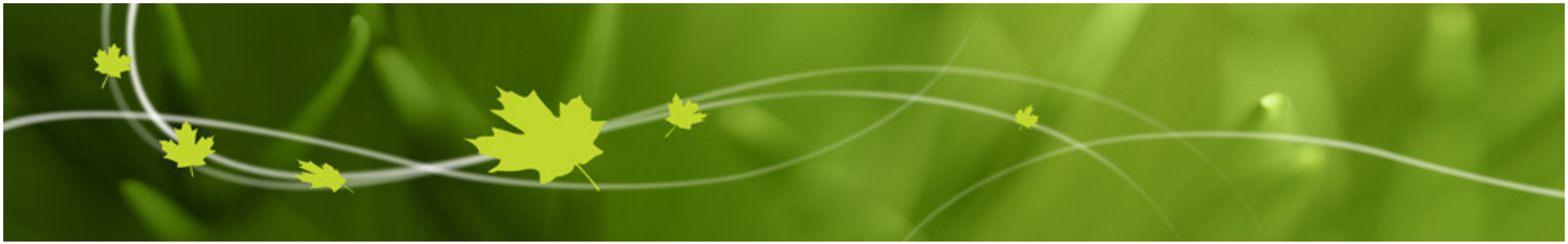
Environment Canada Environnement Canada

Meteorological Service of Canada



The New Canadian Coupled Multi-seasonal Forecasting System

Bertrand Denis[1]

&

Bill Merryfield[2], Juan-Sebastian Fontecilla[1], Slava Kharin[2], Woo-Sung Lee[2], Jacques Hodgson[1], Louis-Philippe Crevier[1], Benoit Archambault[1], Lewis Poulin[1]

[1] Canadian Meteorological Centre (CMC)
[2] Canadian Centre for Climate Modelling and Analysis (CCCma)

APEC Climate Symposium 2011: Harnessing and Using Climate Information for Decision Making
Honolulu, Hawai'i, October 17-20 2011

APEC Climate Center

OUTLINE

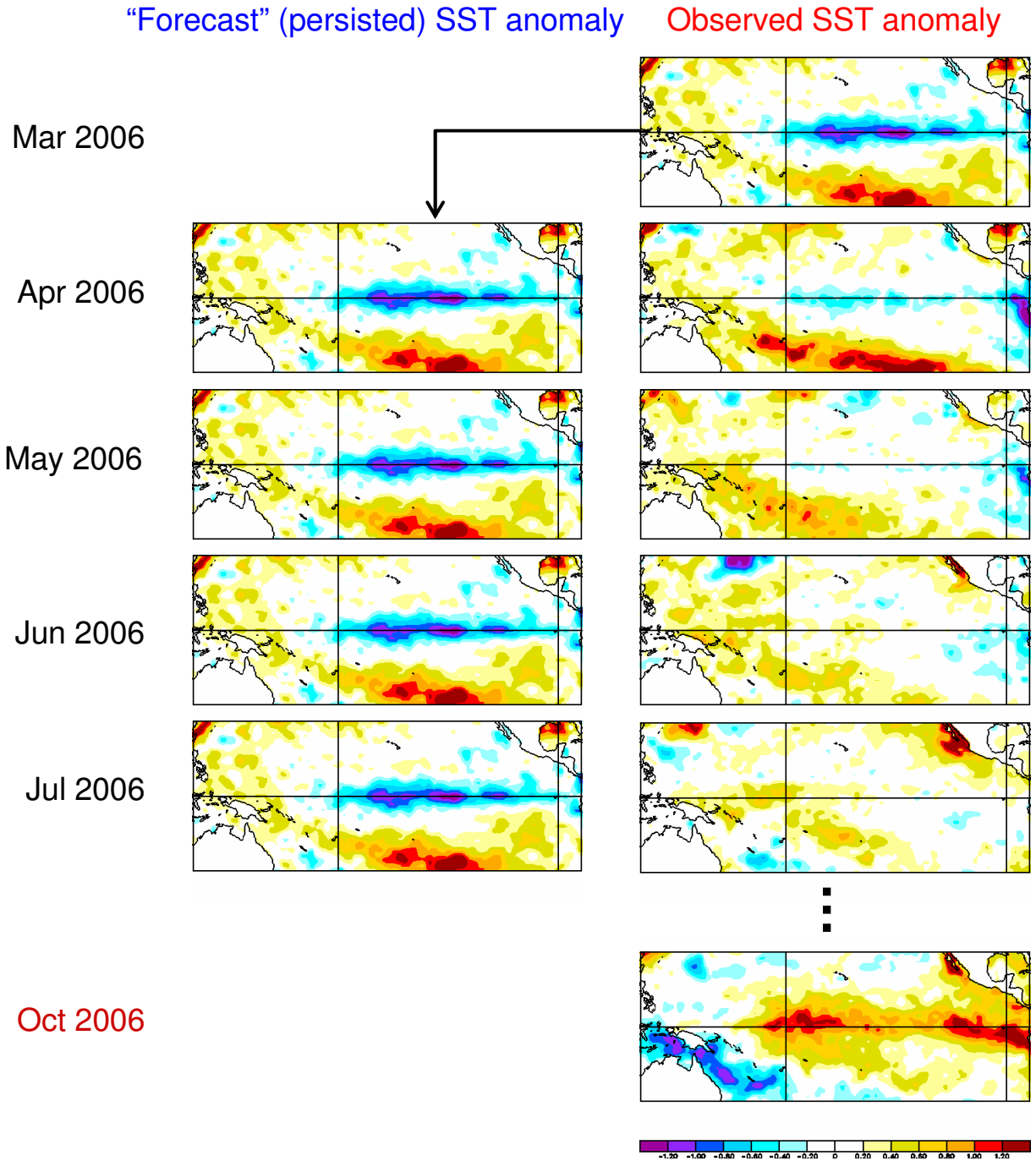
- Motivation
- Description of the new system
- Coupled Historical Forecasting Project (CHFP2)
- Forecast skill improvements
- Some comparisons
- Future plan

APEC Climate Center

Motivation for coupled vs 2-tier system

Example: consider 2-tier forecast (persisted SSTA) from 1 April 2006

→ 2-tier system with persisted SSTA cannot predict an El Nino or La Nina



Current vs new system - summary

	Current system (as of October 2011)	New system (Becoming operational on December 1st)
Atmospheric models	• 10 x SEF (T95 / L27) • 10 x GEMCLIM (2° / L50) • 10 x AGCM2 (T32 / L10) • 10 x AGCM3 (T63 / L31)	• 10 x AGCM3 (T63L31) -> CanCM3 • 10 x AGCM4 (T63L35) -> CanCM4
Ocean and ice models	**2-tier approach** • Ocean: – No dynamical model – Persisted SST anomaly • Sea-ice: – No dynamical model – relaxed toward climatology	**1-tier approach** • Ocean: – CanOM4 (1.41°× 0.94° / L40) – Based on NCOM (NCAR CSM) • Sea-ice: – Modeled as a cavitating fluid dynamics (Flato & Hibler) – mean thickness & concentration
Initial conditions	• 12 h lags atmos analysis over the last 5 days • No assimilation cycle	• no lag; all valid at time 0h • Independent but statistically equivalent • Coupled components nearly in balance with each other • Reduced initial chock; no spin-up

