

12th Annual CCSM Workshop
(June 19-21, 2007 / Breckenridge, CO)

**Coupled Atmosphere – Mixed Layer Ocean
Response to Ocean Heat Transport Variations
in the Kuroshio Current Extension**

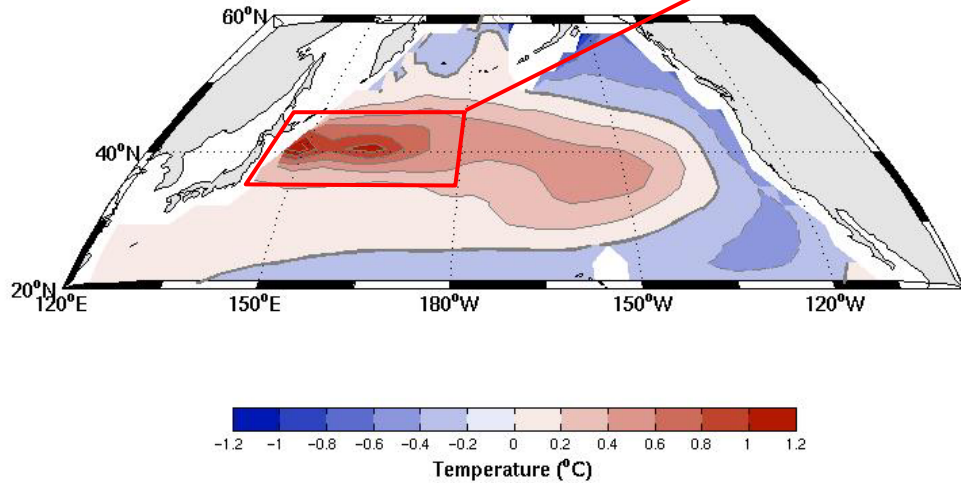
Young-Oh Kwon (WHOI)

Clara Deser (NCAR)

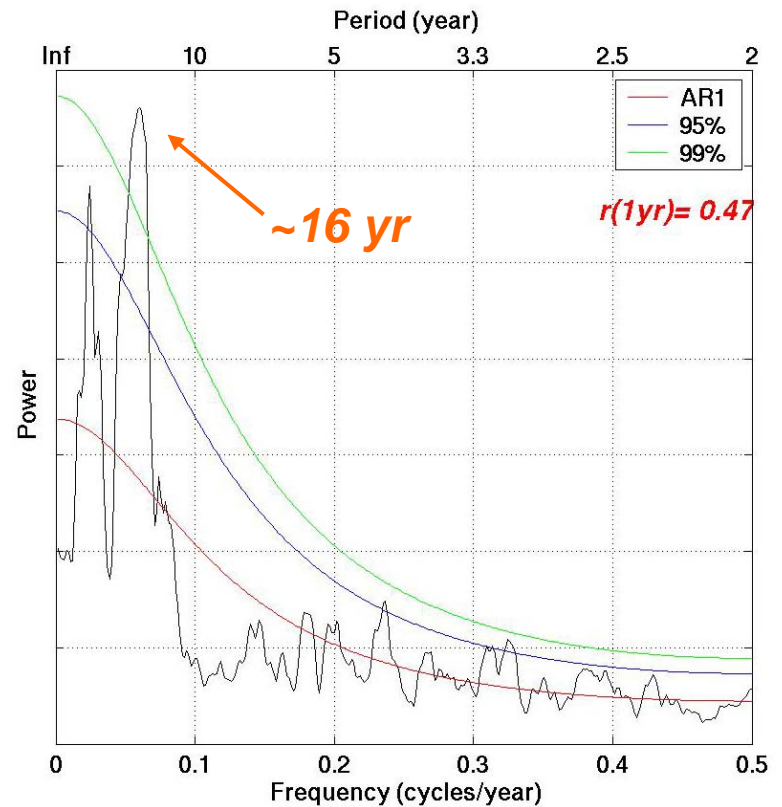
Christophe Cassou (CNRS-CERFACS)

CCSM2 North Pacific Decadal Variability (CCSM2 control integration: b20.007 Yr 350-999)

Winter SST EOF 1 (21%)



