Homogeneous and Heterogeneous Predictability and Forecast Skill in MME

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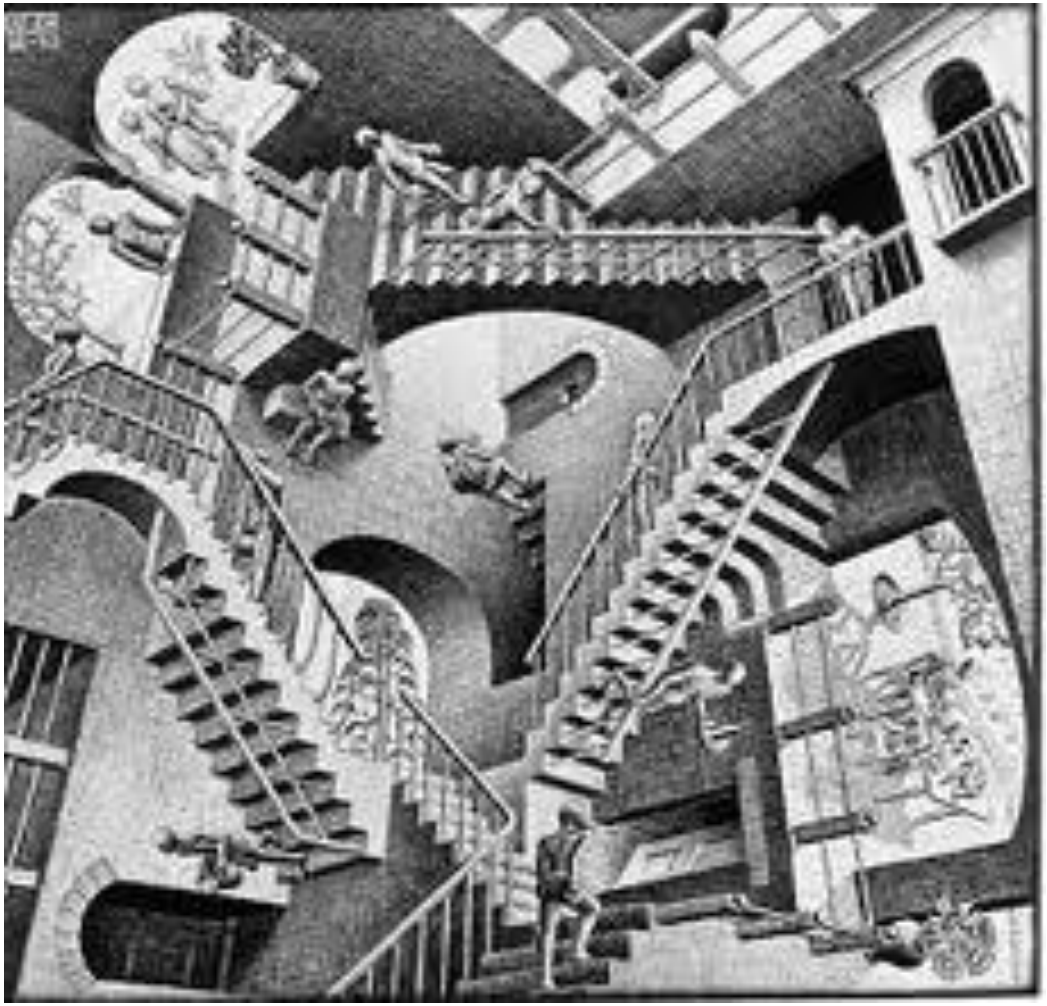


Maurits Escher

Hindcast Situation YEAR 1

	Start months available NOW	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

- Real Time “Year 1” was August 2011 – July 2012.

  NMME was always delivered on time. No small achievement!.

- Real Time Year 2 has already started: August 2012 thru October 2012.

