The Slab Ocean El Niño

Can El Niño exist without ocean dynamics?

The tail wags the dog

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MONASH

Overview

- ENSO model hierarchies
- Slab Ocean El Nino
- A look at other models

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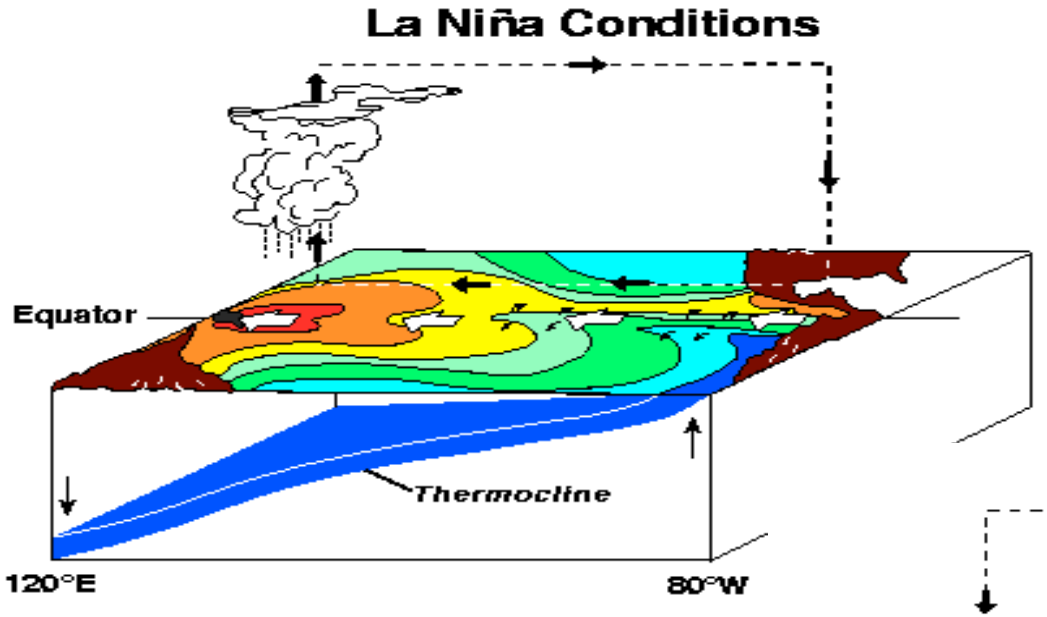
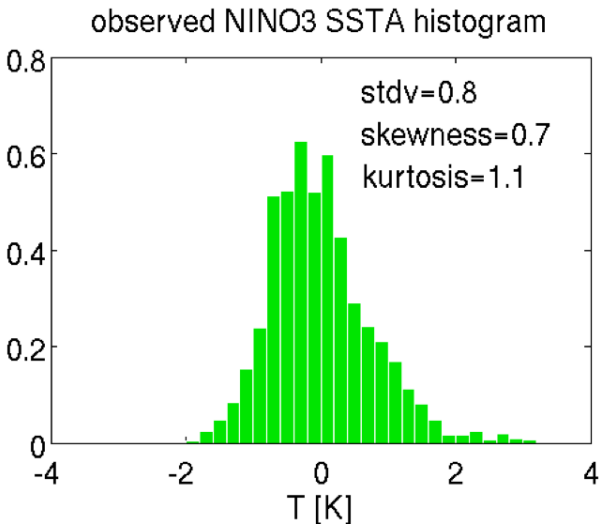
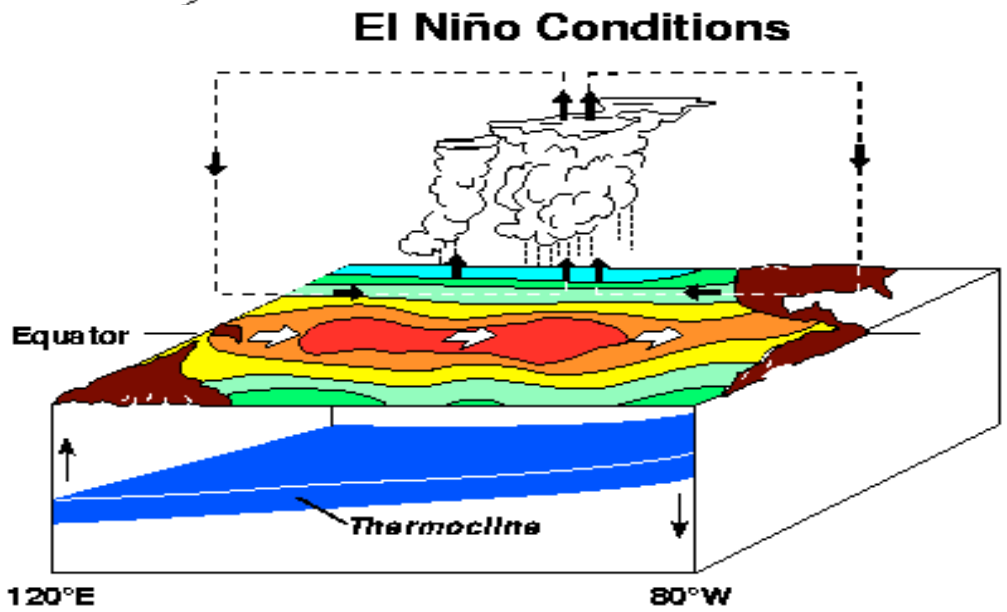
The '*textbook*' El Nino

