# Comparison of the Oceans Simulated by the OGCM and the CGCM:

## Preliminary Report of CES CGCM

**Y. Noh[1], Y.B. Yim[1], B. K. Moon[2], and I.S. Kang[2]**

[1] Department of Atmospheric Science, Yonsei University
[2] Department of Atmospheric Science, Seoul National University

## Model description

| Model | Resolution | Note |
|---|---|---|
| Yonsei Univ. OGCM | 0.5625° x 1.125° (40°S – 48°N) vertical 37 levels | based on GFDL MOM 2.2 Noh and Kim mixed layer scheme ( Noh and Kim 1999) |
| SNU AGCM | T42 (2.8125X2.8125) 20 vertical layers | adapted from CCSR AGCM Kang et al. (2002) |
| CGCM | 0.5625° x 1.125° T42 | OCGM + AGCM |

**Coupling Strategy**

-1-day interval exchange

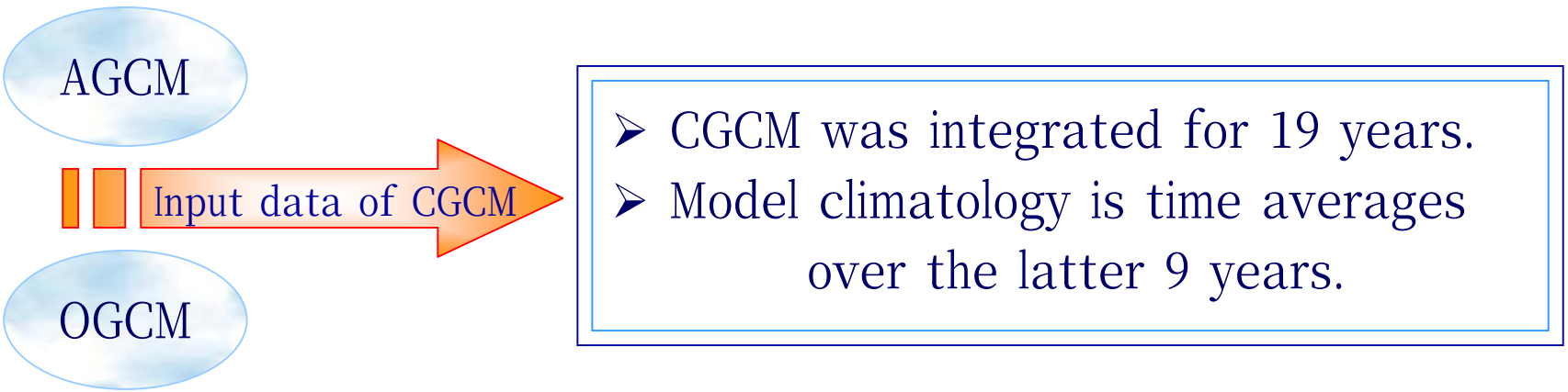
- Ocean : SST
- Atmosphere : Heat, Momentum Flux
- No Flux Correction is applied.

## run

- Before coupling,
  - AGCM was integrated for 1 year forced by the observed SST.
  - OGCM was spun up for 10 years from motionless state initially with January mean temperature and salinity distributions by Levitus (1982)

  Net heat flux(Q) : $Q = Q_{ncep} + \gamma(SST_{lev}-SST_{model})$ , combined (the restoring time scale of 11.5 days)

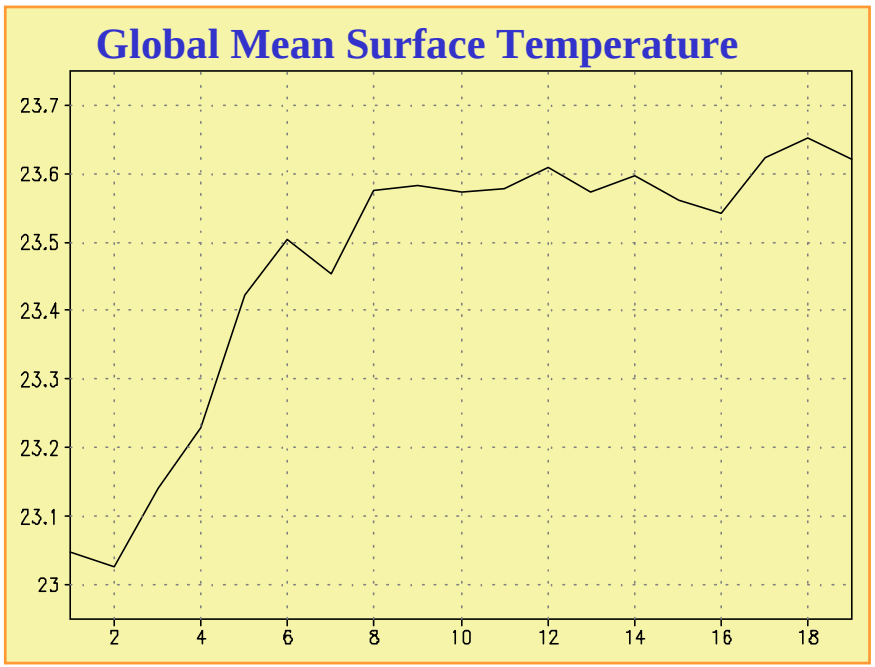
  the monthly heat flux and wind stress from NCEP reanalysis data.



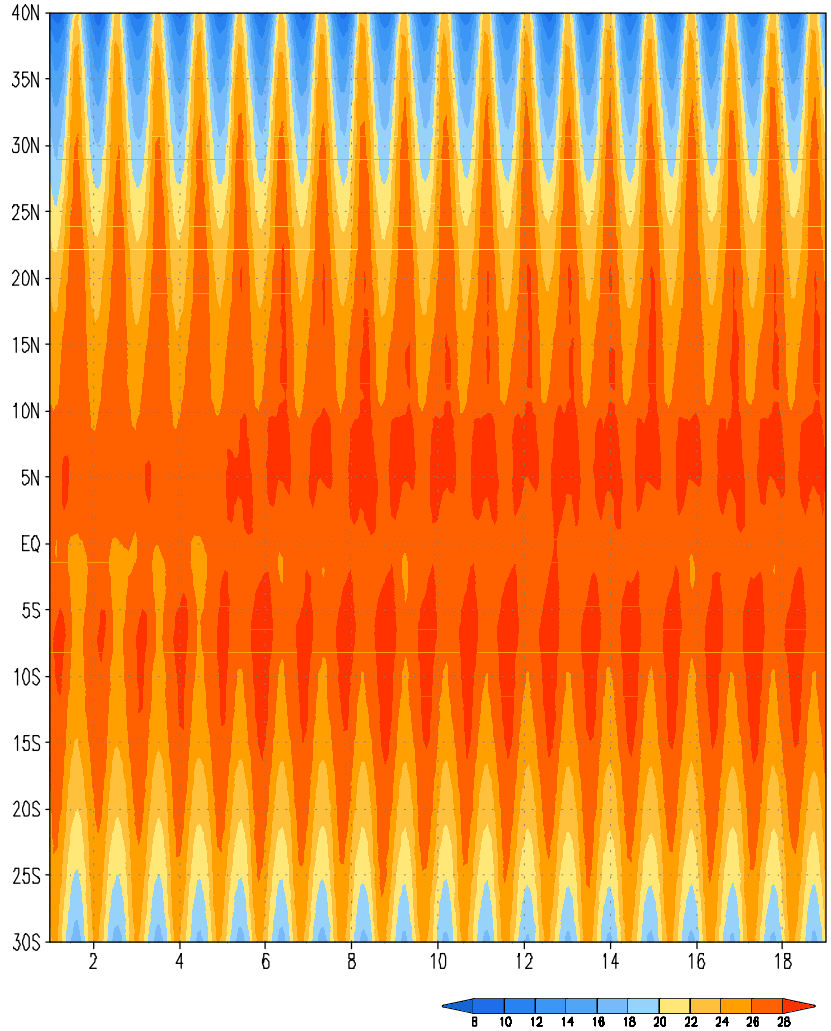
# CGCM integration

**Annual Mean**
**Global Mean Surface Temperature**

| | |
|---|---|
| **Observation (Levitus)** | **23.54 ºC** |
| **CGCM** | **23.60 ºC** |



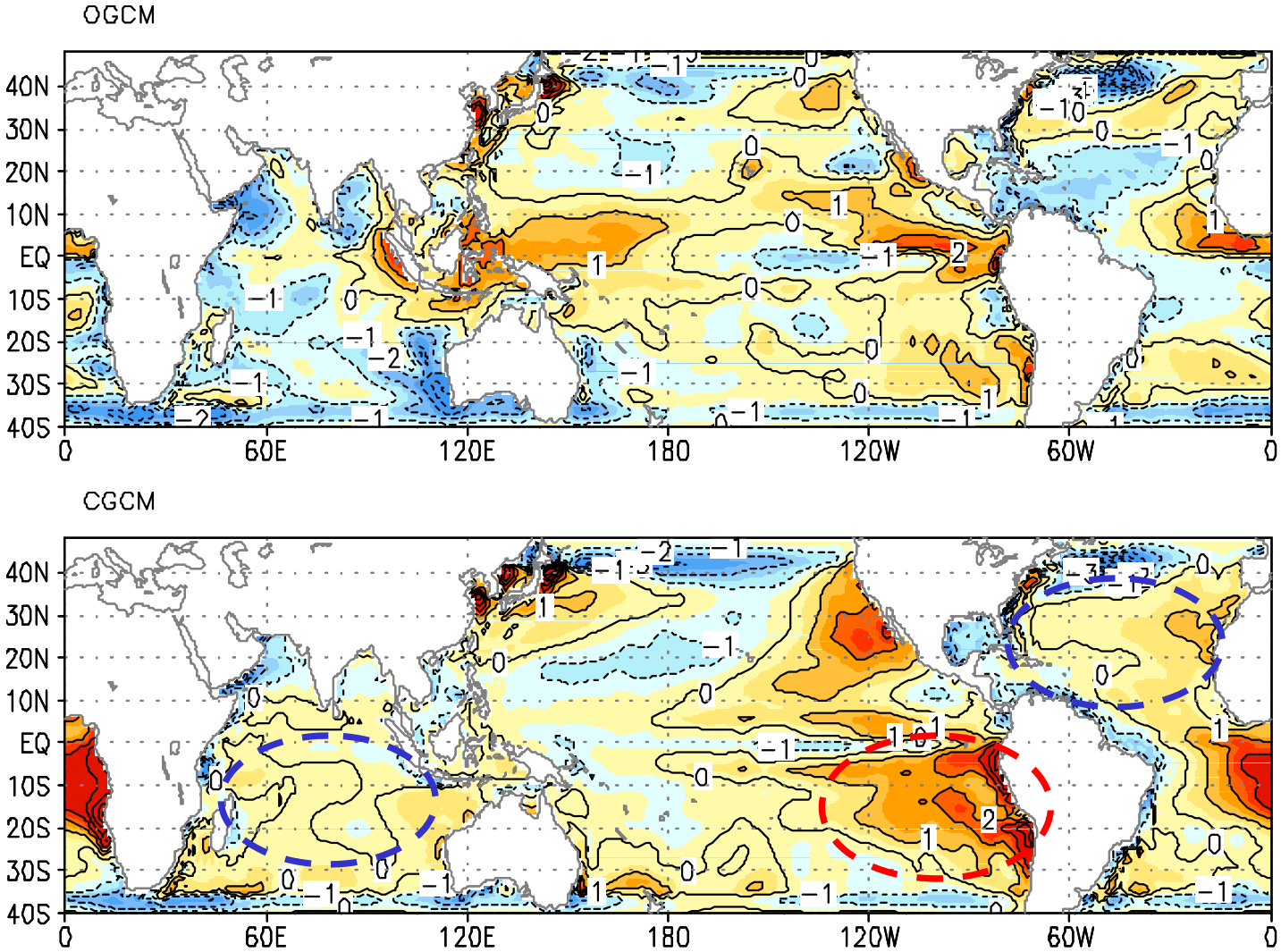

**Zonally averaged SST**



1. understand how the ocean is adjusted to the coupling with the AGCM

2. evaluate the CGCM performance

# Annual averaged SST anomaly

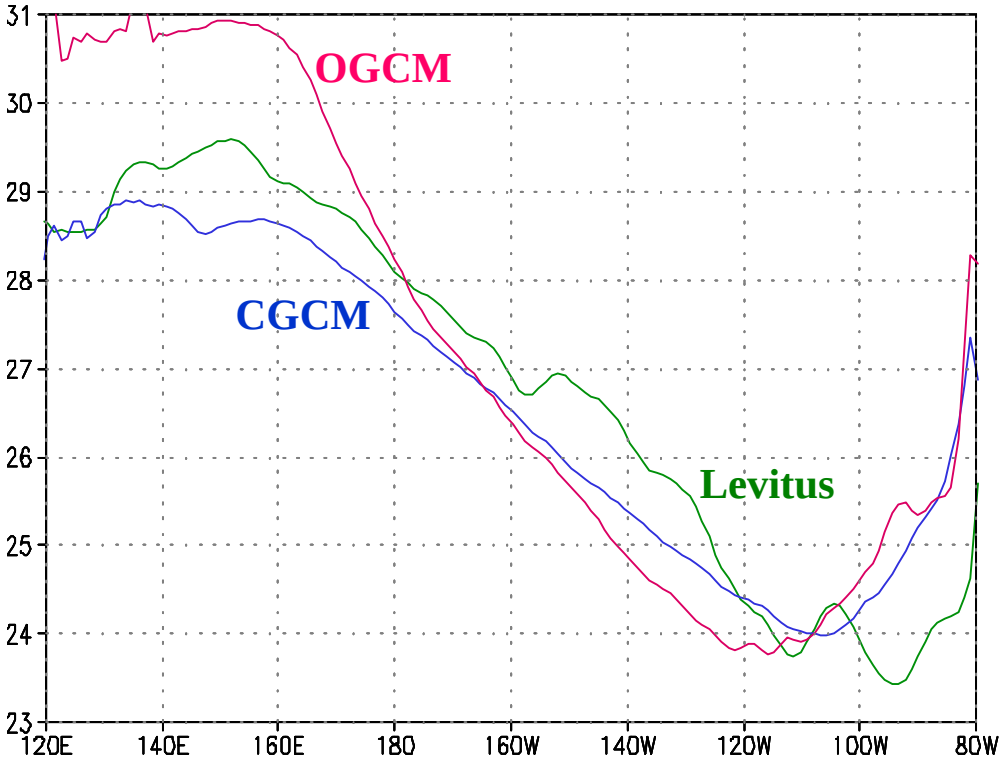



*too warm bias in the eastern parts of the Pacific and Atlantic*

*weaken cold bias in the Indian and the Atlantic*

# Annual averaged SST along the equator

(2°S – 2°N)



