NMME and IMME at NCEP

Huug van den Dool and Malaquias Pena

Climate Prediction Center (CPC)

College Park, March, 25, 2014

Acknowledge: Emily Becker, Qin Zhang, Suranjana Saha, and many many others.

In Early 2011

- There was a sudden decisiveness about organizing a National MME for *seasonal prediction* in the US
- It had been a longstanding wish of some, especially funding agents, for this to happen.
- In a sense, we were ready, since IMME was already being prepared from Dec 2010 onward.
- There was a willingness to go the extra mile on the part of other modeling centers, especially NASA, GFDL, NCAR and IRI to get this done quickly.
- These were all global coupled atmosphere-ocean models.
- NCEP organized the “rules of engagement” such as time table, common grid, hindcasts, etc.
- The first test run in real time was made in August 2011.

Requirements for NMME (Huug van den Dool, 4/7/11)

- Real-time model should be equal to the frozen hindcast model (of course, the initial states may change due to ingest of new data types; a truly constant system is difficult if not impossible)
- Forecast leads out to at least 7 months.
- A minimum of 30 years of hindcasts, especially a common period of 1981-2010.
- All individual ensemble members must be submitted, (not just the ensemble mean).
- Total fields (not anomalies) must be submitted
- No systematic error correction at the originator's end. We want 'raw' data.
- Required output would minimally be ***monthly means*** of global SST, T2m, prate (in original Phase I).
- (Recently, in "Phase I extended" , T_{min} T_{max} , runoff, soil moisture and 200 hPa geopotential have been added.)
- All data must be submitted on a common 1 x 1 degree grid.
- All real time forecasts must be in by the 8^{th} of the month COB, so that they can be used as a tool in CPC's official seasonal predictions.

Non-Requirements for NMME (Huug van den Dool, 4/7/11)

- ……..
- The number of ensemble members is up to the originator, but it is assumed they understand that one ensemble member will keep skill low, and for very large N, the returns are diminishing, so they have to make their own wise choices given resources.
- Resolution and physics/numerics of the model are left entirely up to originators.
- It would be good to follow the CFSv2 lay-out for the start times of the hind-casts.

Participants YEAR 1

	Start months available	Hindcast Period	Members	Arrangement of Members	Lead (months)	Model resident Resolutions: Atmosphere	Ocean	Reference	
NCEP-CFSv1	12	1981-2009	15	1st 0Z +/-2days, 11th 0Z+/-2d, 21st 0Z+/-2d	0-9	T62L64	MOM3L40 0.30 deq Eq	Saha et al 2006	NCEP-CFSv1
NCEP-CFSv2	12	1982-2010	24(28)	4 members (0,6,12,18Z) every 5th day	0-9	T126L64	MOM4 L40 0.25 deg Eq	Saha et al 2012	NCEP-CFSv2
GFDL-CM2.1	12	1982-2010	10	All 1st of the month 0Z	0-11	2x2.5deg L24	MOM4 L50 0.25 deg Eq	Delworth et al 2006	GFDL-CM2.1
IRI-Echam4-f	12	1982-2010	12	All 1st of the month**	0-7	T42L19	MOM3 L25 0.5 deg Eq	DeWitt MWR2005	IRI-Echam4-f
IRI-Echam4-a	12	1982-2010	12	All 1st of the month**	0-7	T42L19	MOM3 L25 0.5 deg Eq	"	IRI-Echam4-a
NCAR-CCSM3.0	12	1982-2010	6	All 1st of the month**	0-11	T85L26	POP L40 0.3 deg Eq	Kirtman and Min 2009	NCAR-CCSM3.0
NASA	12	1981-2010	6	1 member every 5th day as CFSv2	0-9	1x1.25deg L72	MOM4 L40 0.25 deg Eq	Rienecker et al 2008	NASA

