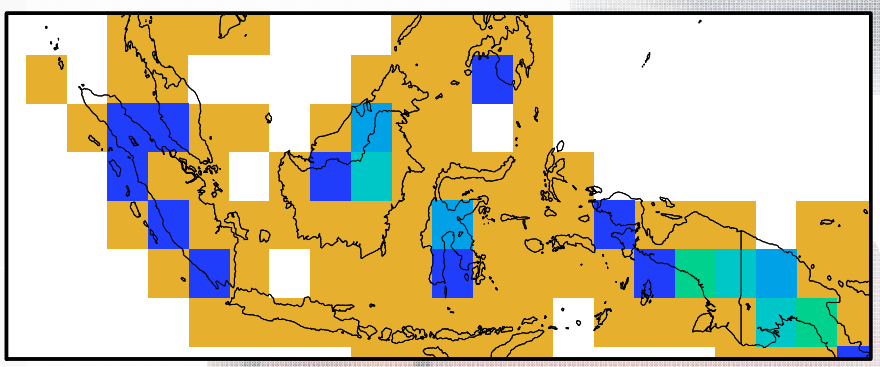
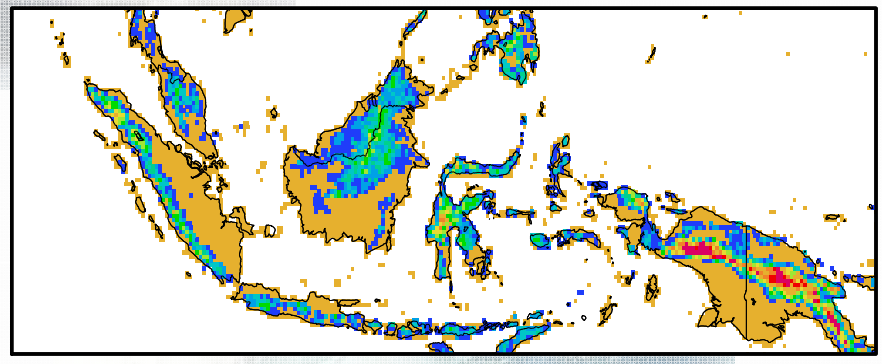
High Resolution Global Climate Modeling

300 km resolution



20 km resolution



In-Sik Kang

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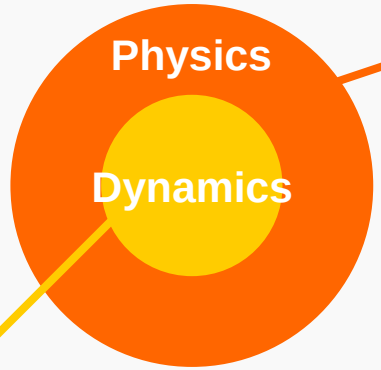
Coauthors: Sung-Bin Park, Young-Min Yang, Daehyun Kim, and Jong-Seong Kug

Model descriptions

Finite volume dynamic core

CES/SNU AGCM

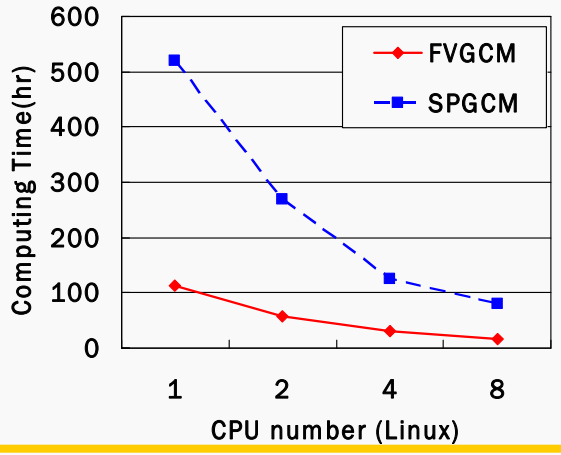


- Simplified Arakawa-Schubert cumulus convection scheme based on Relaxed Arakawa-Schubert scheme (Moorthi and Suarez, 1992)
- Large-scale condensation scheme (Letreut and Li, 1991)
- Diffusion-type Shallow Convection
- Orographic gravity-wave drag (McFarlane, 1987)
- 2-stream k-distribution radiation scheme (Nakajima and Tanaka, 1986)
- Dry adiabatic adjustment
- Bonan's Land Surface Model (Bonan 1996)
- Non-local PBL/Vertical diffusion (Holtslag and Boville 1993)
- Modified CCM3 slab ocean/sea-ice model

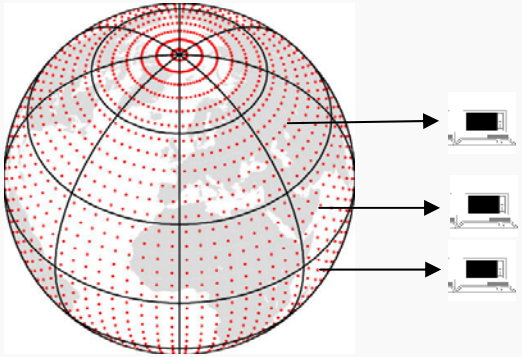
- Three-dimension hydrostatic primitive equations on sphere with normalized pressure coordinate

