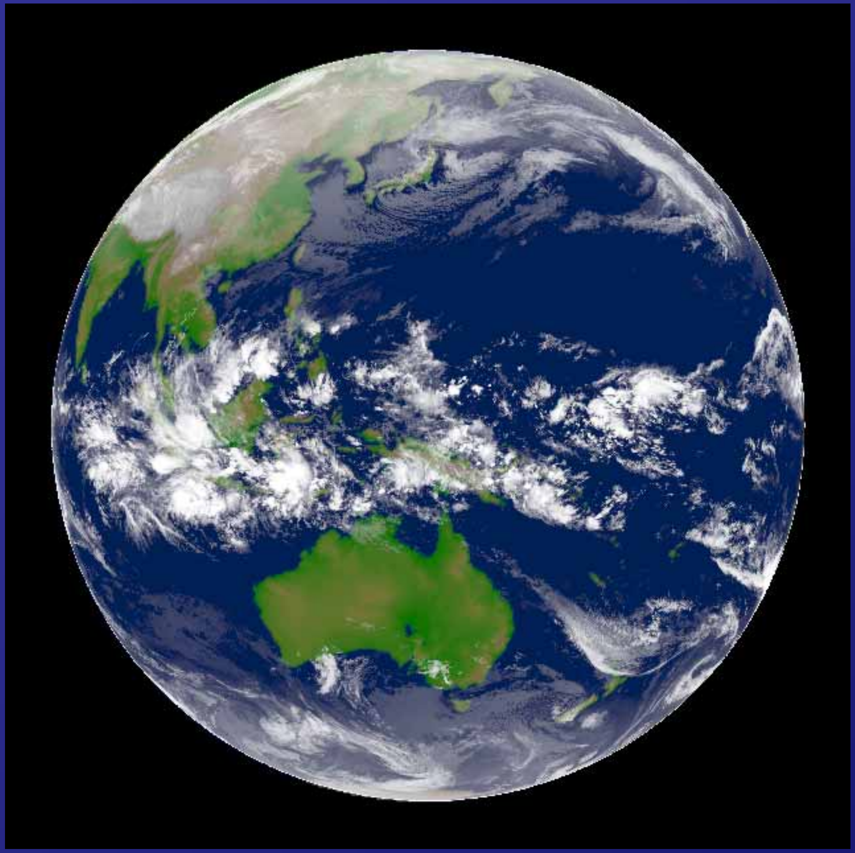
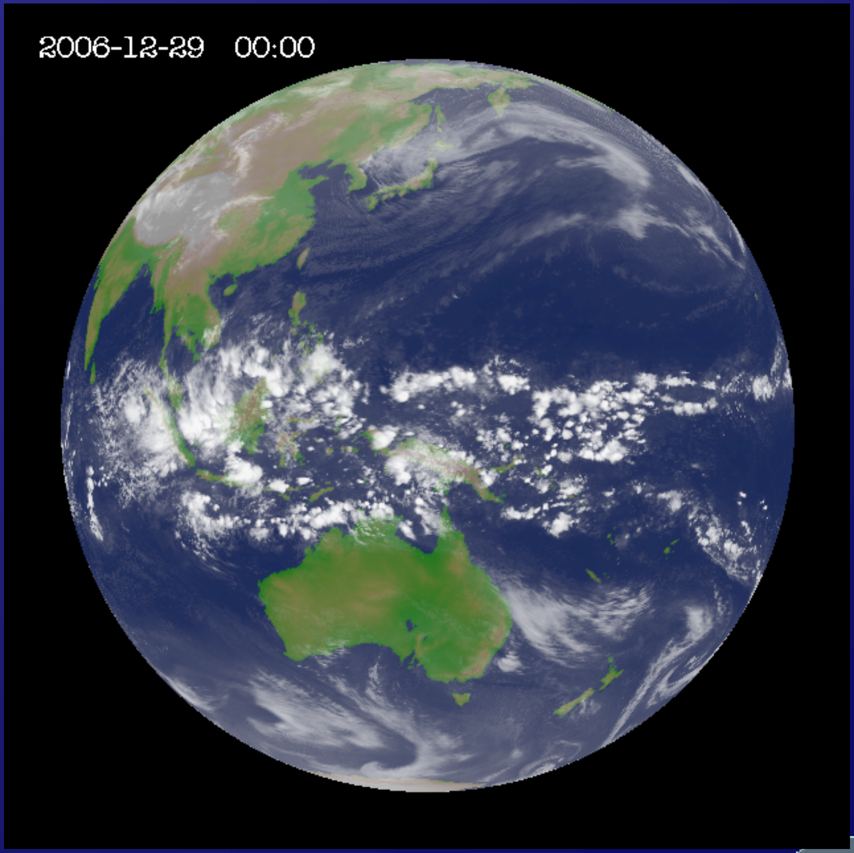
Influence of topography and zonal SST gradient on the MJO

Observation: TBB from MTSAT-1R



Simulation: OLR from a 3.5-km grid run



Hiroaki Miura (FRCGC, JAMSTEC)

Current status of NICAM

• Dynamics (grid-scale)	
Governing equations	Full compressible non-hydrostatic system
Spatial discretization	2nd-order centered scheme (Tomita et al. 2002) 2nd-order upwind biased scheme (Miura, MWR accepted)
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) 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)
Cloud physics	Grabowsky(1998)
Cloud parameterization	no
Shallow clouds	no
Land process	Mixed layer/bucket

Experimental setup of sensitivity tests

Initial conditions:

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

Initial time:

14-km run: 2006-12-15 00:00:00

Boundary conditions:

Reynolds SST, Sea ICE (weekly data): These are linearly interpolated in time.

ETOPO-5 topography, Matthews vegetation

UGAMP ozone climatology (for AMPI2)

Horizontal grid spacing:

14 km

Vertical domain:

0 m ~ 38,000 m

40-levels (stretching grid)

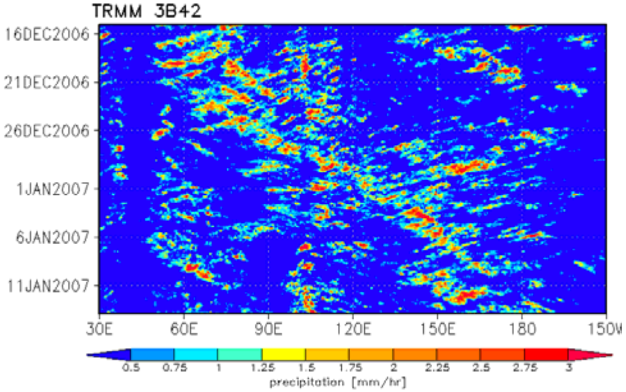
Duration (current situation):

14-km run: 30 days

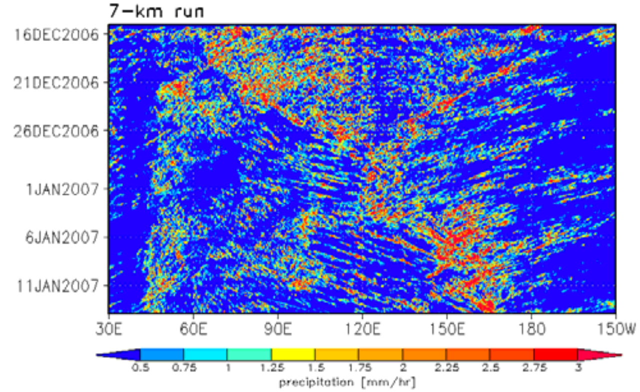
Could the 14-km run simulate the MJO? - 1

