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CHFP2: A coupled multi-seasonal forecast system for Canada

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Louis-Philippe Crevier, Lewis Poulin (CMC)**

WMO Global Producing Centres for Long-Range Forecasts

GPC	System Configuration.	Atmospheric Model Resolution	Hindcast Period	Year of Implementation
Washington, NCEP	Coupled	T126/L64	1982-2010	Summer 2011
ECMWF	Coupled	T255/L92	1981-2010	Late Fall 2011
Montreal, CMC	Coupled	2 Models T63/L31 T63/L35	1981-2010	Late Fall 2011
Tokyo, JMA	Coupled	T95/L40	1979-2008	2010
Exeter, Met Office	Coupled	1.875x1.25/L38	1981-2002	2009
Toulouse, Météo-Fr	Coupled	T63/L91	1997-2007	2008
Beijing, BCC	Coupled	T63/L16	1983-2004	2005
Melbourne, BoM	Coupled	T47/L17	1980-2006	2002
Montreal, CMC	2-tier	4 Models	1969-2004	2007 to be retired in 2011
Seoul, KMA	2-tier	T106/L21	1979-2007	1999 ?
Cachoeira Paulista, CPTEC	2-tier	T62/L28	1979-2001	2009
Moscow, HMC	2-tier	1.1x1.4/L28	1979-2003	2007
Pretoria, SAWS	2-tier	T42	1982-2001	2007



Environment Canada's Current Multi-Seasonal Forecasts



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Temperature and Precipitation Deterministic Forecasts

Current Temperature and Precipitation Deterministic Forecasts

Period	1-3 month	2-4 month	4-6 month	7-9 month	10-12 month
Temperature	Map List	Map List	Map List	Map List	Map List
Precipitation	Map List	Map List	Map List	Map List	Map List

Dynamical
2-Tier

Statistical
CCA

Temperature and Precipitation Probabilistic Forecasts

Current Temperature and Precipitation Probabilistic Forecasts

Period	1-3 month	2-4 month
Temperature	Maps Reliability	Maps Reliability
Precipitation	Maps Reliability	Maps Reliability



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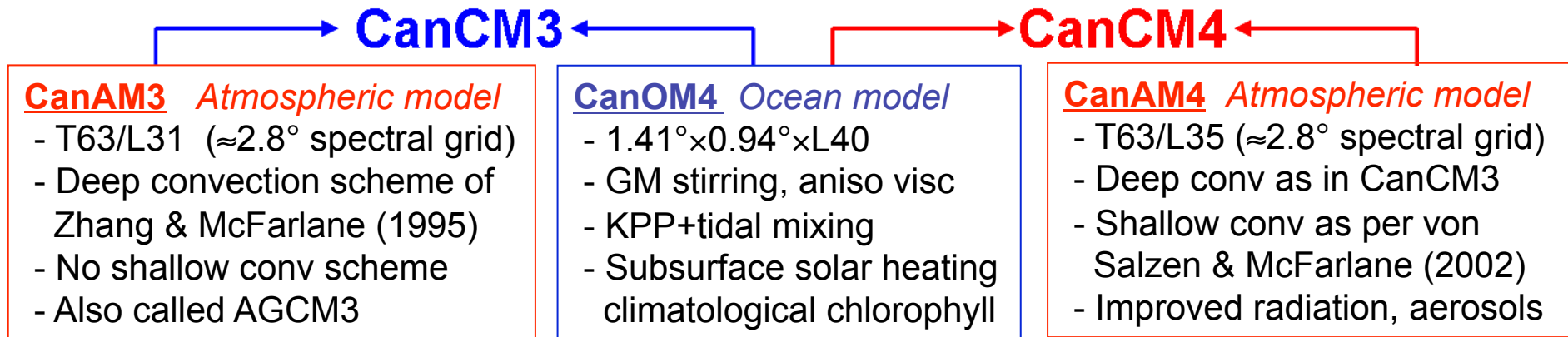
CHFP2 development

CHFP2 = “Coupled Historical Forecasting Project, phase 2”

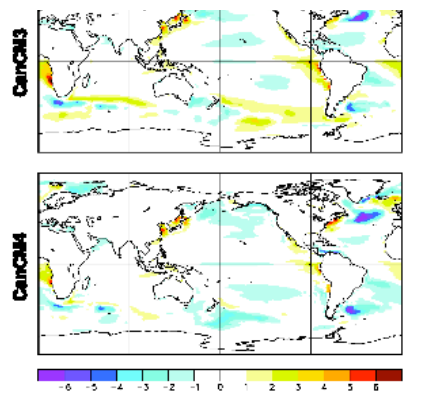
- 2006 Funding from Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
- 2007-2008 CHFP1 pilot project (existing AR4 model, simple SST nudging initialization)
- 2008-2009 Model development leading to CanCM3/4, CHFP2 initialization development
- 2009-2010 CHFP2 hindcast production
- 2011 CHFP2 operational implementation