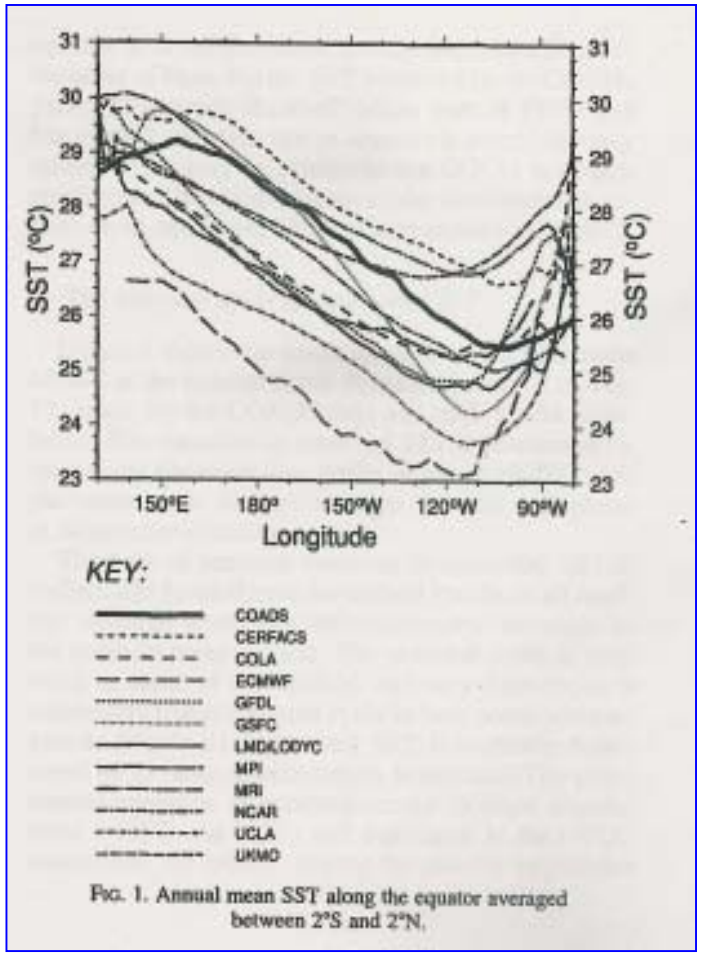
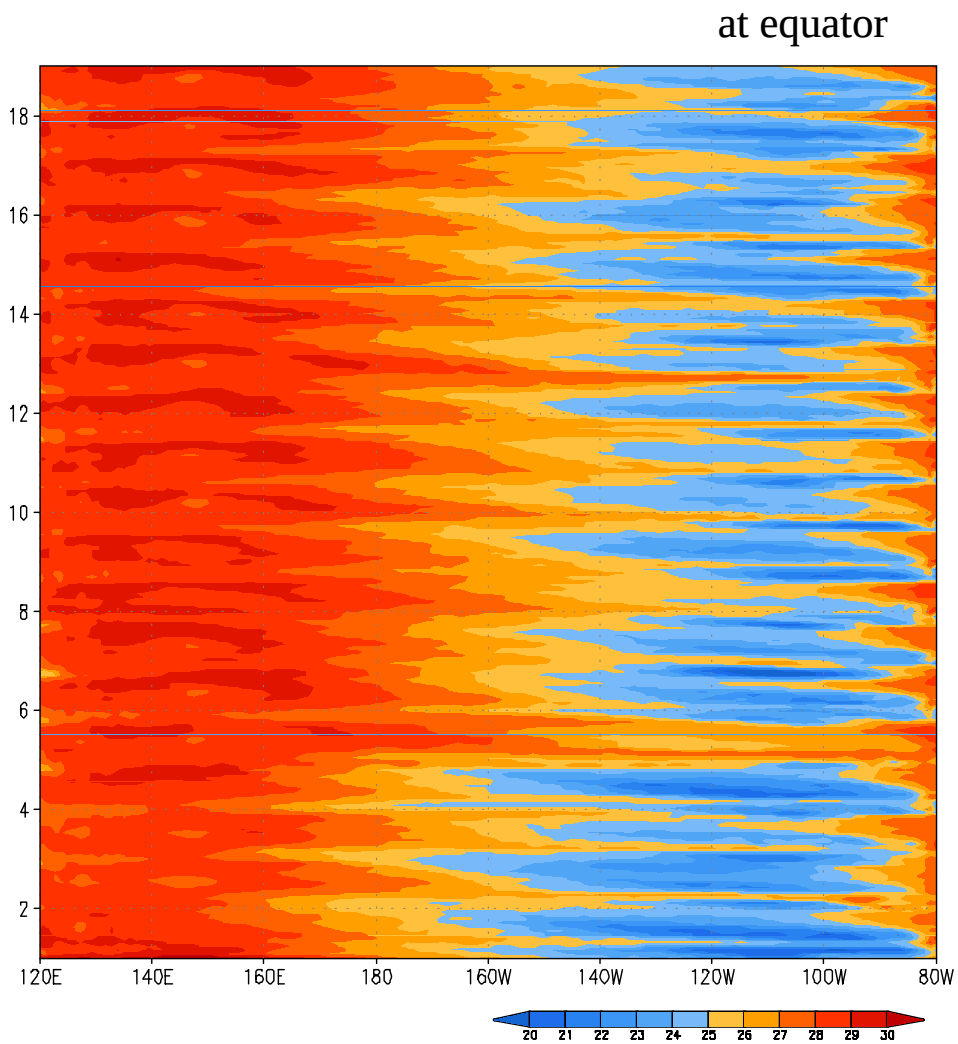



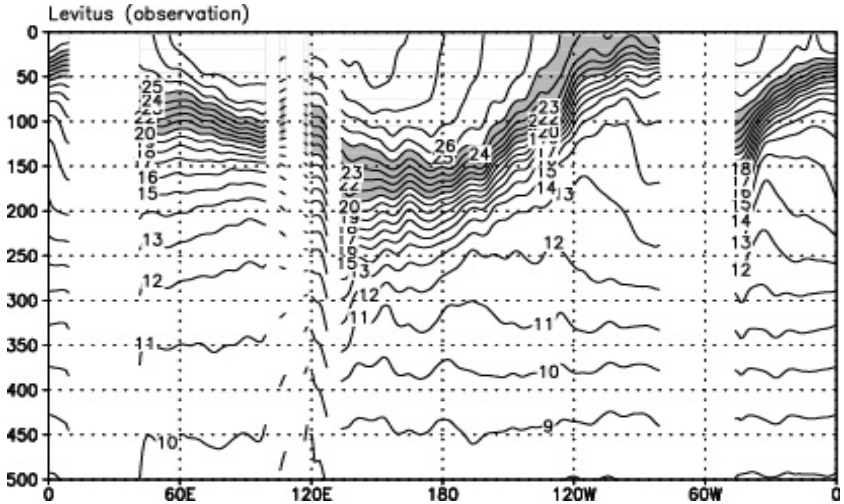

FIG. 1. Annual mean SST along the equator averaged between 2°S and 2°N.

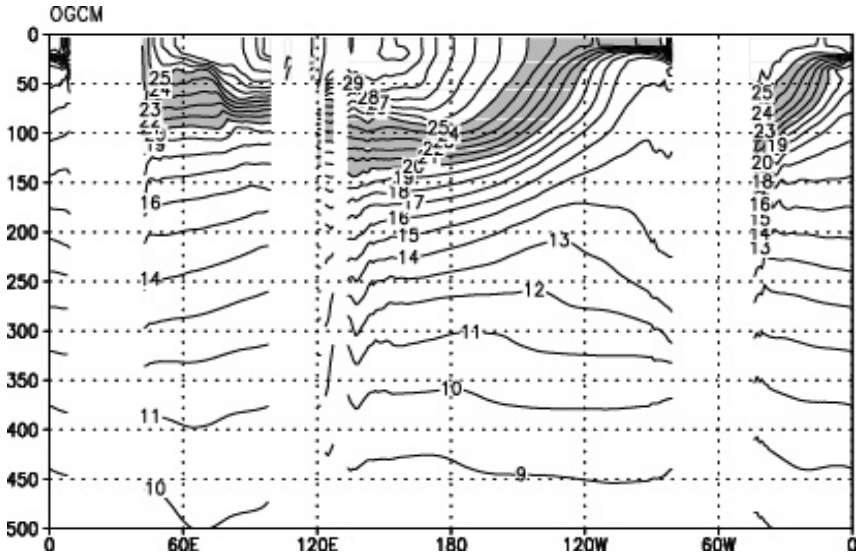
*Mechoso et al. (1995)*

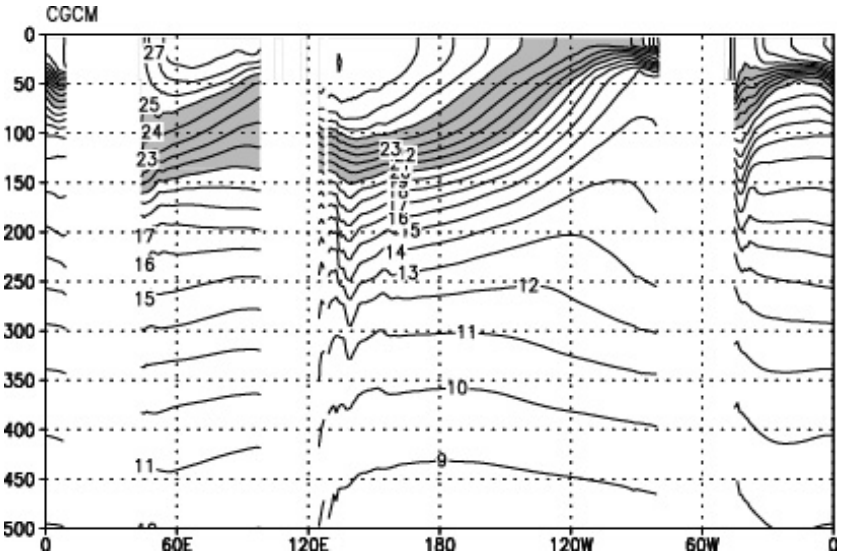
## SST variation



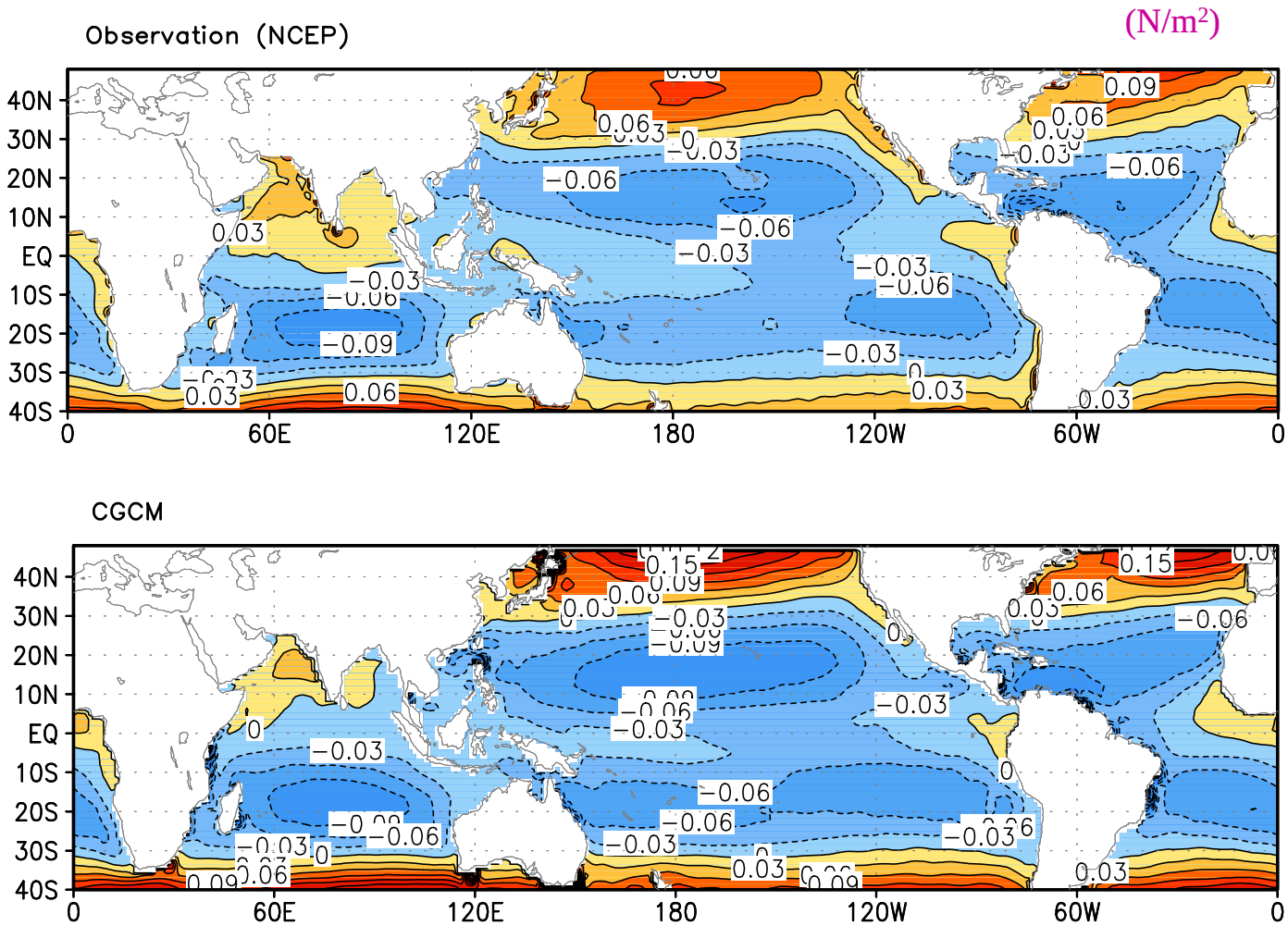
# Annual mean temperature along the equator



