

# 混合式定量降水預報 (Hybrid QPF) 產品之研發

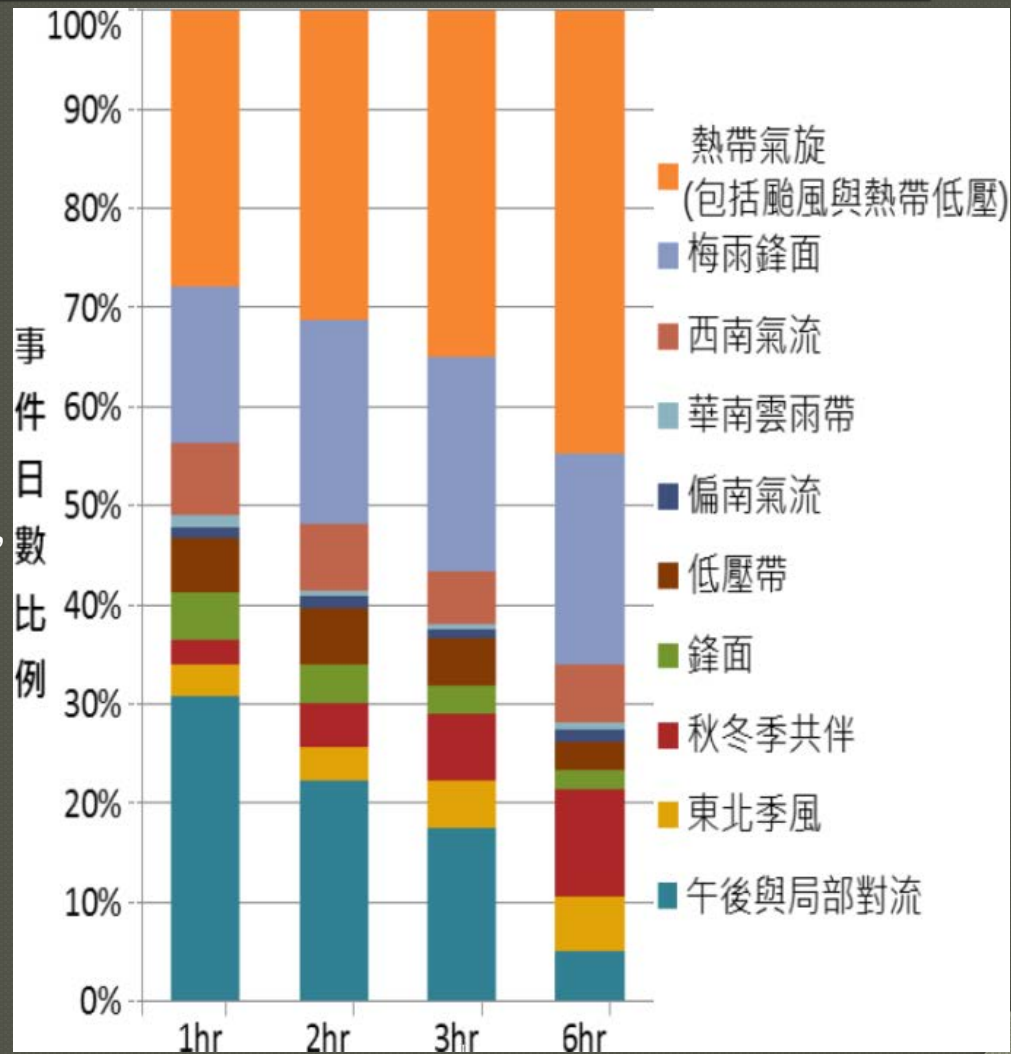
賴曉薇，洪景山  
中央氣象局資訊中心

# 前言

## - 極端降雨

### ◎NCDR極端降雨統計

- 長延時降雨
- 短延時強降雨
  - 發生日數呈上升趨勢
  - 各類型延時的極端降雨每年約13-16日
  - 1小時延時事件高鋒發生於7-8月，主要與局部對流類別有關
  - 2-6小時延時發生日數高鋒分別與梅雨鋒面與侵台颱風的高頻率有關



### ◎ 官方降水預報發展（黃等，2014）

- 降雨機率預報（1993年）
  - 定量降水預報
    - 24小時QPF：12h x2（2005年）
    - 24小時QPF：6h x4（2014年）
- 基於客觀的系集方法的主觀 QPF 預報

### ◎ 防災需求之定量降水預報技術發展

- 系集模式颱風定量降水預報ETQPF（曹和洪，2011）
- 定量降水機率預報、機率定量降水預報（黃等，2014）
- 定量降水預報逐時化提供給水利防災使用（劉等，2016）

## - 逐時定量降水預報開發

### ◎ 混合式逐時定量降水預報 (Hybrid hourly QPF，以下簡稱hQPF)

#### ➤ 目的

整合多元定量降水預報指引，發展有效的逐時定量降水預報產品，以供防災需求之用。

#### ➤ 方法

##### ➔ 氣象局0-72小時各式降水預報客觀指引

- ✓ 盤點可用預報的後設資料(Metadata)，ex. 總類、預報方法、資料解析度、預報長度、到位時間等
- ✓ 統計校驗分析：選取2017年2顯著降雨梅雨個案

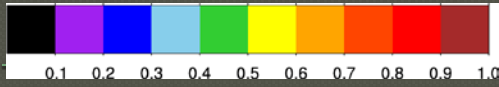
##### ➔ 降水預報客觀指引拚接

- ✓ 約束條件
- ✓ 其它考慮

# 定量降水預報客觀指引

QPF guidance	Description	Resolution	Announce frequency	Forecast length	delivery time	Data inventory	
						amount	Ex.
<b>QPEQPF</b>	雷達降雨估計外延	<b>0.0125 degree</b>	<b>10min</b>	<b>1h</b>	<b>10分</b>	<b>1</b>	<b>0</b>
<b>iTEEN</b>	利用影像辨識技術比對雷達觀測回波vs系集成員預報	<b>0.0125 degree</b>	<b>Hourly</b>	<b>6h</b>	<b>22分</b>	<b>6</b>	0 -1 ... -5
<b>RWRF</b>	快速更新雷達資料同化的高解析度WRF預報	<b>2 km</b>	<b>Hourly</b>	<b>12h</b>	<b>40分</b>	<b>12</b>	0 -1 ... -11
<b>WRFD</b>	氣象局區域預報模式決定性預報	<b>15/3 km</b>	<b>4/day</b>	<b>84h</b>	<b>6-7小時</b>	<b>11</b>	-6 (~ -11) -12 (~ -17) ... -78 (~ -83)
<b>TWRF</b>	與WRFD類似，但針對颱風預報進行調校	<b>15/3 km</b>	<b>4/day</b>	<b>84h</b>	<b>6-7小時</b>	<b>11</b>	
<b>WEPS-PM</b>	20組WRF成員的系集預報的的機率擬合平均	<b>45/15/5 km</b>	<b>4/day</b>	<b>72h</b>	<b>8小時</b>	<b>10</b>	-12 (~ -17) -18 (~ -23) ... -66 (~ -71)
<b>ETQPF</b>	以氣候統計法架構，使用系集預報降雨+颱風官方預報路徑重組颱風降雨預報	<b>0.0125 degree</b>	<b>8/day</b> (颱風警報發布期間)	<b>72h</b>	<b>官方颱風路徑更新後</b>		

