

Predictability Impacts of Indian Ocean Subsurface Conditions

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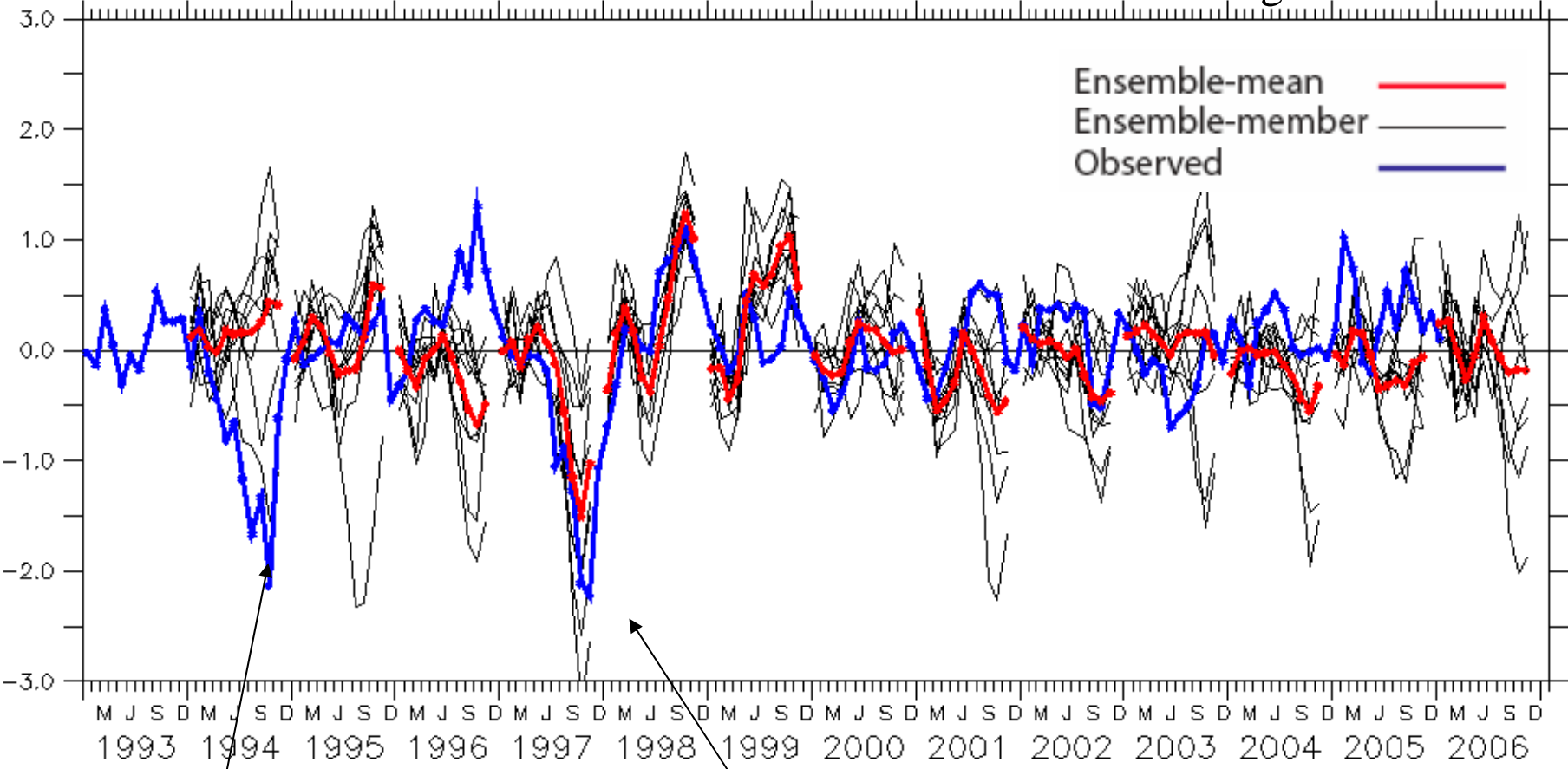
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IOD Experimental Retrospective Forecasts Initialized Dec.

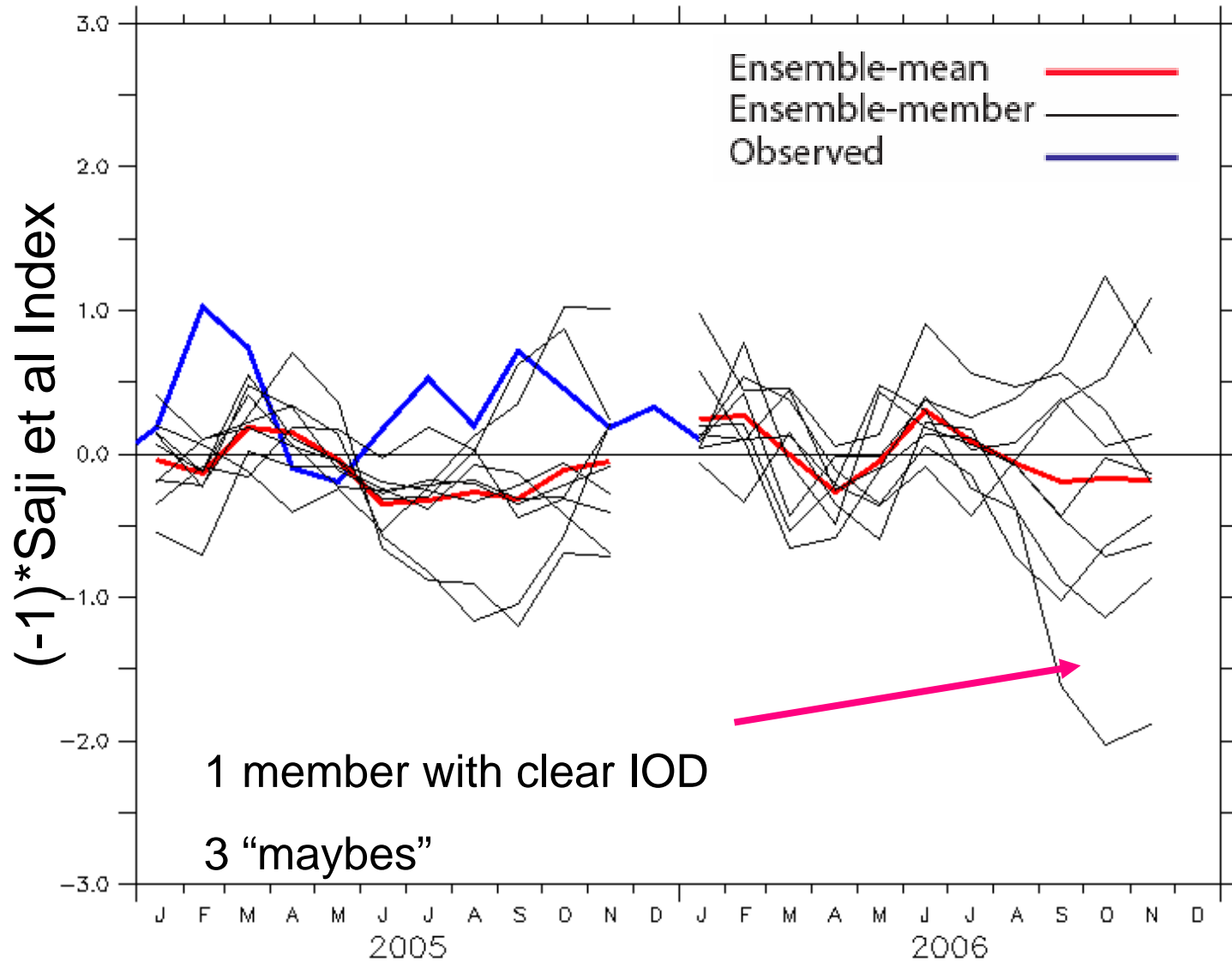
Using GFDL CM2.3



GFDL did not forecast IOD for 1994. Only 1 ensemble member

GFDL consistently forecast IOD for 1997.

