



提高解析度對於TWRF颱風數值預報系統預報能力之影響評估

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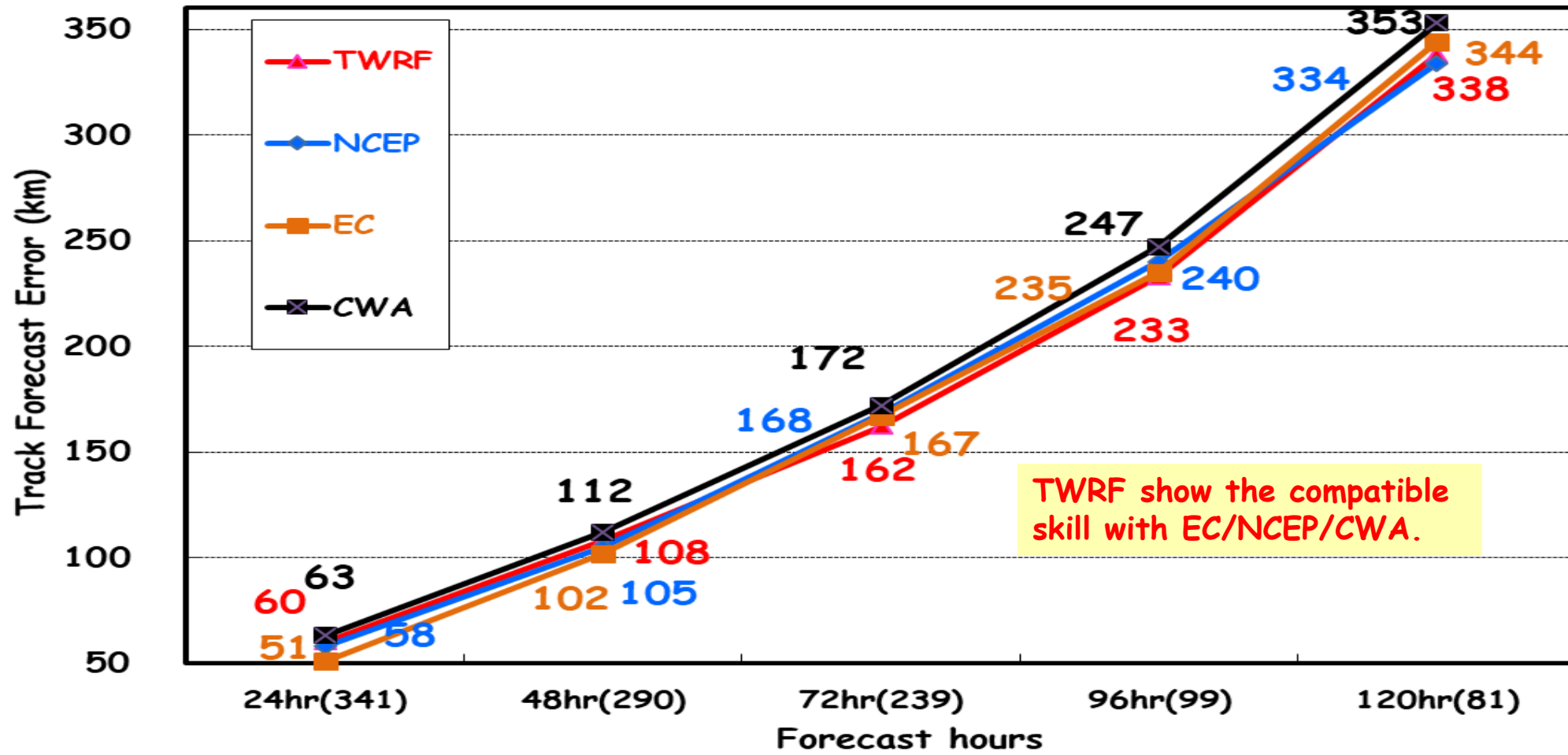
中央氣象署科技發展組



大綱

1. TWRF模式現況介紹
2. 模式解析度提升至10/2km之影響評估
3. 颱風降雨個案
4. 總結及未來工作

TWRF、EC、NCEP、CWA Typhoon track forecast error (homogeneous) -- 2023



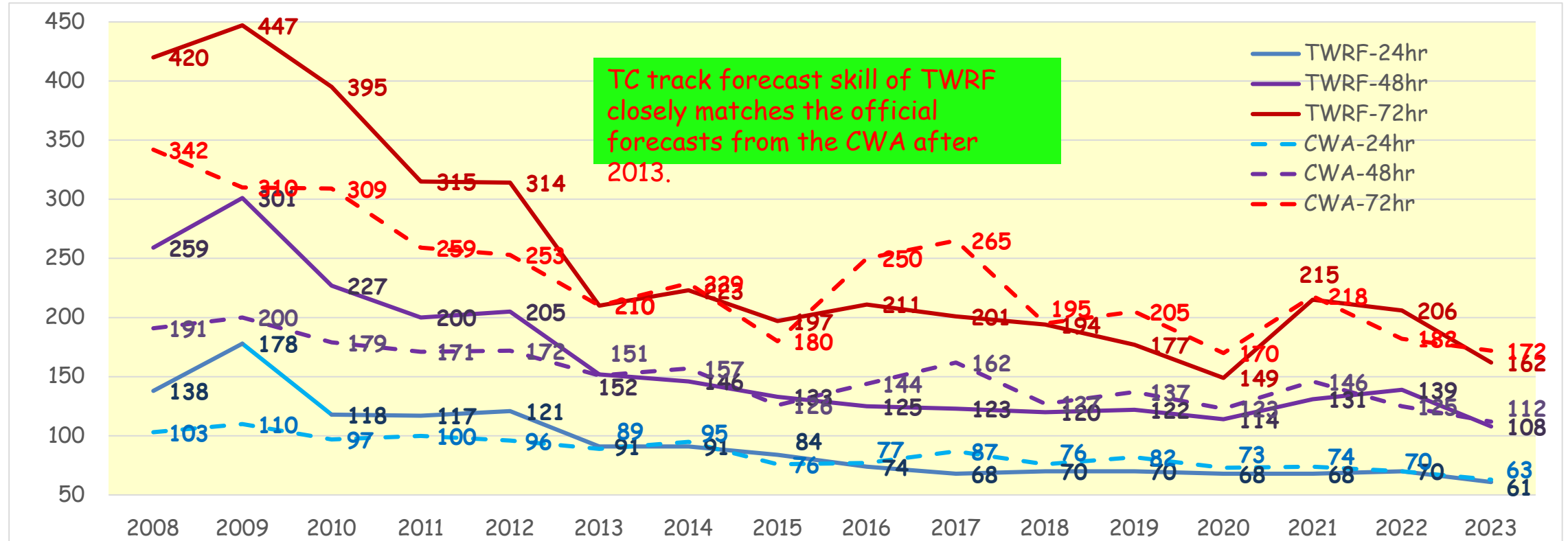
Comparison between TWRF & CWA for the TC Track Forecast Errors

