

The Construction of Taiwan Rainfall Index(TRI) and its Applications

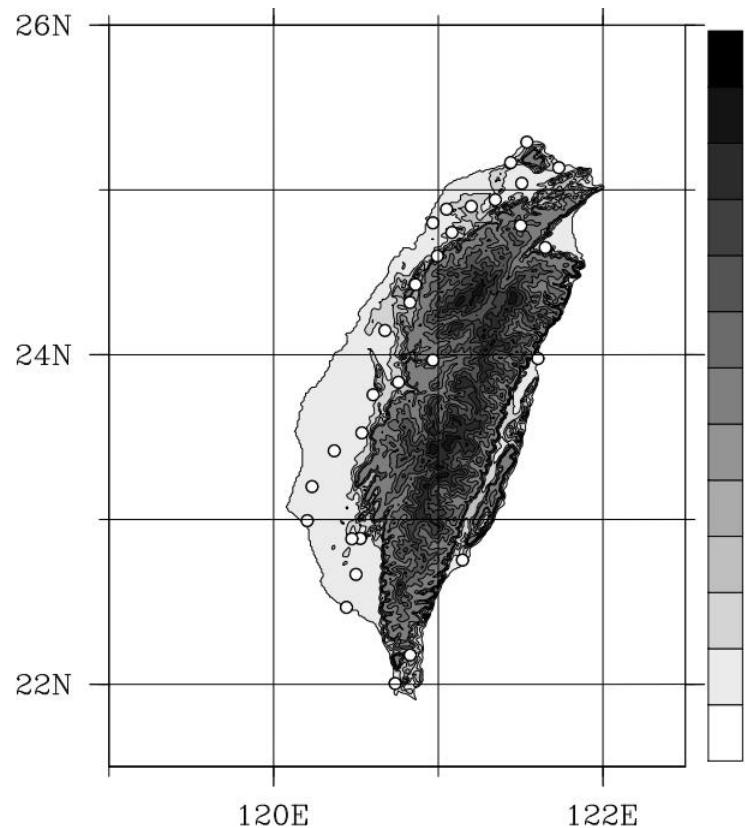
台灣降雨指數（TRI）的建立與其分析應用

Chih-wen Hung
洪致文

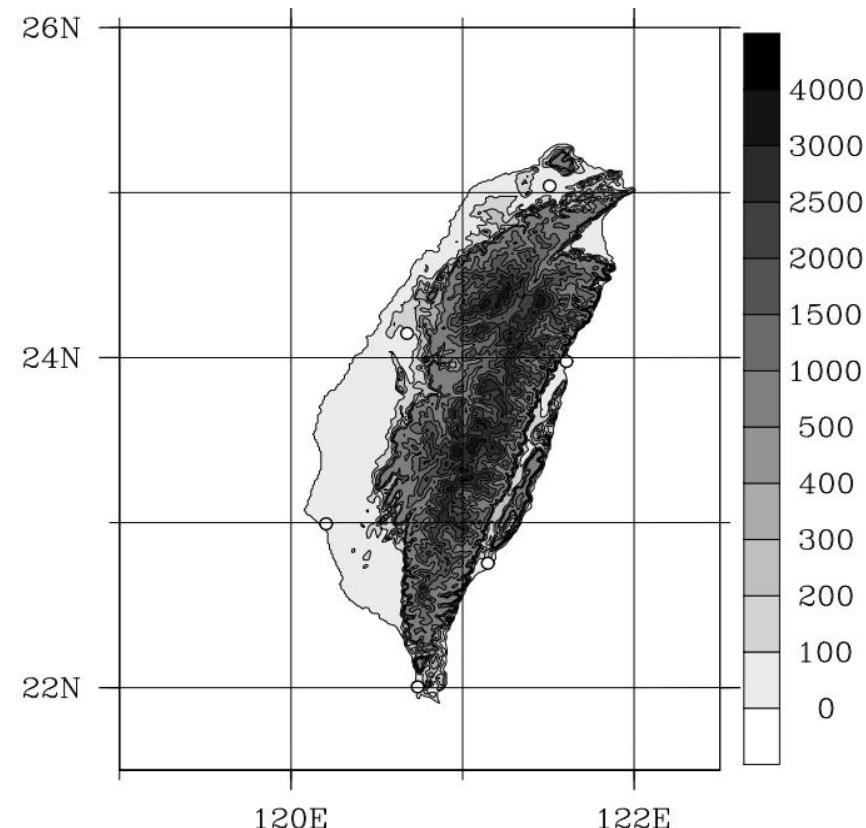
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Department of Geography
National Taiwan Normal University

- This study constructs a Taiwan Rainfall Index (hereafter TRI), the longest rainfall index in the Taiwan meteorological history.
- The TRI is based on the richest data from observational stations in Taiwan.
- More than 1,000 stations are used including observations during the Ching dynasty, the conventional weather stations, the newly acquired **Taiwan Rainfall Data** (TRD, from 51 different sources, including the major contributors as the Water Resources Agency, Irrigation Associations and Taiwan Power Company), and Central Weather Bureau's automatic rainfall station data.

≥80年 (30站)

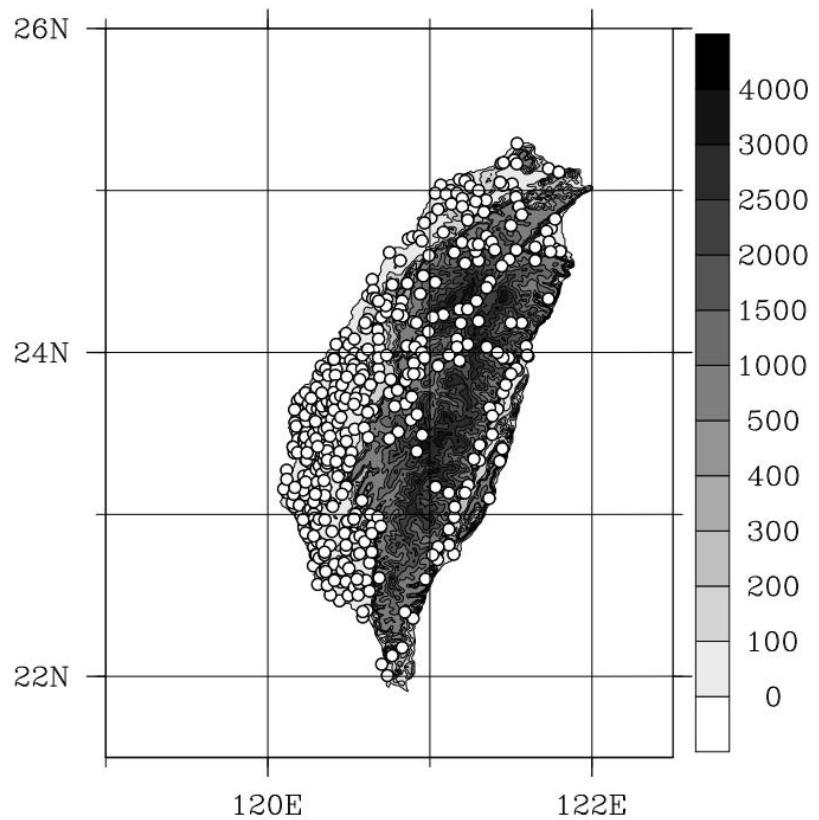


≥100年 (6站)

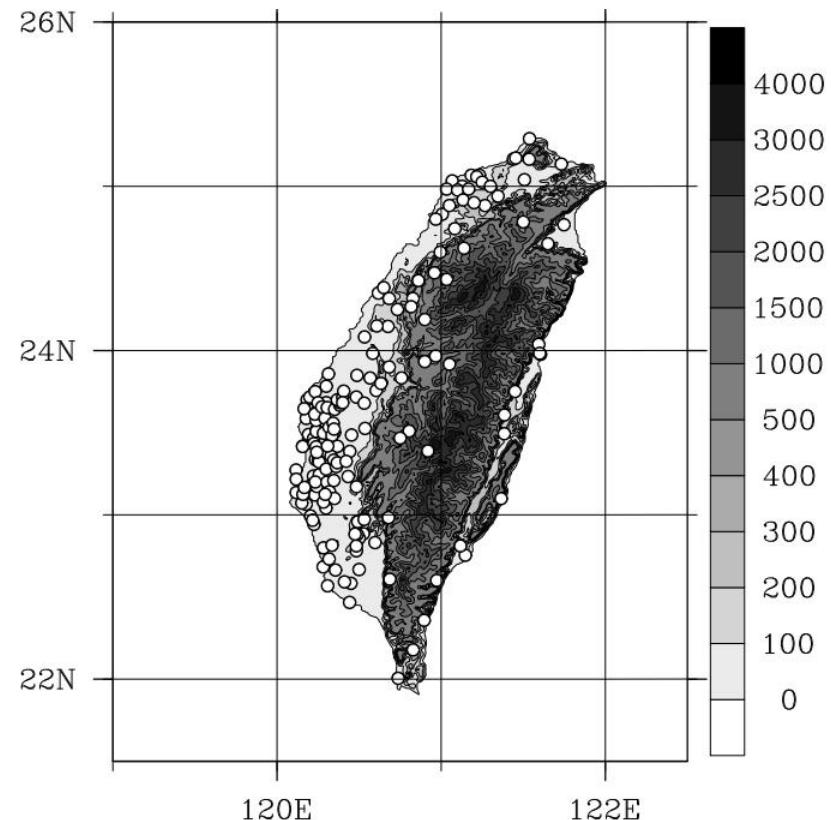


TRI-m(年)	綜觀氣象站	台灣雨量測站	總站數
20	19	567	586
40	18	429	447
60	15	156	171
80	8	22	30
100	6	0	6