Hindcast Situation YEAR 2

Model resident Resolutions

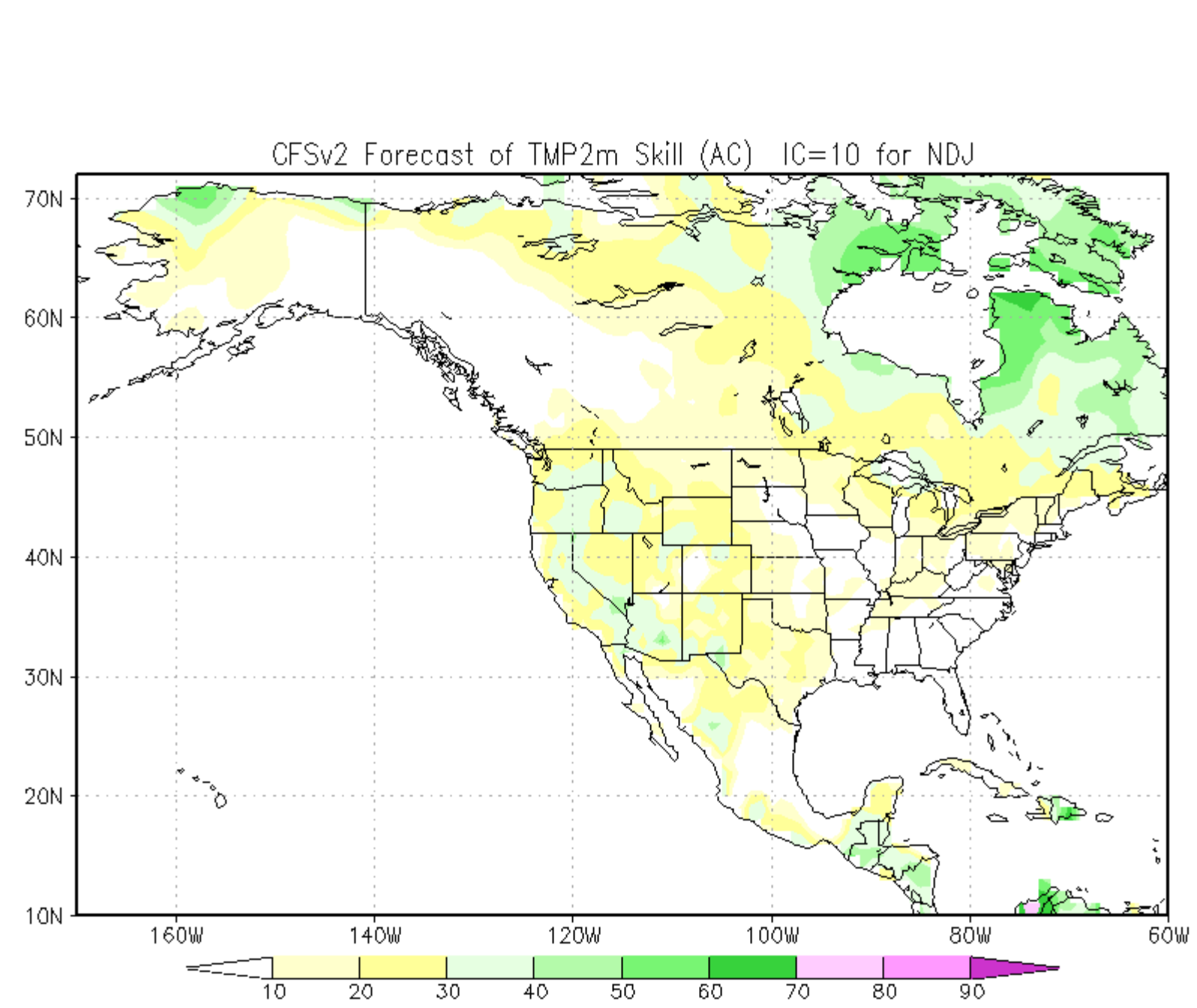
	Start months available NOW	Period	Members	Arrangement of Members	Lead (months)	Atmosphere	Ocean	Reference	
NCEP-CFSv1	12	1981-2009	15	1st 0Z +/-2days, 11th 0Z+/-2d, 21st 0Z+/-2d	0-9	T62L64	MOM3L40 0.30 deq Eq	Saha et al 2006	NCEP-CFSv1
NCEP-CFSv2	12	1982-2010	24(28)	4 members (0,6,12,18Z) every 5th day	0-9	T126L64	MOM4 L40 0.25 deg Eq	Saha et al 2010	NCEP-CFSv2
GFDL-CM2.1	3	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	3	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	3	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	3	1981-2010	6	1 member every 5th day as CFSv2	0-9	1x1.25deg L72	MOM4 L40 1/4 deg at Eq	Rienecker et al 2008	NASA

We lost two models, we gained two models, GFDL and NASA changed model, one more model is riding into the sunset.