# 定量降水預報客觀指引 校驗得分綜覽(1)

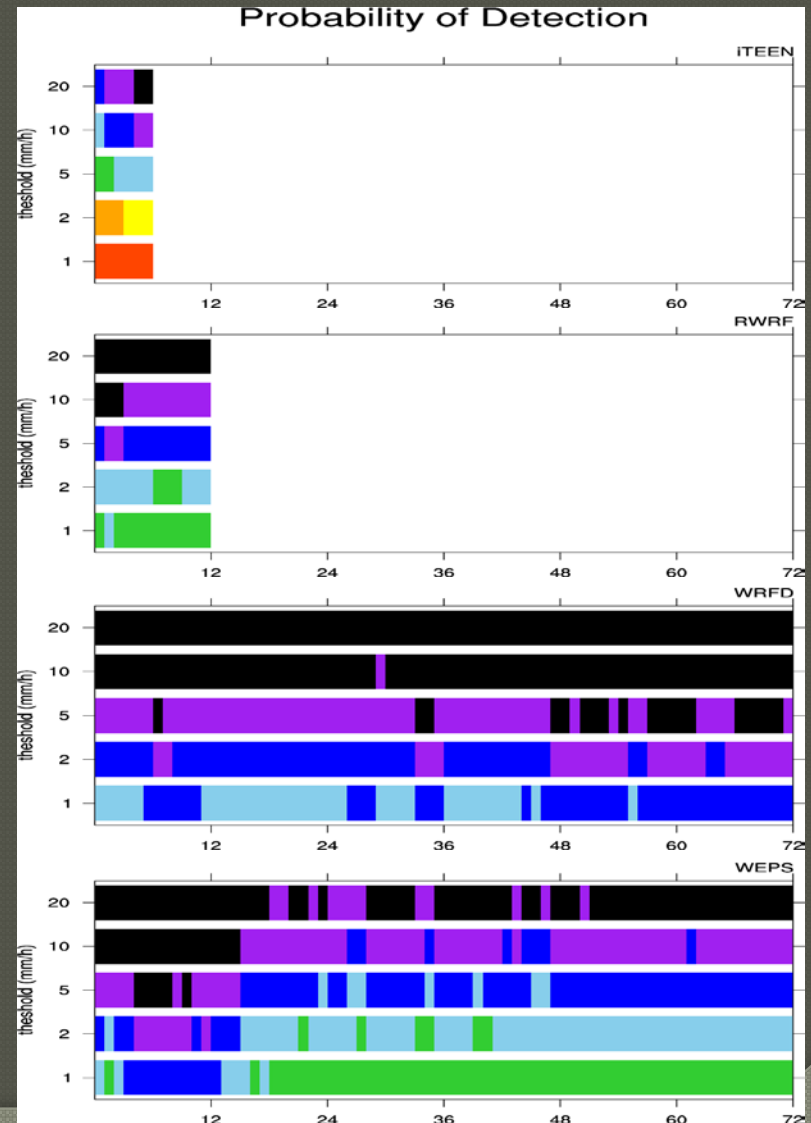
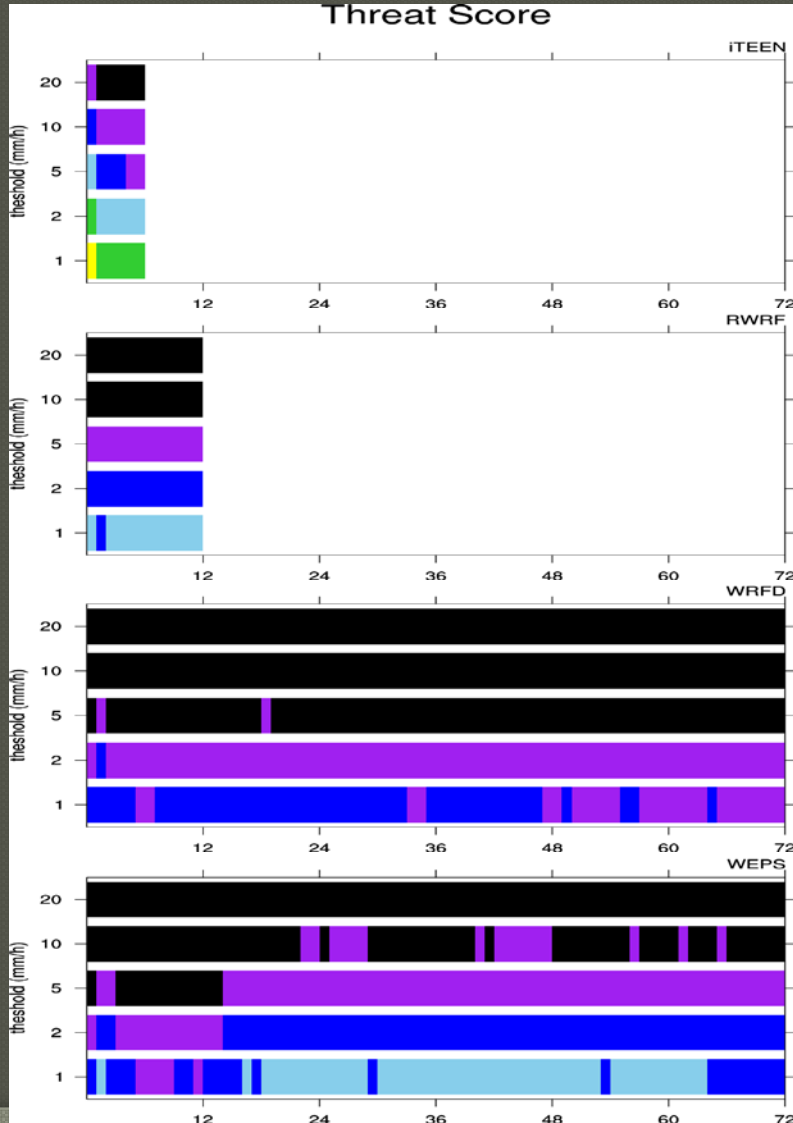


