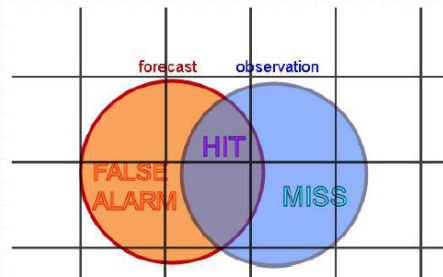# 物件基礎診斷校驗技術於中央氣象局區域模式降水預報表現評估之應用

陳白榆　　林伯勳　　洪景山

中央氣象局
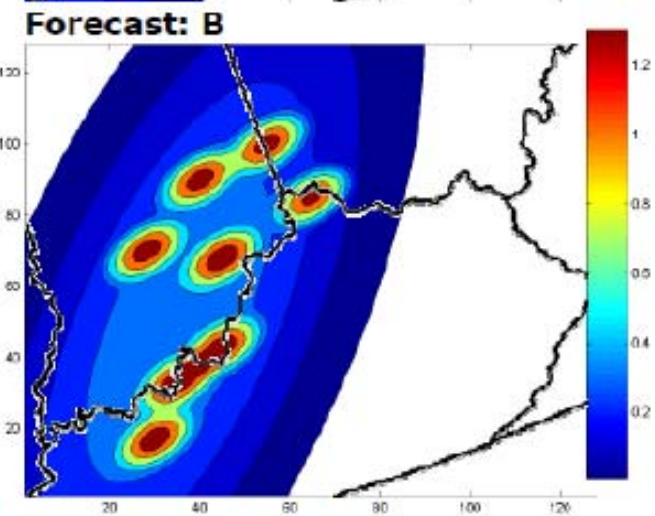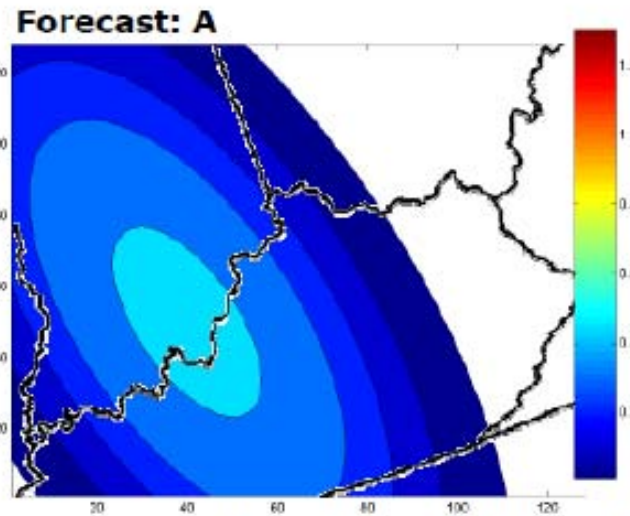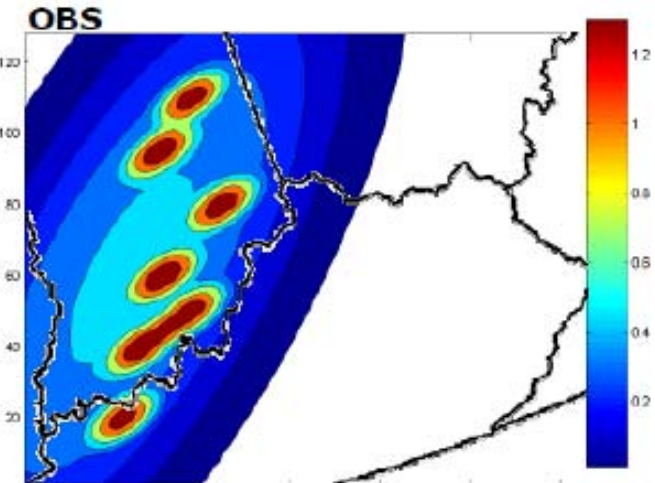
High-resolution models verification

double penalty

From Mike Baldwin of NOAA/NWS/SPC OU/CIMMS

107年天氣分析與預報研討會

Neighborhood approach
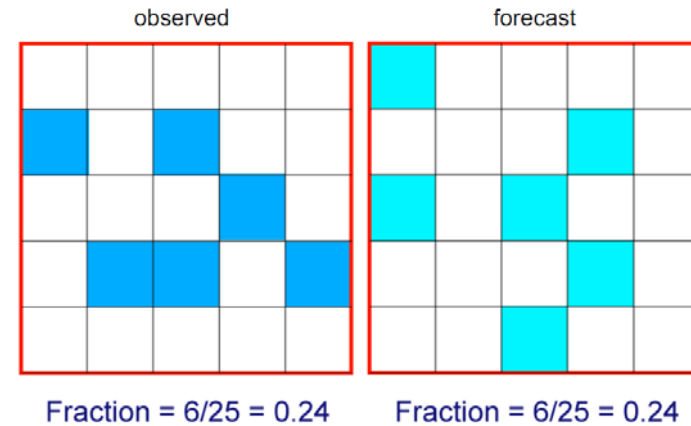
observed · forecast
Fraction = 6/25 = 0.24 · Fraction = 6/25 = 0.24
Intensity threshold exceeded where squares are blue
slide from Mittermaier

(Craig Schwartz, 2018)

- **High-res models are inaccurate at the grid scale**
  - **Verification methods requiring forecast and observed events match at the grid scale are inappropriate**

- **Instead, use a "neighborhood approach"**
  - **Specify a "neighborhood length scale" that defines the tolerance for error**
  - **Can use either square or circular geometry**

