NICAM simulations on ISV and TCs

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Group web page http://nicam.jp

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(社)日本気象学会
気象集誌

Cyclone Nargis made landfall in southern Myanmar on 2 May 2008

with winds in excess of 65 ms^{-1}, with 600 mm total rainfall, plays havoc with Irrawaddy delta

http://www.nasa.gov/mission_pages/hurricanes/archives/2008/h2008_nargis.html）

Planned Newsletter (No. 92) Section A---Cyclone Nargis and its simulation.
” Because, the special issue of JMSJ has been published, and also many related papers appeared in GRL, I feel a need of discussion with you what will be the best way to proceed. I still feel Taniguchi et al. should be the lead article. But some adjustment may be desired. I welcome your counter proposals. “ by Prof. Yanai,4th Oct. , 2010

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Special Edition on the Myanmar Cyclone, Vol. 88, No. 3, 2010
http://www.jstage.jst.go.jp/browse/jmsj/88/3/ contents

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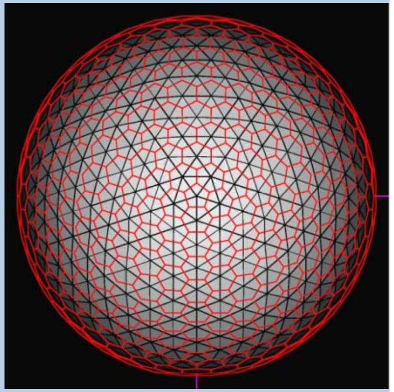
  - **MJO Dec.2006 (Miura et al. 2007,Science)**
  - **MISMO: Nov.2006 (Miura et al. 2009,GRL)**
  - **BoB: Apr. 2008, Myanmar cyclone & Boreal summer ISV (Taniguchi et al. 2010,JMSJ)**
- **NICAM quasi real time forecast**
  - **Collaboration with field observation: PALAU2010**

NICAM

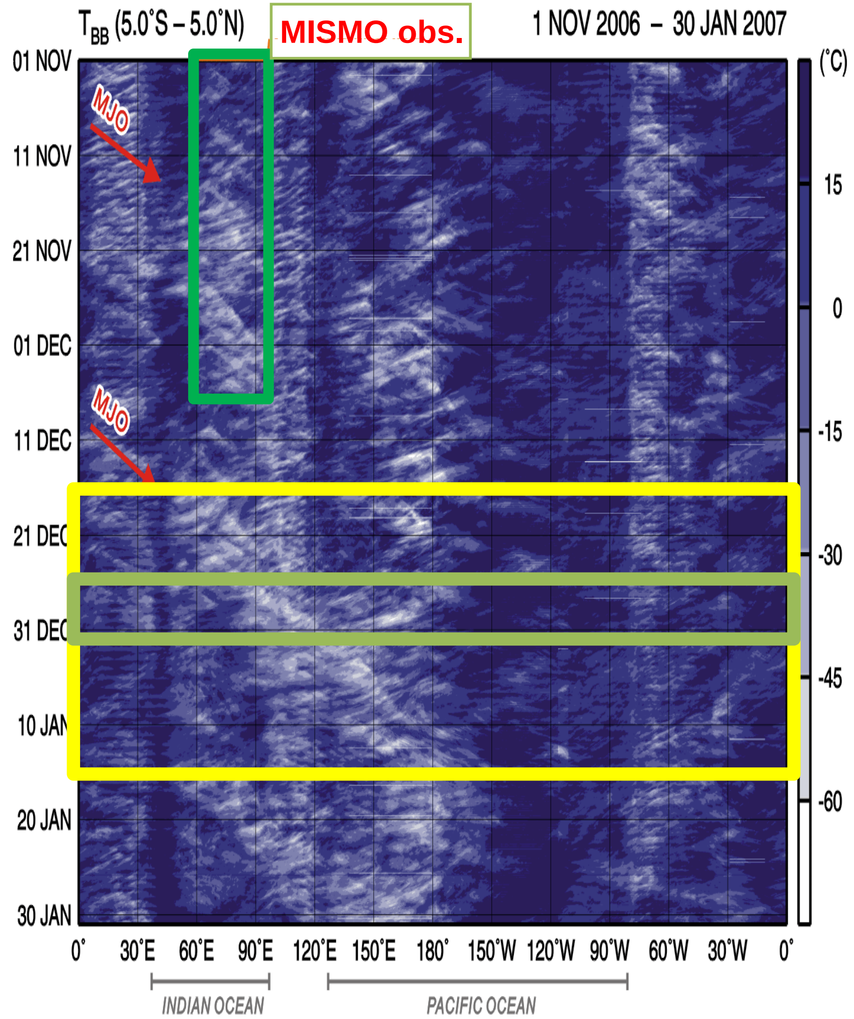
- Nonhydrostatic Icosahedarl Atmospheric Model
  - Development since 2000
    - Tomita and Satoh(2005, *Fluid Dyn. Res.*), Satoh et al.(2008, *J. Comp. Phys.*)
  - First global dx=3.5km run in 2004: Tomita et al.(2005, *Geophys. Res. Lett.*)
- Icosahedral grid
  - Spring dynamics smoothing, Second order accuracy
    - Tomita et al.(2001, *J. Comp. Phys.*), Tomita et al.(2002, *J. Comp. Phys.*)
- Flux-form conservative nonhydrostatic scheme
  - Split-explicit time integration, Mass, total energy & momentum conserving
    - Satoh (2002, *Mon. Wea. Rev.*), Satoh (2003, *Mon. Wea. Rev.*)



Initialization	**NCEP Global analysis on 00Z Jun 01, 2004**
Ocean mixed layer	**None (prescribed SST) / slab ocean – heat balance**
Land-surface	**Bucket / MATSIRO , Weekly Reynolds SST**
Horizontal resolution	**3.5, 7. 14km**
Vertical resolution	**40 levels (0 – 38,000 m; interval; 80 m - 2.9km)**
Cloud microphysics	**Grabowski (1998) / NSW6 (Tomita 2009)**
Turbulence **(Noda et al. 2010)**	**Improved version of Mellor-Yamada Level 2 (e.g., Nakanishi & Niino 2004; Mellor and Yamada 1982) , MYNN2.5, MYNN3 are also testing**
Surface flux	**Bulk parameterization by Louis (1979); Moon et al. (2007) & Fairall et al. (2003)**
Radiation	**MSTRNX (Sekiguchi and Nakajima, 2008)**
Integration period	**Dec 15, 2006-Jan 15, 2007: OLD; June – Oct, 2004: OLD, NEW**