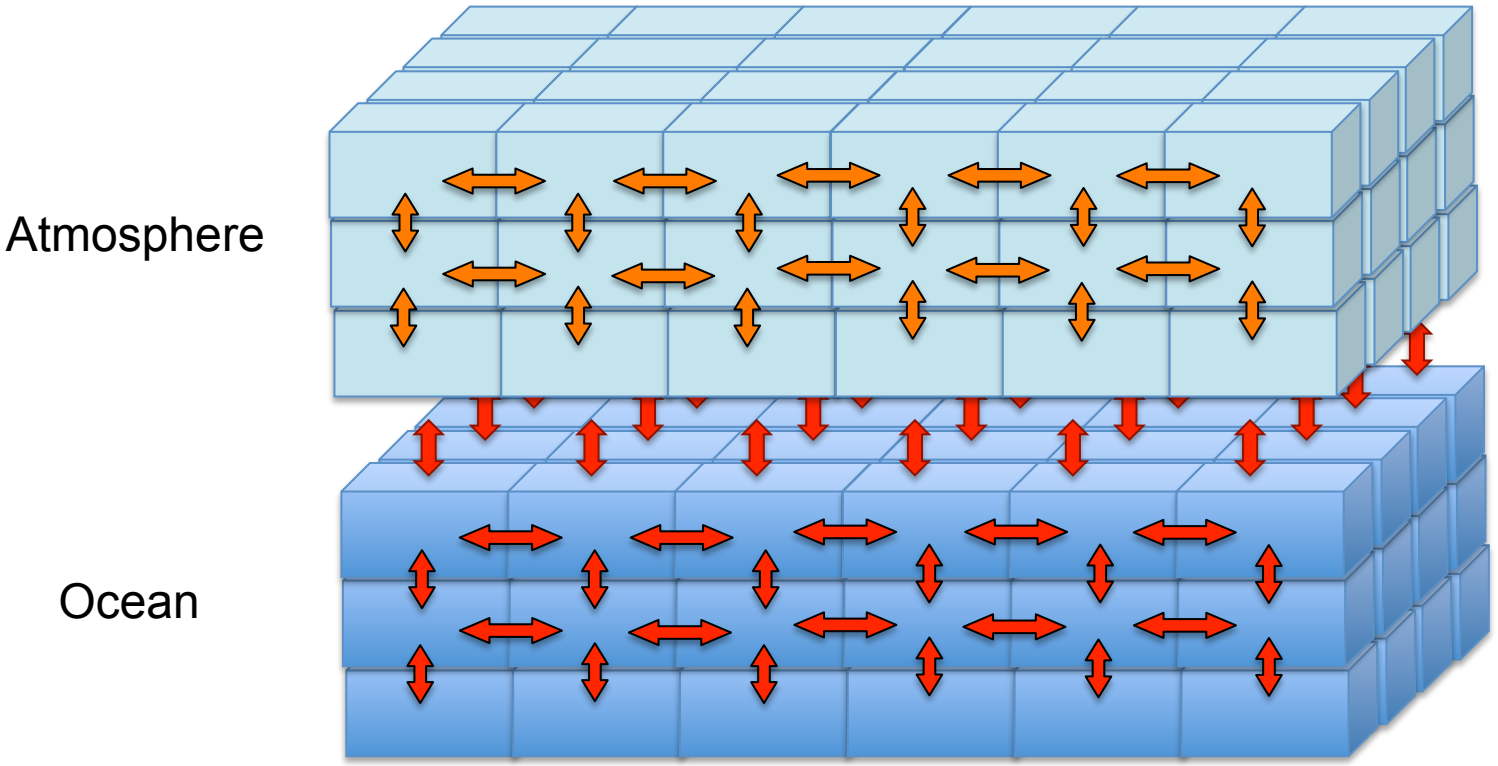






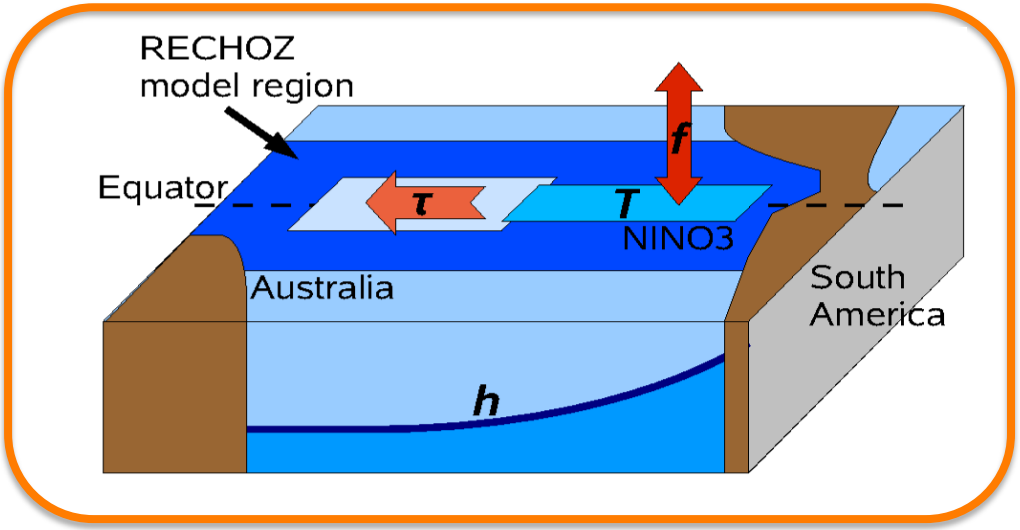
ENSO model hierarchy

Highest complexity: coupled GCMs

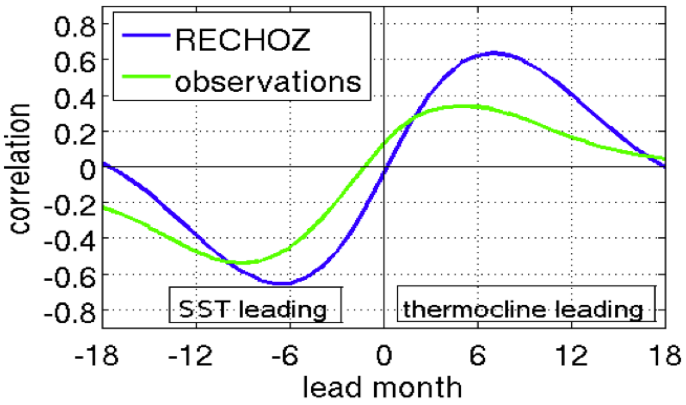


ENSO model hierarchy

Lowest complexity: Recharge Oscillator

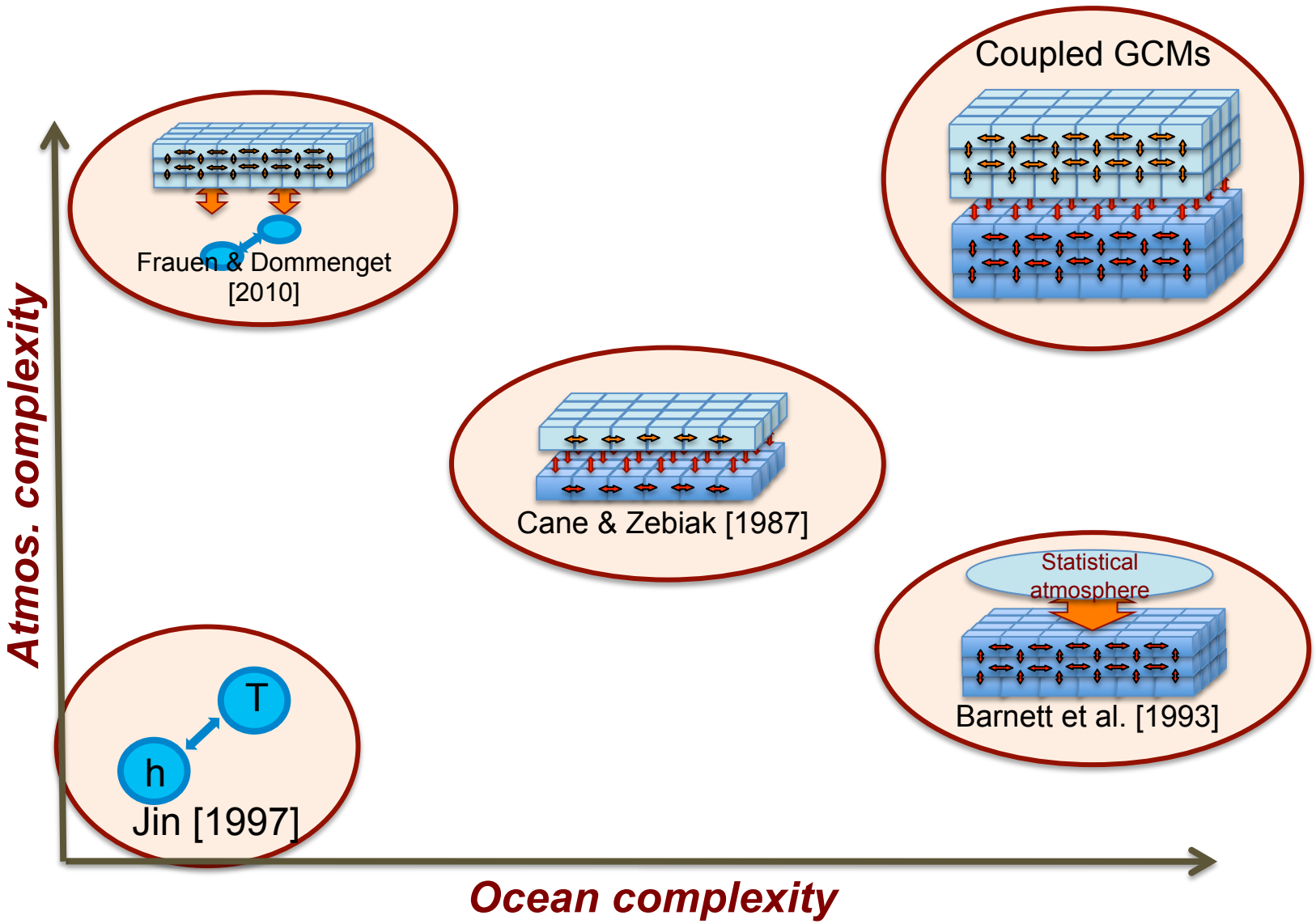


$$\frac{d}{dt}\begin{pmatrix} T \\ h \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}\begin{pmatrix} T \\ h \end{pmatrix}$$