Finite volume dynamic core

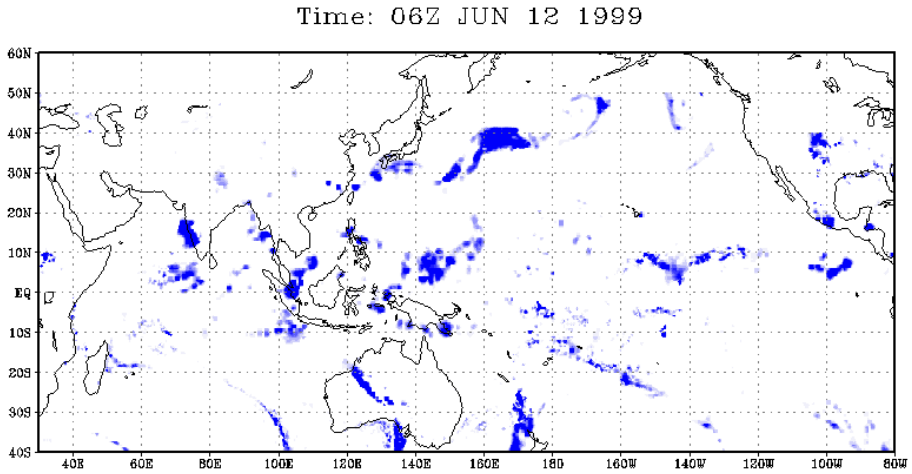
Efficiency

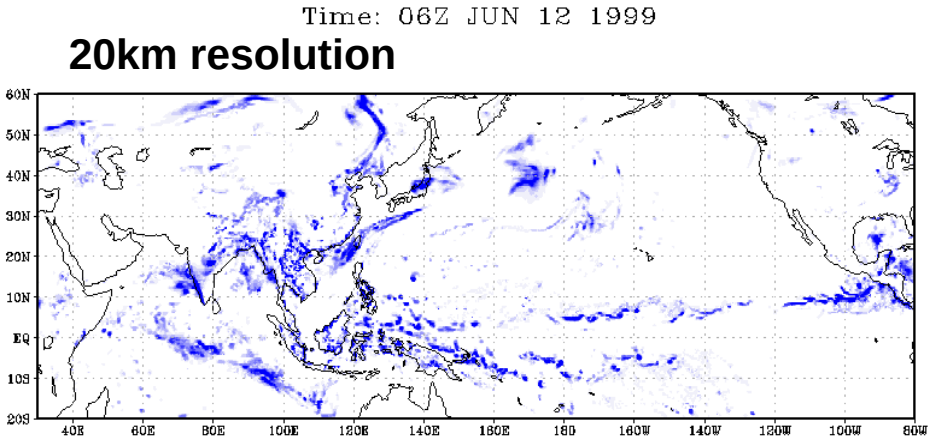


Easy for parallelizing

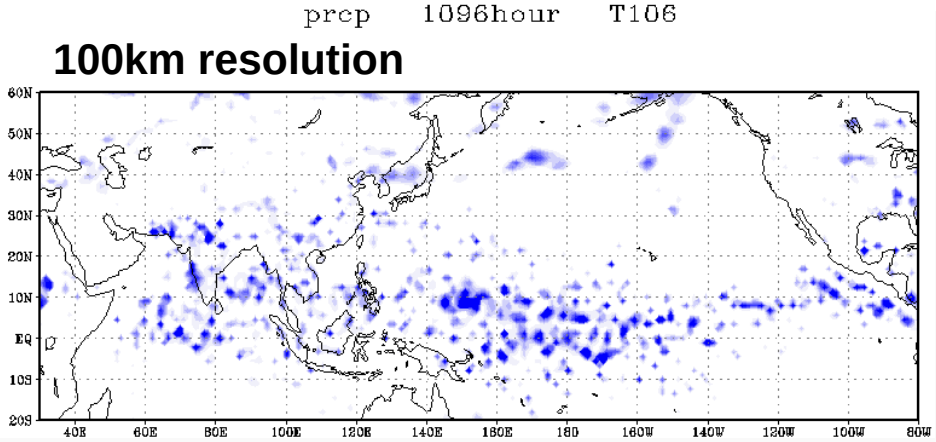


TRMM Satellite observation

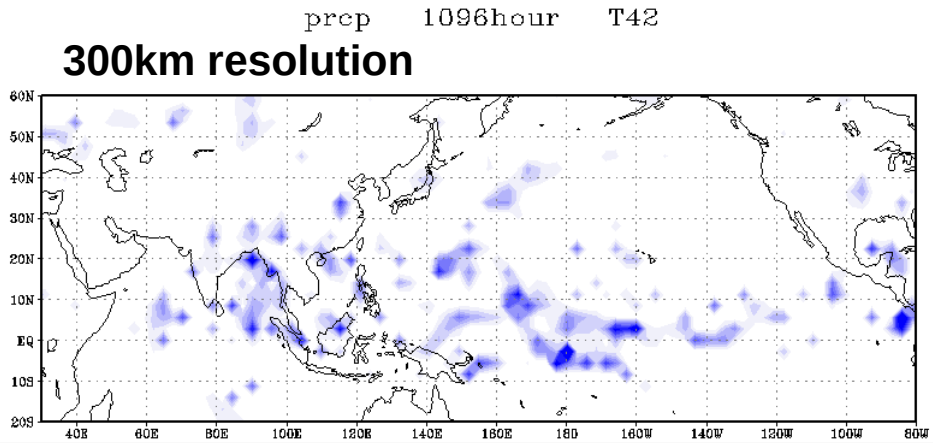




20km resolution



100km resolution



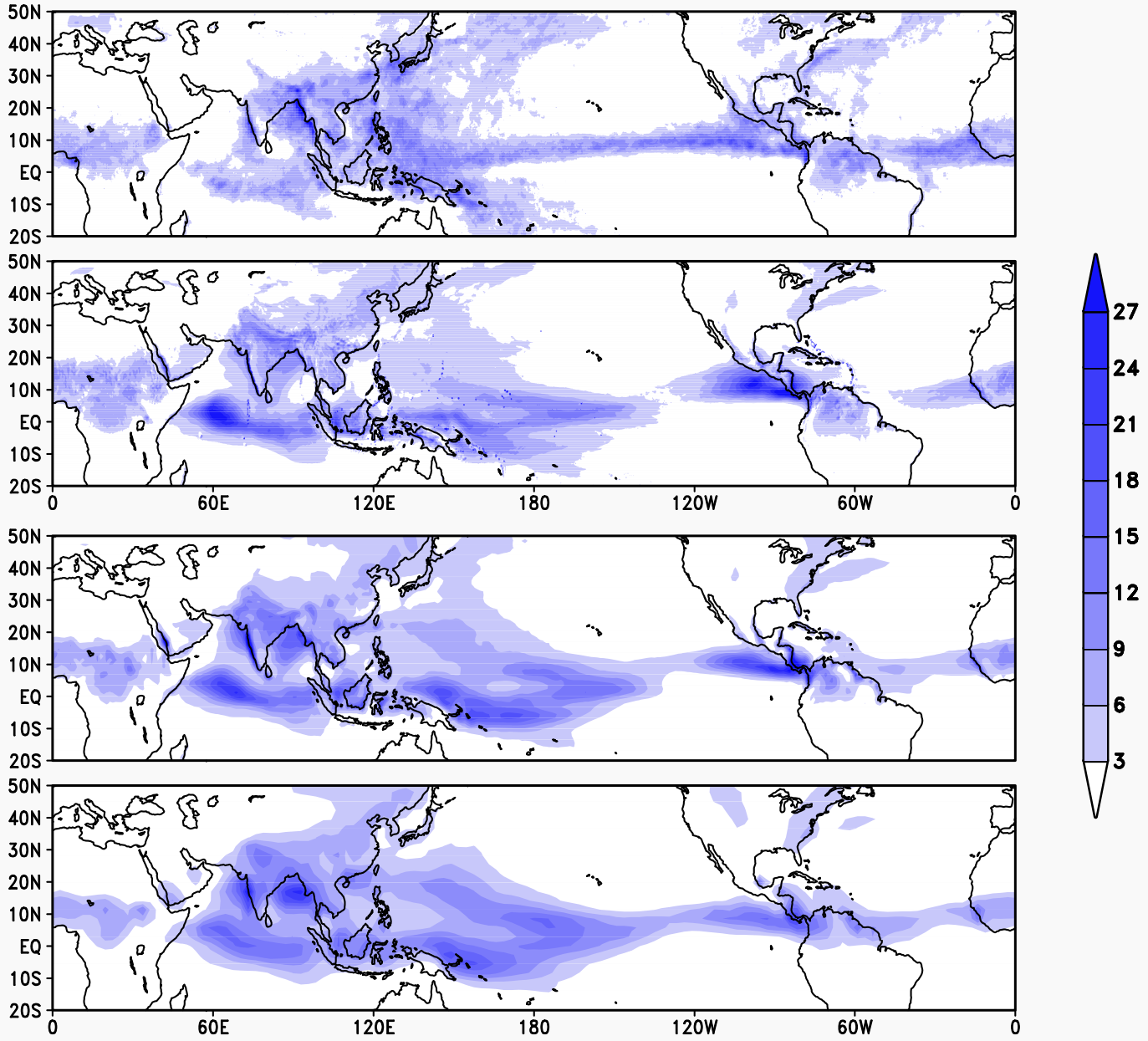
300km resolution

Archive of high resolution model integration

- **High resolution model experiments**

Model	Vertical levels	Grid Size	Description	Period
FV20	L20	**20 km**	Ensemble Case Study 6-Member Ensemble	97/04/15~97/10/31 99/04/15~99/10/31
FV100	L20	**100 km**	Ensemble Case Study 6-Member Ensemble	97/04/15~97/10/31 99/04/15~99/10/31
FV300	L20	**300 km**	Ensemble Case Study 6-Member Ensemble	97/04/15~97/10/31 99/04/15~99/10/31
FV30-AMIP	L20	**30 km**	**Long-term(10yr) Simulation**	96/01/01~05/12/31
FV30-CGCM	L20	**30km**	**Coupled model Simulation**	99/06/01~05/10/31

Climatology/Precipitation



ENSO anomaly

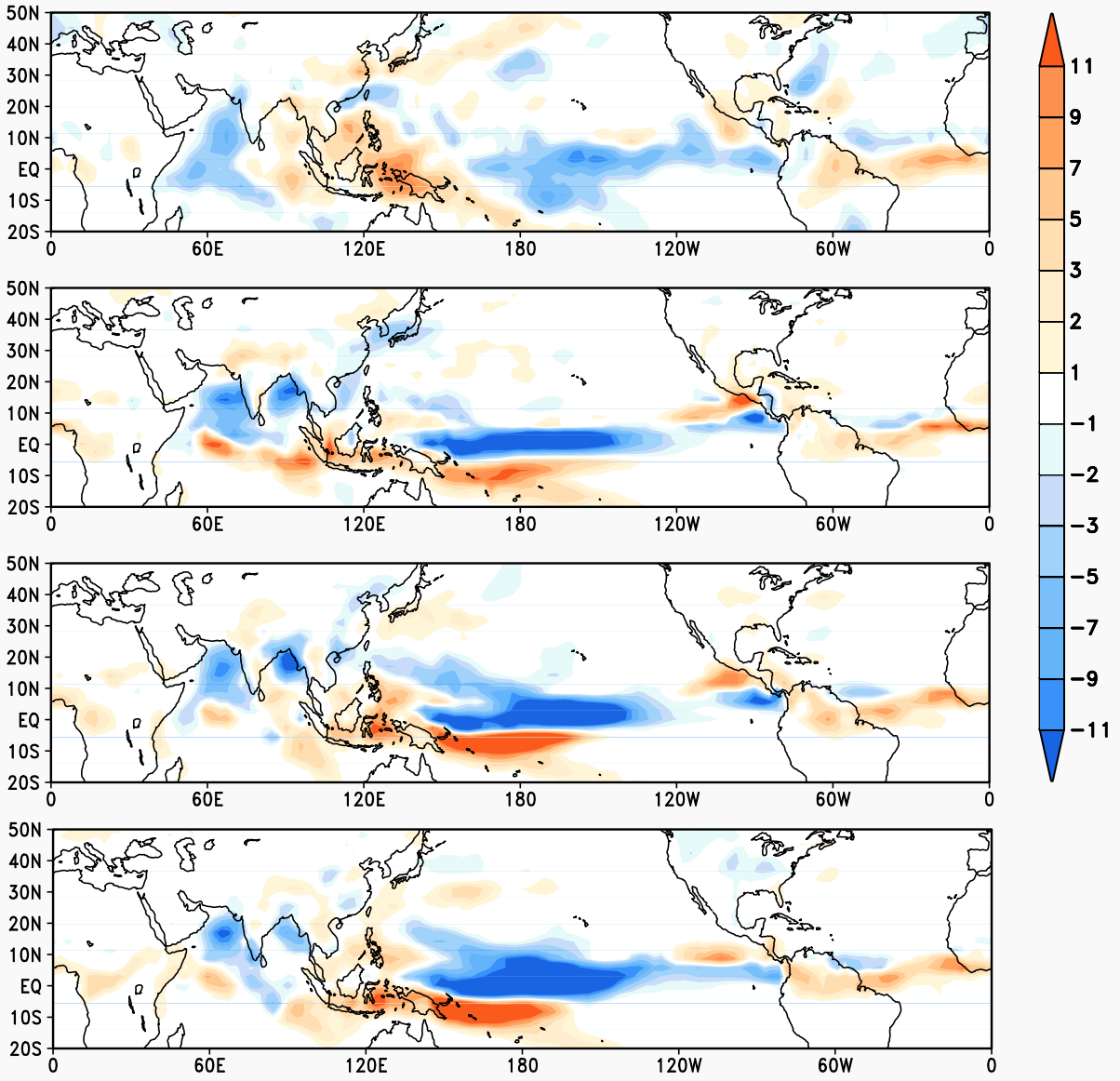
Precipitation difference between 1997 and 1999