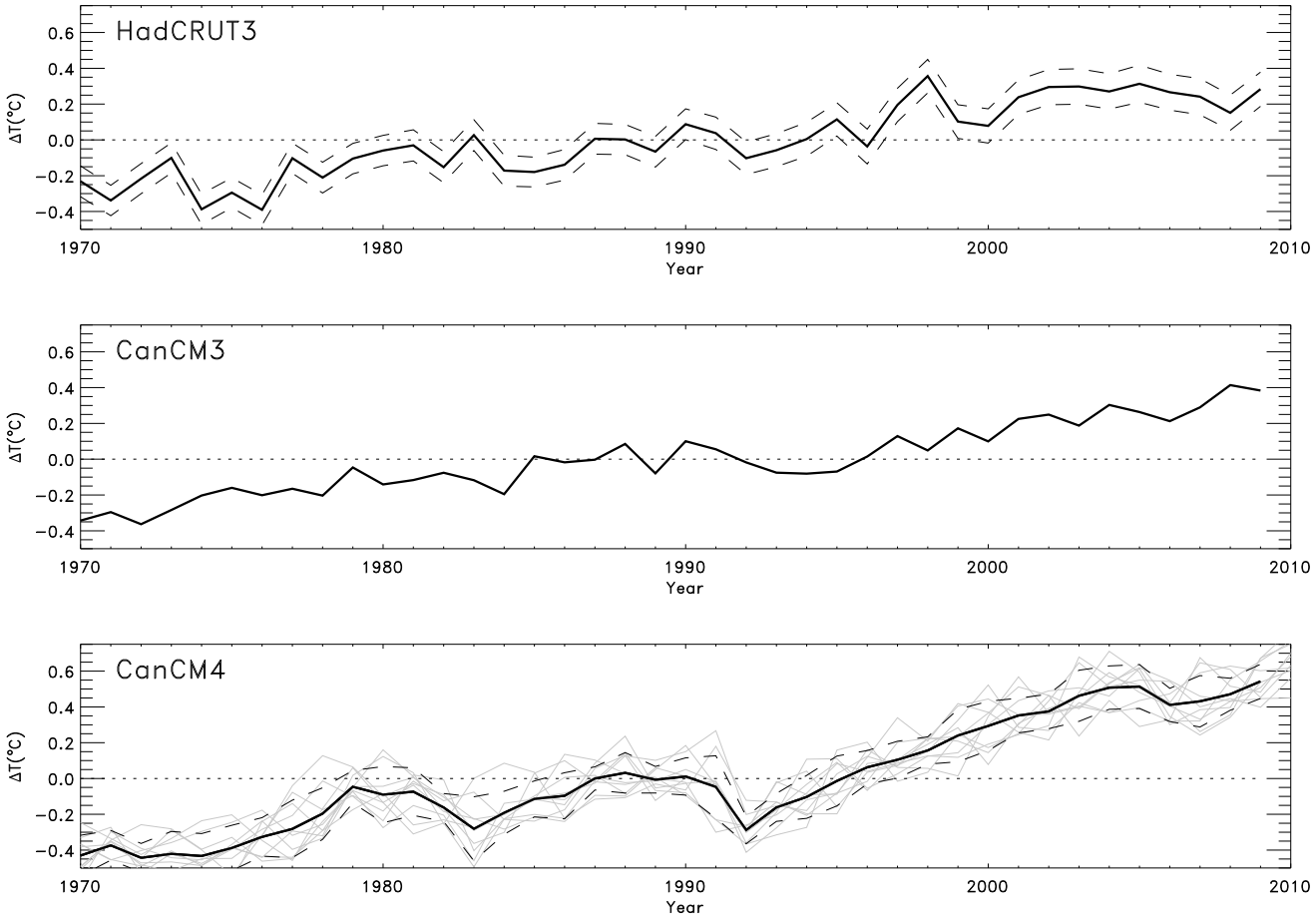
APEC Climate Center

Current vs new system - summary

	Current system (as of October 2011)	New system (Becoming operational on December 1st)
Hindcasts	1969-2004	1981-2010 (WMO std period)
Forecasts	• Months 1 – 4 – Uses dynamical models – Issued every month • Months 4 -12; –Uses Statistical CCA – Issued 4 x per year – Only available over Canada	• Months 1 -12 – Uses dynamical models – Issued every month – Global

APEC Climate Center

New system is based on state-of-the-art coupled climate and earth system models being developed by CCCma



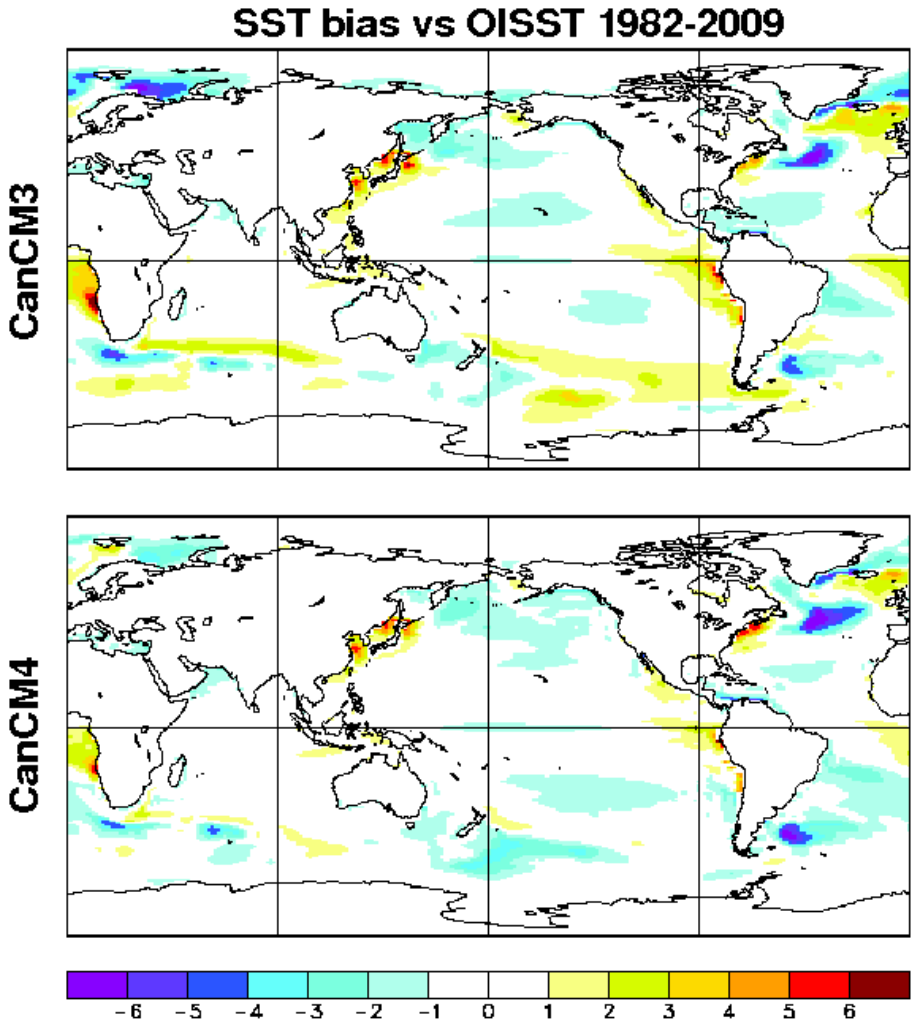
Surface temperature trends over the last 40 years

