First International Science and Planning Workshop on Years of the Maritime Continent
28-30 January 2015, Centre for Climate Research Singapore

# Day 3 (Thursday, January 29)
Session 7 Modeling

Regional nonhydrostatic models

International research collaborations and networking on extreme weather in changing climate in the MC

Shigeo Yoden (Kyoto U., Japan)

❖ International research collaborations and networking on extreme weather in changing climate in the MC
  - FY2015-2017 Japan Society for the Promotion of Science (JSPS) Core-to-Core Program: Asia-Africa Science Platforms
  - PI: Shigeo Yoden (Kyoto U.)
  - Japan: Kyoto U., JMA/MRI (K. Saito), Riken/AICS (T. Miyoshi)
  - Indonesia (T.W. Hadi, ITB), Singapore (T.-Y. Koh, NTU), Vietnam (T.T. Tran, VNU), and S/SE Asian countries
  - Numerical model studies with regional cloud-permitting nonhydrostatic models
    ➢ JMA NHM, WRF, DWD HRM,…
  - Observations and data analyses
  - Applications of probabilistic NWP data
    ➢ for societal, economic, and environmental decisions
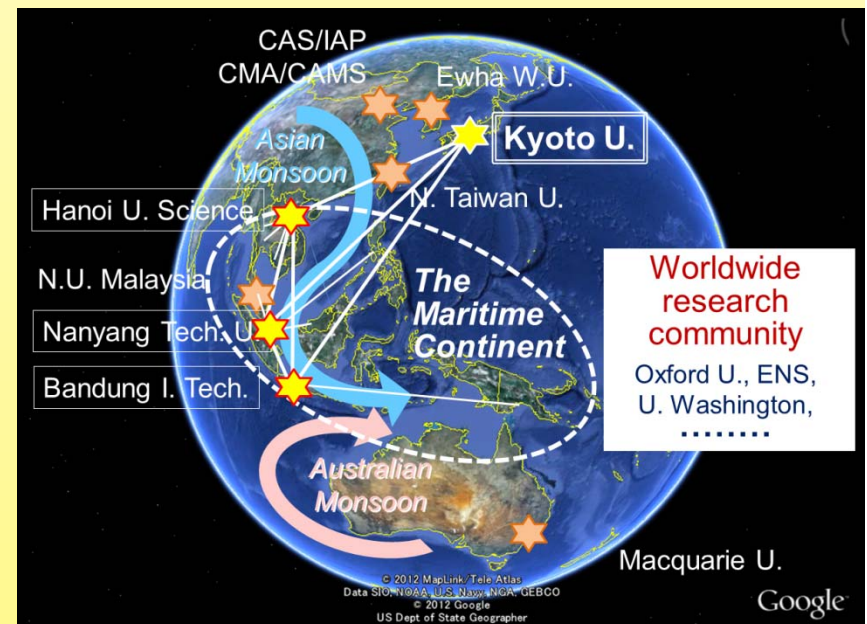
❖ Science and application on synoptic-scale disturbances: cross-equatorial cold surge and Borneo vortex

- ● description of the phenomena
  - ➤ observations and data analyses

    Note: reanalysis datasets have limitations due to the problem of model performance in the tropics

- ● dynamical understanding
  - ➤ numerical model studies
    - – on-off type experiments
    - – GFD-style parameter sweep experiment with hierarchy of models

Science

- ● forecast experiment

Application

  - ➤ pre-operational R&D phase of NHMs
    - – collaboration between operational center and university

      JMA/MRI – Kyoto U

- ● societal application for "needs"
  - ➤ needs of operational forecasts (ensemble probabilistic data)
    - – disaster prevention/mitigation, economical decision, and more

❖ An example: hindcast experiment of Borneo vortex
- similar to Trilaksono, Otsuka and Yoden (2011, 2012)
  - ➢ Japan Meteorological Agency Non-Hydrostatic Model (Saito et al. 07)
  - ➢ Δx = 20 km, 115 x 103 grids;   0 ≤ z* ≤ 22.1 km, 40 levels
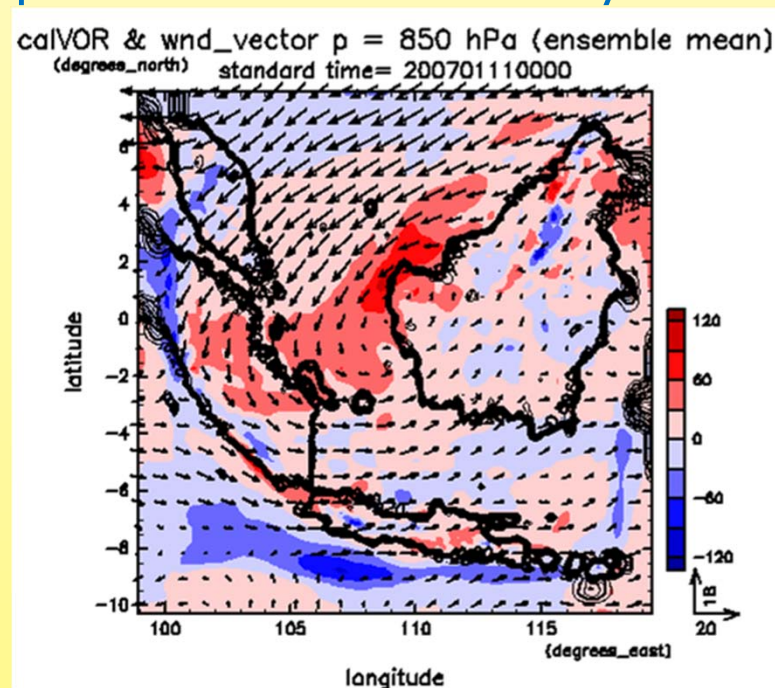 - ➢ 2007 Jan. 11 00:00 UTC ～ Feb. 09 23:00 UTC
  - ➢ 9 members of time-lagged ensemble runs
    start every 6 h and use the period of 19 h ≤ t ≤ 72 h
- animation of two BV events
  - ➢ vertical component of relative forticity and horizontal winds