Track mean forecast errors (km)

WRF(2008-2009)

TWRF V1(2010-2015)

TWRF V2(2016-2023)



WRF
Operation

TC bogus

Partial cycling
Outer loop
New trigger KF

TC Relocation

New TC
initialization

Blending
45km(2013) → →
45/15km(2014)

Two-way
interaction

TWRF V2
→ 15/3km
CLS of Blending
300km

WRF_V3.3.1
→ V3.8.1

3DVAR →
Hybrid 3DVAR

FV3 GFS

LBC 29 →
45 layers

Analysis
blending
fine tune

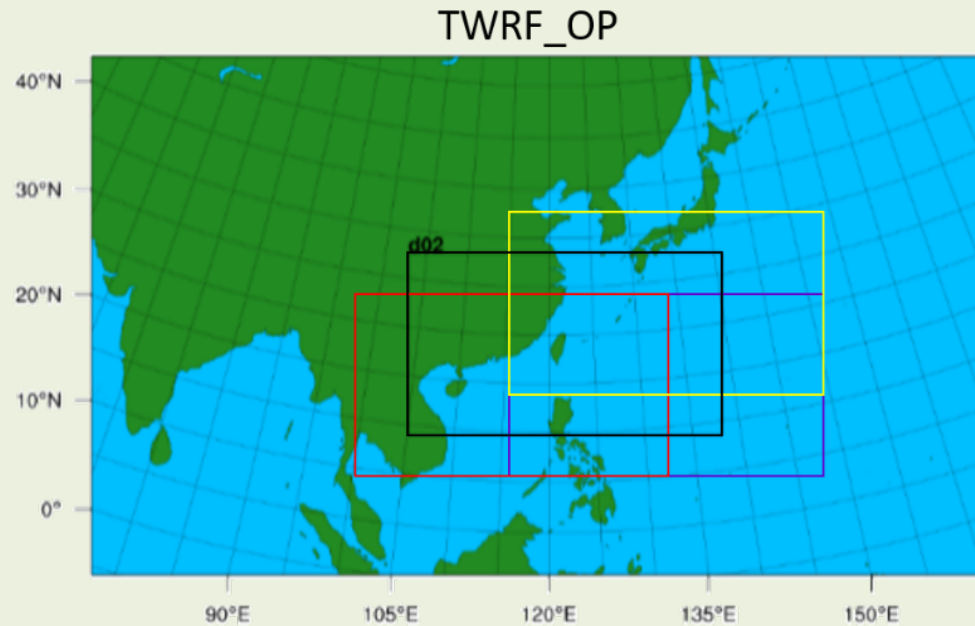
Note : TWRF with
6hr lag to CWA

Hsiao et al. 2010, 2012, 2013, 2015, 2020

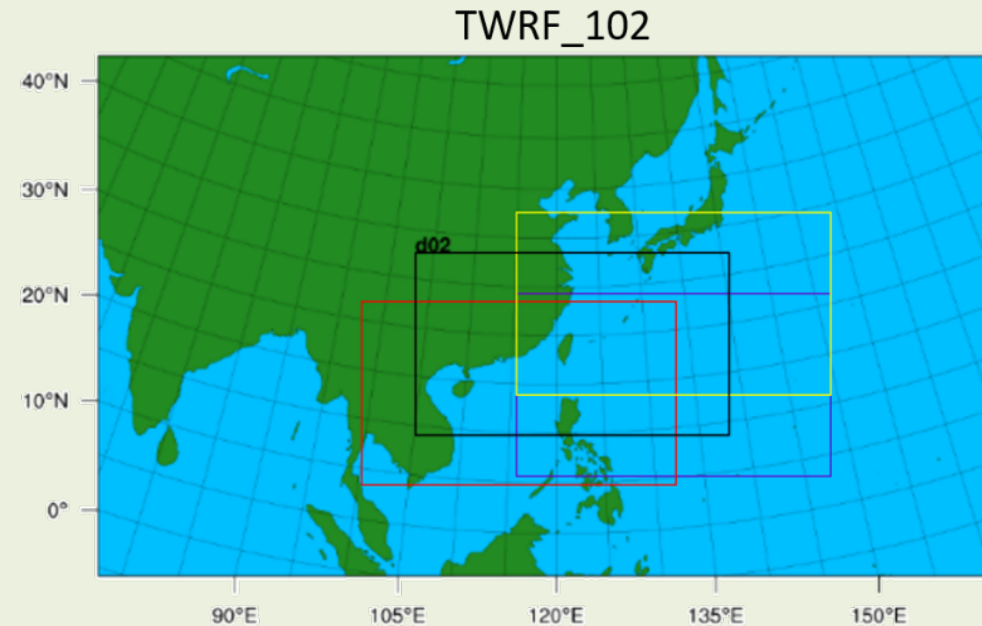


TWRF模式解析度提升至10/2公里之影響評估

TWRF Domain Configuration



Resolution	Grid points	Vertical level	Model top
15 km	662 X 386	52	20 hPa
3 km	1161 X 676	52	20 hPa



