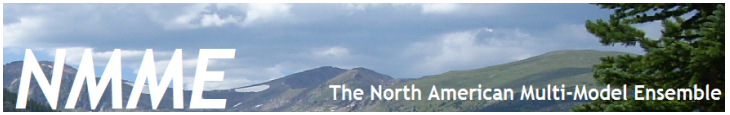


The North American Multi-Model Ensemble: Seasonal to Subseasonal Predictions

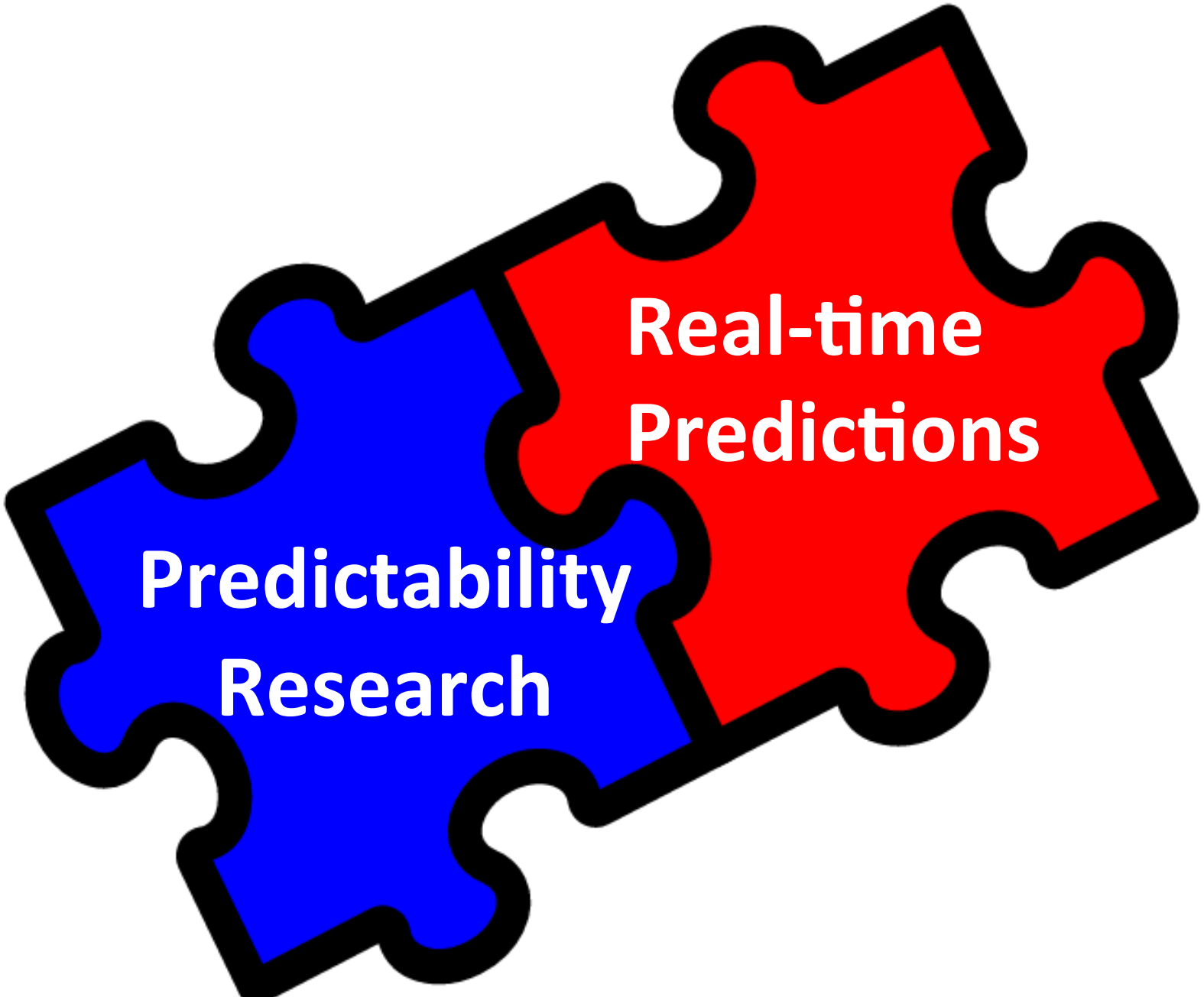
Kathy Pegion

George Mason University &

Center for Ocean-Land-Atmosphere Studies

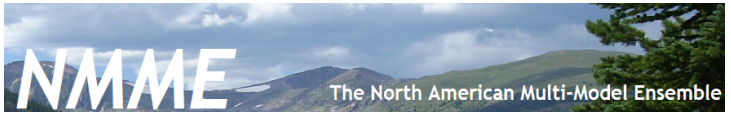
University of Miami
Ben P. Kirtman, Dughong Min, Johnna M. Infanti
GMU/COLA
James L. Kinter III, Daniel A. Paolino
NCEP
Qin Zhang, Huug van den Dool, Suranjana Saha, Malaquias Pena Mendez, Emily Becker, Peitao Peng, Patrick Tripp, Jin Huang
IRI
David G. DeWitt (now at NCEP), Michael K. Tippett, Anthony G. Barnston,
GFDL
Shuhua Li, Anthony Rosati, Gabe Vecchi
NASA/GMAO
Siegfried D. Schubert, Michele Rienecker, Max Suarez, Zhao E. Li, Jelena Marshak, Young-Kwon Lim
NCAR
Joseph Tribbia
NOAA/ESRL
Kathleen Pegion (now at COLA/GMU)
Environment Canada
William J. Merryfield, Bertrand Denis
Princeton
Eric F. Wood

What is the NMME?



What is the NMME?

- **Real-Time Seasonal Forecasts**
  - Model Updates (FLOR, CCSM4, CESM, CMC)
- **Coordinated Predictability Research**
  - Benefits of MM, Model Combinations, Inform Model Development and Applications
- **Development & Evaluation of a Subseasonal protocol**
  - Subseasonal Demonstration Experiment
  - Subseasonal Exploratory Workshop
  - Proposal to develop a subseasonal NMME
- **Data distribution**
  - Supporting Prediction/Predictability Research
  - Supporting Forecast Applications