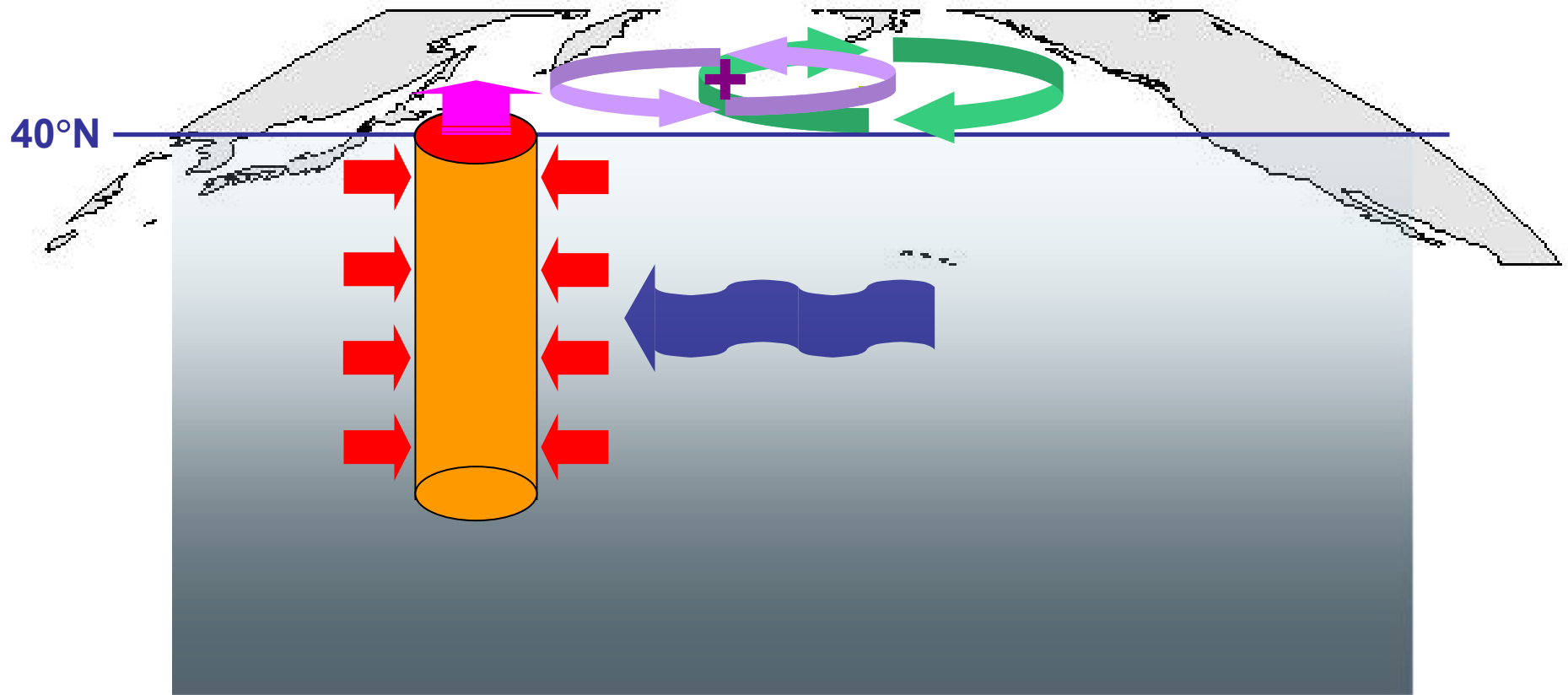
Kuroshio Extension SST Index



Kwon and Deser (2007, J. Climate)