Precipitation: lat=5S-5N

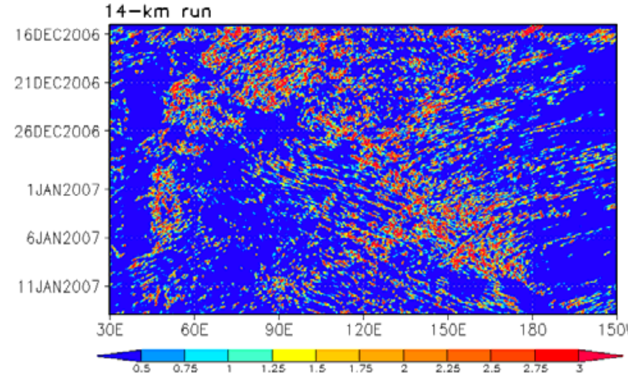
TRMM 3B42



7-km run

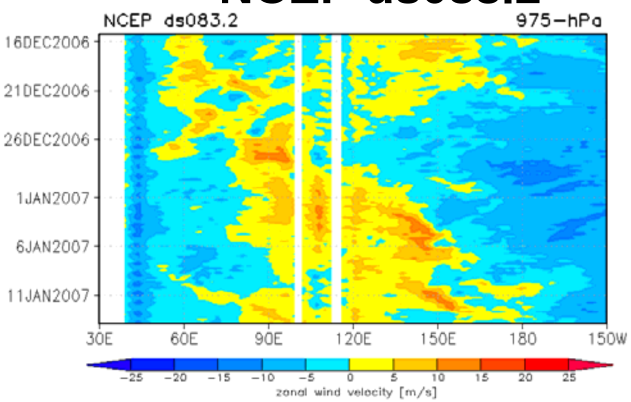


14-km run

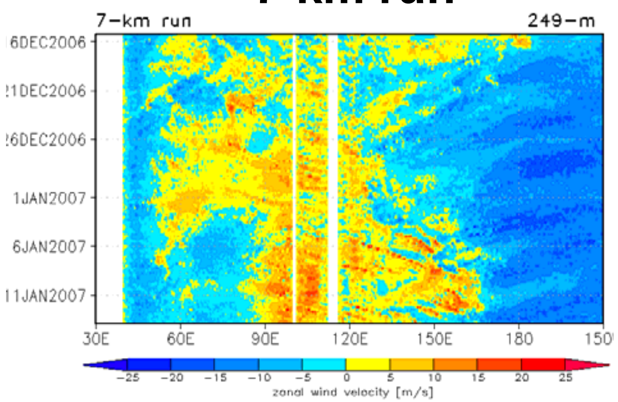


Zonal wind: lat=0, p=975 hPa/z=249 m

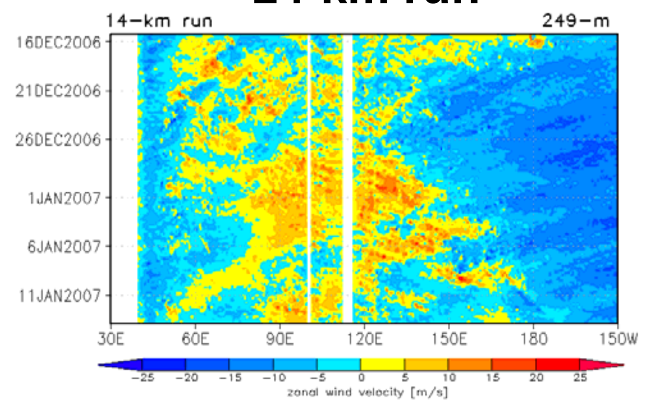
NCEP ds083.2



7-km run



14-km run



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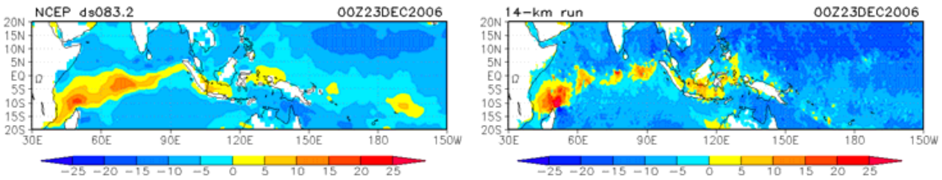
Could the 14-km run simulate the MJO? - 2

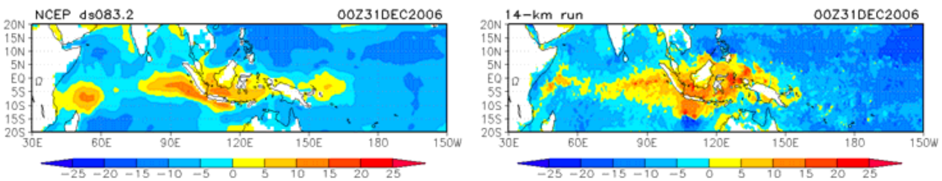
Time change of zonal wind

NCEP ds083.2: p=975 hPa   14-km run: z=249 m   NCEP ds083.2:lat=0   14-km run:lat=0

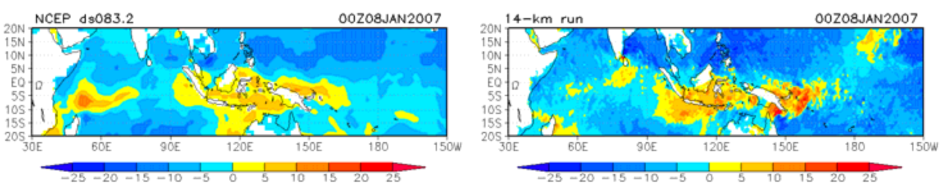
2006-12-23

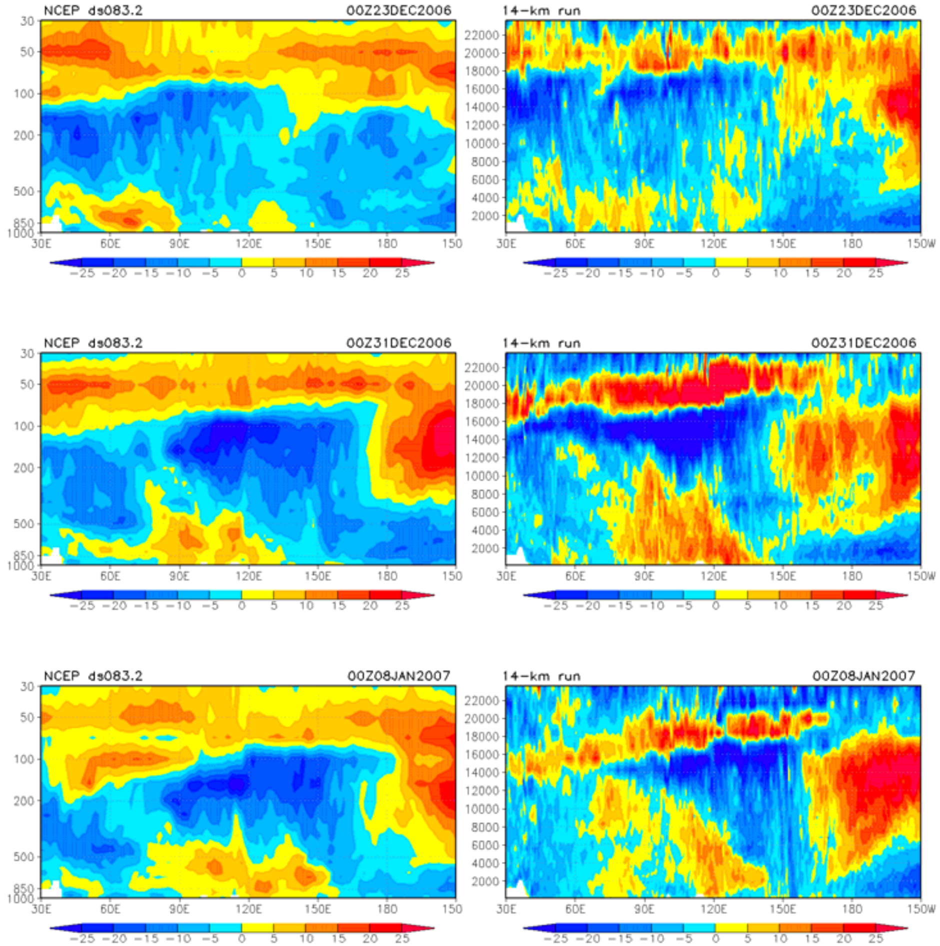


2006-12-31



2007-01-08



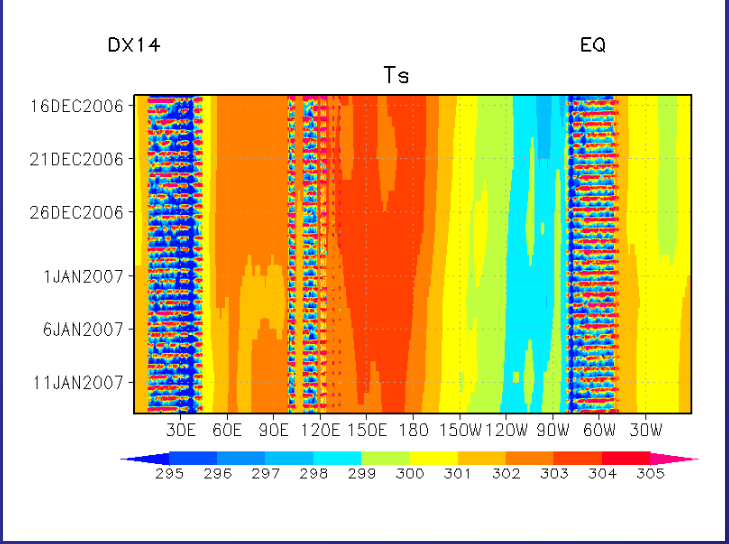


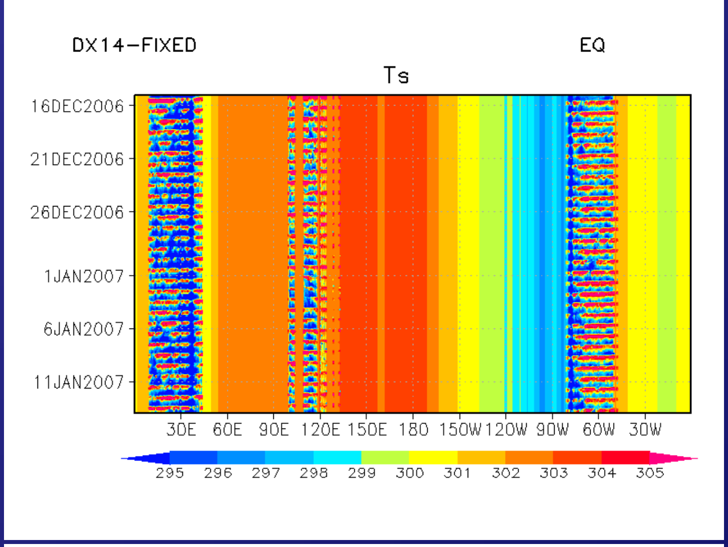
Test-1: No time change of SST

FIXED: SST was fixed to data at 2006-12-13.

