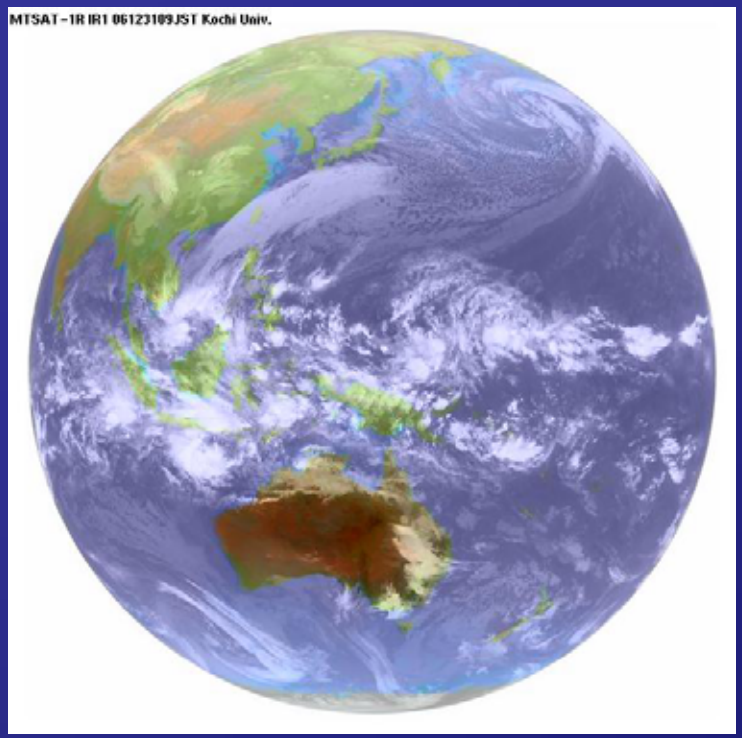
# Preliminary Results from a Simulation of a MJO Event in This Winter

**Observation**: TBB from MTSAT-1




**Simulation**: OLR after 16-days integration with a 14-km grid

Hiroaki Miura (FRCGC, JAMSTEC)
Masaki Satoh (CCSR, Univ. Tokyo)
Hirofumi Tomita, Akira Noda, Tomoe Nasuno, Shin-ichi Iga (FRCGC, JAMSTEC)

# Model configuration

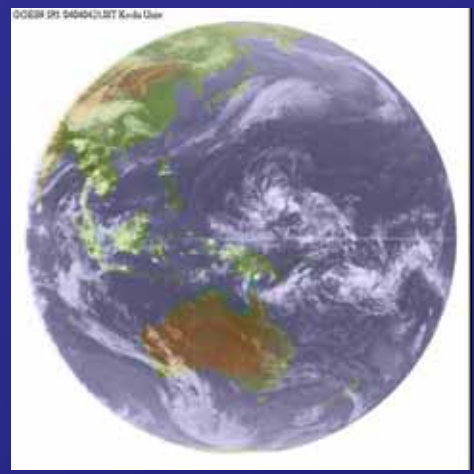
| | |
|---|---|
| • Dynamics (grid-scale) | |
| Governing equations | Full compressible non-hydrostatic system |
| Spatial discretization | 2nd-order centered scheme (Tomita et al. 2002)<br>2nd-order upwind biased scheme (Miura, MWR in revision) |
| Horizontal grid configuration | Icosahedral grid |
| Vertical grid configuration | Lorenz grid |
| Topography | Terrain-following coordinate |
| Conservation | mass, tracers, total energy (Satoh 2003) |
| Temporal scheme | Slow mode – explicit scheme (RK2, RK3)<br>Fast mode – Horizontal Explicit Vertical Implicit scheme |
| • Physics (subgrid-scale) | |
| Turbulence / surface flux | Modified Mellor & Yamada → Yamada and Mellor (1979) /Louis(1979), Uno et al.(1995) |
| Radiation | MSTRNX (Sekiguchi 2004) (with ISCCP) |
| Cloud physics | Grabowsky(1999) |
| Cloud parameterization | Arakawa & Schubert; large-scale condensation |
| Shallow clouds | no |
| Land process | Mixed layer/bucket; MATSIRO (SiB2-like model) |

# Resolution of unrealistic organization of clouds

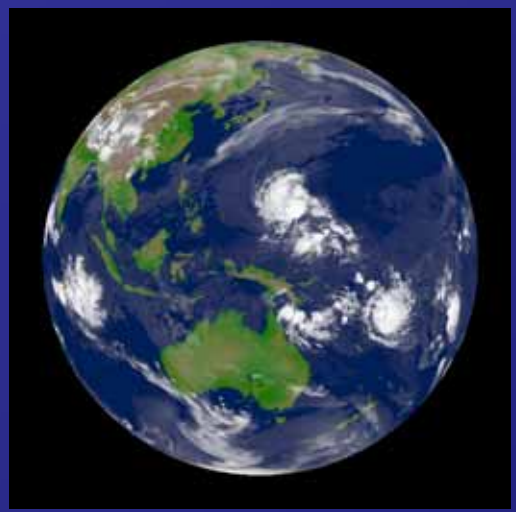
Level-2 scheme of Yamada and Mellor (1979) has been implemented. (A. Noda)

Simulated OLR for 2004-04-04 12Z with a 7-km grid

(Initial data: 2004-04-01 00Z)



GOES-9



OLD scheme

- overemphasized organization of clouds
- no convective clouds over the maritime continents

NEW scheme

- more realistic distribution of clouds

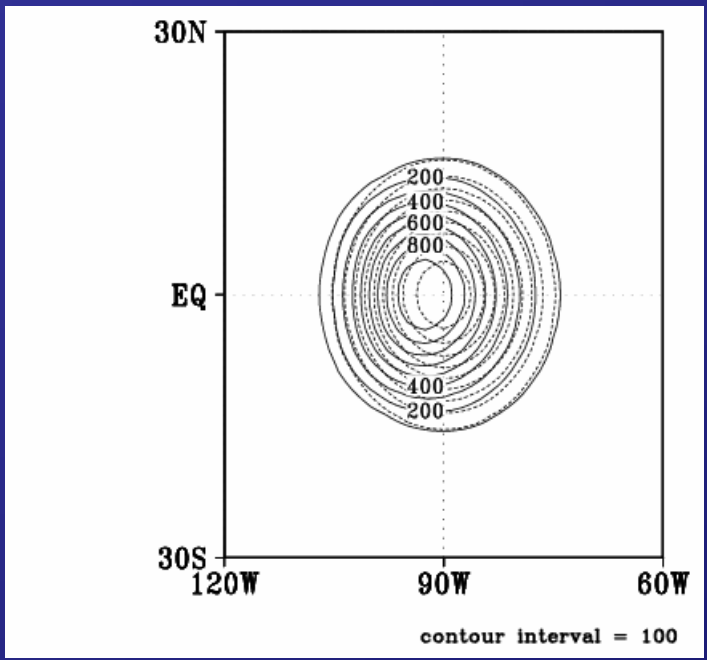
# Improvement of tracer advection scheme

"Scheme I" of van Leer (1977) was extended to spherical hexagonal-pentagonal grids.