≥40年 (447站)



≥60年 (171站)



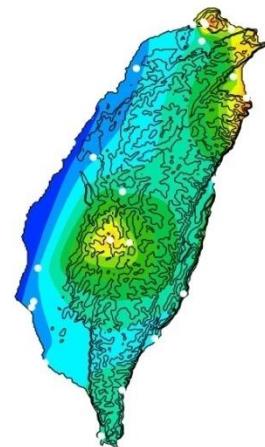
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100	6	0	6

比較各資料台灣雨量分佈

ALL

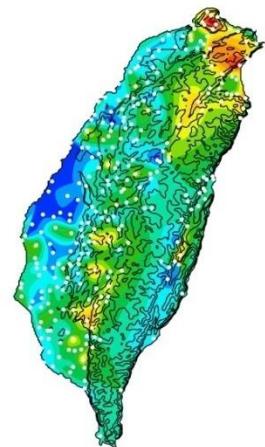
CWB (22 sts)

1897~2010



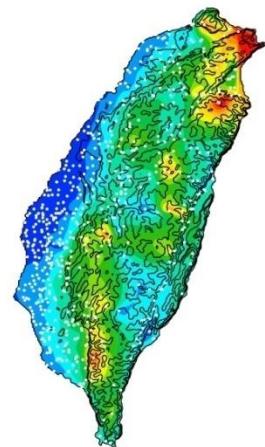
CWB+AUTO (275 sts)

1987~2010



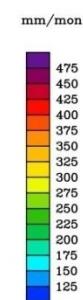
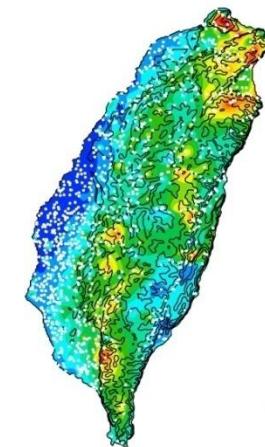
TRI-m (586 sts)

1901~2000



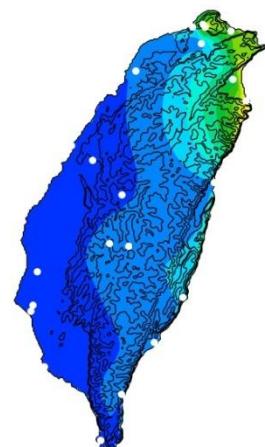
TRI-mex (1176 sts)

1897~2010

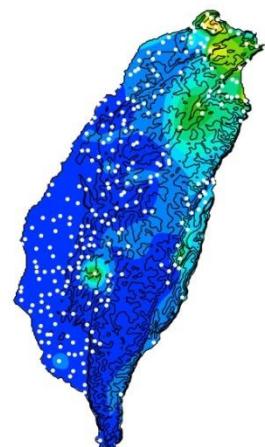


NDJ

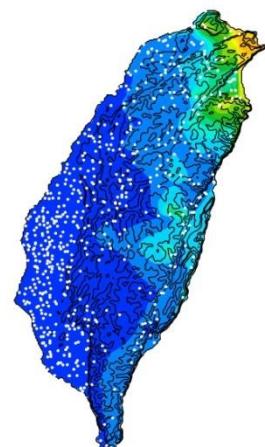
CWB (22 sts)



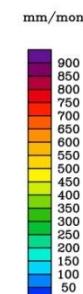
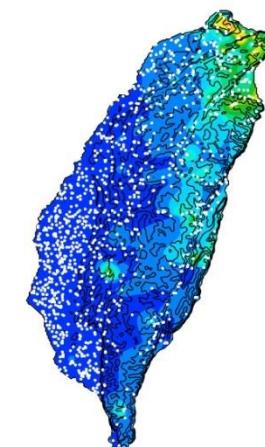
CWB+AUTO (275 sts)



TRI-m (586 sts)



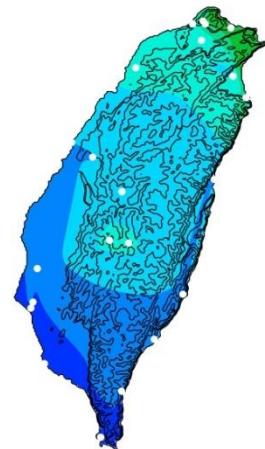
TRI-mex (1176 sts)



FMA

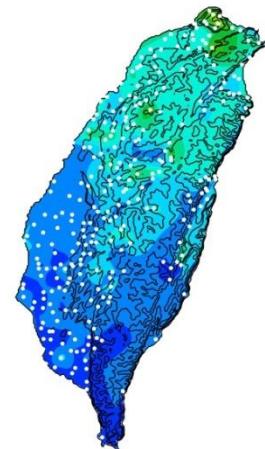
CWB (22 sts)

1897~2010



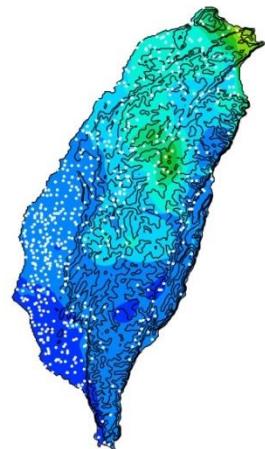
CWB+AUTO (275 sts)

1987~2010



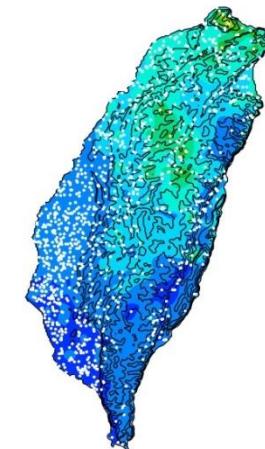
TRI-m (586 sts)

1901~2000



TRI-mex (1176 sts)

1897~2010



mm/month

900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50

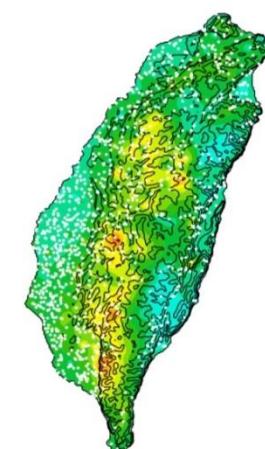
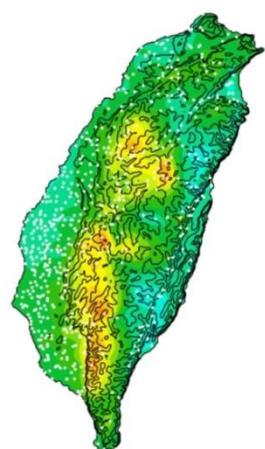
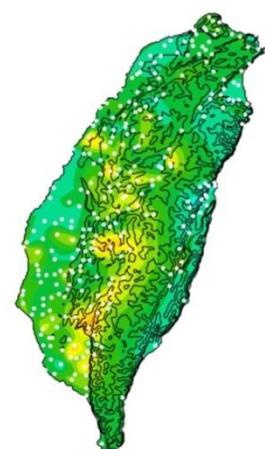
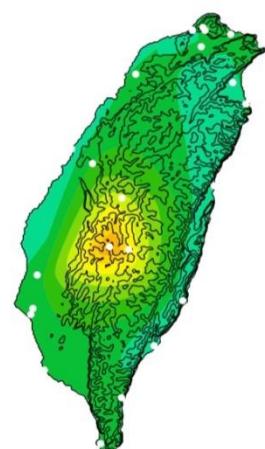
MJ

CWB (22 sts)

CWB+AUTO (275 sts)

TRI-m (586 sts)

TRI-mex (1176 sts)



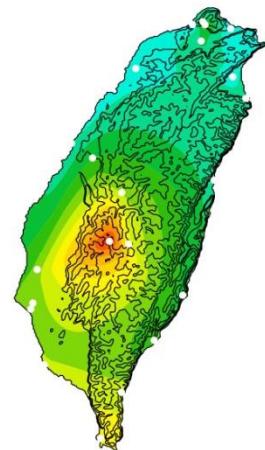
mm/month

900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50

JA

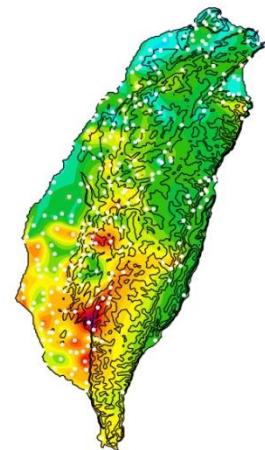
CWB (22 sts)