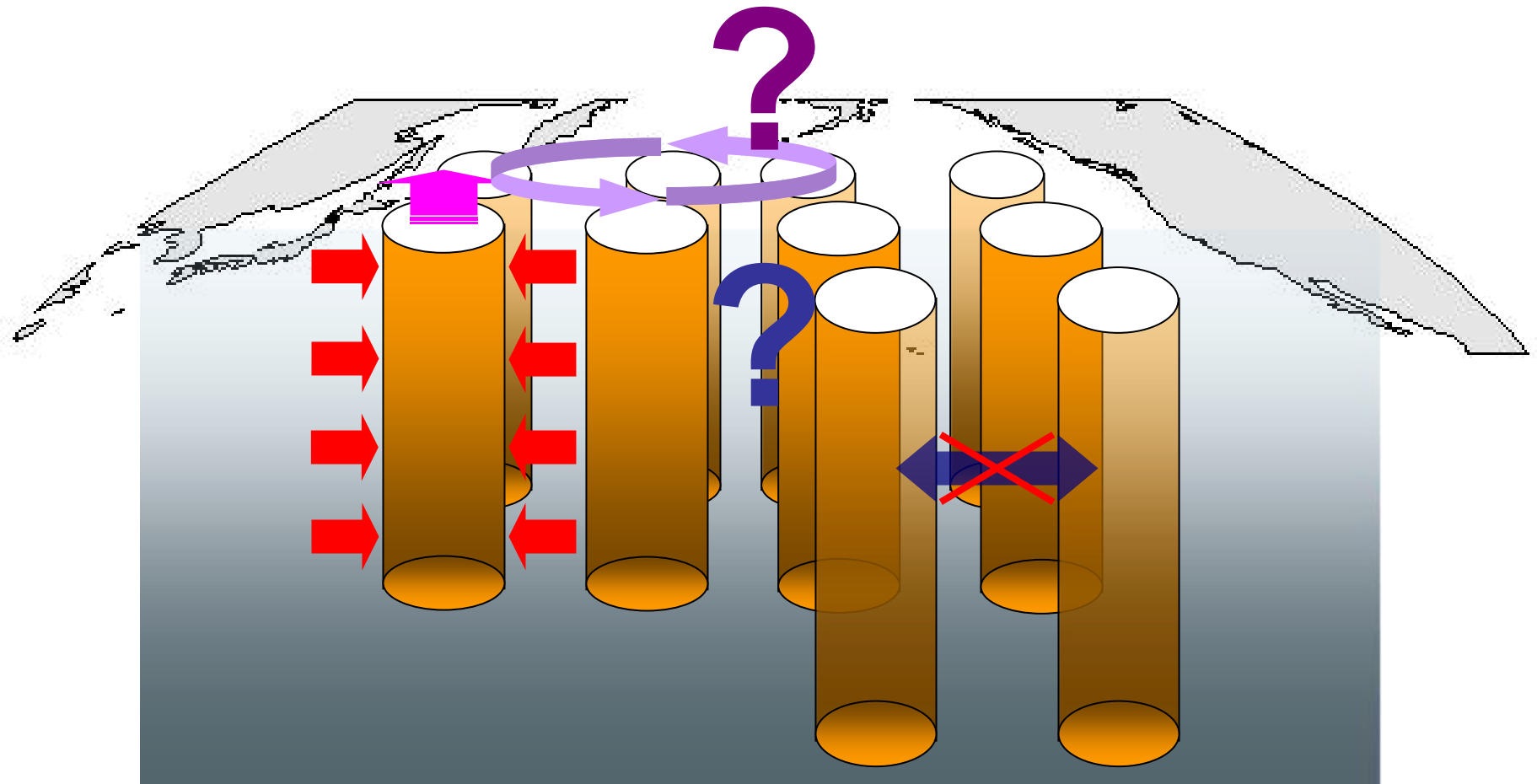
Ocean-Atmosphere Coupled Mode in CCSM2

(~16-yr Time Selection: First Mode Baroclinic Adjustment)



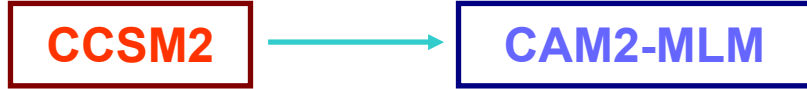
Kwon and Deser (2007, J. Climate)

Experimental Design : CAM2-MLM + KE Heat Transport Variation



Experimental Design :

CAM2-MLM + KE Heat Transport Variation



CAM2

CLM2

POP (OGCM) MLM (Mixed Layer Model)

- Ref: Alexander et al (2002), Cassou et al (2007)
- Array of 1-D columns / No lateral communication
- 36 Vertical levels in upper 1500m
- Prognostic mixed layer (Gaspar (1988))
- Same grids as the CAM2 (128 long x 64 lat)
- Surface flux correction for T (Q_{cor}) and S (S_{cor})
: accounts for mean horizontal advection and etc.

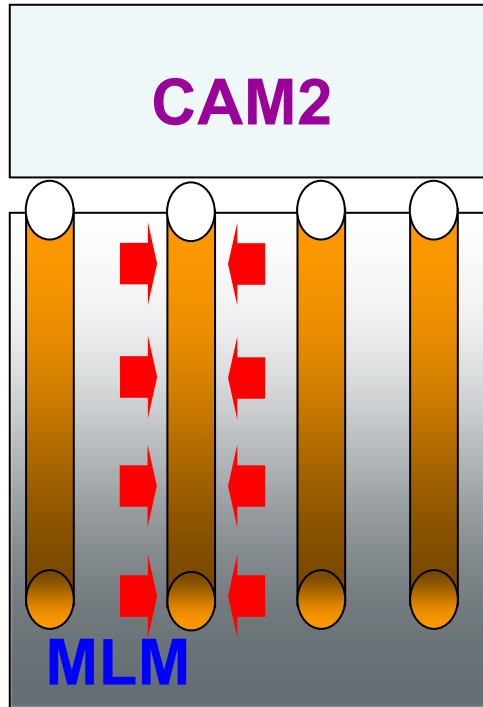
+ CCSM2 Geostrophic Ocean Heat Flux Convergence Anomalies in KE

