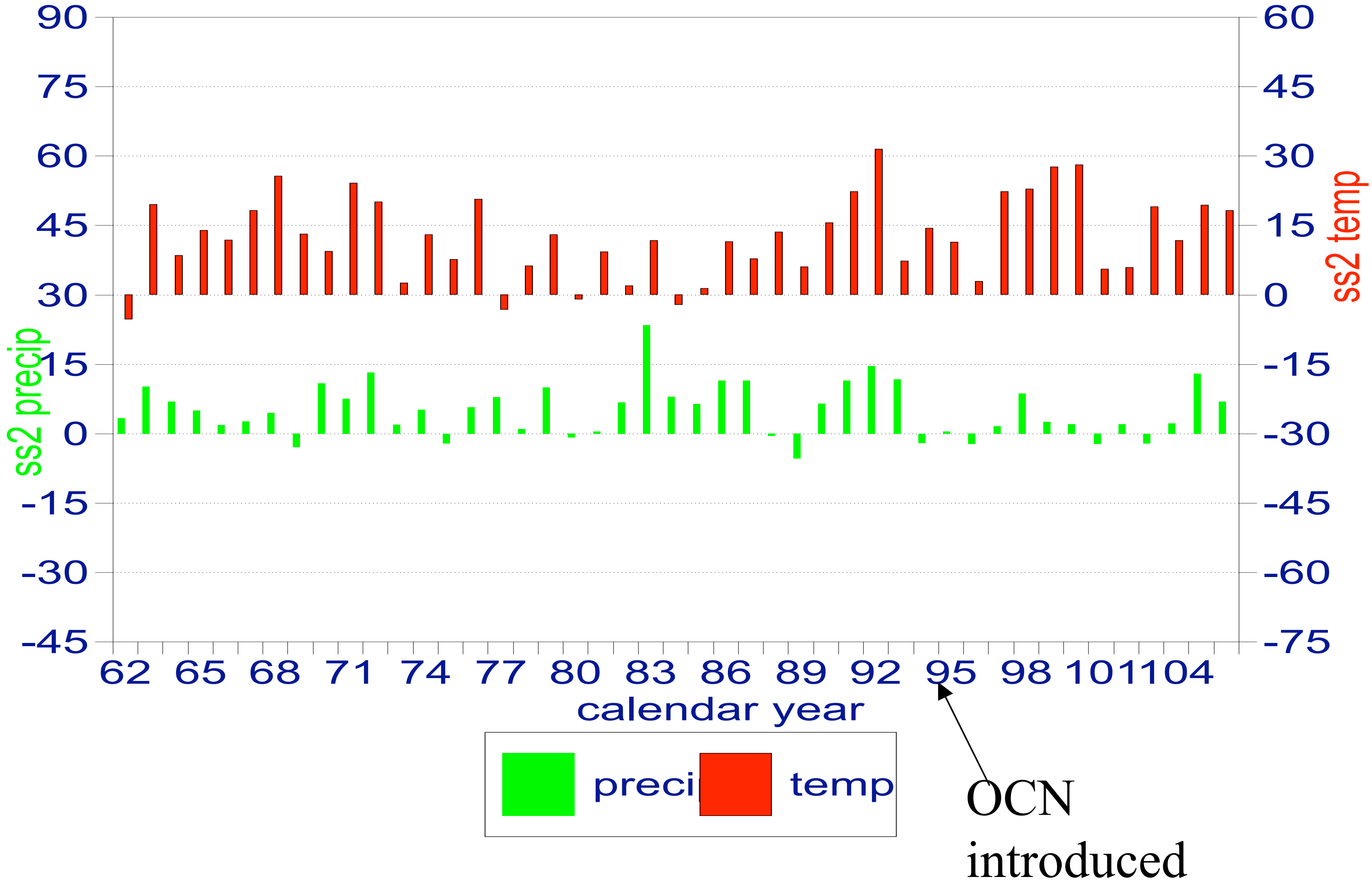


Table 1. Weights (X100) of the constructed analogue on global SST with data thru Feb 2001. An example.

Yr(j)	Wt(α_j)	Yr	Wt	Yr	Wt	Yr	Wt
56	5	67	-8	78	-1	89	8
57	2	68	-5	79	-3	90	13
58	-4	69	-3	80	-4	91	7
59	-7	70	-5	81	-8	92	11
60	-3	71	-2	82	1	93	-6
61	1	72	6	83	0	94	2
62	-1	73	1	84	-1	95	7
63	-1	74	1	85	3	96	2
64	-3	75	2	86	12	97	14
65	-8	76	5	87	5	98	2
66	-5	77	1	88	0	99	26
sum	-24	sum	-7	sum	+4	sum	+86

$$\text{CA-SST}(s) = \sum_j \alpha_j \, \text{SST}(s,j)$$

where α_j is given as in the Table.