Anomaly Correlation

- Prediction Skill: One Model's EM vs OBS.

  (EM stands for Ensemble Mean)
- Homogeneous Predictability: One Model's EM (based on N-1 members) vs the one member left out.
- Heterogeneous Predictability: One model's EM (based on N members) vs one member of another model.
- AC has been calculated for a large area (land), and many leads and all starts combined.


CFSv2 Forecast of TMP2m Skill (AC) IC=10 for NDJ
70N
60N
50N
40N
30N
20N
10N
160W
140W
120W
100W
80W
60W
10
20
30
40
50
60
70
80
90

Remember

- Predictability of the 1st and 2nd kind?
- Identical twins. Fraternal twins ?

TMP2m Northern Hemisphere Leads 1-3

	cfsv1	cfsv2	echama	echamf	gfdl	nasa	ncar	obs (EM skill)	EM RMSE (C)	*EM SD*
cfsv1 EM	0.19	0.08	0.05	0.06	0.07	0.09	0.04	0.06	2.07	*0.814*
cfsv2 EM	0.09	0.27	0.09	0.08	0.16	0.19	0.01	0.19	1.98	*0.772*
echama EM	0.04	0.08	0.15	0.16	0.08	0.08	0.05	0.08	2.06	*0.765*
echamf EM	0.06	0.07	0.16	0.15	0.08	0.08	0.05	0.07	2.07	*0.760*
gfdl EM	0.06	0.14	0.07	0.06	0.25	0.15	0.01	0.15	2.08	*1.050*
nasa EM	0.07	0.14	0.07	0.05	0.15	0.27	0.00	0.14	2.06	*0.933*
ncar EM	0.03	0.01	0.04	0.04	-0.01	0.00	0.12	-0.01	2.24	*1.071*
singmem & obs SD	*2.280*	*2.086*	*2.128*	*2.086*	*2.367*	*1.991*	*2.263*	*2.143*		

Conclusions I

T2m, NH land 23N-75N, 1982-2010. All start months, leads 1-3 combined, No CV

1. Prediction Skill (AC) varies from -0.01 to +0.19

2. Predicted sd(of EM) ~ .75-1C, which is much smaller than verifying SD (2-2.4C) for individual realization.

3. Point 2 is a matter of taking the ensemble mean (EM), some sqrt(N) damping of noise while retaining alleged signal.

4. All models have about the right interannual sd (near 2C)! Not over or under-done. This is high praise, and very different from underdispersive reputation as per Demeter.

5 Homogeneous predictability (no CV required) ranges from 0.12 to 0.27. This is higher than skill reported in item 1 (0-0.19) but not hugely so.

6 For those who like high (homogeneous) predictability, there is not much to pick from among the 7 opinions.

Conclusions II

7. Heterogeneous predictability ranges from 0.00 to 0.19.
   Curiously this is already realized (item 1). Are better days ahead????

8. Symmetry by and large in "to predict" or "be predicted“

9. NCAR has a hard time predicting other models, or, be predicted by other models.
This is not bad in and of itself since we like orthogonal, but in this case.....

10. CFSv2, GFDL and NASA correlate the most to each other, AND,
    have the higher observed skill

11. The two IRI models predict each other,
   so maybe it is one ensemble of 24 as opposed to two ensembles of 12 each

12. In spite of shared pedigree CFSv1 and v2 do not predict each other very well.

About prate: -) all AC's are lower, but > 0 (less variation, greater dof than T2m),
-) homog: 0.06-0.15, heterog 0.01-0.06 (leaving IRI aside), obs skill 0.01-0.07

Closing comments

- Seven opinions of homogeneous predictability give some hope for improvement, once the systematic errors become zero.
- Forty two opinions of heterogeneous predictability give little hope for improvement.
- Tables for SST (NH), and Nino34 available (Much) more skill.
- Results for IMME are forthcoming (this contains a widely respected model).

For your one stop shopping for NMME and IMME products, visit

http://www.cpc.ncep.noaa.gov/products/NMME/

NEXT:

10:40-11:00 Emily Becker Evaluation of **Multi-Model Ensemble** System for Seasonal and Monthly Prediction

11:00-11:20 David Unger A Consolidated Seasonal Temperature Forecast based on the National **Multi-Model Ensemble**

11:20-11:40 Malaquias Pena **International Multi-Model Ensemble**: Products and Forecast Skill Assessments