CMAP

FV20

FV100

FV300

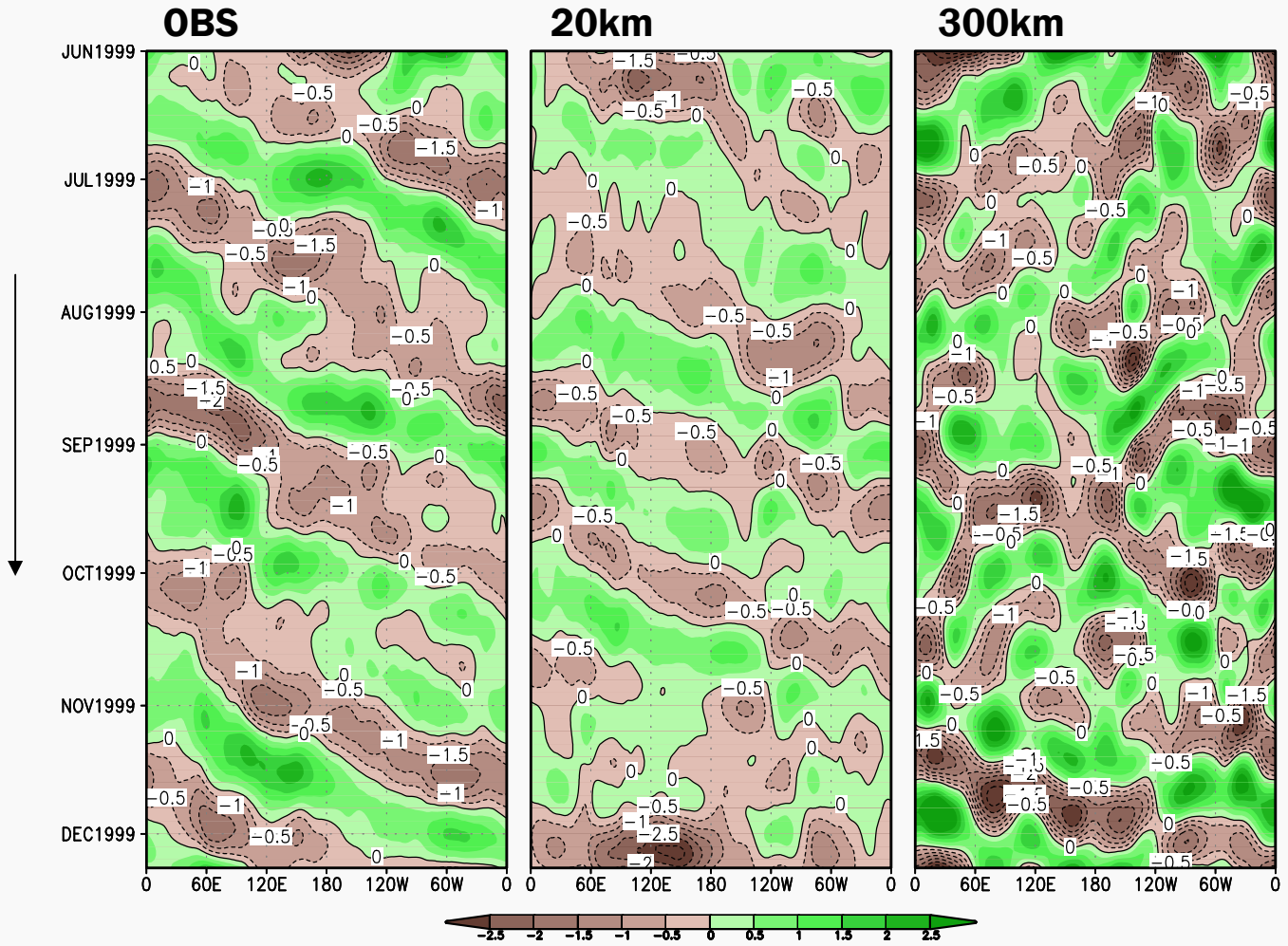


MJO Simulation

MJO Propagation

- 200hPa velocity potential (1999)

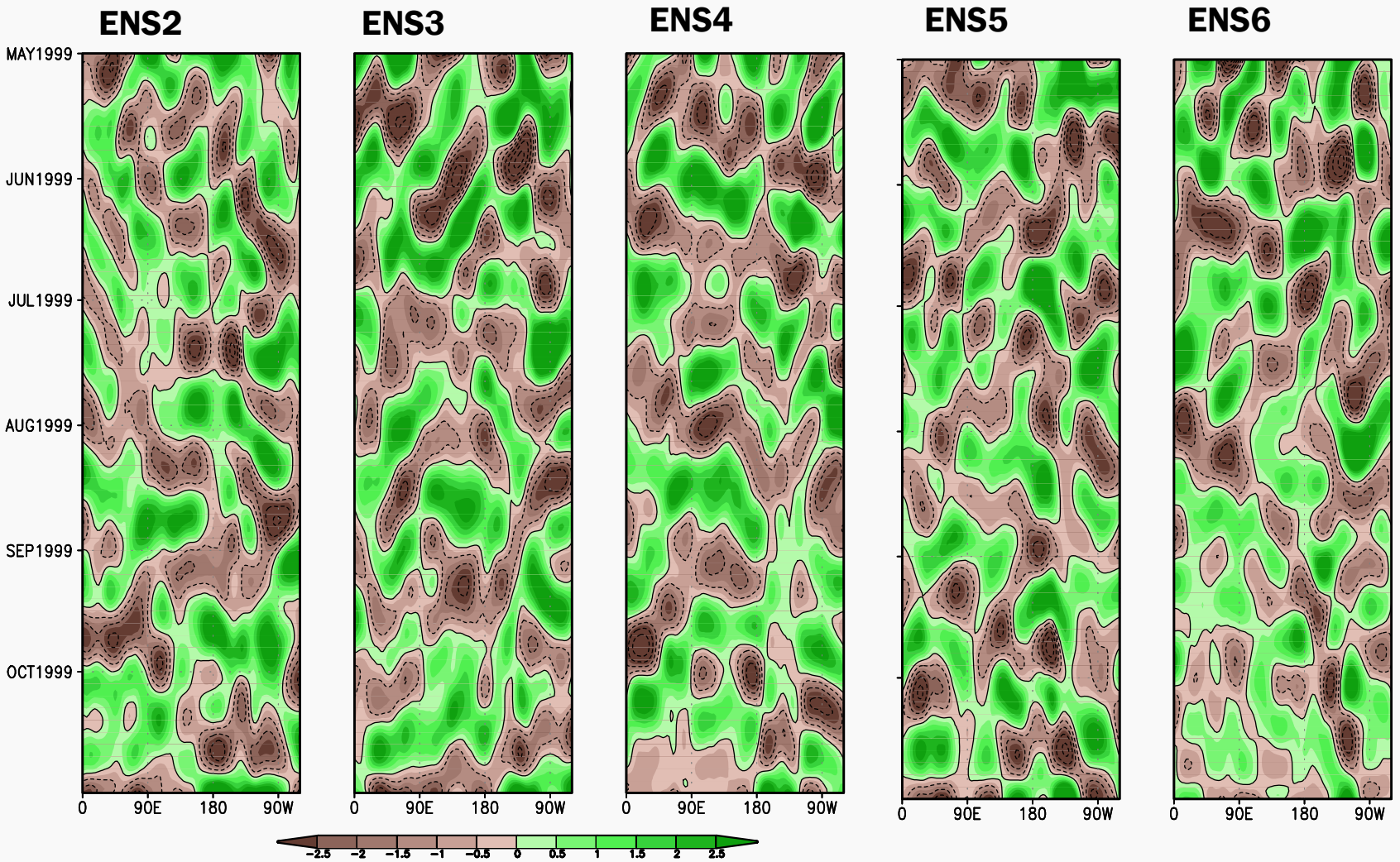
The FIRST Ensemble case



MJO Propagation

- 200hPa velocity potential (1999)