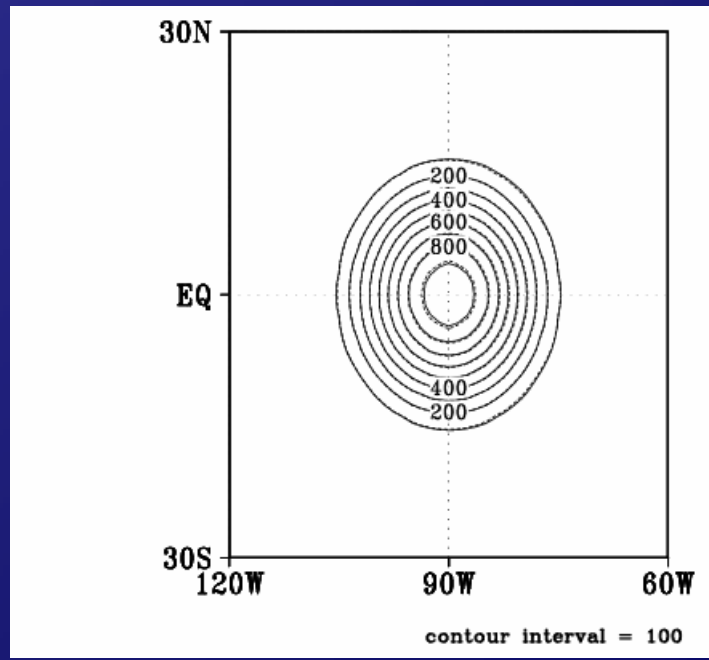
- A piecewise linear approximation was relaxed to a "local linear approximation".
- A flux limiter of Thuburn (1996) is used.

Test case #1: advection of a cosine bell
Williamson et al. (1992)

Solid contours – computed solution
Dashed contours – exact solution




2nd-order centered scheme




2nd-order upwind biased scheme

# Motivation

## Future issue

- Understanding and prediction of intraseasonal variations
  - Diurnal variation
  - Typhoon
  - MJO

Successful simulations of MJO by MMF (or super-parameterization) approach suggest that realistic time-scale for consuming water vapor is a key for simulating MJO. Meso-scale organization of clouds may be important. So, global CRMs are hopeful.

## Current issues

- Understanding of characteristics of (global) CRMs
  - sensitivity to horizontal/vertical resolution
  - sensitivity to subgrid-scale parameterizations (microphysics, turbulence, etc.)
- Validation (and improvements) of our global CRM

**It is sure that our global CRM should be improved further.**
**But, we decided to try a MJO simulation to get an insight into potential of global CRMs to simulate MJO.**

# Experimental setup

Initial conditions:

Interpolated from NCEP tropospheric analyses (6 hourly, 1.0x1.0 degree grids)

Initial data: 2006-12-15 00:00:00 (only initialized, without nudging techniques)

Boundary conditions:

Reynolds SST, Sea ICE (weekly data)

ETOPO-5 topography, Matthews vegetation

UGAMP ozone climatology (for AMPI2)

Horizontal grid spacing:

dx~14 km (DX14), 7 km (DX7), 3.5 km (DX3.5)

Vertical domain:

0 m ~ 38,000 m

40-levels (stretching grid)

Duration (current situation):

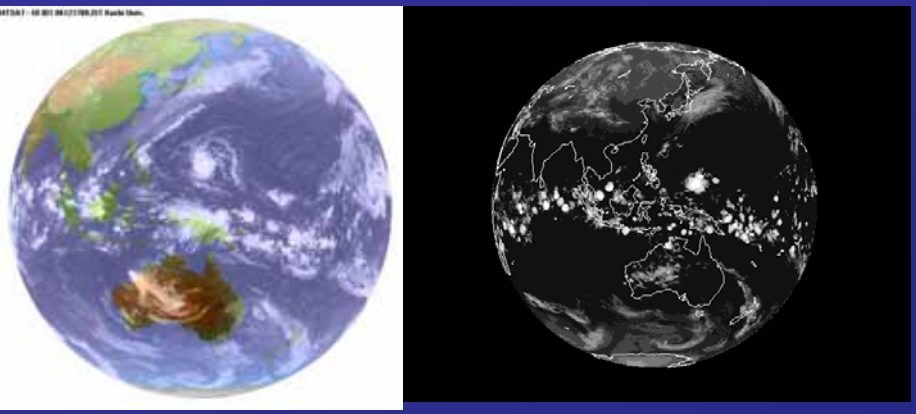
16 days for DX14

4 days for DX7

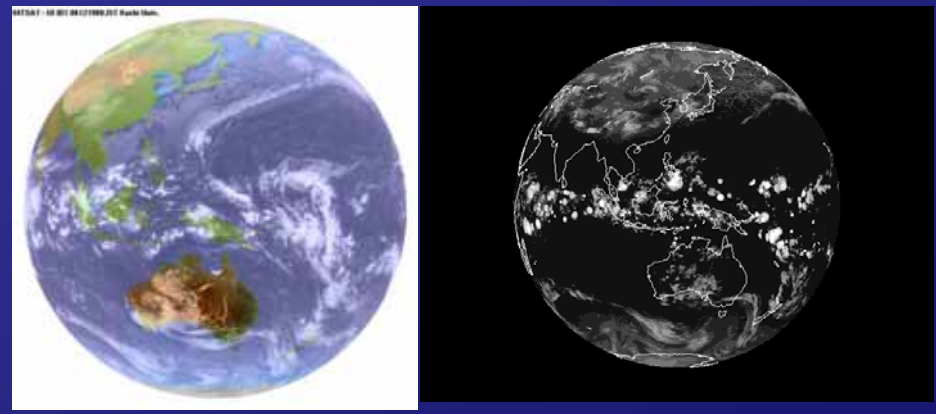
0 days for DX3.5

# Time evolution

2006-12-17 00Z



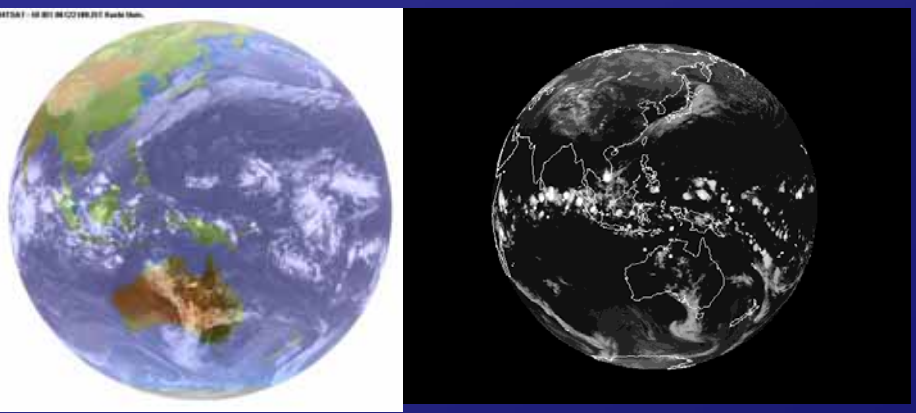
2006-12-19 00Z



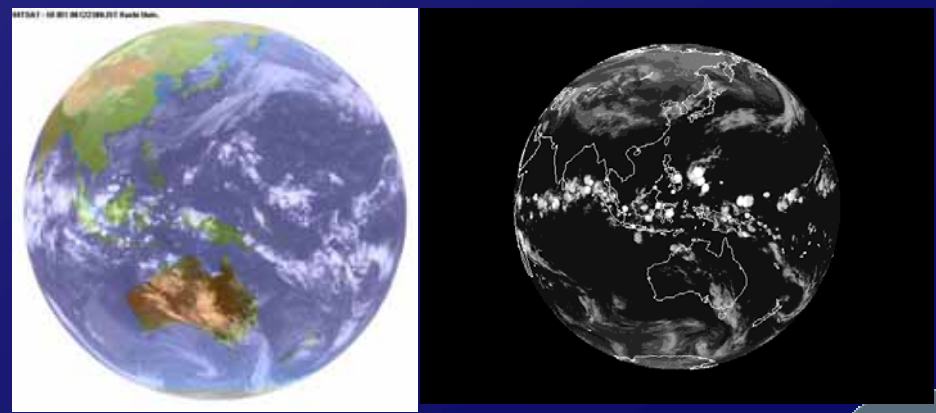
TBB(MTSAT-1) Simulated OLR

Kochi University Meteorological Web
(http://weather.is.kochi-u.ac.jp/)