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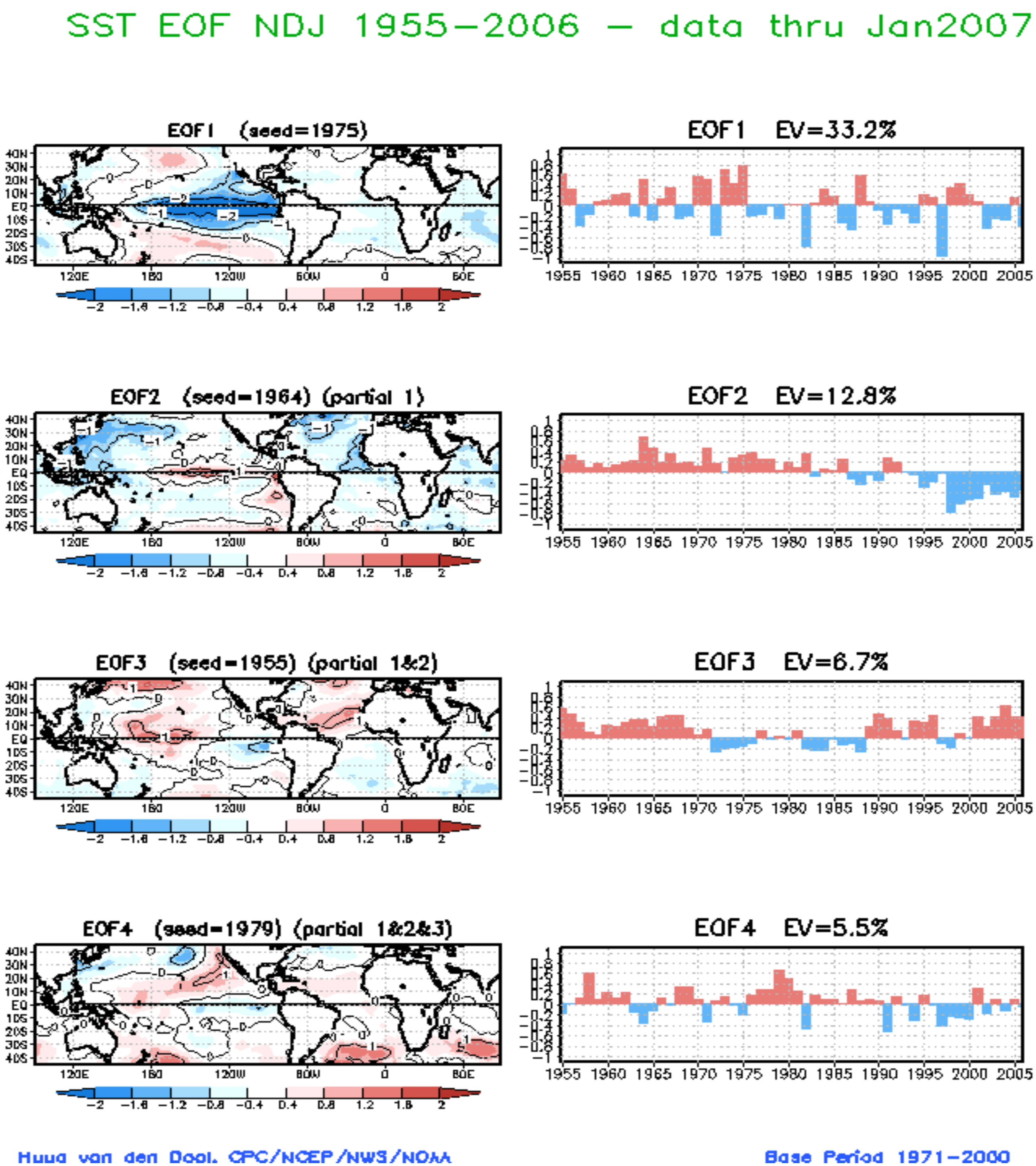
59	-7	70	-5	81	-8	92	11
60	-3	71	-2	82	1	93	-6
61	1	72	6	83	0	94	2
62	-1	73	1	84	-1	95	7
63	-1	74	1	85	3	96	2
64	-3	75	2	86	12	97	14
65	-8	76	5	87	5	98	2
66	-5	77	1	88	0	99	26
sum	-24	sum	-7	sum	+4	sum	+86

$$\text{CA-SST}(s) = \sum_j \alpha_j \, \text{SST}(s,j),$$ where α_j is given as in the Table.

$$\text{OCN-SST}(s) = \sum_j \alpha_j \, \text{SST}(s,j),$$ where α_j=0 (+1/K) for older(recent) j.

