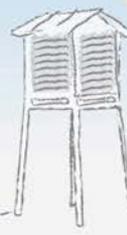




# STMAS-WRF 定量降水預報評估

王溫和 張惠玲 方偉庭 陳嘉榮

中央氣象局 氣象衛星中心



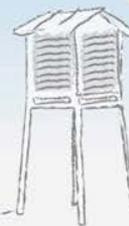
生活有氣象

# STMAS-WRF



**STMAS** (Space and Time Multiscale Analysis System)  
資料同化系統

極短期 ( 0-6 hr : 0-3 hr 、 3-6 hr ) QPF預報系統



生活有氣象

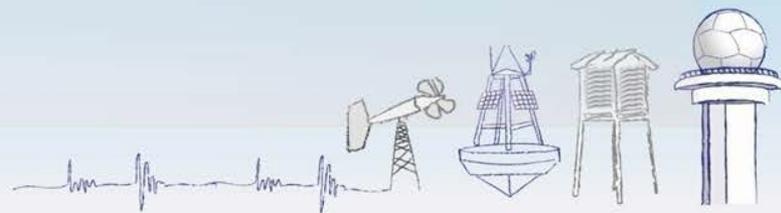
# 大綱



- ✚ 研究動機、系統特性
- ✚ 現行作業狀況
- ✚ 校驗成績與個案分析
- ✚ 小結與展望

Weather<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# ● 研究動機

使用者(預報人員、防災單位)，瞭解STMAS-WRF  
相關預報產品特性，作為0-6小時QPF預報指引。  
→ 提高VSTQPF準確度，提前因應措施，以達  
避災、減災目的。



From [tw.yahoo.com](http://tw.yahoo.com)

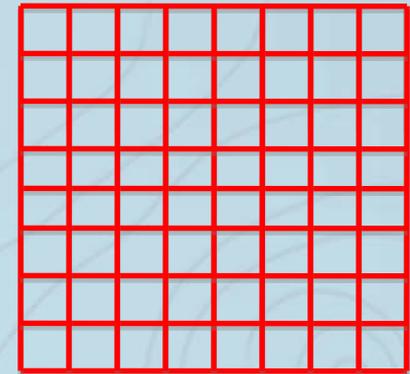
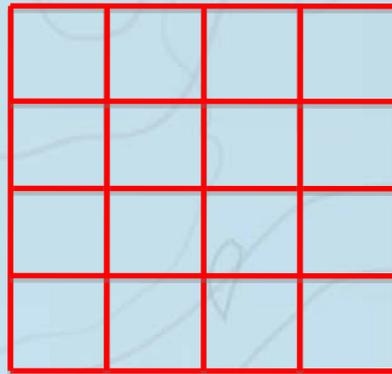
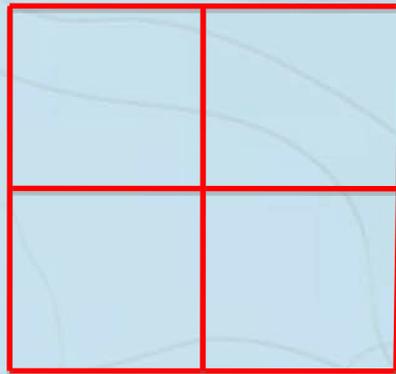
# ● STMAS 特性(一):採多重網格



## Multi-grid analysis system

Long waves

Short waves



Constrain : **GE**

**QG**

**non-div**

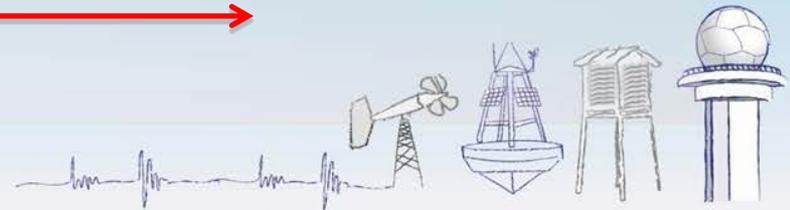
**Sequence** of 3-4DVARs with proper balances

Similar to LAPS analysis with less requirement of covariance

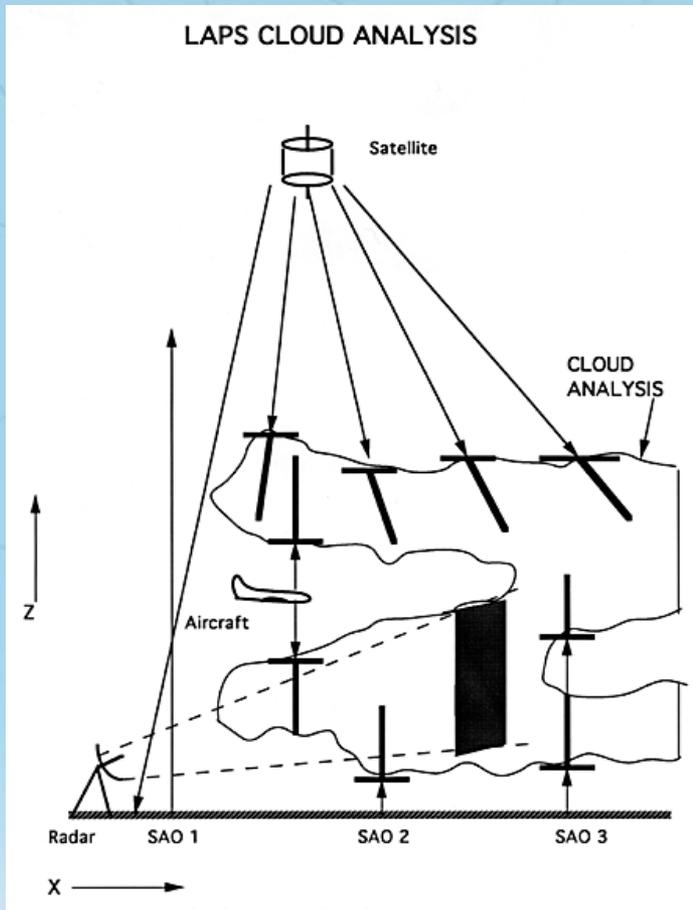
From OAR/ESRL/GSD/Forecast  
Applications Branch

*Weather*

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# ● STMAS 特性(二): 具雲分析能力



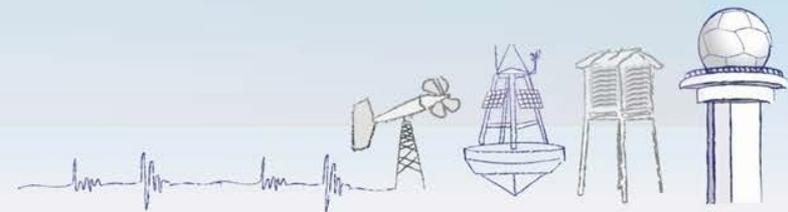
From OAR/ESRL/GSD/Forecast Applications Branch

結合數值模式預報、  
衛星資料、雷達資料、  
飛機報告、地面觀測，  
→ 反演降水粒子，而  
使模式在初始時，既有雨、  
雪、冰雹及雲水、雲冰等  
資訊。(hot start)

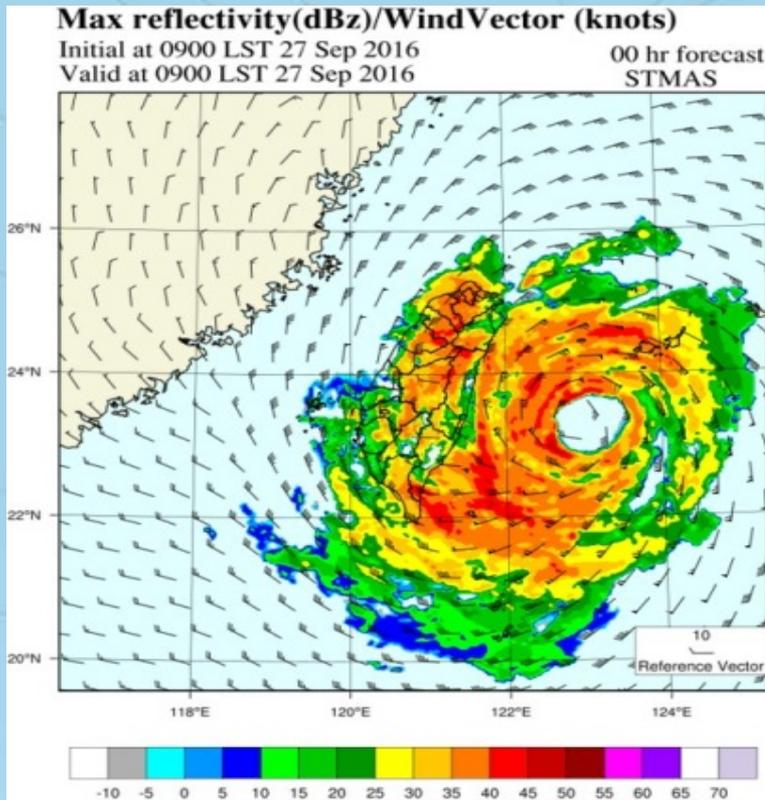
→ 提高0-6 hr QPF可靠性

Weather<sup>+</sup>

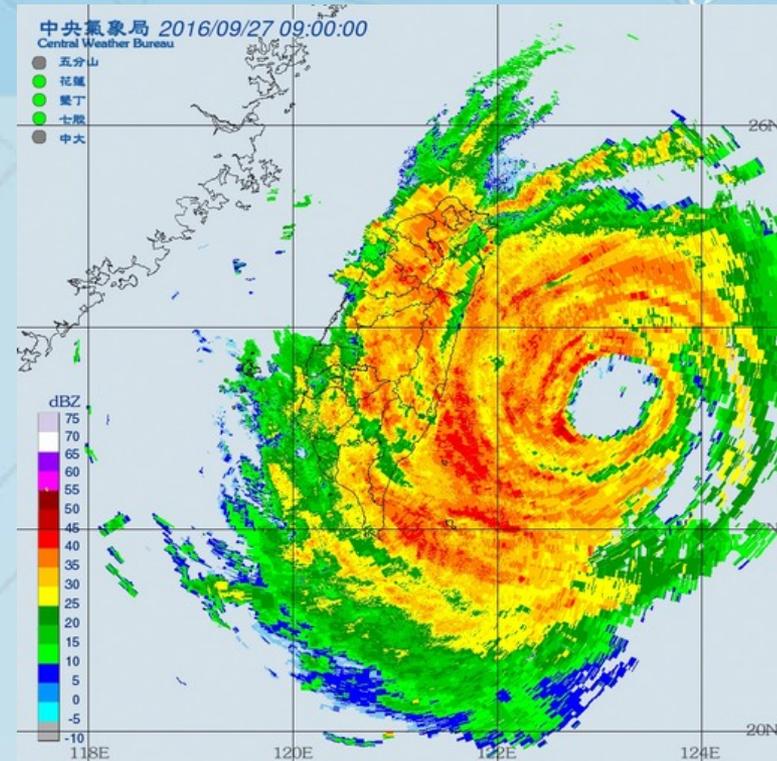
Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# Model Initial CV