❖ Dynamical uniqueness of cross-equatorial cold surge and Borneo vortex

- geographical asymmetry with the equator
  ➜ boreal winter

- around the equator ($f \sim 0$)
  ➜ free from
     quasi-geostrophic balance
  ➜ vertically independent
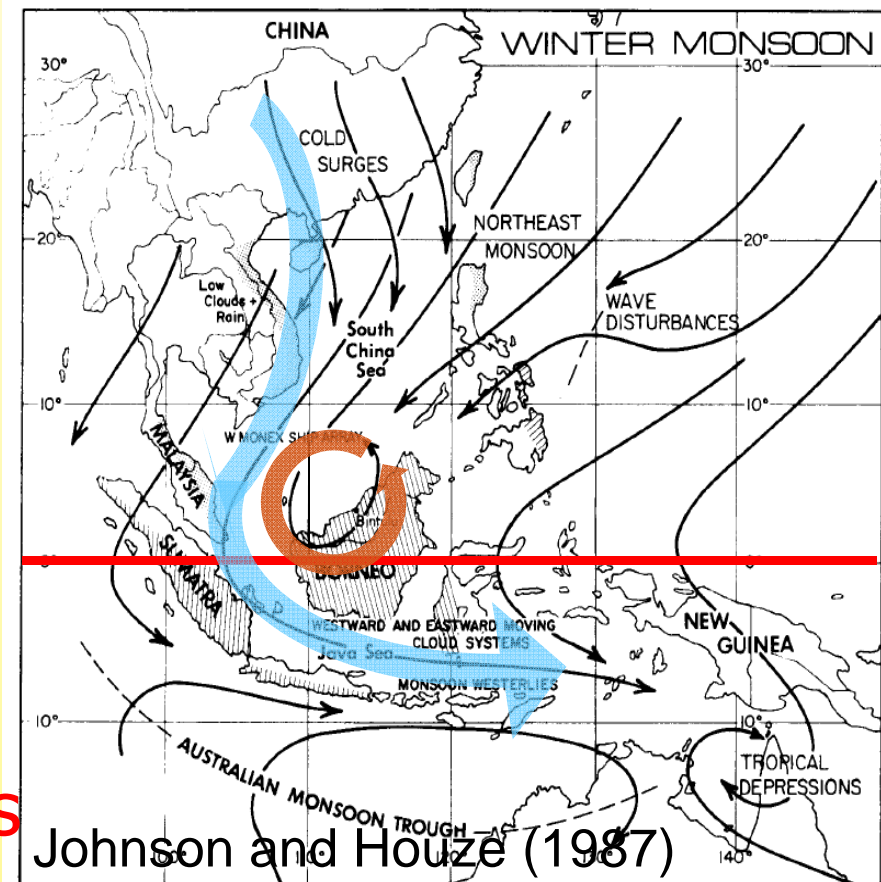   "thin-layered" motions

