

# TAPEX之颱風降雨機率預報結果

## - 初步分析

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2014.09.18

### 報告內容

- 前言與目的
- 氣候降雨機率分析
- TAPEX降雨機率分析
- 校驗分析

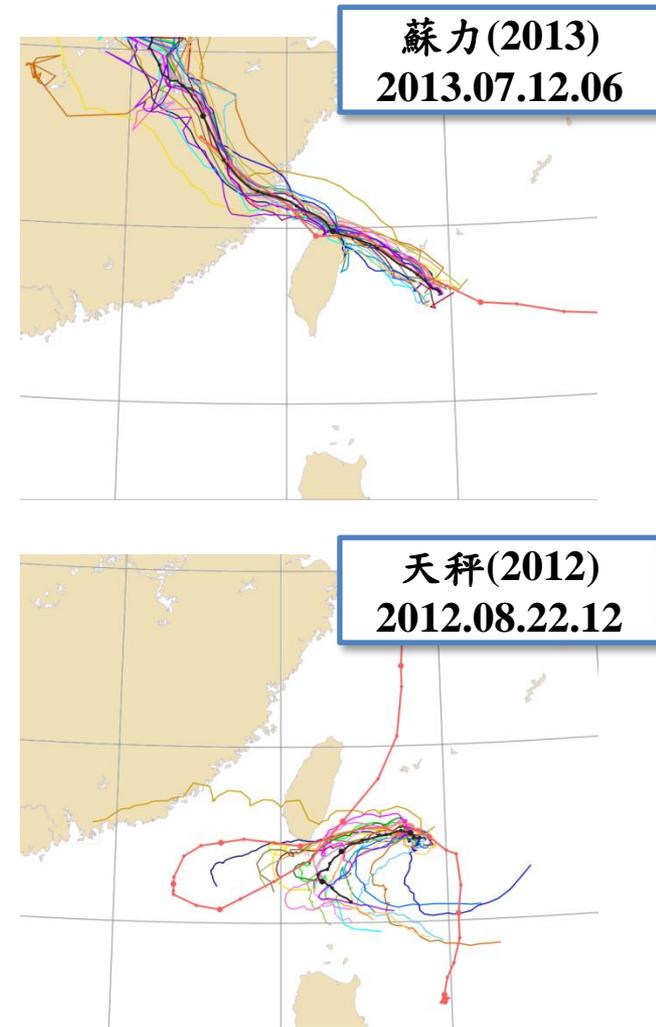
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- 本研究特別感謝：  
劉宇其<sup>1</sup>先生、謝宜桓<sup>1</sup>先生與  
翁進登<sup>1</sup>先生協助。

# 前言與目的

- 傳統的數值天氣預報期望由最佳的單一模式、單一初始資料，以獲得最佳之模式預報結果。而系集預報的發展則是為了彌補單一模式預報的不足，期望系統能包含模式預報的不確定性，並將不確定性量化。
- 預報結果呈現方式，將由單一定值改以機率預報的形式呈現，以反應預報之不確定性。
- 本研究利用 **TAPEX** (Typhoon Quantitative Precipitation Ensemble Forecast Experiment) 資料發展 **PQPF** (Probabilistic Quantitative Precipitation Forecast) 技術，並分析、比較校驗之結果。



# TAPEX 資料介紹

- 本研究使用颶洪中心所提供之TAPEX資料
- 分析**2011-2013年共17個發布警報之颱風個案**
- 系集成員數約**20-26個**之間

## TAPEX系集成員設定

Model configuration for ensemble members. The table elements from initial conditions (ICs), lateral boundary conditions (LBCs) and various physical parameterizations are described in the text.

Ensemble member	Model	ICs	LBCs	Cumulus scheme	Microphysics scheme	Boundary layer
01	WRF	Partial cycle	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
02	WRF	Partial cycle	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
03	WRF	Partial cycle	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
04	WRF	Partial cycle	3DVAR (CV5)	Bogus	NCEP GFS	Goddard YSU
05	WRF	Partial cycle	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
06	WRF	Cold start	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
07	WRF	Cold start	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
08	WRF	Cold start	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
09	WRF	Cold start	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
10	WRF	Partial cycle	3DVAR (CV3)	Bogus	NCEP GFS	Goddard YSU
11	WRF	Partial cycle	3DVAR (CV5 + OL)	Bogus	NCEP GFS	Goddard YSU
12	WRF	Partial cycle	3DVAR (CV3)	Bogus	CWB GFS	Goddard YSU
13	WRF	Cold start	3DVAR (CV3)	Bogus	NCEP GFS	Goddard YSU
14	WRF	Cold start	3DVAR (CV5)	Bogus	NCEP GFS	Goddard YSU
15	WRF	Cold start	3DVAR (CV5)	Bogus	NCEP GFS	Goddard YSU
16	WRF	Cold start	NODA	Bogus	NCEP GFS	WSMS YSU
17	MM5	Cold start	NODA	Bogus	NCEP GFS	Goddard MRF
18	MM5	Cold start	4DVAR	Bogus	NCEP GFS	Goddard MRF

年份	中文名	路徑	警報期間	近臺強度
2013	菲特	1	2013-10-04 23:30 2013-10-07 08:30	中度
2013	天兔	5	2013-09-19 23:30 2013-09-22 14:30	強烈
2013	康芮	6	2013-08-27 11:30 2013-08-29 20:30	輕度
2013	潭美	1	2013-08-20 11:30 2013-08-22 08:30	輕度
2013	西馬隆	---	2013-07-17 10:30 2013-07-18 11:30	輕度
2013	蘇力	2	2013-07-11 08:30 2013-07-13 23:30	強烈
2012	杰拉華	---	2012-09-27 02:30 2012-09-28 20:30	強烈
2012	天秤	特殊	2012-08-21 14:30 2012-08-25 14:30	中度
2012	啟德	---	2012-08-26 11:30 2012-08-28 23:30	中度
2012	啟德	---	2012-08-14 14:30 2012-08-15 17:30	輕度
2012	海葵	---	2012-08-06 11:30 2012-08-07 17:30	中度
2012	蘇拉	2	2012-07-30 20:30 2012-08-03 14:30	中度
2012	杜蘇芮	---	2012-06-28 05:30 2012-06-29 08:30	輕度
2012	泰利	9	2012-06-19 05:30 2012-06-21 05:30	輕度
2011	南瑪都	4	2011-08-27 05:30 2011-08-31 08:30	強烈
2011	梅花	---	2011-08-04 17:30 2011-08-06 11:30	中度
2011	米雷	---	2011-06-23 23:30 2011-06-25 14:30	輕度
2011	桑達	---	2011-05-27 02:30 2011-05-28 14:30	強烈

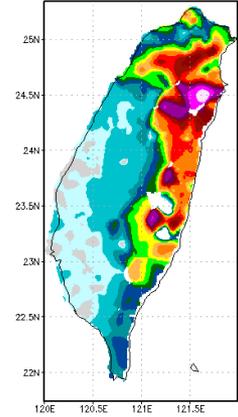


# 個案分析

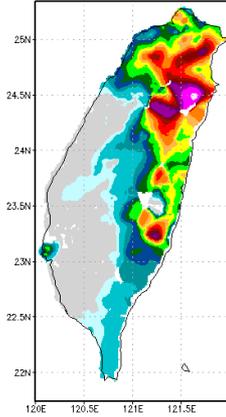
- 以2012年蘇拉颱風為例
- 初始時間為：2012年07月31日0000 UTC