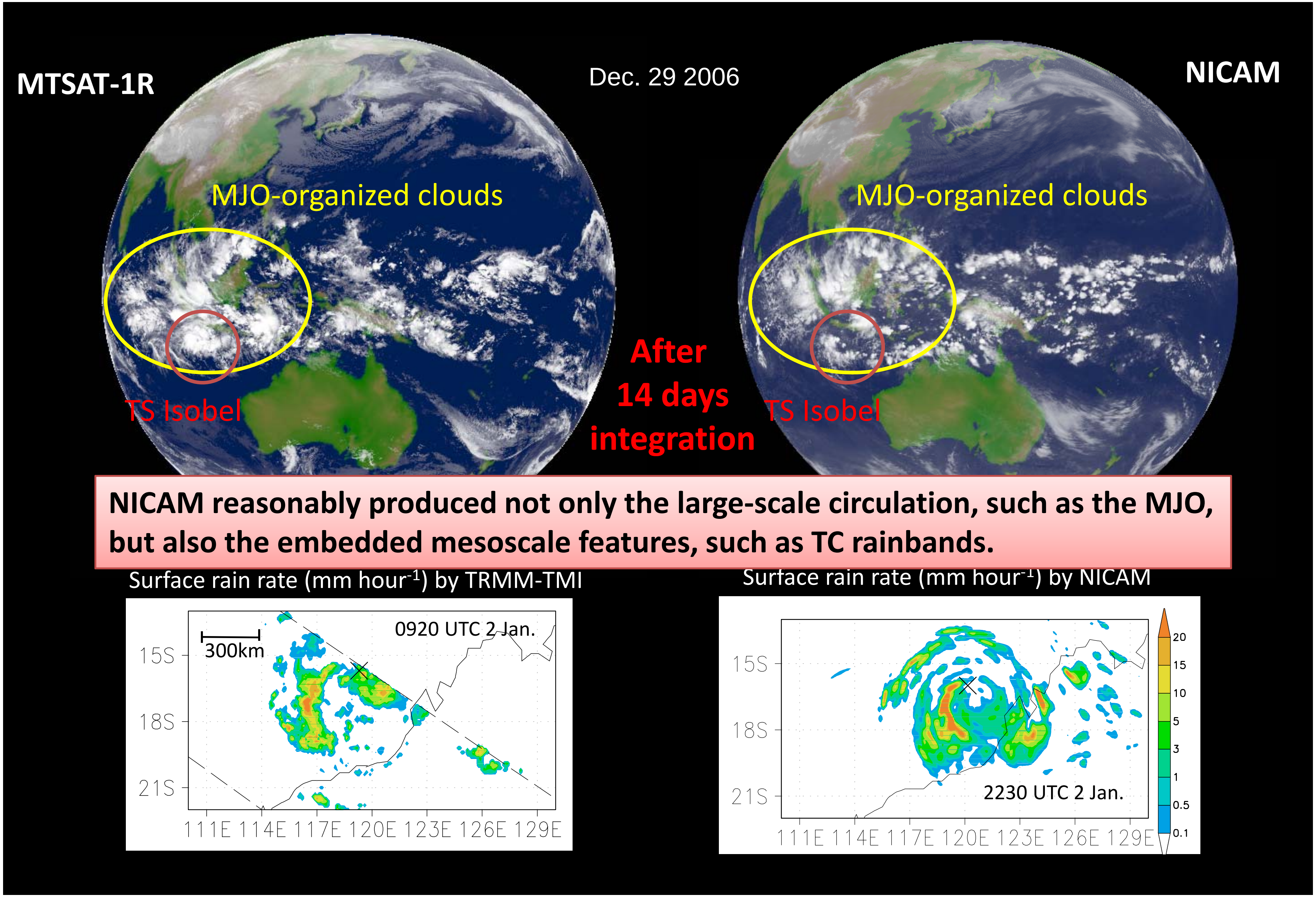
2006 boreal Winter MJO hindcasts

Horizontal grid spacing: 14 km, 7 km, 3.5 km
Vertical domain:
0 m ~ 38,000 m 40-levels (stretching grid)
Integration:
7km, 14km runs: 30 days from 15 Dec 2006
7km, 14km runs: 30 days from 1 Nov 2006
3.5km run: 7 days from 25 Dec 2006
Initial conditions:
Interpolated from NCEP final analysis
(6 hourly, 1.0x1.0 degree grids)
Boundary conditions:
Reynolds SST, Sea ICE (weekly data)
ETOPO-5 topography
Matthews vegetation
UGAMP ozone climatology (for AMPI2)



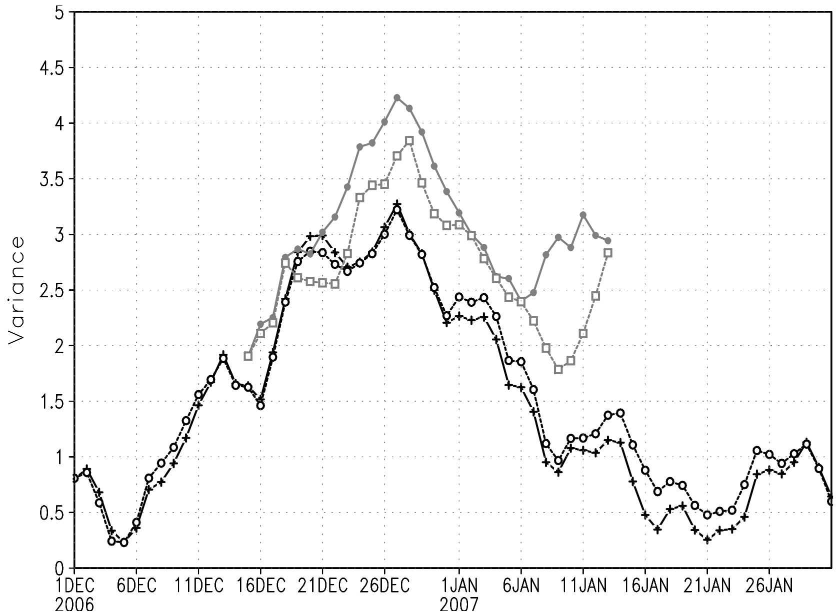
- EXP. Dec 2006: Miura et al.(2007,Science), Nasuno et al.(2009,JMSJ),
- Fudeyasu et al. (2009, GRL), Liu et al. (2009, MWR), Sato et al. (2009, J.Clim)
- EXP. Nov. 2006 (MISMO): Miura et al. (2009, GRL)

Fudeyasu, H., Wang, Y., Satoh, M., et al. (2008) The global cloud-resolving model NICAM successfully simulated the lifecycles of two real tropical cyclones. Geophys. Res. Lett., 35, L22808.



Liu, P. et al. (2009), Mon. Wea. Rev.

MJO index



Phase diagram

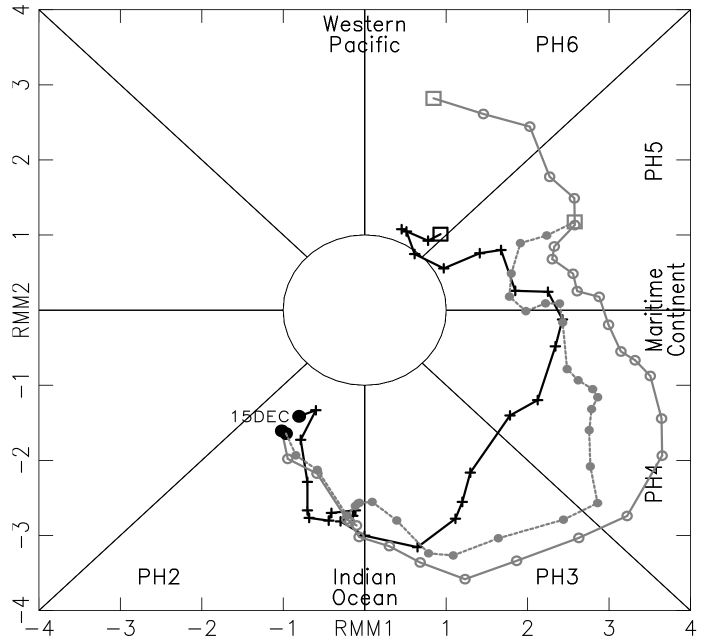
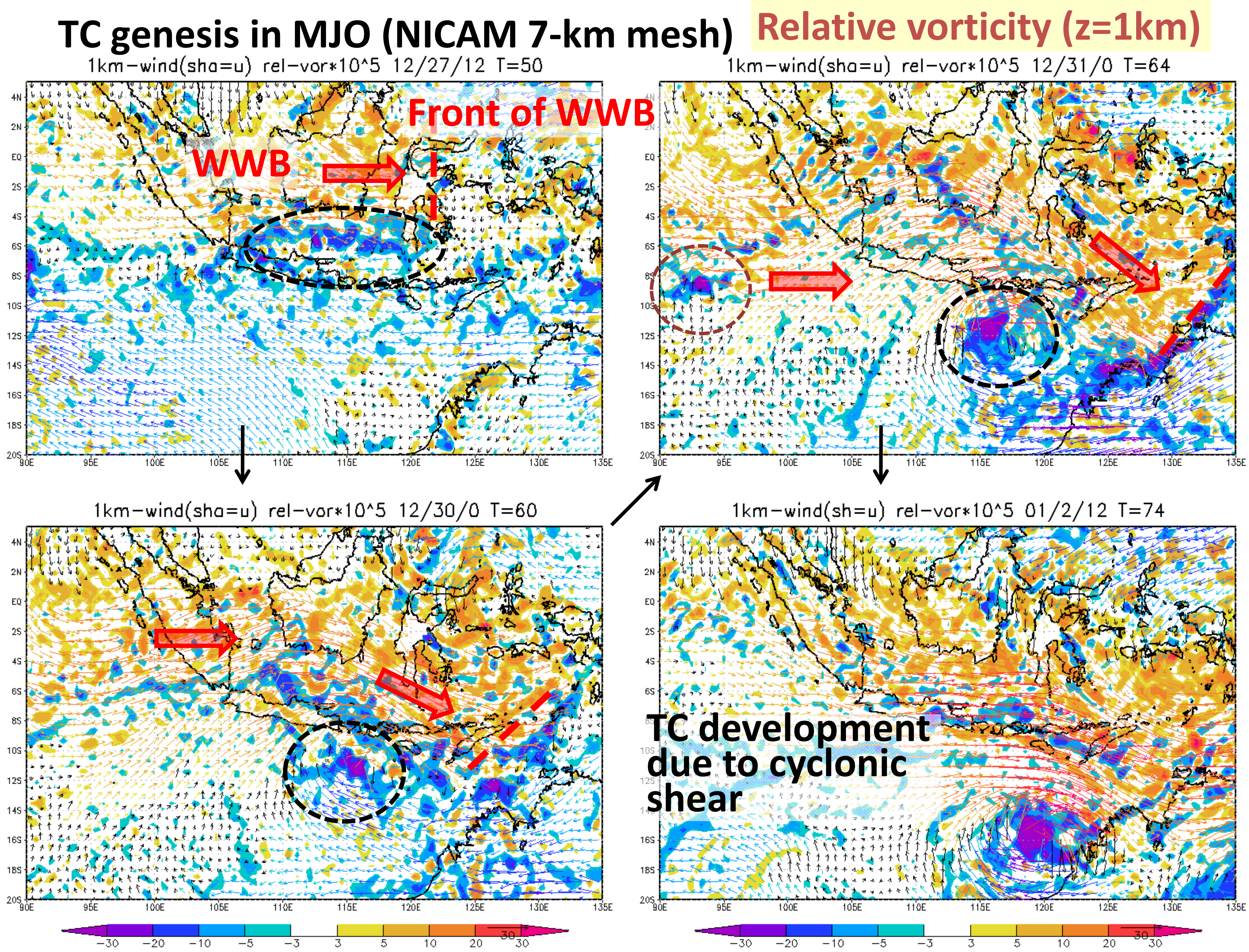


