Climate of the Philippines and the sea surface temperature effect on summer monsoon rainfall in the Philippines

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Mt Pinatubo Lahar and Mt. Arayat on the way from Manila to Baguio, March 2012
Outline of this talk

1. Climatic seasonal changes of regional rainfall and wind at 850 hPa in the Philippines by 5-day mean TRMM and ERA_Interim data, respectively.

2. The effect of spatial resolution on simulated rainfall over the western Philippines

3. The potential impact of sea surface temperature on rainfall over the western Philippines

For items 2&3: Using WRF-ARW v3.6.1 Model
2. Effect of spatial resolution on simulated rainfall over the western Philippines

What resolution can RCMs reproduce summer monsoon rainfall on the northwestern coast of the Philippines?

• >50–70 % of annual rainfall occurs in June–August during Southwest Monsoon Season (SWM)
Model & experimental setup

WRF-ARW v3.6.1

Domains
1. D01 – 25km
2. D01 – 12.5km
3. D02 – 8km, nested in 40km
4. D02 – 5km, nested in 25km

Simulation Period
June to August 1982-2012
Model &
experimental setup
WRF-ARW v3.6.1

Boundary Conditions
  Atmospheric --- ERA Interim
  SST --- NOAA monthly OISSTv2

Parameterization
  Microphysics --- WSM 6-class graupel
  Planetary boundary layer --- Mellor-Yamada-Janjic
  Land surface --- Unified NOAH

No cumulus convective parameterization (CCP)
Data for evaluation of monthly rainfall

1. **APHRODITE**
   
   Asian Precipitation Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources (Yatagai et al. 2012)
   
   - Daily rainfall from 1982–2007
   - 0.25deg resolution

2. **Seven (7) stations from PAGASA**
   
   Philippine Atmospheric Geophysical and Astronomical Services Administration
   
   - Daily rainfall amount, 1982-2012
   - Stations span the WPH region.
Monthly rainfall amount
WRF model vs APHRODITE 1982–2007

Rainfall amount improved in the higher resolution models.
Model performance in terms of spatial distribution of monthly rainfall

Climatological mean (1982-2012 mean) rainfall per STATION for every month June, July, August

Location of the 7 PAGASA stations

Grids are for visualization purposes only, not the actual model grids.
12.5 km has the closest distribution to PAGASA in terms of climatological rainfall distribution

5km is better than 25km downscaling improves model’s spatial variation of rainfall thru minimizing RMS difference
3. Potential impact of sea surface temperature on rainfall over the western Philippines

What is the impact of local SST west of the Philippines on the summer monsoon rainfall on the northwestern coast of the Philippines?

Can SST affect rainfall west of the Philippines?

850 mb winds (vectors) + SST (shaded contours)
Model & experimental setup

**Boundary Conditions**
- Atmospheric: ERA Interim
- Sea surface temperature: NOAA monthly OISSTv2

**Parameterization**
- Microphysics: WSM 6-class graupel
- Planetary boundary layer: Mellor–Yamada–Janjic
- Land surface: Unified NOAH
- No cumulus convective parameterization (CCP)
WRF-ARW v3.6.1
-- Simulation Period: June to August, 1982-2012
-- Resolution analysis: 5km, nested within 25km domain
-- ERA Interim atmospheric boundary condition
-- NOAH Land Surface Model
-- No cumulus convective parameterization (CCP)

CTL experiment
w/ monthly mean SST data from NOAA OISST v2

CLM experiment
w/ monthly climatological SST (1982-2012) from NOAA OISST v2

Compare CTL and CLM results
Determine the sensitivity of rainfall to the variations of SST
SST impact

For each year,
Spatial distribution of monthly rainfall vs TRMM-PR 1998-2012

1. Results
SST impact on rainfall

REGRESSION ANALYSIS
relationship between rainfall sensitivity to SST anomaly in WSST region

Regression coefficient
Slope $\rightarrow$ rate of change of rainfall per 1K SST warming

Theil–Sen method
Estimate trend using median slope among all lines through all pairs of points
SST impact on rainfall

SPATIAL MAP of the regression coefficient

regression coefficient of the rainfall sensitivity to the SST anomaly in the WSST region
Positive rainfall sensitivity to 1-K SST warming over the domain.
Higher and statistically significant sensitivity was observed for oceanic rainfall near the WSST region.
Rainfall in the WPH increased by ~100 mm K\(^{-1}\) SST warming in the WSST.
Conclusions

1. Onset of southwest monsoon is very abrupt in mid-May, while it retreats gradually from the north in mid-September, and fully retreat in late October.

2. Best RCM resolutions reproducing summer monsoon rainfall on the northwestern coast of the Philippines: 12.5km for spatial distribution of climatological monthly rainfall, 5km for interannual monthly rainfall amount.

3. Positive SST anomalies in WSST region induce positive rainfall anomalies in the WPH region.
   - Based on regression analysis, WPH rainfall is modulated by interannual variation in WSST by ~100mm per 1K SST warming.
Sunset in the Manila Bay on March 27, 2007

The END

Thank you!