## 12小時累積雨量

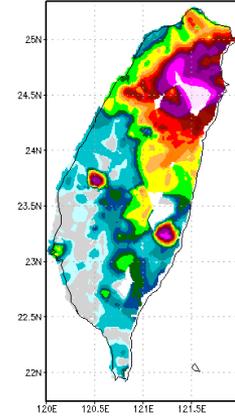
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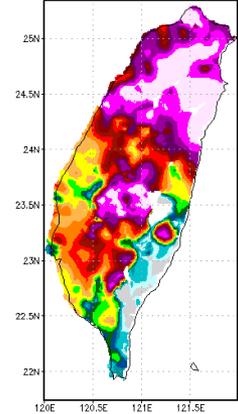
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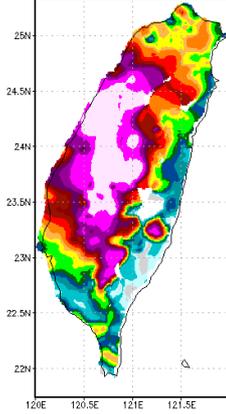
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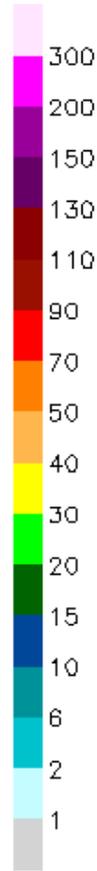
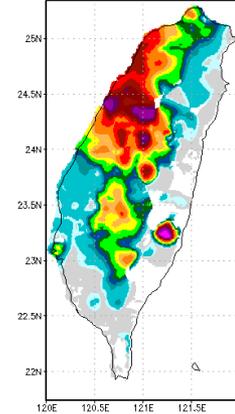
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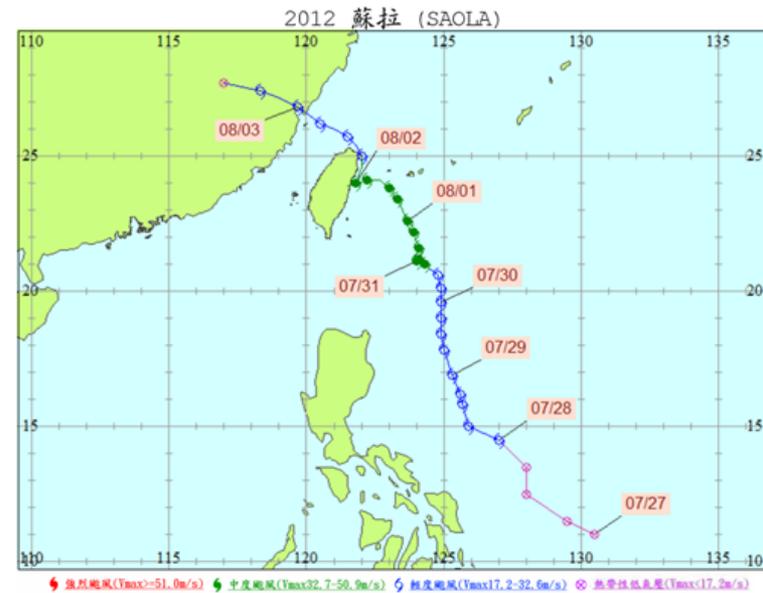
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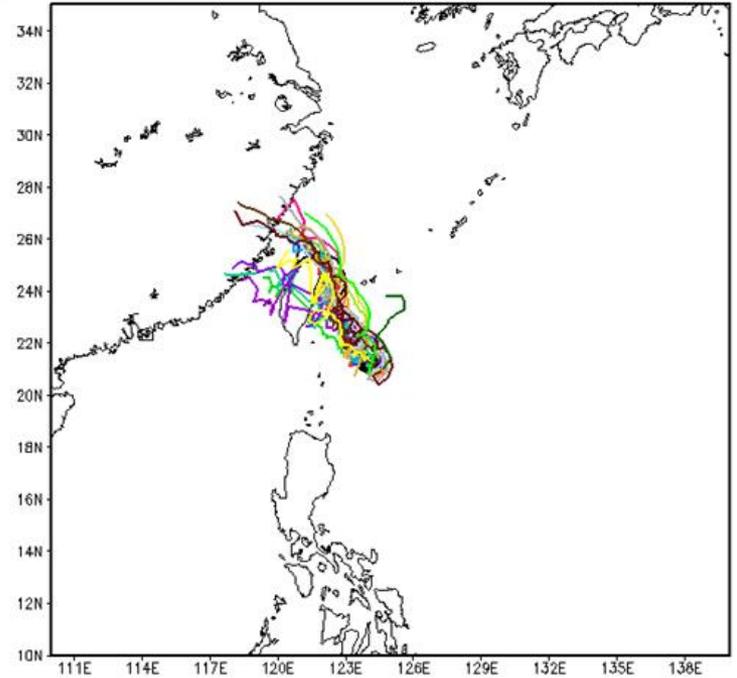
(a)



(取自CWB)

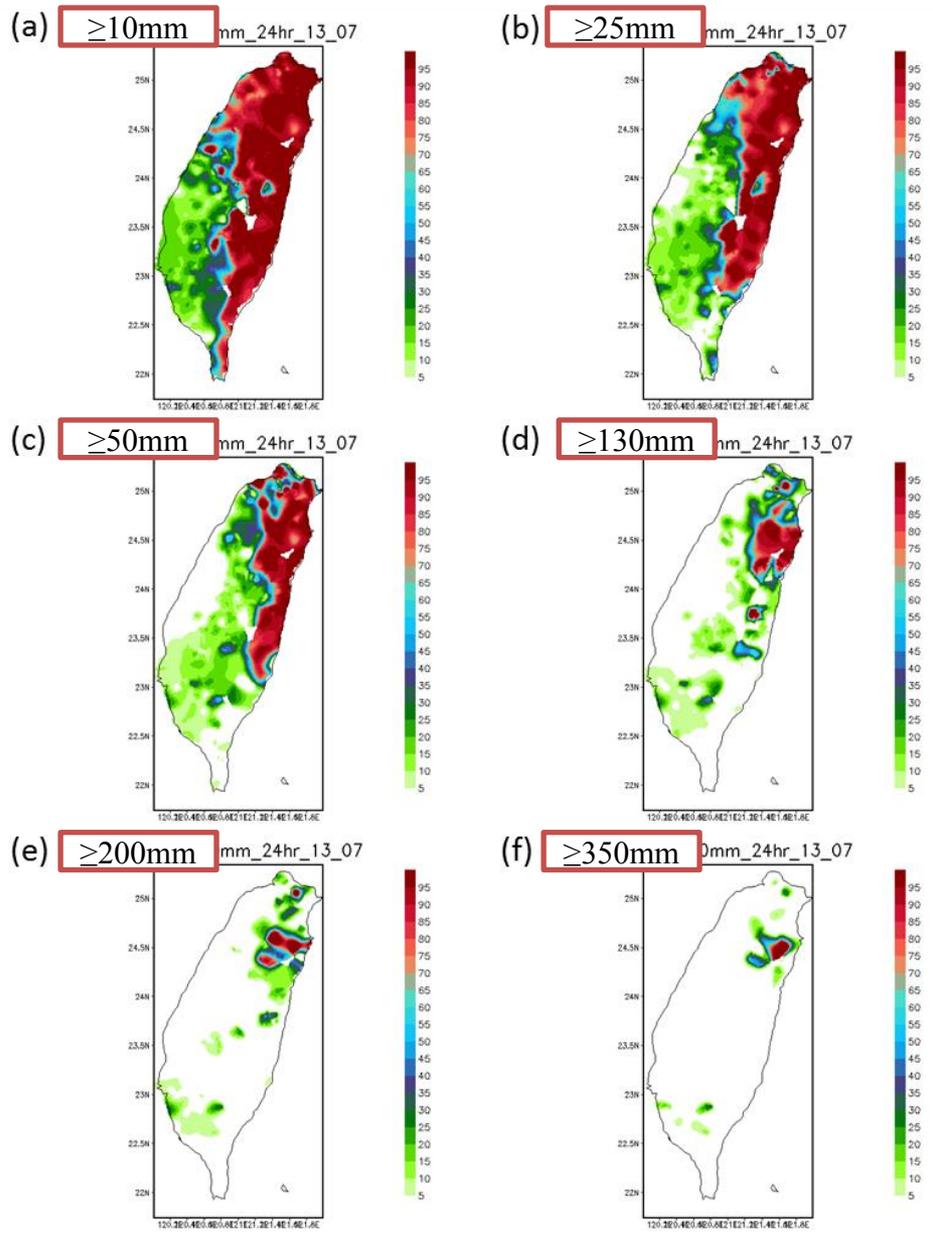
(b)