Fig. 3 Evolution of the MJO event in amplitude represented by $(RMM1^2 + RMM2^2)^{1/2}$. The black-solid curve is derived using the anomalous fields described in WH04; others use simple anomalies by excluding the observed climatology for observations (black-dashed), the 14-km NICAM (gray-solid), and the 7-km NICAM (gray-dashed).

Fig. 4 RMM diagram for the MJO event in observations (black-solid), the 14-km NICAM (gray-solid) and the 7-km NICAM (gray-dashed).

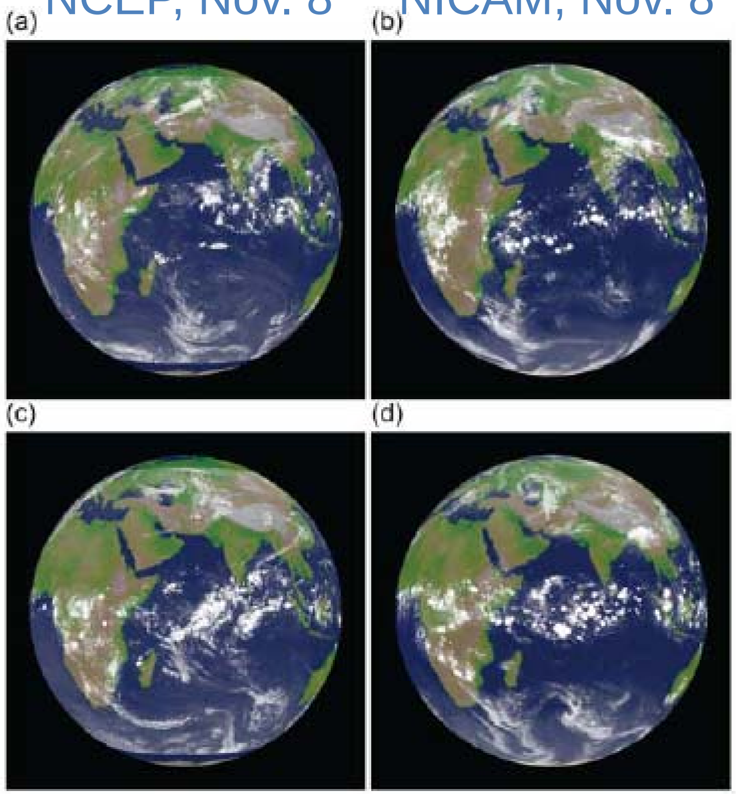
TC genesis in MJO (NICAM 7-km mesh)



MISMO simulation (Nov 2006)

