

# 聖嬰現象與臺灣降雨



中央氣象局

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天氣分析研究會

桃園渴望園區

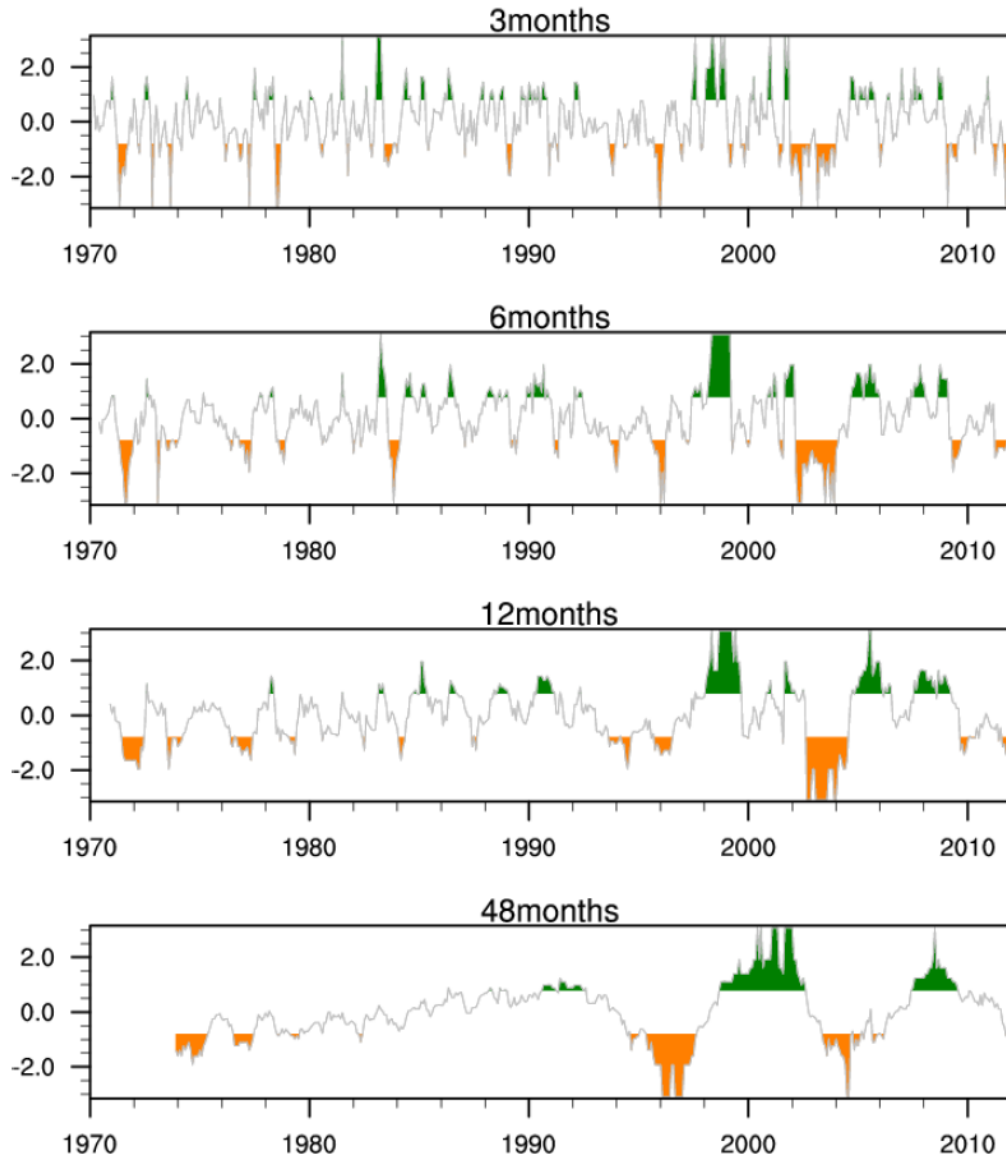
## Data

- ❖ 分析時間：1940年至2011年
- ❖ 局屬氣象站：臺北、新竹、臺中、阿里山、臺南、高雄、恆春、宜蘭、花蓮、臺東，共10站。
- ❖ NCEP/NCAR Reanalysis I。
- ❖ GPCP
- ❖ ERSST v3
- ❖ APHRODITE(Asian Precipitation Highly Resolved Observational Data Integration Towards Evaluation , 60°E-155°E, 15°S-55°N, 0.5° x 0.25°)

# 雨量指標定義

1. 計算時間往前N個月的累積雨量，如N=3時，2011年3月的數值為2011年1月至3月共3個月累積雨量。  
(N=3, 6 12, 48 for this study)
2. 分別將12個月份的資料進行百分化轉換，去除年內變化 (annual cycle)。  
(1940.1-2011.1; 1940.2-2011.2;...; 1940.12-2011,12)
3. 常態累積分佈函數(Cumulative distribution function)轉化，數值會在 $\pm 3.2$ 之間，此指標具有類似SPI(Standardized Precipitation Index)的特性與優點，且可完全地符合常態分佈，將此指標命名為新標準化雨量指標(New Standardized Precipitation Index, NSPI)。

# 雨量指數的時間係列-以臺北站為例



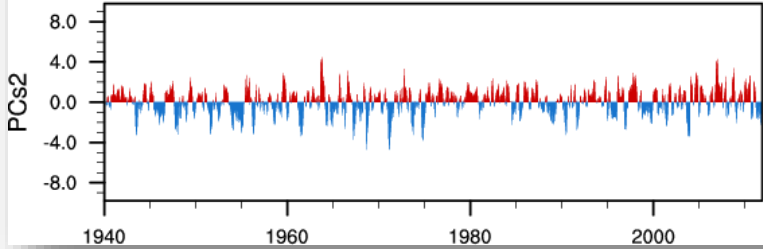
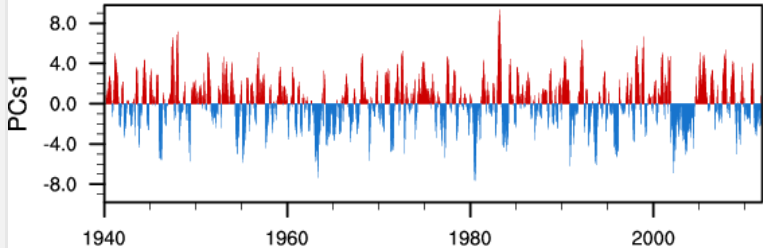
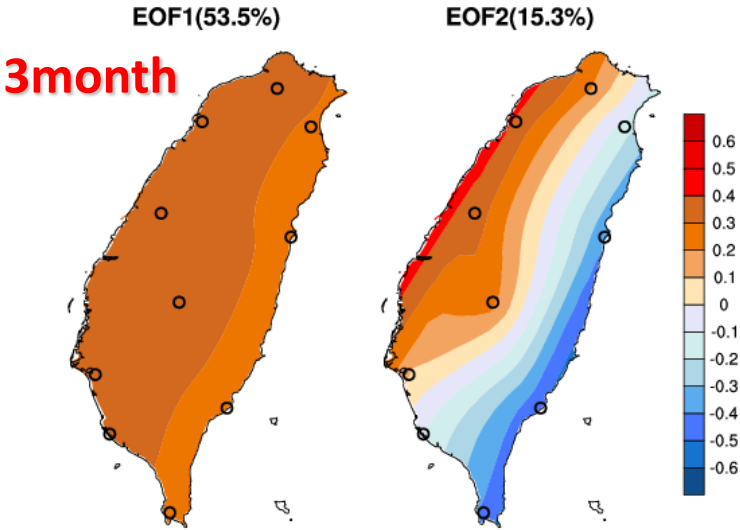
Defined amplitude of anomaly larger than  $\pm 0.8$  as **drought/flood**. The drought/flood events in Taipei station is **more persistent and frequently after 1990** especially for 12 and 48 month.