TRK-2012073100-SAOLA

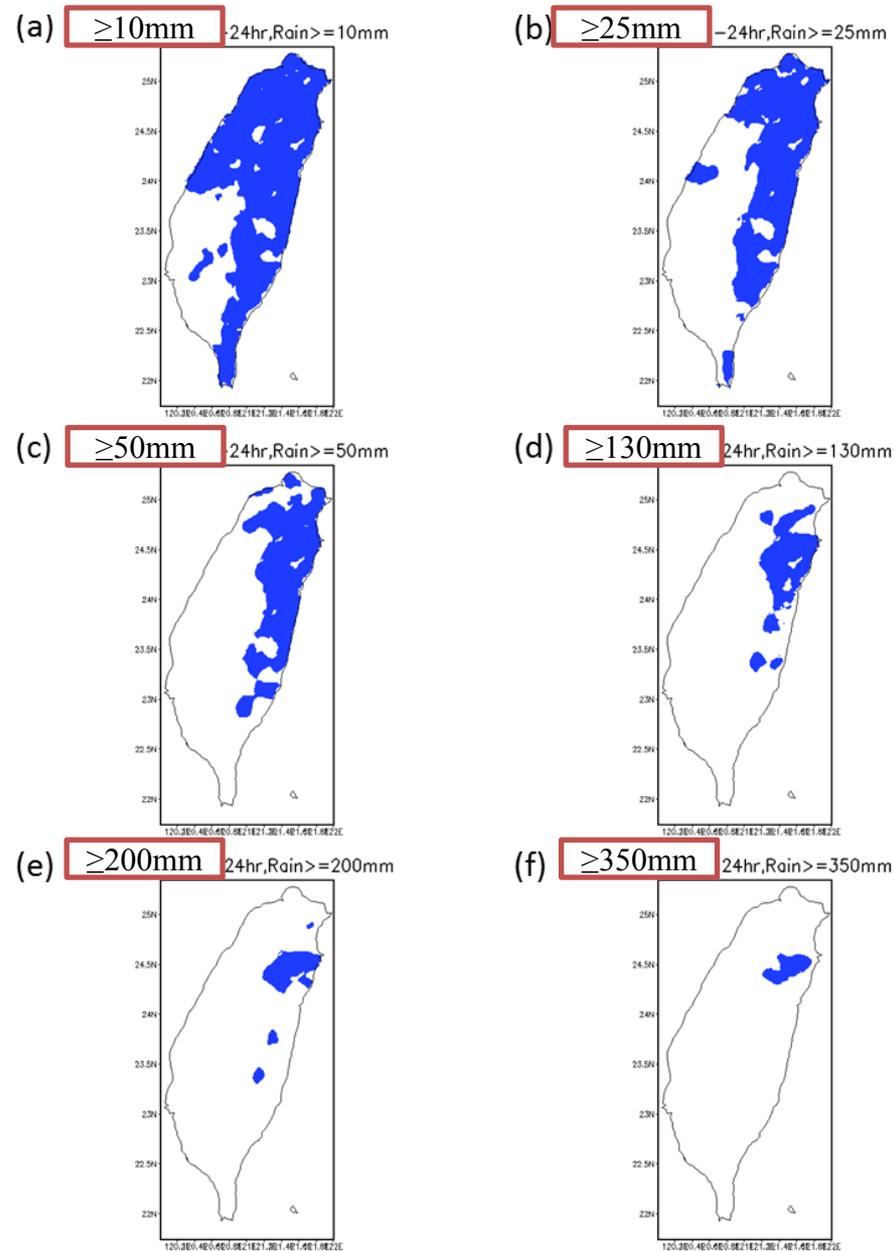




蘇拉 - 2012年07月31日 0000UTC  
0-24小時累積雨量 - 氣候PQPF

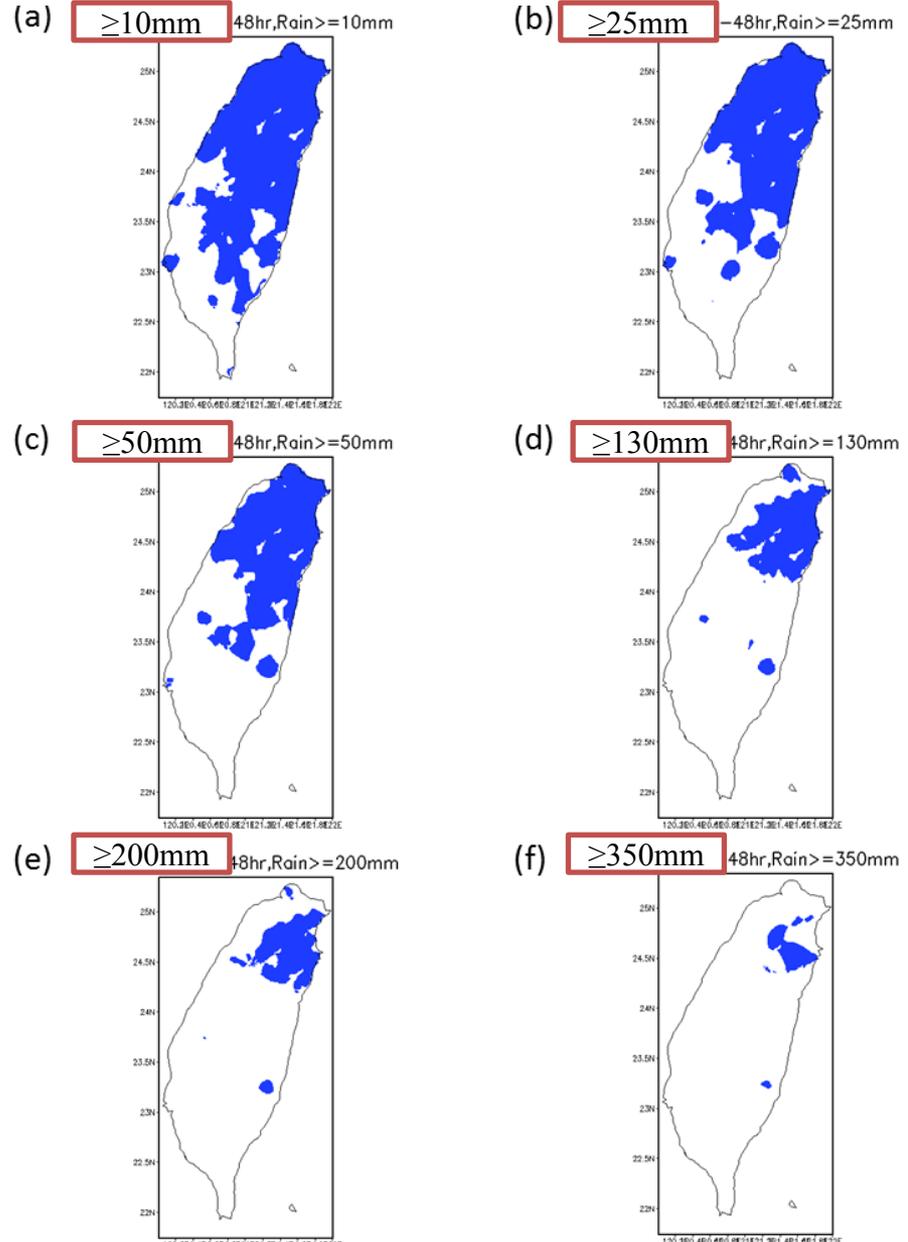
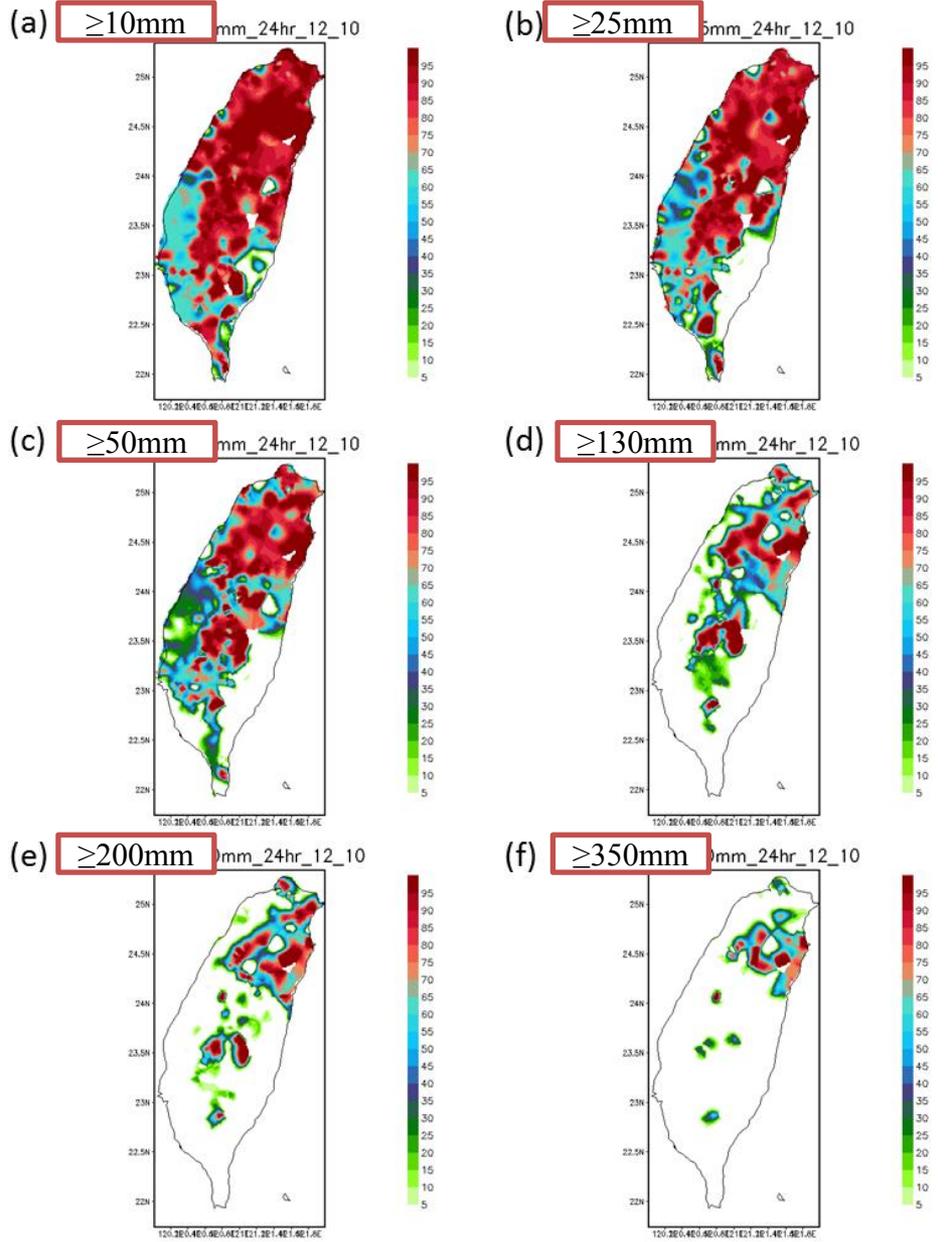


