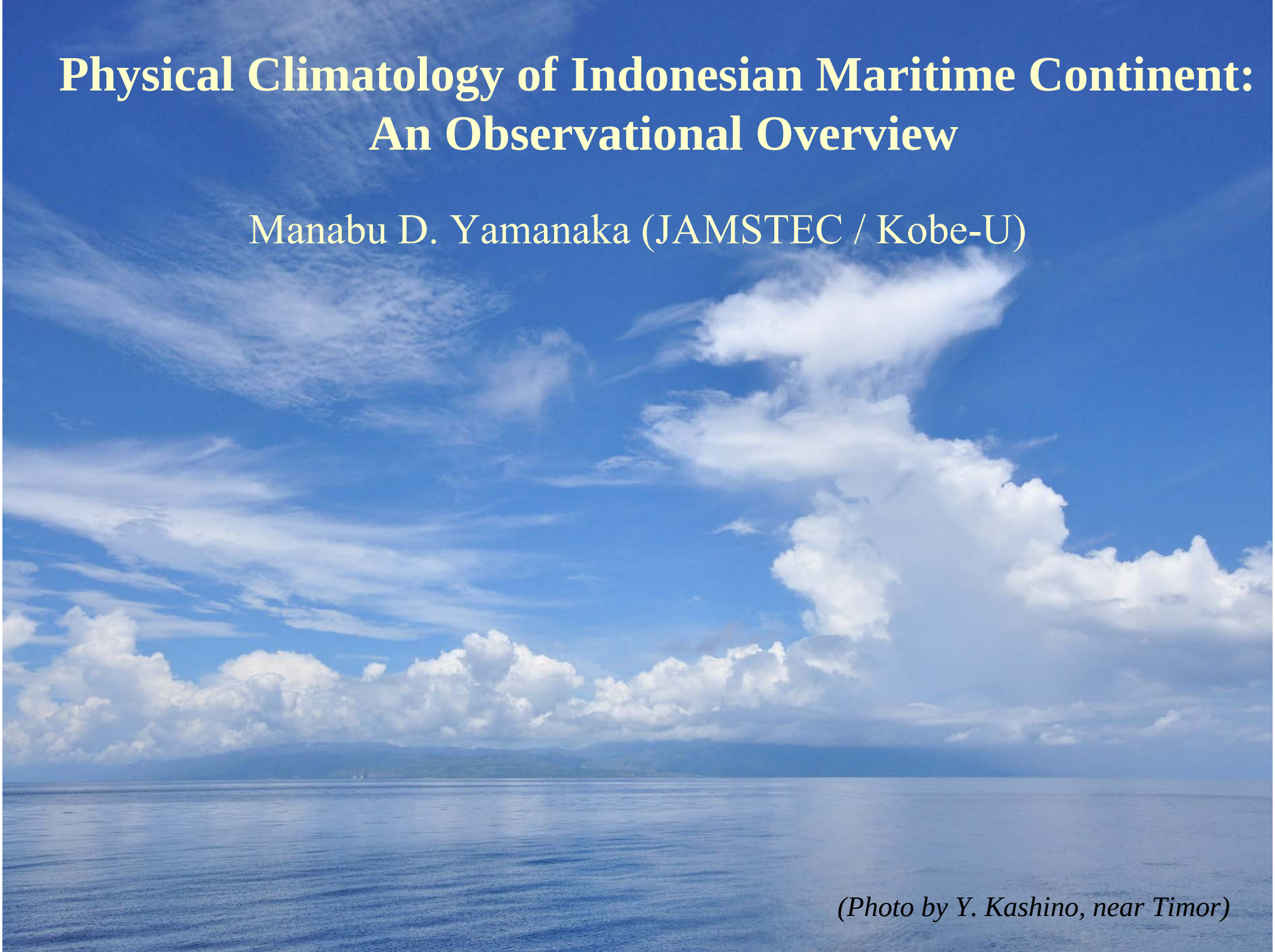
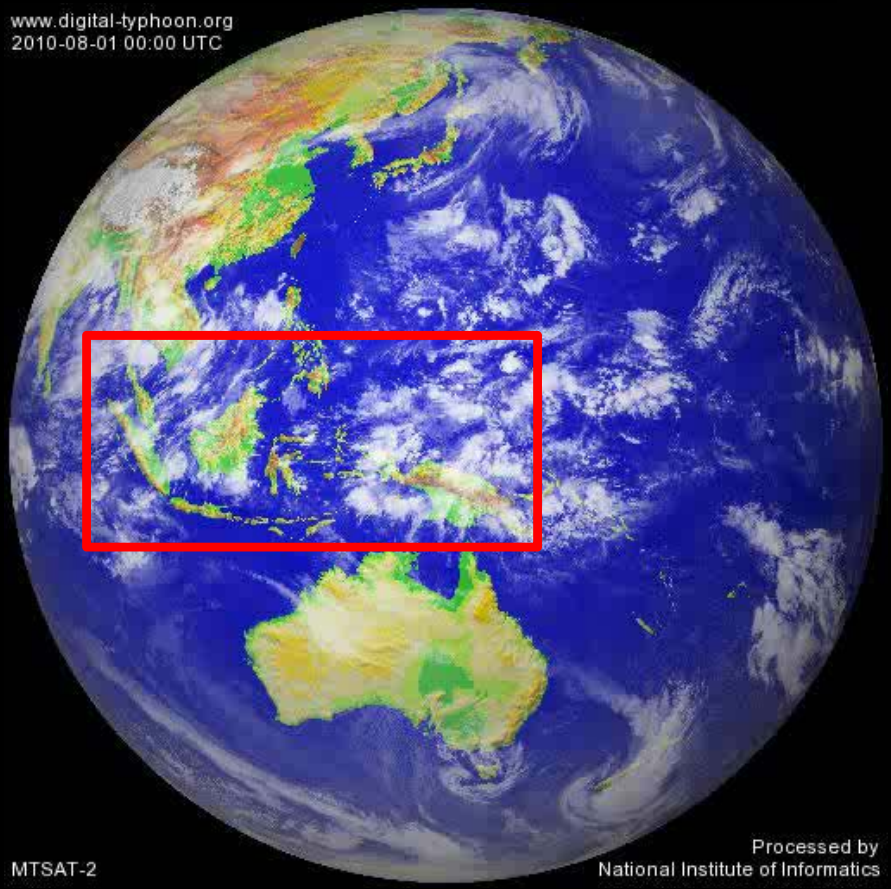
Physical Climatology of Indonesian Maritime Continent: An Observational Overview

Manabu D. Yamanaka (JAMSTEC / Kobe-U)

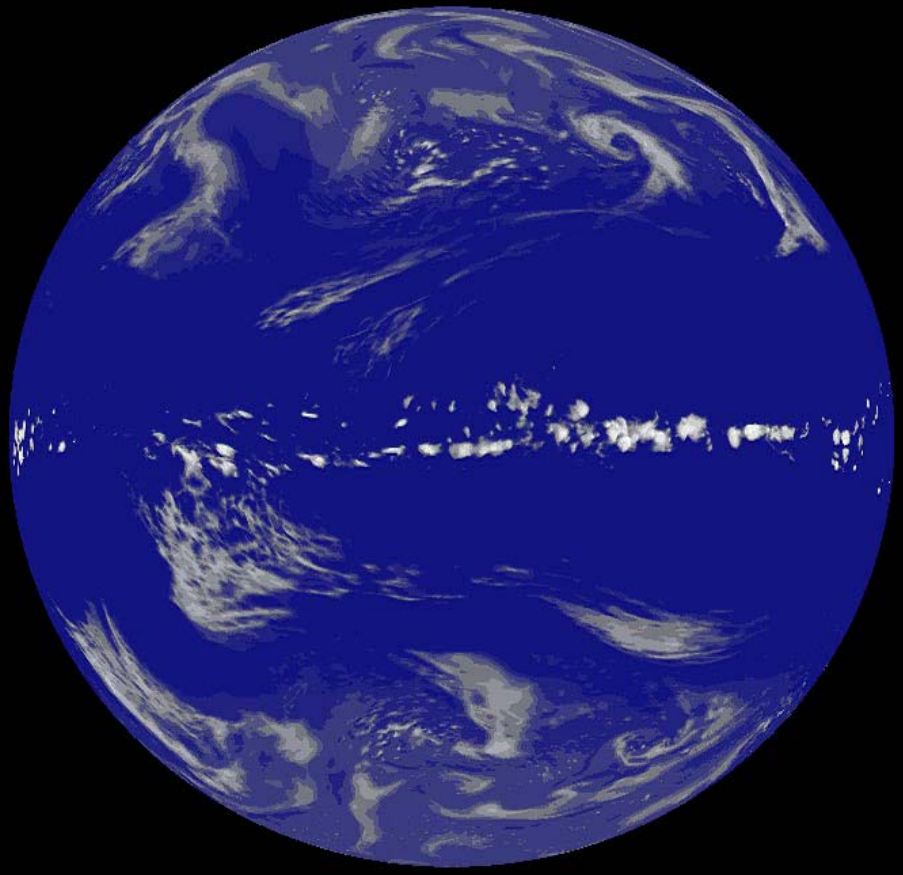


(Photo by Y. Kashino, near Timor)

Earth and “Aqua-Planet”

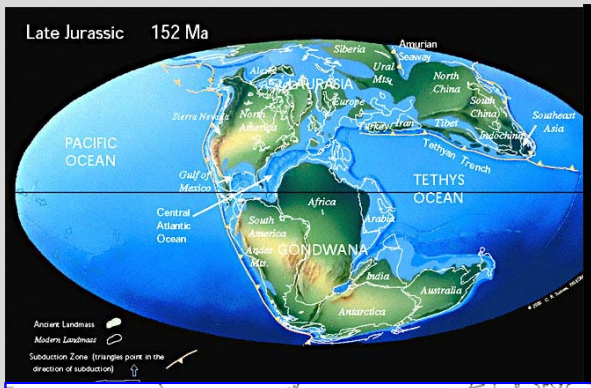


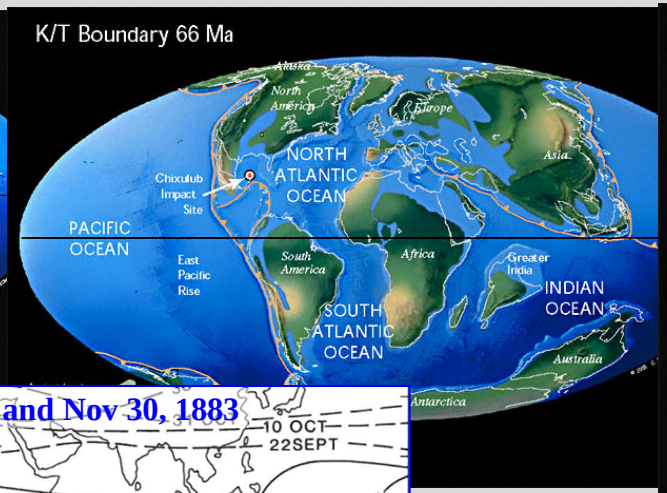
MTSAT-IR (August 2010）

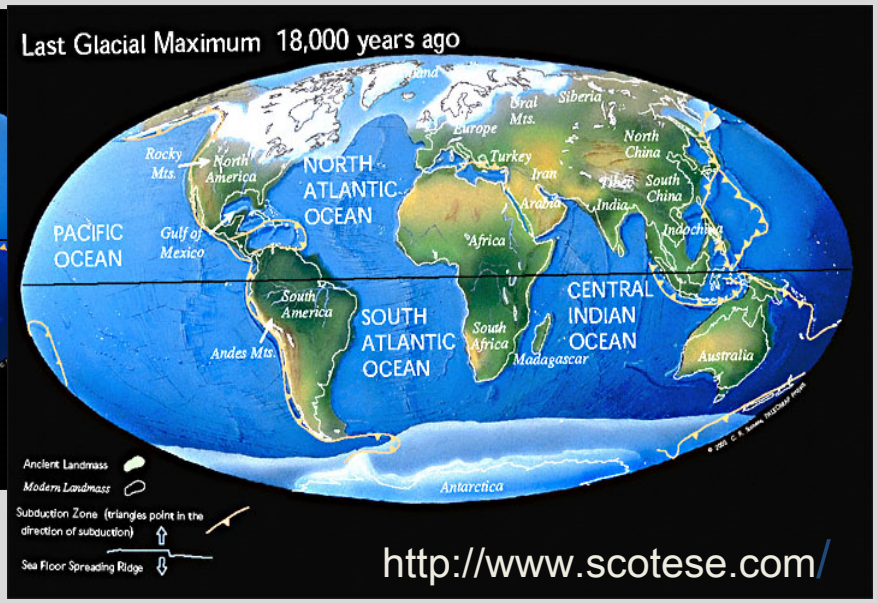


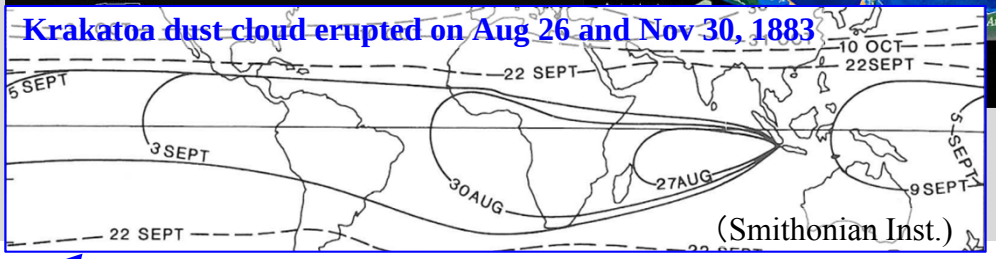
(by IFREE/JAMSTEC)

