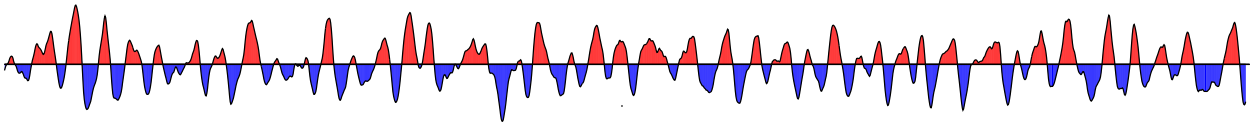
ENSO in the GFDL Coupled Model



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Coupled model as of May 2003. . .

OM2p2 ocean

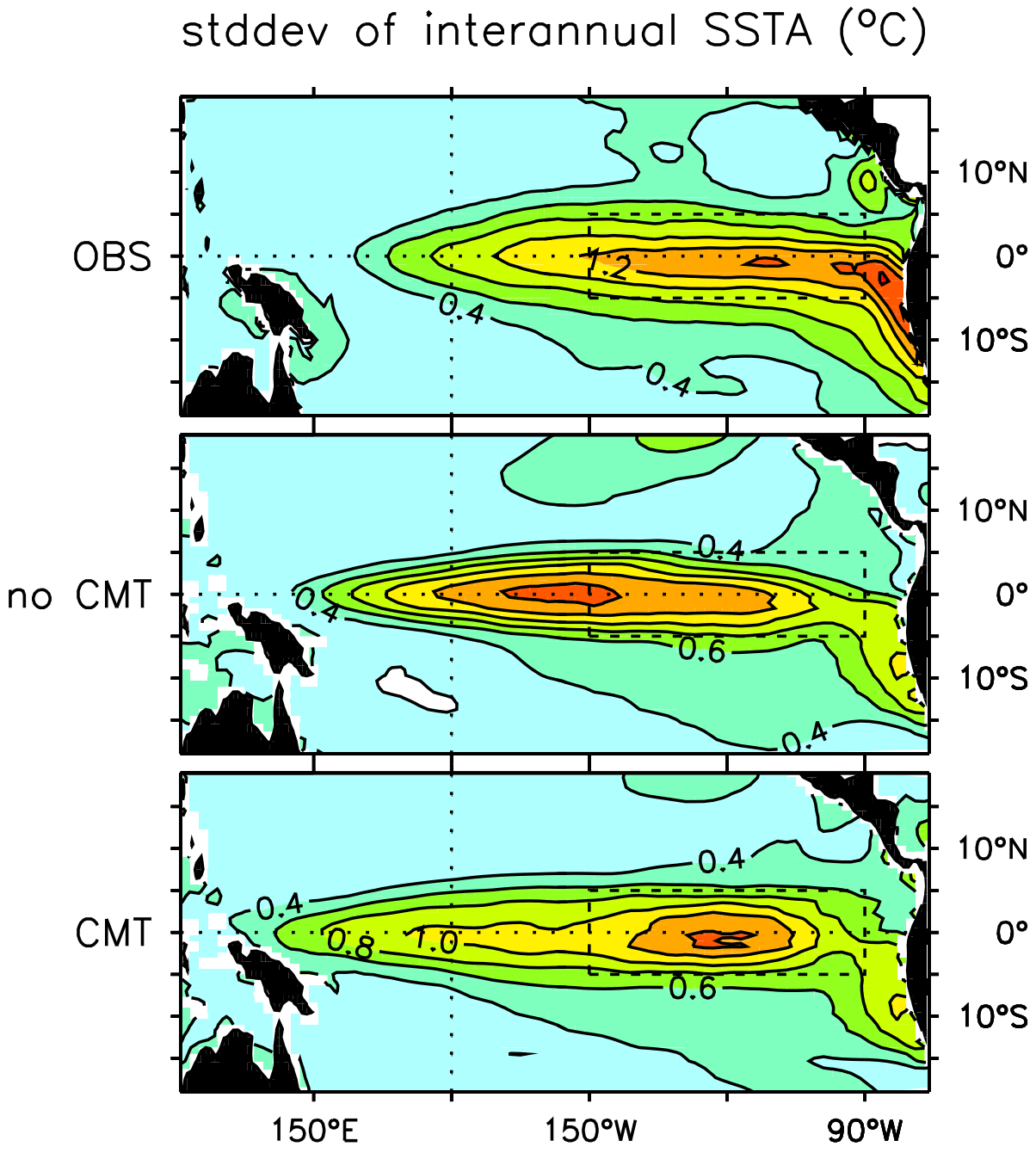
- MOM4: tripolar grid, 2° Mercator south of 65°N, telescoping to $\frac{2}{3}^\circ$ latitude within 12° of equator
- 50 levels (10m thickness above 220m)
- explicit free surface
- Quicker advection, KPP, neutral physics, sigma diffusion, Smagorinsky friction, 1-hour timestep
- diurnal cycle, shortwave penetration depends on spatially-varying climatological “color”