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0-24小時累積雨量 - 實際觀測



# 蘇拉 24-48小時累積雨量 - 氣候PQPF

# 蘇拉 24-48小時累積雨量 - 實際觀測

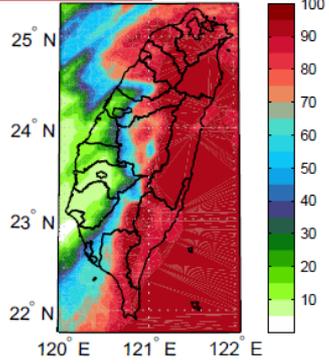


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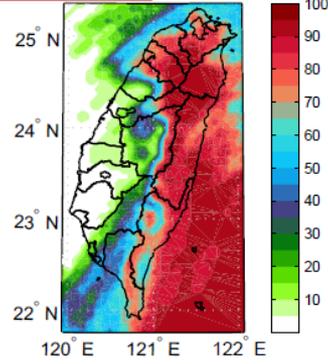
# 系集PQPF

實際觀測

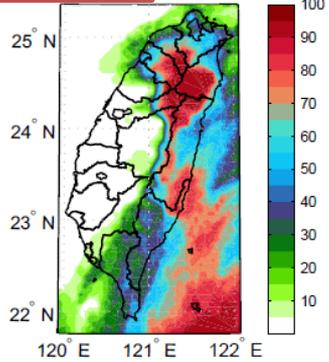
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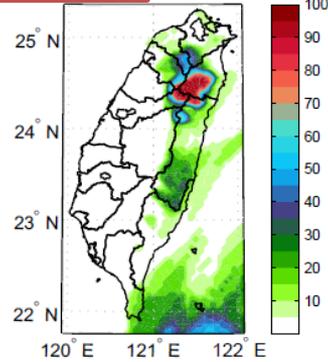
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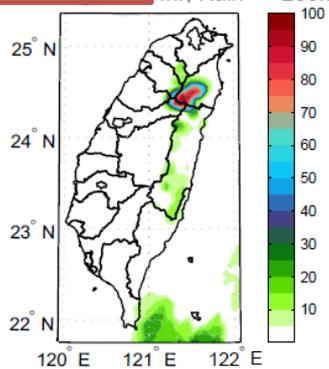
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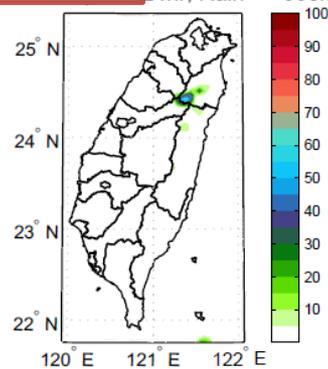
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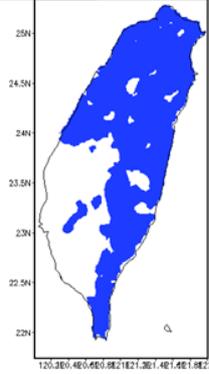
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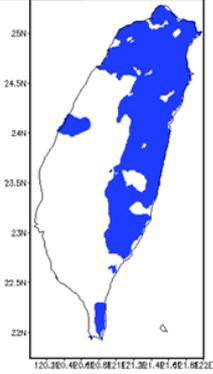
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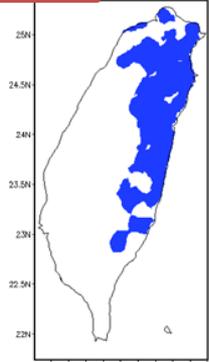
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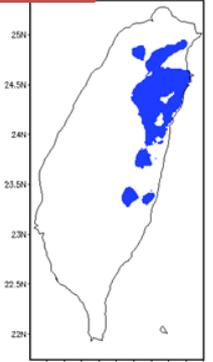
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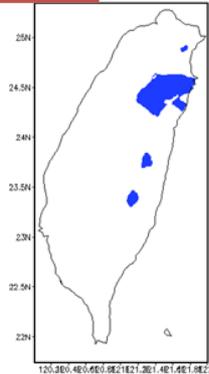
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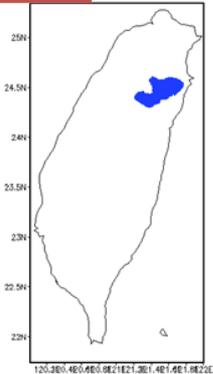
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(e)  $\geq 200\text{mm}$  24hr, Rain  $\geq 200\text{mm}$