(Freely running models)

APEC Climate Center

New system is based on state-of-the-art coupled climate and earth system models being developed by CCCma

SST Biases of freely running models



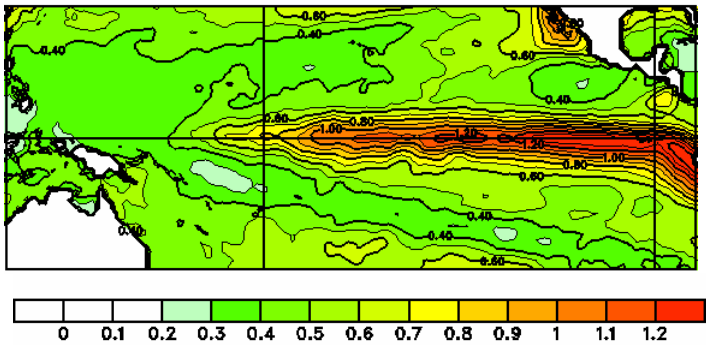
APEC Climate Center

New system is based on state-of-the-art coupled climate and earth system models being developed by CCCma

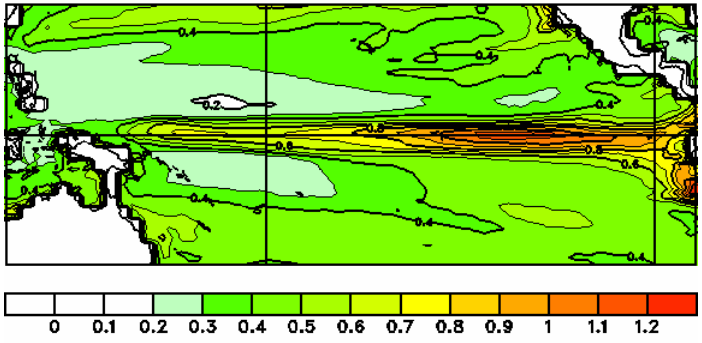
ENSO variability

Observations (HadISST 1970-99)

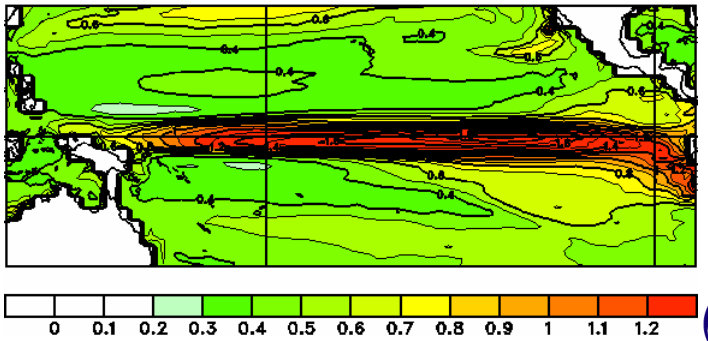
Monthly SSTA std dev



CanCM3



CanCM4



freely running models

APEC Climate Center

Coupled Historical Forecasting Project II (CHFP2)