OLR

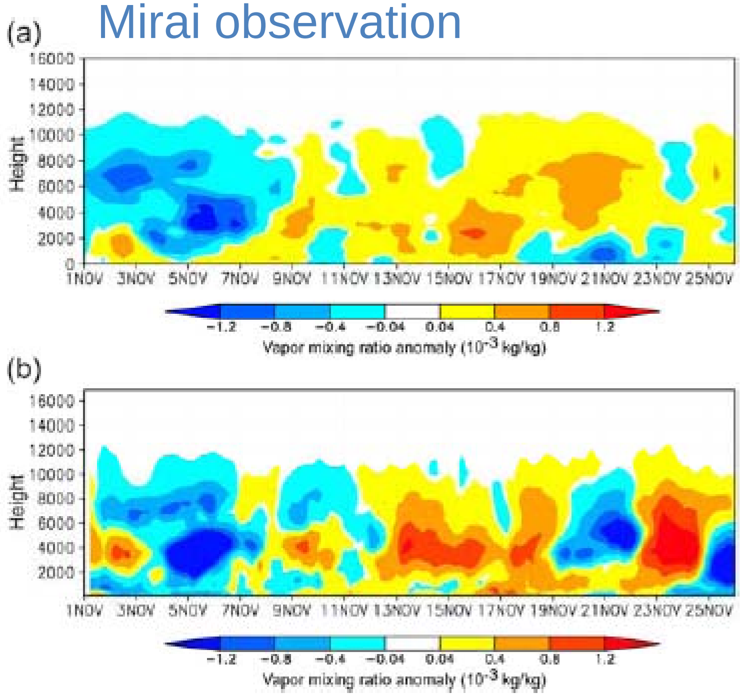
NCEP, Nov. 8 NICAM, Nov. 8



NCEP, Nov. 17 NICAM, Nov. 17

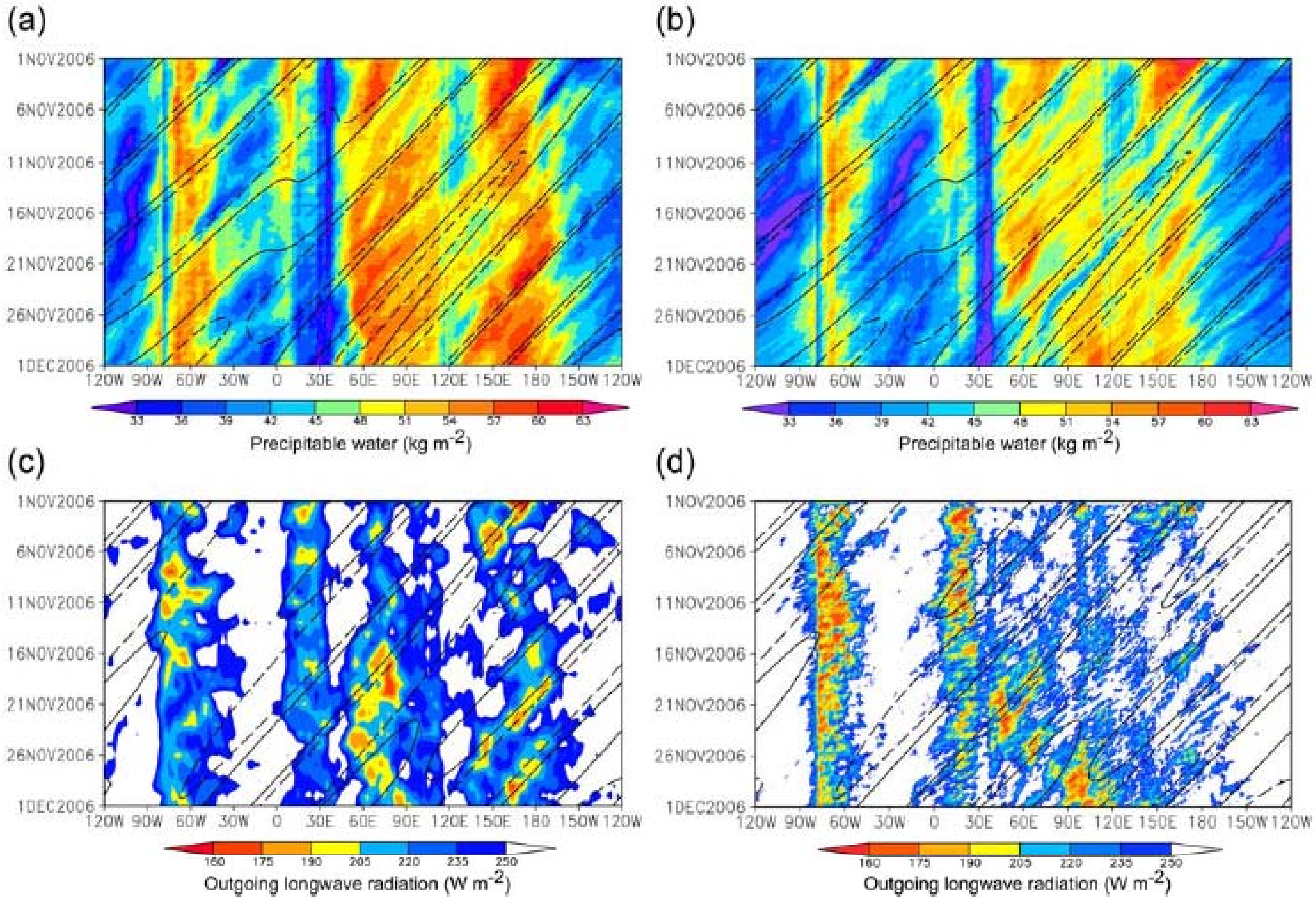
Vapor mixing ratio

Mirai observation



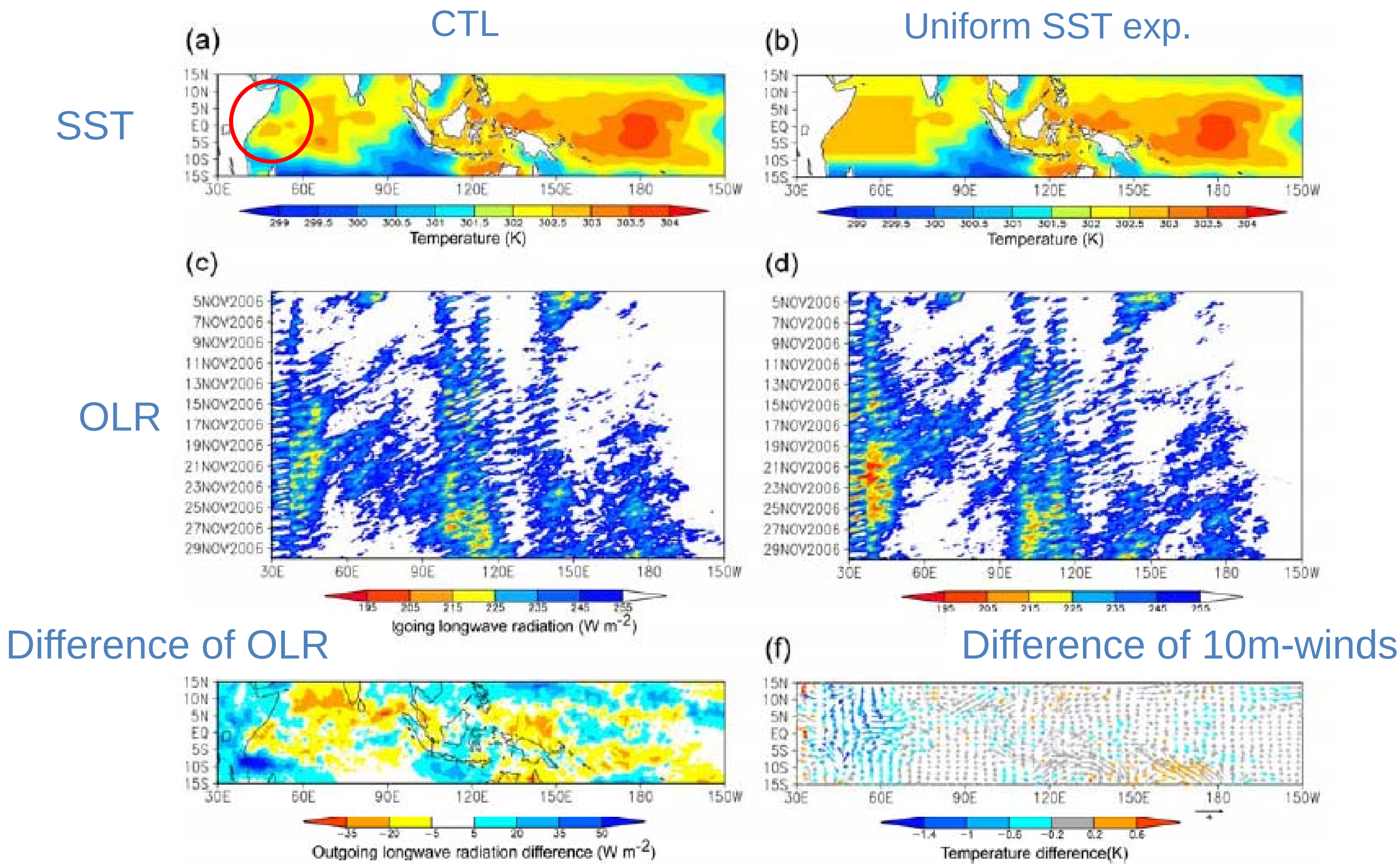
NICAM simulation
1S-3N, 73-80E

Miura et al. (2009, GRL)



Proposed mechanisms:

1. Rossby waves' meridional winds



Proposed mechanisms:

2. SST lower-variation in the west of the Indian Ocean maintains accumulation of convection

TC Nargis ensemble simulation

Taniguchi et al. (2010), JMSJ special edition on the Myanmar Cyclone, in press

Horizontal mesh size: **14 km**

Vertical mesh size: 0 m ~ 38,000 m

（40 layer, stretching grid ）

Integration: **30-days**

http://www.nasa.gov/mission_pages/hurricanes/archives/2008/h2008_nargis.html）

Initial condition:

linear interpolation from **JMA GPV/GSM data** (every 6hr, 0.5x0.5grid)

initial time: **1200UTC, 10, 23, 24, 25, 26, 27, 28, Apr 2008**

(7 control run without any perturbation:

Lagged Average Forecasting (LAF) method, Hoffman and Kalnay, 1993)

without any nudging process (Nargis formed on **27 Apr 2008**)

Boundary condition:

weekly Reynolds-SST , Sea ICE

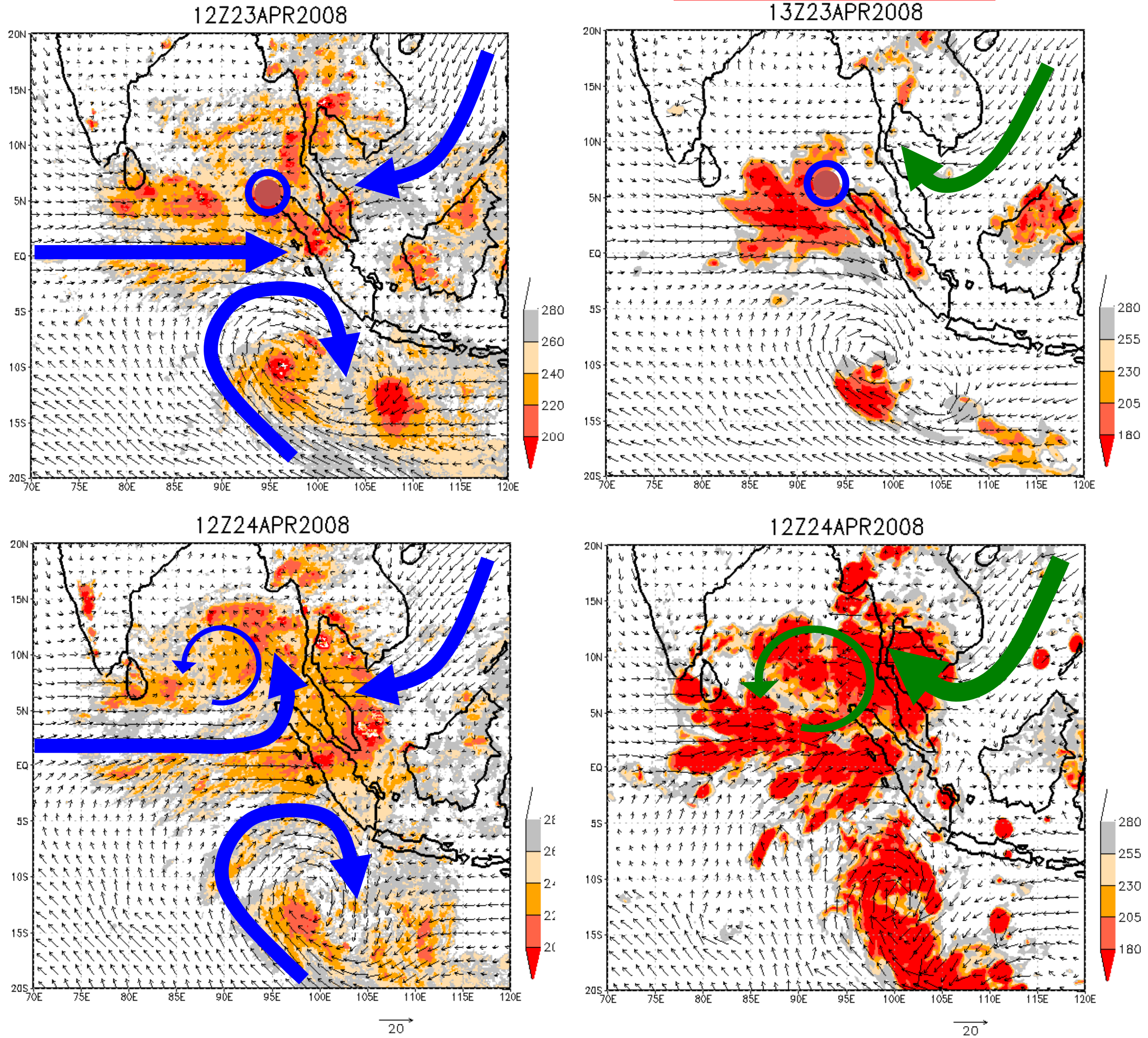
ETOPO-5 topography, Matthews vegetation

UGAMP ozone climatology (AMIP2)

Taniguchi et al. (2010), J. Meteor. Soc. Japan

Incipient disturbances for cyclone Nargis: U10m & OLR (IR)

Obs. **NICAM : 4/23**



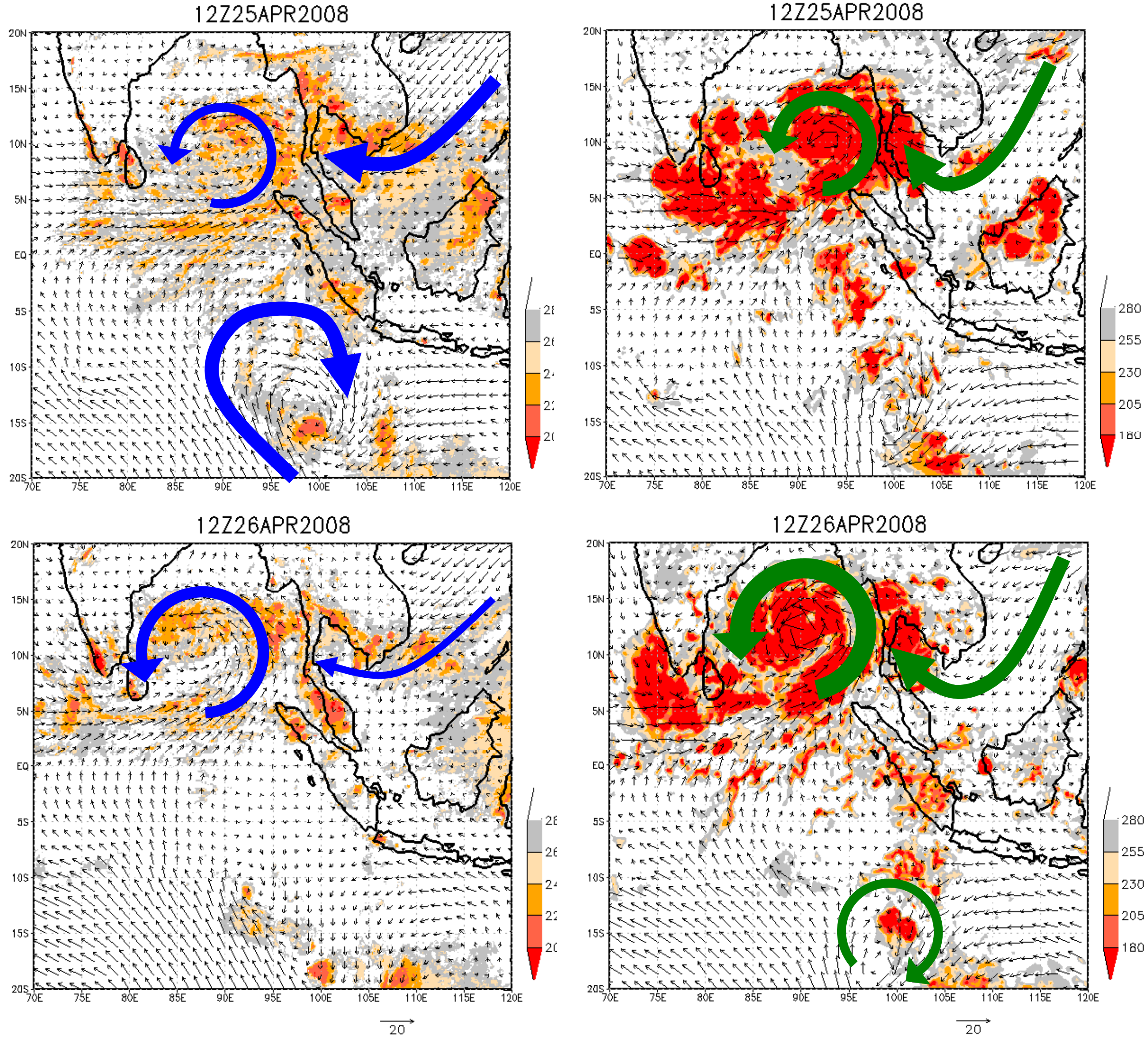
- **WWB**
- **Cyclonic eddy in SIO**
- **Wind from the South China Sea**
- **A weak cyclonic circulation**

- **Northward migration of WWB**
- **Cyclonic eddy in NIO**
- **Wind from the South China Sea**