AM2p11 atmosphere

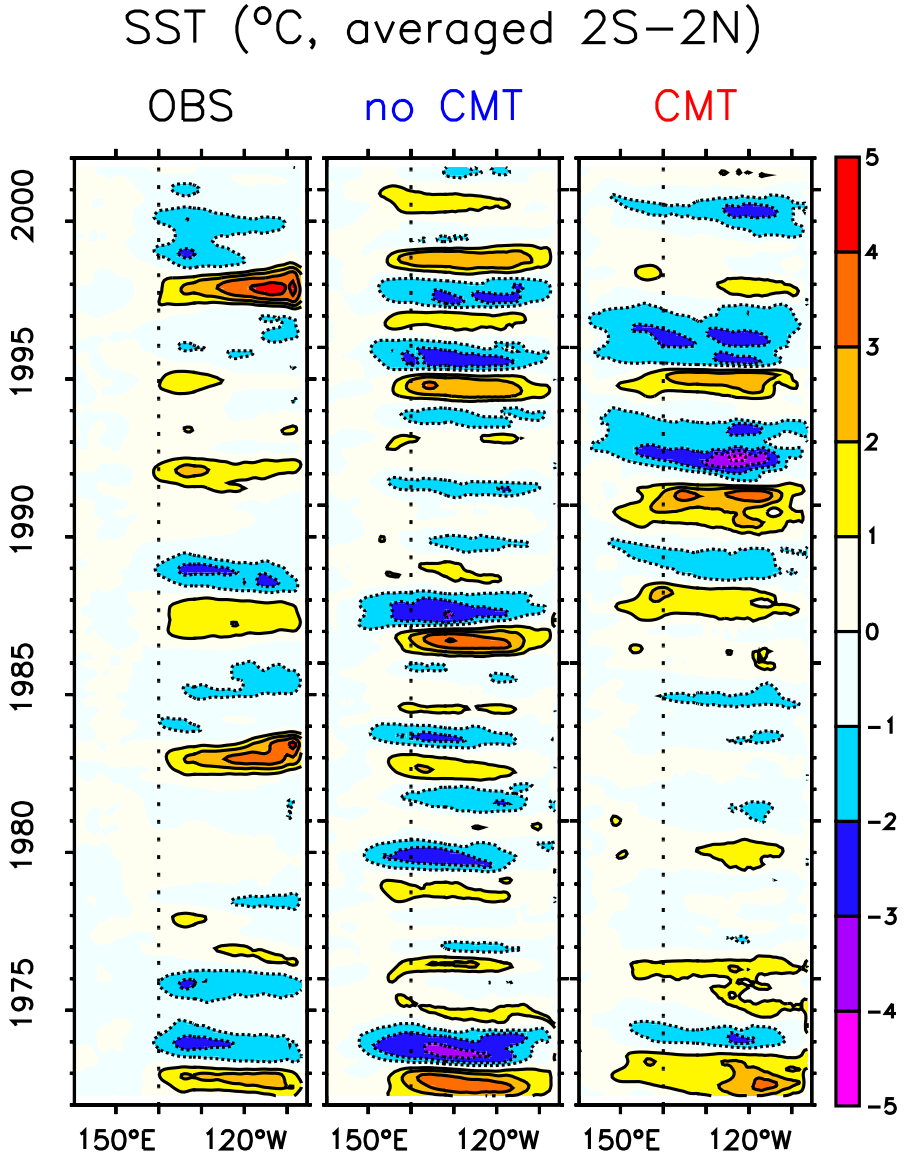
- B-grid core: 2.5°lon $\times$ 2°lat $\times$ 18 levels
- RAS convection
- MY 2.5 dry PBL w/ prognostic TKE
- “gustiness” & enhanced ocean roughness for weak winds; surface stress depends on ocean currents
- diurnal cycle w/ 3-hour radiation, 30min physics
- cumulus momentum transport (CMT): vertical diffusion of momentum where convection occurs