Model	Hindcast Period	No. of Members	Arrangement of Members	Lead (month)	Model resolution (atmos)	Model resolution (ocean)	Reference
Active							
NCEP/CFSv2	1982-2010	24 (28)	4 members (0, 6, 12, 18z) every 5th day	0-9	T126L64	MOM4L40 .25deg Eq	Saha et al (2010)
GFDL/CM2.1	1982-2010	10	All 1st of the month 0Z	0-11	2x2.5degL24	MOM4L50 .3deg Eq	Delworth (2006)
GFDL/CM2.5 (FLOR)	1982-present	24	All 1st of the month 0Z	0-11	C18L32 (50km)	MOM5 L50 0.30 deg Eq 1degPolar1.5	Vecchi et al (2014)
CMC1-CanCM3	1981-2010	10	All 1st of the month 0Z	0-11	CanAM3 T63L31	CanOM4L40 .94deg Eq	Merryfield et al (2013)
CMC1-CanCM4	1981-2010	10	All 1st of the month 0Z	0-11	CanAM4 T63L35	CanOM4L40 .94deg Eq	Merryfield et al (2013)
NCAR/CCSM4	1982-2010	10	All 1st of the month 0Z	0-11	0.9x1.25degL26	POPL60 .25deg Eq	Kirtman et al. (in prep)
NASA/GEOS5	1981-2010	11	4 mems every 5 days; 7 mems on last day of last month	0-9	1x1.25 deg L72	MOM4L40 .25deg Eq	Vernieres et al (2012)
Retired							
NCEP/CFSv1	1982-2009	15	1st 0Z +/-2 days, 21st 0z +/-2d, 11th 0z +/-2d	0-8	T62L64	MOM3L40 0.30 deq Eq	Saha et al (2006)
NCAR/CCSM3	1982-2010	6	All 1st of the month 0Z	0-11	T85L26	POPL42 0.3deg Eq	Kirtman and Min2009)
IRI-ECHAM4f	1982-2010	12	All 1st of the month 0Z	0-7	T42L19	MOM3L25(1.5x0.5)	DeWitt (2005)
IRI-ECHAM4a	1982-2010	12	All 1st of the month 0Z	0-7	T42L19	MOM3L25 (1.5x0.5)	DeWitt (2005)
Planned							
NCAR/CESM1	1982-2010	10	All 1st of the month 0Z	0-11	0.9x1.25degL30	POPL60 .25deg Eq	Tribbia et al.

Climate Prediction Center
Kathy
www.cpc.ncep.noaa.gov/products/NMME/seasanom.shtml
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NMME Forecasts of Monthly Climate Anomalies for

October 2015 - April 2016

NMME Forecasts of Monthly Climate Anomalies Home

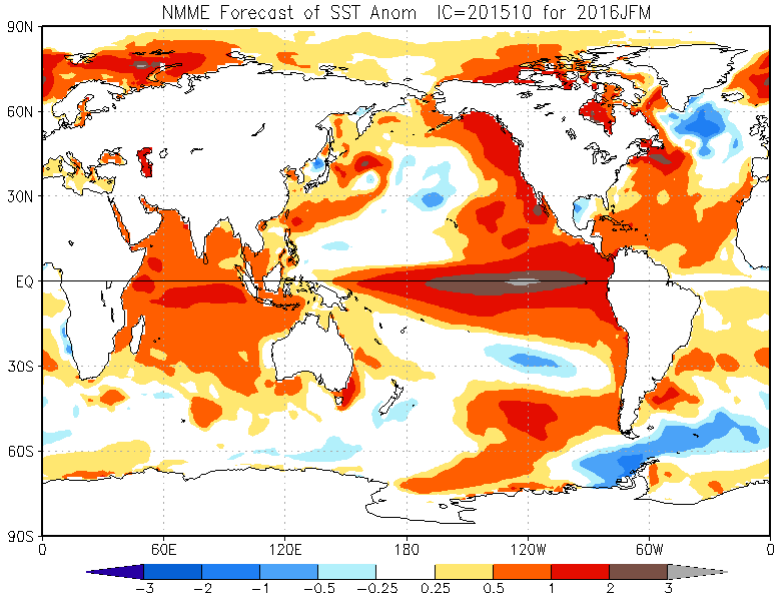
View Forecasts by Model

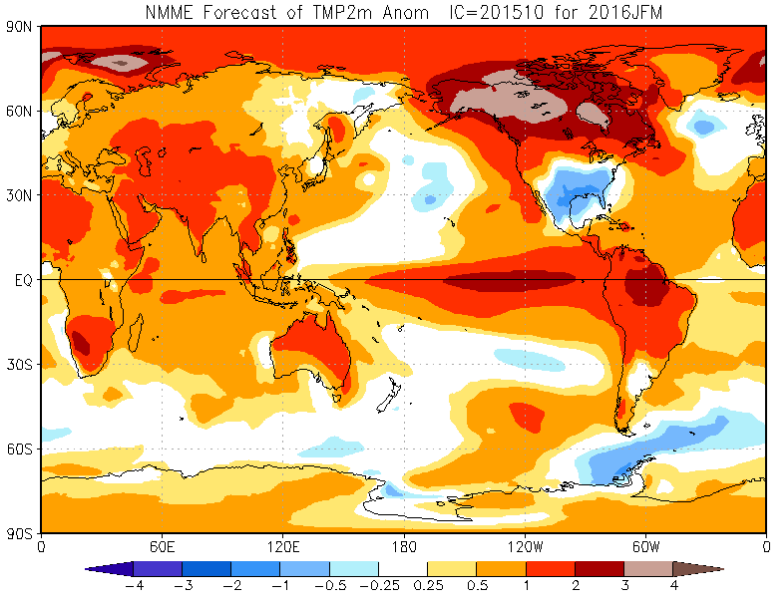
Three-month mean spatial anomalies					
	Season 1	Season 2	Season 3	Season 4	Season 5
Global SST					
Global prate					
Global tmp2m					
US prate					
US tmp2m					

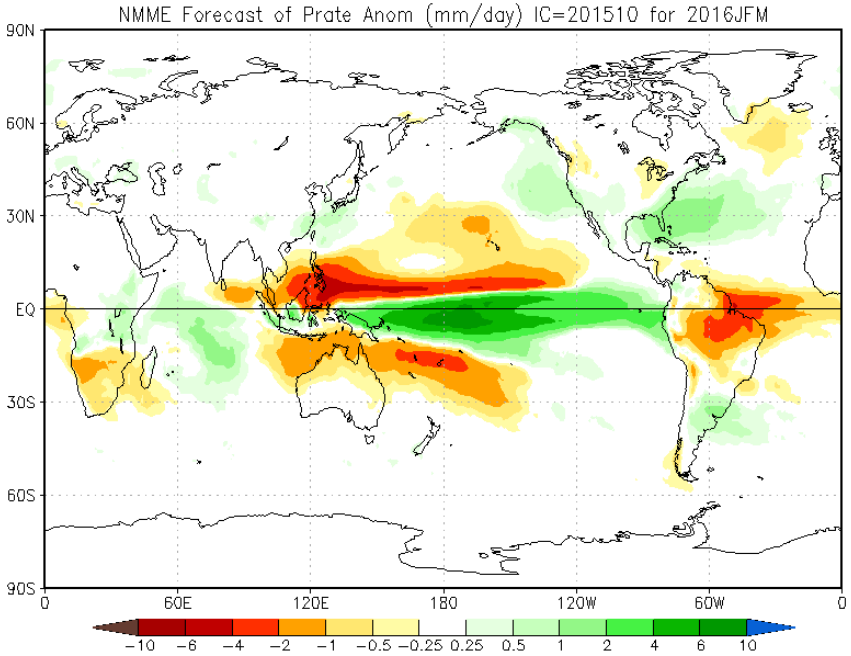
Skill maps for 3-month means					
	Season 1	Season 2	Season 3	Season 4	Season 5
Global SST					
Global prate					
Global tmp2m					
US prate					
US tmp2m					