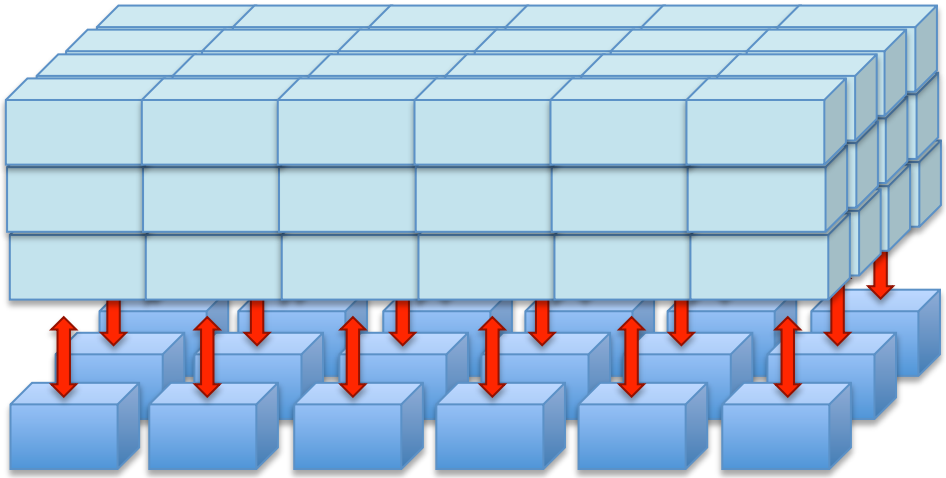
[Jin 1997]

ENSO model hierarchy



Slab Ocean Dynamics

Atmosphere GCM



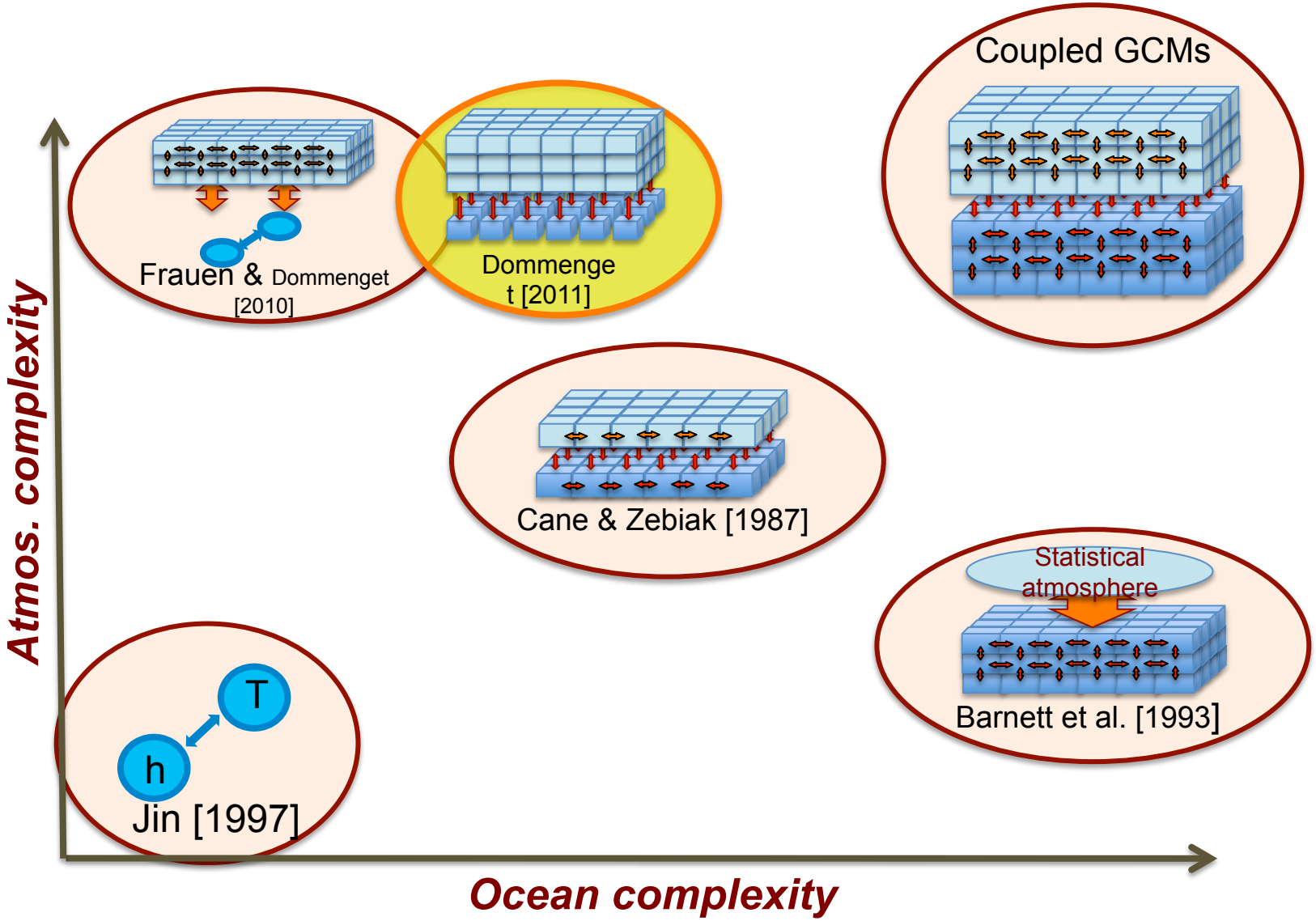
Slab ocean

Complete Slab ocean model

$$\gamma \frac{dSST}{dt} = F_{atmos}(t,x) + Q_{correct}(t_{julian},x)$$

- Ocean points do not interact
- No thermocline dynamics
- All spatial coherence comes from the atmosphere