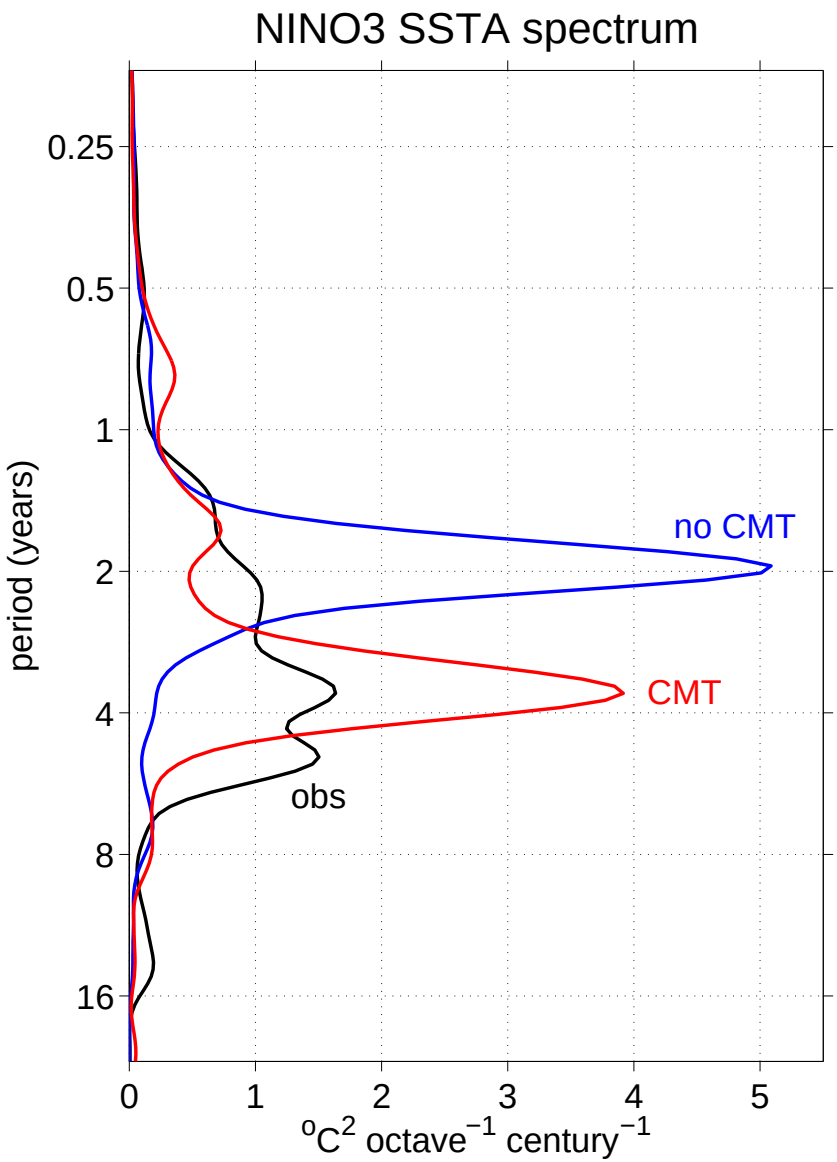
Coupled to ocean every 3 hours.

