

The analysis of Taiwan dry-season precipitation and frontal system variations from 1980 to 2015

Shih-Hao Su, Bing-Kui Chiou and Kao-Yuan Liu
Chinese Culture University, Taipei, Taiwan

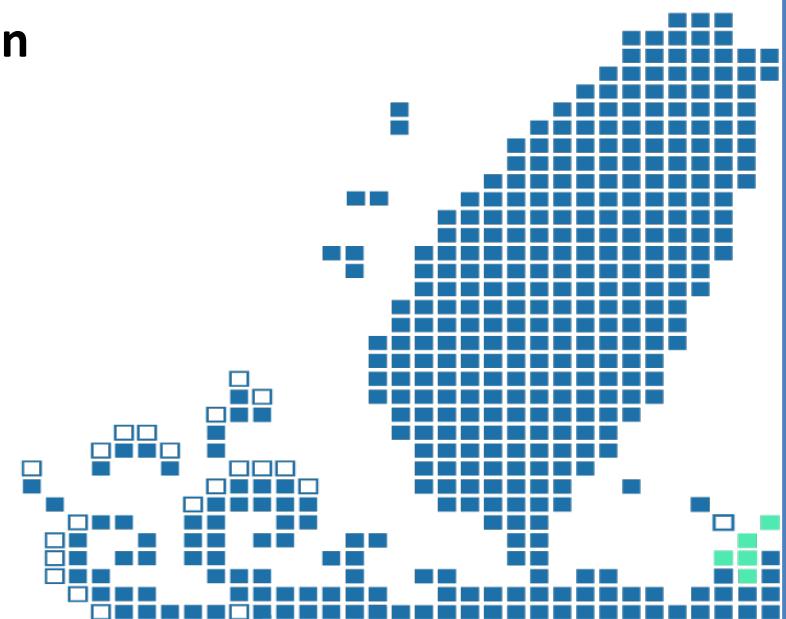


行政法人國家災害防救科技中心
National Science and Technology Center
for Disaster Reduction

2017/4/5

Collaborators: Mr. Jiang, PCCU; Chien; Dr. Chu and Dr. Lin , NCDR; Dr. Chen, CWB

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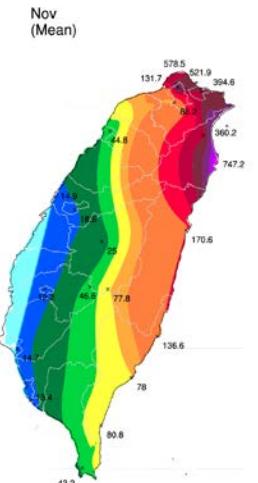
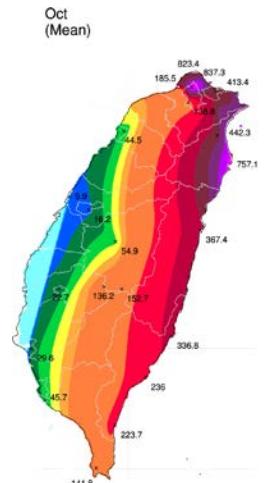
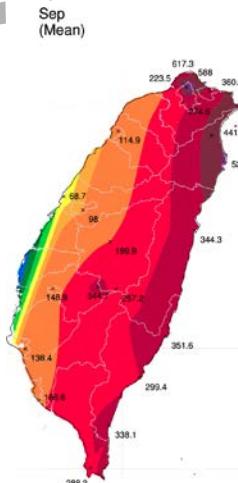
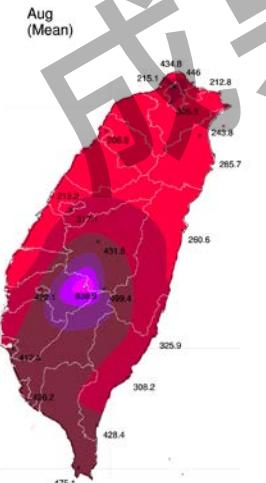
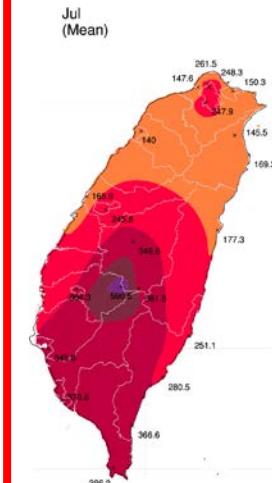
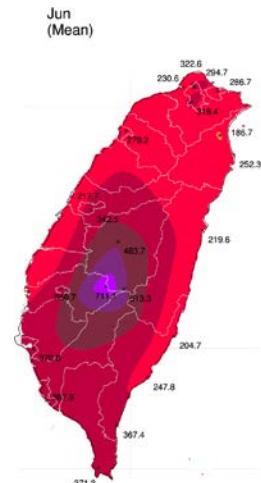
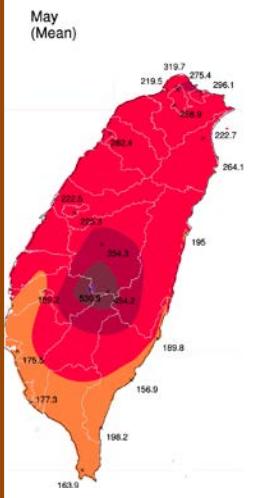
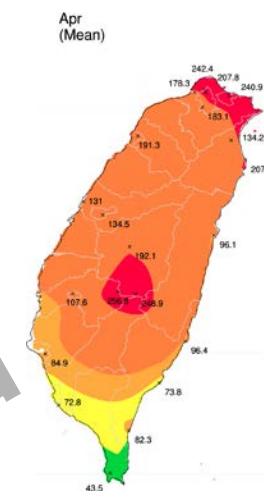
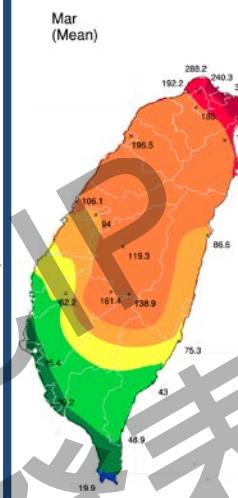
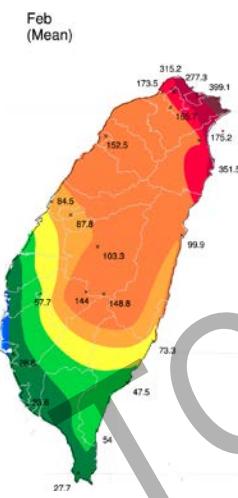
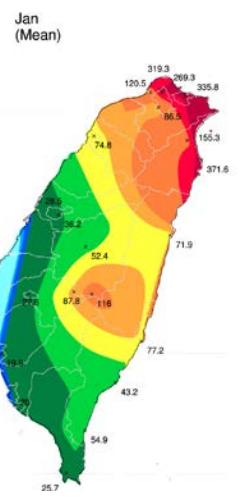
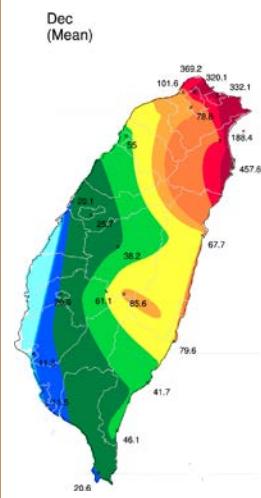
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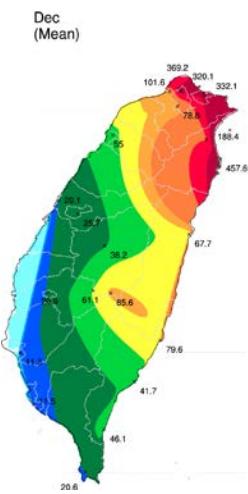
01/18/2017