**More persistent and frequently**

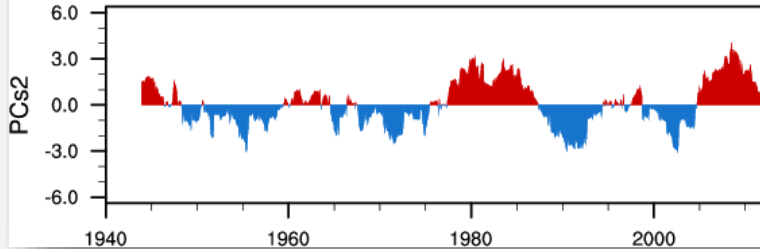
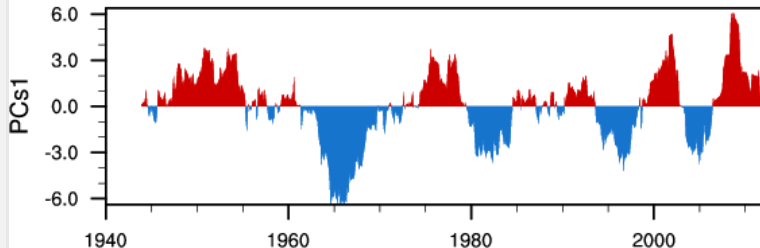
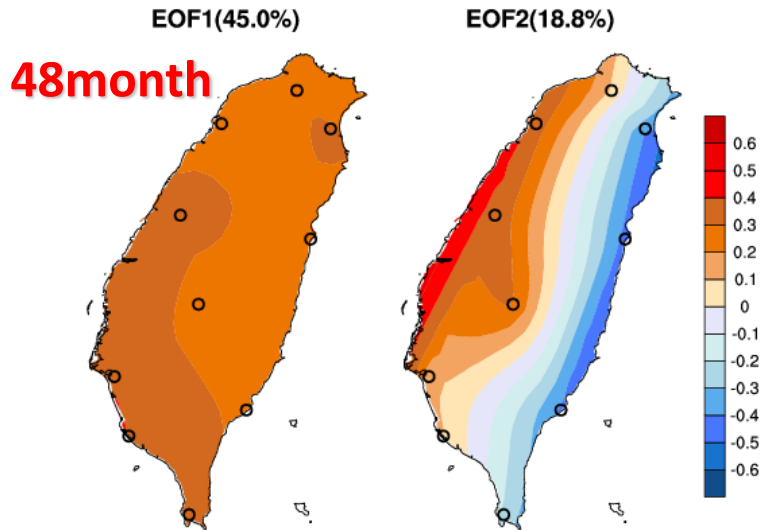


# EOF analysis

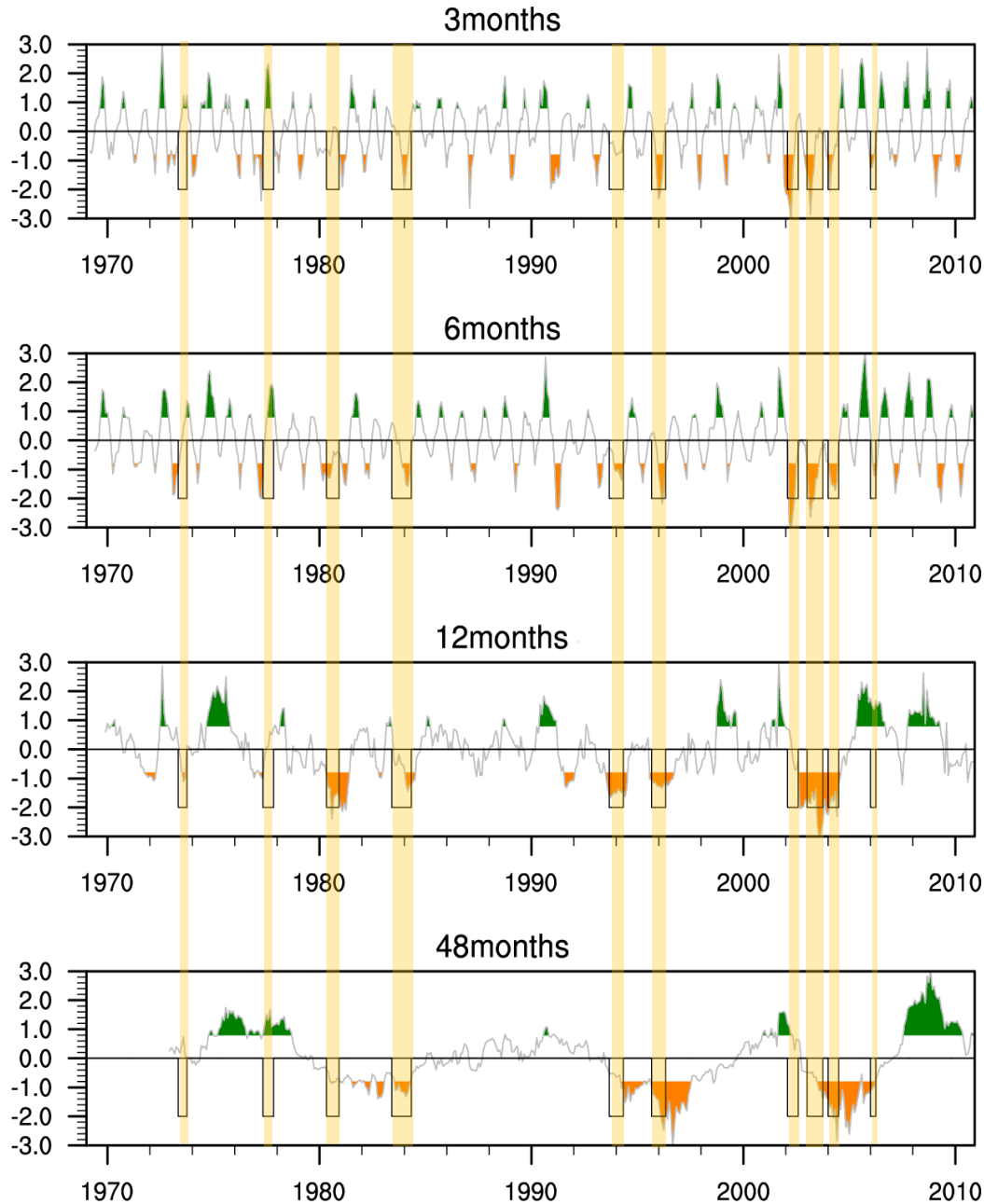
EOF of Drought Index(3 months, Correlation matrix)



EOF of Drought Index(48 months, Correlation matrix)