107年天氣分析與預報研討會

New spatial verification approaches

Neighborhood
Successive smoothing of forecasts/obs
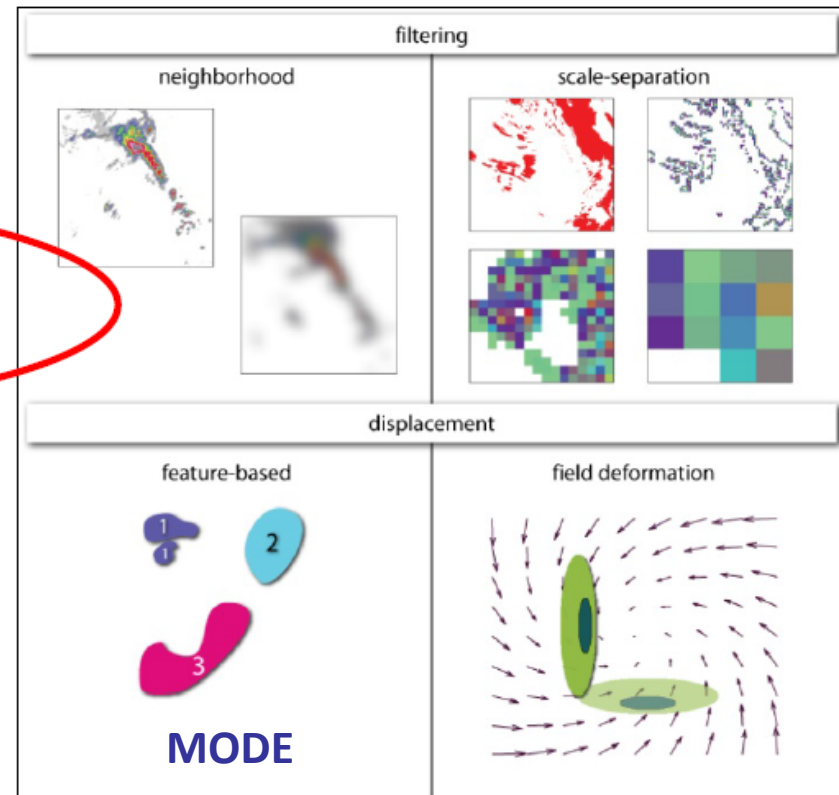
Object- and feature-based
Evaluate attributes of identifiable features

Scale separation
Measure scale-dependent error

Field deformation
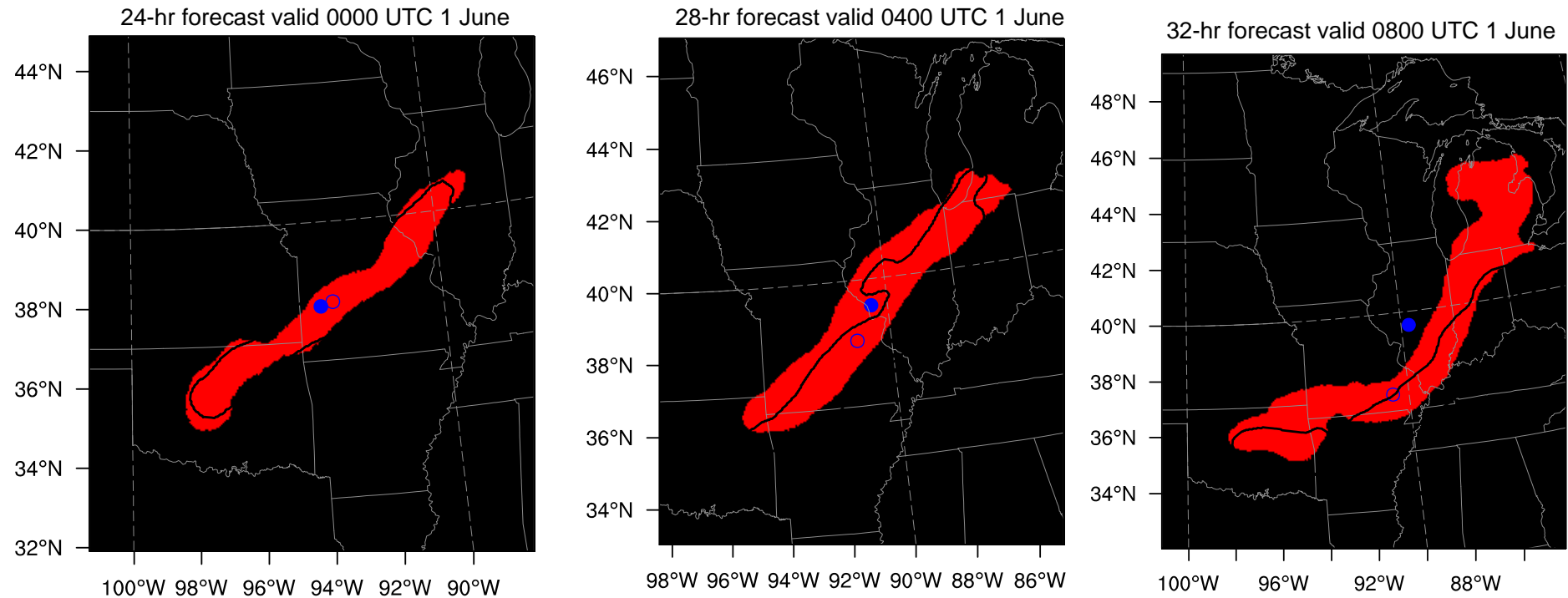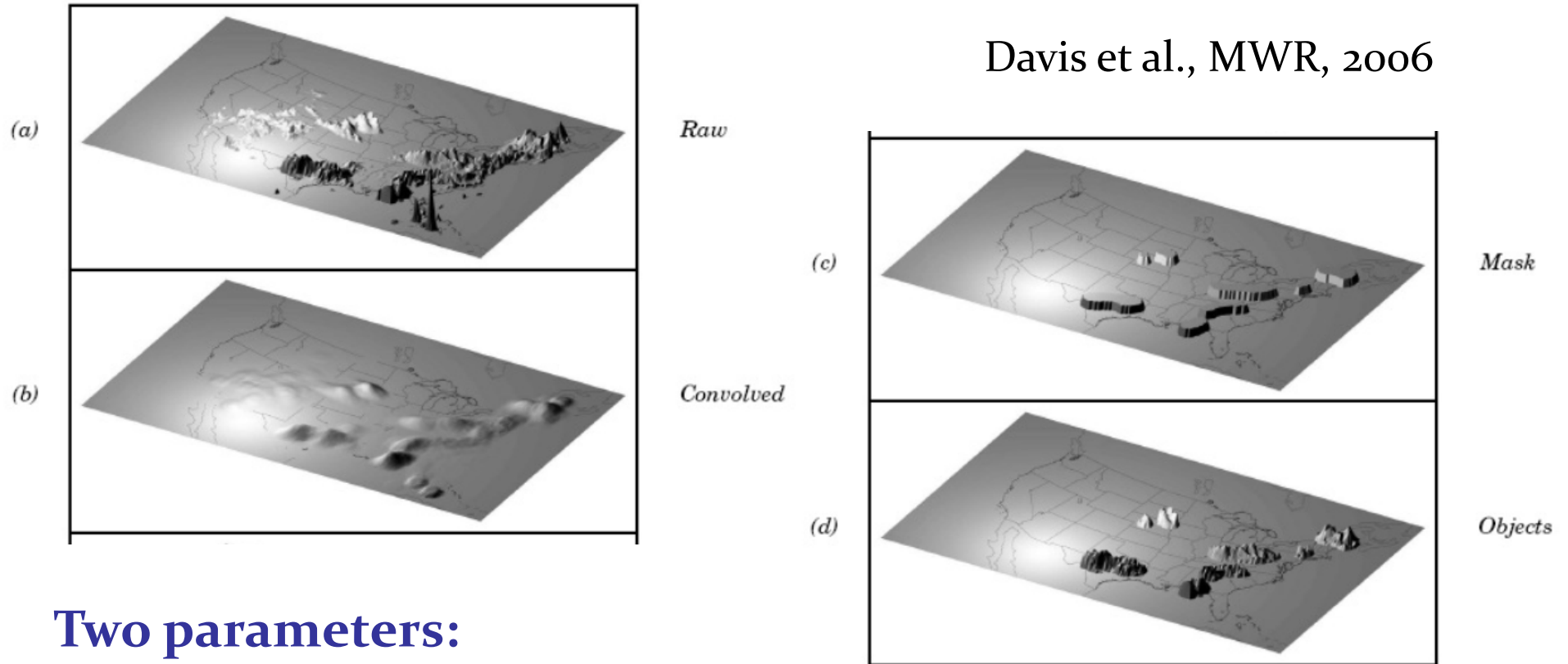*Measure distortion and displacement (phase error) for whole field*