Collaborators: Dr. Chen, CWB; Ms. Chen, NTU; Prof. Kuo, NTU

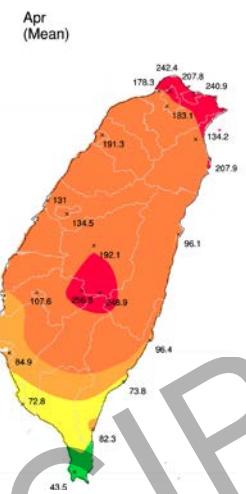
Average precipitation in Taiwan



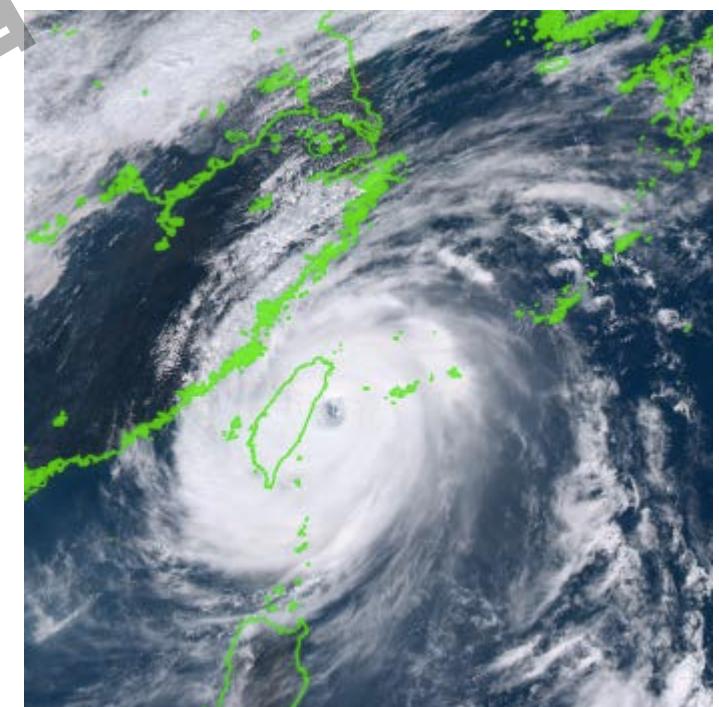
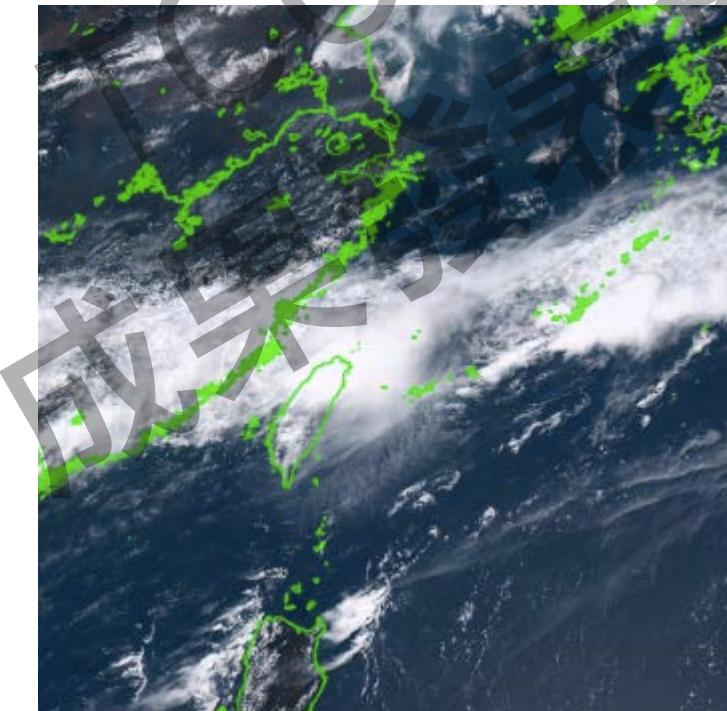
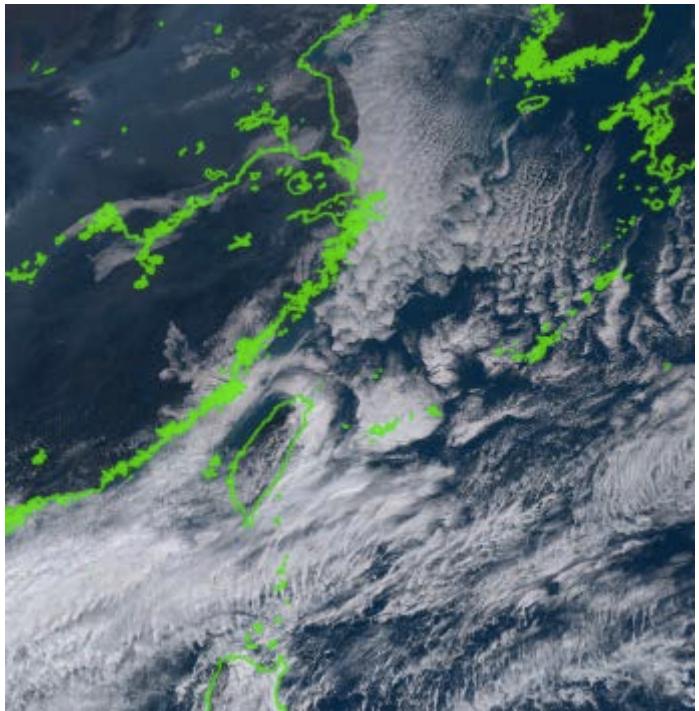
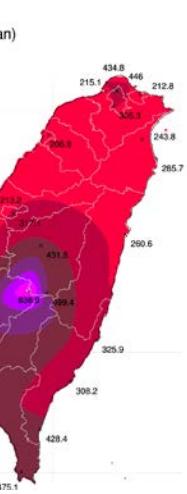
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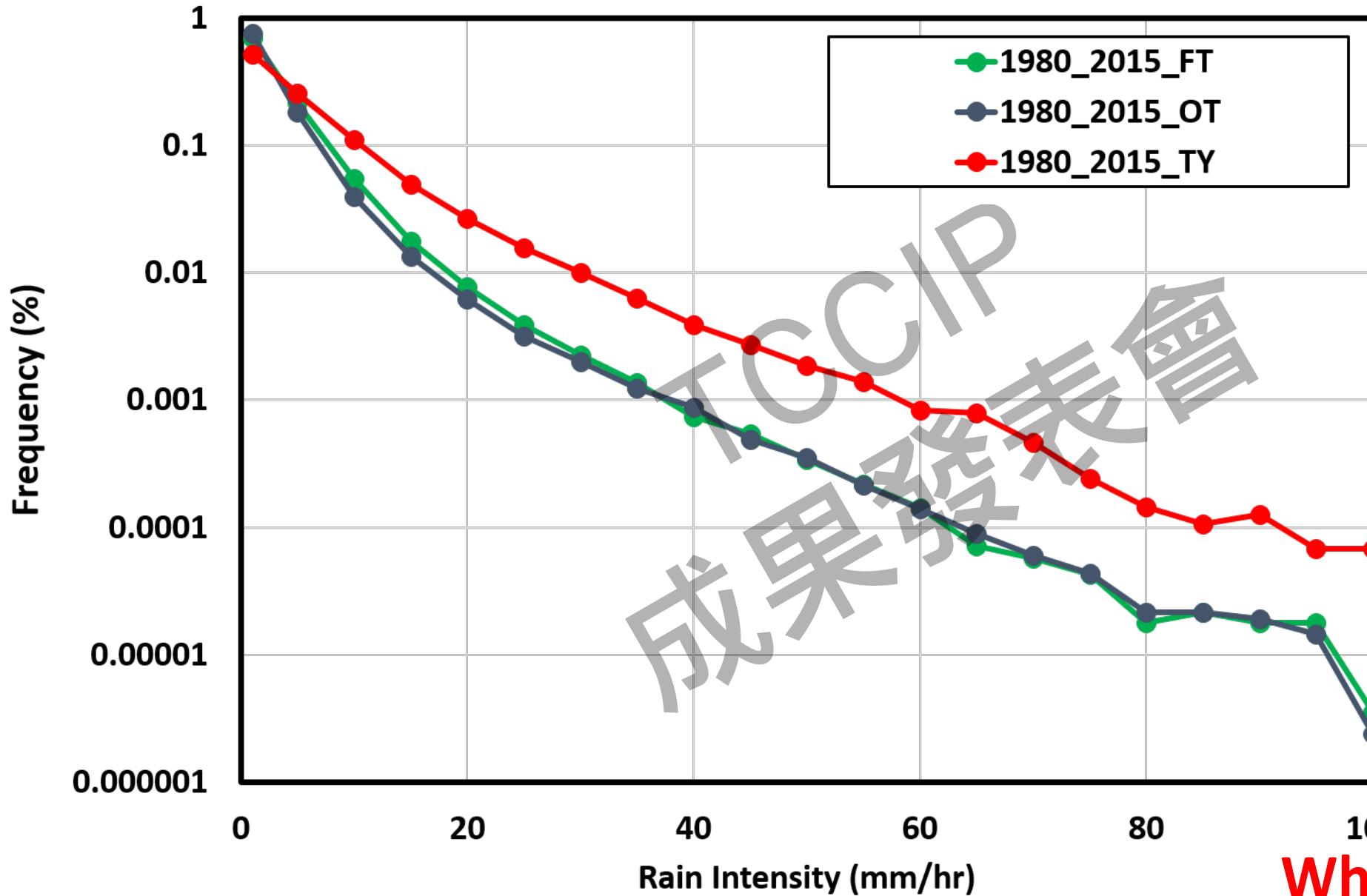
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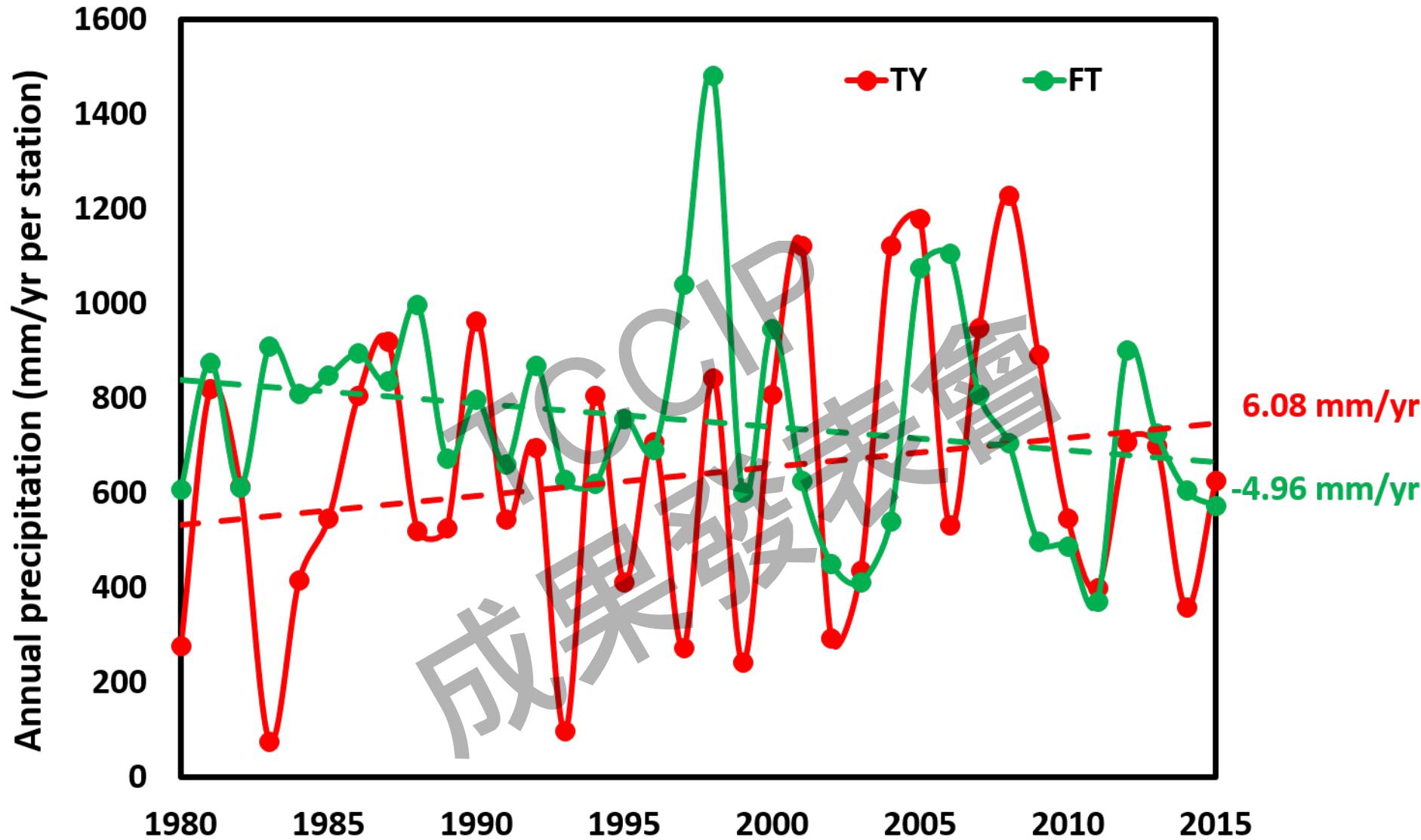
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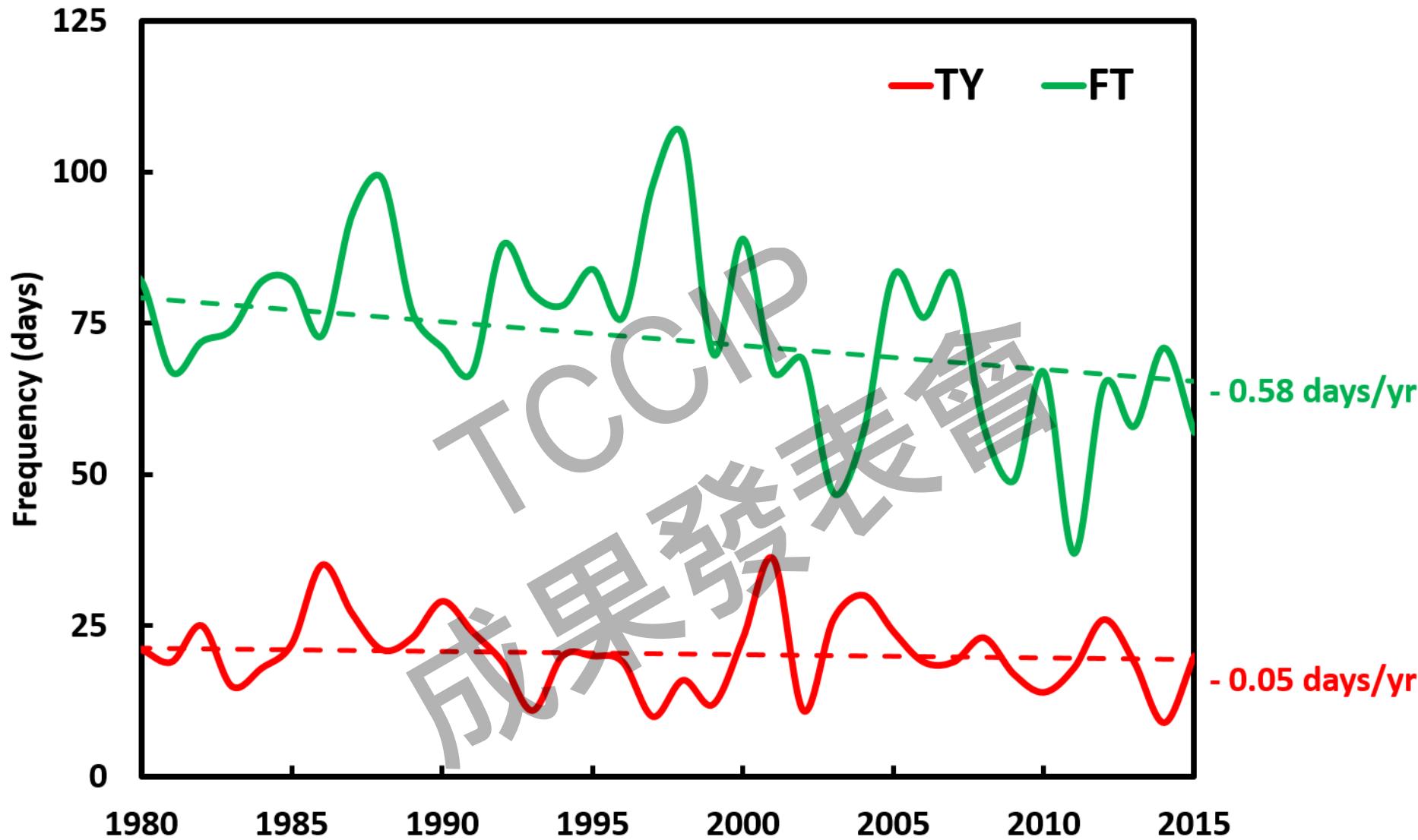