- complex topography
  ➜ wind-terrain interaction
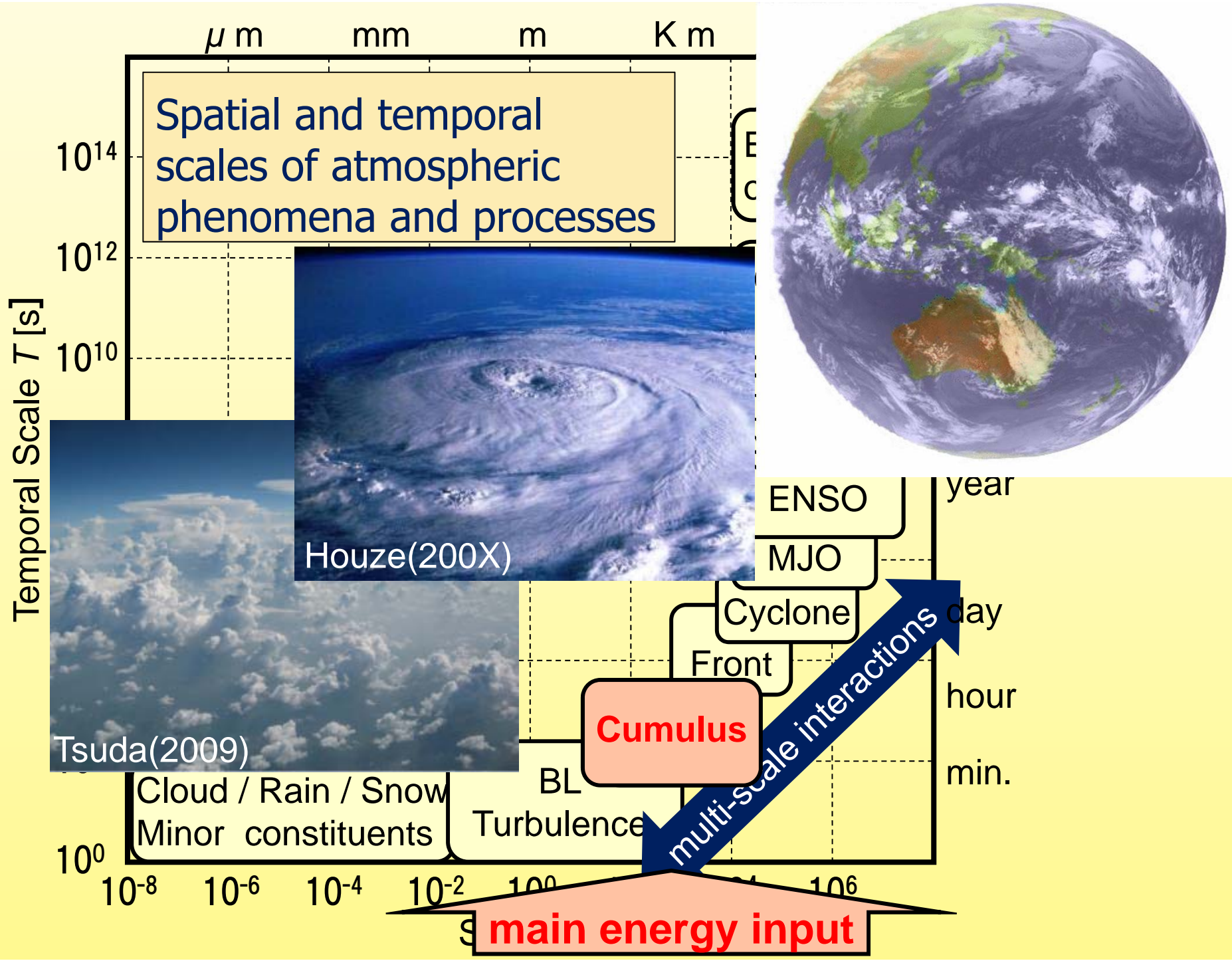 ➜ multiple-scale variations