(f)  $\geq 350\text{mm}$  24hr, Rain  $\geq 350\text{mm}$

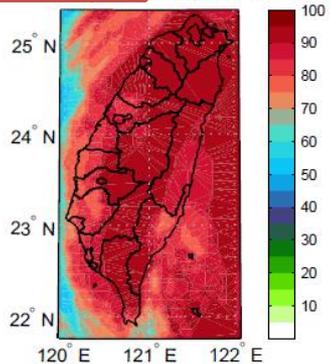


蘇拉 - 2012年07月31日 0000UTC  
24-48小時累積雨量

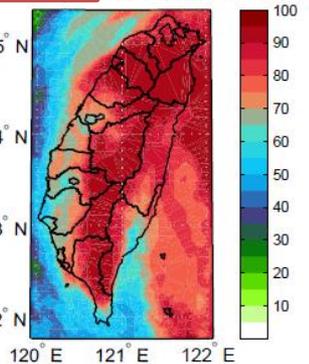
# 系集PQPF

實際觀測

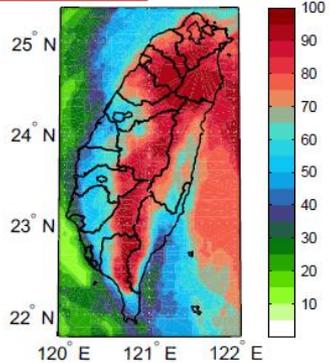
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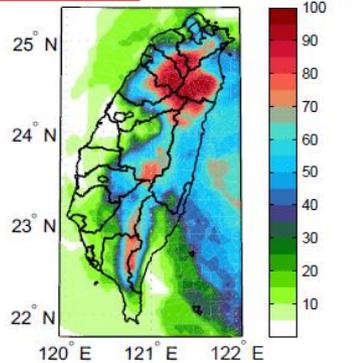
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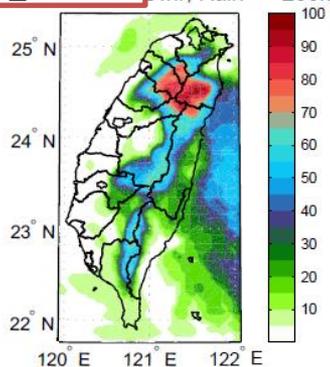
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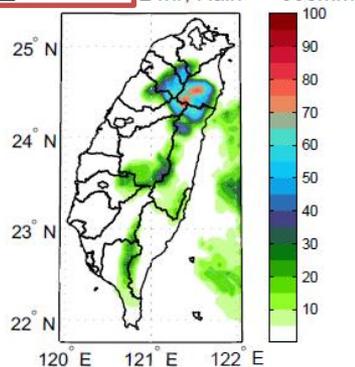
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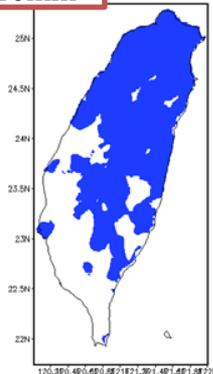
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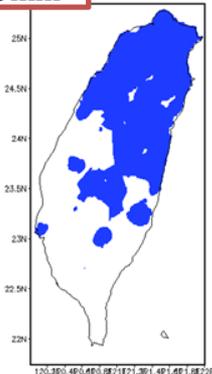
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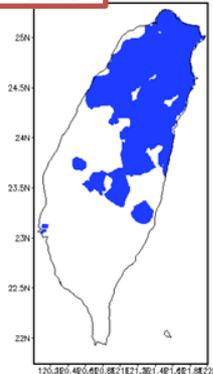
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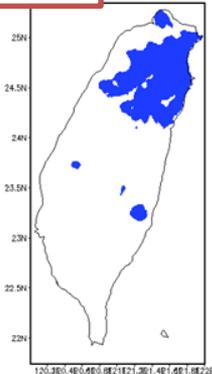
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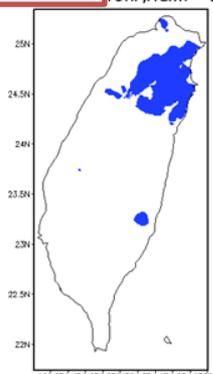
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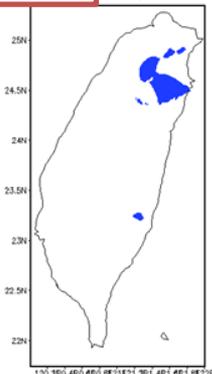
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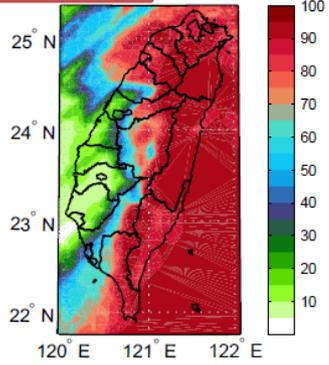


蘇拉 - 2012年07月31日 0000UTC  
0-24小時累積雨量

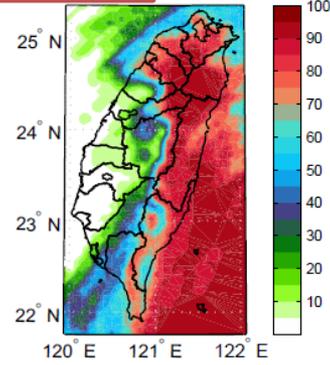
# 系集PQPF

氣候PQPF

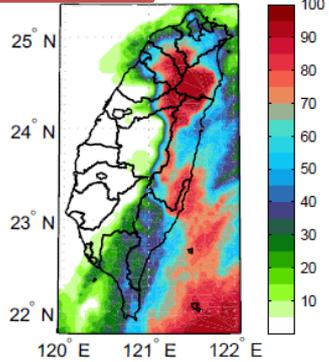
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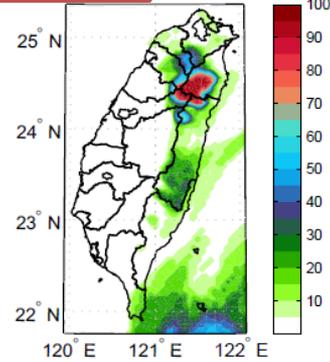
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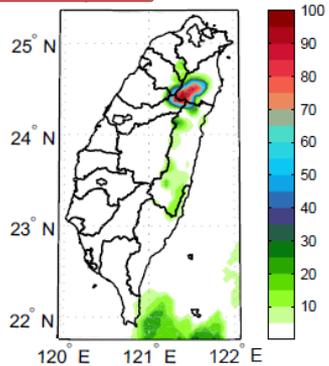
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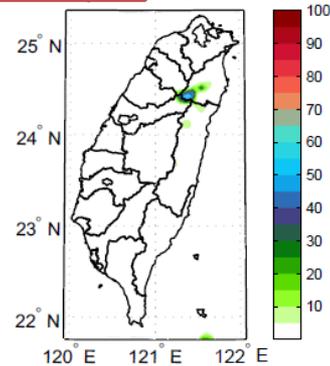
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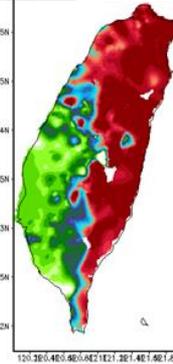
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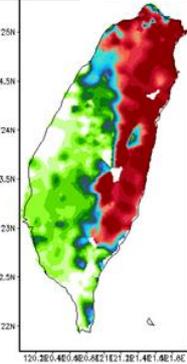
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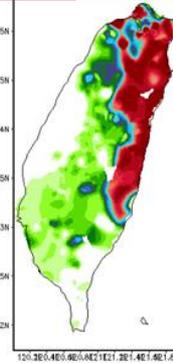
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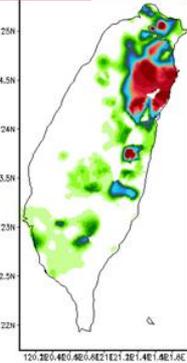
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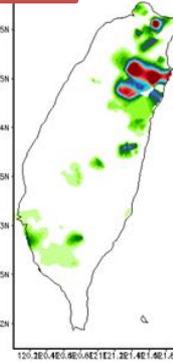
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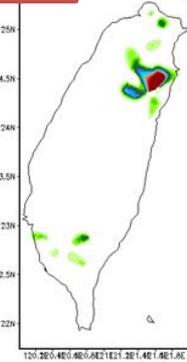
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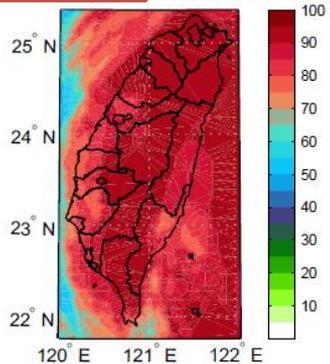