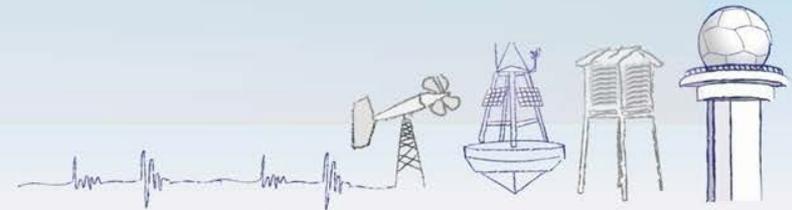
# Obs CV



雲分析 降水粒子所反演之雷達回波

Weather<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# ● 現行作業狀況：

## 逐時進行預報



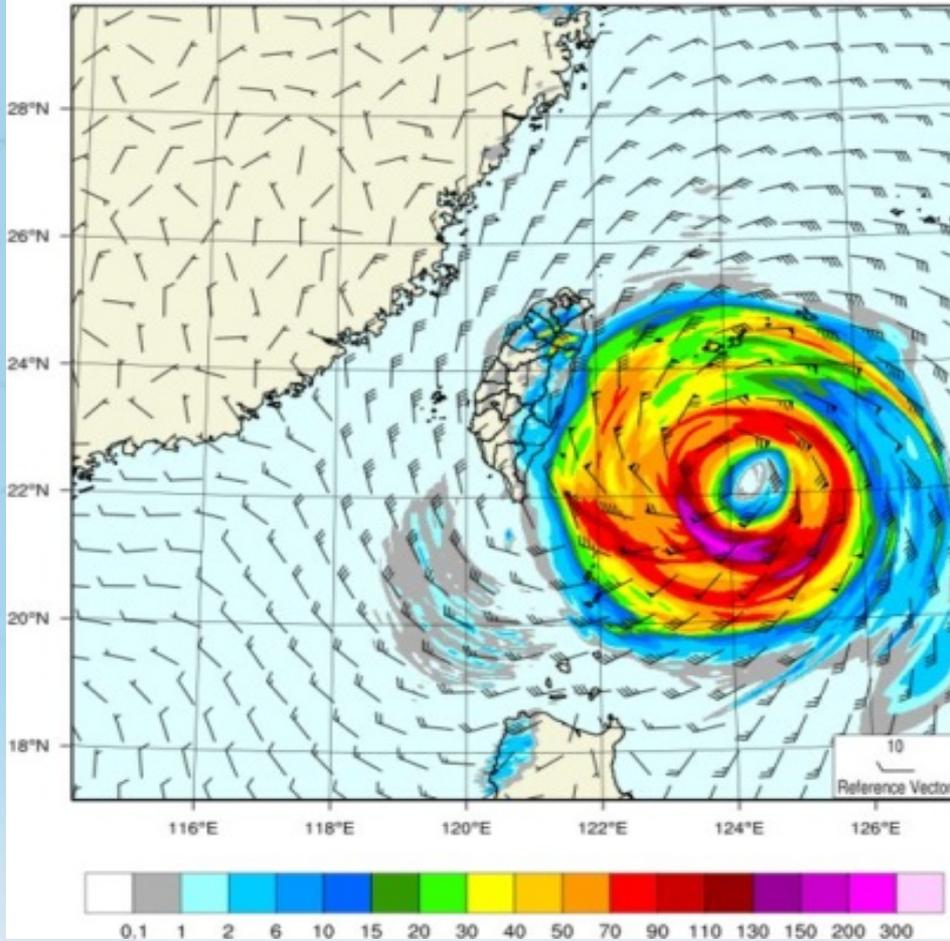
6-HR Accu.Rainfall(mm) / Wind Vector(knots)

Initial at 2100 LST 26 Sep 2016

00-06 hr forecast

Valid at 2016092621-2016092703 LST

STMAS



### ☀ 1. 決定性預報

STMAS-WRF 3KM

STMAS(449 \*449\*43)

WRF (449\*449\*51)

### ☀ 2. 系集預報

STMAS- WRF /PM 9KM

系集平均 (Ensemble Mean)

機率擬合平均

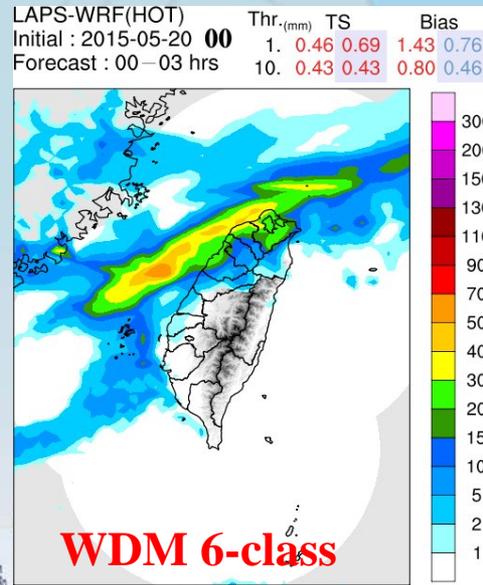
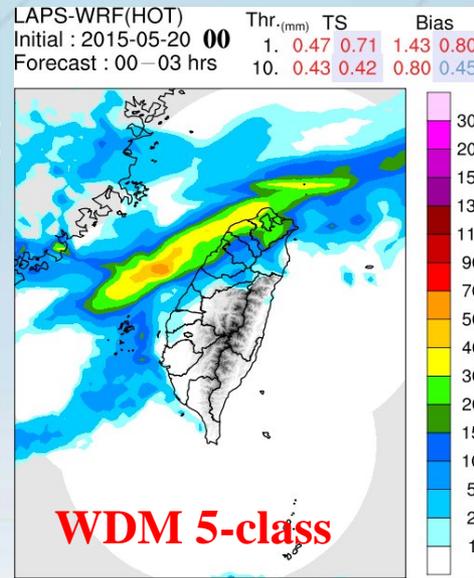
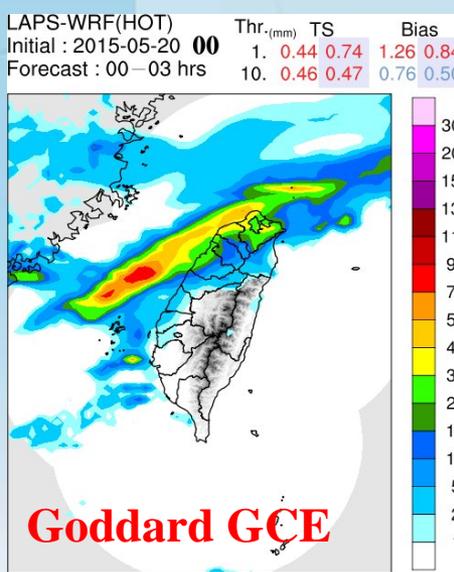
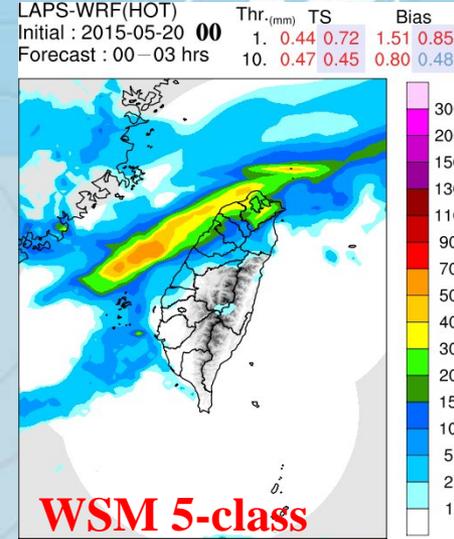
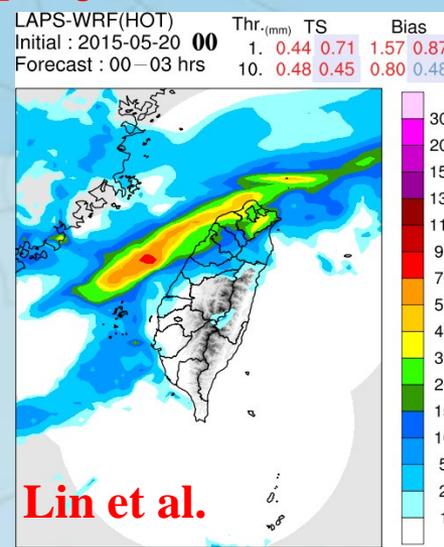
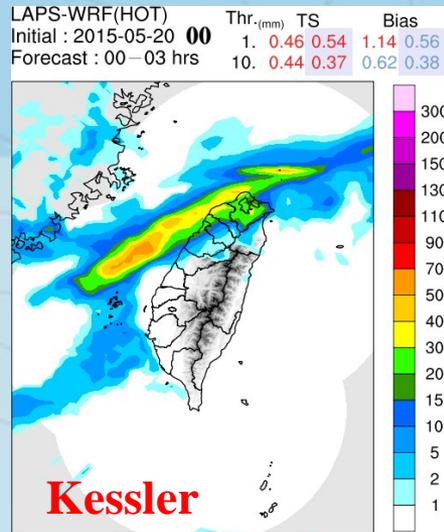
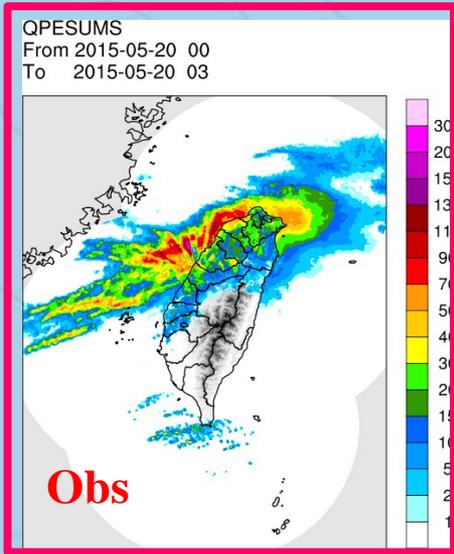
(PM, Probability matched Mean)