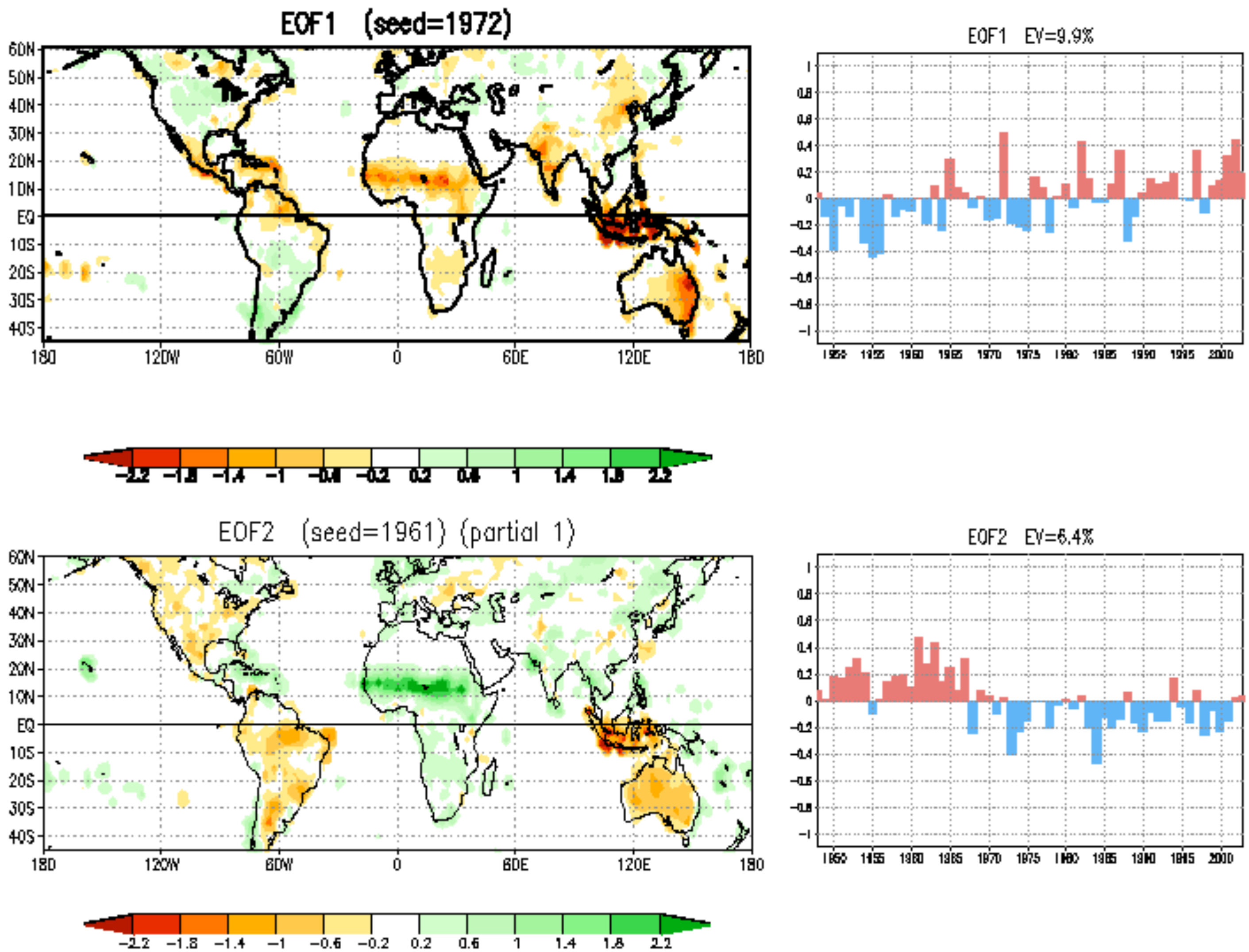
Trends in lower boundary conditions?: global SST