# 雨量指標與乾旱



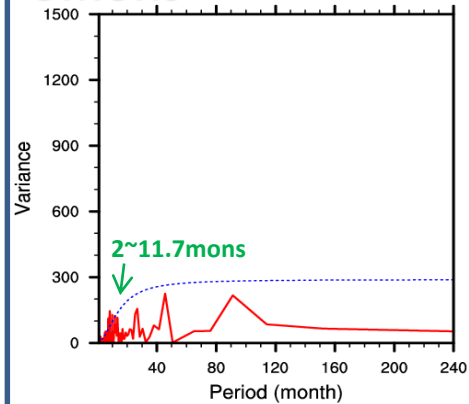
3、6、12、48個月累積雨量的第1主成份的時間系列

黃色區塊：水利署定義的乾旱事件

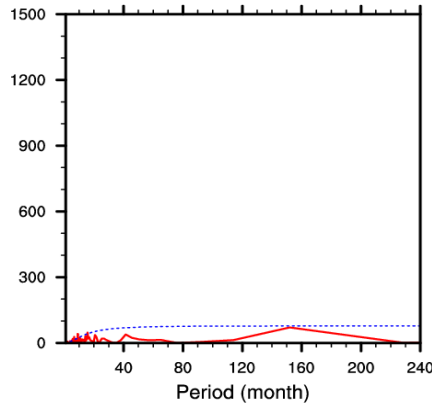
# Spectral analysis for PCs

**3mons**

PCs1

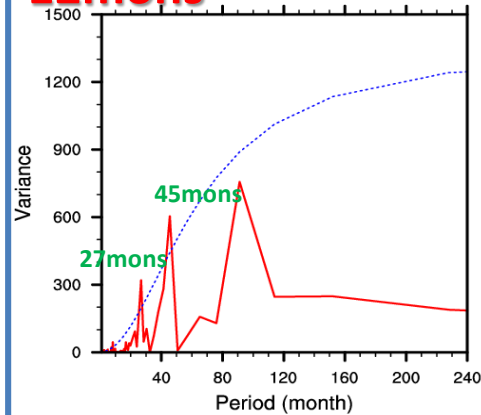


PCs2

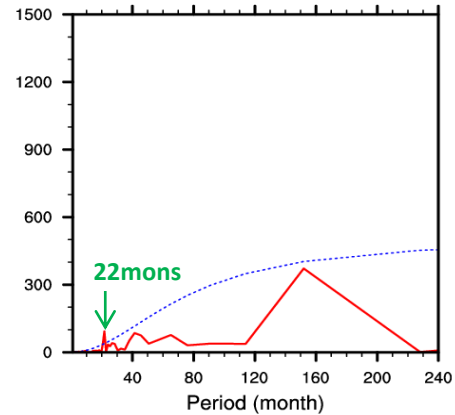


**12mons**

PCs1

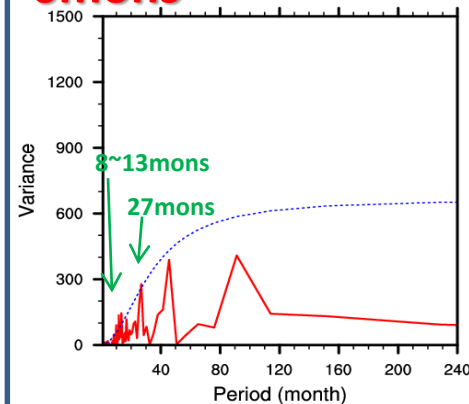


PCs2

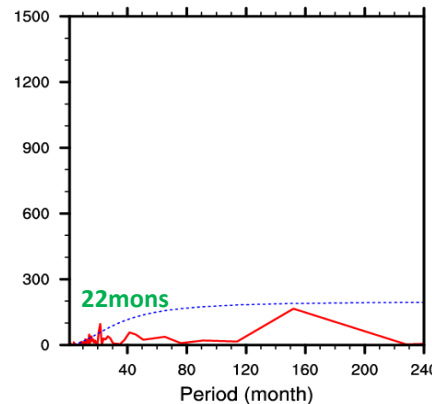


**6mons**

PCs1

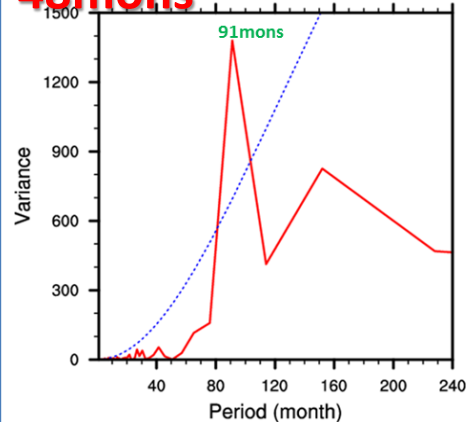


PCs2

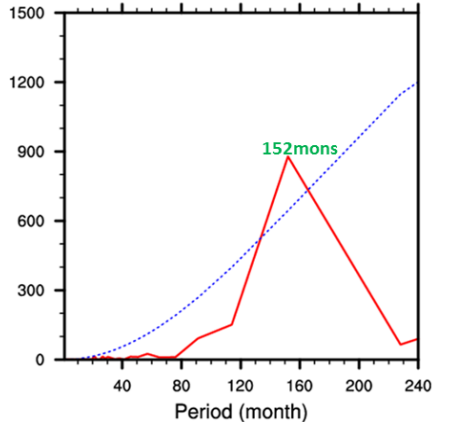


**48mons**

PCs1



PCs2



Spectral分析顯示，臺灣雨量有高、低頻訊號，接下來的分析以13-60個月波段、61個月低頻濾波分析

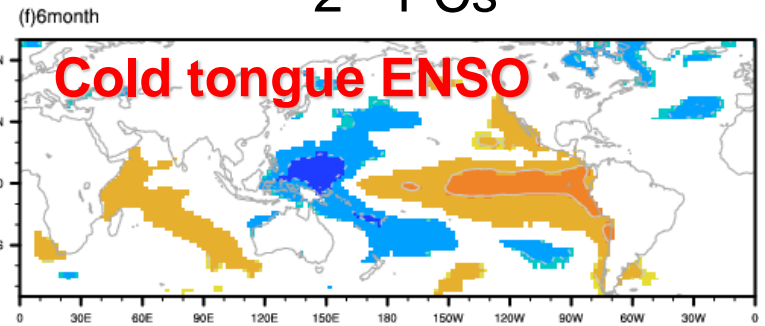
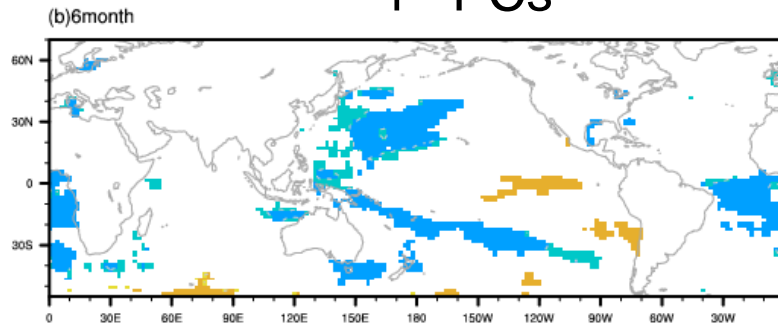
# 影響臺灣雨量的海溫

## 臺灣雨量與海溫的相關係數分析(1971-2011)

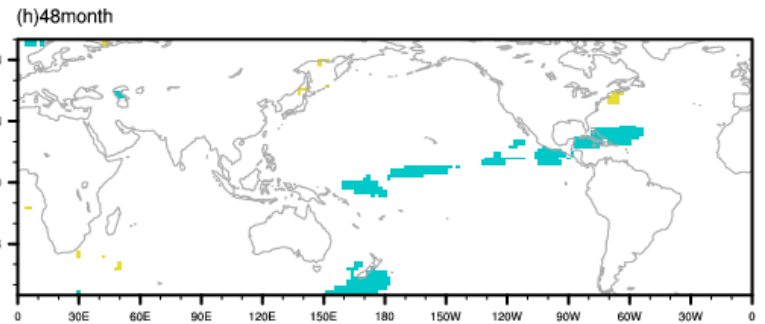
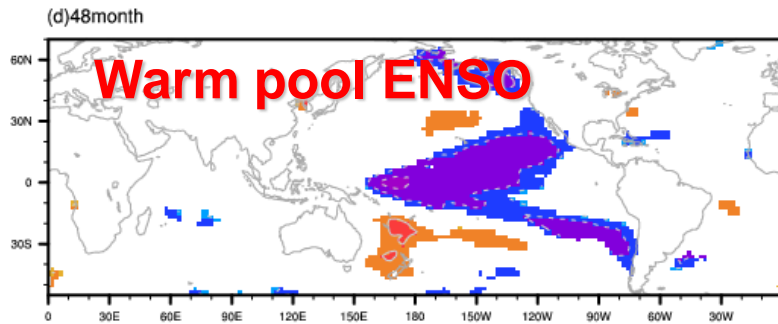
1<sup>st</sup> PCs