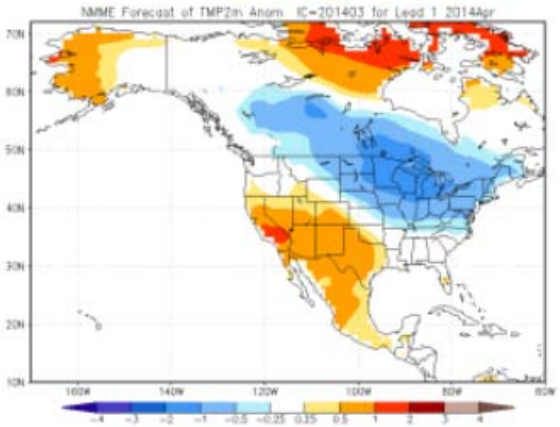
Participants YEAR 2

	Start months available NOW	Hindcast Period	Members	Arrangement of Members	Lead (months)	Model resident Resolutions: Atmosphere	Ocean	Reference	
NCEP-CFSv1	12	1981-2009	15	1st 0Z +/-2days, 11th 0Z+/-2d, 21st 0Z+/-2d	0-9	T62L64	MOM3L40 0.30 deq Eq	Saha et al 2006	NCEP-CFSv1
NCEP-CFSv2	12	1982-2010	24(28)	4 members (0,6,12,18Z) every 5th day	0-9	T126L64	MOM4 L40 0.25 deg Eq	Saha et al 2010	NCEP-CFSv2
GFDL-CM2.1	12	1982-2010	10	All 1st of the month 0Z	0-11	2x2.5deg L24	MOM4 L50 0.30 deg Eq	Delworth et al 2006	GFDL-CM2.1
CMC1-CanCM3	12	1981-2010	10	All 1st of the month 0Z	0-11	CanAM3 T63L31	CanOM4 L40 0.94 deg Eq	Merryfield et al 2012	CMC1
CMC2-CanCM4	12	1981-2010	10	All 1st of the month 0Z	0-11	CanAM4 T63L35	CanOM4 L40 0.94 deg Eq	Merryfield et al 2012	CMC2
NCAR-CCSM3.0	12	1982-2010	6	All 1st of the month**	0-11	T85L26	POP L40 0.3 deg Eq	Kirtman and Min 2009	NCAR-CCSM3.0
NASA	12	1981-2010	11	1 member every 5th day as CFSv2	0-9	1x1.25deg L72	MOM4 L40 1/4 deg at Eq	Rienecker et al 2008	NASA

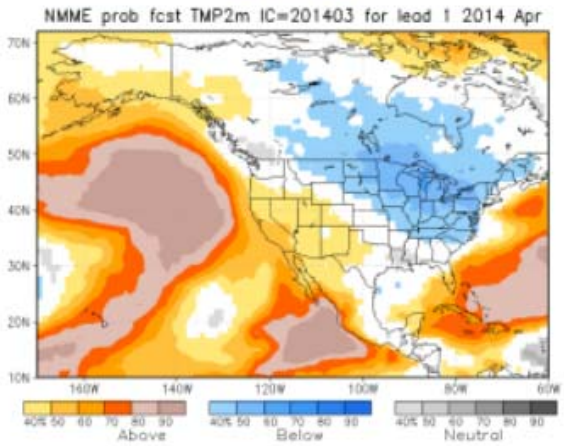
Comings and goings in 3rd year (now)

- Nobody left so far, CCSM3 may go?
- GFDL added FLORa and FLORb in March 2014
- GFDL may add yet another “perturbed” model
- CCSM4 may come in soon, CCSSM5 may come in a little later
- Several other centers would like to join.
- (Activity is ‘vibrant’)