Interannual SST variability: Obs vs. CGCM

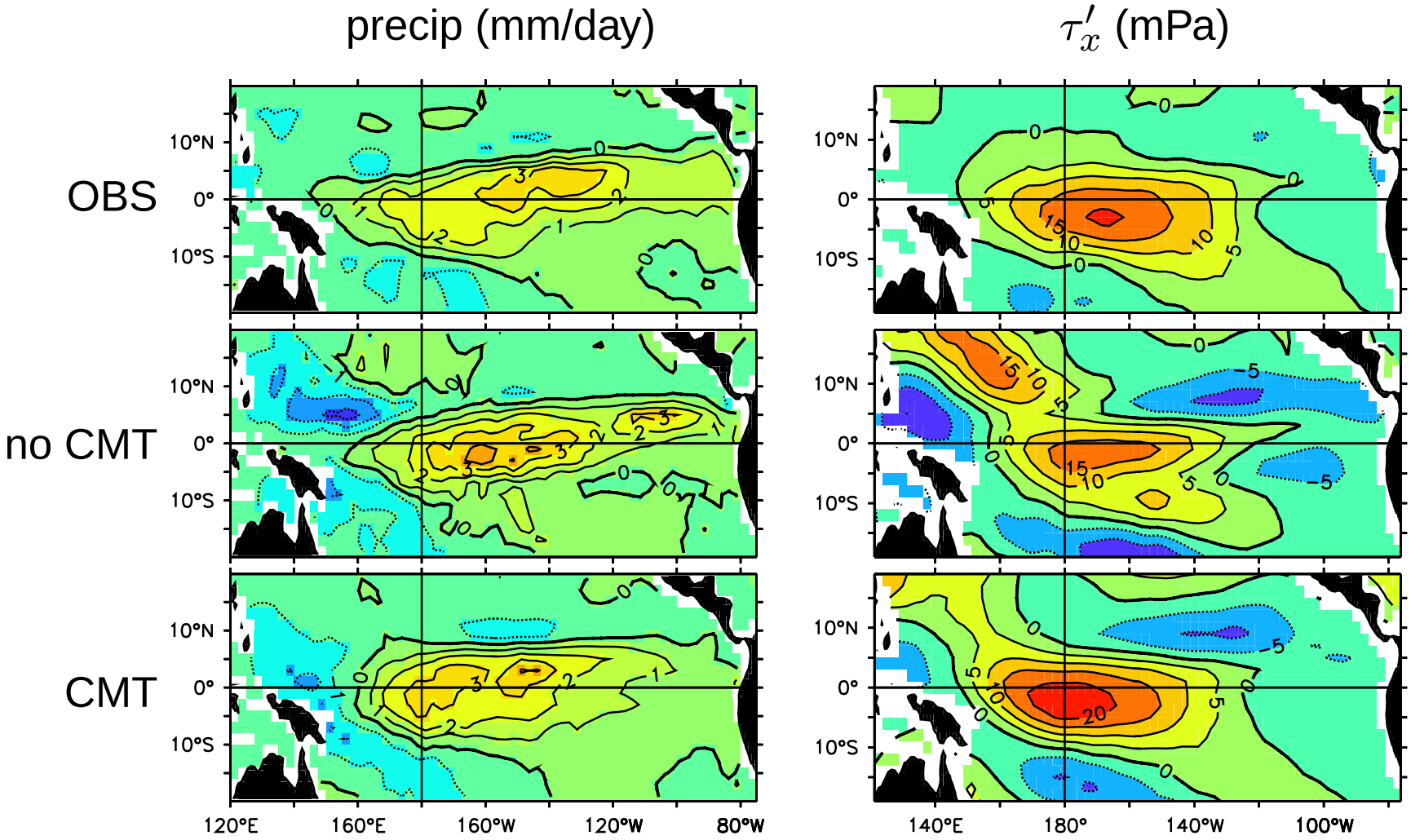


CMT Impact on Coupled ENSO Simulation

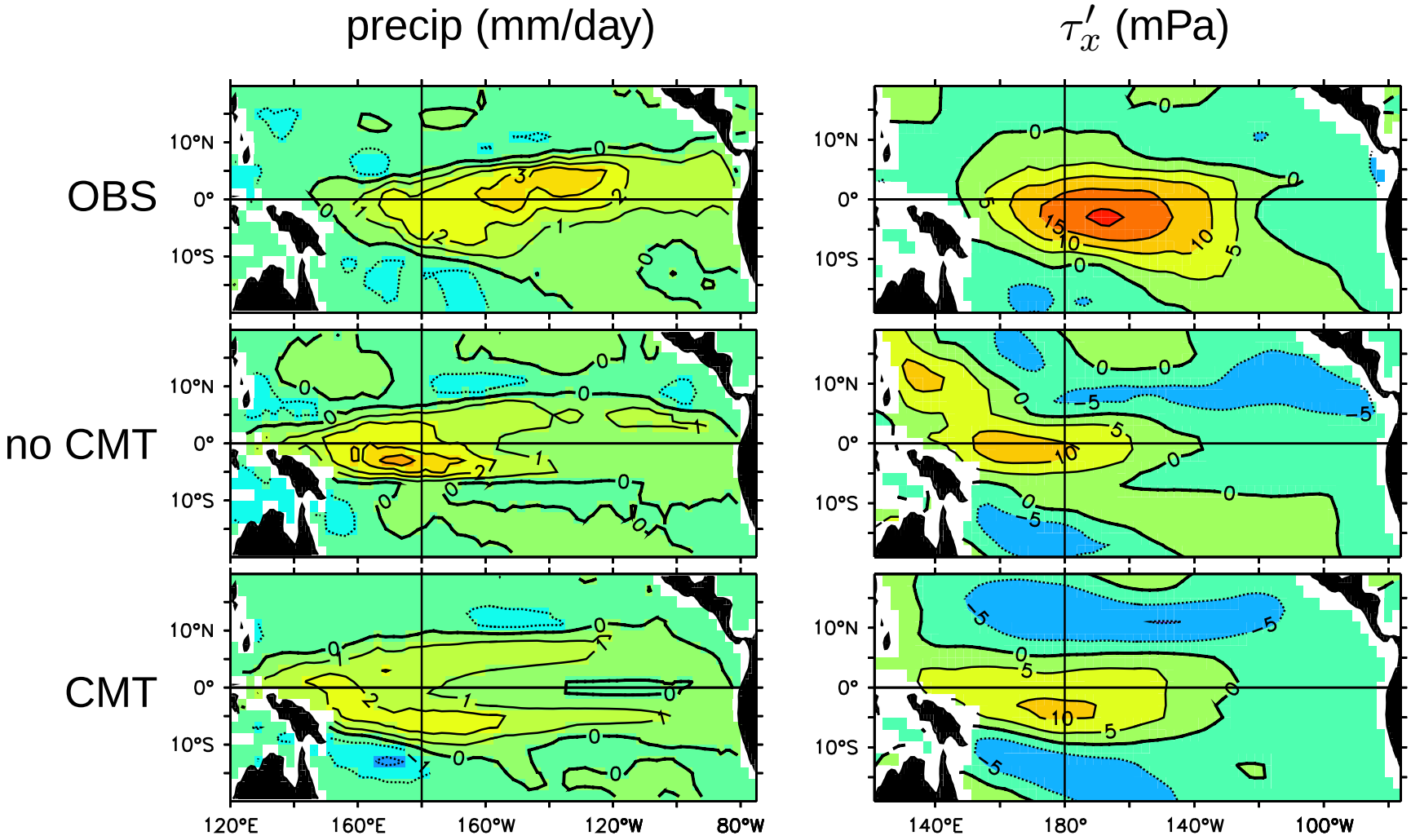