- *1-tier system -> two atmos-ocean-ice coupled systems*

  - CanCM3 = AGCM3 (T63/L31) + OGCM4 → 10 members

  +

  - CanCM4 = AGCM4(T63/L35) + OGCM4 → 10 members

- *20 Assimilation & forecast streams*

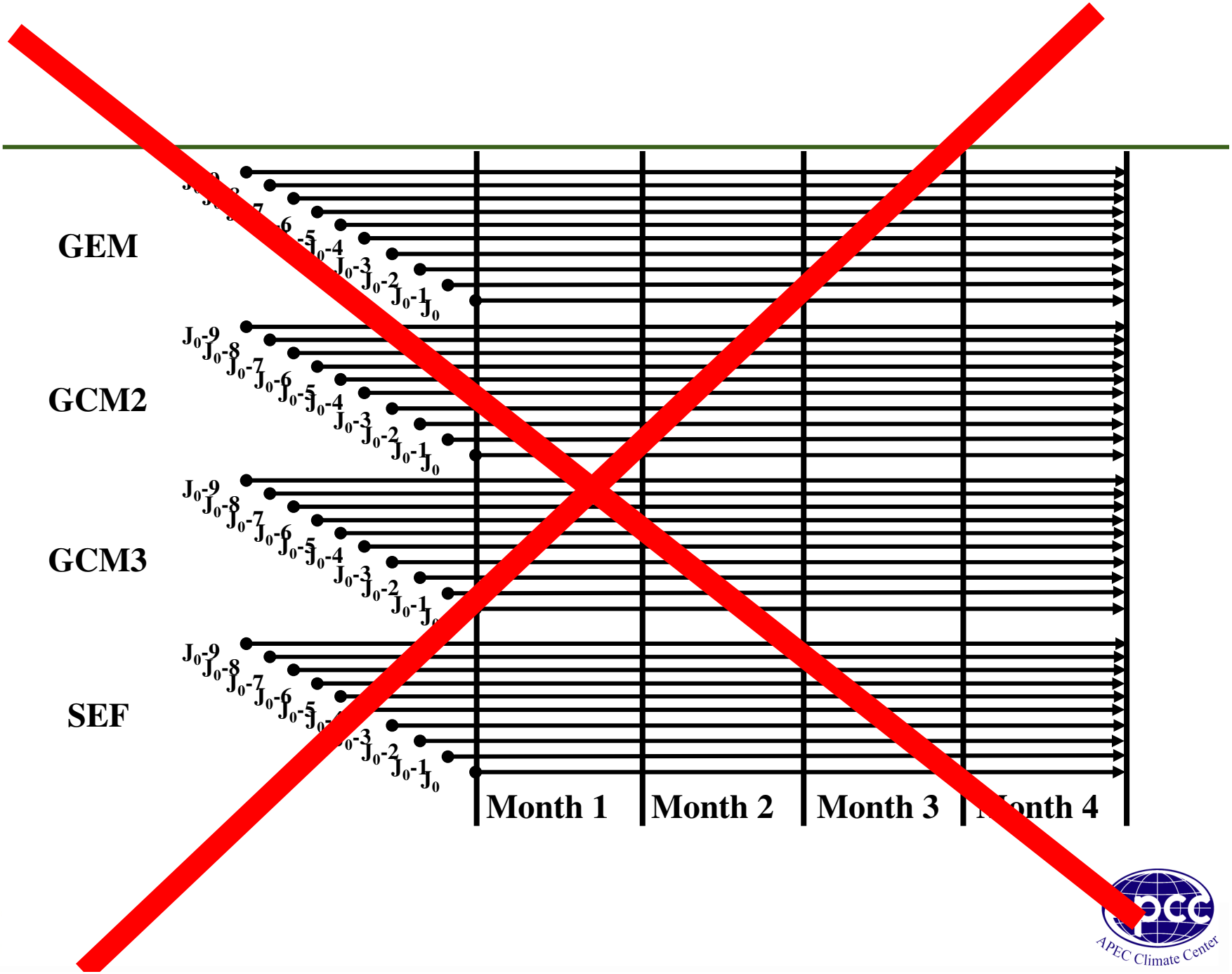
- *"Burst" initialization*

  - Initial conditions valid just before forecast starts – no time lags

- *System climatology based on CanCM3 + CanCM4 Hindcasts*

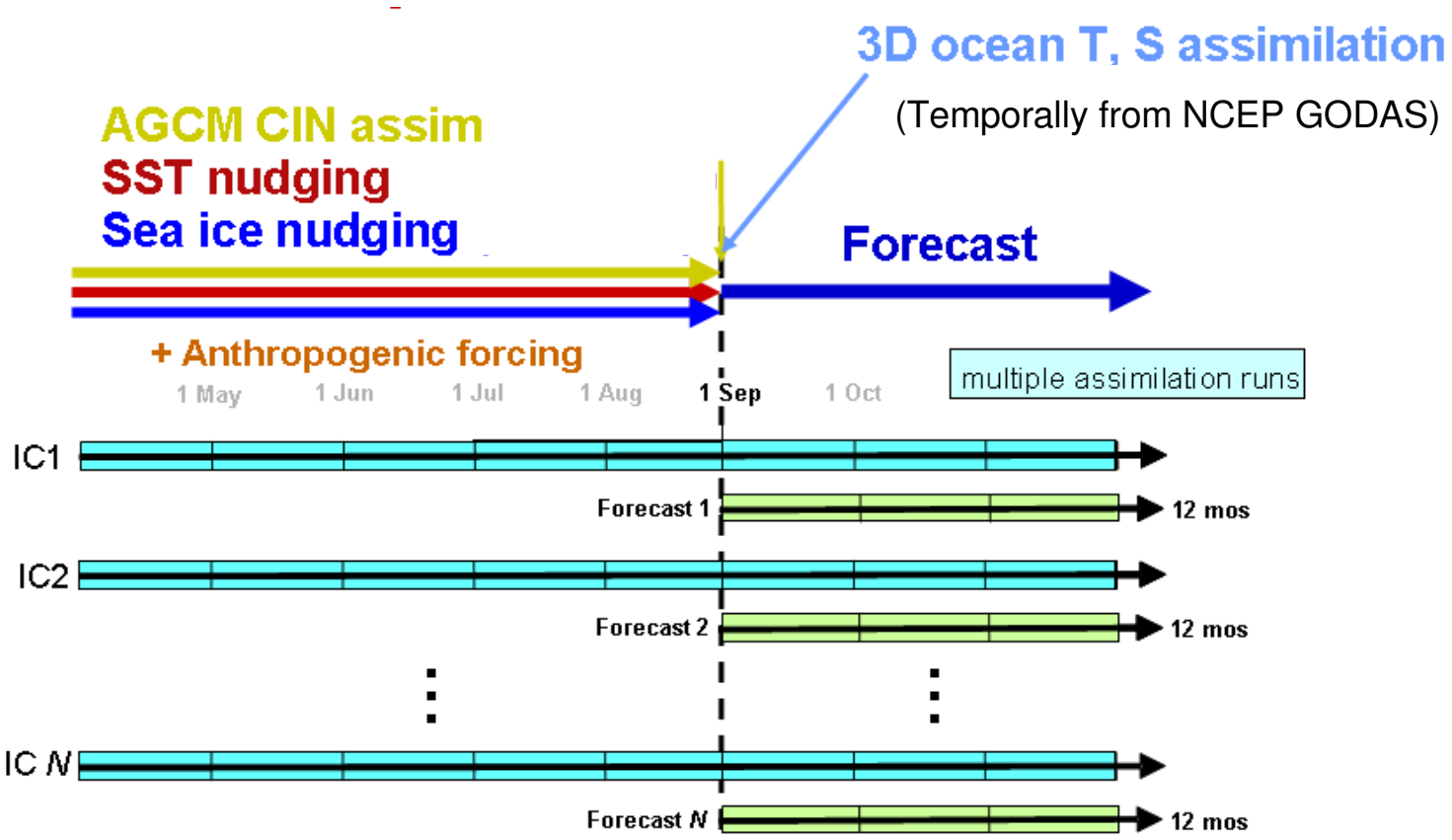
  - Initialized every month 1981-2010 (30 years)

APEC Climate Center



APEC Climate Center

Forecast initialization set up



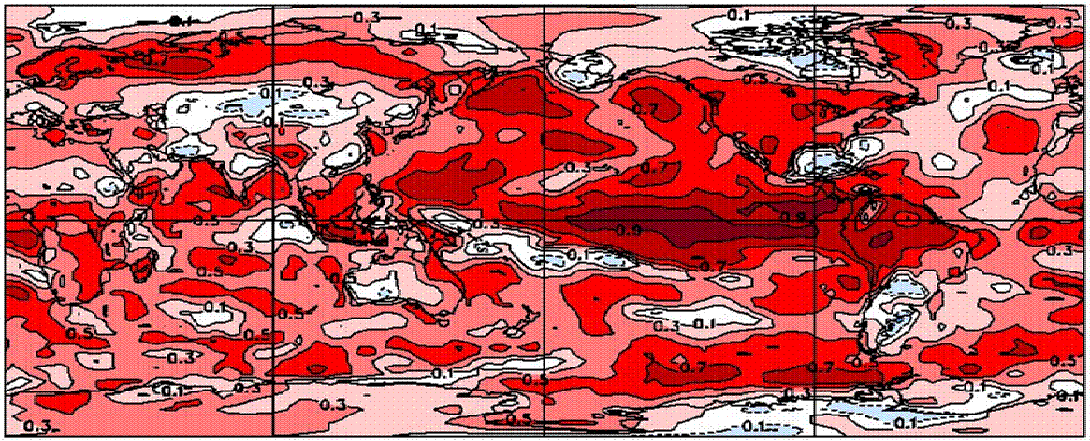
*

APEC Climate Center

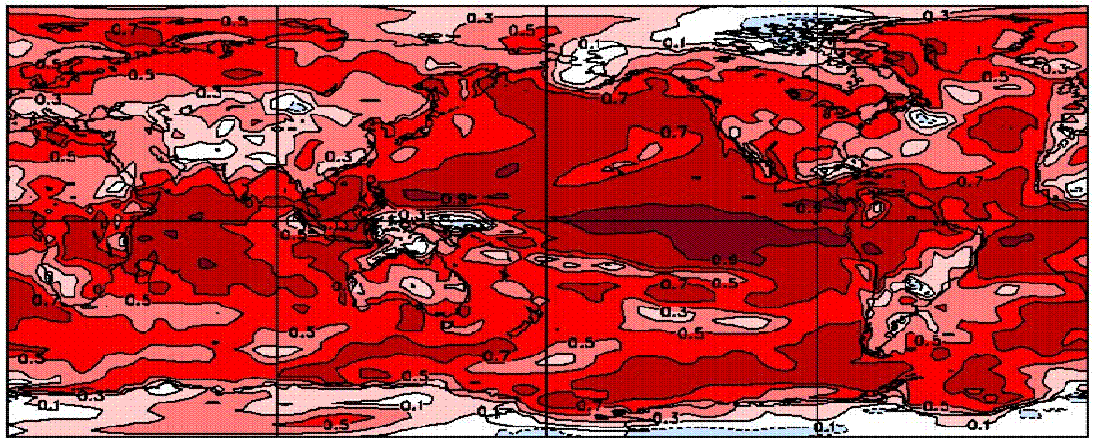
Anomaly correlation skill CHFP2 vs HFP2

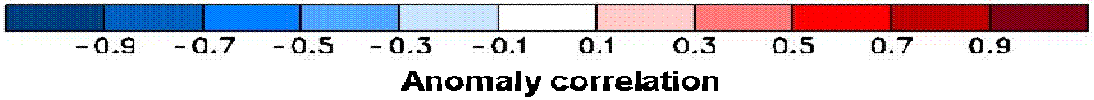
JFM near-surface temperature Lead 0 1979-2001