ENSO model hierarchy



The Slab Ocean El Niño

Model Simulations

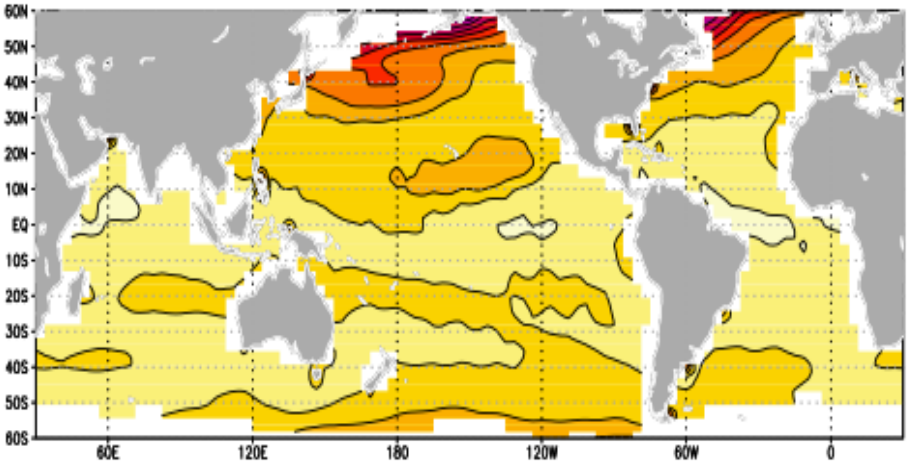
Atmosphere:	ECHAM5; T31 resolution
Ocean:	Slab ocean; 50m fix depth; Q-flux correction for control of mean SST

name	# of runs	# of years	description
	24	50	SST mean states forced by Q-flux to be as for the 24 CMIP3 20th .
ECHAM-slab (slab-50m)	1	1000	One member of the 24 runs, was continued to study the El Nino 'on' regime variability.
ECHAM-slab-20m	1	400	As ECHAM-slab, but with 20m slab ocean
ECHAM-slab-100m	1	400	As ECHAM-slab, but with 100m slab ocean