1897~2010



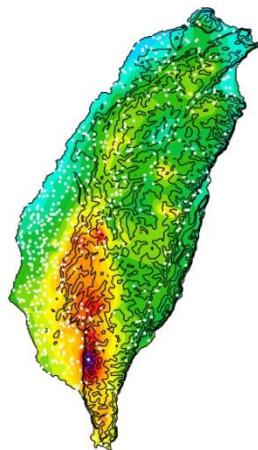
CWB+AUTO (275 sts)

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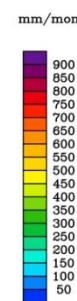
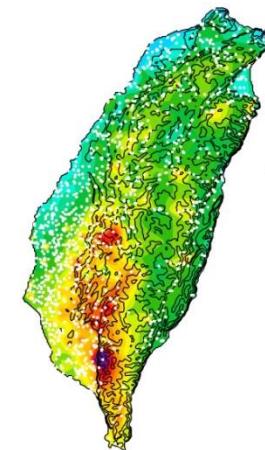
TRI-m (586 sts)

1901~2000



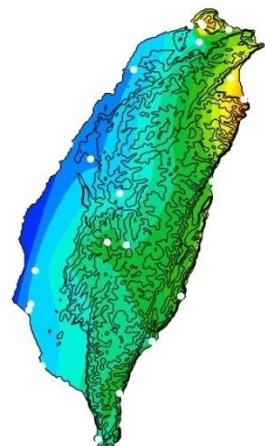
TRI-mex (1176 sts)

1897~2010

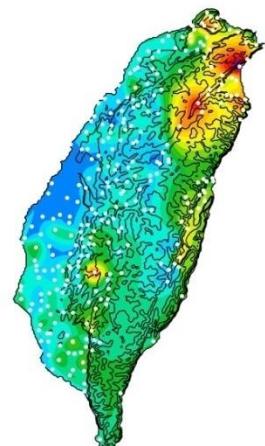


SO

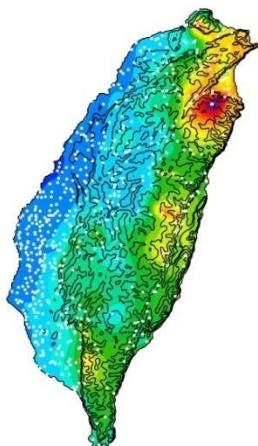
CWB (22 sts)



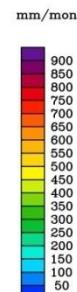
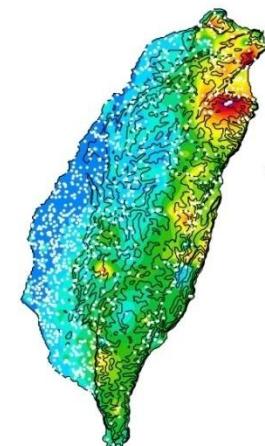
CWB+AUTO (275 sts)



TRI-m (586 sts)

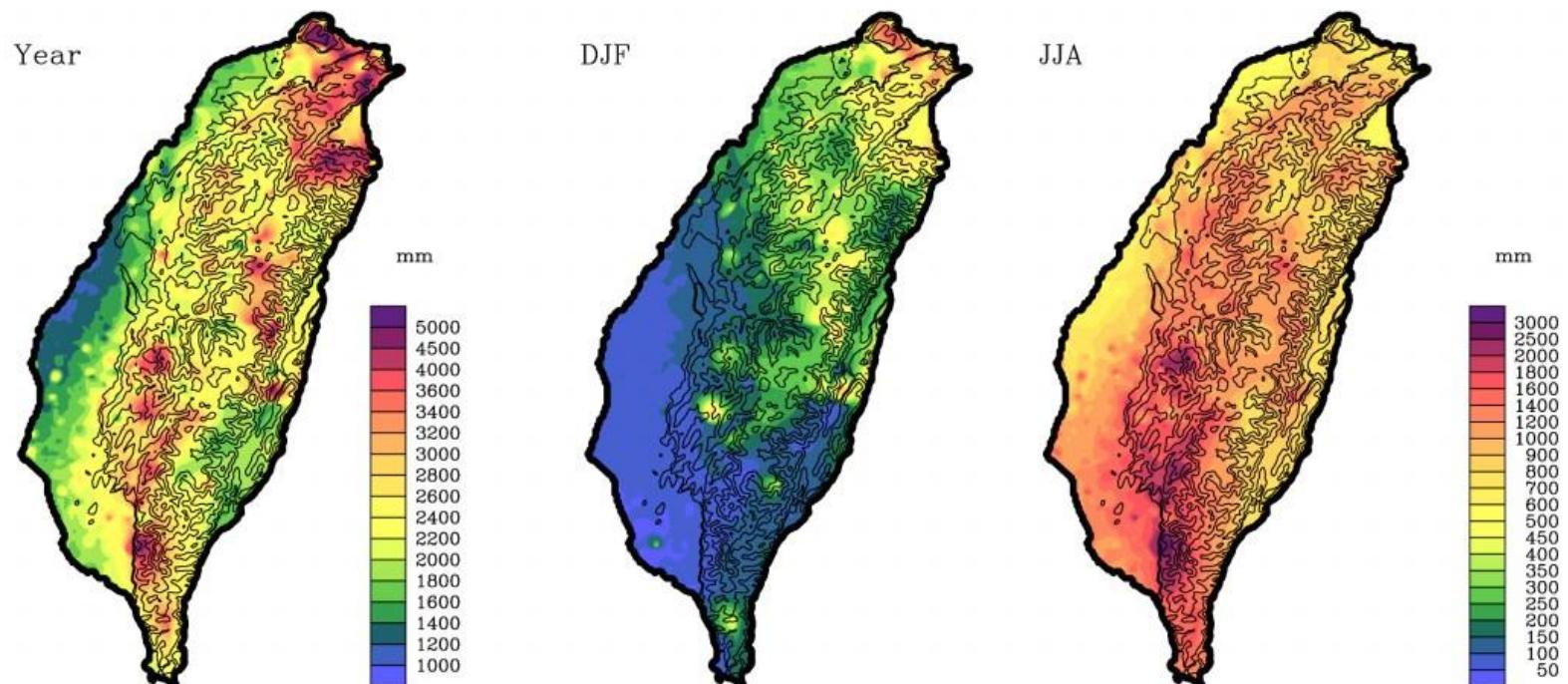


TRI-mex (1176 sts)



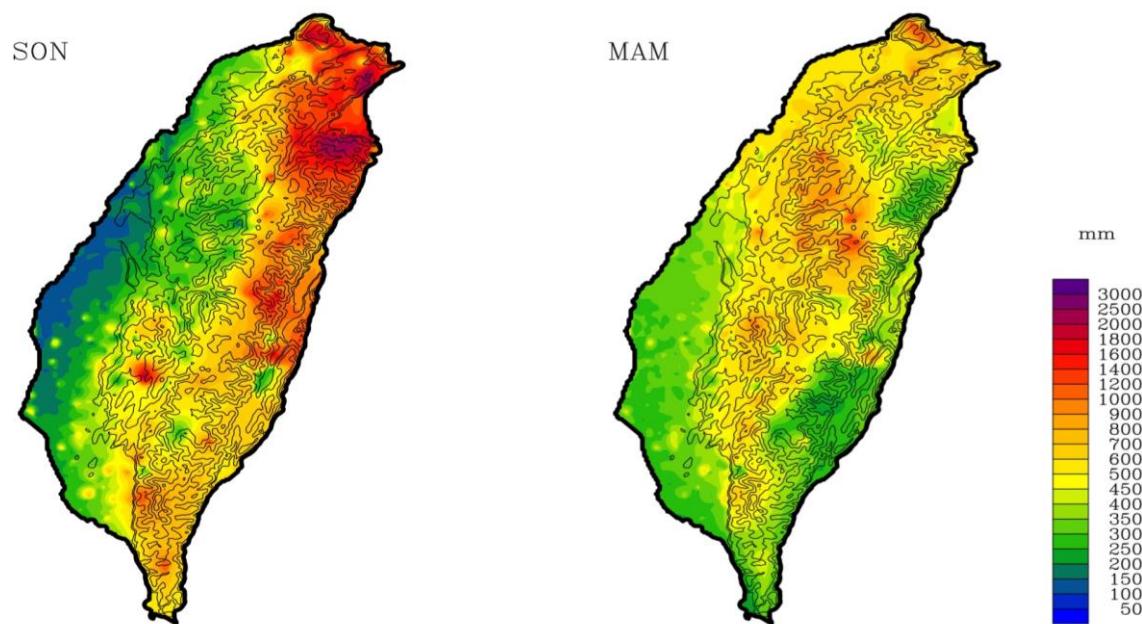
The climatology of Taiwan rainfall (TRD)