filtering

neighborhood scale-separation

displacement

feature-based field deformation

MODE

Web site:
http://www.ral.ucar.edu/projects/icp/

107年天氣分析與預報研討會

Object-based verification

- **Verify features, rather than individual points**

- **3-km (shaded) and 1-km objects (contours)**

24-hr forecast valid 0000 UTC 1 June
28-hr forecast valid 0400 UTC 1 June
32-hr forecast valid 0800 UTC 1 June

(Courtesy of Craig Schwartz)

107年天氣分析與預報研討會

Method for Object-based Diagnostic Evaluation (MODE)

Davis et al., MWR, 2006

Two parameters:
1. **Convolution radius (R) - Smoother**
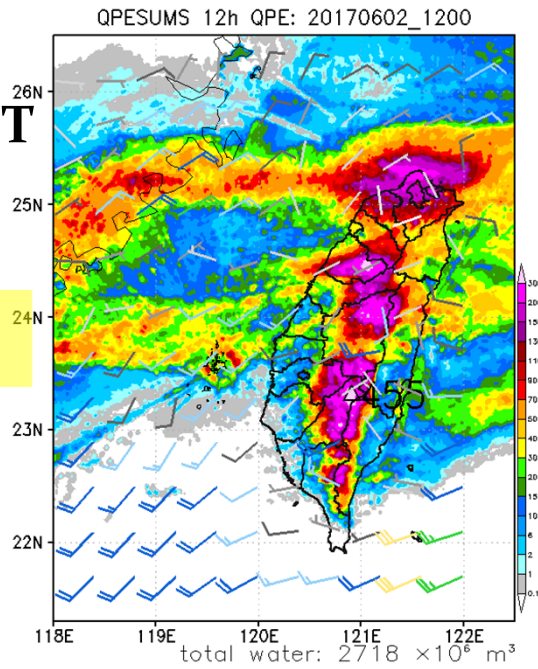2. **Threshold (T)**

107年天氣分析與預報研討會

2017 Meiyu case (WRF 3 km vs. 5 km)

- **Comparison of CWB WRF 3 km and 5 km deterministic QPF performance using MODE technique**

  - **Meiyu case valid time:**
    2000 LST 02 June 2017
  - **Radius (R) = 3 km and 5 km, slightly smoothing**
  - **Thresh (T) $\geqq$ 90 mm for 12 hr accumulated rainfall**
  - **12~24 hrs forecast lead time**