GFDL CM2.3 Experimental Forecasts for 2006



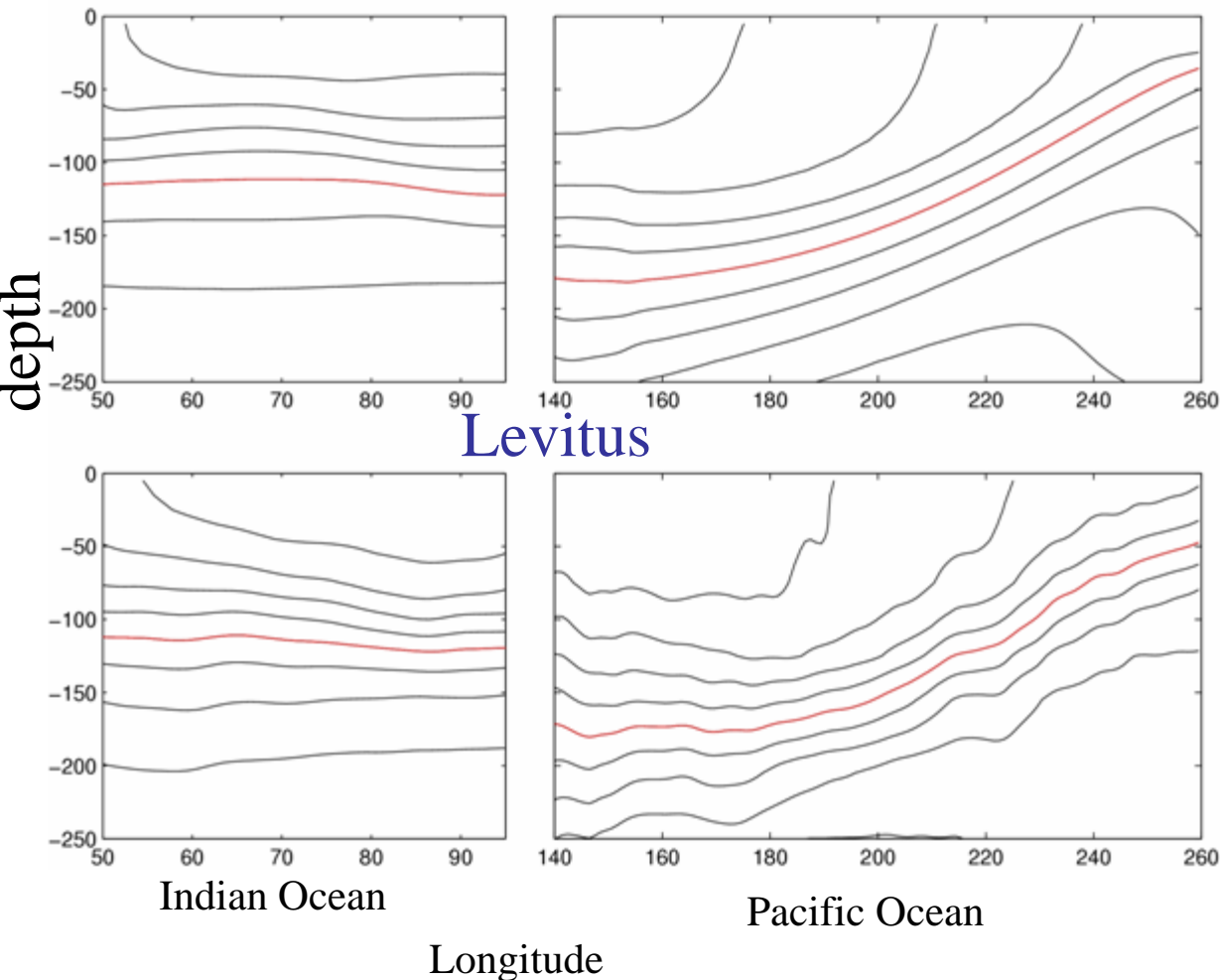
GFDL CM2.1 Coupled Climate Model

- Described in: Delworth et al (2006), Stoufer et al (2006), Wittenberg et al (2006), Gnanadesikan et al (2006), Song et al (2007)
- OM3 Ocean (1x1, 0.33° merid near Eq, 50 levels)
- M45 Atmosphere (2x2.5 resolution, finite volume)
- Interactive land and ice models.

- Has decent ENSO (Wittenberg et al 2006), Indian Ocean mean state and IOD (Song et al 2007), and Indian Ocean/ENSO connection (Annamalai et al 2007).
- Is basis of GFDL experimental forecast system, and part of GFDL contribution to IPCC-AR4/ CMIP3.

CM2.1 simulation of the Indian Ocean climatology

CM2.1



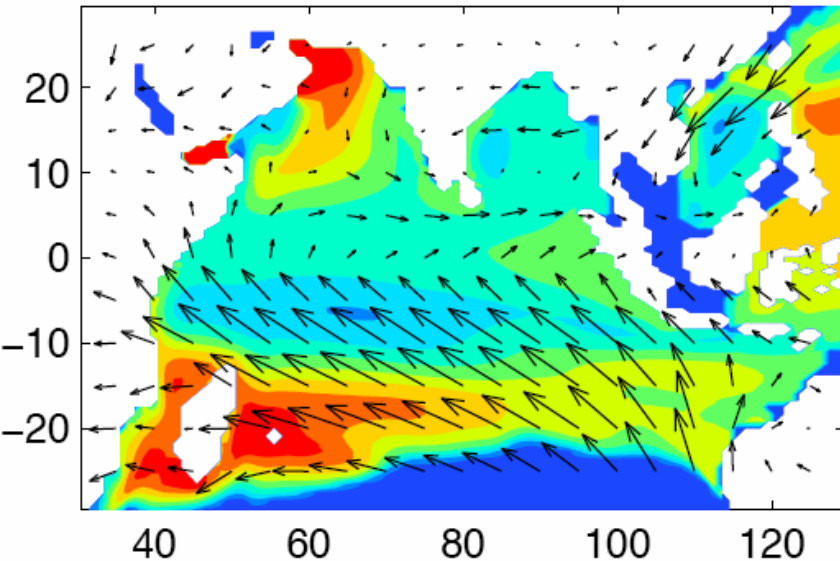
CM2.1 reproduces aspects of the equatorial thermocline tilting (slight downward toward the east in Indian Ocean, upward in Pacific).

Figure: temp. 2S-2N averaged. Red curve is 20C isotherm.