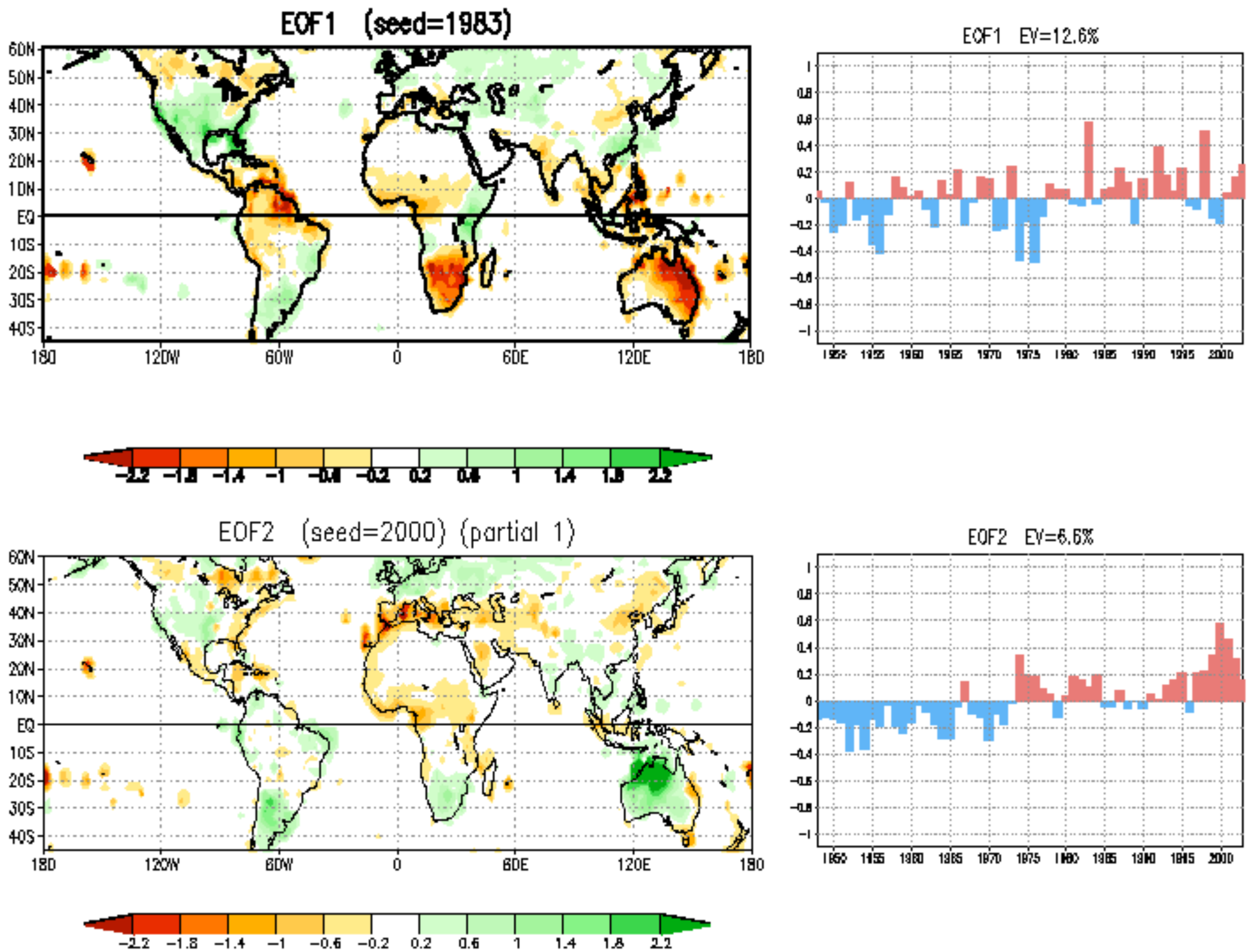
EOFs for NDJ global SST 1948-2006

Trends in lower boundary conditions?: global Soil Moisture

Soil Moisture EOF September 1948-2003

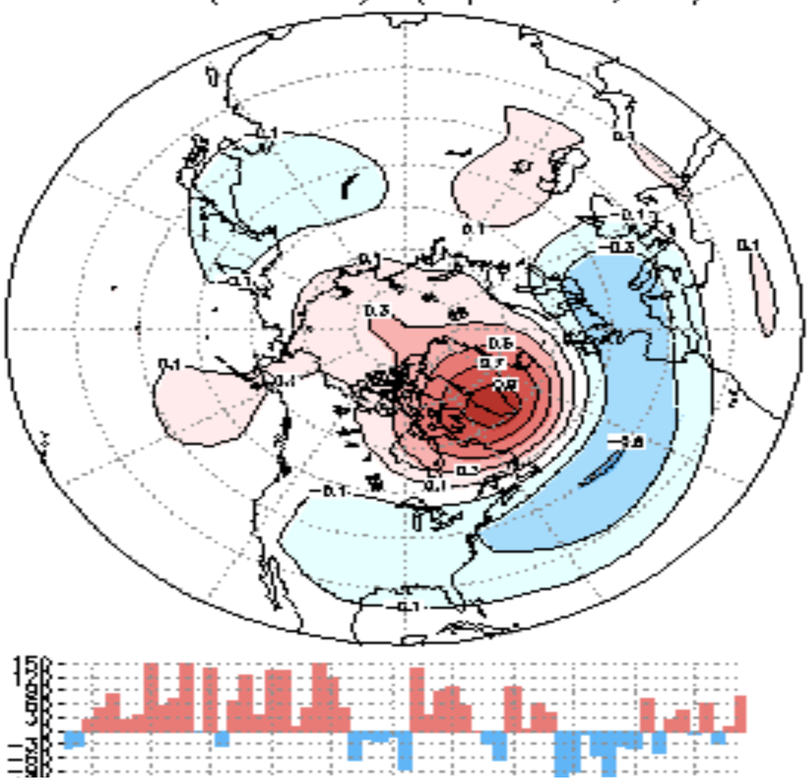


Soil Moisture EOF March 1948–2003

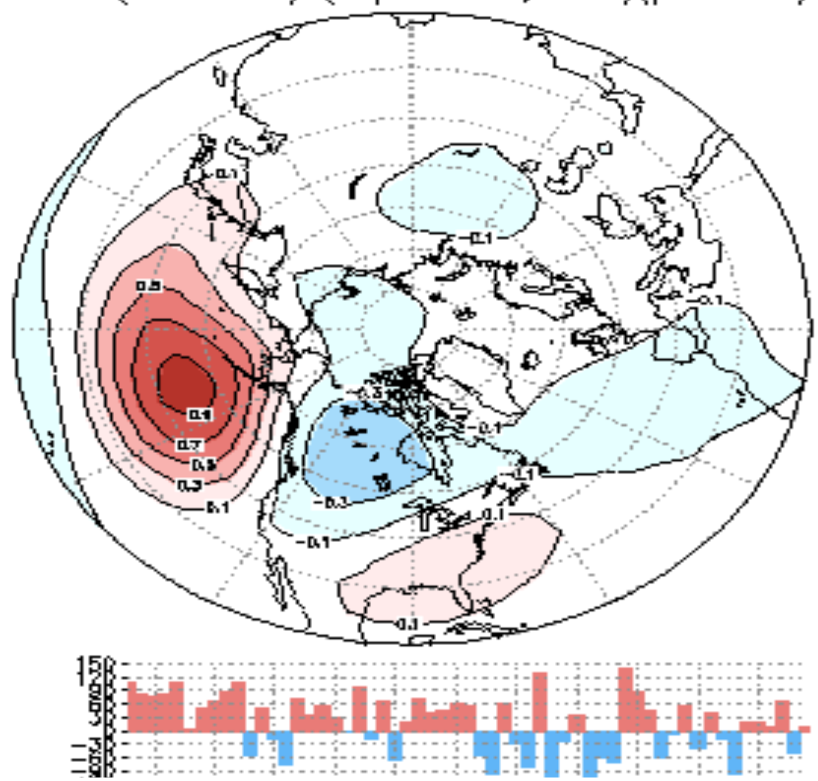


normal EOT JFM 1948–2004 HGT 500 mb

EOT1 (21.1%EV) (bspnt=65N,50W)