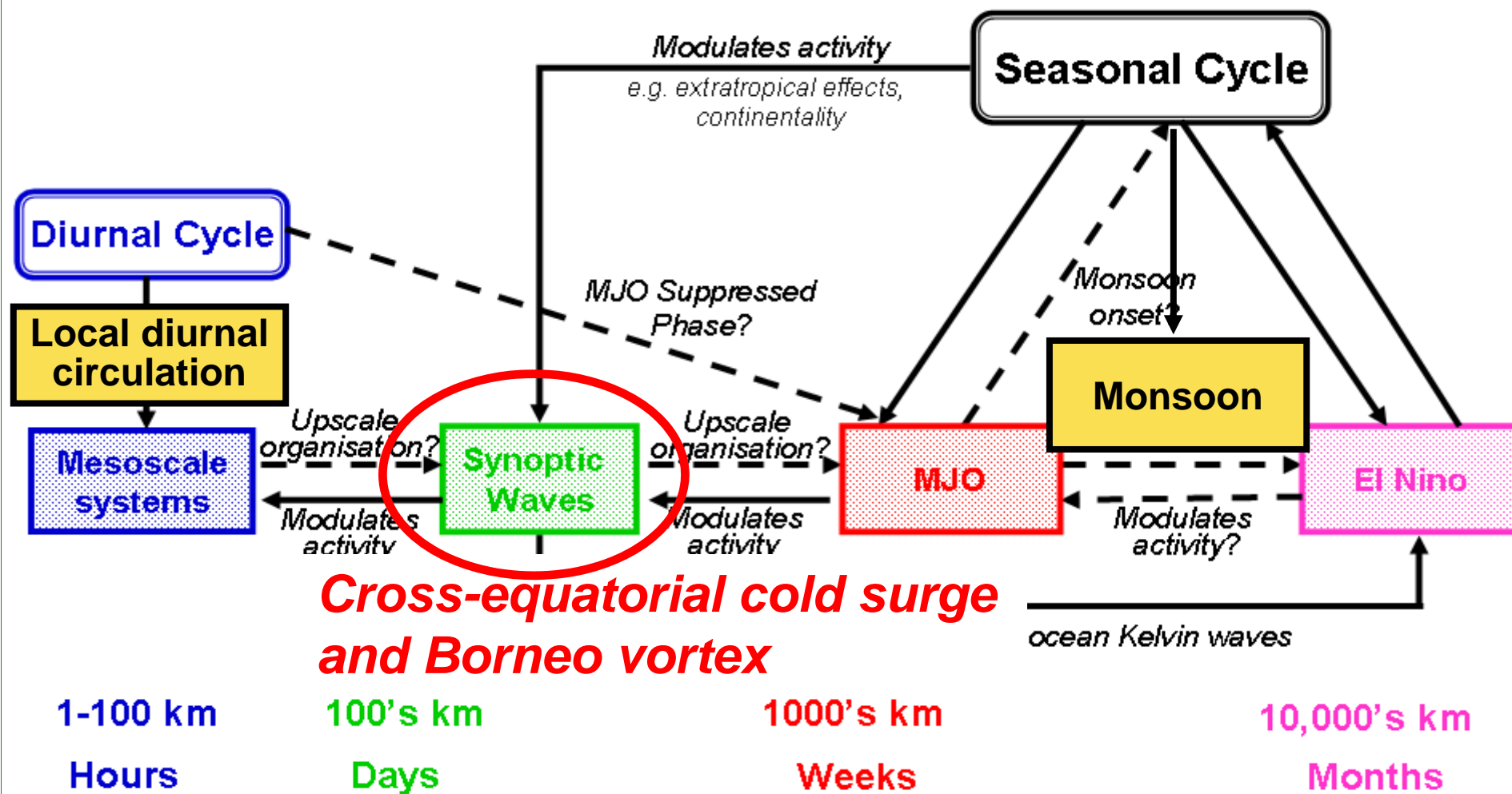❖ Further studies in all aspects should be necessary for better understanding the dynamics and their roles in the maintenance and variations of the MC monsoon

Johnson and Houze (1987)

Spatial and temporal scales of atmospheric phenomena and processes

Temporal Scale T [s]

μm   mm   m   K m

10^{14}

10^{12}

10^{10}

Houze(200X)

Tsuda(2009)

ENSO   year

MJO

Cyclone   day

Front

Cumulus   hour

BL   min.

Cloud / Rain / Snow
Minor constituents   Turbulence

multi-scale interactions

10^0

10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^0 10^6

main energy input

Interactions between space and time scales of tropical convection: Linking THORPEX and WCRP

Slingo (2006)

❖ **Science** and **application** on synoptic-scale disturbances: **cross-equatorial cold surge** and **Borneo vortex**