CM2.1 simulation of the Indian Ocean climatology

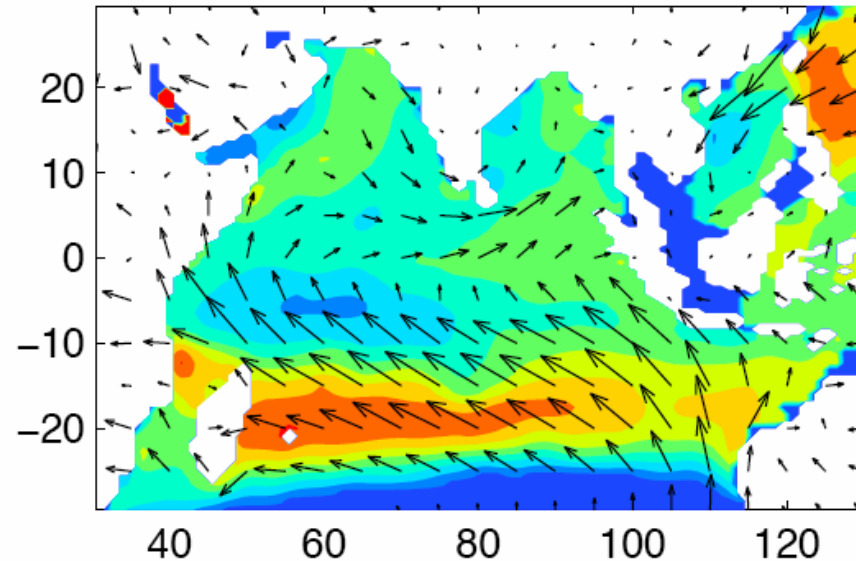
CM2.1

(d) SON



Levitus

(h) SON



Shade: 20° C Isotherm Depth

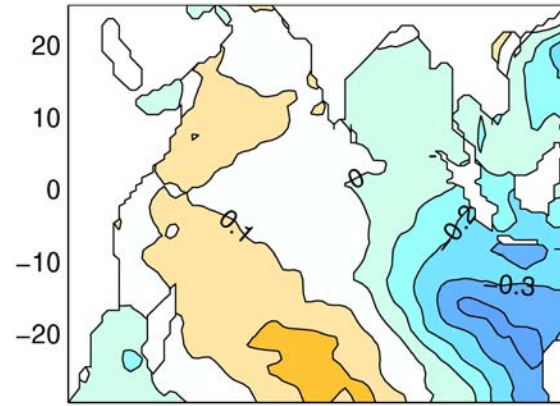
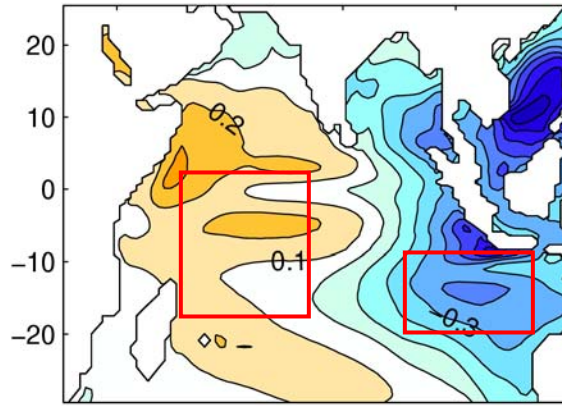
→ 10m/s

Vector, 10m wind

Dipole Index

CM2.1 (15.3%)

Reynolds (9.5%)

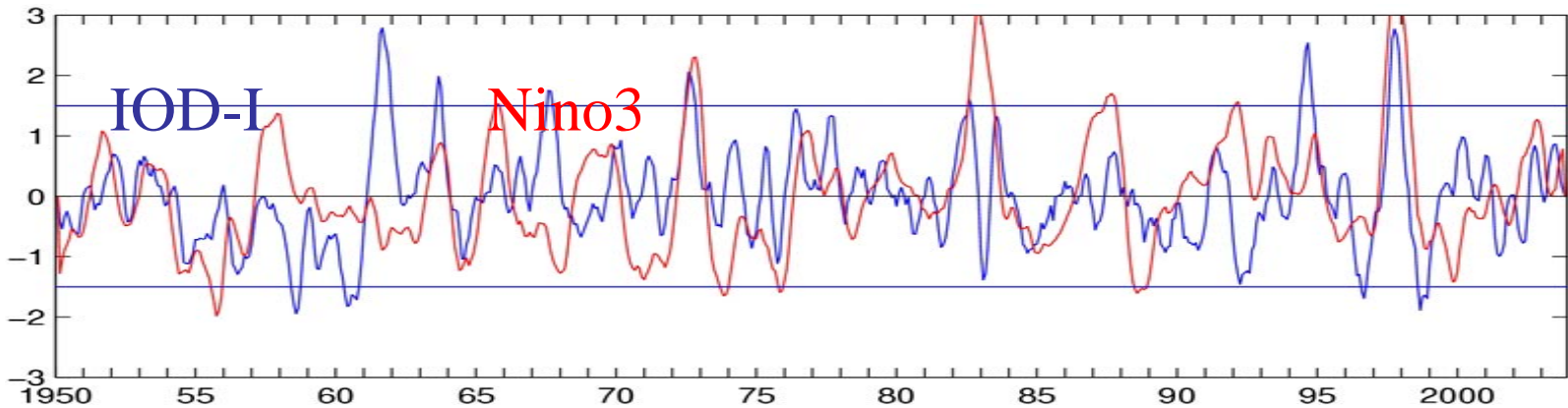


← Second SSTA
EOF



$$\text{IOD-I} = \text{WTIO-I} - \text{ETIO-I}$$

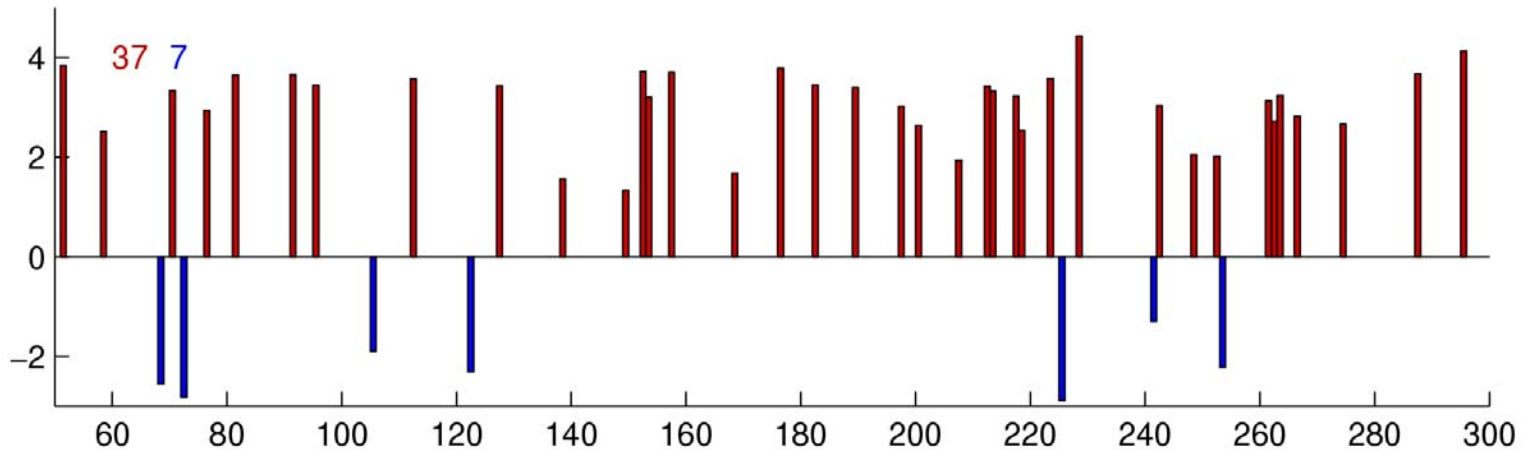
Saji et al. (1999)