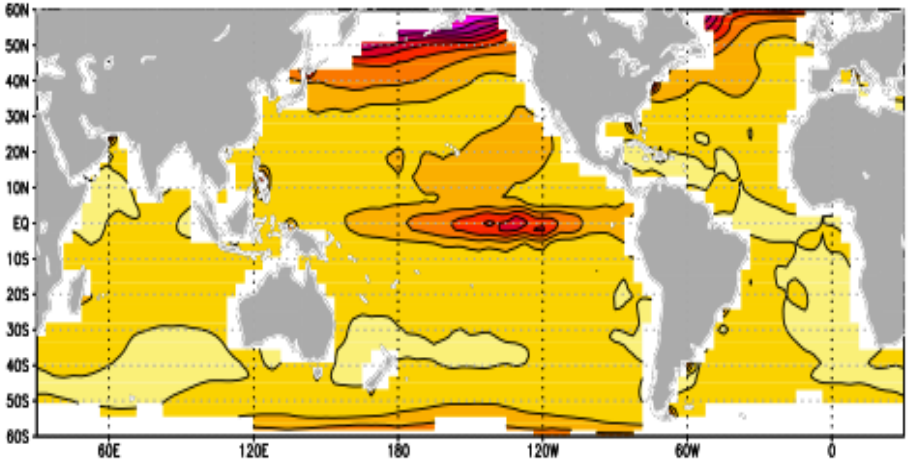
The Slab Ocean El Niño

SST standard deviation

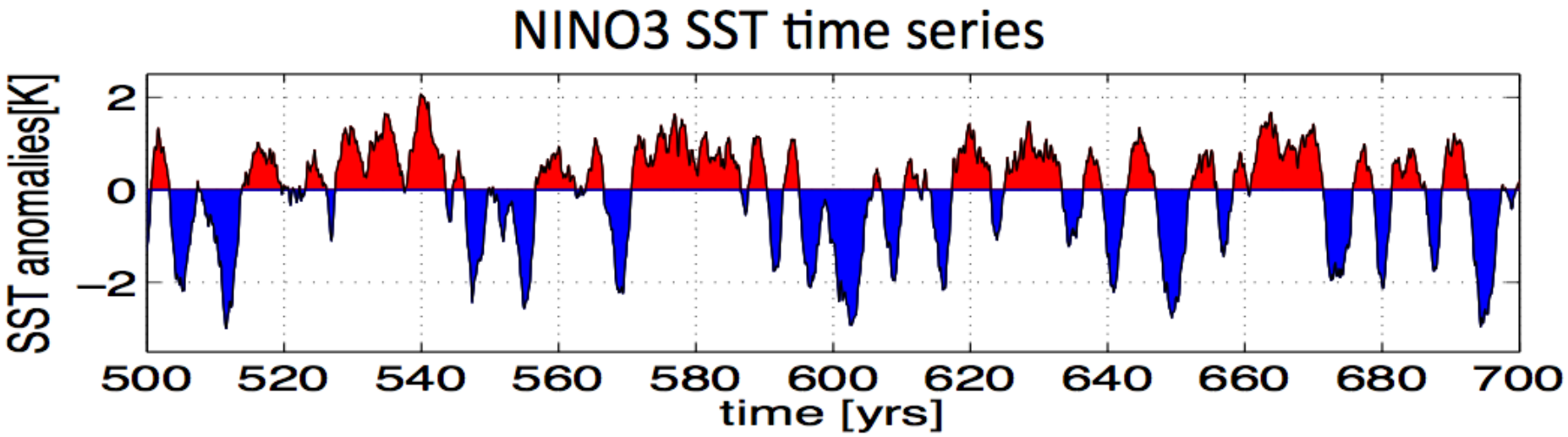
20 slab ocean models

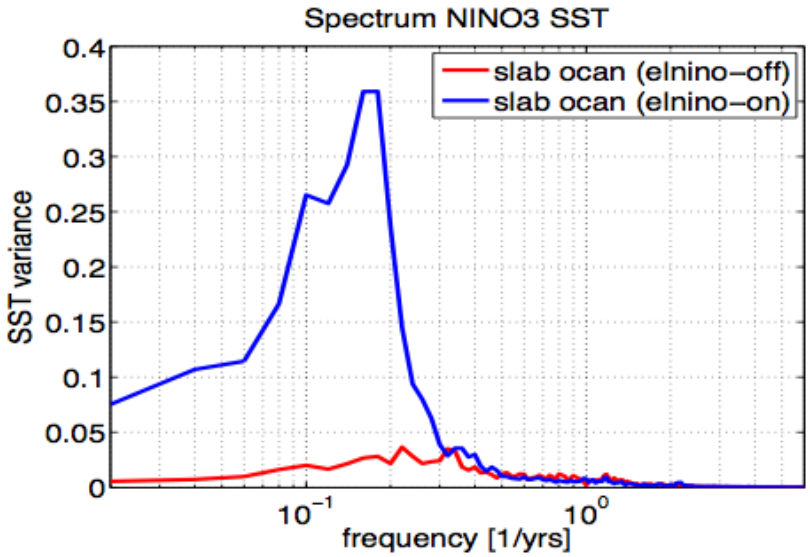


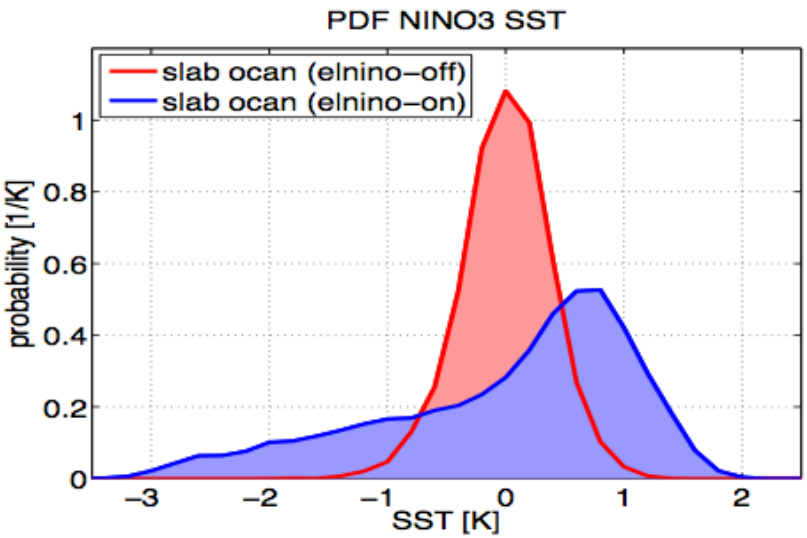
4 slab ocean models



The Slab Ocean El Niño

