# Physical Climatology of Indonesian Maritime Continent: An Observational Overview

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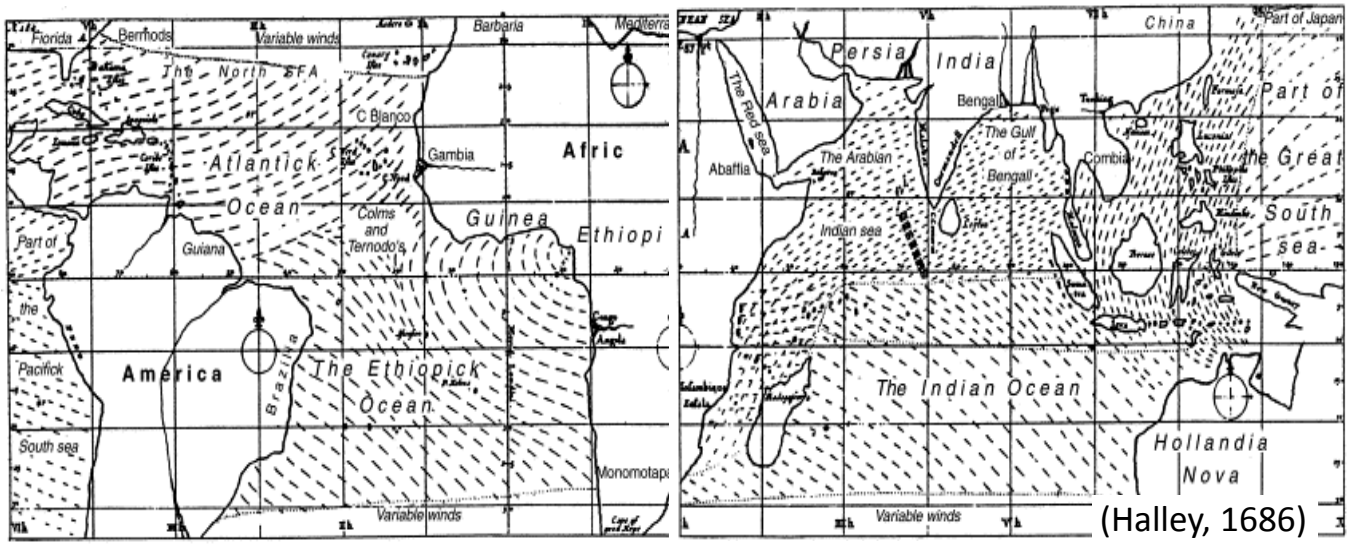
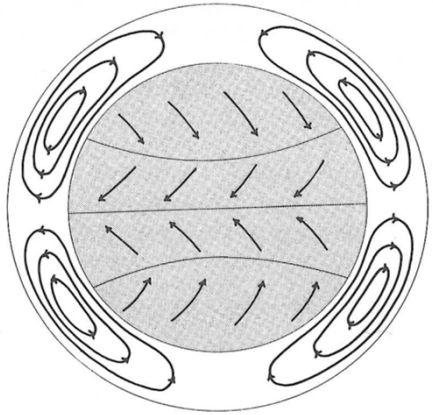
*(Photo by Y. Kashino, near Timor)*

# Dawn of scientific description of monsoon and Hadley circulations

(Discovery/utilization of monsoon: Greek /Arabian sailors >2,400/1,400 years ago;
Trade wind recognition/utilization: Polynesian/European >2,000/600 years ago)

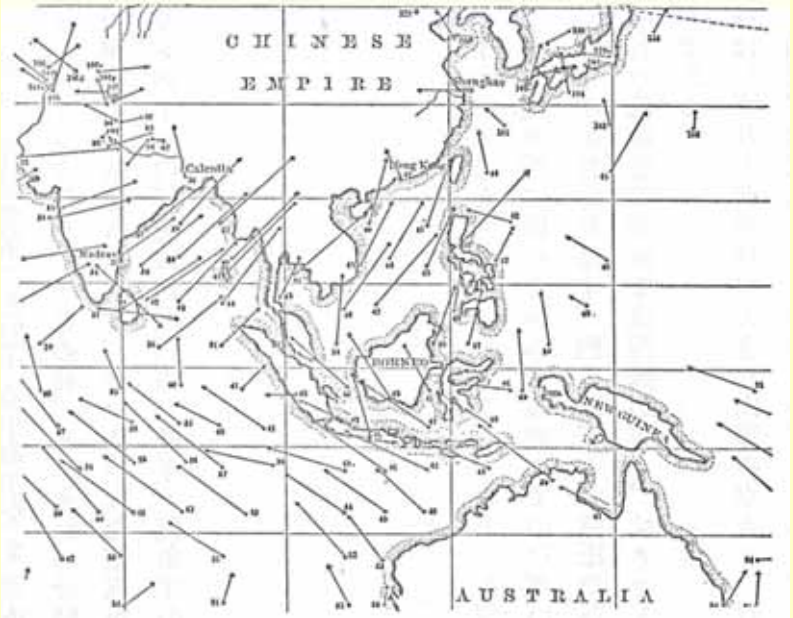



(Halley, 1686)



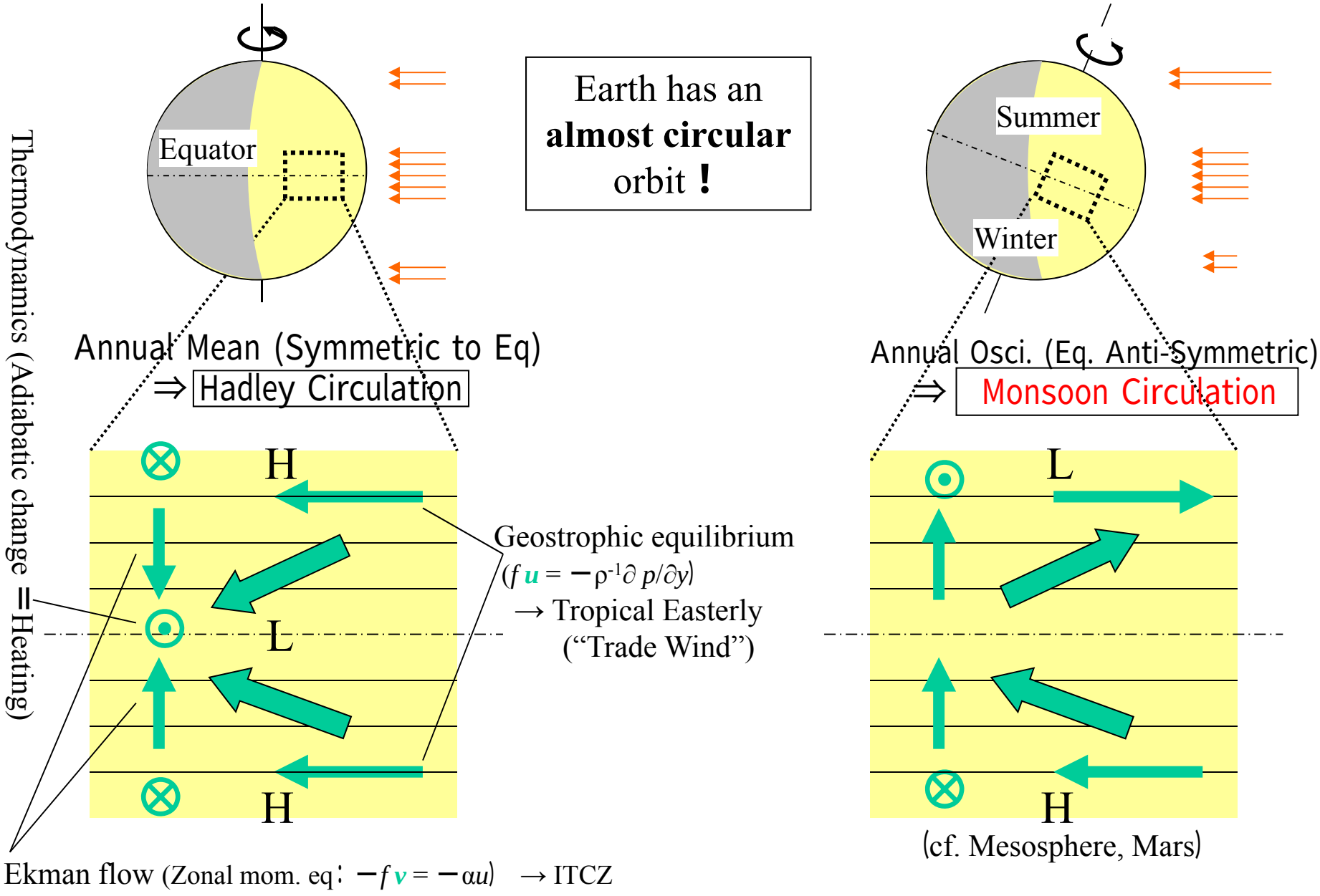
(Hadley, 1735;
reproduced by Lorenz, 1967)

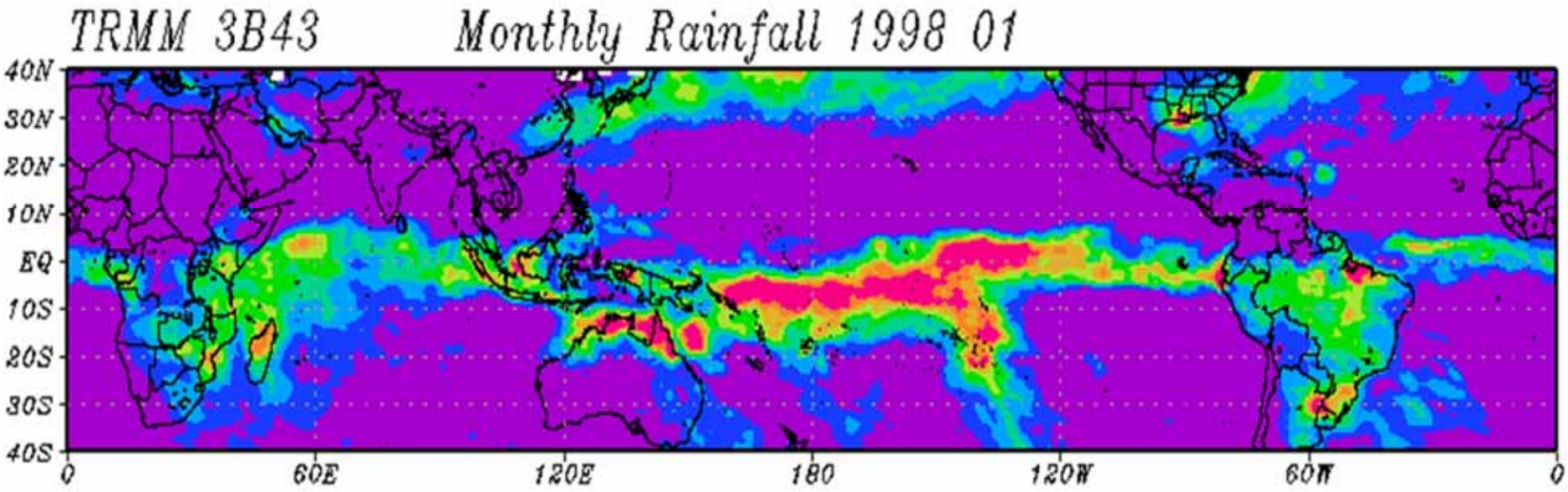

(Coffin, 1876;
Copied by
Yoshino, 1989)

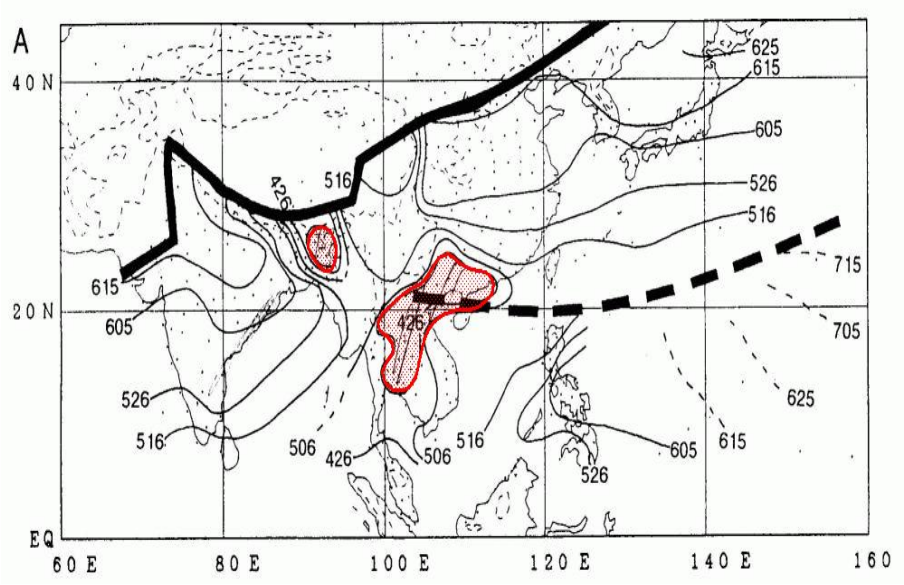


# Hadley and ("astronomical") monsoon circulations

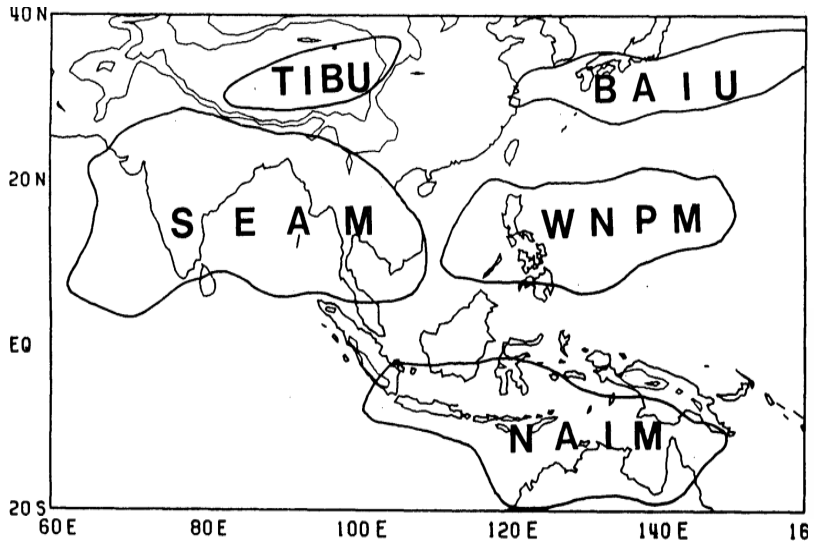
## Axi-Symmetric Meridional Circulation due to Differential Solar Heating





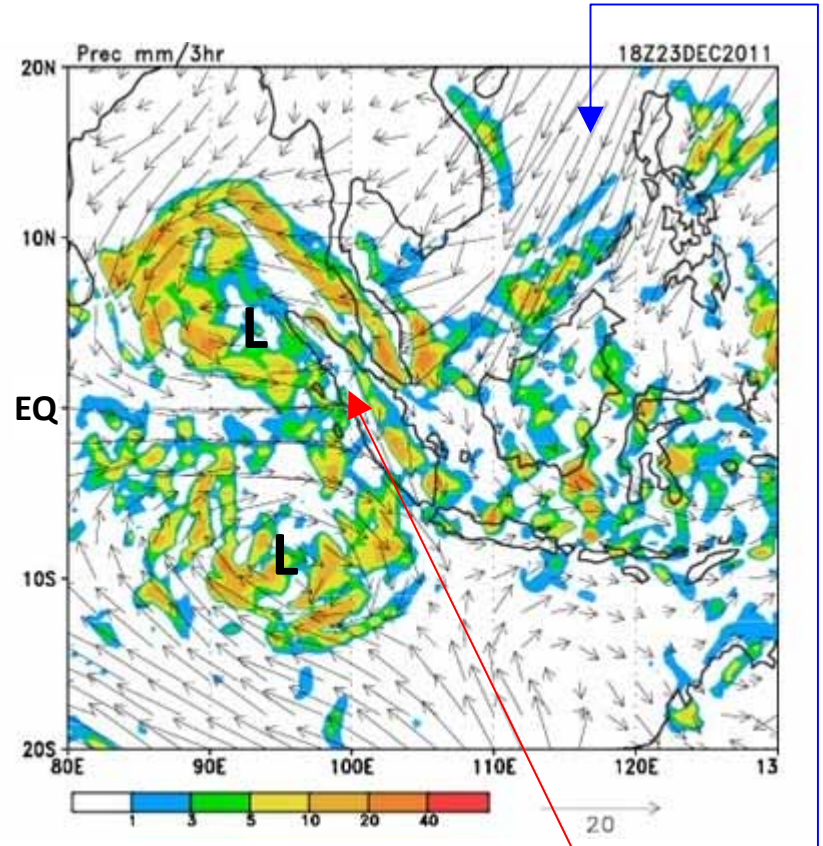




(Matsumoto and Murakami, 1992)