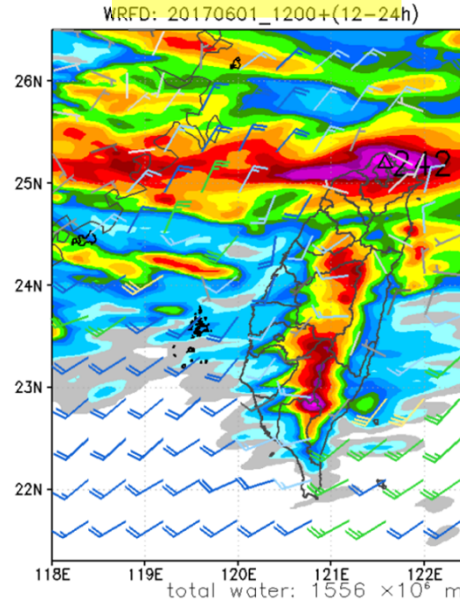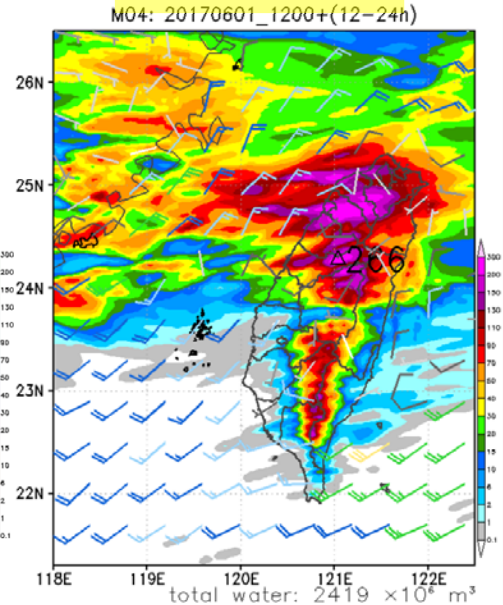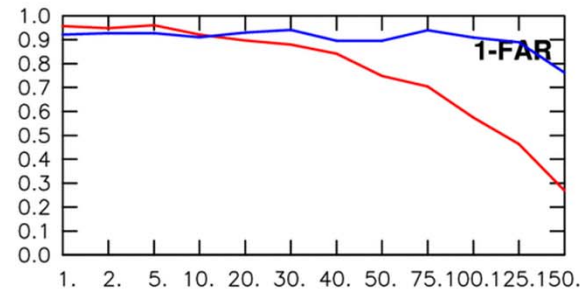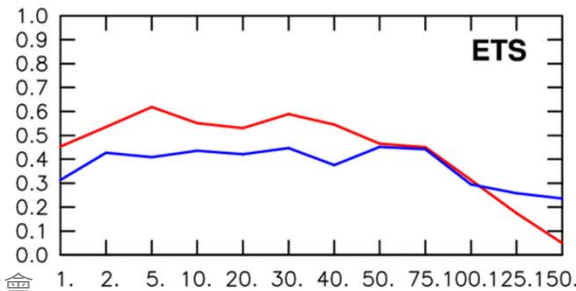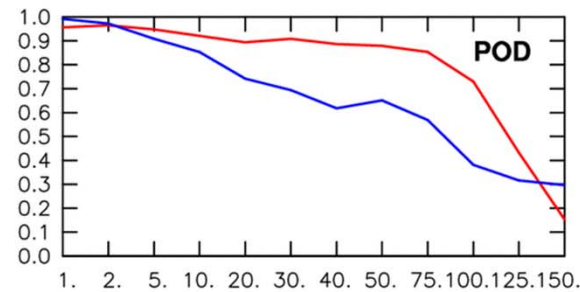Valid time：
2017.6.2 20 LST

OBS

5 km

3 km

RAINSCORE 5km 12-24 hr
17060112 UTC Initial

WRFM04
WRFM00

ETS (90mm) =

3 km: 0.313

5 km: 0.295
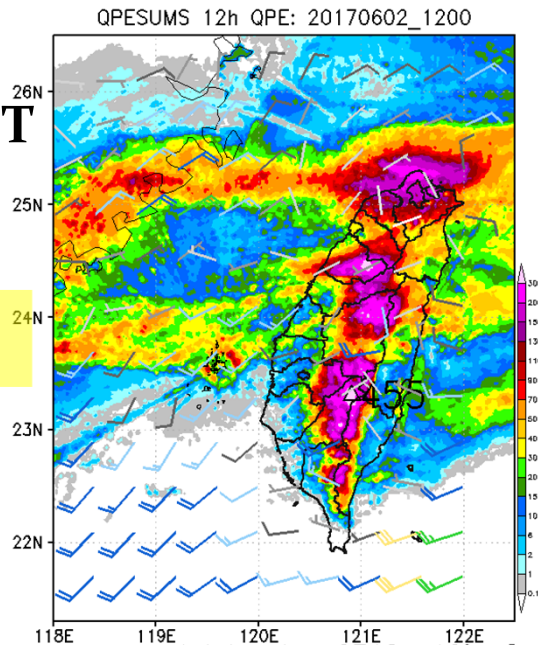
BIAS

POD

ETS

1-FAR

107年天氣分析與預報研討會

Valid time：

2017.6.2 20 LST

QPESUMS 12h QPE: 20170602_1200

OBS

5 km

WRFD: 20170601_1200+(12-24h)

total water: 2718 ×10⁶ m³

3 km

M04: 20170601_1200+(12-24h)