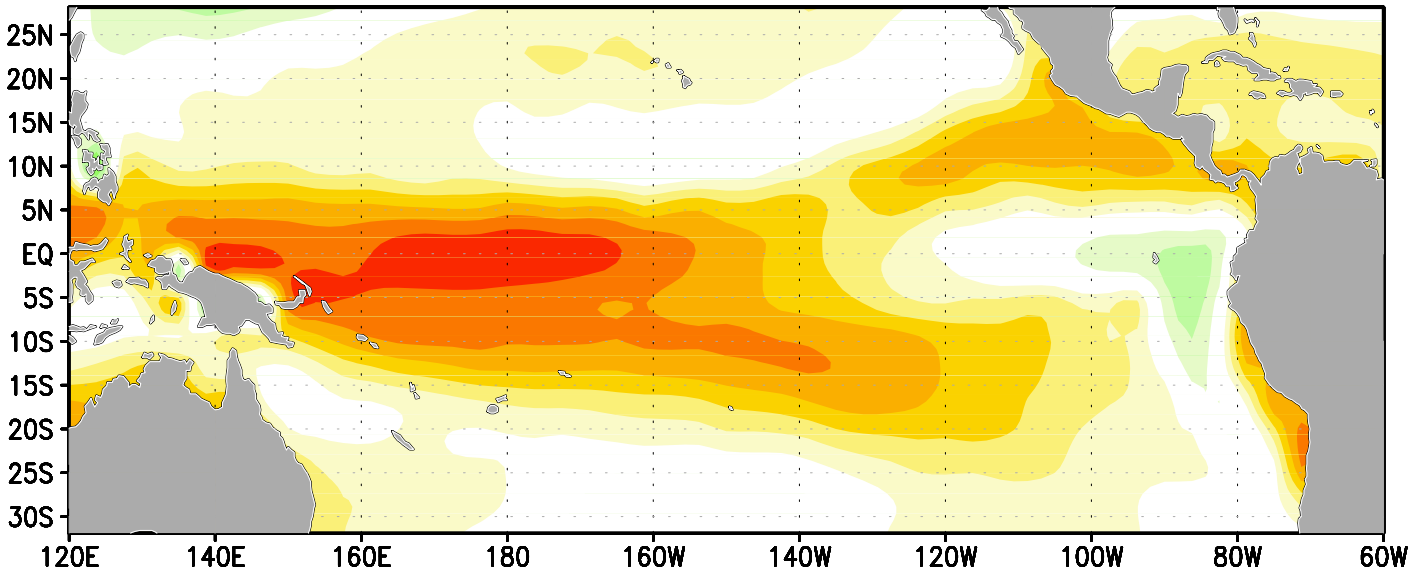






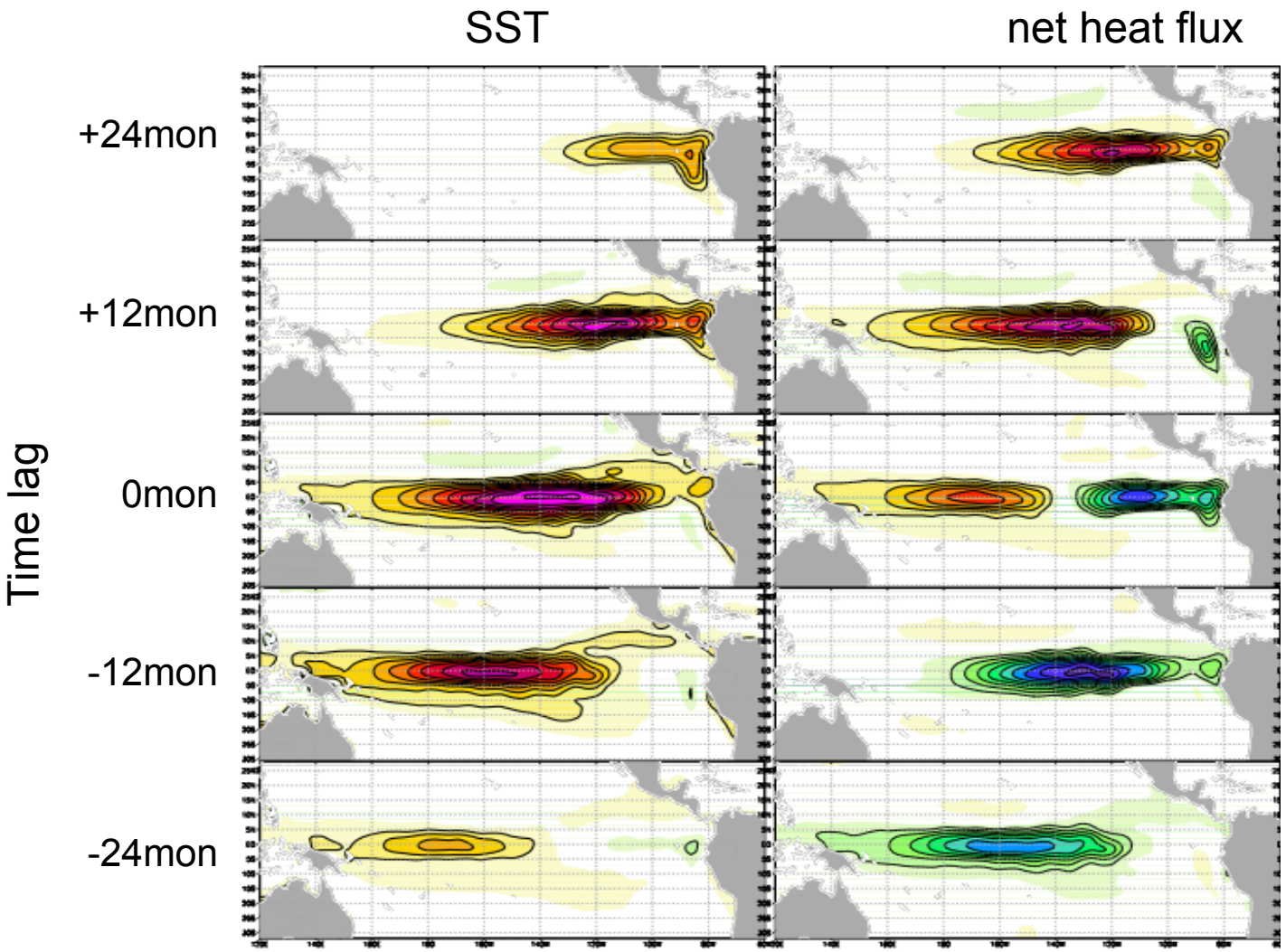
The Slab Ocean El Niño

Evolution of the Slab El Nino event



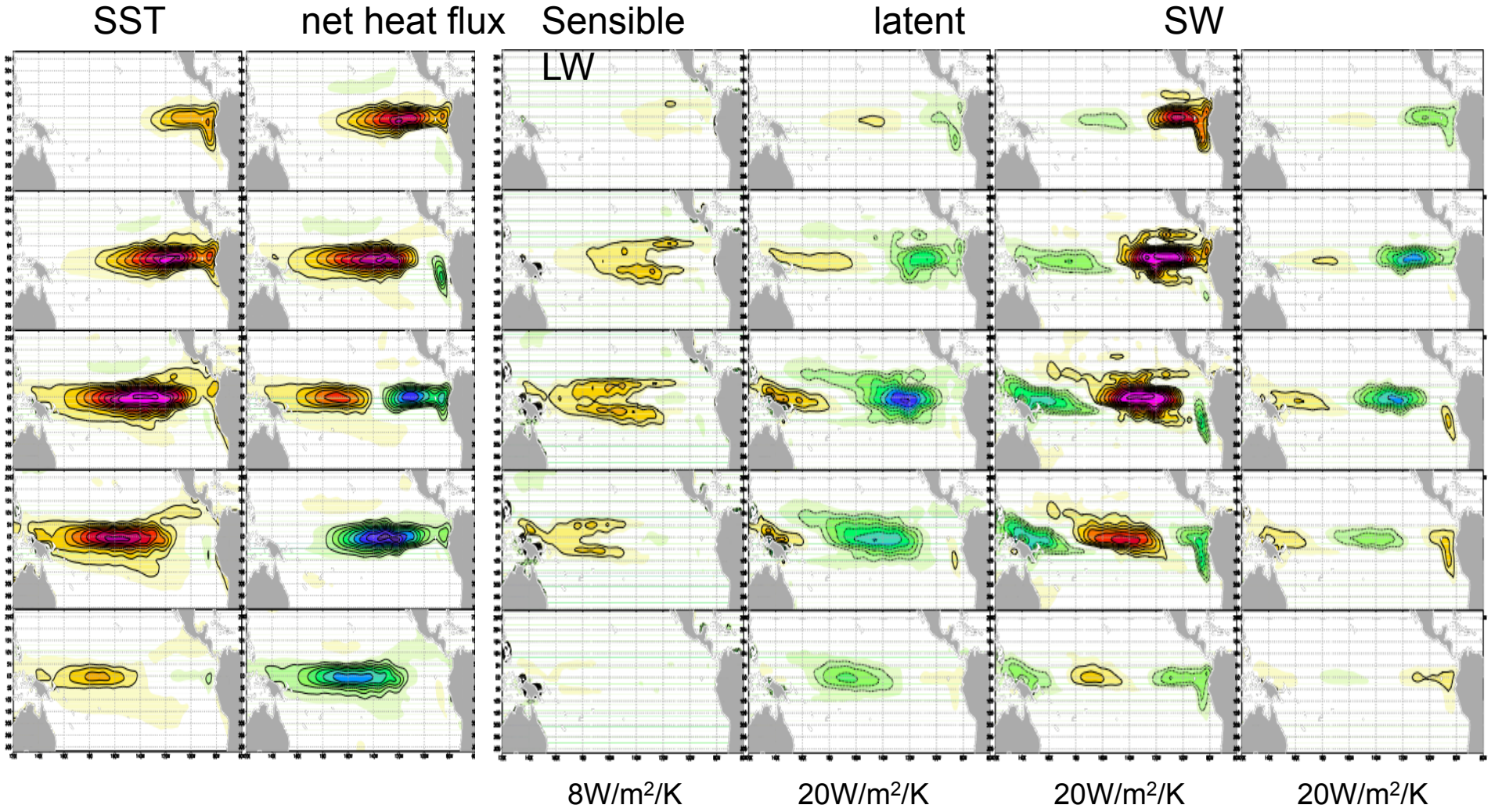
It looks like the SST-mode forced by the atmosphere [e.g. Neelin et al. 1998]