Weather<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



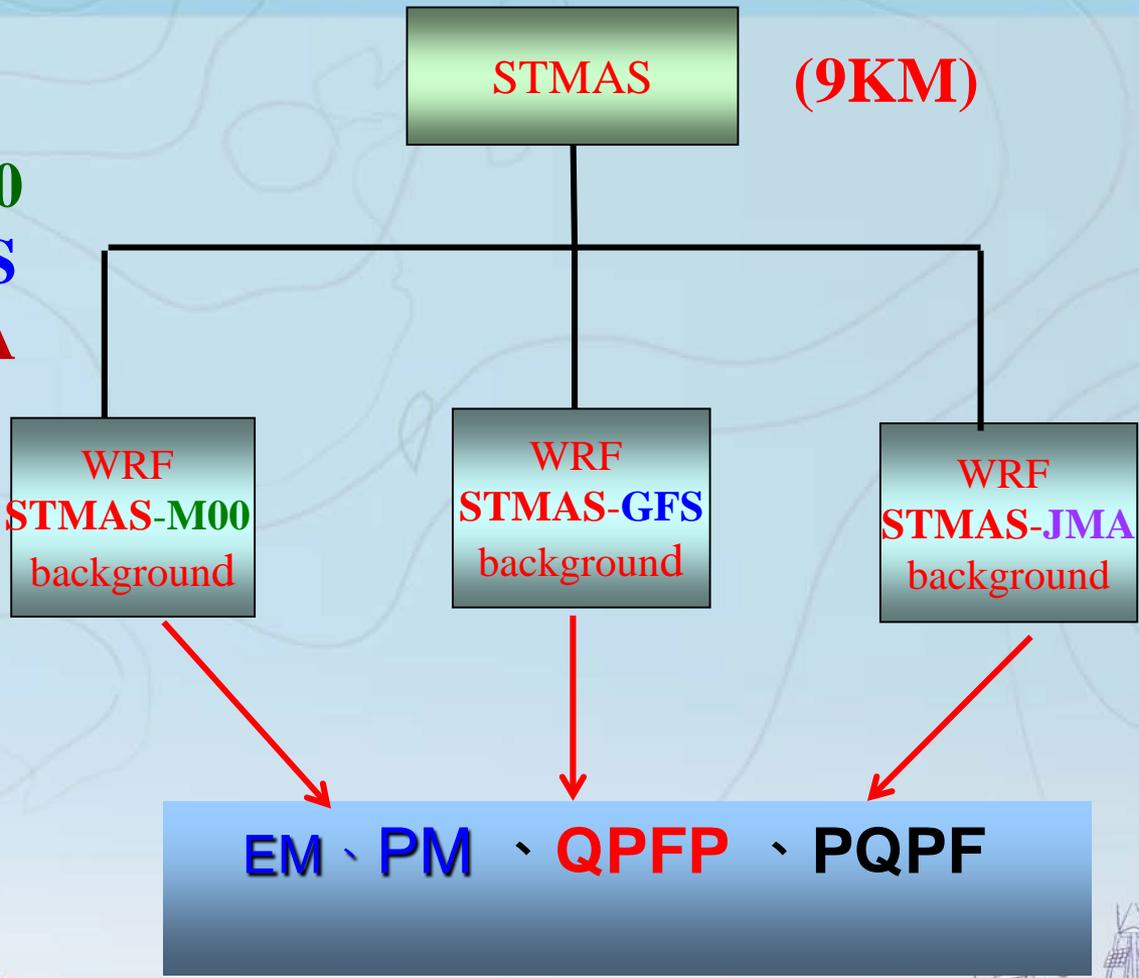
# 測試不同微物理(microphysics): 0-3hr QPF



*Weather*

# 系集預報設計 → STMAS 採不同background model

CWB WRF: M00  
NCEP GFS: GFS  
JMA GSM: JMA

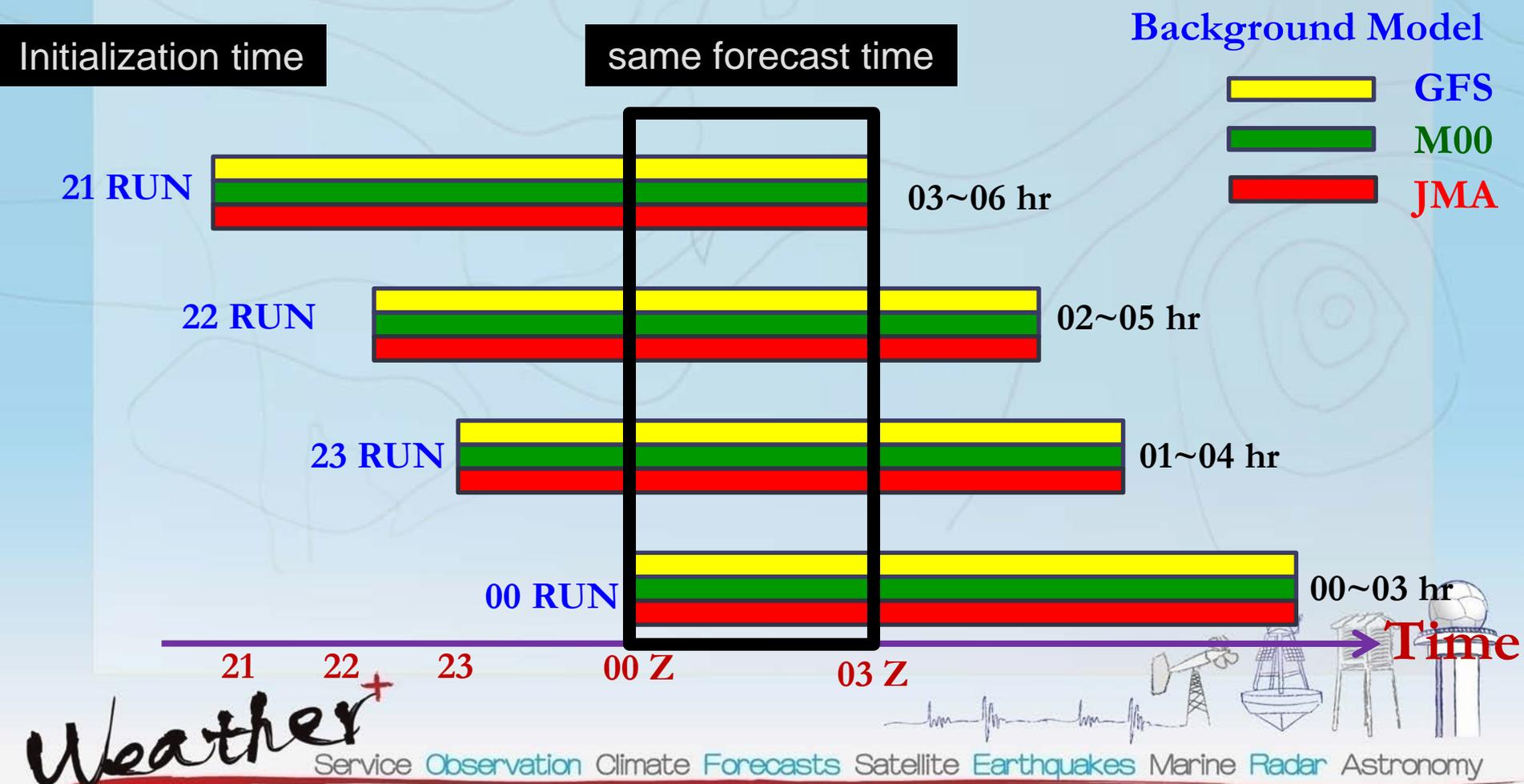


*Weather*<sup>+</sup>



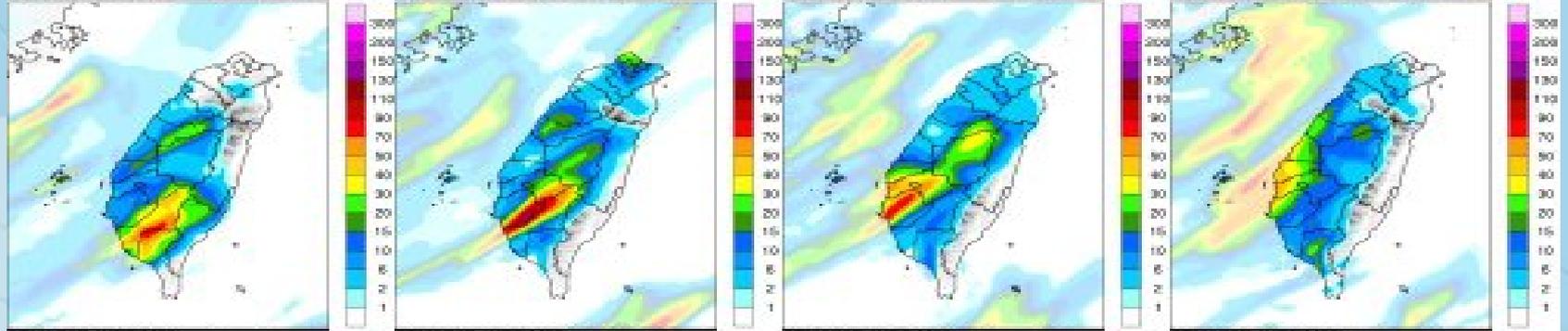
增加預報成員：4 Diff init. \* 3 Bg. model = 12

Time-lagged：在不增加電腦資源下，增加系集成員  
→ 結合前幾報預報結果

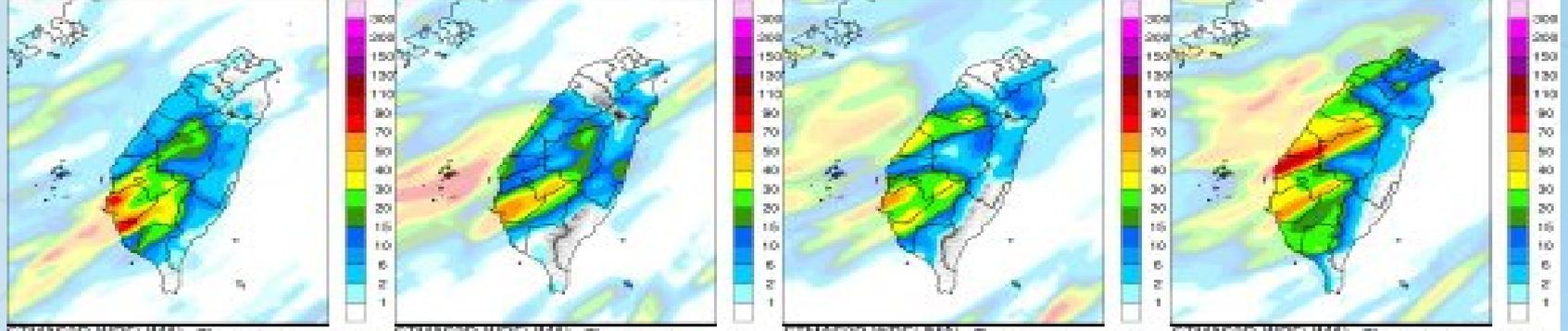


**06Run: 0-3hr**   **05Run: 1-4hr**   **04Run: 2-5hr**   **03Run: 3-6hr**

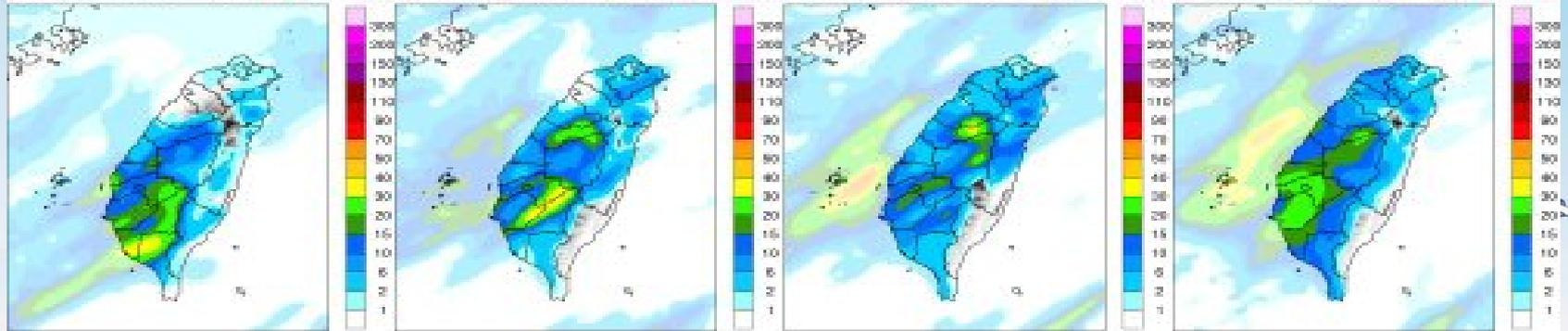
| STMAS3D-WRF(GFS)       | Th <sub>max</sub> TS | Bias      |
|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|
| Initial: 2015-06-12 06 | 1. 0.50 0.74         | 1.20 1.03 | Initial: 2015-06-12 05 | 1. 0.50 0.71         | 1.50 1.11 | Initial: 2015-06-12 04 | 1. 0.47 0.73         | 1.07 1.54 | Initial: 2015-06-12 03 | 1. 0.44 0.74         | 1.20 1.03 |
| Forecast: 00-03 hrs    | 10. 0.10 0.40        | 0.02 1.20 | Forecast: 01-04 hrs    | 10. 0.10 0.44        | 0.30 1.54 | Forecast: 02-05 hrs    | 10. 0.00 0.30        | 0.31 1.55 | Forecast: 03-06 hrs    | 10. 0.00 0.30        | 0.10 1.57 |



| STMAS3D-WRF(MR9)       | Th <sub>max</sub> TS | Bias      |
|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|
| Initial: 2015-06-12 06 | 1. 0.40 0.70         | 1.20 1.03 | Initial: 2015-06-12 05 | 1. 0.30 0.60         | 1.37 1.01 | Initial: 2015-06-12 04 | 1. 0.40 0.70         | 1.50 1.05 | Initial: 2015-06-12 03 | 1. 0.50 0.70         | 1.03 1.25 |
| Forecast: 00-03 hrs    | 10. 0.10 0.40        | 0.05 1.20 | Forecast: 01-04 hrs    | 10. 0.00 0.30        | 0.50 1.20 | Forecast: 02-05 hrs    | 10. 0.00 0.30        | 0.11 1.20 | Forecast: 03-06 hrs    | 10. 0.11 0.30        | 0.05 1.20 |



| STMAS3D-WRF(JMA)       | Th <sub>max</sub> TS | Bias      |
|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|------------------------|----------------------|-----------|
| Initial: 2015-06-12 06 | 1. 0.40 0.67         | 1.20 1.03 | Initial: 2015-06-12 05 | 1. 0.30 0.70         | 1.40 1.14 | Initial: 2015-06-12 04 | 1. 0.40 0.74         | 1.50 1.10 | Initial: 2015-06-12 03 | 1. 0.40 0.74         | 1.40 1.22 |
| Forecast: 00-03 hrs    | 10. 0.10 0.40        | 0.01 1.00 | Forecast: 01-04 hrs    | 10. 0.10 0.30        | 0.10 0.80 | Forecast: 02-05 hrs    | 10. 0.00 0.30        | 4.51 0.80 | Forecast: 03-06 hrs    | 10. 0.11 0.30        | 0.00 1.52 |