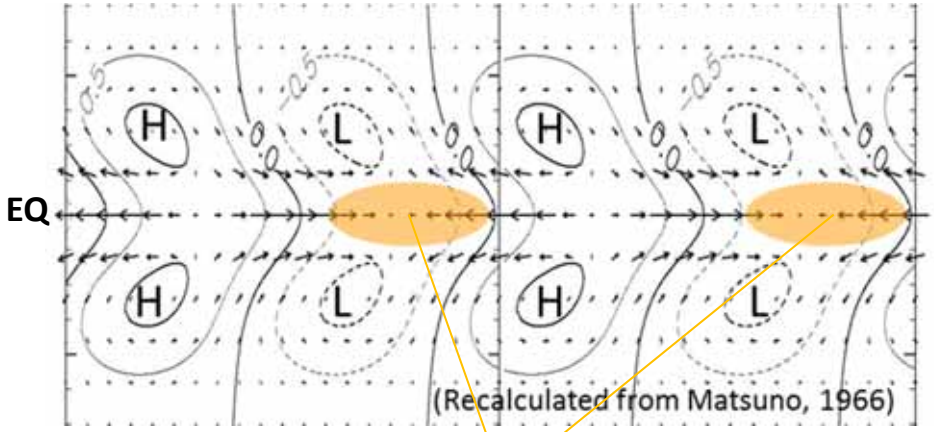



(Murakami and Matsumoto, 1994)

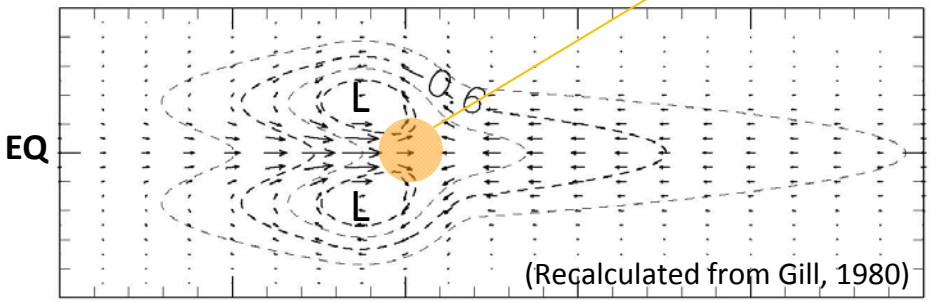
# intraseasonal variation (ISV)
# or Madden-Julian oscillation (MJO)
# or super cloud cluster (SCC) or Matsuno-Gill pattern
# observed during HARIMAU2011 IOP




Diurnal cycle (clear land after midnight)

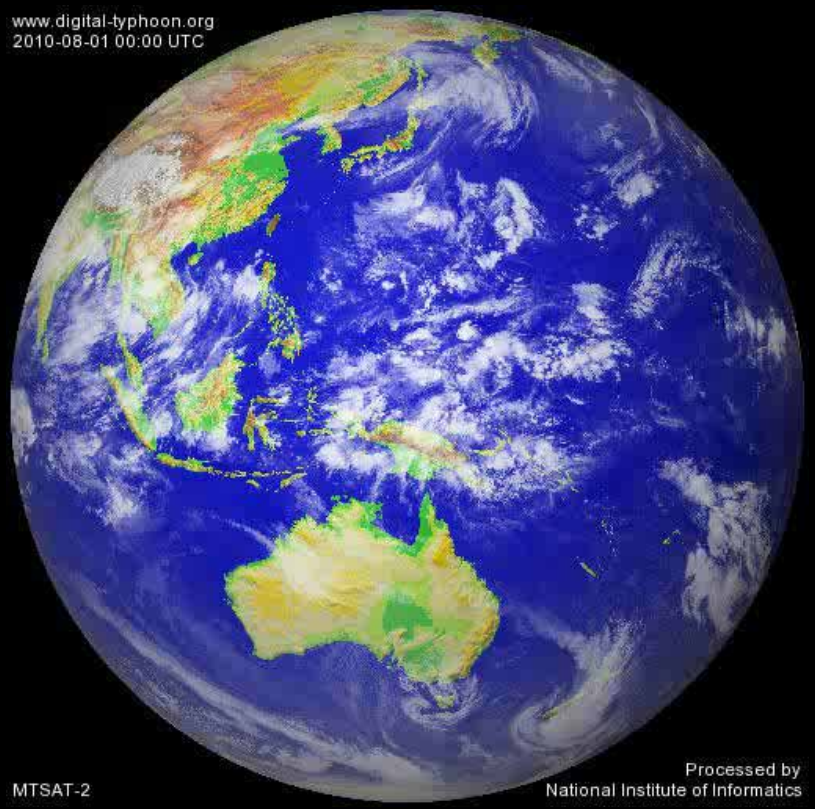



"Hot spot" (aligned or isolated)

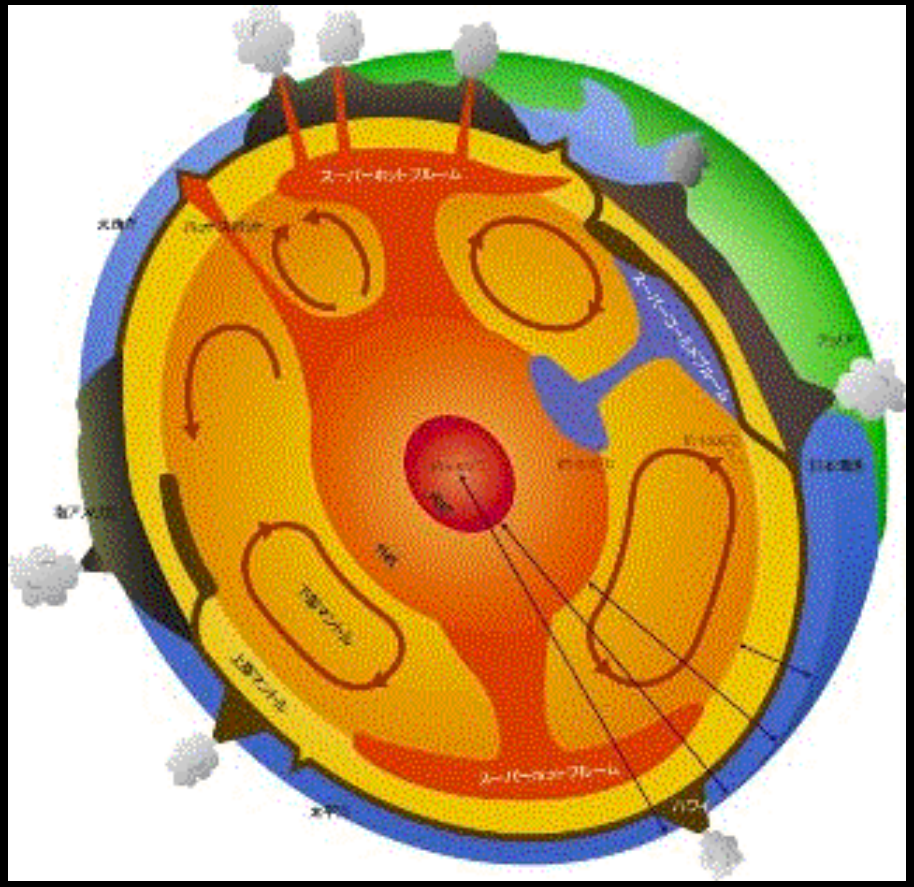



Boreal winter monsoon (so-called *cold surge*)

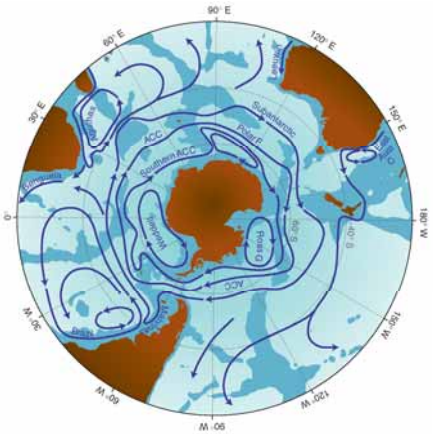
# Convection produces uneven earth

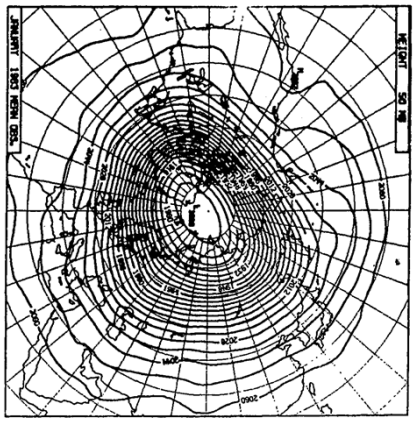



MTSAT-IR (August 2010)



(by IFREE/JAMSTEC)

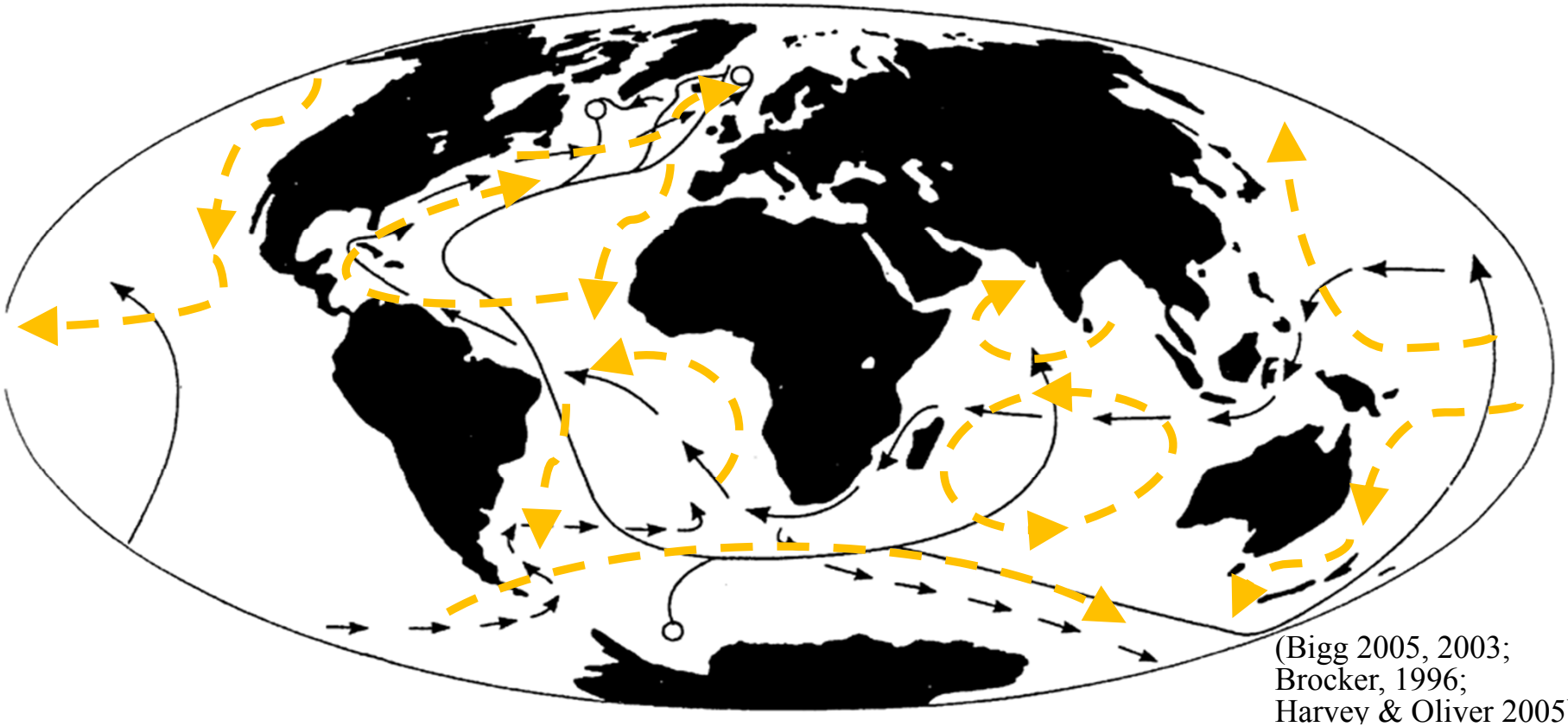




Without lands
almost zonal
circulations

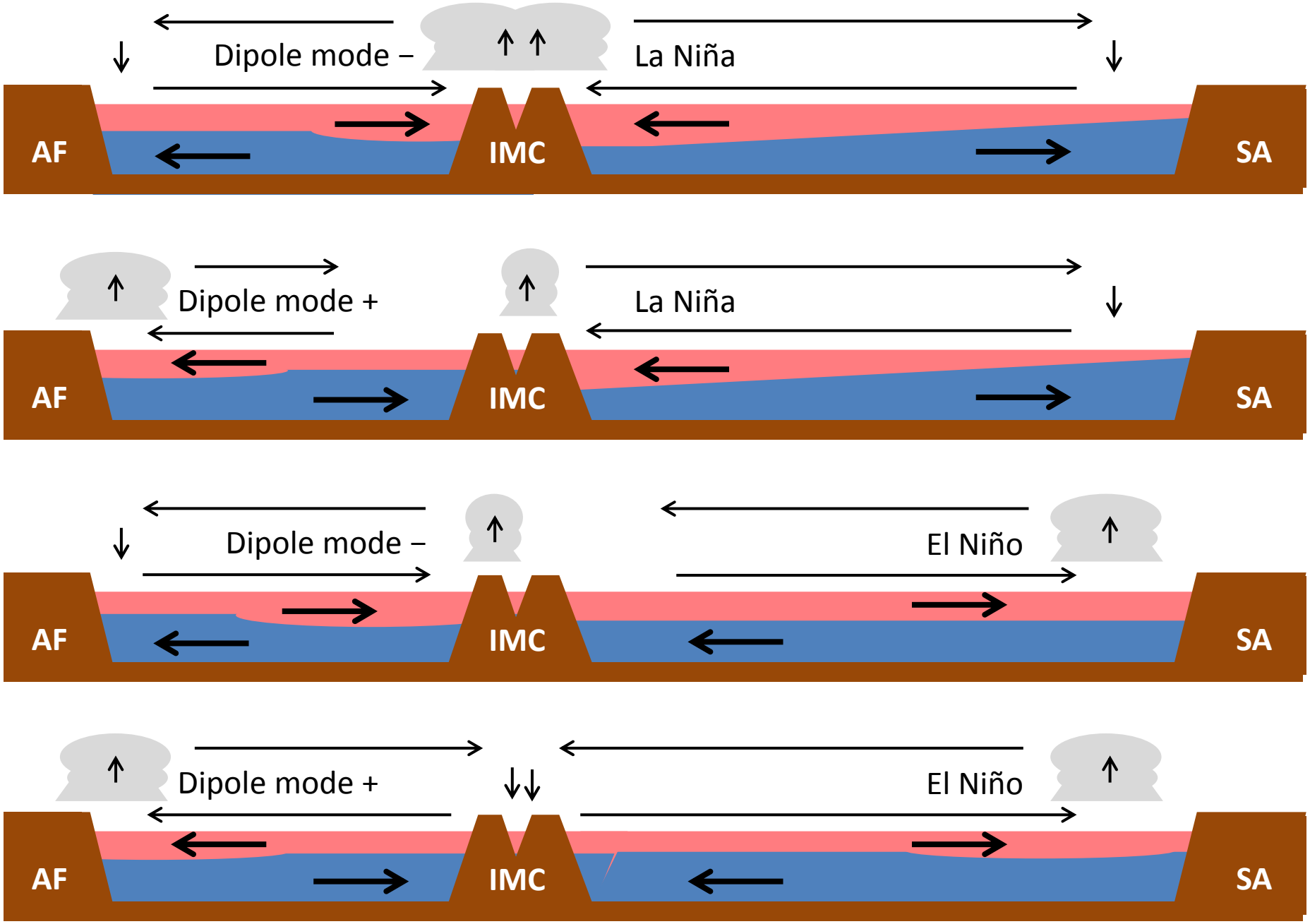
(such as in Jupiter,
in circum-Antarctic,
in the stratosphere)