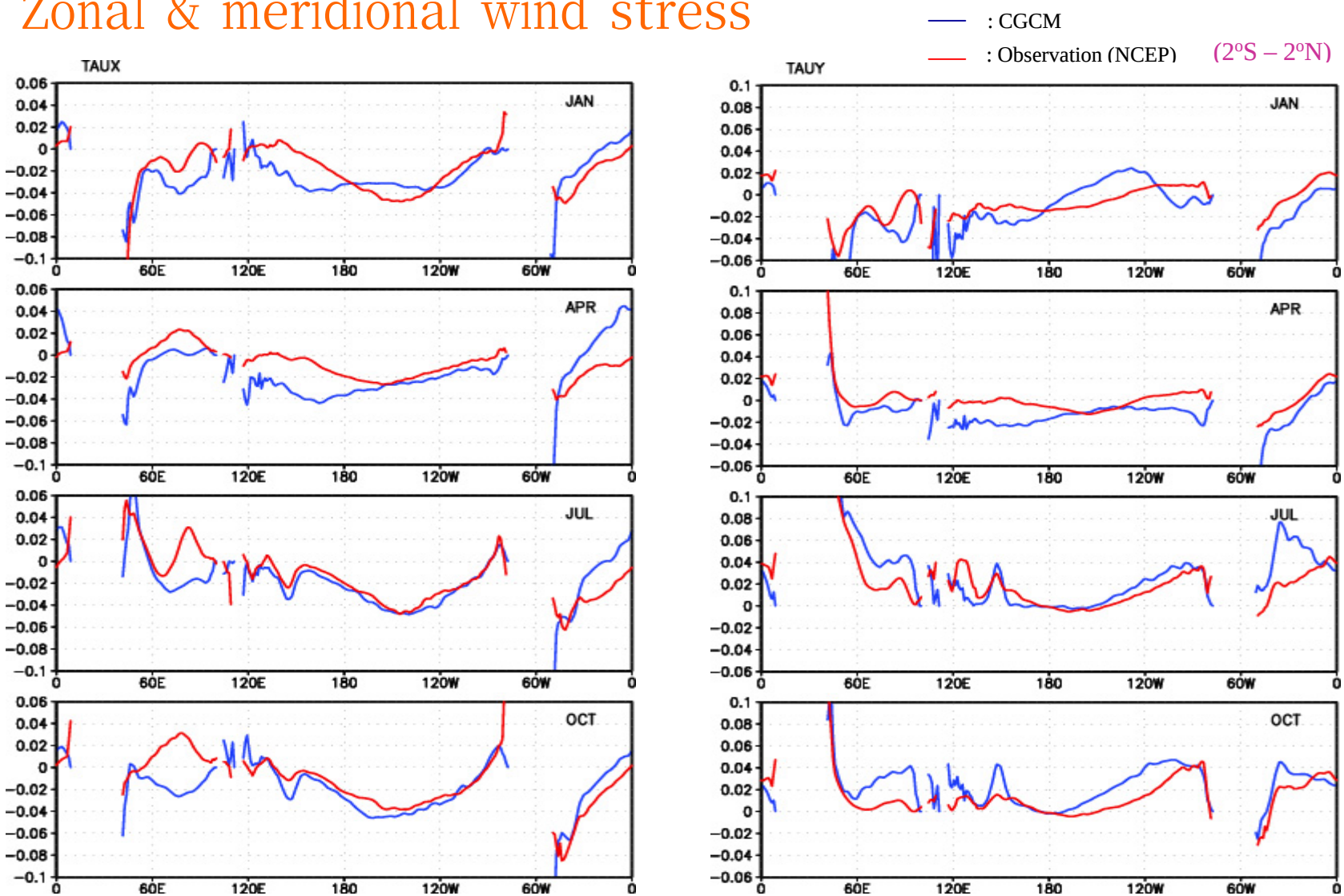



# Annual averaged zonal wind stress

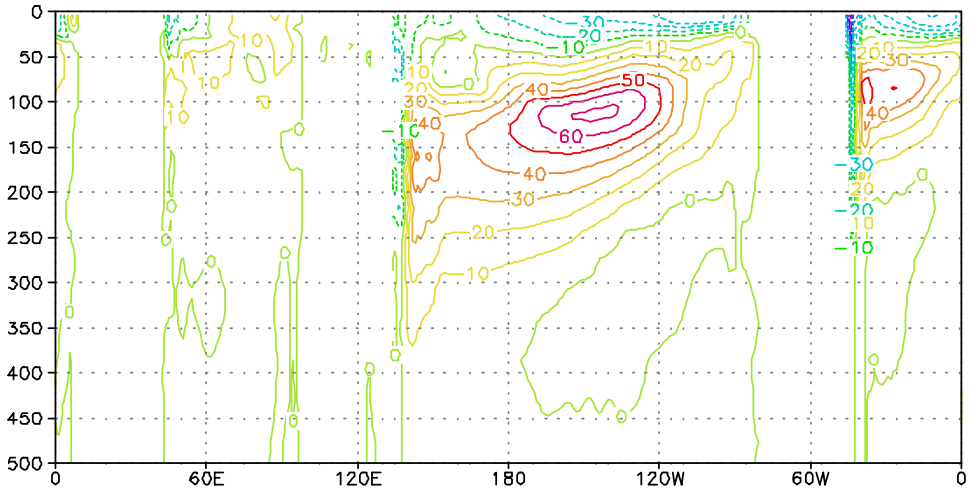


# Zonal & meridional wind stress

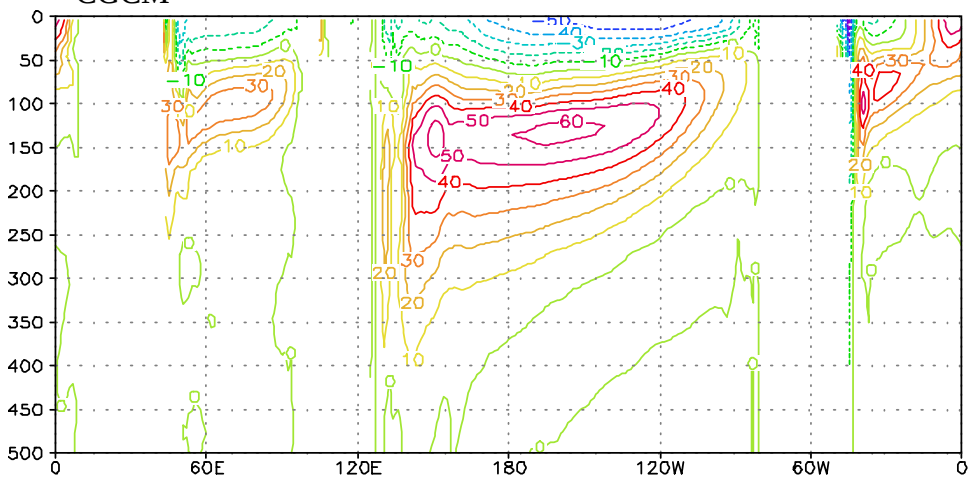


# Annual mean zonal velocity along the equator

OGCM



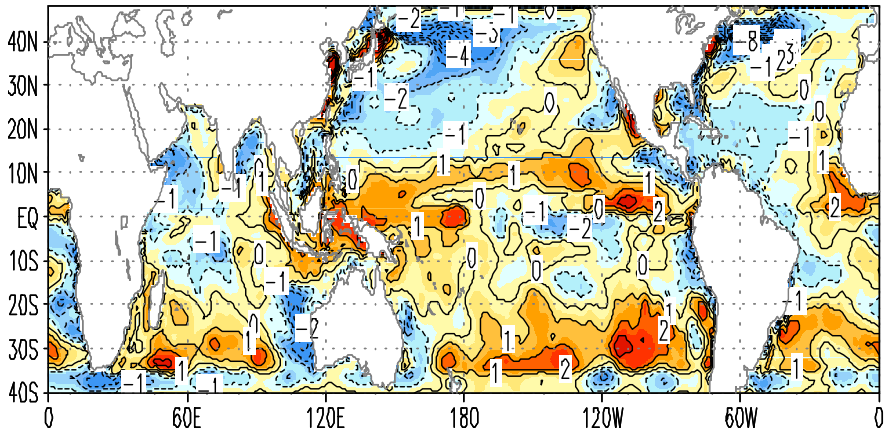

CGCM



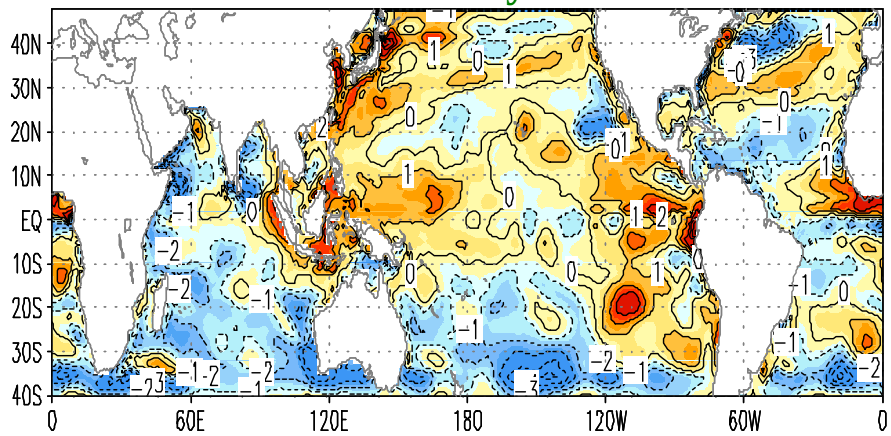

*EUC is shifted toward west.*

## SST anomaly

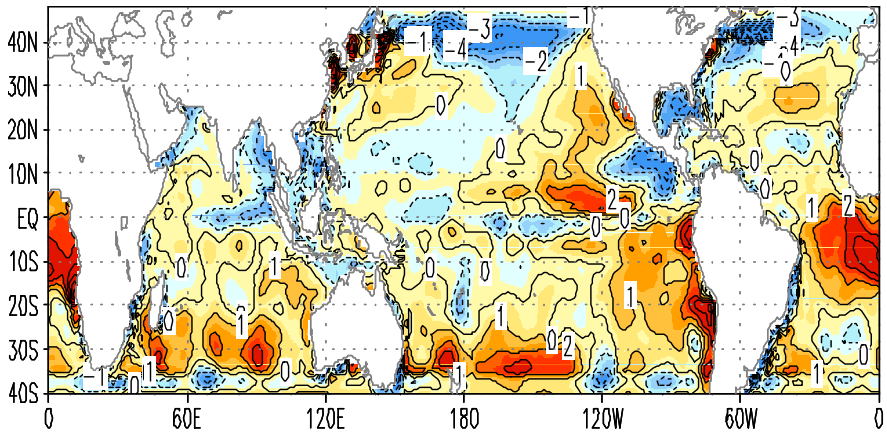
OGCM **January**



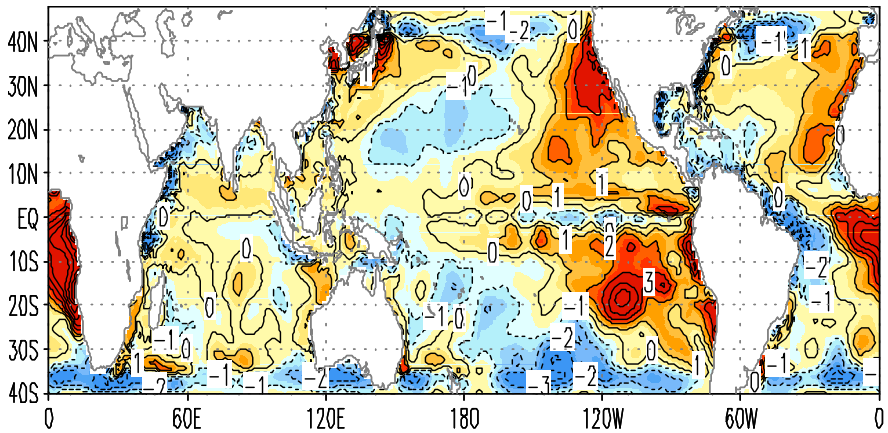

OGCM **July**




CGCM

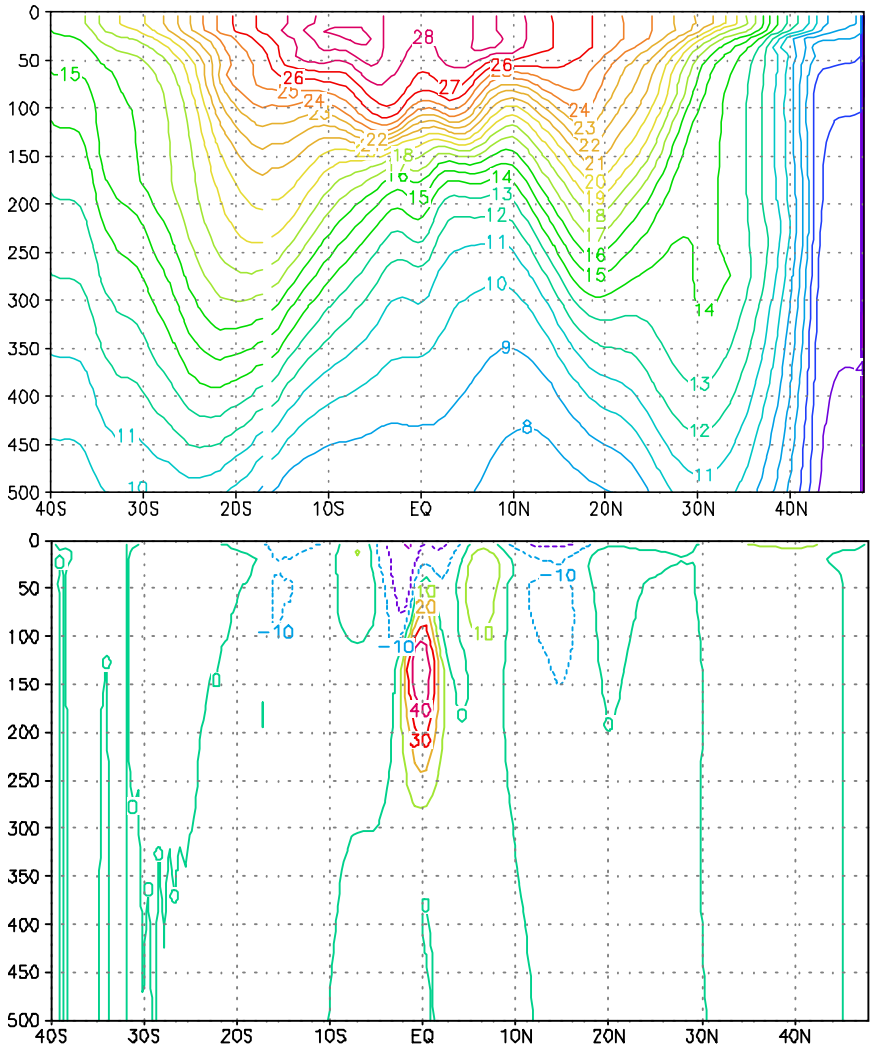



CGCM

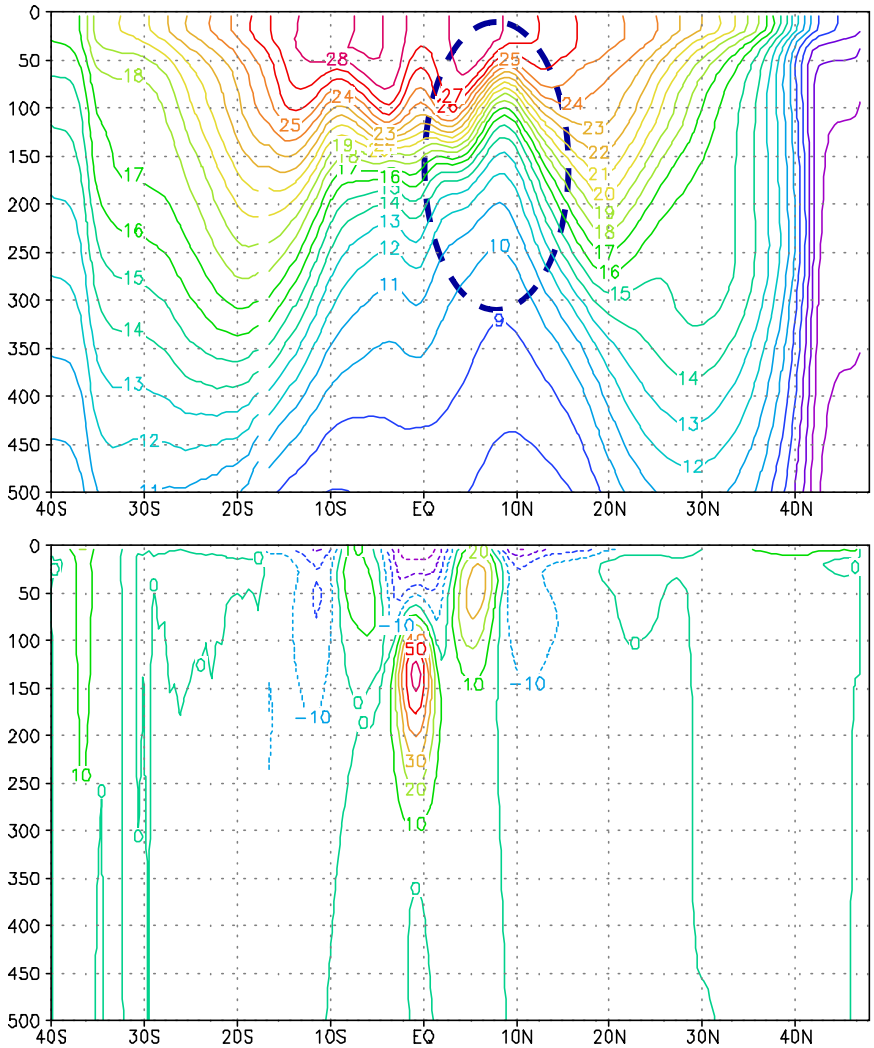


# Annual mean temperature & zonal velocity at 180E

OGCM