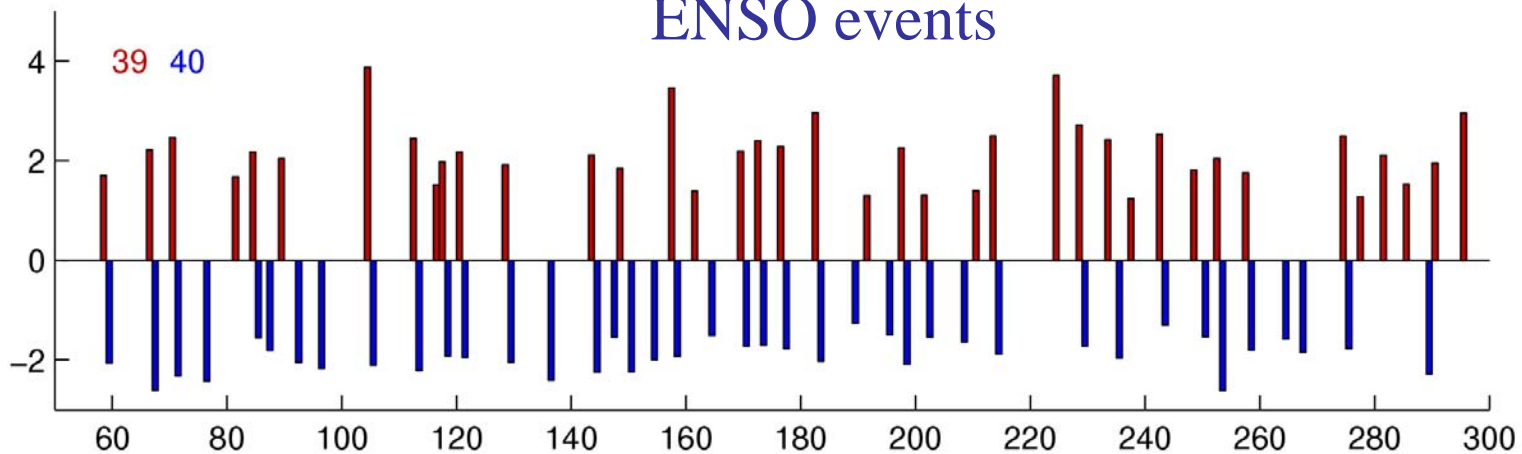
Song et al (2007, J. Clim.)

CM2.1 simulation of IOD and ENSO events

IOD events



ENSO events

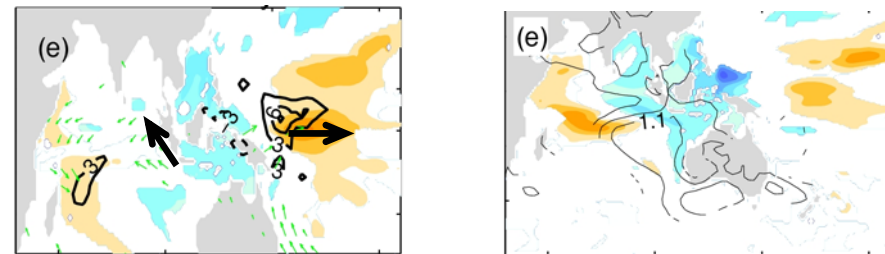
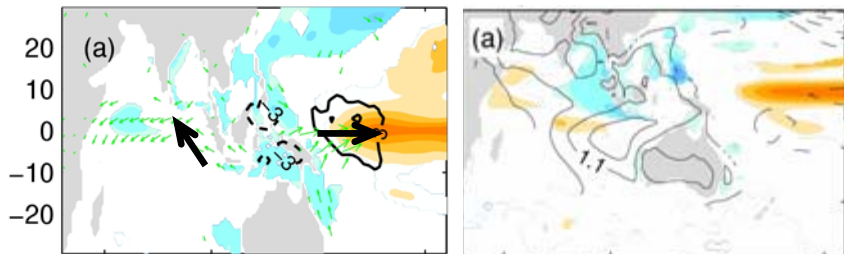


IOD&ElNino group

IOD-Only group

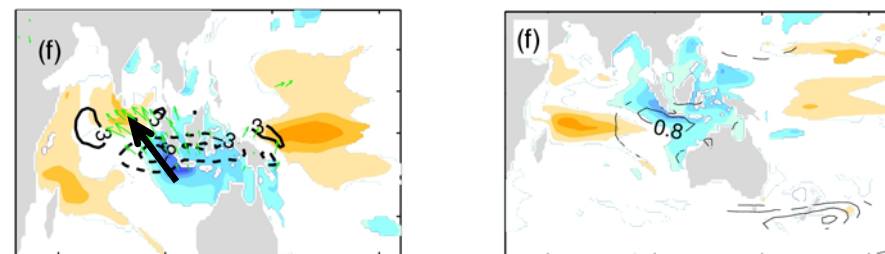
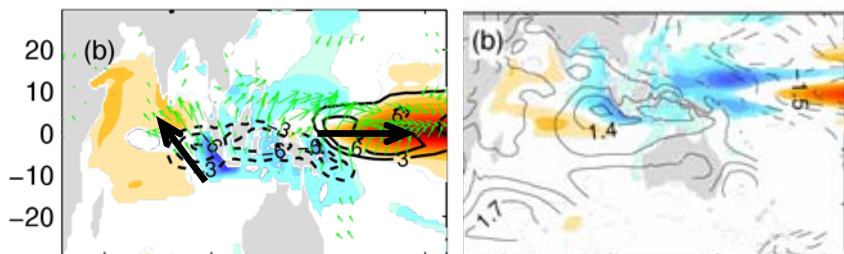
MAM

SST(shade), rain, wind

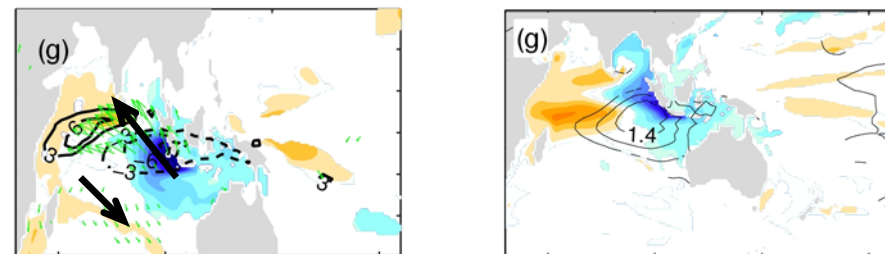
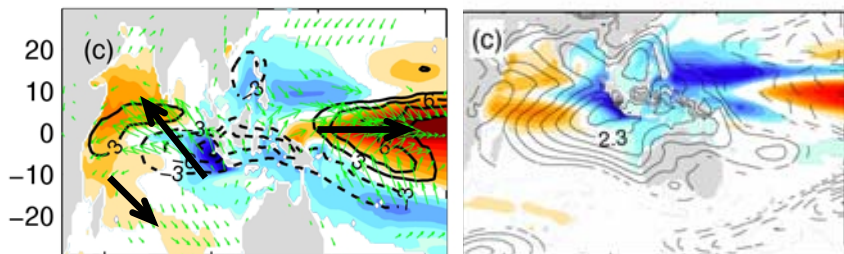