HFP2



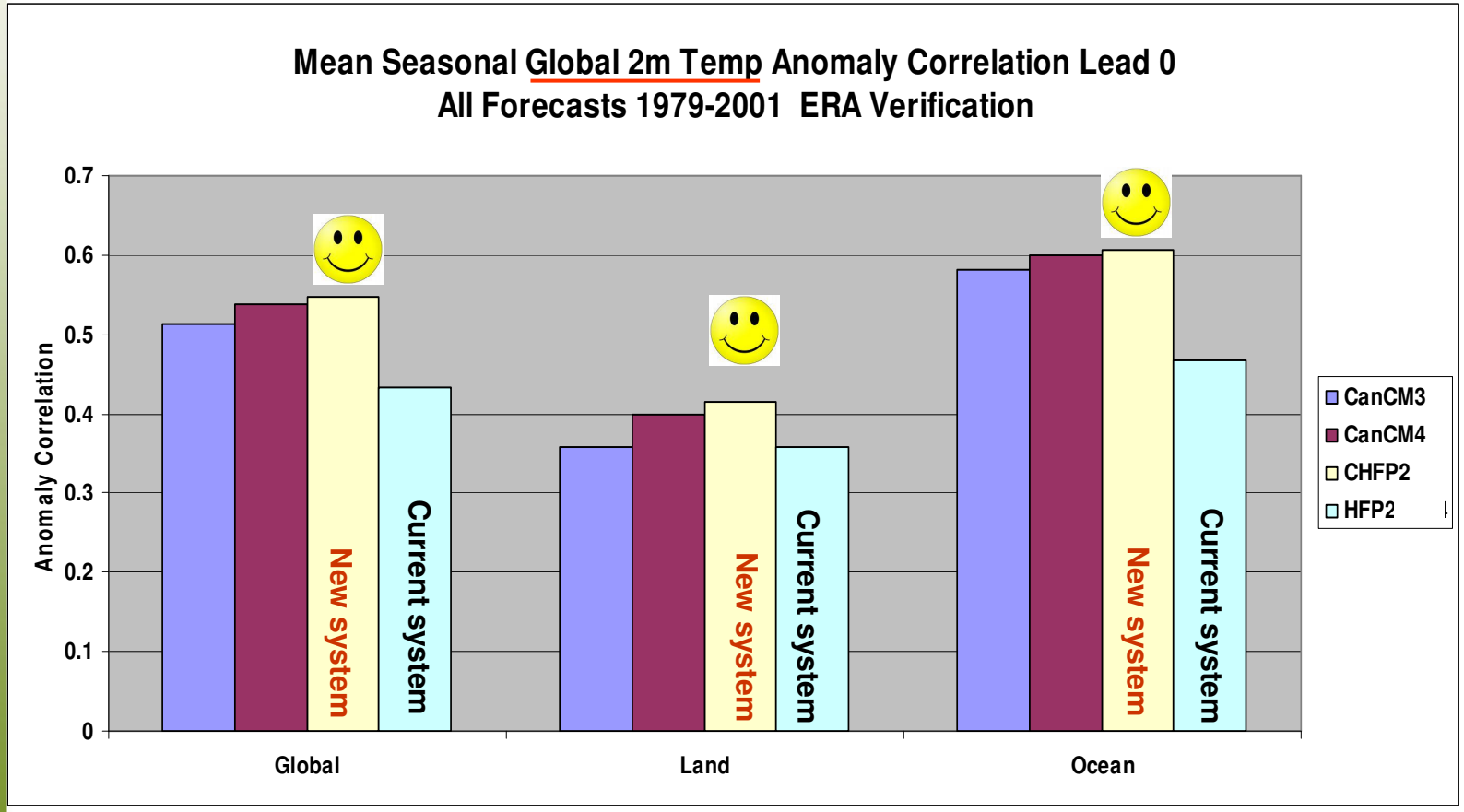
CHFP2





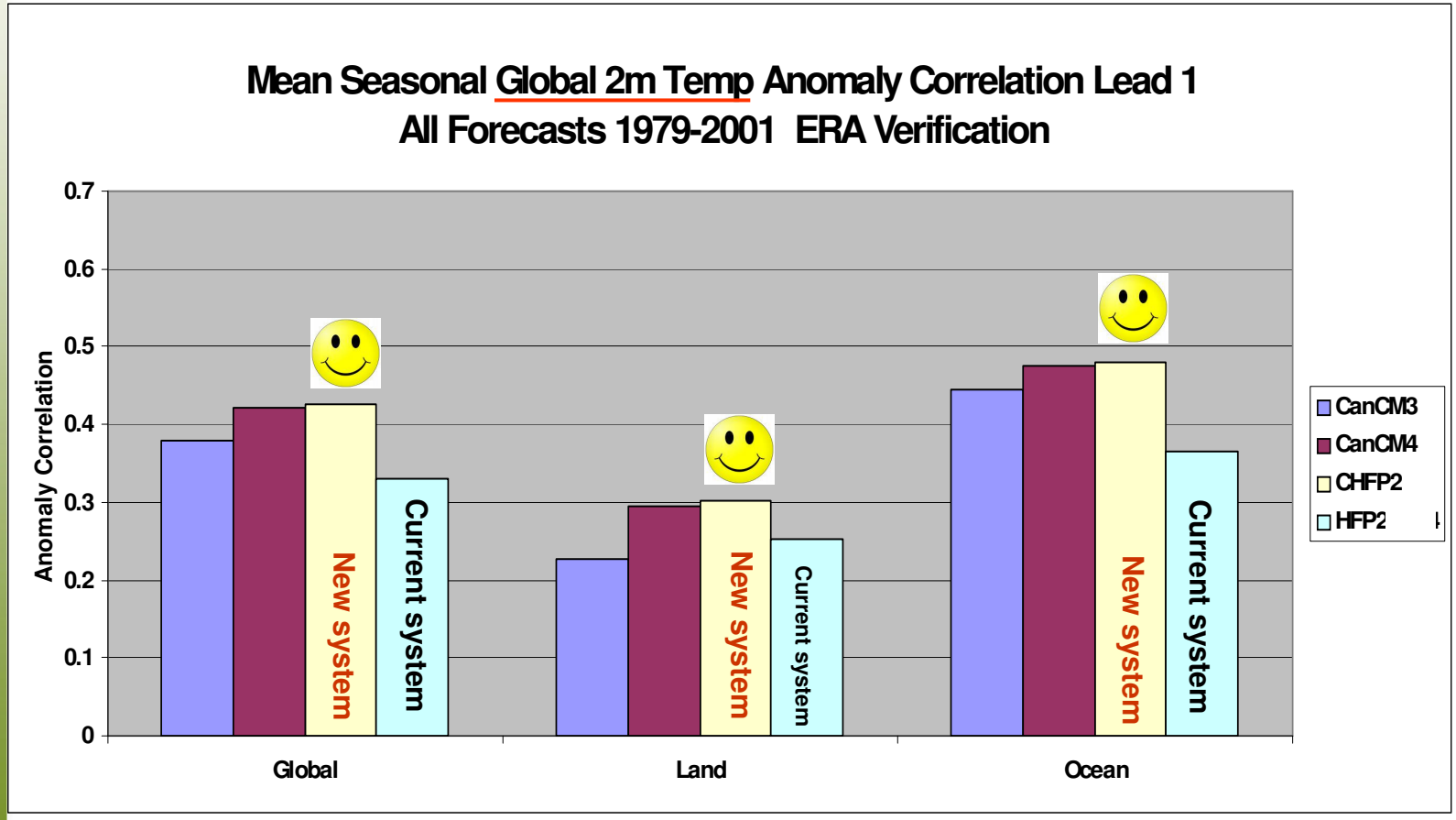
APEC Climate Center

First season (Lead 0 months)