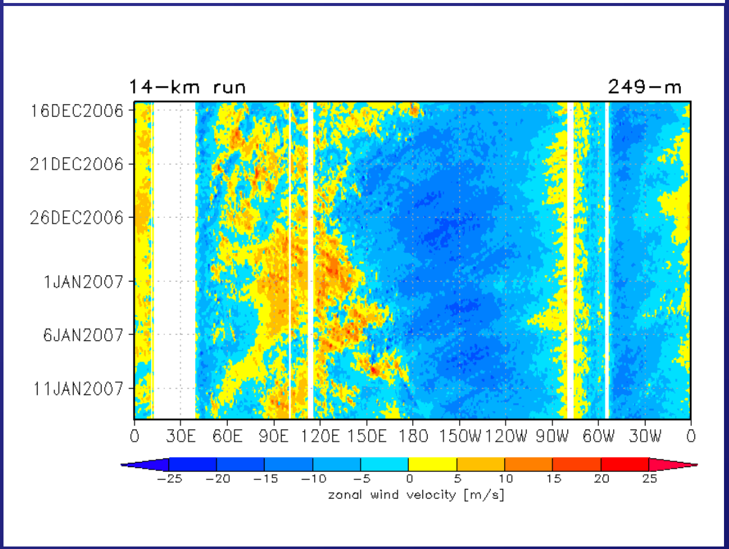
CTL (Control) | FIXED

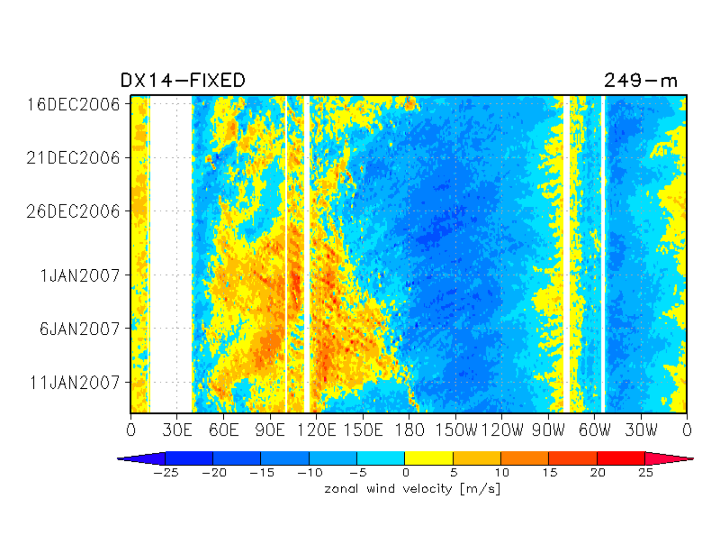
Surface temperature: lat=0





Zonal wind: lat=0



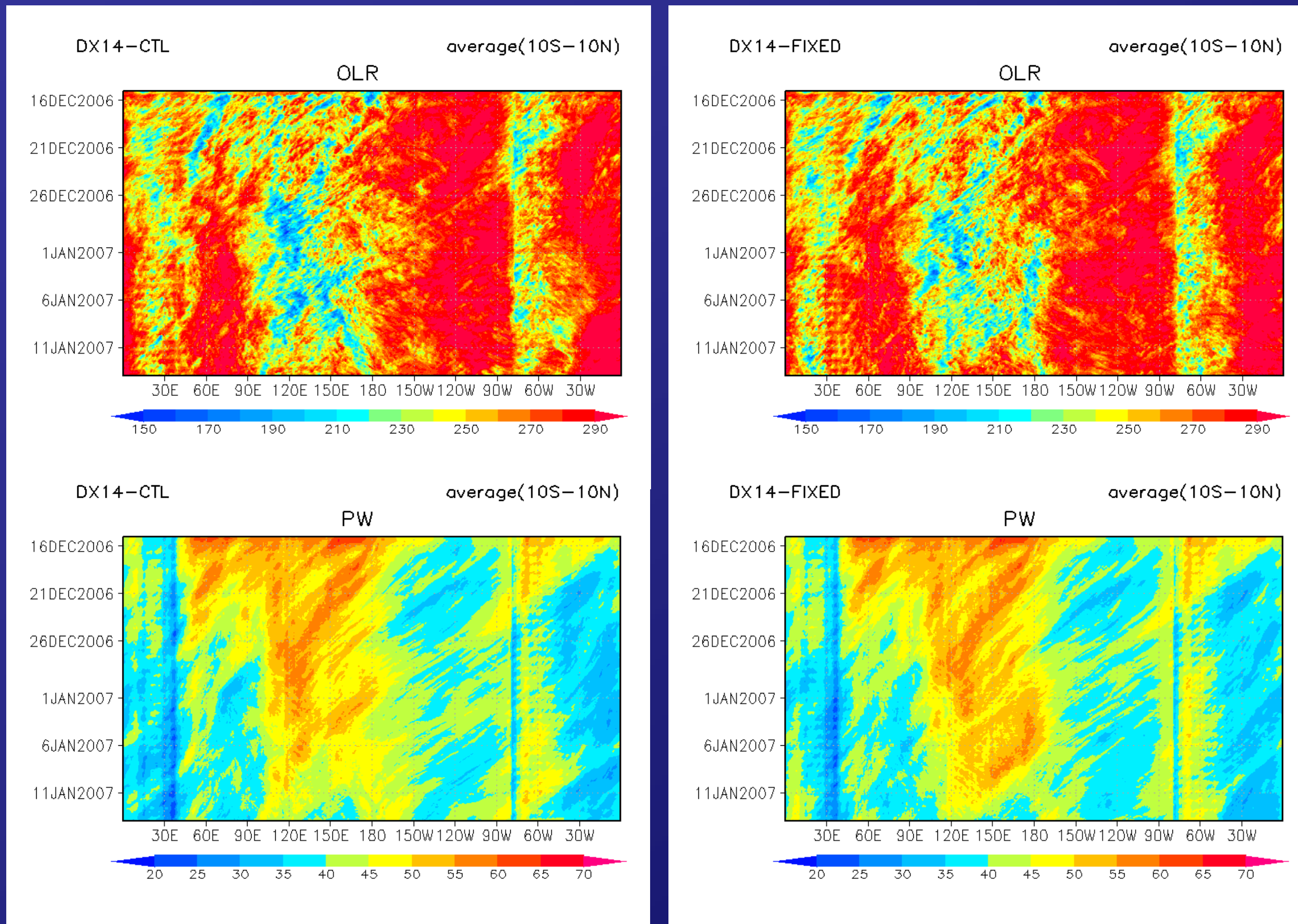


Test-1

CTL (Control) | FIXED

Outgoing long-wave radiation: lat=10S-10N

Precipitable water: lat=10S-10N



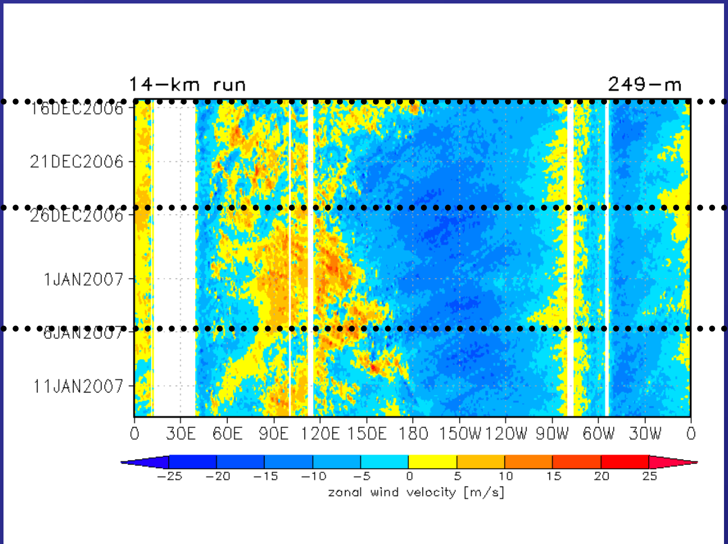
- At least in the simulations, the SST feedback was not essential for the slow eastward movement of the MJO.

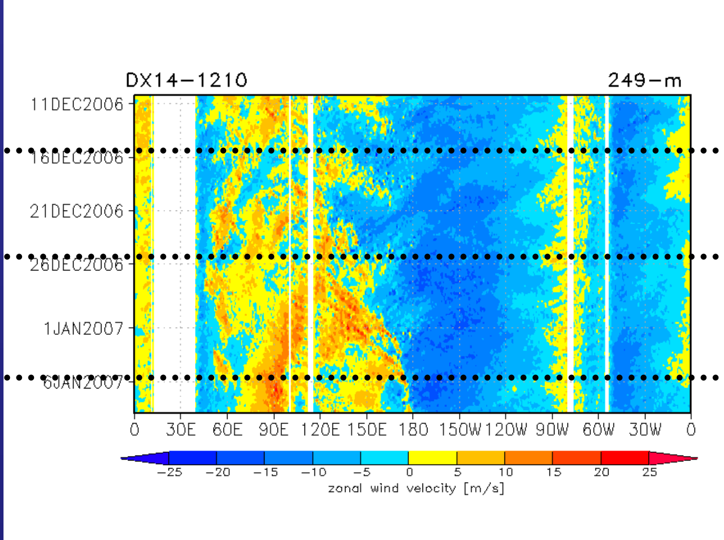
Test-2: Another initial date

1210: Initial conditions were given at 2006-12-10.