**GFS**



**MR9**

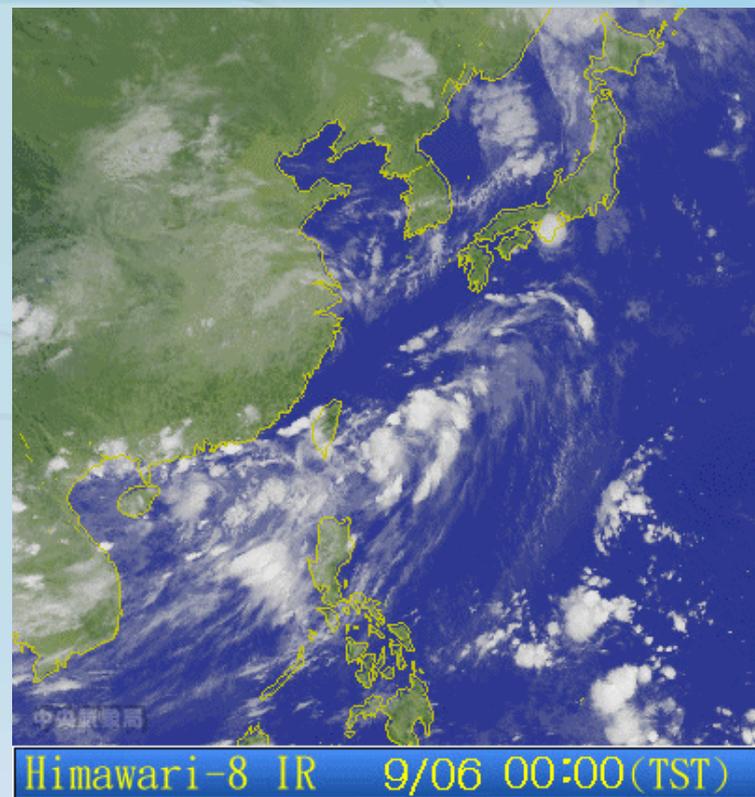
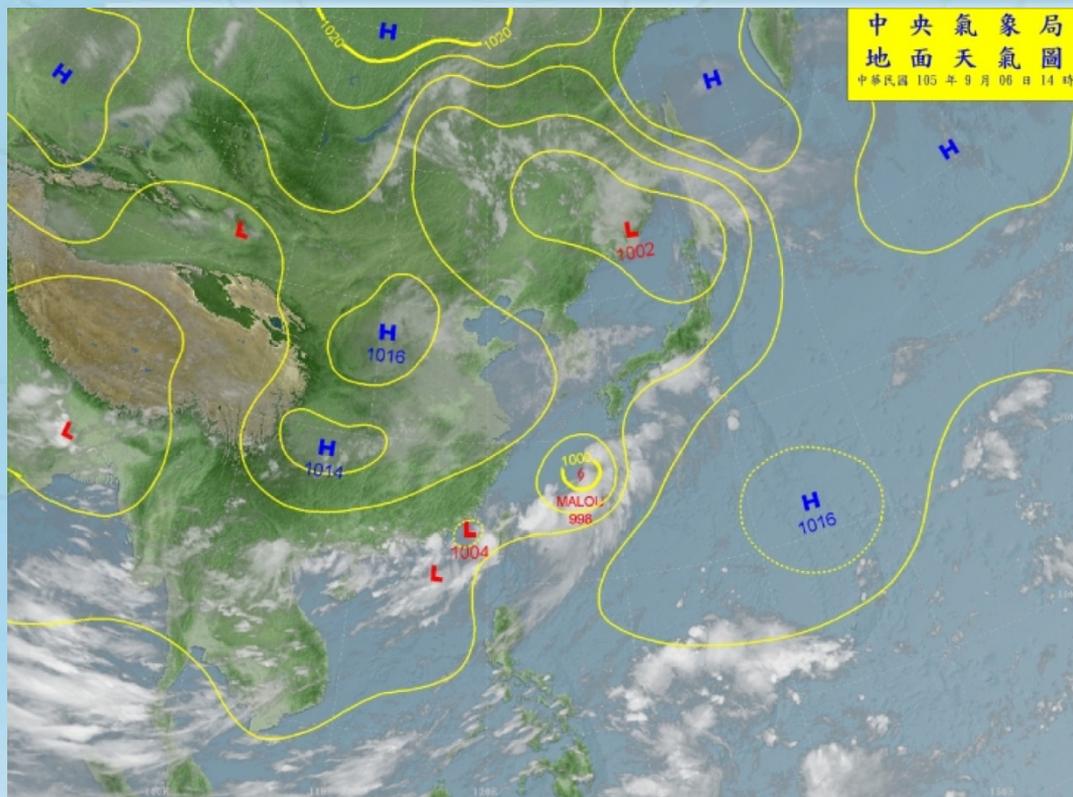


**JMA**



*Weather*

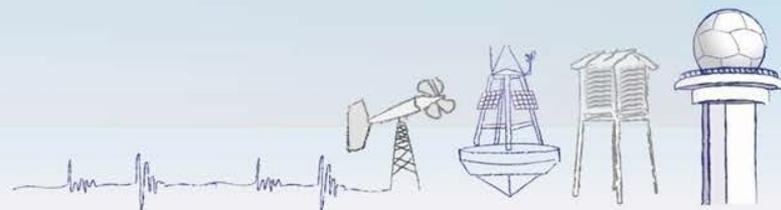
# 研究個案：2016年梅雨期(5、6)及9月(9/1-9/10)



2016-09-06

Weather<sup>+</sup>

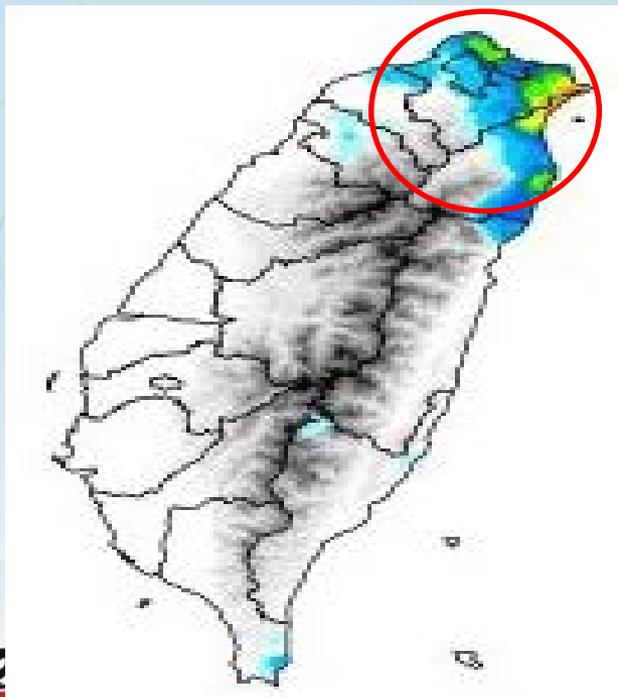
Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# 2016年：5、6、9月



**降雨個案** (1) 陸地降雨面積  $\geq 3\%$  面積  
(2) 3小時累積雨量  $\geq 30$  mm)



5 月 : 23 個案  
6 月 : 84 個案  
9 月 : 51 個案

**Total : 158 個案**

W



# ● 不同背景場(GFS、MOO、JMA)預報特性

校驗成績(TS、ETS、BIAS) 評估:

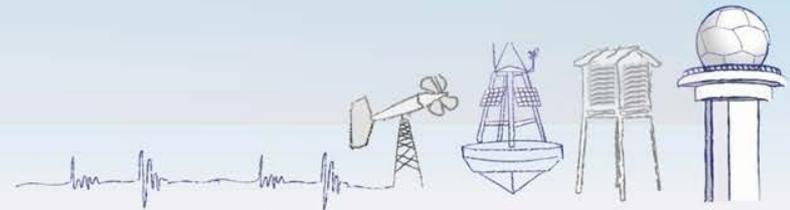
**TS** : Threat Score 預兆得分

**ETS**: Equitable Threat Score 公正預兆得分

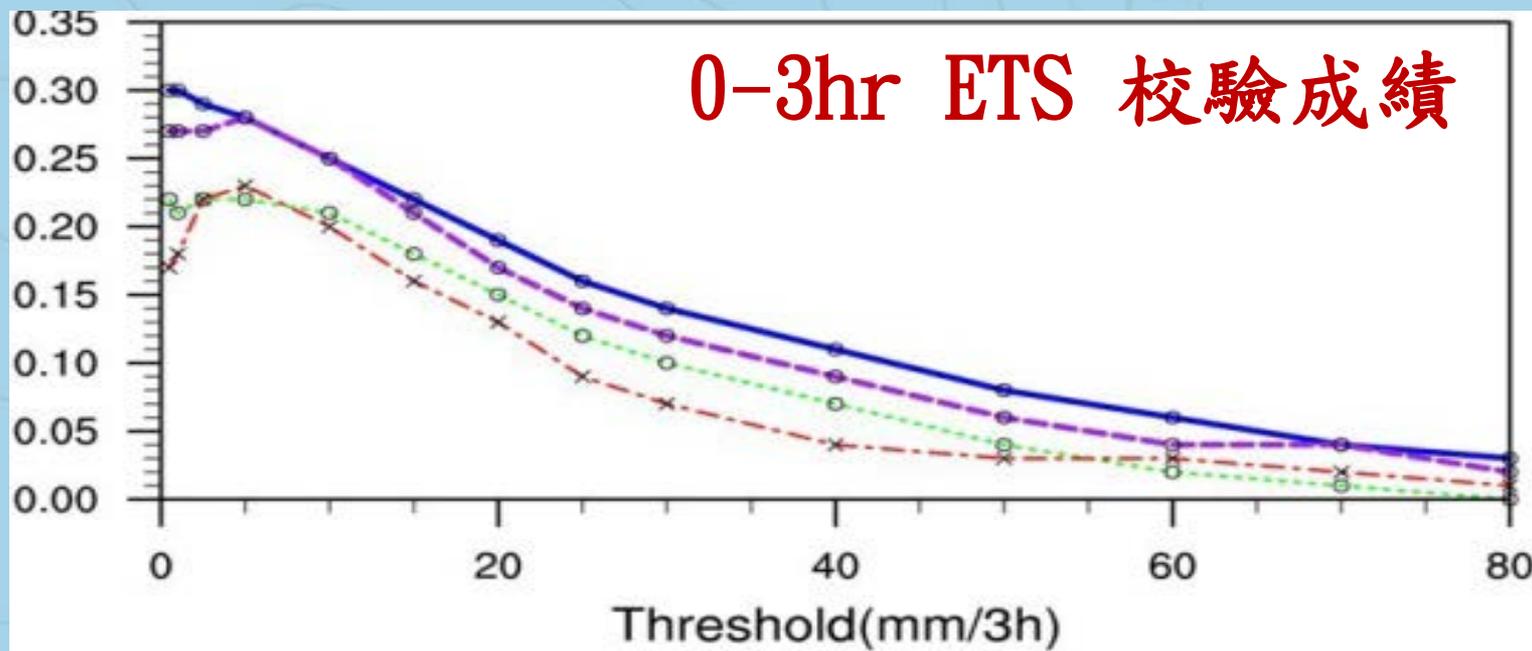
**BIAS**: 偏離係數(降雨高、低估)

Weather<sup>+</sup>

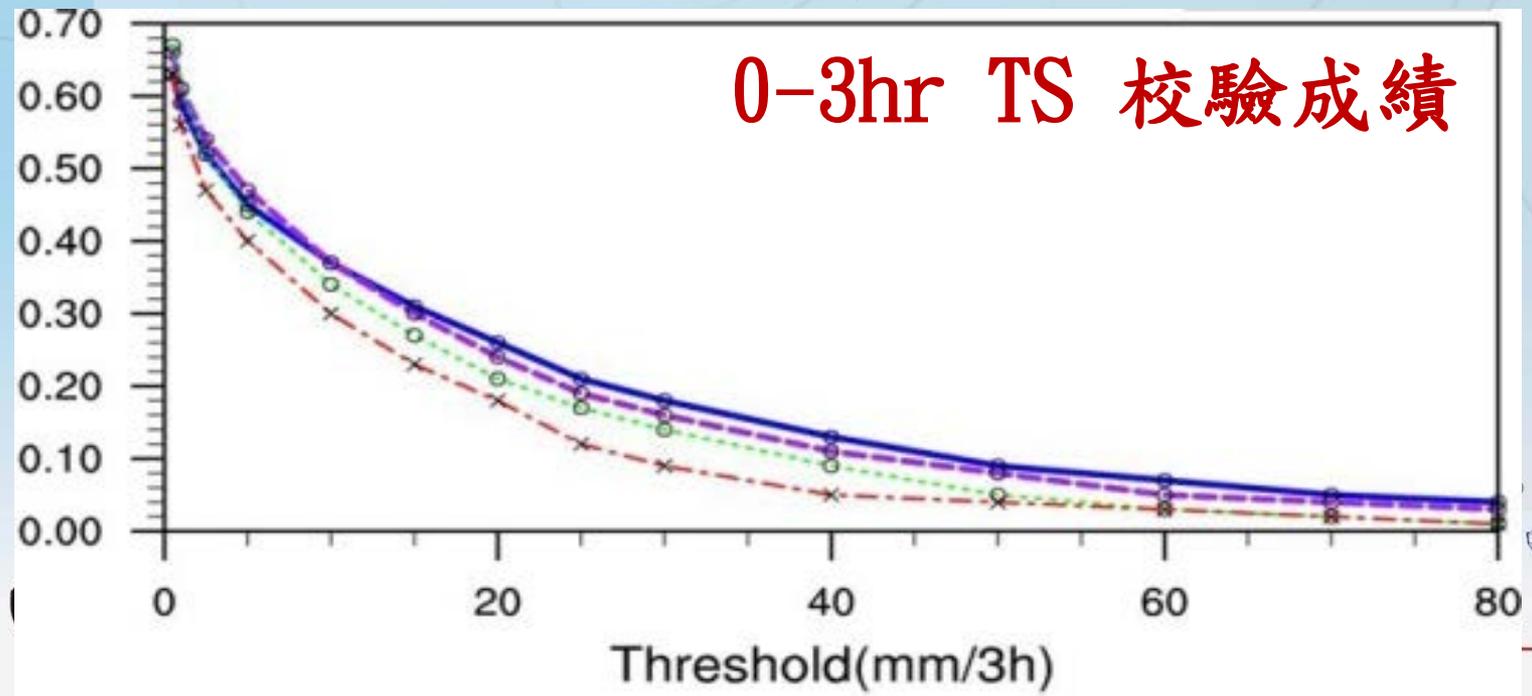
Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