Atmospheric heat fluxes



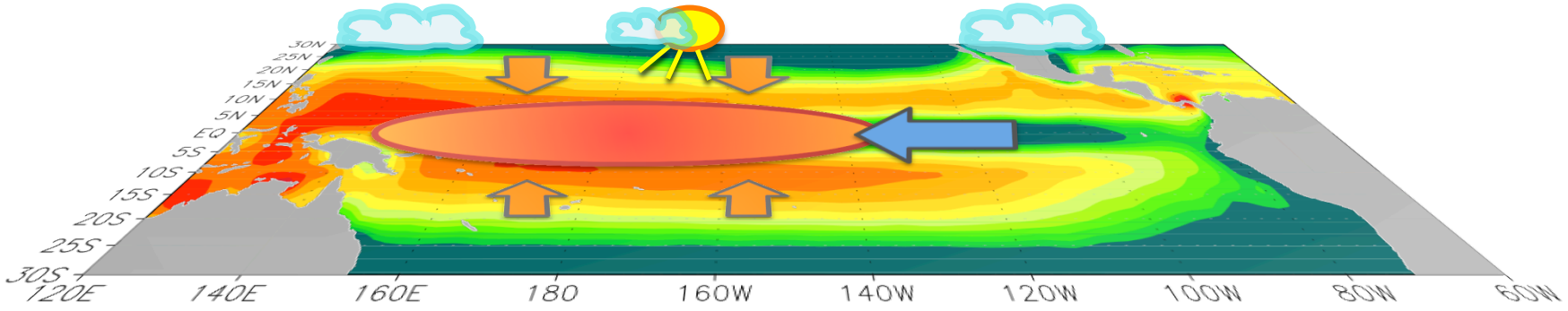
Atmospheric heat fluxes

Lag-lead regressions



The Slab Ocean El Niño Dynamics

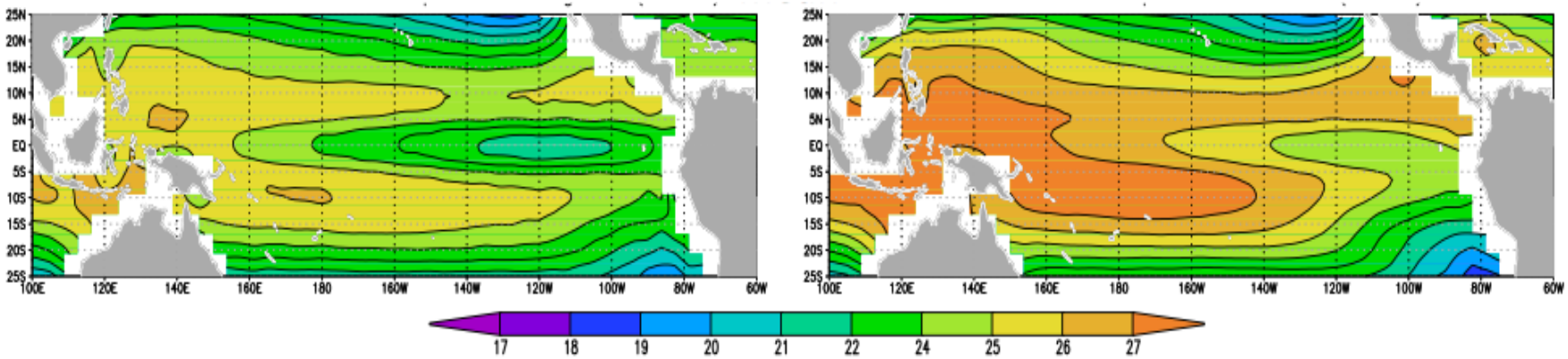
Decay phase



SST mean state dependence

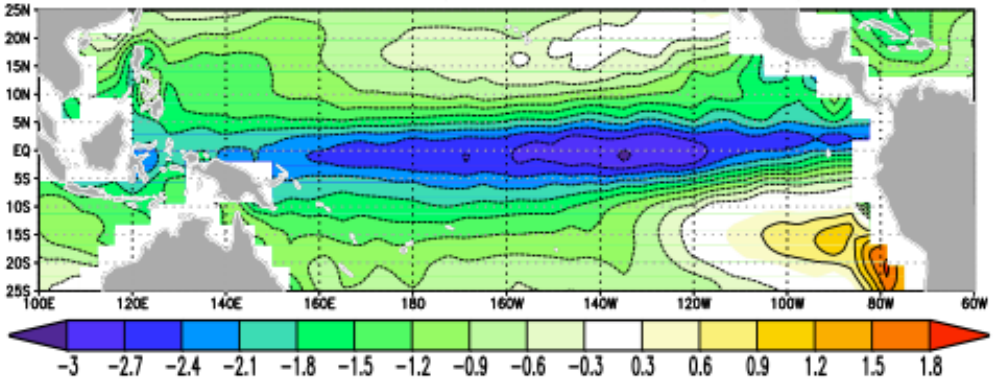
Mean SST climate

4 slab ocean models



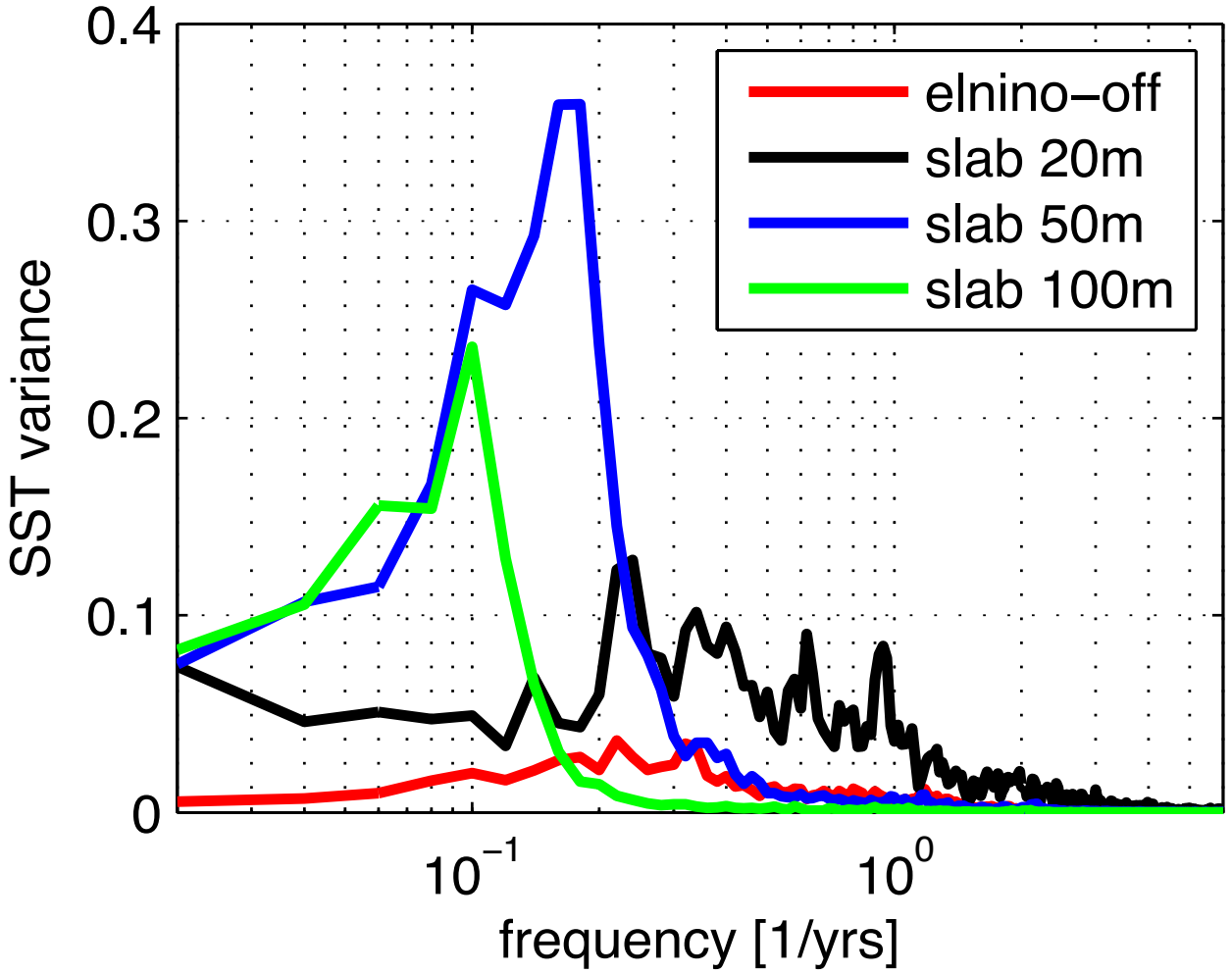
20 slab ocean models

mean difference



The Slab Ocean El Niño Inertia

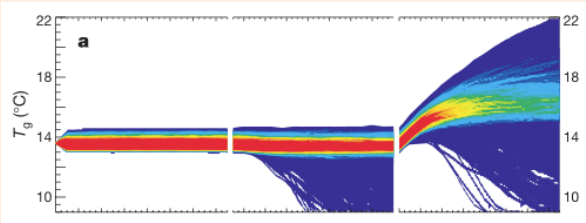
NINO3 SST Spectra



Other Slab models

Hint 1

ClimatePrediction.org



Perturbed Physics experiments

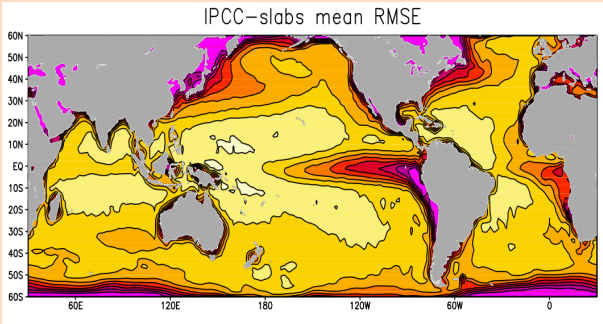
-> Slab ocean models

"There is a well understood mechanism for models with a mixed layer ocean to produce dramatic, unphysical cooling. "