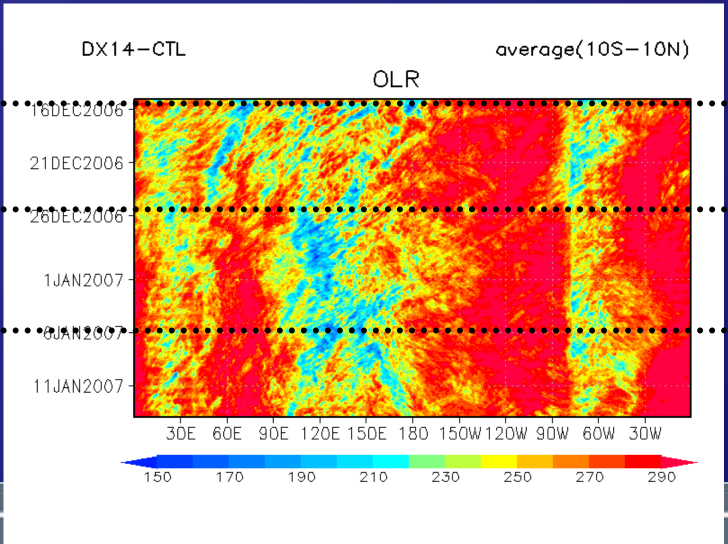
CTL (Control) | **1210**

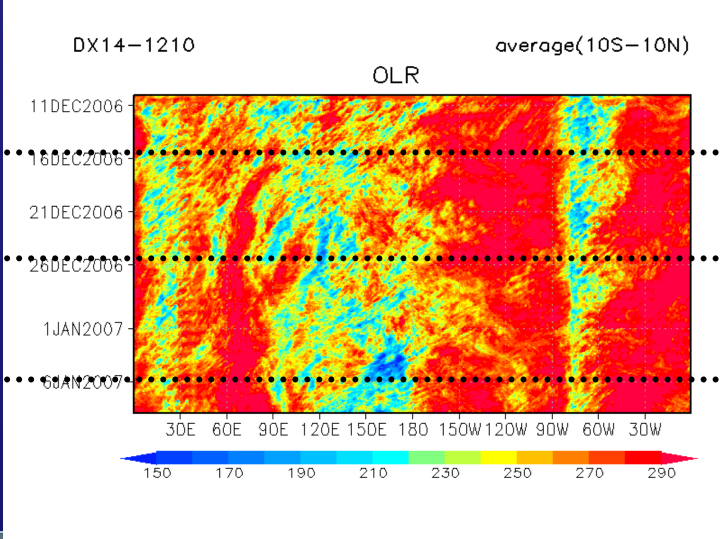
Zonal wind: lat=0





Outgoing long-wave radiation: lat=10S-10N

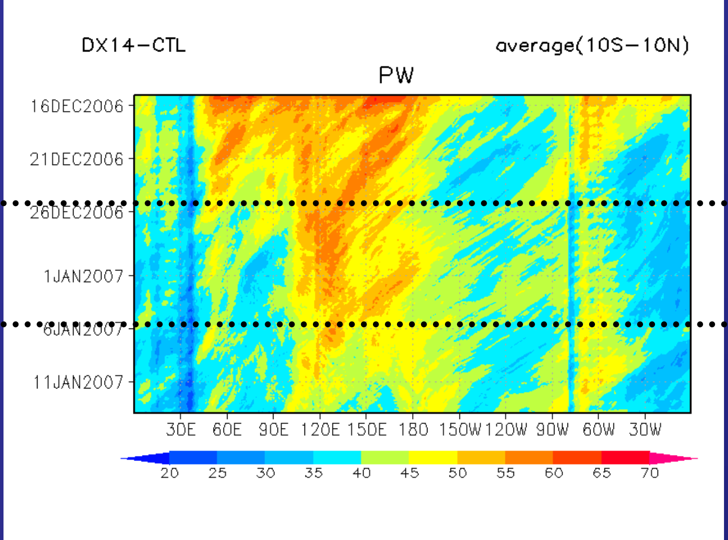




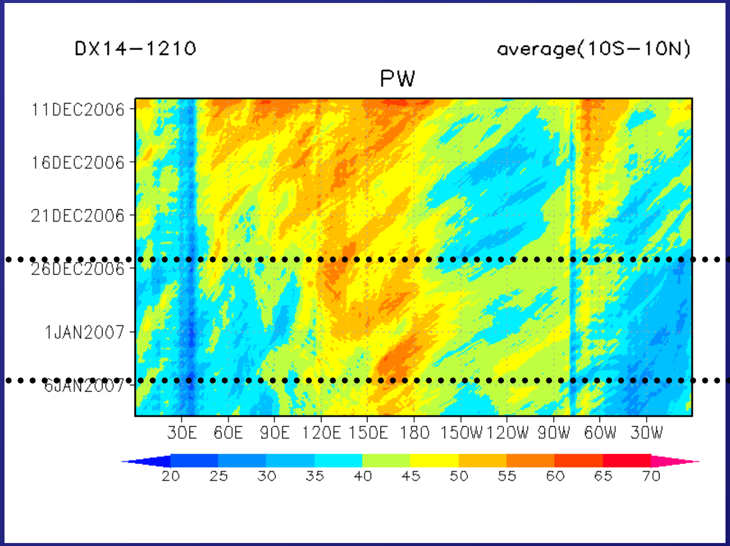
Test-2

Precipitable water: lat=10S-10N

CTL (Control)



1210



- Convective activity over the maritime continents in 1210 was enhanced at the same timing as in CTL.
- However, eastward movement was faster in 1210 than in CTL.
- There were smaller amount of moisture over the maritime continents.

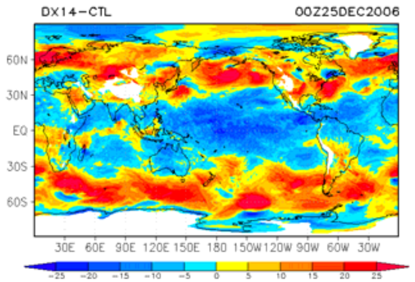
Test-3: Influence of topography

TOPO0: Topographic height was zero over the globe.

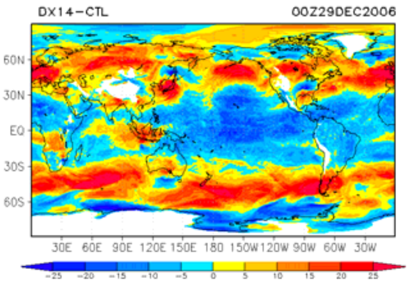
Time change of zonal wind: z=1570 m

CTL (control)