蘇拉 - 2012年07月31日 0000UTC  
24-48小時累積雨量

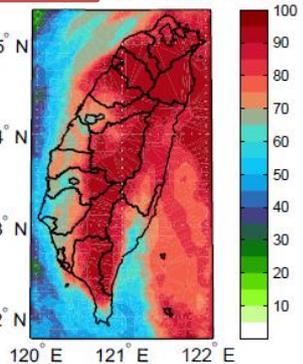
# 系集PQPF

氣候PQPF

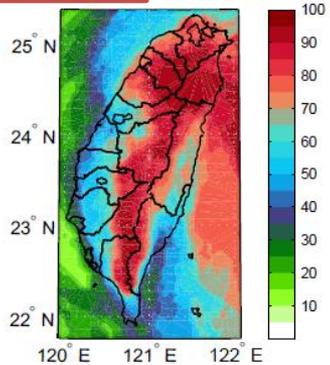
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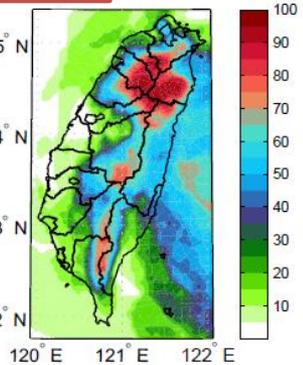
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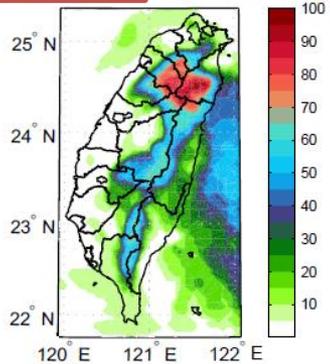
(c)  $\geq 50\text{mm}$  24hr, Rain  $\geq 50\text{mm}$



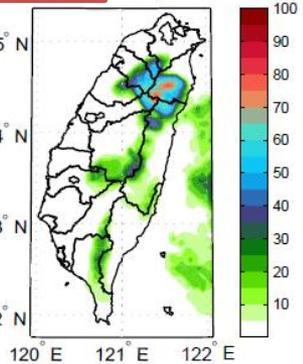
(d)  $\geq 130\text{mm}$  24hr, Rain  $\geq 130\text{mm}$



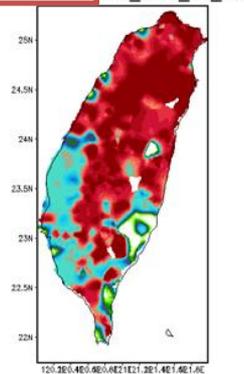
(e)  $\geq 200\text{mm}$  24hr, Rain  $\geq 200\text{mm}$



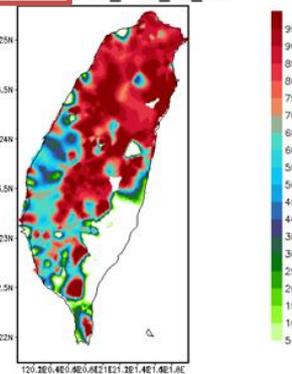
(f)  $\geq 350\text{mm}$  24hr, Rain  $\geq 350\text{mm}$



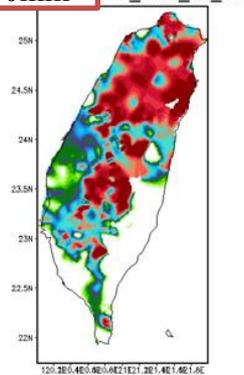
(a)  $\geq 10\text{mm}$  mm\_24hr\_12\_10



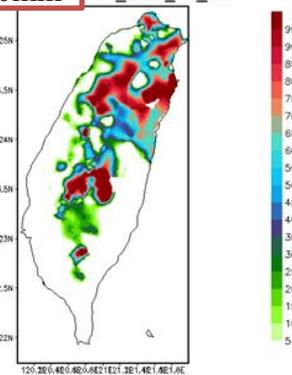
(b)  $\geq 25\text{mm}$  mm\_24hr\_12\_10



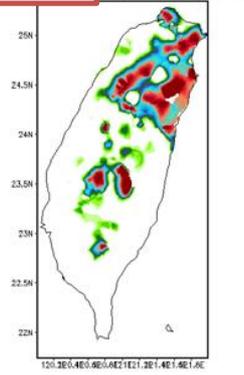
(c)  $\geq 50\text{mm}$  mm\_24hr\_12\_10



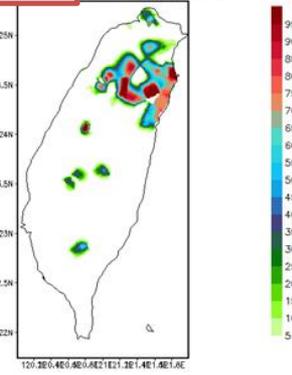
(d)  $\geq 130\text{mm}$  mm\_24hr\_12\_10