1897-2010 TAIWAN RAINFALL (mm)



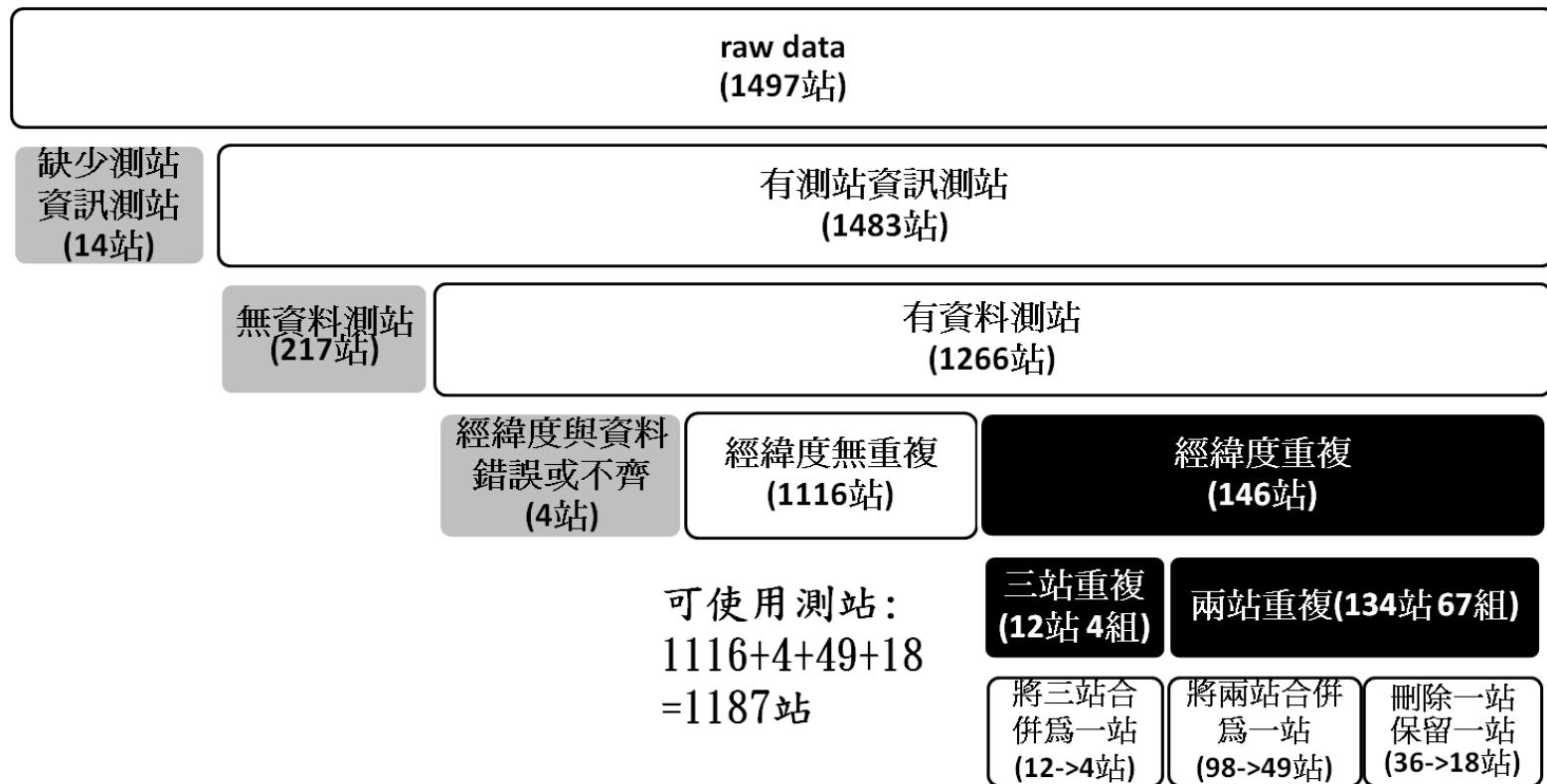
The climatology of Taiwan rainfall

1897-2010 TAIWAN RAINFALL (mm)

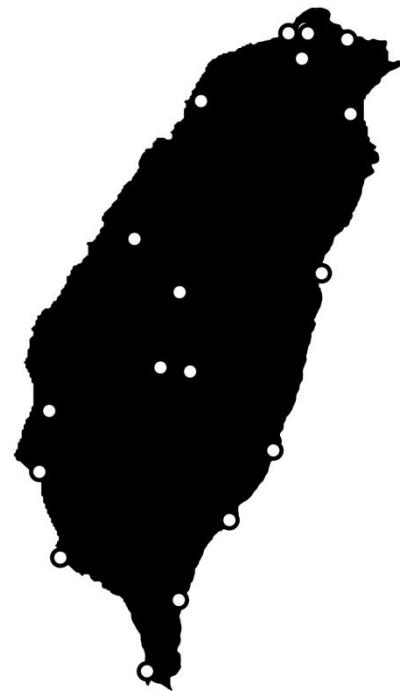


- The TRIs have daily and monthly versions with standard time series (TRI-d and TRI-m) and extended time series (TRI-dex and TRI-mex) .
- The longest index starts from 1885 and ends in 2010. Similar to the well-known "All India Monsoon Rainfall Index", the TRIs represent the variations of Taiwan rainfalls and can be used for many different research purposes.

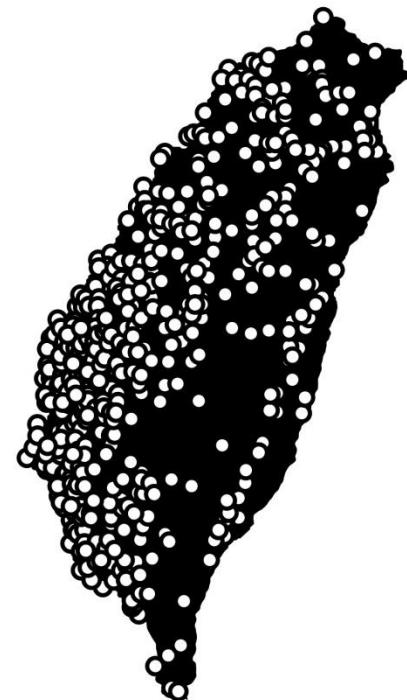
The diagram for the processing of the Taiwan Rainfall Data (TRD)