“AMIP” Response to Observed NINO3 SST Anomalies

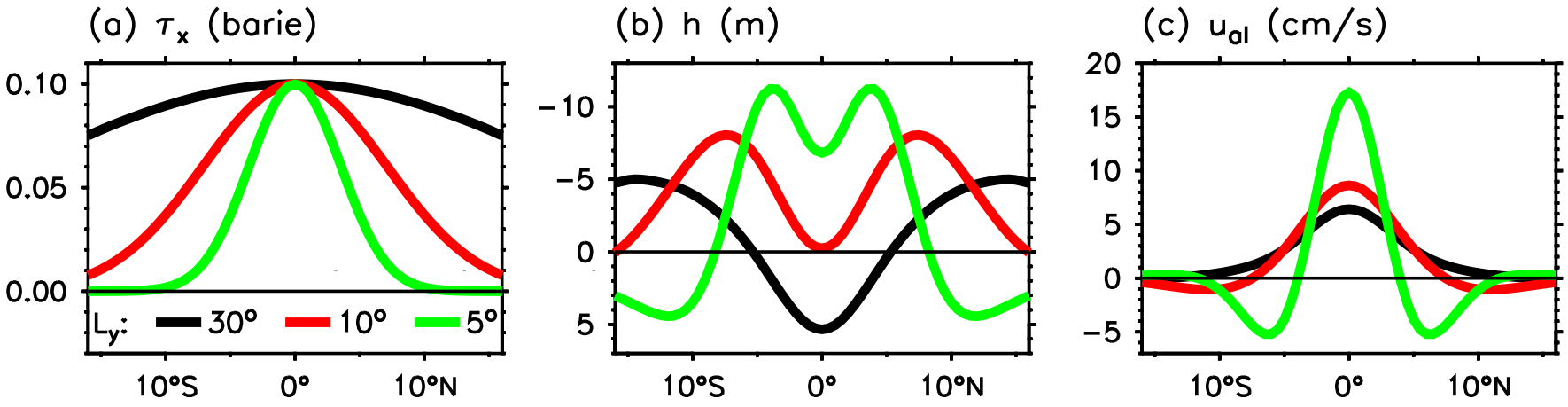


Impact of CMT in the Coupled Model



Why does CMT affect the ENSO period?

