Climate Sensitivities of ENSO

Bridging theory, observations, and modeling

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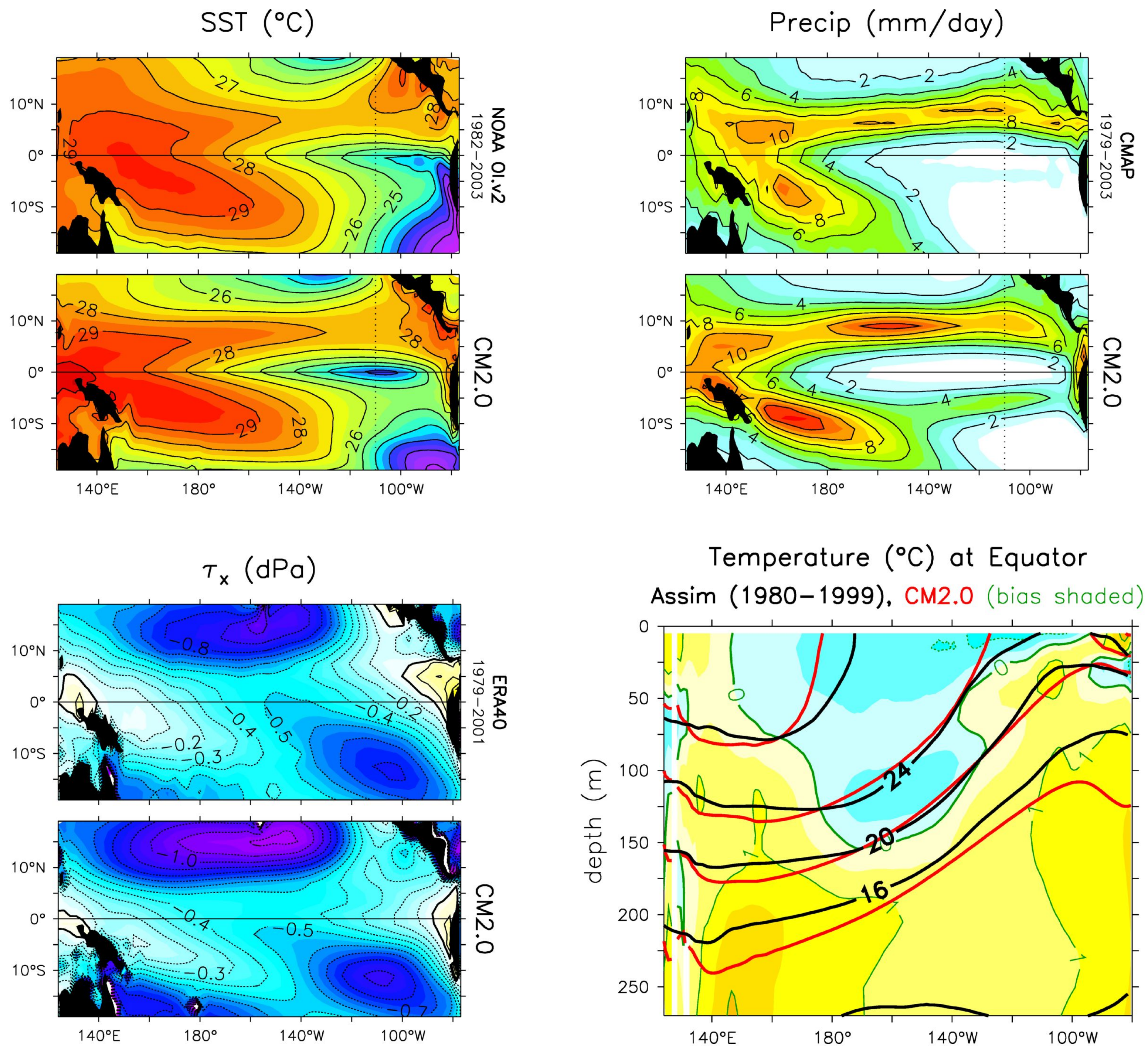
Thanks to: Gabriel Vecchi, Qian Song, and Anthony Rosati

“Other worlds” in CGCMs



Mixed layer temperature anomaly tendency equation

$$
\begin{aligned}
T'_t = \; & -u'\overline{T}_x \quad -\overline{u}T'_x \quad -(u'T'_x)' \\
& -v'\overline{T}_y \quad -\overline{v}T'_y \quad -(v'T'_y)' \\
& -w'\overline{T}_z \quad -\overline{w}T'_z \quad -(w'T'_z)' \\
& +\text{eddy} \quad +Q'_{\text{sfc}}
\end{aligned}
$$

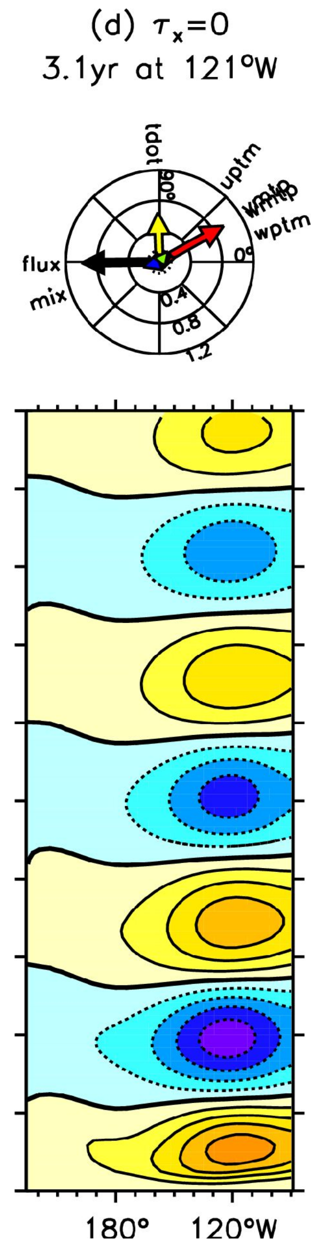
Key to understanding impact of background state on ENSO.

Mixed layer temperature anomaly tendency equation

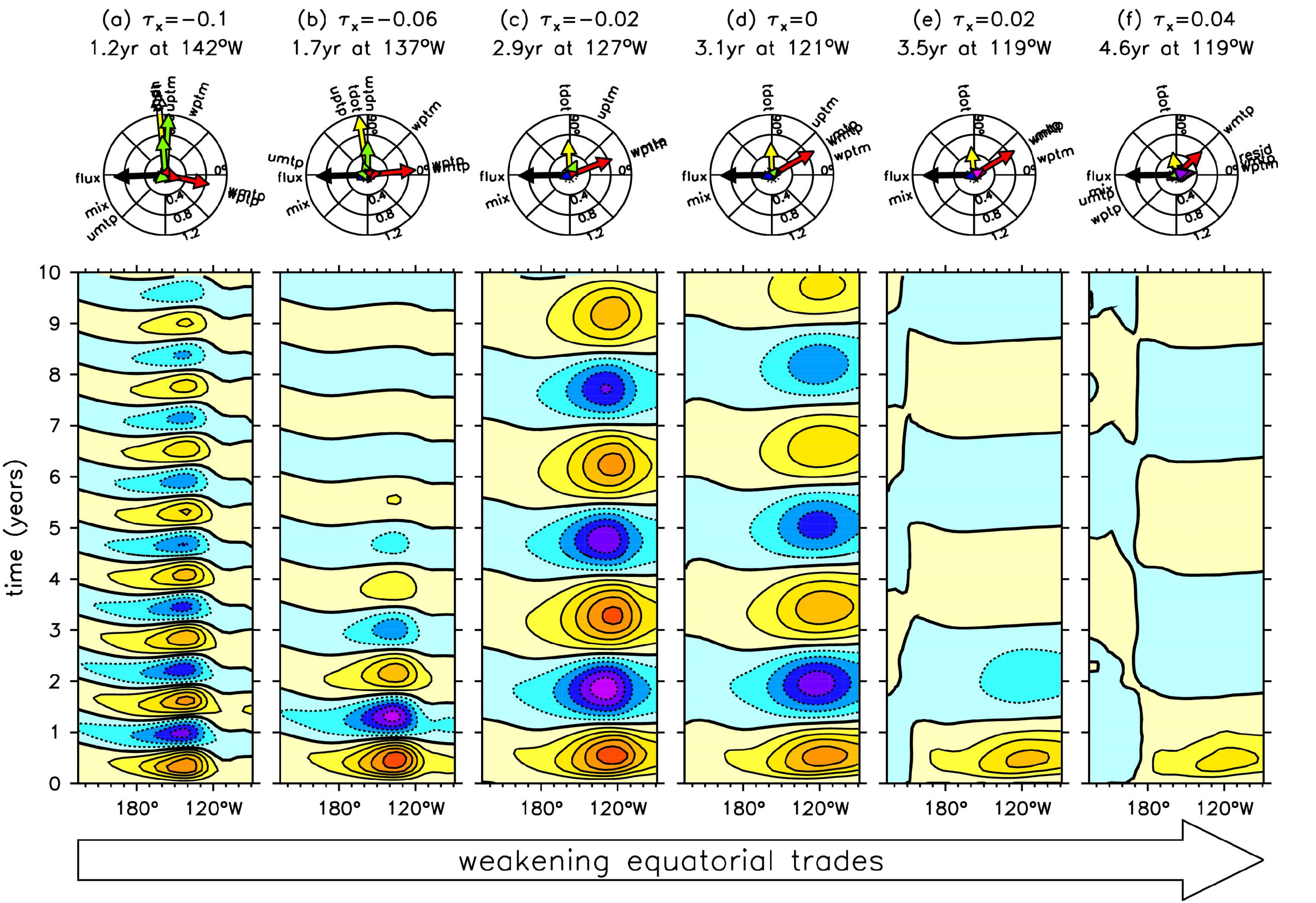
$$T'_t = -u'\overline{T}_x - \overline{u}T'_x - (u'T'_x)' - v'\overline{T}_y - \overline{v}T'_y - (v'T'_y)' - w'\overline{T}_z - \overline{w}T'_z - (w'T'_z)' + \text{eddy} + Q'_{\text{sfc}}$$