total water: 1556 ×10⁶ m³

total water: 2419 ×10⁶ m³

5 km

QPESUMS   ~ 2017060212 UTC   M00   12~24hr fcst accumulated rainfall

OBJECT_ID   OBJECT_ID

3 km

OBJECT_ID   OBJECT_ID
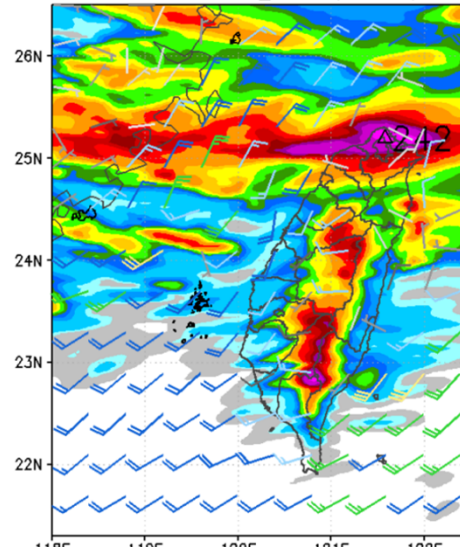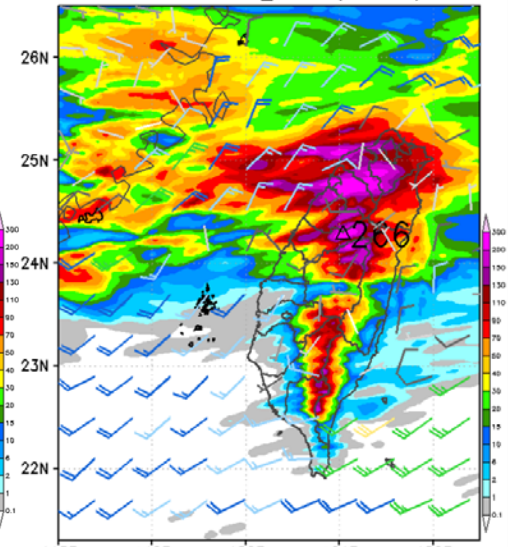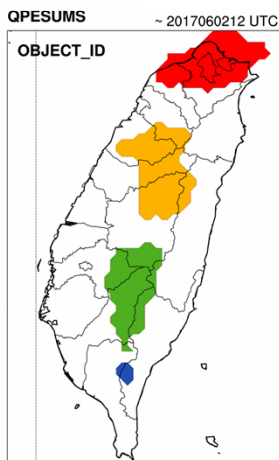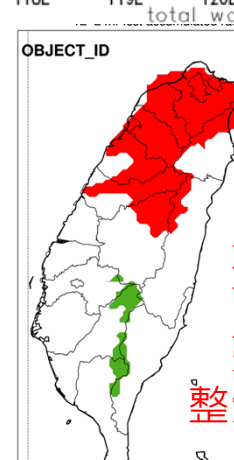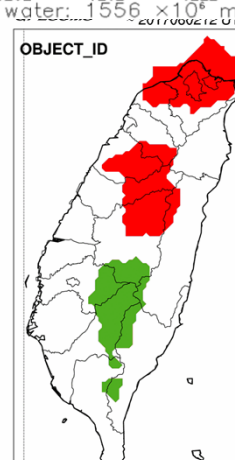
低估(尤其中部)
強度不足
位置掌握佳

北部高估
南部低估
強度不足
整體表現梢佳

CLUS PAIR	CEN DIST	ANG DIFF	FCST AREA	OBS AREA	INTER AREA	UNION AREA	SYMM DIFF	FCST INT 50	OBS INT 50	FCST INT 90	OBS INT 90	TOT INTR
1	0.54	8.57	122	131	112	141	29	158.52	167.47	215.54	241.74	1.0000
2	4.59	2.64	49	120	34	135	101	126.14	171.27	170.71	247.72	0.9419
3	3.71	58.39	3	135	3	135	132	126.98	177.73	132.66	247.50	0.8451

CLUS PAIR	CEN DIST	ANG DIFF	FCST AREA	OBS AREA	INTER AREA	UNION AREA	SYMM DIFF	FCST INT 50	OBS INT 50	FCST INT 90	OBS INT 90	TOT INTR
1	6.11	0.85	890	758	460	1188	728	142.73	173.04	212.71	248.90	1.0000
2	7.24	0.71	75	360	53	382	329	126.12	173.77	151.70	247.98	0.9096

- Area ratio: 0.93 0.41 0.02
- Median intensity ratio: 0.95 0.74 0.71
- Centroid distance: 0.54 4.59 3.71
- **Total interest: 0.929**

- Area ratio: 1.17 0.21
- Median intensity ratio: 0.82 0.73
- Centroid distance: 6.11 7.24
- **Total interest: 0.955**

9/18

2017 Meiyu case for 1 month (WRF 3 km)

- **Evaluate CWB WRF 3 km deterministic QPF performance using MODE technique**

  - **Meiyu case valid time:**

    0800 LST 20 May ~ 0200 LST 21 June 2017
  - **Radius (R) = 3 km, slightly smoothing**
  - **Thresh (T) $\geqq$ 30 mm for 6 hr accumulated rainfall**
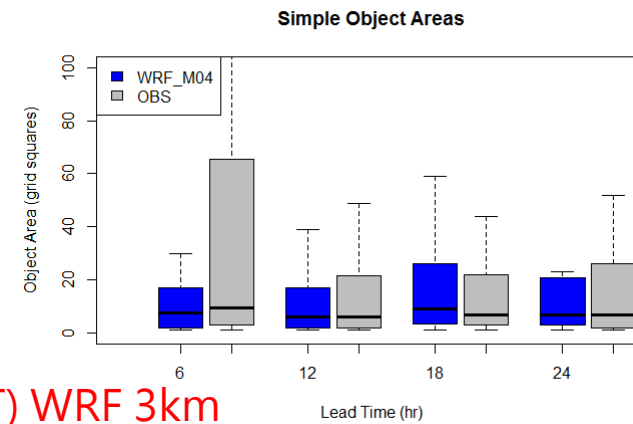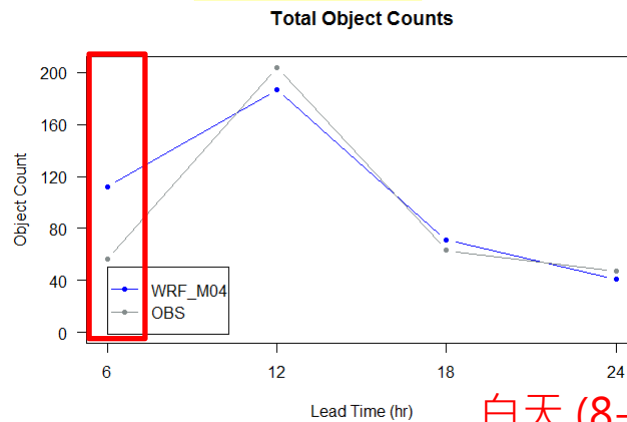 - **0~6, 6~12, 12~18, 18~24 hrs forecast lead time**
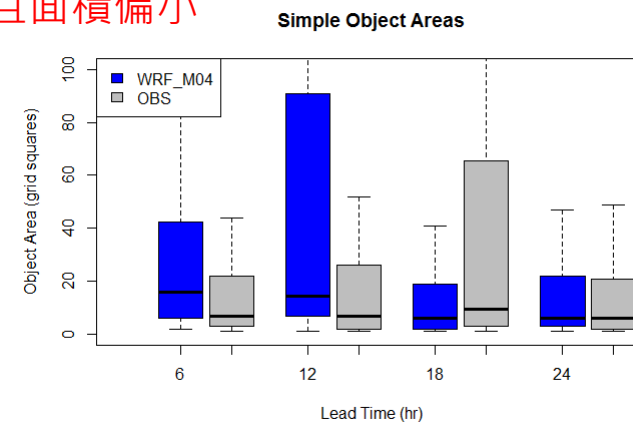
Simple object counts and areas (3 km)