## Surface (wind-driven) & deep (thermohaline) Ocean Circulation

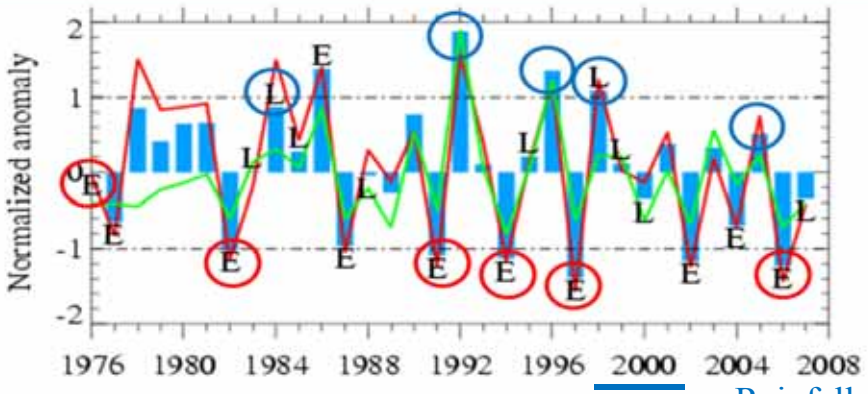


(Bigg 2005, 2003;
Brocker, 1996;
Harvey & Oliver 2005)

# Indian Ocean — Indonesia — Pacific Ocean



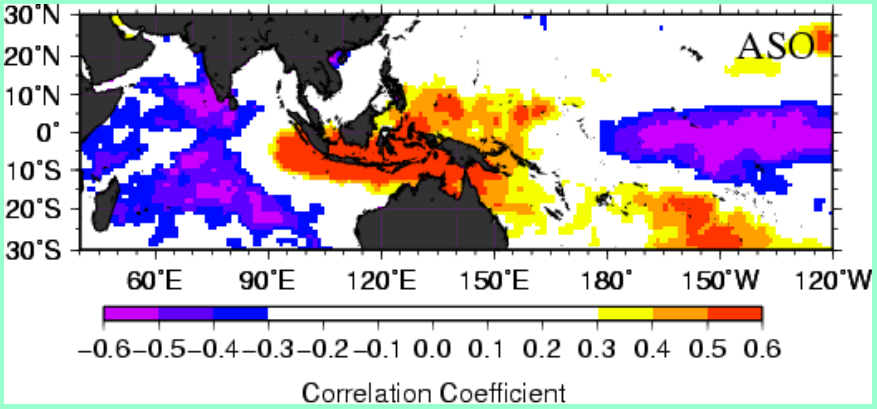
Jakarta (9 stations) in the dry season (ASO)




Rainfall amount
Rainfall days
Heavy rainfall days

E: El Nino, ◯: Positive IOD
L: La Nina, ◯: Negative IOD

Jakarta rainfall vs. SST in the dry season

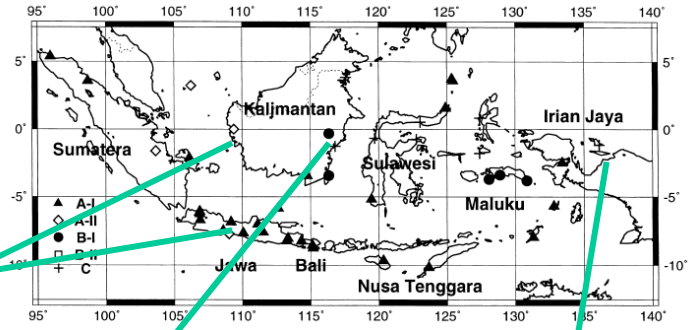


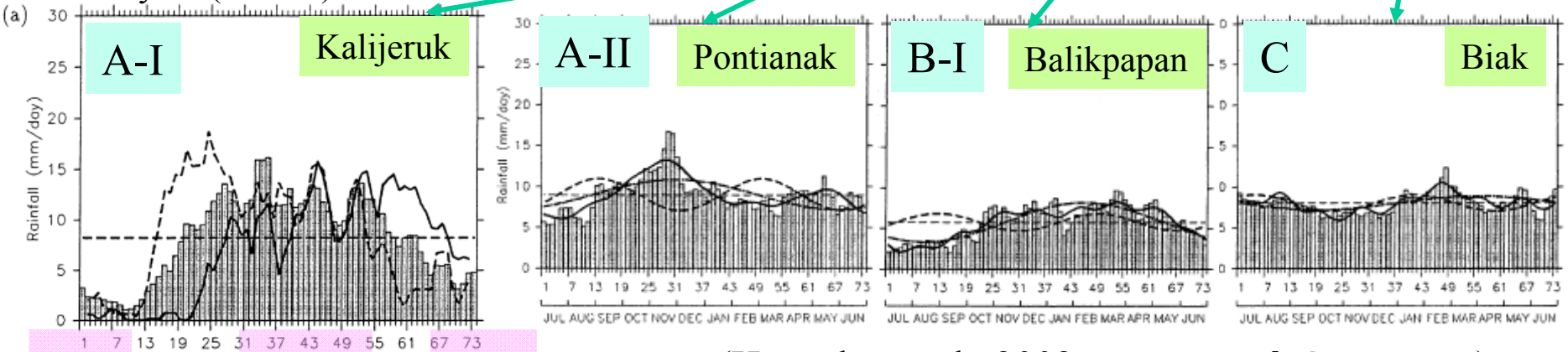

(Hamada, Urip, Sopia, et al., 2012, SOLA)

# Seasonal cycle modification by ENSO

El Nino year (solid )

La Nina year (dashed)



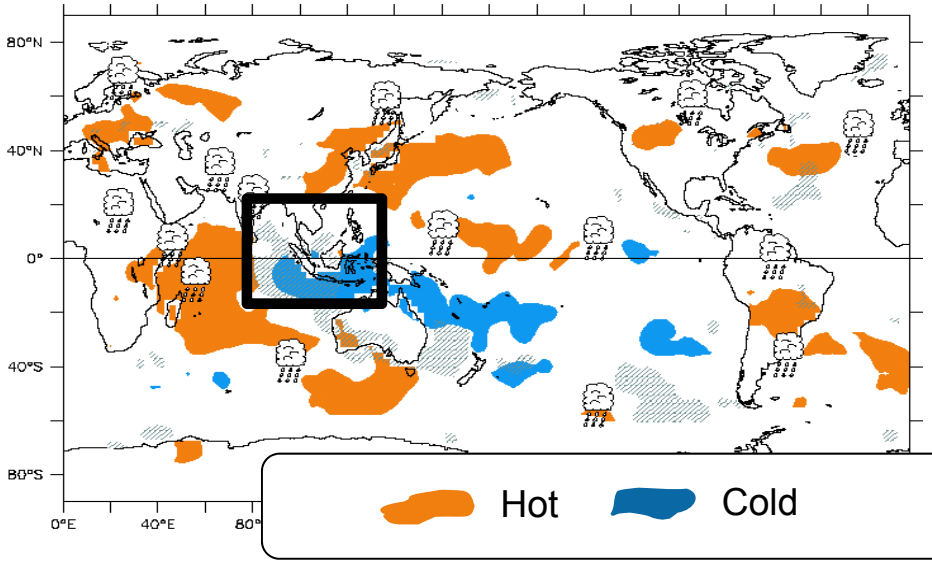




JUL JAN JUN

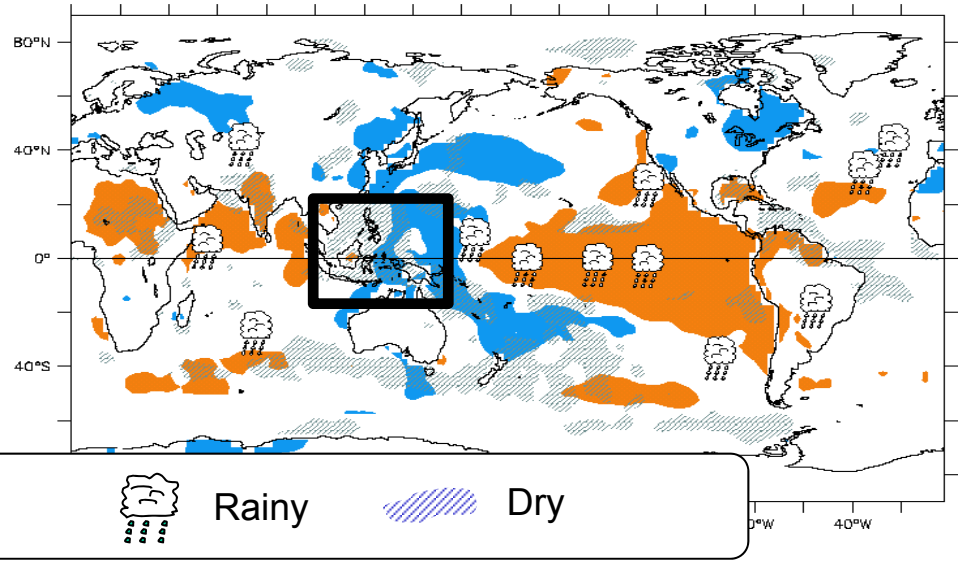
(Hamada , et al., 2002, *J. Meteorol. Soc. Japan*)

# Global / local effects of IOD / ENSO

IOD effects (boreal summer/autumn)

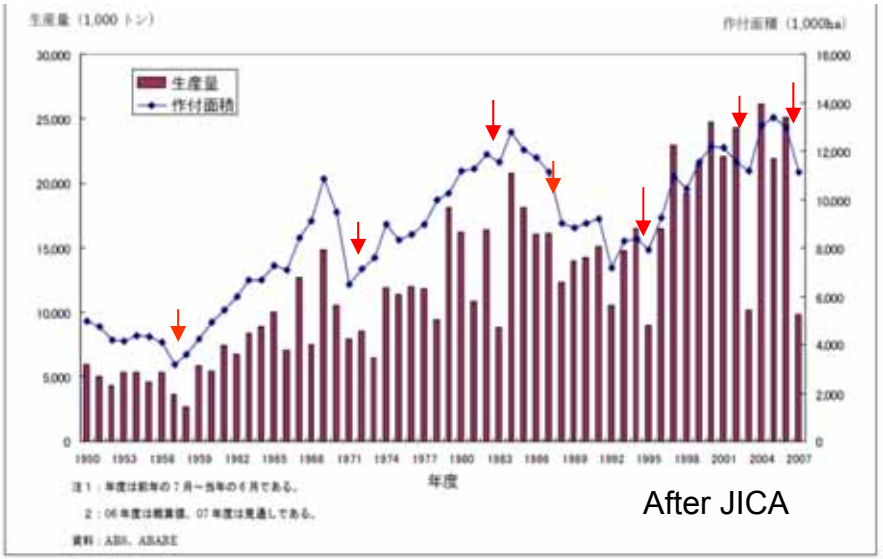



El Nino effects (boreal summer/autumn)

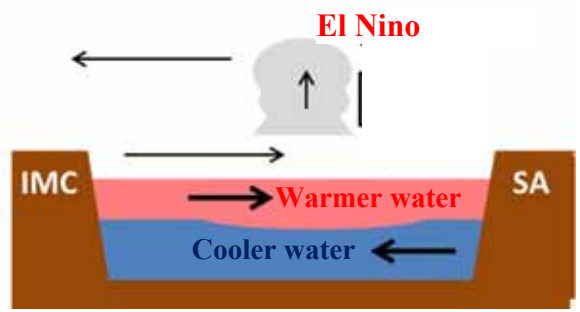


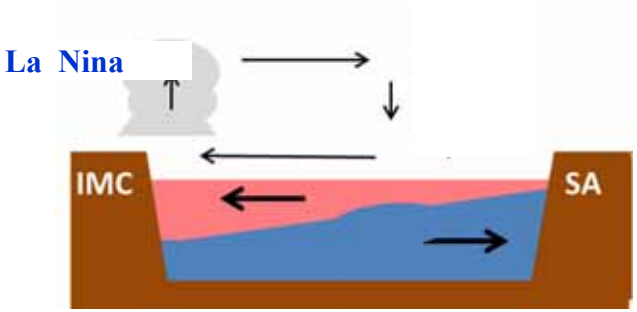

**Forest fires and transbounbdary haze (1994, 1998, 2006)**

**Low wheat production in Australia in El Nino/IOD years**

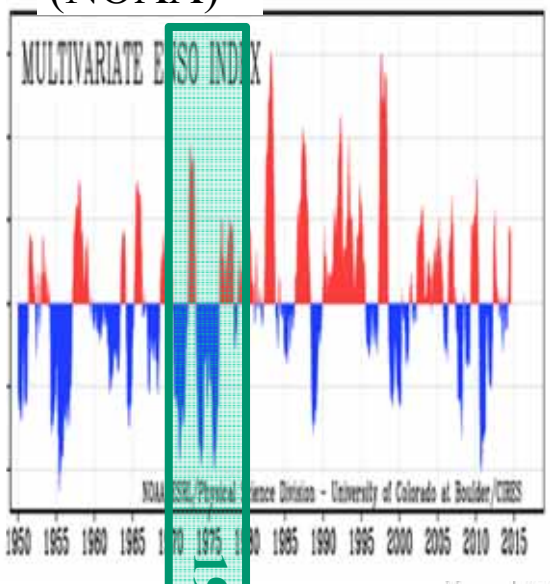



After JICA



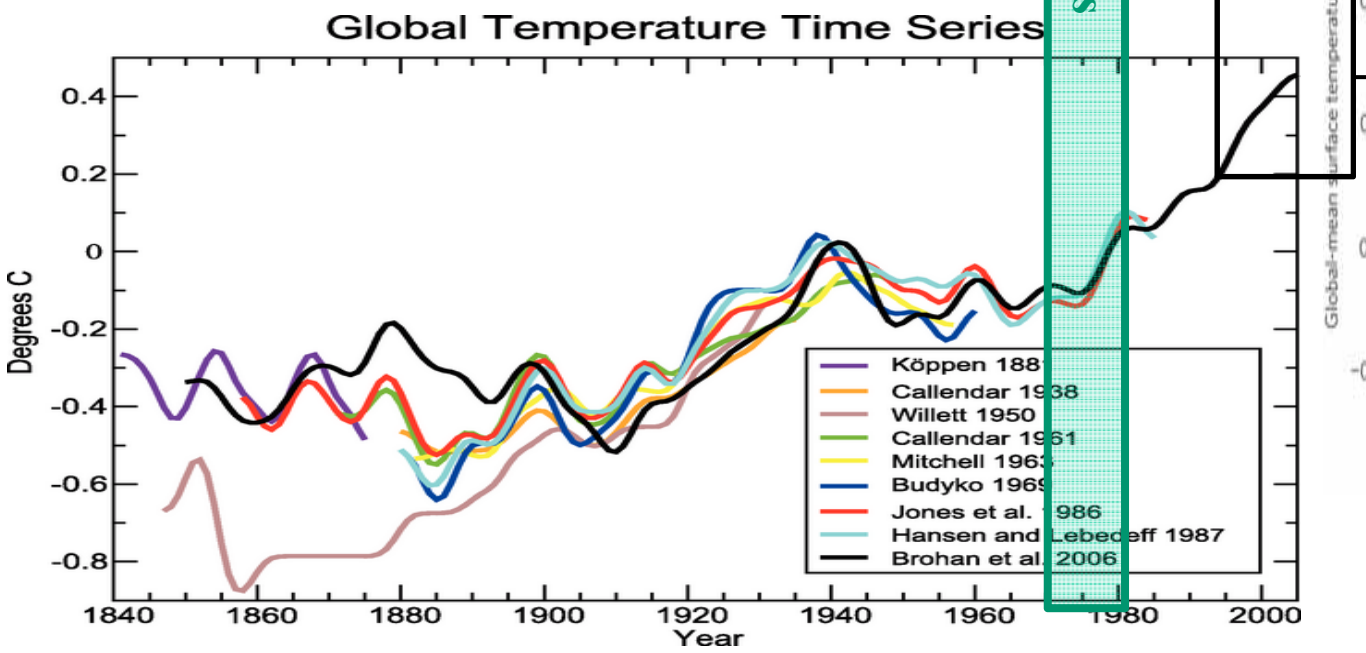



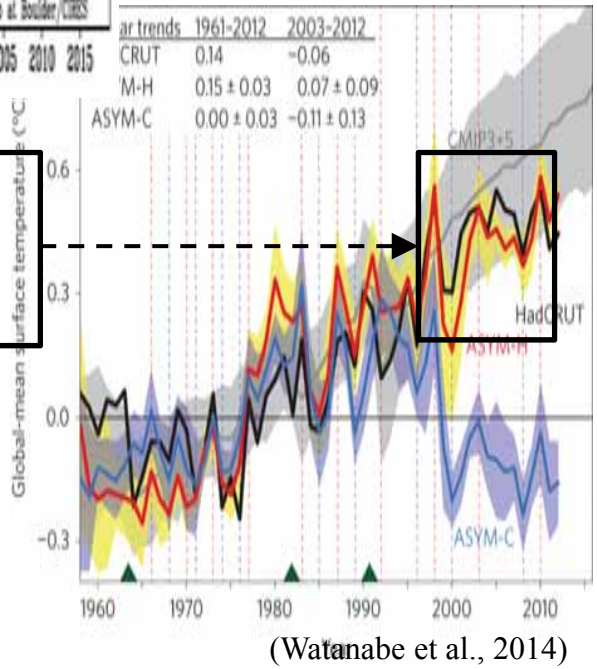

(NOAA)