Ocean response to equatorial westerlies

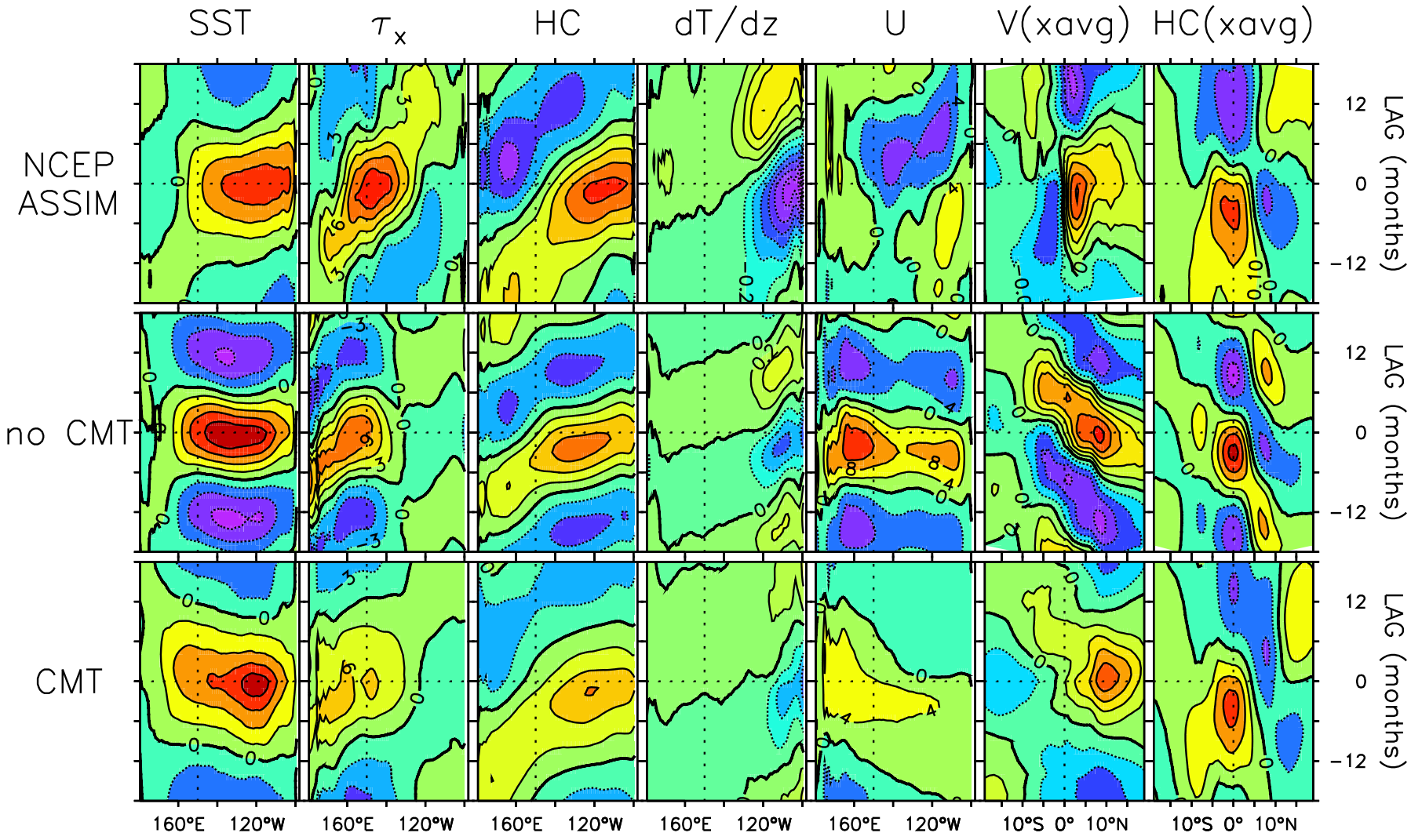


Intermediate coupled model studies (Kirtman 1997, An & Wang 2000):