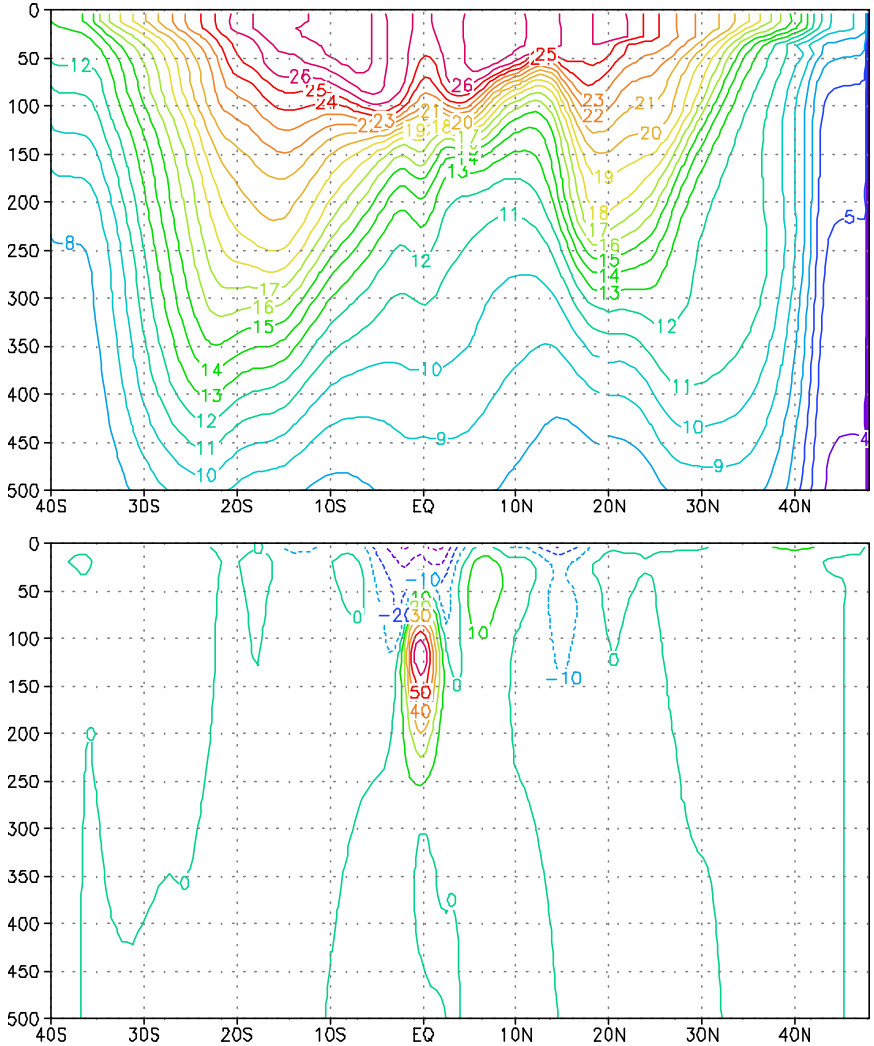



CGCM

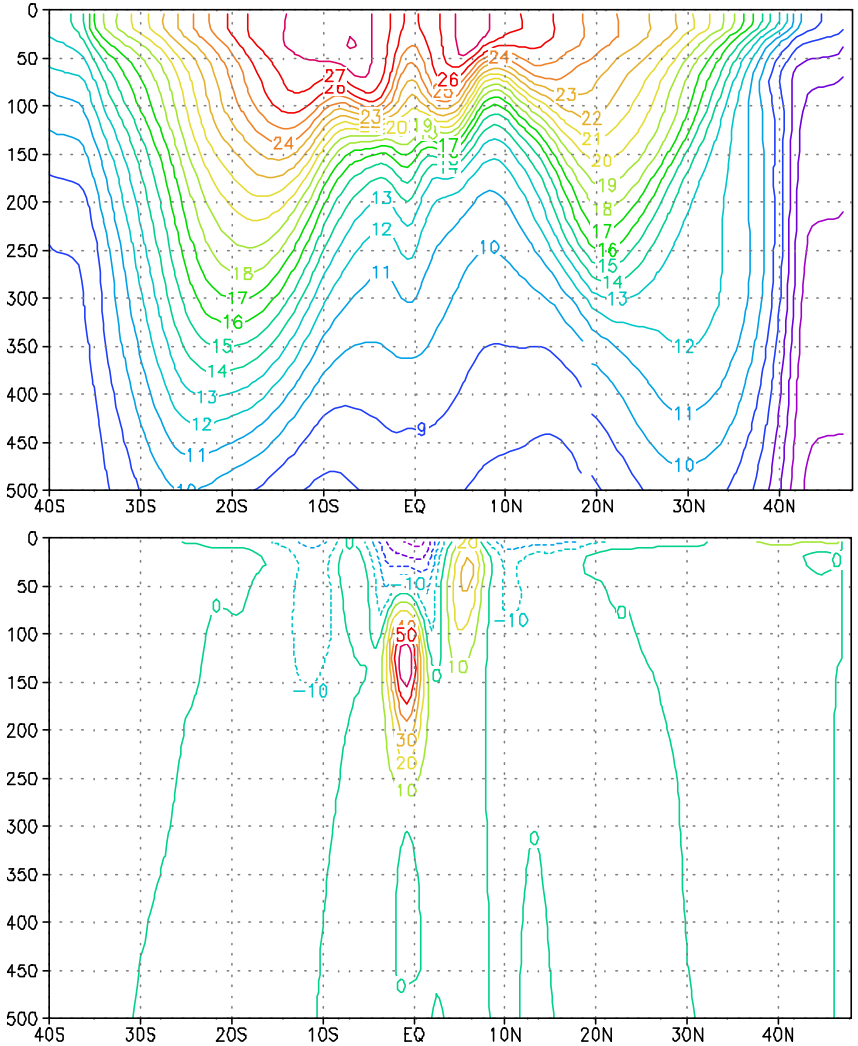


# Annual mean temperature & zonal velocity at 155W

OGCM




CGCM

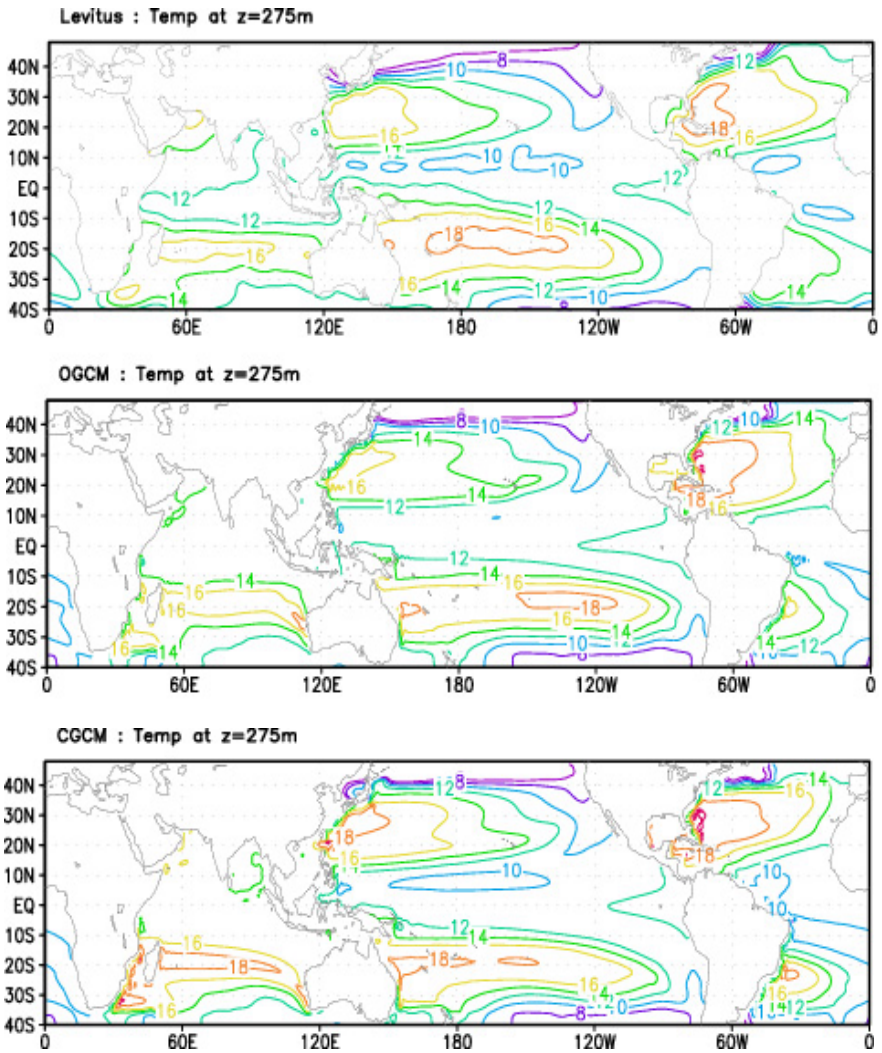


# 4. Comparison of the CGCM results

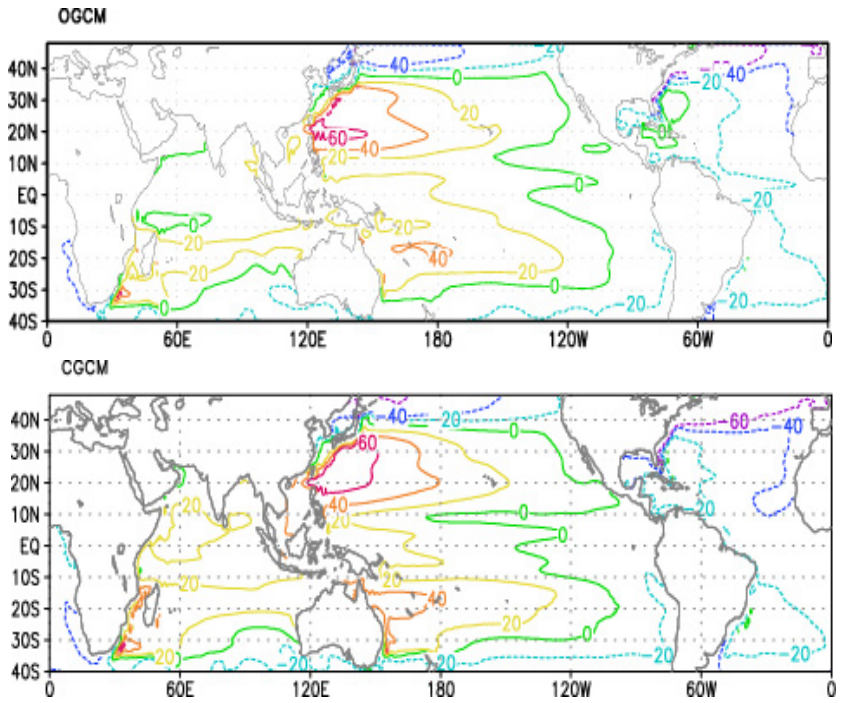
| Model | **OPAE/ARPEGE-T21 CGCM** (*E. Guilyardi & G. Madec, 1997*) | **CGCM** |
|---|---|---|
| In the tropical Pacific | weakened zonal wind stress along the equator | *(rather slightly stronger)* |
| | decreased zonal slope of a thermocline<br>warm anomaly | |
| vertical temperature distirbution (equator) | symmetric | more realistic |