T0300(shade), SLP JJA

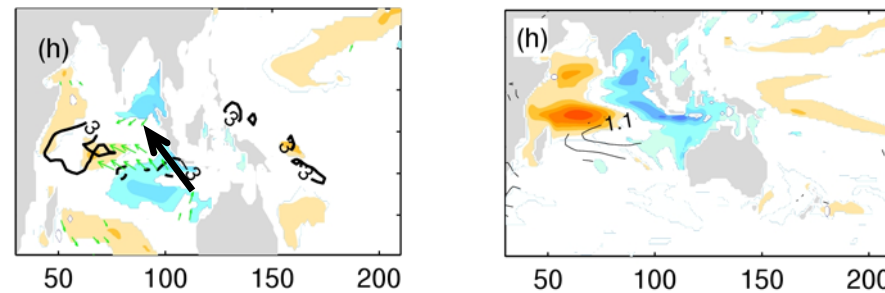
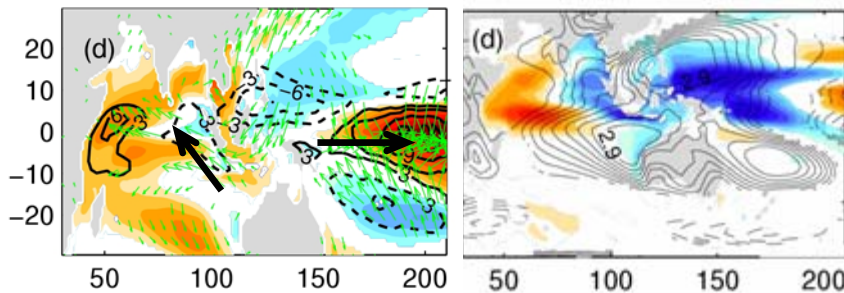
T0300(shade), SLP



SON SST(shade), rain, wind



DJF

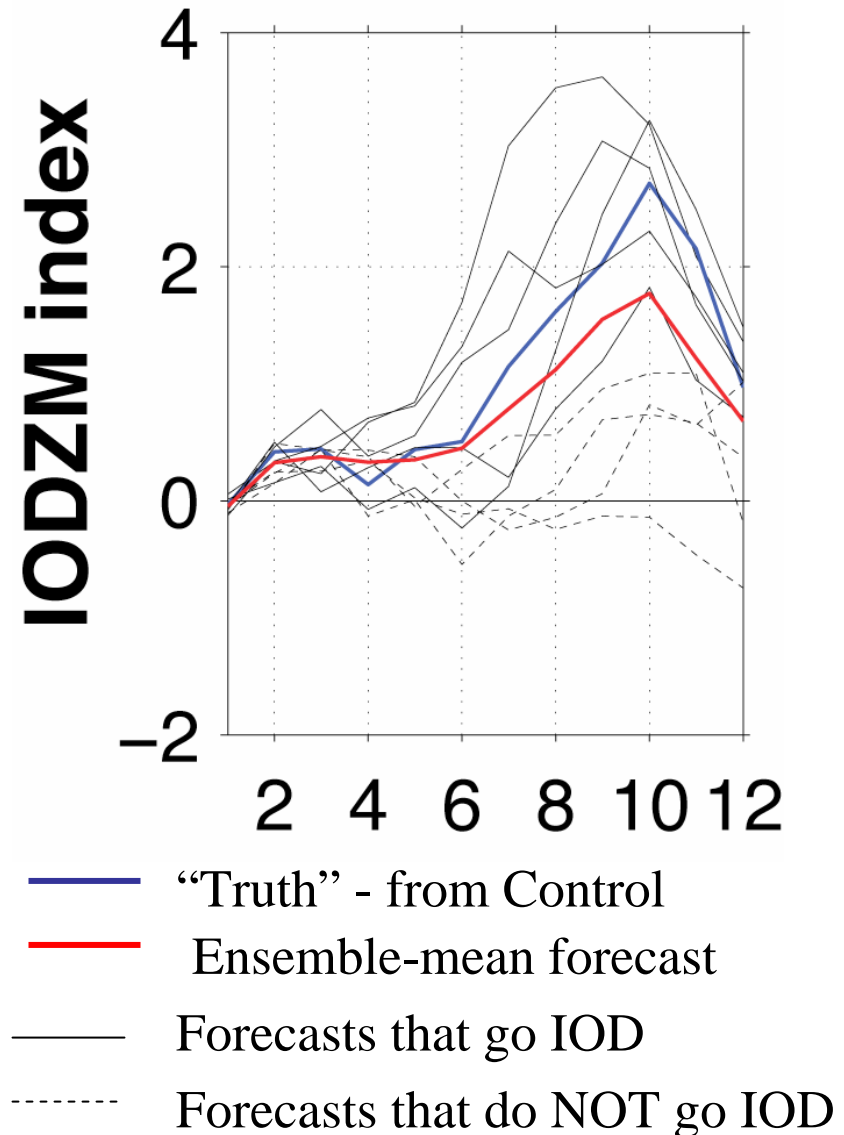


How good is coupled model at predicting itself?

From Song et al (2007, in prep.)

Use GFDL CM2.1 CGCM.

- Pick 10 IOD events from 300-year Control (1990 Conditions) run.
- Perturb atmospheric initial conditions - 10 ensemble members.
- Null, at $p=0.05$, expect 0-4 IODs per forecast experiment.



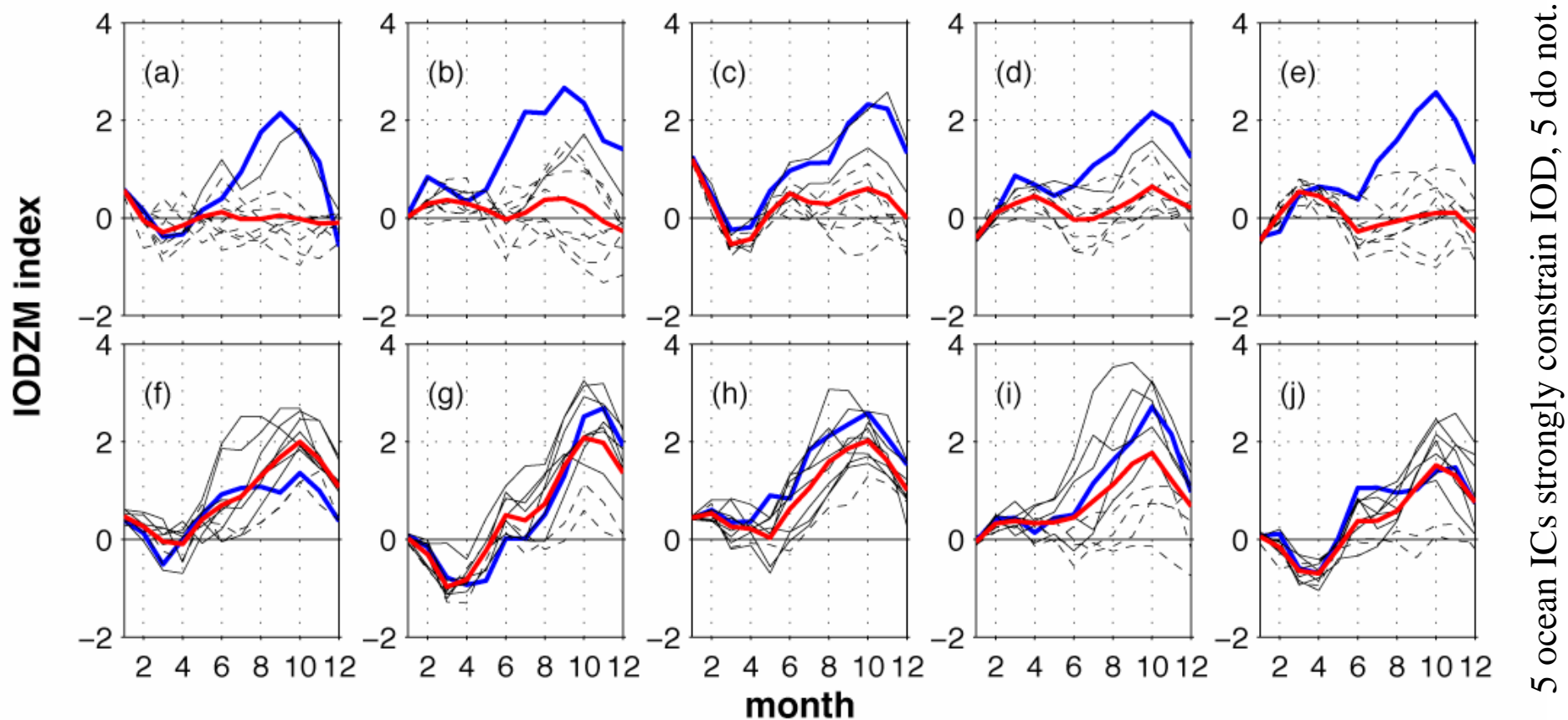
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PERFECT MODEL/PERFECT OBSERVATION IOD FORECAST EXPERIMENTS WITH GFDL CM2.1