CHFP2 Models



SST bias vs OISST 1982-2009



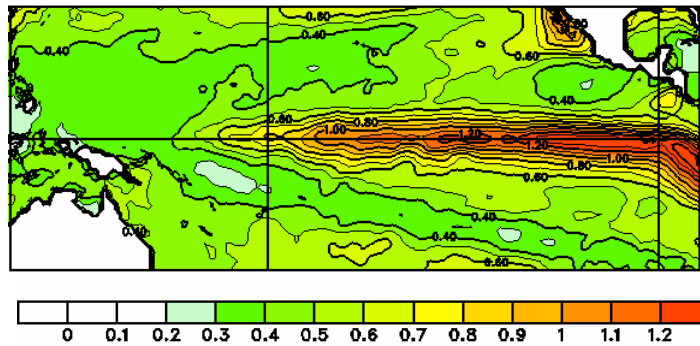
°C

°C

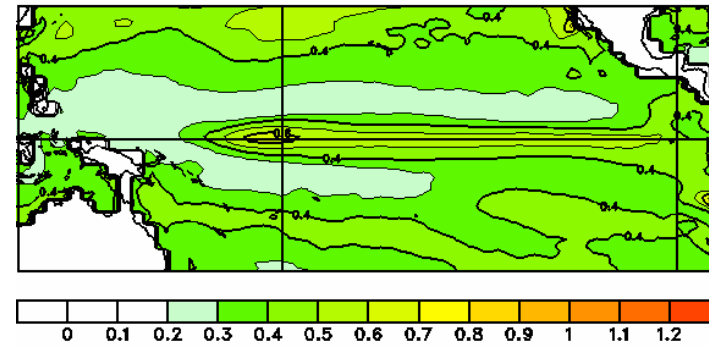
ENSO variability in models

Monthly SSTA standard deviation

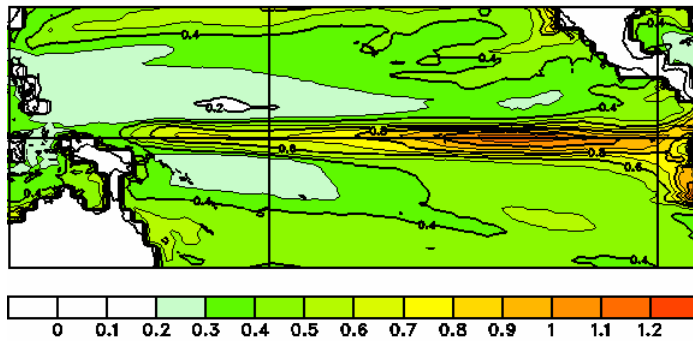
HadISST 1970-99



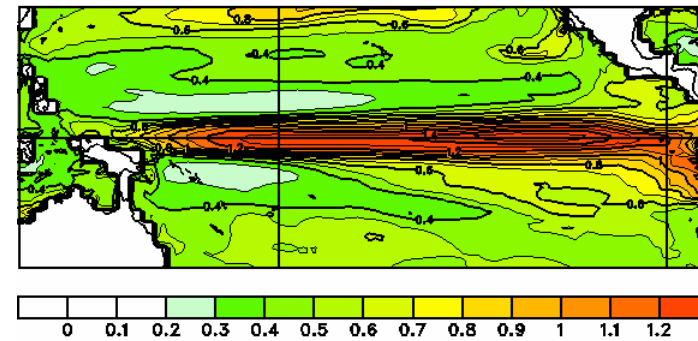
CGCM3.1 IPCC AR4, CHFP1



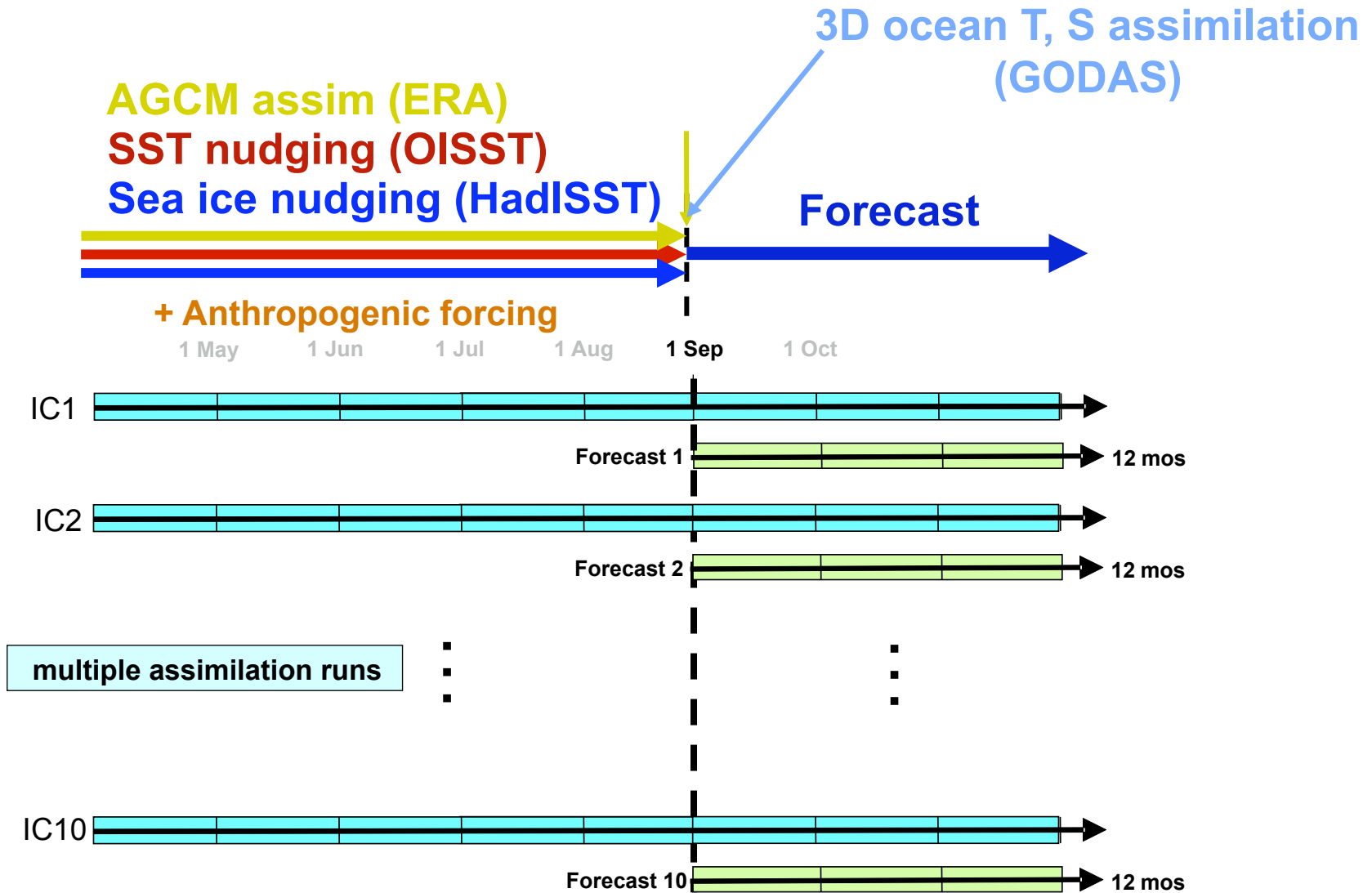
CanCM3 CHFP2



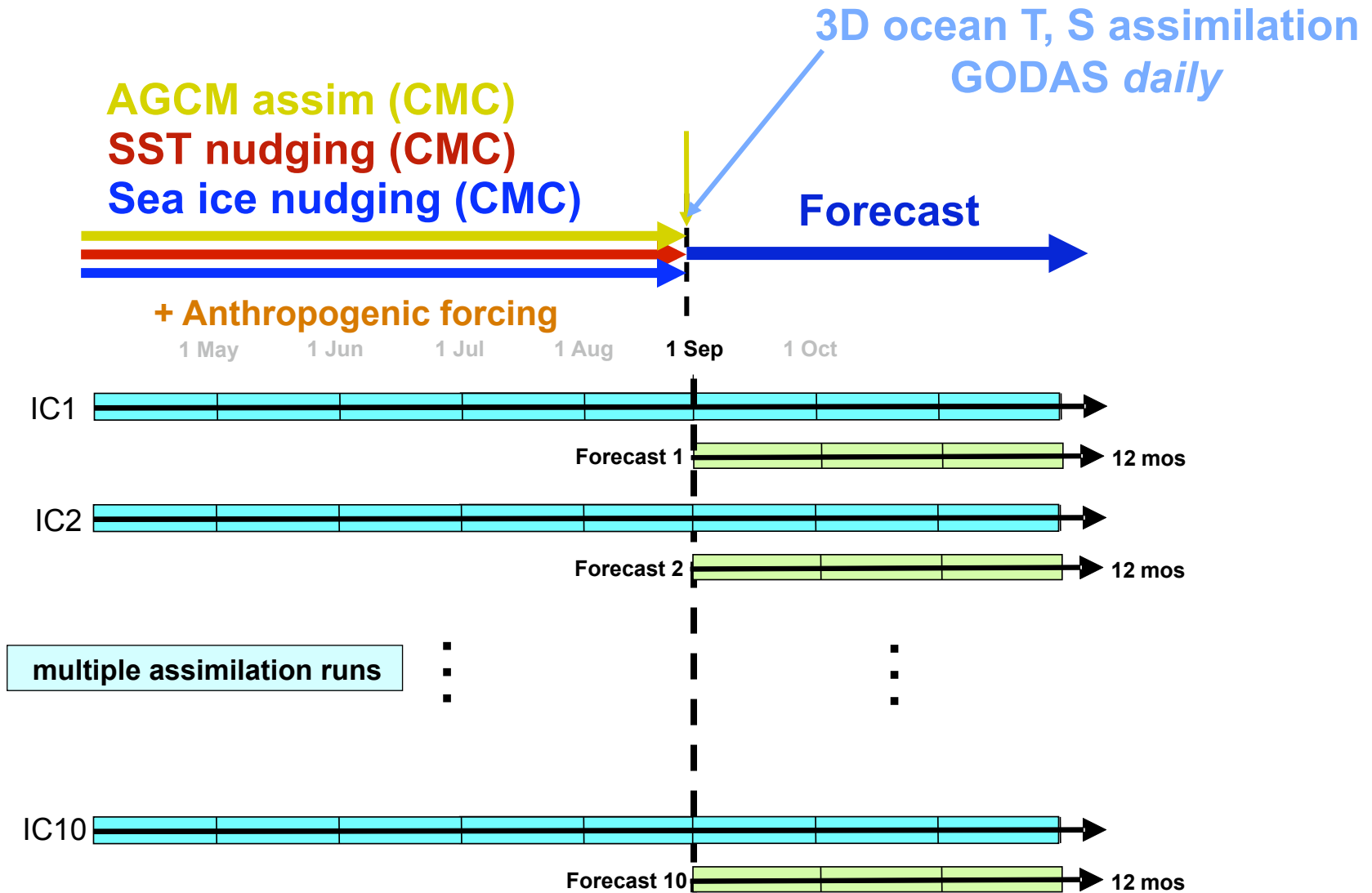
CanCM4 CHFP2



CHFP2 hindcast initialization



CHFP2 operational initialization

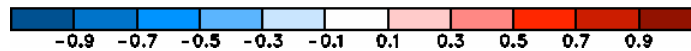
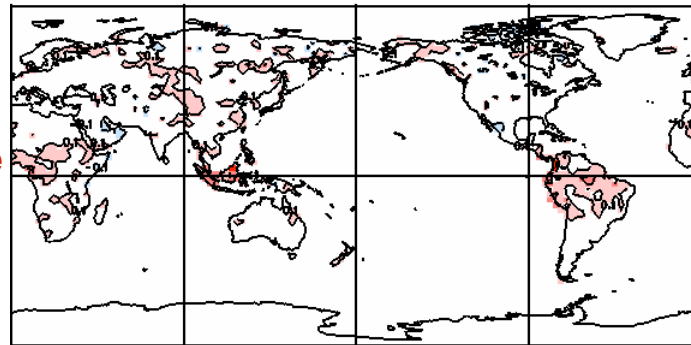


Benefits of coupled atmospheric assimilation: Improved land initialization

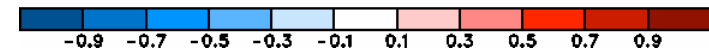
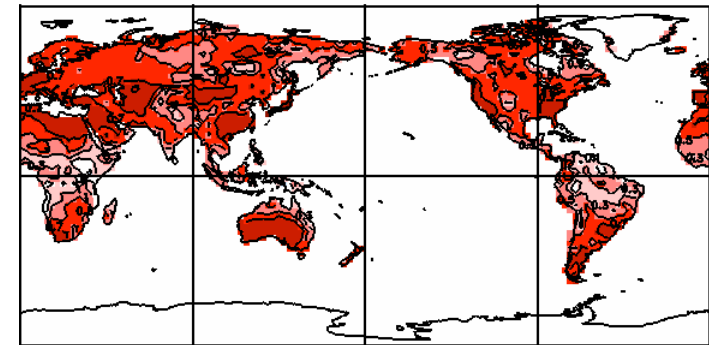
Correlation of assimilation run vs offline analysis