# 3. Results

## Temperature at 275m




## Surface pressure

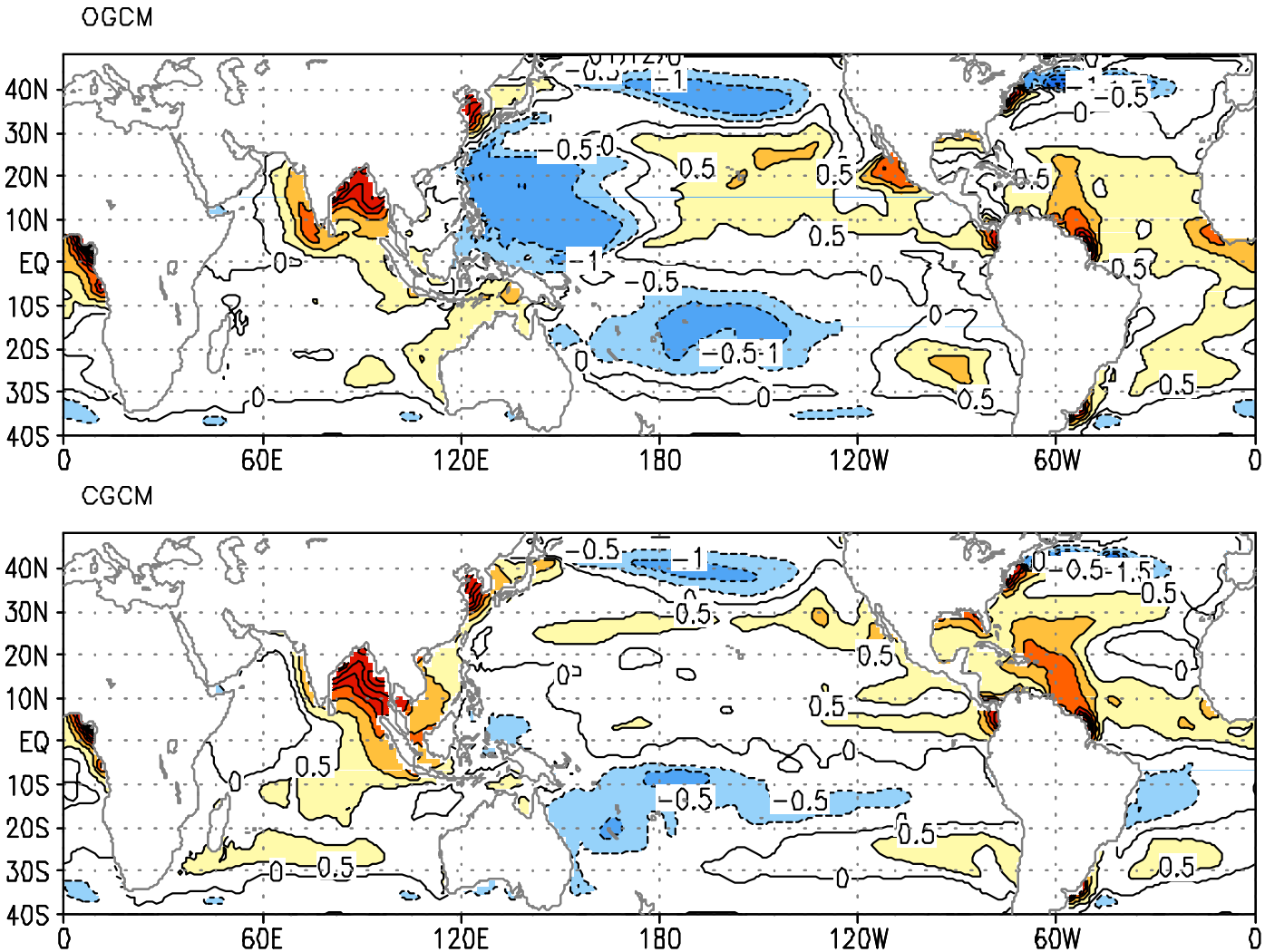



*In the mid-latitude,*

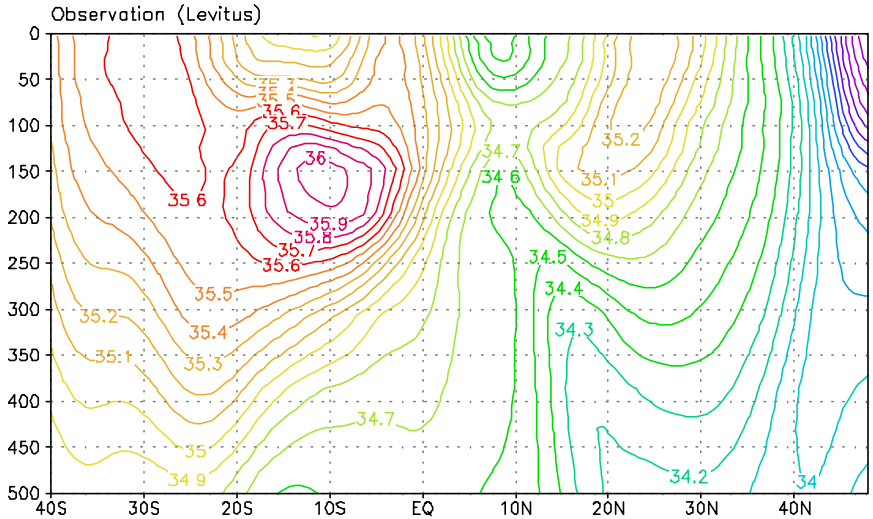
*zonal slope of thermocline - larger*

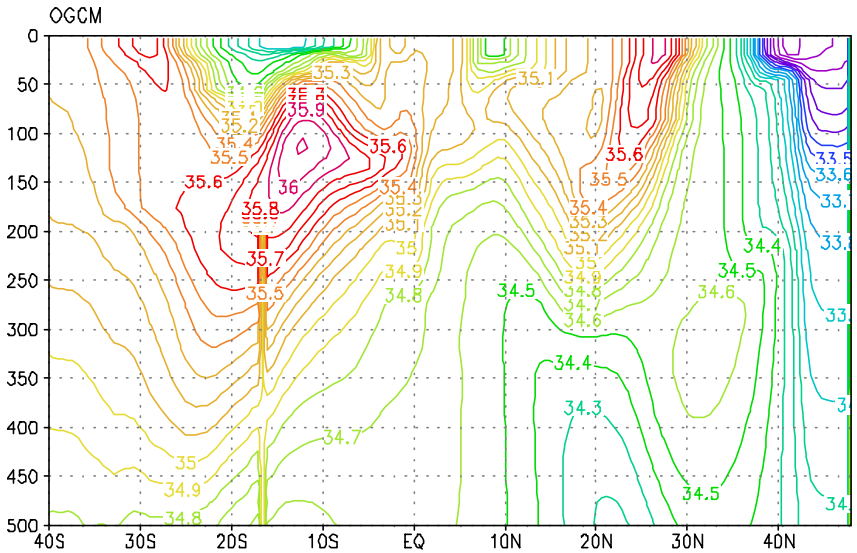
*western boundary current - stronger*

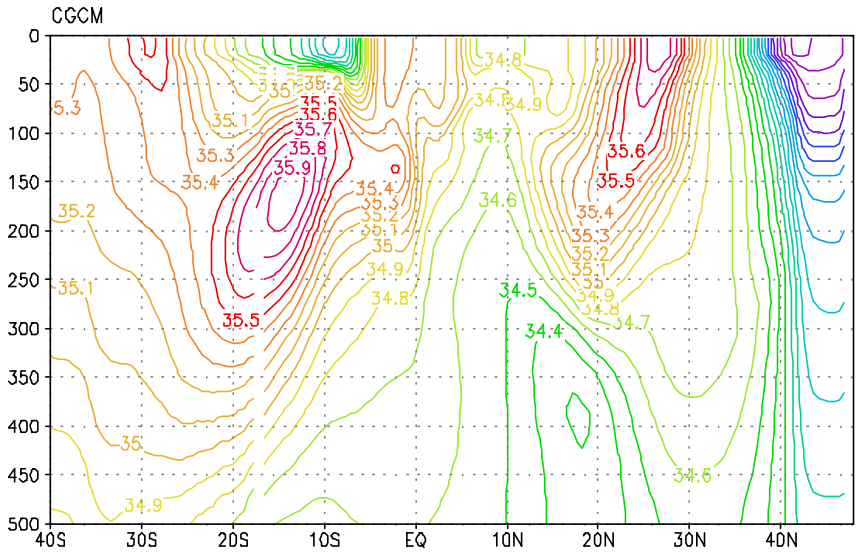
# Annual averaged SSS anomaly



# Annual mean SSS at 180E



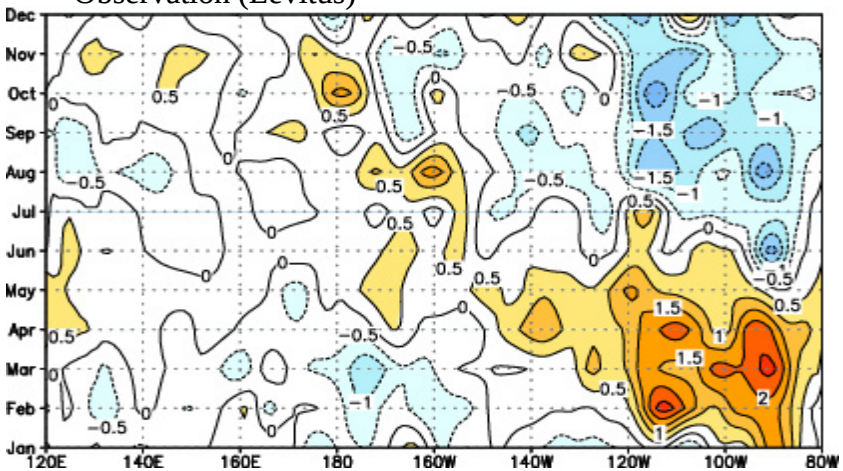



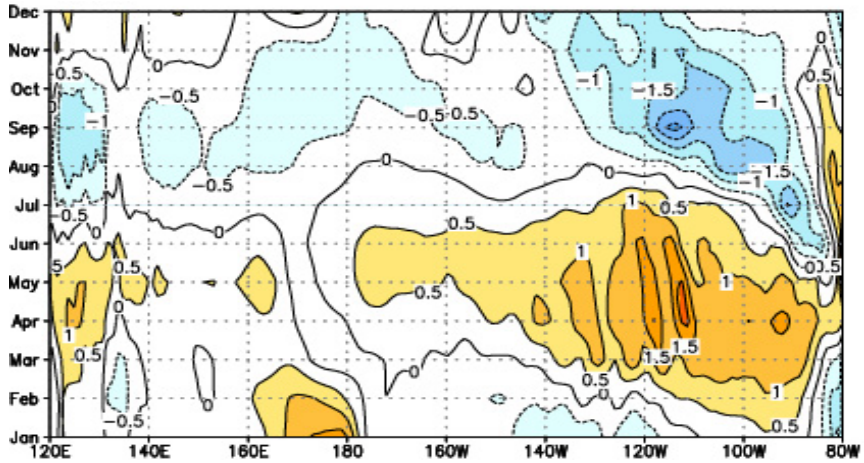
# Seasonal cycle SST anomaly

(2°S – 2°N)

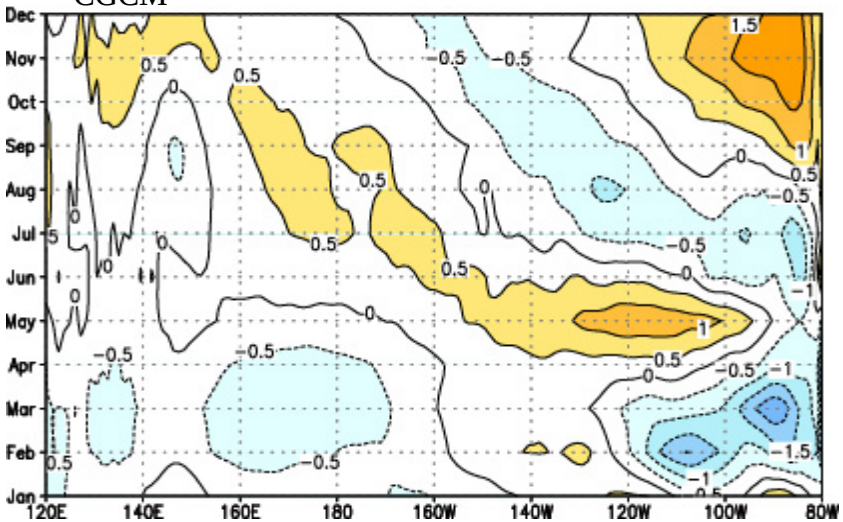
Observation (Levitus)

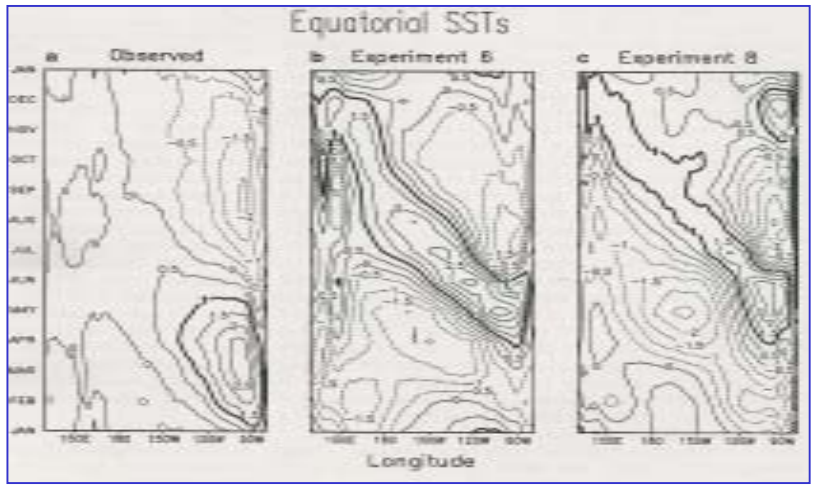



OGCM




CGCM




*Meehl et al. (2001)*

# 5. Conclusion

1. The general features of the ocean circulation & the T-S structure

   are reproduced reasonably well by the CGCM

2. In the equatorial ocean,

   - zonal gradient of SST → smaller
   - thermocline → more realistic (Its slope appears over much larger latitudes.)
   - EUC → shifted westward
   - zonal wind stress → slightly stronger

3. In the mid-latitudinal ocean,

   - zonal slope of a thermocline → larger
   - western boundary current → stronger

4. SSS anomaly is reduced in the CGCM

5. The semiannual pattern in the seasonal variation of the SST along the equator

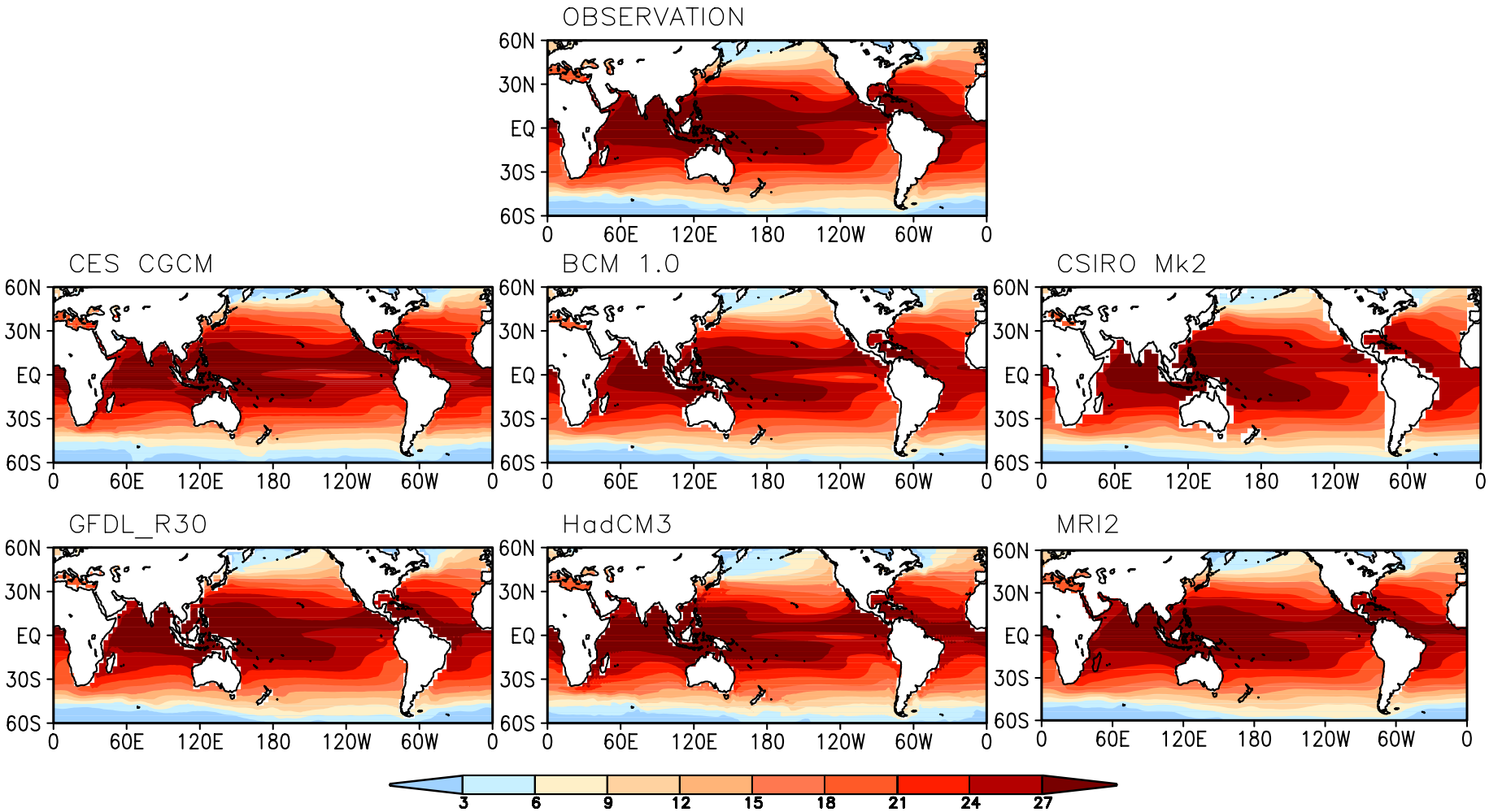
# Coupled Model Intercomparison Project (CMIP)

- Under the auspices of the Working Group on Coupled Modeling (WGCM)
- The PCMDI supports CMIP by helping WGCM to determine the scope of the project.
- CMIP has received model output from the pre-industrial climate simulations ("control runs") and 1% per year increasing-CO2 simulations.