τ_x' widens $\Rightarrow$ weaker discharge, weaker u' $\Rightarrow$ longer period

τ_x' shifts east $\Rightarrow$ u' less of a transitioner $\Rightarrow$ longer period

ENSO Mechanism: Lag-Regressions onto NINO3 SSTA



Summary

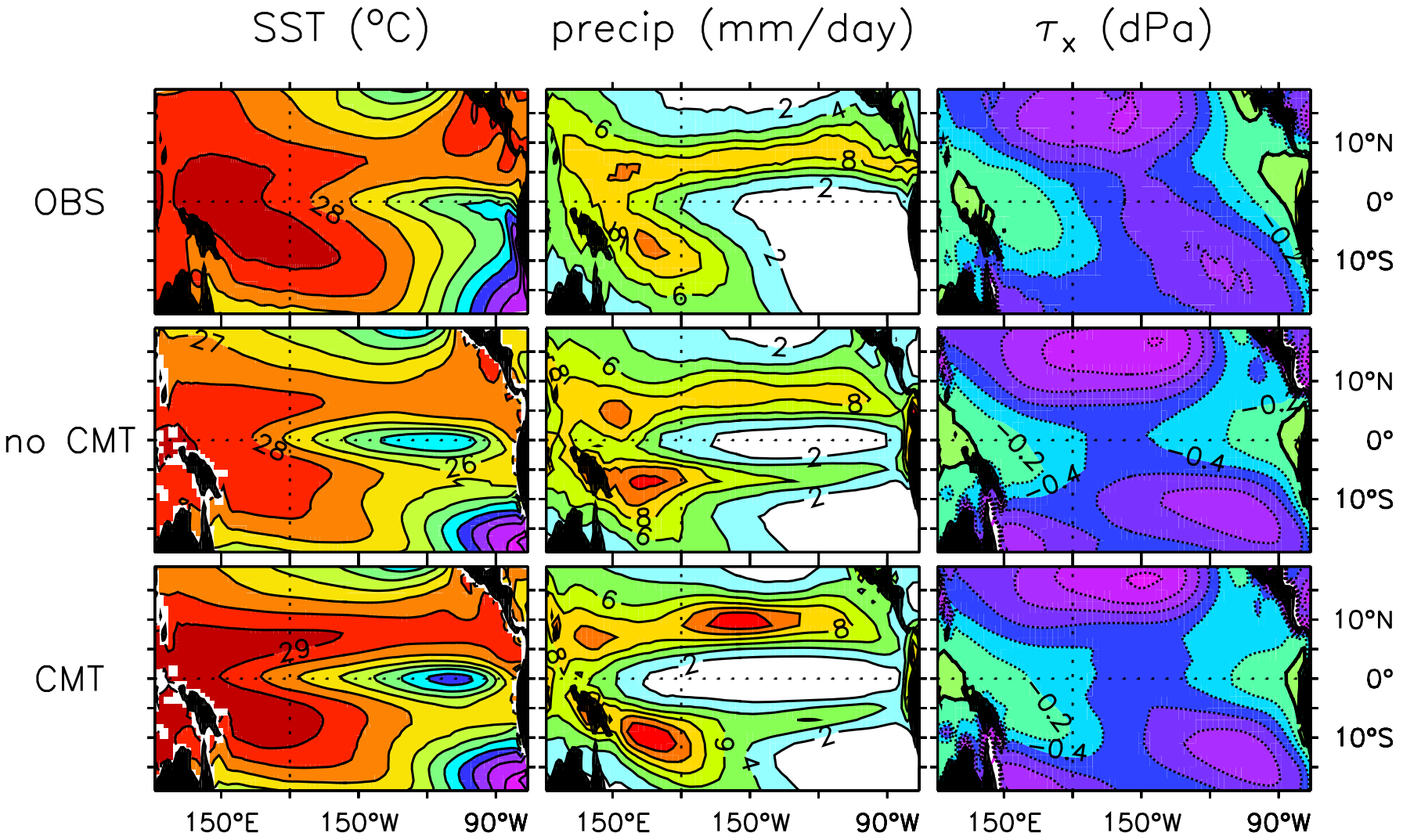
1. The GFDL coupled model with CMT gives a decadally-modulated ENSO with reasonable amplitude, period, structure, and mechanism,

2. but the simulated ENSO variability is too regular in time, too far west, and shows too much westward propagation of SSTAs. Seasonal phase-locking is also a problem.