Soil temperature
(top layer)

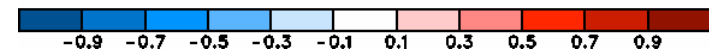
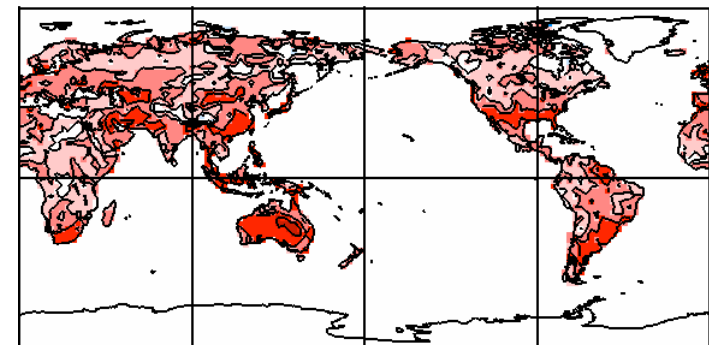
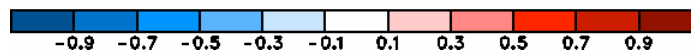
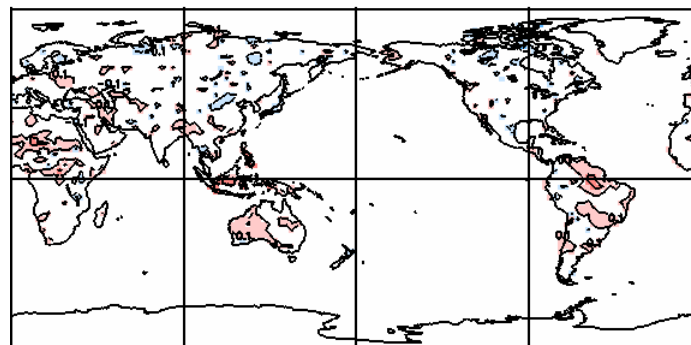
SST nudging only



SST nudging + atmospheric assim

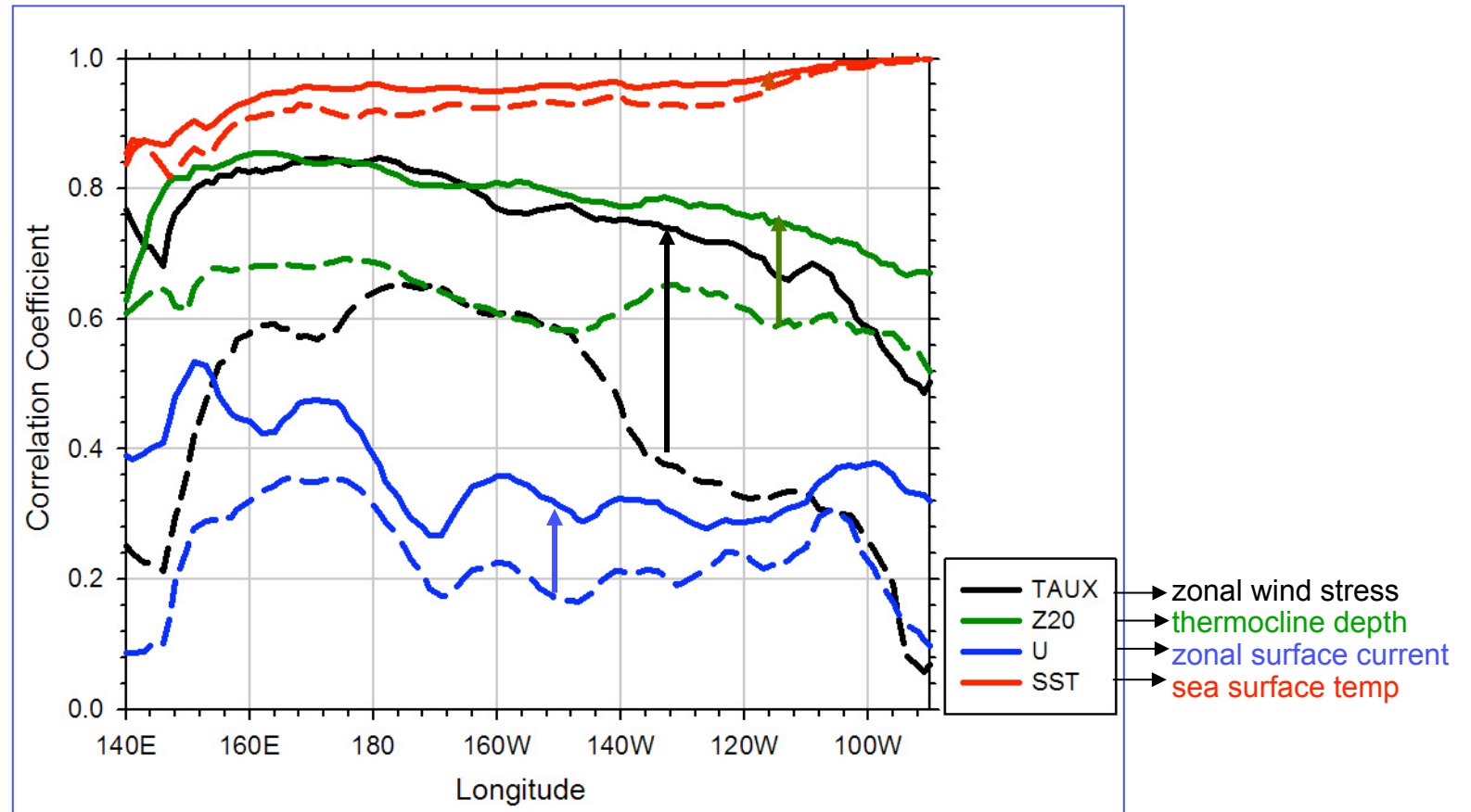


Soil moisture
(top layer)



Benefits of coupled atmospheric assimilation: Improved ocean initialization

Correlations vs obs in equatorial Pacific (5S→5N)



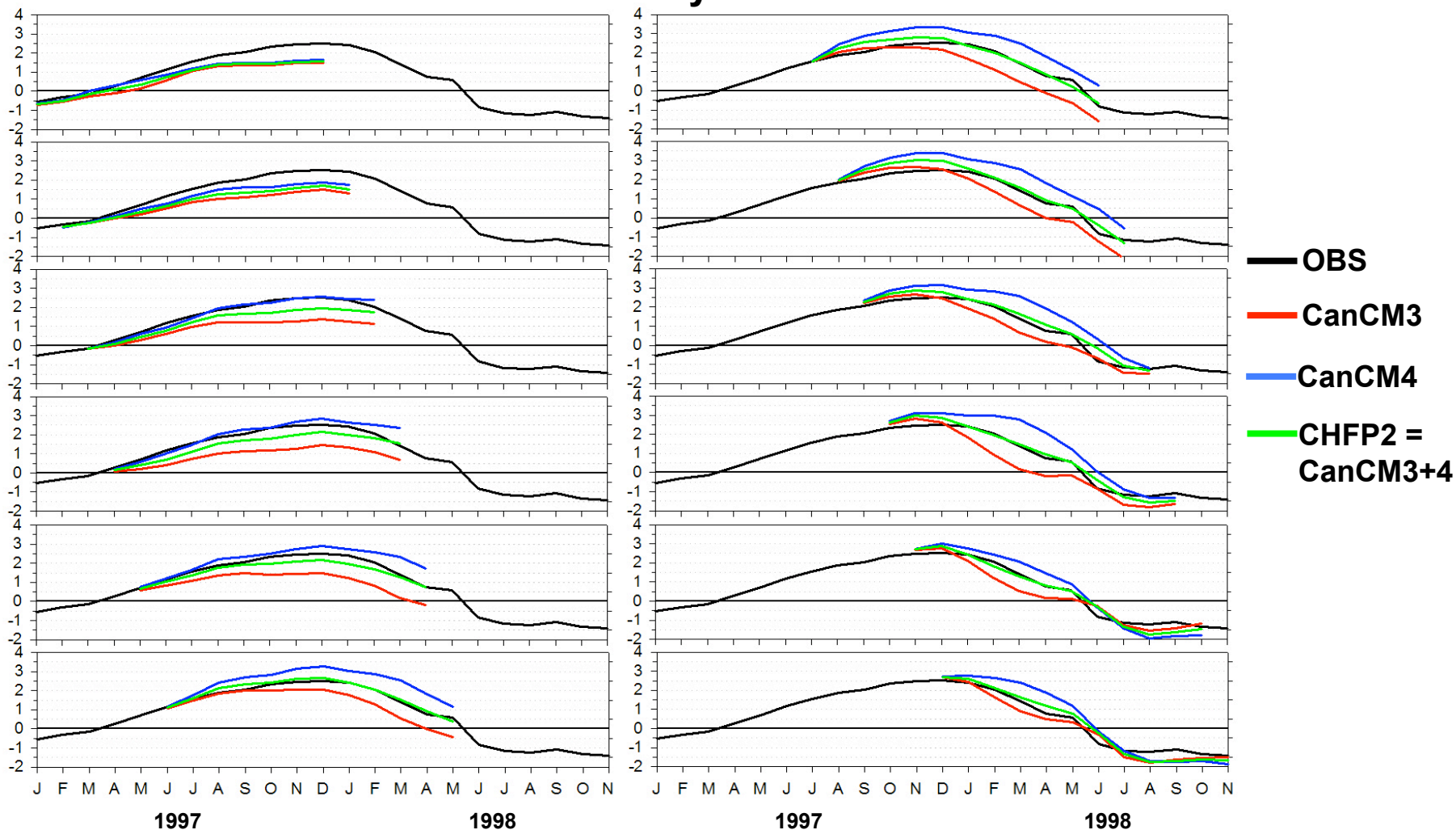
———— SST nudging + atmos assim - - - - - SST nudging only