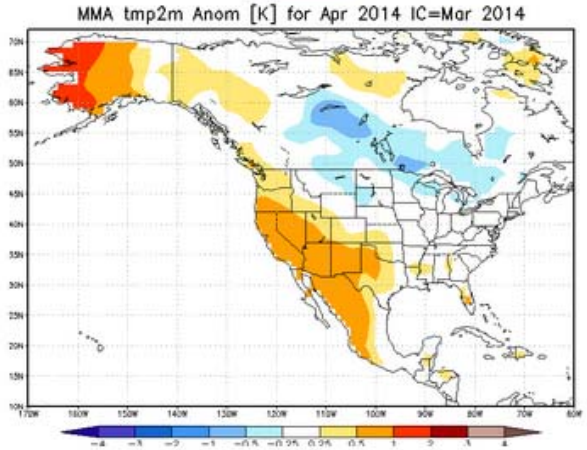
NMME



Prob fcst

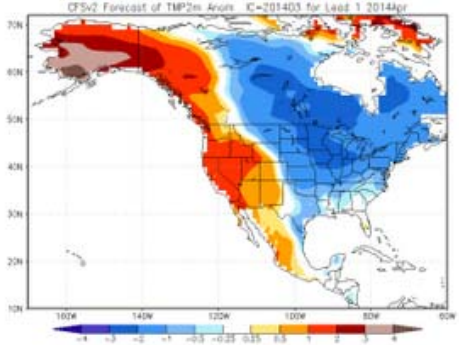


IMME

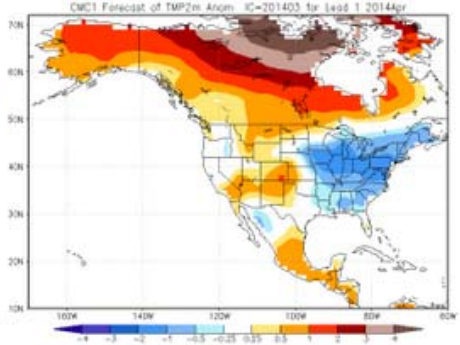


Example, prediction for April 2014

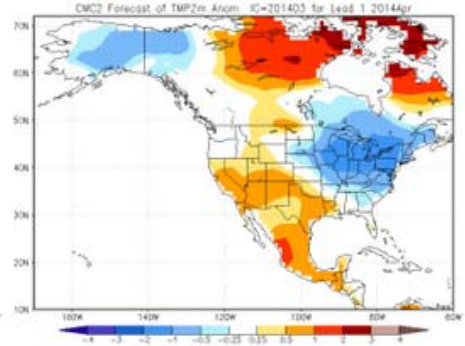
CFSv2



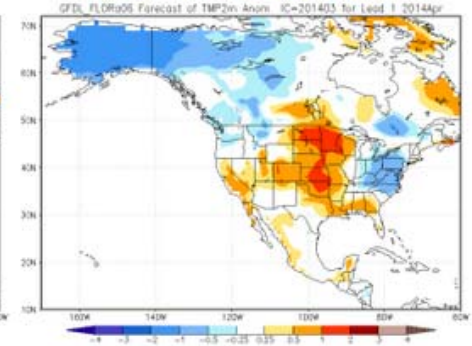
CMC1



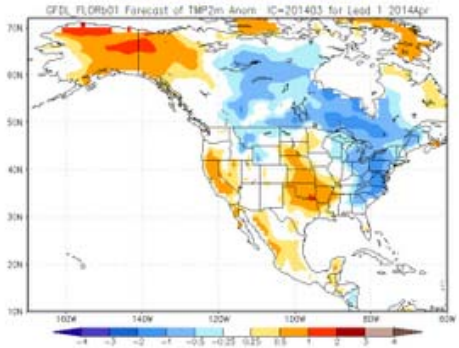
CMC2



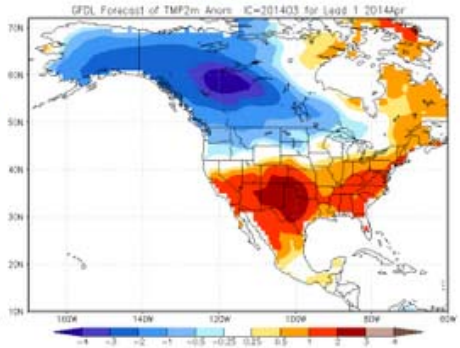
GFDL FLORa06



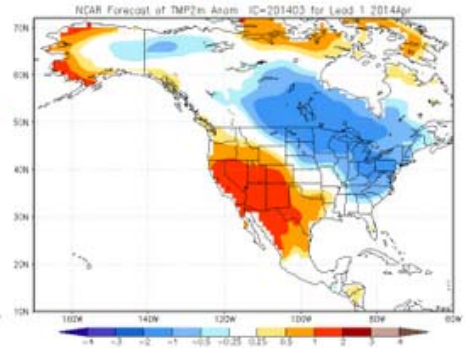
GFDL FLORb01