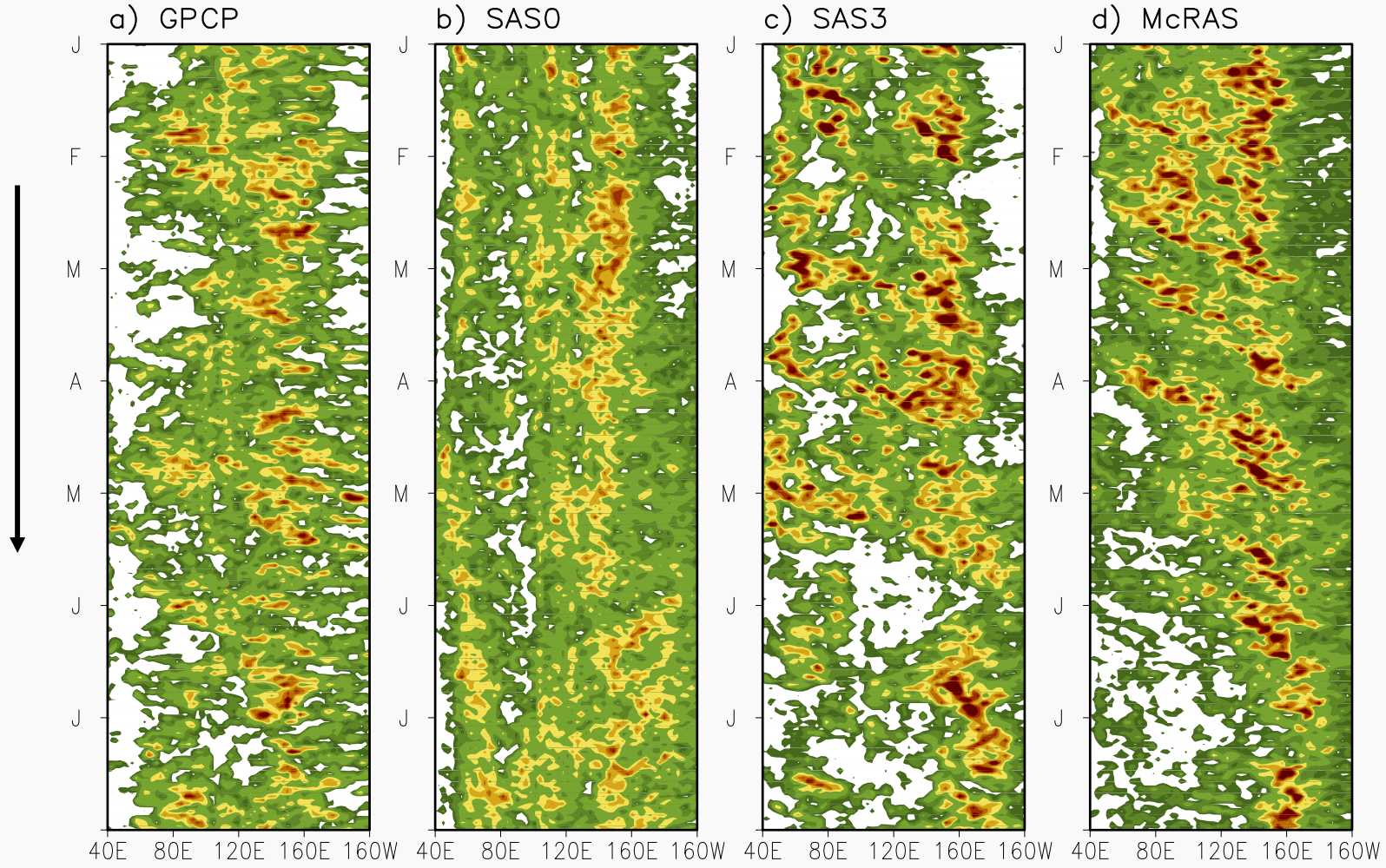
ENSEMBLES in 20km High resolution !



MJO Simulation with Different Convective Parameterization

Low Resolution (300km)

Longitude-time diagram of total precipitation (5S-5N)

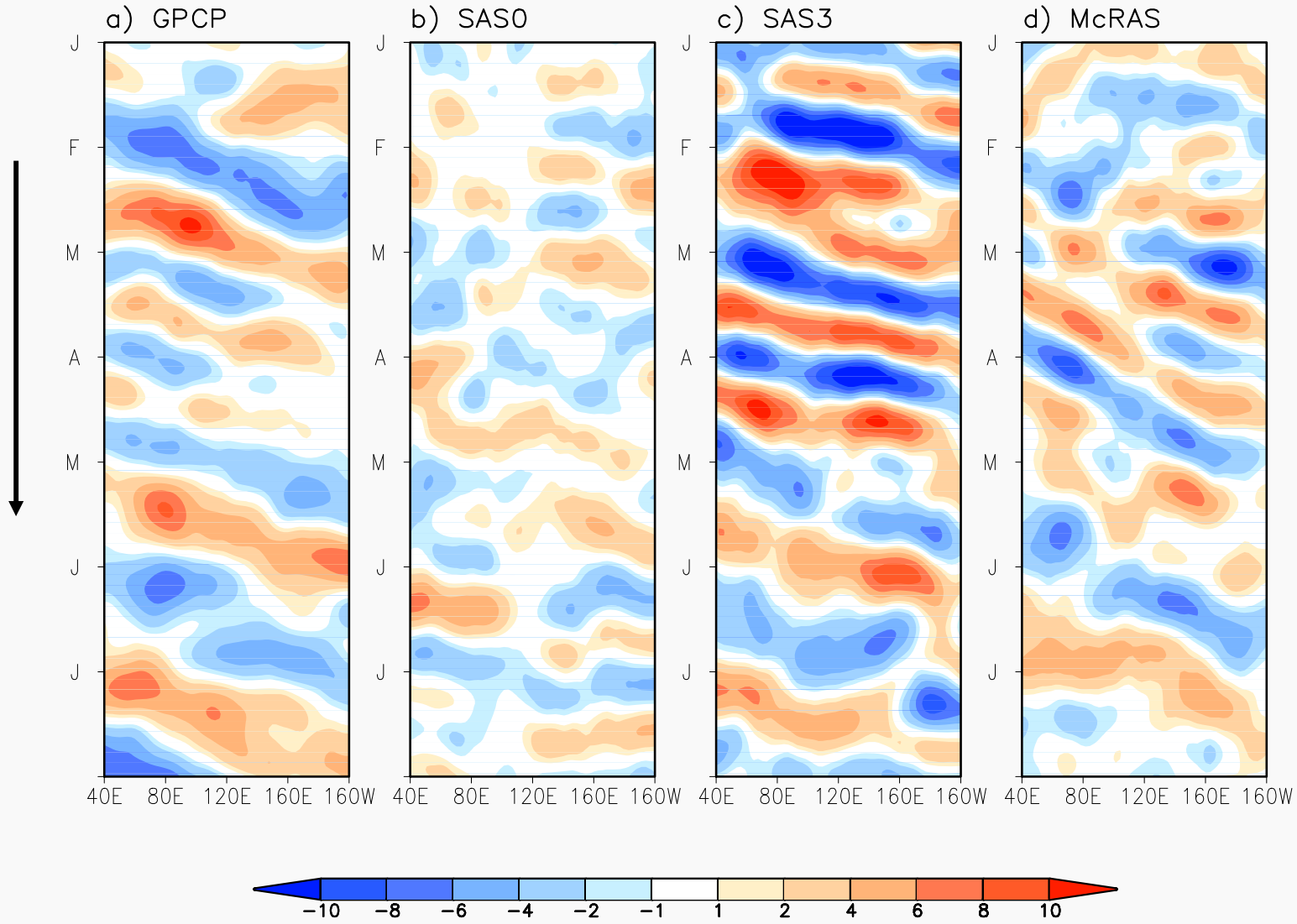


unit : [mm/day]

MJO Simulation with Different Convective Parameterization

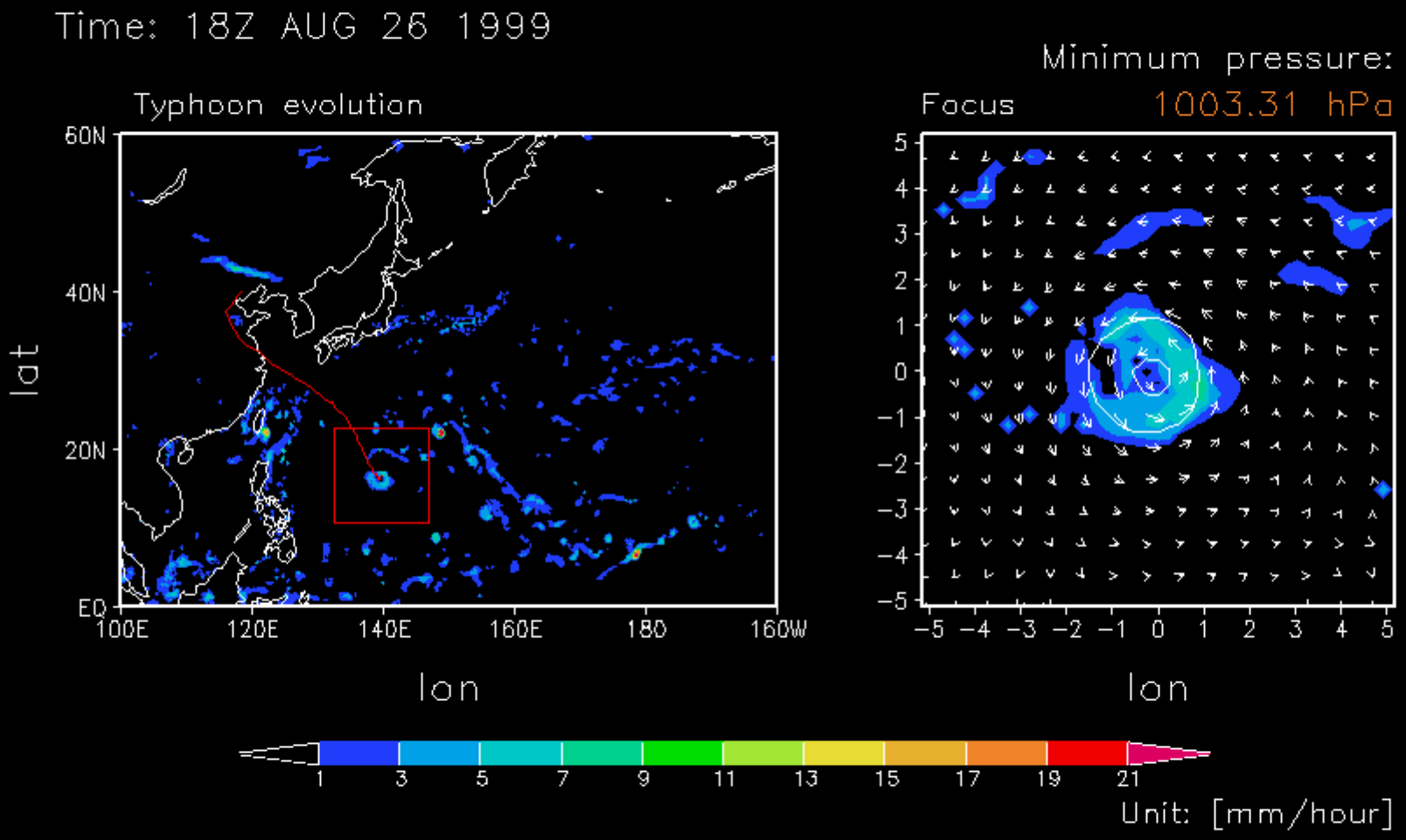
Low Resolution (300km)