APEC Climate Center

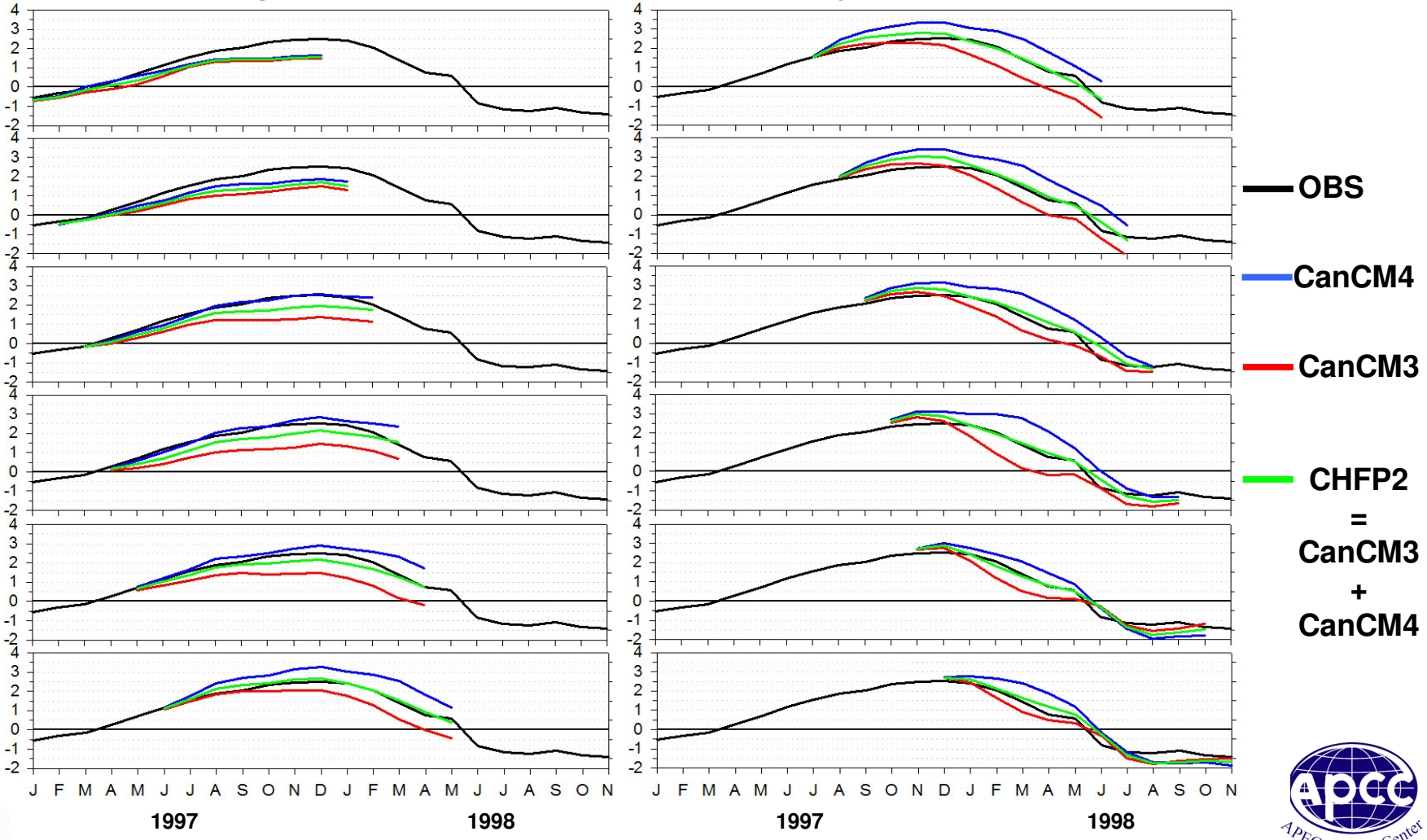
First season (Lead 1 month)



APEC Climate Center

ENSO Skill
Case Study: 1997-98 El Niño

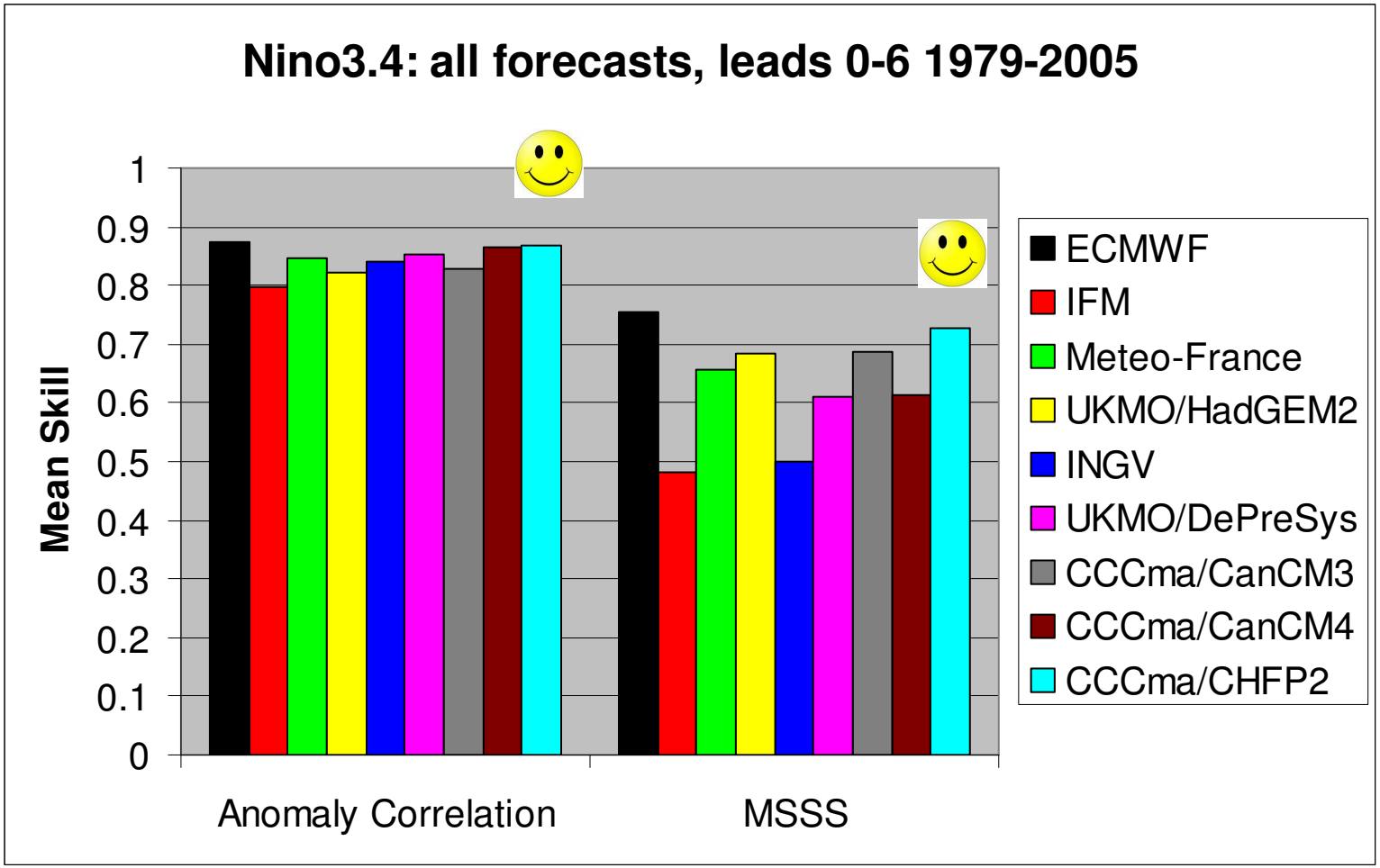
Niño3.4 retrospective forecasts initialized monthly from 1 Jan 1997 to 1 Dec 1997