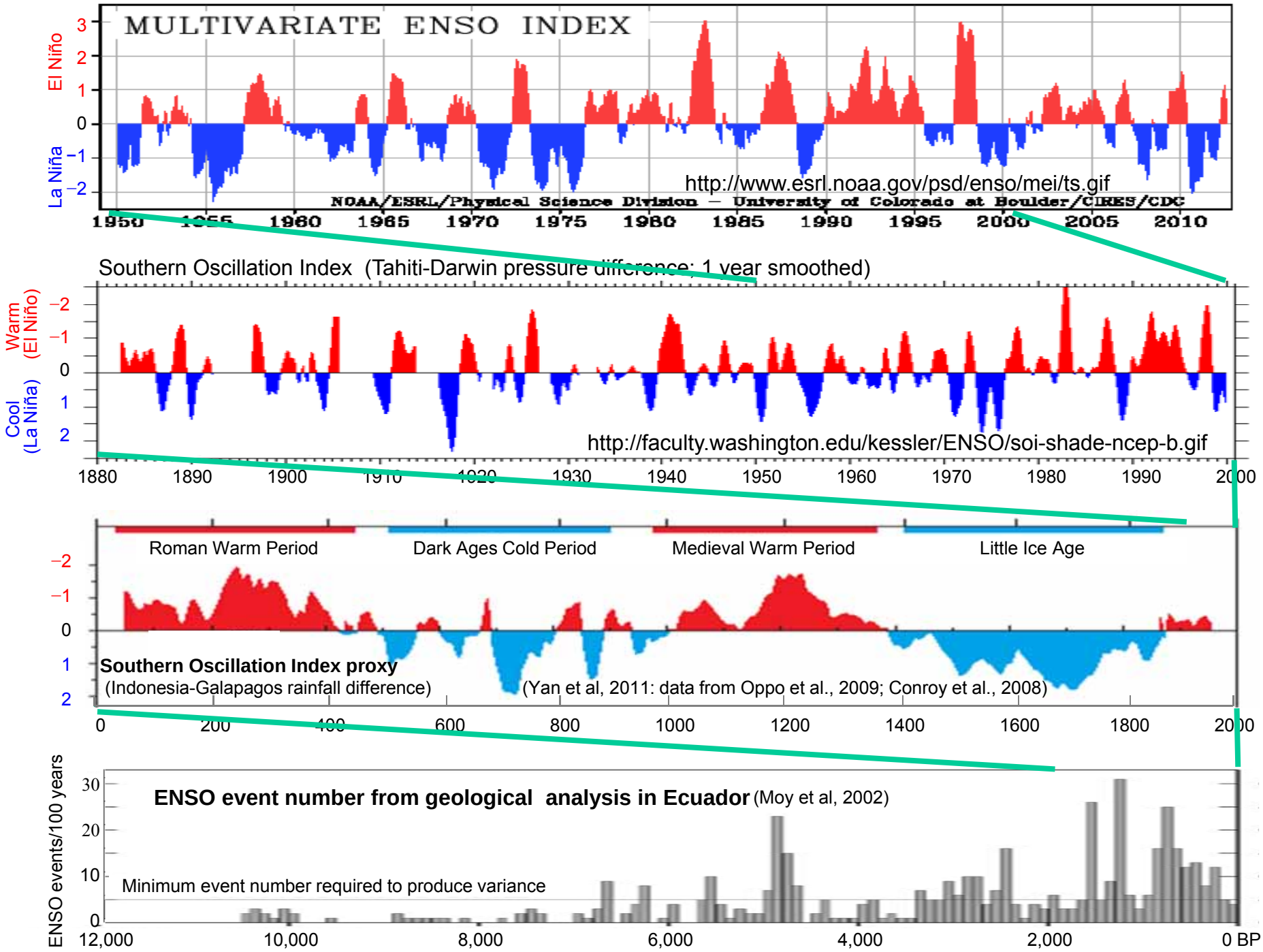

1970s

**Around 2000s**
**"Hiatus"**

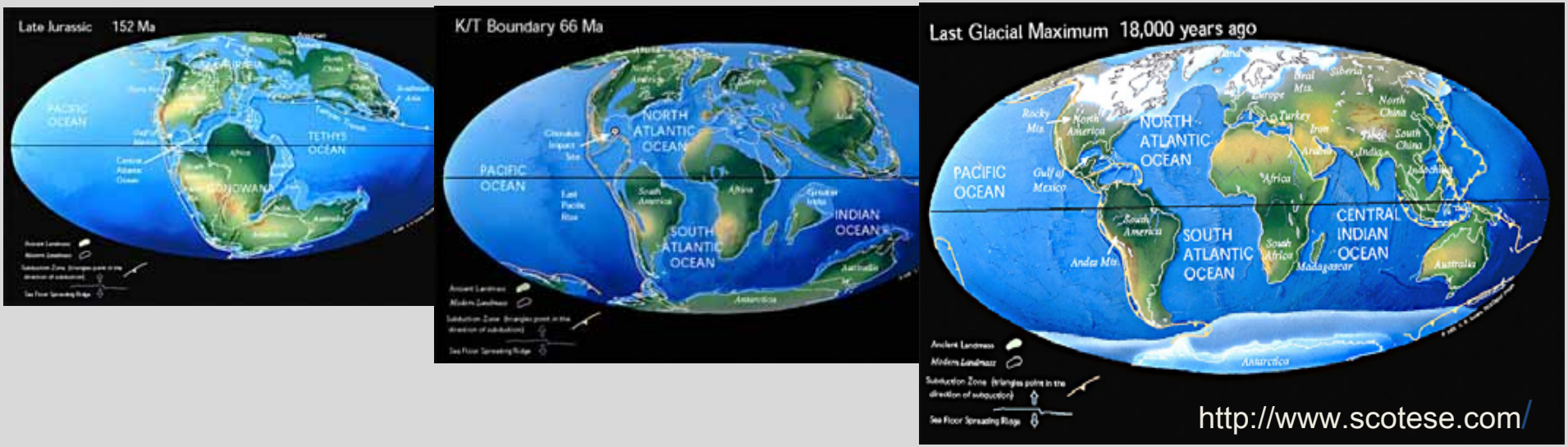



(Watanabe et al., 2014)

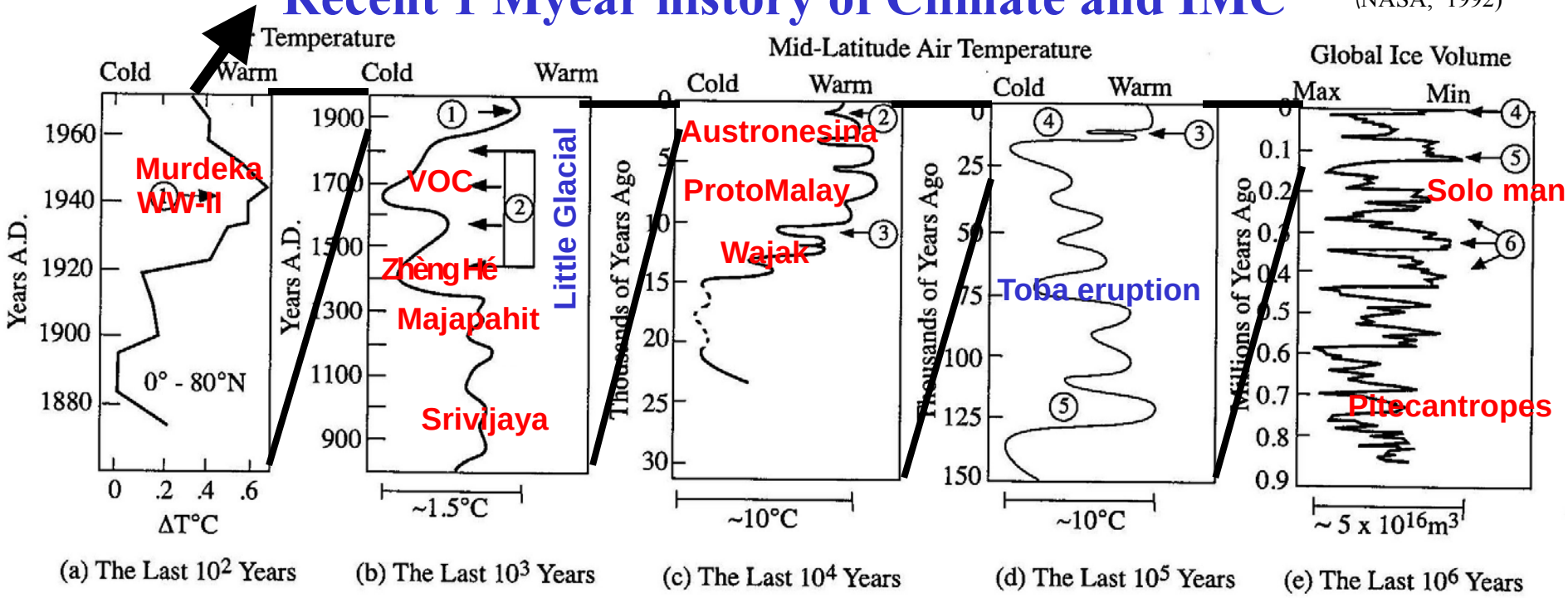

MULTIVARIATE ENSO INDEX
El Niño
La Niña
http://www.esrl.noaa.gov/psd/enso/mei/ts.gif
NOAA/ESRL/Physical Science Division – University of Colorado at Boulder/CIRES/CDC
Southern Oscillation Index (Tahiti-Darwin pressure difference; 1 year smoothed)
Warm (El Niño)
Cool (La Niña)
http://faculty.washington.edu/kessler/ENSO/soi-shade-ncep-b.gif
Roman Warm Period
Dark Ages Cold Period
Medieval Warm Period
Little Ice Age
Southern Oscillation Index proxy
(Indonesia-Galapagos rainfall difference)
(Yan et al, 2011: data from Oppo et al., 2009; Conroy et al., 2008)
ENSO event number from geological analysis in Ecuador (Moy et al, 2002)
ENSO events/100 years
Minimum event number required to produce variance
12,000
10,000
8,000
6,000
4,000
2,000
0 BP

# Ocean: Continent ~ 7: 3 concerved for 400 MYears



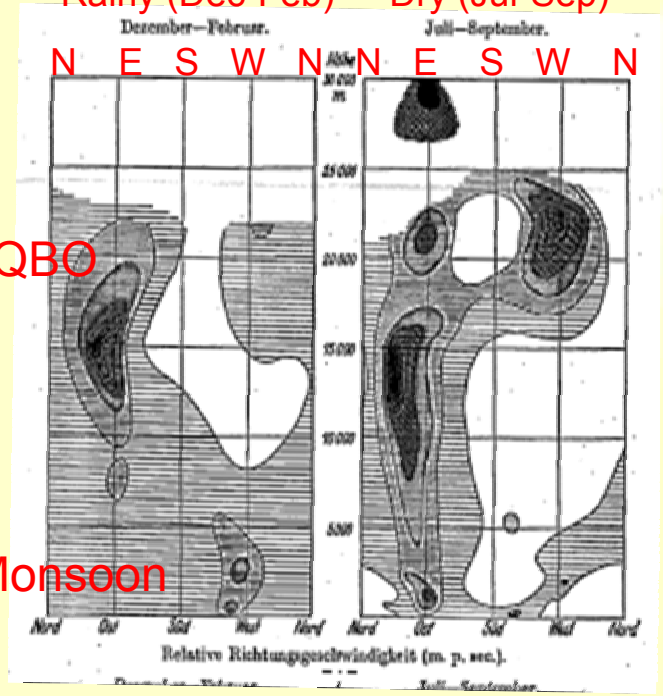

# Recent 1 Myear history of Climate and IMC

(NASA, 1992)

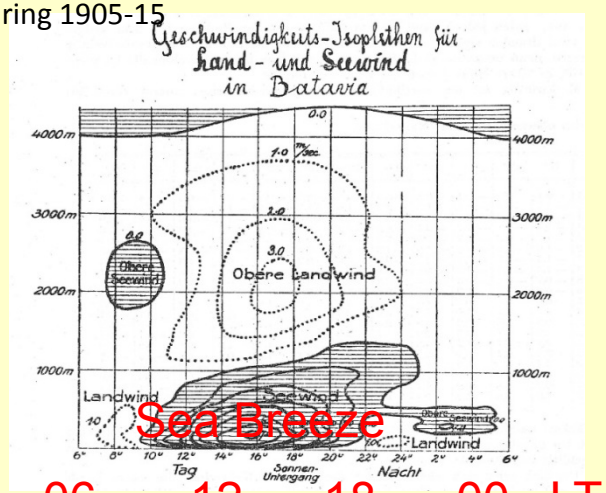


## van Bemmelen (1913, 1922)

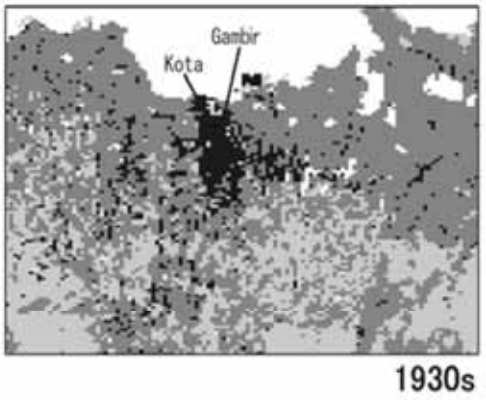
Rainy (Dec-Feb) Dry (Jul-Sep)



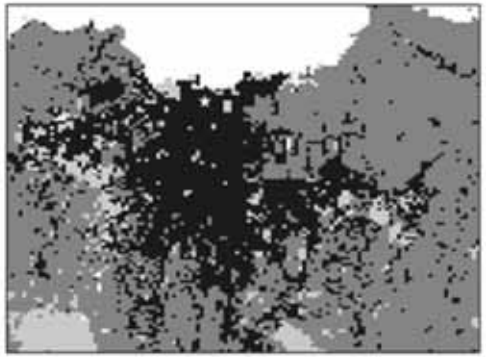

06-24 LT hourly for May-Nov;
08, 14, 19 LT for Dec-Apr
during 1905-15



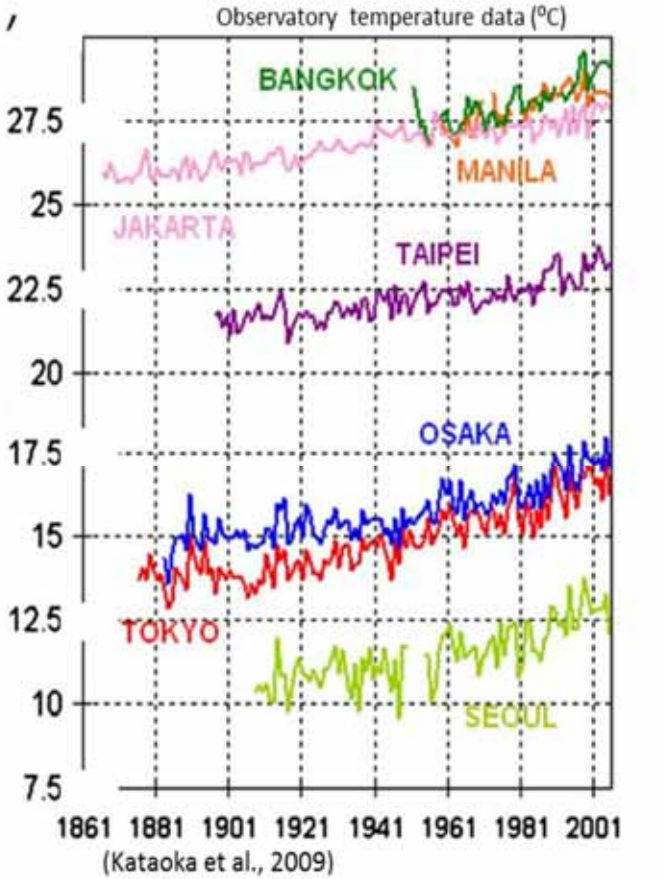

## Urbanization of Batavia/Jakarta





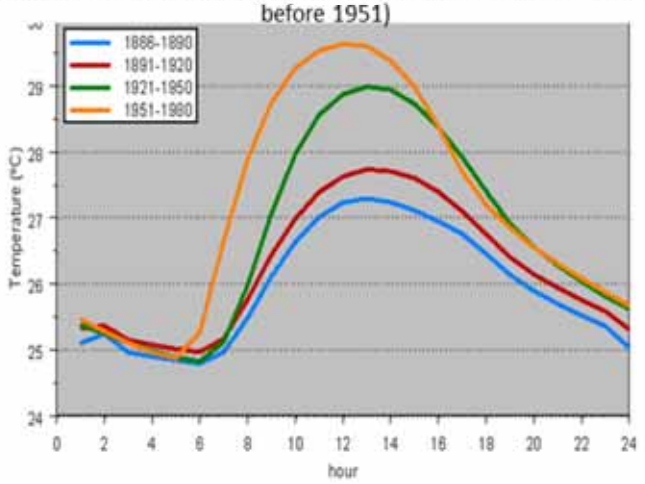



(Yamashita, 2011)