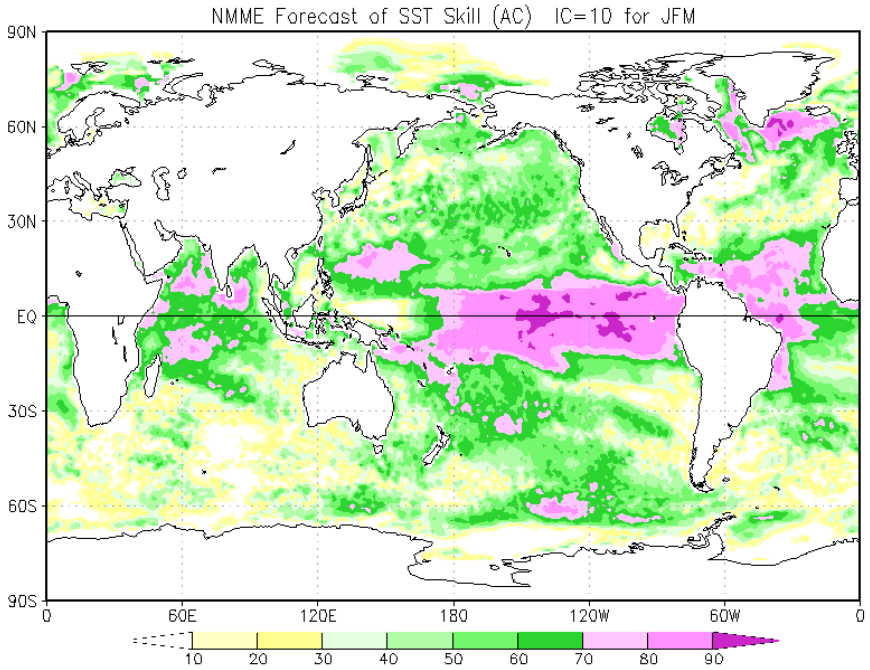
Anomalies with Skill Masks Applied

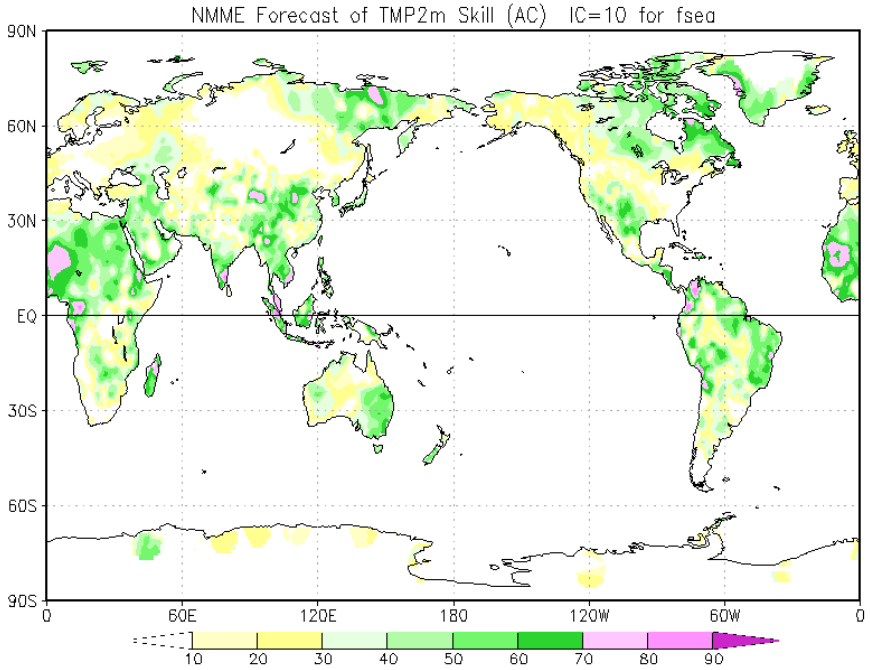
Real-Time Seasonal Forecasts








NMME Forecast of SST Skill (AC) IC=10 for JFM
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
10
20
30
40
50
60
70
80
90