WRF
OBS

Counts

Areas

IT=08 LST

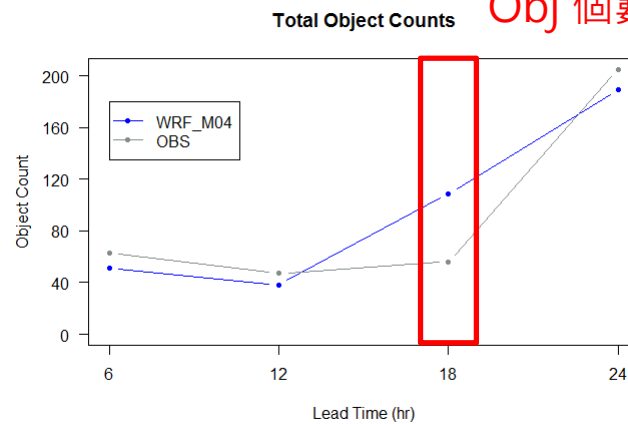**IT=20 LST**
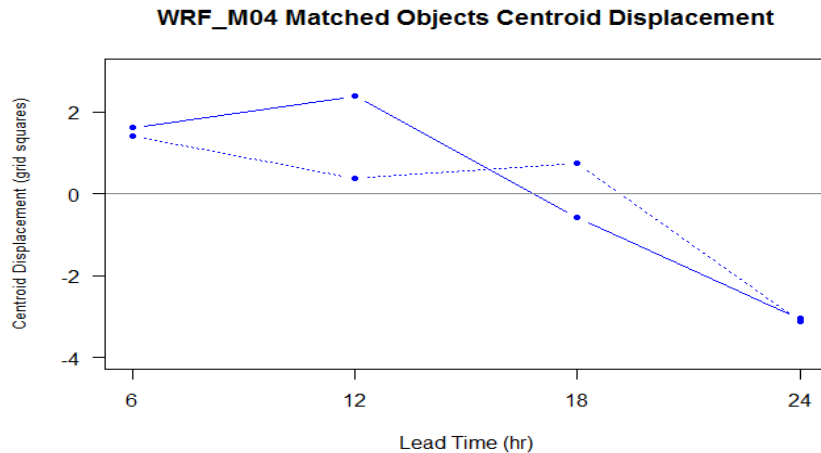
白天 (8-14 LST) WRF 3km
Obj 個數較多且面積偏小

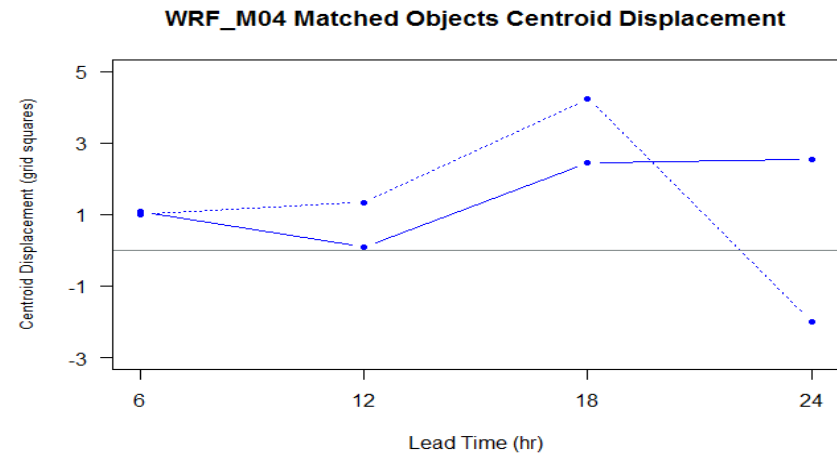**8-14 LST has larger total numbers & smaller area**

Matched objects centroid displacement (3 km)

—— **WRF (CENTX)**

···· **WRF (CENTY)**

Initial time = 0800 LST

Initial time = 2000 LST

X: easterly -> westerly

X: easterly

Y: 0~18 hrs northerly, 18~24 hrs southerly
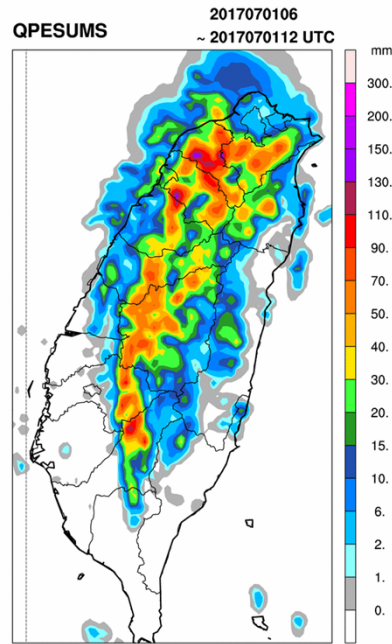
107年天氣分析與預報研討會