PDF of rain intensity for different weather systems



Why it's important?





(a) Frontal convection event



(b) Diurnal convection event

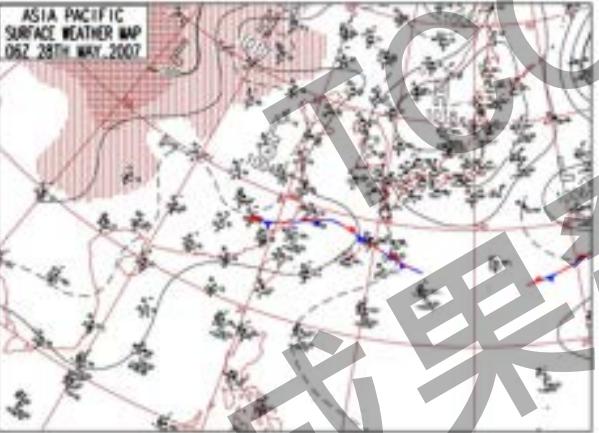
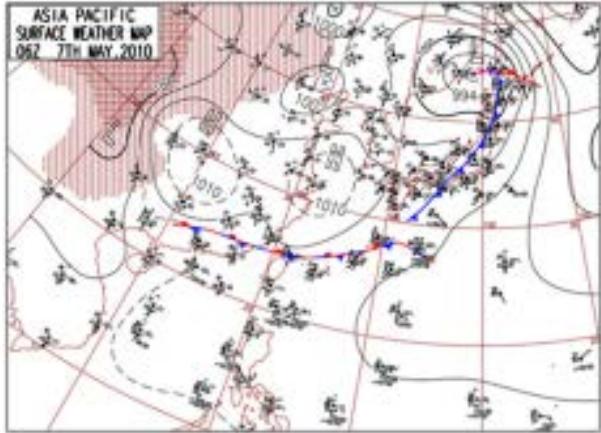


Table 1. Changes in the occurrence frequency (i.e. number of days) and rainfall intensity (i.e. rainfall rate) for different types of rainfall events in Taiwan (Southeast China) during the 1982–2012 MJ months. The value for each variable is calculated from the rain gauge data based on Equation (1) in the manuscript. The values significant at 90% and 99% confidence intervals are denoted by * and **.

| Type of event | Occurrence frequency Taiwan (Southeast China) | Rainfall intensity Taiwan (Southeast China) |
|------------------------|---|---|
| Frontal rainfall event | -20.3%* (-16.3%)* | -12.1% (-11.5%) |
| Diurnal rainfall event | +19.6%* (+15.6%)* | +48.2%** (+40.8%)** |
| Other event | +3.1% (+4.7%) | +10.3% (+11.2%) |

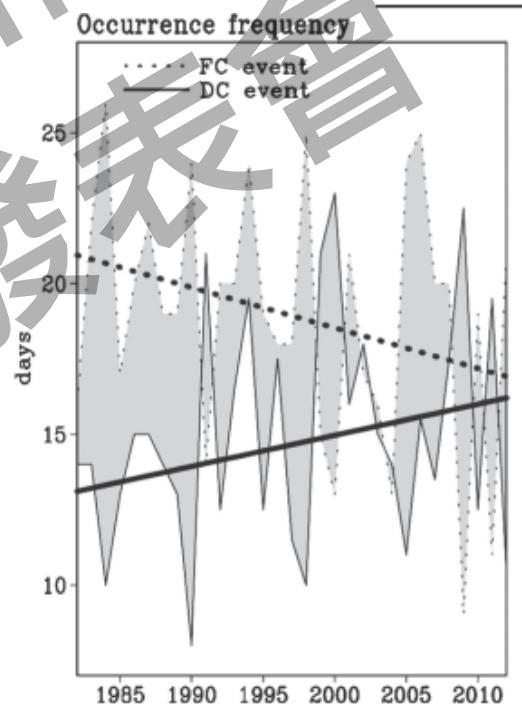
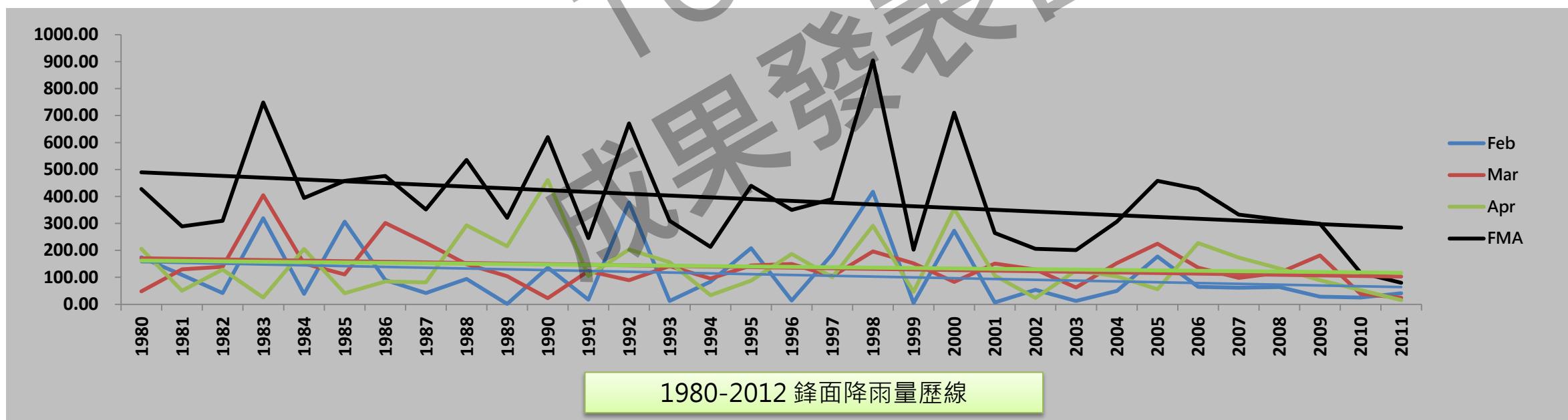