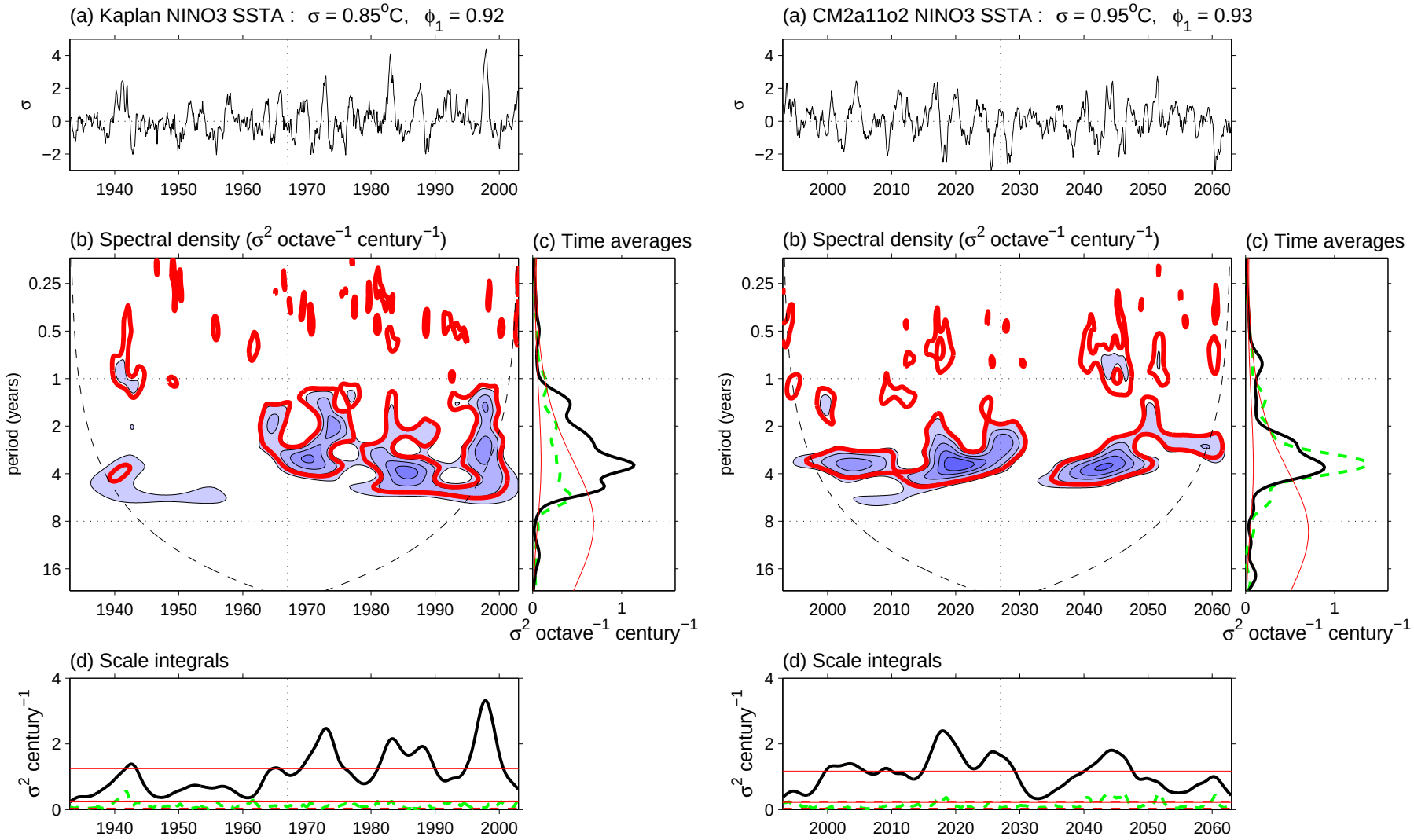
3. Precip & τ_x' are highly sensitive to CMT.
   As τ_x' spreads eastward & poleward
   $\Rightarrow u'$ and recharge are weakened & delayed
   $\Rightarrow$ longer ENSO period (2.0 $\rightarrow$ 3.6 yr)

4. Equatorial cold bias splits the precip response to SSTAs. The τ_x' response remains weak, narrow, and too far west.

Annual-Mean Tropical Pacific Climatology



Spectrum of NINO3 SST Anomalies



Impact of Coupling