Key to understanding impact of background state on ENSO.

ICM Control Run

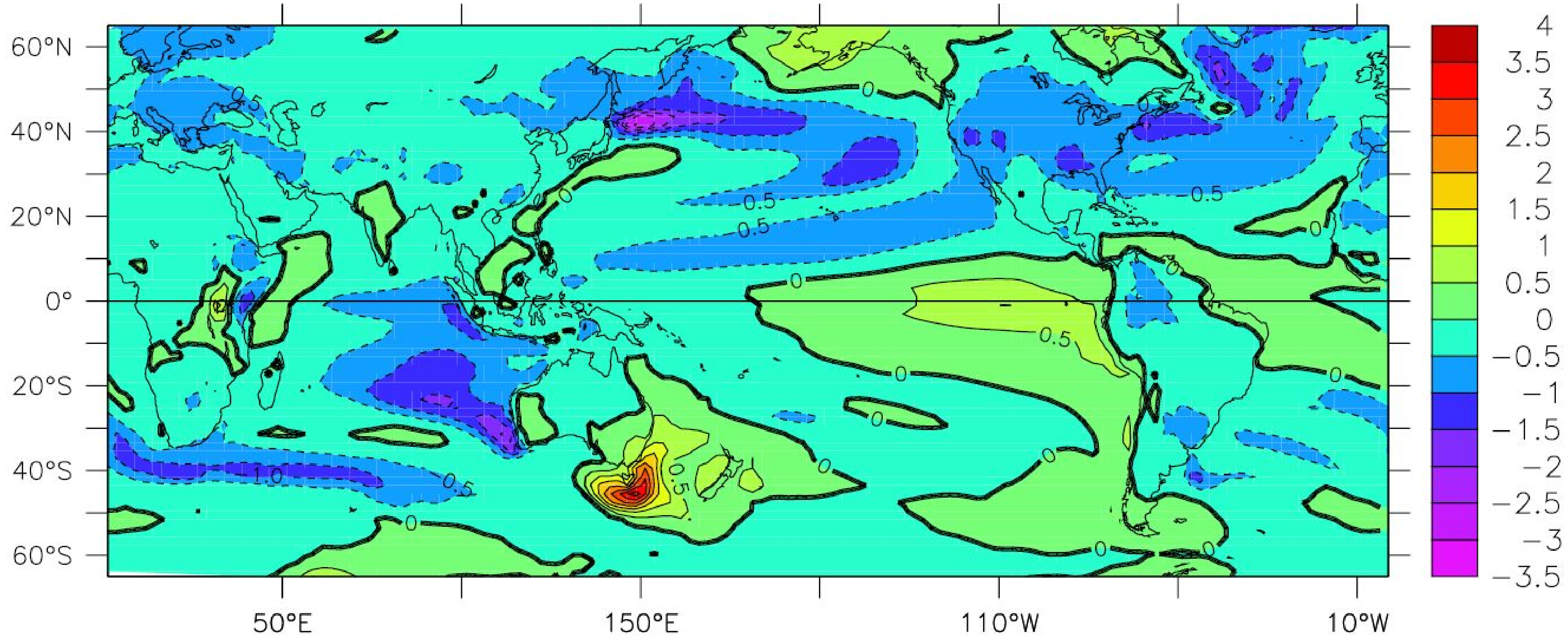


ICM: Impact of trade wind strength



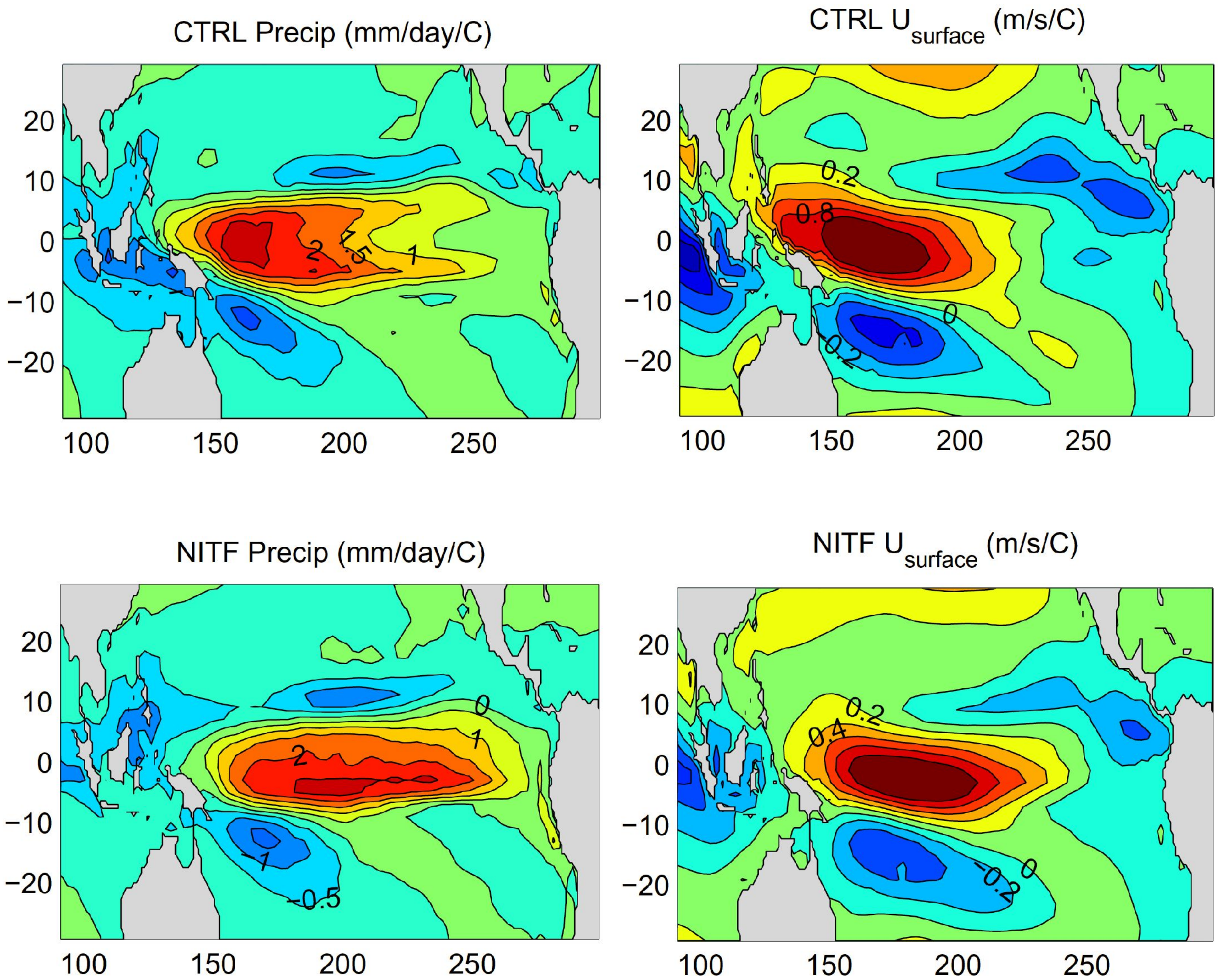
Blocking the Indonesian Throughflow:

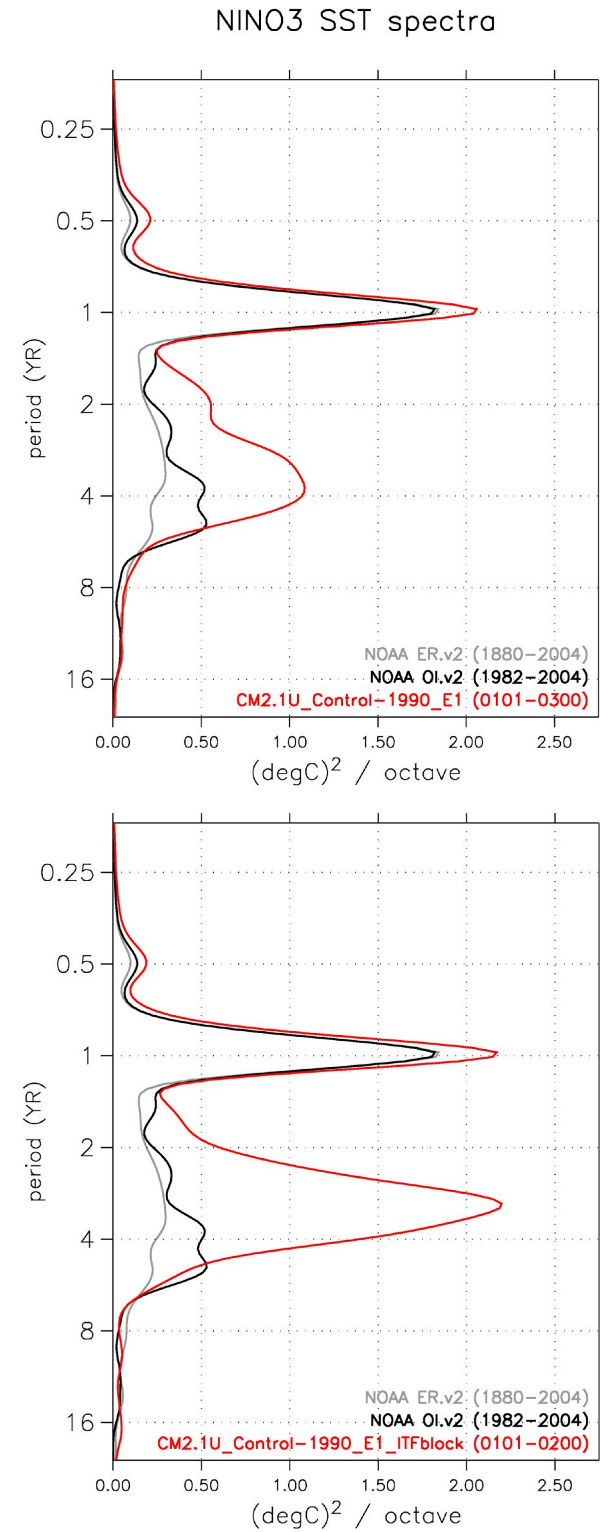
Change in mean SST (degC)



Blocking the Indonesian Throughflow:

Anomaly patterns (regressed on NINO3)