The locations of stations included in TRI-m and TRI-d

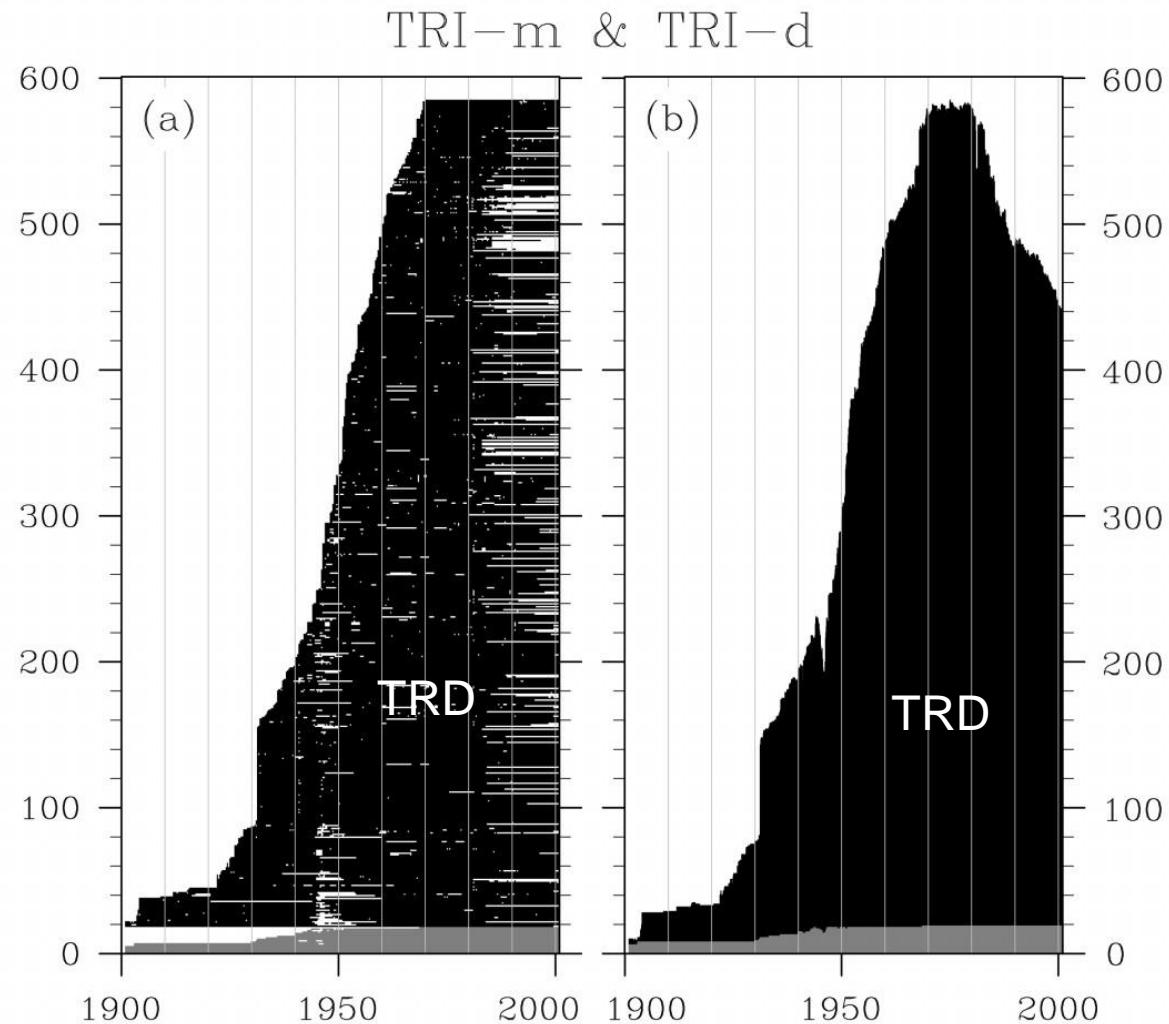


氣象局綜觀氣象站
19站



台灣雨量測站(TRD)
567站

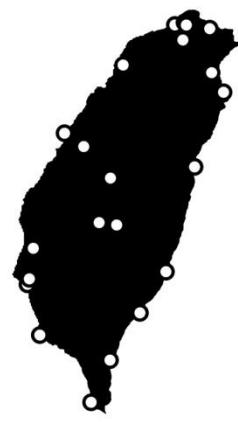
The data period and total number used for TRI-m and TRI-d



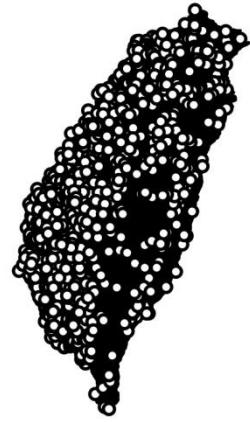
The locations for stations included in TRI-mex



