The structure of convective activities on extreme rainfall observed on 2005/06 winter over tropical western Pacific

Hisayuki Kubota

Submitted to JMSJ Meteorological Research Note (.........
(in Japanese)
Feb. 2007
Introduction

- On 2005/06 winter, cold weather was observed over Northeast Asia.
- Extreme rainfall was observed at same period in Koror of Palau, where we are performing continuous observation.
- In this study, we investigated the feature of extreme rainfall and the structure of convective activities around Palau region over tropical western Pacific using fruitful amount of observation data.
Sea level pressure and surface winds on Dec. 2005

Maeda (2007)
Sensitivity experiment using linear AGCM (Watanabe and Kimoto 2000)

Color shading: latent heat source

200hPa stream function

850hPa stream function

Maeda (2007)
Schematic diagram for explaining cold winter on December 2005

- Continuous cold air mass
  Flow along the meander
  Of westerly jet

- Active tropical convections
  Intensified meander of westerly jet
  → induces more cold air mass inflow

- Meander of westerly jet

- Westerly jet meandered Southerly during Dec. 2005

- Ordinary path of westerly jet

- Northern hemisphere circulation during December 2005

Japan Meteorological Agency (2006)
Data

Rainfall

NOAA 30 stations (1945-2006)

JAMSTEC 5 stations (2000-2006)

South Sea Bureau monthly report 7 stations (1923-1941)

(data: available more than 90% within a year, month, if it relocated within 1° (about 2km), regards as a same site, take into account homogeneity after Buishand (1982))

Peleliu observation site (2001-06)
Rain gauge, GPS: precipitable water. Ceiometer: cloud amount

Aimeliik observation site (2003-2006)
Wind profiler: horizontal wind profile
Koror NWS radiosonde (2005)

Satellite data (2005-06)

SSM/I precipitable water 0.25° x 0.25°
QuikSCAT surface wind 0.25° x 0.25°
TRMM 3G68 near surface rain 0.5° x 0.5°
MTSAT TBB 0.05° x 0.05°
South Sea Bureau monthly report (July 1923-Dec. 1941)
South Sea Bureau weather station (at present Koror)
  hourly-daily: surface T, RH, pressure, wind, cloud amount, cloud type, precipitation, visibility, radiation, soil temperature, evaporation
Weather stations 10 sites  2hourly-daily
Trusted observation sites (Elementary schools etc.) 31 sites
daily: surface T, RH, pressure, wind, precipitation
daily precipitation data were converted into electronic files (Mar.2007)
Observational fields of Republic of Palau
Observation site at Peleliu

Potable Radiation Package

Automatic Weather Station

Total sky imager

Solar panel

Microwave radiometer

GPS receiver

Ceilometer

From
November 2000 (AWS, GPS)
June 2001-Feb 2003, May 2005-(Ceilometer)
October 2001 (TSI, PRP)
December 2001-Oct 2002 (MWR)
Mar 2005- (Disdrometer)
Observation site at Aimeliik

- Microwave radiometer
- Ceilometer
- Automatic Weather Station
- Wind Profiler and RASS
- Micro Rain Radar

From March 2003 (Wind Profiler, RASS and MWR)
June 2003 (AWS, Ceilometer and Disdrometer)
March 2004 (Micro Rain Radar)
Koror Three months accumulated rainfall (November to January)

- Average 903mm November 2005 - January 2006
- 1430mm maximum November 2001 - January 2002
- ENSO normal phase closer to average rate 1017mm (2006/07) 737mm
- November 2001 - January 2002 ENSO normal phase closer to average rate 1017mm.
Three months rainfall
Three months rainfall NDJ and anomaly over western Pacific
TRMM 3G68 three months precipitation November 2005-January 2006 anomaly from 98.05 NDJ average
Meridional cross section of precipitable water (SSM/I), surface wind (Qscat)

November 2005-January 2006

November 2001-January 2002

Palau
Zonal cross section of precipitable water (SSM/I), surface wind (Qscat)

December 2005

2005 Dec SSM/I Qscat 6–9N Zonal average along 6-9N

January 2006

made a composite on Dec. 4, 9, 14, 19, 24, 29
Composite of 5-day-period disturbances
Composite of wind profile, rainfall, cloud amount, precipitable water

WP V composite

km

Wind profiler
meridional wind anomaly

Day lags

Peleliu composite

Precipitable water

Cloud amount

precipitation
Composite of wind, temperature, relative humidity profile by Koror raindiosonde

meridional wind anomaly

temperature anomaly

relative humidity
Takayabu and Nitta (1993)
Convective activity

Reed and Recker (1971)

Horizontal and vertical structure of easterly wave disturbances

Fig. 4. Composite diagram of meridional wind speed (m sec\(^{-1}\)) for KEP. The letters R, N, T and S refer to the ridge, north wind, trough and south wind regions, respectively, of the wave as defined by its structure in the lower troposphere.

Meridional wind
Relative humidity

Fig. 5. Composite diagram of temperature deviations (°C) at various levels from their respective mean values at KEP. Refer to Fig. 4 for further explanation.

Fig. 6. Composite diagram of relative humidity for KEP. Values in brackets at the top are for saturation with respect to ice. Refer to Fig. 4 for further explanation.

Reed and Recker (1971)
Summary

- Cold weather and heavy snowfall were observed in Japan and Northeast Asia on December 2005. The meander of westerly jet was affected by the active convections over Bay of Bengal to Philippines Sea.
- Extreme rainfall was observed over Palau and spread widely zonal over off-equatorial region of western Pacific on 2005/06 winter.
- ENSO was weak La Nina phase. In contrast, rainfall over equatorial region was relatively weaker compared to off-equatorial region.
- Comparing to 2001/02 winter, high precipitable water was observed continuously and convection was active during December 2005 over Palau region. It was due to the northward shift of active convections associated with MJO.
- Internal structure of westward propagating five-day-period systems was observed within MJO at off-equatorial region.
- The structure of five-day-period systems shows that horizontal scale is about 1000km and meridional wind reverses the direction during its passage. These structures resemble to easterly wave disturbances.
Further discussions

• How rare or often is the 5-day-period disturbances observed in ISO?
• 5-day-period disturbances will change their structures when they reached South China Sea influenced by cold surge.
  Some disturbances were developed to tropical depression.
  How does they change their structures?
Composite of 5-day-period disturbances