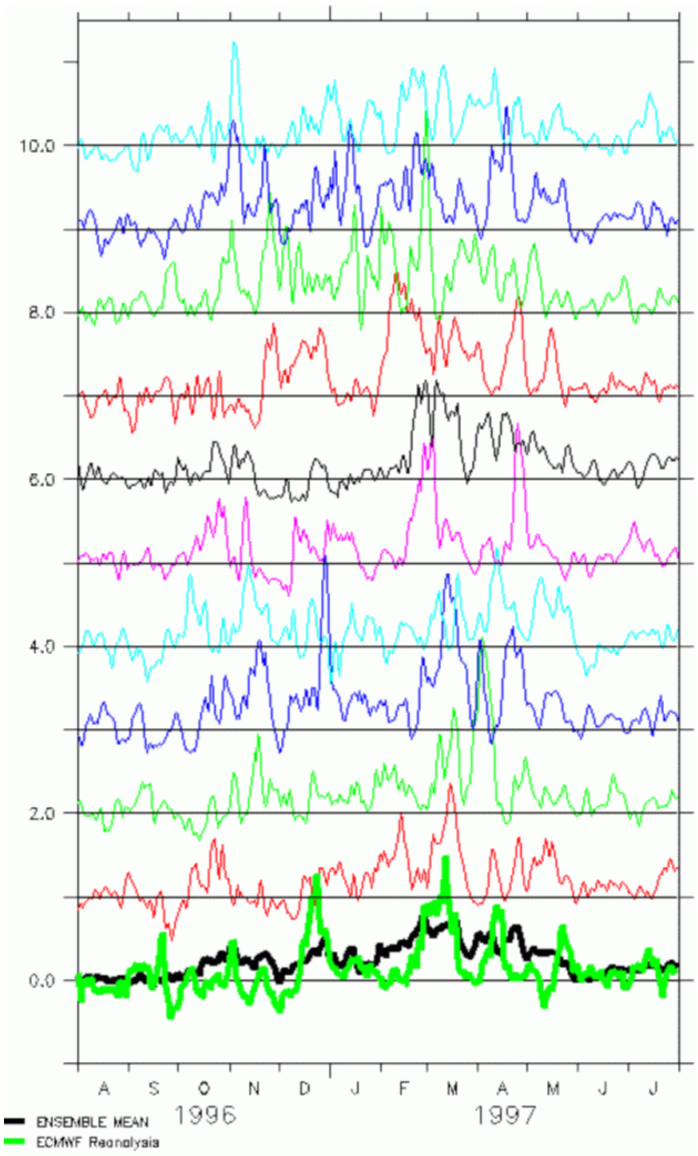




Stochastic forcing: A role for the Indian Ocean

Daily west-Pacific zonal stress from 10 AM2 runs

Observed SST forcing



Stochastic forcing: A role for the Indian Ocean

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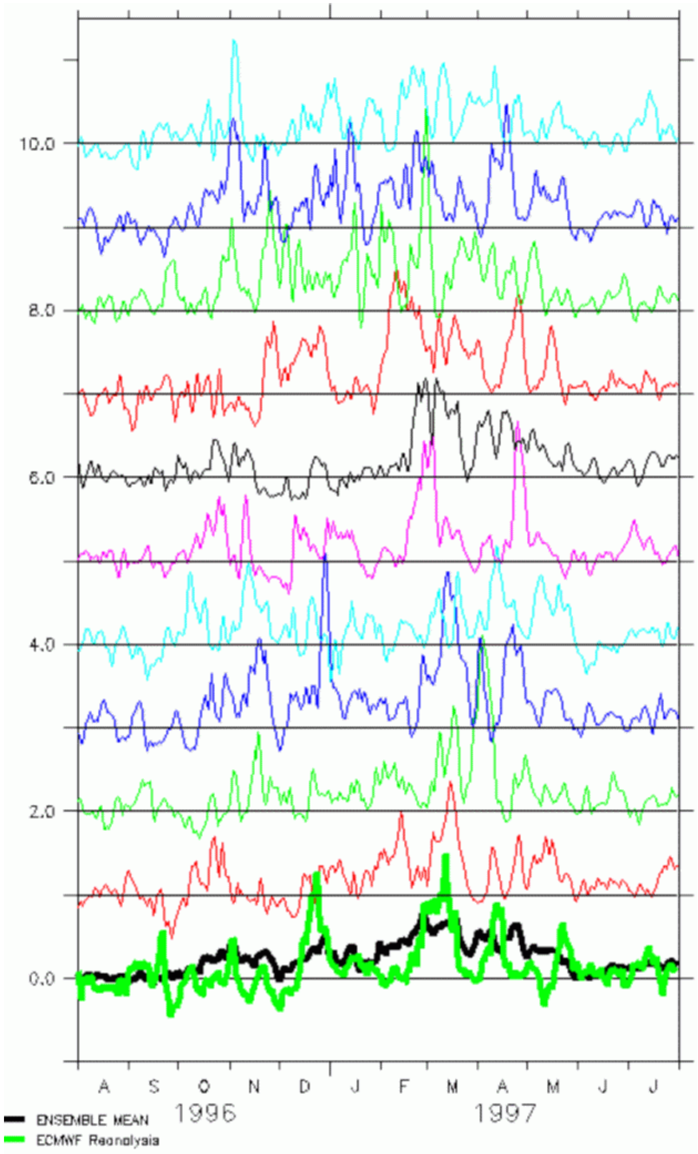
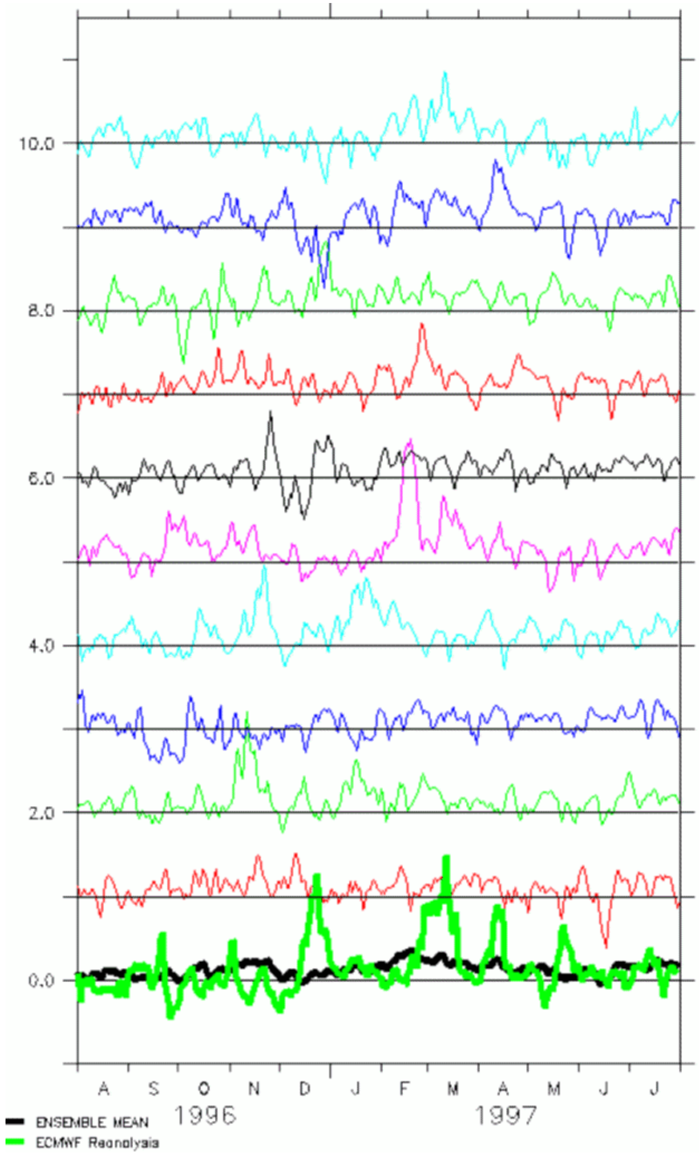


Warm East Indian



Summary

1) CGCMs: "Other Worlds"

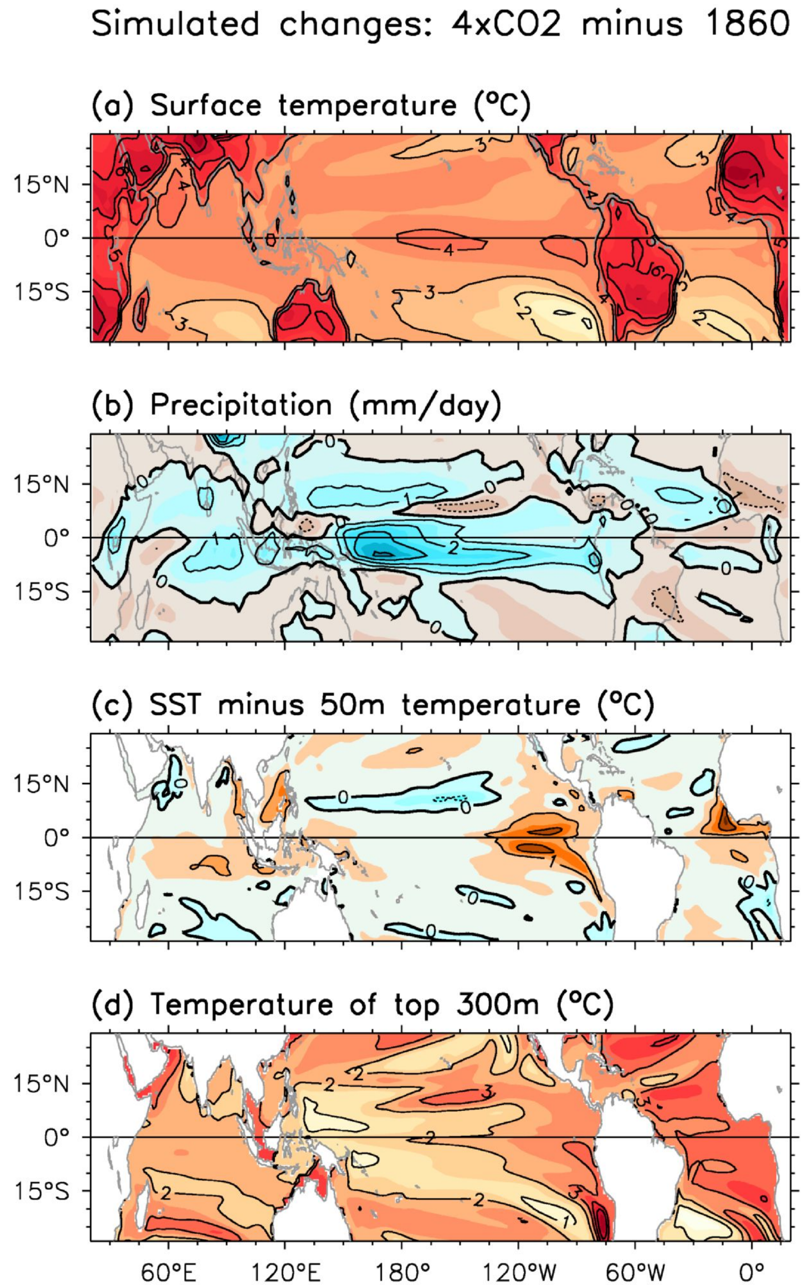
2) Mixed layer heat budget & "frequency budget"