Resolution	Grid points	Vertical level	Model top
10 km	993 X 579	64	10 hPa
2 km	1741 X 1016	64	10 hPa

- 使用相同運算資源，10/2km花費時間約為目前作業版本的3.5倍
- 提高運算資源，10/2km 預報120小時需花費2小時 (目前作業約1.5小時)

TWRF模式解析度提升至10/2公里之影響評估

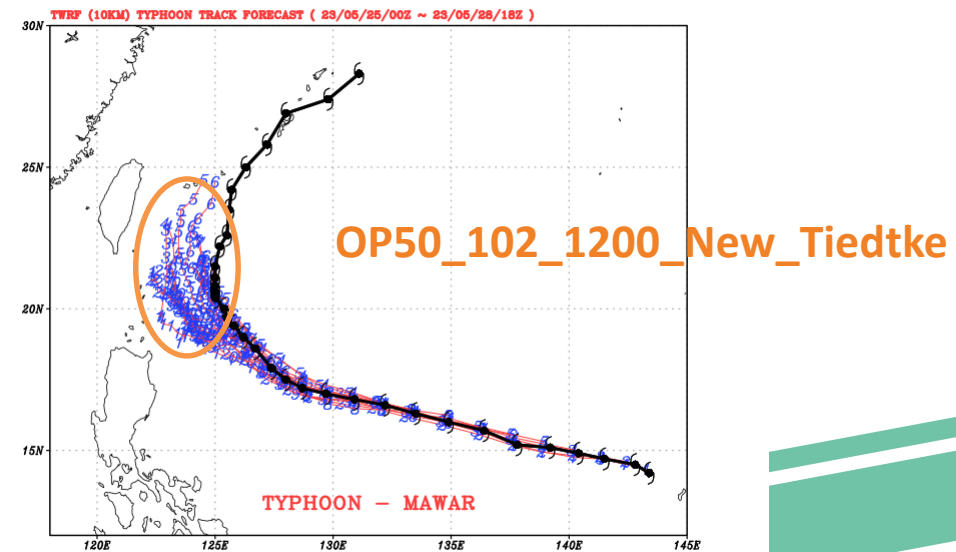
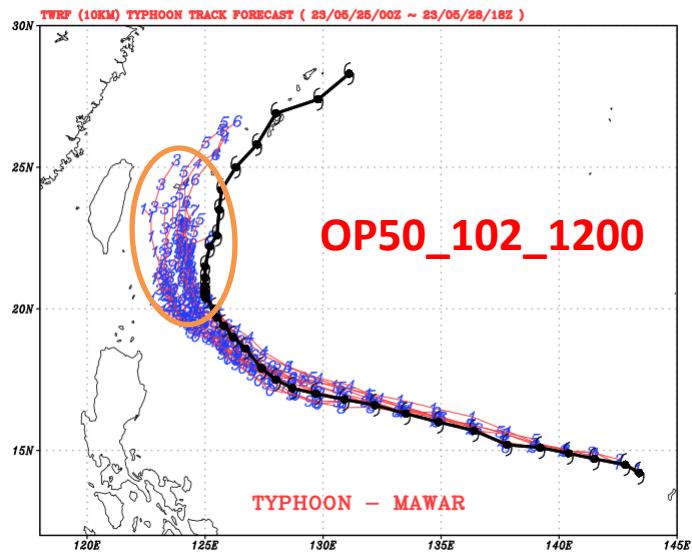
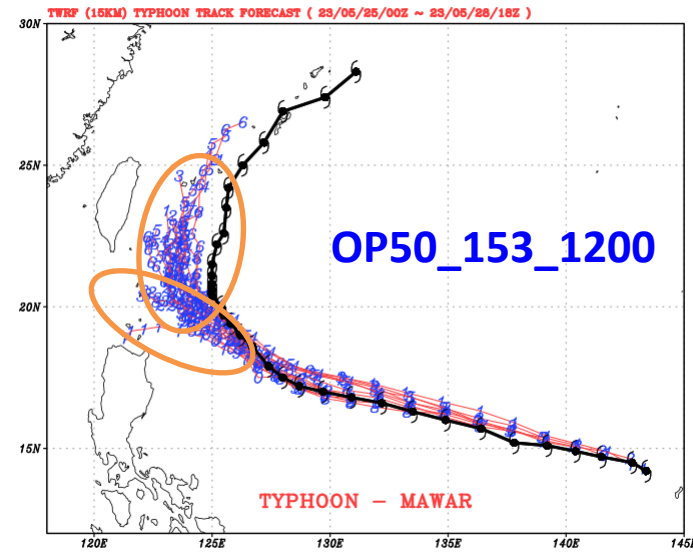
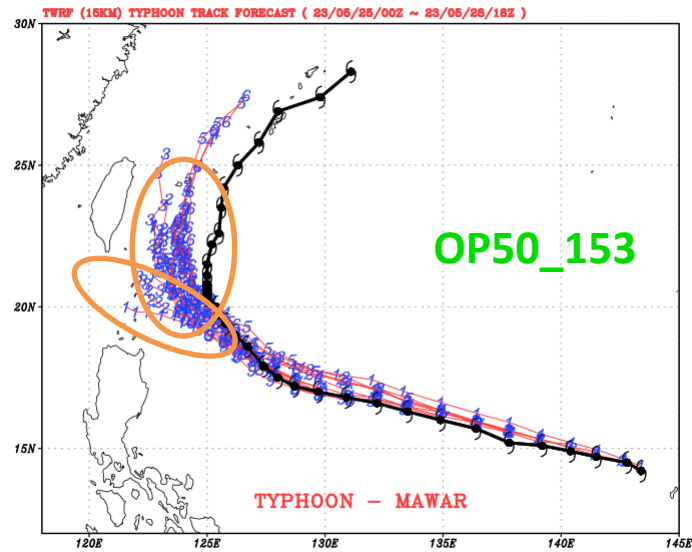
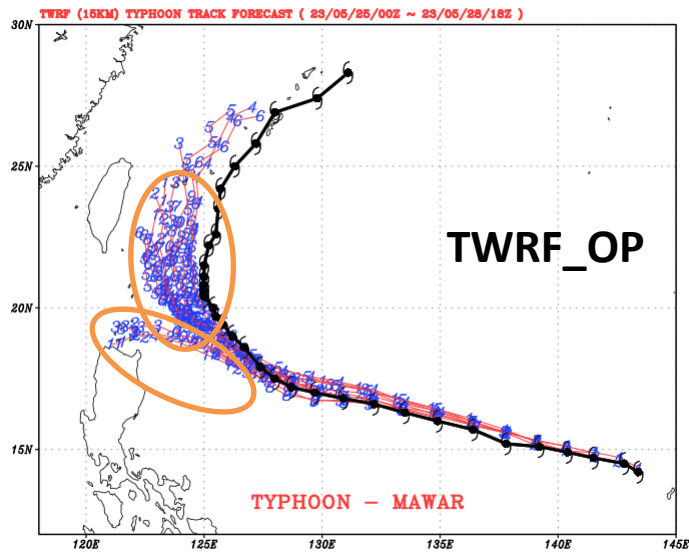
實驗設計及個案選取

