ENSO and Pacific Islands Rainfall

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Water and Environmental Issues in Tropical Pacific Islands
Overview

- Pacific rainfall distribution and variability
- Broad impacts of El Niño
- Time-scale interactions are important
- Prediction capabilities are improving
Tropical Pacific Rainfall Regimes

- **Mean distribution**
  - Wet regions/warm SST
  - Dry regions/colder SST
  - Orographic influences for high islands

- **Seasonal modulation**
  - West Pacific influenced by monsoons
  - East Pacific weak monsoonal effects
  - Central Pacific smaller variation
Data from National Oceanic and Atmospheric Administration
Climate System

- SST associated with winds and rainfall
- Warmest SST – converging winds – heaviest rainfalls
- Changes in one associated with changes in the others – *coupled system*!
Rainfall Variability

- Largest variability over warm waters
- Non-seasonal variability largest over WPWP
Monthly data do not resolve intraseasonal oscillations
Warm ENSO events

CMAP Precipitation anomaly EOF 1: 13.9%

Cold ENSO events
What is ENSO?

- ENSO = El Niño/Southern Oscillation
- ENSO warm phase = El Niño
- ENSO cold phase = La Niña
El Niño Schematic

- **Normal**
  - deep warm pool and rainfall in west
  - shallow thermocline & cold tongue in east
- **El Niño**
  - warm pool & rain shift to central Pacific
  - thermocline flattens
  - cold tongue disappears

National Oceanic and Atmospheric Administration
What does ENSO do?

- East-west migration of rainfall with WPWP
- Extratropical atmospheric Rossby wave response to near-equatorial convection [e.g. Pacific-North American teleconnection]
- Intraseasonal oscillation pulses near-equatorial convection during warm phase
El Niño Global Impacts

Note seasonality in ENSO impacts
La Niña Global Impacts

COLD EPISODE RELATIONSHIPS  DECEMBER - FEBRUARY

COLD EPISODE RELATIONSHIPS  JUNE - AUGUST

Climate Prediction Center
NCEP
Simultaneous correlations of CPac SST with rainfall

(a) Correlation between JFM Niño3.4 and JFM Precipitation (0 month lead)

(b) Correlation between AMJ Niño3.4 and AMJ Precipitation (0 month lead)

(c) Correlation between JAS Niño3.4 and JAS Precipitation (0 month lead)

(d) Correlation between OND Niño3.4 and OND Precipitation (0 month lead)
Correlations with SST leading by 6 months
Intraseasonal Oscillation

- AKA Madden-Julian Oscillation (MJO)
- 30-60 day period, alternating
  - easterly and westerly wind variations
  - drier and wetter phases
- Equatorially confined (±10°)
- Eastward propagating – 10-20 ms⁻¹
- Global, but strongest over warmest waters
- Stronger before and during warm ENSO phase
- Equatorial westerlies spawn cross-equatorial cyclones
Proxy rainfall anomalies along equator.

OLR Anomalies, 5N-5S

Data updated through 08 JAN 2003
As El Niño develops, MJO becomes stronger especially in Indian Ocean and western Pacific.
October 17, 2002

You are here

Warmest SST
Present Event

- Moderate in ocean, strong in atmosphere
- Should start decaying in April
Observed Sea Surface Temperature (°C)

Observed Sea Surface Temperature Anomalies (°C)

7-day Average Centered on 08 January 2003
OLR Anom 12/5/2002 - 1/3/2003 W/M**2
Base Period, 1/79-12/95

more rain less rain
More rain

Less rain

Australian Bureau of Meteorology
(Oscar Alves)
January 9th

Cyclone Ami

Westerlies
Conclusions

- ENSO rainfall anomalies vary
  - by season,
  - by phase of ENSO,
  - from event to event
- MJO modulates warm ENSO rainfall anomalies
  - Interacting short and long time scales
  - Cyclonic disturbances are affected by ENSO and MJO
5-day Running Mean

OLR Anomalies 5N-5S

Data updated through 03 JAN 2003

CLIMATE PREDICTION CENTER/NCI

CLIMATE PREDICTION CENTER/NCEP
LONG-LEAD RAINFALL PREDICTION FOR US-AFFILIATED PACIFIC ISLANDS

1-HD03 2-DJF03 3-FM03 4-FM03 5-AM03 6-MJ03 7-JJA03 8-JJA03 9-JAS03 10-SON03 11-DN03 12-DN03 13-HD03

GUAM

JOHNSTON IS WSO AP

KOROR WSO

KWAJALEIN MISSILE RGN

MAJURO WSO AP

POHINPEI WSO

WAKE ISLAND WSO AP

YAP ISLAND WSO AP

CHUUK (TRUK)
LONG-LEAD RAINFALL PREDICTION FOR NON-US-AFFILIATED PACIFIC ISLANDS (B)

1-NOJ03 2-JJF03 3-FMA03 4-FMA03 5-JJA03 6-MAJ03 7-JJA03 8-JJA03 9-JAS

Graphs showing rainfall predictions for different locations and seasons.
Mean Rainfall

- Inter-Tropical Convergence Zone (ITCZ)
- South Pacific Convergence Zone (SPCZ)
- Confluence of convergence zones over western Pacific warm pool
Winter Rainfall Anomalies
(courtesy P.S. Chu, UH Meteorology)