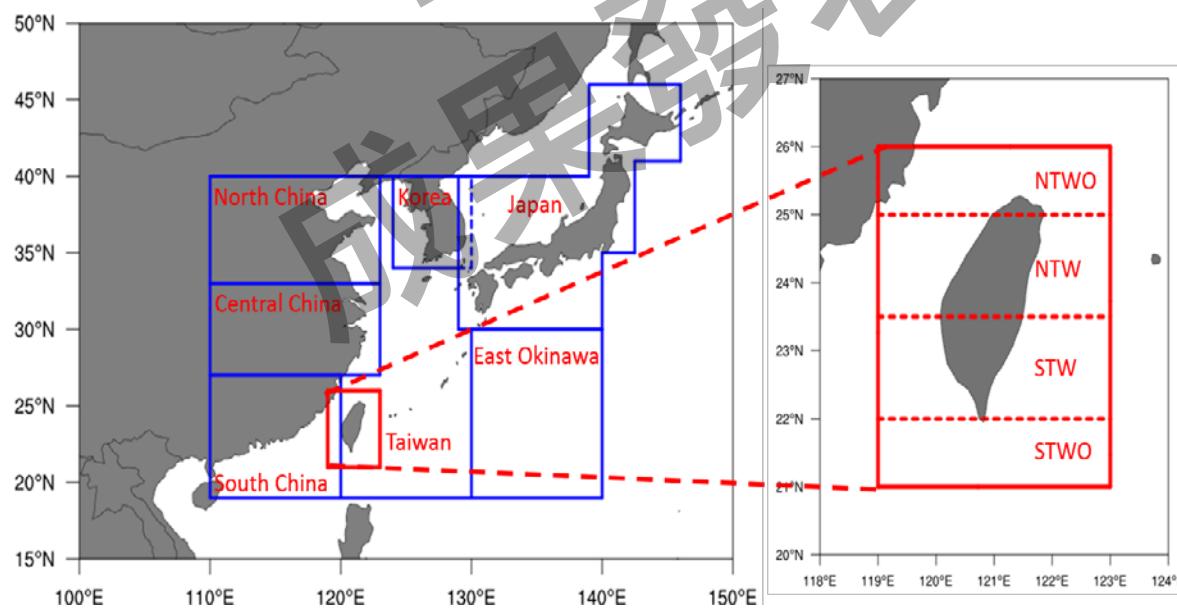
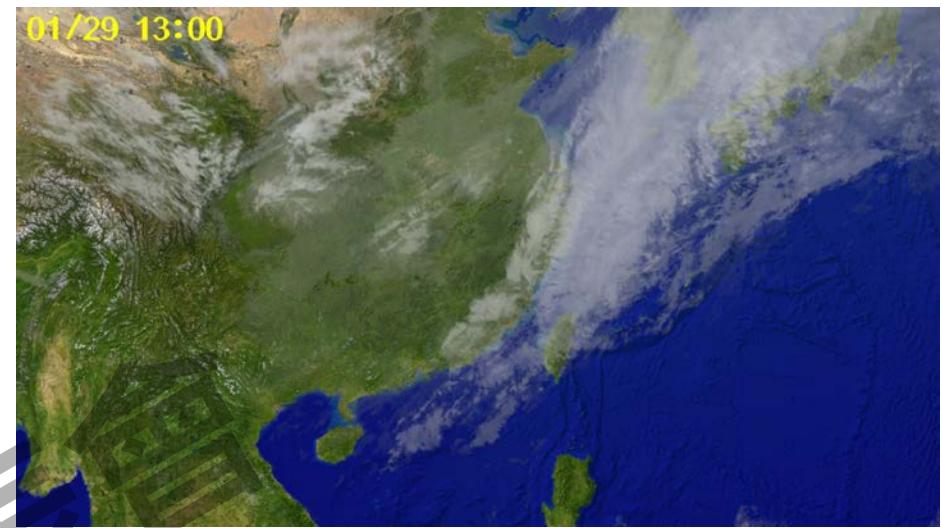
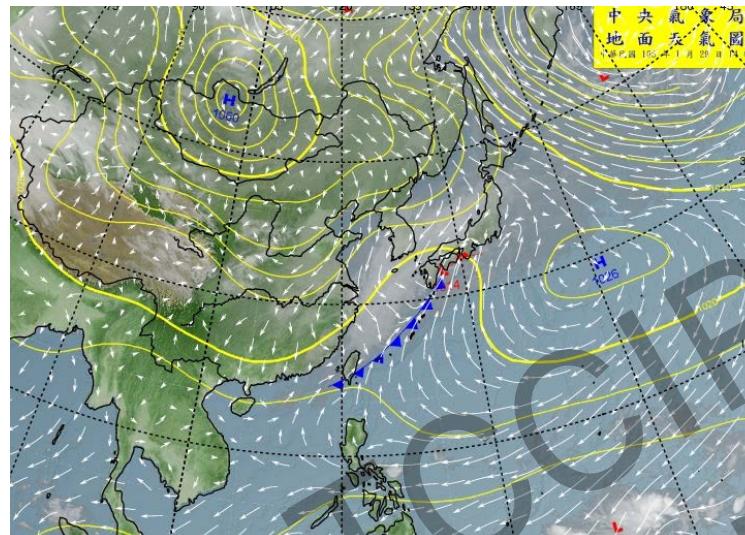
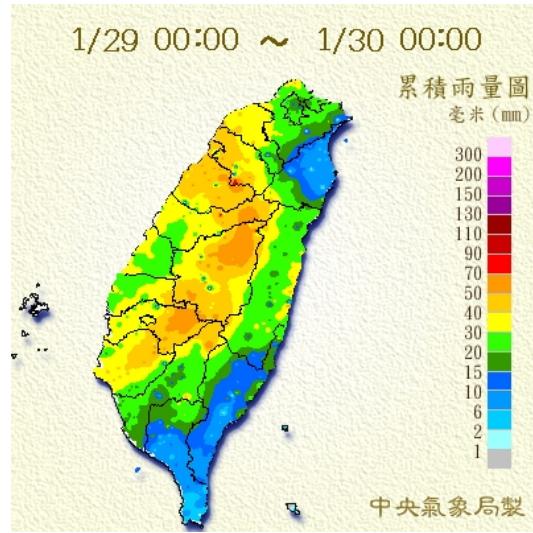
Figure 2. Variability (thin line) and linear trend (thick line) of the occurrence frequency of FC (i.e. number of days in one MJ; dotted line) and DC (solid line) events that occurred over Taiwan during 1982–2012 May and June (MJ) months. Here, the rain gauge data (see Section 2) is used for the estimation of occurrence frequency of FC and DC.

鋒面降雨對春雨的重要性為何？

| 32年平均鋒面降雨量 (mm) | Feb | Mar | Apr | FMA |
|--------------------|--------|--------|--------|--------|
| 台北站 | 110.26 | 136.95 | 139.46 | 386.68 |
| 石門站 | 118.22 | 163.84 | 146.38 | 428.44 |

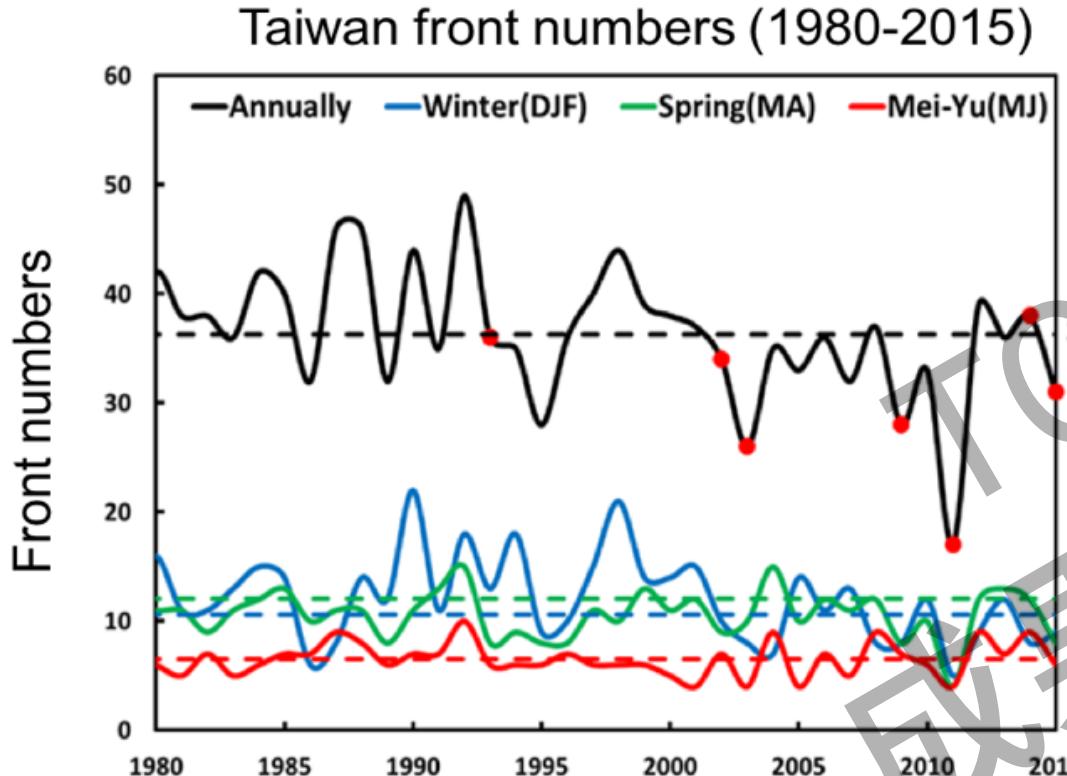


Subjective analysis of frontal system



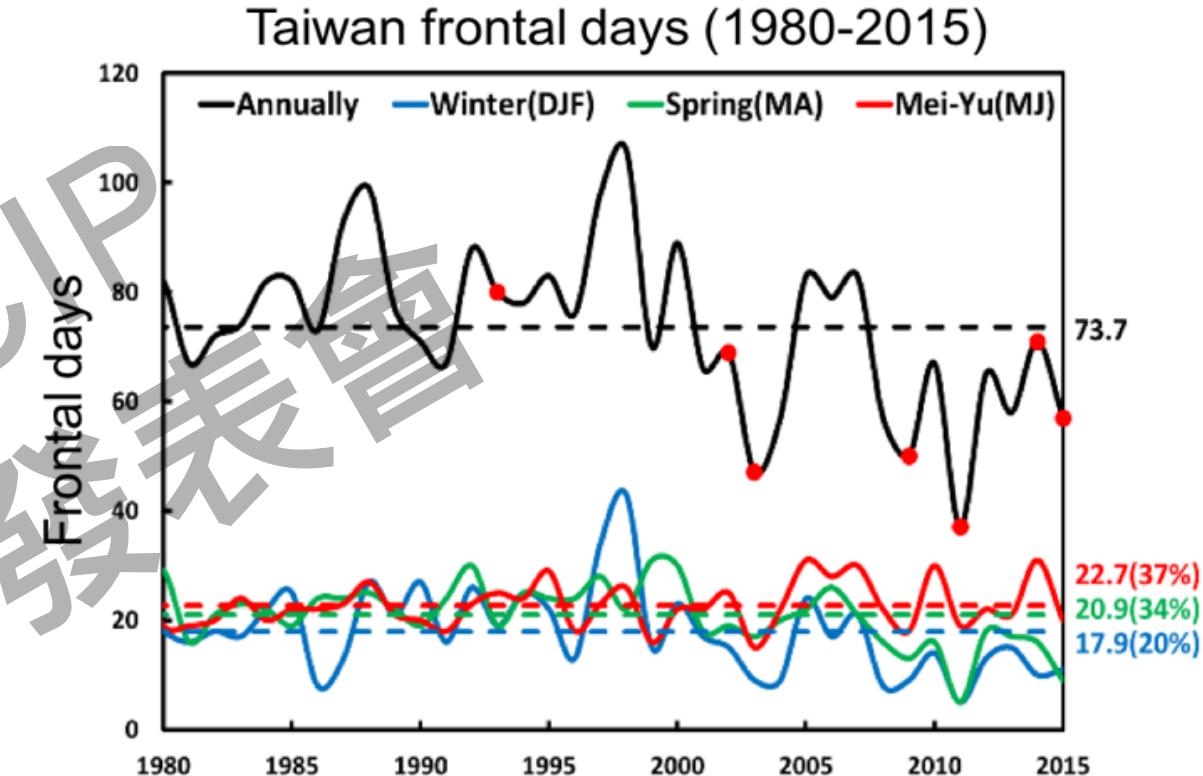
How many frontal systems and frontal fays?