NMME Forecast of TMP2m Skill (AC) IC=10 for fsea
90N
60N
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EQ
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90S
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120W
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80
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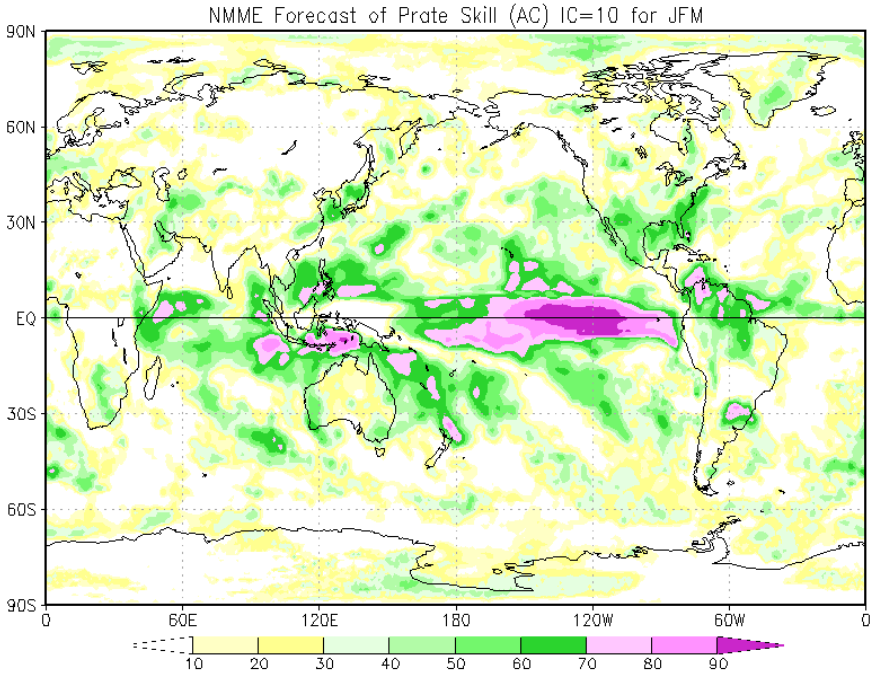
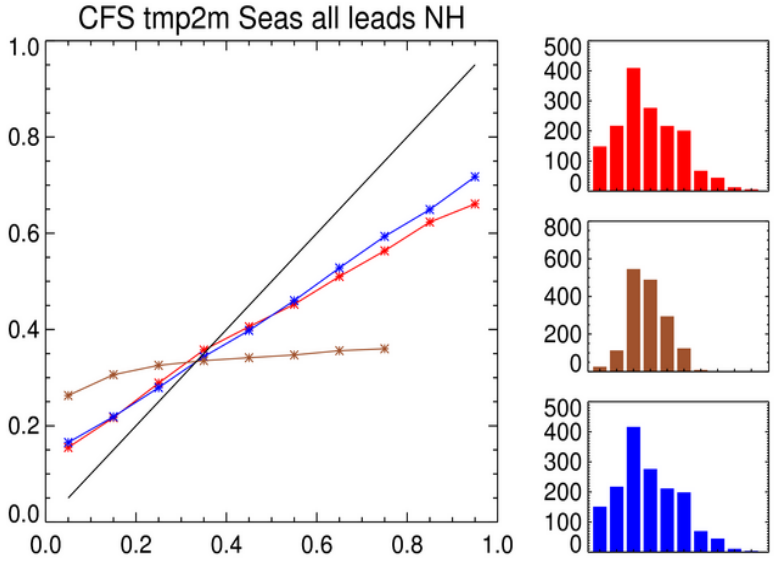
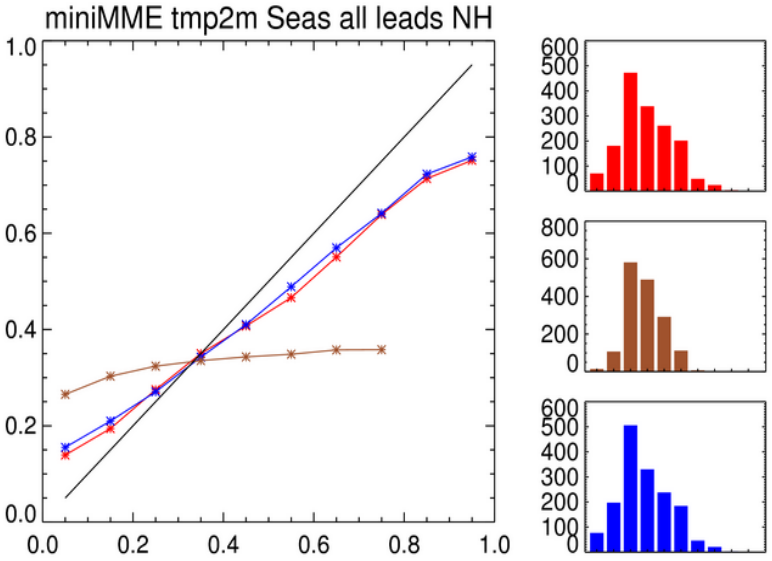
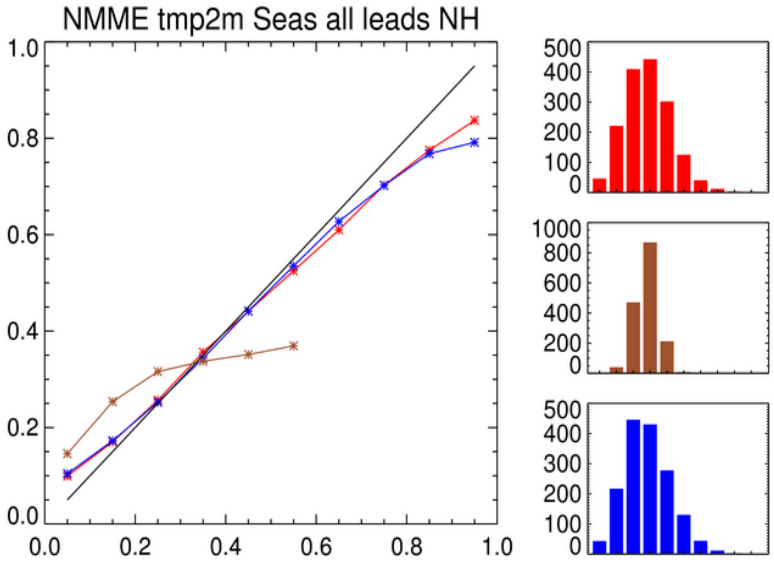

NMME Forecast of Prate Skill (AC) IC=10 for JFM
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
10
20
30
40
50
60
70
80
90

Model Diversity is Enhancing Quality







Emily Becker (NCEP)

Brier Skill Score for T2m Northern Hemisphere Extra-tropics Land (23N-75N)

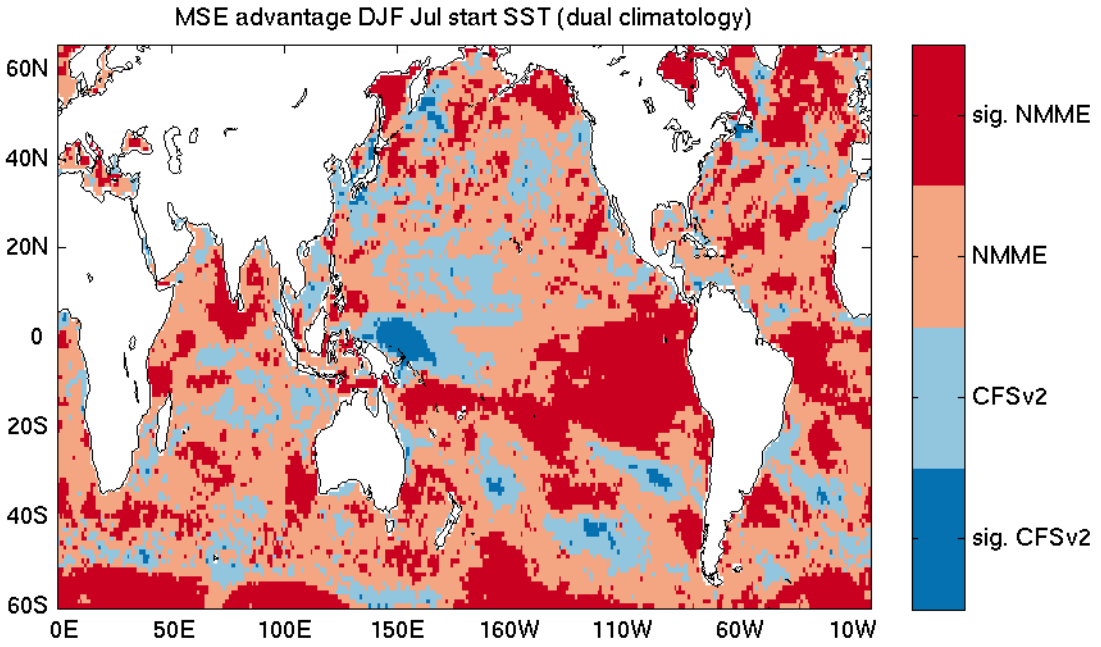
	A/N/B	Lead 0	Lead 1	Lead 2	Lead 3	Lead 4	Lead 5
CFS (24 Members)	Above	0.10	0.03	0.01	0.01	0.01	0.01
	Normal	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04
	Below	0.10	0.04	0.03	0.02	0.02	0.02
Mini-NMME (24 Members)	Above	0.12	0.05	0.03	0.03	0.02	0.02
	Normal	-0.02	-0.04	-0.04	-0.04	-0.04	-0.04
	Below	0.11	0.05	0.04	0.03	0.03	0.03
Full NMME	Above	0.14	0.07	0.06	0.06	0.05	0.05
	Normal	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
	Below	0.14	0.08	0.06	0.06	0.06	0.05