20-100 day filtered velocity potential (10S-10N)



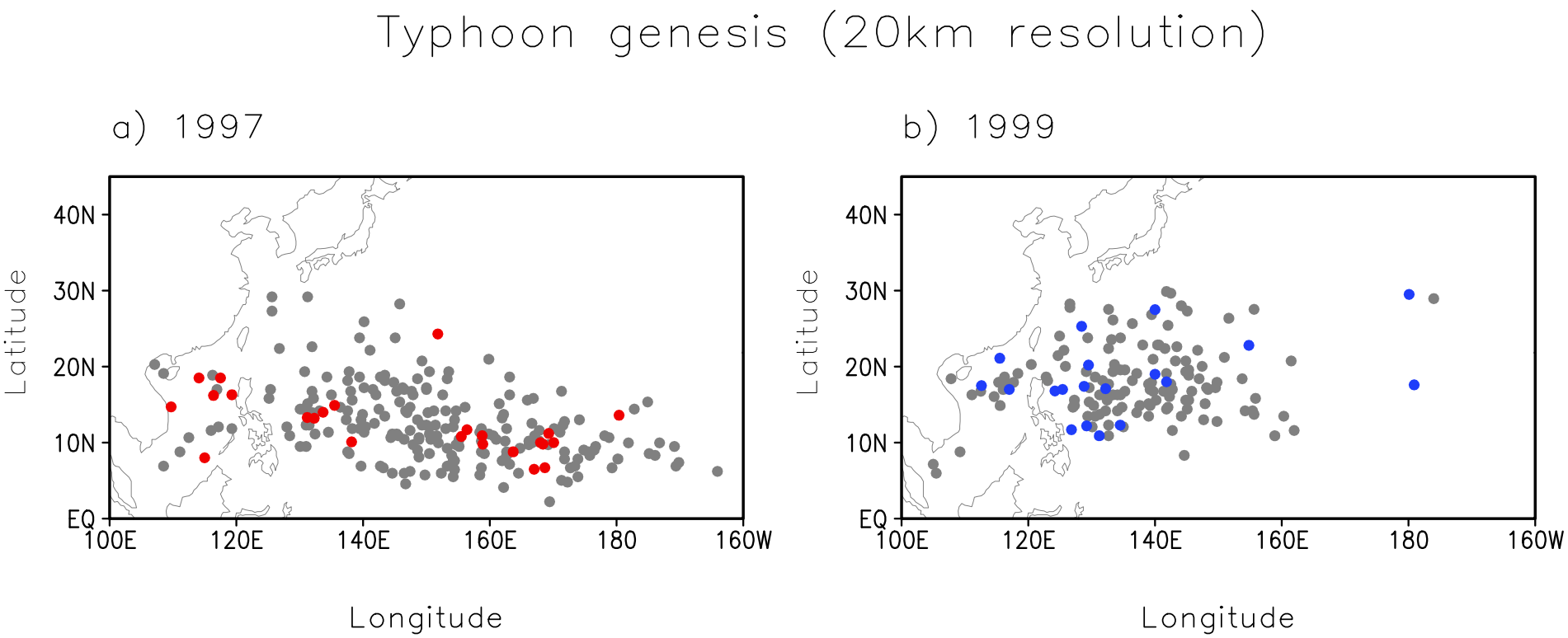
Typhoon

The strongest typhoon simulated by 20km GCM



Minimum surface pressure : fall to 962hPa

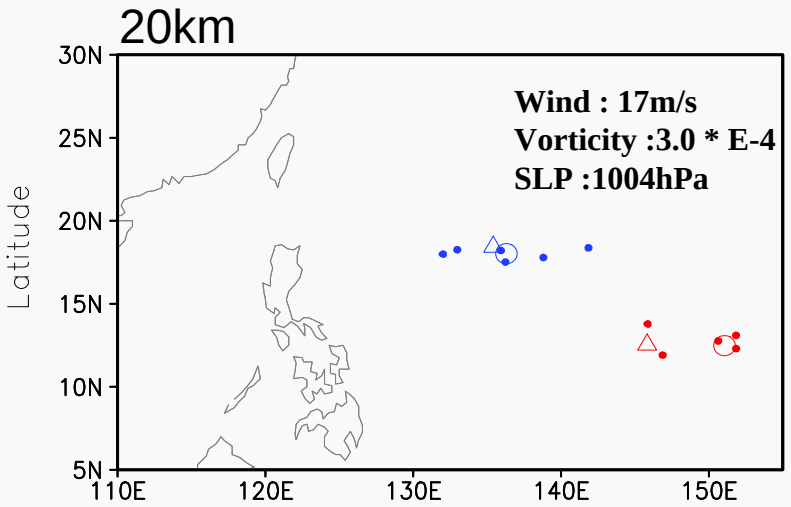
Typhoon Genesis/6-Member Ensemble



Wind – 17m/s
Vorticity – 3.0 * E-4
SLP – 1004hPa

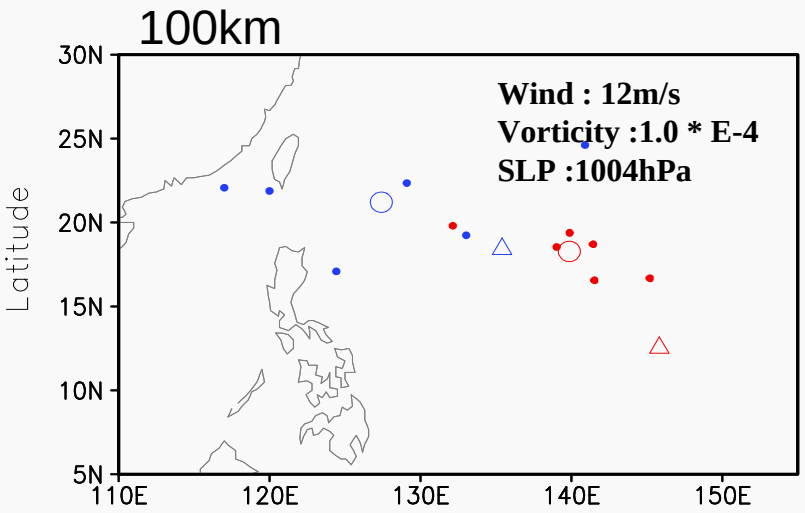
=> 6 ensemble members can cover out almost all observed genesis region

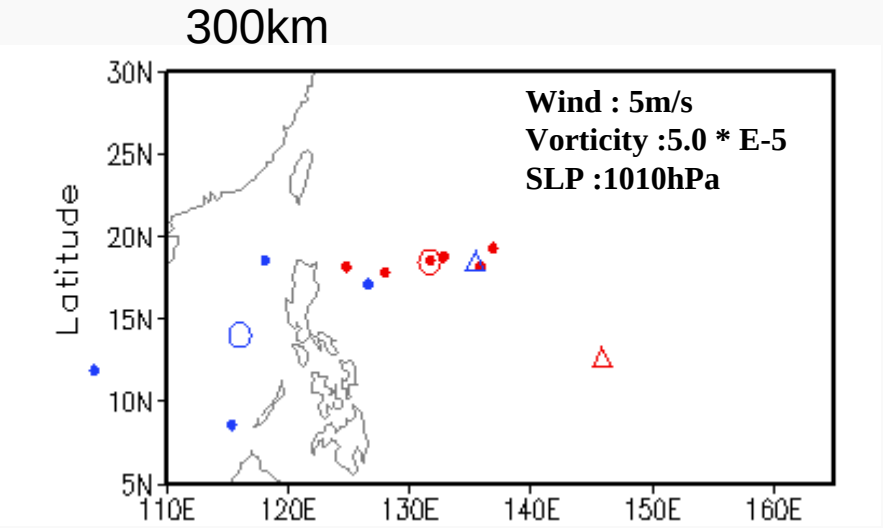
Mean Location of Typhoon Genesis



1997
- Each ensemble
- 6-Member Ensemble mean
- Observation (Tokyo-Typhoon center)

1999
- Each ensemble
- Ensemble mean
- Observation (Tokyo-Typhoon center)