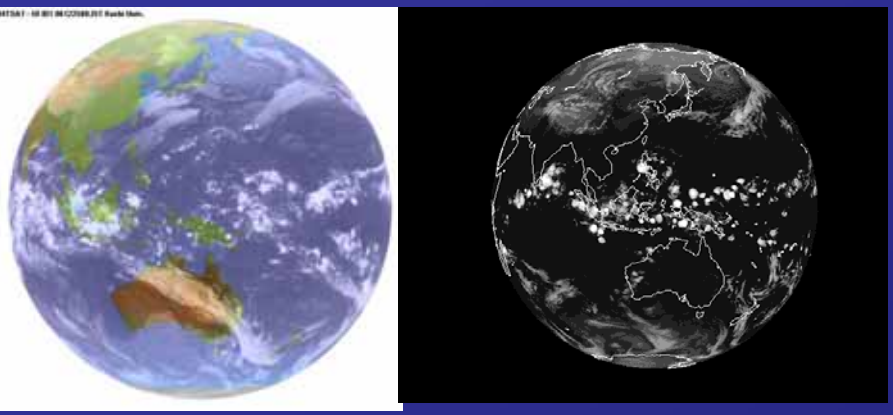
2006-12-21 00Z



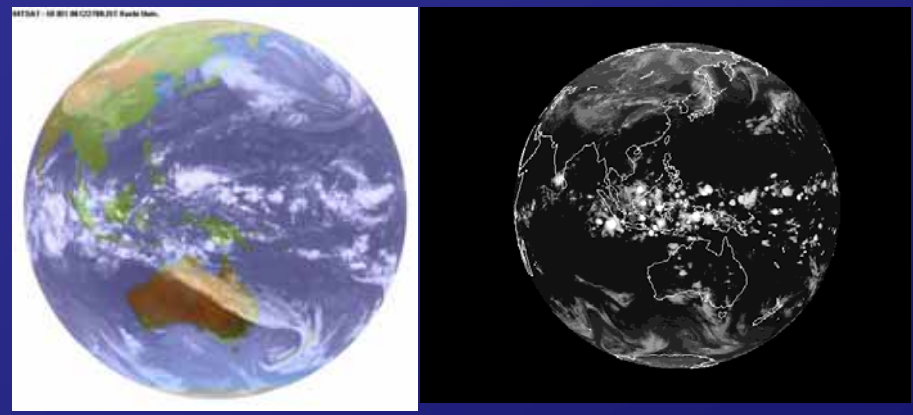
2006-12-23 00Z



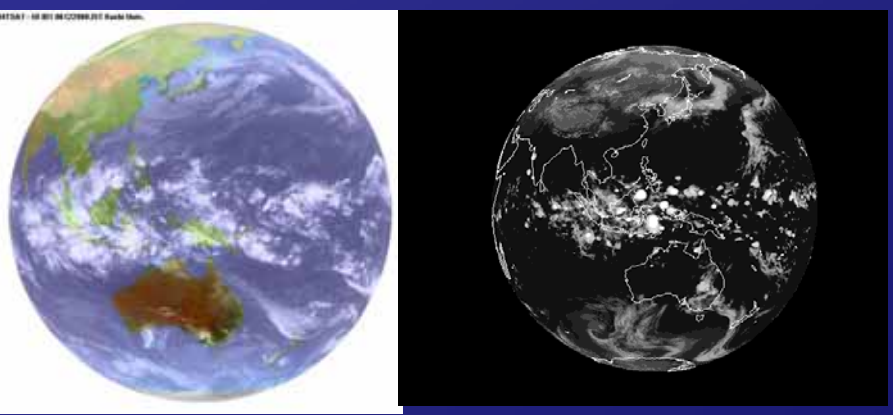
2006-12-25 00Z



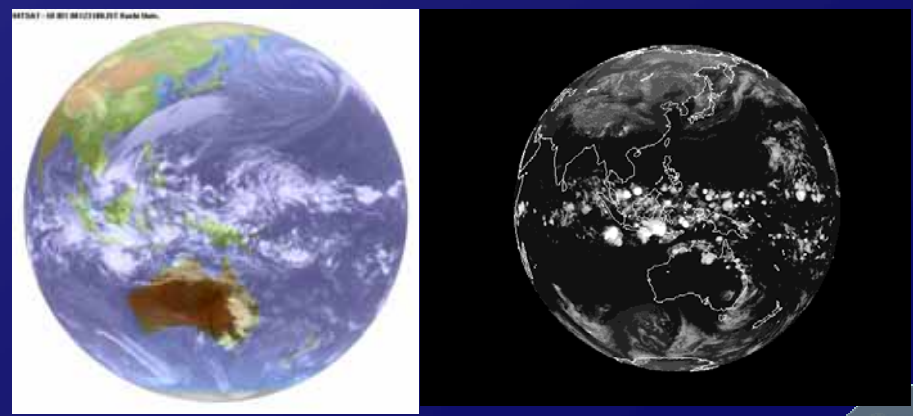
2006-12-27 00Z



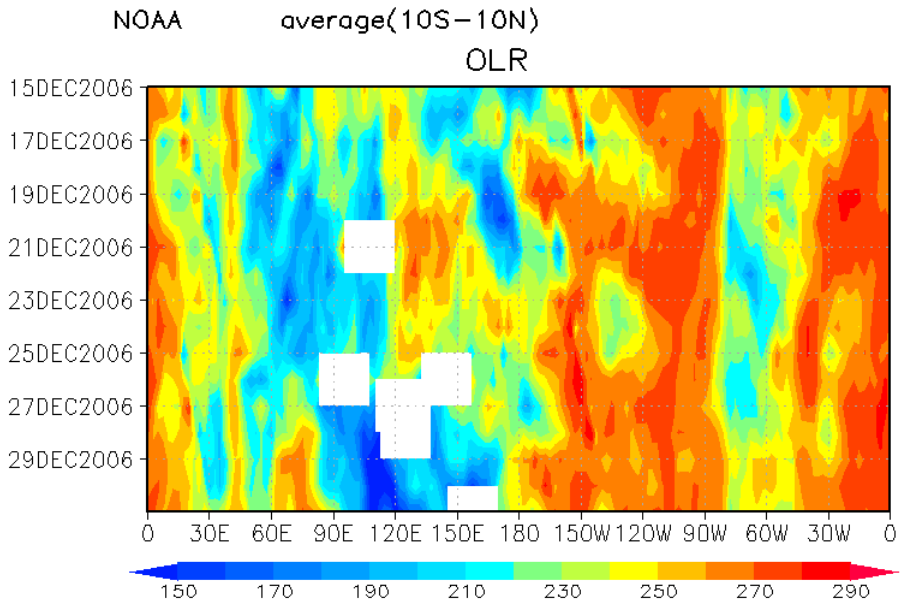
2006-12-29 00Z



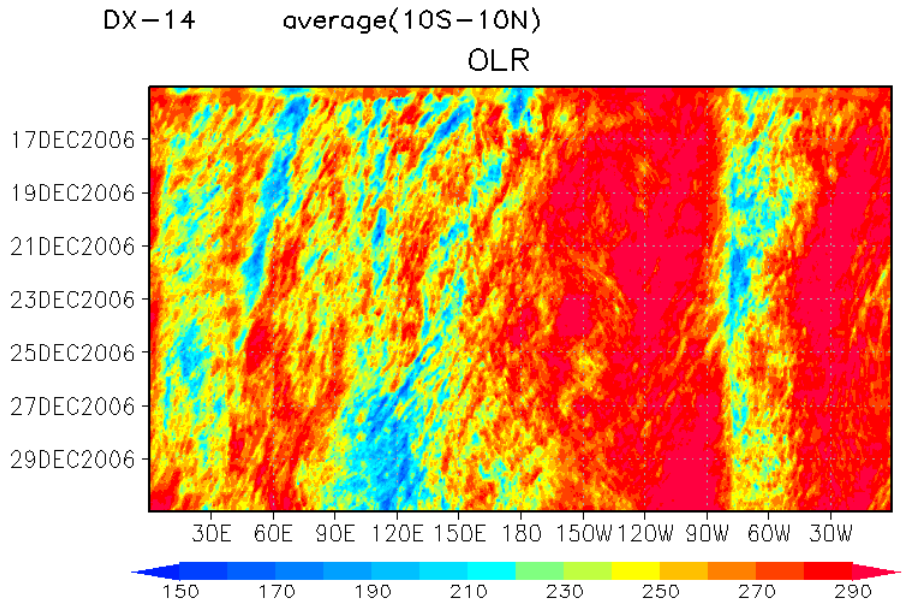
2006-12-31 00Z



# Hovmoller diagram of OLR (16 days)



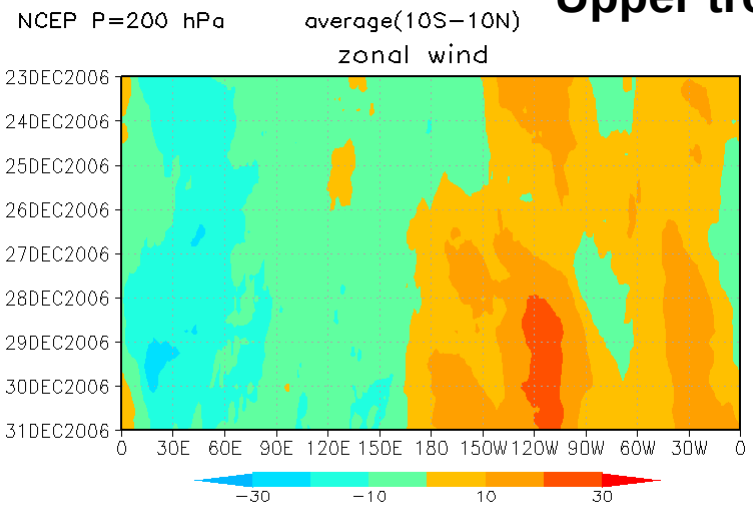

NOAA