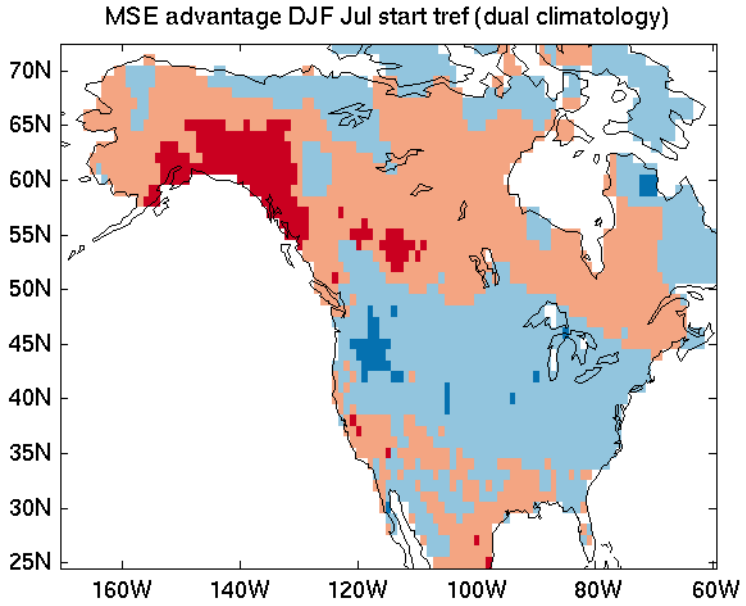
Brier Skill Score for Nino3.4

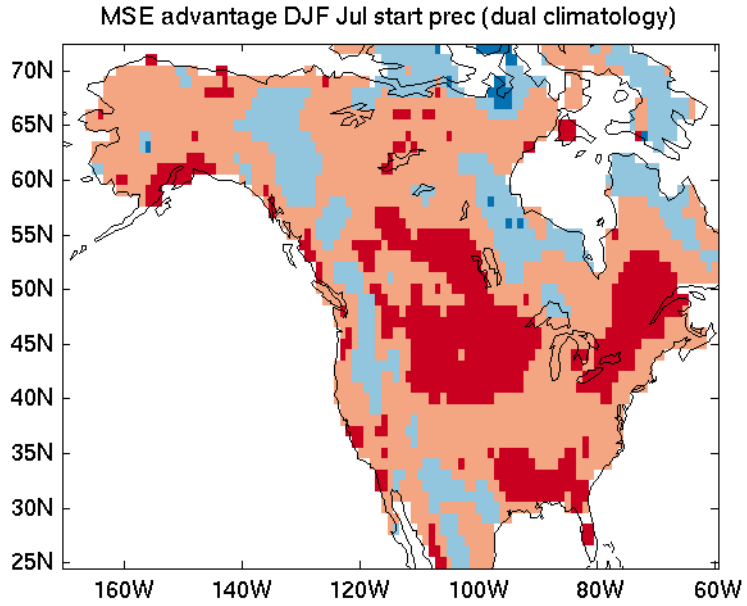
	A/N/B	Lead 0	Lead 1	Lead 2	Lead 3	Lead 4	Lead 5
CFS (24 Members)	Above	0.54	0.45	0.39	0.33	0.28	0.25
	Normal	0.10	0.05	0.03	0.03	0.03	0.02
	Below	0.49	0.43	0.40	0.38	0.36	0.35
Mini-NMME (24 Members)	Above	0.68	0.60	0.55	0.48	0.42	0.37
	Normal	0.34	0.24	0.18	0.15	0.13	0.09
	Below	0.66	0.59	0.56	0.53	0.49	0.45
Full NMME	Above	0.68	0.61	0.55	0.49	0.43	0.38
	Normal	0.35	0.25	0.19	0.16	0.14	0.11
	Below	0.65	0.58	0.54	0.52	0.49	0.46

Emily Becker (NCEP)

Mean Squared Error Sign Test







Tim DelSole (GMU/COLA)

dataset: Models NMME

iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/

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Data Library: Models NMME

Language: english

Description | Expert Mode

served from IRI/LDEO Climate Data Libr

SOURCES > Models > NMME

Models NMME

Models NMME from SOURCES: the IRI/LDEO collection of climate data.

Documents

overview	an outline showing sub-datasets of this dataset
CTB home	Climate Test Bed
NMME Home	Information about the NMME project

Semantic Documents

auxinfo.owl

Datasets and Variables

CMC1-CanCM3	Models NMME CMC1-CanCM3[**FORECAST HINDCAST**]
CMC2-CanCM4	Models NMME CMC2-CanCM4[**FORECAST HINDCAST**]
COLA-RSMAS-CCSM3	Models NMME COLA-RSMAS-CCSM3[**MONTHLY**]
COLA-RSMAS-CCSM4	Models NMME COLA-RSMAS-CCSM4[**MONTHLY**]
CPC-CMAP	Models NMME CPC-CMAP[**prate**]

IRI Data Library

- Monthly data
- All Models
- Subset of variables (8)

2m temperature
Precipitation
SST
Tmin
Tmax
Z200
Soil moisture
runoff

dataset: Models NMME CO

iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/.COLA-RSMAS-CCSM4/.MONTHLY/

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Models NMME COLA-RSMAS-CCSM4 MONTHLY

Models NMME COLA-RSMAS-CCSM4 MONTHLY from SOURCES: the IRI/LDEO collection of climate data.