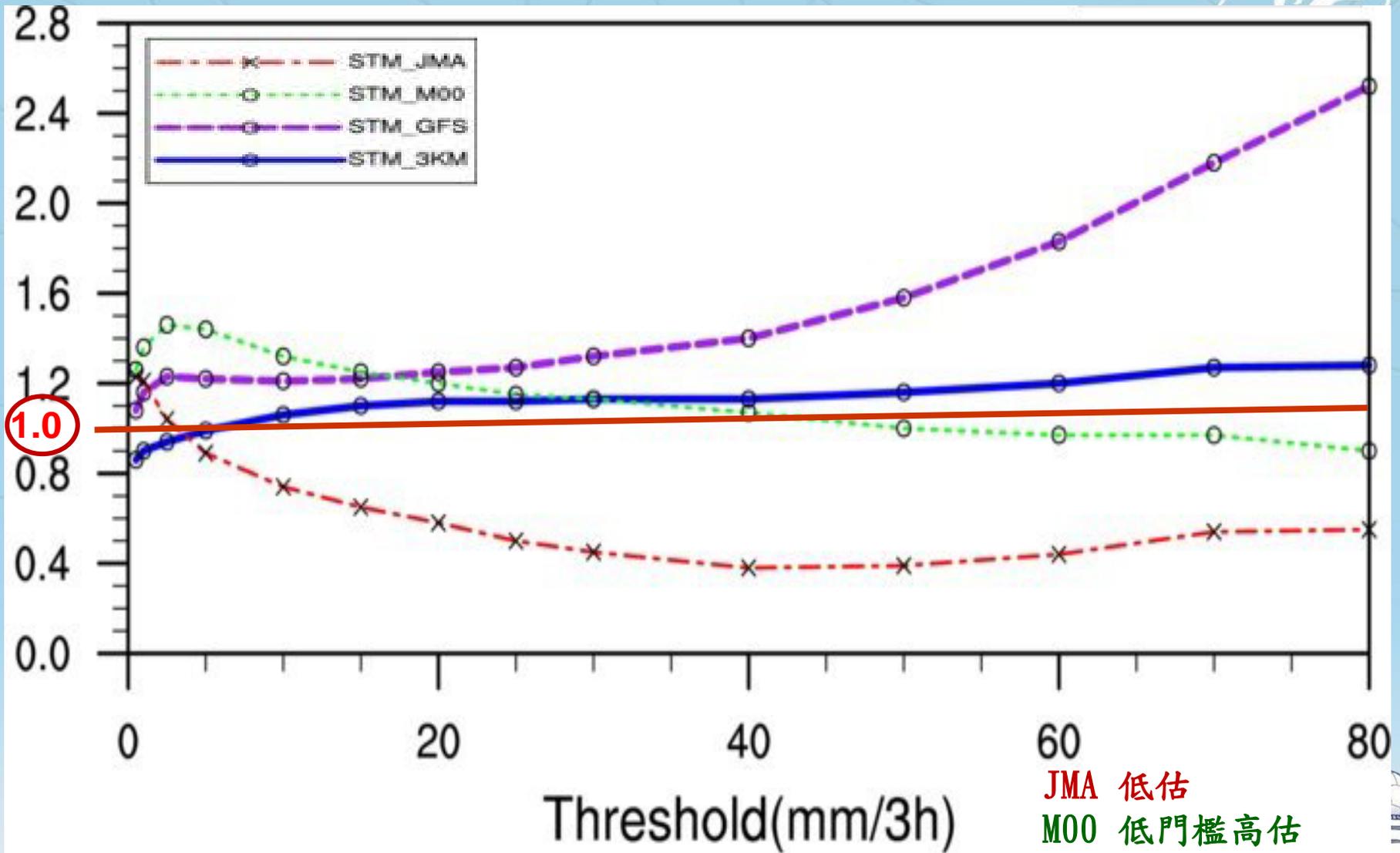
# 0-3hr ETS 校驗成績



# 0-3hr TS 校驗成績



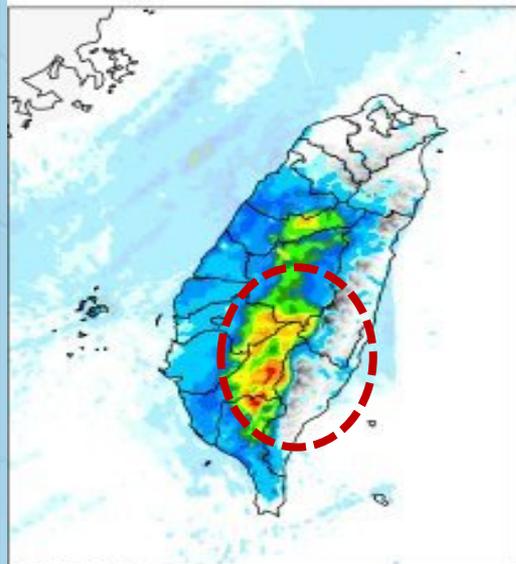
# 0-3hr BIAS 校驗成績



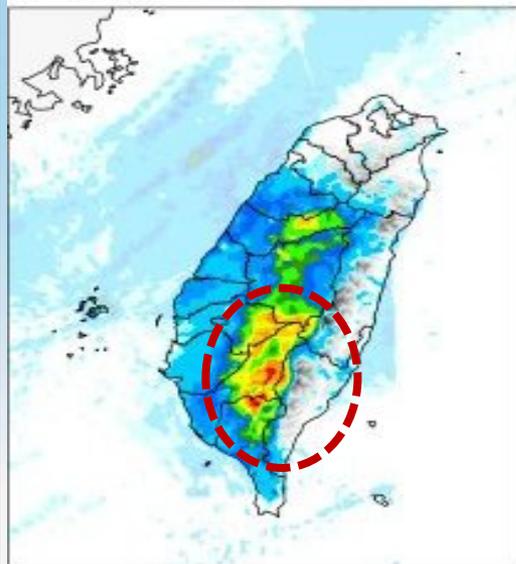
Weather<sup>+</sup>

# 2016-06-12\_06: 0-3hr QPF

QPESUMS  
From 2016-06-12 06  
To 2016-06-12 09 **Obs (QPE)**



QPESUMS  
From 2016-06-12 06  
To 2016-06-12 09 **Obs (QPE)**



STMAS3D-WRF(HPC)  
Initial : 2016-06-12 06  
Forecast : 00-03 hrs

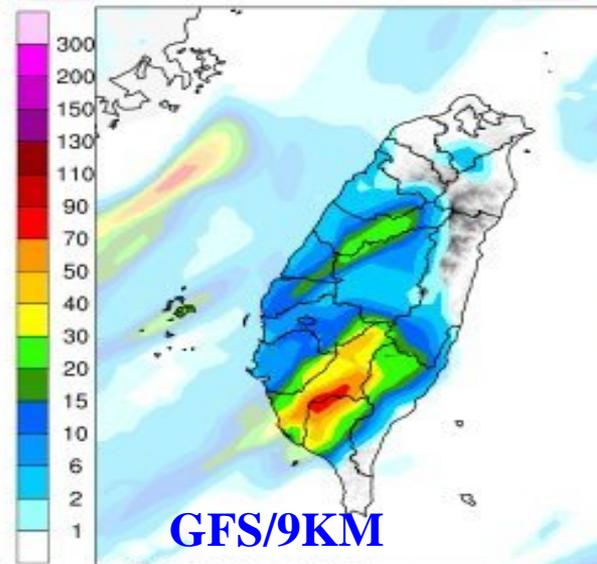
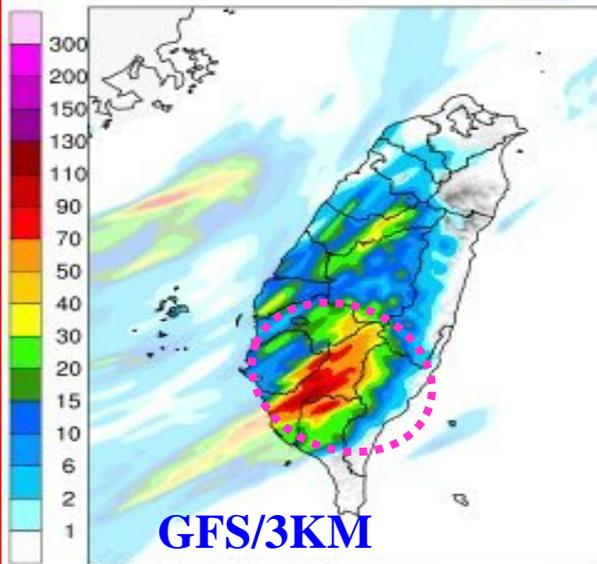
Thr.(mm) TS  
1. 0.54 0.76  
10. 0.20 0.47

Bias  
1.00 1.05  
3.10 1.54

STMAS3D-WRF(GFS)  
Initial : 2016-06-12 06  
Forecast : 00-03 hrs

Thr.(mm) TS  
1. 0.58 0.74  
10. 0.16 0.40

Bias  
1.20 1.02  
3.02 1.26



STMAS3D-WRF(M00)  
Initial : 2016-06-12 06  
Forecast : 00-03 hrs

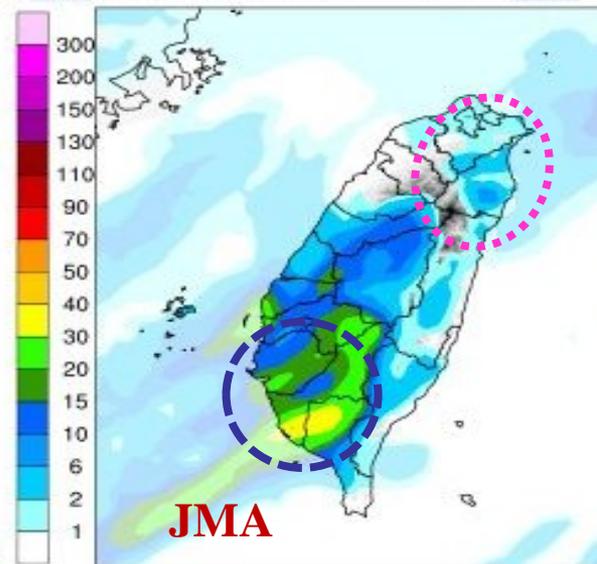
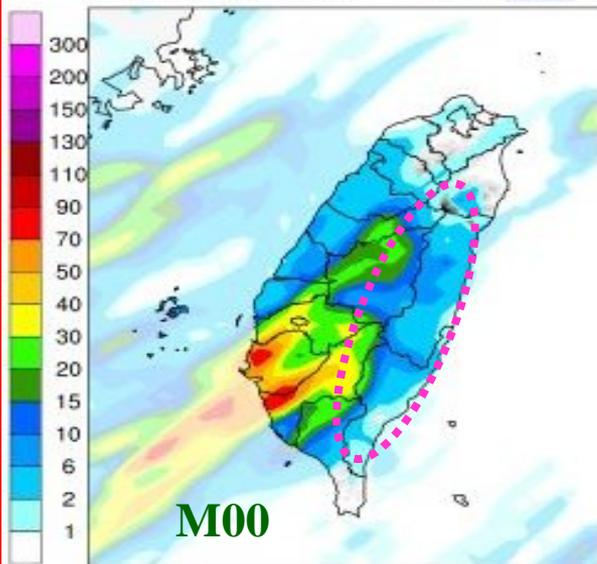
Thr.(mm) TS  
1. 0.43 0.76  
10. 0.14 0.46

Bias  
1.26 1.19  
3.65 1.31

STMAS3D-WRF(JMA)  
Initial : 2016-06-12 06  
Forecast : 00-03 hrs

Thr.(mm) TS  
1. 0.48 0.67  
10. 0.17 0.40

Bias  
1.58 1.09  
2.51 1.18





決定性預報：STMAS-WRF/GFS (3km)

VS.