ENSO Skill

Case Study: 1997-98 El Niño

Niño3.4 hindcasts initialized monthly from 1 Jan 1997 to 1 Dec 1997



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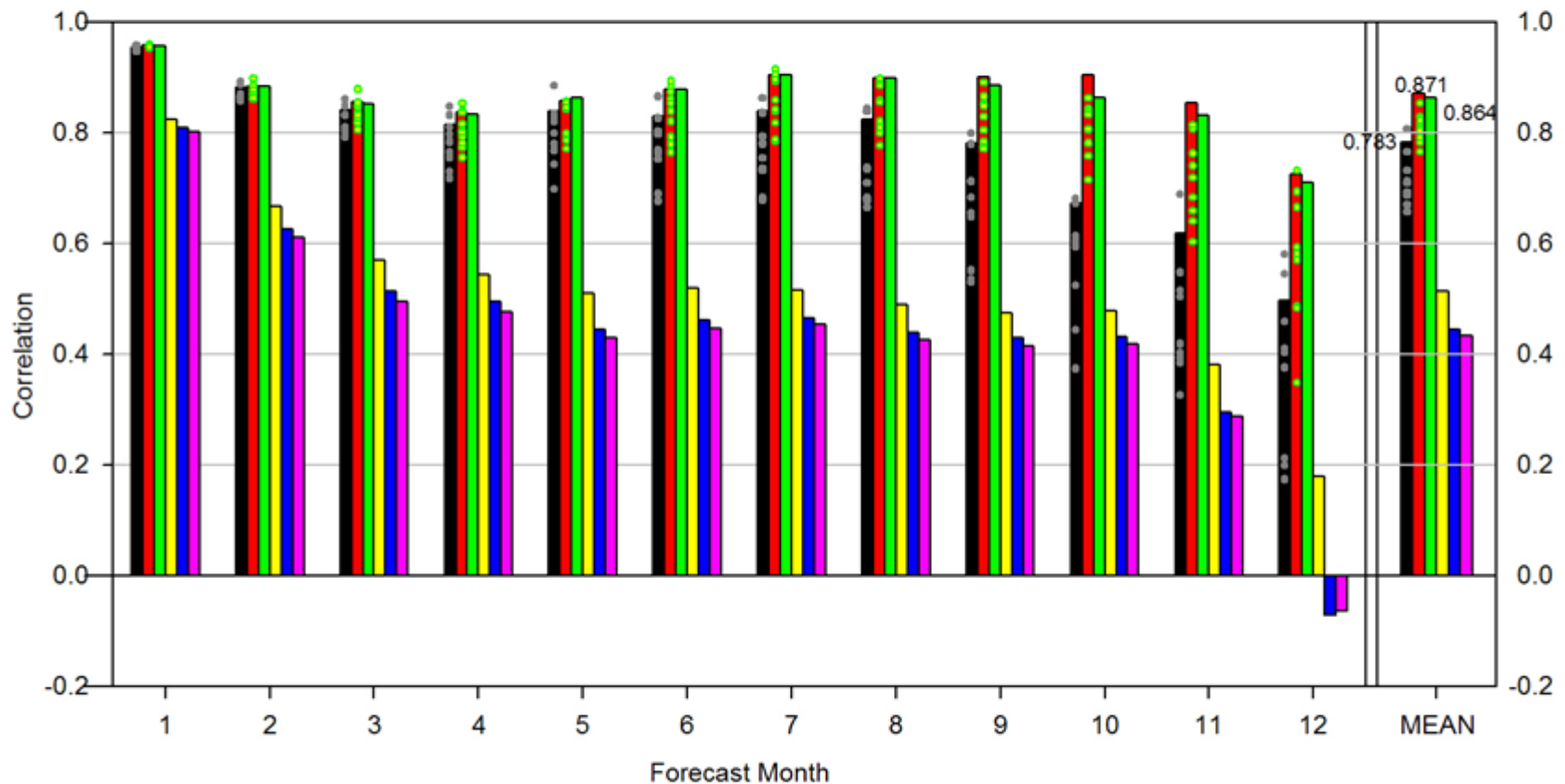
Nino3.4 Anomaly Correlation Skill

Ensemble Forecasts
 Initialization
 1 June 1979-2008
 ERSST/OISST verification

CanCM3
 CanCM4
 CanCM3+4
 Persistence

 } Damped persistence

$-1 \leq AC \leq 1$
 $=1$ perfect fcst
 $=0$ clim fcst



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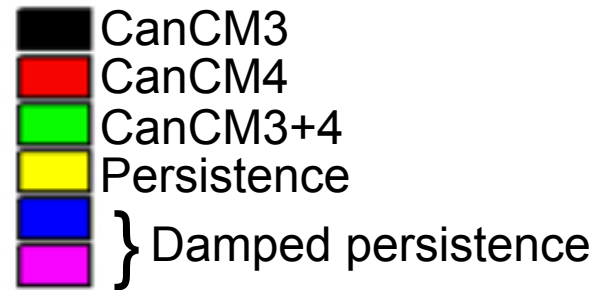
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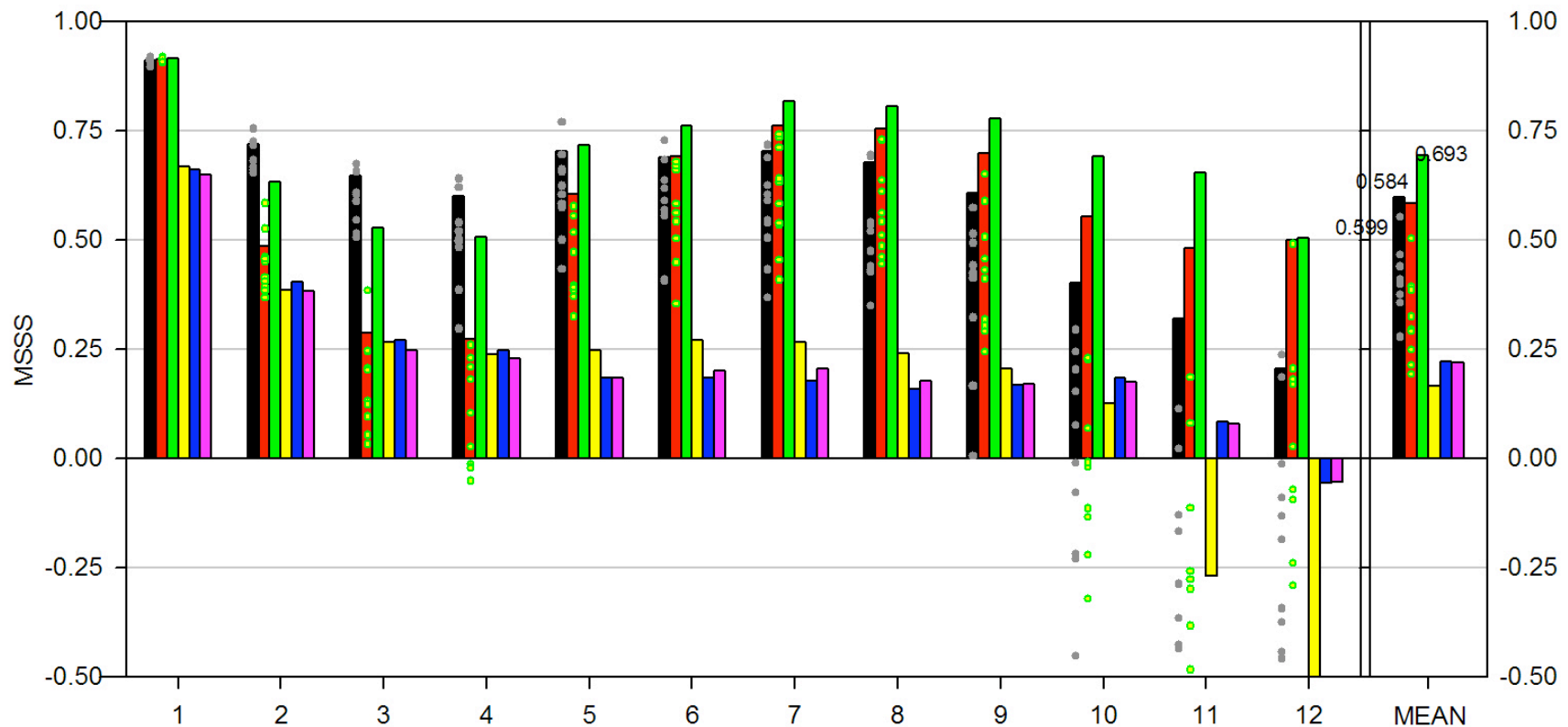
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Nino3.4 Mean Square Skill Score (MSSS)