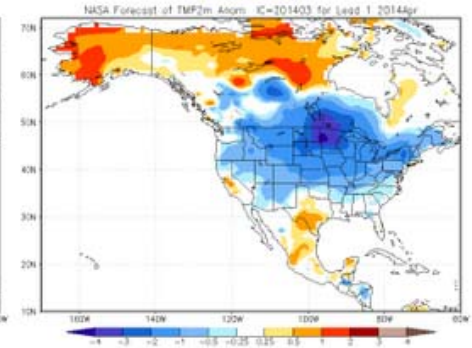
GFDL

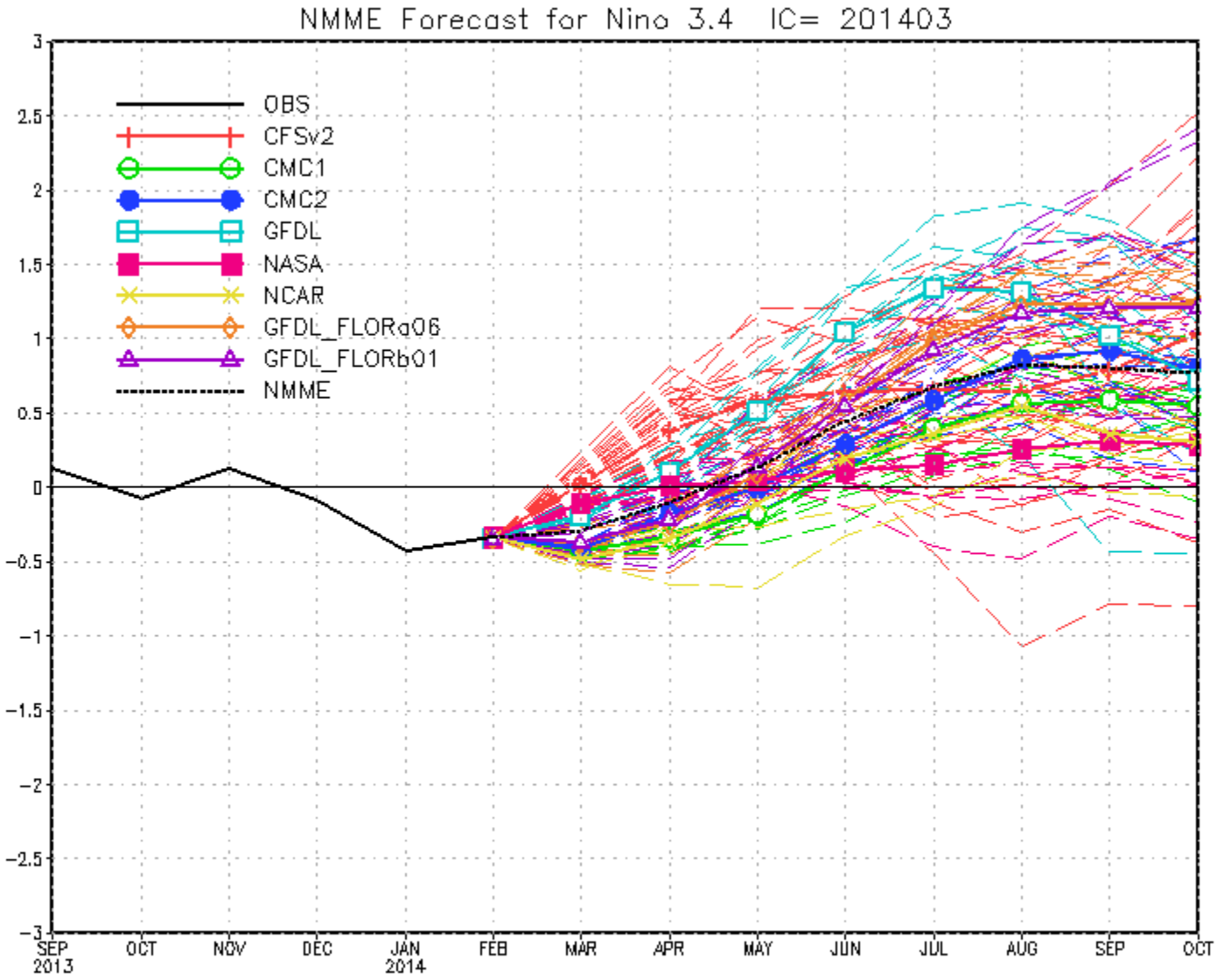


NCAR



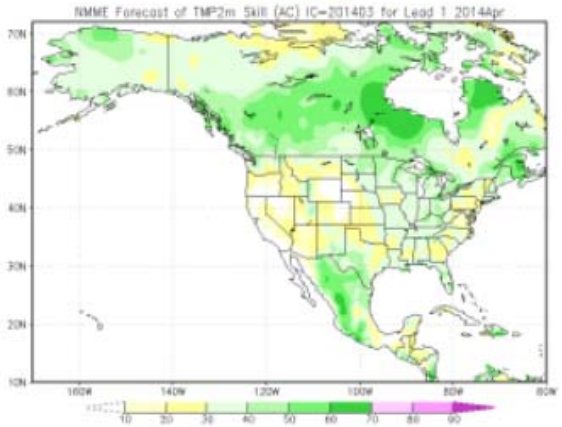
NASA



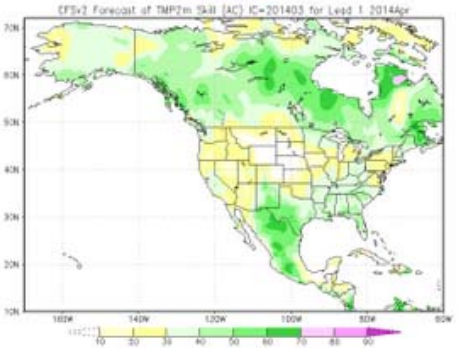

NMME Forecast for Nino 3.4 IC= 201403
OBS
CFSv2
CMC1
CMC2
GFDL
NASA
NCAR
GFDL_FLORa06
GFDL_FLORb01
NMME
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
SEP 2013
OCT
NOV
DEC
JAN 2014
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT

Oh, before we forget…
Is there any skill??