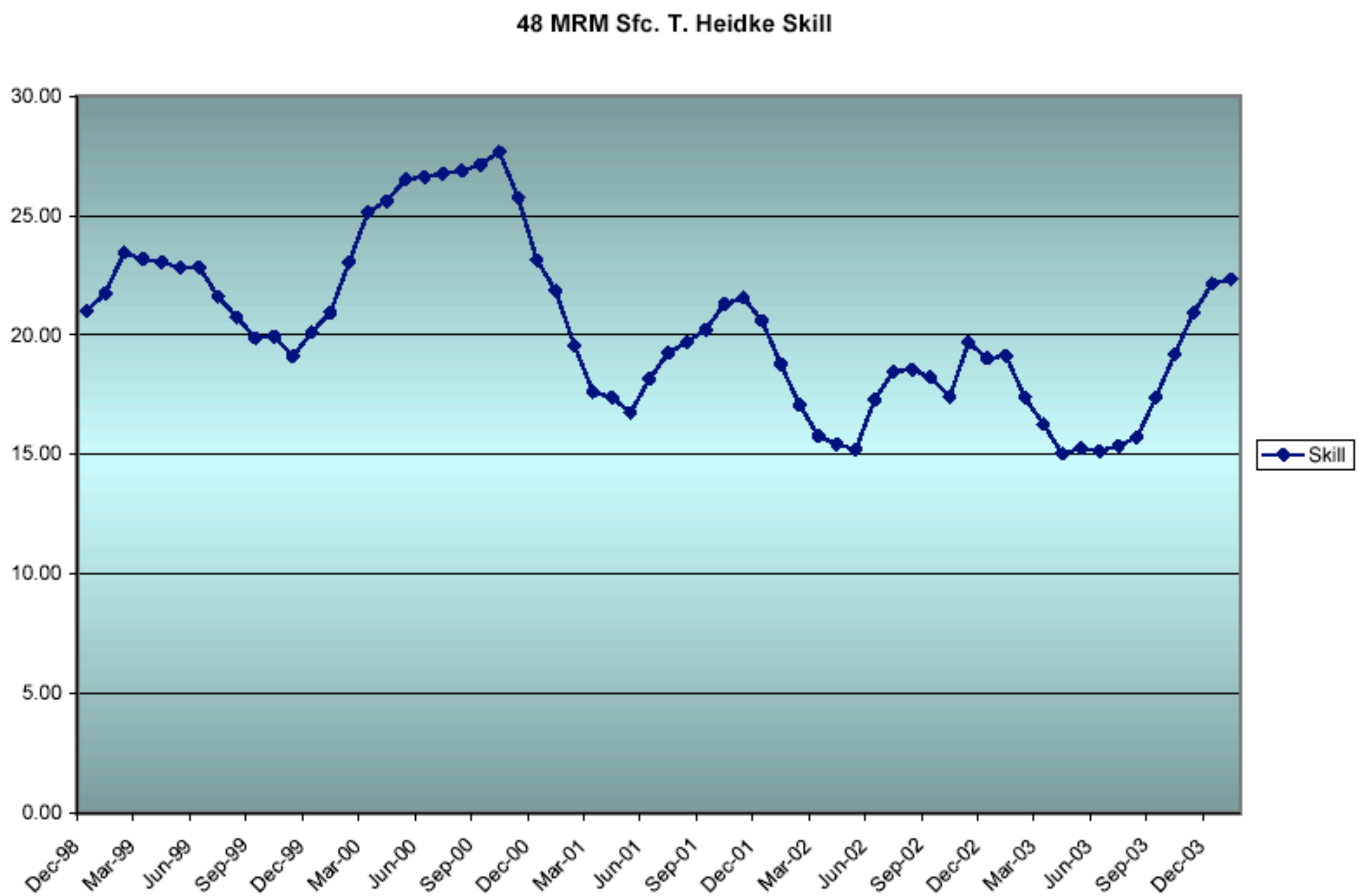


EOT2 (16.2 %EV) (bspnt=45N,160W)(partial 1)