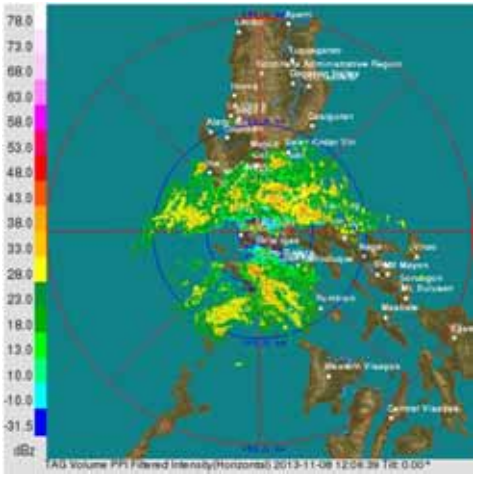



(Kataoka et al., 2009)

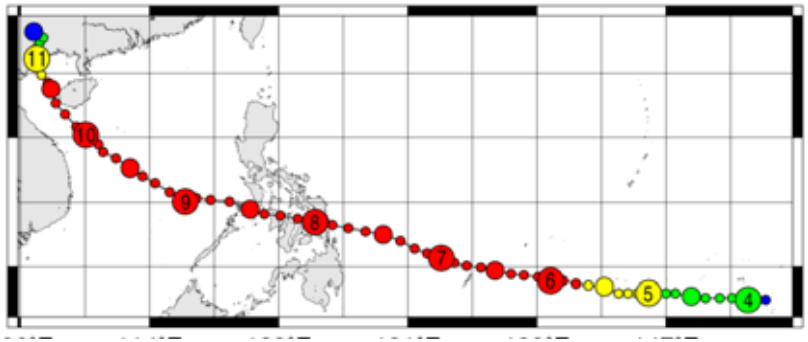
Batavia/Jakarta diurnal cycle changes (1866-1980)
(Brandsma, 2012, @KNMI; probably standard-time was 1 h ahead before 1951)



# Lessons from Typhoon Haiyan (Yolanda, T1330)

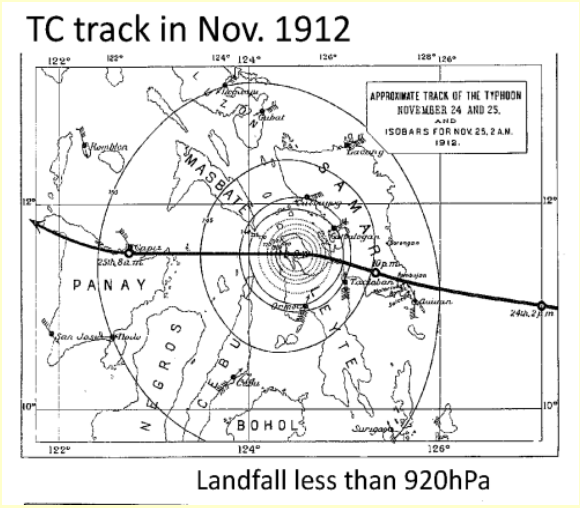


(credit: Dr. Cayanan/PAGASA)

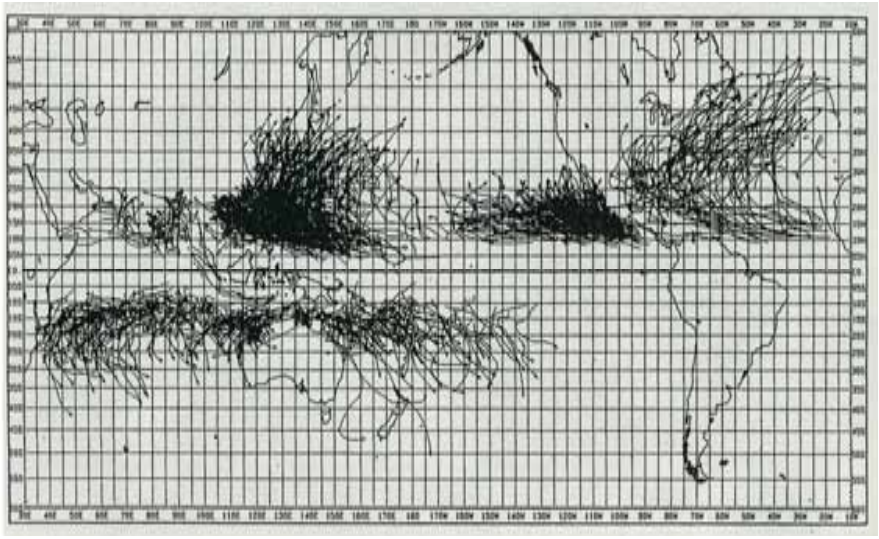



- Radar operated
- Prediction correct

- Not new (not due to global warming)




(credit: Dr. Kubota/JAMSTEC)

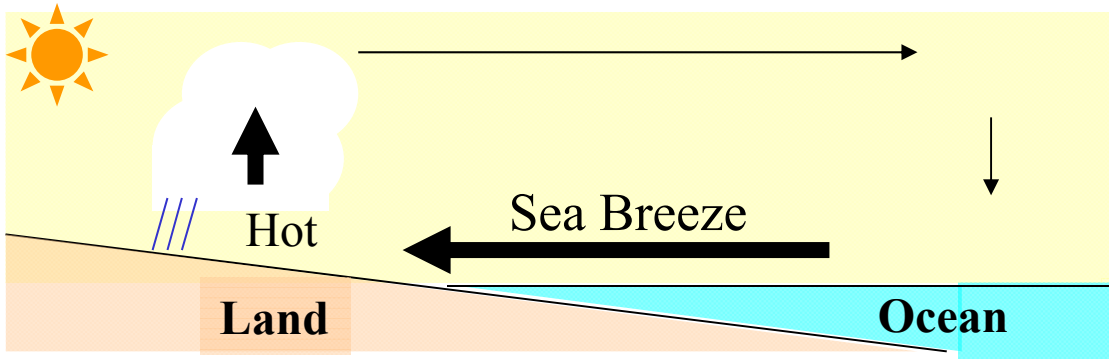


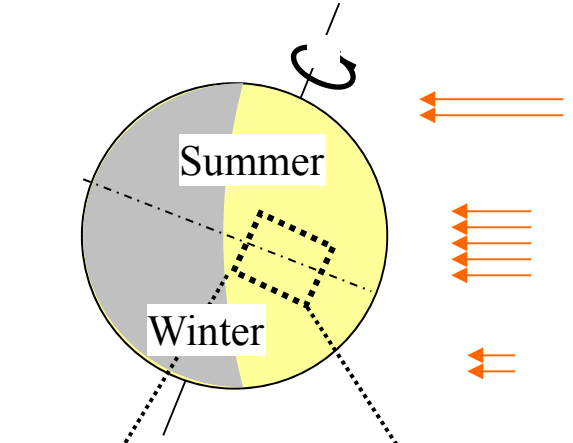
# "Astronomical" Monsoon

## Axi-Symmetric Meridional Circulation due to Differential Solar Heating

### "Terrestrial" Monsoon

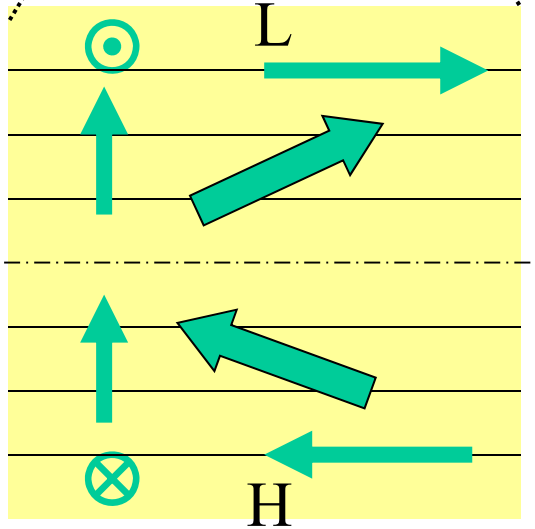
Sea-Land Breeze Analogue



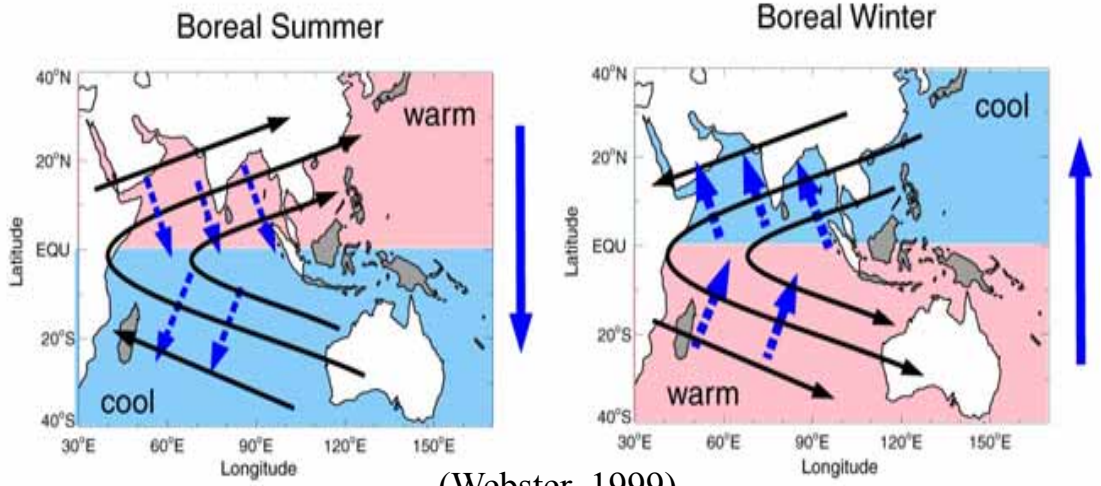

Annual Osci. (Eq. Anti-Symmetric)

⇒ Monsoon Circulation



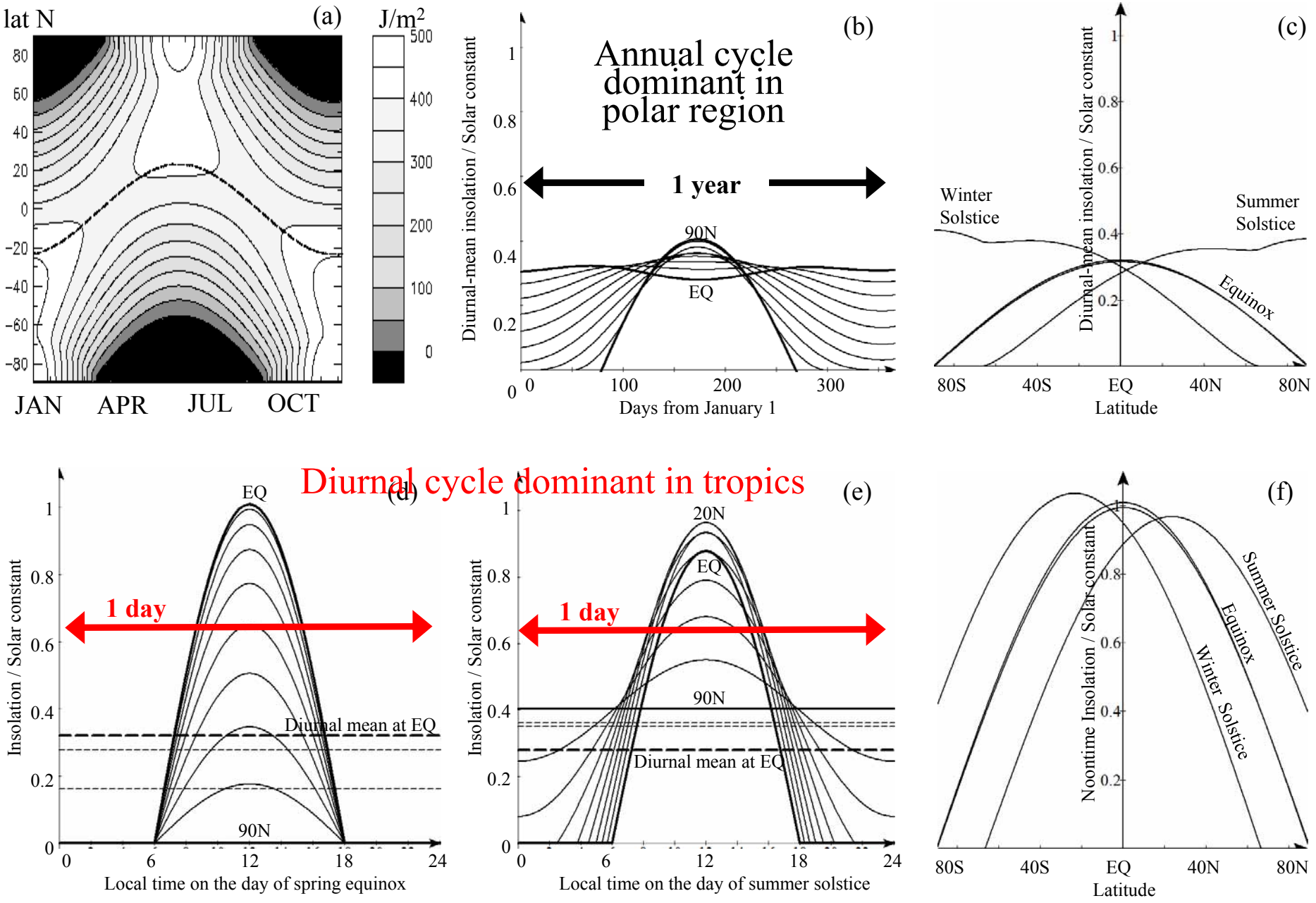

(cf. Mesosphere, Mars)

### Monsoon-driven Seasonal Ocean Current



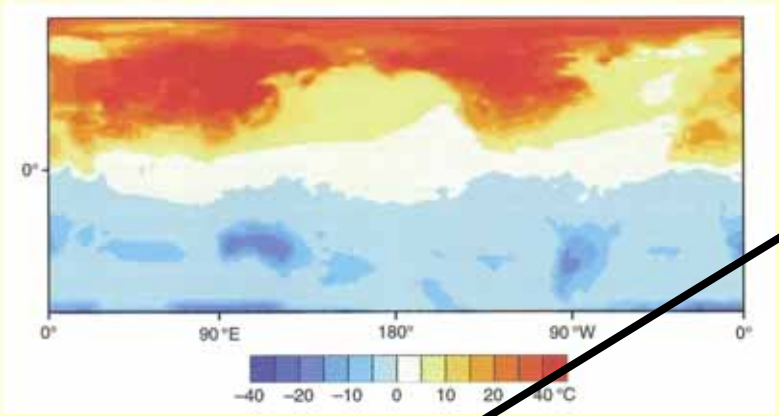

(Webster, 1999)