2<sup>nd</sup> PCs

6mons



48mons

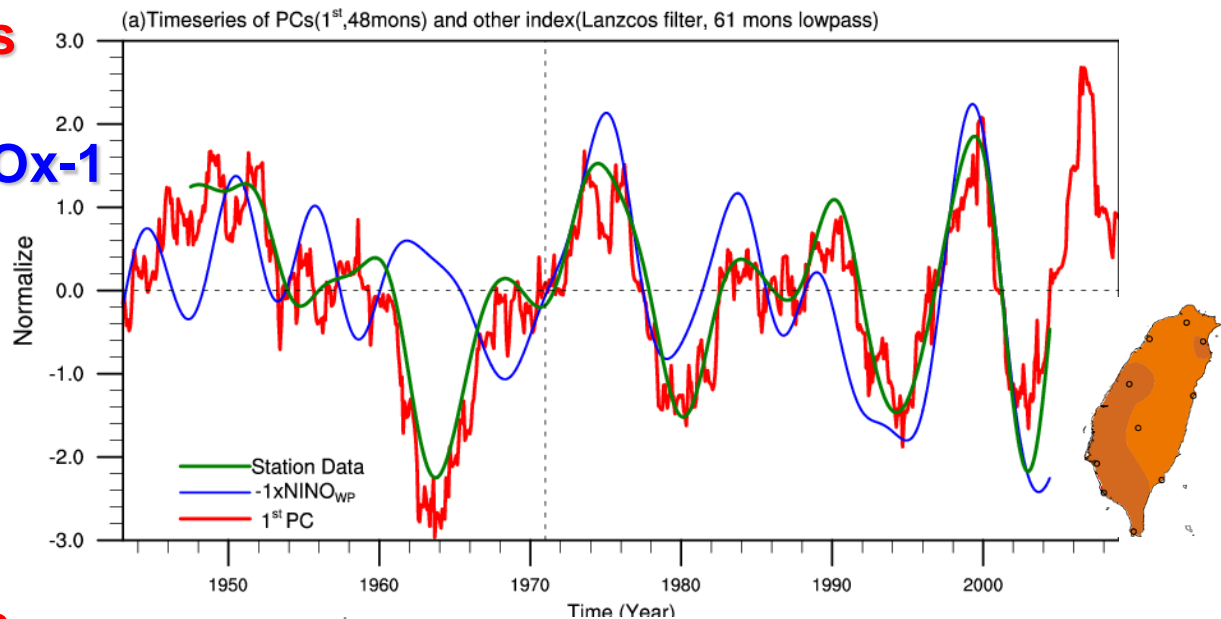


*Shaded : 95% confidence level*

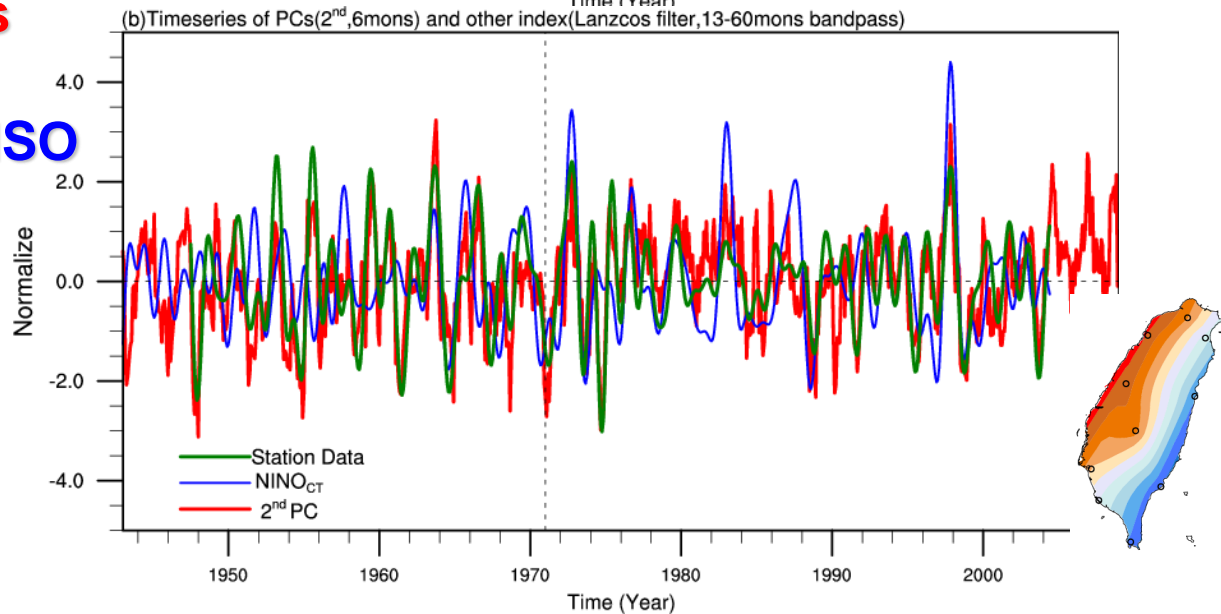


# 臺灣雨量&暖池、冷池聖嬰指標

**0.93\*\*\*** { **48 month 1<sup>st</sup> PCs**  
 { 全臺雨量平均  
**-0.84\*\*** { **Warm pool ENSOx-1**



**0.72\*\*\*** { **6 month 2<sup>nd</sup> PCs**  
 { 東西部雨量差異  
**0.55\*\*\*** { **Cold tongue ENSO**



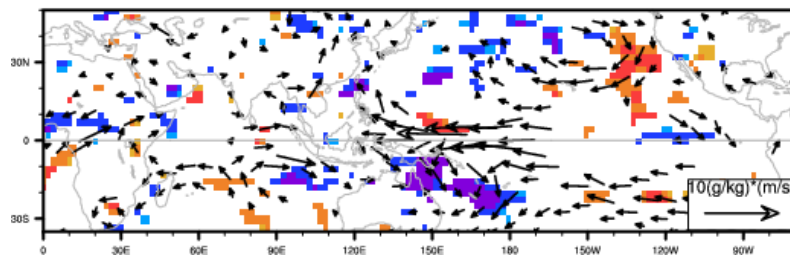
# 影響低、高頻臺灣雨量環流-相關係數分析

## 低頻(61month lower pass)

## 高頻(13-60month band pass)

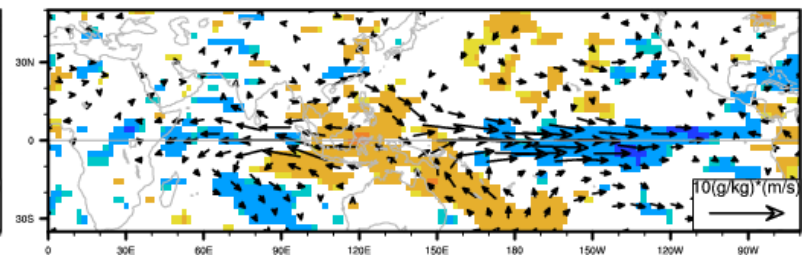
(a)925-700hPa Moisture Flux and Div.

48month 1<sup>st</sup> PCs



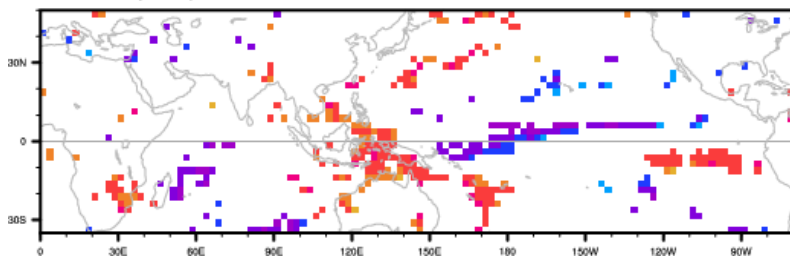
(f)925-700hPa Moisture Flux and Div.

6month 2<sup>nd</sup> PCs



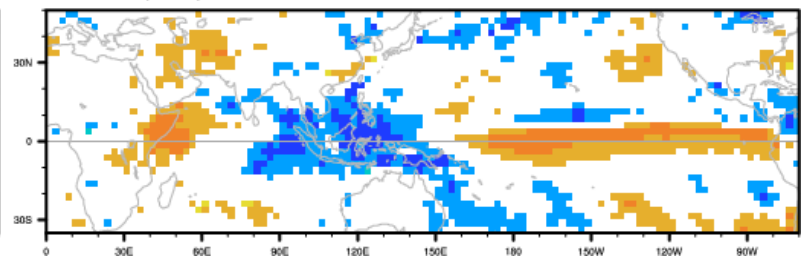
(c)GPCP precip.

48month 1<sup>st</sup> PCs



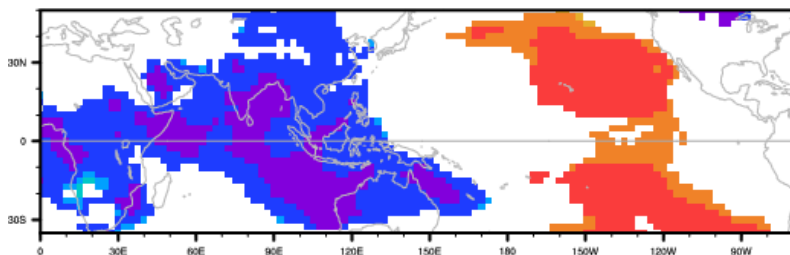
(h)GPCP precip.