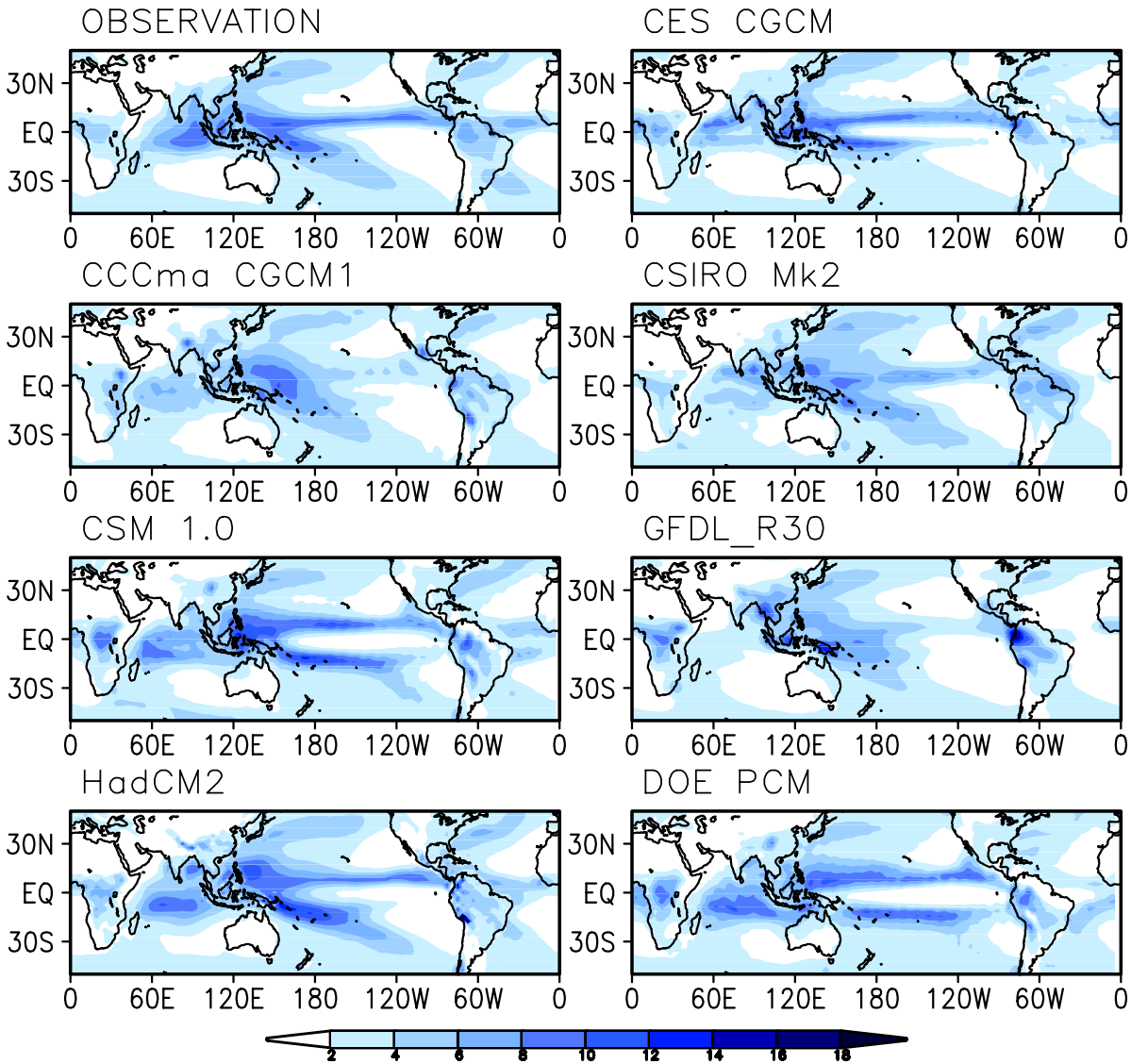
## Participating Model

| | Atmospheric model | Oceanic model | Atmospheric resolution | OCEAN resolutio | Flux adjust |
|---|---|---|---|---|---|
| MRI2 | MRI/JMA98 | Bryan-Cox Primitive eq. code | T42(2.8X2.8),L30 | 2.0X2.5,L23 | H,W,M |
| GFDL_R30 | GFDL | GFDL MOM 1.1 | R30(2.25X3.75),L14 | 1.875X2.25,L18 | H,W |
| CSIRO Mk2 | CSIRO 9-level agcm | Bryan-Cox Primitive eq. code | R21(3.2X5.6),L9 | 3.2X5.6,L21 | H,W,M |
| HadCM3 | Unified model | Bryan-Cox Primitive eq. code | 2.5X3.75,L19 | 1.25X1.25,L20 | . |
| HadCM2 | Unified model | Bryan-Cox Primitive eq. code | 2.5X3.75,L19 | 2.5X3.75,L20 | H,W |
| CCCma CGCM1 | GCM2 | GFDL MOM1.1 | T32(3.8X3.8),L10 | 1.8X1.8,L29 | H,W |
| DOE PCM | CCM3 | LANL POP | T42(2.8X2.8),L18 | 0.67X0.67,L32 | . |
| CSM 1.0 | CCM3.0 | NCOM1.1 | T42(2.8X2.8),L18 | 2.0X2.4,L45 | . |
| ECHO-g | ECHAM | HOPE-g | T30(3.75X3.75),L19 | T42(2.8X2.8),L20 | H,W |
| ECHAM4/OPYC3 | ECHAM | Ocean isoPYCnal GCM | T42(2.8X2.8),L19 | 2.8X2.8,L11 | H,W |

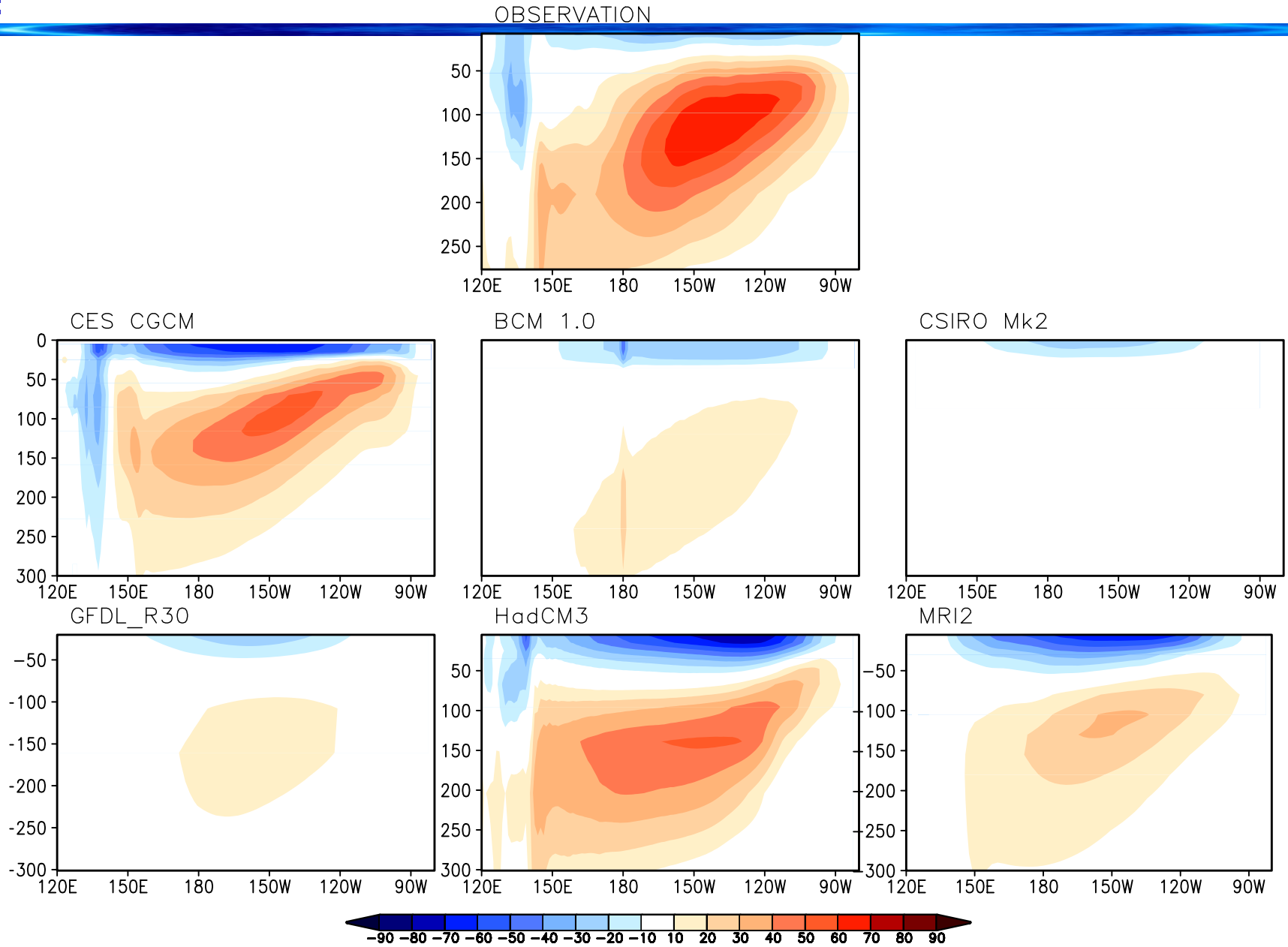
# SST Climatology/CMIP Simulations



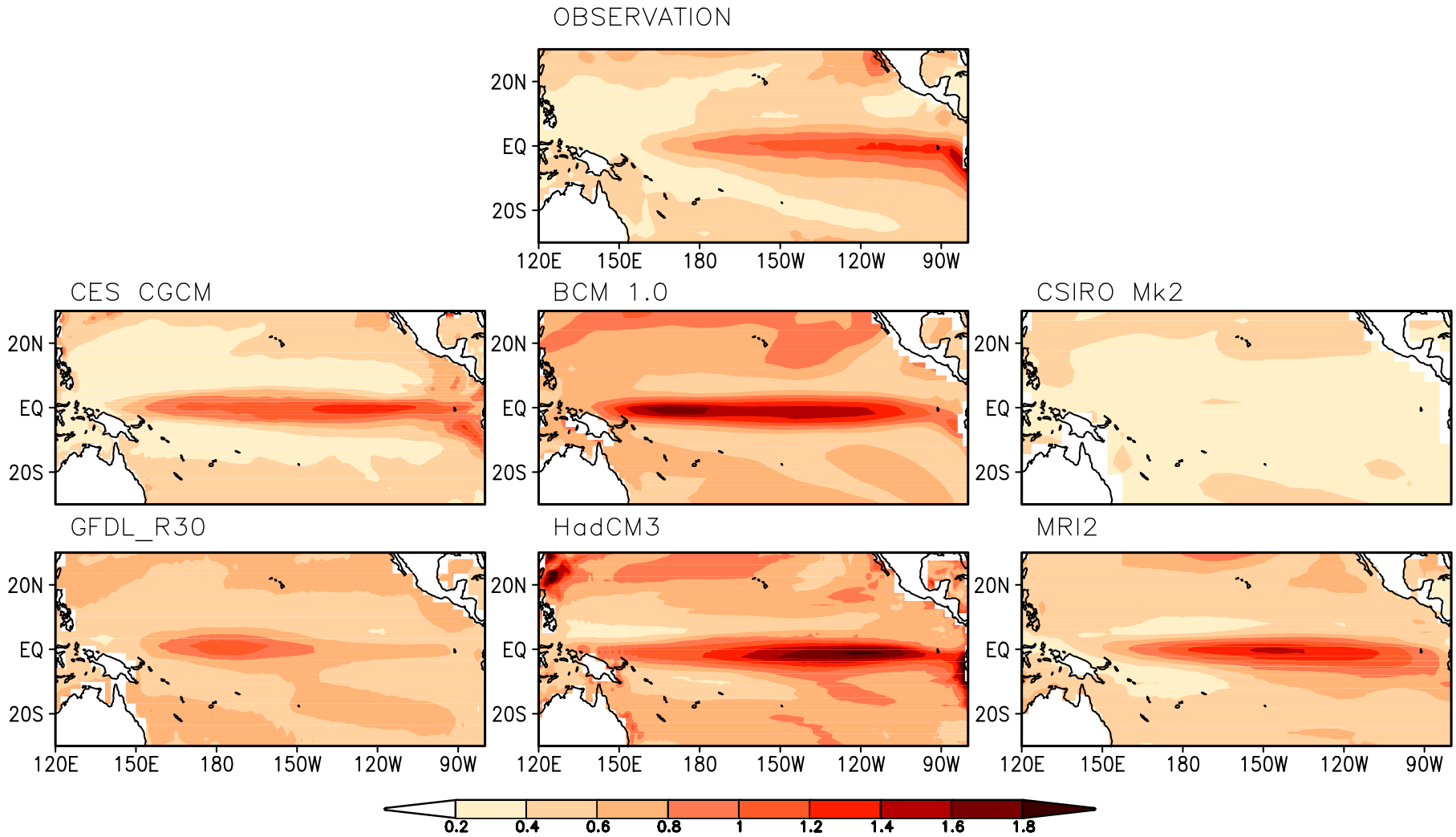
# Precipitation Climatology /CMIP Simulations



# Vertical Structure of Zonal Current /CMIP Simulations

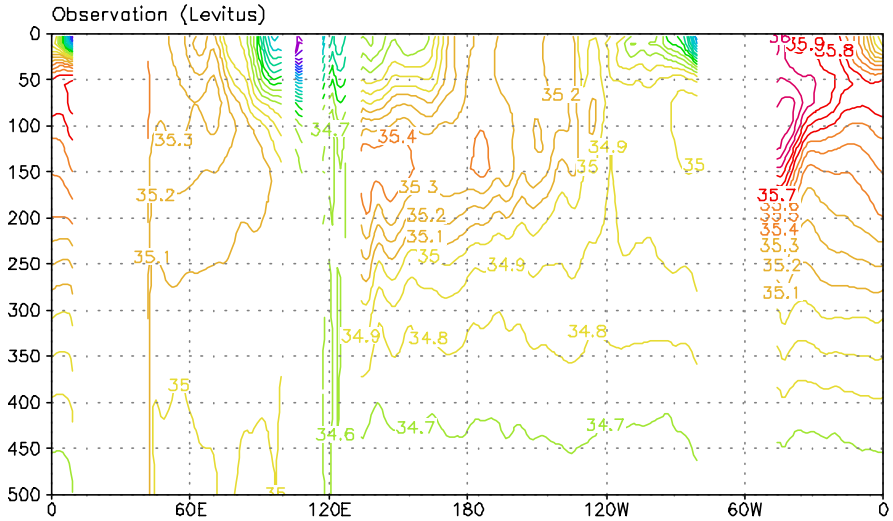


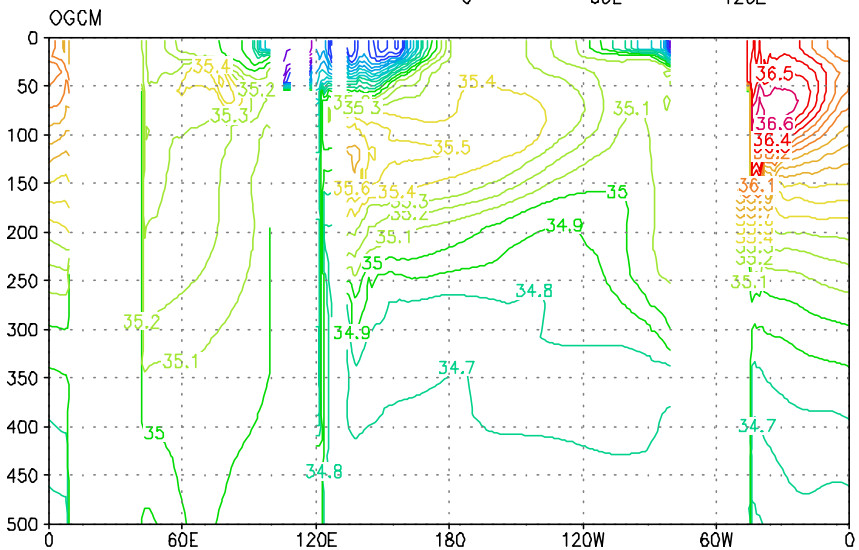
# Interannual SST Variability /CMIP Simulations