	Resolution	Model Ver.	Blending cut-off length	Cumulus physics
TWRF_OP	15/3 km	OP44 (WRF 381)	300 km	Kain-Fritsch
OP50_153	15/3 km	OP50 (WRF 442)	300 km	Kain-Fritsch
OP50_153_1200	15/3 km	OP50 (WRF 442)	1200 km	Kain-Fritsch
OP50_102_1200	10/2 km	OP50 (WRF 442)	1200 km	Kain-Fritsch
OP50_102_1200_NewTiedtke	10/2 km	OP50 (WRF 442)	1200 km	New Tiedtke

- IC : partial cycling + analysis blending with hybrid of NCEP/EC
- LBC : hybrid of NCEP/EC
- BBC : ECMWF SST

typhoon	Intensity	Movement	Date	Cases no. (D01 / D02)
* MUIFA (梅花) (2212)	Medium-strength	Recurved	2022/09/08/00Z~09/10/00Z	9 / 9
* MAWAR (瑪娃) (2302) @	Strong	Recurved	2023/05/25/00Z~05/28/18Z	16 / 16
* GAEMI (凱米) (2403)	Strong	Westward	2024/07/20/06Z~07/23/18Z	15 / 15
Total cases (2022年 ~ 2024年, 3個颱風)				40 / 40