6month 2<sup>nd</sup> PCs



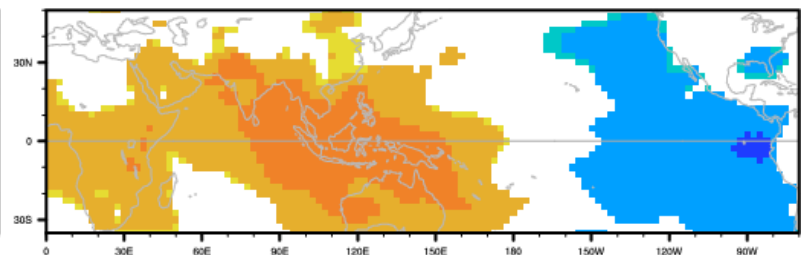
(d)MSLP

48month 1<sup>st</sup> PCs



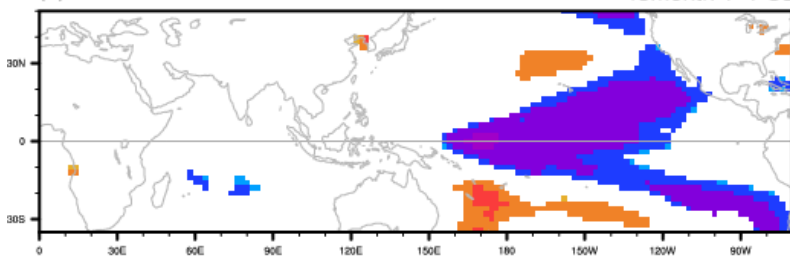
(i)MSLP

6month 2<sup>nd</sup> PCs



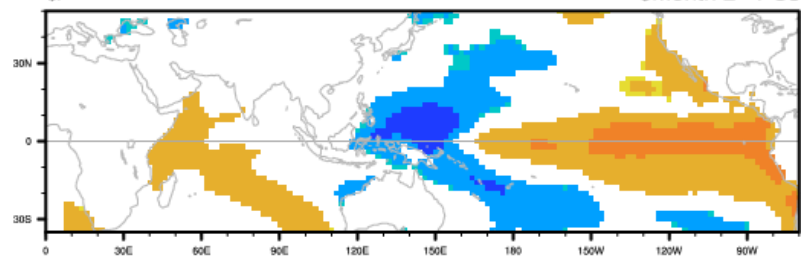
(e)SST

48month 1<sup>st</sup> PCs



(j)SST

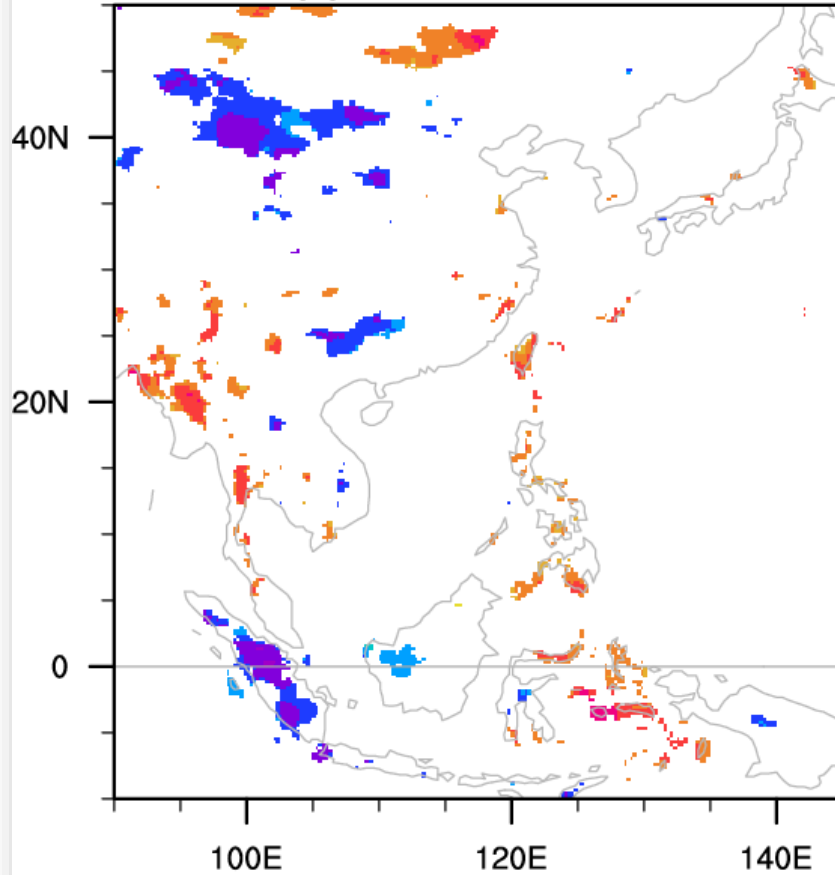
6month 2<sup>nd</sup> PCs



# 臺灣雨量&高解析度雨量

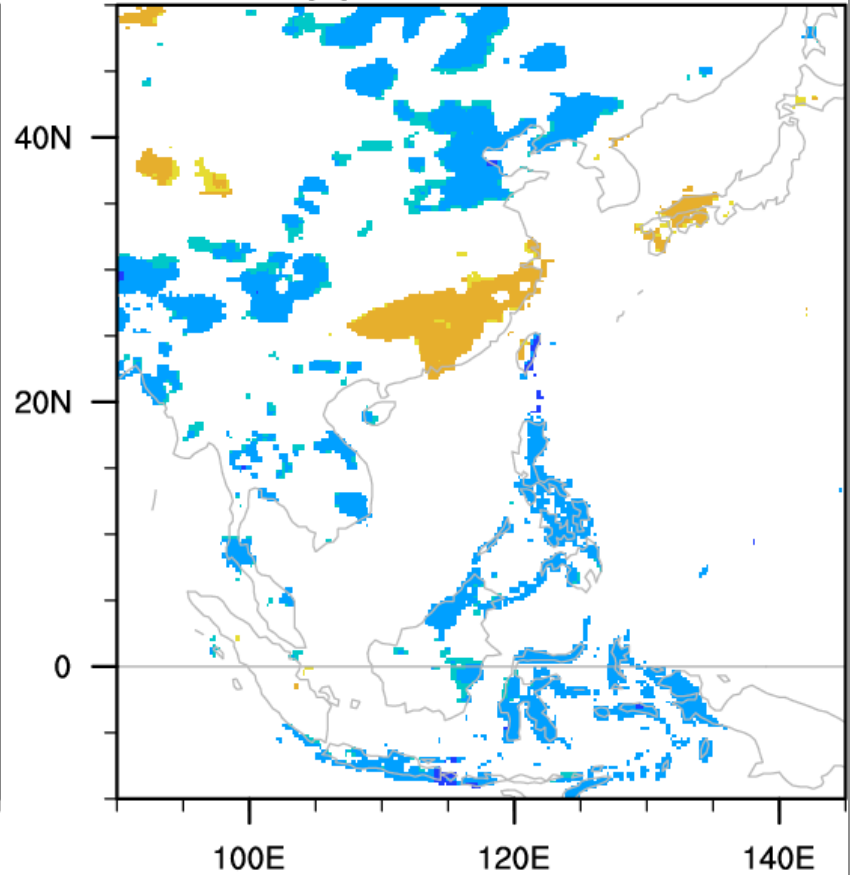
Correlation map for Taiwan's PCs & APHRODITE Precip (Lanczos filter)

(a) 48month 1<sup>st</sup> PCs



低頻(61month lower pass)

(b) 6month 2<sup>nd</sup> PCs



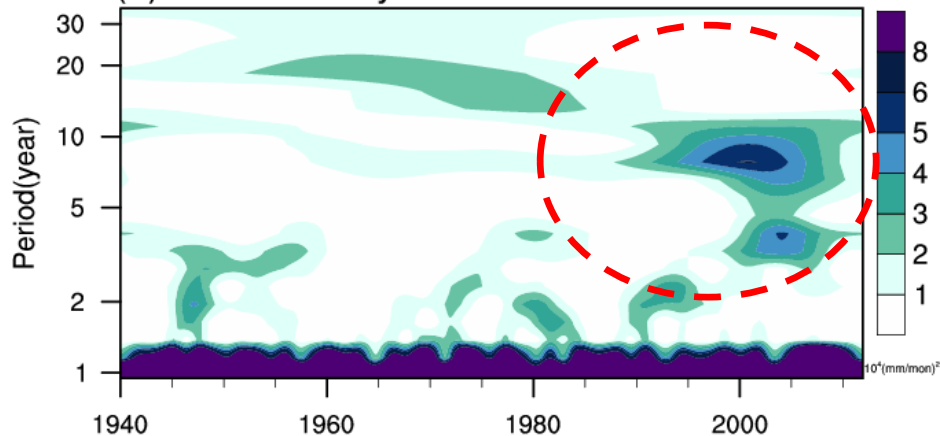
高頻(13-60month band pass)



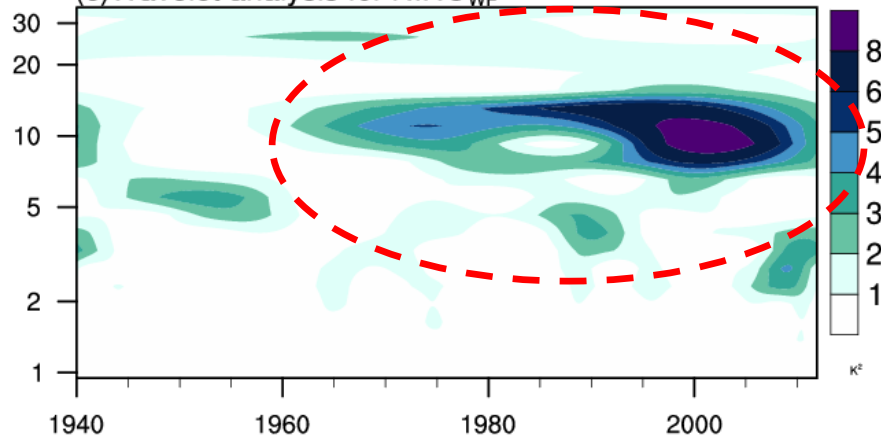
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8