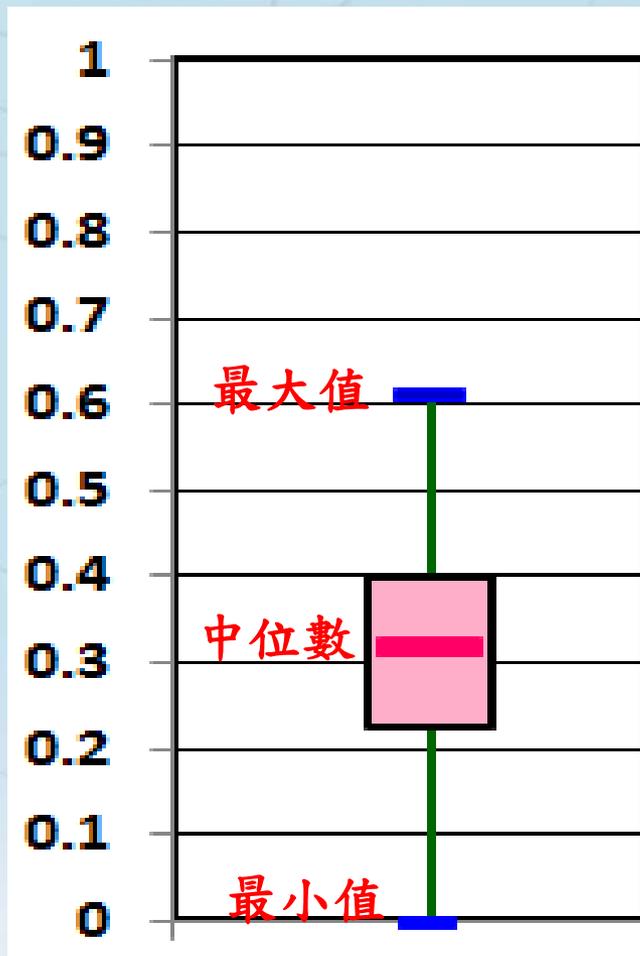
系集預報：STMS-WRF/PM (9km)

*Weather*<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



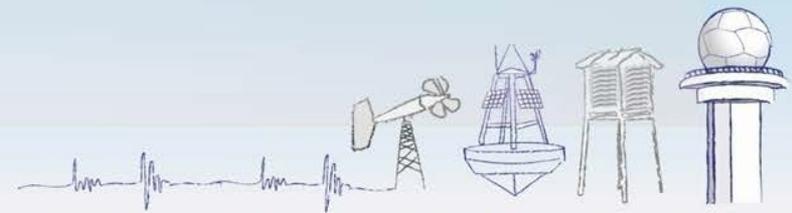
# ● Boxplot (盒鬚圖)