註：*，發佈警報之颱風。@，慢速颱風，作業強度預報過強

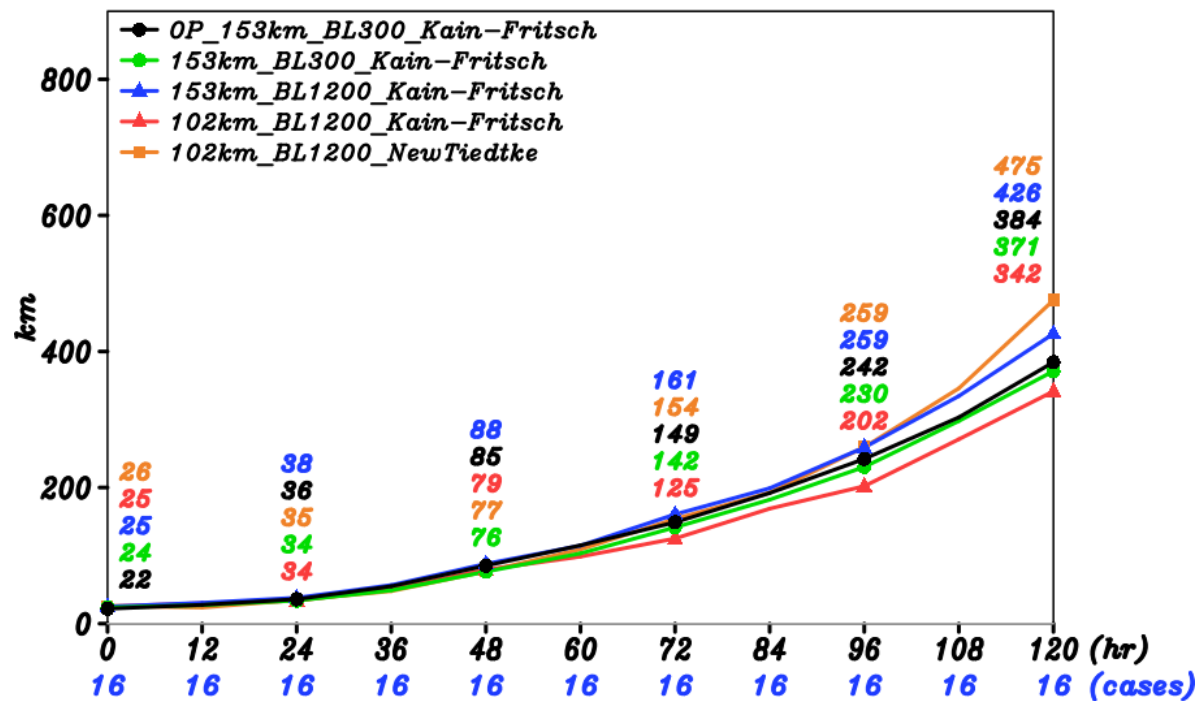


TY MAWAR (2023)

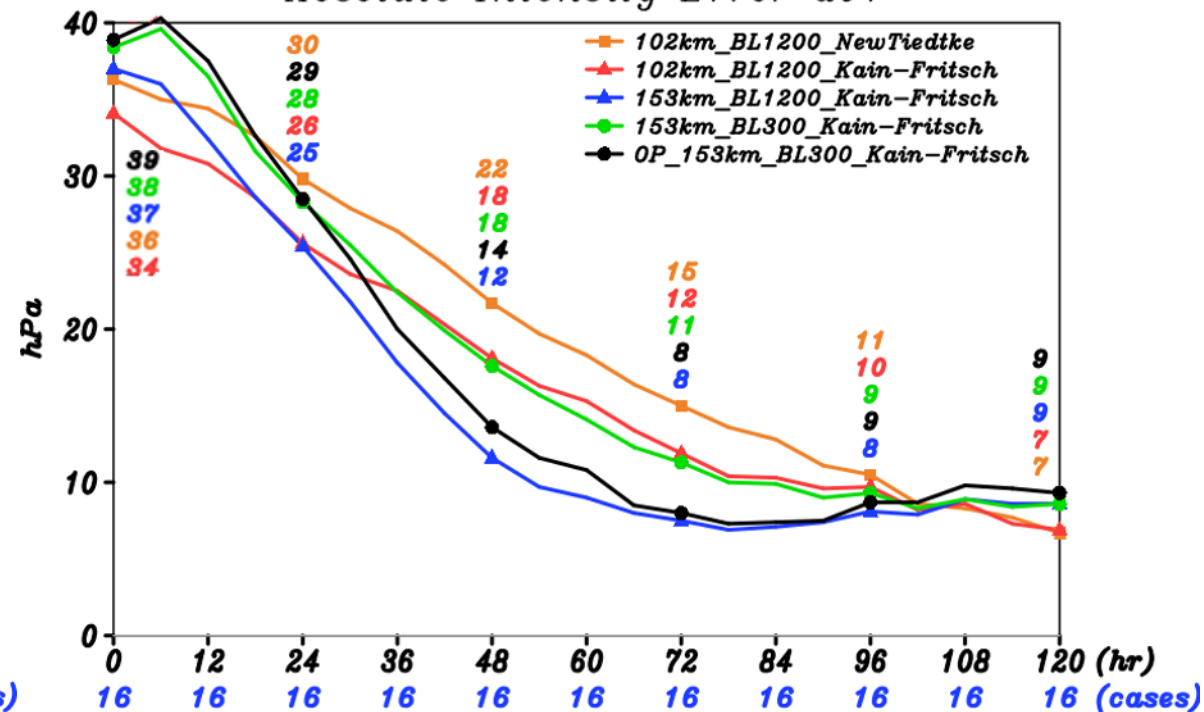
D01: Domain 1
(15 or 10 km)