2017 Afternoon thunderstorm case (WRF 3 km)

- **Evaluate CWB WRF 3 km deterministic QPF performance using MODE technique**

  - **Thunderstorm case valid time:**

    2000 LST 01 、 2000 LST 02 July 2017

  - **Radius (R) = 15 km smoother**

  - **Thresh (T) $\geqq$ 20 mm for 6 hr accumulated rainfall**
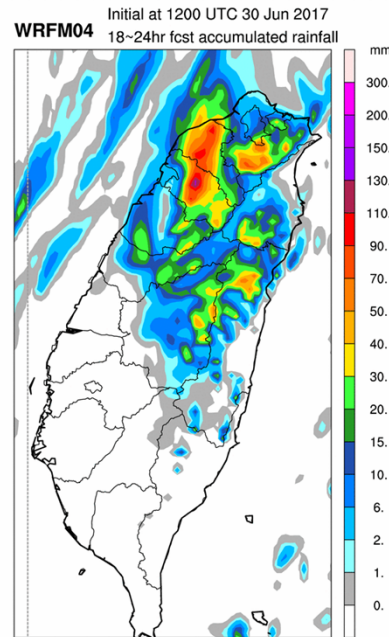
  - **18~24 hrs forecast lead time**

107年天氣分析與預報研討會

Afternoon thunderstorm case

OBS

QPESUMS
2017070106
~ 2017070112 UTC

3 km

WRFM04
Initial at 1200 UTC 30 Jun 2017
18~24hr fcst accumulated rainfall

OBS

QPESUMS
2017070106
~ 2017070112 UTC

OBJECT_ID

3 km

M04
Initial at 1200 UTC 30 Jun 2017
18~24hr fcst accumulated rainfall

OBJECT_ID
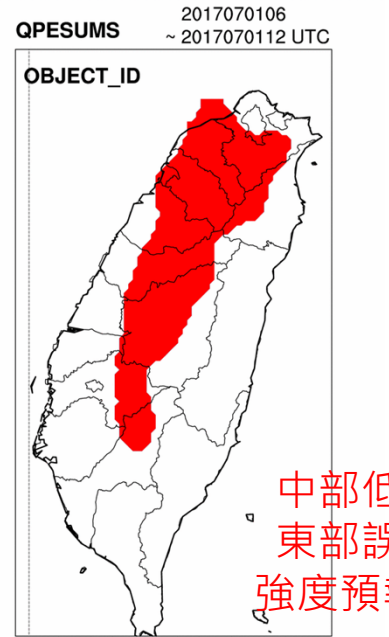
中部低估
東部誤報
強度預報佳
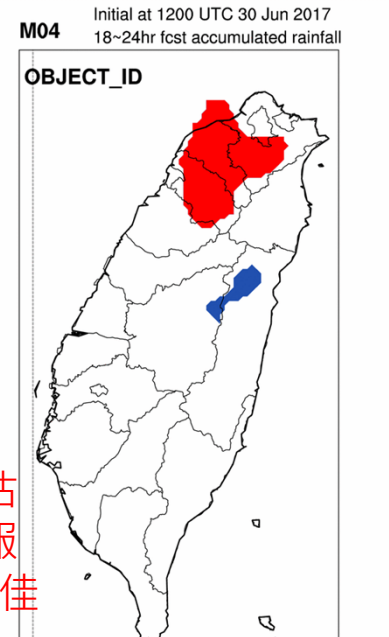
Valid time：

2017.7.1 20 LST

CLUS PAIR	CEN DIST	ANG DIFF	FCST AREA	OBS AREA	INTER AREA	UNION AREA	SYMM DIFF	FCST INT 50	OBS INT 50	FCST INT 90	OBS INT 90	TOT INTR
1	20.61	4.77	398	1258	398	1258	860	30.81	31.89	74.90	72.30	0.9254

- Area ratio: 0.32
- Median intensity ratio: 0.97
- Centroid distance: 20.61
- Total interest: 0.925
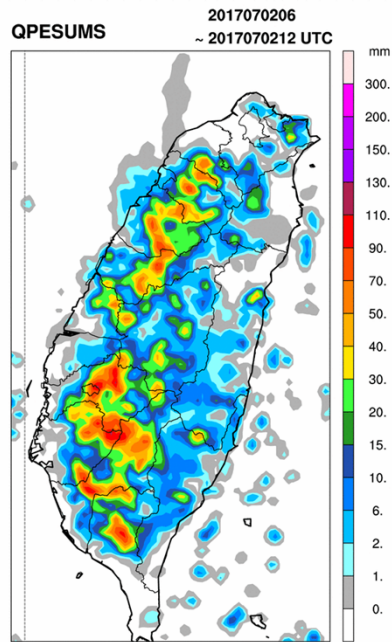
107年天氣分析與預報研討會

Afternoon thunderstorm case

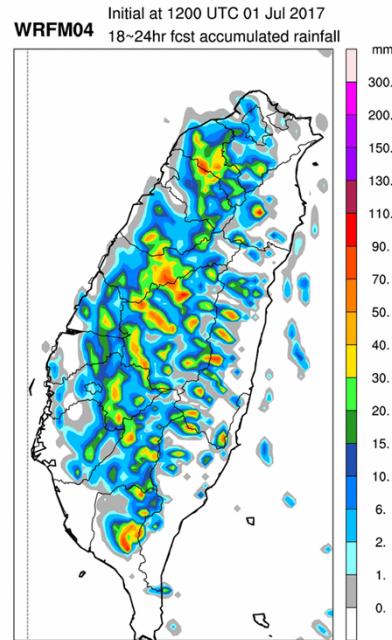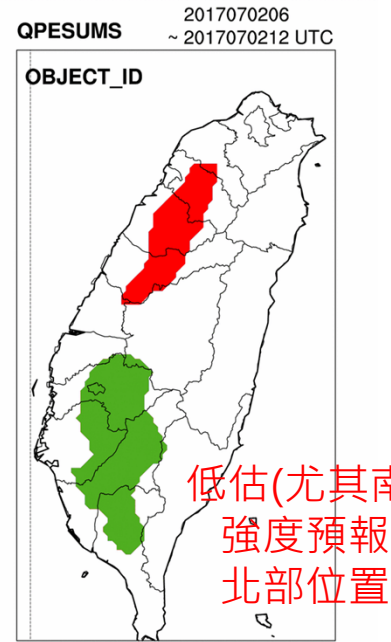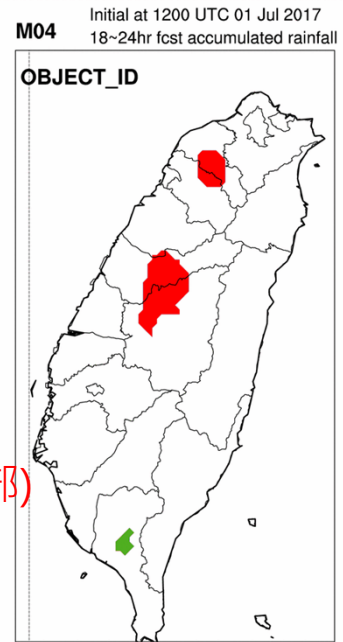低估(尤其南部)
強度預報佳
北部位置佳