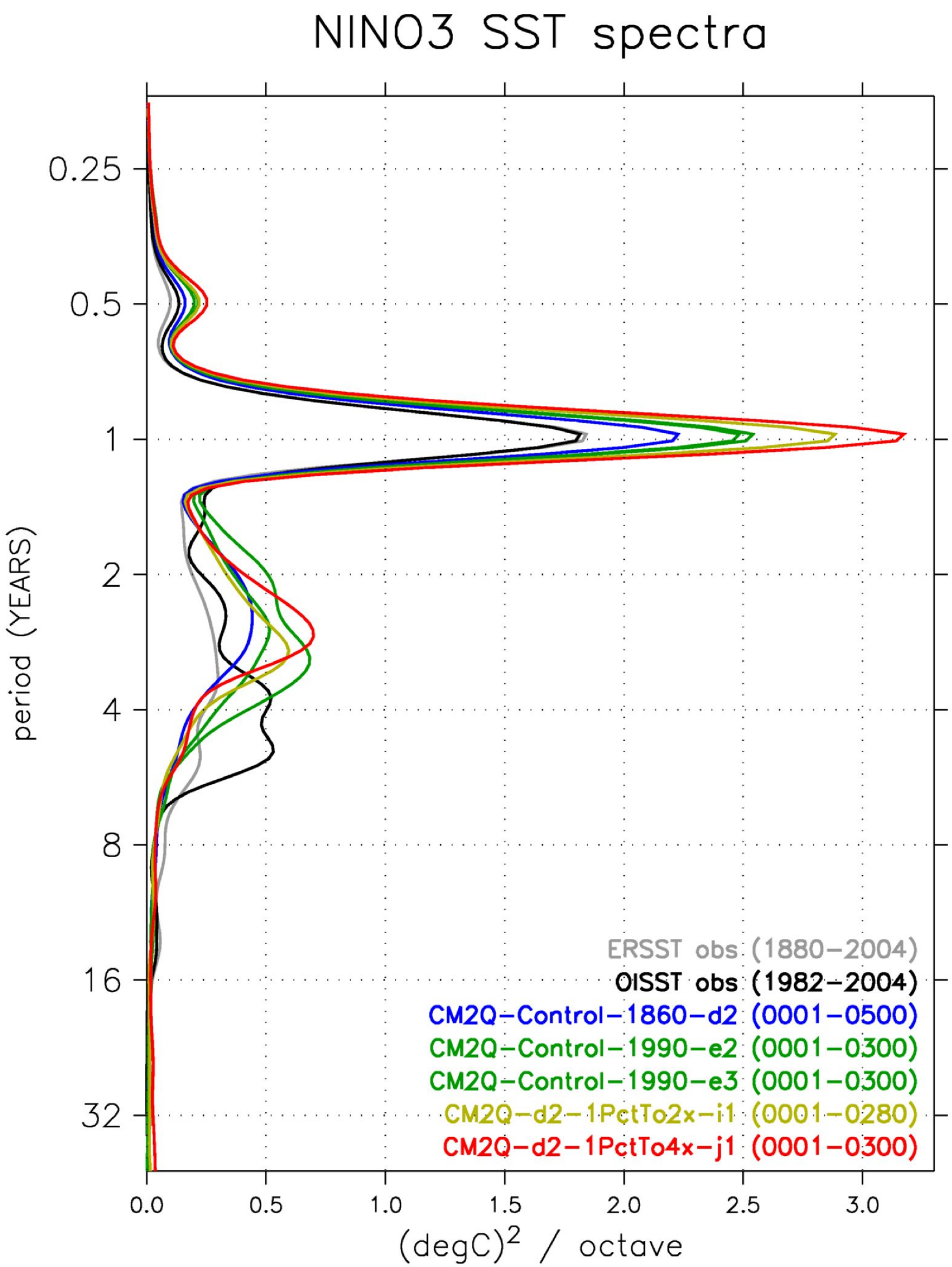
3) ICM: perturbations seed feedbacks, which alter ENSO

4) CM2: flux anomaly patterns sensitive to background

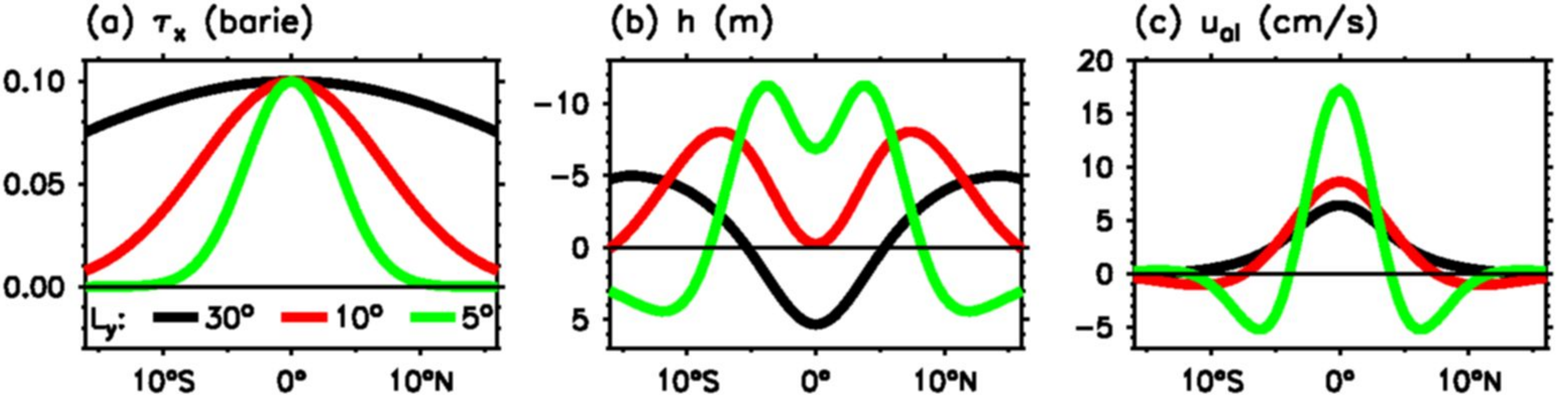
5) WWBs, nonlinearity, and a role for the Indian Ocean