颱風路徑及強度預報校驗

Track Error d01

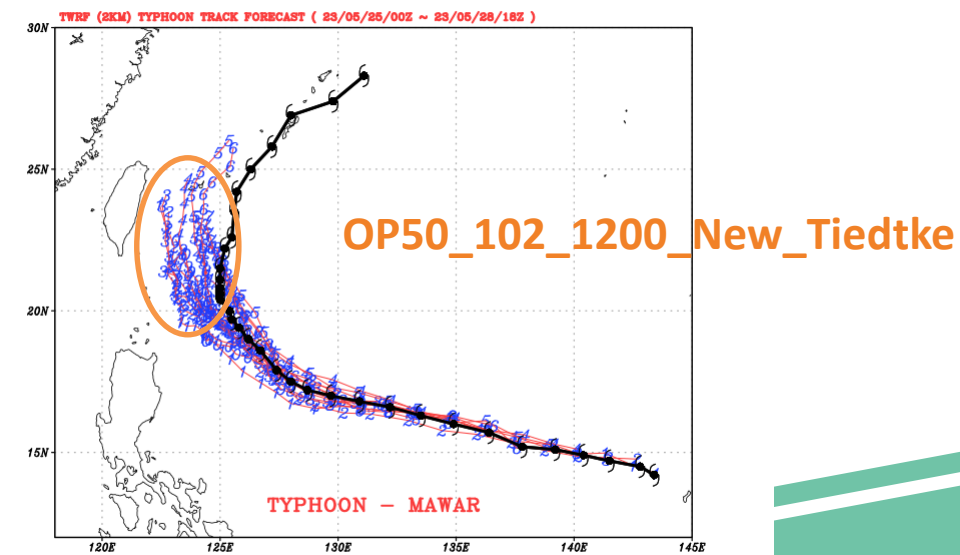
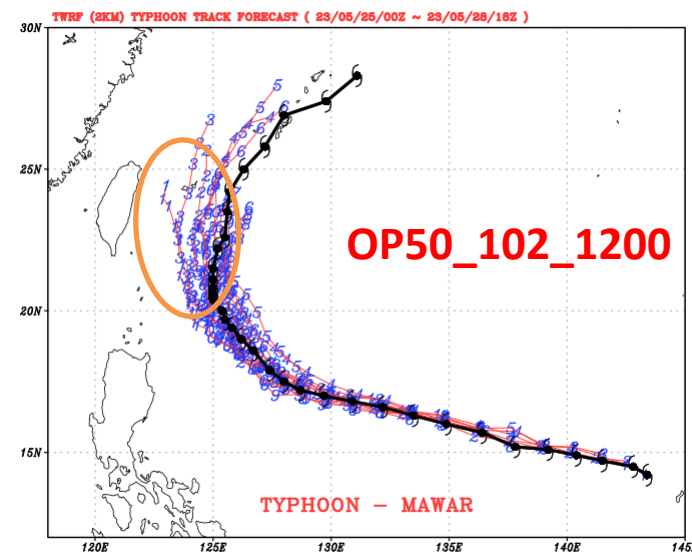
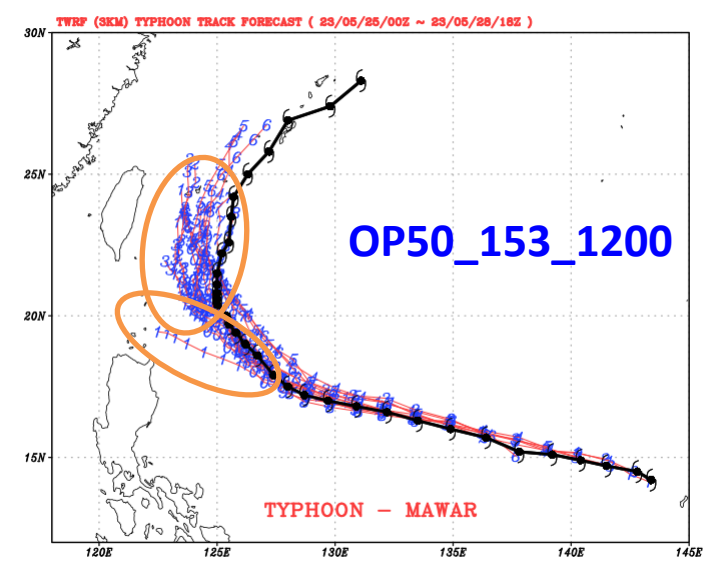
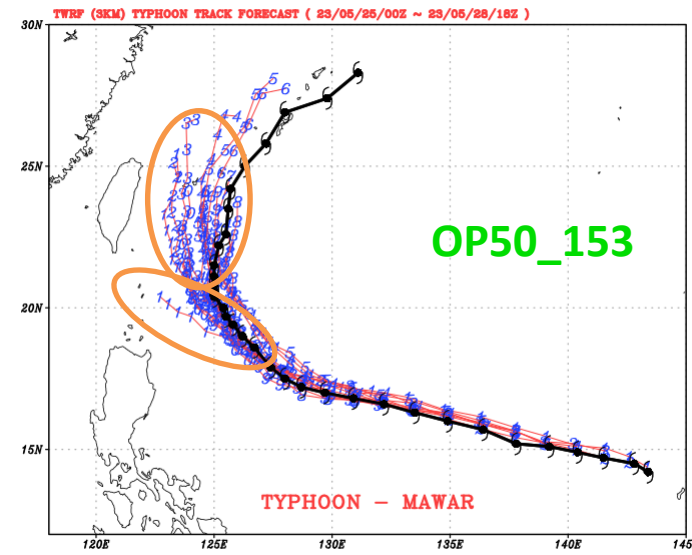
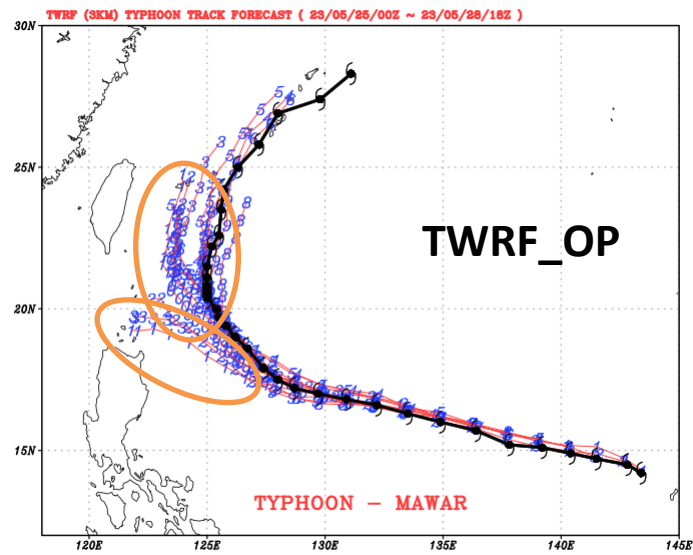


Absolute Intensity Error d01



TY MAWAR (2023)

D01: Domain 1
(15 or 10 km)