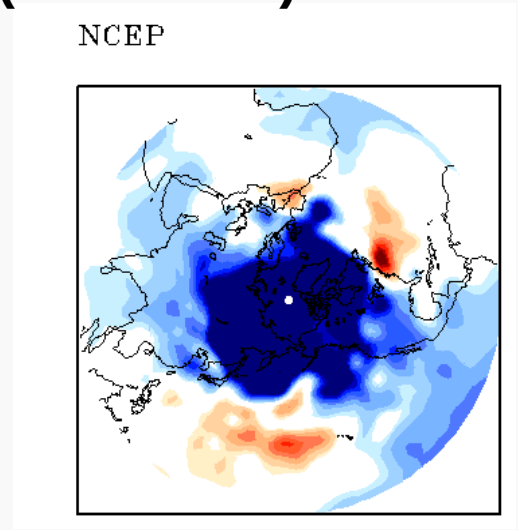




Transient Eddies

Transient eddy forcing

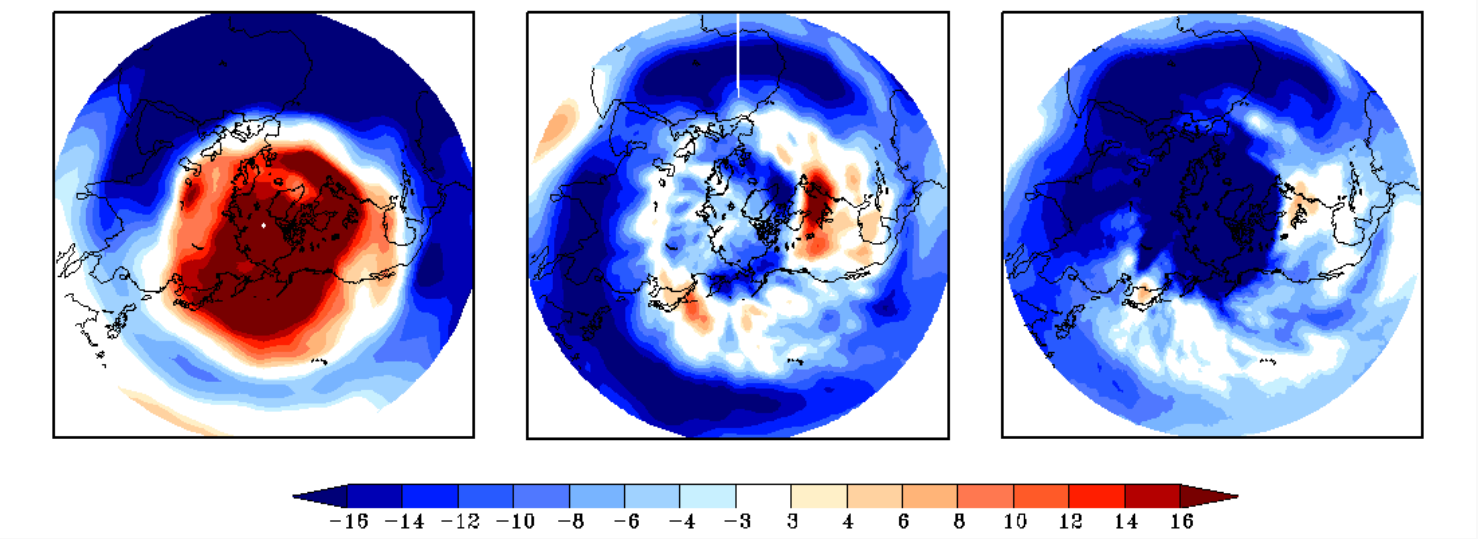
- **1997 El Nino case (JJA mean) – 200 hPa u-wind , v-wind**



Using quaisi-geostropic approximation,

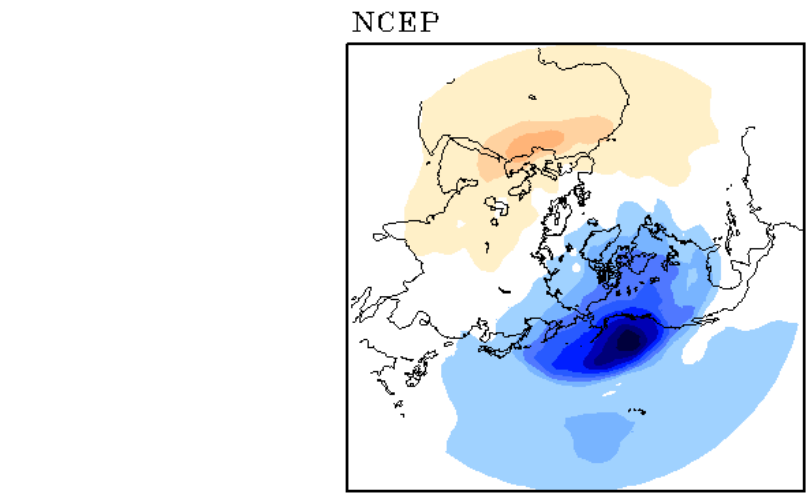
$$\frac{\partial \overline{\psi}}{\partial t} = -\nabla^{-2}[\nabla \cdot (\overline{V'\zeta'})]$$

6-member Mean



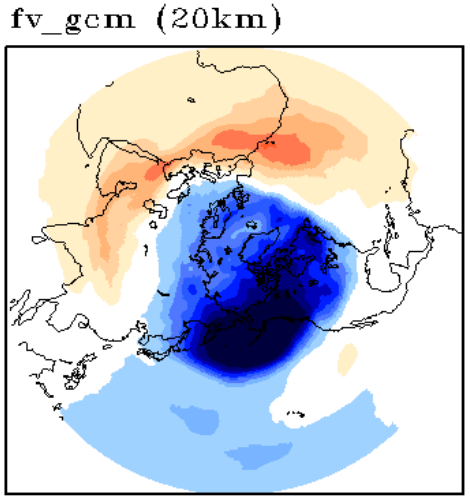
Transient Eddy forcing $\frac{\partial \overline{\psi}}{\partial t} \propto -\nabla^{-2}[\nabla \cdot (\overline{V'\zeta'})]$

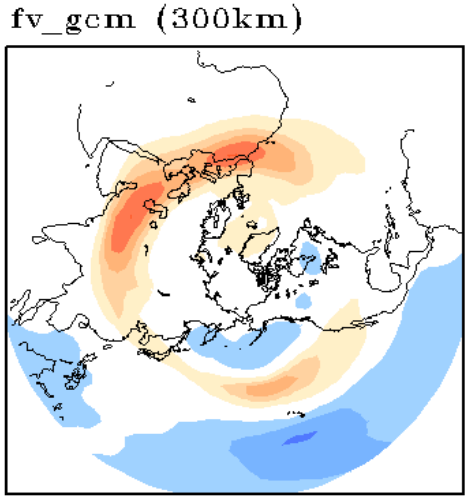
- **1997 El Nino case (DJF mean) – 200 hPa u-wind , v-wind**

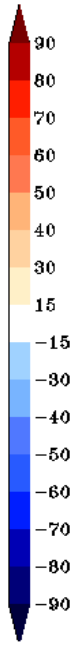


Using quaisi-geostropic approximation,

$$\frac{\partial \overline{Z}}{\partial t} = -\frac{f}{g}\nabla^{-2}[\nabla \cdot (\overline{V'\zeta'})]$$





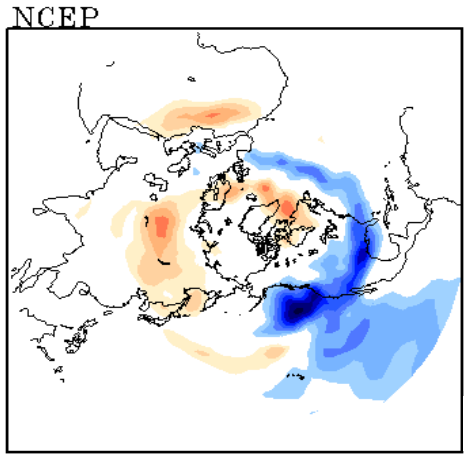


[1 X 10 $^{-5}$ m s^{-1}]

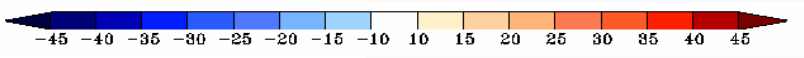
2~8 day filtered u-wind(u') / v-wind (v')

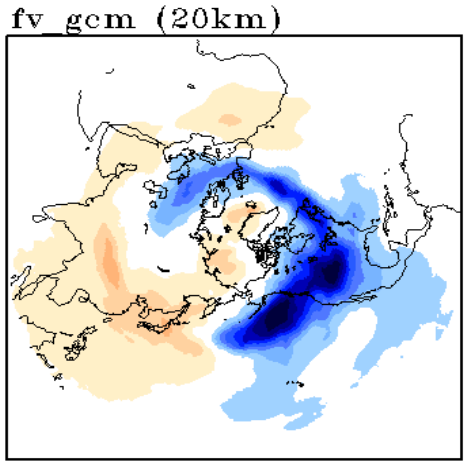
Transient Eddy forcing

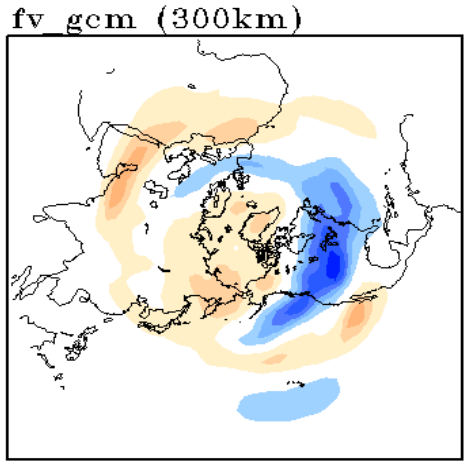
- **1997 El Nino case – 1999 La Nina case (winter mean)**

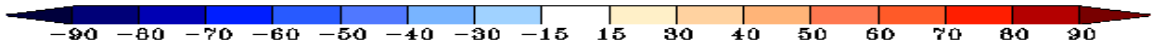


The source of baroclinicity in the eastern Pacific provides energy to the eddies, preventing the localization of any vorticity forcing by the high-frequency eddies.