(a)



● Drought events

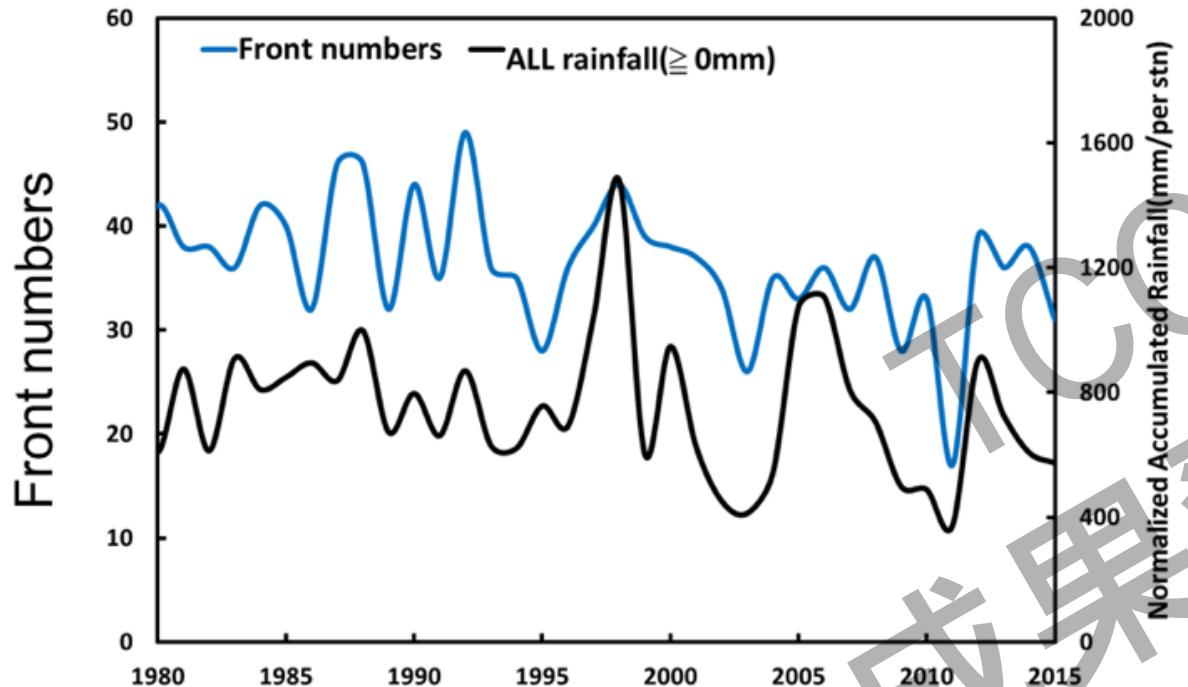
(b)



Fronts and precipitation

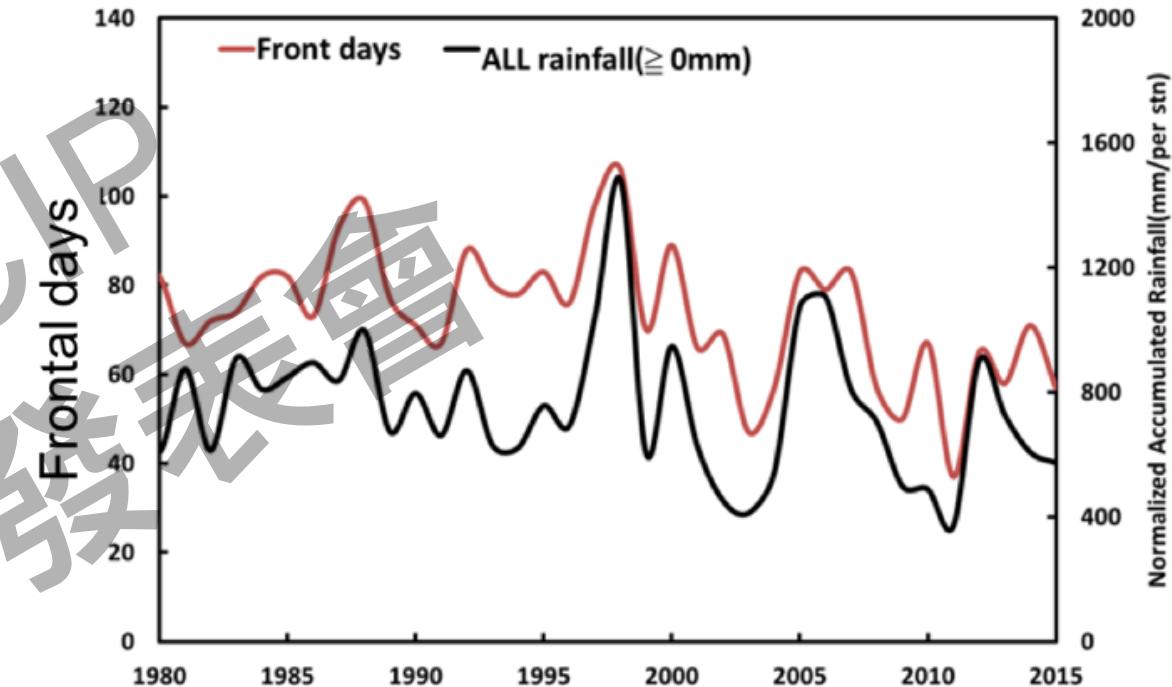
(a)

Correlation: 0.53
Taiwan frontal systems (1980-2015)



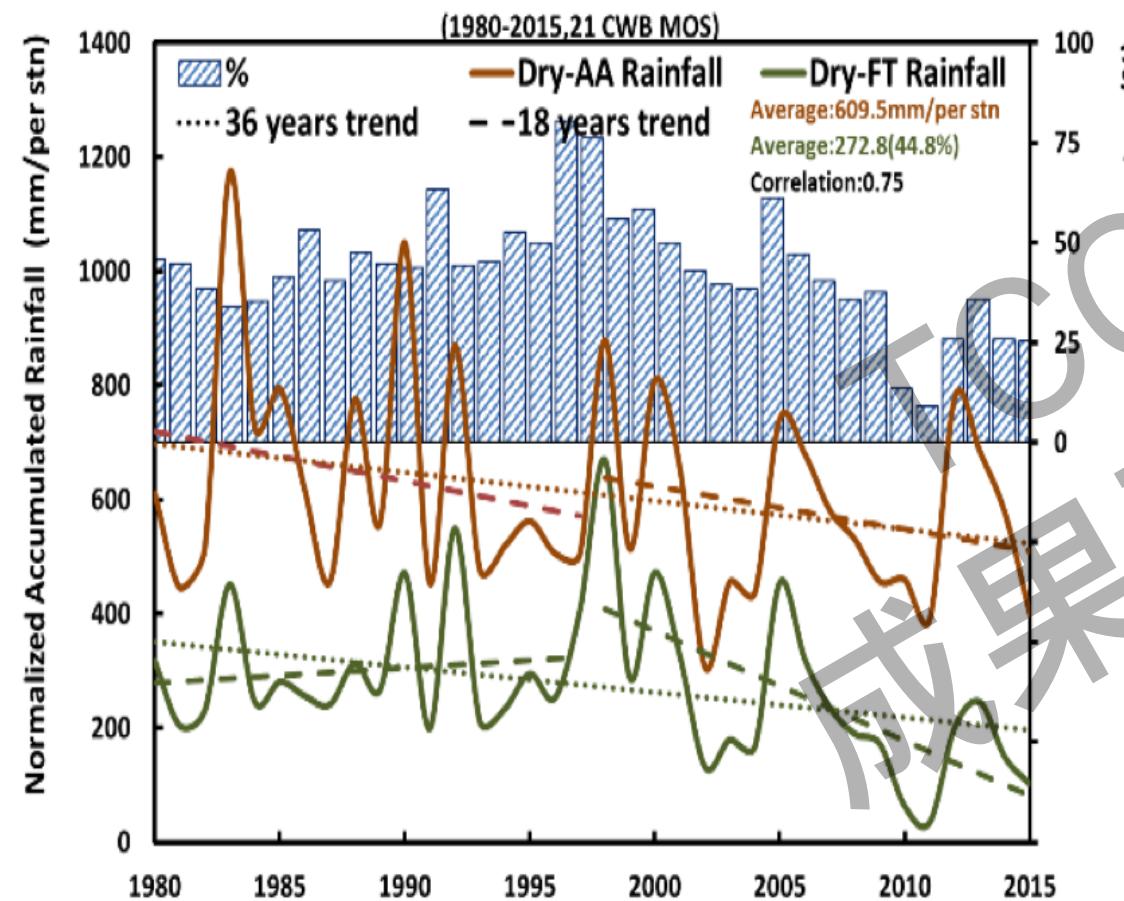
(b)

Correlation: 0.74
Taiwan frontal systems (1980-2015)