# Solar heating on earth with revolution and rotation



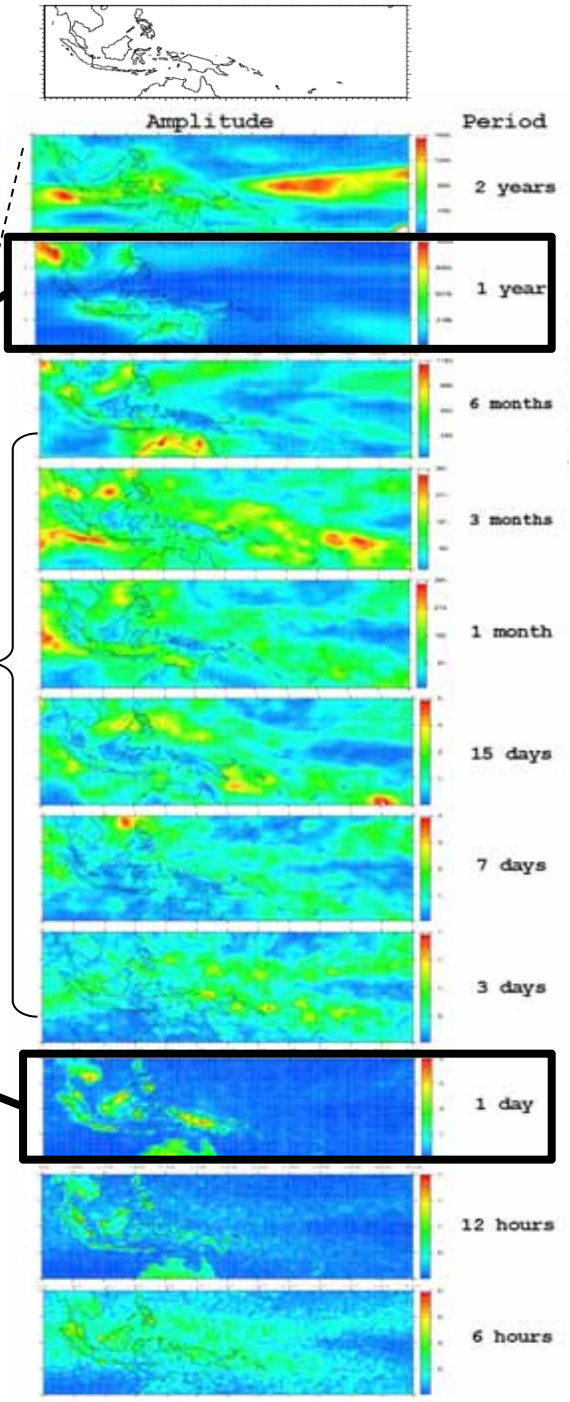
# Spectral distribution of GMS cloud height

"Find the continents" game
July – January
(Wallace & Hobbs, 2006; original by Mitchel)



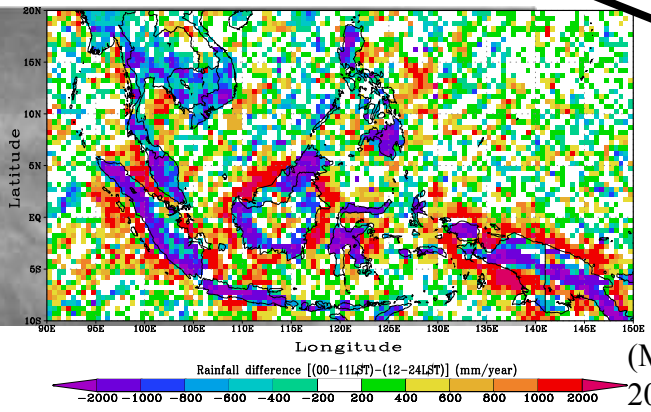

**Annual & Diurnal cycles around lands**

Interannual & intraseasonal variations over oceans



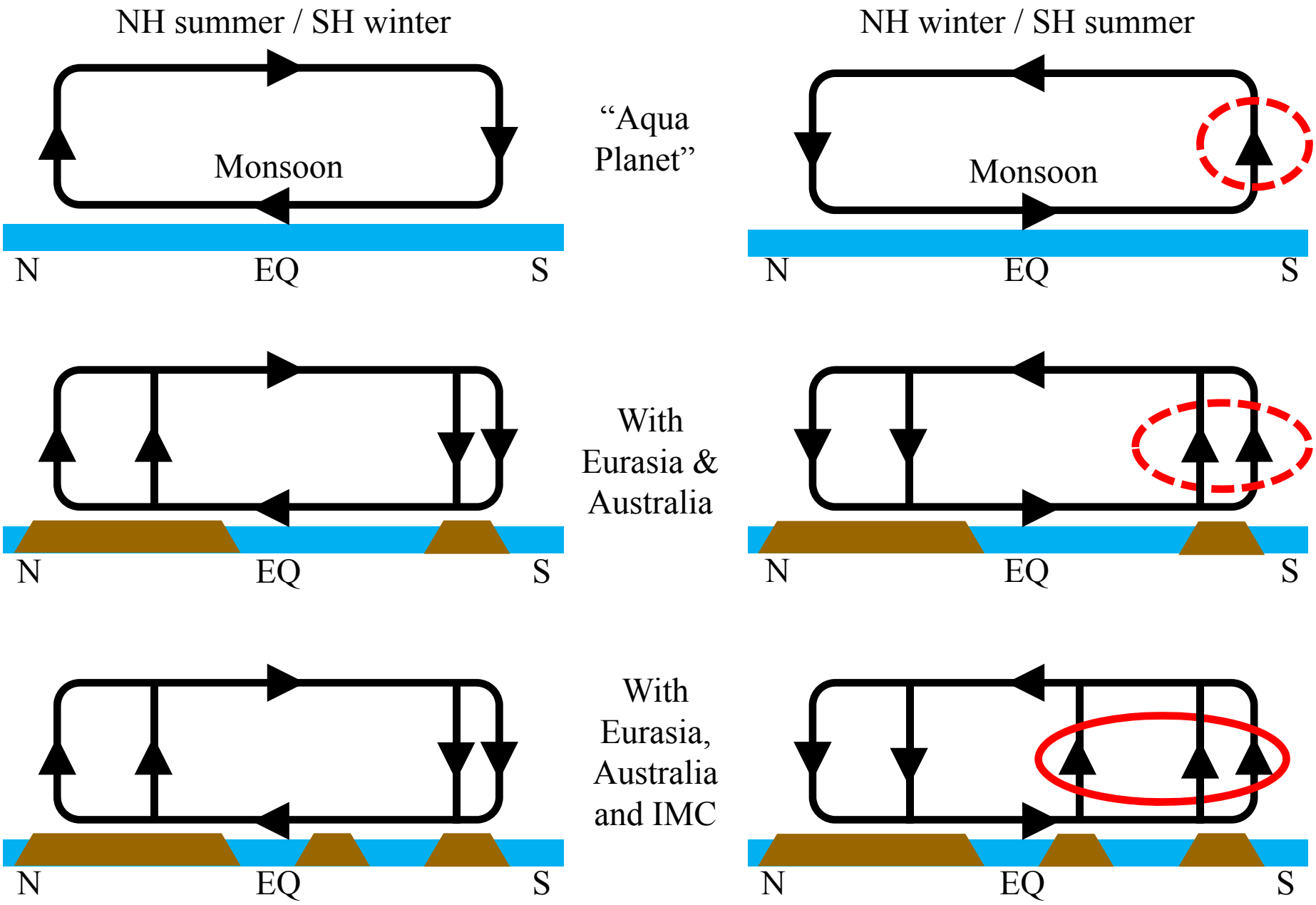

**Mon. mean GMS clouds**


**TRMM Morning − Evening Rain**




(Mori et al , 2004)

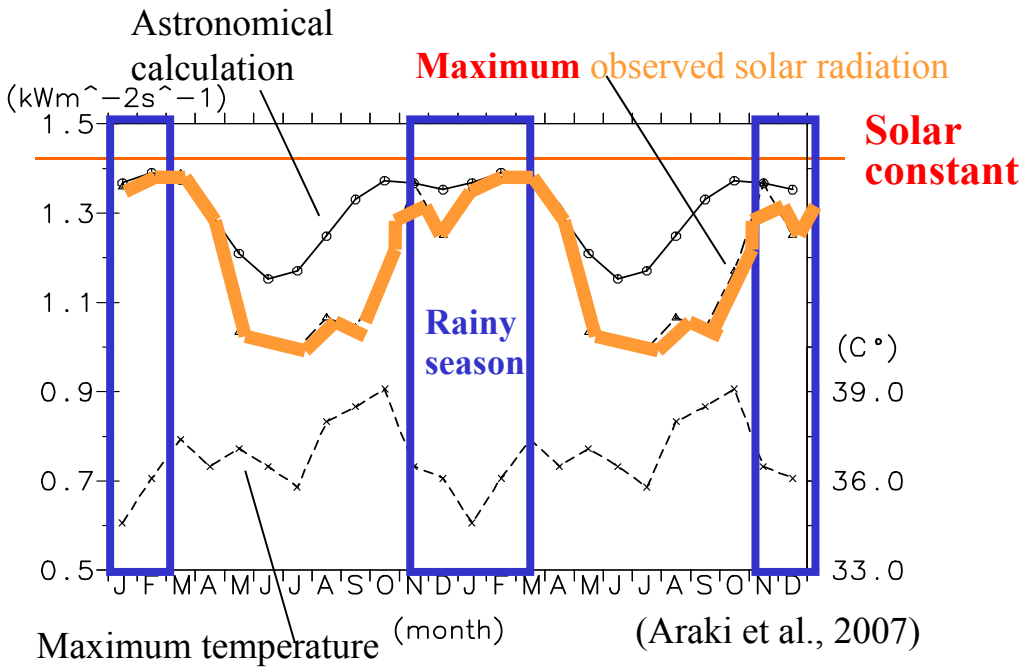
# Southern-hemispheric summer pushed northward



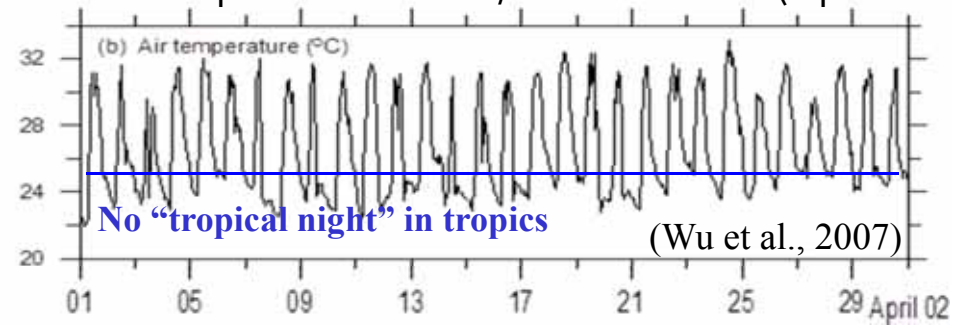
# Mechanism of Seasonal and Diurnal Cycles

**Strong solar radiation in the morning of "rainy season"**

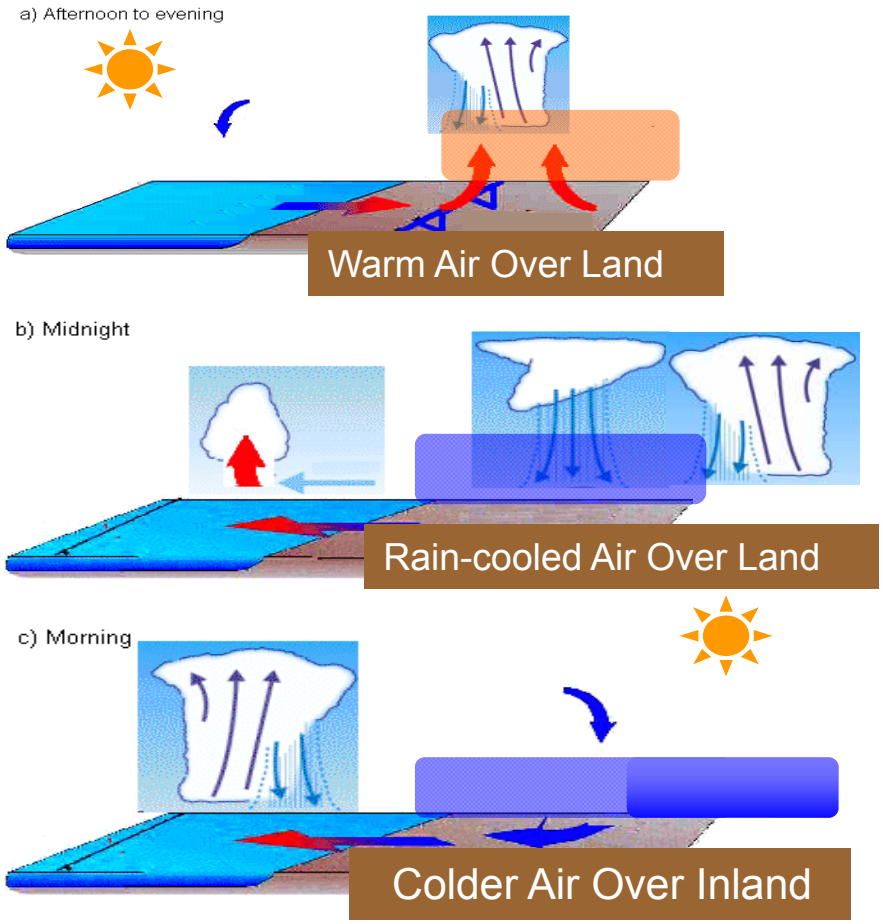
Solar rad. at Serpong/WJawa11-13LT (1993-2002)




Surface Temp. at Pontianak/WKalimantan (Apr 2002)

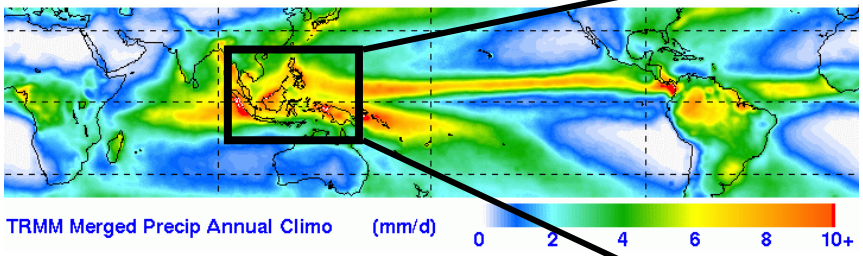


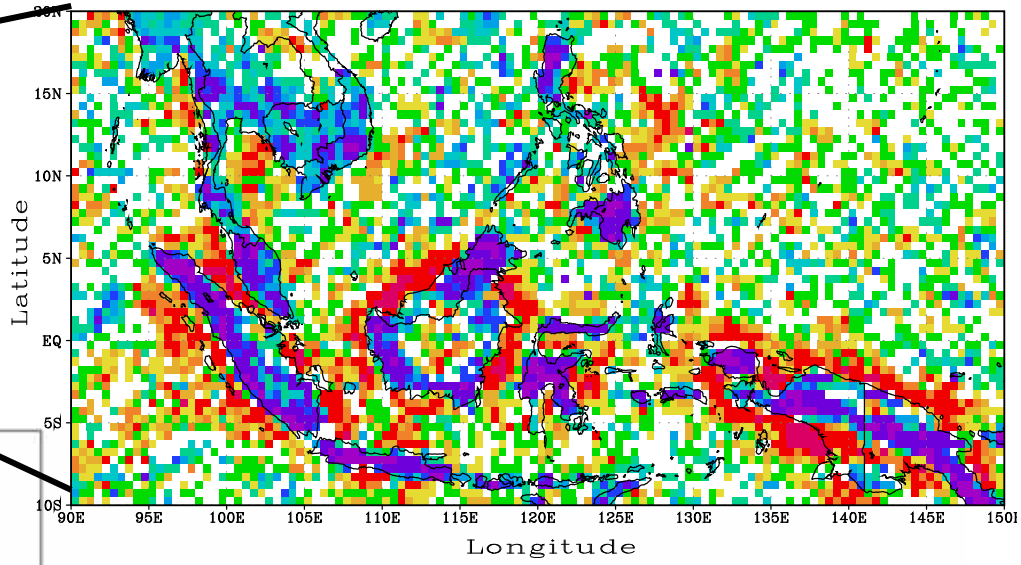

**Sea-Land Breeze circulation with cloud "sprinkler" effect**




(Wu, Yamanaka & Matsumoto., 2008)