iTEEN

RWRF

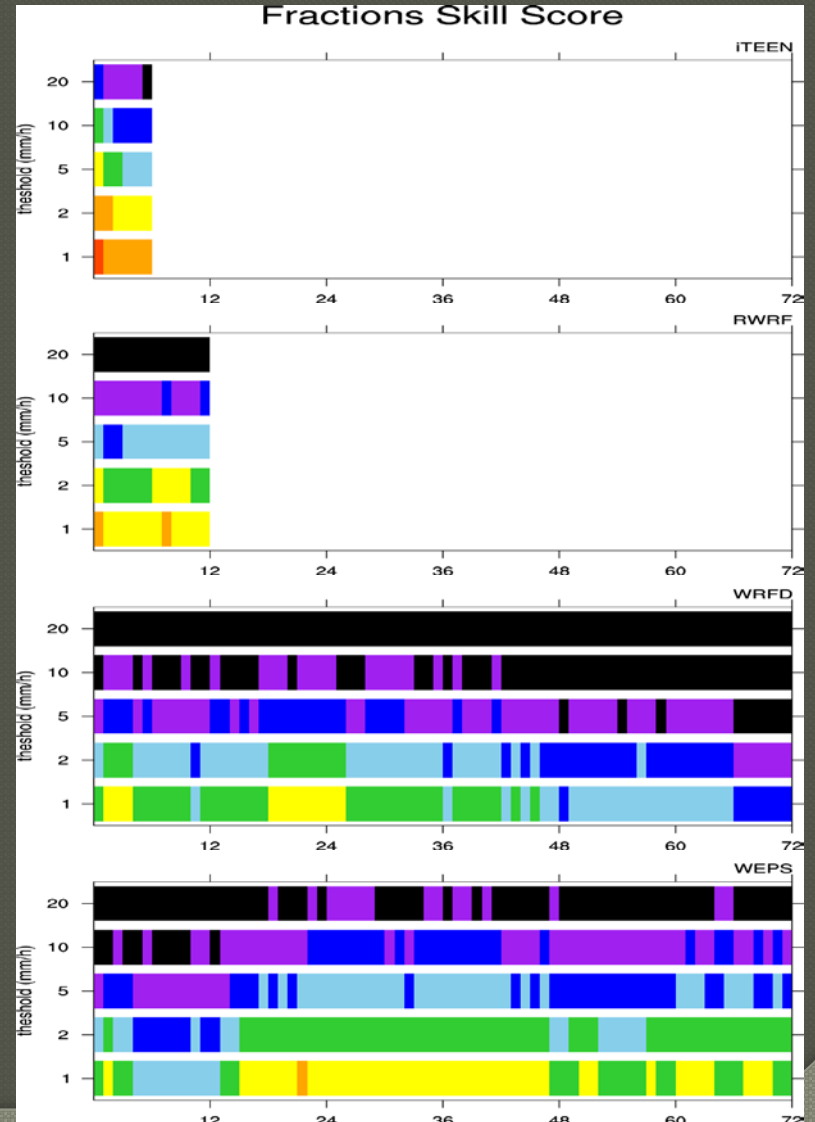
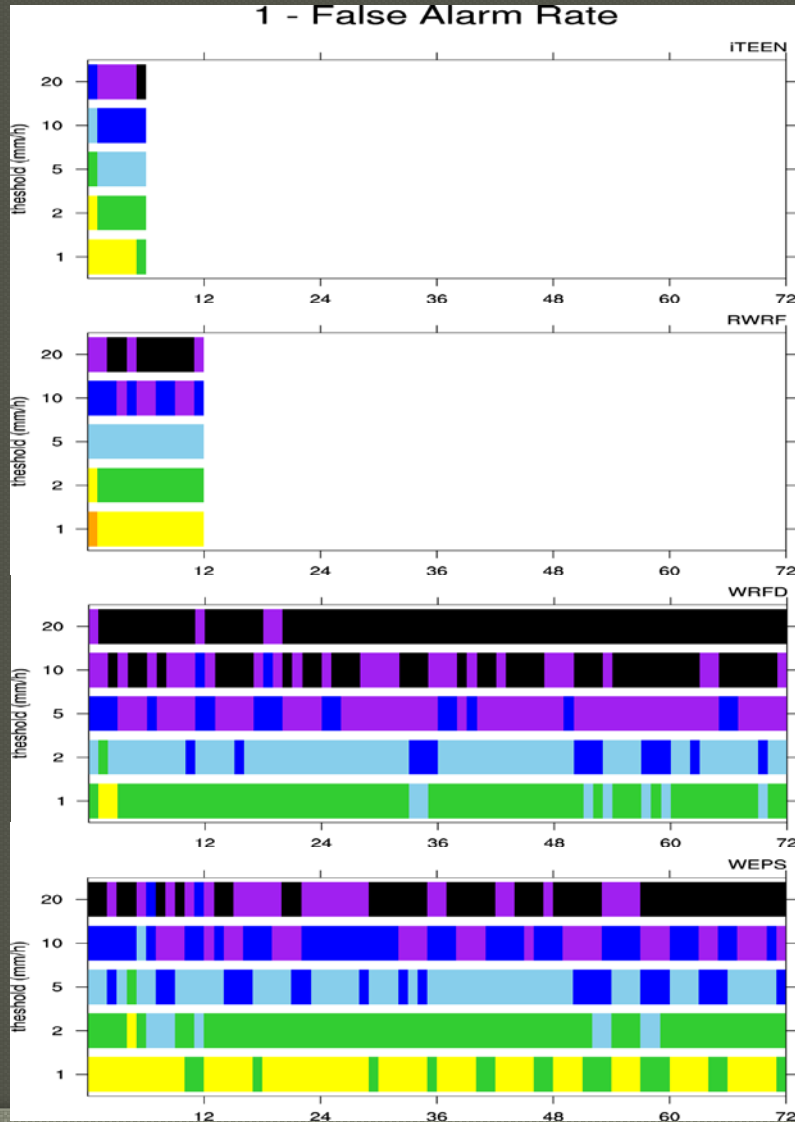
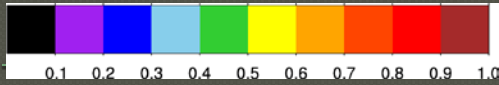
WRFD