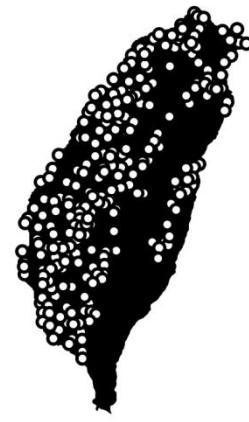
清代測站
6站



氣象局綜觀氣象站
22站

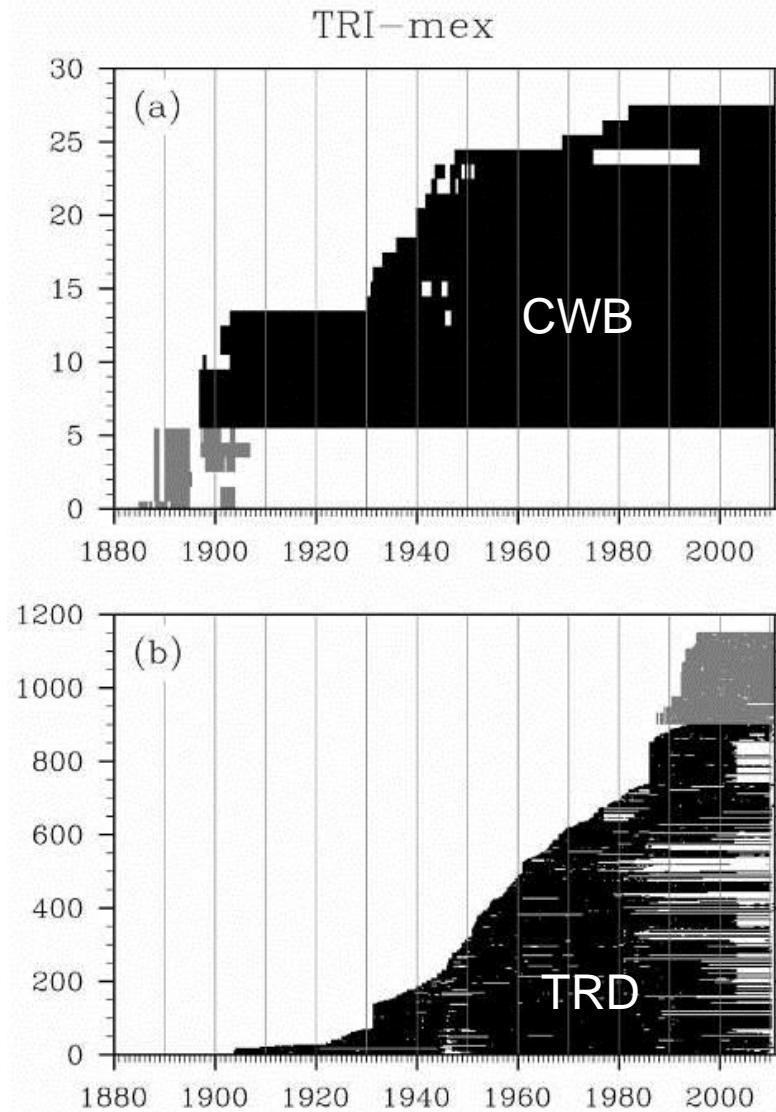


臺灣雨量測站(TRD)
901站

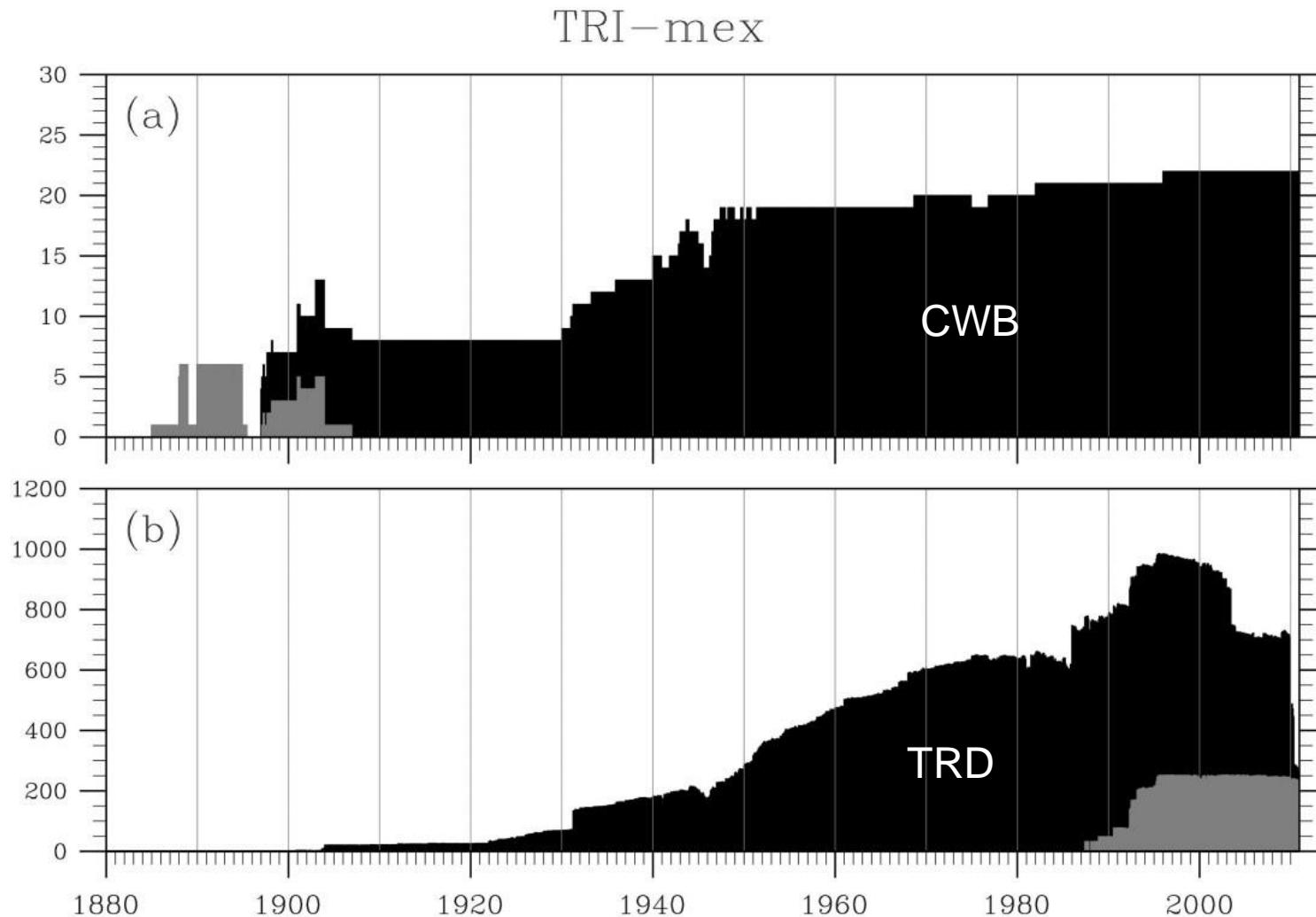


氣象局自動雨量站
253站

The data period used for TRI-mex



The data number used for TRI-mex



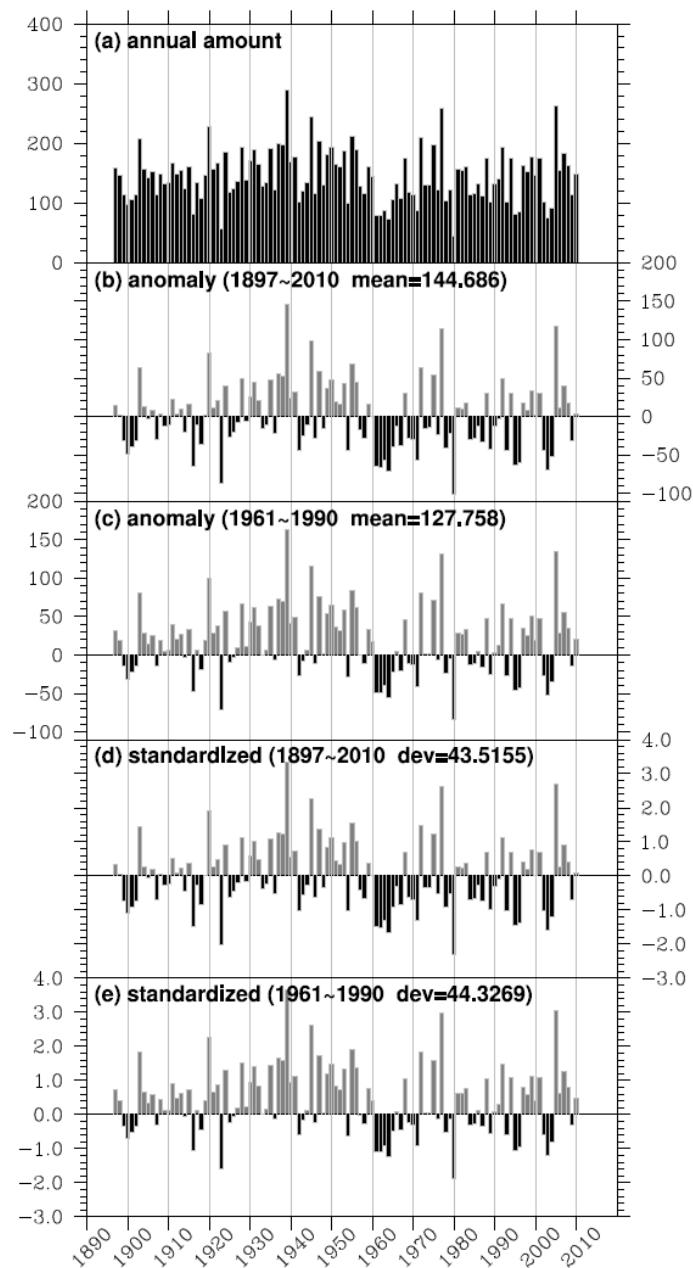
The construction of TRI

- The TRIs are the rainfall time series remaining rainfall properties in statistics with adjustment between stations. In short, the index is the average of rainfall amounts for each station divided by its own long-term averaged climatology.
- Therefore, the sum of any kind of the TRIs for any specific year will be closed to 1, and the value of TRIs in any time step means its proportion to the climatology yearly mean.

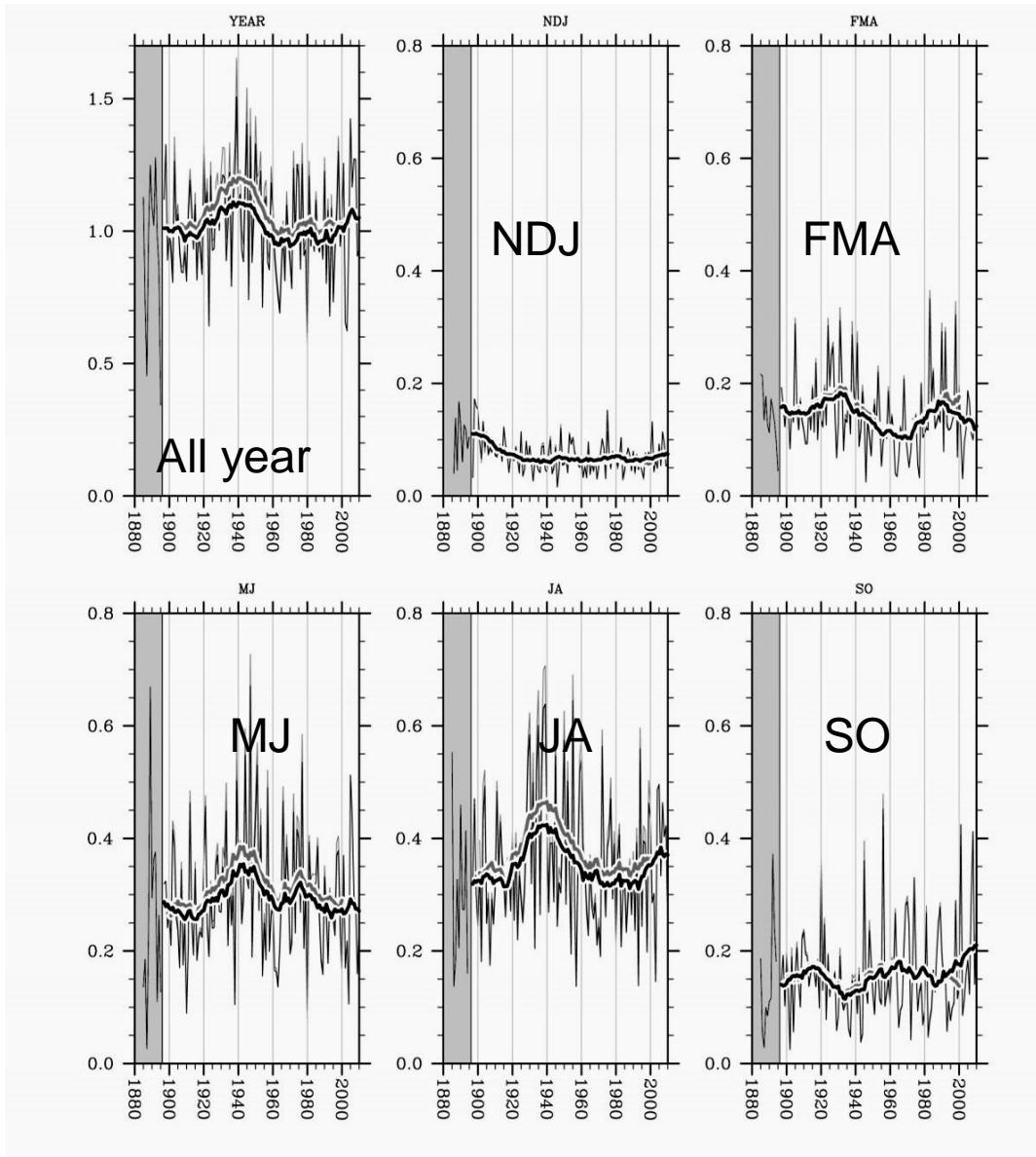
TRI-m, TRI-mex, TRI-d, TRI-dex

- Different TRIs have different bases for the long-term averaged climatology when constructing the time series. For example, the TRI-m and TRI-d have the fixed long-term averaged climatology, i.e., 1961-1990.
- In order to get the longest time series as possible, the TRI-mex and TRI-dex use all available observations to create long-term averaged climatology.
- By doing so, those stations have no completed data observations in 1961-1990 can be included in the time series.