Documents

outline	an outline showing all sub-datasets and variables contained in this dataset
data availability	

Datasets and Variables

canopy evaporation	Models NMME COLA-RSMAS-CCSM4 MONTHLY evap[X Y I M L S]
Geopotential Height (above sea level)	Models NMME COLA-RSMAS-CCSM4 MONTHLY gz 200 hPa[X Y I P M L S]
Total Precipitation	Models NMME COLA-RSMAS-CCSM4 MONTHLY prec[X Y I M L S]
surface runoff + sub-surface drainage + surface runoff at glaciers, wetlands, lakes	Models NMME COLA-RSMAS-CCSM4 MONTHLY runoff[X Y I M L S]
merely sum of soil liquid water over levels	Models NMME COLA-RSMAS-CCSM4 MONTHLY soilw[X Y I M L S]
Sea Surface Temperature	Models NMME COLA-RSMAS-CCSM4 MONTHLY sst[X Y I M L S]
Time	Models NMME COLA-RSMAS-CCSM4 MONTHLY T[S L I]
Reference Temperature	Models NMME COLA-RSMAS-CCSM4 MONTHLY tref 2.0 m[X Y I Z M L S]
Minimum surface temperature over output period	Models NMME COLA-RSMAS-CCSM4 MONTHLY tsmn 2.0 m[X Y I Z M L S]
Maximum surface temperature over output period	Models NMME COLA-RSMAS-CCSM4 MONTHLY tsmx 2.0 m[X Y I Z M L S]

Project: NMME
Kathy
https://www.earthsystemgrid.org/project/nmme.html
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Project: NMME

Summary *Edit*

Description: The US National Multi-Model Ensemble (NMME) is an experimental multi-model seasonal forecasting system consisting of coupled models from US modeling centers including NOAA/NCEP, NOAA/GFDL, IRI, NCAR, NASA, and Canada's CMC.

When using the NMME data please cite the BAMS article describing the project (Kirtman et al. 2014) and in the acknowledgements please note that the NMME project and data dissemination is supported by NOAA, NSF, NASA and DOE. Please also acknowledge the help of CPC, IRI and NCAR personnel in creating, updating and maintaining the NMME archive.

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

Child Datasets

8860 entries

project=NMME, model=CanCM4, experiment=19880701, time_frequency=day, modeling realm=atmos

project=NMME, model=NCAR Community Climate System Model, CCSM version 4, experiment=20100101, time_frequency=mon, modeling realm=atmos

project=NMME, model=FLORB-01, experiment=19971001, time_frequency=mon, modeling realm=atmos

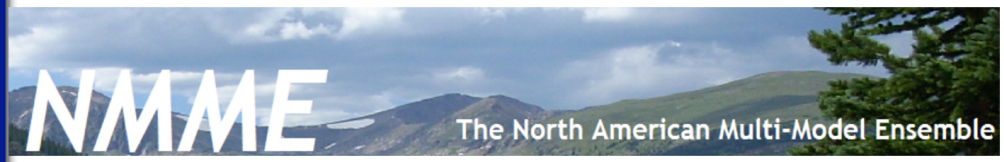
project=NMME, model=NCAR Community Climate System Model, CCSM version 4, experiment=19970201, time_frequency=day,

More information

National Weather Service
Climate Prediction Center

Home | Site Map | News | Organization | Search | Go

HOME > NMME Forecasts of Monthly Climate Anomalies



Welcome to the North American Multi-Model Ensemble home!

3-month mean spatial anomalies
1-month mean spatial anomalies

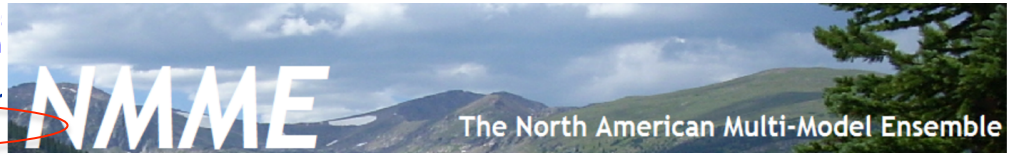
Niño3.4 Plumes
International MME
Experimental: Probability forecasts
Preview: additional variable
Real-time verification (prelimin

NMME Realtime Forecasts **Arch**
***** Data Access *****

About the NMME
Join the NMME mailing lis

For additional information, contact Qin Zhang (**Qin.Zhang@noaa.gov**) c
(**Emily.Becker@noaa.gov**)

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



NMME Data Access

Phase-I hindcasts
Phase-II data

Real-time forecast anomalies
Real-time probabilistic forecasts
Model hindcast climatologies
CPC International Desk
Seasonal forecast and hindcast in CPT format

User's Guide
Send a question

When using the NMME data, *please cite the BAMS article describing the project (Kirtman et al. 2014) and in the acknowledgements please note that the NMME project and data dissemination is supported by NOAA, NSF, NASA and DOE. Please also acknowledge the help of NCEP, IRI and NCAR personnel in creating, updating and maintaining the NMME archive. Thank you.*

For additional information, contact Qin Zhang (**Qin.Zhang@noaa.gov**) or Emily Becker (**Emily.Becker@noaa.gov**)

A Subseasonal Demonstration Experiment

Limited scope re-forecast experiment

Demonstrate Potential for MJO Prediction with NMME

1. 1999-2012
2. Initialization Dates: November only on the 2nd, 7th, 12th, 17th, 22th, 27th, following the CFSv2rr dates
3. 45-days
4. Ocean and atmosphere initialized; land initialization is strongly encouraged, but not required
5. The method of initialization is left up to the modeling group
6. Number & method of perturbations/ensemble members is left up to the modeling group (at least 3 recommended).
7. Daily means: SST, U200, U850, OLR, Precip, MSLP, Z200