(e)  $\geq 200\text{mm}$  mm\_24hr\_12\_10



(f)  $\geq 350\text{mm}$  mm\_24hr\_12\_10

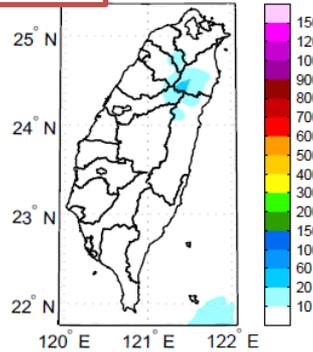


# Quantitative Precipitation Forecasts Probability (QPFP)

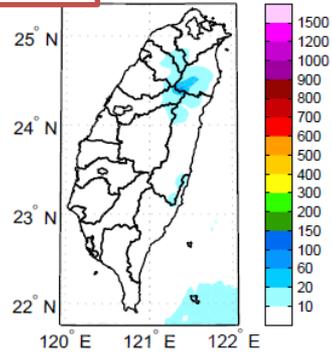
蘇拉 - 2012年07月31日 0000UTC 0-24小時

蘇拉 - 2012年07月31日 0000UTC 24-48小時

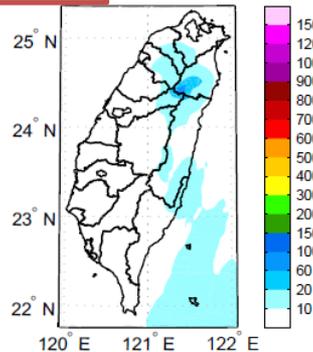
(a) f **90 %** = 24hr, Percentage = 90%



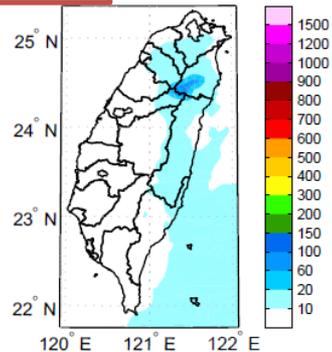
(b) f **80 %** = 24hr, Percentage = 80%



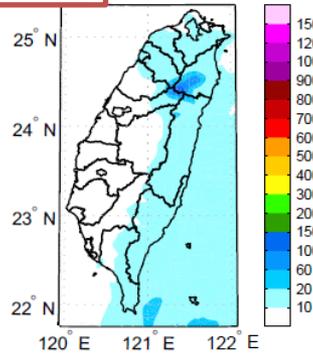
(c) f **60 %** = 24hr, Percentage = 60%



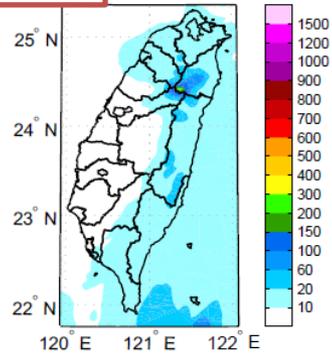
(d) f **40 %** = 24hr, Percentage = 40%



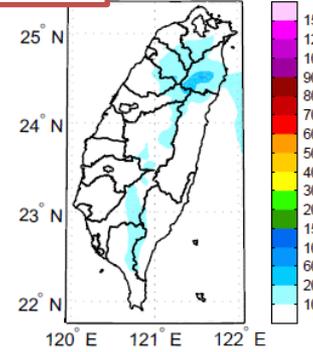
(e) f **20 %** = 24hr, Percentage = 20%



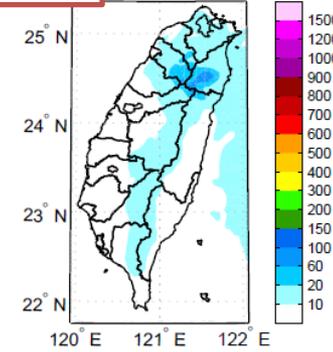
(f) f **10 %** = 24hr, Percentage = 10%



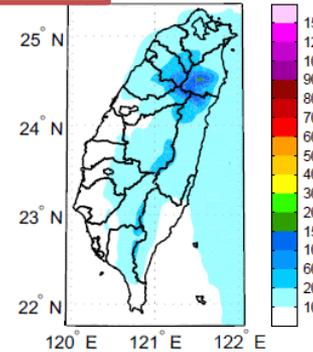
(a) f **90 %** = 24hr, Percentage = 90%



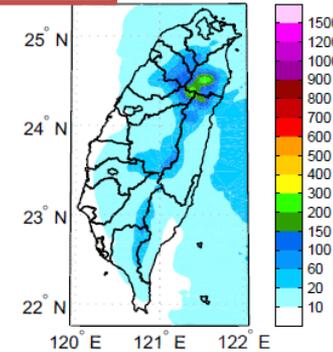
(b) f **80 %** = 24hr, Percentage = 80%



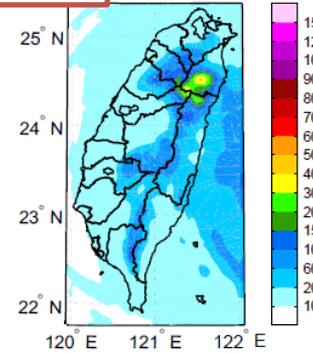
(c) f **60 %** = 24hr, Percentage = 60%



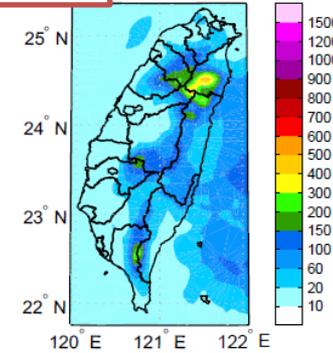
(d) f **40 %** = 24hr, Percentage = 40%



(e) f **20 %** = 24hr, Percentage = 20%



(f) f **10 %** = 24hr, Percentage = 10%



# 初步校驗分析

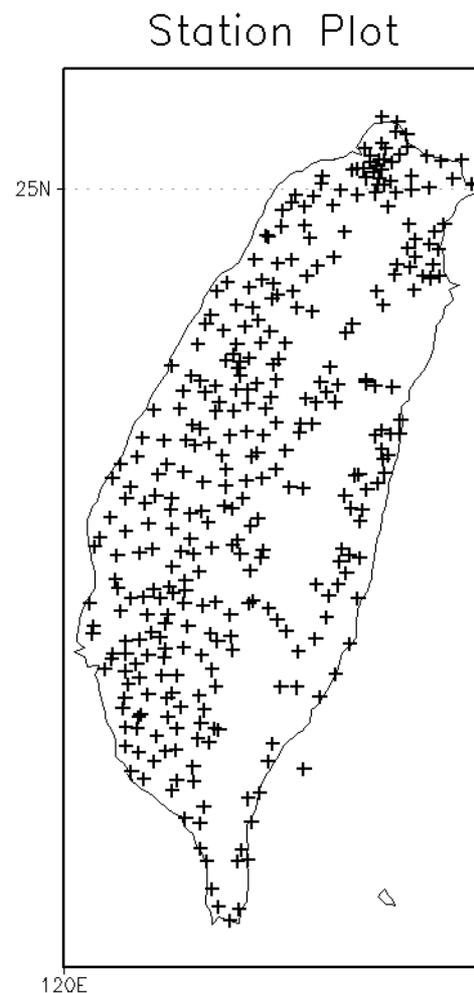
- 針對每個測站為中心，取**半徑10km**內TAPEX網格平均之PQPF值，進行校驗分析
- 一個測站約對應**10個TAPEX網格點**
- **Relative operating characteristic (ROC)**
  - 2011、2012、2013年之面積皆大於0.7

- **Brier score (BrS)**

$$BrS = \frac{1}{n} \sum_{j=1}^n (p_j - o_j)^2$$

- **Rank probability score (RPS)**

$$RPS = \frac{1}{M-1} \sum_{m=1}^M \left( \sum_{j=1}^m p_f(j) - \sum_{j=1}^m p_o(j) \right)^2$$



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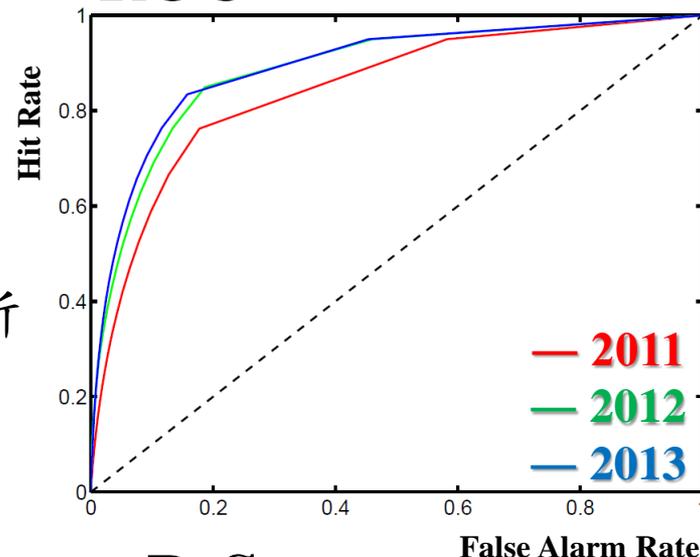
- **Brier score (BrS)**

$$BrS = \frac{1}{n} \sum_{j=1}^n (p_j - o_j)^2$$

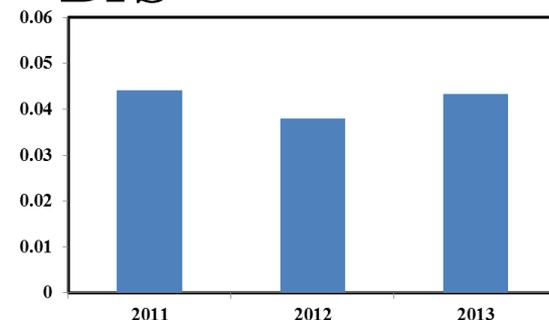
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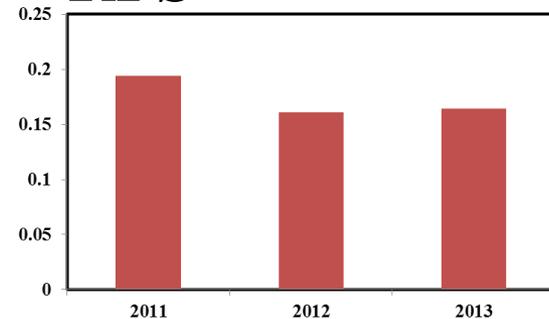
## ROC