# Wavelet analysis

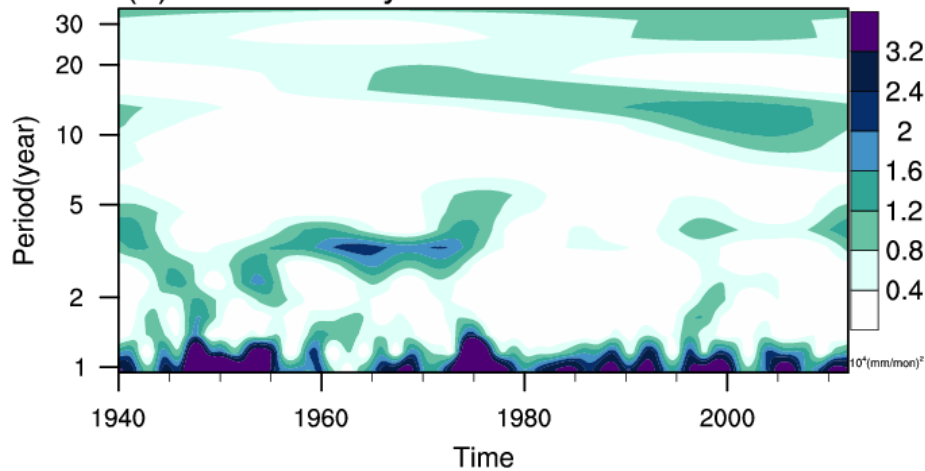
(a) Wavelet analysis for Taiwan 10Sta Rainfall



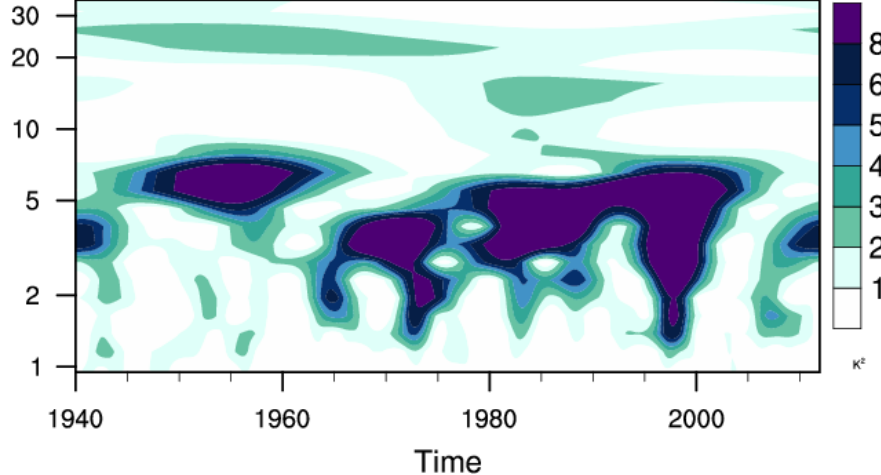
(c) Wavelet analysis for NINO<sub>WP</sub>



(b) Wavelet analysis for Taiwan W-E Rainfall

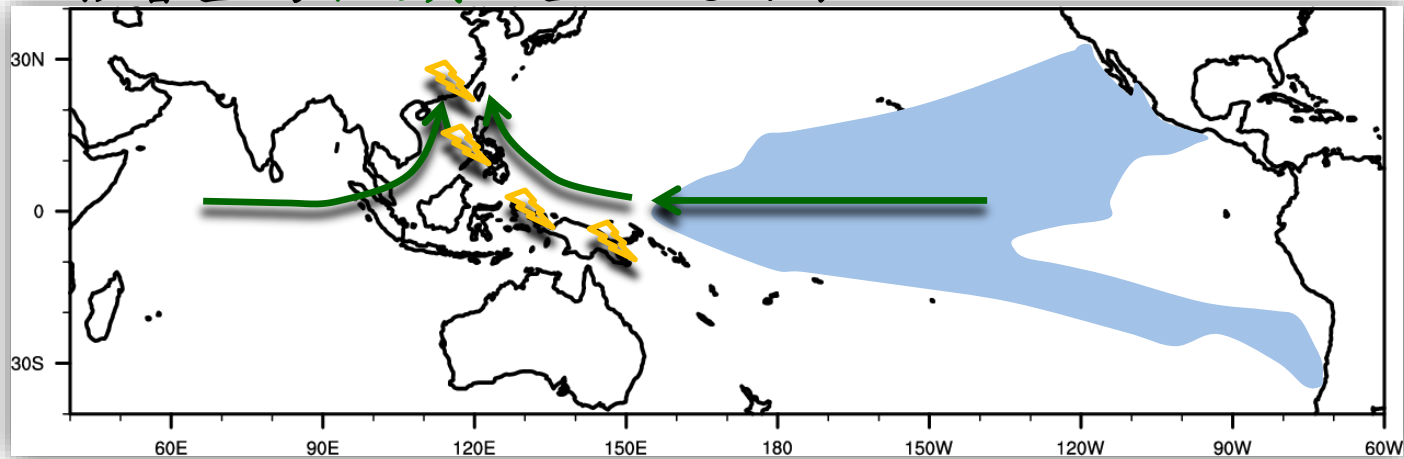


(d) Wavelet analysis for NINO<sub>CT</sub>

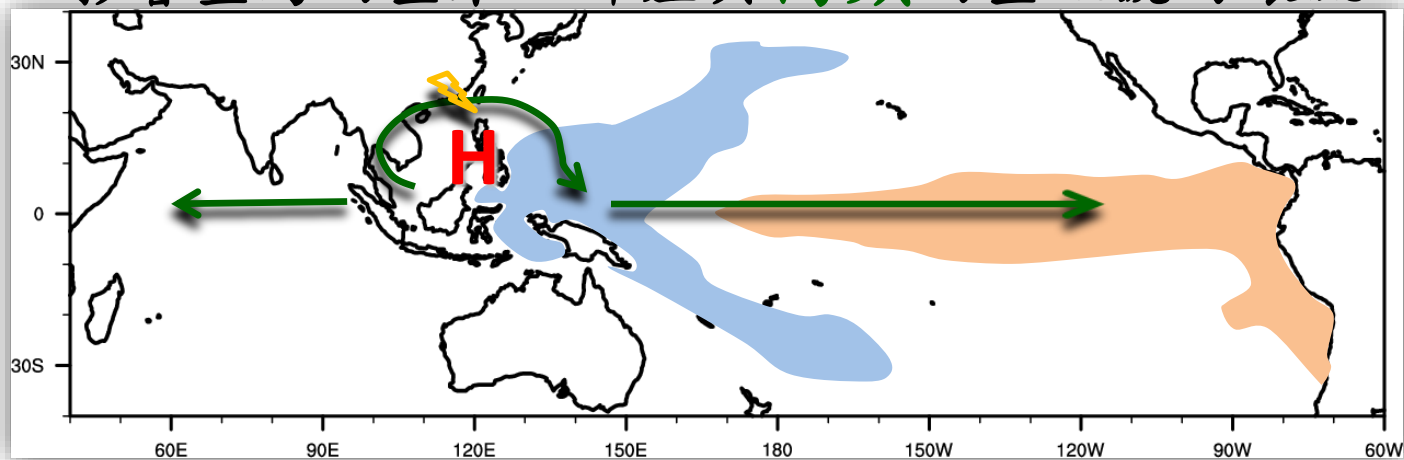


# Summary

## 影響臺灣低頻雨量訊號的環流



## 影響臺灣雨量東西部差異高頻雨量訊號的環流



**Thanks a lot.** 😊 😄 😁 😂 😃

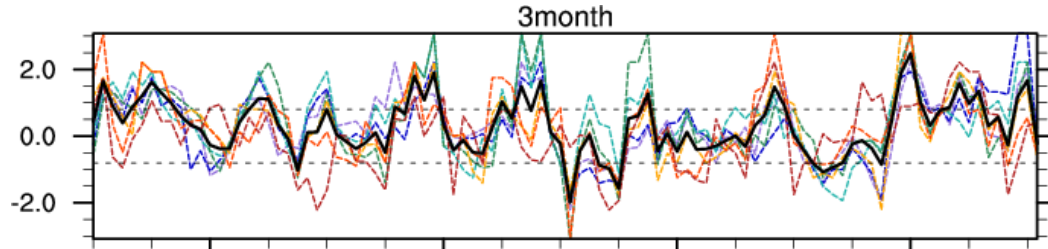
Any questions, comments are welcome!!!