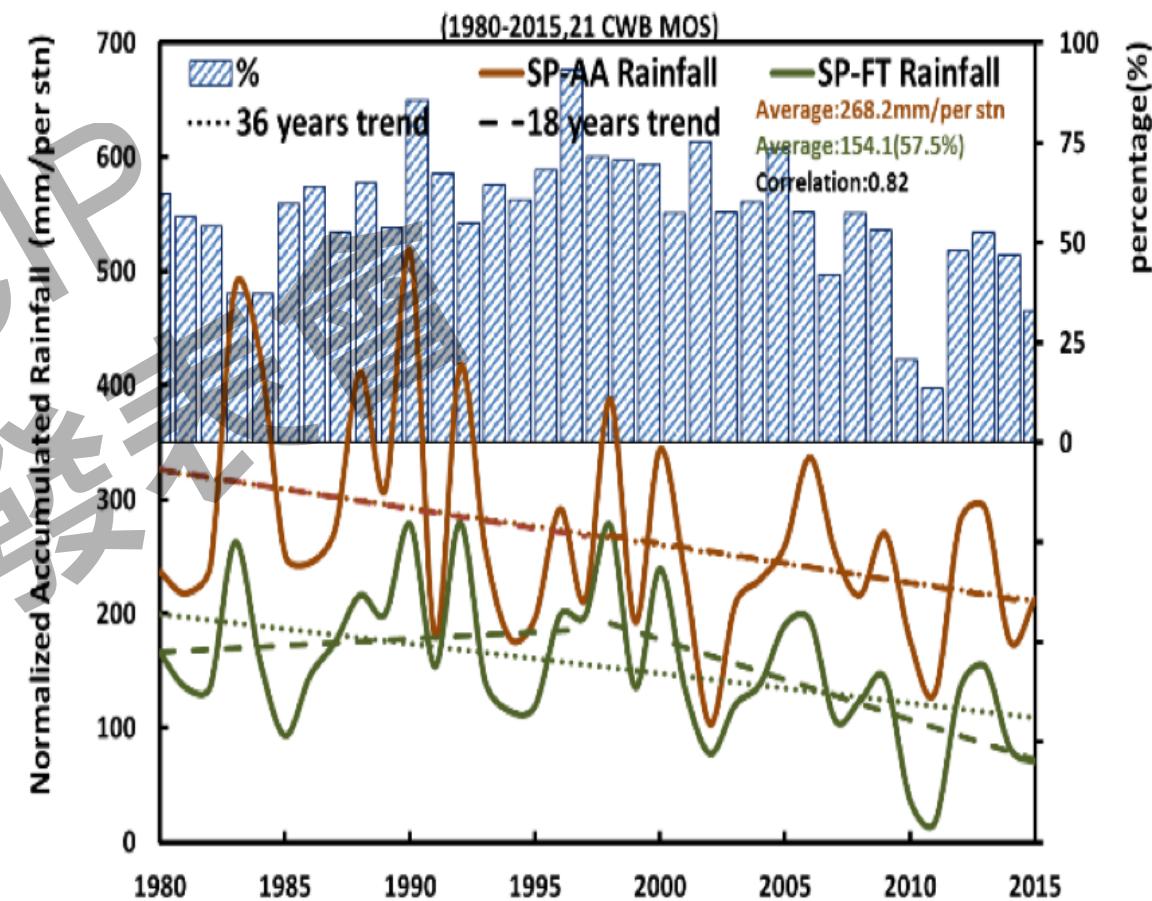


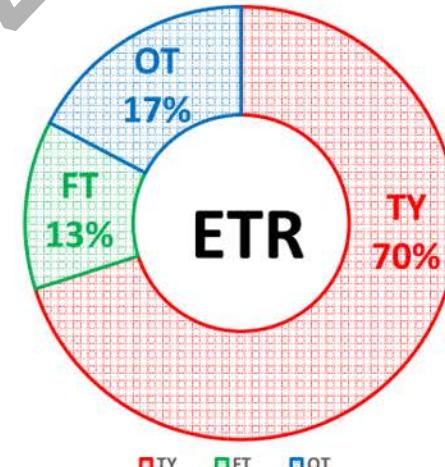
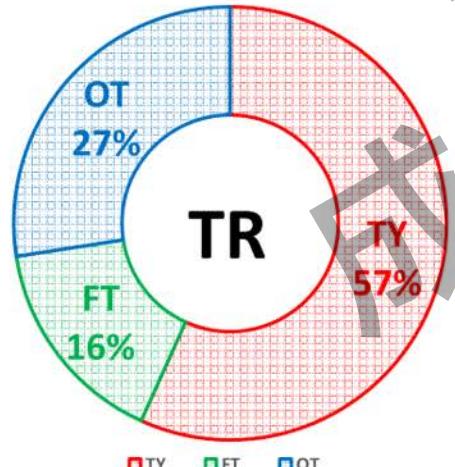
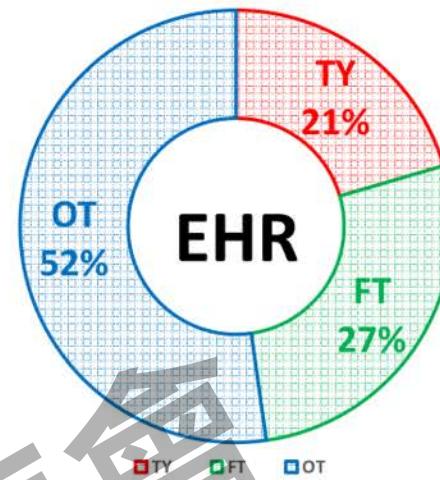
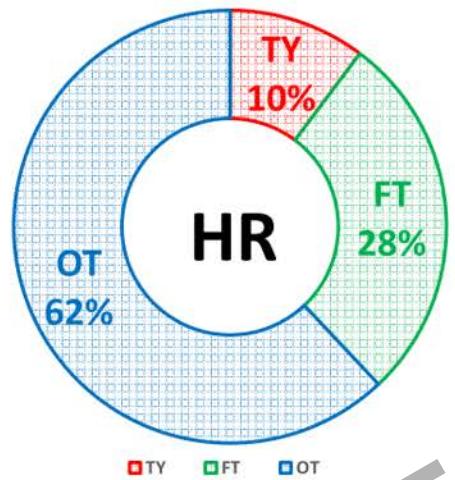
| Dry Season (DJFMA) | Correlation | Days | Numbers |
|-----------------------|-------------|------|---------|
| | ALL | 0.81 | 0.66 |
| | 95% | 0.54 | 0.55 |

(a)

Taiwan Dry Season(Dec-Apr) Annual Rainfall ≥ 0 mm

(b)

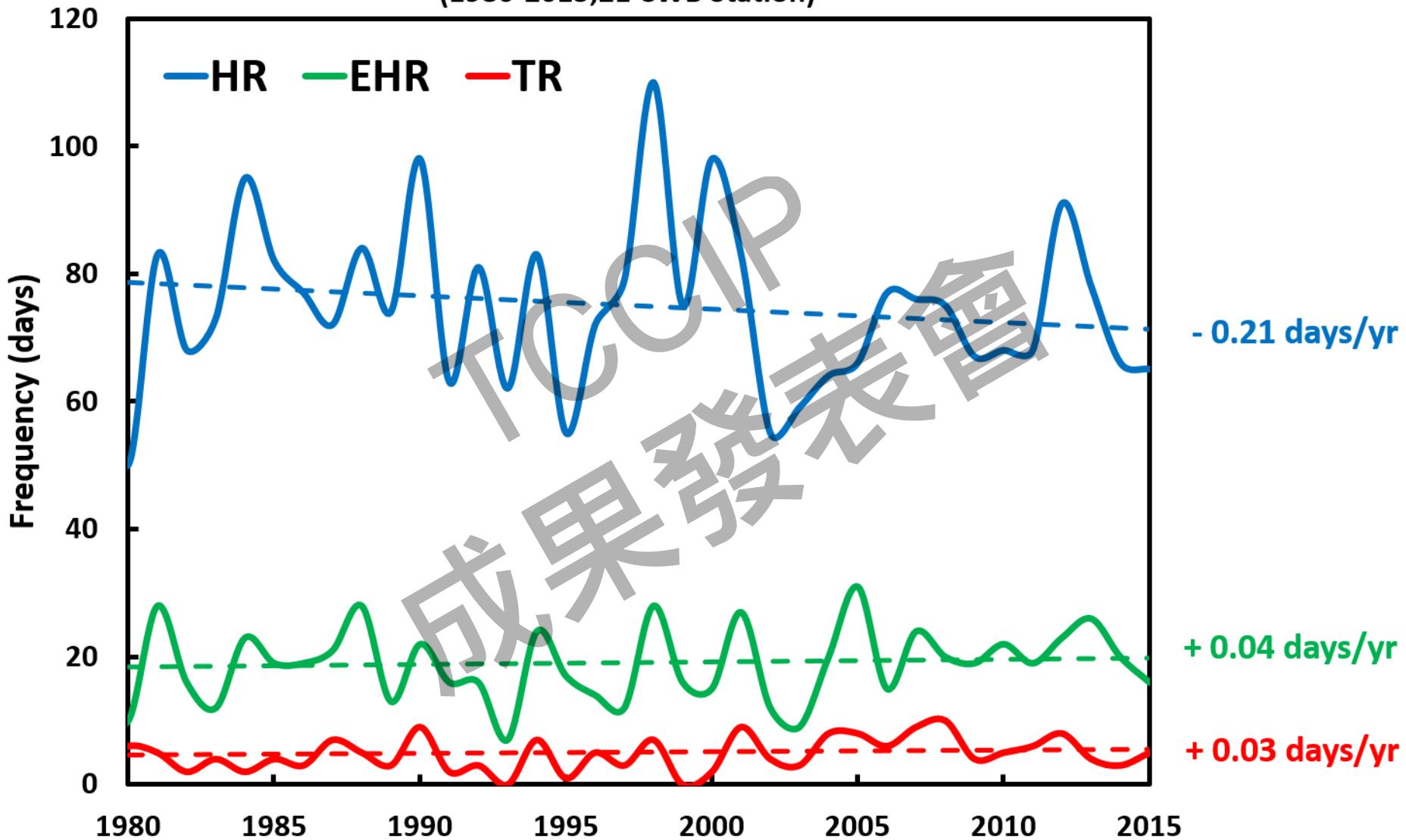
Taiwan SP Season(Mar-Apr) Annual Rainfall ≥ 0 mm



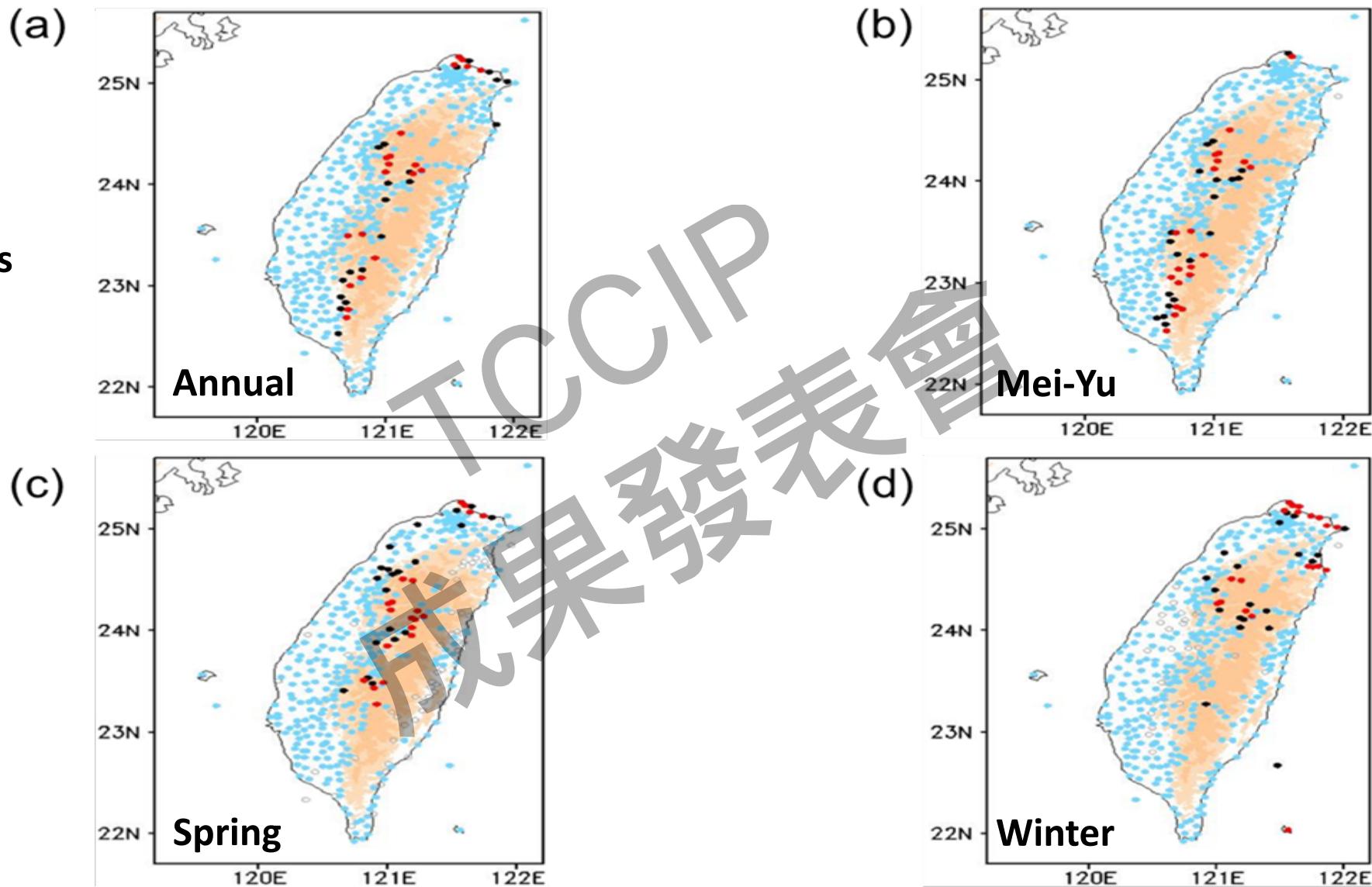
HR (大雨) 、EHR(豪雨) 、TR(大豪雨) 、ETR(超大豪雨)