Taniguchi et al. (2010), J. Meteor. Soc. Japan

Incipient disturbances for cyclone Nargis

Obs. **NICAM : 4/23**

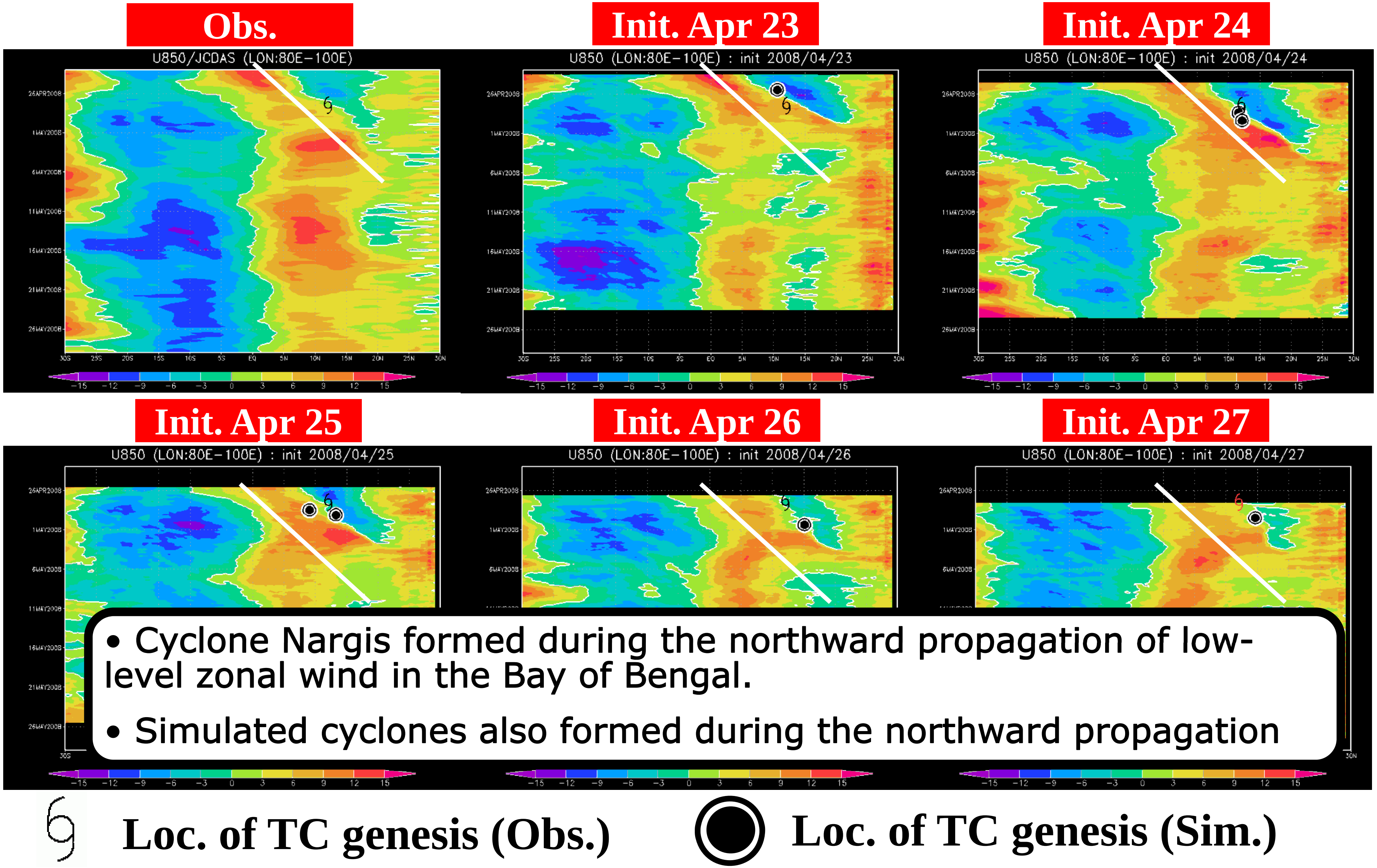


- **Northward migration of Cyclonic eddy in NIO**
- **Wind from the South China Sea**

- **Northward migration of Cyclonic eddy in NIO**
- **northward movement of northern vortex and its cyclonic circulation development**

Taniguchi et al. (2010), J. Meteor. Soc. Japan

U850 (Averaged: 80E-100E)

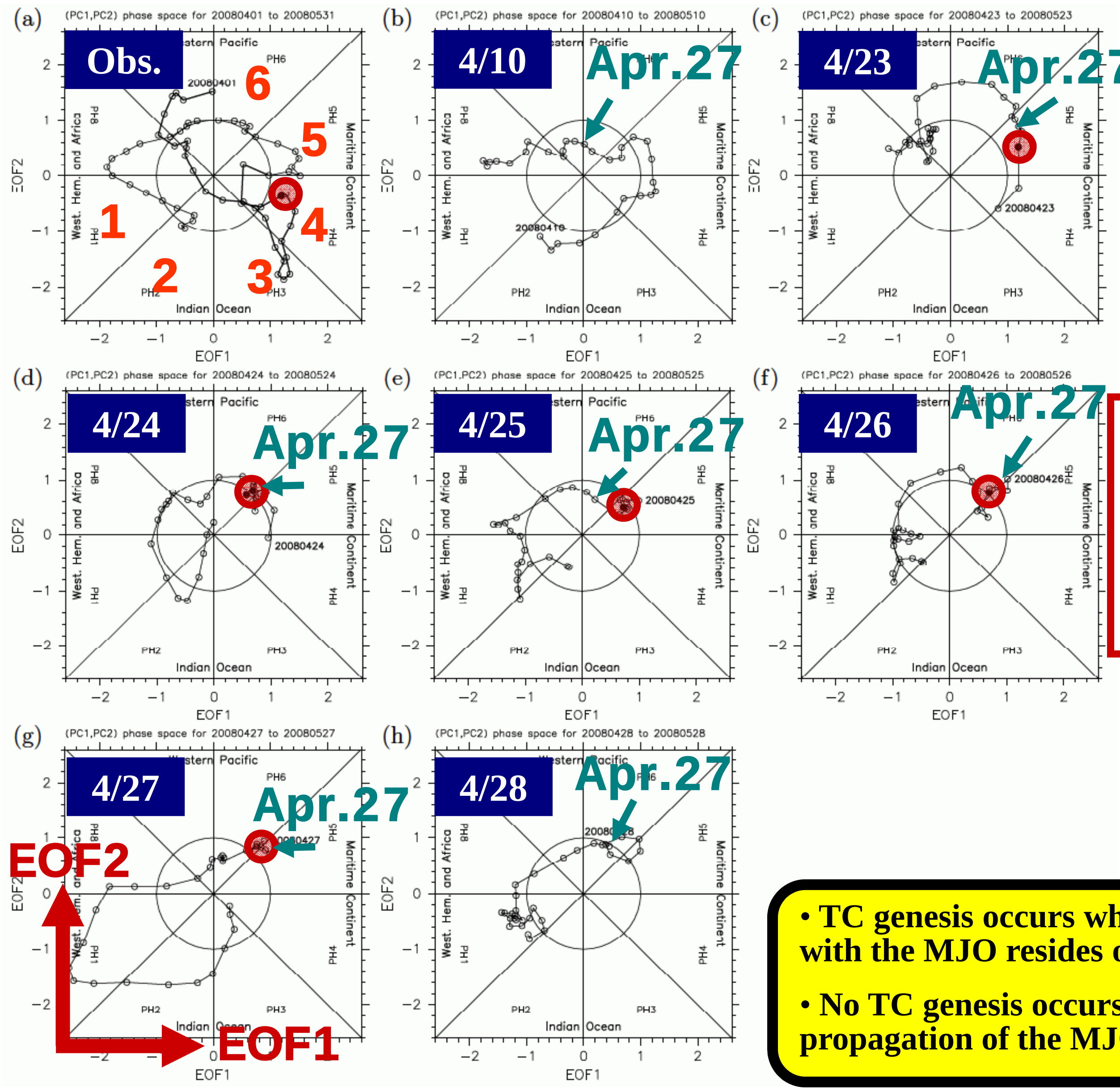


- Cyclone Nargis formed during the northward propagation of low-level zonal wind in the Bay of Bengal.
- Simulated cyclones also formed during the northward propagation

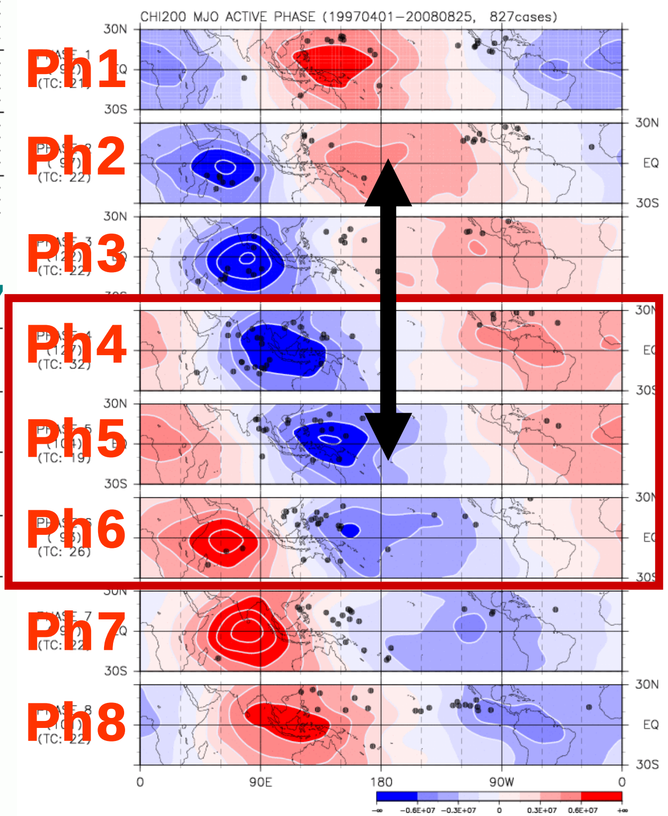
Taniguchi et al. (2010), J. Meteor. Soc. Japan