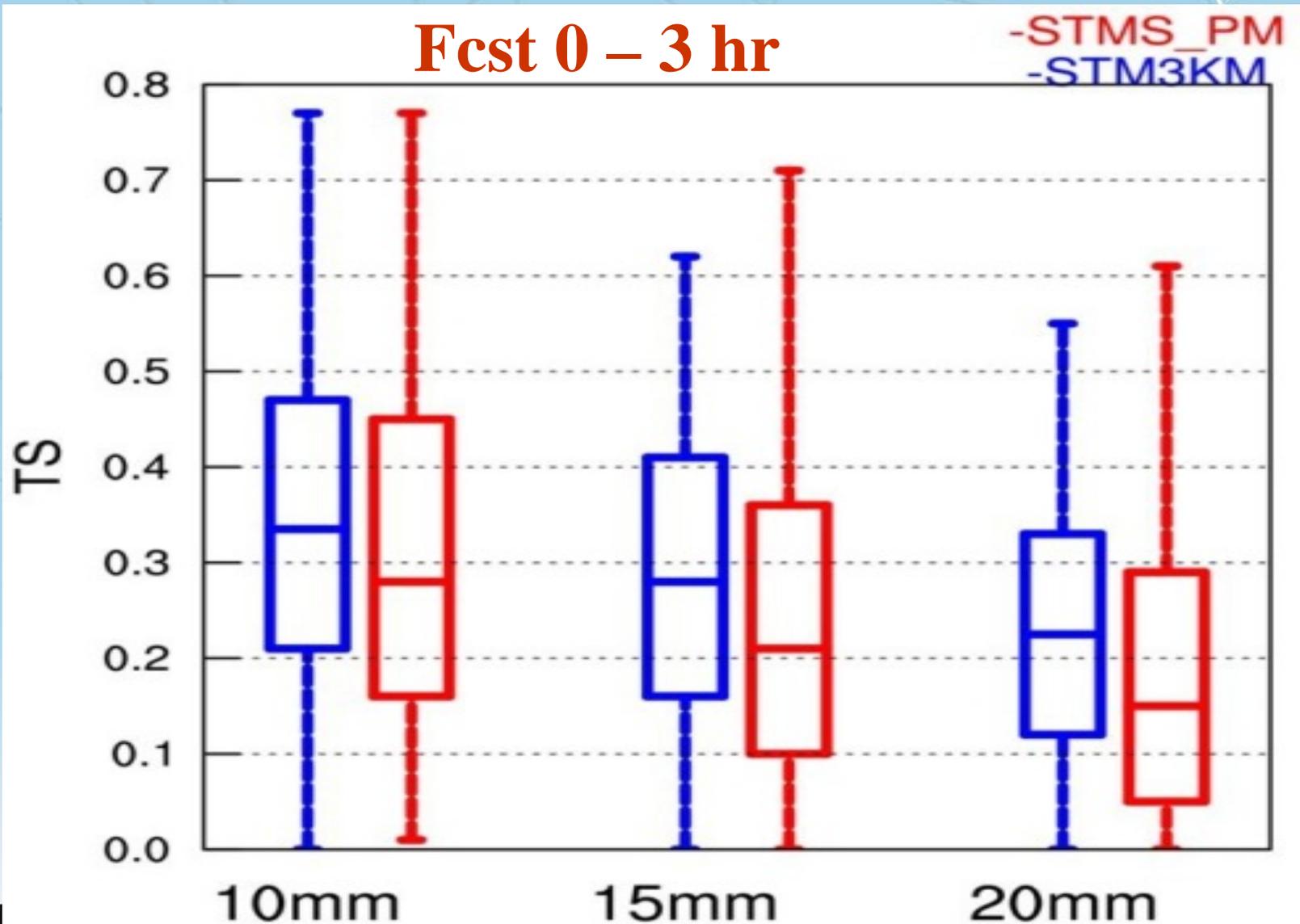
評估資料分散情形

Weather<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy



# 校驗成績: TS

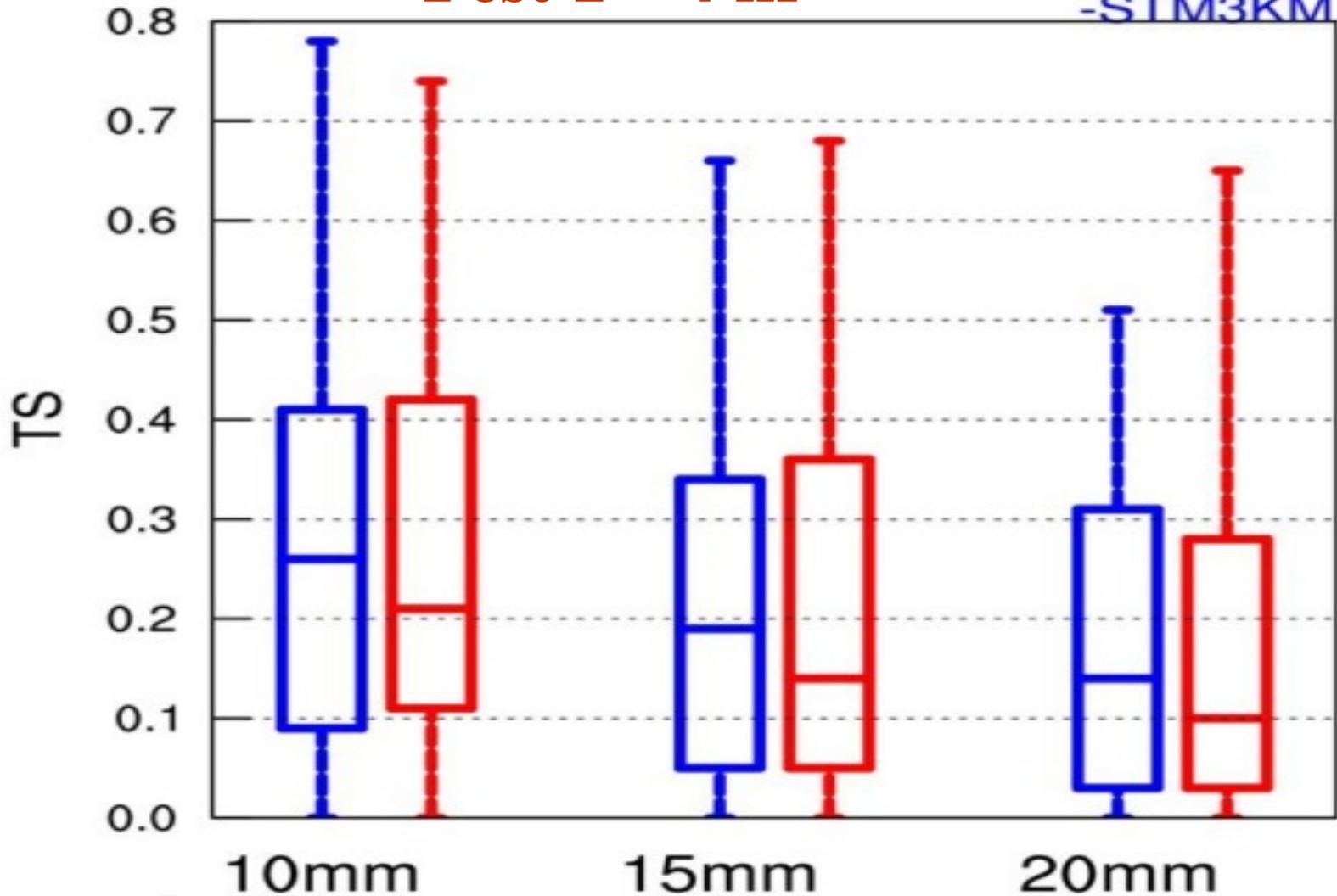


Weather



# Fcst 1 – 4 hr

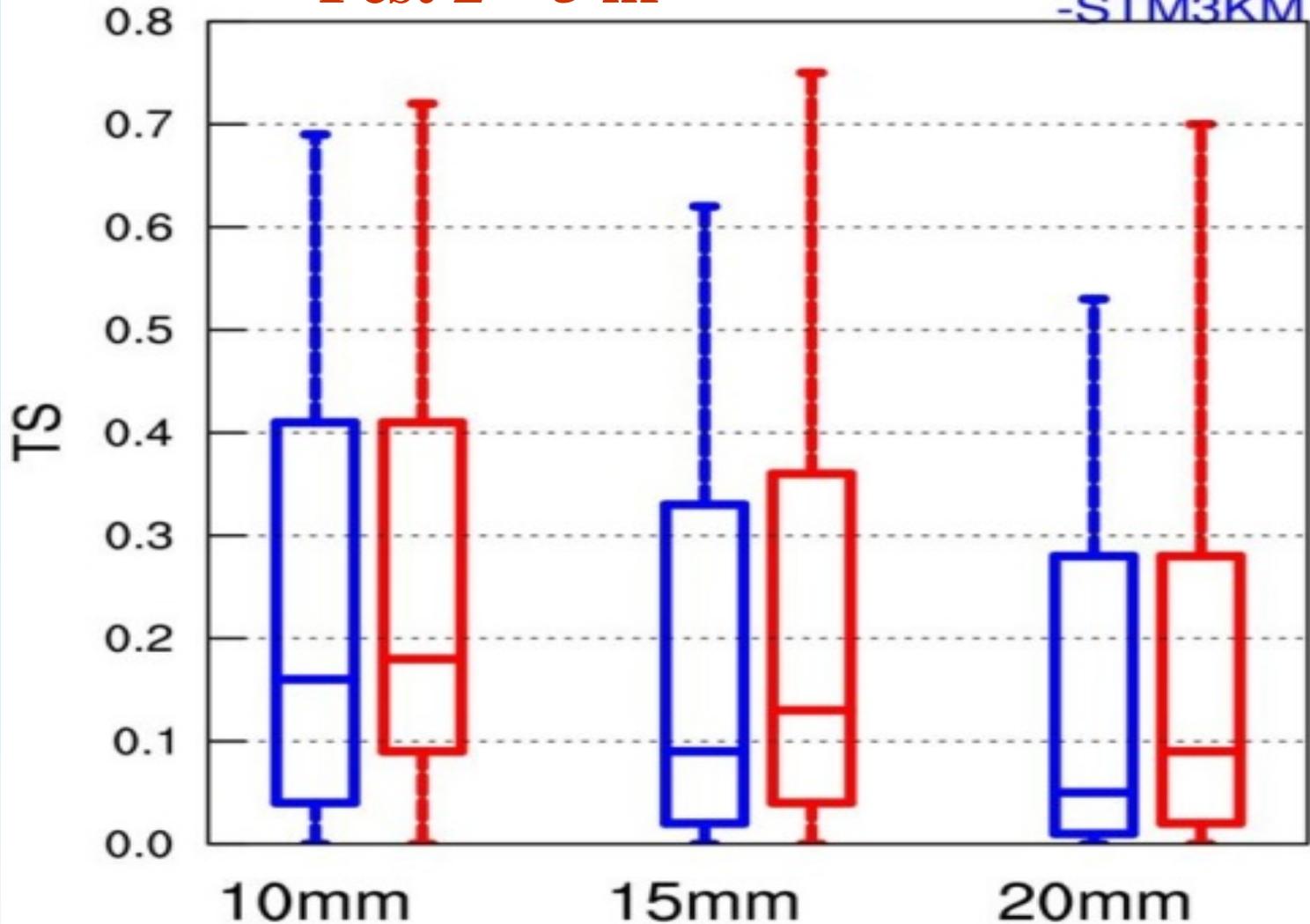
-STMS\_PM  
-STM3KM



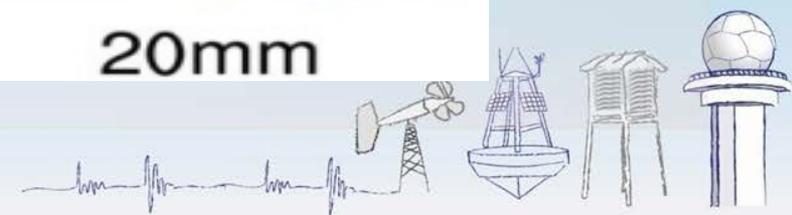
*Weather*

# Fcst 2 – 5 hr

-STMS\_PM  
-STM3KM

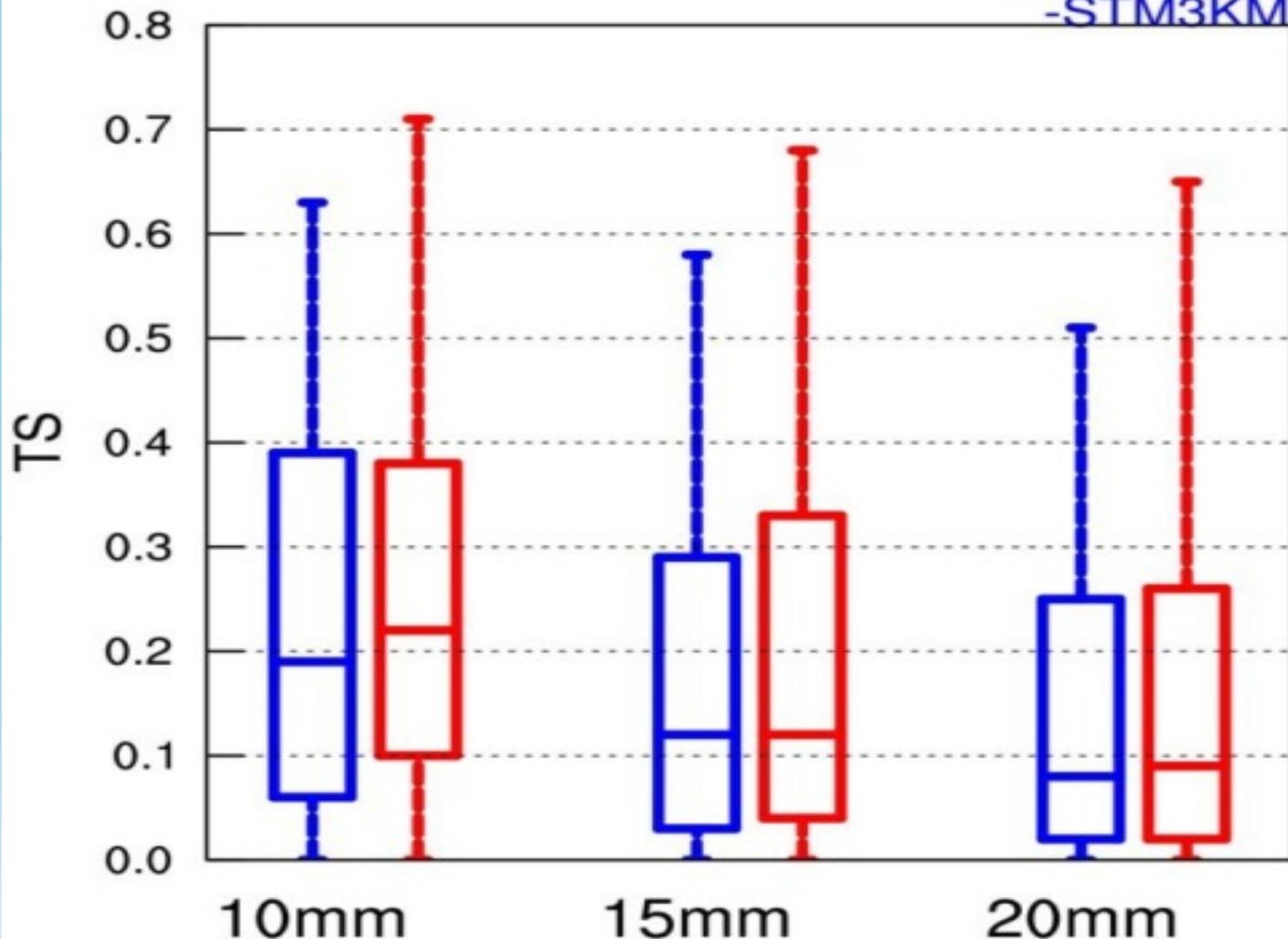


*Weather*<sup>+</sup>



# Fcst 3 – 6 hr

-STMS\_PM  
-STM3KM

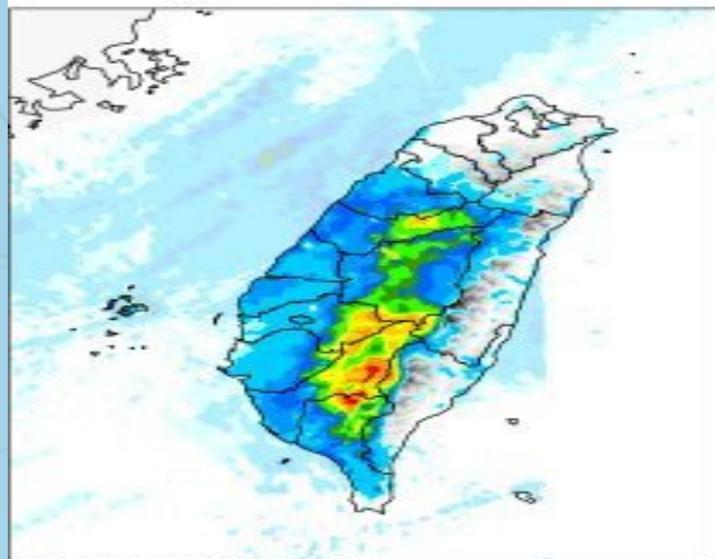


Weather<sup>+</sup>

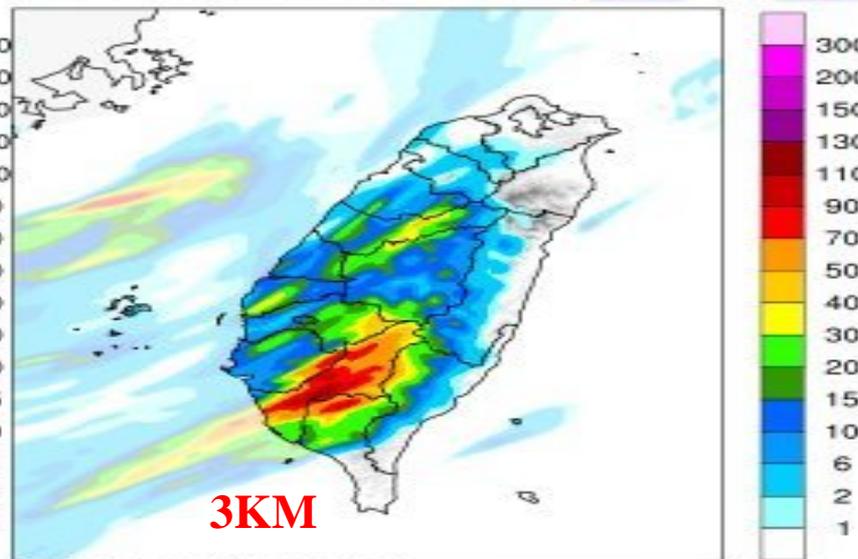
# 2016-06-12\_06: 0-3 QPF

QPESUMS  
From 2016-06-12 06  
To 2016-06-12 09

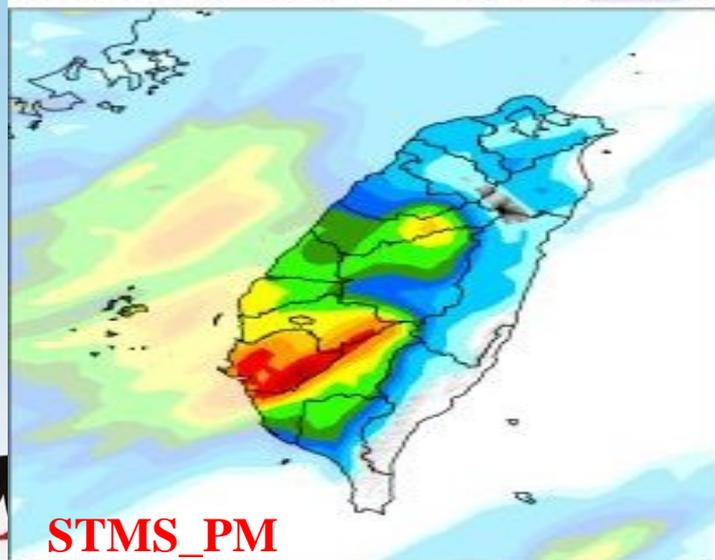
**Obs (QPE)**



STMAS3D-WRF(HPC) Thr. (mm) TS Bias  
Initial : 2016-06-12 06 1. 0.54 0.76 1.00 1.05  
Forecast : 00-03 hrs 10. 0.20 0.47 3.10 1.54

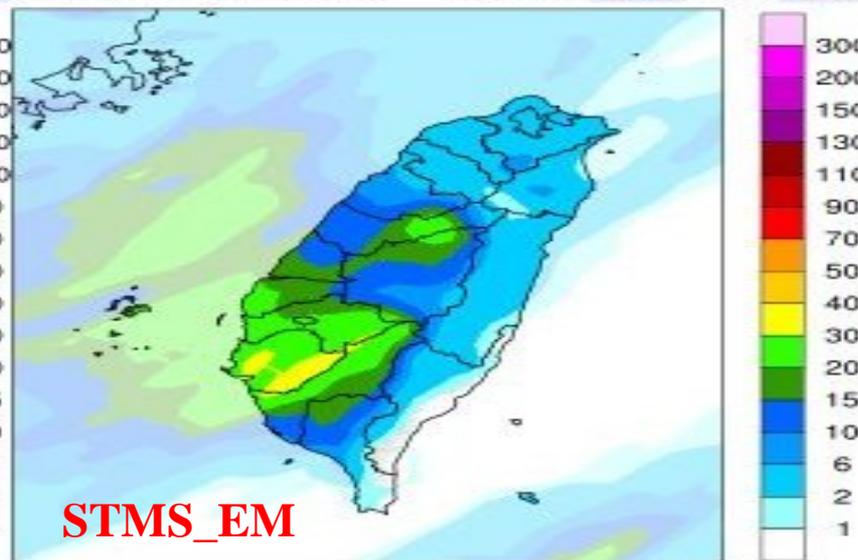


STMAS3D-WRF(PM) Thr. (mm) TS Bias  
Initial : 2016-06-12 06 1. 0.51 0.72 1.63 1.20  
Forecast : 00-03 hrs 10. 0.12 0.46 6.21 1.68