Extreme Rainfall Frequency

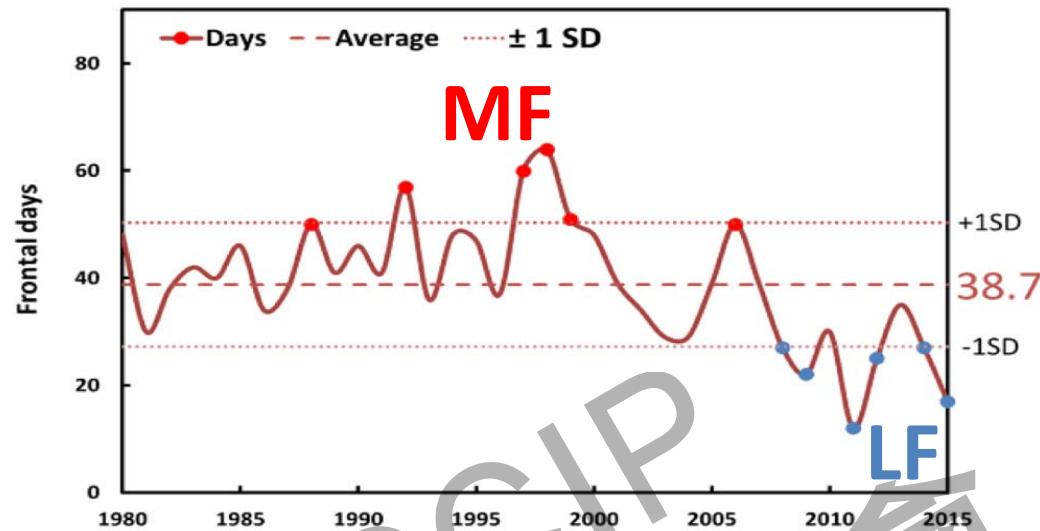
(1980-2015, 21 CWB Station)



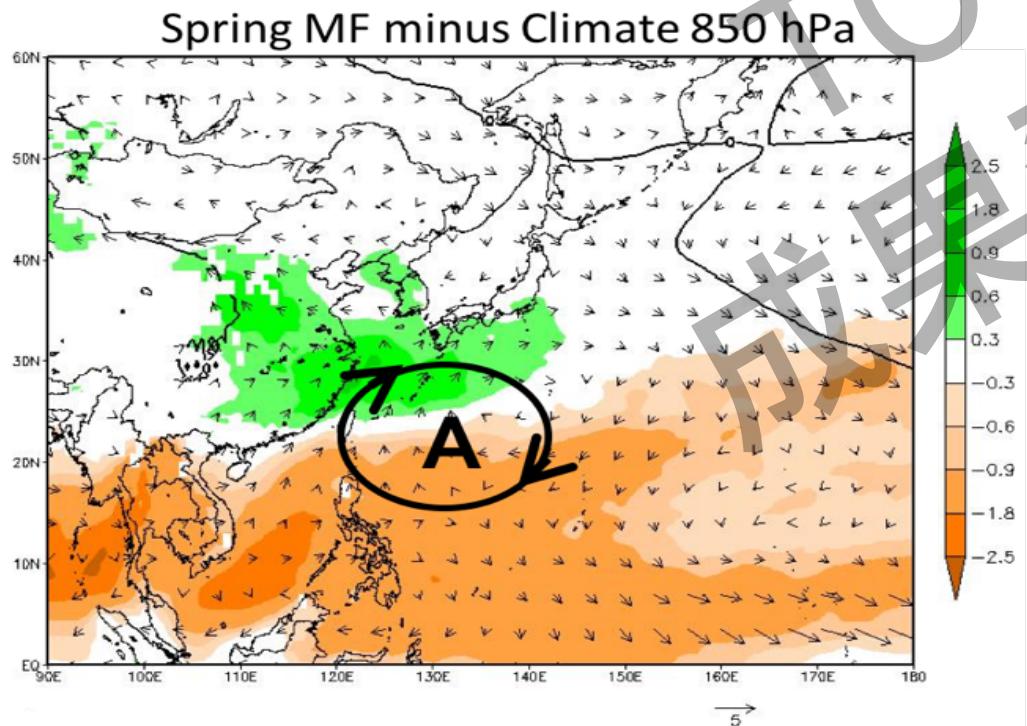
- All HR events
- Top 40
- Top 20



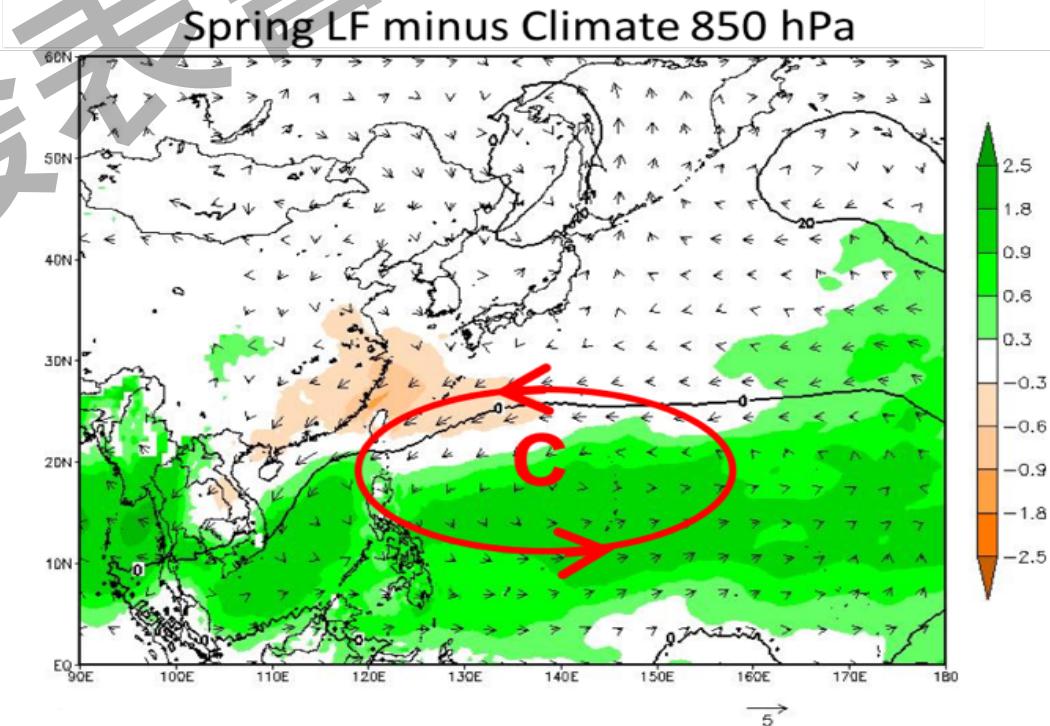
DrySeason frontal systems (1980-2015)



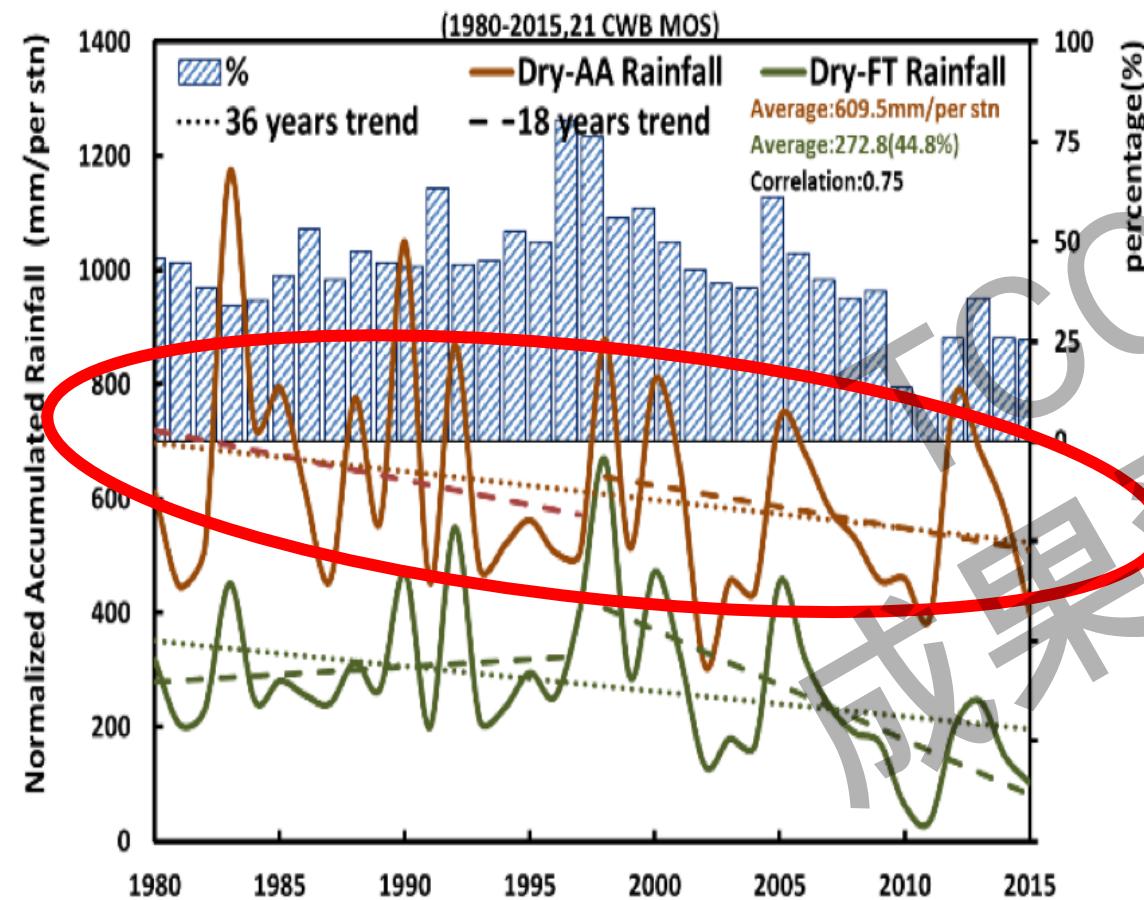
(a)