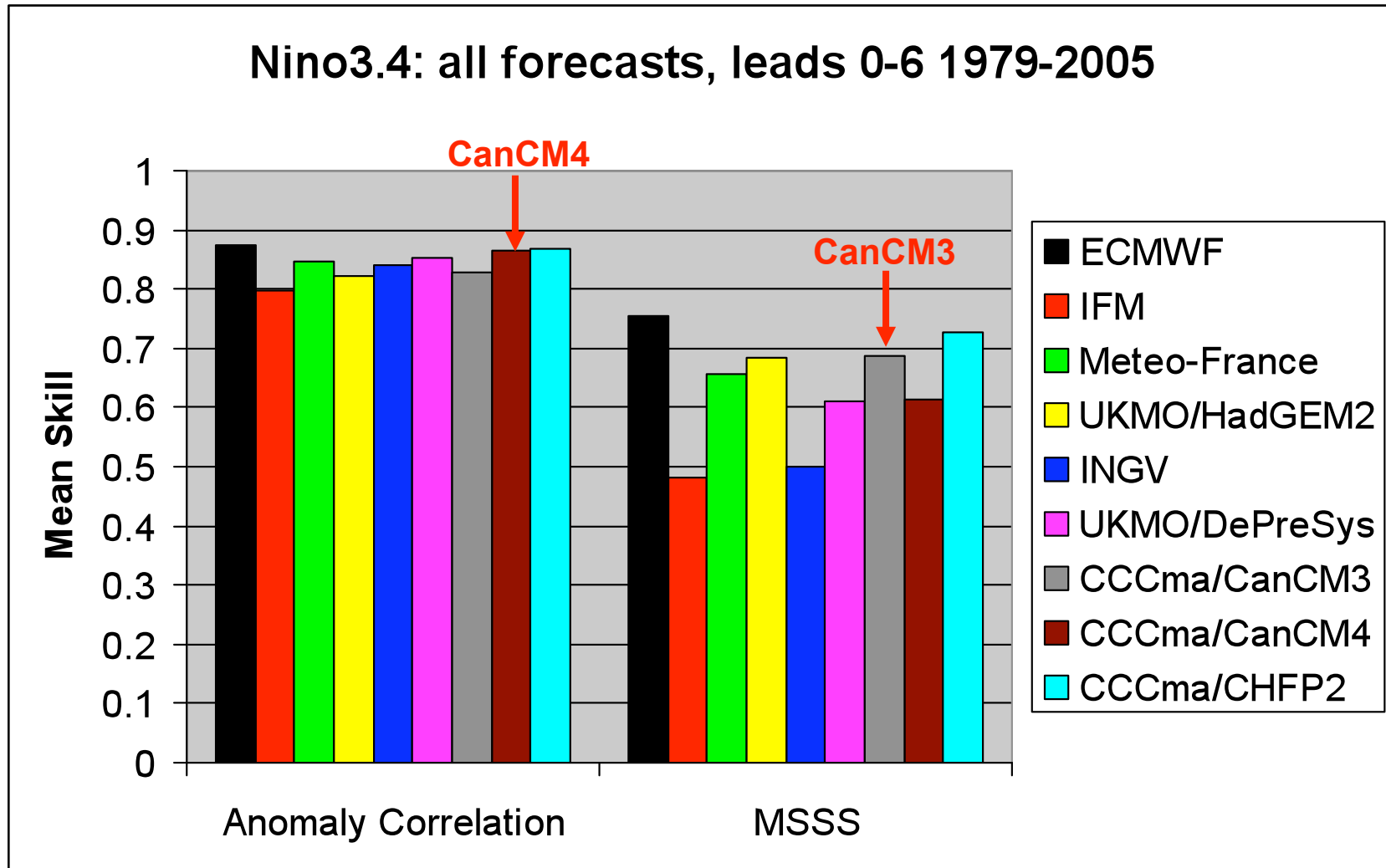
Ensemble Forecasts
 Initialization
 1 June 1979-2008
 ERSST/OISST verification



$-\infty \leq \text{MSSS} \leq 1$
=1 perfect fcst
=0 clim fcst



Comparison with EU ENSEMBLES

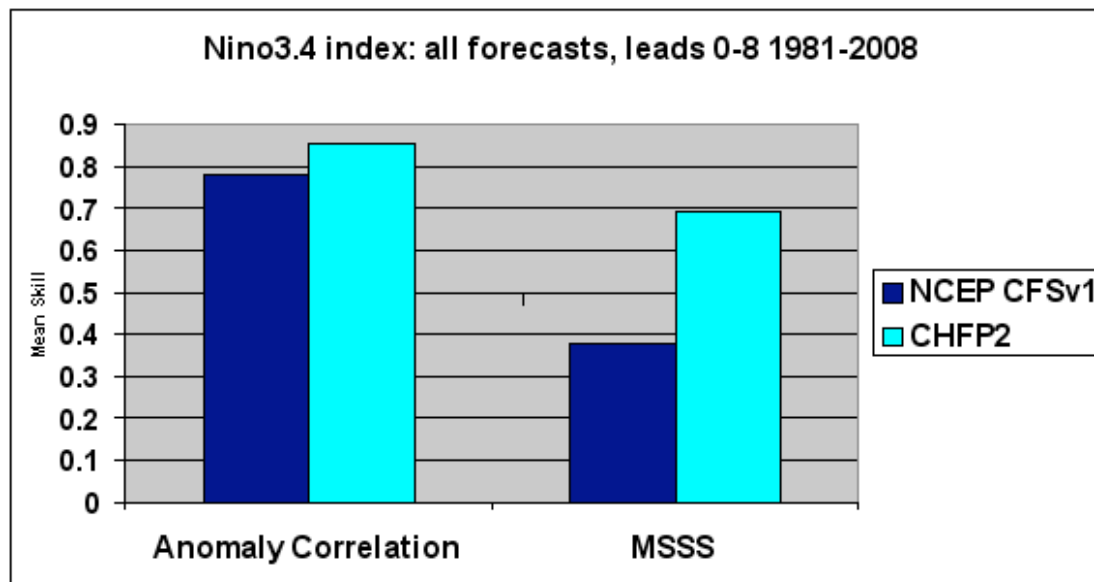


Comparison of **individual model forecasts** (ENSEMBLES forecasts use ensemble size 9, CCCma ensemble size 10), with CHFP2 skills shown for comparison