- ● description of the phenomena
  - ➤ observations and data analyses
    - Note: reanalysis datasets have limitations due to the problem of model performance in the tropics
- ● dynamical understanding
  - ➤ numerical model studies
    - – on-off type experiments
    - – GFD-style parameter sweep experiment with hierarchy of models
- ● forecast experiment
  - ➤ pre-operational R&D phase of NHMs
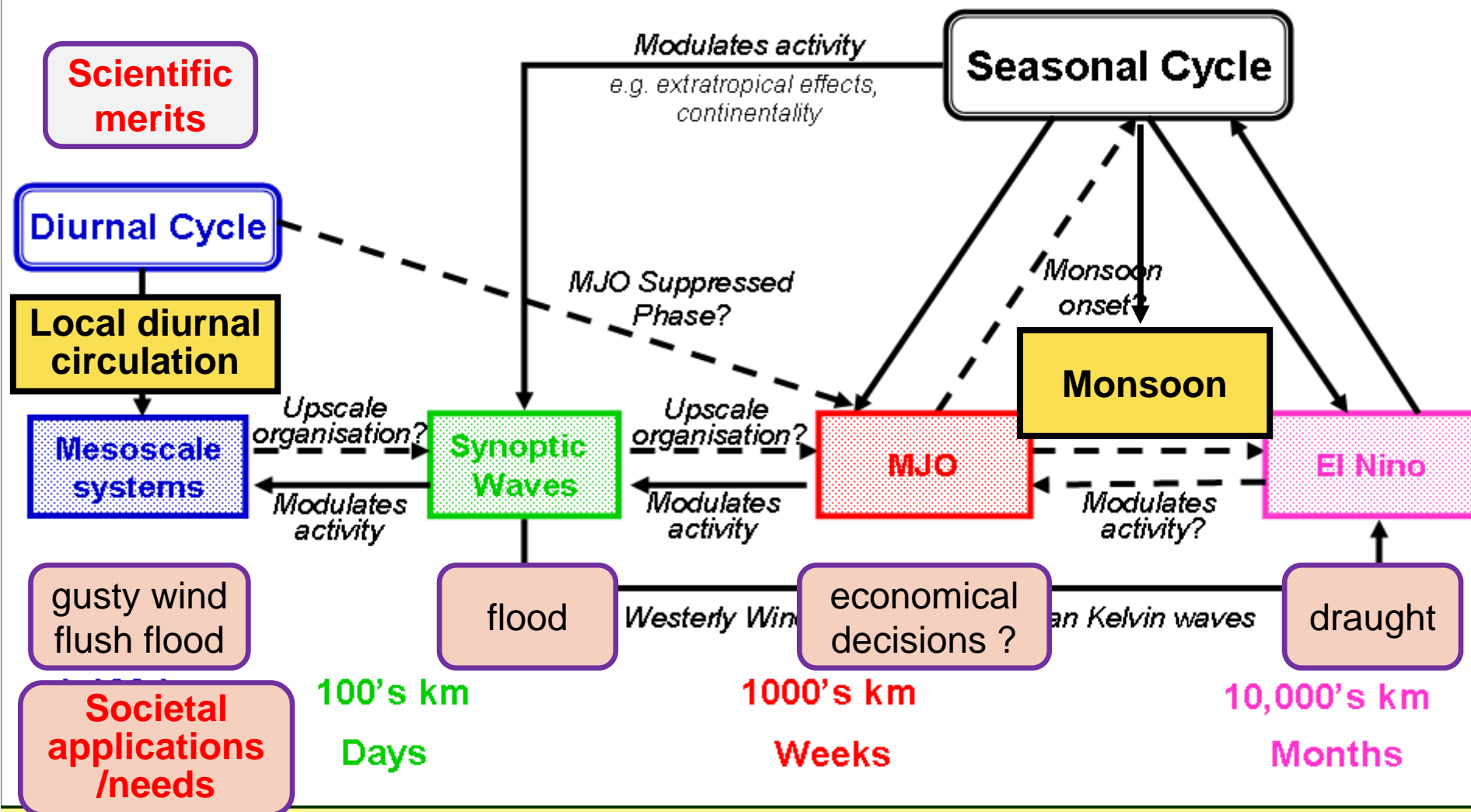   - – collaboration between operational center and university
      JMA/MRI – Kyoto U
- ● societal application for "needs"
 - ➤ needs of operational forecasts (ensemble probabilistic data)
    - – disaster prevention/mitigation, economical decision, and more