TAINAN (46741)

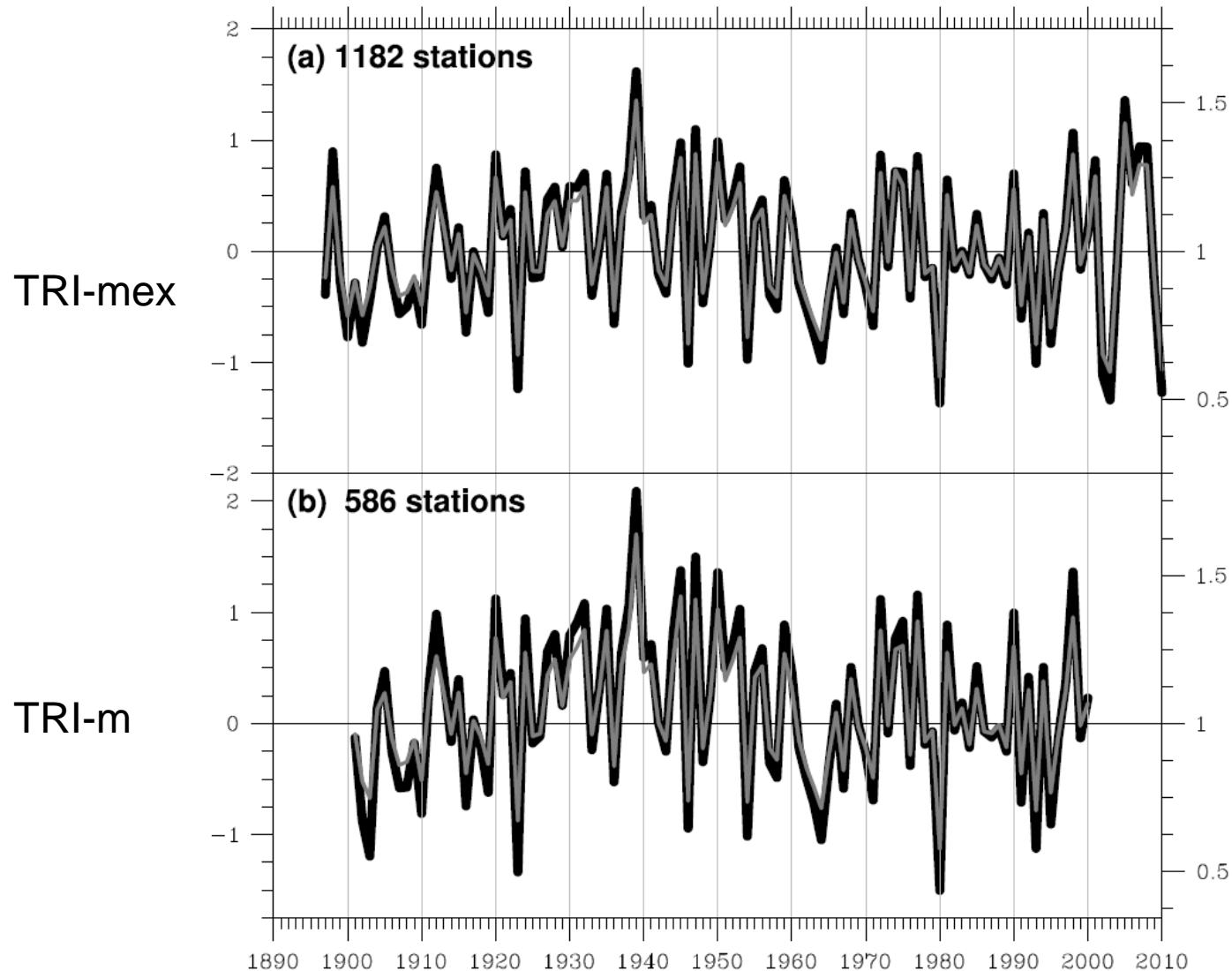


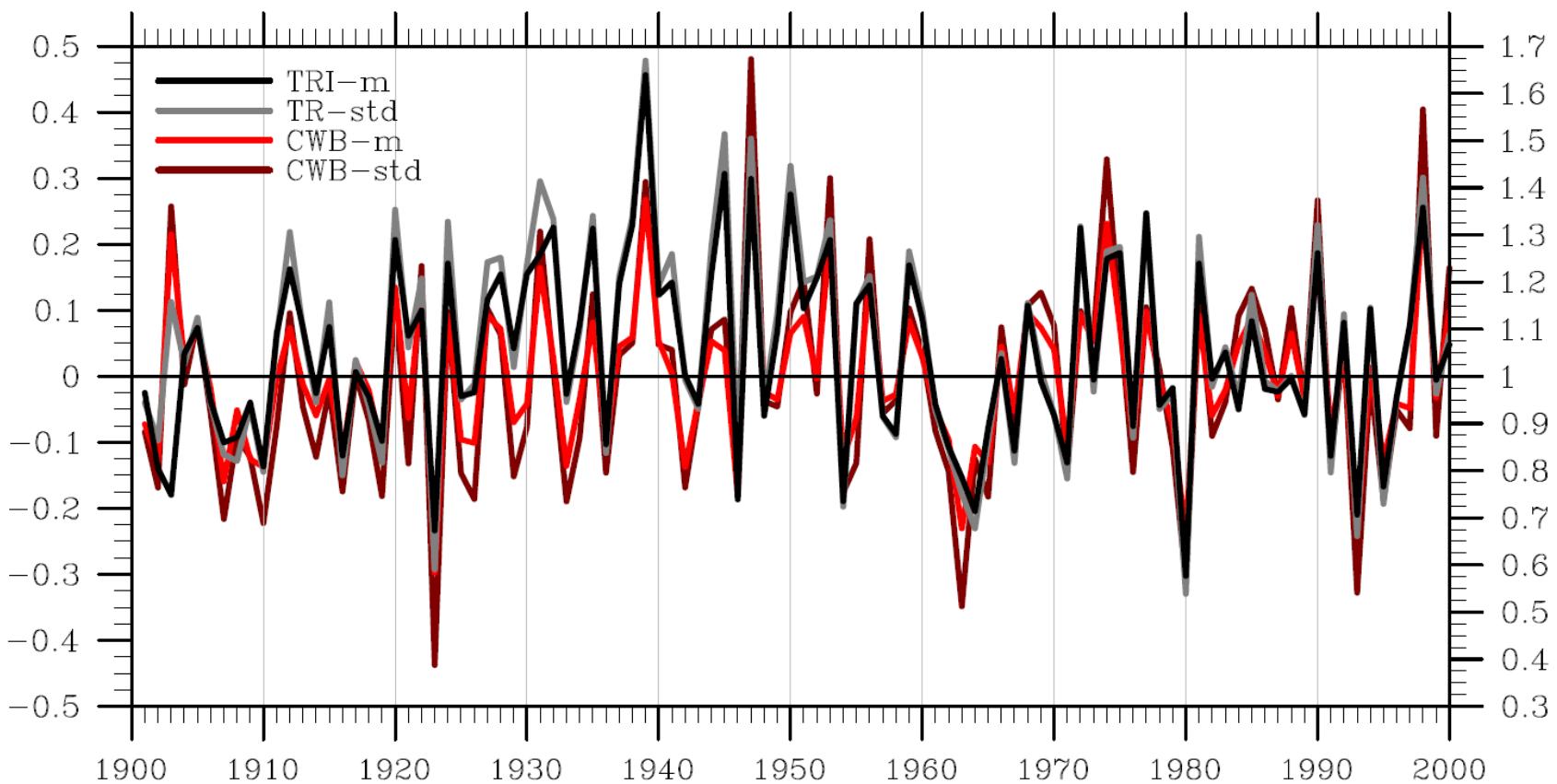
The interannual and inter-decadal variations of the Taiwan rainfall in various seasons



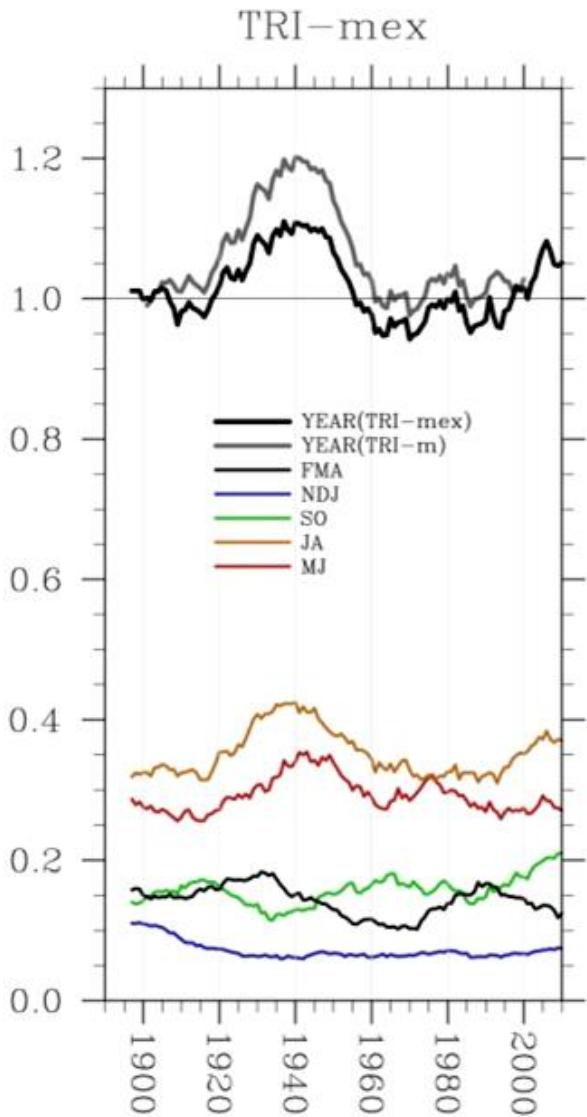
TRI-m(gray)
TRI-mex(black)
21-y running mean