Valid time：

2017.7.2 20 LST

CLUS PAIR	CEN DIST	ANG DIFF	FCST AREA	OBS AREA	INTER AREA	UNION AREA	SYMM DIFF	FCST INT 50	OBS INT 50	FCST INT 90	OBS INT 90	TOT INTR
1	4.78	6.76	201	301	91	411	320	26.51	28.62	57.47	58.84	0.9819
2	20.96	22.74	21	594	21	594	573	30.00	29.23	82.99	75.27	0.8736

- Area ratio: 0.67 0.04
- Median intensity ratio: 0.93 1.02
- Centroid distance: 4.78 20.96
- Total interest: 0.982 0.874

Summary

- **Evaluation of high-impact weather is moving toward use of spatial verification methods.**

- **Object-based techniques (MODE) have been applied to assess QPF performance of CWB WRF for Meiyu frontal and afternoon thunderstorm rainfall in 2017.**

- **MODE verify the location, size, shape, intensity, and other attributes of the object, and are therefore very intuitive in their interpretation.**

107年天氣分析與預報研討會

Future Work

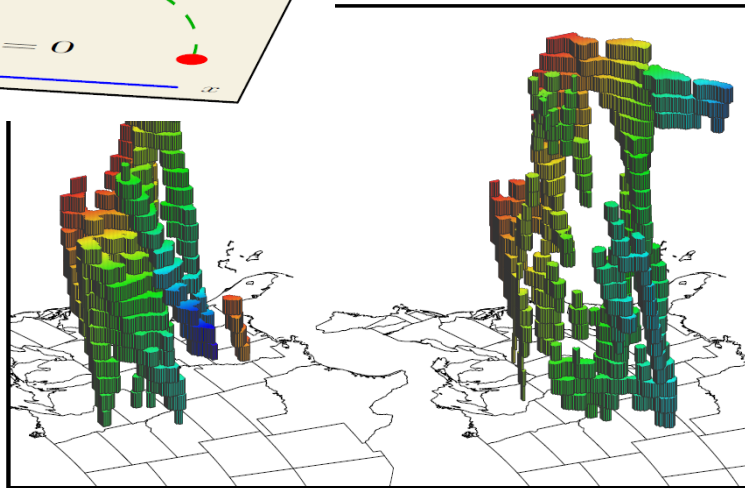- **Apply to evaluate the 3 km or 2 km model improvement activities performance.**

- **Fine-tune to enhance high-resolution QPF characteristics over terrain (mountain/plain).**

- **How to evaluate the ensemble QPF performance?**

- **How to evaluate model radar maximum reflectivity performance?**
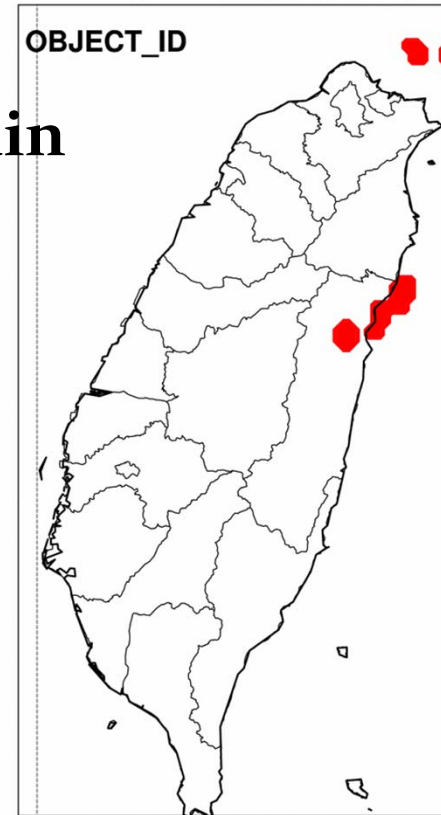
- **How to evaluate the storm initiation?**

107年天氣分析與預報研討會

Valid time：

2017.7.1 14~20 LST
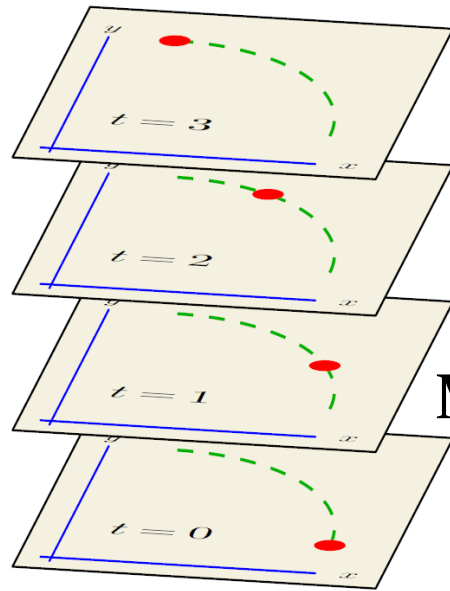
M04   Initial at 1200 UTC 30 Jun 2017
       23~24hr fcst accumulated rainfall

OBJECT_ID

MODE Time Domain

Thank You ☺