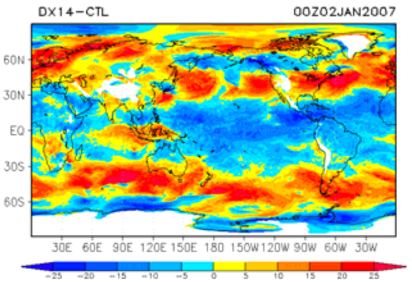
2006-12-25



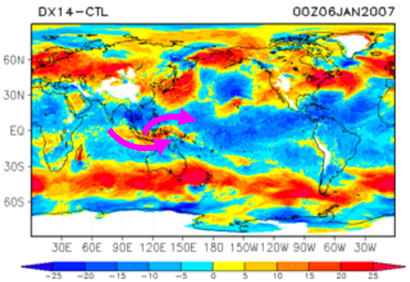
2006-12-29



2007-01-02

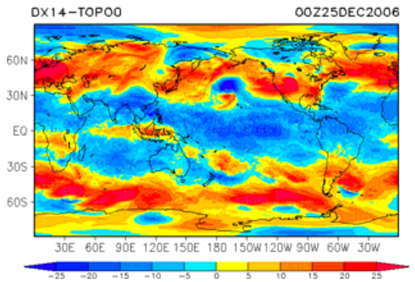


2007-01-06

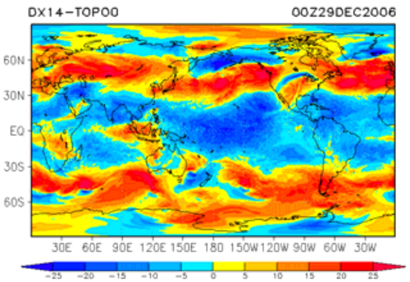


TOPO0

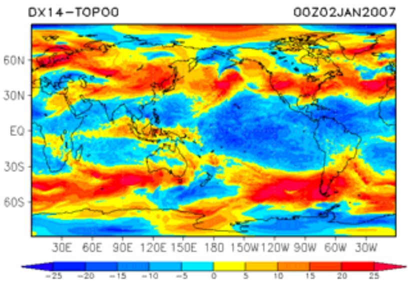
2006-12-25



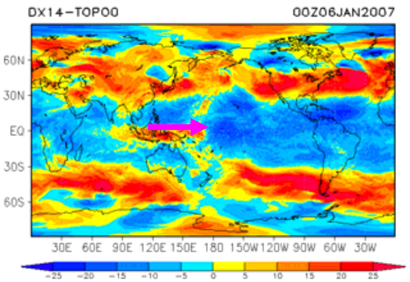
2006-12-29



2007-01-02



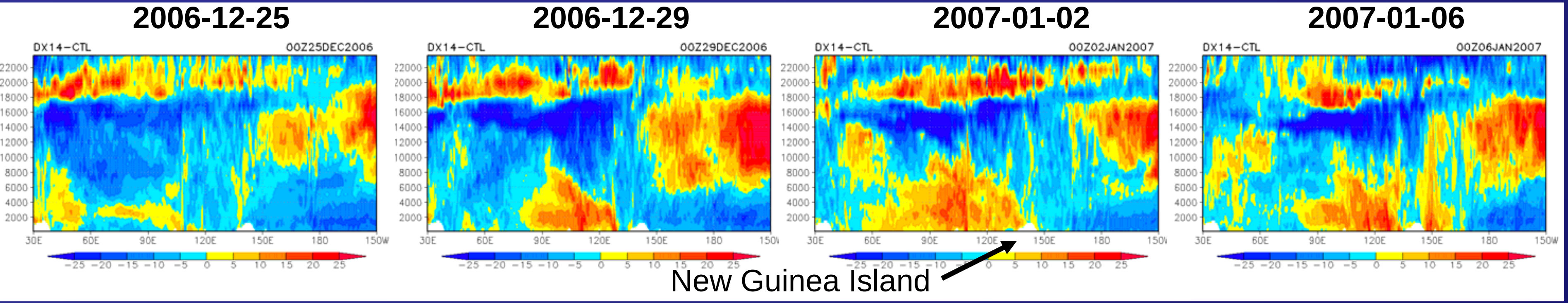
2007-01-06



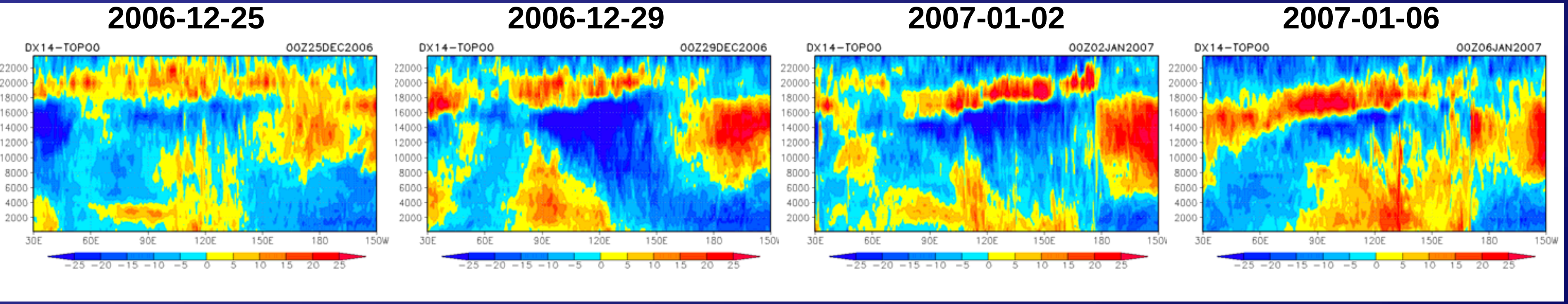
Test-3

Time change of zonal wind: lat=-5

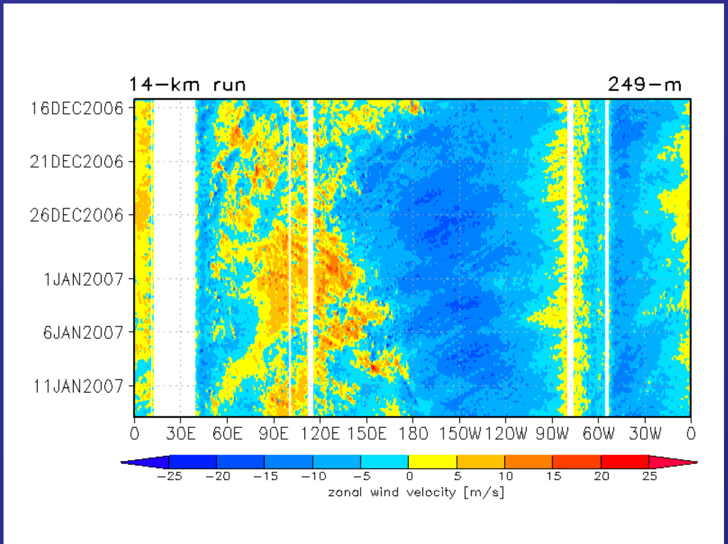
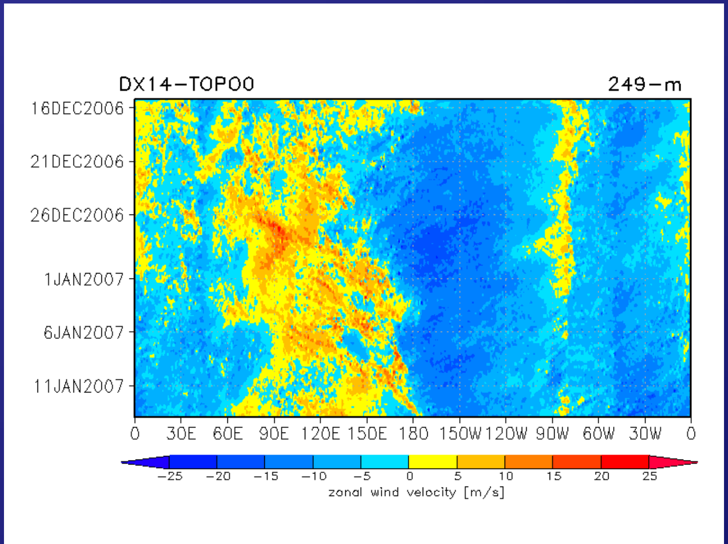
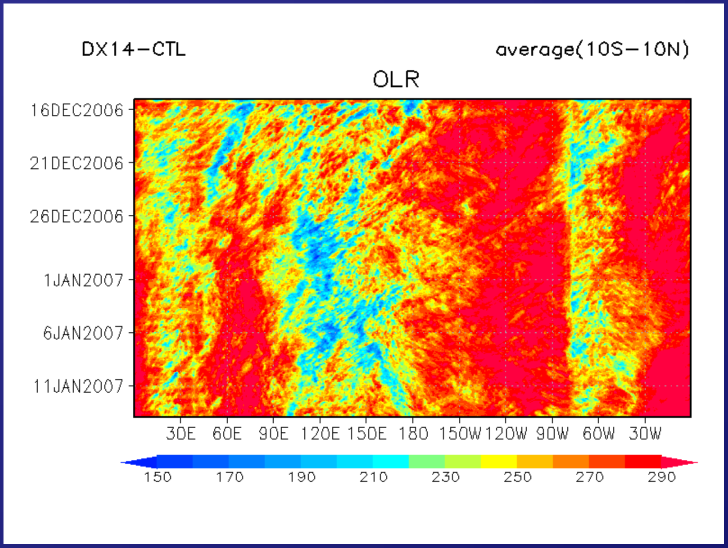
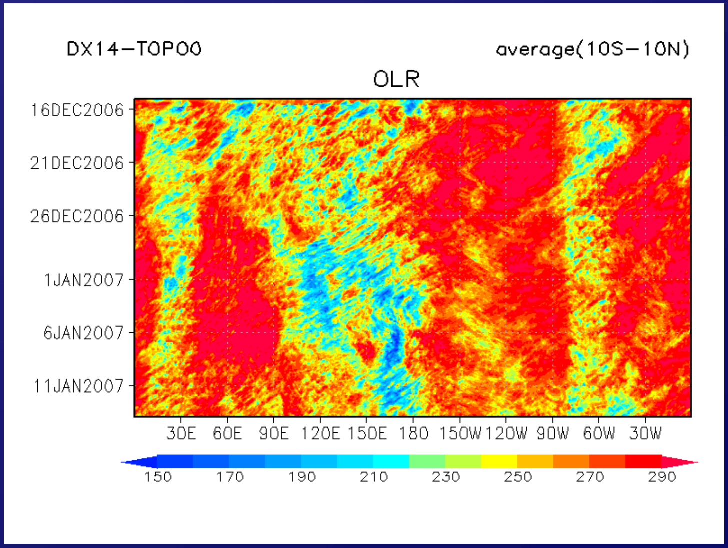
CTL (control)