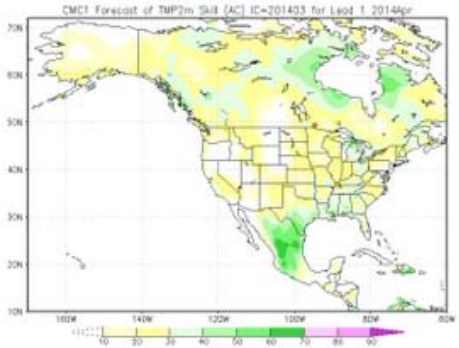
NMME



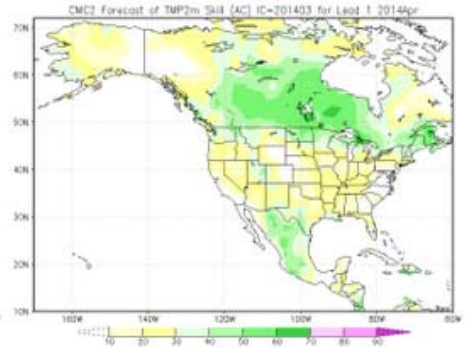
CFSv2



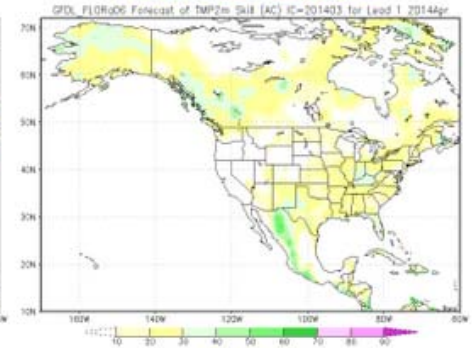
CMC1



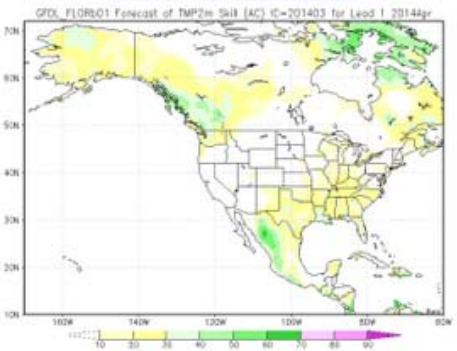
CMC2



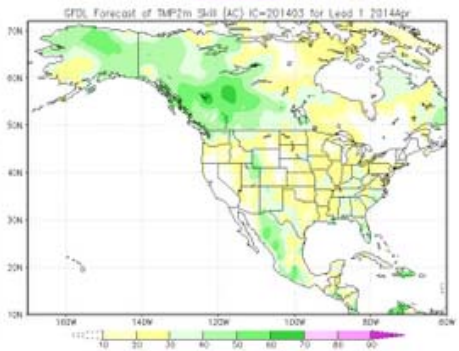