MJO phase: (a) observed, (b-h) simulated

TC genesis

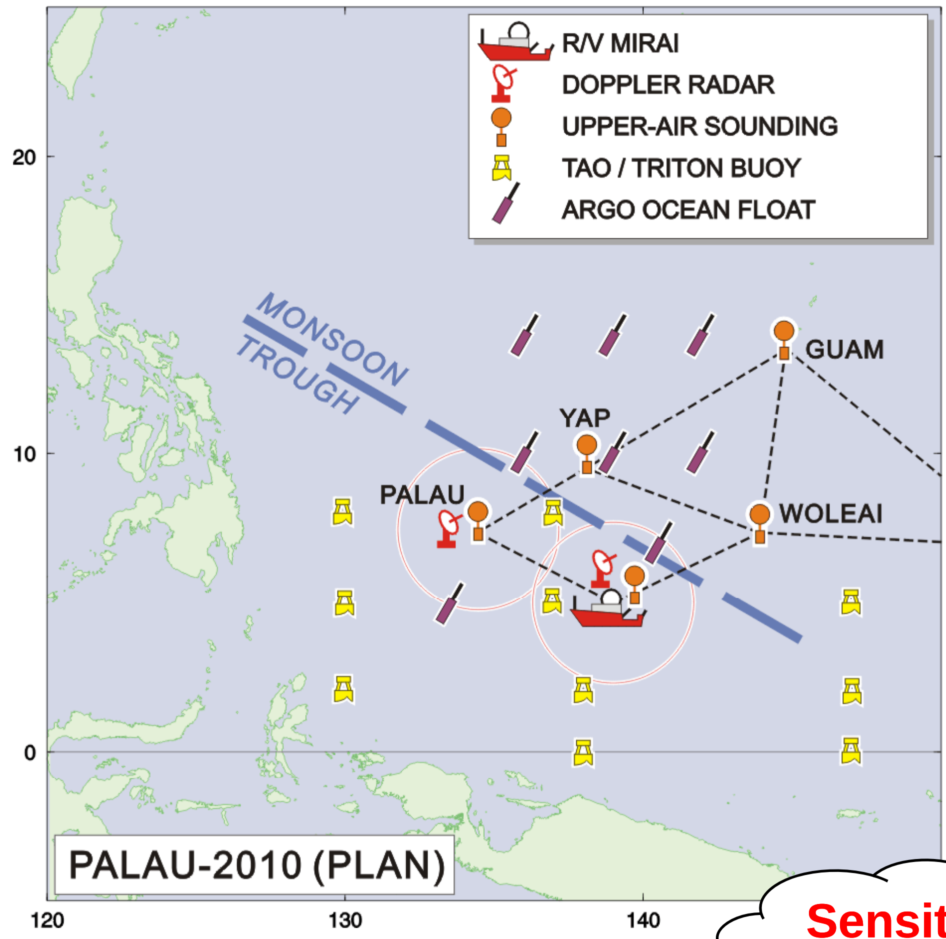


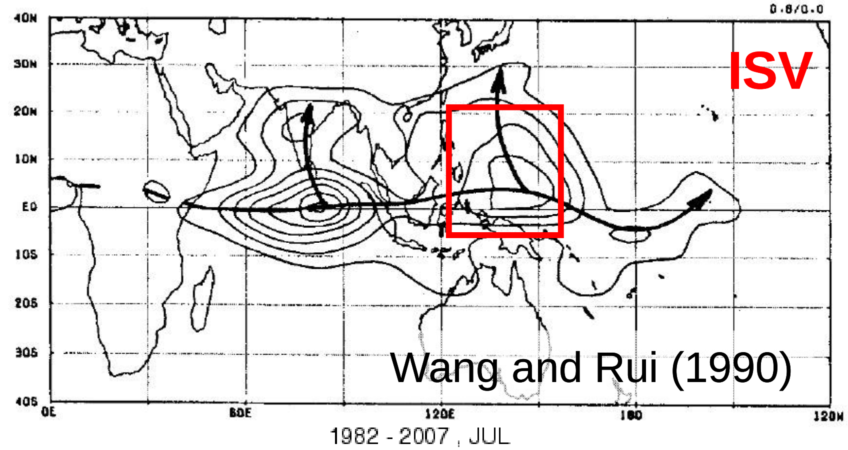
CHI200 composite on each MJO phase

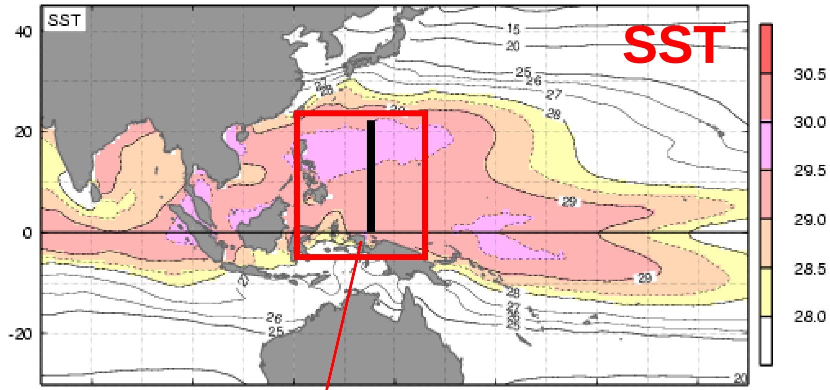


- TC genesis occurs when active convective region associated with the MJO resides over the maritime continent region.
- No TC genesis occurs for the member of which phase propagation of the MJO is not reproduced.

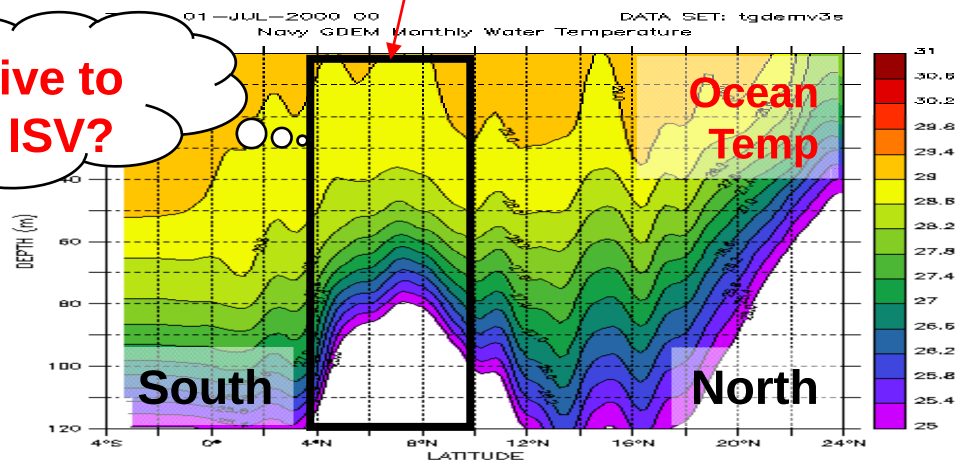
PALAU Field Campaign in June—Aug. 2010







Sensitive to MJO / ISV?



Purposes:

- **Mechanisms of N-propagation of a summertime ISV (w/ TC genesis) over the monsoon trough**
- **Role of a thin ocean mixed layer**

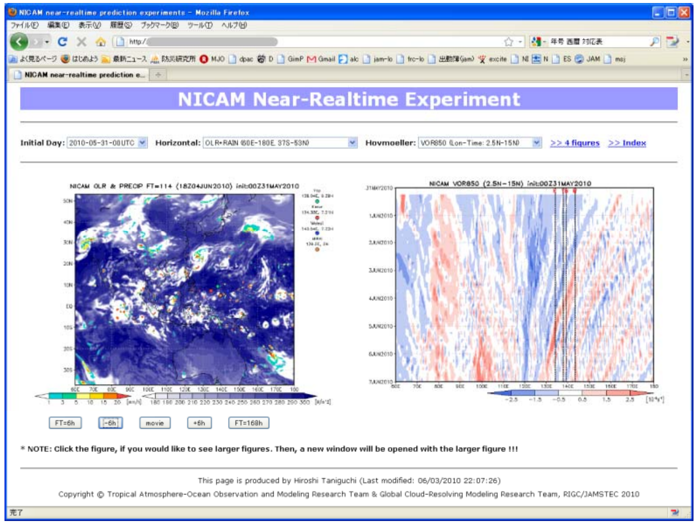
Outline of 1-week prediction system by NICAM

initial data (ATM, LND, OCN) at 00UTC
NCEP/FNL (http://dss.ucar.edu/datasets/ds083.2/)