WEPS



# 定量降水預報客觀指引

## 校驗得分綜覽(2)



iTEEN

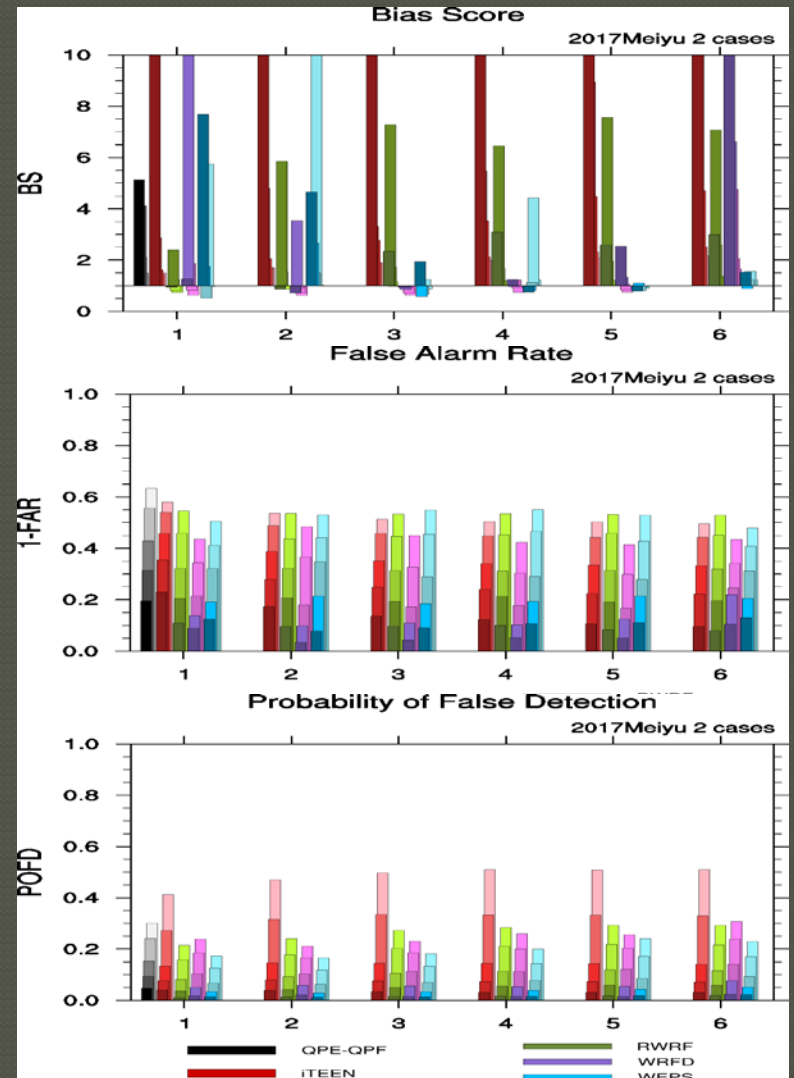
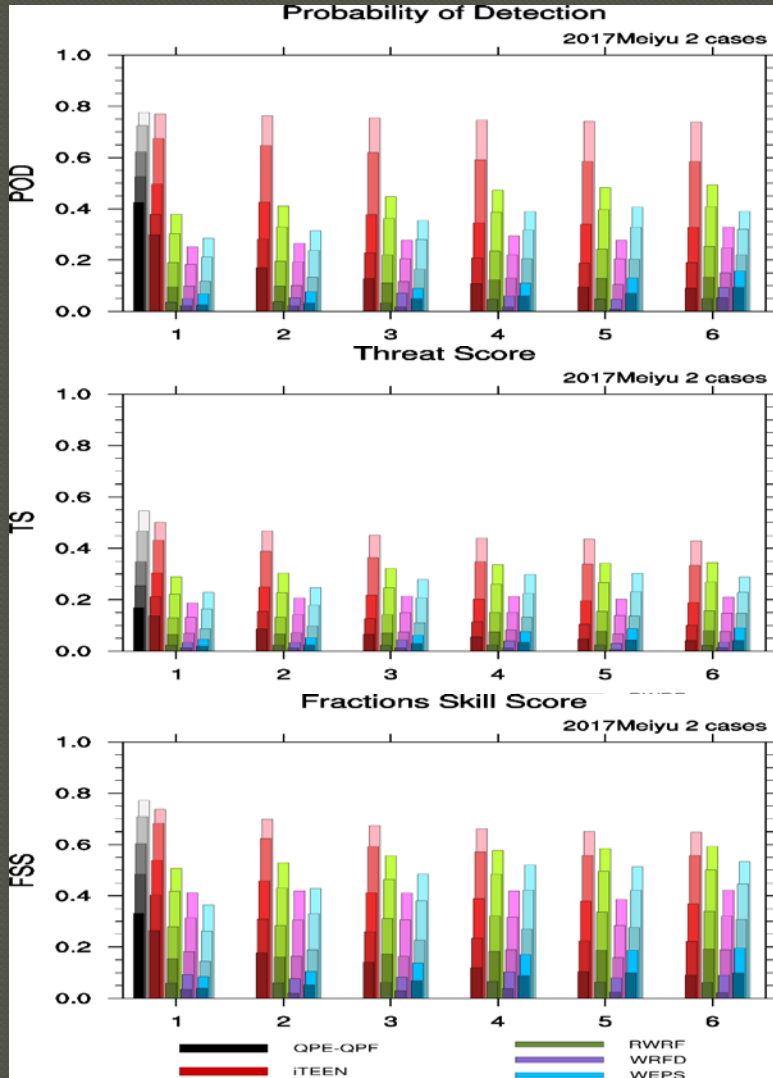
RWRF

WRFD

WEPS

# 定量降水預報客觀指引

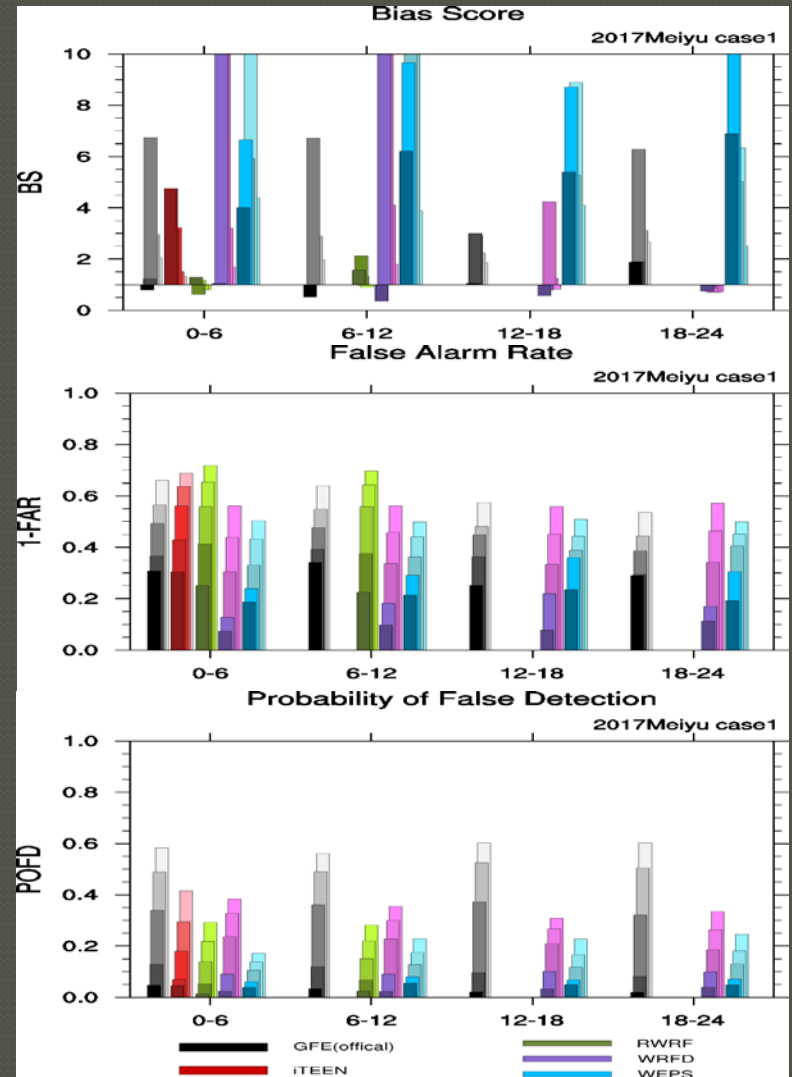
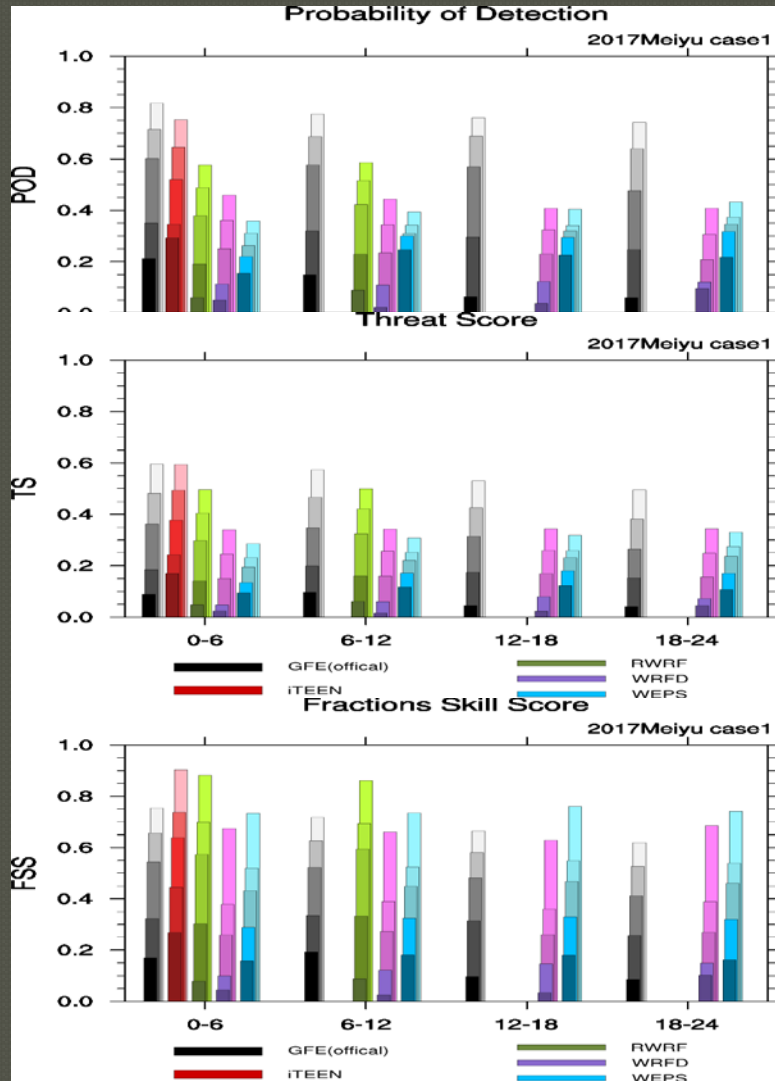
## 1-6小時逐時校驗得分