CSIM4

Thermo-dynamic

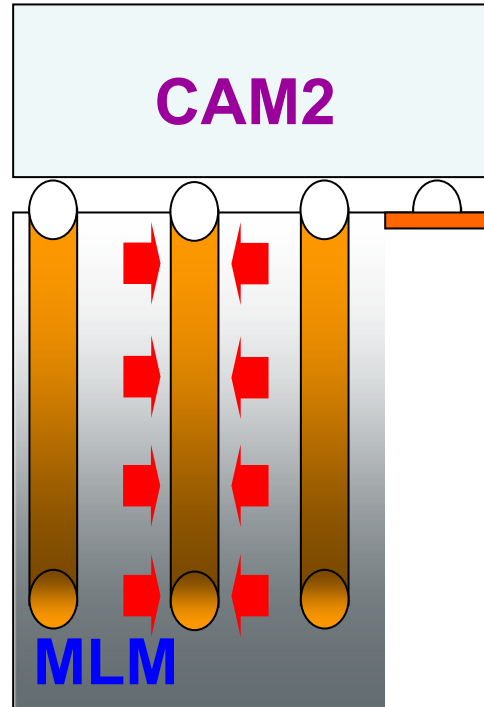
Experiments

GOGA



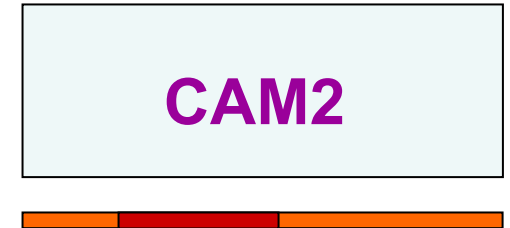
**Geostrophic Ocean
Heat Flux Convergence
Anomalies only in KE**

MOGA



**Climatological
SST in Tropics
(20°S-20°N)**

AMIP

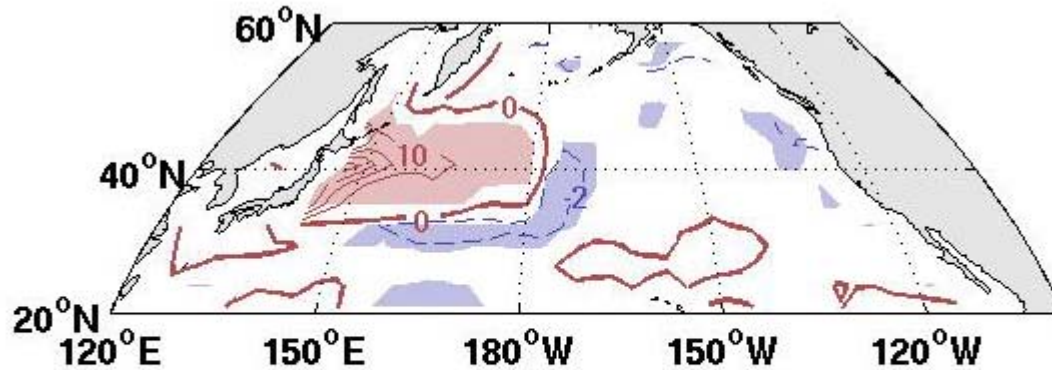


**MOGA SST
Anomalies
Specified in KE**

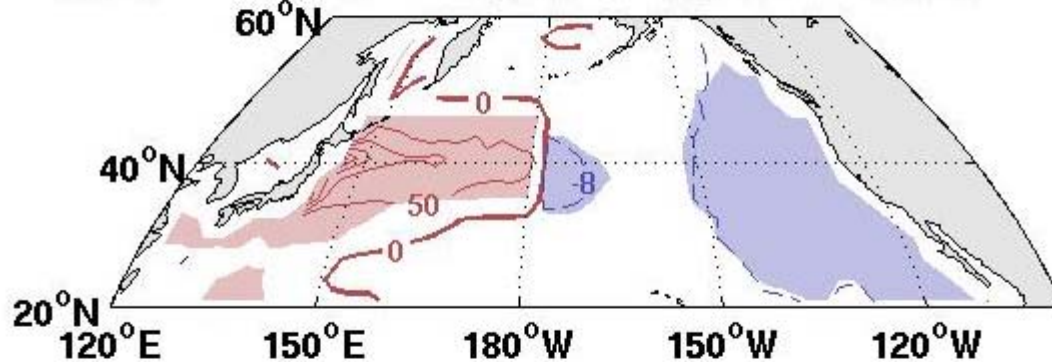
Equilibrium Responses = Perturbation Run (100-yr) Mean – Control Run (150-yr) Mean

MOGA Responses in the North Pacific (JFM)

850 mb
Diabatic
Heating
(10×10^{-6} K/s)