CM2 greenhouse response

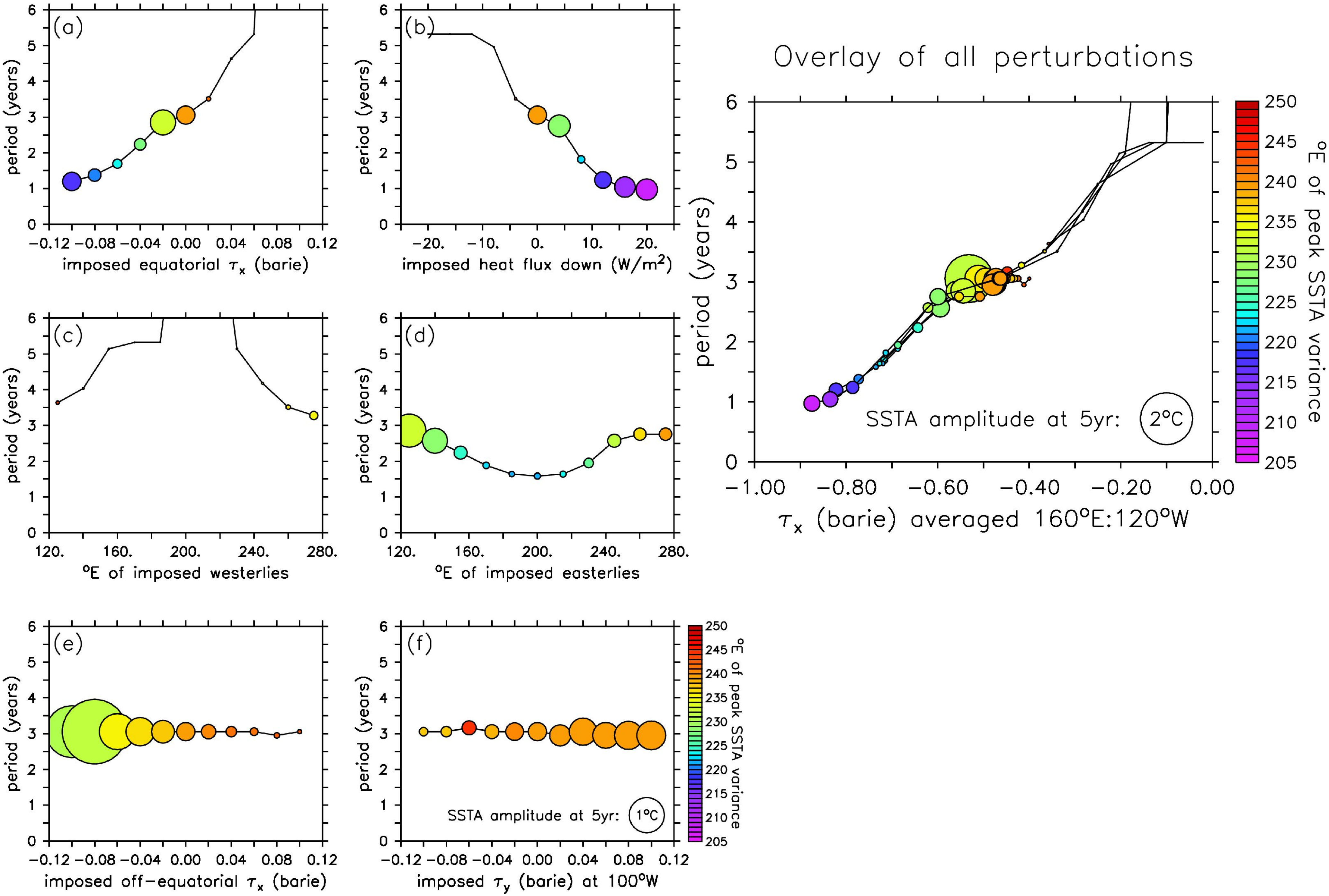




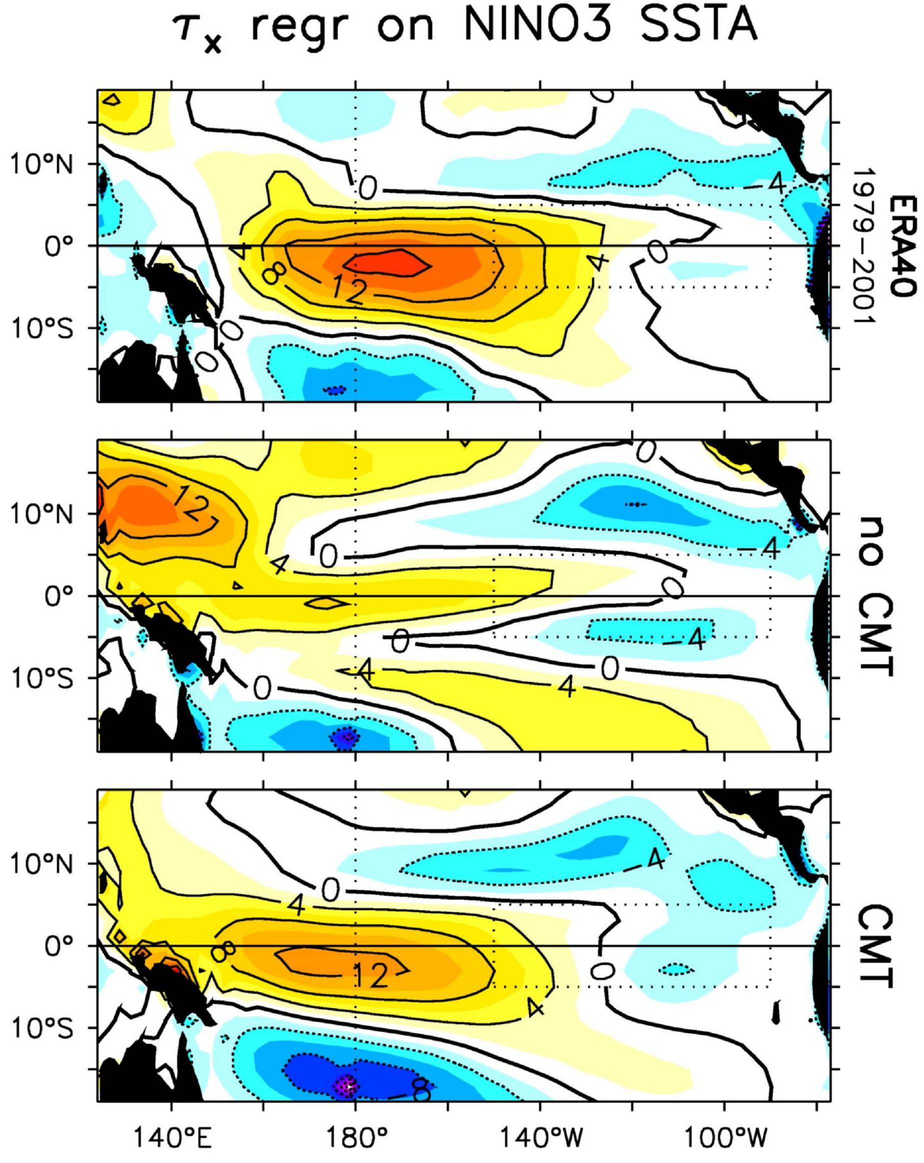
Equatorial adjustment to off-equatorial stress