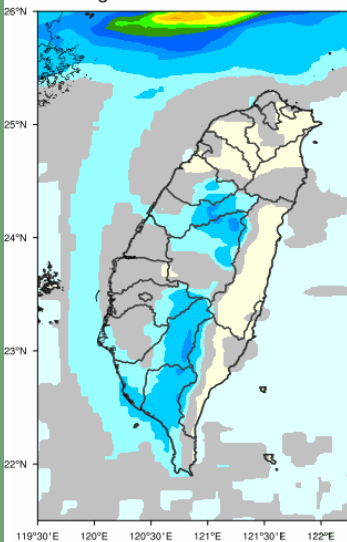
# 定量降水預報客觀指引

## - 相較於官方預報case



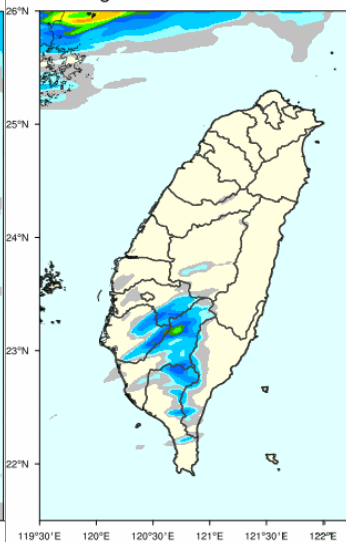
# iTEEN

Accu. 1-hrs rainfall  
Initial at 17060112  
Valid at 17060112-17060113  
Fct length 00-01h



# RWRF

Accu. 1-hrs rainfall  
Initial at 17060111  
Valid at 17060112-17060113  
Fct length 01-02h



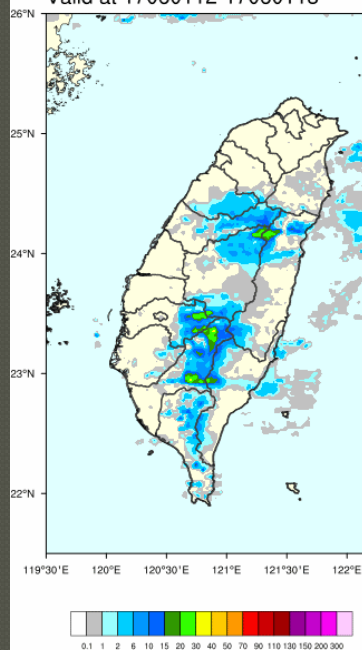
# Nowcasting

- iTEEN(0-6)
- RWRF(1-7)

## - 相較於官方預報case

# QPESUMS

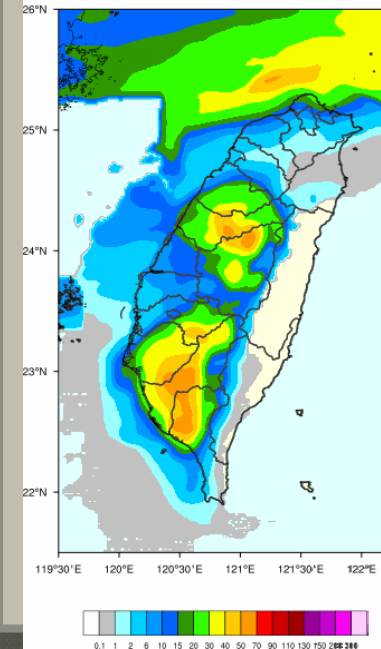
Accu. 1-hrs rainfall  
Valid at 17060112-17060113



# Official QPF

## GFE

Accu. 6-hrs rainfall  
Valid at 17060112-17060118

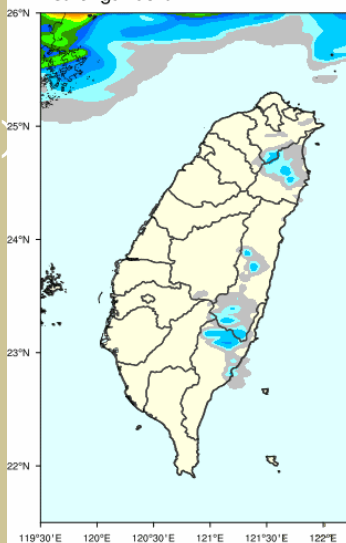


# High-resolution forecasting

- WRFD(6-12)
- WEPS(12-18)

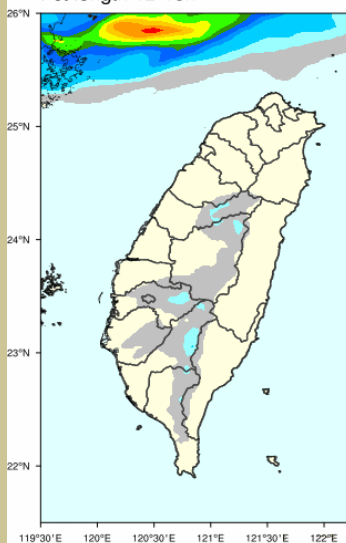
# WRFD

Accu. 1-hrs rainfall  
Initial at 17060106  
Valid at 17060112-17060113  
Fct length 06-07h