Ocean: Continent ~ 7: 3 concerved for 400 MYears



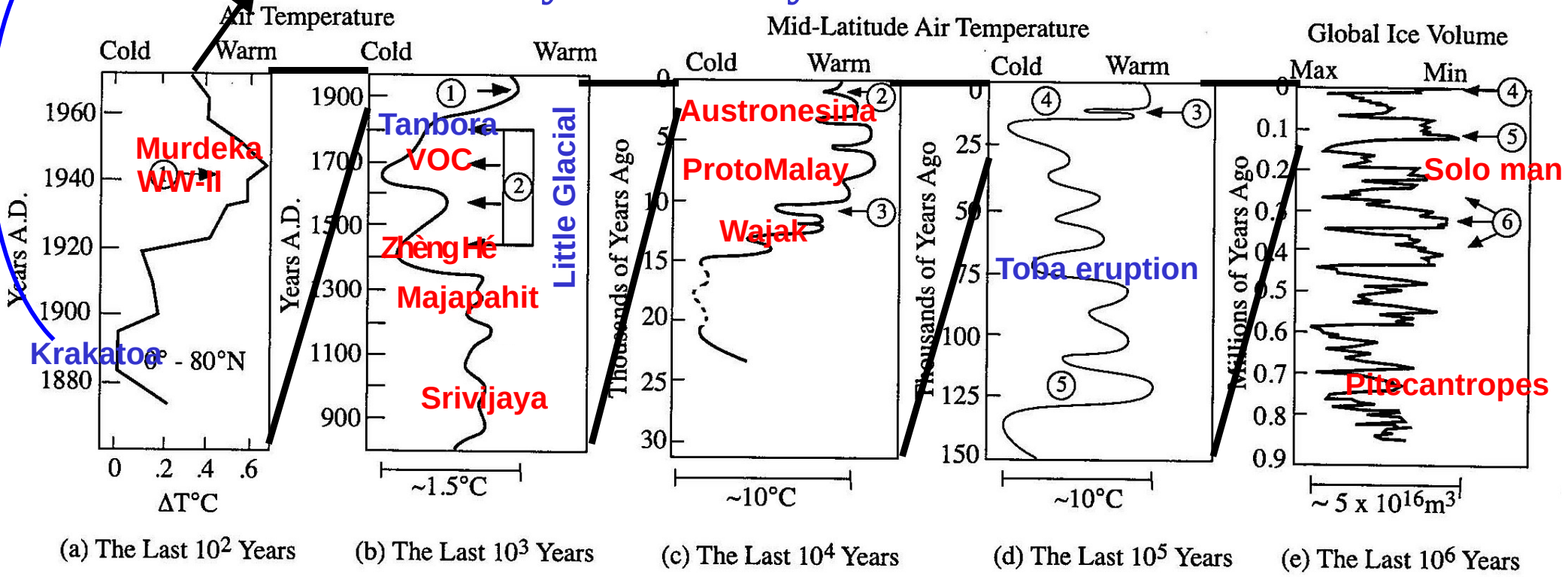




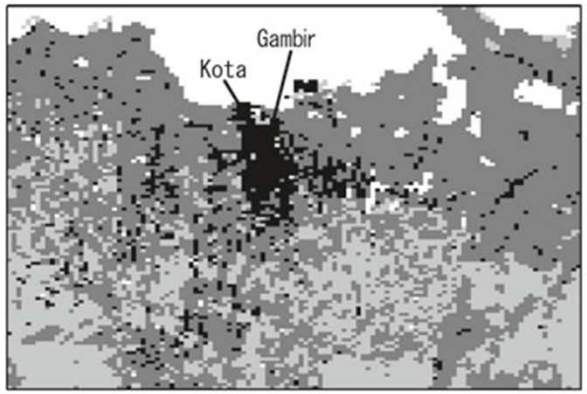


Recent 1 Myear history of Climate and IMC

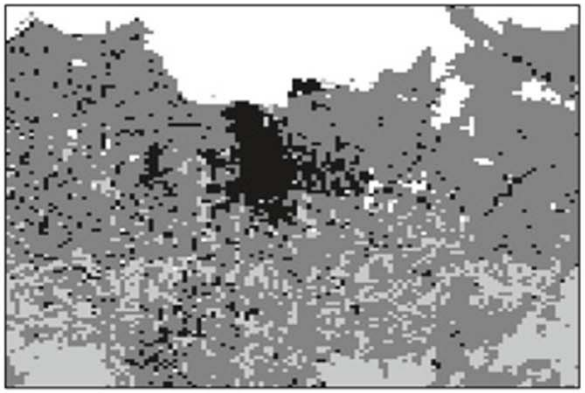
(NASA, 1992)



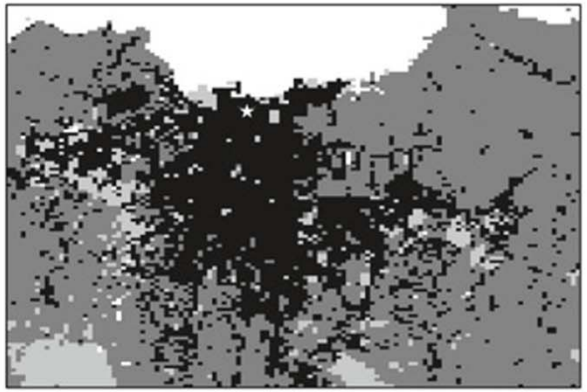
Urbanization of Batavia/Jakarta



1930s



1960s

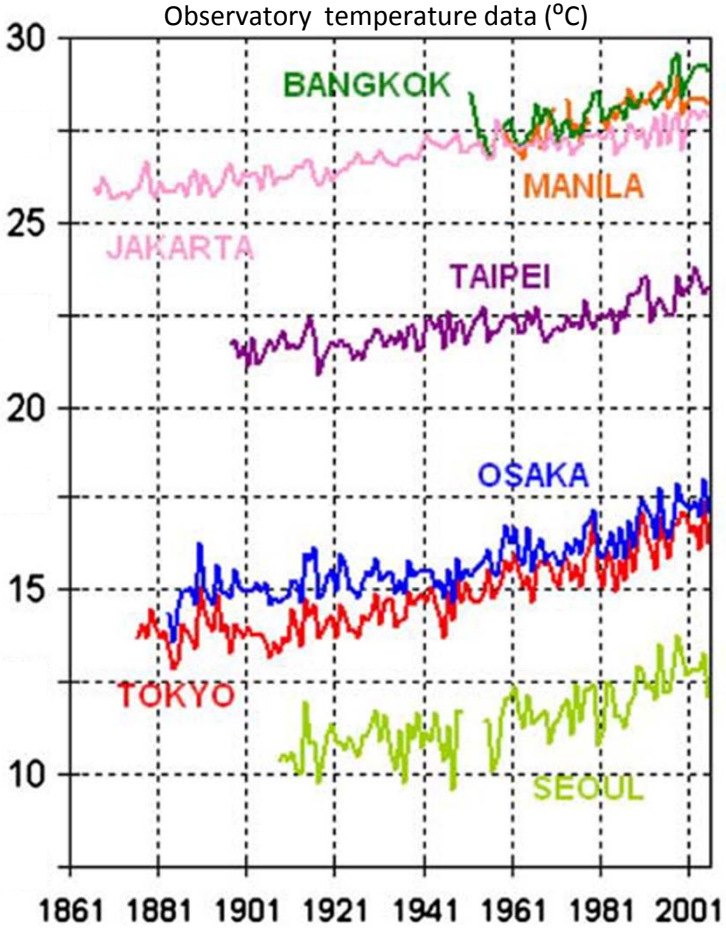


2000s

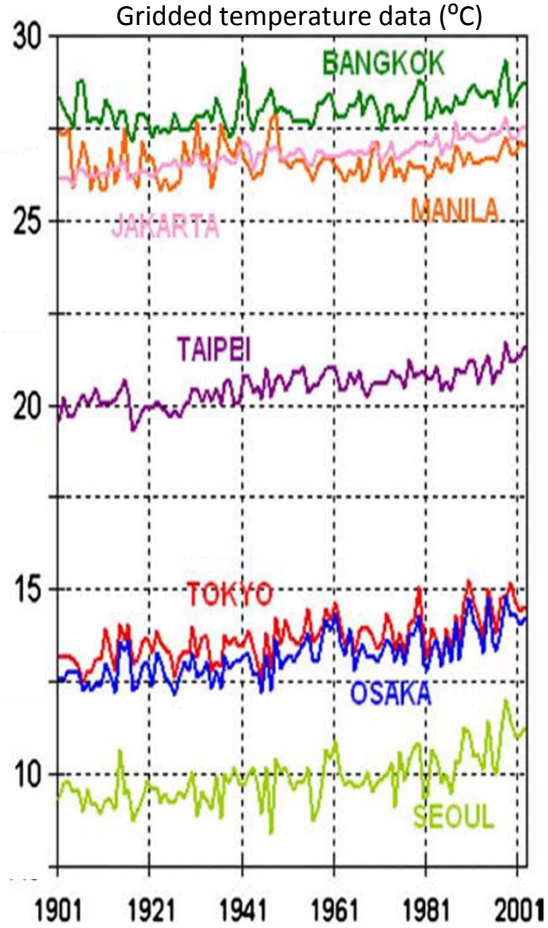
green field
farmland
urban area
others
kota station
0 5 10 20 km

(Yamashita, 2011)

Observatory temperature data (°C)



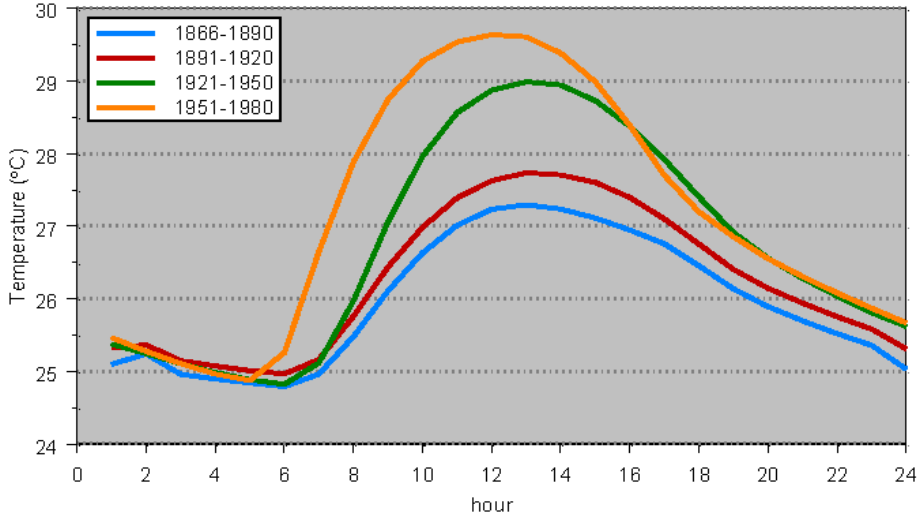
Gridded temperature data (°C)