## BrS



## RPS

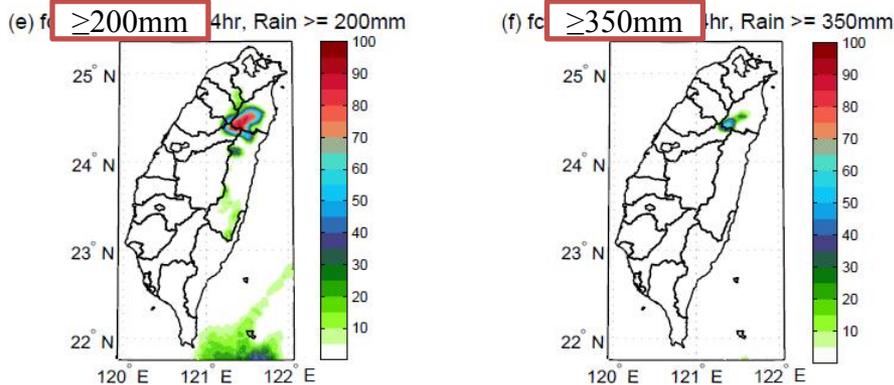
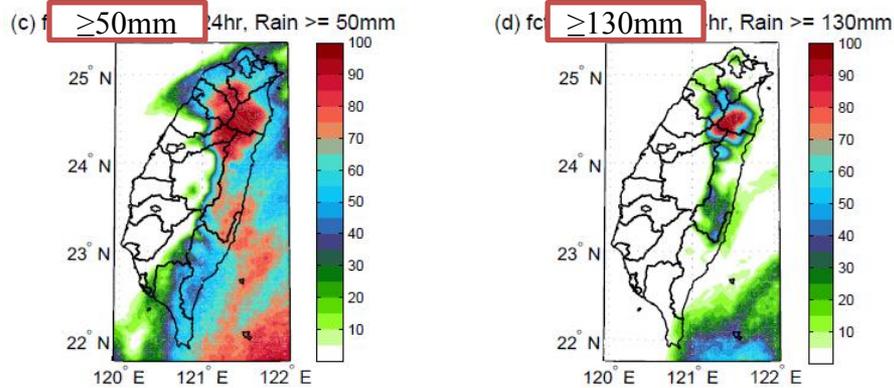
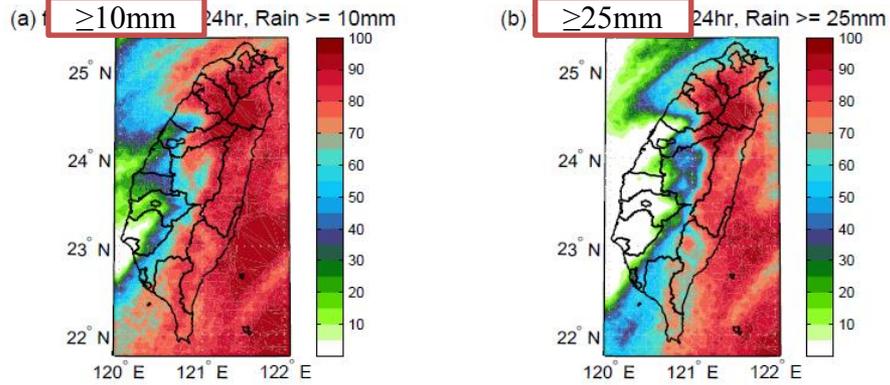


# 總結

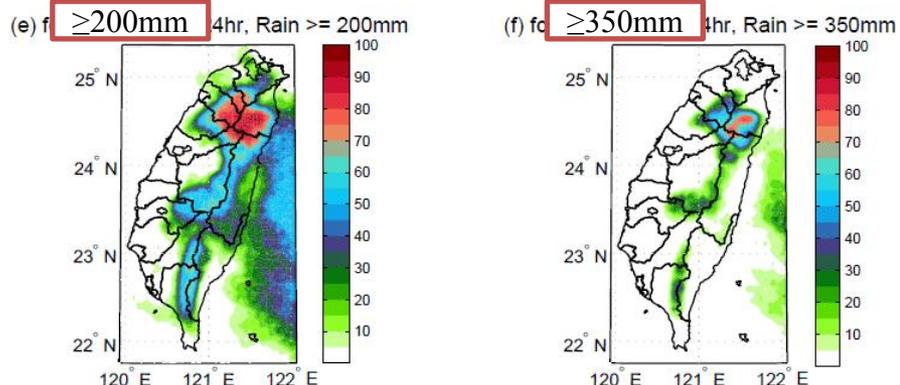
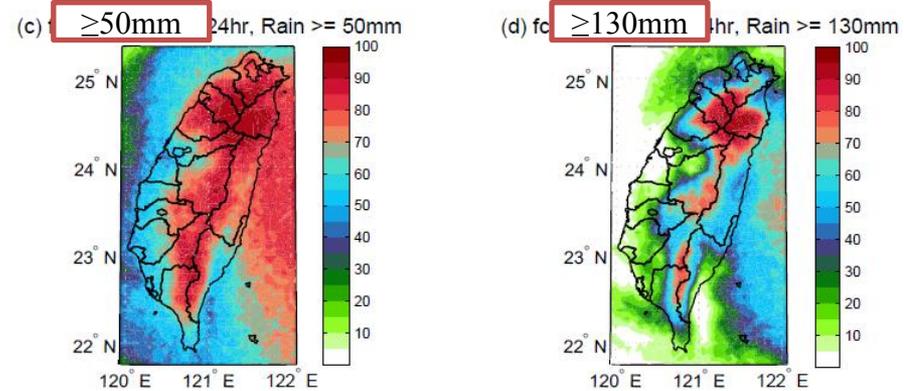
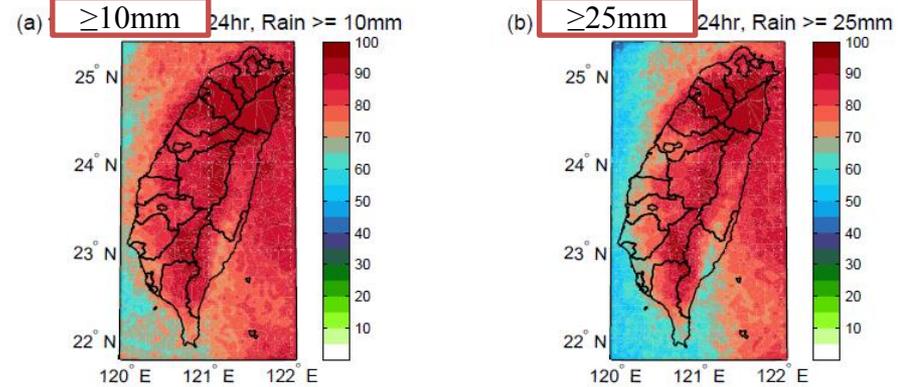
- 本研究利用 **TAPEX** (Typhoon Quantitative Precipitation Ensemble Forecast Experiment) 資料發展 **PQPF** (Probabilistic Quantitative Precipitation Forecast) 技術，並 **分析2011-2013年有發布警報之颱風個案的PQPF結果(共17個)**。
- 本研究透過 **1994-2013年之歷史颱風個案**，建立 **氣候PQPF系統**。初步結果顯示，**氣候PQPF已具有一定的預報能力**。
- 系集PQPF校驗分析顯示，TAPEX資料對於2011-2013年發布警報之颱風個案之PQPF **具有理想的預報能力**，其中 **2012、2013年的預報結果較佳**。
- 在未來，本研究亦將 **針對氣候PQPF進行校驗分析**，並與系集PQPF進行比對。此外，亦將 **嘗試不同方法協助改善目前TAPEX之PQPF技術**，如中央氣象局 **ETQPF** (Ensemble based Typhoon Quantitative Precipitation Forecast)、**統計抽樣...** 等方法。

# 抽樣法 - PQPF

蘇拉 - 2012年07月31日 0000UTC 0-24小時



蘇拉 - 2012年07月31日 0000UTC 24-48小時



**謝謝聆聽，敬請指教**

**Thank you for your listening !!**