# 近期雨量指數(2005-2013年2月)

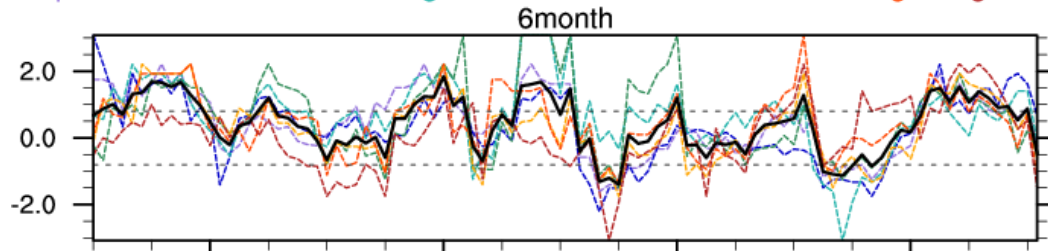
短期雨量變化



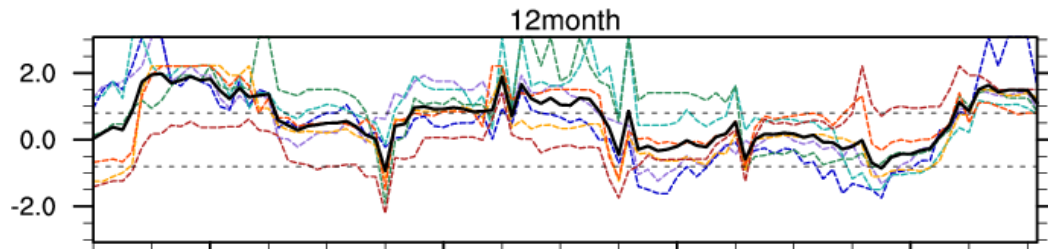
長期雨量變化



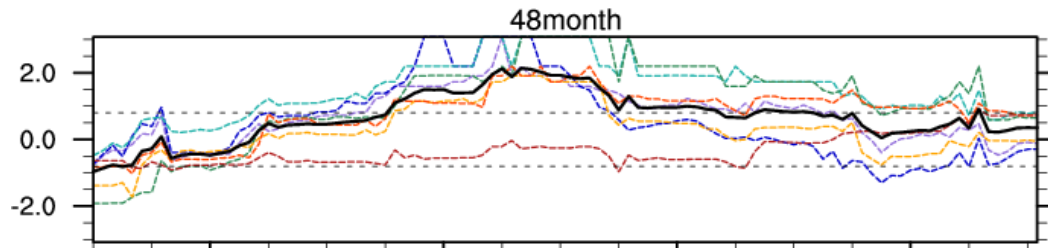
Taipei Hsinchu Taichung Alishan Tainan Kaohsiung Hengchun



2006 2008 2010 2012



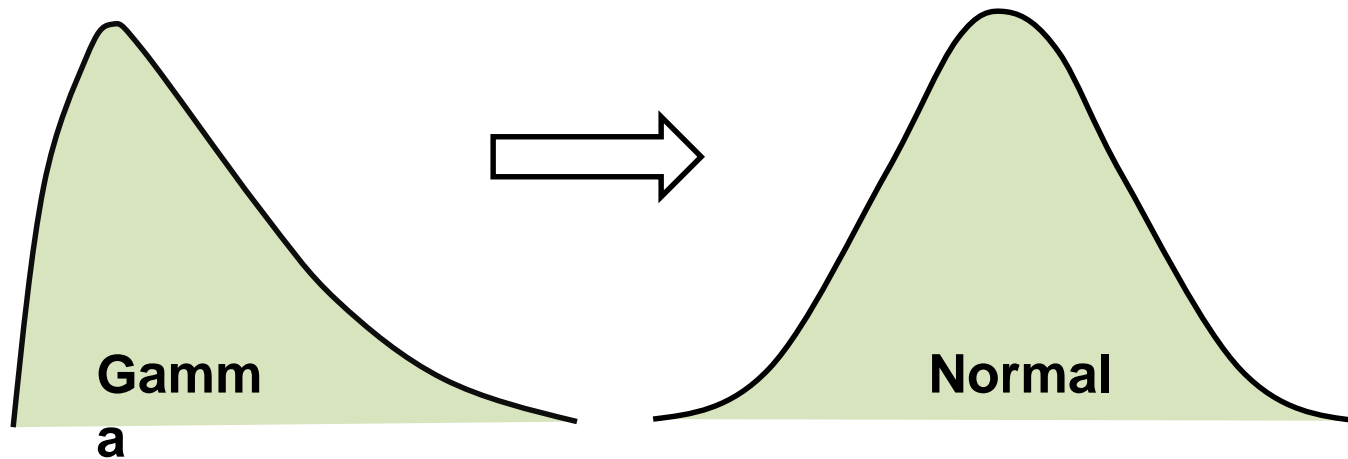
2006 2008 2010 2012



2006 2008 2010 2012

彩色線分別代表：  
臺北、新竹、臺中、阿里山、臺南、高雄、恆春，  
黑色線代表上述7站平均

# Conception of SPI



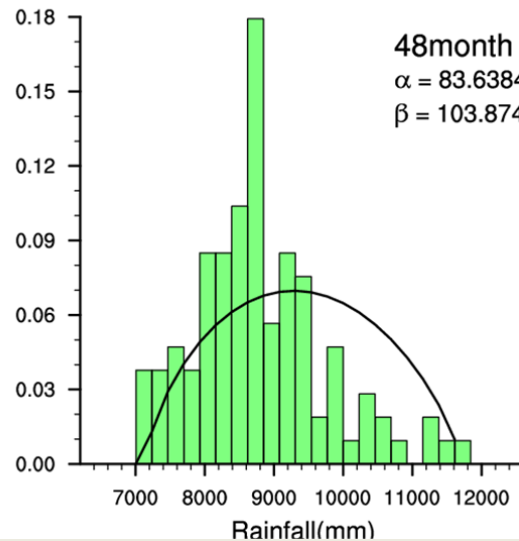
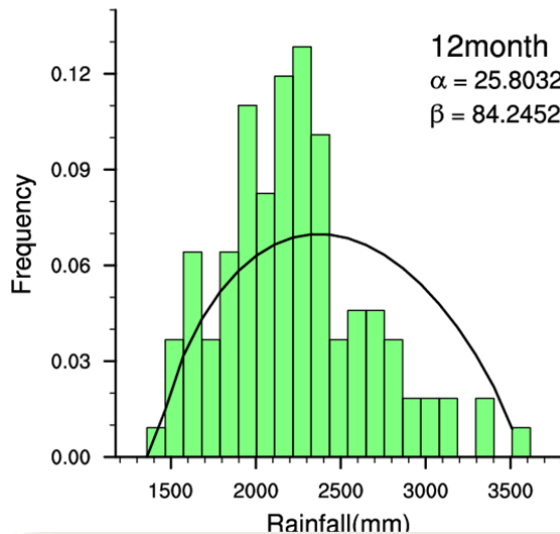
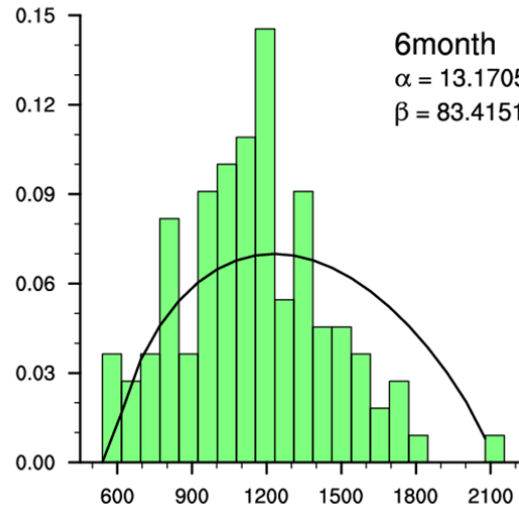
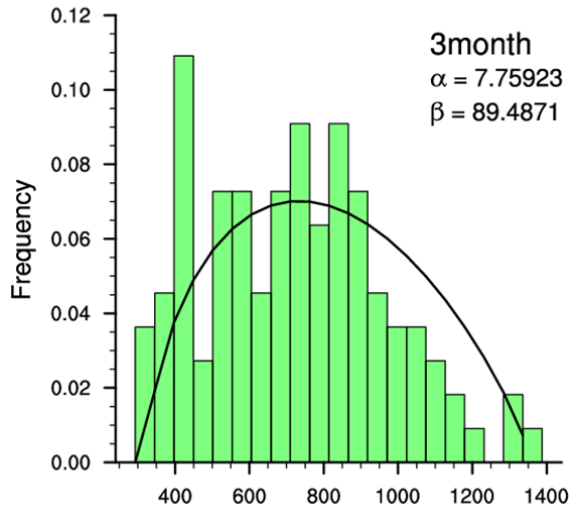
## ***The conception of SPI is :***

- Assumed climatological precipitation fit gamma distribution.
- Transformed the distribution from gamma to normal(mean=0, SD=1), and the SPI can represent standard deviation.