Stainforth et al. 2005

Hint 2

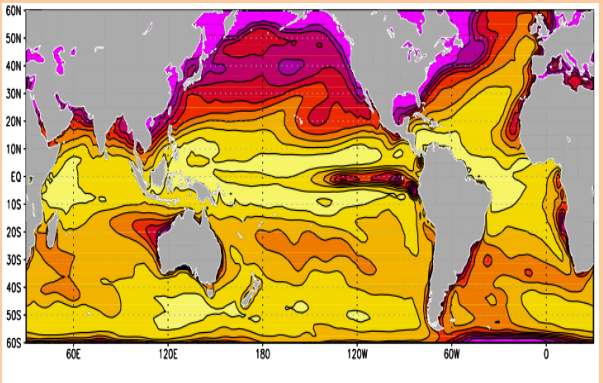
CMIP3 slab model



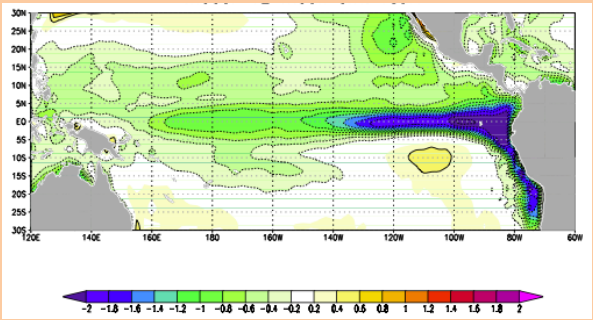
Spread of 13 slab models in mean SST

Hint 3

NCAR CCSM 3.0 slab-control



SST Stdv

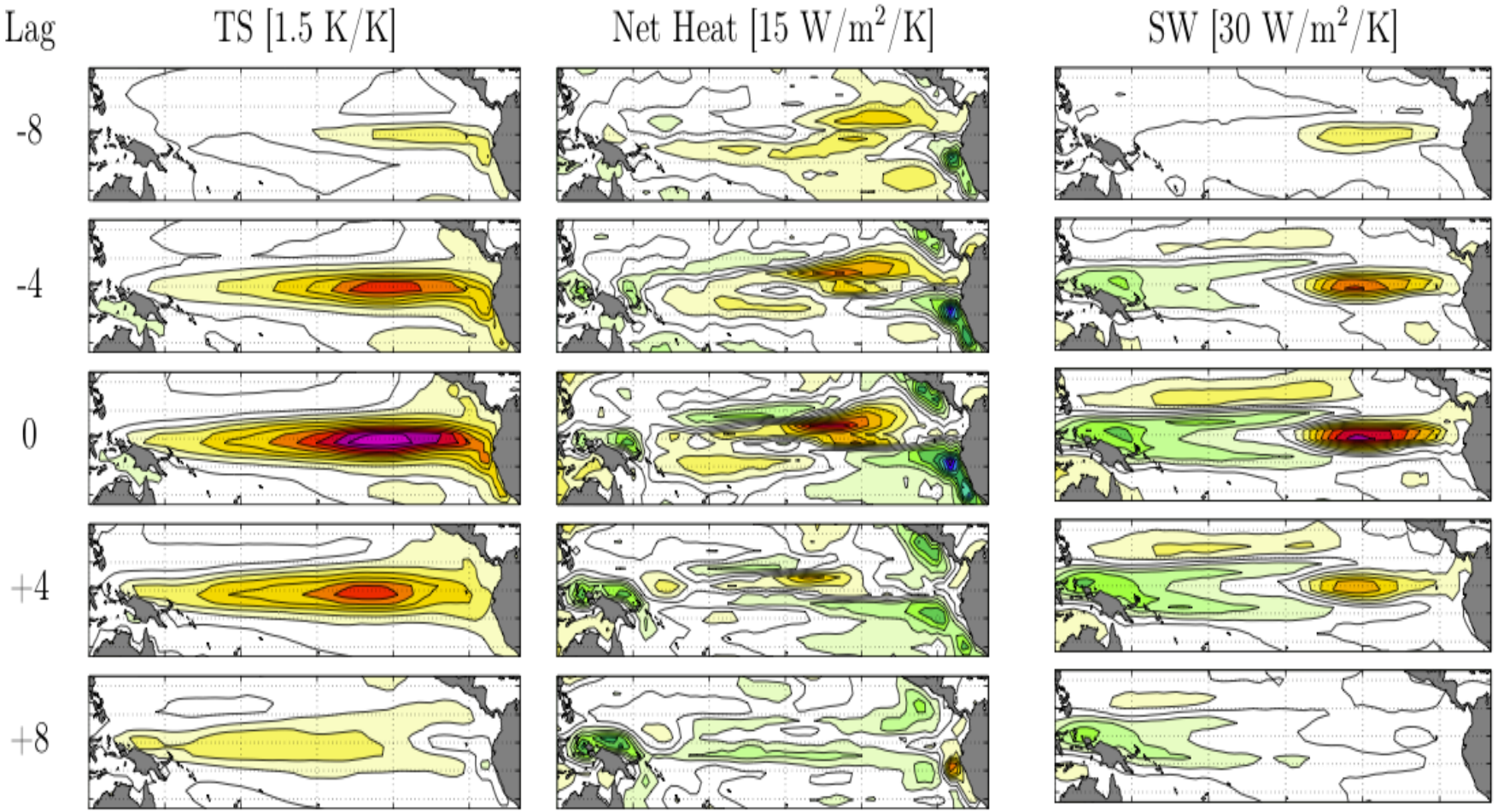


Diff. mean SST from ensemble mean SST

Coupled GCM models

Have the Slab El Nino dynamics any relevance for coupled GCMs?

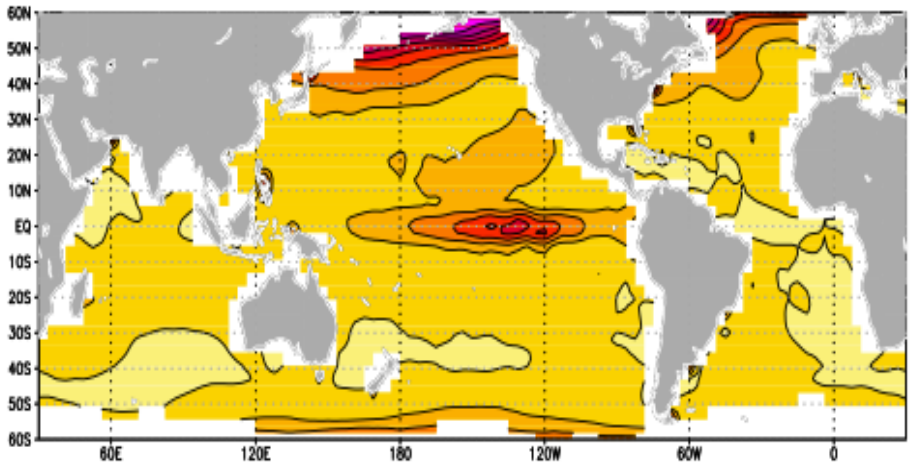
BCCR-BCM2.0



Conclusions: Slab Ocean El Niño

- ✧ El Niño can exist without ocean dynamics in a **CGCM**
- ✧ It is ***NOT*** a ECHAM model artifact
- ✧ It looks like the SST-mode [e.g. Neelin et al. 1998]
- ✧ It could indicate important atmospheric feedbacks

4 slab ocean models



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