Interactions between space and time scales of tropical convection: Linking THORPEX and WCRP
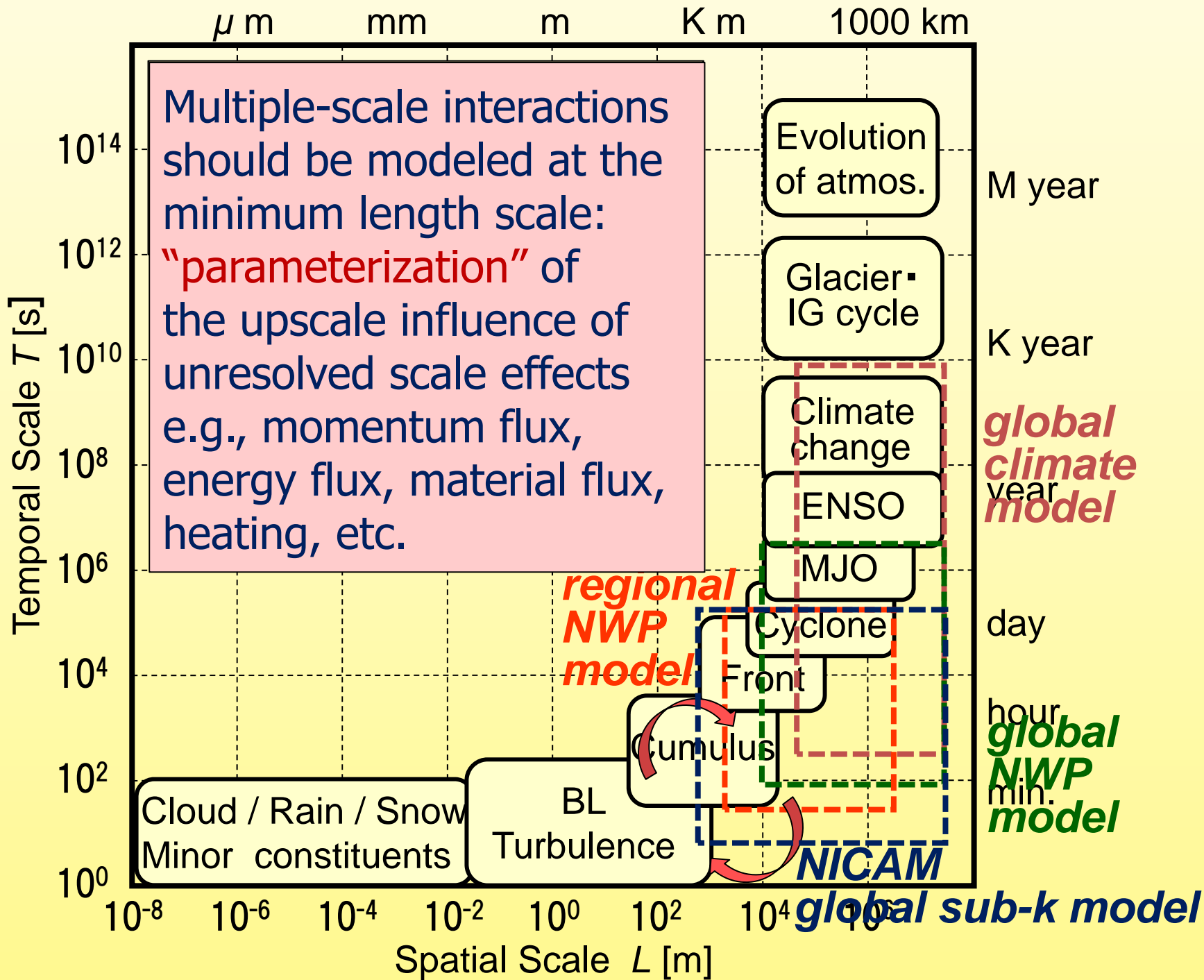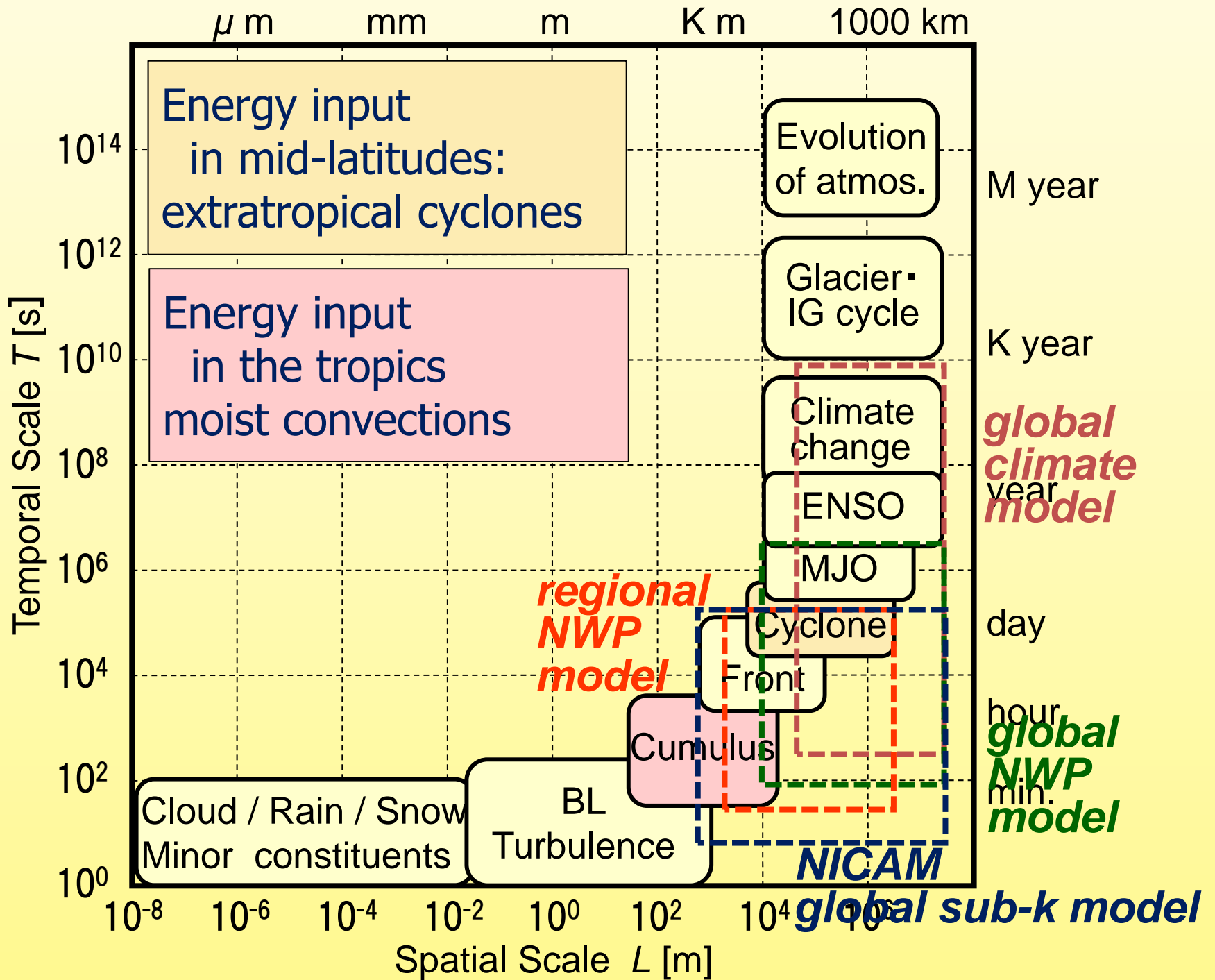
Slingo (2006)