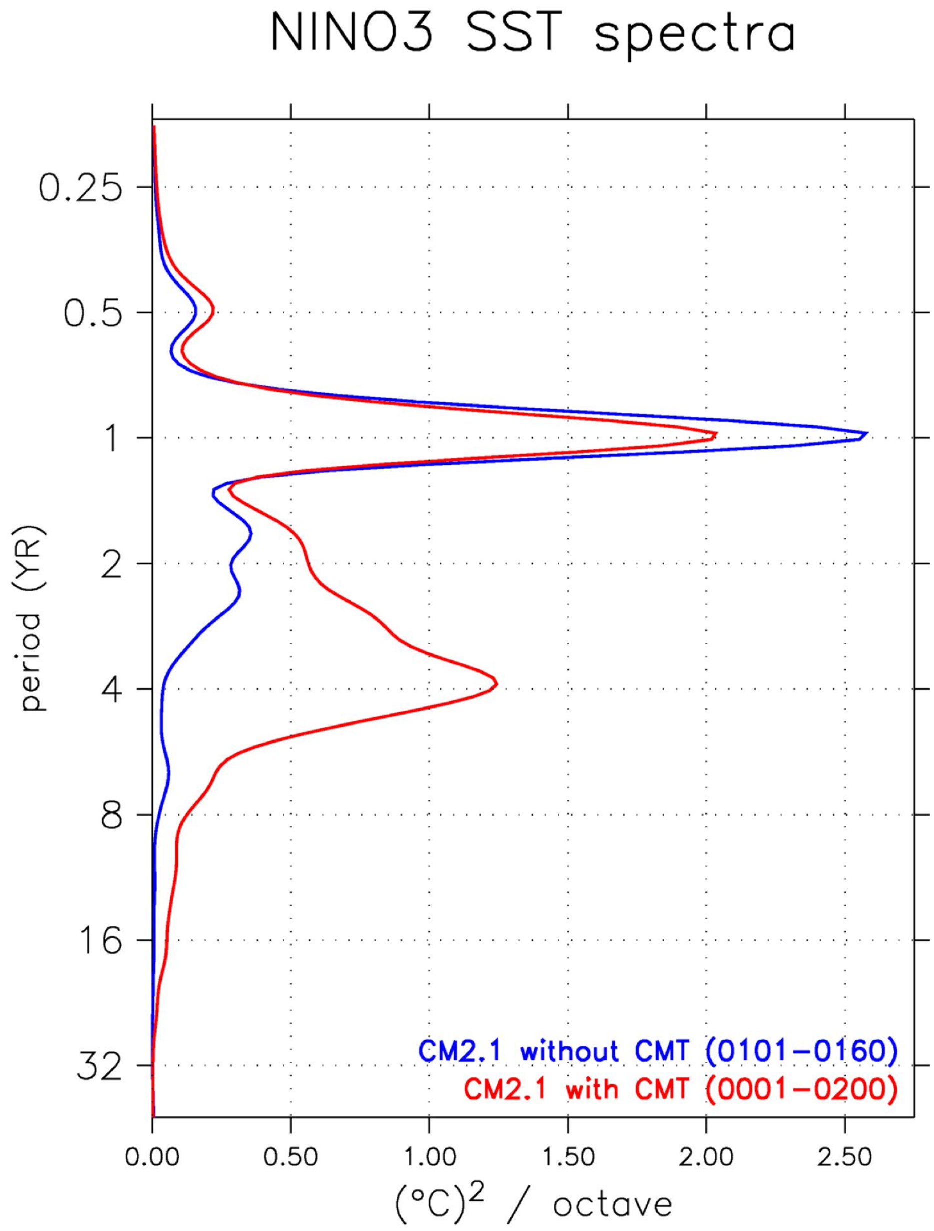


ICM: Different climate perturbations, similar effects

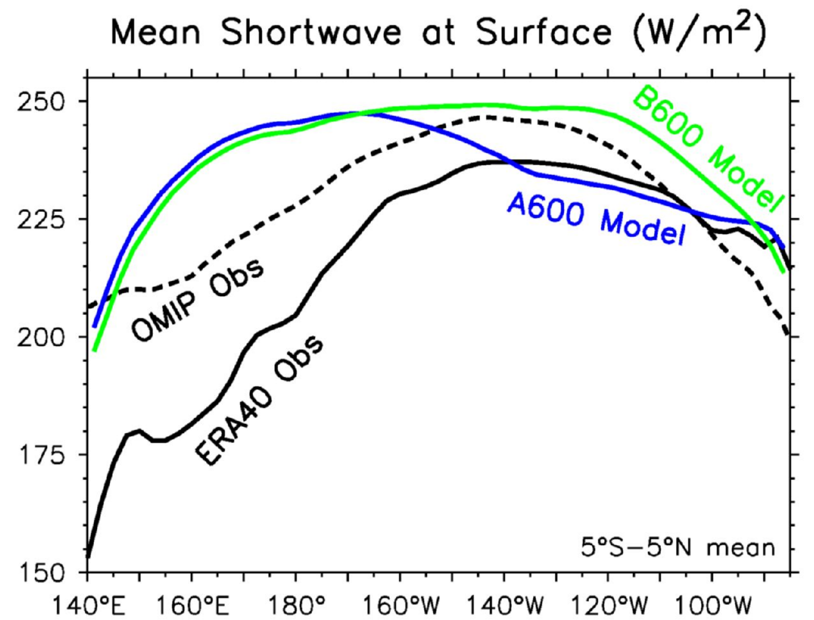


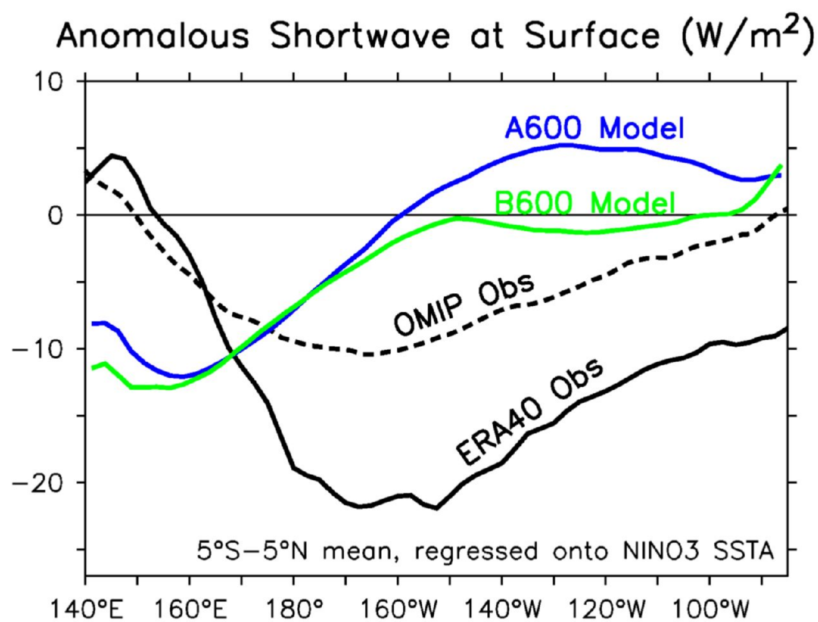
CM2 anomaly patterns: Wind stress

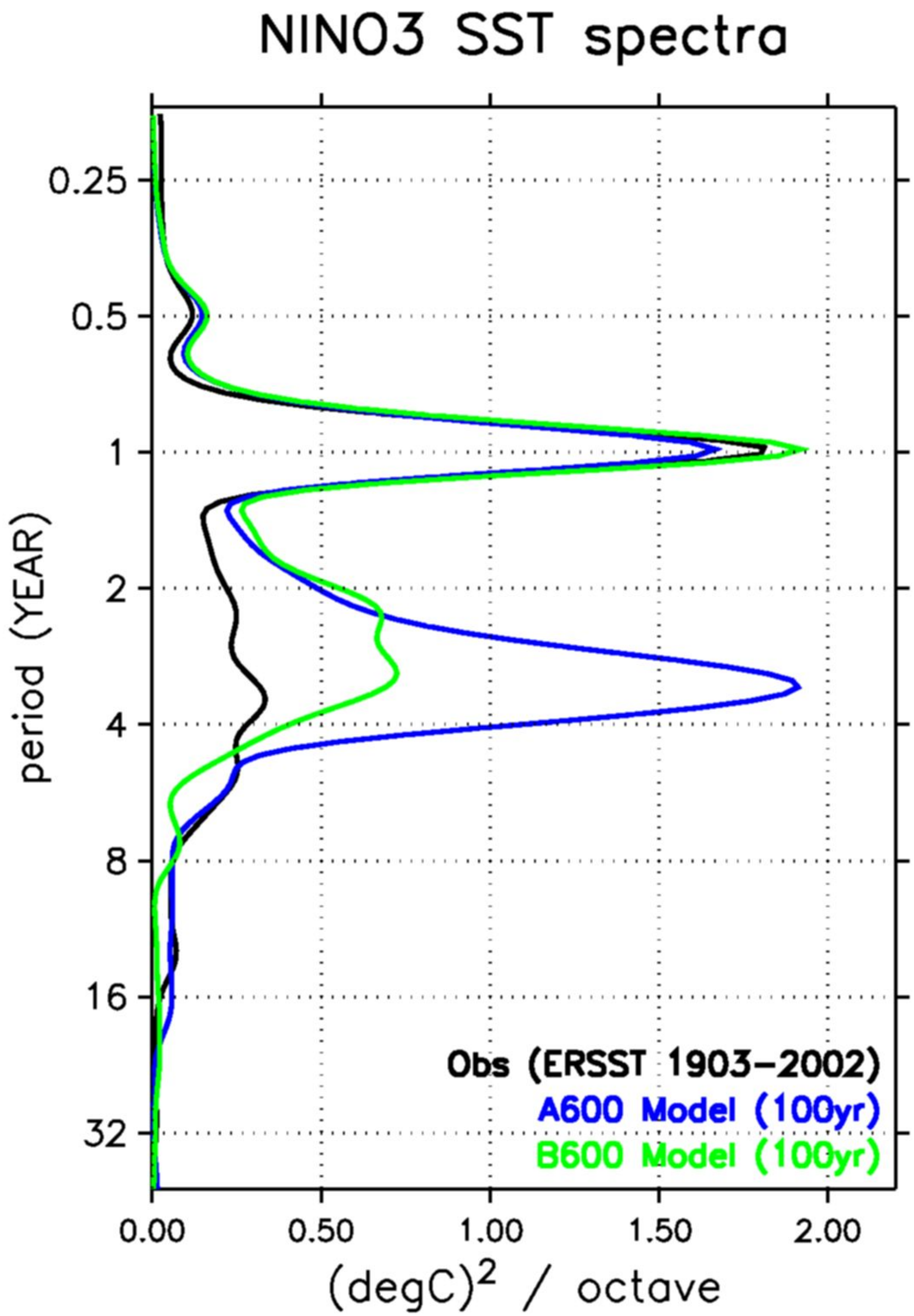




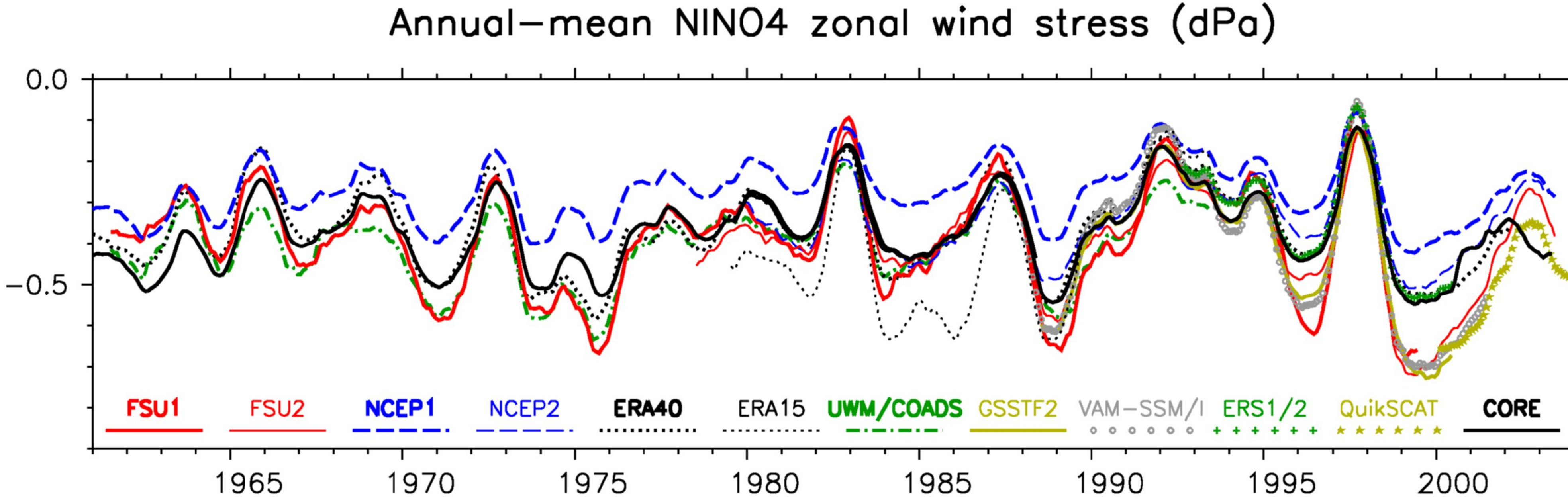