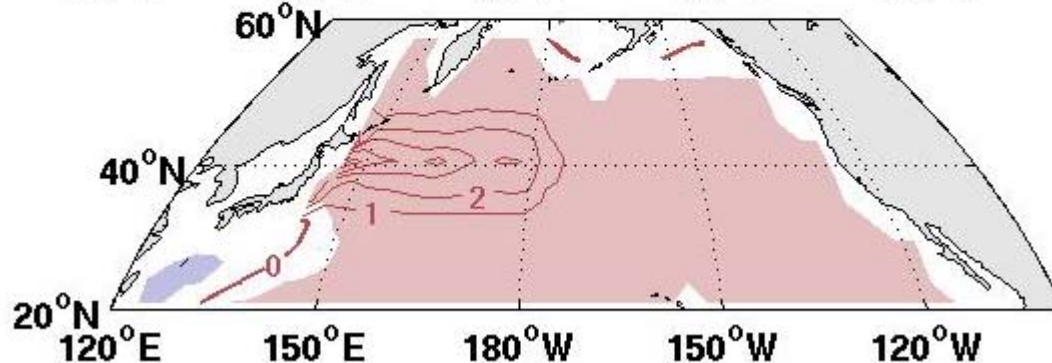


Net Surface
Heat Flux
(50 W/m²)



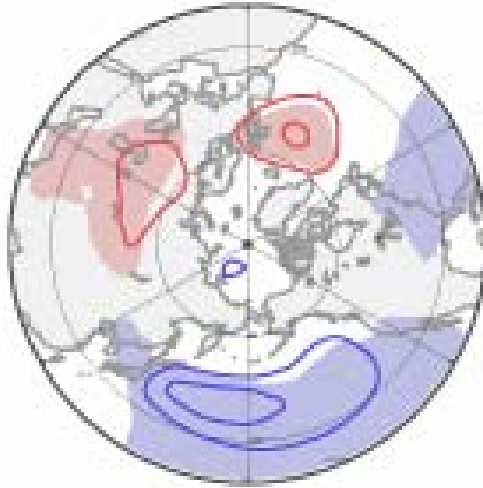
*Positive :
ocean-to-
atmosphere*

SST
(1°C)

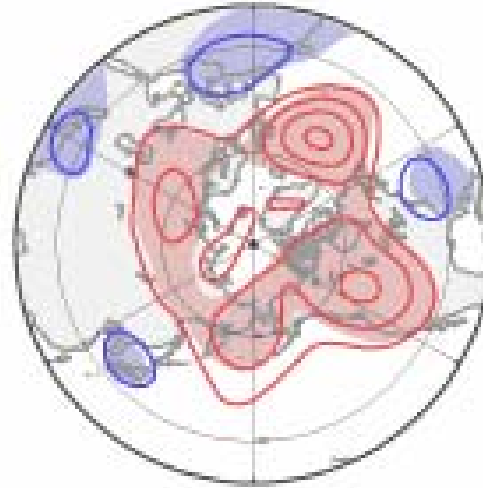


MOGA Responses in the Northern Hemisphere ($\geq 20^\circ\text{N}$, JFM)

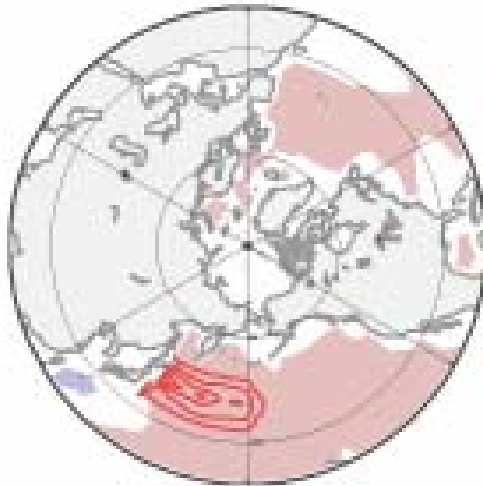
SLP
(1 mb)



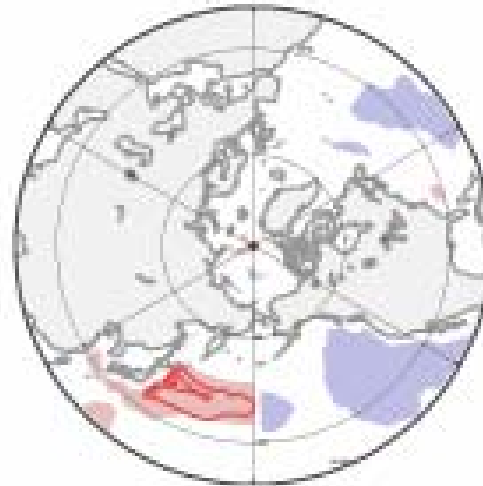
Z250
(10 m)



SST
(1°C)