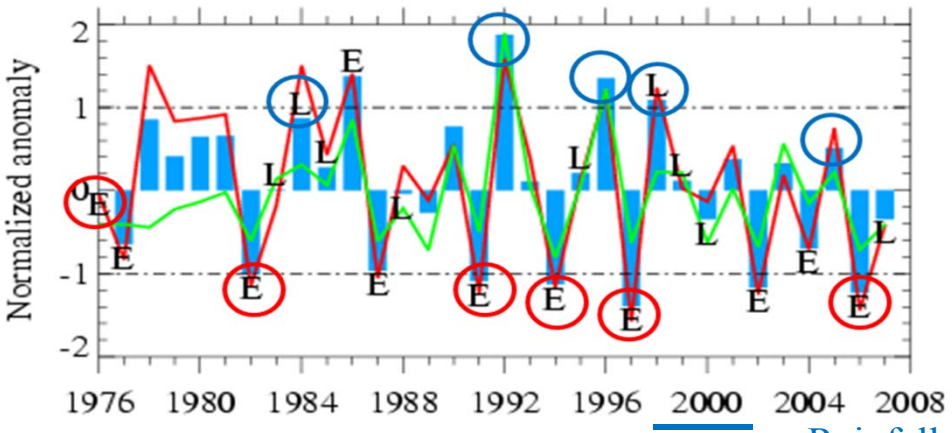
(Kataoka et al., 2009)

Batavia/Jakarta diurnal cycle changes (1866-1980)

(Brandsma, 2012, @KNMI; probably standard-time was 1 h ahead before 1951)



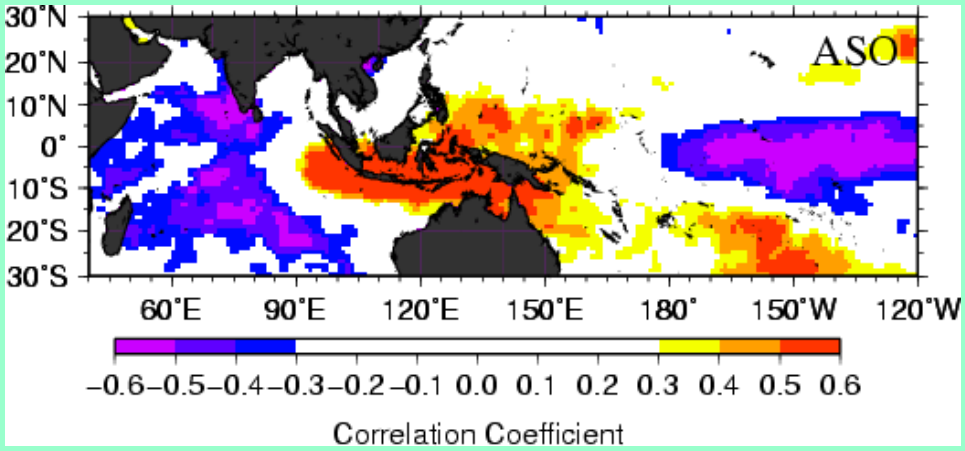
Jakarta (9 stations) in the dry season (ASO)



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

Rainfall amount
Rainfall days
Heavy rainfall days

Jakarta rainfall vs. SST in the dry season

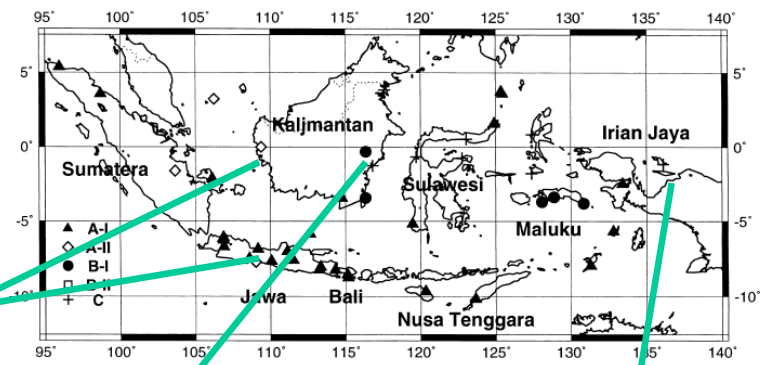


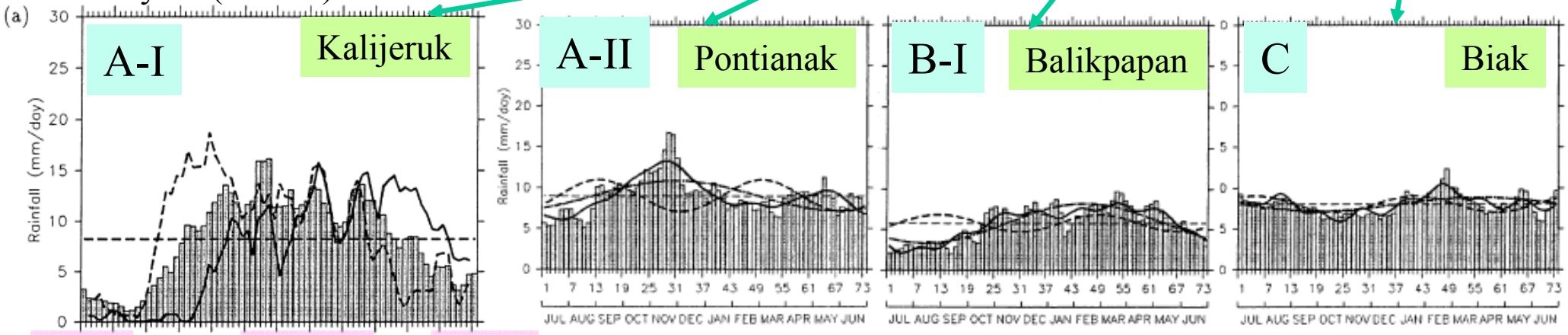
(Hamada, Urip, Sopia, et al., 2012, SOLA)

Seasonal cycle modification by ENSO

El Nino year (solid)

La Nina year (dashed)

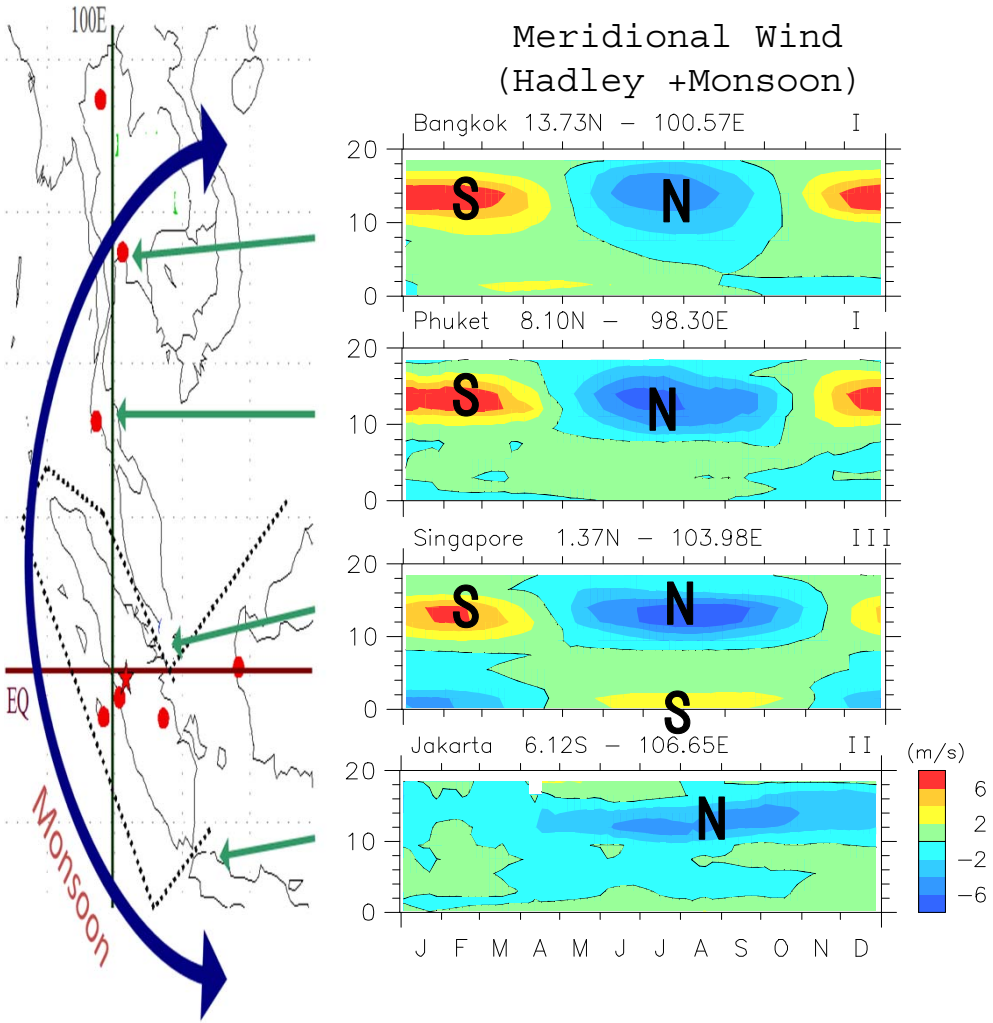




JUL JAN JUN

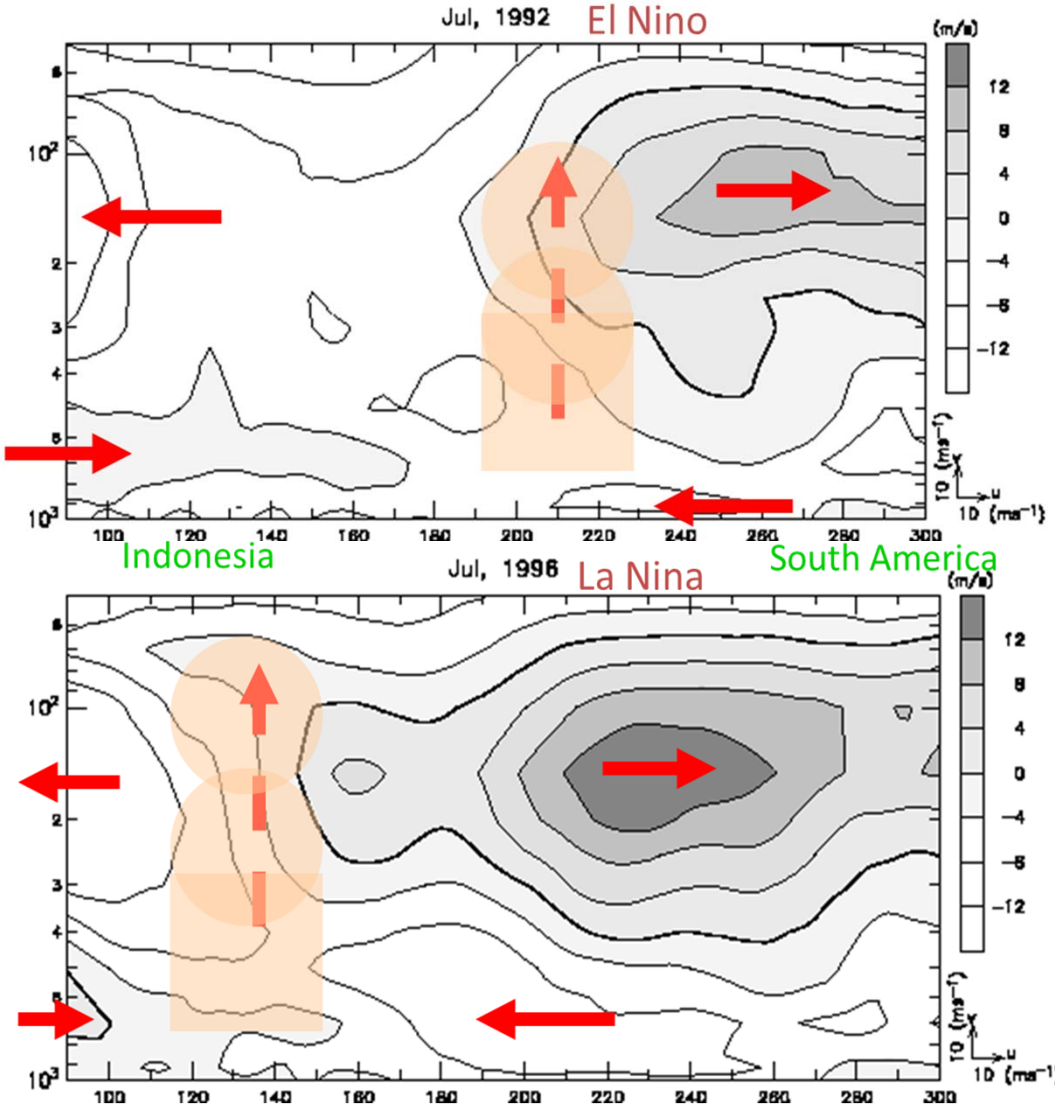
(Hamada , et al., 2002, *J. Meteorol. Soc. Japan*)