TOPO0



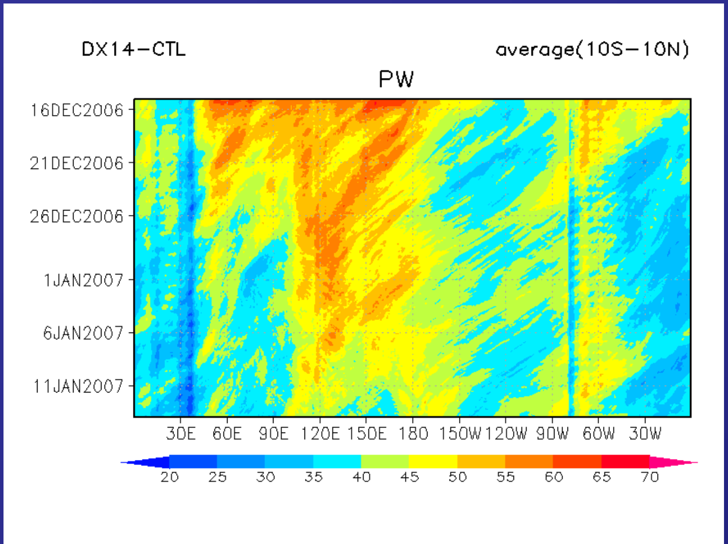
Test-3

	Control	TOPO0
Zonal wind: lat=0		
Outgoing long-wave radiation: lat=10S-10N		

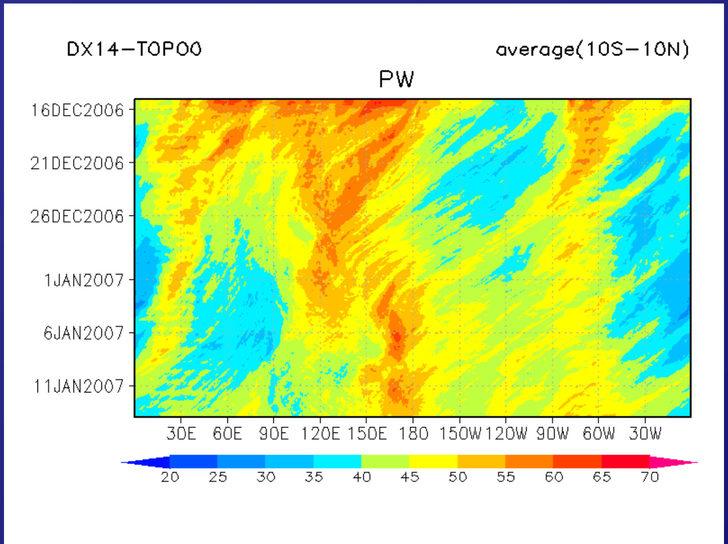
Test-3

Precipitable water: lat=10S-10N

Control



TOPO0



- The eastward moving signal (OLR) was separated into two signals in TOPO0.
- A fast propagating signal (~15 m/s) and a localized signal (at 120E).
- The fast propagating signal in CTL was apparently blocked by topography.
- Influence of mid-latitude signals seemed small, but it is not confirmed now.

Test-4: Influence of land surface

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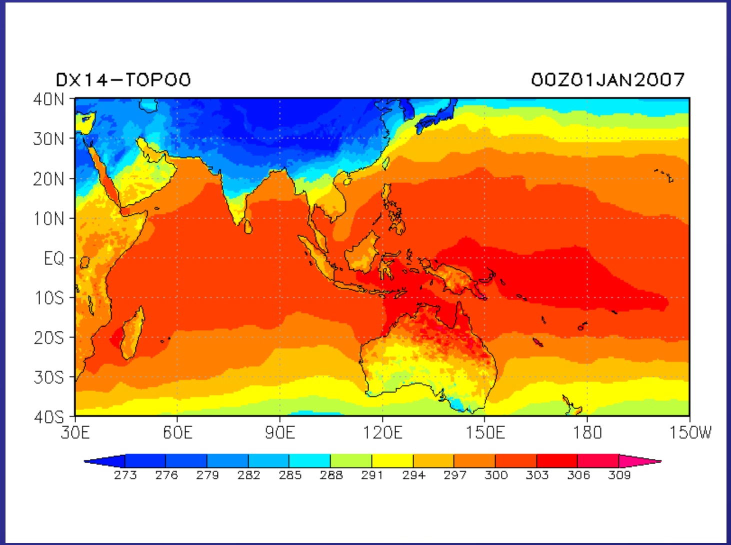
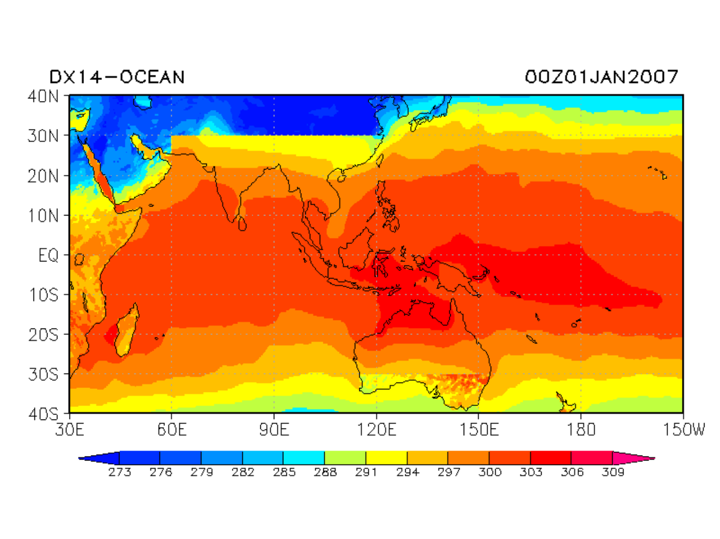
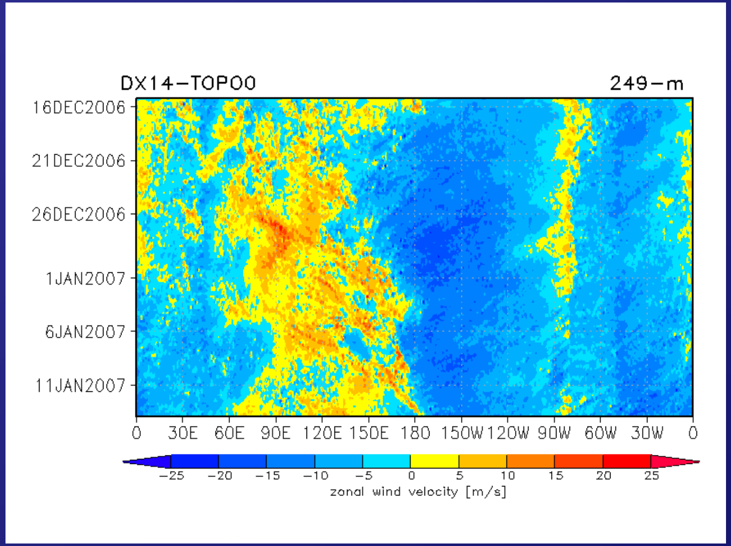
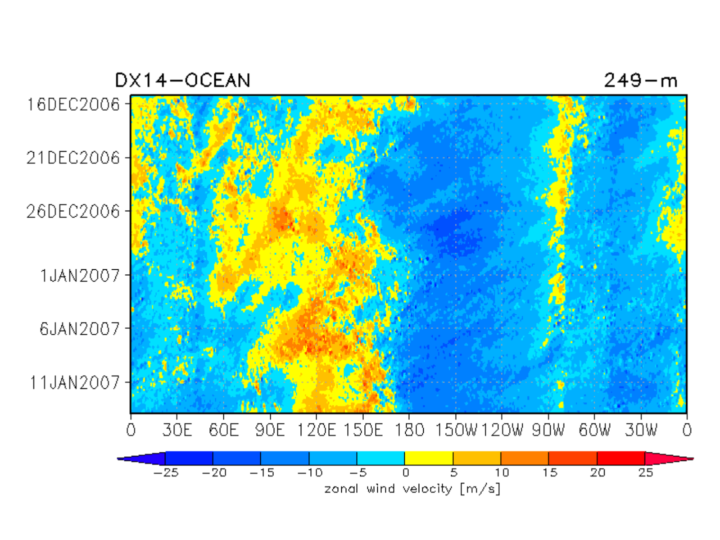
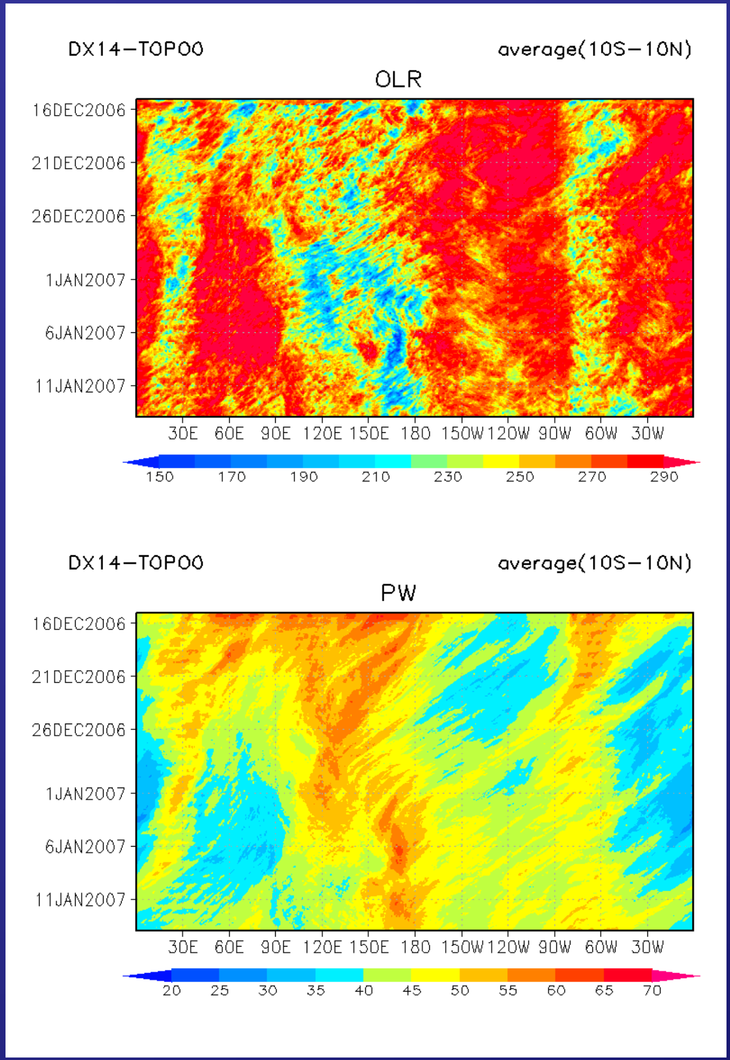
OCEAN: TOPO0+surface condition was ocean over 30S-30N and 60E-180.