The rest is extra

Metric



48 MRM Sfc. T. Heidke Skill
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Dec-98
Mar-99
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
Sep-01
Dec-01
Mar-02
Jun-02
Sep-02
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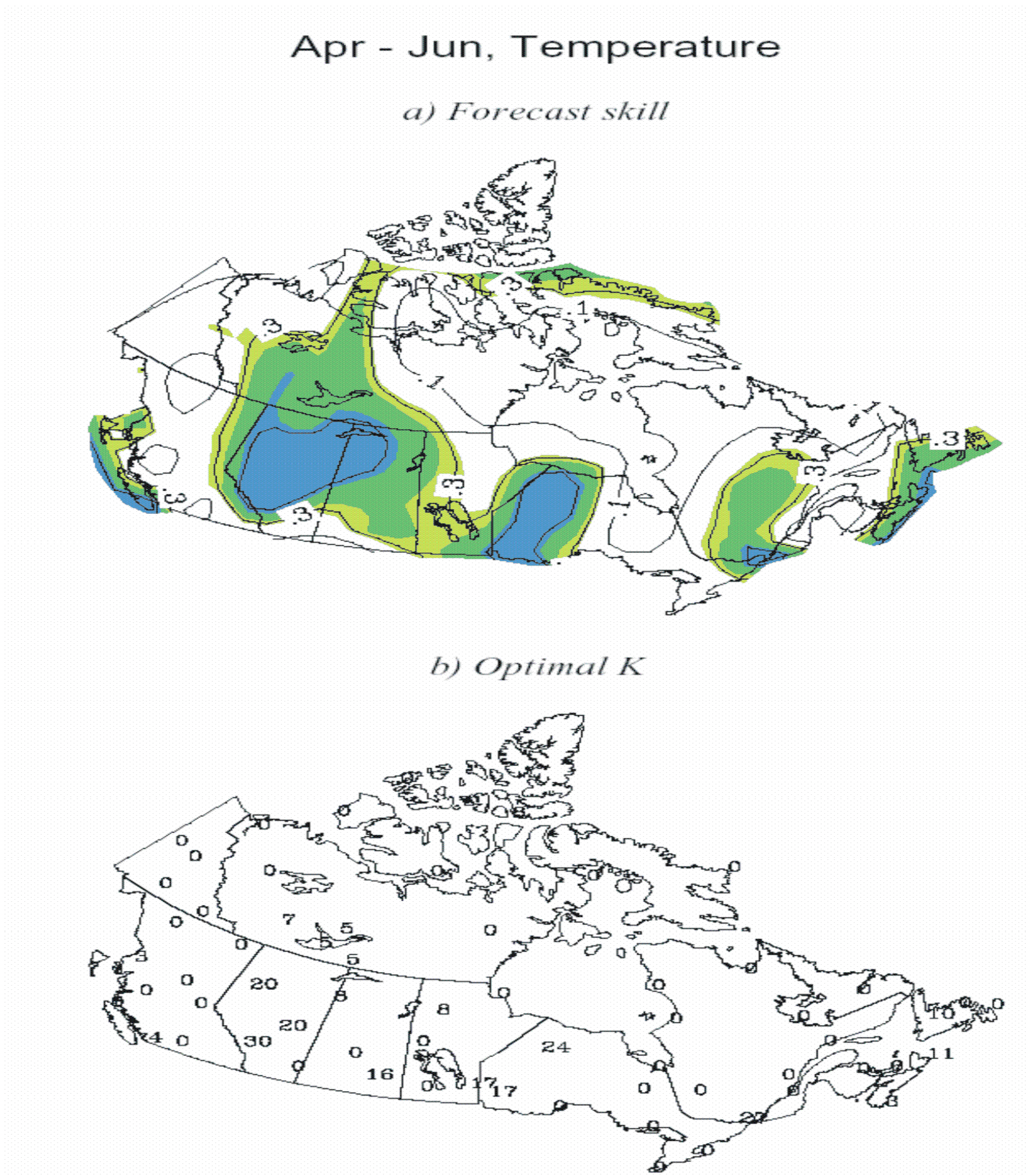
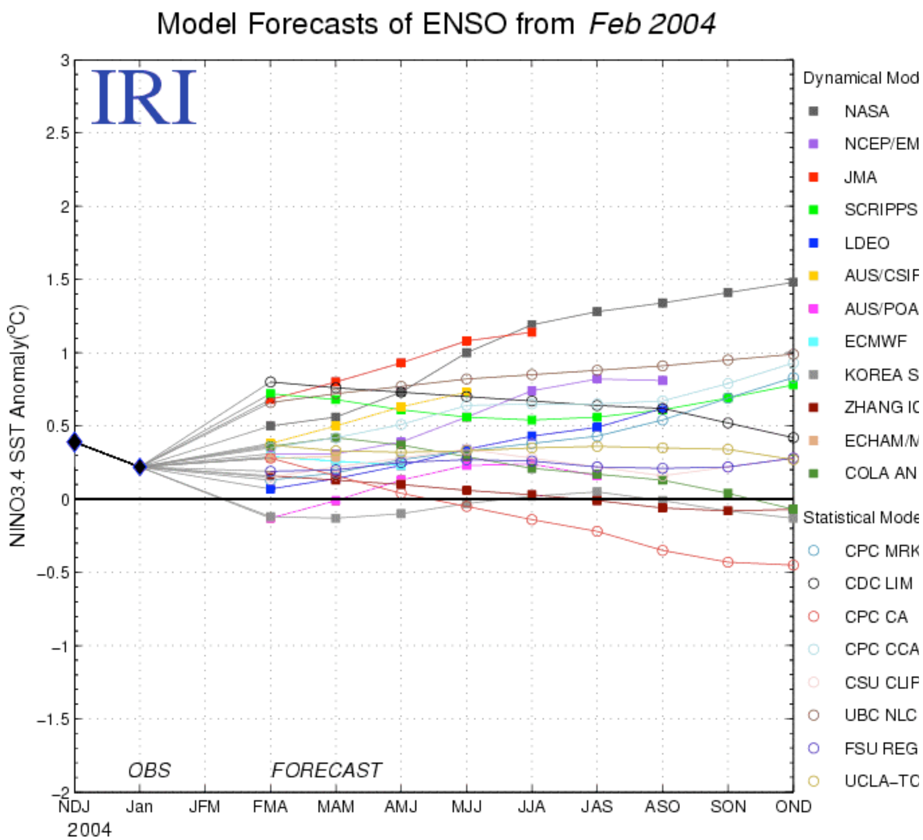
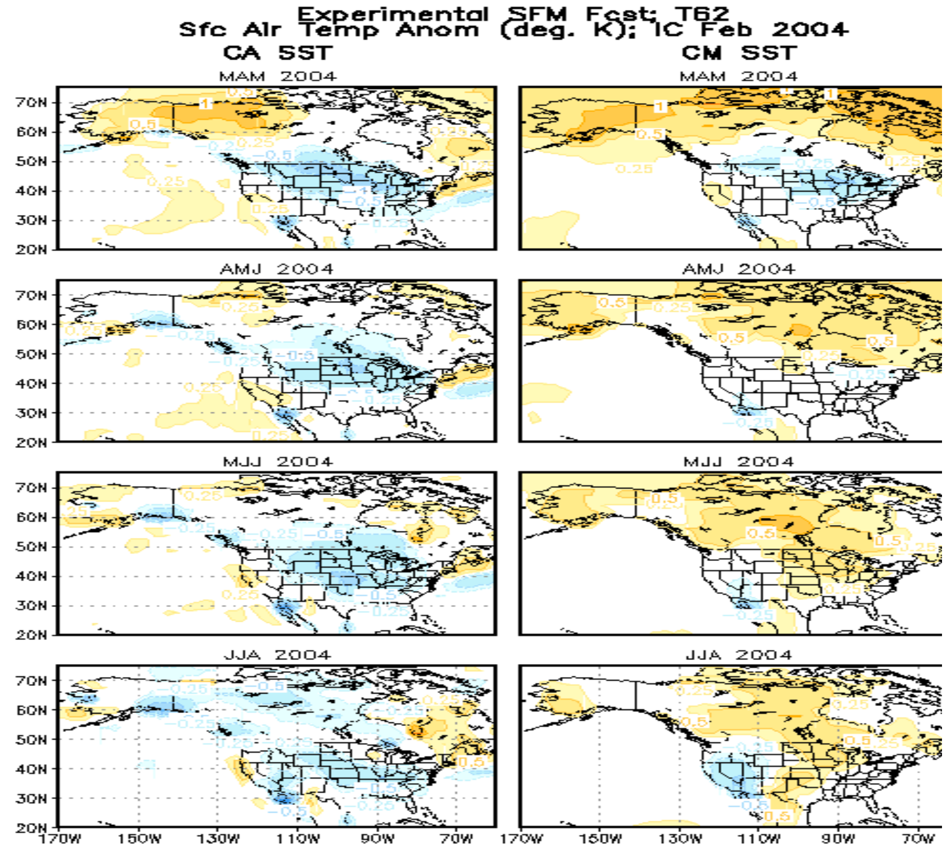
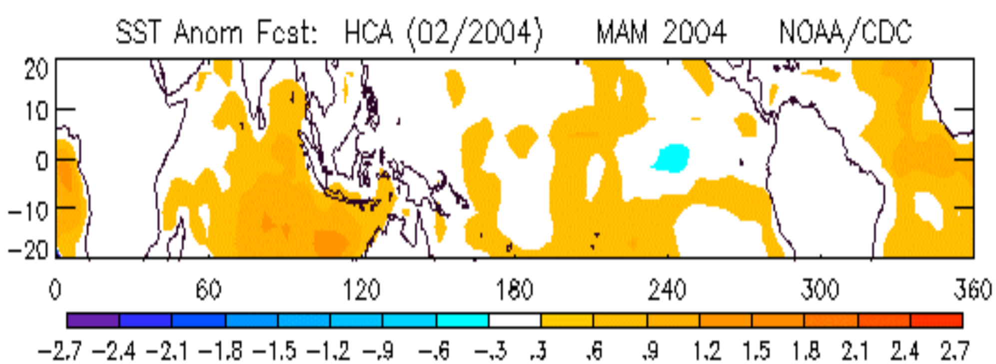
Mar-03
Jun-03
Sep-03
Dec-03
Skill