Models

NCEP-CFSv2
NASA-GMAO
U. Miami/NCAR-CCSM4

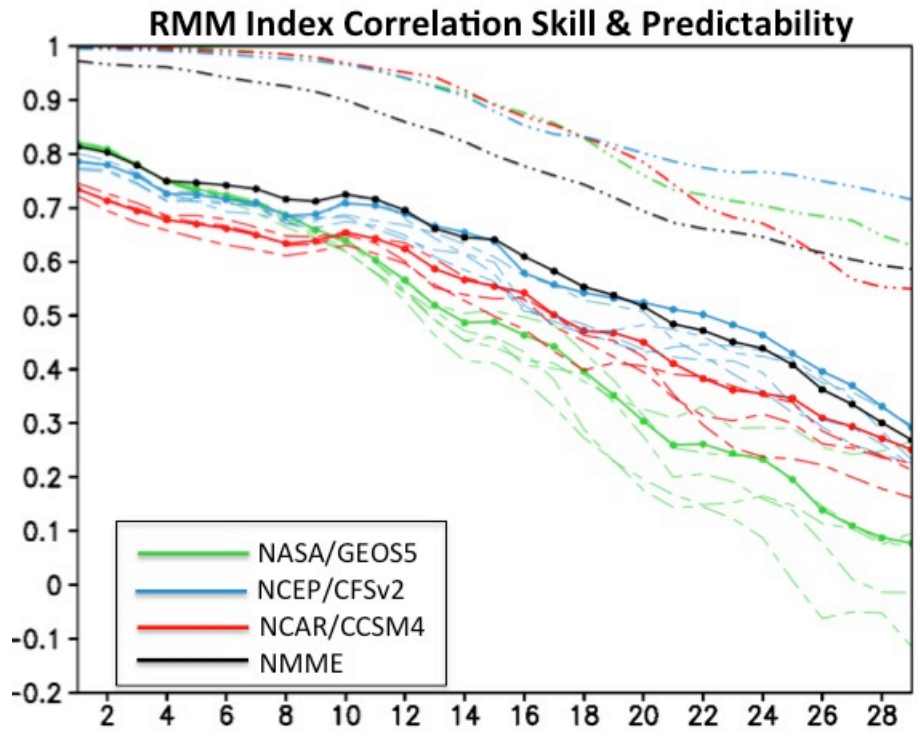
Data

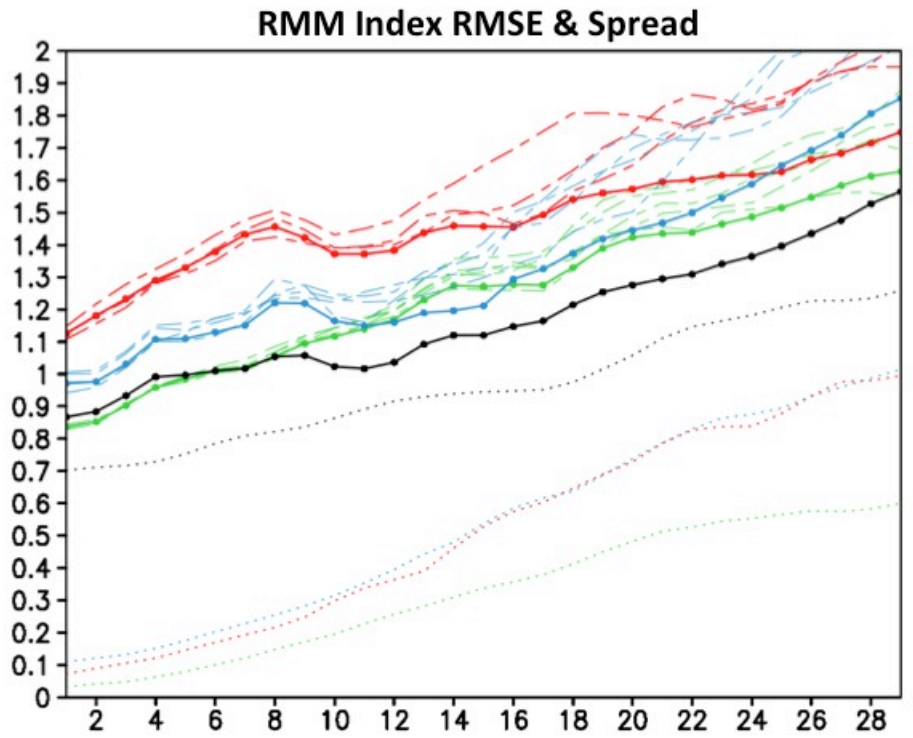
COLA made available via ftp to NMME subseasonal team

Metrics

RMM index skill & predictability

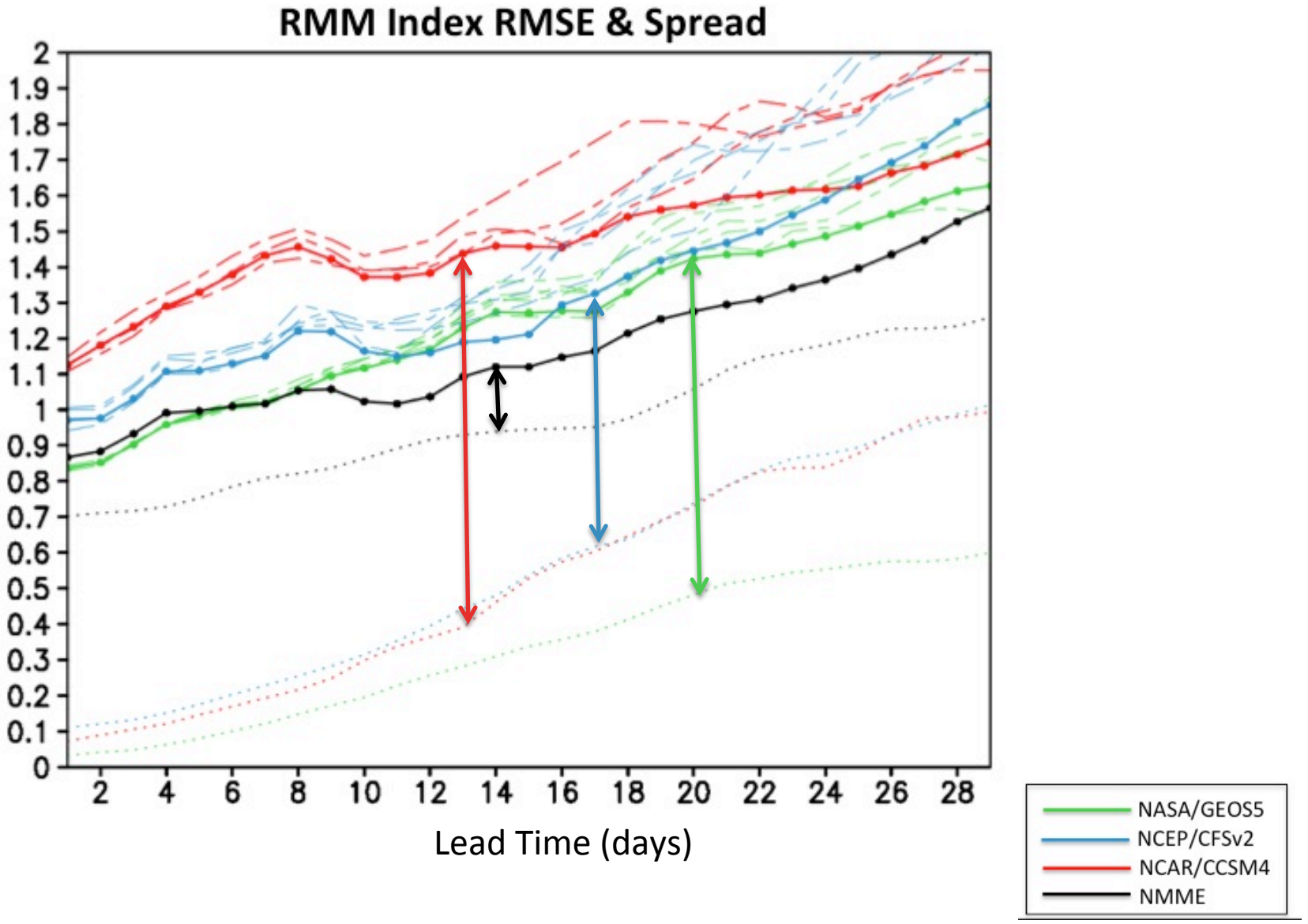
A subseasonal NMME can take advantage of differing model skill at different lead-times