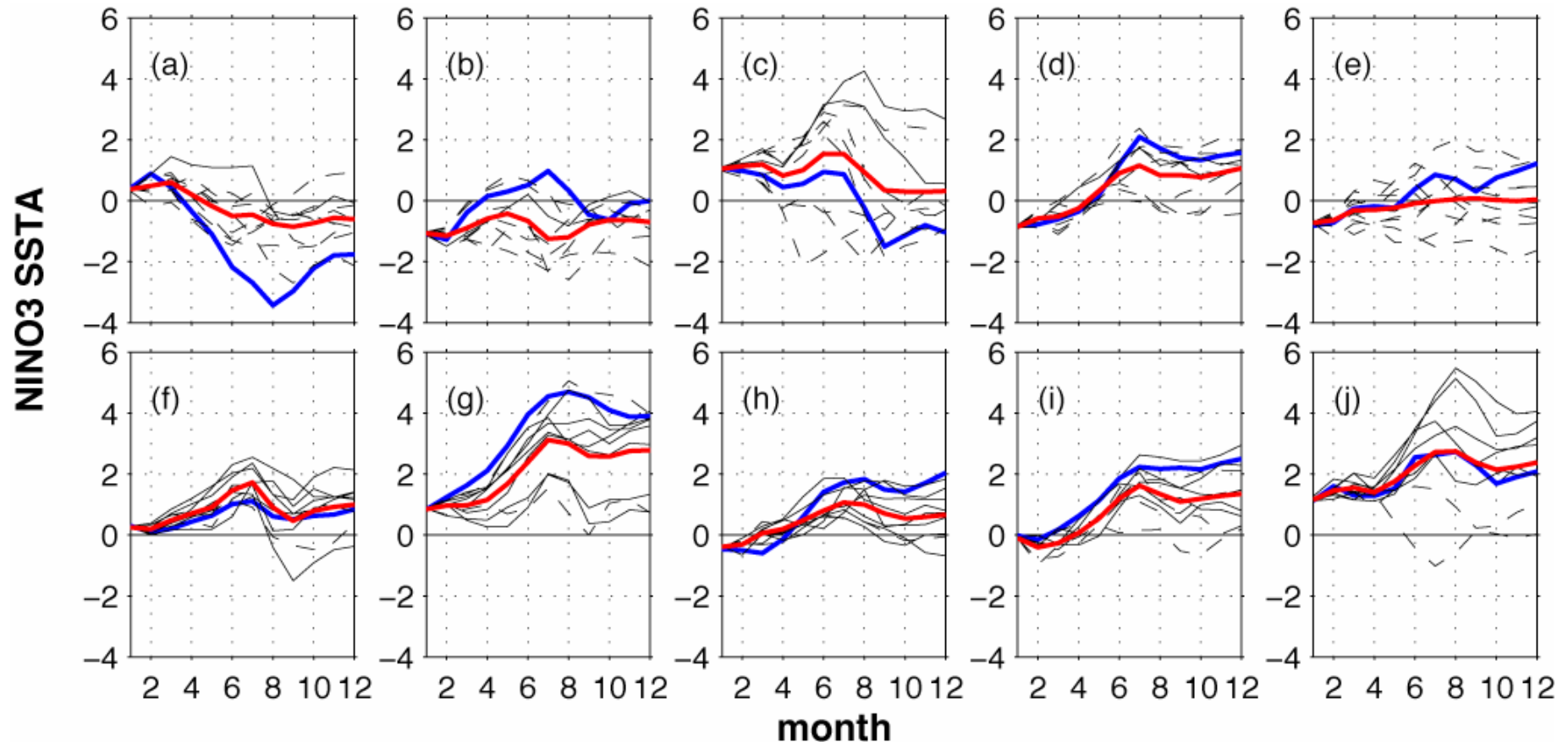


— “Truth” - from Control
— Ensemble-mean forecast

— Forecasts that go IOD
- - - Forecasts that do NOT go IOD

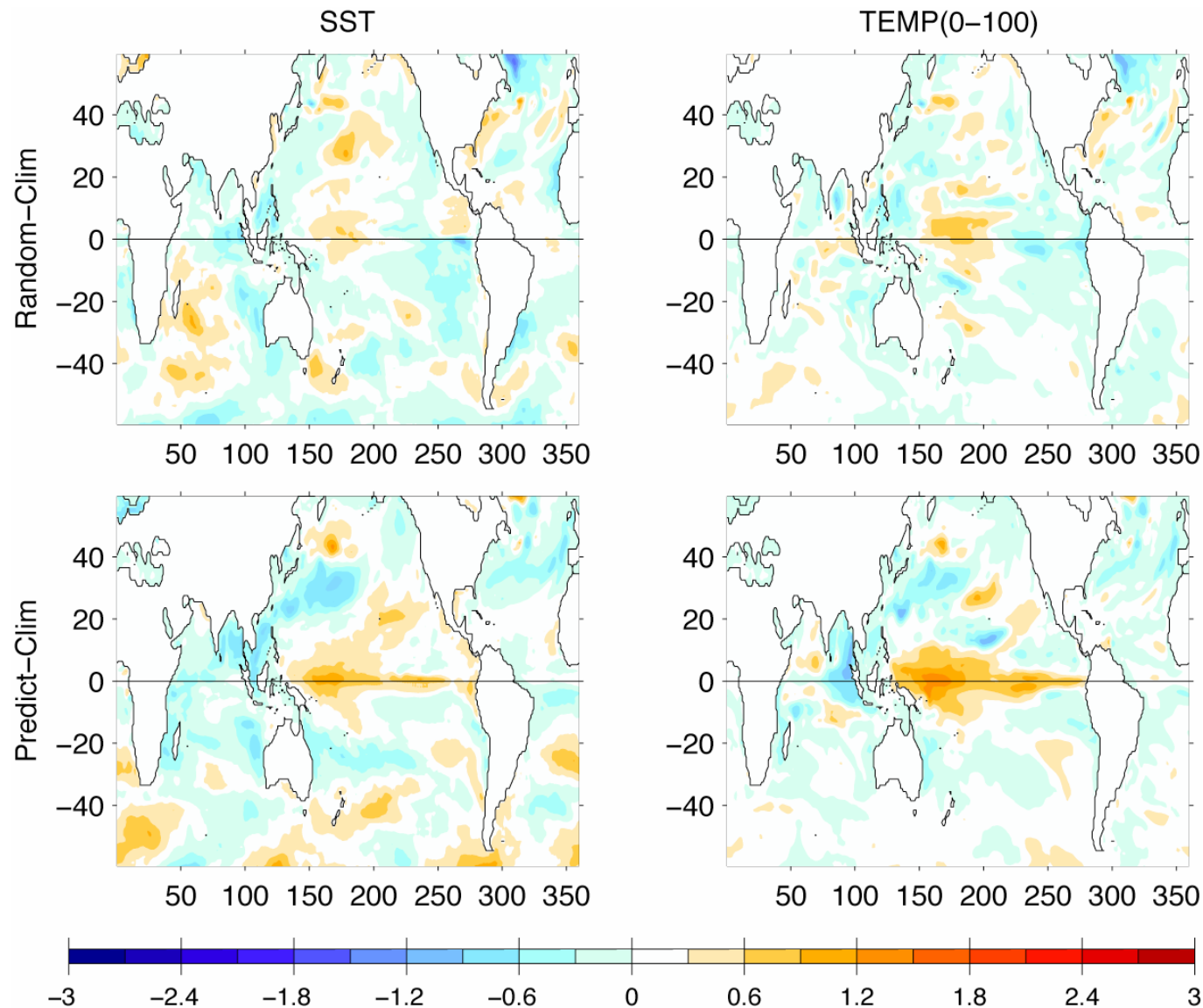
5 ocean ICs strongly constrain IOD, 5 do not.

Some - not statistically significant - tendency to develop El Niño during “predictable IOD”