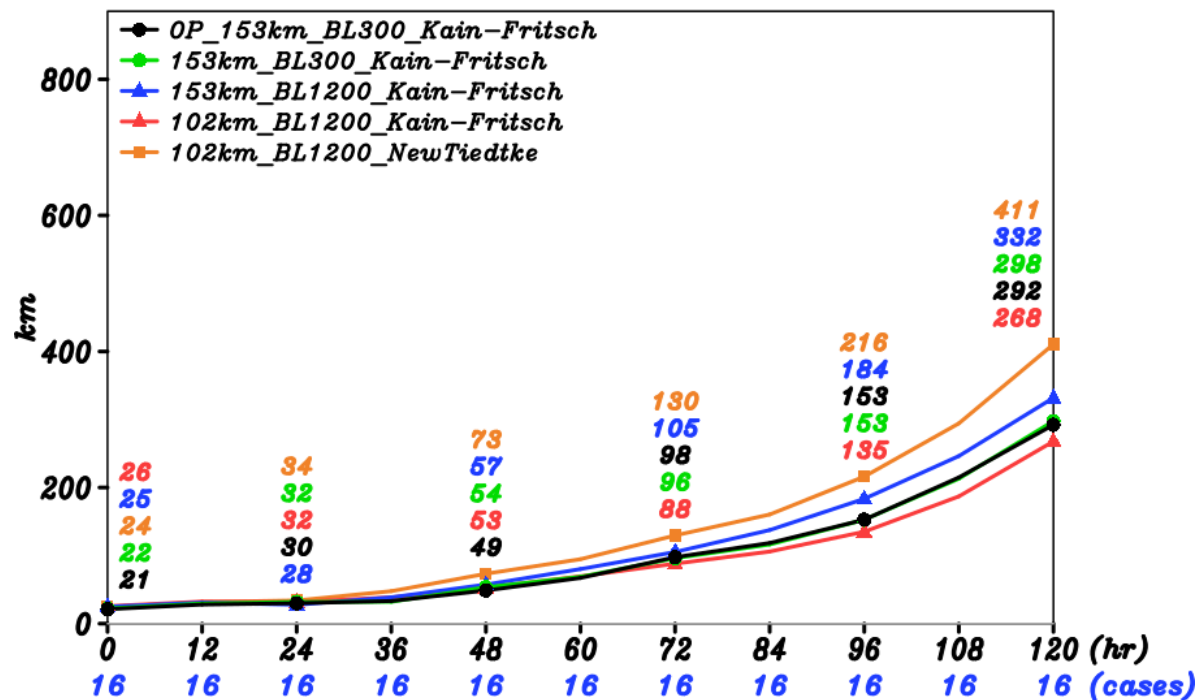


TY MAWAR (2023)

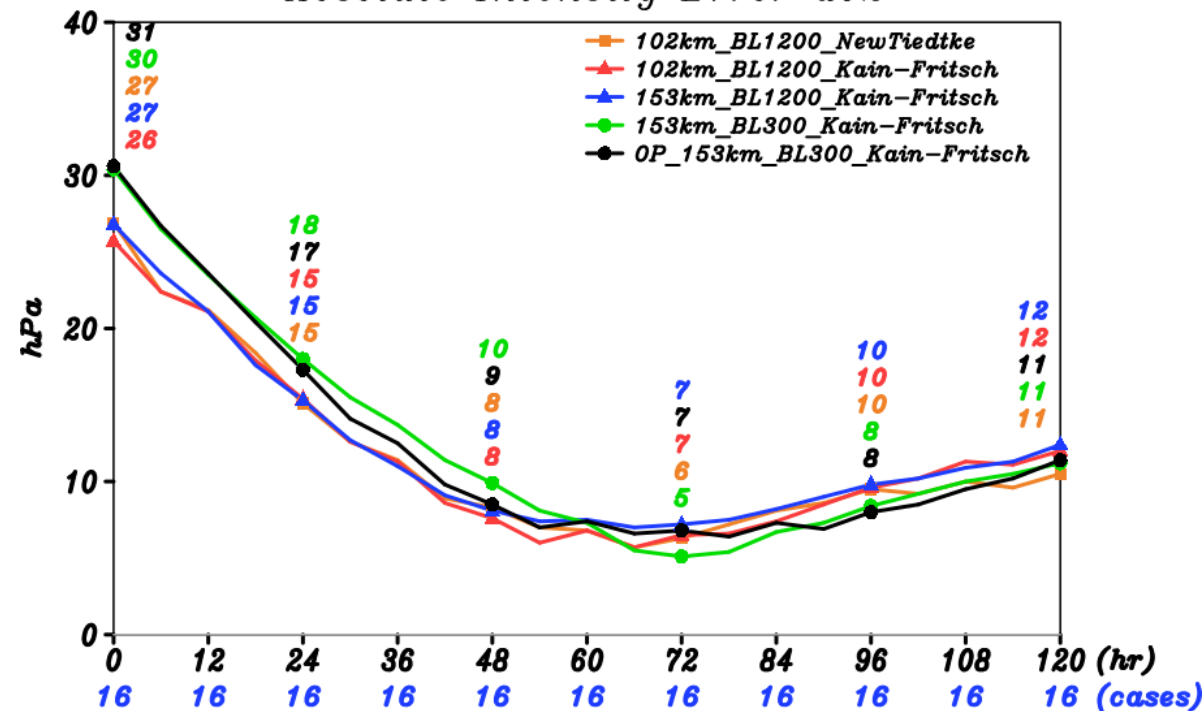
D02: Domain 2
(3 or 2 km)