Meridional variations of meridional winds show the seasonal shift of Hadley circulation



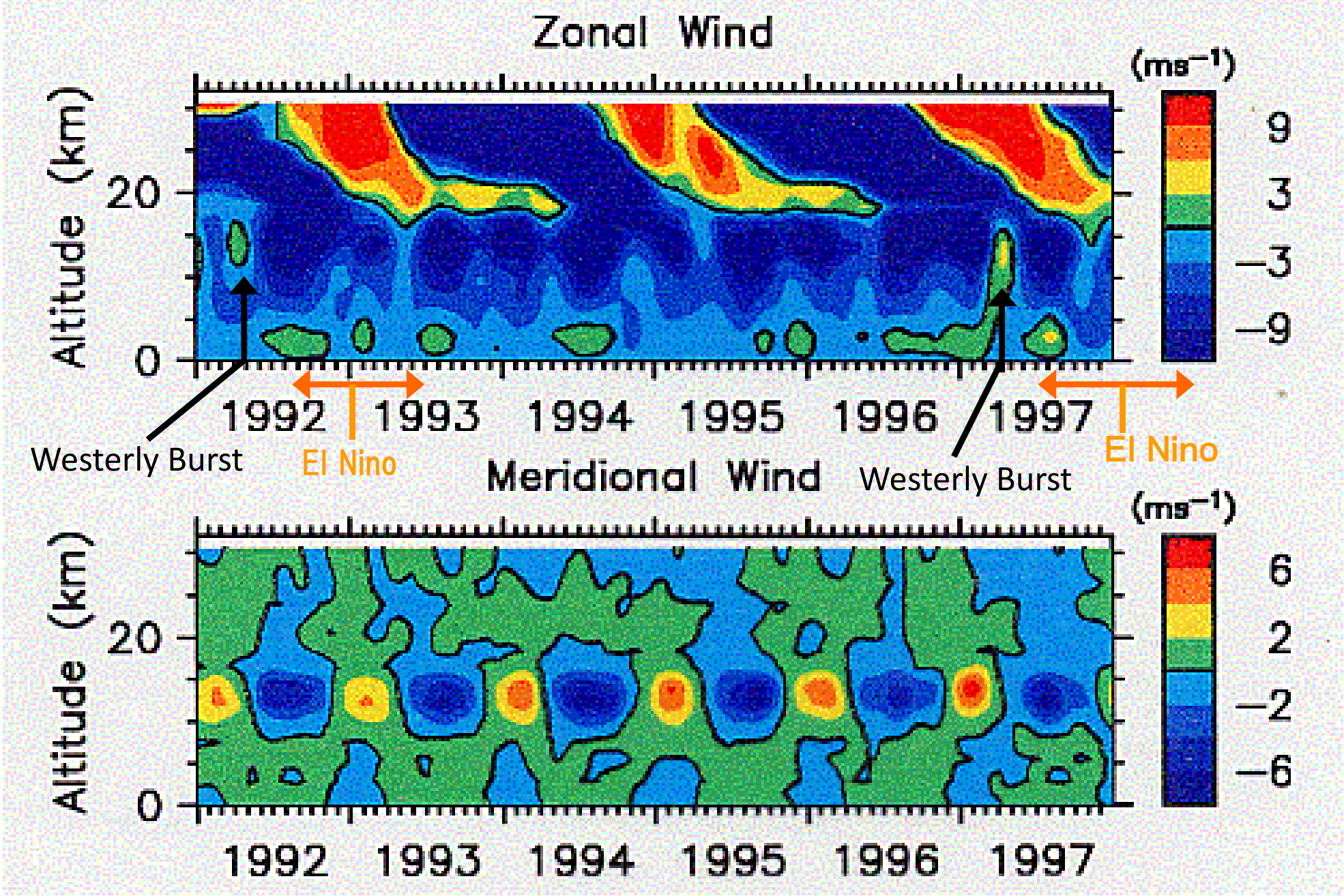
（Okamoto et al., 2004)

Zonal variations of zonal winds show the ENSO-shift of Walker circulation

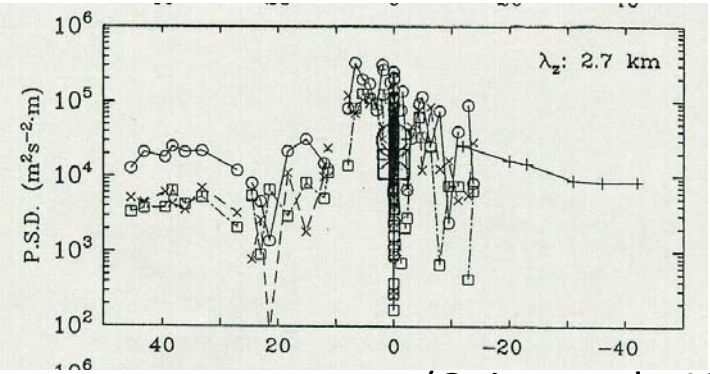


Interannual Variations of Wind over Indonesia

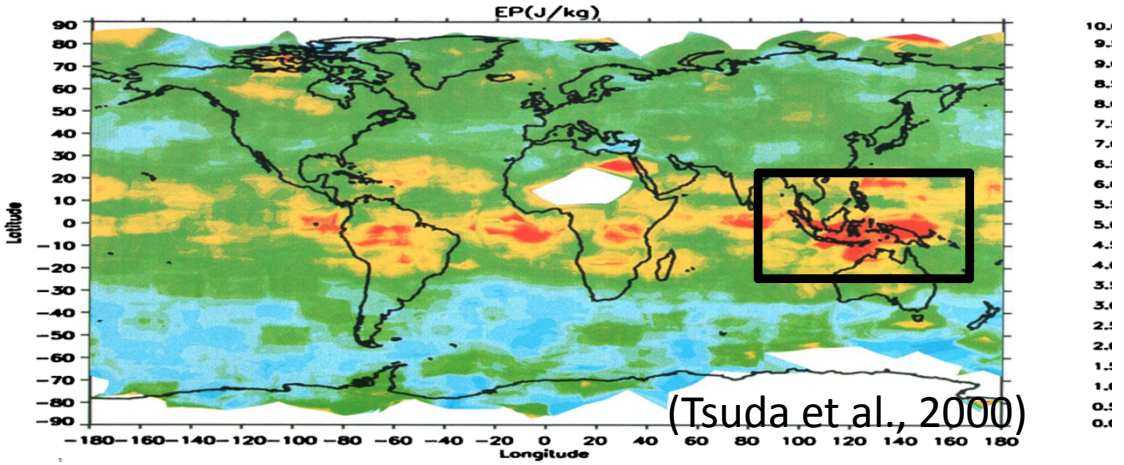
（Okamoto, Yamanaka et al., 2003b)



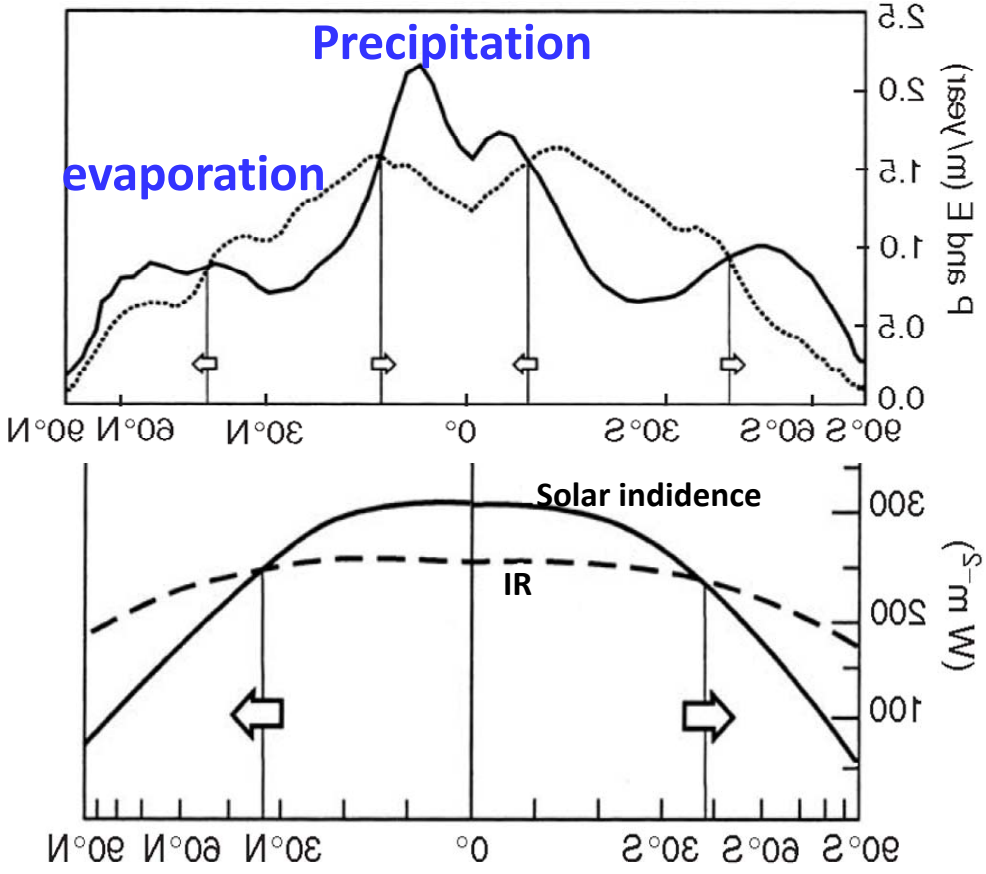
Stratospheric gravity waves & tropospheric convection

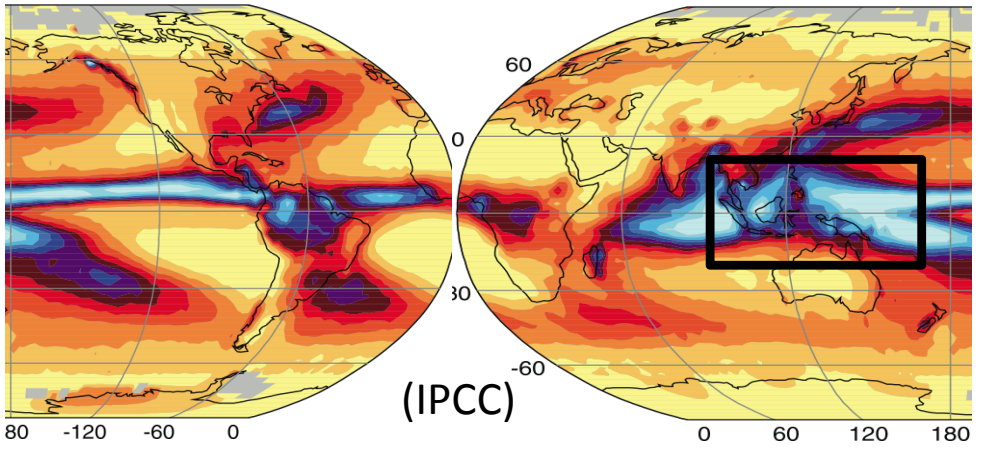


(Ogino et al., 1995)

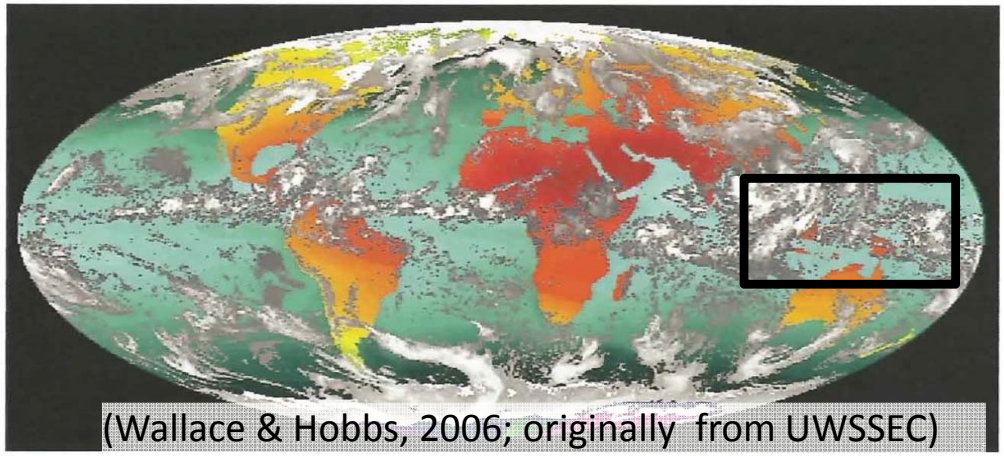


(Tsuda et al., 2000)





