Multi-Scale Climate Processes & Rainfall Variability over the Maritime Continent

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20 June 2012

CESM Workshop, Breckenridge Colorado

Acknowledgement: A. Robertson, V. Moron, A. Giannini
Climate risk management: Demonstration sites in SE Asia

Diversity of climate hazards + socio-economic systems

Multi-scale partnerships

- Quang Tri
- Angat, Bulacan
- Iloilo
- Can Tho
- Kalimantan
- Indramayu
- Bali
- Nusa Tenggara Timur
- Timur
Multi-scale processes:

**ENSO**
(El Nino – Southern Oscillation)

**Monsoon**

**Diurnal Cycle**
(land-sea breezes)
What is the mechanism for the Java Dipole – a dipolar pattern of precipitation anomalies over Java Island associated with El Nino – Southern Oscillation (ENSO)?
In SON (left), spatially coherent dry anomaly in El Nino years. In DJF (right), dipolar pattern of El Nino impact: dry anomaly on north coast, but wet anomaly on south coast.
STATION OBSERVATION:

In SON, spatially coherent dry anomaly in El Nino years.

In DJF, dipolar pattern of El Nino impact: with dry anomaly on north coast, but wet anomaly on south coast.

El Nino year
Station Precipitation Anomaly (EN-Climatology Composite)
La Nina year
Station Precipitation Anomaly
(LN-Climatology Composite)
Canonical Correlation Analysis, CCA (ERSST & GHCN rainfall) 1922-1975 Dec-Feb (DJF)

SST ENSO pattern

Java rainfall dipolar pattern

Low predictability in DJF, but slightly enhanced predictability at north coast
Inverse relationship between monsoonal wind speed and diurnal cycle

Fig. 7 Diurnal cycles of RegCM3 rainfall (mm/day, thick) and wind speed (m/s) over the whole area of Java Island in SON (a) and DJF (b) for climatology (black), El Niño year composite (red long dash), and La Niña year composite (green short dash). “LT” denotes the local standard time at Jakarta. Wind speeds at 10 m are plotted with the same scale, but with unit m/s.
Dry easterly monsoon WT1 & WT2

Strong westerly monsoon WT3

Quiescent monsoon WT4

Strong westerly monsoon WT5

Intraseasonal variability:
Weather Typing (WT) Analysis

Fig. 8 Climatology of CMORPH (2004–2007) precipitation WT1–5 (mm/day; shaded) and NNRP reanalysis winds at 850 hpa (m/s).
Frequency of Weather Types (WT) (%)

Blank bar: Climate, Red bar: El Nino, Green bar: La Nina

Fig. 9 Frequencies of five weather types, WT1 to WT5, in all years (blank left bar), El Nino years (red middle bar), and La Nina years (green right bar) in the SON and DJF season, respectively.
Diurnal cycle of observed and simulated rainfall for the 5 WTs

Fig. 10: Diurnal cycles of CMORPH and RegCM3 rainfall (mm/day) over the whole area of Java Island (a, b) and over mountainous regions (terrain height > 250m) (c, d) for weather types: WT1 (black), WT2 (blue), WT3 (green), WT4 (red), WT5 (purple). "LT" denotes the local standard time at Jakarta Indonesia.
Mechanism for the dipolar pattern:

MULTI-SCALE PROCESSES (for Java Dipole):

El Nino (with southeasterly wind anomalies)
Weaken northwesterly monsoon in DJF

→ Strengthen diurnal cycle of winds

→ Strengthen sea-valley-breeze convergence,
  Produce more rainfall over mountains and less rainfall over plains.

Key: Inverse relationship between monsoon intensity and diurnal cycle !!!

(Qian et al. (2010) J. Atmos. Sci.)
Conclusion

• Mechanisms for the north-south Java Dipole of rainfall variability: ENSO → Monsoon wind speed → Diurnal cycle of winds → Rainfall over mountains versus plains.

Key: Inverse relationship between the monsoonal wind speed and the diurnal cycle of land-sea & mountain-valley breezes.
Fig. 3: Climatology (top panels) and (ENSO - climatology) composite of GPCC (1991-2007) precipitation; (mm/day; shaded) and NRT (1979-2005) winds (vector) at 850 hPa, for SON (a,c,e), and DJF (b,d,f). The ENSO developing years are denoted by (O). Composite of 22 El Niño years are in (c,d). Composite of 22 La Niña years are in (e,f). Differences significant above 90% level of t-test are shown by darker colors.