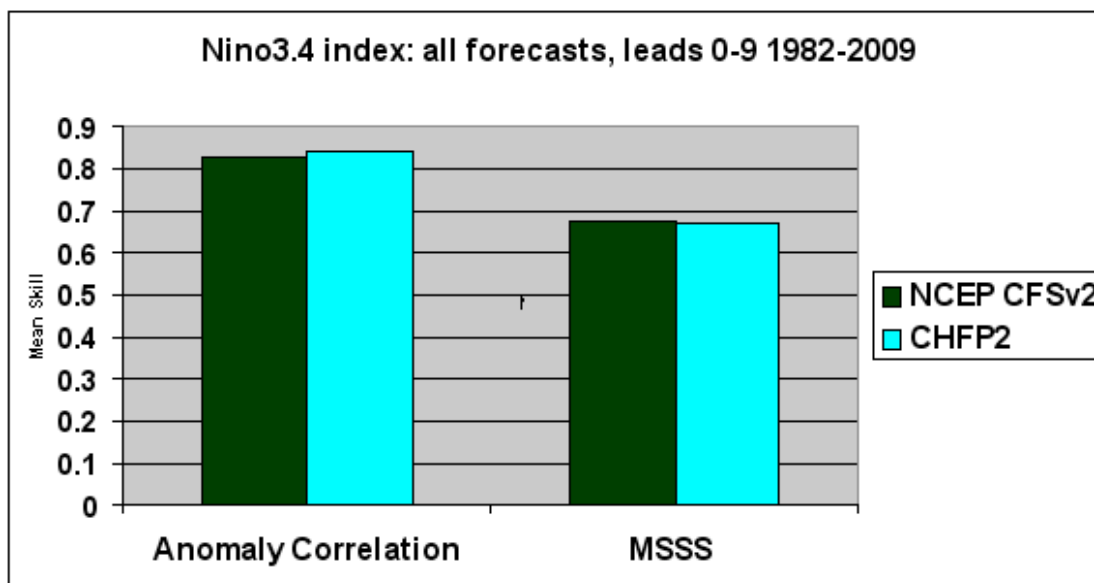


Comparison with NCEP CFS

CHFP2
VS
CFSv1

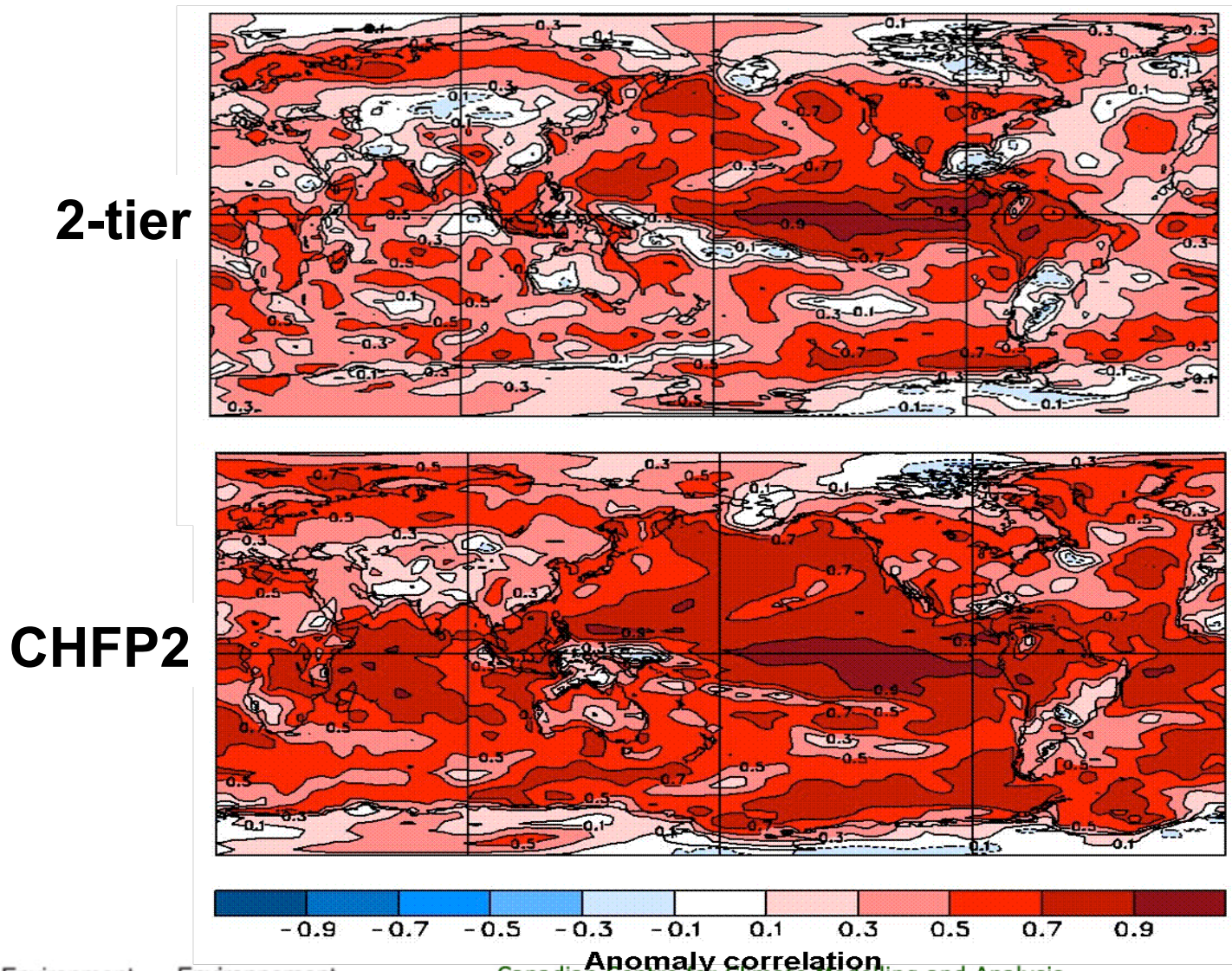


CHFP2
VS
CFSv2

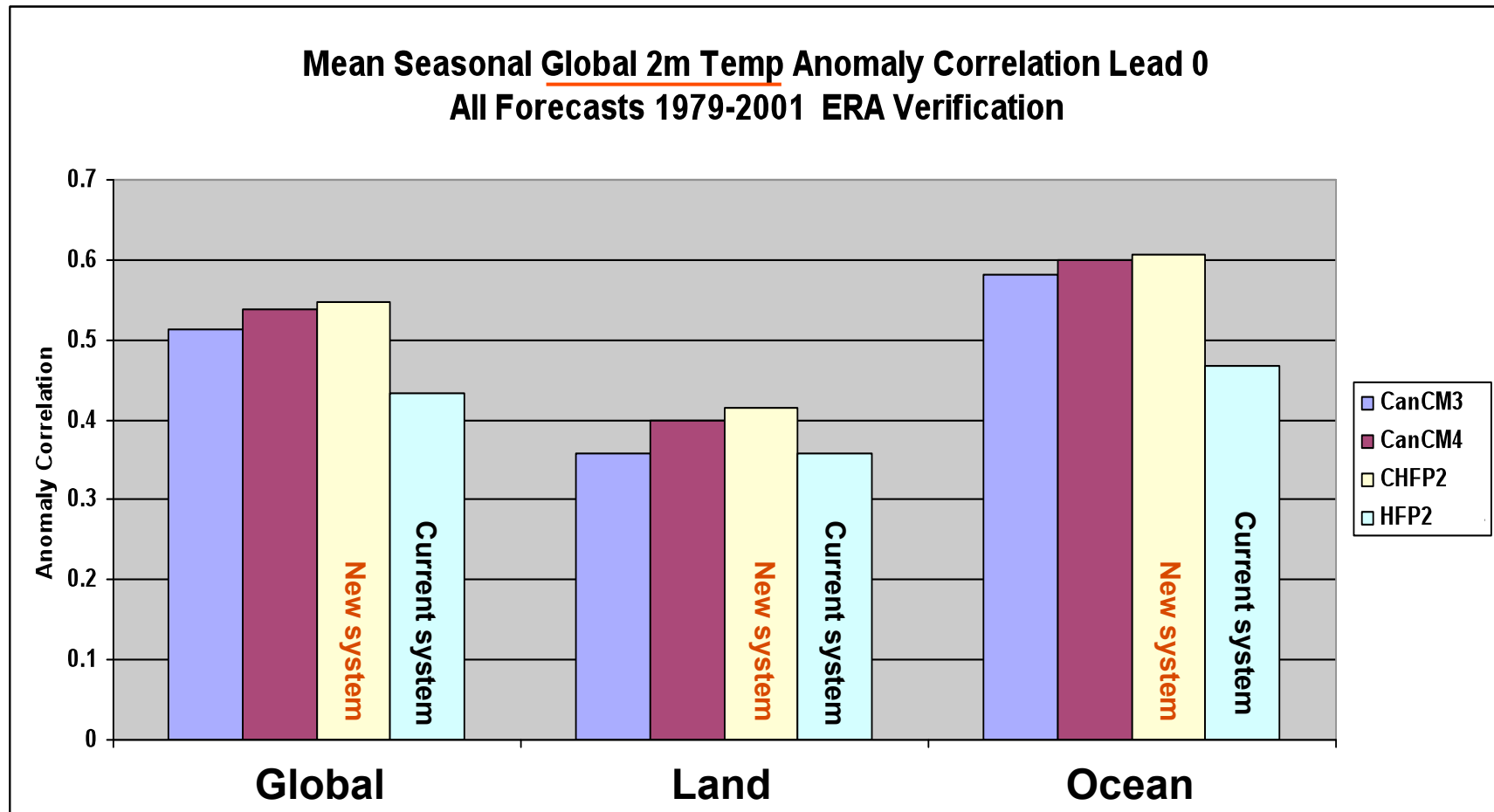


Anomaly correlation 2-tier vs CHFP2

JFM near-surface temperature Lead 0 1979-2001



Anomaly correlation 2-tier vs CHFP2

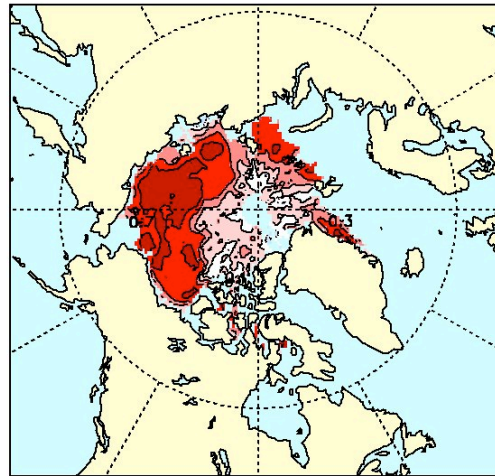


CHFP2 sea ice predictions

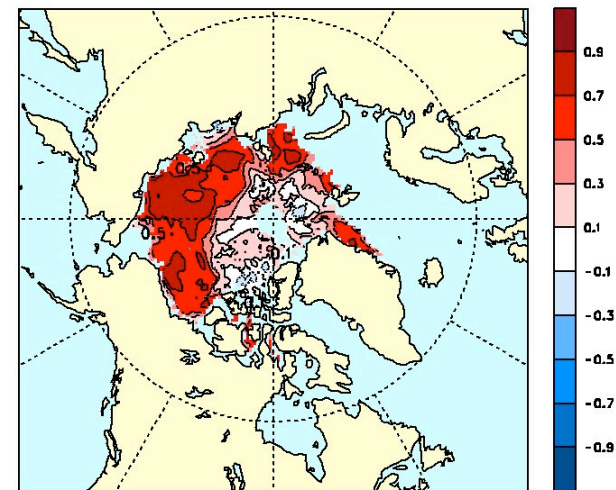
Anomaly correlation, Sep mean ice concentration