GFDL_FLORa06



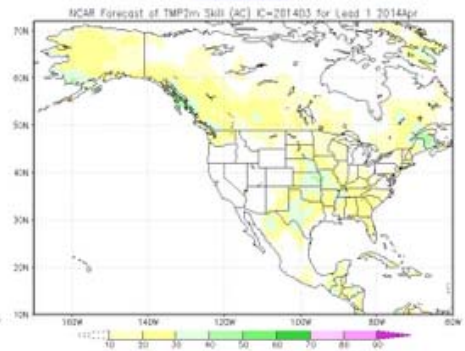
GFDL_FLORb01



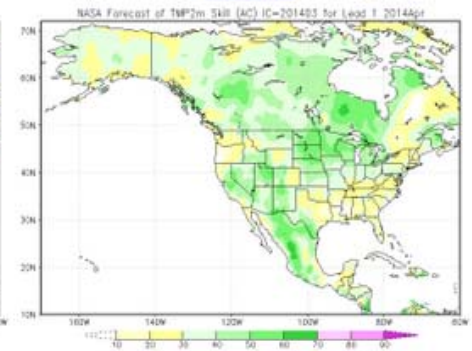
GFDL



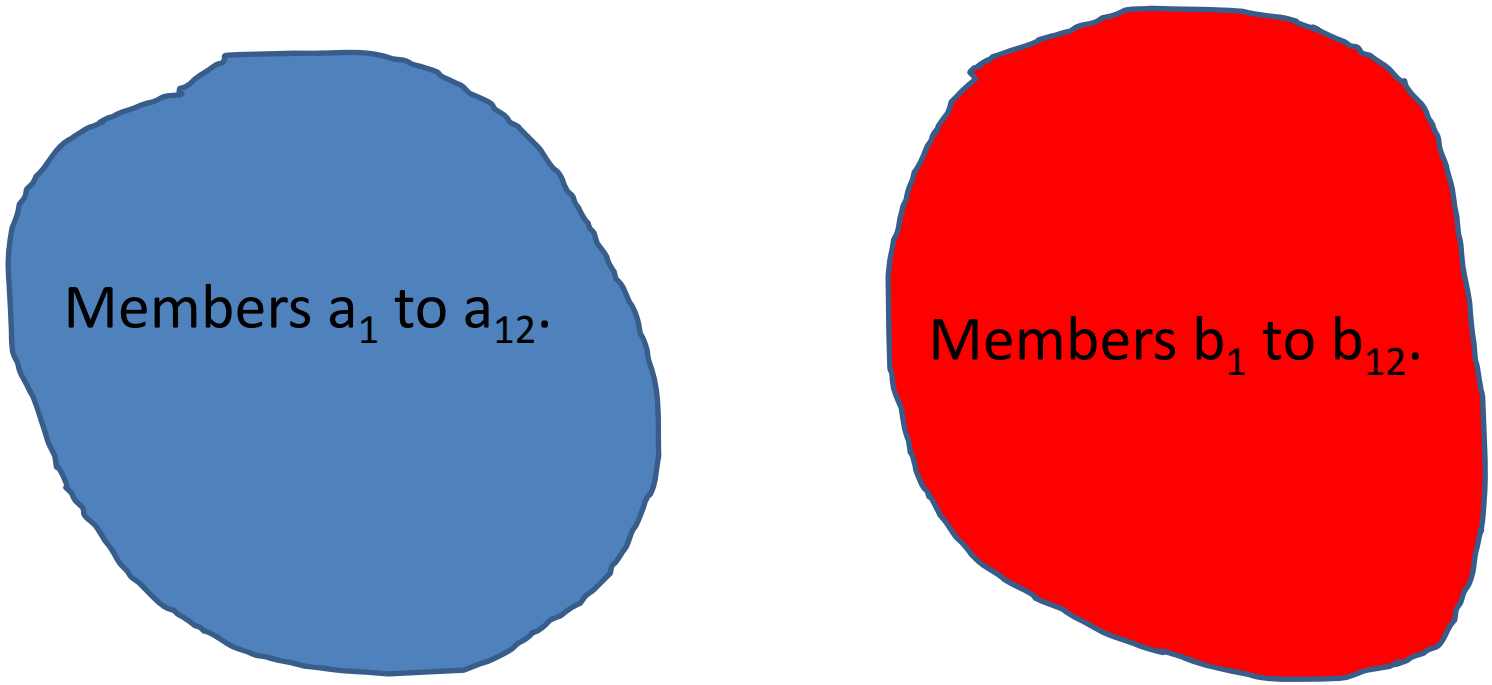
NCAR



NASA



Are these two models “the same”?