Self-organization of convective clouds in the tropics

Interaction with complex topography and land-sea contrast, particularly in the Maritime Continent
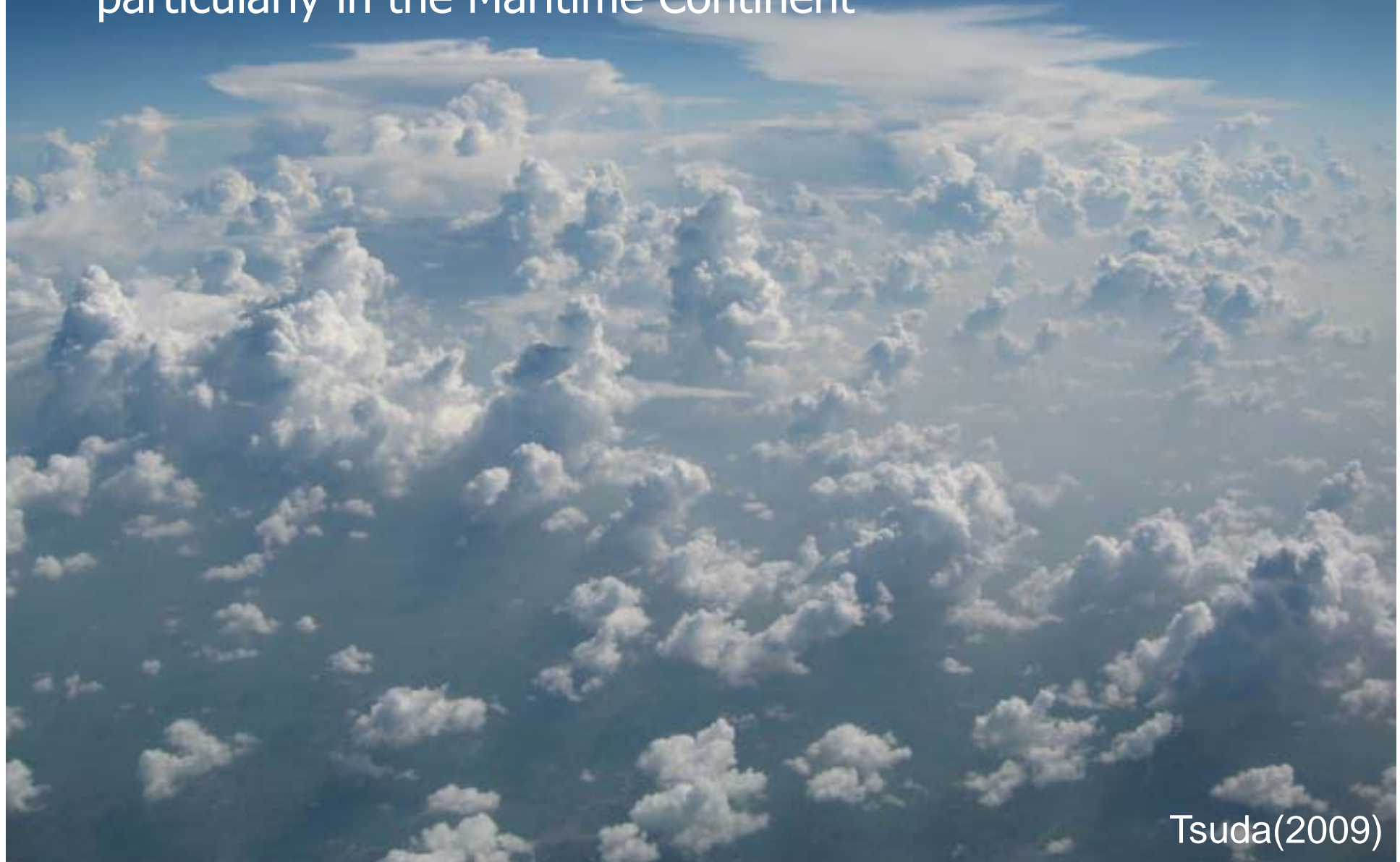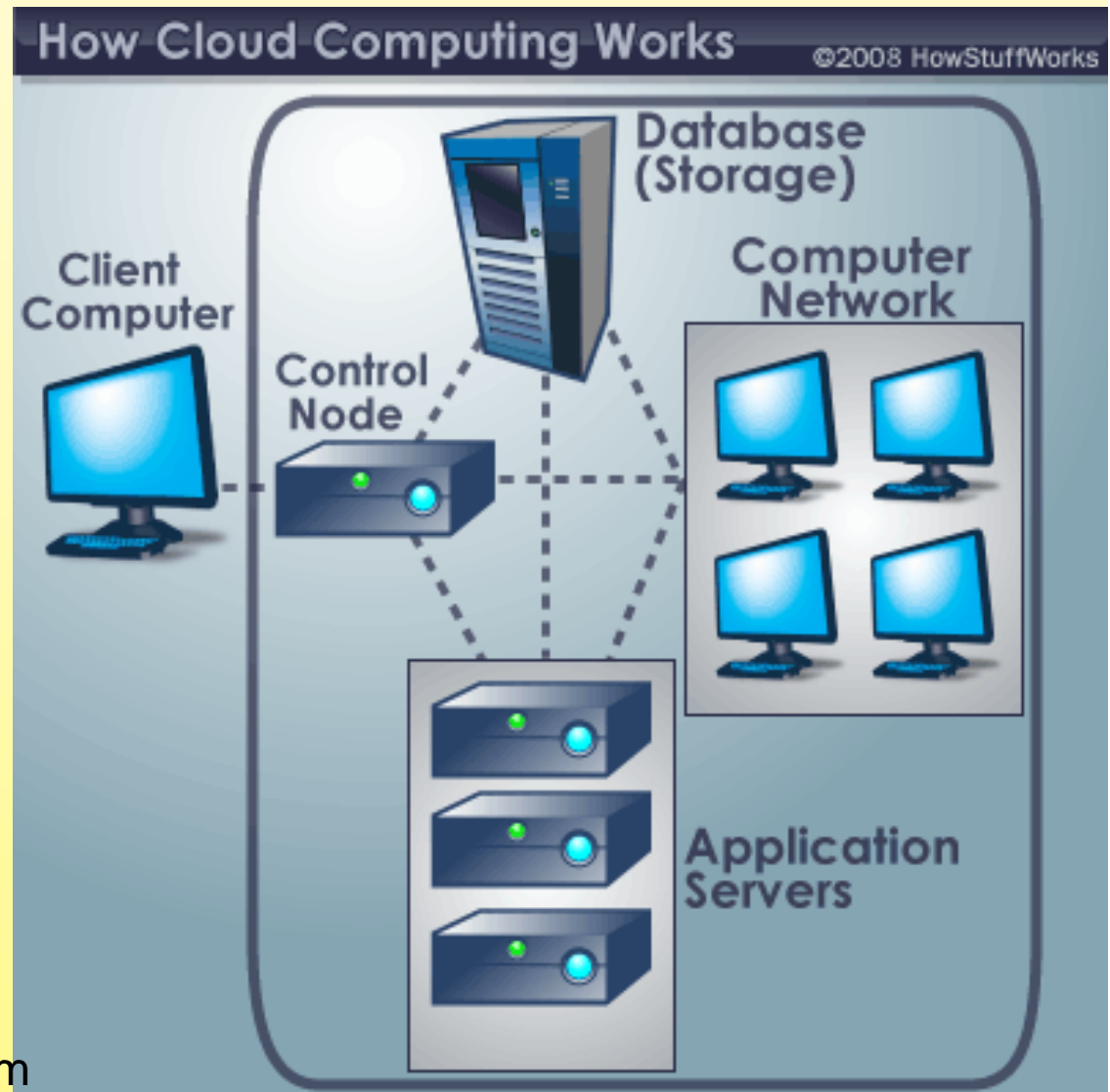
Tsuda(2009)