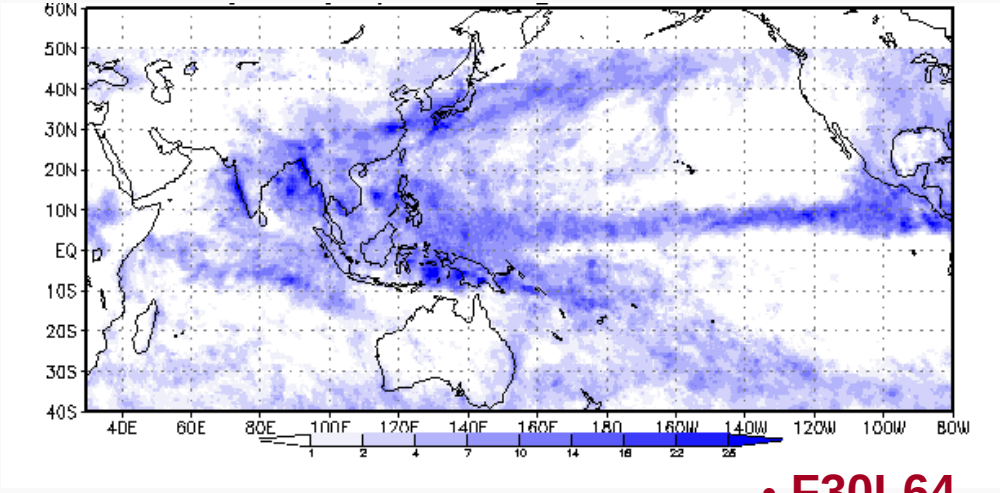




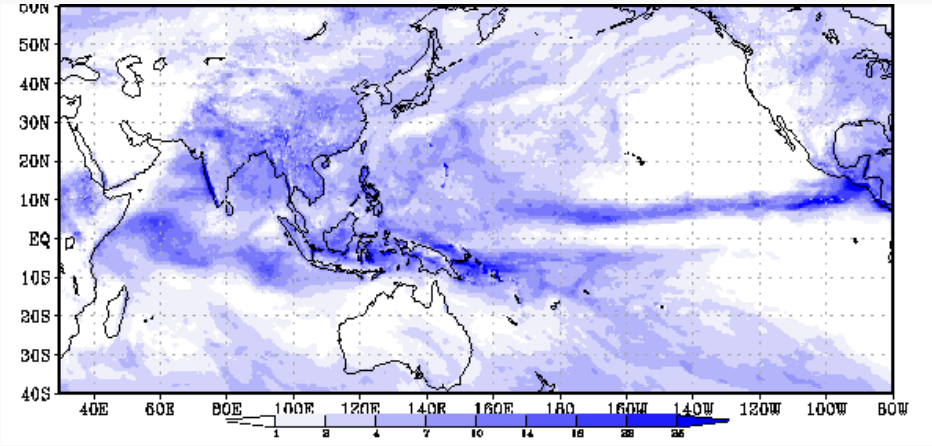


High Resolution GCM – vertical 64 levels

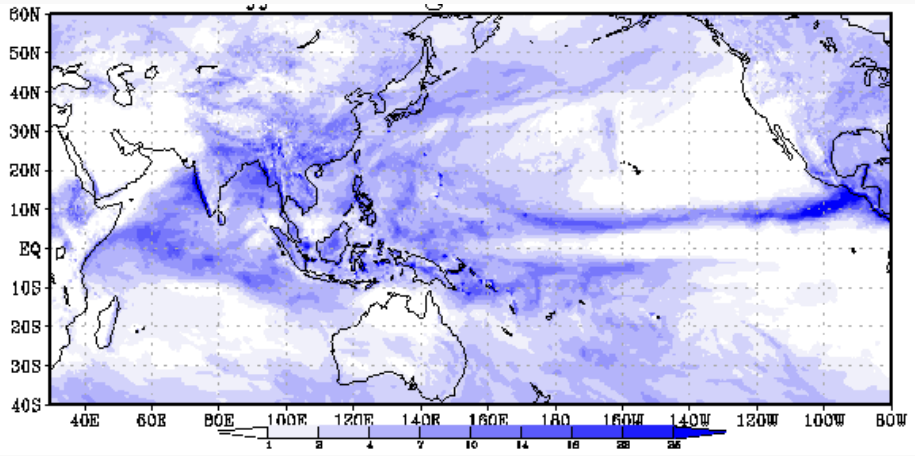
- **TRMM(99.06)**



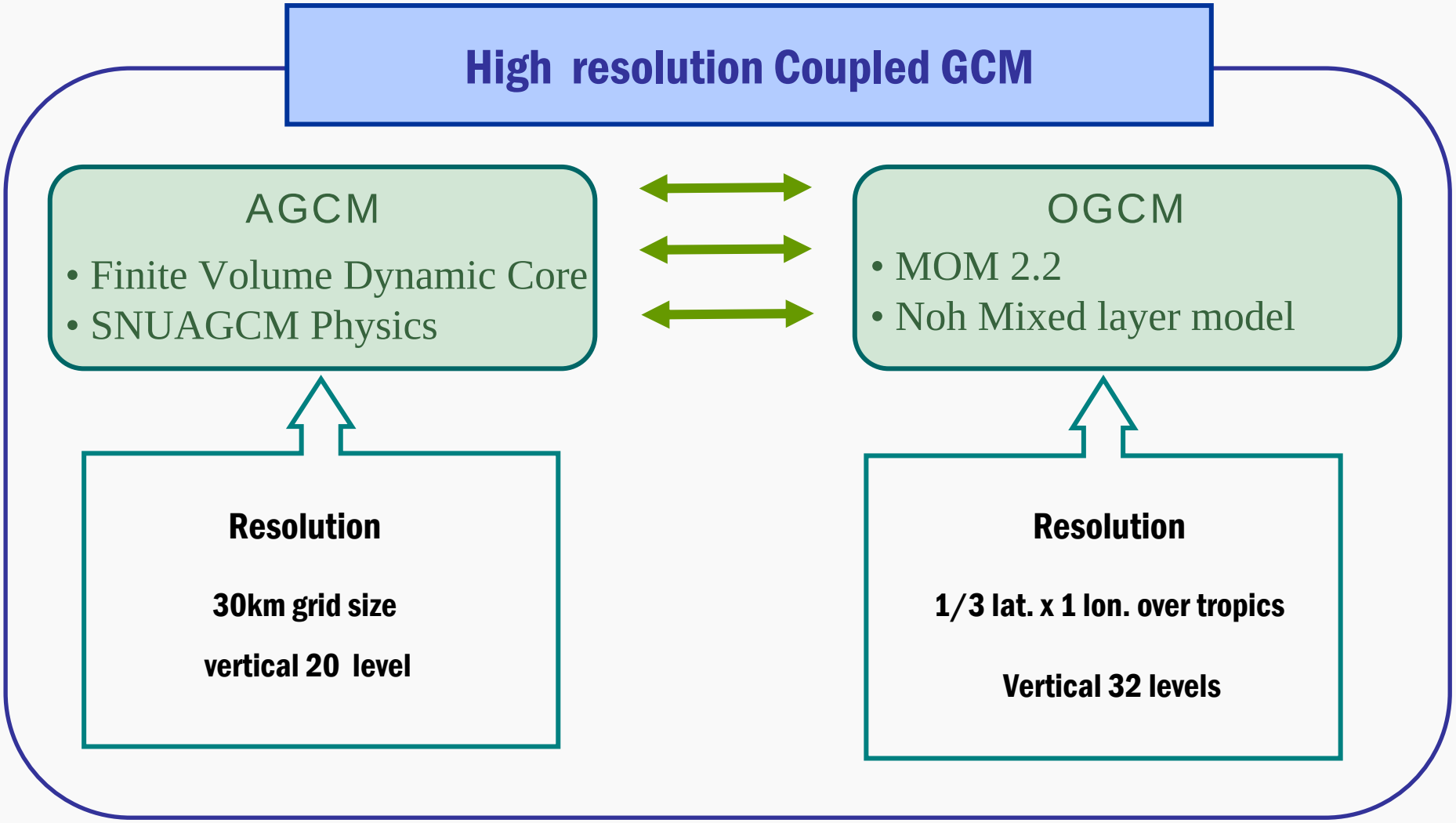
- **F30L20**



- **F30L64**



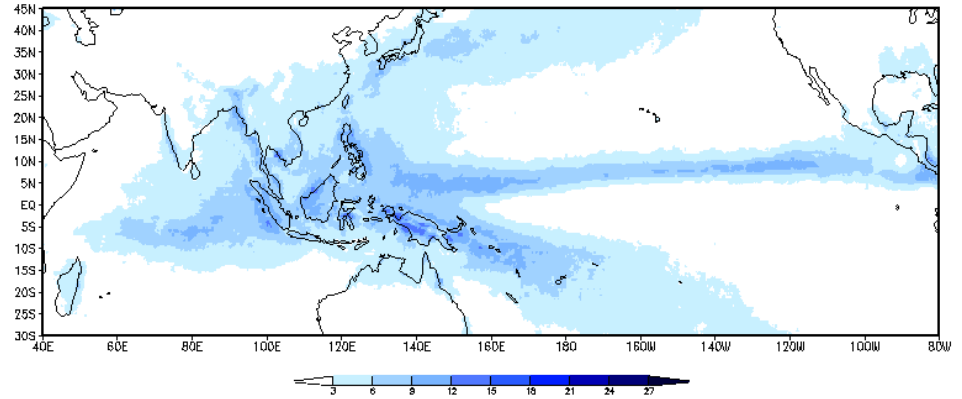
High-Resolution Coupled GCM


High resolution Coupled GCM
AGCM
• Finite Volume Dynamic Core
• SNUAGCM Physics
OGCM
• MOM 2.2
• Noh Mixed layer model
Resolution
30km grid size
vertical 20 level
Resolution
1/3 lat. x 1 lon. over tropics
Vertical 32 levels