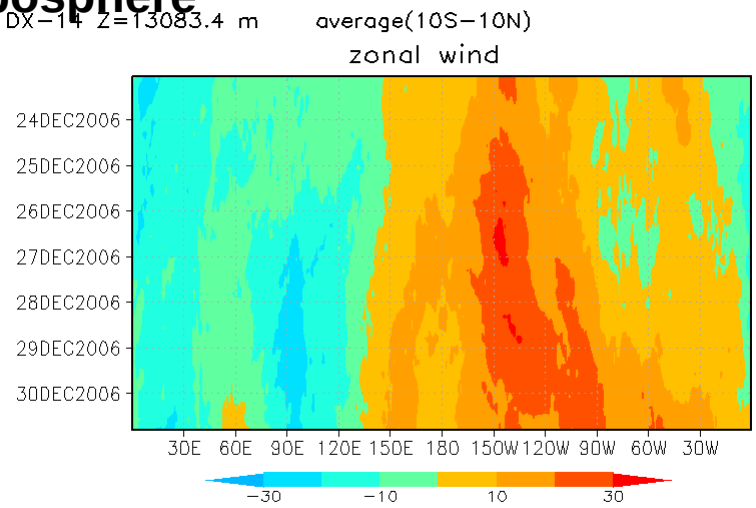

Simulation

# Hovmoller diagram of zonal wind (8 days)

## Upper troposphere

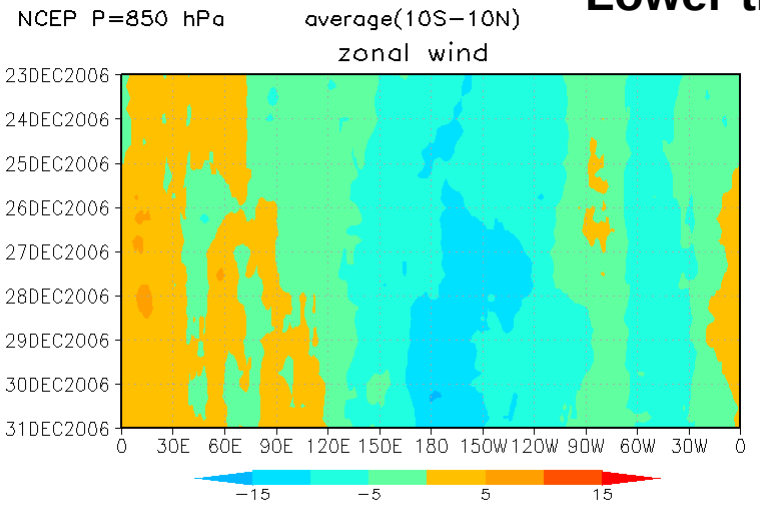


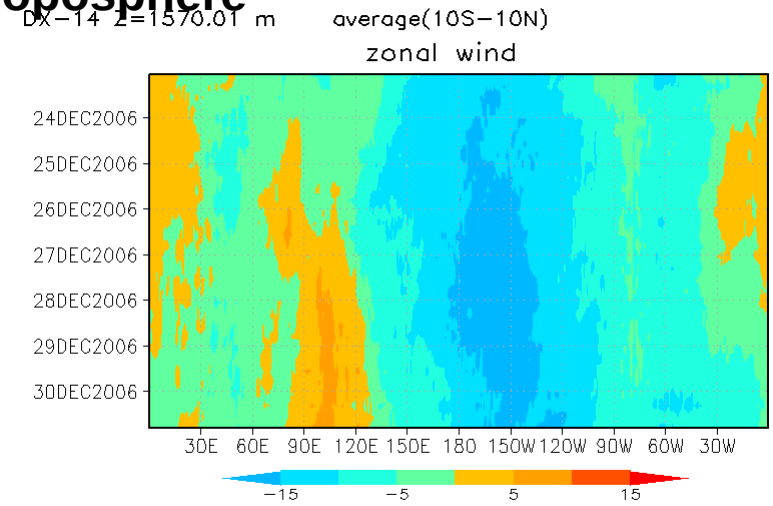

NCEP




Simulation

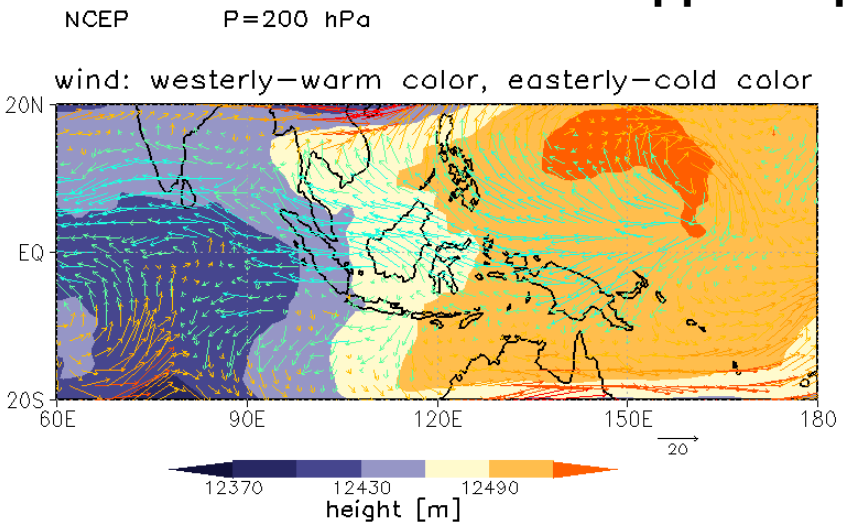
## Lower troposphere

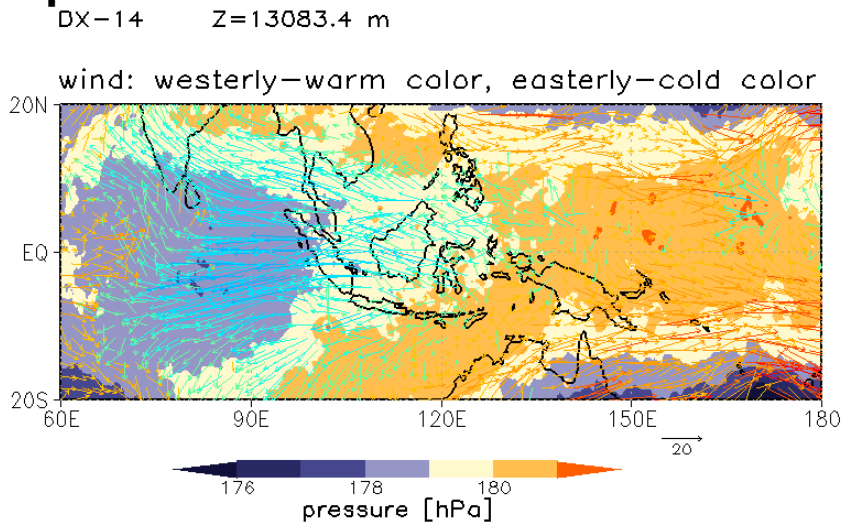


# Wind field & pressure (31DEC 00Z)

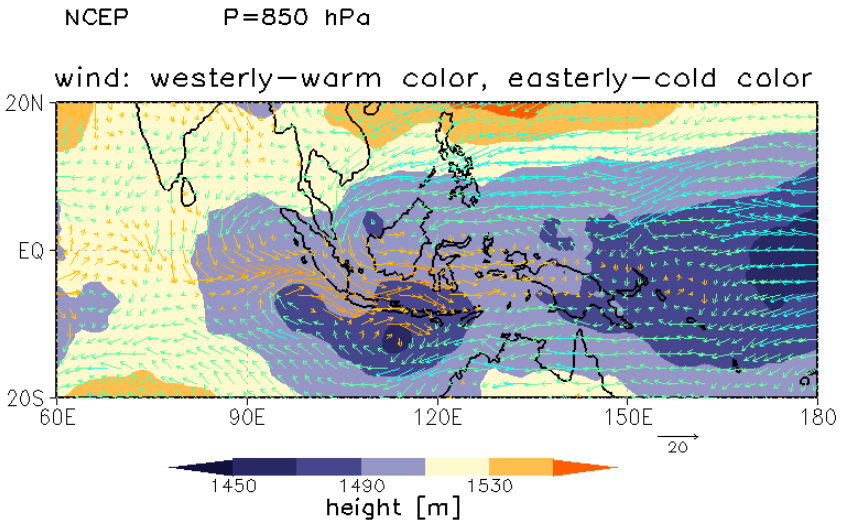
## Upper troposphere

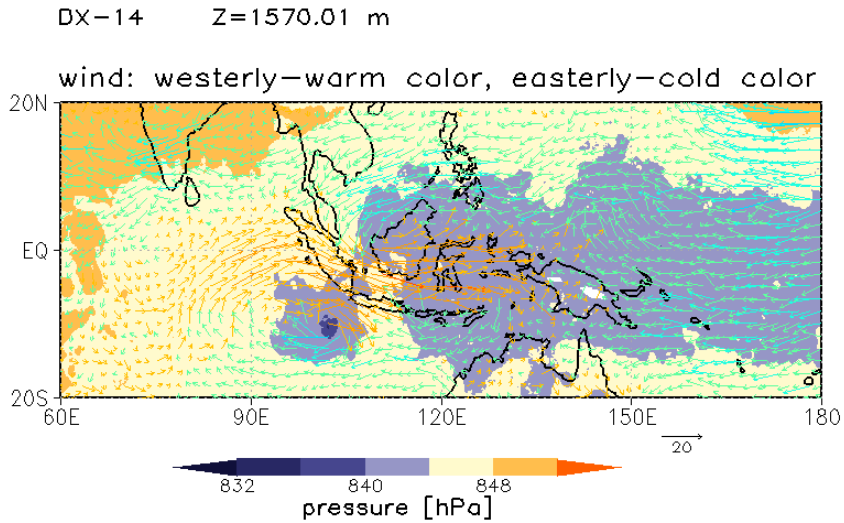