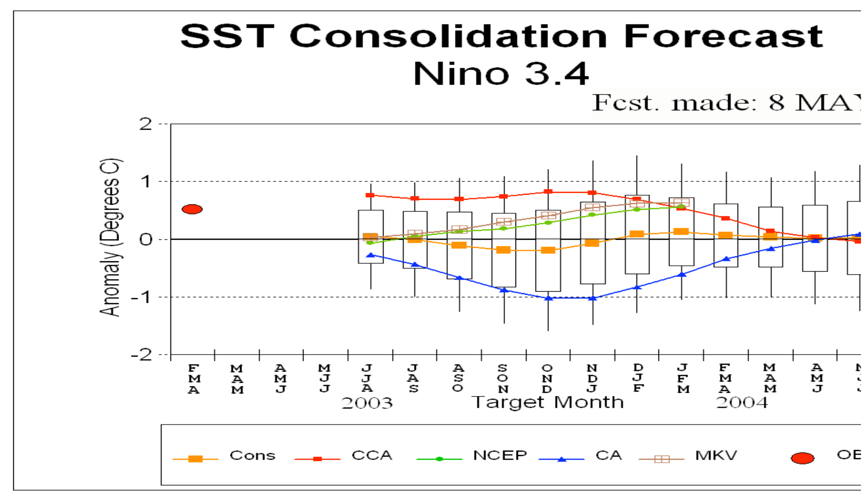


Correlation (upper panel) between OCN forecast and observed values of seasonal temperature and the optimal K (lower panel). Local significance levels are shown for 99%, 95% and 90%. K is zero if the skill in not significant.


Model Forecasts of ENSO from Feb 2004
IRI
NINO3.4 SST Anomaly(°C)
OBS
FORECAST
NDJ
2004
Jan
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
Dynamical Mod
NASA
NCEP/EM
JMA
SCRIPPS
LDEO
AUS/CSIF
AUS/POA
ECMWF
KOREA S
ZHANG IC
ECHAM/N
COLA AN
Statistical Mode
CPC MRK
CDC LIM
CPC CA
CPC CCA
CSU CLIF
UBC NLC
FSU REG
UCLA-TC


Experimental SFM Fcst; T62
Sfc Air Temp Anom (deg. K); IC Feb 2004
CA SST
CM SST
MAM 2004
AMJ 2004
MJJ 2004
JJA 2004
70N
60N
50N
40N
30N
20N
170W
150W
130W
110W
90W
70W


SST Anom Fcst: HCA (02/2004) MAM 2004 NOAA/CDC
20
10
0
-10
-20
0
60
120
180
240
300
360
-2.7 -2.4 -2.1 -1.8 -1.5 -1.2 -.9 -.6 -.3 .3 .6 .9 1.2 1.5 1.8 2.1 2.4 2.7


SST Consolidation Forecast
Nino 3.4
Fcst. made: 8 MA
Anomaly (Degrees C)
2003
Target Month
2004
Cons
CCA
NCEP
CA
MKV
OE