APEC Climate Center

Average skills over all target & lead months

- ENSEMBLES Project -

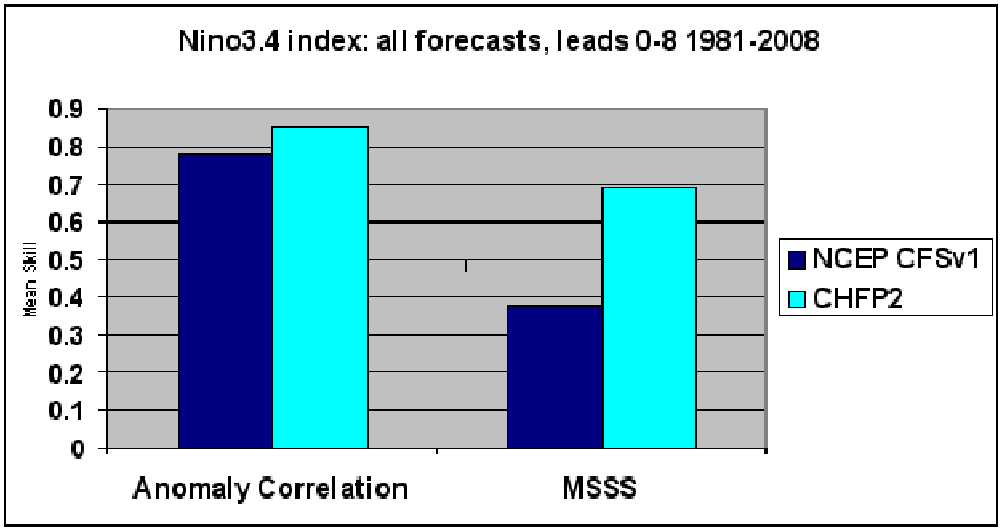


Comparison of **individual model forecasts** (ENSEMBLES forecasts use ensemble size 9, CCCma ensemble size 10), with CHFP2 skills shown for comparison