Forecasts initialized
End of July

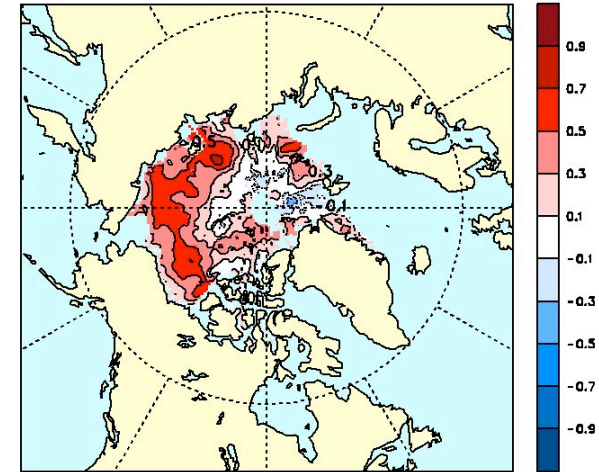
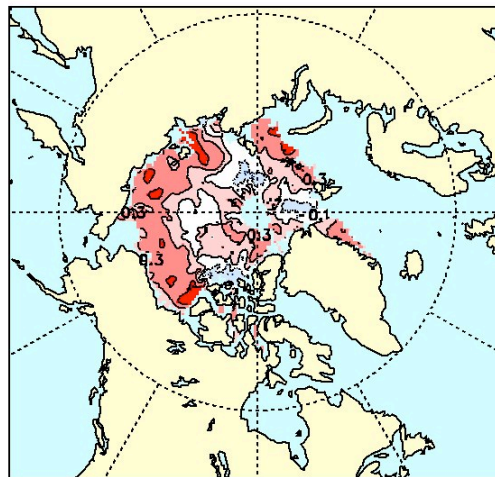
CanCM3



CanCM4



Forecasts initialized
End of June

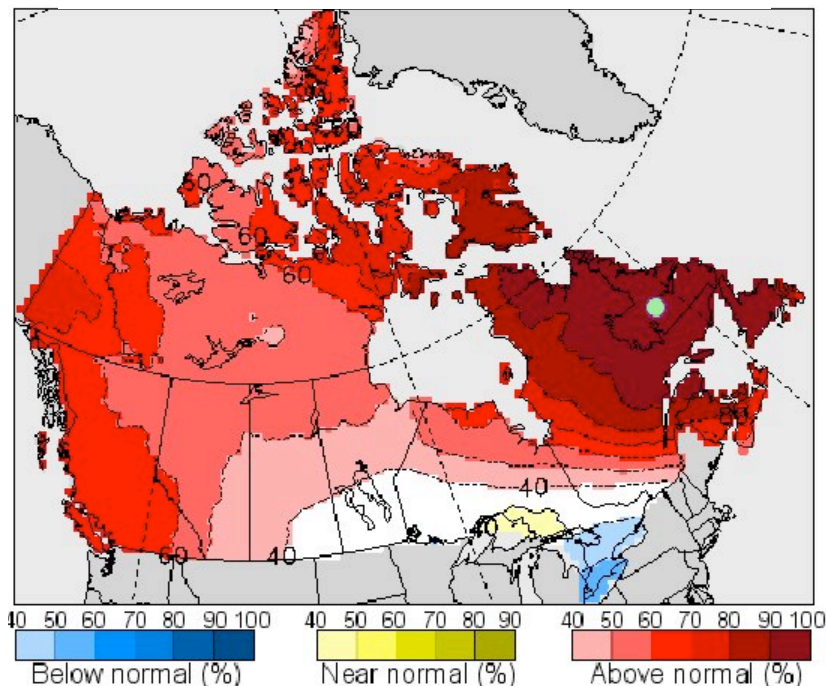


Probability forecast interface

CHFP2 EXPERIMENTAL PROBABILITY HINDCASTS/FORECASTS

Variable	Type	Lead	Month(s)	Year	Region	Validation	Base period	Version	Thresh	Action
Temperature	Seasonal	0-month	JFM	2010	Canada	era40int	1981_2010	era	40	Go!

3-category Probabilistic Forecast year=2010 JFM 0-month lead



Areas where forecast probability exceeds 40% are shaded in colours. Its color indicates areas where forecasted probabilities of all 3 categories are below 40% and are approximately equal.



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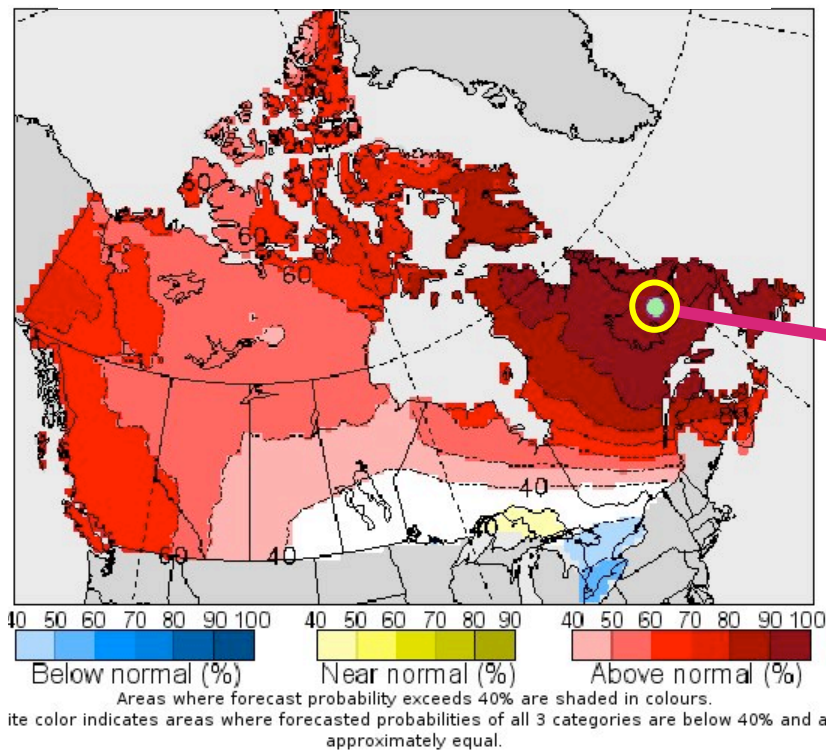
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Probability forecast interface

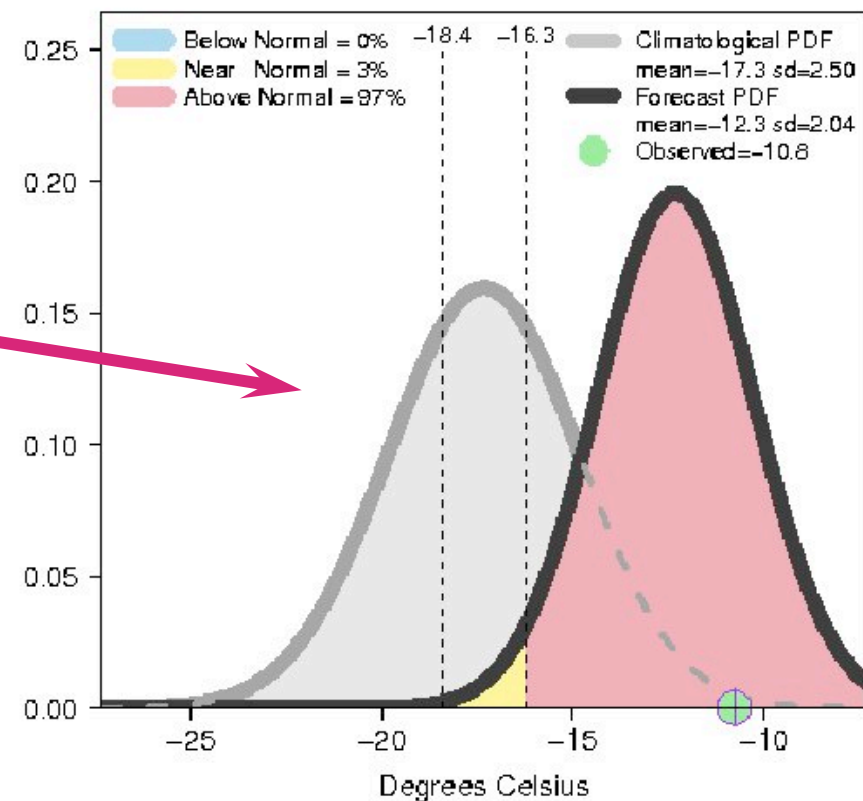
CHFP2 EXPERIMENTAL PROBABILITY HINDCASTS/FORECASTS

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Temperature	Seasonal	0-month	JFM	2010	Canada	era40int	1981_2010	era	40	Go!

