Recent unusually high extremity of Taiwan rainfall extremes and the modulation of Interdecadal Pacific Oscillation

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• Changes of the rainfall extremes is a most concerned climate issue in Taiwan.
• Rainfall data shows increasing rain intensity since 1961.
• Typhoon Morakot in 2009 took at least 600 people in Taiwan by deadly landslides.

From: Liu, Shaw Chen
Mean annual # of TC (tropical storms and typhoons) formed over WN Pacific: 27
Hit Taiwan: 12-16%
Taiwan Mei-Yu
May-June

From: S.S. Chi
紀水上
Taiwan rainfall climatology - daily (orange) & pentad (blue)

Mei-Yu

TC& SW monsoon

TC& NE monsoon
More frequent extreme events in the warm climate?

to quantify the interannual variations of the extreme rainfall event frequency ....

Define “extremity” index

**EERF** (Extremity of the Extreme Rainfall Frequency) – the annual total count of the extreme rainfall events. Unit: events/year

**Extreme Rainfall Event** -

a rainfall event that the amount of rain is larger than the biennial maximum event (the return period > 2 years / the two-year event) estimated by the extreme value statistics at each station based on the 50 years (1961-2010) of hourly data.
1. The 52-year **hourly rainfall data** at 21 stations during the period of 1961-2012 are analyzed.

2. **Typhoon rainfall events** are identified according to whether a typhoon center can be identified within the 300 km boundary marked by the red circle. The typhoon information is obtained from the Joint Typhoon Warning Center website (http://metocph.nmci.navy.mil/jtwc/best_tracks/)

**Note:** Only the data with measurement larger than 5mm/hr is included when analyzing the statistics of the extreme events.
Variations of the Extremity of Taiwan Rainfall Extremes represented by index EERF

![Graph showing variations of Taiwan rainfall extremes](image)
Counts of the extreme rainfall events per month
**TYPHOON**

extreme rainfall events

<table>
<thead>
<tr>
<th>Year</th>
<th>24hr typhoon extreme events</th>
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<tbody>
<tr>
<td>1961</td>
<td></td>
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<tr>
<td>1966</td>
<td></td>
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<tr>
<td>1971</td>
<td></td>
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<td>1976</td>
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</tbody>
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**WHY ?**

**Unusual seasons:**

- Sep-Oct (1998-2001)
- Jul-Sep (2004-2008)
- Aug (2009-2013)

**total counts / month**

- 1998
- 2001
- 2004
- 2008
Global Warming

Interdecadal Pacific Oscillation

Wang et al. (Clim Dyn 2012)
total extreme events

counts


(d) EOF2 time expansion coefficient

1966 1977 1997

IPO mode

Wang et al. (Clim Dyn 2012)
NON-TYPHOON extreme rainfall events

Active periods:
Sep-Oct (1966-1977)
June (2005-2013)

Quite period:
Wang et al. (Clim Dyn 2012)

IPO mode
**Summary**

- The 52-year (1961-2012) variations of the extremity index **EERF** indicates a sudden jump of the rainfall extremity in Taiwan after **1997**.
- The unusually frequent occurrence of the extreme rainfall events is attributed to the intensification of the Global Monsoon Precipitation driven by **the Inter-decadal Pacific Oscillation** of the SST and **global warming**.
- The **active** (1967-1976) and **inactive** (1977-2004) periods of the non-typhoon (i.e. monsoon) type of extreme events are coherent with the rhythm of Global Monsoon Precipitation variations.
- The unusually active years (1988, 1998) during the inactive periods reflect strong **ENSO – East Asian monsoon** connection.
- For further forecast applications, **the western North Pacific subtropical high** that connect Pacific SST and Taiwan weather is a key.
Western North Pacific Subtropical High – a key controlling factor of typhoon and monsoon influence on Taiwan

Vimont et al. (J Climate 2009)

Wang et al. (J Climate 2000)
THANK YOU 謝謝 THANK YOU 謝謝 ...