**STMS\_PM**

STMAS3D-WRF(ENS) Thr. (mm) TS Bias  
Initial : 2016-06-12 06 1. 0.48 0.73 1.92 1.32  
Forecast : 00-03 hrs 10. 0.13 0.46 5.57 1.62



**STMS\_EM**



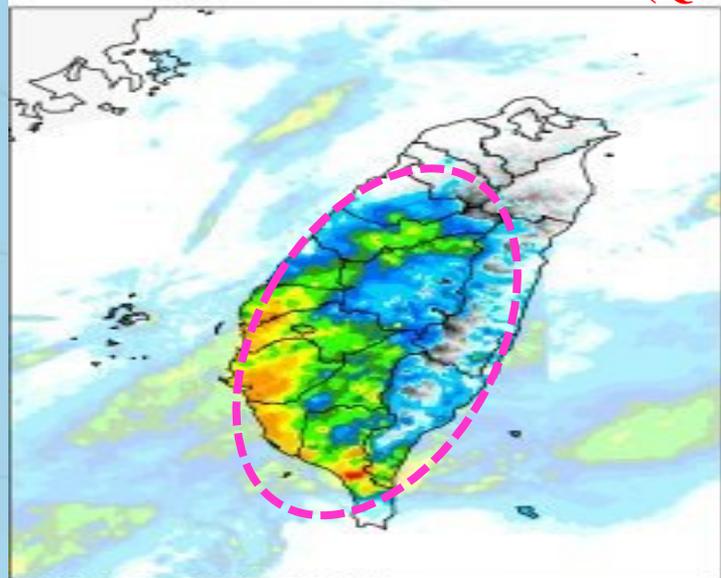
my

# 2016-06-11 00: 3-6 QPF

QPESUMS

From 2016-06-11 00  
To 2016-06-11 03

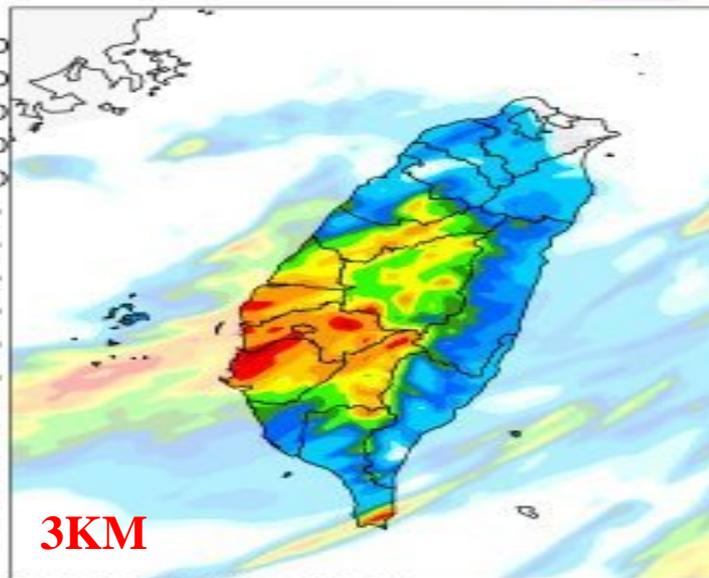
Obs (QPE)



STMAS3D-WRF(HPC)

Initial : 2016-06-10 21  
Forecast : 03 - 06 hrs

| Thr.(mm) | TS        | Bias |      |
|----------|-----------|------|------|
| 1.       | 0.52 0.73 | 1.10 | 1.36 |
| 10.      | 0.26 0.58 | 1.63 | 1.41 |

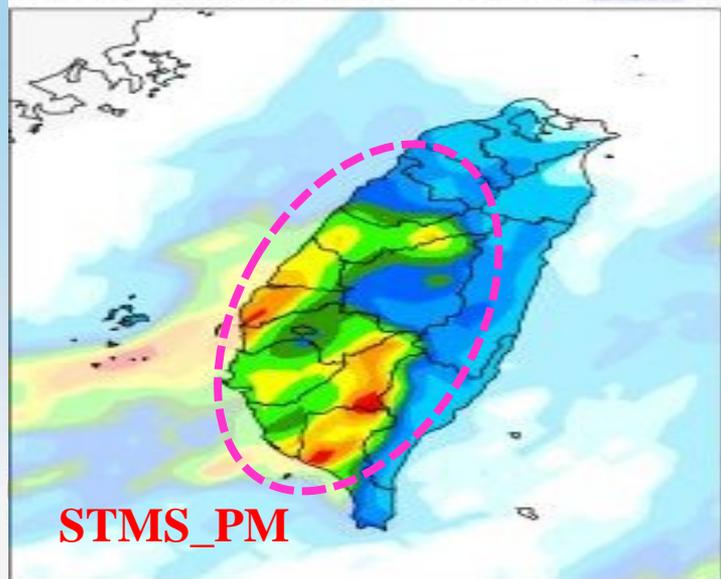


3KM

STMAS3D-WRF(PM)

Initial : 2016-06-10 21  
Forecast : 03 - 06 hrs

| Thr.(mm) | TS        | Bias |      |
|----------|-----------|------|------|
| 1.       | 0.55 0.71 | 1.24 | 1.41 |
| 10.      | 0.31 0.66 | 1.29 | 1.34 |

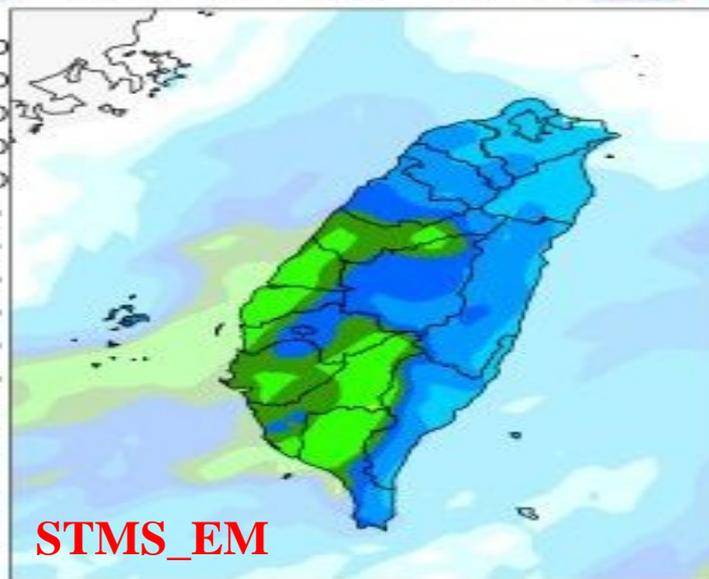


STMS\_PM

STMAS3D-WRF(ENS)

Initial : 2016-06-10 21  
Forecast : 03 - 06 hrs

| Thr.(mm) | TS        | Bias |      |
|----------|-----------|------|------|
| 1.       | 0.55 0.70 | 1.55 | 1.42 |
| 10.      | 0.31 0.67 | 1.23 | 1.30 |



STMS\_EM



# ● 小結與展望



1. 0-3小時QPF優劣依次: STMS-WRF/GFS(3KM)、STMS-WRF/GFS(9KM)、STMS-WRF/M00、STMS-WRF/JMA。  
STMS-WRF/M00在小降雨門檻會高估，STMAS-WRF/JMA 低估趨勢。
2. 0-3小時QPF，系集預報的效果並不明顯，  
2-5、3-6小時QPF，系集預報優於決定性預報。
3. 發展STMAS雲變分技術 → 提高QPF的準確性。
4. 本局正發展雷達資料同化技術，完成之前；  
0-3小時QPF: STMAS-WRF/GFS 3KM  
3-6小時QPF: STMAS-WRF/PM 9KM。

Weather<sup>+</sup>

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy





簡 報 完 畢  
謝 謝 !!

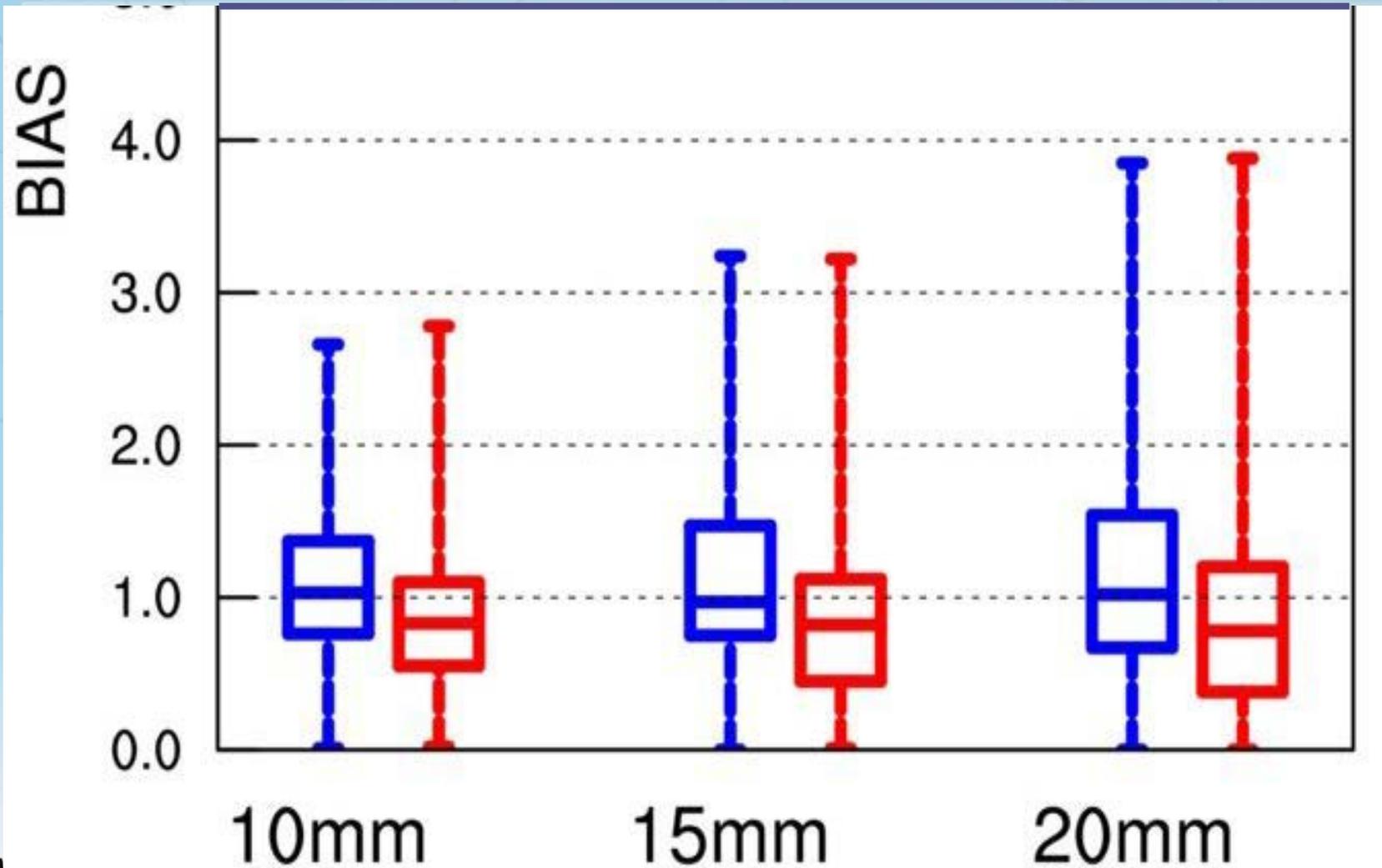
Weather<sup>+</sup>

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# Fcst 0 – 3 hr

- STMS\_PM
- STM\_3KM



Weather