3-category Probabilistic Forecast year=2010 JFM 0-month lead



Local Probability Forecast Lat=53.6N Lon=62.8W

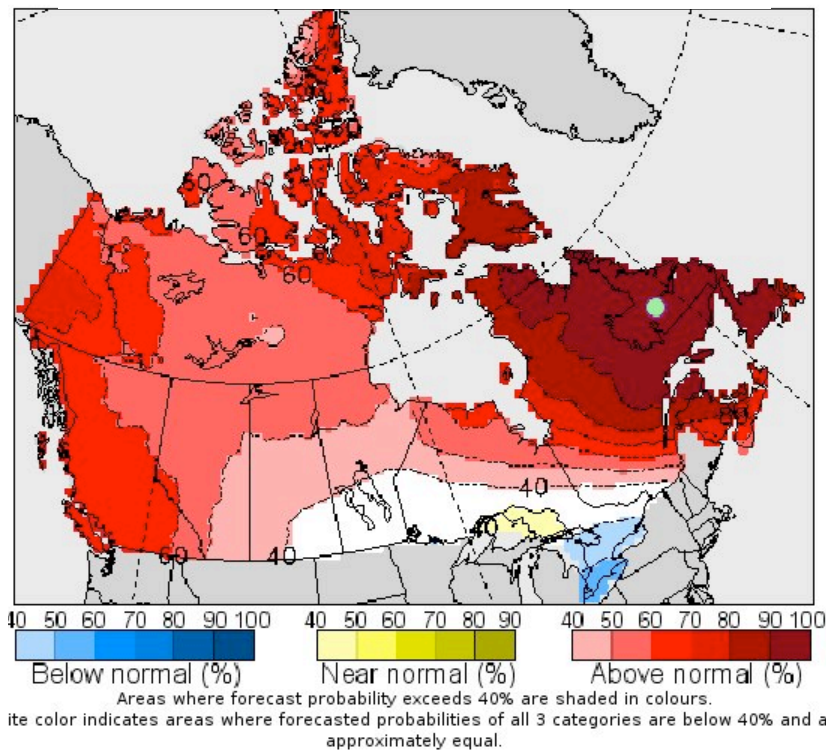


Probability forecast verification

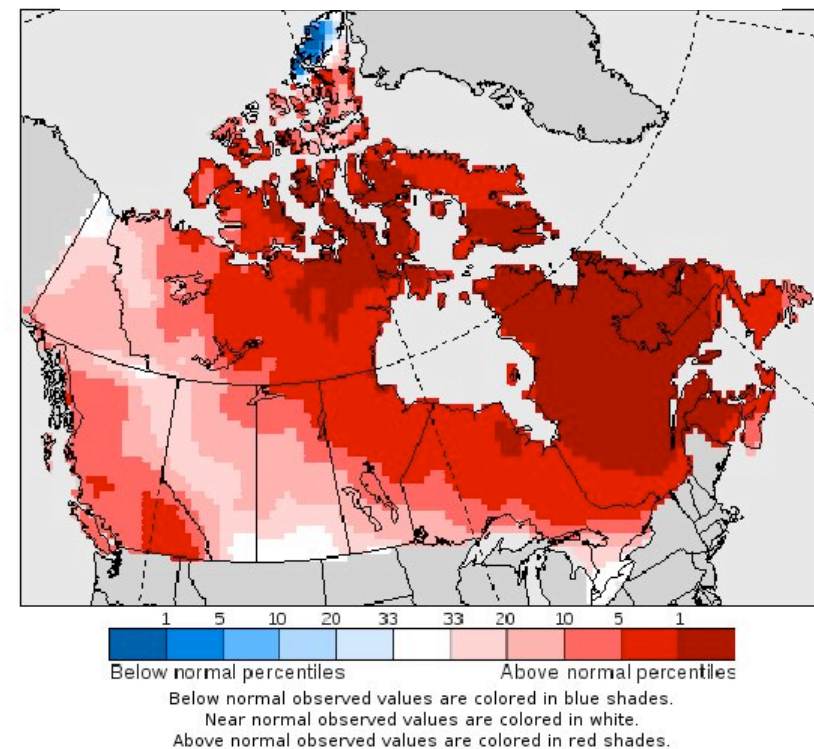
CHFP2 EXPERIMENTAL PROBABILITY HINDCASTS/FORECASTS

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Temperature	Seasonal	0-month	JFM	2010	Canada	era40int	1981_2010	era	40	Go!

3-category Probabilistic Forecast year=2010 JFM 0-month lead



Observed Temperature Percentile year=2010 JFM



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Conclusions

- Competitive ENSO skill achieved with limited resources, low-tech ocean assimilation



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Conclusions

- Competitive ENSO skill achieved with limited resources, low-tech ocean assimilation
- CHFP2 to replace 2-tier + statistical system December 1



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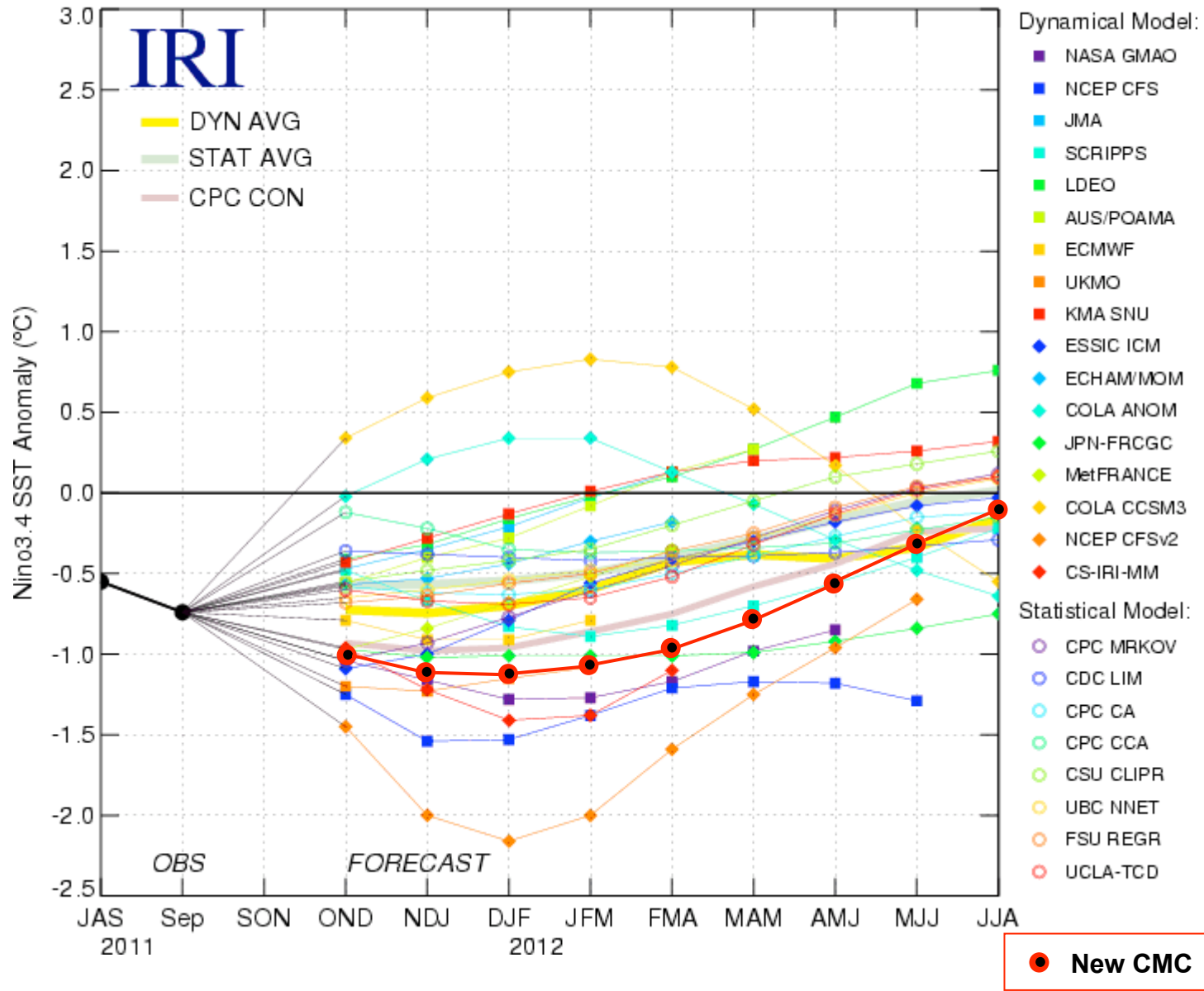
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Conclusions

- Competitive ENSO skill achieved with limited resources, low-tech ocean assimilation
- CHFP2 to replace 2-tier + statistical system December 1
- Watch out for La Nina!



Model Predictions of ENSO from Oct 2011



http://iri.columbia.edu/climate/ENSO/currentinfo/SST_table.html



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