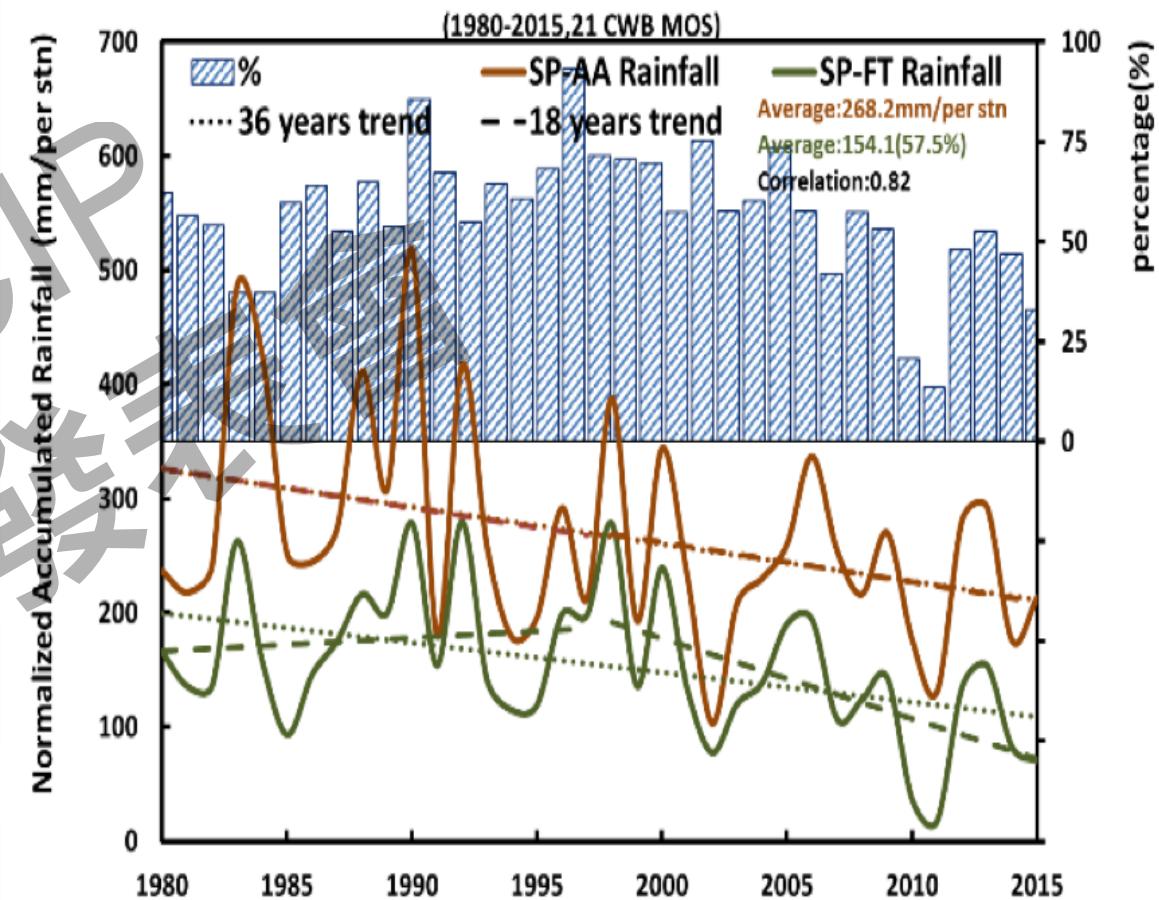
(b)



(a)

Taiwan Dry Season(Dec-Apr) Annual Rainfall ≥ 0 mm

(b)

Taiwan SP Season(Mar-Apr) Annual Rainfall ≥ 0 mm

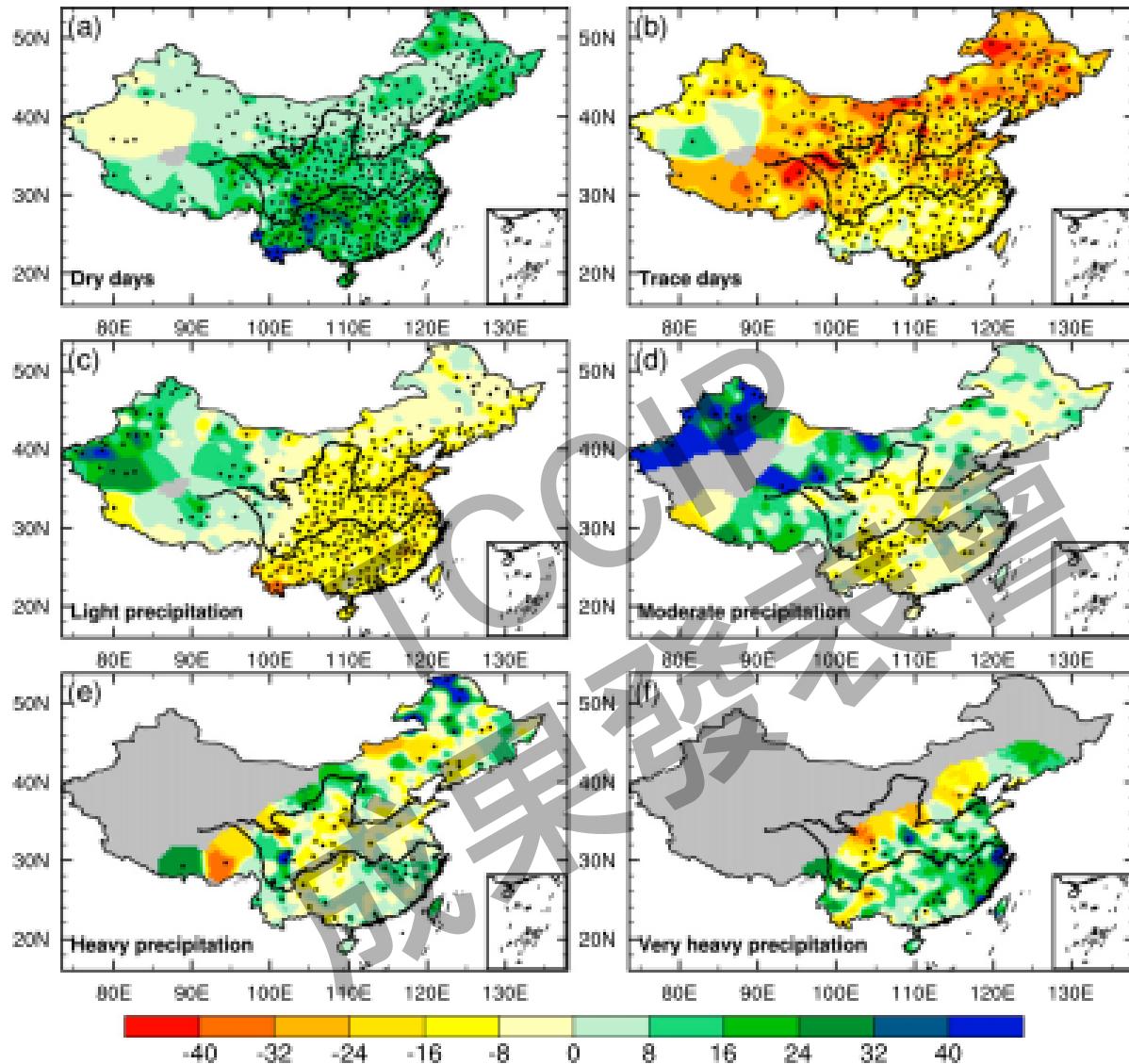


FIG. 7. Spatial distributions of the percentage change from 1960–86 to 1987–2013 in the frequency of occurrence (POC) for (a) dry days (daily $P = 0$), (b) trace days (daily $0 < P < 0.1 \text{ mm day}^{-1}$), and (c) light (daily $0.1 \leq P < 10 \text{ mm day}^{-1}$), (d) moderate (daily $10 \leq P < 25 \text{ mm day}^{-1}$), (e) heavy (daily $25 \leq P < 50 \text{ mm day}^{-1}$), and (f) very heavy (daily $P \geq 50 \text{ mm day}^{-1}$) precipitation. Black dots denote stations with statistically significant changes at the 0.10 level. Only stations with more than 40 years of events during 1960–2013 were used. The small inset in the bottom right represents the South China Sea.

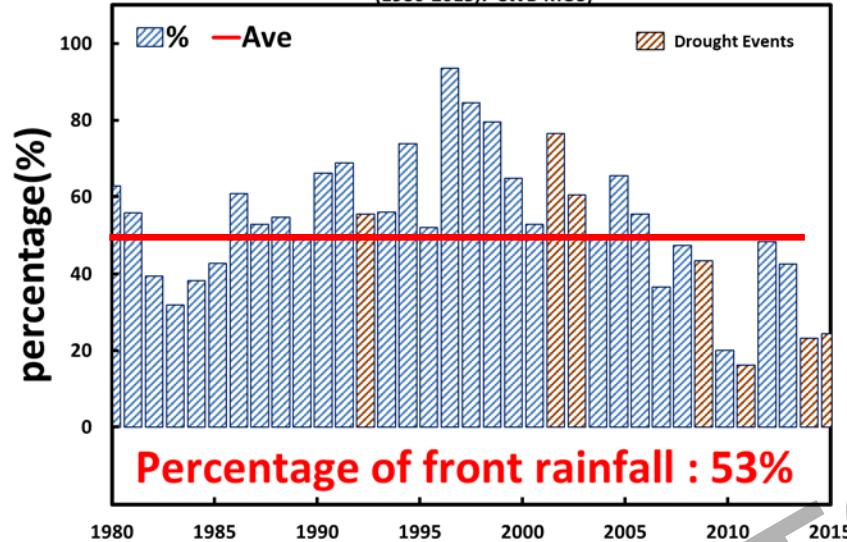
**Thanks for attention!
comments or questions**



END

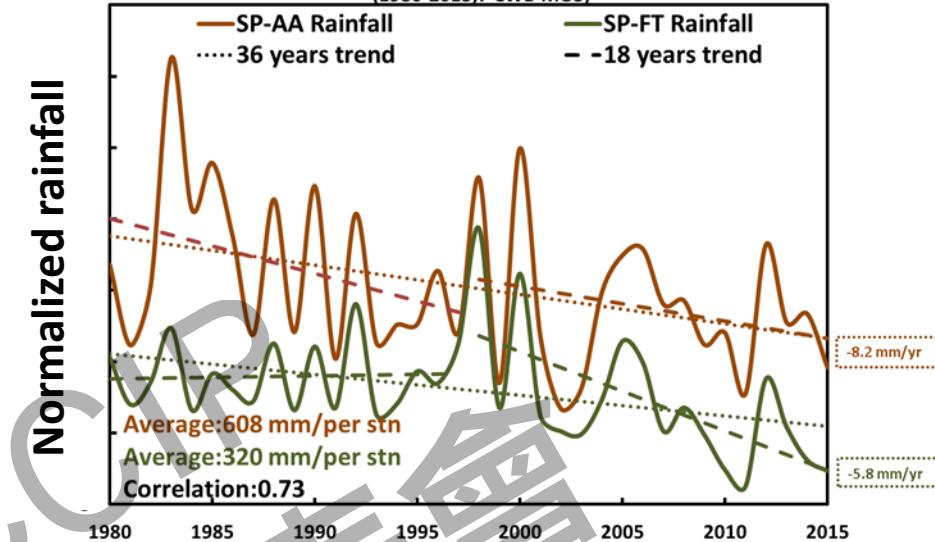
North Taiwan Spring (Mar-Apr) Rainfall

(1980-2015, 7 CWB MOS)



North Taiwan Spring (Mar-Apr) Rainfall

(1980-2015, 7 CWB MOS)



- Frontal rainfall contribute 53% of spring precipitation
- Spring rainfall have decreasing trend in past 20 years

| Spring (MA) | Correlation | Days | Numbers | Mei-Yu (MJ) | Correlation | Days | Numbers |
|-----------------------|-------------|------|---------|----------------|-------------|------|---------|
| | ALL | 0.61 | 0.32 | | ALL | 0.59 | -0.01 |
| | 95% | 0.30 | 0.27 | | 95% | 0.57 | 0.00 |
| Winter (DJF) | Correlation | Days | Numbers | All Year | Correlation | Days | Numbers |
| | ALL | 0.81 | 0.66 | | ALL | 0.74 | 0.53 |
| | 95% | 0.42 | 0.33 | | 95% | 0.50 | 0.40 |
| Dry Season (DJFMA) | Correlation | Days | Numbers | | | | |
| | ALL | 0.81 | 0.66 | | | | |
| | 95% | 0.54 | 0.55 | | | | |

1981-2015(35 years CWB local 21 station) ER events (9mm/hr)