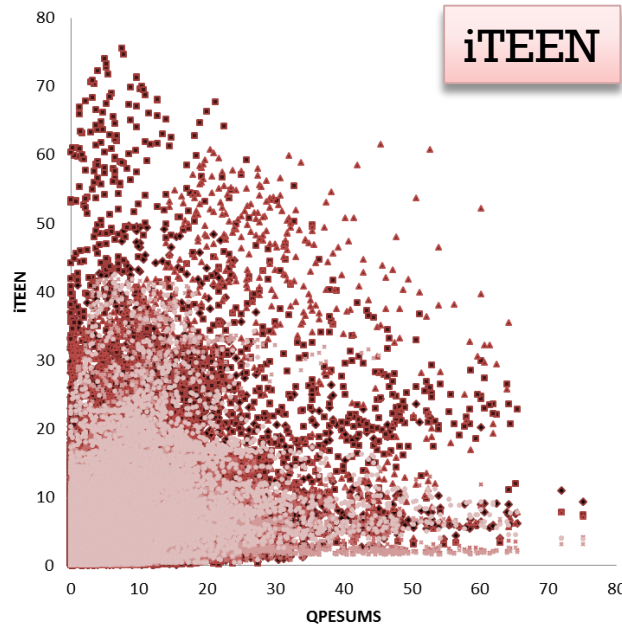
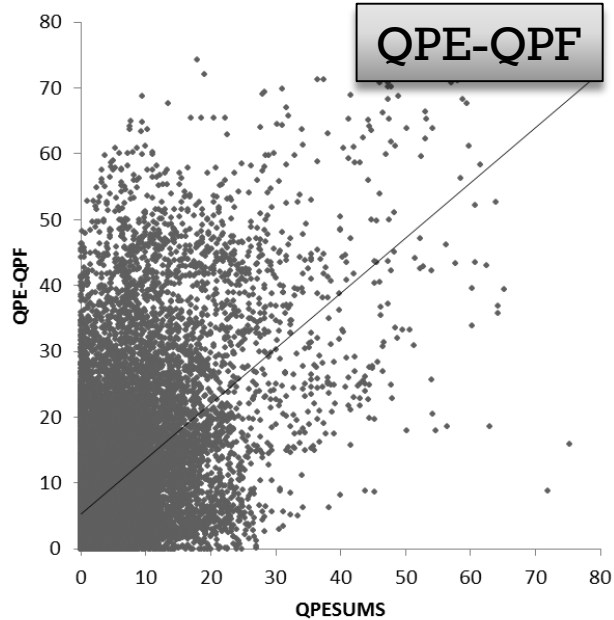
# WEPS

Accu. 1-hrs rainfall  
Initial at 17060100  
Valid at 17060112-17060113  
Fct length 12-13h



# 1小時累積雨量QPESUMS

## vs. QPF



校驗時間: 2017 0603 0100Z

預報時間(tau)

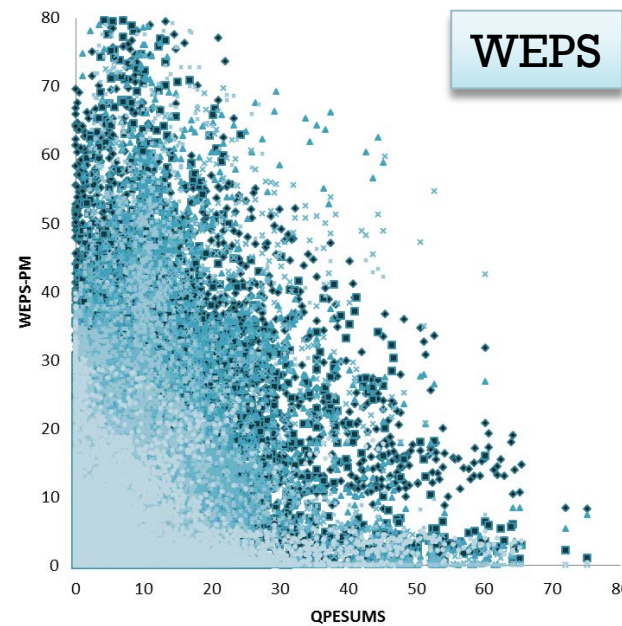
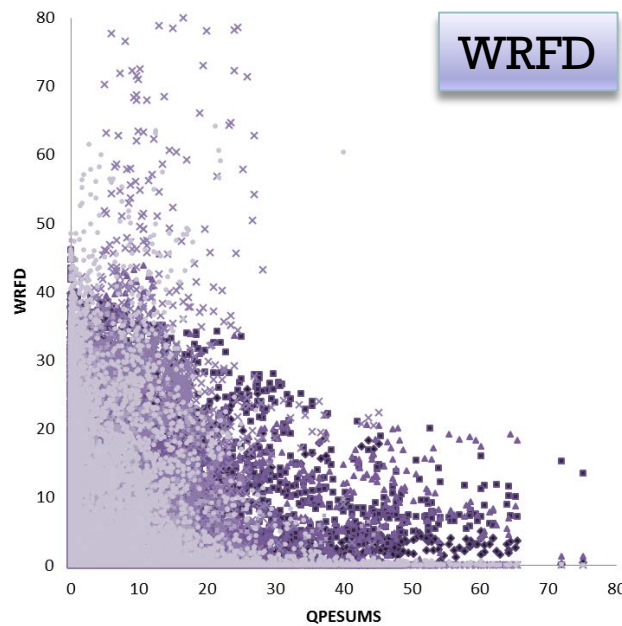
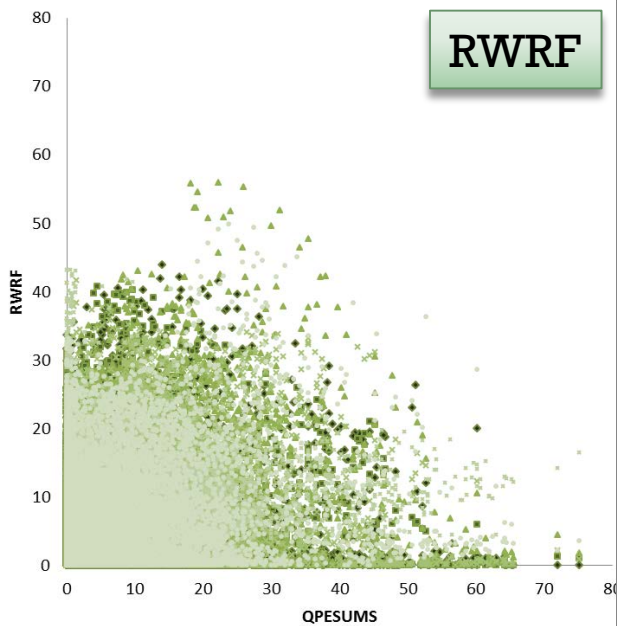
QPEQPF: 1

iTEEN: 1, 2, 3, 4, 5, 6

RWRF: 2, 4, 6, 8, 10, 12

WRFD: 7, 13, 19, 25, 31, 37

WEPS: 13, 19, 25, 31, 37, 43



# 逐時混合式定量降水預報拼接

## 1. 考慮各客觀指引資料的可用性 (到位時間)

Ex 00:30

Issue Time	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
QPEQPF					0	1																								
iTEEN					0	1	2	3	4	5	6																			
RWRF				0	1	2	3	4	5	6	7	8	9	10	11	12														
WRFD		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
WEPS		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