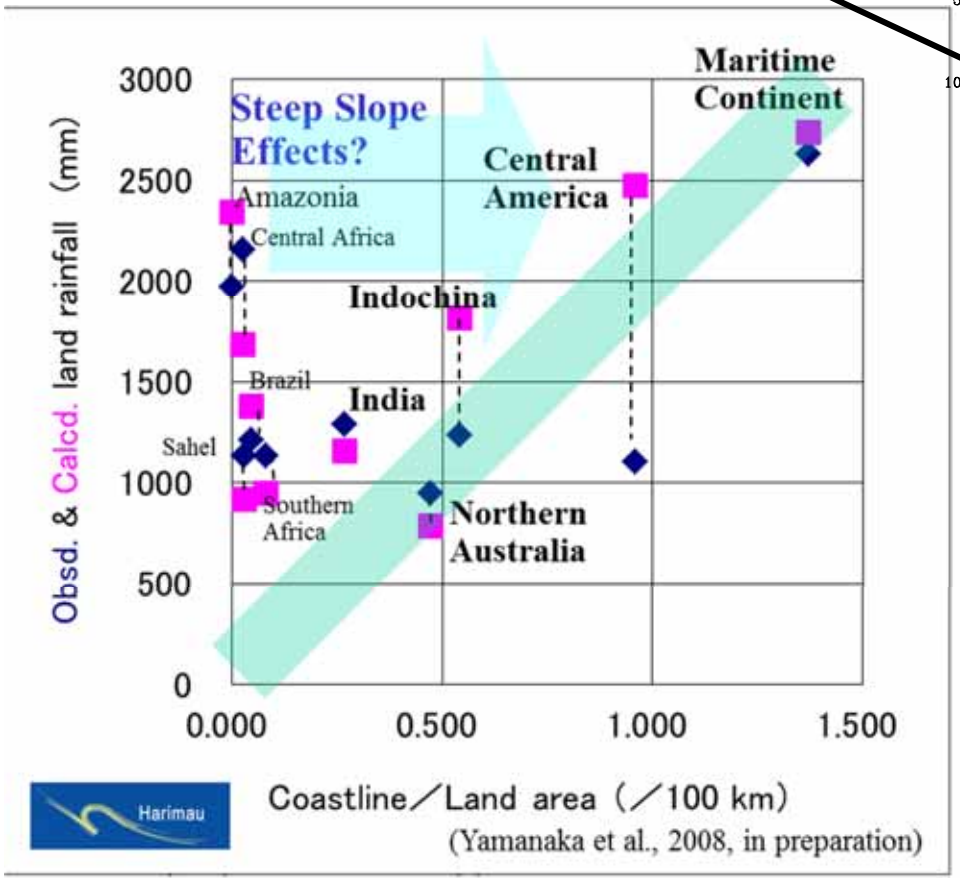
# IMC coastal diurnal-cycle rainfall controlling global climate

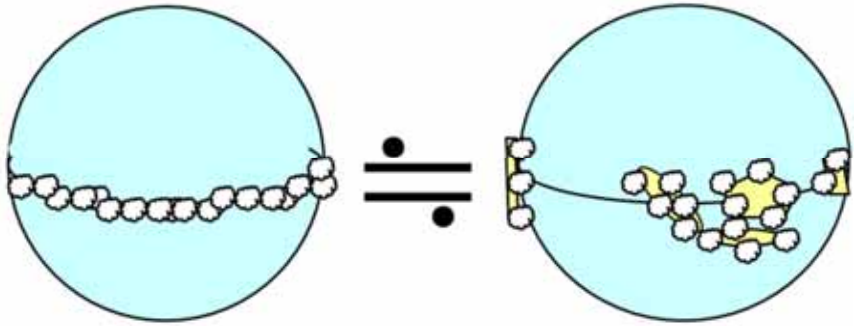


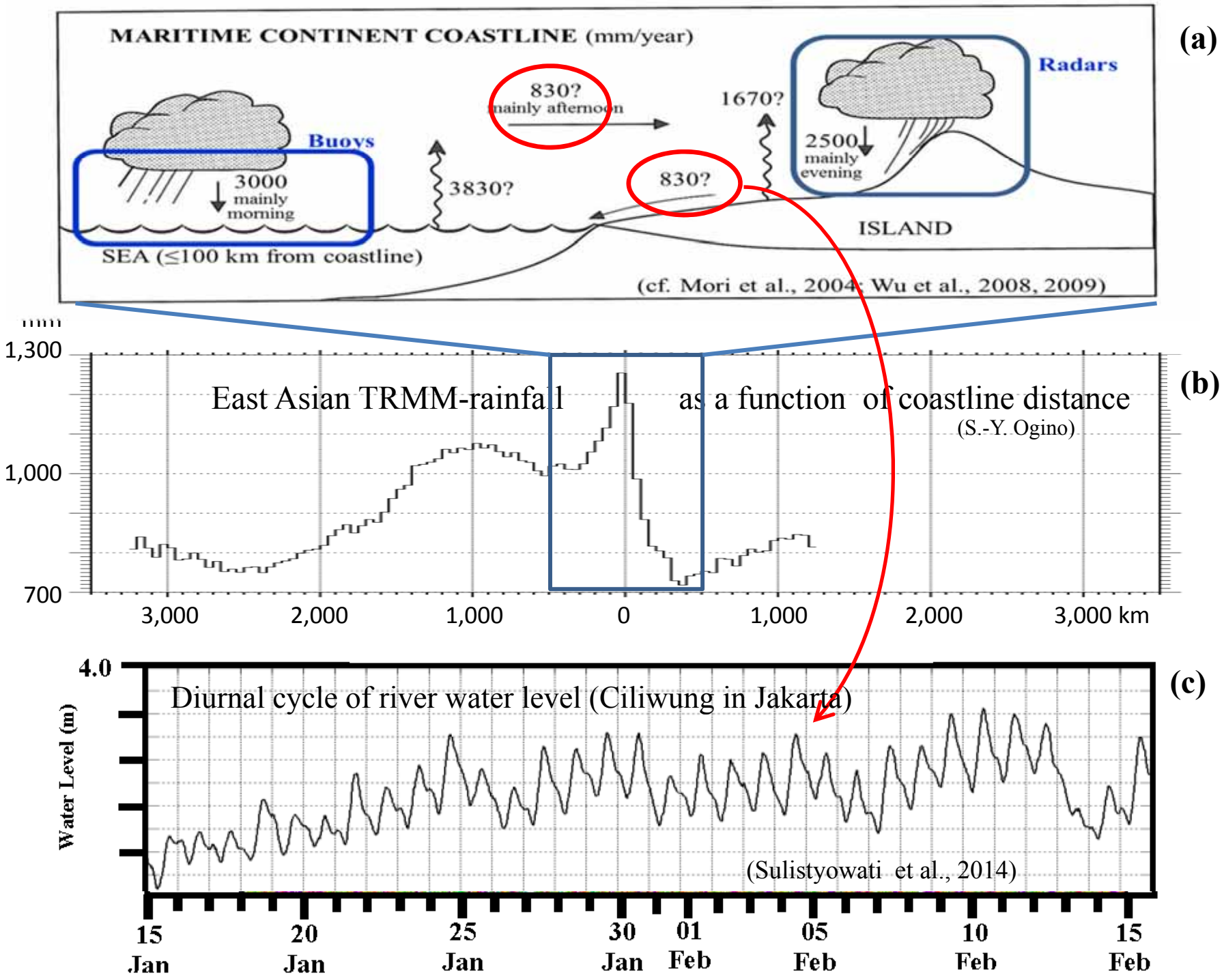




**Morning Rain − Evening Rain**

(Mori et al., 2004, *Mon. Wea. Rev.*)




MARITIME CONTINENT COASTLINE (mm/year)
(a)
Radars
830?
mainly afternoon
1670?
Buoys
2500
mainly
evening
3000
mainly
morning
3830?
830?
ISLAND
SEA (≤100 km from coastline)
(cf. Mori et al., 2004; Wu et al., 2008, 2009)
1,300
1,000
700
East Asian TRMM-rainfall as a function of coastline distance
(S.-Y. Ogino)
(b)
3,000
2,000
1,000
0
1,000
2,000
3,000 km
4.0
Water Level (m)
Diurnal cycle of river water level (Ciliwung in Jakarta)
(c)
(Sulistyowati et al., 2014)
15 Jan
20 Jan
25 Jan
30 Jan
01 Feb
05 Feb
10 Feb
15 Feb

# Diurnal amplified by monsoon/intraseasonal → Jakarta flood

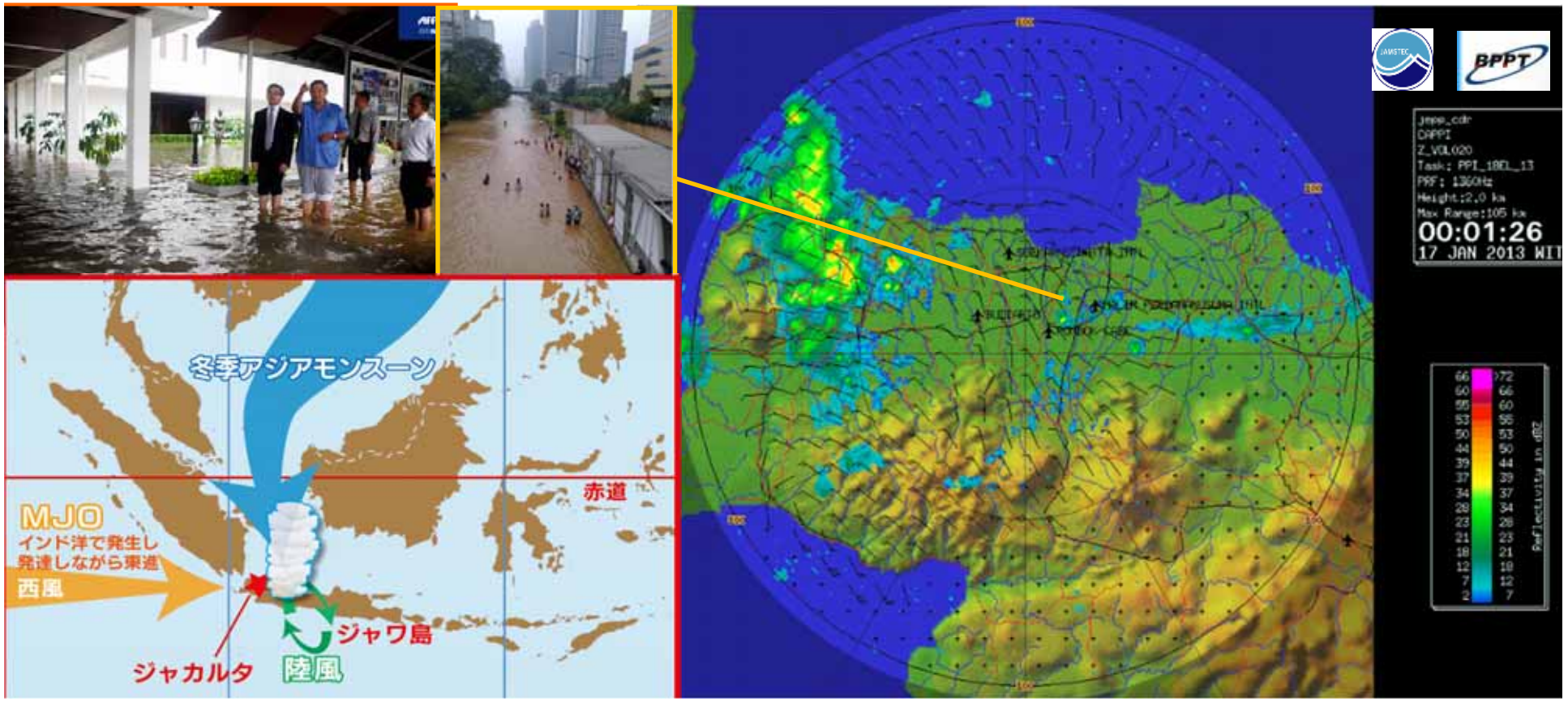
78 *SOLA, 2013, Vol. 9, 78−82, doi:10.2151/sola.2013-018*

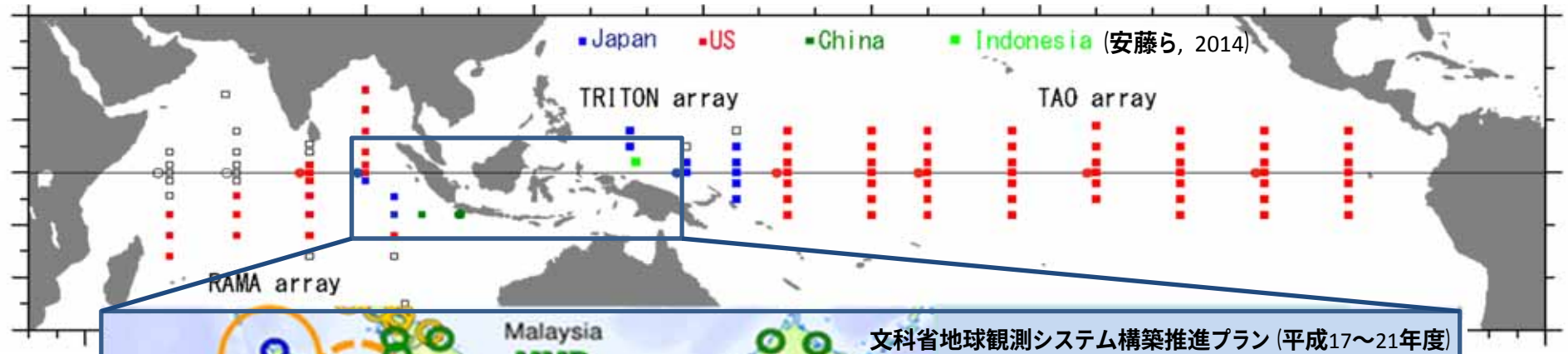
## The Effects of an Active Phase of the Madden-Julian Oscillation on the Extreme Precipitation Event over Western Java Island in January 2013

Peiming Wu[1], Ardhi Adhary Arbain[2], Shuichi Mori[1], Jun-ichi Hamada[1], Miki Hattori[1], Fadli Syamsudin[2] and Manabu D. Yamanaka[1]

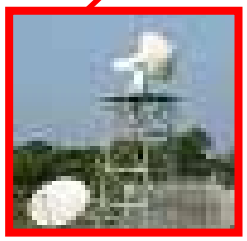
[1]*Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan*

[2]*Agency for the Assessment and Application of Technology (BPPT), Indonesia*









気象レーダー


可搬型マルチパラメタレーダー

インドネシア国立海大陸研究所 (MCCOE)

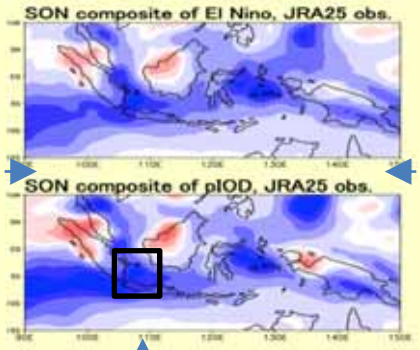
ウインドプロファイラー

気候観測 (InaTRITON) ブイ

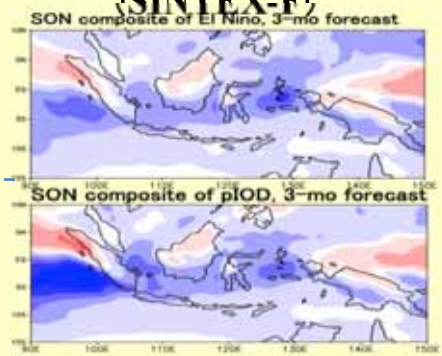
# Contribution to accurate climate prediction

InaTRITON

Global analysis (JRA)

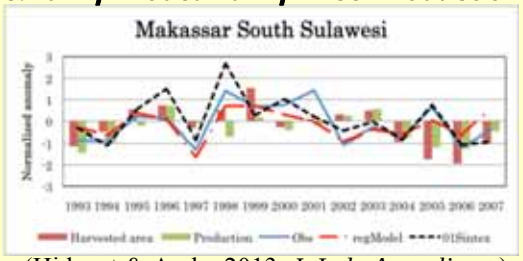



Global ocean-atmosphere model (SINTEX-F)




LN
IOD—
rainy

Obs.Rain / Model Rain / Rice Production

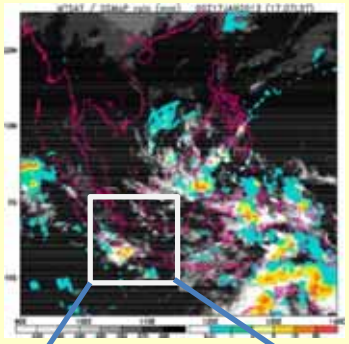



(Hidayat & Ando, 2013, *J. Indo.Agroclimat.*)