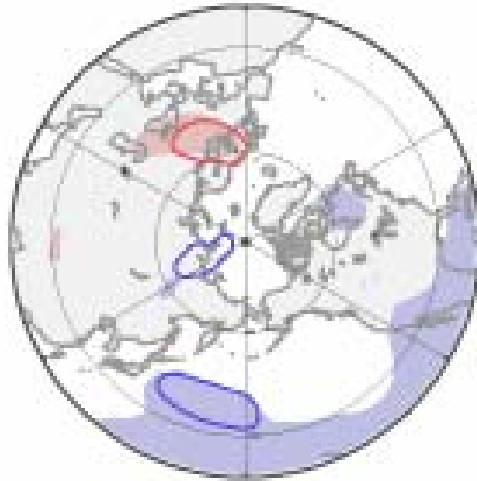


Net Surface
Heat Flux
(50 W/m²)

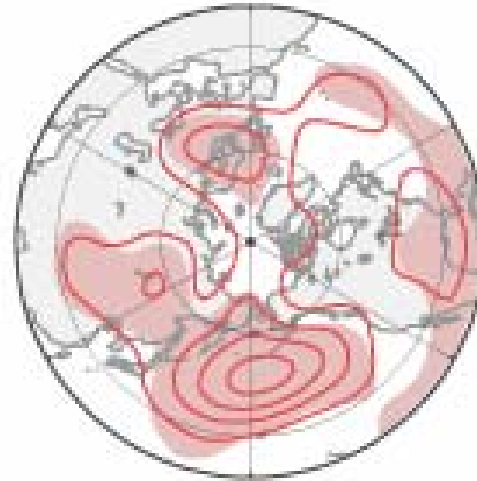


GOGA Responses (JFM)

SLP
(1 mb)

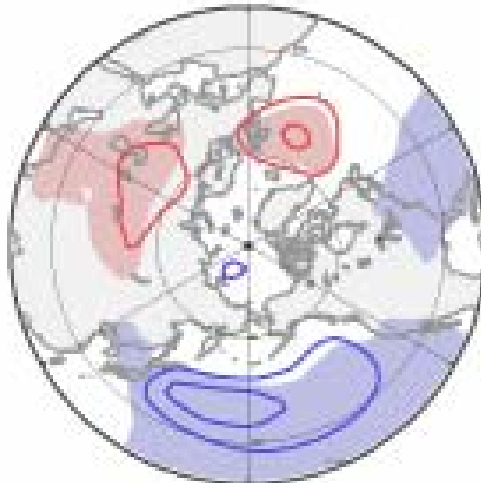


Z250
(10 m)

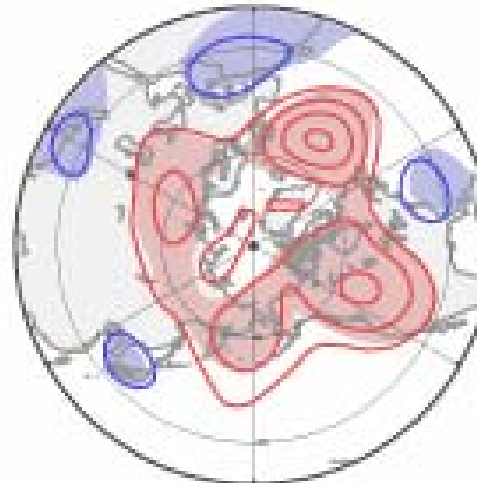


MOGA Responses (JFM)

SLP
(1 mb)

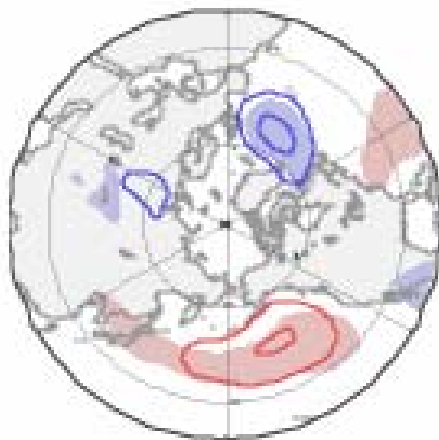


Z250
(10 m)

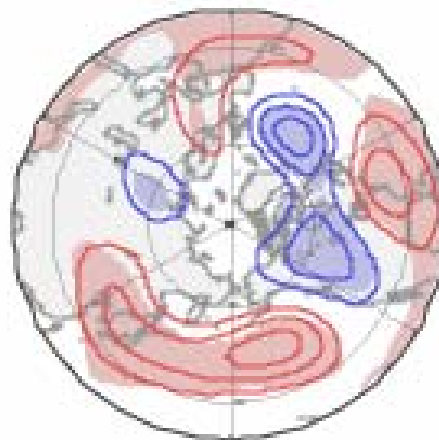


GOGA minus MOGA (JFM)