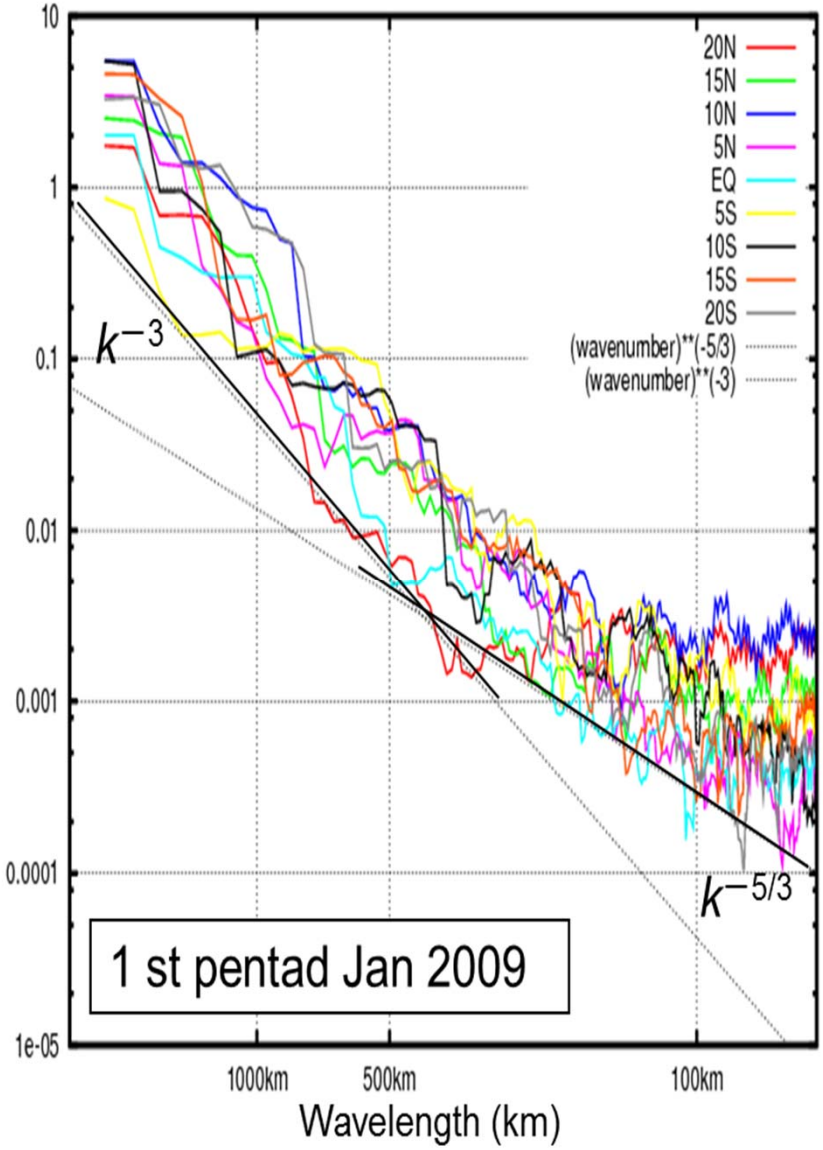
(IPCC)

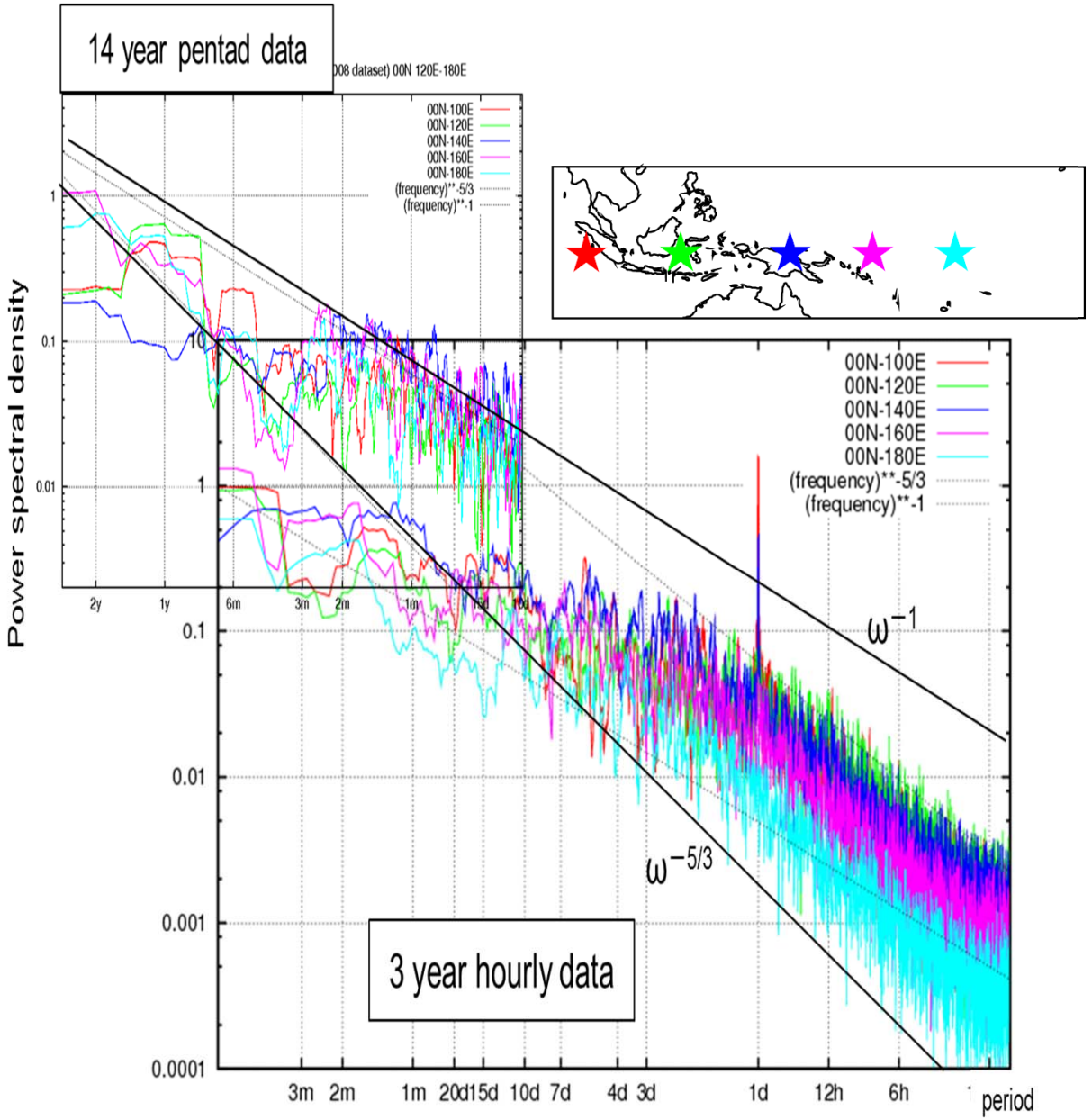


(Wallace & Hobbs, 2006; originally from UWSSEC)

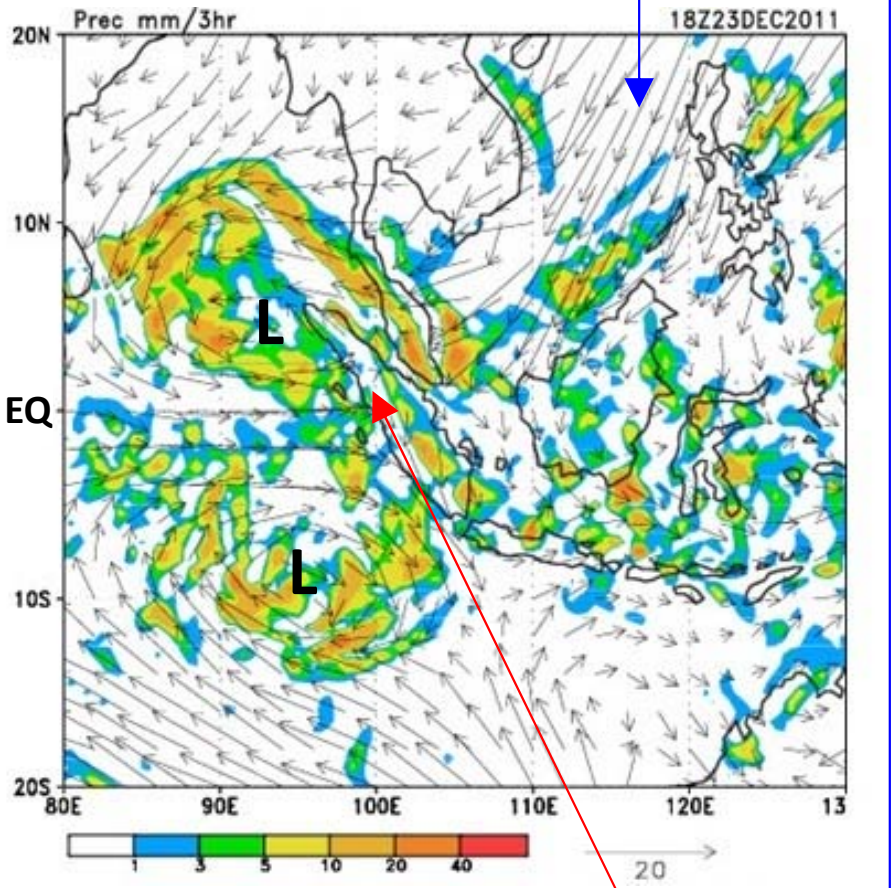
Meinardus (1934), Sellers (1965), Palmen & Newton (1969)
Newton (1972) Baumgartner and Reichel (1975), Hartmann (1994)

GMS cloud top temperature (hourly, 14 years, 0.25 º) zonal wavenumber and frequency spectra

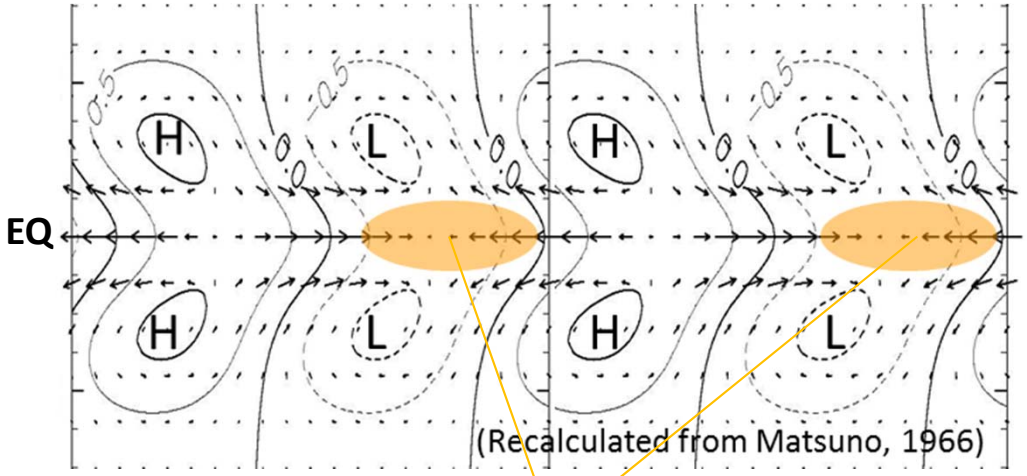




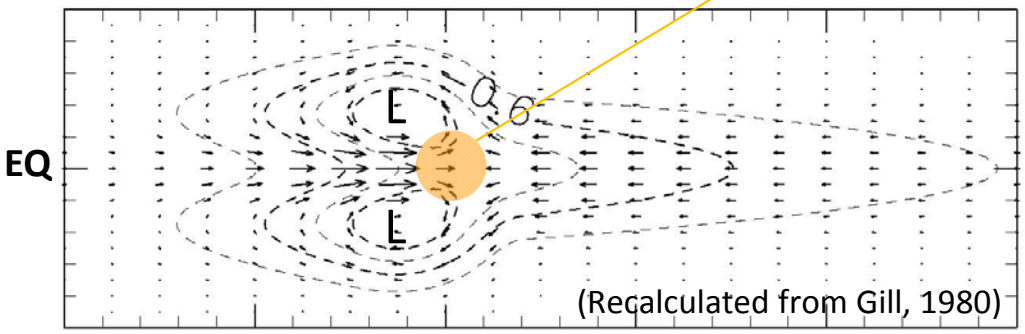
intraseasonal variation (ISV)
or Madden-Julian oscillation (MJO)
or super cloud cluster (SCC) or Matsuno-Gill pattern
observed during HARIMAU2011 IOP