2. Plan of participating in the YMC field campaign

❖ In the MC countries, infrastructures in computations and internet communications have been improved largely in these years

❖ It would be a good timing to start international research collaboration on numerical model studies of extreme weather events in the MC, such as

- cross-equatorial cold surge
- Borneo vortex

with high-resolution regional non-hydrostatic models

❖ Multi-model and multi-analysis ensemble experiments will be possible through "cloud computing"
   ● with our own application servers and database storages

How Cloud Computing Works   ©2008 HowStuffWorks

Client Computer

Database (Storage)

Control Node

Computer Network

Application Servers

http://computer.howstuffworks.com/
cloud-computing/cloud-computing.htm

❖ The following subjects should be pursued under the YMC

    (1) Hindcast experiments on some typical events

        such as, cross-equatorial cold surge and Borneo vortex

        <a> to check and tune the performance of numerical models

           → process oriented validation of numerical models

        <b> to make detailed dynamical analyses

    (2) Near real-time forecast experiments

        in collaboration with the YMC observational campaigns, including

        <1> the design of adaptive observations

        <2> the assessment of their impact to improve the forecast

    (3) Geophysical Fluid Dynamics-oriented numerical experiments

        for better understanding the fundamental dynamics of

        cross-equatorial cold surge and Borneo vortex

❖ JSPS Core-to-Core Program: Asia-Africa Science Platforms

    ● International Research Collaborations and Networking on Extreme Weather in Changing Climate in the MC (FY2015-17)

Thank you !

July 2, 2010, way to Visakhapatnam from Delhi, India