10 years

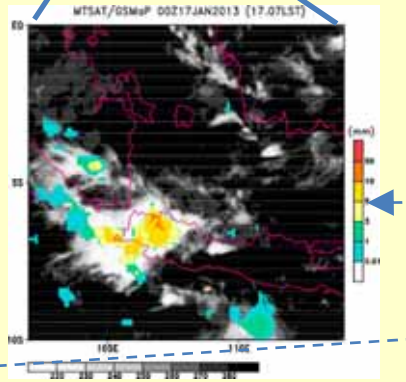
MPR

Satellite obs (MTSAT)

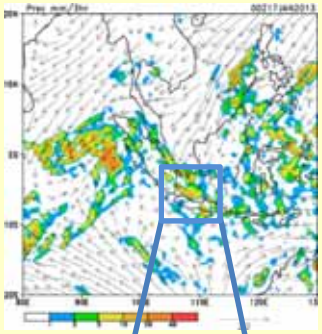


XDR

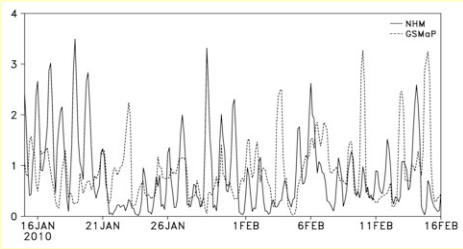
CDR



Global weather forecast (GSM)



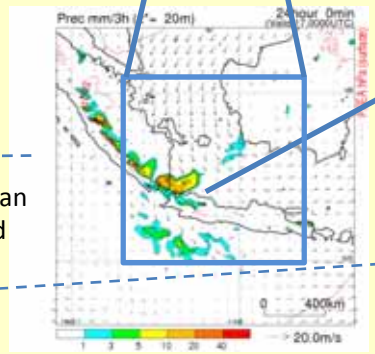
Obs / Model - rainfall




(Hattori, Mori, et al., 2014, in preparation)

1 month

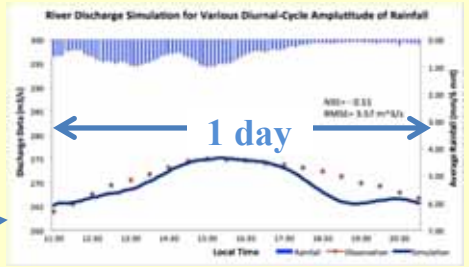
Local weather forecast (NHM)



2013 Jan flood

Hydrological model (CDRMV5)

Obs /Model – River water



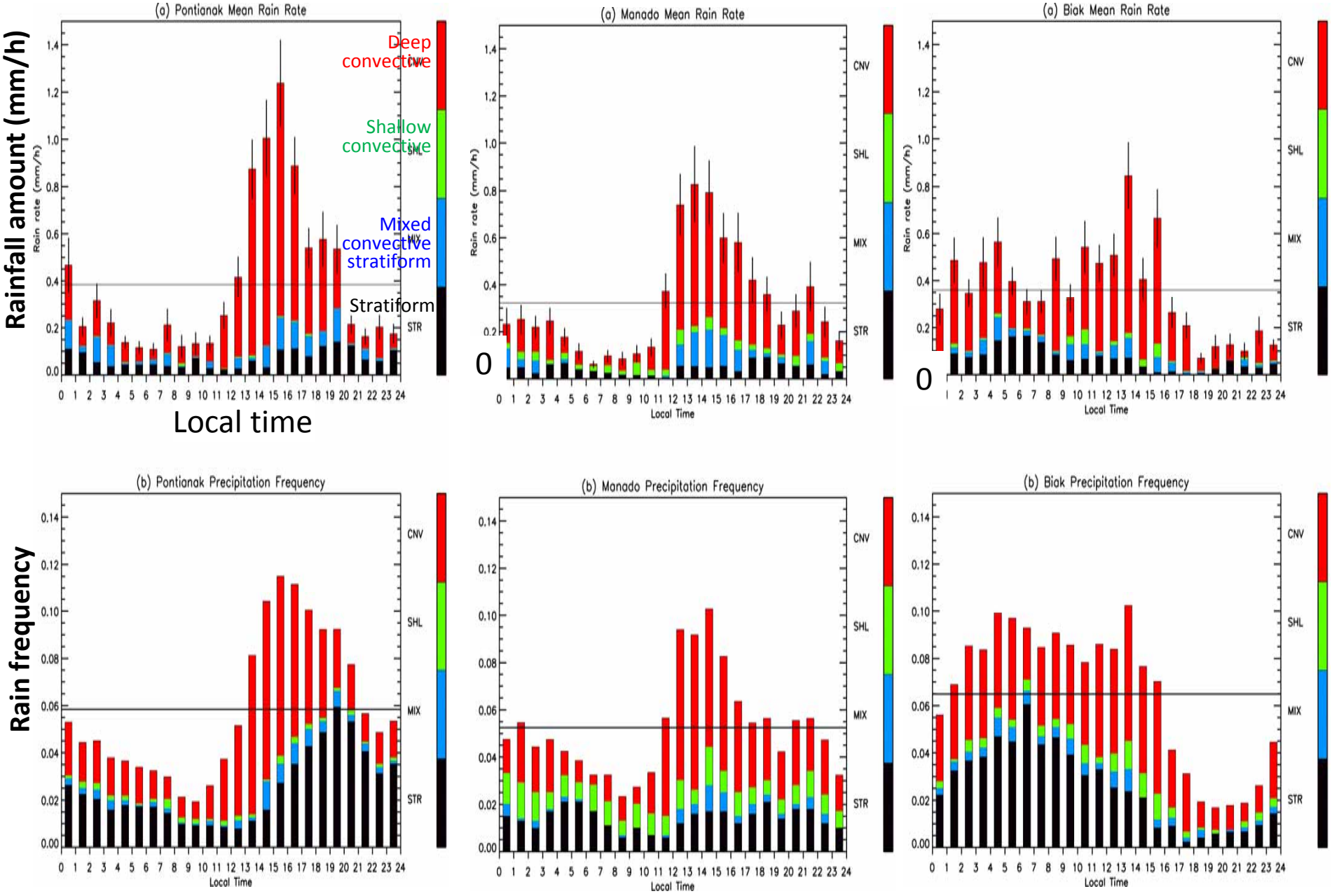

Simulated by radar obs

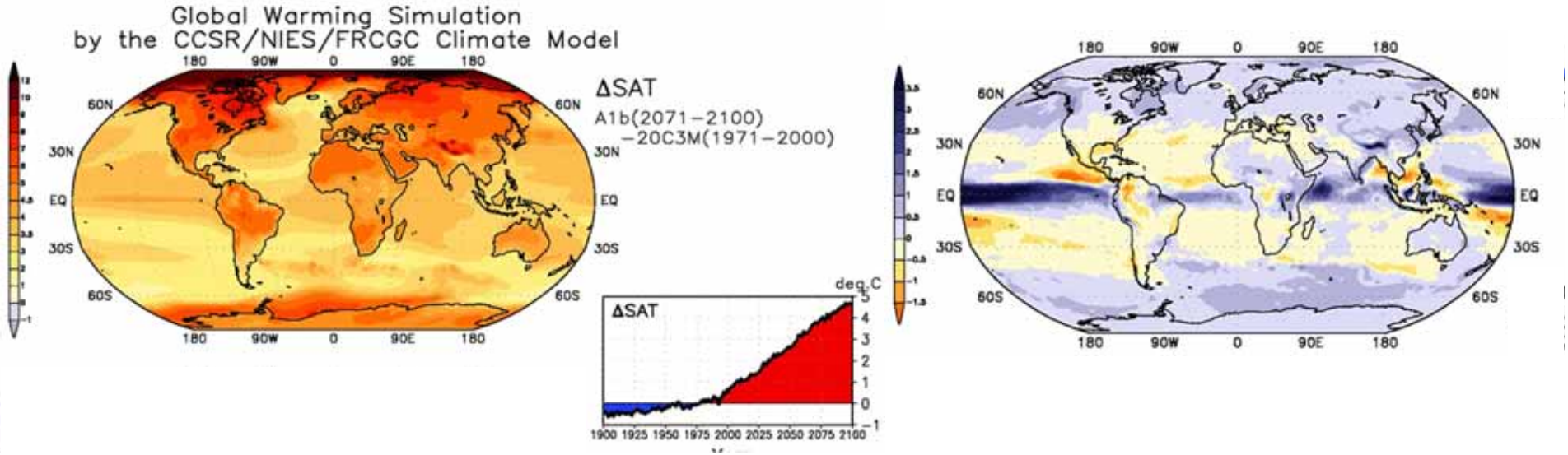
(Sulistyowati, Hapsari, Mori, Oishi, Yamanaka, 2014, in preparation)

# Geographical variety of diurnal-cycle "rainfall observed by WPR"

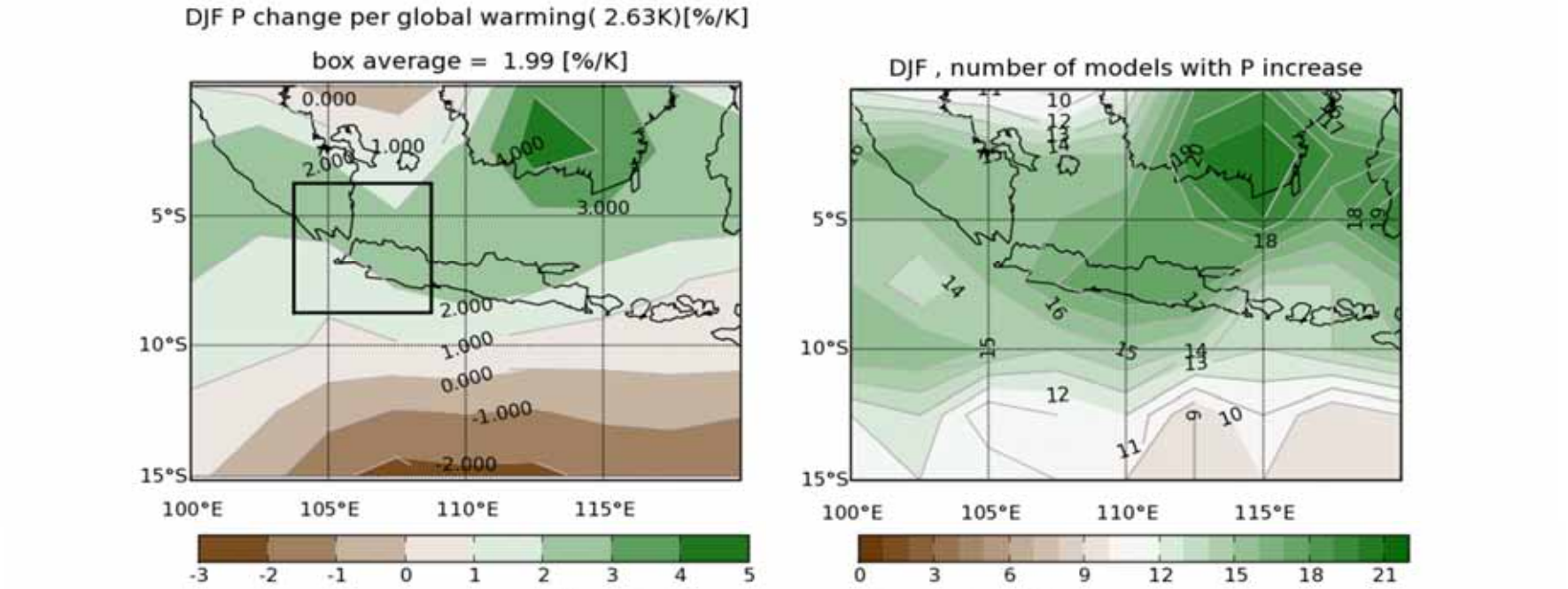
(Tabata et al, 2011a, b)

**Pontianak** **Manado** **Biak**






# Downscaling of climate/weather prediction

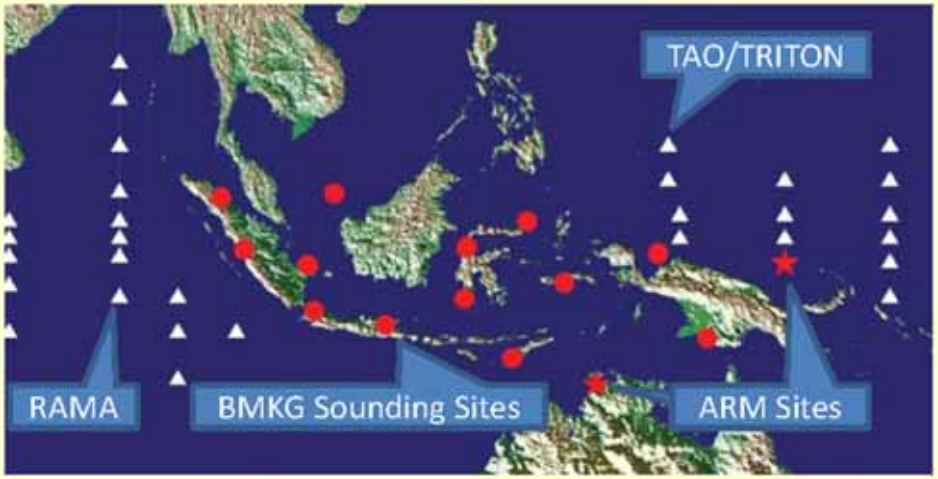



(Sumi, 2011, presentation at BMKG)

# Climate Researches at MCCOE

## International Project

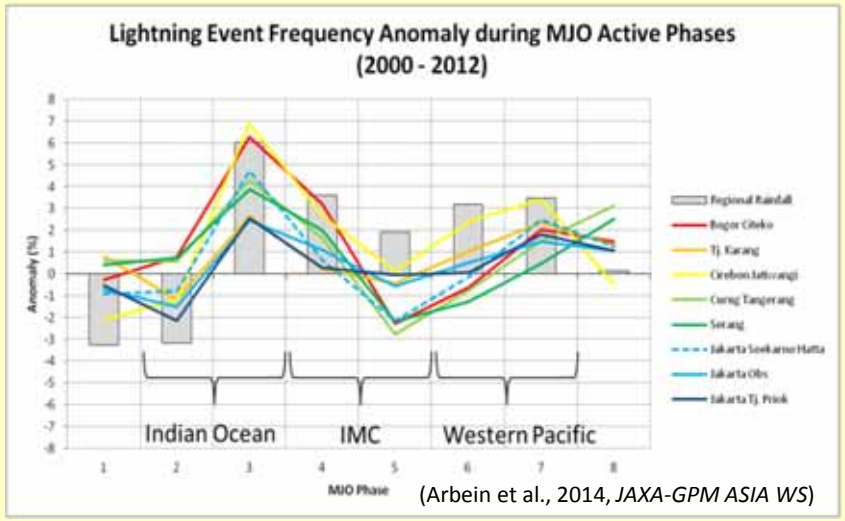
Year of Maritime Continent (YMC)
(2017-8, with US, Aus, France, …)




(Yoneyama)

## ASEAN Collaboration

(AHA Center)


(Arbein et al., 2014, *JAXA-GPM ASIA WS*)

## Basic Research

(with JAMSTEC, JAXA, …)


## Disaster Prevention

(with BMKG, BNPB, PU, DKI,…)

# Additional important lesson (from technical failures)

**Fukushima-1st Nuclear Power Plant**

- **Made by GE (US) in 1971 and 1974**
- **Pollutant diffusion predicted but not utilized**

**HARIMAU-CDR at Serpong stoppage by connector shortage (in humid dusty situation)**


# Summary

- **"Aqua-planet"** generates **Hadley**, (astronomical) monsoon, (global) tides and **ISV/MJO**.
- **Lands** in oceans turns currents poleward, and reflects waves (making interannual **ENSO/IOD**)
- **Indonesian maritime continent** with longest coastlines have largest rainfall mainly through **diurnal cycle** (sea-land breeze circulation) induced by liquid-solid contrast for solar heating.
- **High-resolution observation/modeling** (< 100 km) over islands/seas resolving coastlines are necessary to watch/understand/predict the global climate over our planet Earth.
- **Multi-lateral** international collaboration promoted by **scientifically established** countries must be promoted to cover both lands and seas by high resolutions.
- **Tropically/equatorially specialized science/technology** different from extratropics must be developed/established by Indonesia and surrounding ASEAN countries.