NCEP Simulation

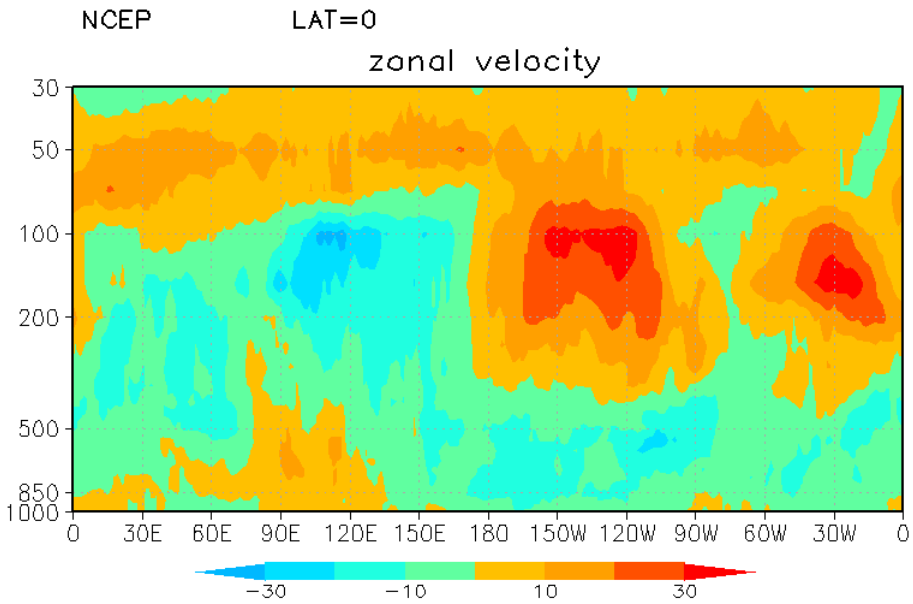
## Lower troposphere



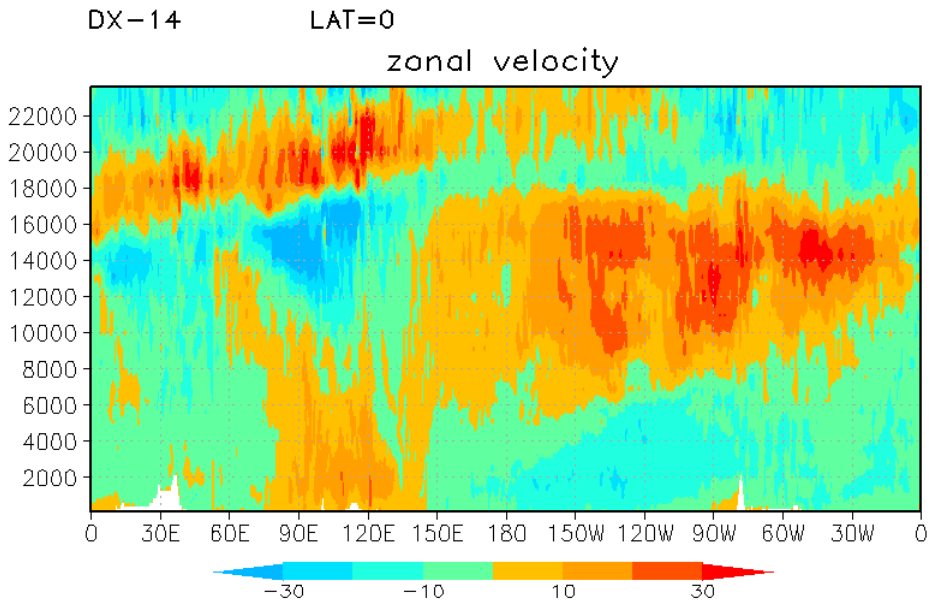



# Latitude-Height section of zonal wind (31DEC 00Z)

latitude = 0



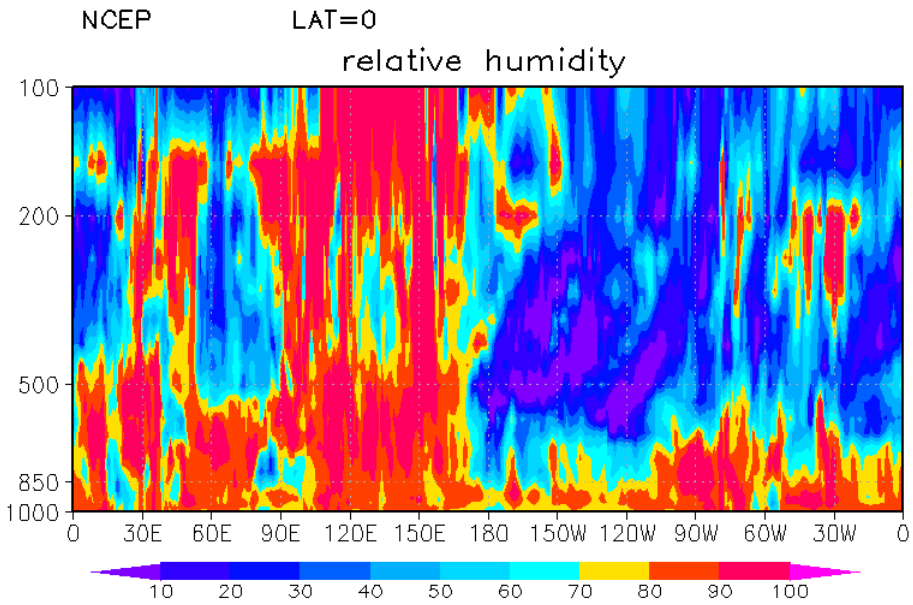

NCEP



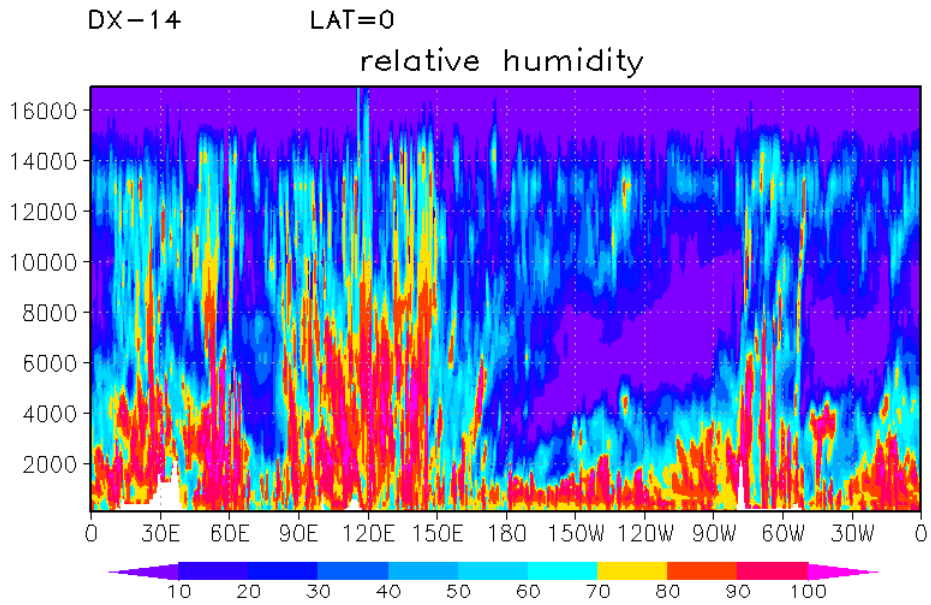

Simulation

# Latitude-Height section of RH (31DEC 00Z)

latitude = 0

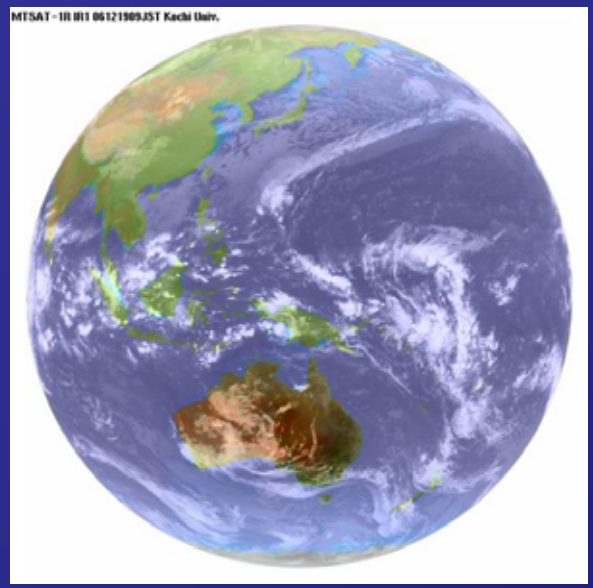



NCEP



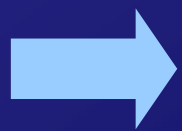