From Song et al (2007, in prep.)

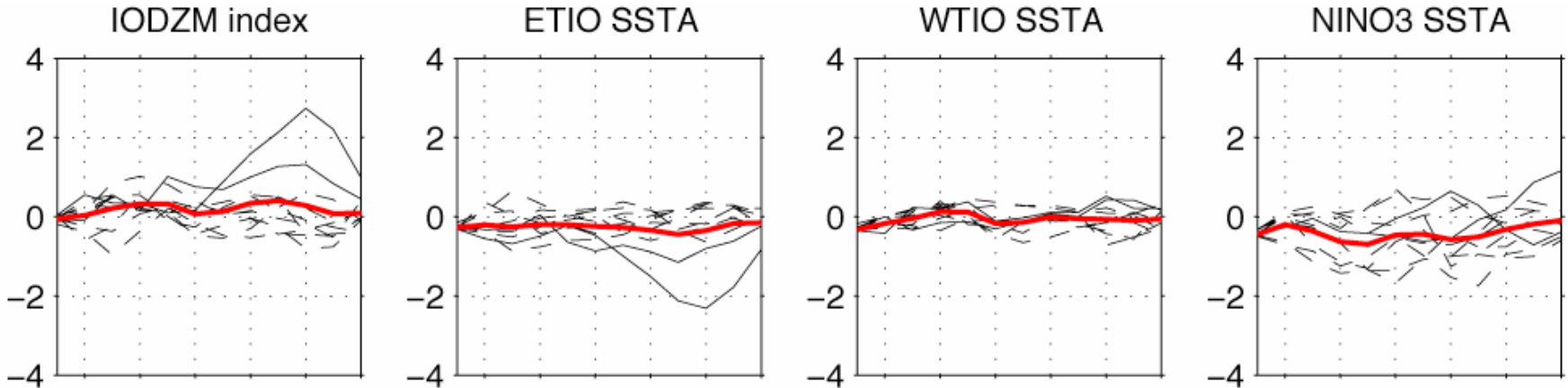
Ensemble-mean Ocean Initial Conditions for “Random” and “Predictable” IOD Events



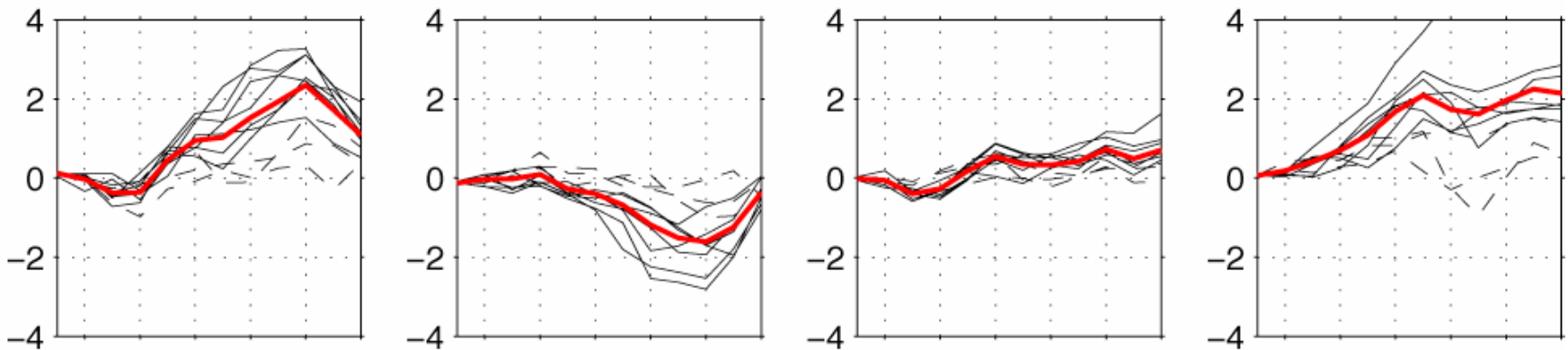
From Song et al (2007, in prep.)

What is effect of “Random” and “Predictable” ICs?