# Frequency Distribution of Rainfall in Taipei

Frequency distribution of rainfall in Taipei (End in Jun, Period:1901-2010)



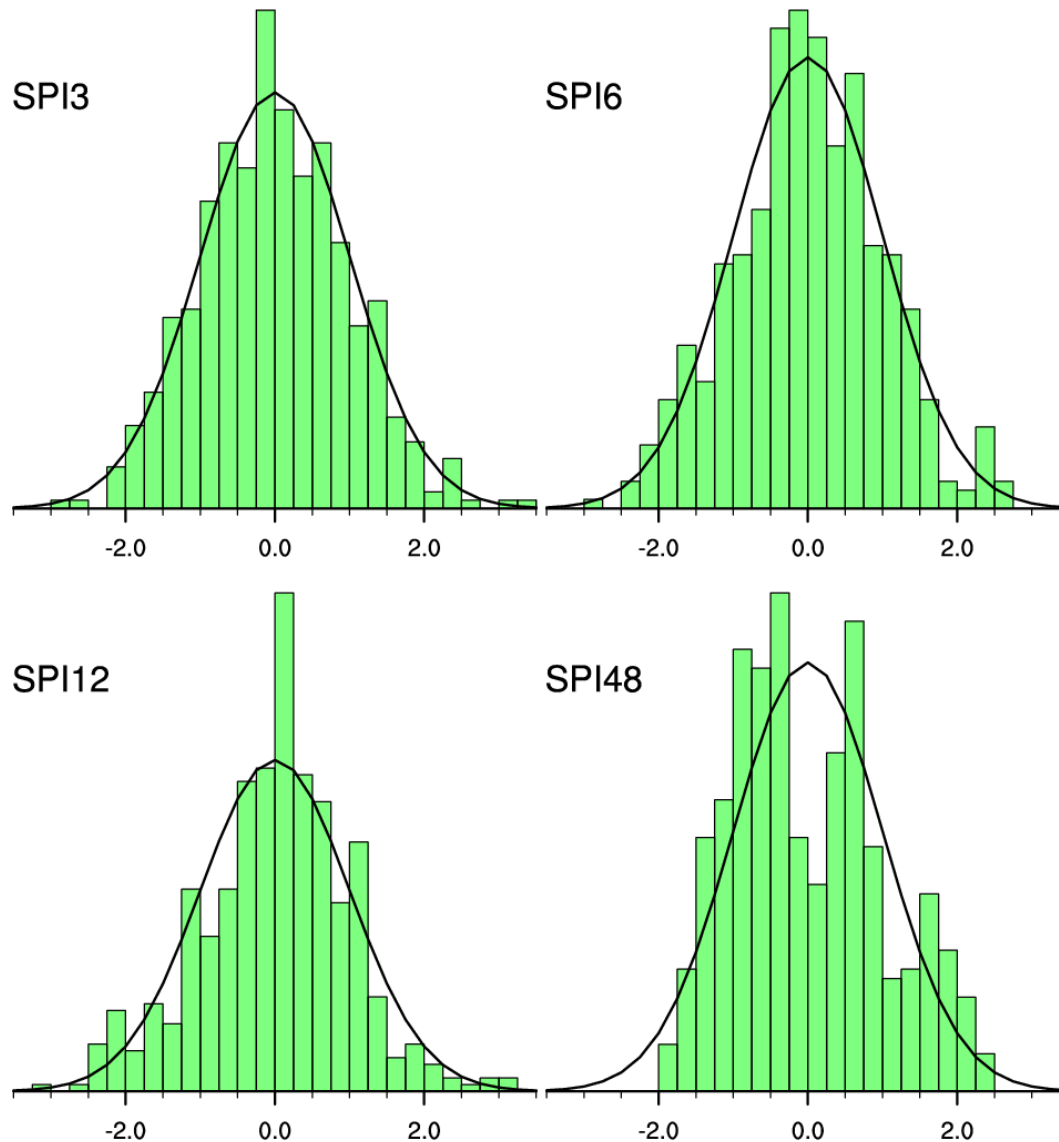
Left figures show the 3, 6, 12 and 48 months accumulated rainfall in Taipei in 1969-2010.

These figures shown the real rainfall (green bar) don't fit the gamma distribution (black line).

$\alpha$ : Shape parameter  
 $\beta$ : Scale parameter

# Does the Standard Precipitation Index(SPI) suit Taiwan?

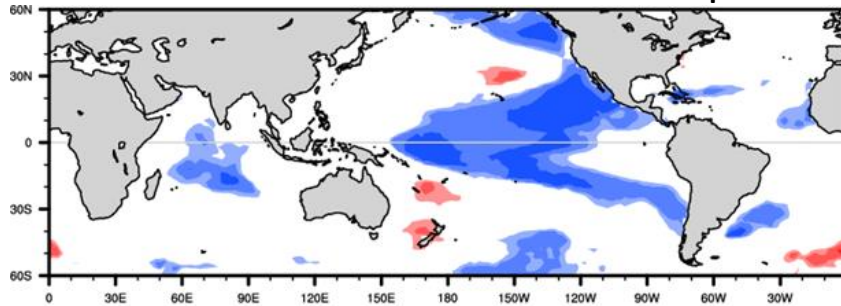
Frequency distribution of SPI in Taipei



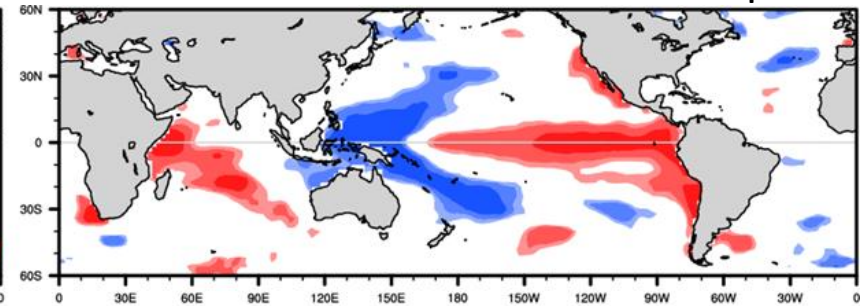
The rainfall in Taiwan was quite complex in time and spacial. The SPI had been used to monitor meteorological drought in many official bureau. Can we apply the SPI to monitor meteorological drought in Taiwan ?

Left figures shown the frequency distribution of SPI3, SPI6, SPI12 and SPI48 in Taipei station. All of the SPI was not normal distribution perfectly especially on SPI48. It imply **SPI is not a nice index for meteorological drought in Taiwan especially for long period.**

SPI48's 1<sup>st</sup> PCs & 61 months lowpass

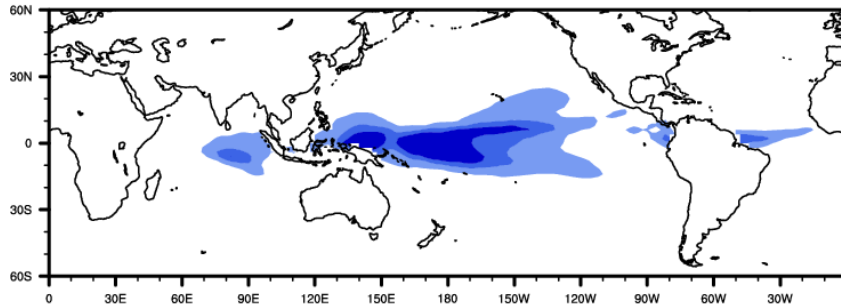


SPI6's 2<sup>nd</sup> PCs & 13-60 month bandpass

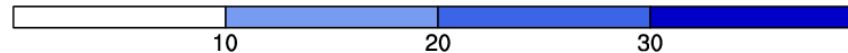
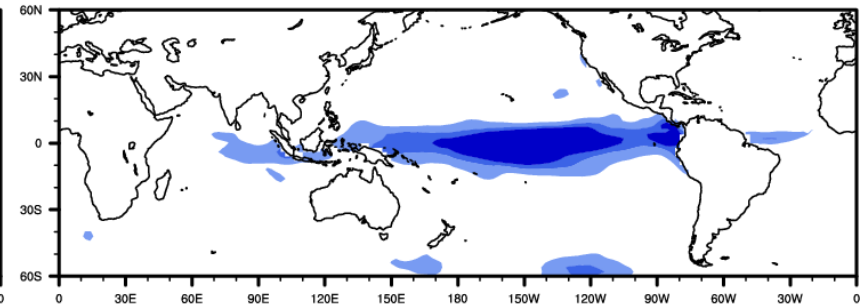


## Ratio of ERSST Variance

>61months/total



13-60months/total



Upper two figures shown the correlation map for Taiwan's PCs & ERSST. Bottom two figures were the ratio of fractional variance for long(>61months) and short(13-60month) term SST. Comparing those figures, it indicated the fractional variance is large in high correlation areas in the tropics.