Two ensembles of 12 each, OR, 1 ensemble of 24?

Mean distance of members for T2m 1982-2010

lead	a_i vs a_j	b_i vs b_j	a_i vs b_j	number of pairs
0	3.5	3.2	3.2	132 132 144
1	3.4	3.6	3.4	132 132 144
2	3.1	3.3	3.2	132 132 144
3	2.8	2.6	2.7	132 132 144
4	3.3	3.3	3.4	132 132 144
5	3.2	3.3	3.3	132 132 144
6	3.2	3.0	3.1	132 132 144
7	2.8	2.6	2.7	132 132 144

Basically a and b do not seem different.
Same for prate and SST.

Concern in Real Time: The ensemble mean of these two models are too similar.

Mean correlation of members for T2m 1982-2010

lead	a_i vs a_j	b_i vs b_j	a_i vs b_j	number of pairs	a, b ensemble means
0	33.0	42.6	41.4	132 132 144	96.9
1	17.8	14.4	18.4	132 132 144	79.9
2	15.4	8.0	11.1	132 132 144	59.0
….					
7	12.1	9.1	10.8	132 132 144	60.0

Indeed 12 member ensemble means of essentially the same model look very much alike.

The power of the ensemble mean as filter!
Convergence to …the signal…as seen by the model.

How does a distributed system work?

- Voluntary, and because of a strong wish to do it.
- Both at outlying centers, and at NCEP.
- Outlying centers must see a benefit
- NCEP must see a benefit (talk to CPC forecasters)
- New to NCEP
- Will it be sustained? And how?
- Operational, or “experimental”- operational.
- A strong research component (all data can be downloaded)
- A strong real time component for CPC

Issues

- What happened in real time? Aug 2011 forward
- Live Performance in Yr 1, Yr 2 and Yr 3.
- Bias error *
- Role of soil moisture *
- Prediction and Predictability *
- The upward trend in SST and T2m*
- Model diversity vs more members*

* Worthy of papers

Can the experience be applied to other areas?

- Intra-seasonal MME and phase II (‘daily’ data)

IMME= CFS+ EUROSIP MODELS

	NCEP/CFSv2	ECMWF	UKMET	MFRANCE
Atmospheric Model	T126L64	Syst 4: T255L91	Glosea4 (120km) L85	Syst 4 (ARPEGE) T127 (160km) L31
Ocean Model	MOM4 L40 0.25 deg Eq, 0.5 deg global	NEMO 0.3 deg Eq 1 deg global	NEMO L75 0.3 deg Eq 1 deg global	ORCA .5 deg Eq 2 deg global
Atmosphere/Ocean Coupling Frequency	30 minutes	3 hr	IN	IN
Land Model	NOAH 4-layer	IN	IN	ISBA (Interaction Soil Biosphere Atmosphere)
Sea Ice Model	3-layer interactive Seaice model	IN	IN	IN
Period of Hindcasts	1982-2010 (29 years)	1981-2011 (30 years)	1989-2002 (14 years)	1991-2011 (21 years)
Number of hindcast members	24(28)	15	12	15
Operational Ensemble Size	40	51	42	51
Number of Leads	0-9 months	0-7 months	0-6 months	0-7 months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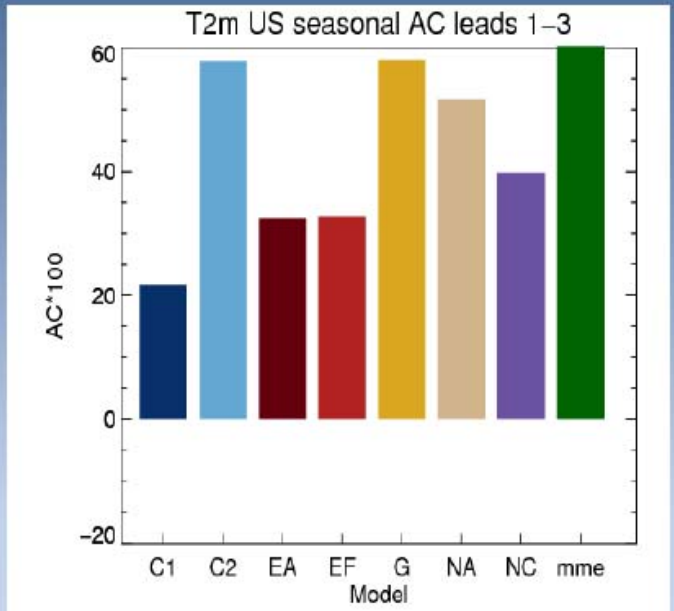
Extras