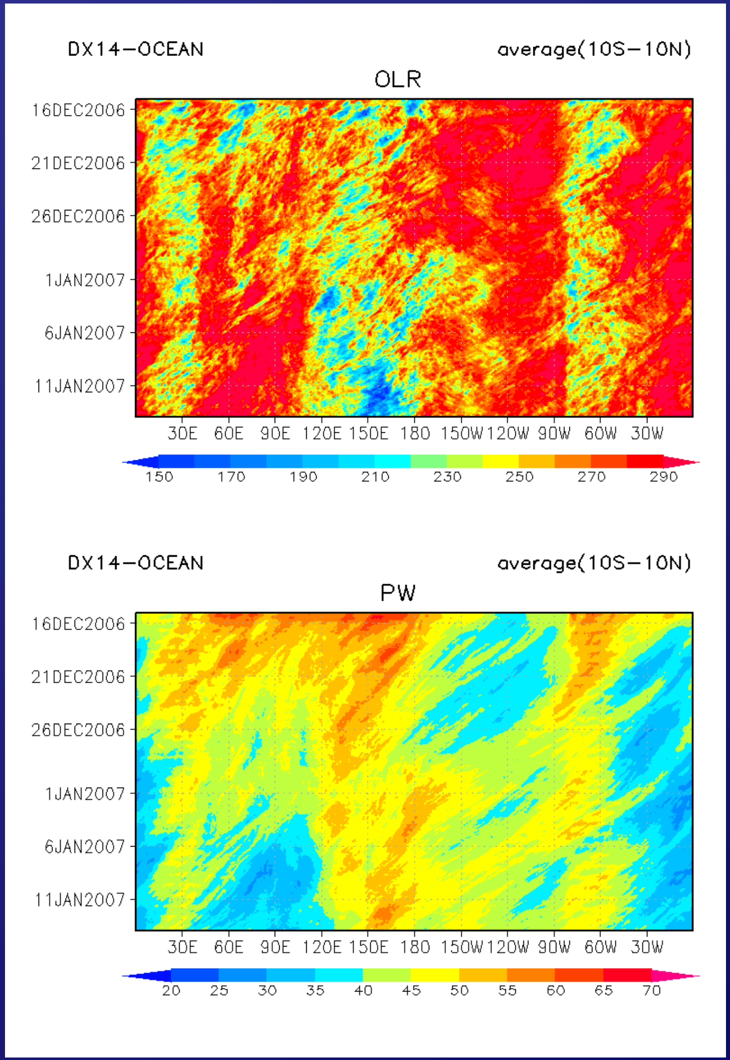
	CTL (Control)	OCEAN
Surface temperature: 2007-01-01		
Zonal wind: lat=0		

Test-4

CTL (Control)



OCEAN



Outgoing long-wave radiation: lat=10S-10N

Precipitable water: lat=10S-10N

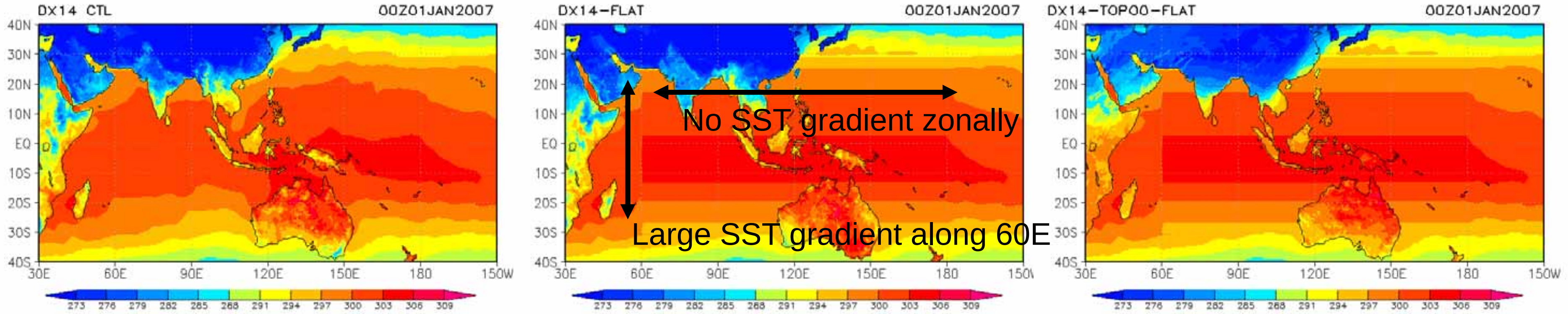
- Land surface (surface heating) seemed to help fast organization of convection.

Test-5: Influence of zonal SST gradient

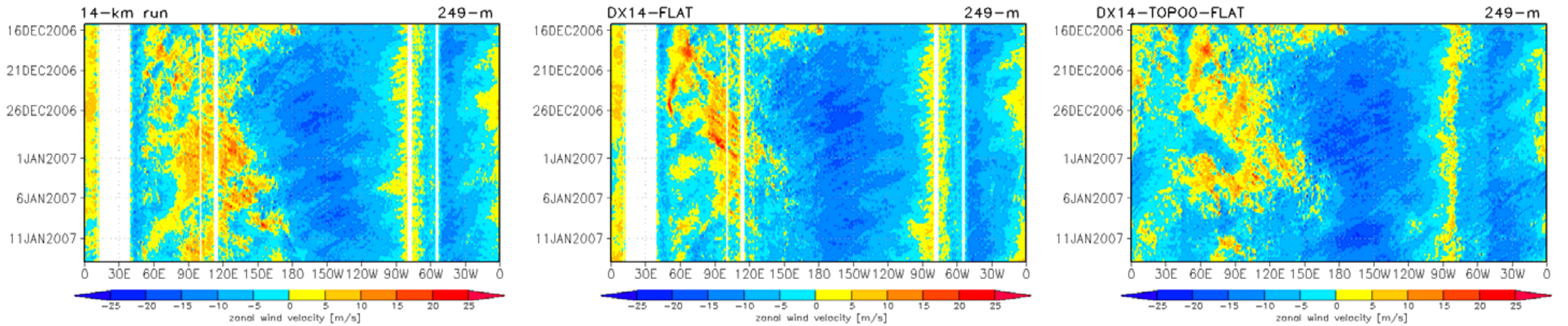
FLAT: SST over 30S-30N and 60E-180 was the same as SST of lon=180.