## 2. 選取綜合校驗指數較高的指引做為拼接資料

## 3. 以官方預報0-24 h GFE做為調整總量的約束條件

Issue Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
QPEQPF	0	1																																					
iTEEN	1	2	3	4	5	6																																	
RWRF	1	2	3	4	5	6	7	8	9	10	11	12																											
WRFD	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42		
WEPS	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48		

## 4. 不同指引接縫的平滑處理

Issue Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
QPEQPF	0	1																																					
iTEEN	1	2	3	4	5	6																																	
RWRF	1	2	3	4	5	6	7	8	9	10	11	12																											
WRFD	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42		
WEPS	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48		

# 應用上的建議

WRFD

1-h accumulation

6-h accumulation

WEPS

1-h accumulation

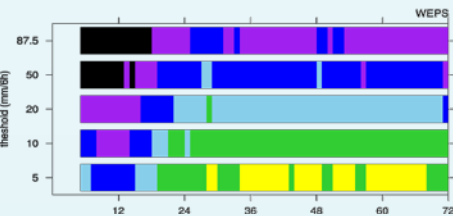
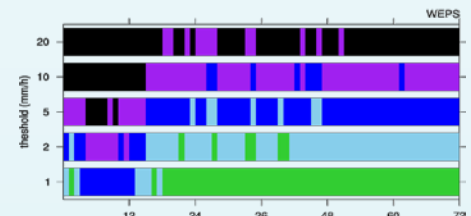
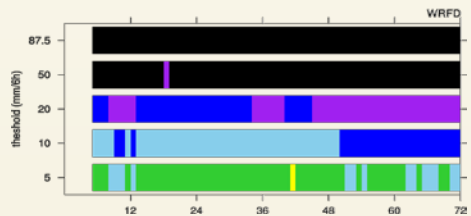
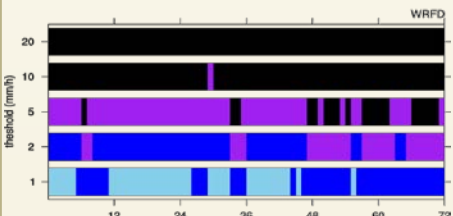
6-h accumulation.

Probability of Detection

Probability of Detection

Probability of Detection

Probability of Detection

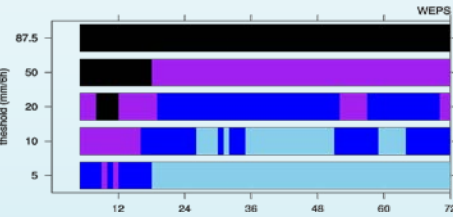
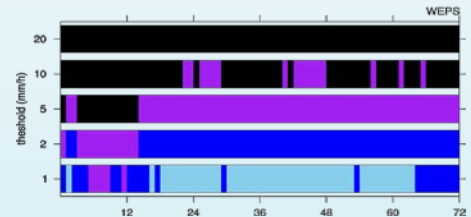
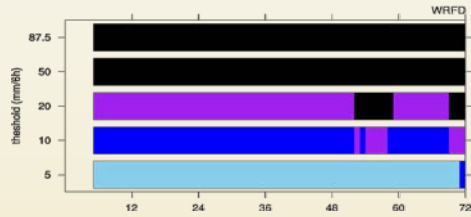
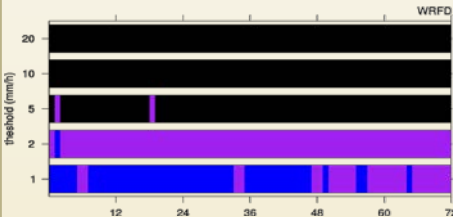


Threat Score

Threat Score

Threat Score

Threat Score

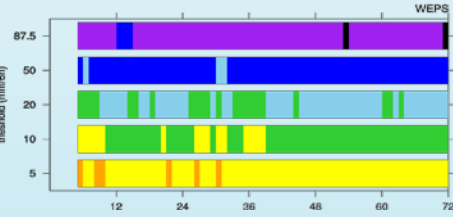
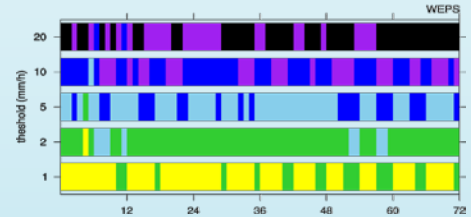
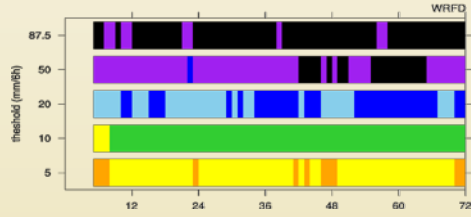
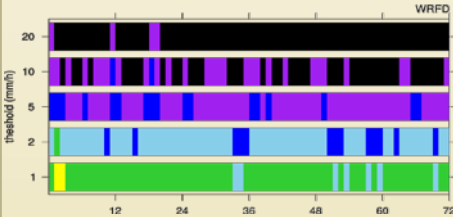


1 - False Alarm Rate

1 - False Alarm Rate

1 - False Alarm Rate

1 - False Alarm Rate

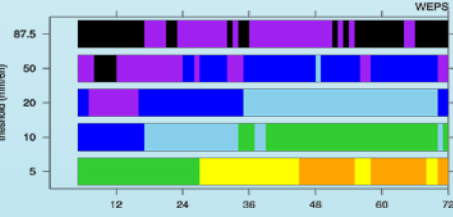
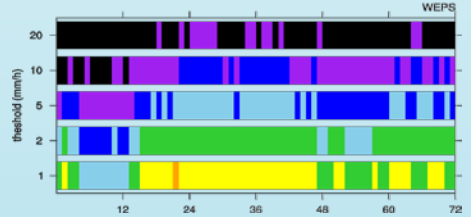
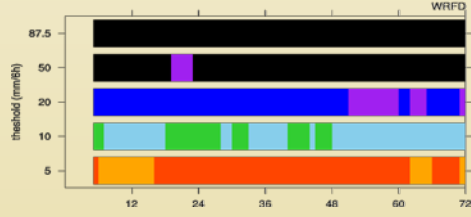
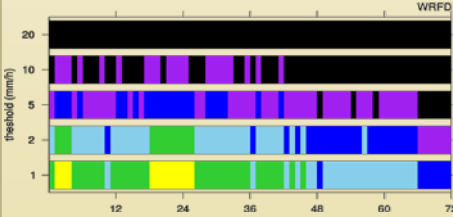