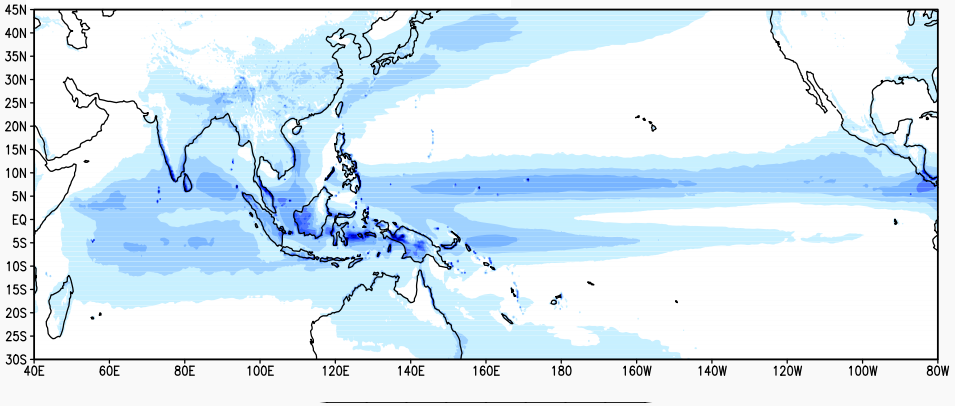
Annual Mean Precipitation/ CGCM

- Annual precipitation

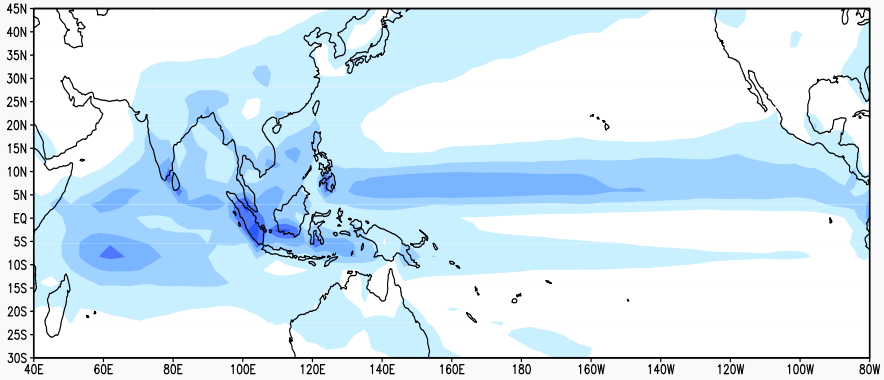
TRMM



30km FVCGCM (6.5yr)



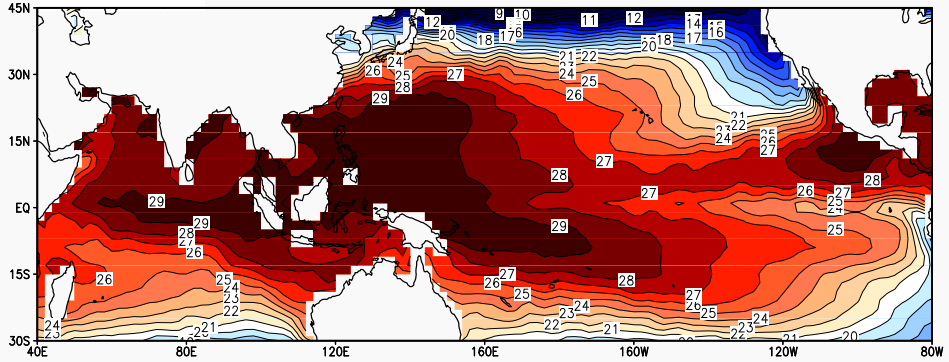
300km FVCGCM(5yr)



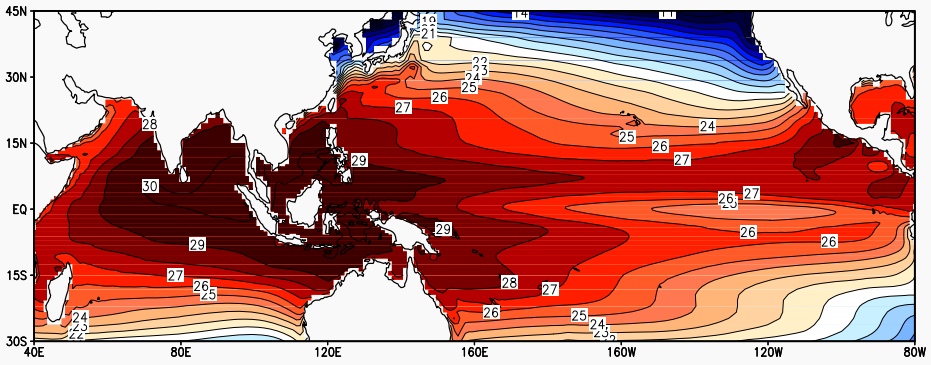
Annul Mean SST/ CGCM

- Annual SST

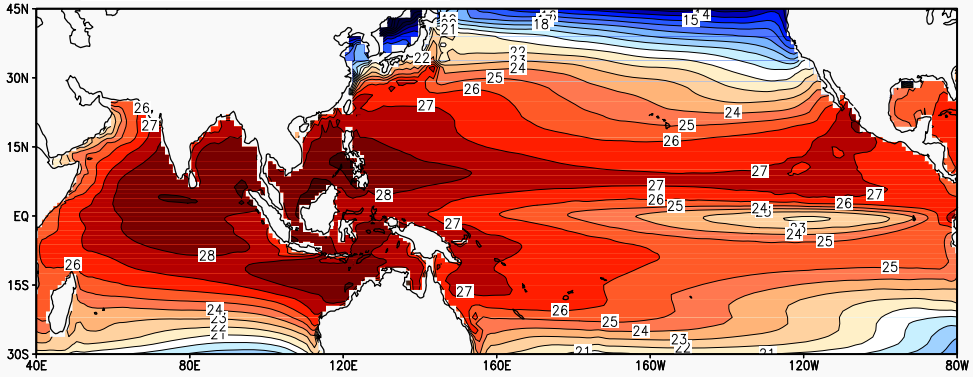
OISST



30km FVCGCM

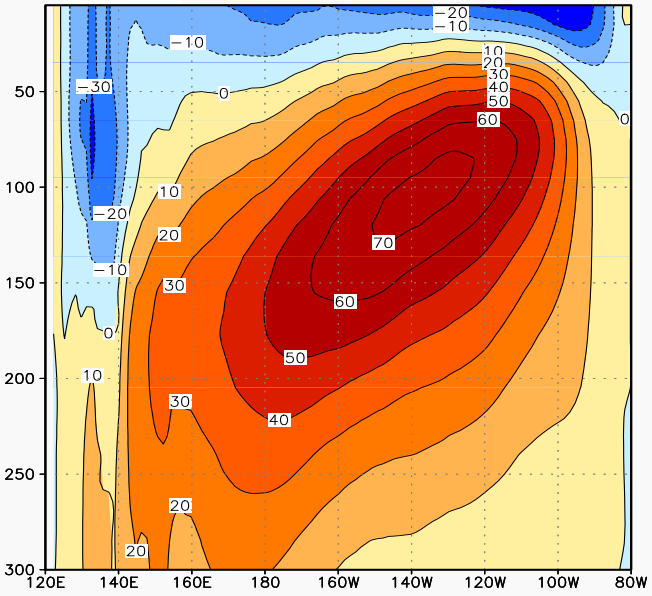


300km FVCGCM

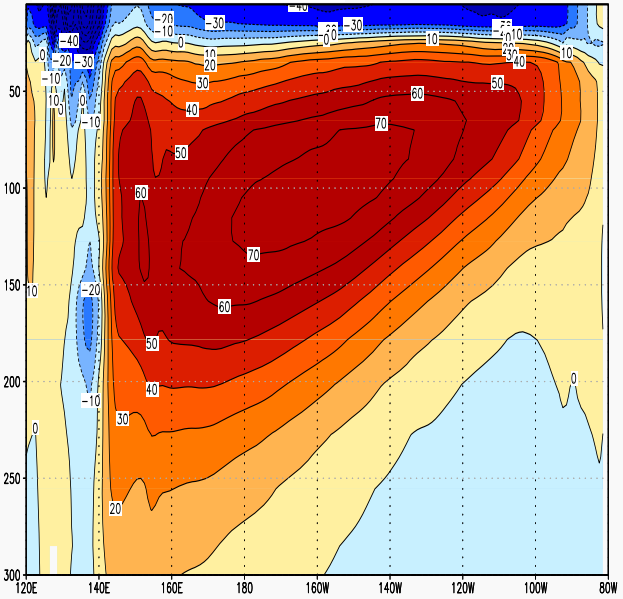


Equatorial Zonal Current 1S - 1N

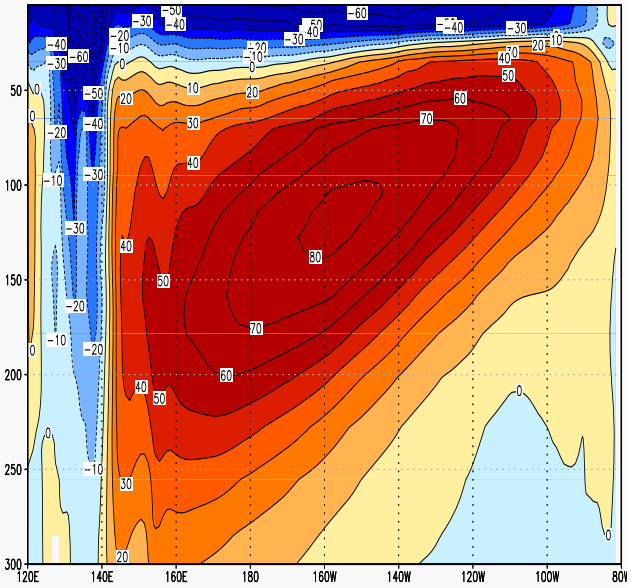
OBS



30km FVCGCM



300km FVCGCM



Thank You