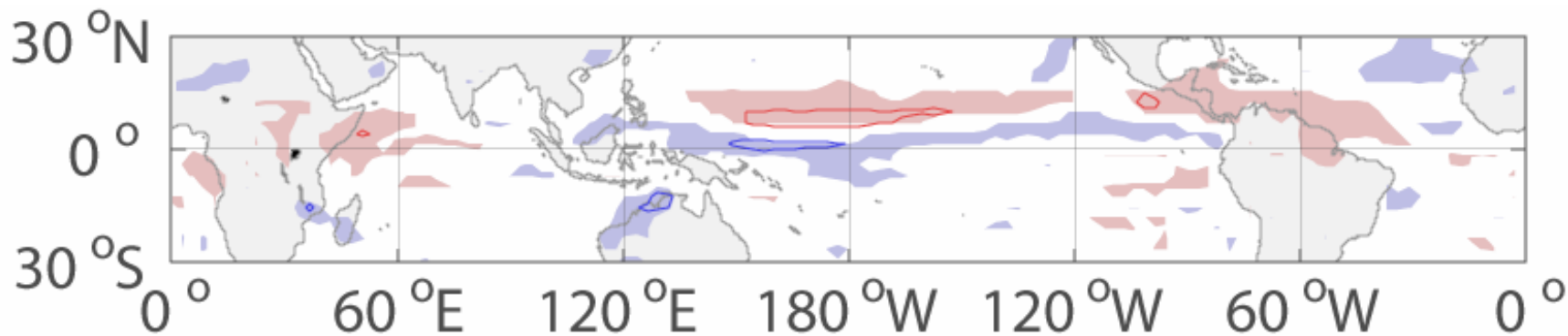
SLP
(1 mb)



Z250
(10 m)

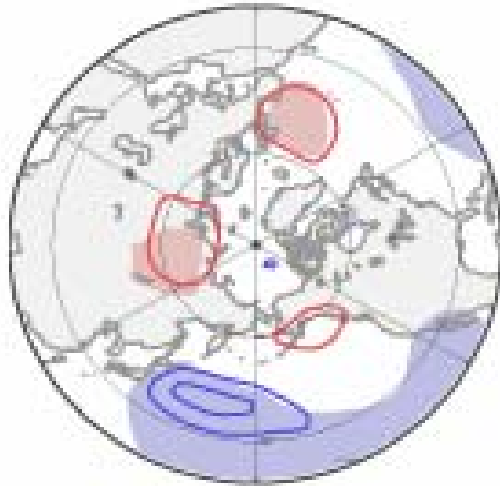


Precipitation (1 mm/day)

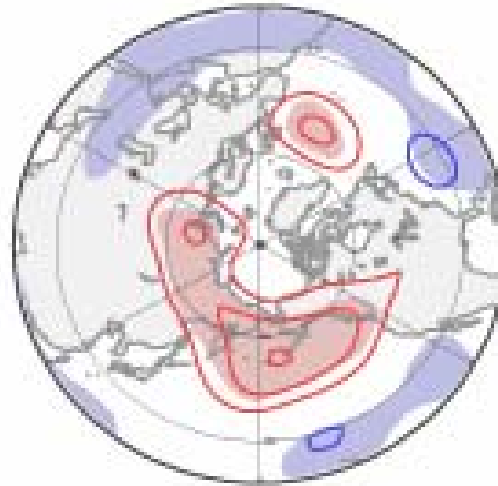


AMIP Responses (JFM)

SLP
(1 mb)

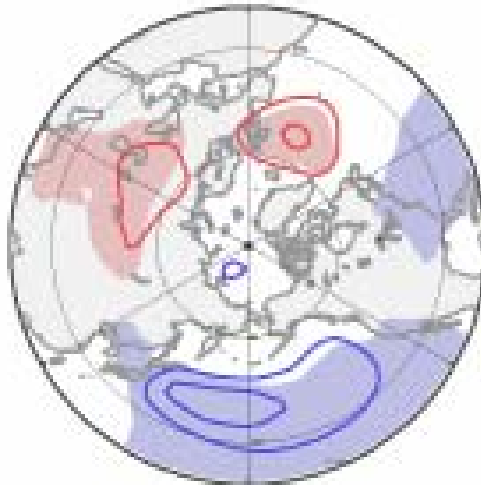


Z250
(10 m)

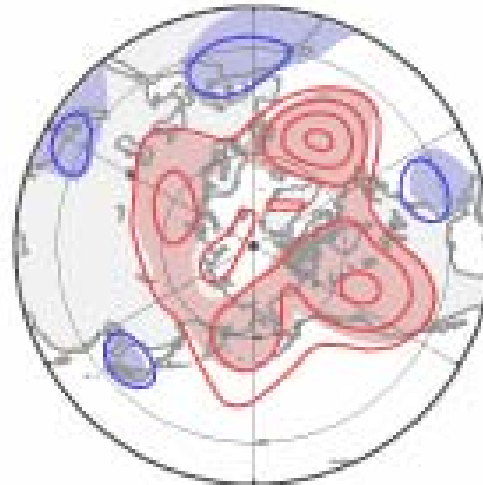


MOGA Responses (JFM)