Fractions Skill Score

Fractions Skill Score

Fractions Skill Score

Fractions Skill Score



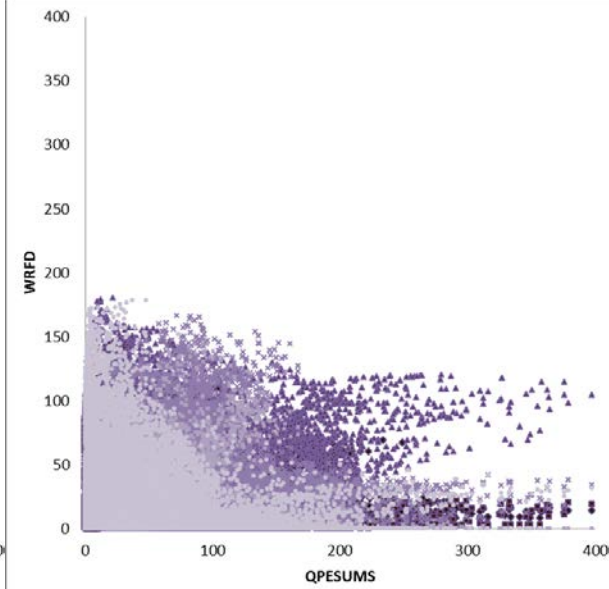
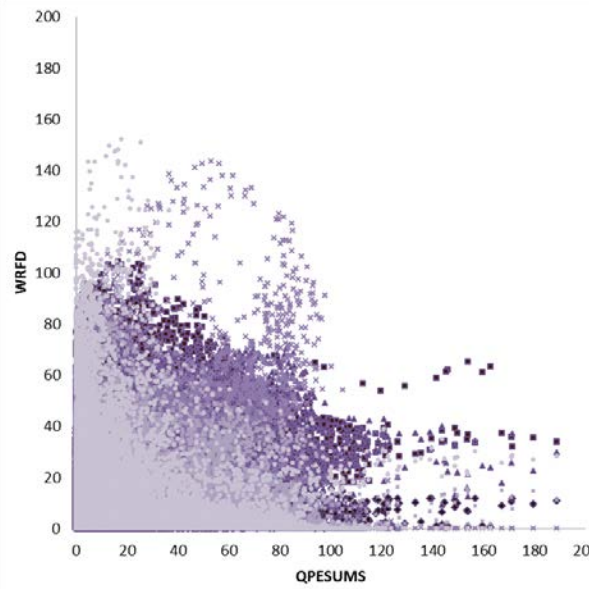
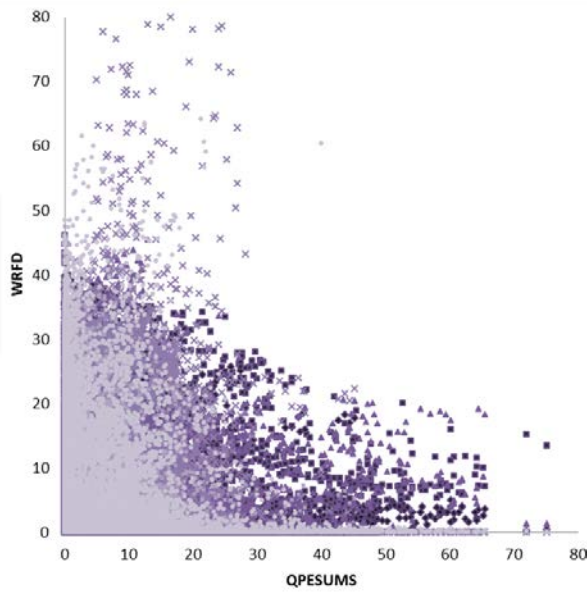
# 應用上的建議

1小時累積雨量

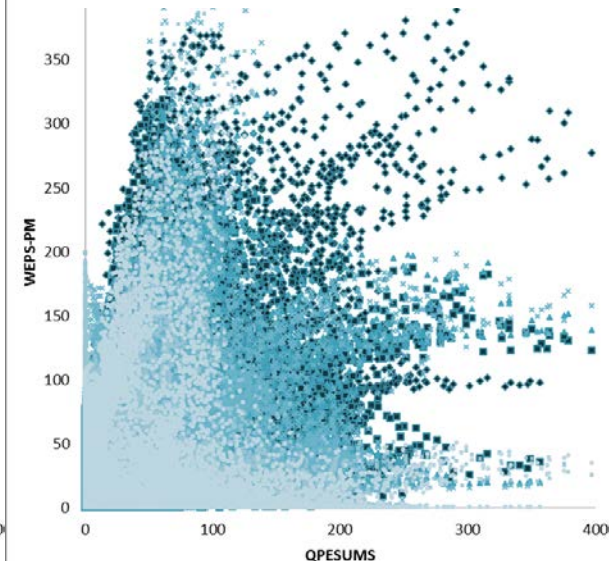
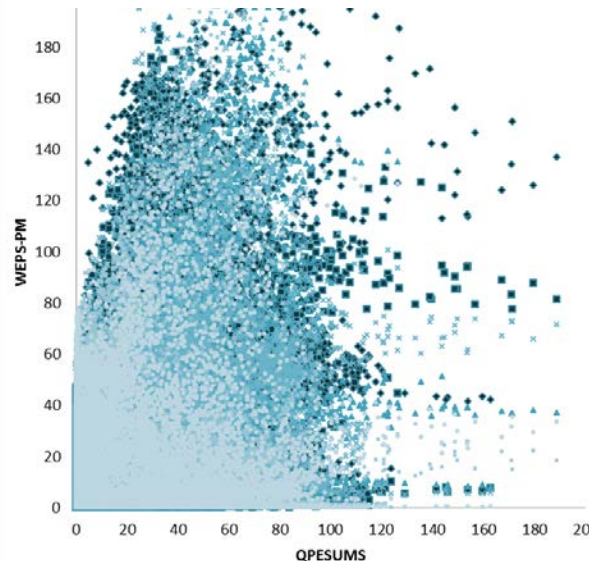
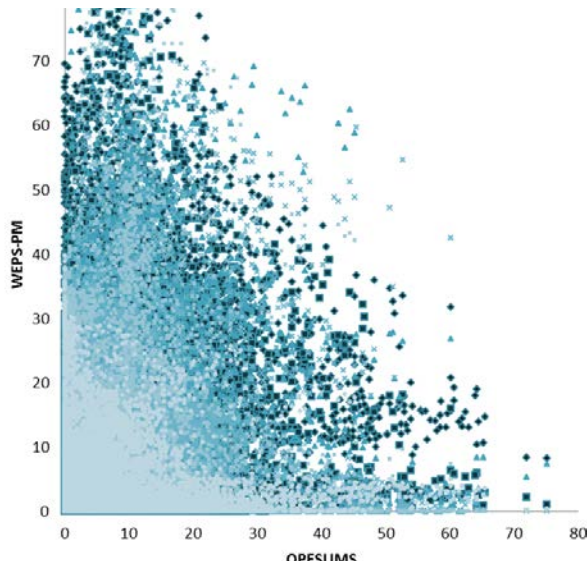
3小時累積雨量

6小時累積雨量

WRFD



WEPS



# 總結

- ◎ 定量降水預報客觀指引的統計特性
- ◎ 逐時混合式定量降水預報拼接
  - 考慮各客觀指引的可用性（到位時間）
  - 以官方預報0-24 h GFE做為調整的約束條件
  - 其它考慮：
    - 不同預報指引拼接時的平滑過程
    - 24~72h 拼接策略：PM總量為約束條件，WRFD趨勢
    - 拼圖策略調整的機動性
- ◎ 應用上的建議  
考慮天氣系統的可預報度及校驗可信度，ex.
  - 0 - 6h: 對流尺度天氣 → 1小時累積QPF
  - 6 -24h: 中尺度天氣 → 3小時累積QPF
  - 24-72h: 綜觀尺度天氣 → 6小時累積QPF