Simulation

# More resolution?



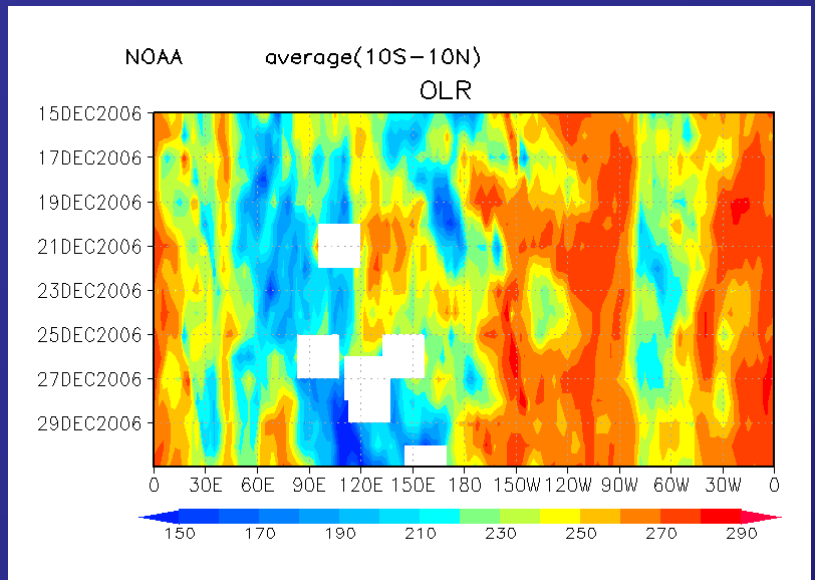

19DEC 00Z

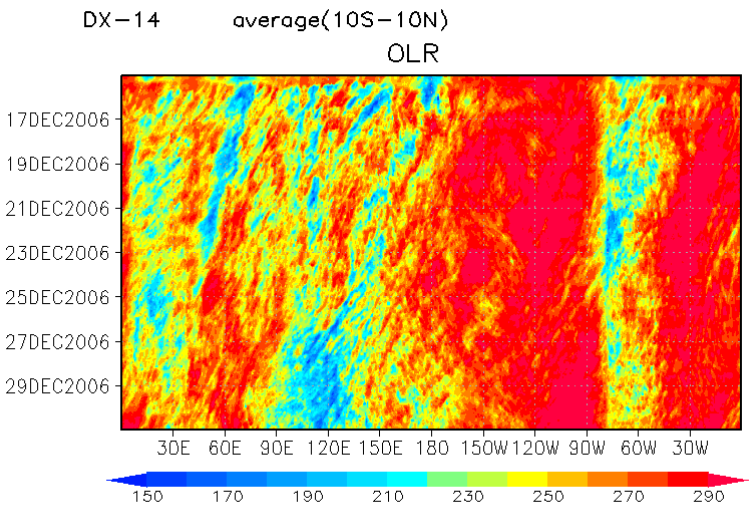
14-km grid

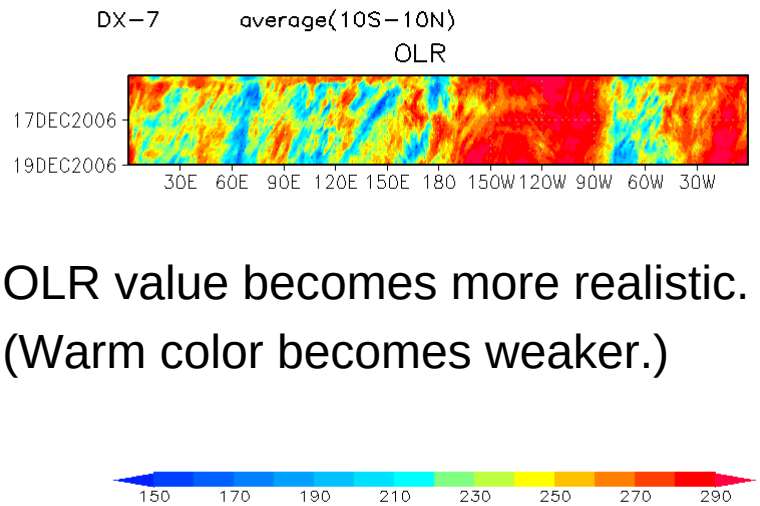


7-km grid

# An improvement



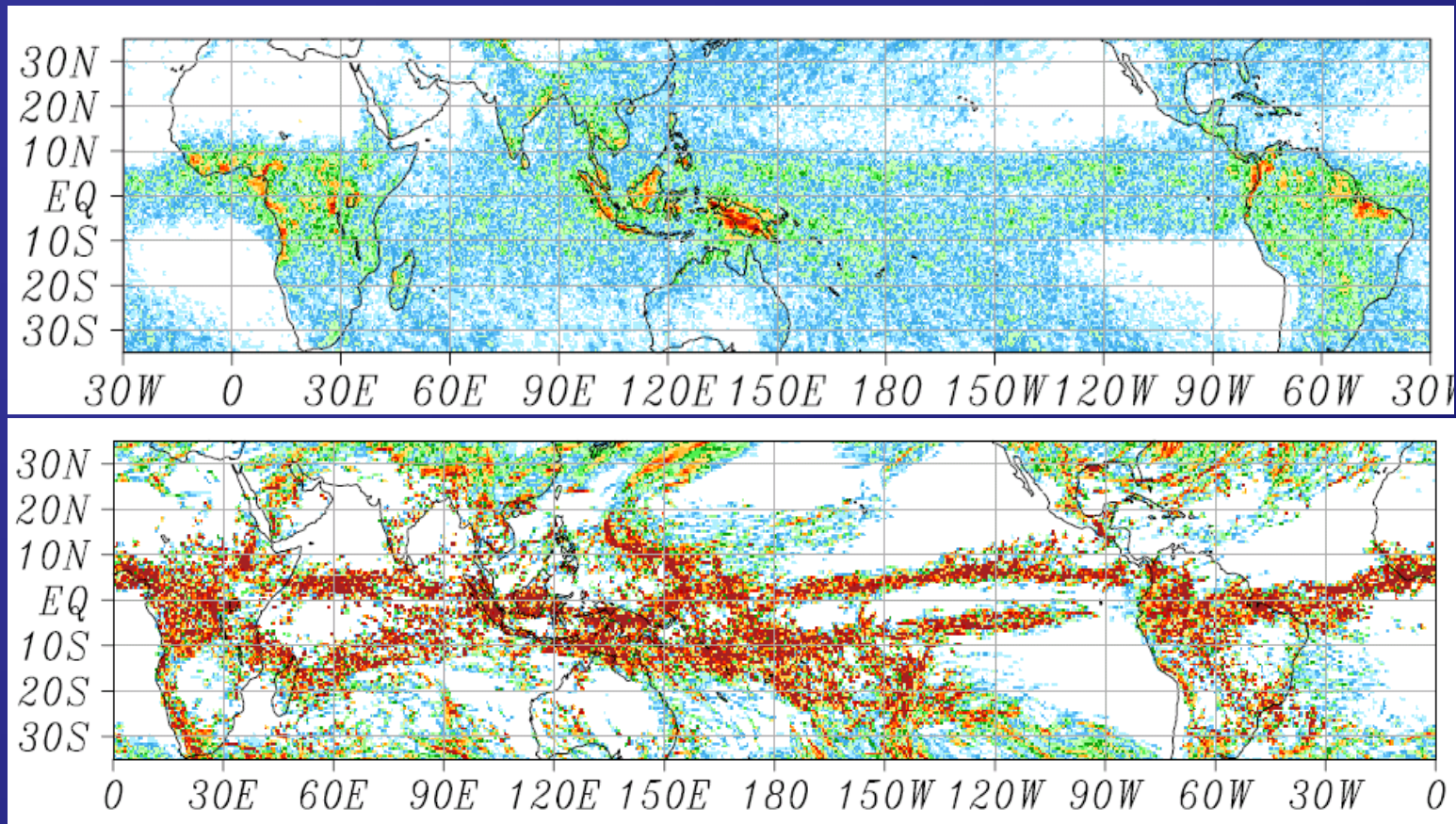

OLR value becomes more realistic.
(Warm color becomes weaker.)

# Summary

- **Simulations of a MJO event in this winter are ongoing.**
  - Simulations are initialized at 2006-12-15 without nudging.