SLP
(1 mb)

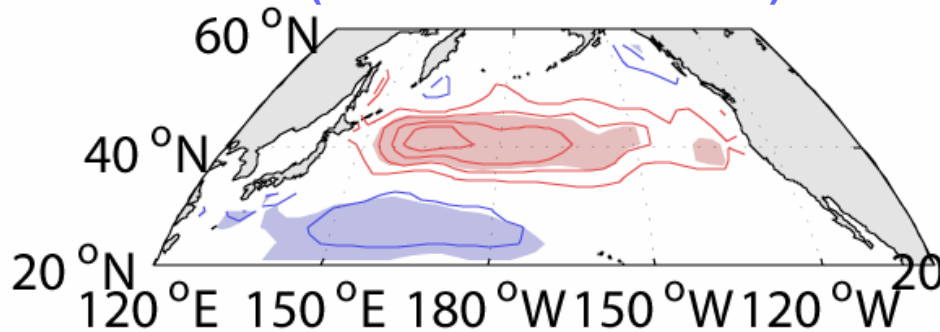


Z250
(10 m)

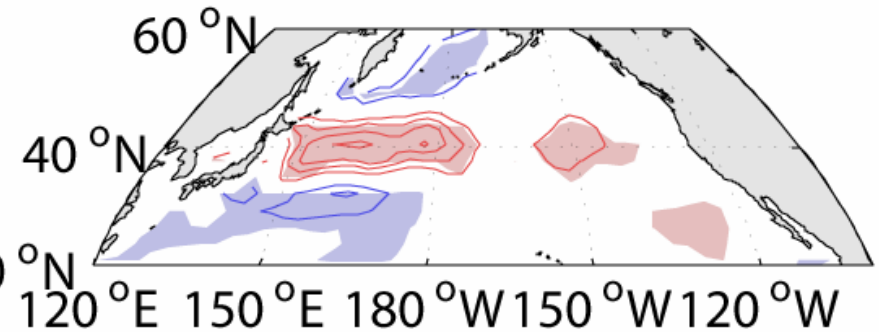


Wind Stress Curl Responses (JFM)

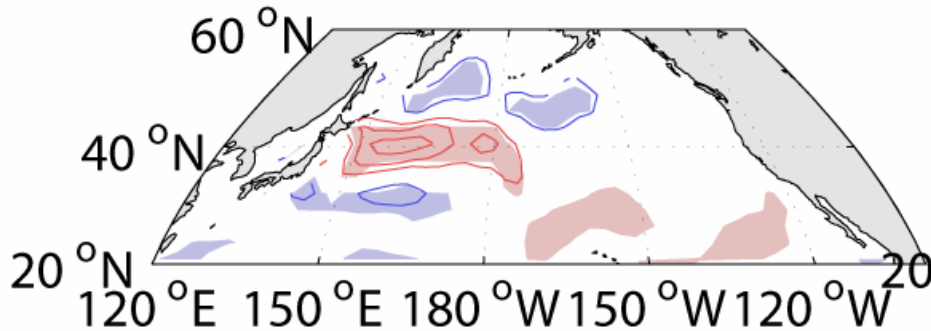
CCSM2 Regression
(Kwon & Deser 2007)



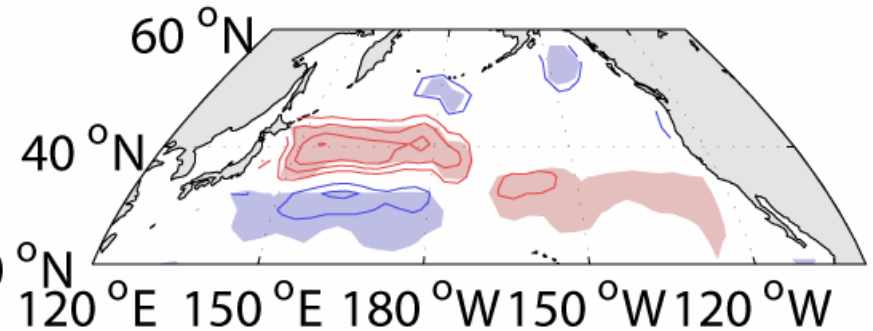
MOGA



GOGA



AMIP



$(0.5 \times 10^{-8} \text{ N/m}^3)$

Summary

In the CAM2-MLM with specified ocean geostrophic heat flux convergence (OGHFC) anomalies in KE ...

- Direct responses to the KE OGHFC are baroclinic with anomalous surface low pressure.
- Indirect responses via tropics are equivalent barotropic with anomalous high pressure.
- SST-forced integration exhibits weaker and less persistent surface responses than MOGA.
- Wind stress curl responses are less sensitive to the differences in model configurations.

Thank You.