CM2 anomaly patterns: Surface heat flux



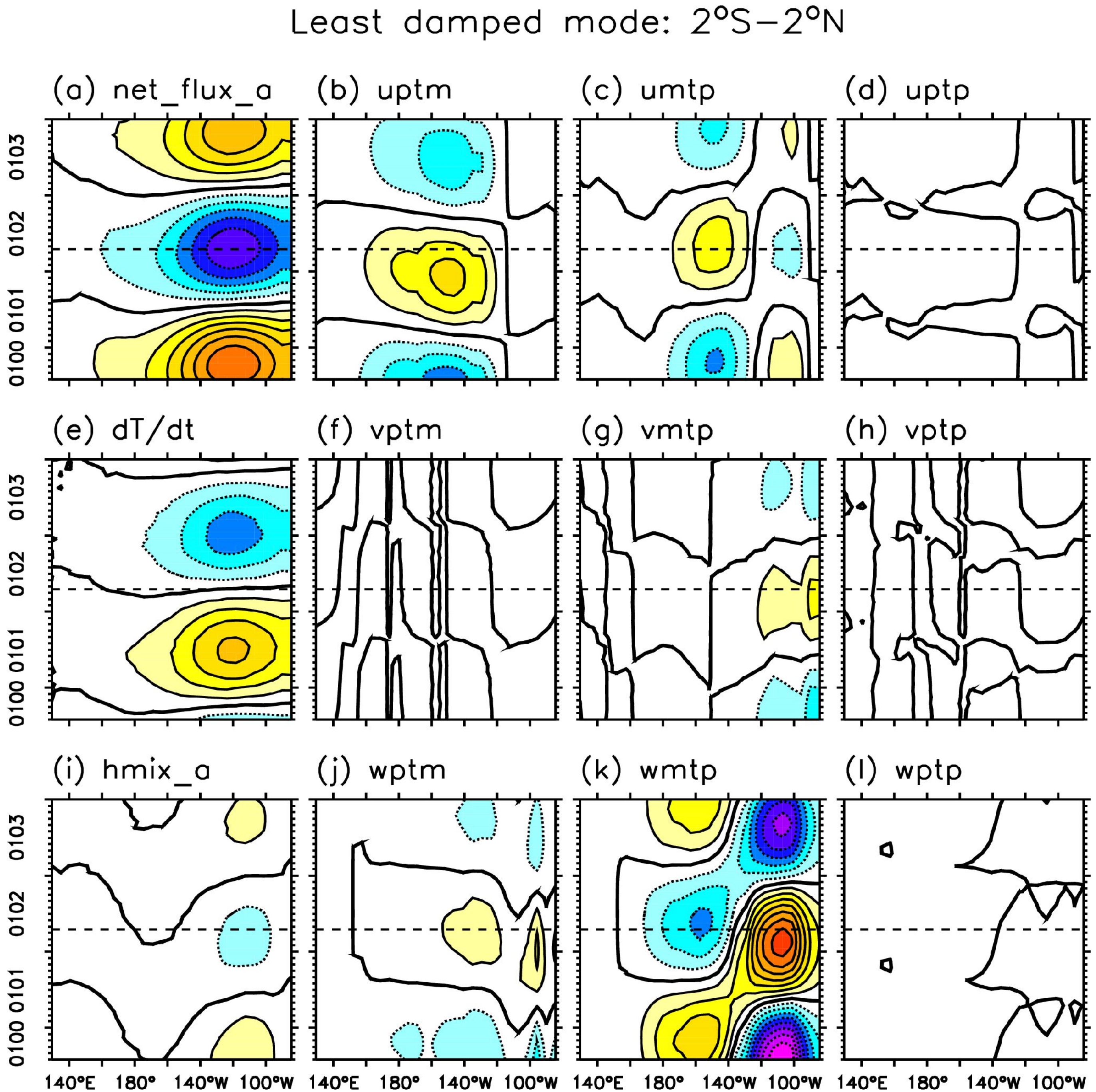




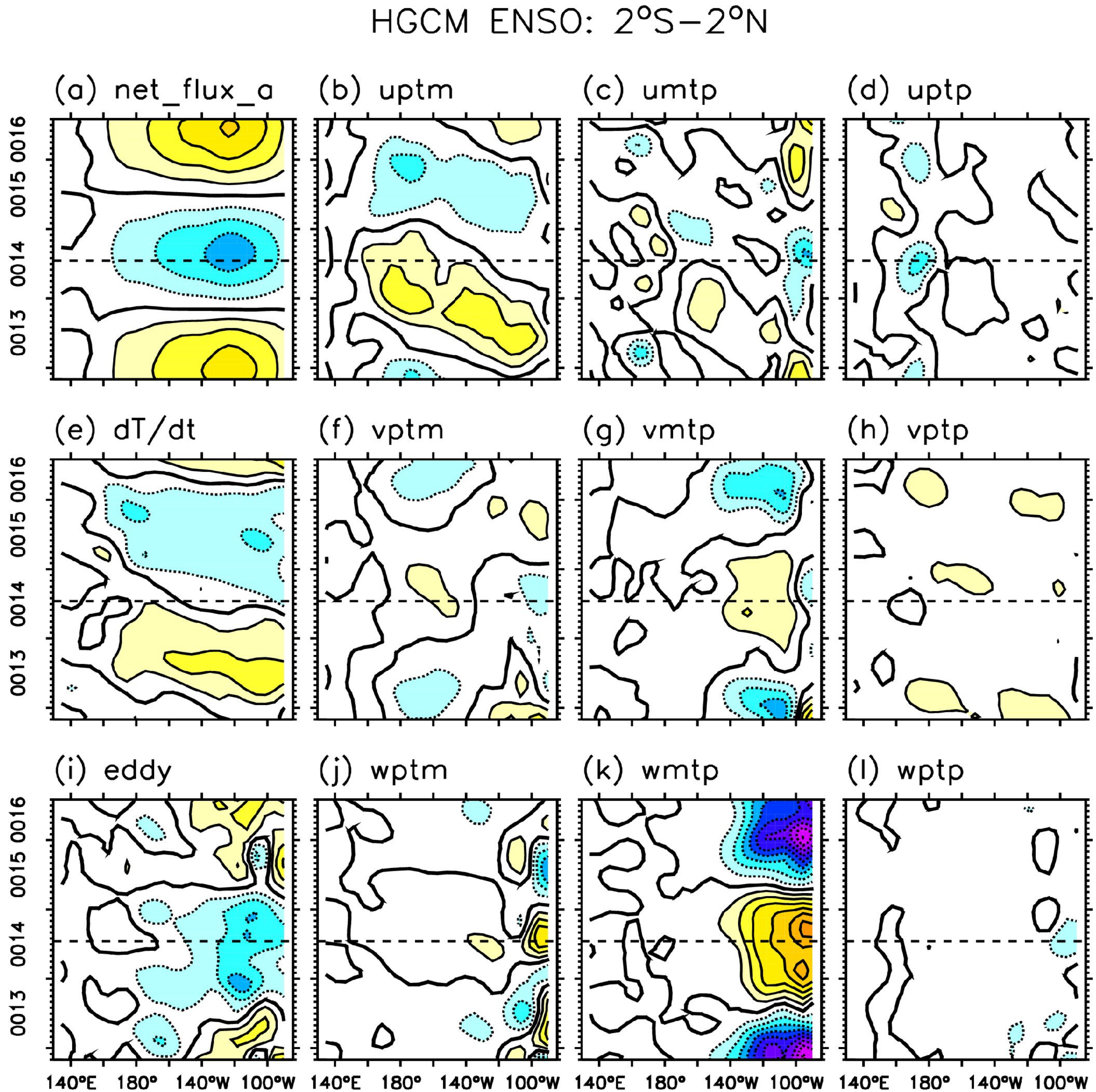
A wide variety of products



ICM: Mixed layer heat budget



Hybrid CGCM mixed layer heat budget



Impact of weakening equatorial zonal stress