TRI指數方式（灰）與標準化方式（黑）之比較





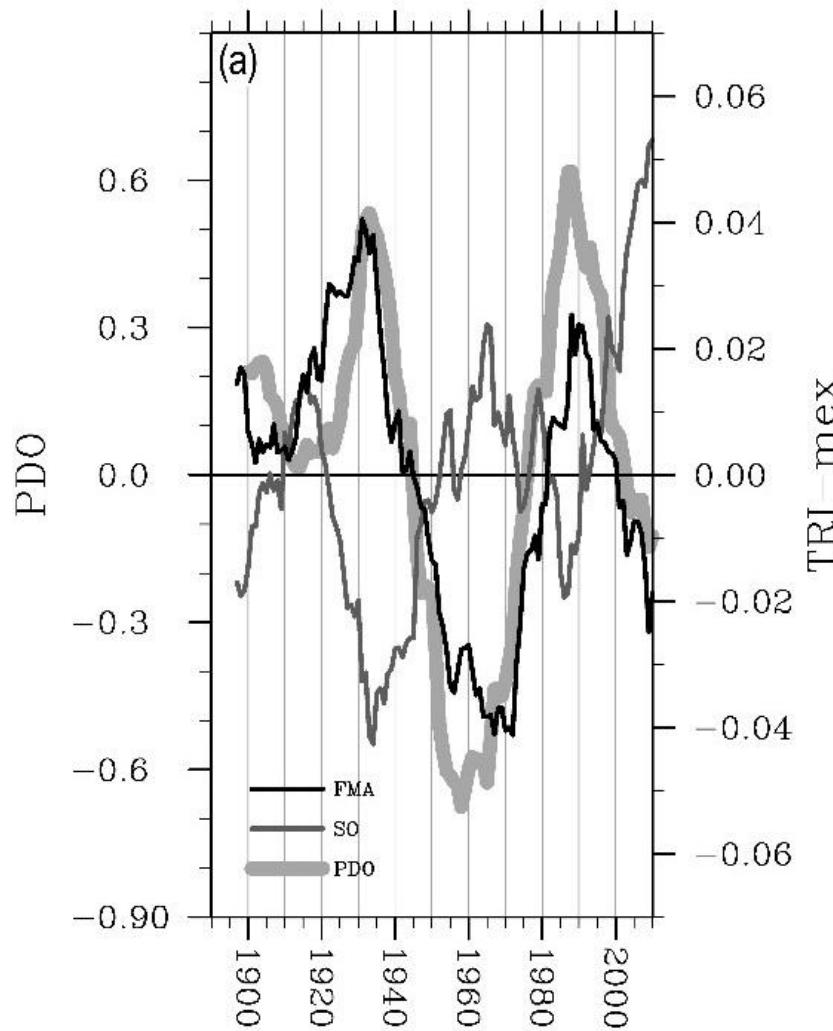
The decadal variations of each natural season based on the 21-y running averages of TRI-mex



Using the TRI, the long-term rainfall variability in Taiwan is studied. Results show that there were more rain in 1920-1960s, less rain in 1960-1990s, and more rain again after mid-1990s (especially after 2000) with respect to the long-term climatology.

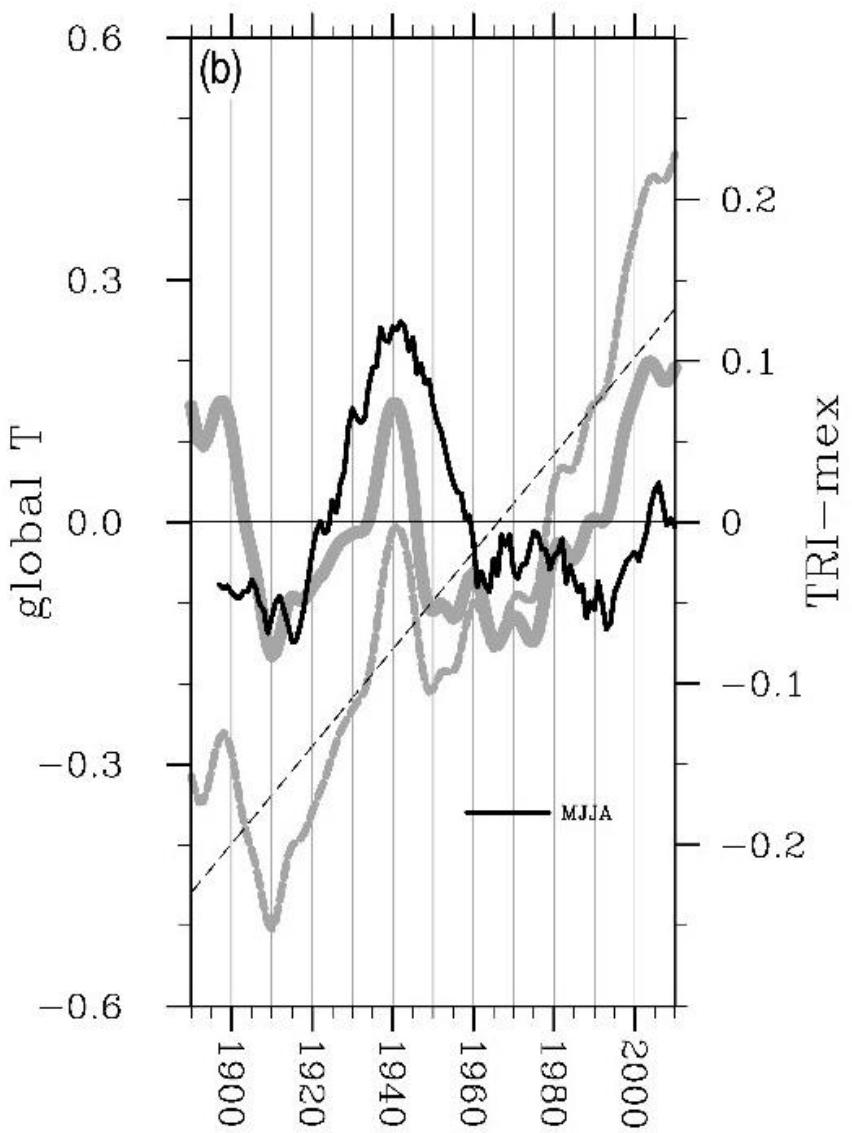
日本時代中後期（1920年至戰後1960年間）雨量較多，1960-1990年雨量較少，1990年代中期後（特別是2000年後）又開始明顯增加的變化。

The decadal variations of spring and autumn rainfall in Taiwan associated with the PDO.



- (1) the spring rain is highly correlated with the Pacific Decadal Oscillation
- (2) the spring rain and autumn rain are negatively correlated

春雨與北太平洋年代際震盪有正相關，秋雨與春雨有明顯負相關



The decadal variations of rainfalls in Mei-yu (May-June) and early summer season (July-August) are related to the global temperature change in which the long -term warming trend is removed.

梅雨季與夏季前期（七、八月）的雨量年代
際變化，則與全球的溫度去掉長期暖化趨勢
後的變動有關。

淺灰折線：全球溫度距平
淺灰直線為全球溫度距平之趨勢線
深灰折線為全球溫度距平與其趨勢線之差值

台灣降雨指數 (Taiwan Rainfall Index) 使用說明

- 台灣降雨指數 (TRI, Taiwan Rainfall Index) 預計在2011年底或者2012年初正式對外公開。TRI 指數的建立，是臺灣氣象科學觀測史上，首度整合最多降雨資料所彙整成的最長雨量數據，以類似國際上著名印度季風降雨指數方式，提供研究者一個方便處理且具有區域降雨特色的雨量觀測數據。本研究使用臺灣超過一千站的雨量數據，並首度納入清代與近年氣象局自動雨量站的觀測數據，將臺灣降雨紀錄往前與往後延伸，所計算出的臺灣長期日與月降雨指數，最長起自1885年（目前止於2010年），可作為臺灣整體一致降雨狀況的指標，適合應用在各領域的研究中。
- 月資料為TRI-m 與TRI-mex
- 日資料為TRI-d 與TRI-dex
- 標準版的TRI-m 與TRI-d 是用1961-1999的氣候平均場做基底，故使用的測站數較少，但在氣候長期變遷上有相同的比較基準。延長版的TRI-mex 與TRI-dex 是用各測站各自的氣候平均場做基底（例如該站1900-1945有值，之後沒有資料，做平均場計算時就只是以這1900-1945來算），故可容納進一些只有戰前或戰後才存在的觀測數據。這個版本資料較長，但在做氣候變遷上必須小心。不過，經過比對，兩種資料的差異度還不是很大。

END