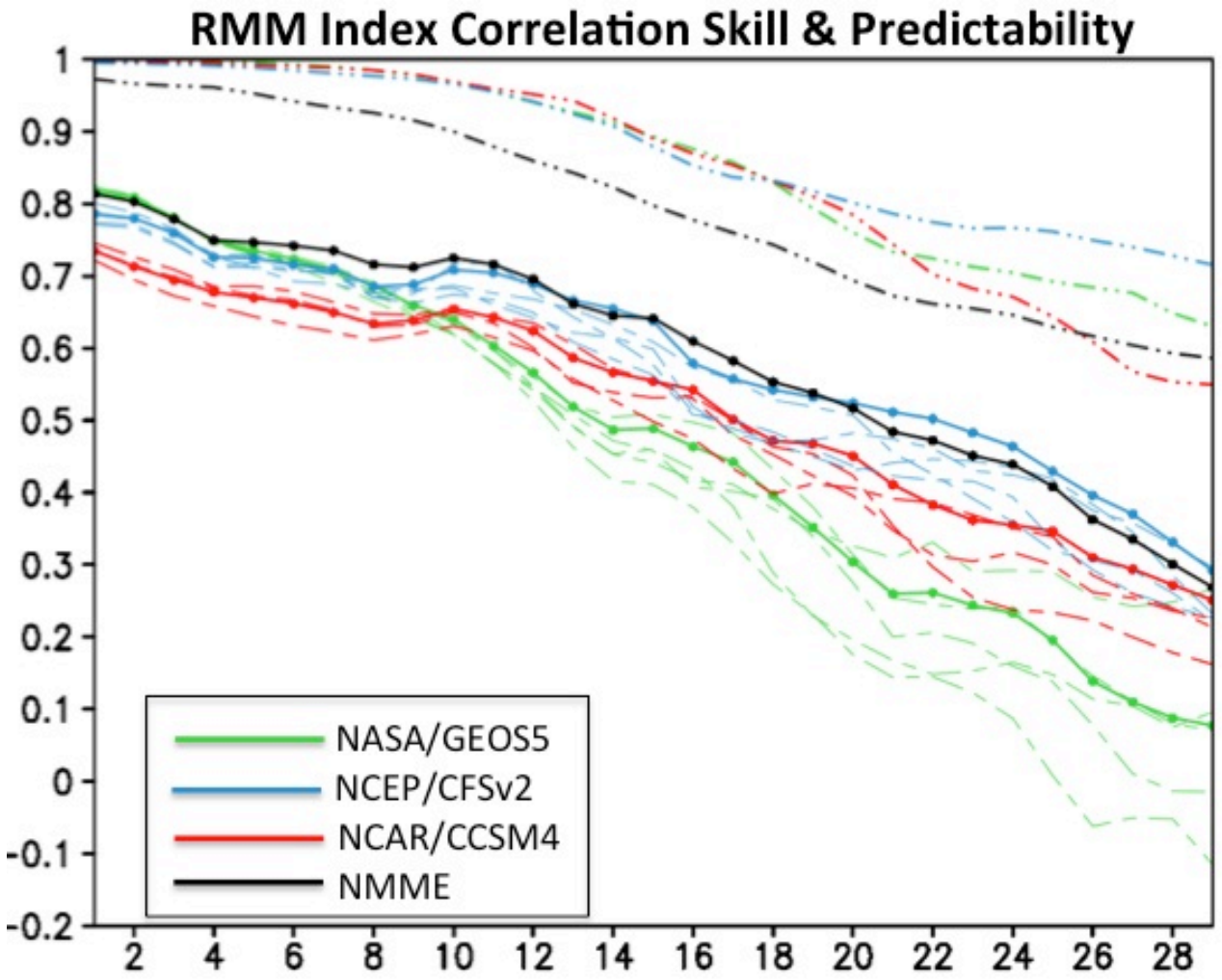


Lead Time (days)

A subseasonal NMME better represents the relationship between ensemble spread & error



A subseasonal NMME can provide understanding of predictability limits



Perfect Model Skill

Actual Skill

1. There is a evidence for a potential benefit for subseasonal NMME

2. This is a very limited experiment, so the benefit cannot be rigorously assessed.

3. We have barely scratched the surface by looking at one source of predictability.

4. Need to assess benefit for other sources of predictability/ phenomena, operational forecasting, and applications.

This will require a more substantial re-forecast experiment designed to look like an operational forecast system

NMME Subseasonal Exploratory Workshop

Meeting Objectives

- Assess current operational sub-seasonal prediction practice and skill and ongoing sub-seasonal system development at NCEP and other centers nationally and internationally.

- Assess the sources of sub-seasonal predictability based on broad research and analysis including that of NMME data.

- Improve understanding of operational requirements to help assess sub-seasonal prediction system requirements and feasibility characteristics.

- Identify research priorities, pathways and experiments to help design an NMME sub-seasonal forecast system.

- Coordinate with WCRP/WWRP S2S Prediction Project efforts.

Outcome

Subseasonal NMME re-forecast and real-time forecast protocol

http://www.nws.noaa.gov/ost/CTB/Documents/Protocol_Subseasonal_NMME.pdf

Important aspects of Protocol

- Re-forecast and forecast model must be the same
- Coupled ocn-atm or atm-only
- Re-forecast period 1999-2015
- Minimum of 4 ensemble members
- Minimum 32-day forecasts (45 preferred)
- Once a week initialization
- Atm, ocean (if applicable), and land must be initialized
- 19 daily fields + tmax & tmin will be archived
- 6 daily fields will be provided to NCEP by 5pm ET every Wed
- All ensemble members must be provided
- Total fields must be provided

What is the NMME?