wget at 19:00 on the day

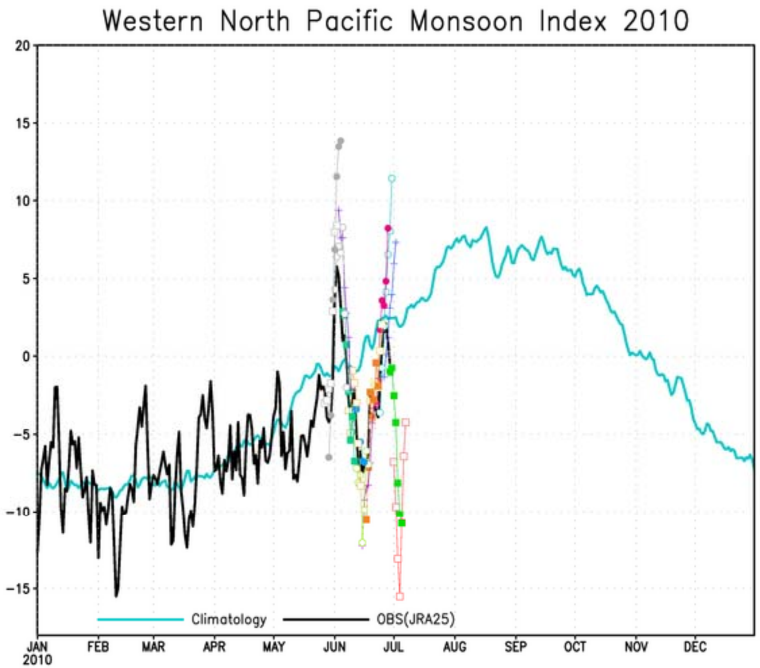
After 2days

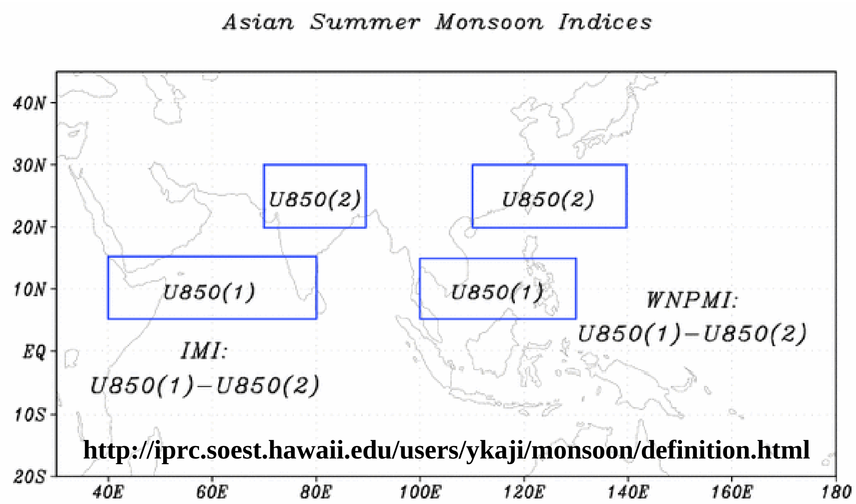
data available

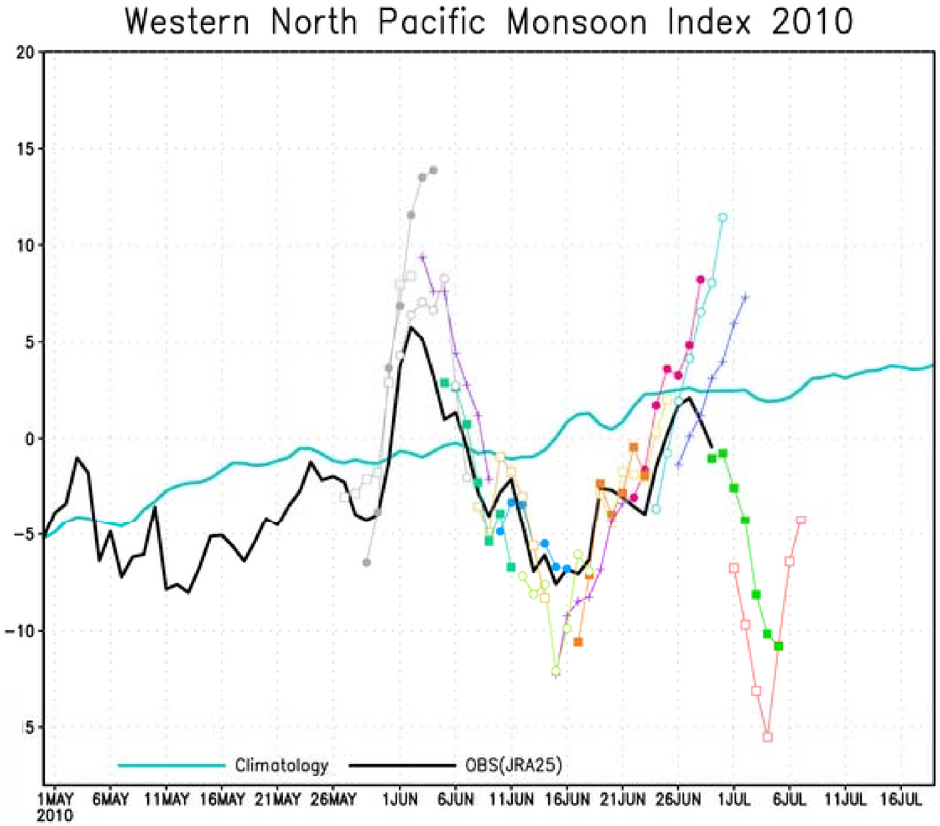


1. make initial state (ATM, LND, OCN) for NICAM grids system
2. make ocean data for nudging
3. make configuration file for the run with above initial state
4. start run (7-days integ., MAT+Mix-Ocn+MY2Moist, 14km, 136E-8N)
   - multi-level: every 3hr (snapshot)
     - u, v, w, t, p, rho, qv, dh
   - single-level: every 1hr (average)
     - cldi, cldw, evap, olr, q2m, qr, slp, t2m,
     - t_sfc, tppn, u10m, v10m vap_atm

calc. time:1.7 days


Western North Pacific Monsoon Index 2010
Climatology
OBS(JRA25)
JAN 2010
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


Asian Summer Monsoon Indices
U850(2)
U850(2)
U850(1)
U850(1)
IMI:
U850(1)−U850(2)
WNPMI:
U850(1)−U850(2)
http://iprc.soest.hawaii.edu/users/ykaji/monsoon/definition.html


Western North Pacific Monsoon Index 2010
Climatology
OBS(JRA25)
1MAY 2010
6MAY
11MAY
16MAY
21MAY
26MAY
1JUN
6JUN
11JUN
16JUN
21JUN
26JUN
1JUL
6JUL
11JUL
16JUL

NICAM contributions to CINDY/DYNAMO

- Real-time forecast: one week
  - Probably capture ISV variation of a week
  - Water vapor profiles, wave propagations
- NICAM global simulation: one month
  - Roles of equatorial waves on the onset: remote effects
  - Roles of cold pools in various scales
  - Air-sea interaction: with ocean mixed layer schemes
  - Various sensitivity experiments to test proposed mechanisms

Tomoe Nasuno will follow up details of our plan

Summary

- Analysis of observational data
  - Cyclone Nargis formed during the northward propagating of zonal wind, associated OLR and precipitation in the BOB.
  - when the active convective region associated with the MJO passed though the Bay of Bengal and resided over the Maritime continent
- An ensemble simulation of cyclone Nargis has been performed by NICAM
  - Northward migration of zonal wind, OLR, and precipitation
    - » successfully simulated in the ensemble results except for the case with initial day of April 10.
  - Each simulated TC genesis also occurs
    - » with the northward migration
    - » with the timing that active convective region associated with the MJO resided over east side of the Maritime continent (consistent with the climatology; its position and intensity vs. MJO phase)
  - MJO index
    - » good reproducible of decrease trend of the amplitude of the MJO in the late April
  - WWB index, WY index, vertical shear
    - » successfully simulated in the late April when the cyclone Nargis formed except for the case with initial day of April 10
- The relationship between TC genesis and intra-seasonal factor
  - can be also applied to the BoB
  - The predictability of the MJO and the associated monsoon onset are closely-related the TC genesis in the BoB.