  - 16-days integration with a 14-km grid/4-days integration with a 7-km grid
- **Some features of the event were simulated.**
  - Enhancement of convective activity over the maritime continents
  - Westerly wind burst in the lower troposhere
  - Wind fields consistent with NCEP reanalysis
- **Why dose a coarse resolution permit the MJO(-like) signal?**
  - It is interesting to consider mechanisms which can be represented even with a 14-km grid.
- **Future plan**
  - 30 days integrations with 14-km and 7-km grids
  - ?? days integration with 3.5-km grid
  - sensitivity studies: another initial time?, fixed SST?, w/o mountains?

# Diurnal Amplitude (TMI vs. NICAM) from Dr. Takayabu

## 2004-04 run

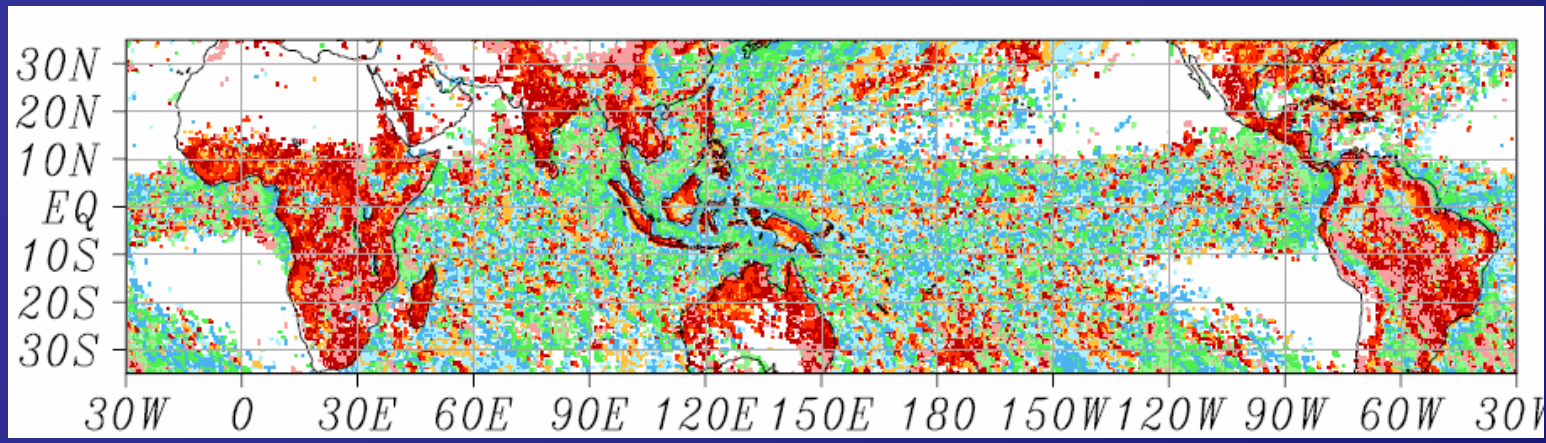



TMI MAM

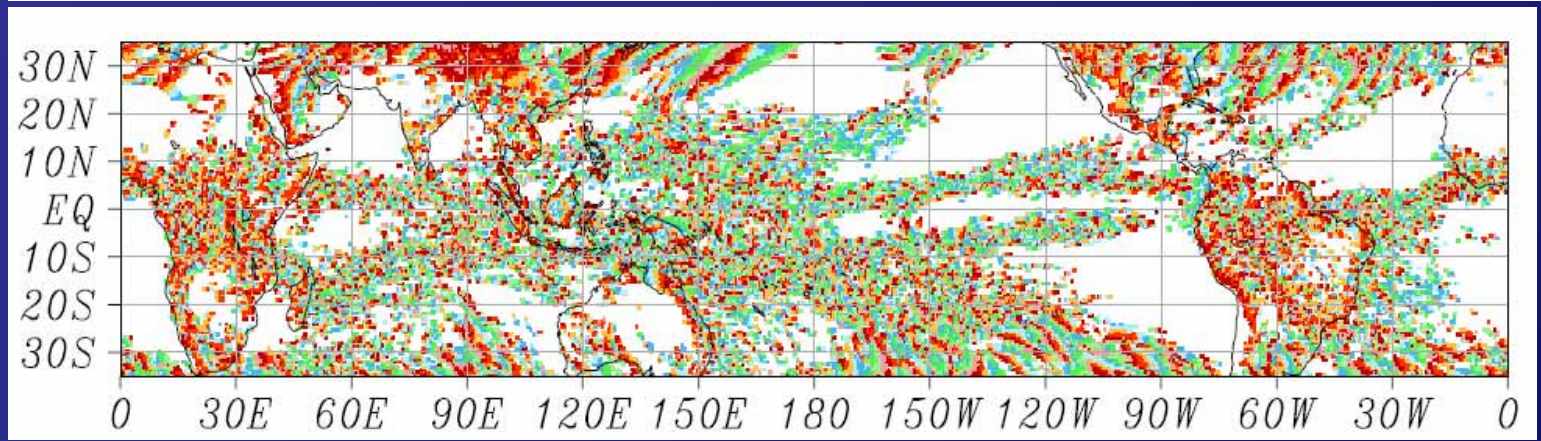
NICAM
14-km grid

# Diurnal Phase (TMI vs. NICAM) from Dr. Takayabu

**2004-04 run**




TMI MAM




NICAM
14-km grid