Diurnal cycle (clear land after midnight)



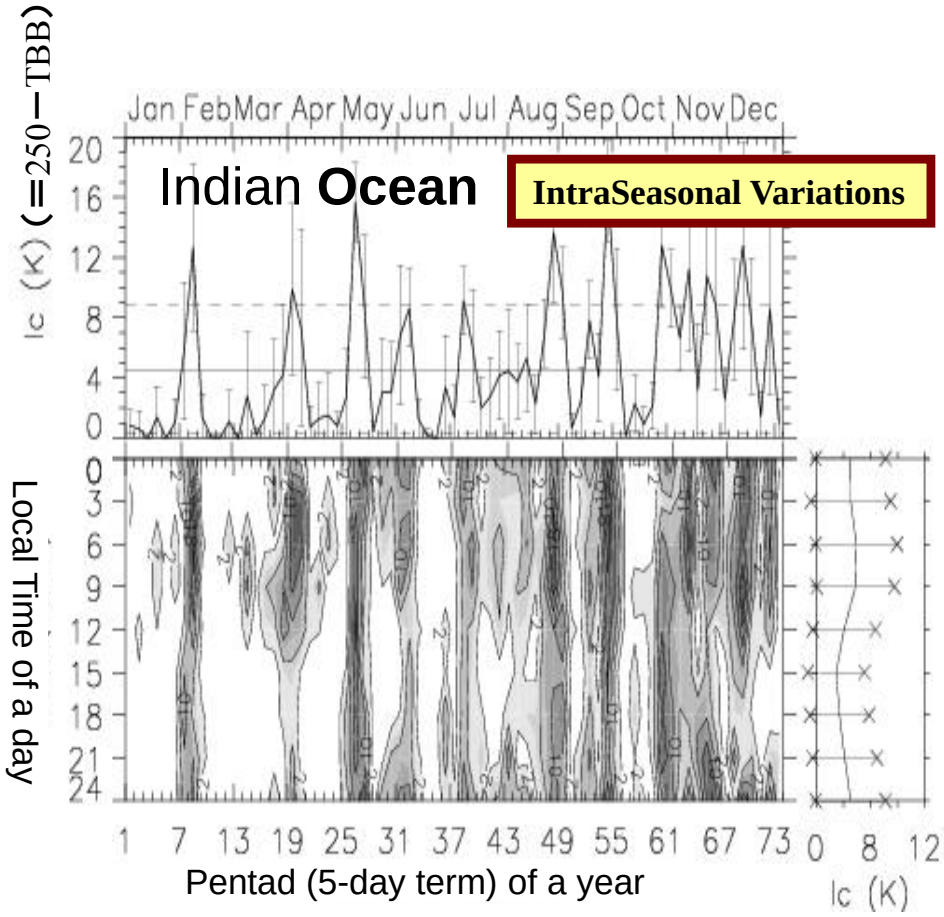
"Hot spot" (aligned or isolated)

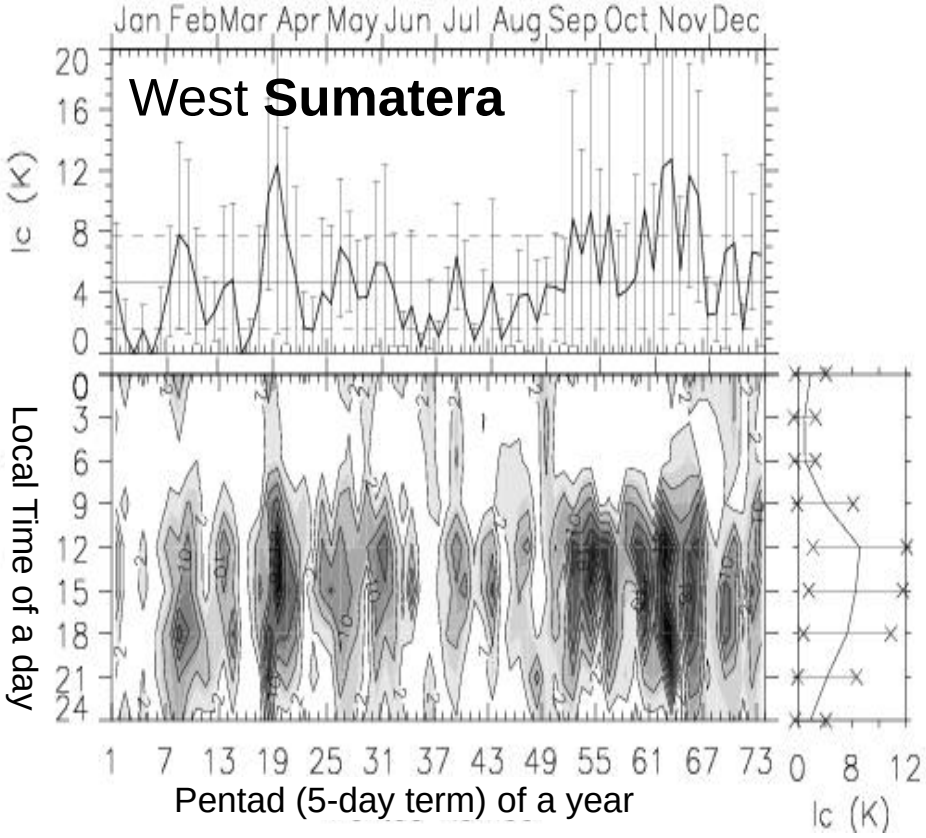


Boreal winter monsoon (so-called *cold surge*)

Intraseasonal / diurnal variations of convection

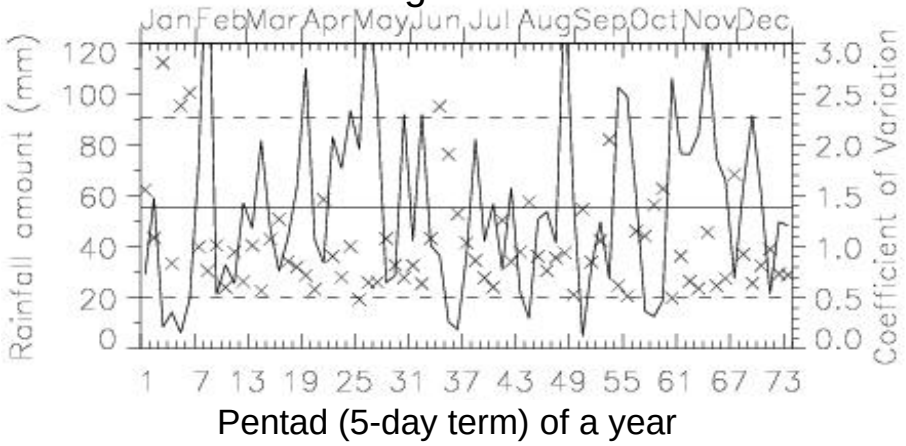
(Hamada et al., 2003)