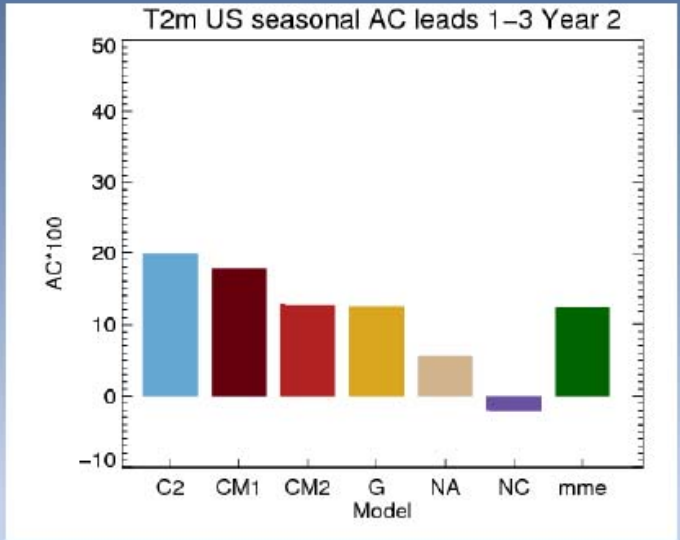
RT verification: CONUS

Year 1

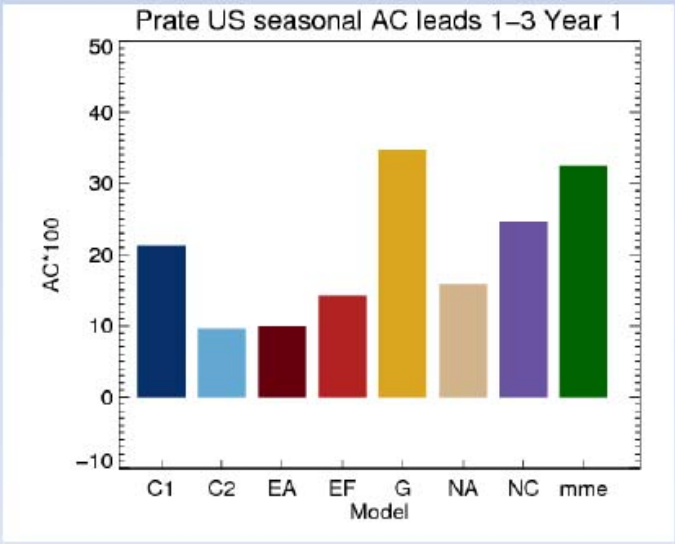
Year 2

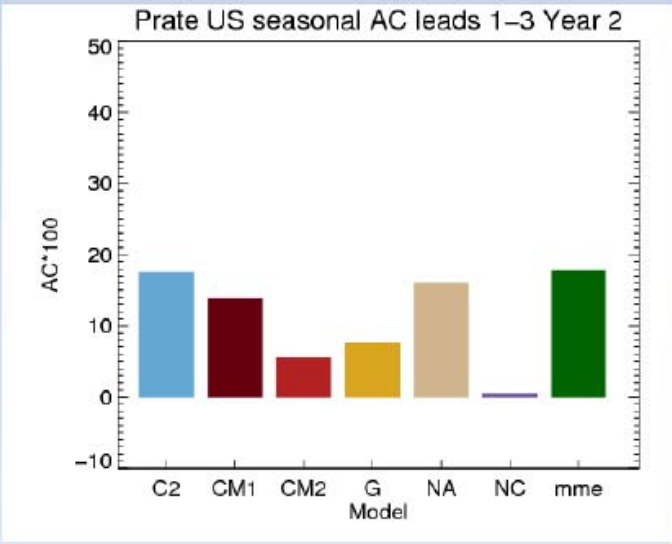
T2m





Prate





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