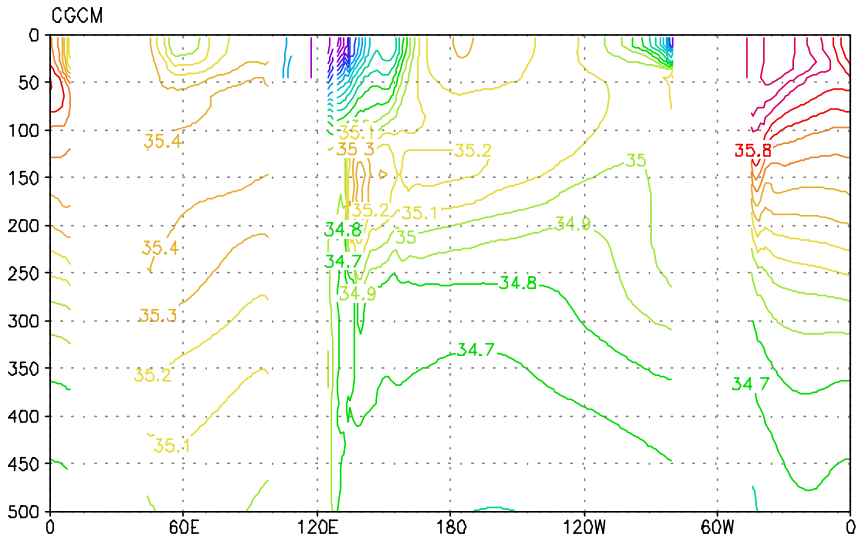


*Thank you*

# Annual mean SSS at equator



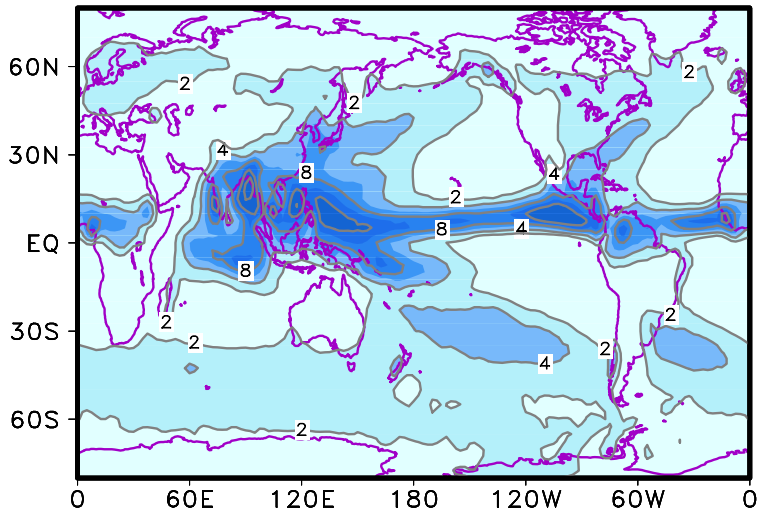



# Model Performance-Summer Climatology (T106 AMIP)

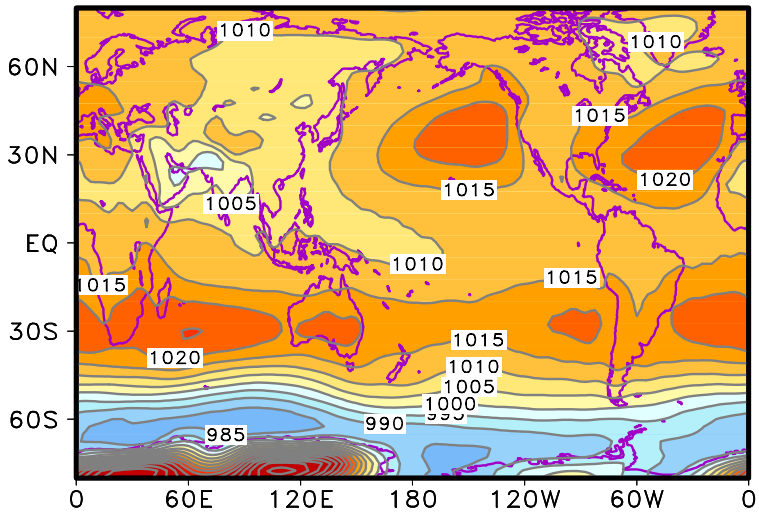
Rainfall

CMAP OBS

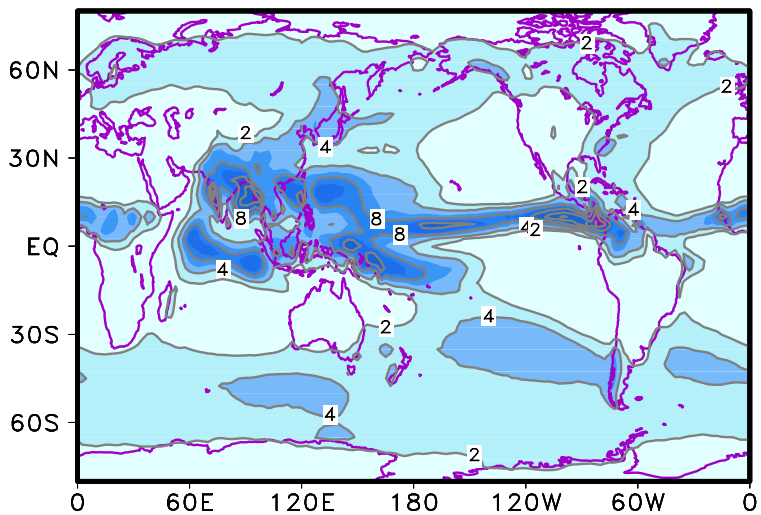



SLP

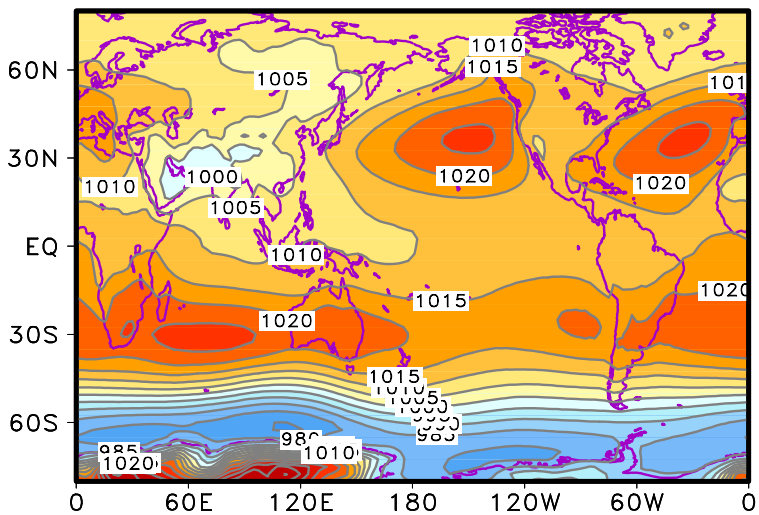
NCEP




SNUGCM

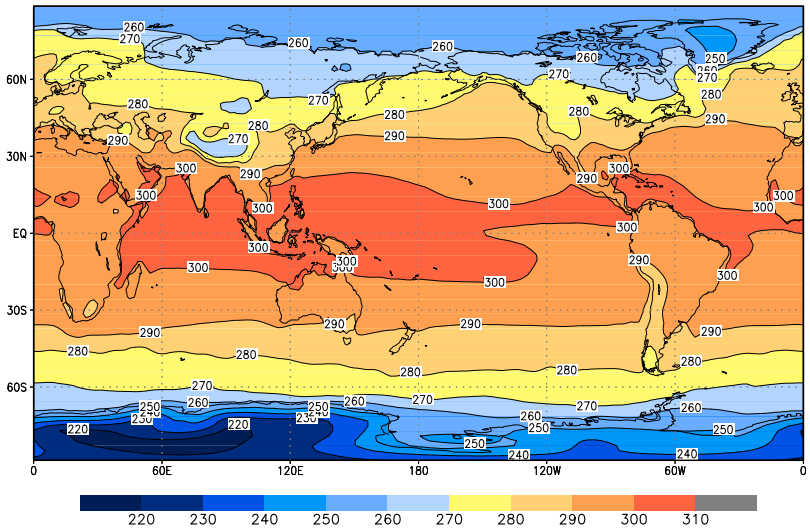



SNUGCM

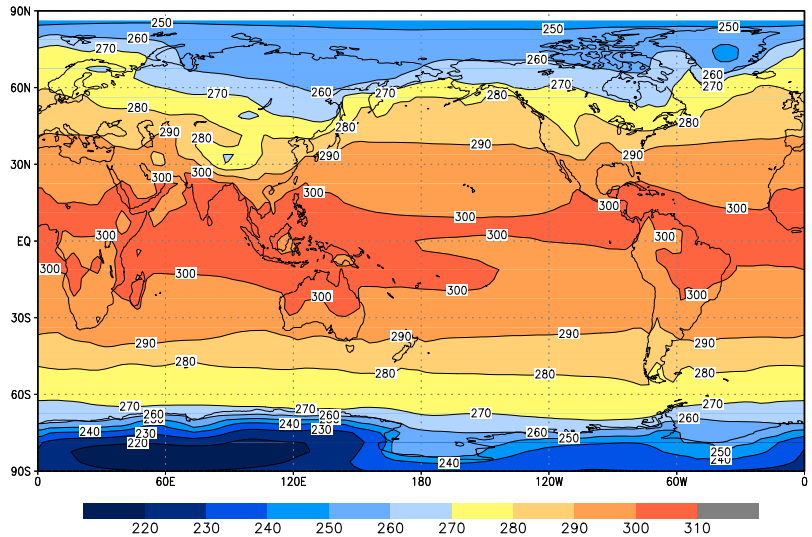


# Surface Air Temperature

Observation




SNUGCM

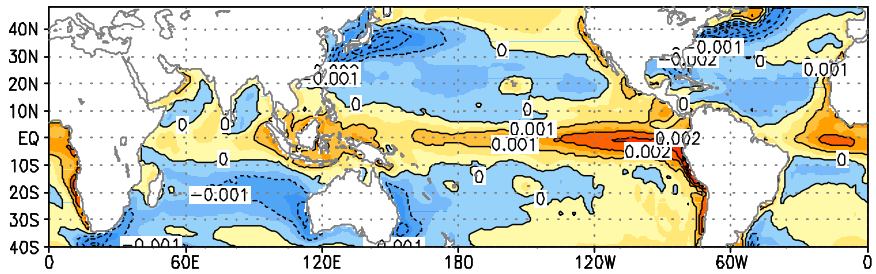


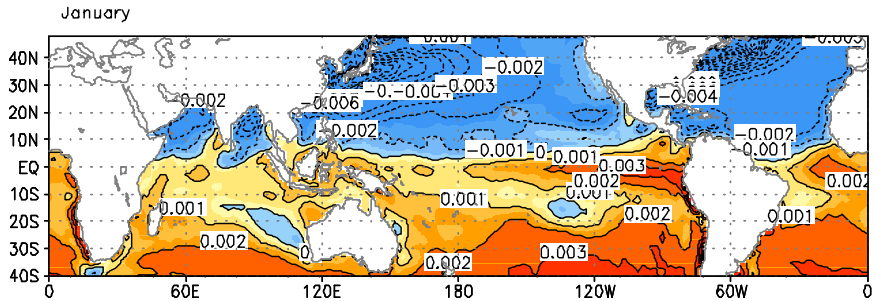
# 3. Results

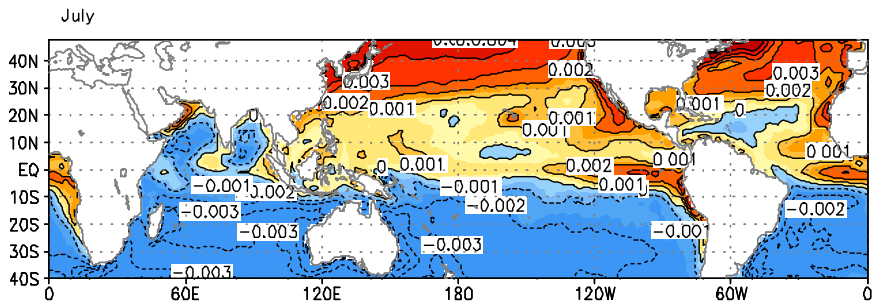
## Heat flux

(cal/cm$^2$/sec)

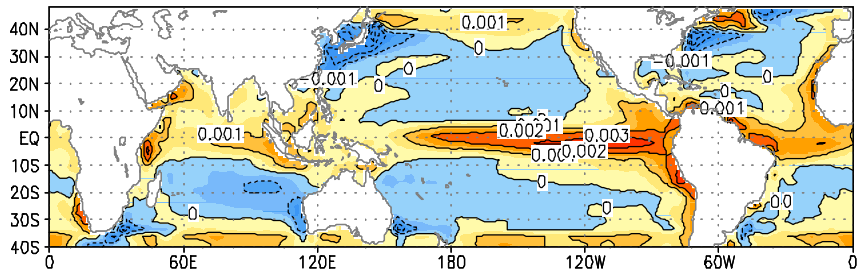
Observation (NCEP)

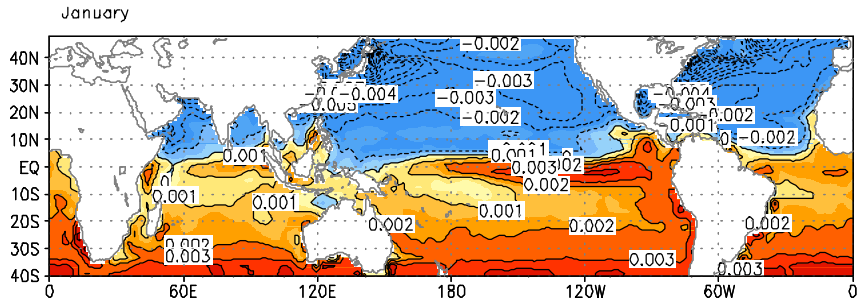


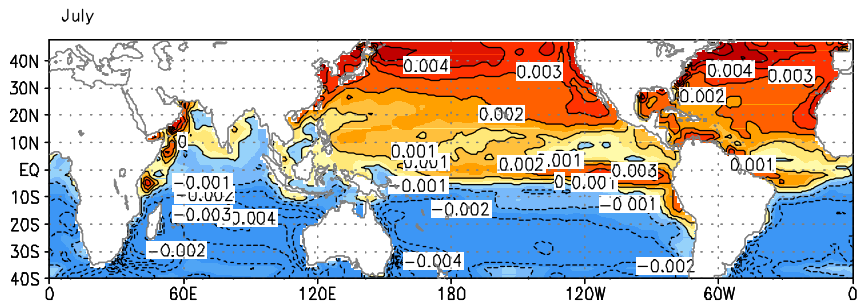




CGCM

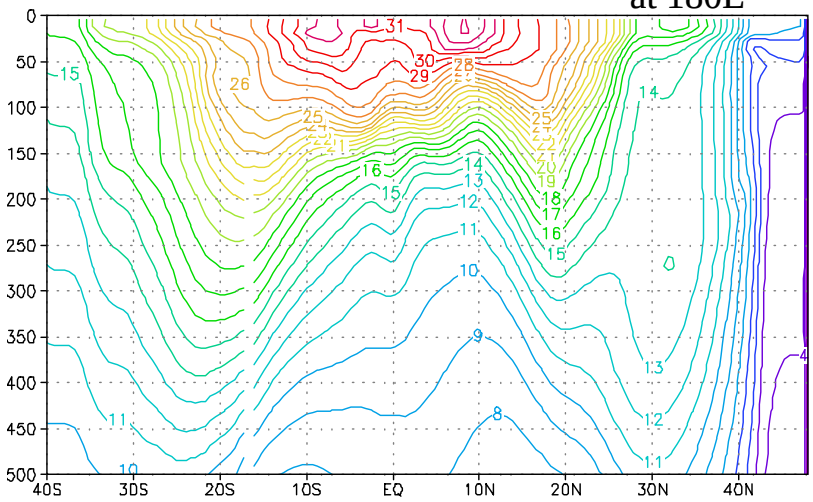


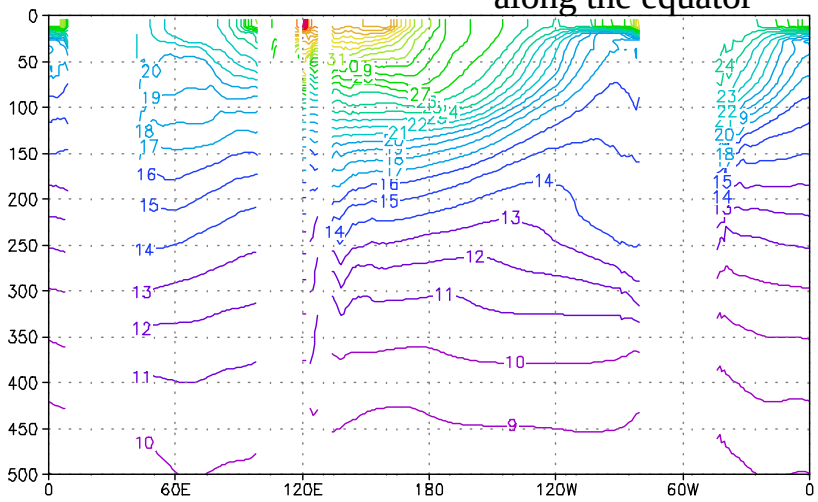



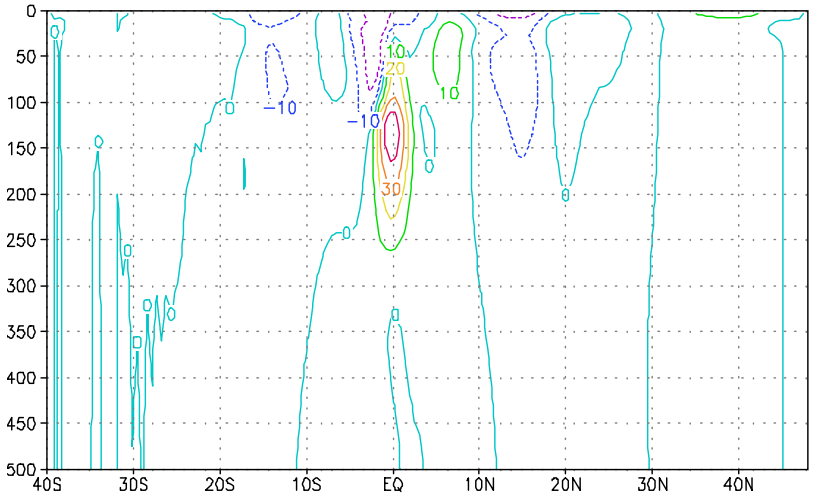
# Experiment with only climatological heat flux