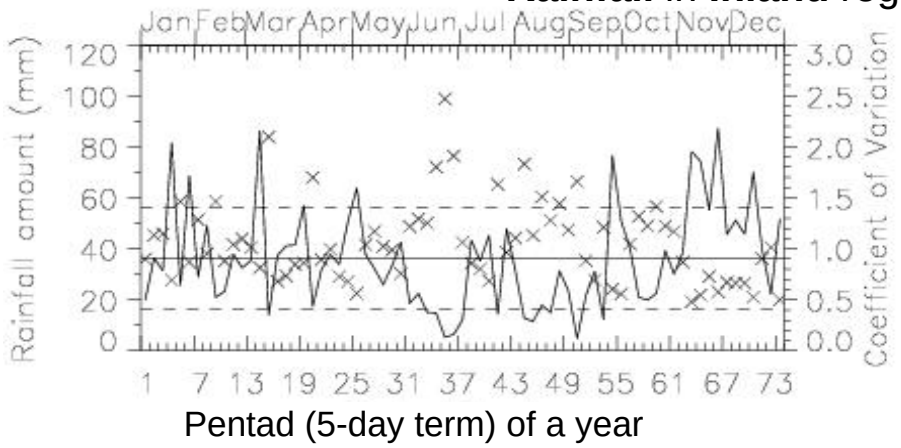


Afternoon rain

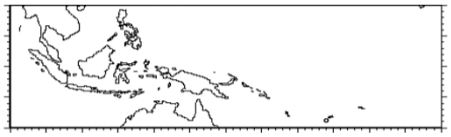
Rainfall in **Coastal** region



Rainfall in **Inland** region



Spectral distribution of GMS cloud height

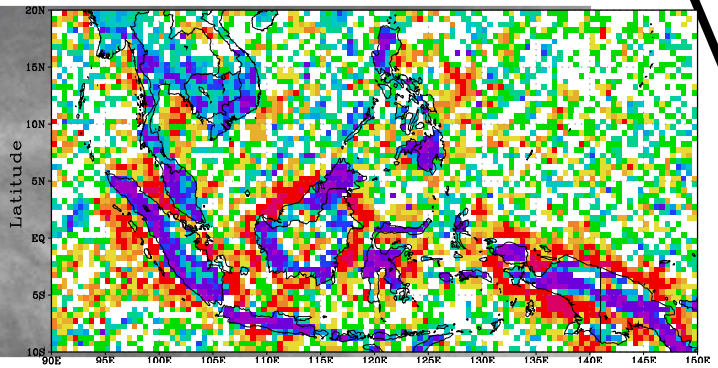


Interannual, intraseasonal
& subdiurnal variations
over oceans

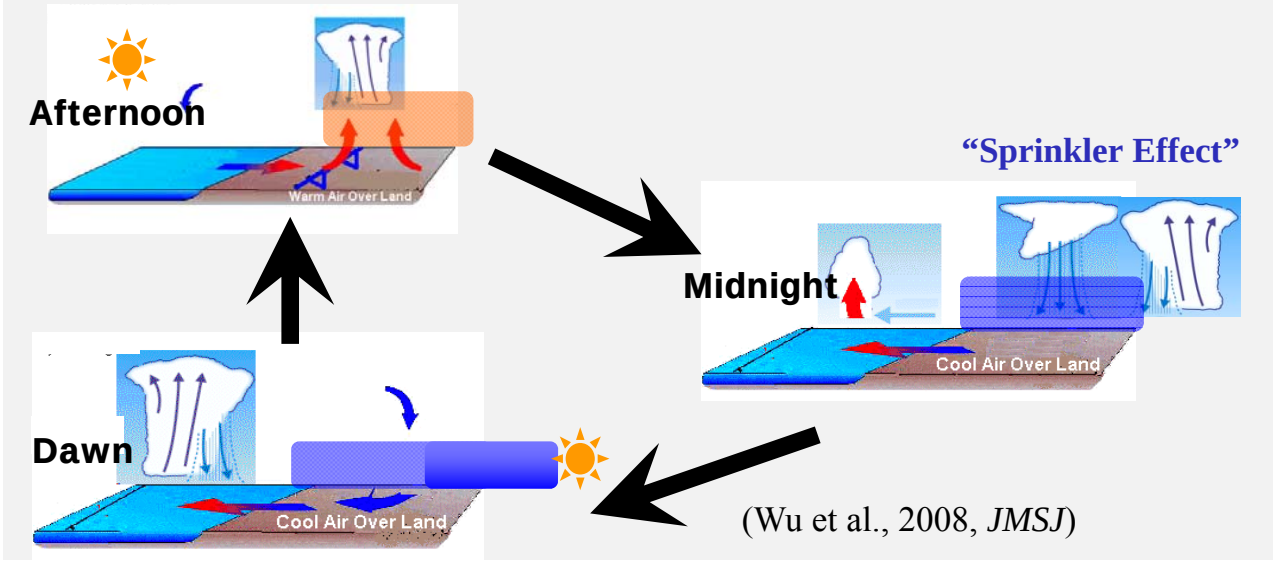
Annual & Diurnal cycles around lands

Mon. mean GMS clouds

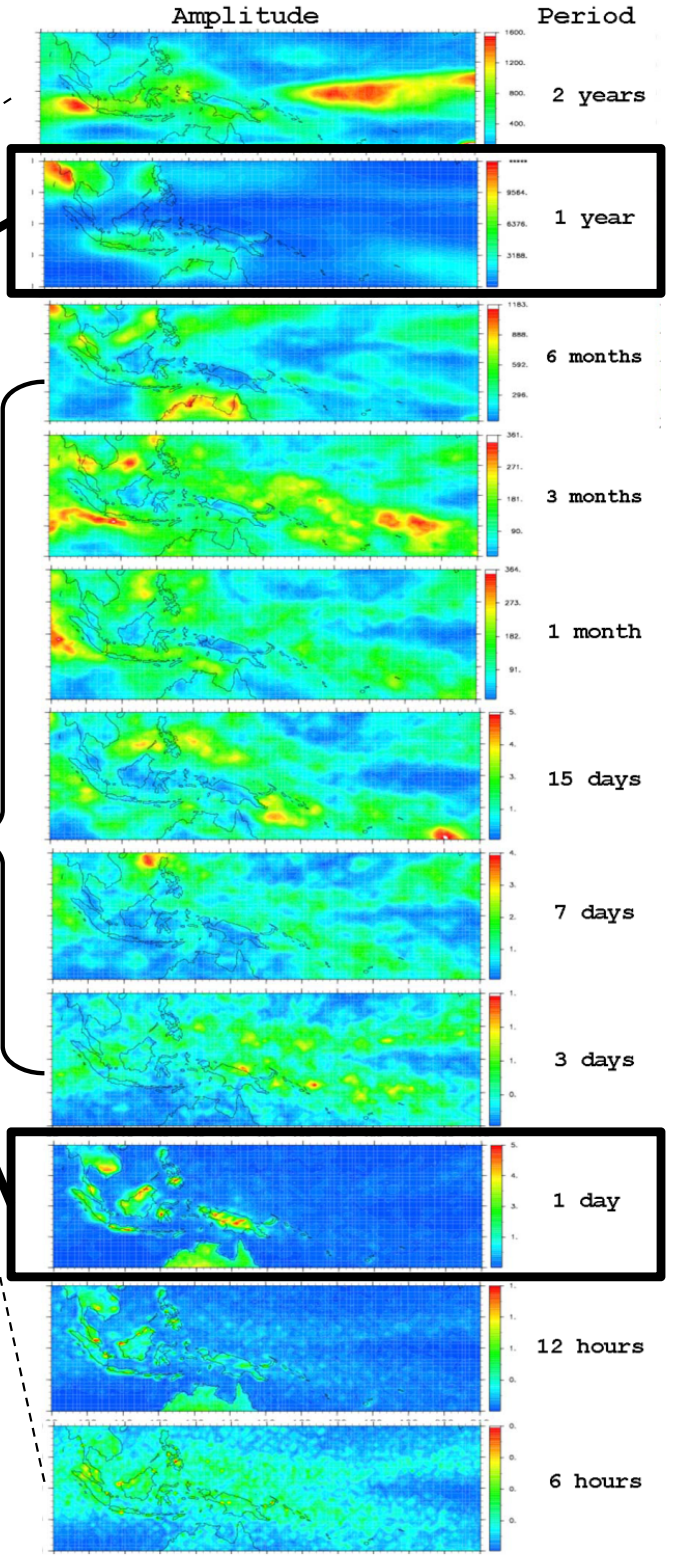
TRMM Morning−Evening Rain

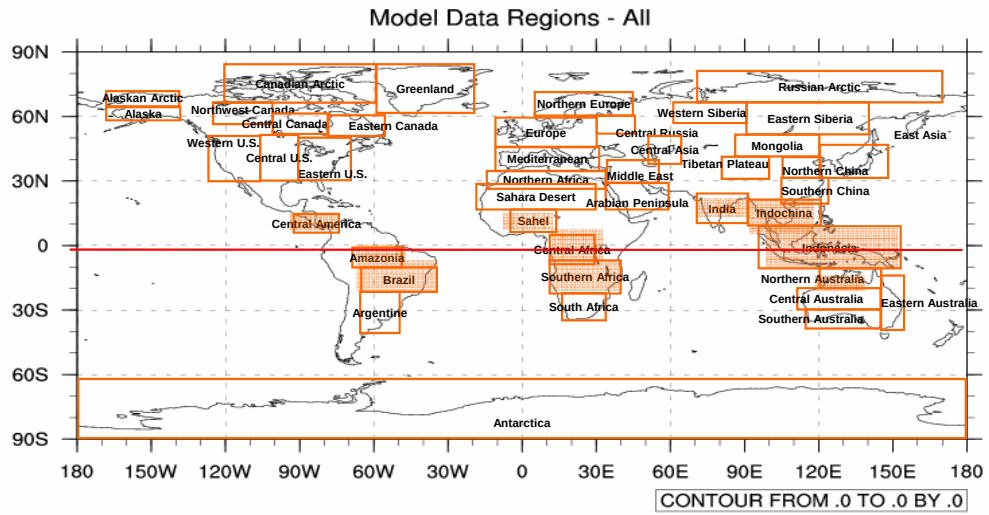


(Mori et al., 2004, *Mon. Wea. Rev.*)

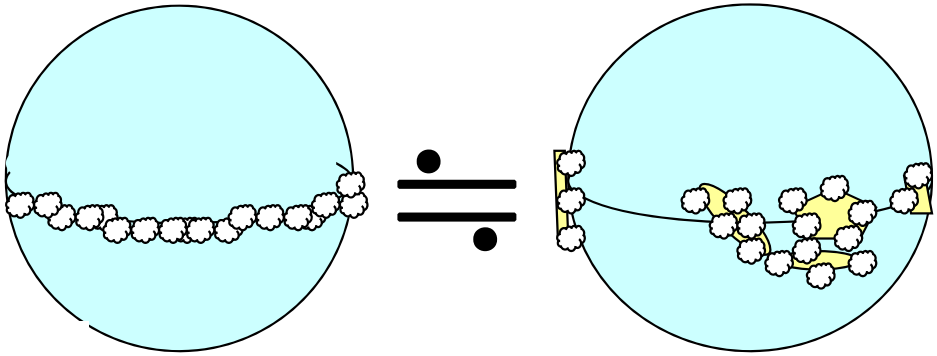


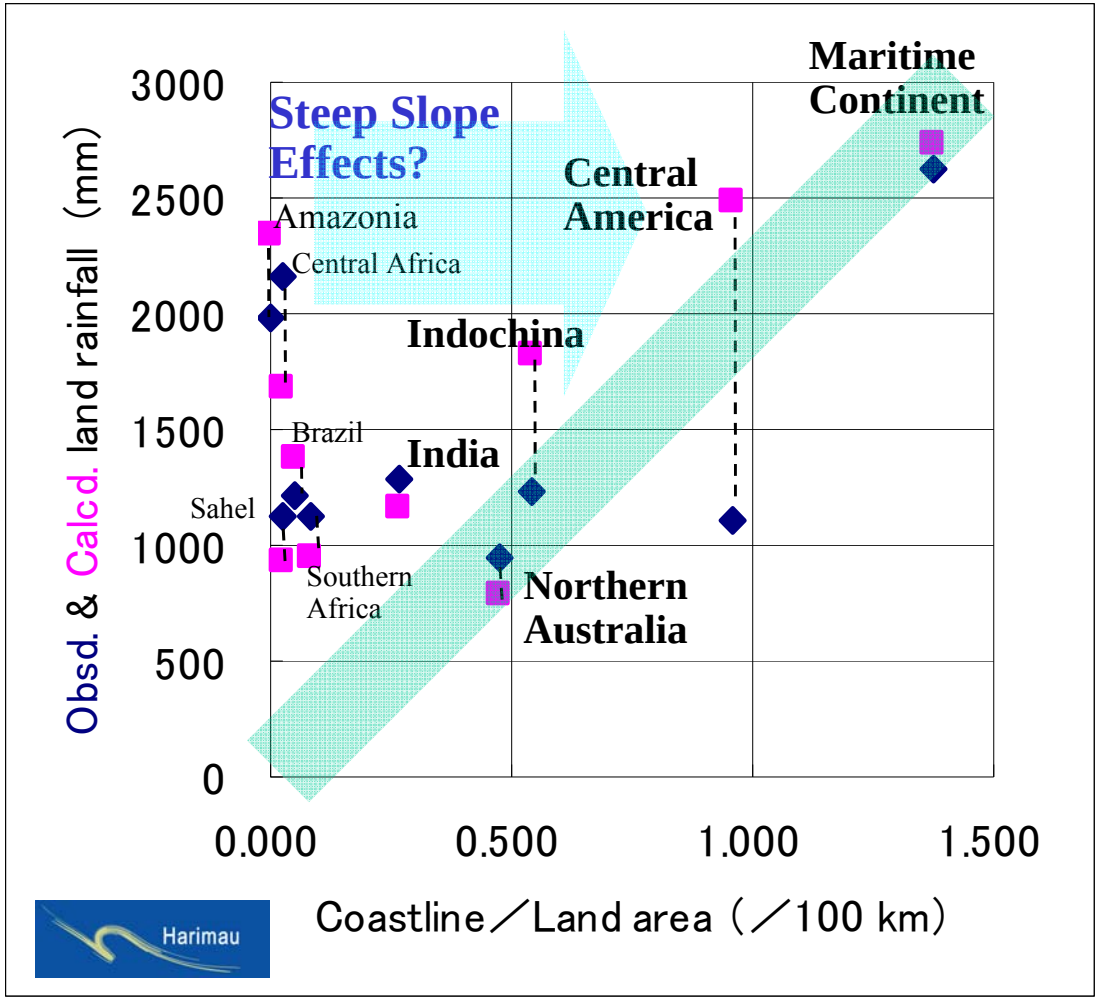
(Wu et al., 2008, *JMSJ*)





43 regions for local climate examination using 600-year (1870-2450) run of NCAR-CCSM3 on Earth Simulator. (Maruyama et al., 2000; Yoshida et al., 2005)