CTL (Control) | **FLAT** | **TOPO0-FLAT**

Surface temperature: 2007-01-01



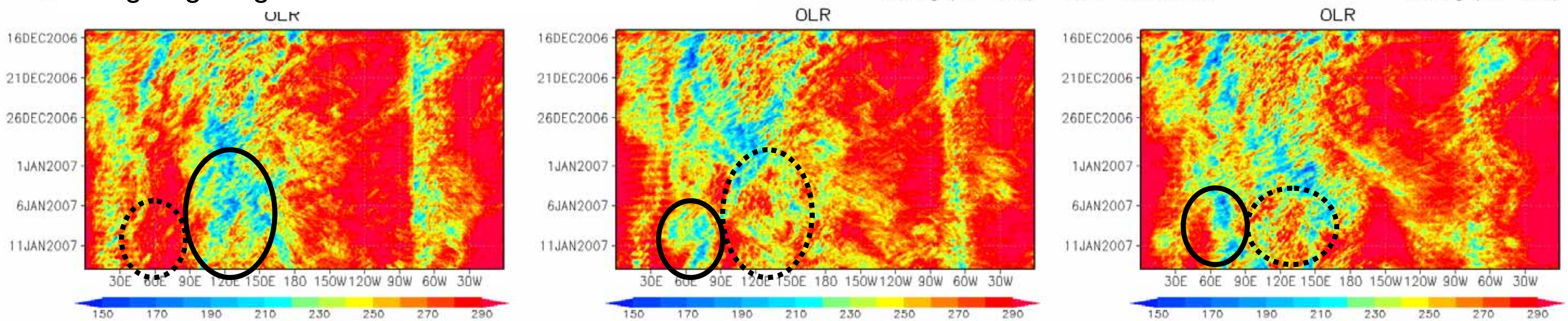
Zonal wind: lat=0



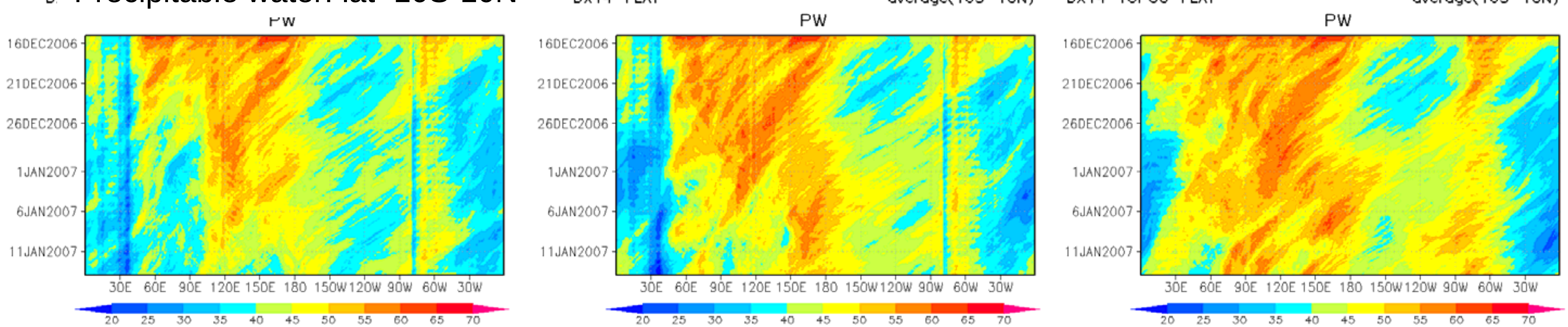
Test-5

CTL (Control) | **FLAT** | **TOPO0-FLAT**

Outgoing long-wave radiation: lat=10S-10N



Precipitable water: lat=10S-10N



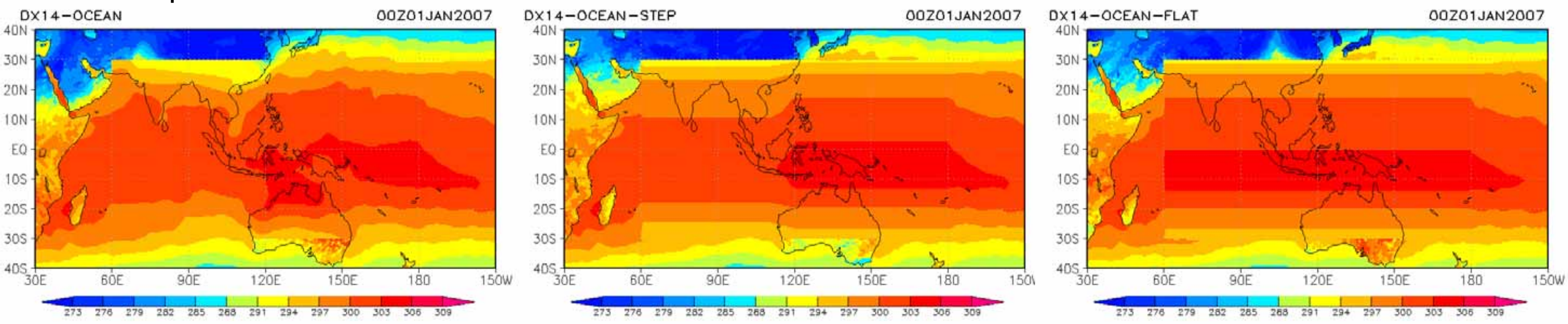
- Convection over the maritime continents was not maintained in FLAT cases.
  - Moisture passed through over the maritime continents.
  - Convection was enhanced around 60E in FLAT cases.
- A eastward propagating signal in TOPO0-FLAT was likely a single wave.

Test-5

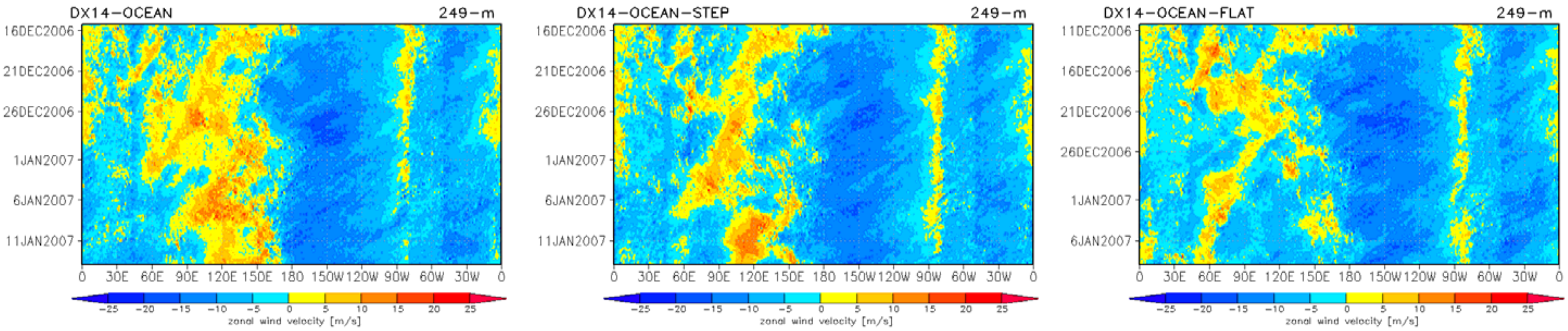
STEP: SST was 1 K cooler than SST of FLAT over 30S-30N and 60E-110E. SST(110E<lon<120E) was interpolated zonally and linearly.

OCEAN | **OCEAN-STEP** | **OCEAN-FLAT**

Surface temperature: 2007-01-01

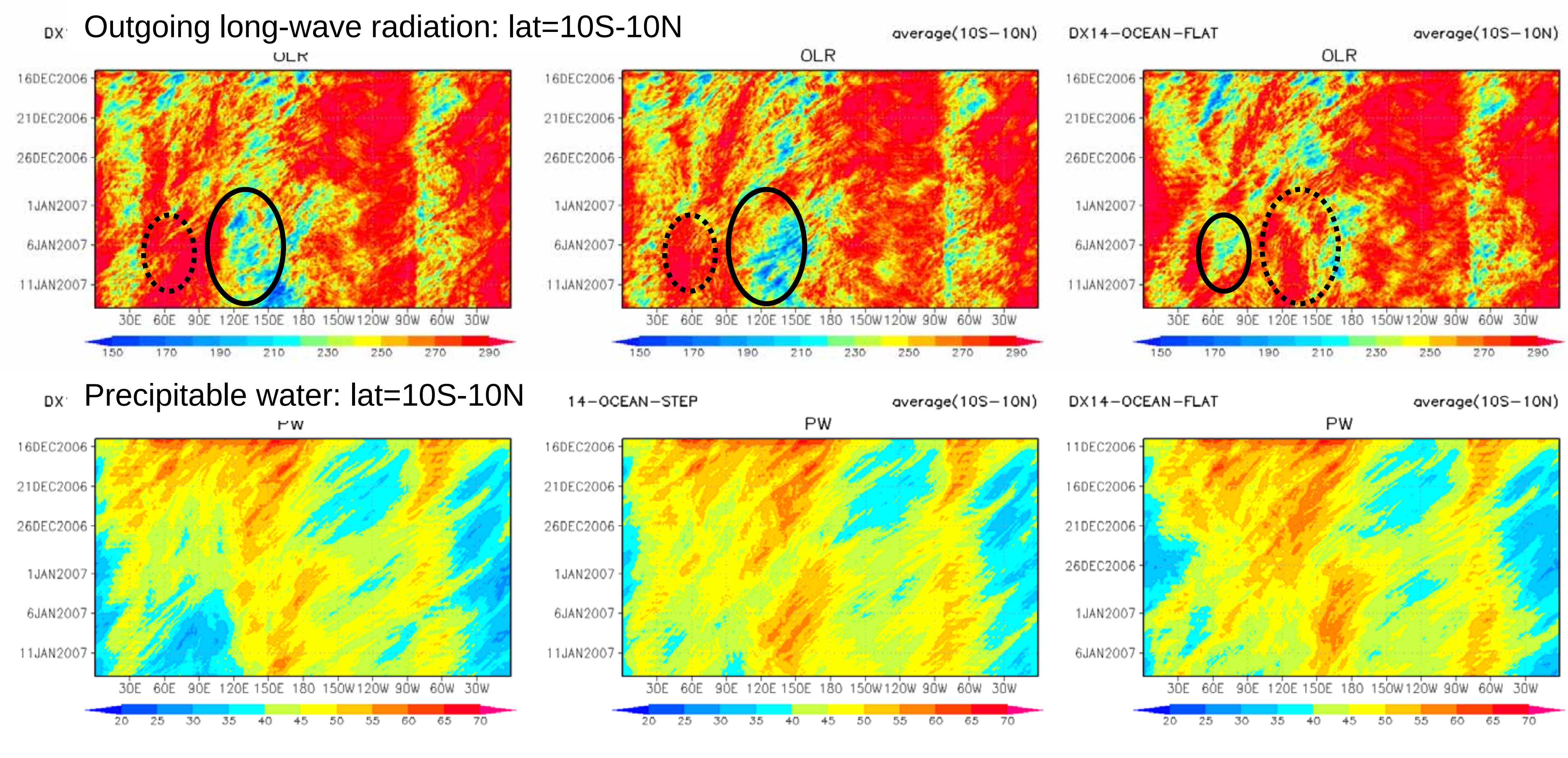


Zonal wind: lat=0



Test-5

OCEAN | **OCEAN-STEP** | **OCEAN-FLAT**



- Convection over the maritime continents was maintained in OCEAN-STEP, but it was not simulated in OCEAN-FLAT.
- Which is important?
  - local equilibrium, meso-scale circulation, and lifting of warmer air over cooler air.

Summary

- <u>Some sensitivity tests were done using a 14-km grid.</u>
- <u>Influence of SST variation</u>
  - The SST feedback was not essential for the slow eastward movement of the MJO at least in this event.
- <u>Influence of topography</u>
  - There was a westerly signal which proceeded over the maritime continents at the end of 2006.
  - The westerly signal seemed to be blocked by topography.
  - And, the other westerly signals took over a role in the eastward movement of the MJO.
- <u>Influence of zonal SST gradient</u>
  - Convective activity over the maritime continents could not be maintained without zonal SST gradient.
  - Convection was forced around the region where zonal SST gradient was large.