Significance of Indonesian “maritime continent”

The HARIMAU project (FY 2005-9)

Contribution to MAHASRI/CEOP/GEWEX/WCRP and GEOSS

Past collaboration with MISMO (Oct-Dec 2006)

Future collaboration with CINDY
Indonesian maritime continent:
- The most active convective clouds
- The largest rainfall

Why?

Surrounded by “warm water pool”? If so, why large rainfall does not appear over ocean but over land?

Land with smaller specific heat generates convection much easily?

Again, why not Africa nor S. America but maritime continent?

**Conditional instability:**
- Convection generated spontaneously only when cloud appears.
- Cloud becomes most active when convection is developed.

- **Forced motions (waves, circulations), or CISK**
2,000 mm/year


Hashiguchi et al. (1995)  
Hayashi & Sumi (1985)

Hashiguchi et al. (1995)  
Hayashi & Sumi (1985)
Correlation between **annual rainfall** and **diurnal cycle** dominancy of rainfall


**Morning Rain** - **Evening Rain**
(Mori et al., 2004, *Mon. Wea. Rev.*)
Regional (land) rainfall (mm/year) = **2000 (mm/year•10^2 km)** \[\text{Coastline (10^2 km)}/\text{Land area (10^4 km^2)}\]  
\[\rightarrow\] Total rain water amount on land (Gt/year) = 2000 (mm/year•10^2 km) \[\text{Coastline (10^2 km)}\] 

- **The maritime continent with the longest coastlines has the largest rainfall.**
- Numerical models must resolve coastlines with 100 km or higher resolution.
- Radar-AMeDAS-like observations must cover all the coastlines/mountain slopes.
Indian Ocean \rightarrow \text{Maritime Continent} \rightarrow \text{Pacific Ocean}

\text{Warm Water} \quad \text{Air-Sea Interaction} \quad \text{Warm Water}

\text{Air-Land-Sea Interaction Diurnal Cycle}

\text{SLB circulation with cloud “sprinkler” effect}

(Wu, Yamanaka & Matsumoto,, 2008)
The image shows a chart with the title "Onset of Monsoon & Rainy Season". The chart indicates the average over 2-3 km with data points for December 11 and December 21. The chart also shows zonal wind (m/s) with values ranging from -15 to 15. The chart is labeled with locations such as Pontianak, Kototabang, and Biak. The chart includes a color scale for temperature with values ranging from 230 to 275 degrees C. The chart is accompanied by a map in the top right corner, which shows the location of Manado, labeled as "installed last week! Sep 2008". The source of the data is cited as Yamanaka et al., 2008, J. Disaster Res.
(Tabata et al., 2008, private commun.)
Zonal Wind

Meridional Wind

Vertical Velocity

Echo power

(From Tabata et al., 2008, private commun.)
Jakarta Flood (Jan-Feb 2007)

Hydrometeorological ARray for ISV-Monsoon AUtomonitoring (HARIMA
It is an observation system made of Rain Radars and wind-profilers installed in the Indonesian maritime continent (IMC), to observe IMC-excited global climate variations such as El Nino, with a large potential to prevent hydro meteorological / climatological disasters such as flood not only in IMC but also all over the world.

Data are openly available on the internet in real time.

Collaborating countries are: Japan, Indonesia, Thailand, Vietnam, Myanmar

(Wu et al., 2007, SOLA)
<Science promotion>
(科学の成果)
- Land-Ocean-Atmosphere science
  (陸面海洋大気系科学)
- Physical climatology
  (気候変動物理学)
- Synergy between S&T and diplomacy
  (地球環境科学と国際社会科学の結合)

<Social benefits>
(社会貢献)
- Capacity development
  (地球環境科学の基礎科学技術者育成)
- Disaster prevention
  (気候変動の緩和・適応, 自然災害の減災)
- Security for Japanese
  (海外在住日本人への防災情報提供)
HARIMAU Radar-Profiler Network over the Maritime Continent: Collaborations with MISMO until now and CINDY in future

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MISMO Workshop, 25-26 November 2008, Yokohama, Japan
Background of our study  Importance of “Land (Island)” for Abundant Rainfall over the Equator and its Diurnal variation

Annual rainfall distribution observed by TRMM PR

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Clear contrast between

Morning rain (00-11LST)
over the Coastal sea region

and

Evening rain (12-23 LST)
over the Land region

(Mori et al., 2004, MWR)
Latest MIA-XDR CAPPI 80km Range Images
(Top: Reflectivity, Bottom: Doppler Velocity)

Height: 2km
Height: 5km
Height: 8km

http://www.jamstec.go.jp/iorgc/harimau/HARIMAU.html
HARIMAU2006 in collaboration with MISMO during October 28 – November 27, 2006

For better understanding on atmospheric and oceanic variability in MJO convection onset, and role of diurnal variations in MJO onset, maintenance, and modulation over the MC region.
**HARIMAU2006 Intensive Observation**

- **Background and Objective**
  
  To better understand structures and dynamics of diurnally generated convective systems over the southwestern coastal region of Sumatra Island, and their interactions with intraseasonal variation (MJO).

- **Observation Sites**
  
  X-band Doppler radars at MIA (JEPP) and Tiku (Hokkaido Univ)
  
  Soundings at Tabing and Siberut

- **Observation Period**
  
  October 28 – November 27, 2006

- **Status**
  
  Various kinds of convections (e.g., isolated, organized, hazardous) embedded in diurnally developed cloud systems during MJO inactive phase were frequently observed.
Nocturnal re-development of coastal precipitation

Reflectivity

Precipitation

Accumulated Rainfall Amount

Topography

(a) Reflectivity (dBZ)

(b) Rainfall Intensity (mm h⁻¹)

(c) Convective Rain Fraction (%)
Reflectivity (Horiz.)

Reflectivity (Vert.) Doppler Vel. (Vert.)

2nd Case for 0300LT-1000LT 07 November 2006
Sakurai et al. 2008 (in preparation)

Approximately 100 km
Future plan ..... 

1. JEPP/HARIMAU program comes to end in March 2010, however, we’re applying another funding (JICA-JST) to develop our activity with Indian Ocean moored buoy research/develop group directed by Dr. Mizuno.

2. Furthermore, the IORGC is going to be reorganized in 2009, and our “large-scale hydrological research group”, MJO study groups directed by Dr. Yoshizaki, and buoy study/develop group are merged in one research program.

3. Therefore, we’ll have closer collaboration with CINDY 2011 by using HARIMAU radar-profiler network which can obtain comprehensive structure of MJOs passing over MC and study “effect of land/island” on MJO modulation.

4. Detailed strategy of CINDY collaborated activity in the MC is under discussion in our group and Indonesian researchers.
Buoy array and Atmospheric radars in Tropics for Application of climate variability study through Indonesia-Japan scientific Alliance (BATAVIA)
MARINE RESEARCH FACILITIES

1. BRKP - DKP
2. BAKOSURTANAL
3. LAPAN
4. BMG
5. DISHIDROS
6. BPPT
7. LIPI
8. MGI - DESDM

Wahana K/R BPPT & LIPI
RADAR BARU
(7 LOKASI)

ACEH

PADANG

LAMPUNG

PONTIANAK

SURABAYA

MANADO

BIAK
Coastal Rain Bands in South-Southeastern Asian Monsoon Region

Rainfall distribution (JJA) observed with TRMM PR and related coastal mountain ranges in Asian region (Xie et al. 2006 JC)

QSCAT sea surface wind (Xie et al. 2006 JC)