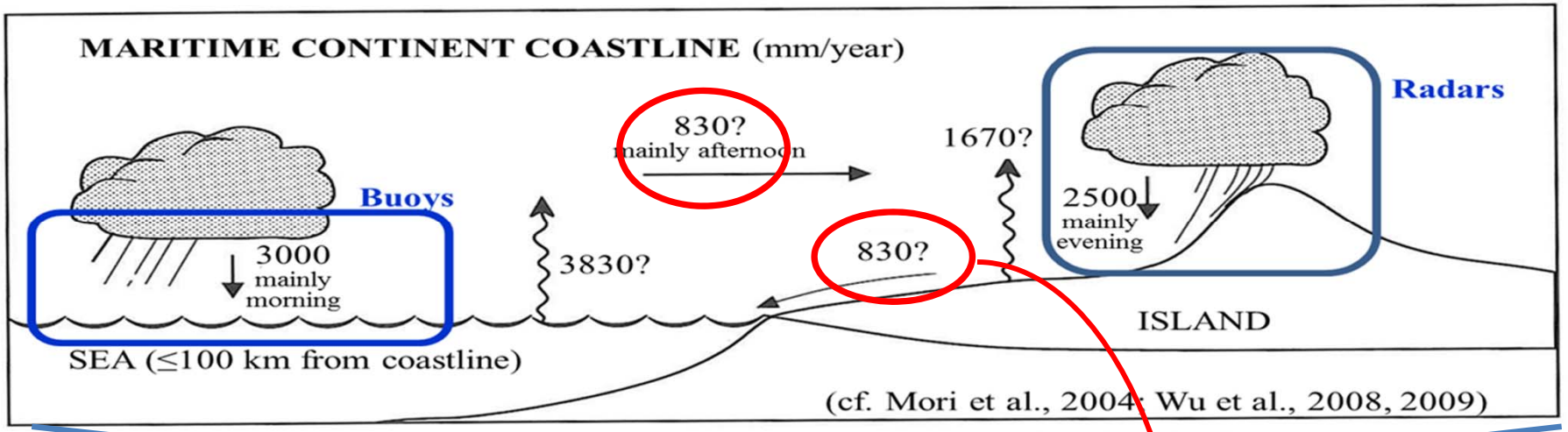


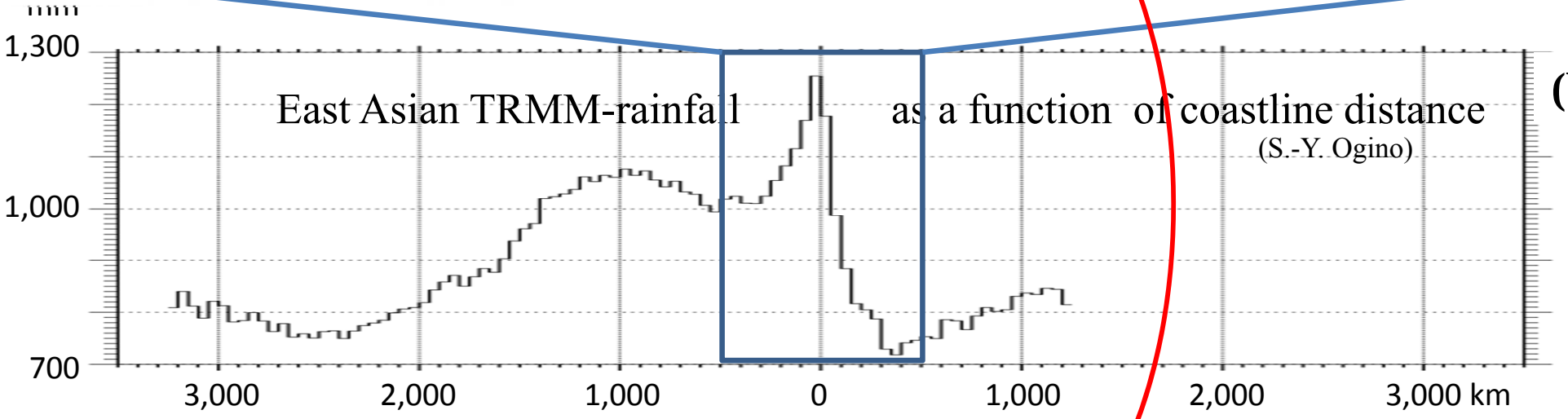


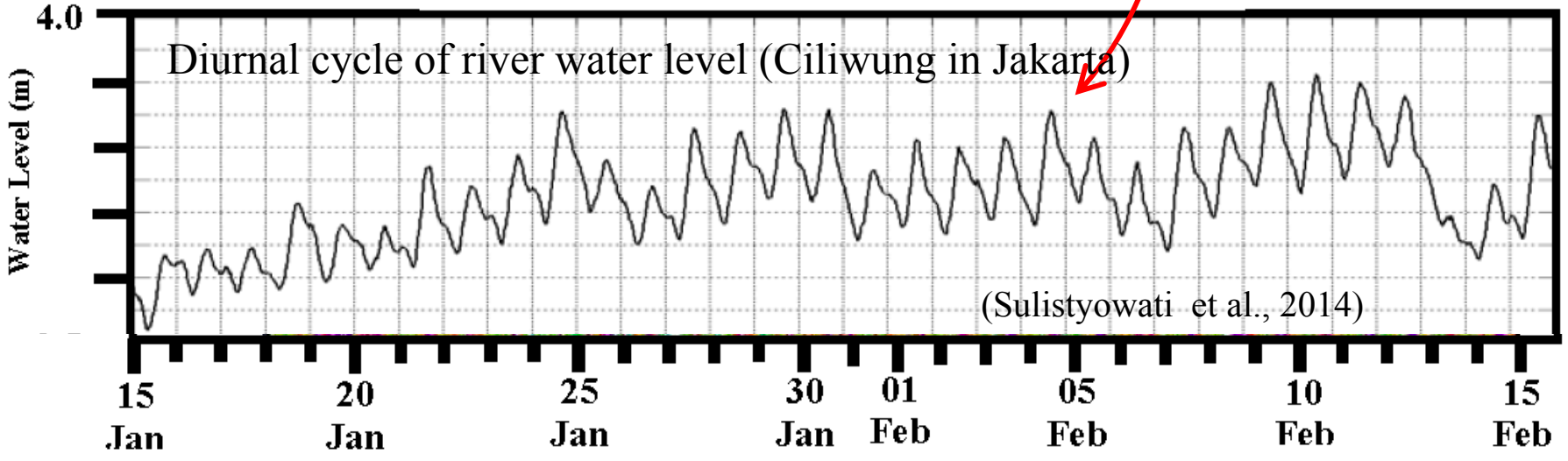
Regional (land) rainfall (mm/year) ＝2000 (mm/year•10^2 km) ×[Coastline (10^2 km)/Land area (10^4km^2)

→ Total rain water amount on land (Gt/year) ＝2000 (mm/year•10^2 km) ×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.

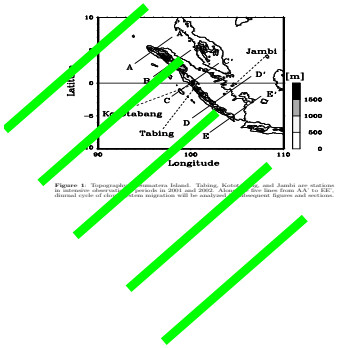

MARITIME CONTINENT COASTLINE (mm/year)
(a)
Radars
830?
mainly afternoon
1670?
Buoys
2500
mainly
evening
3000
mainly
morning
3830?
830?
ISLAND
SEA (≤100 km from coastline)
(cf. Mori et al., 2004; Wu et al., 2008, 2009)


mm
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, Intraseasonal and Seasonal variations over Sumatera

(Sakurai et al., 2005: *JMSJ*)



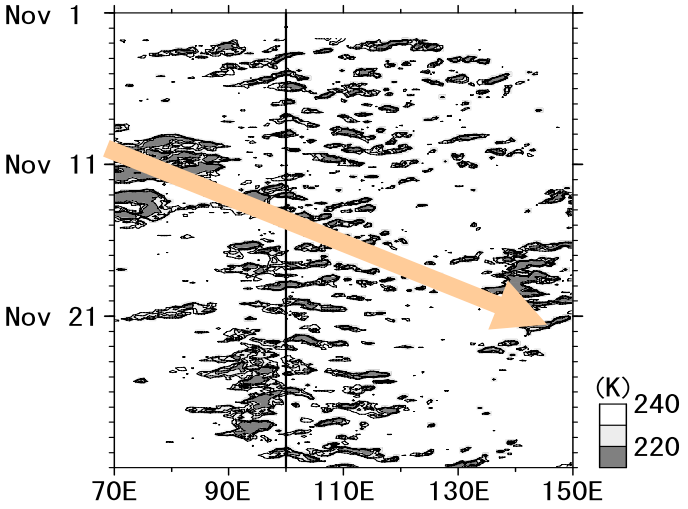


Figure 4: Time-longitude cross-section of T_{BB} on the equator in November 2001, based on GMS IR1 data with a spatial resolution of 0.5° × 0.5°. The vertical solid line indicates 100 °E which corresponds to the location of the central mountain range of Sumatera Island on the equator.

Table 2: Seasonal-'meridional' distributions of occurrences of westward and eastward migrations (see text for definitions) of tall cloud systems (cloud top temperature ¡ 230 K) during May 2001-April 2002.

		Westward migration												Eastward migration											
		01								02											02				
		M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
N	AA'	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○	○	○		○				
↑	BB'	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○		○						
EQ	CC'	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○		○						△
↓	DD'	○	○	○	○	○	○	○	○	○	○	○	○						○						
S	EE'	○	○	○		○	○	○		○	○	○	○	○											

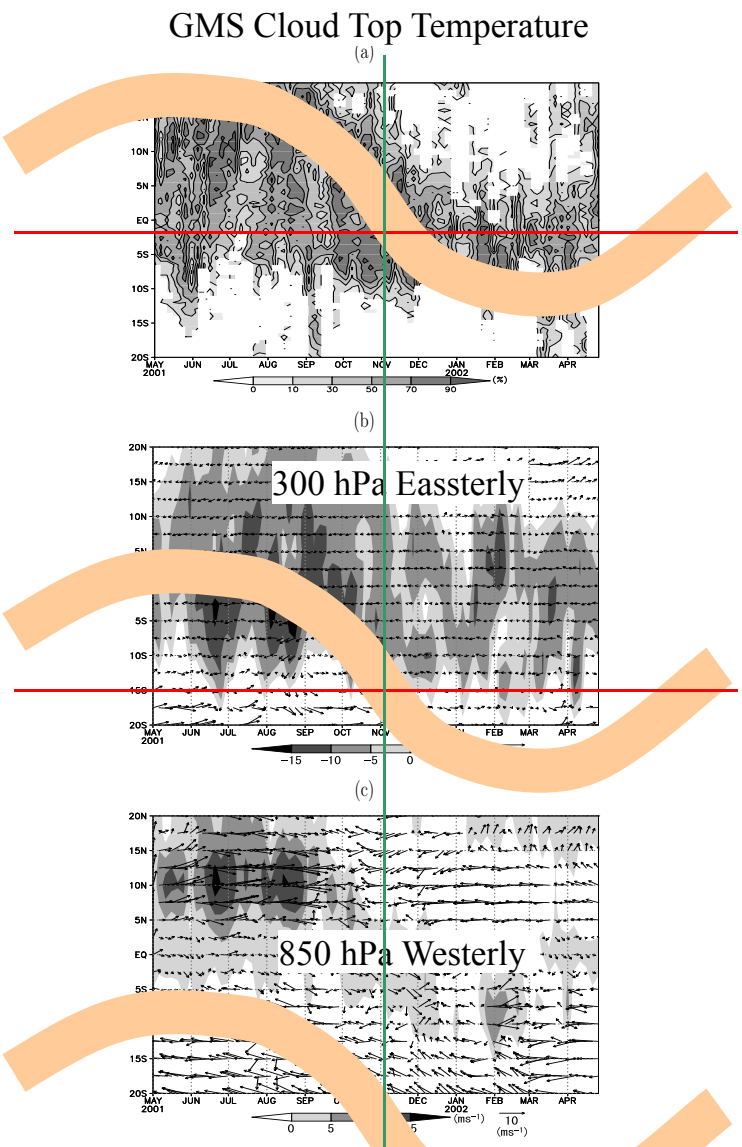
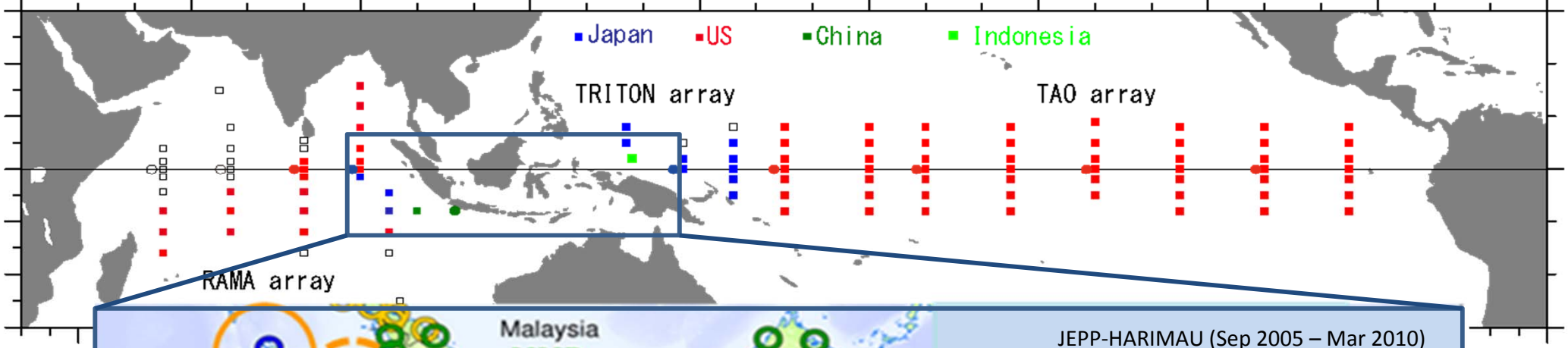
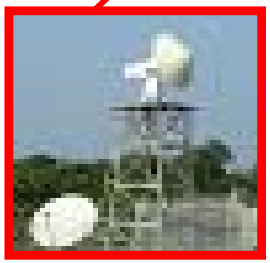


Figure 10: Latitude-time cross-sections (along 100°E du... ...002) of (a) occurrence frequency α of $I_{T_{BB}}$ (T_{BB} is between 170 and 270 K) (see Subsection 2.1.1), and (b) 300- and (c) 850-hPa horizontal wind (arrows: upward is northward; shaded represents easterly in (b) and westerly in (c)) based on the NCEP/NCAR objective analysis.





XDR & CDR

Transportable X-MPR

Research institute (MCCOE)

UHF-WPRs

InaTRITON buoy

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.