“Random” ICs

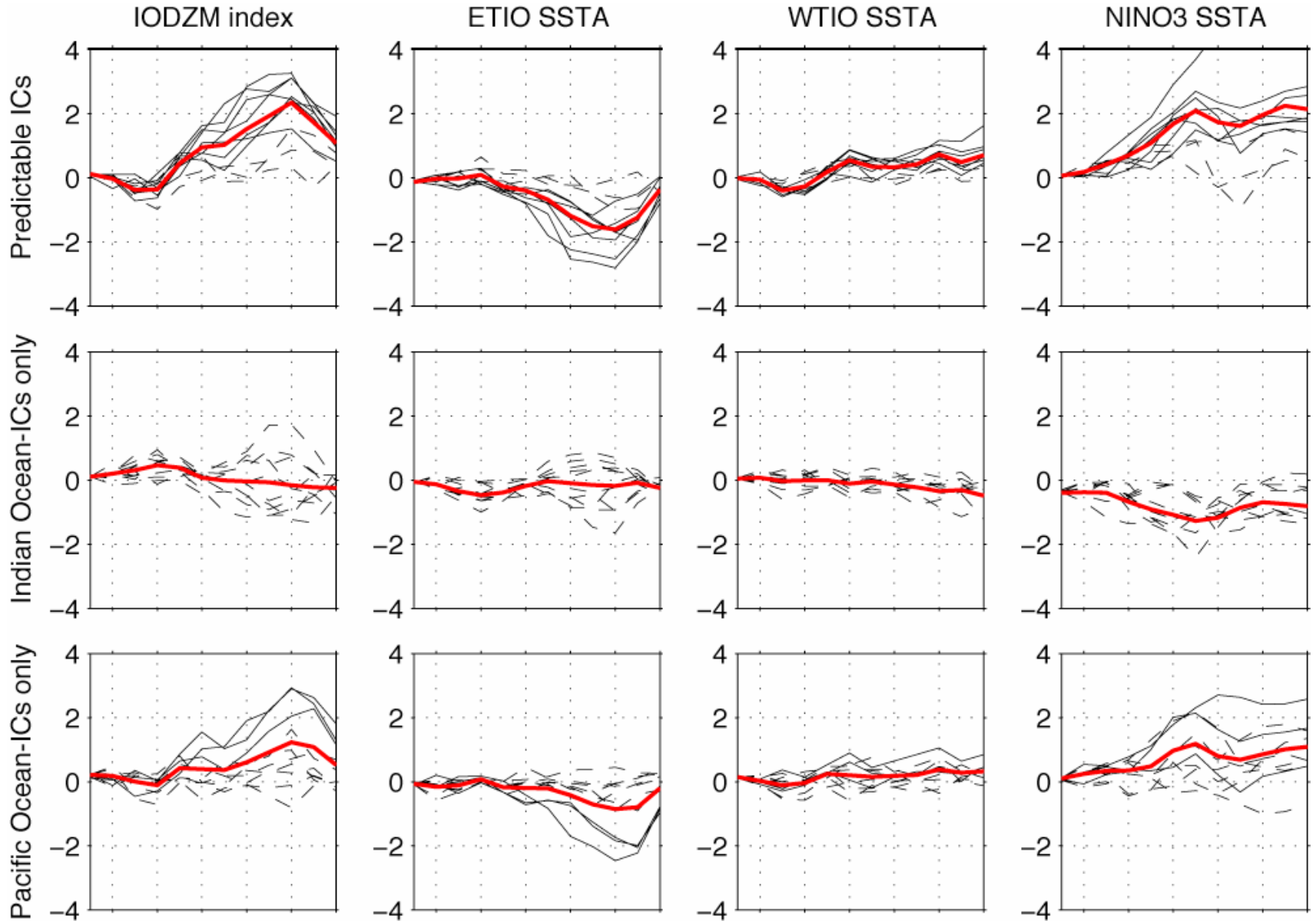


“Predictable” ICs



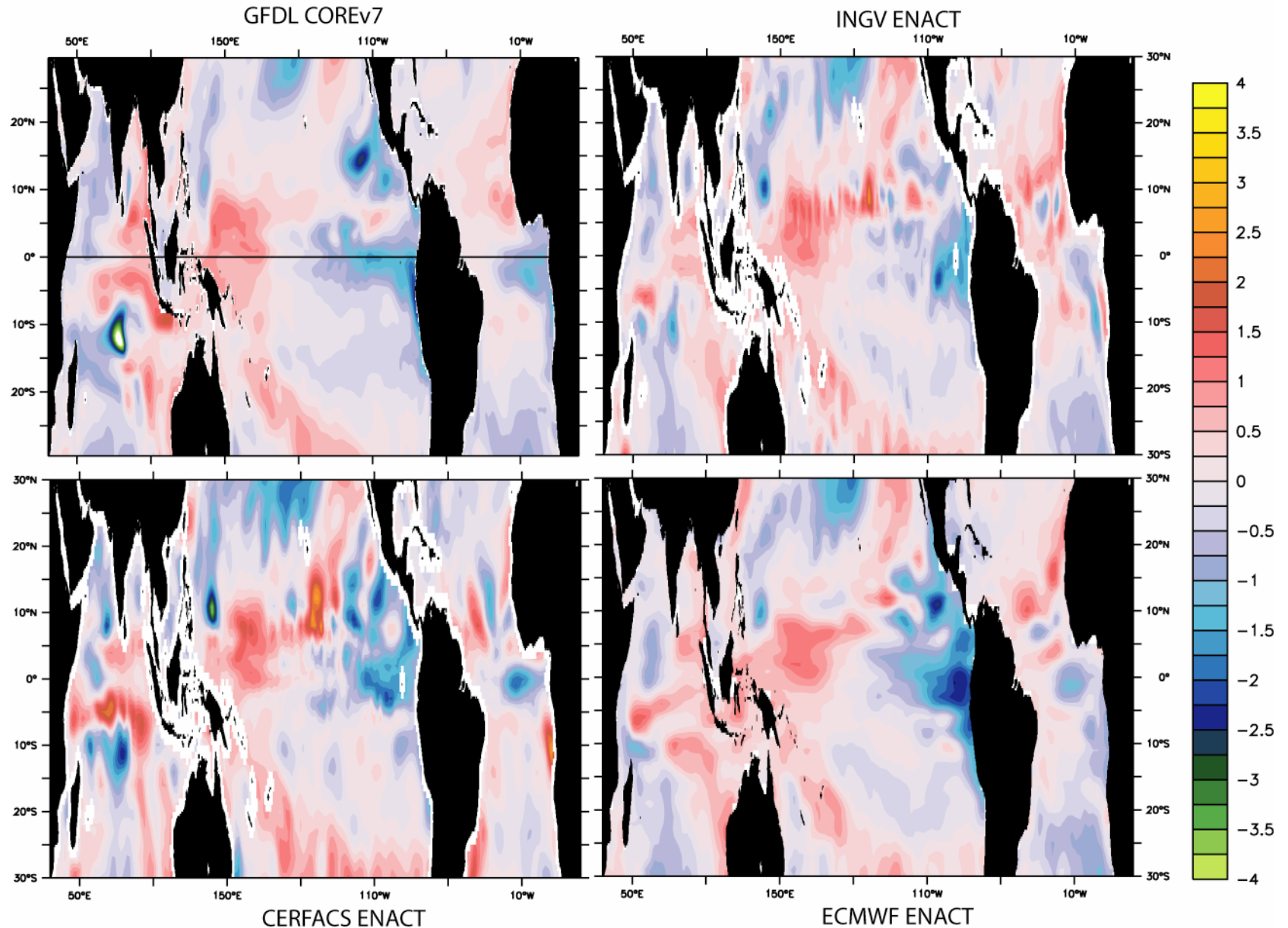
From Song et al (2007, in prep.)

Where is predictability coming from?



From Song et al (2007, in prep.)

Jan 1997 0-100m TEMPERATURE ANOMALY FROM FOUR ODAs



Summary

- GFDL CM2.1 has reasonable representation of aspects of climatology and interannual variability in Indian Ocean.
- “Perfect model/perfect observations” experiments indicate that some IOD events are predictable 9 months ahead, while others are not.
 - Identify “predictable” initial conditions that strongly constrain system - in GFDL CM2.1 (would they constrain another model?).
- Predictability comes from both the Indian and Pacific ICs.
 - Though either does not constrain model on its own. Hypothesize that need consistent state across ITC and atmospheric bridge.