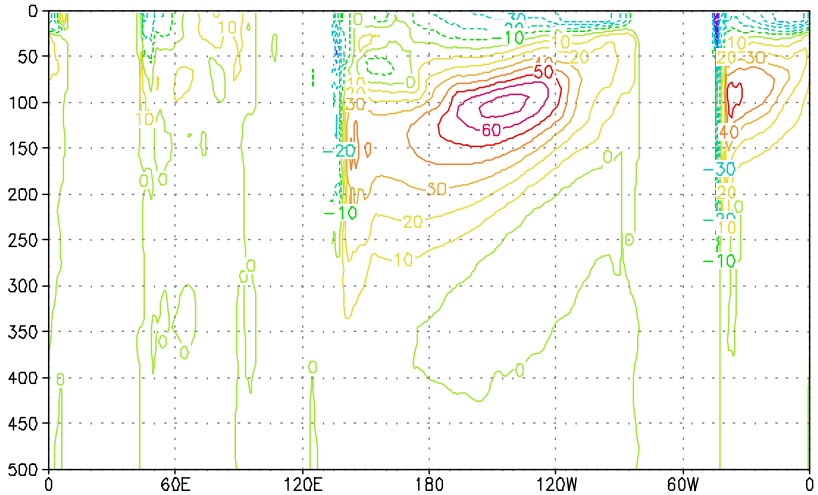
at 180E




along the equator

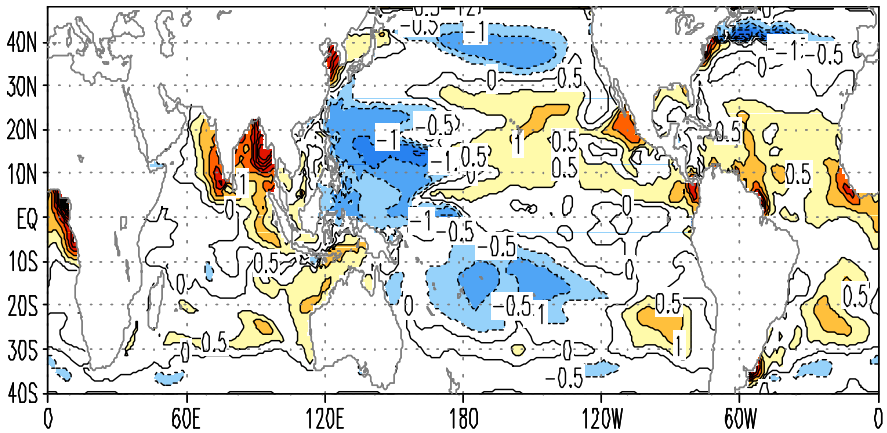


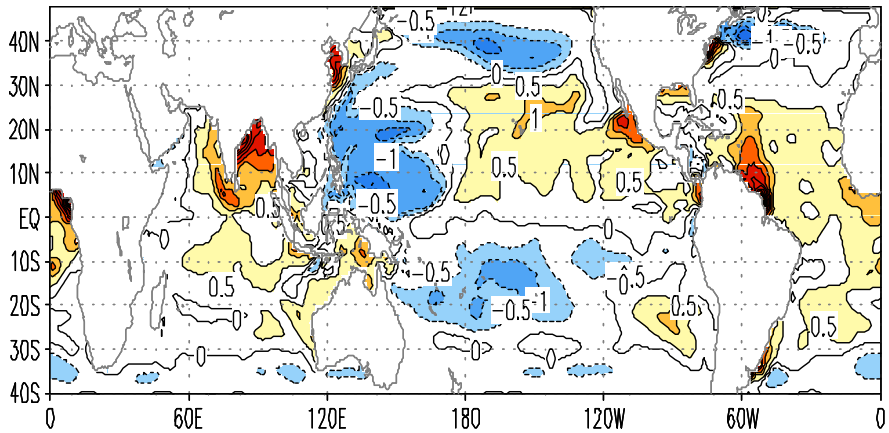



## SSS anomaly

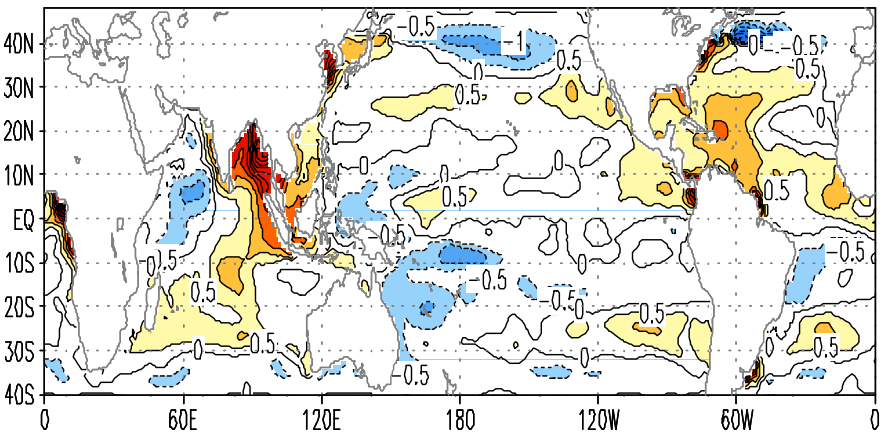
OGCM **January**



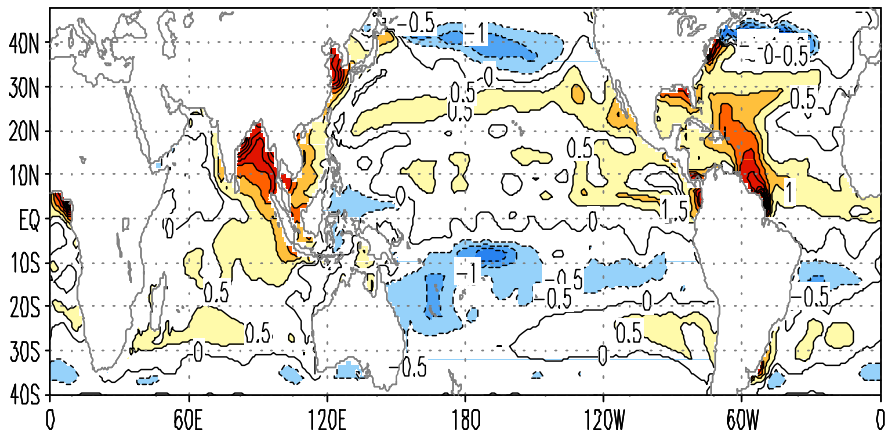

OGCM **July**



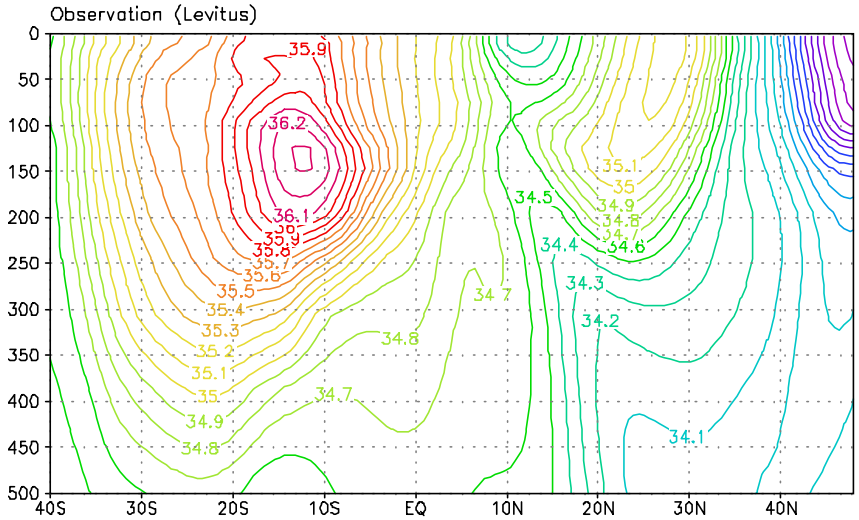

CGCM

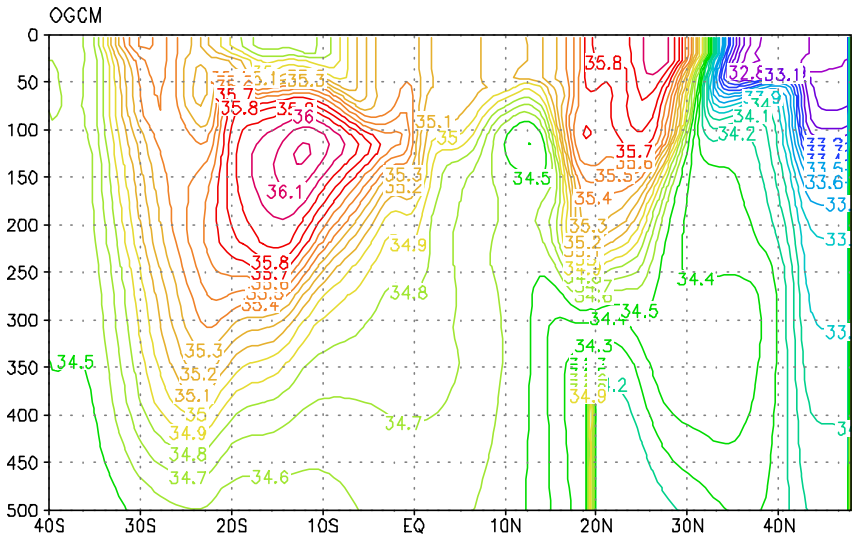


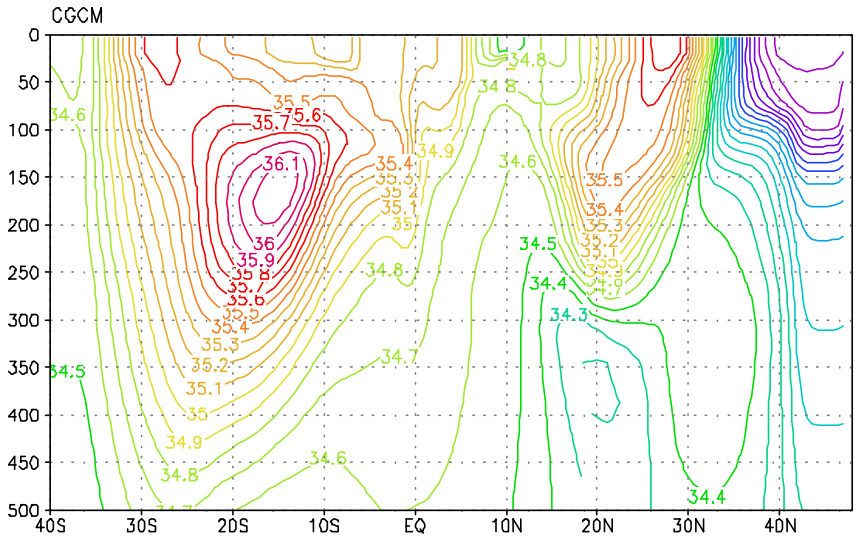

CGCM



# Annual mean SSS at 155W



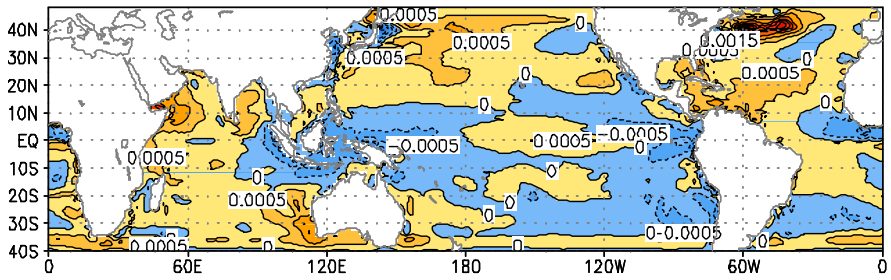



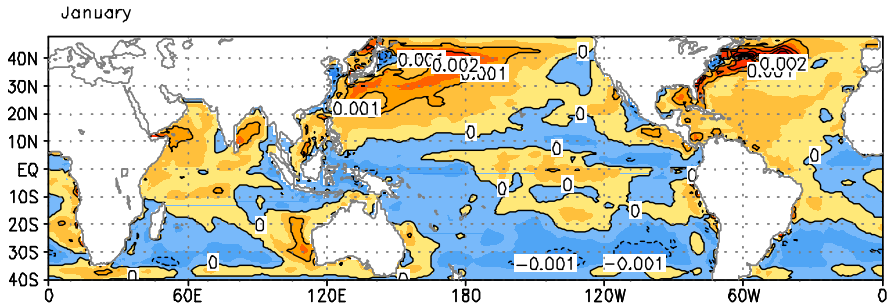
# 3. Results

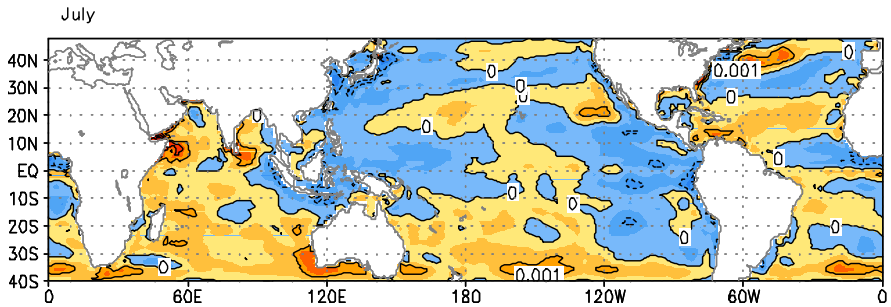
## Heat flux anomaly

(cal/cm$^2$/sec)

OGCM




CGCM