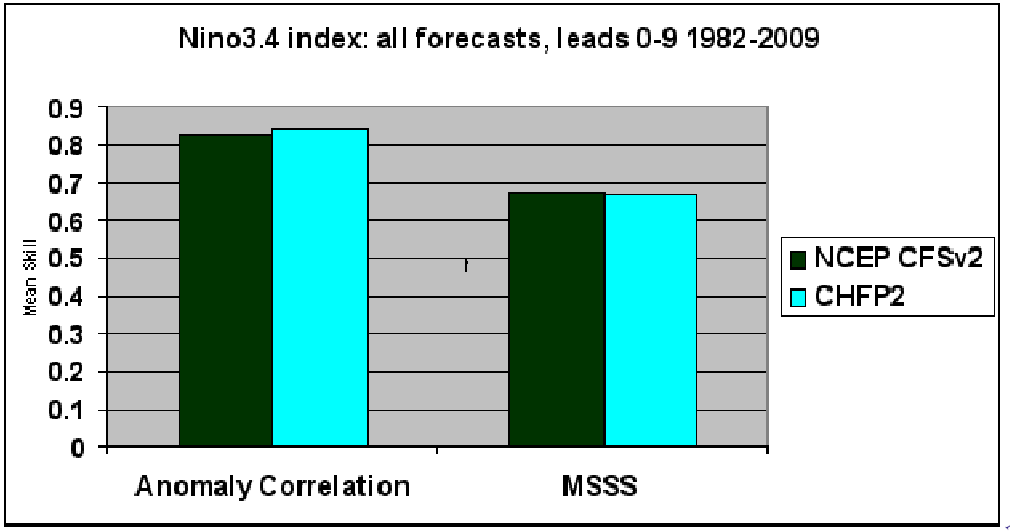
APEC Climate Center

CHF2 vs NCEP CFSv1 and CFSv2

CHF2 vs CFSv1

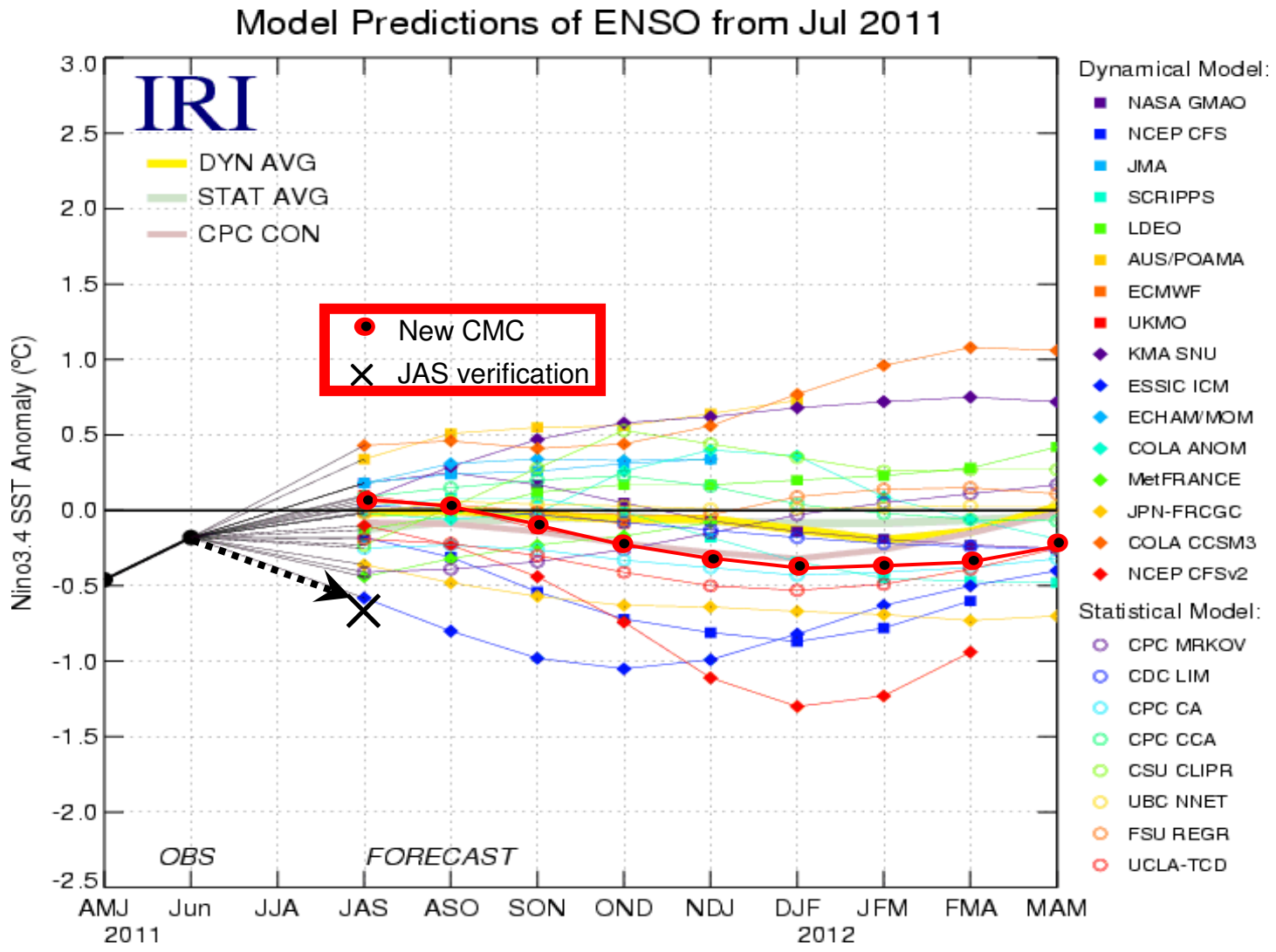


CHF2 vs CFSv2



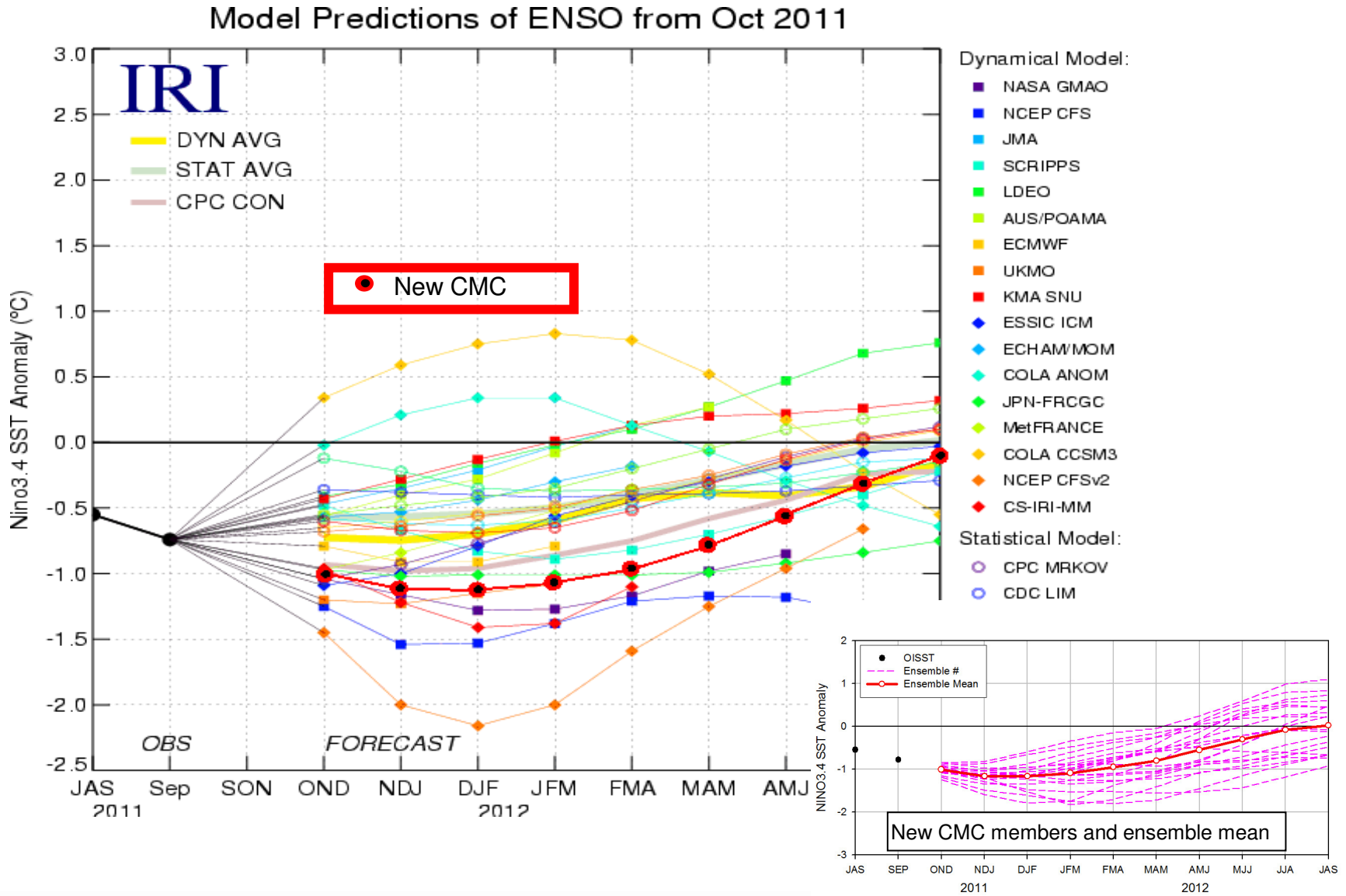
APEC Climate Center

Last July Nino3.4 Anomaly SST Forecast



APEC Climate Center

Last October Nino3.4 Anomaly SST Forecast



WMO Global Producing Centres

GPC	System Configuration.	Atmospheric Model Resolution	Hindcast Period	Year of Implementation
Washington, NCEP	Coupled	T126/L64	1982-2010	Spring 2011
ECMWF	Coupled	T255/L92	1981-2010	Late Fall 2011
Melbourne, BoM	Coupled	3 model configs T47/L17	1960-2011	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

Timetable

- October 2011 - Installation within operational environment
- November 1st, 2011 - Staging
- December 1st, 2011 - Fully operational : 12-months forecasts

APEC Climate Center

Future work

- Probability forecast calibration will be implemented asap
- Create additional products based on this 1-tier system:
  - ENSO plume forecasts
  - A long range sea-ice forecast product
- Implementation of new monthly forecast system
  - Extension of the global medium-range CMC EPS to 32 days
  - 20 member
  - IC from Kalman filter assimilation system

APEC Climate Center

For more information

- Description of Climate models developed at CCCma
  - http://www.ec.gc.ca/ccmac-cccma/default.asp?lang=En&n=4A642EDE-1
- Details of recent implementations at CMC
  - http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/changes_e.html
- Environment Canada's official seasonal forecast web pages
  - http://www.weatheroffice.gc.ca/saisons/index_e.html

Mahalo!

APEC Climate Center