颱風路徑及強度預報校驗

Track Error d02

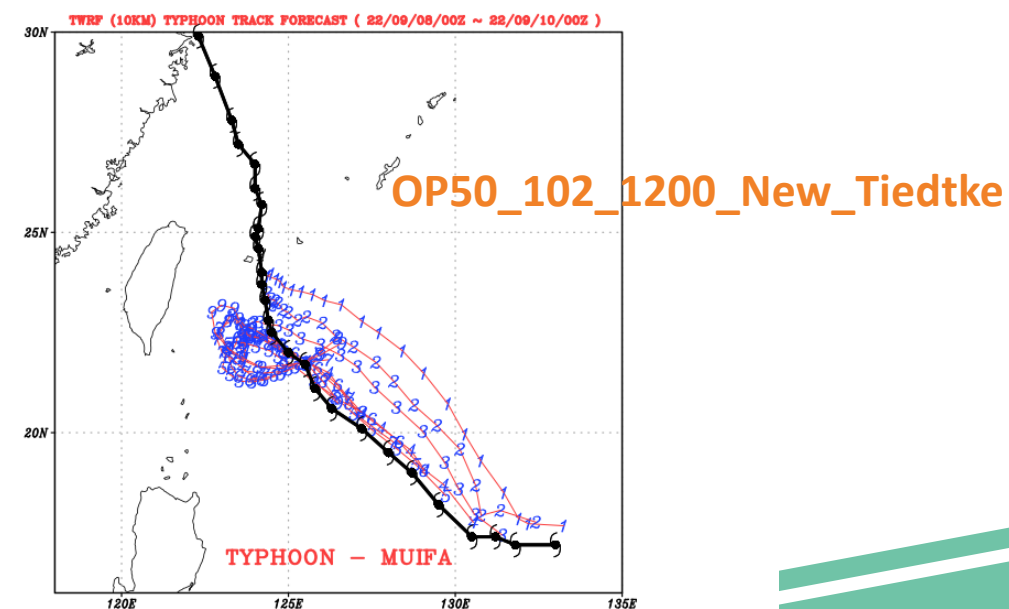
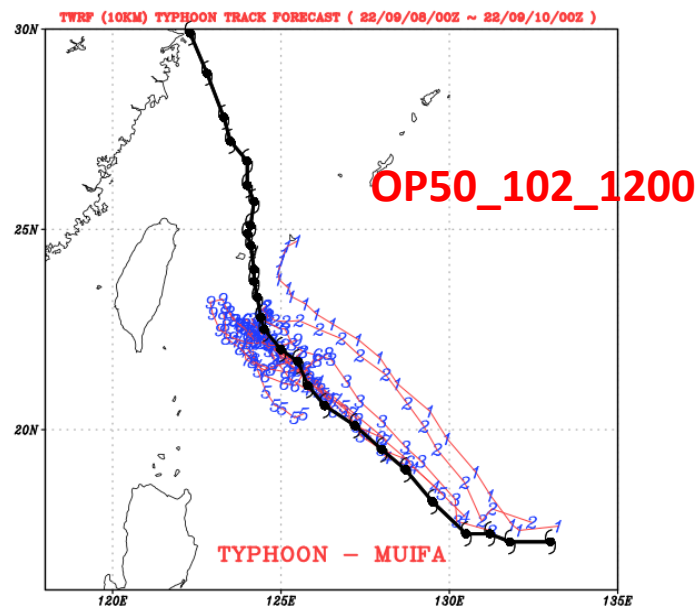
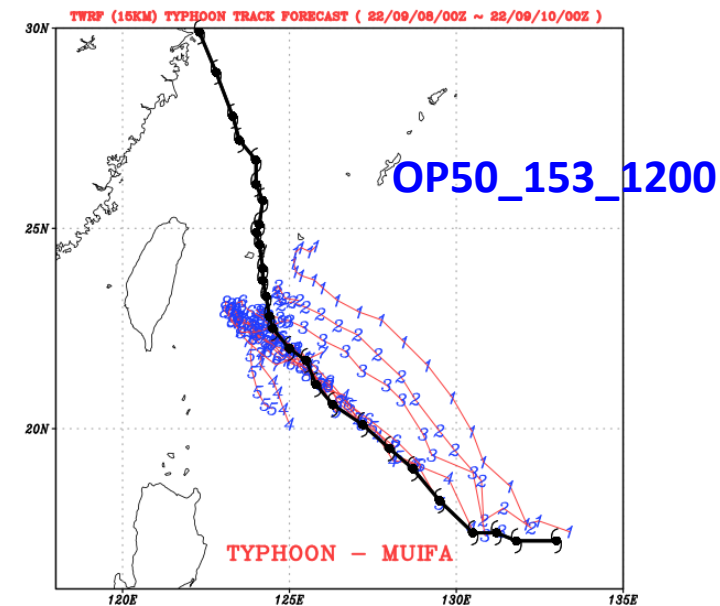
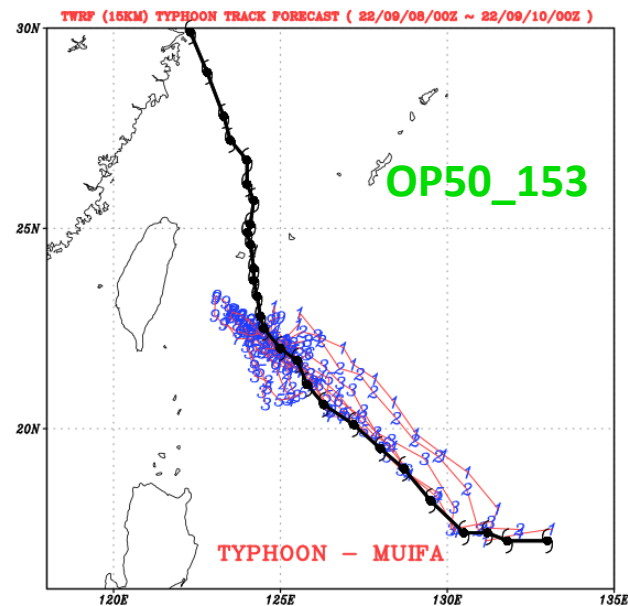
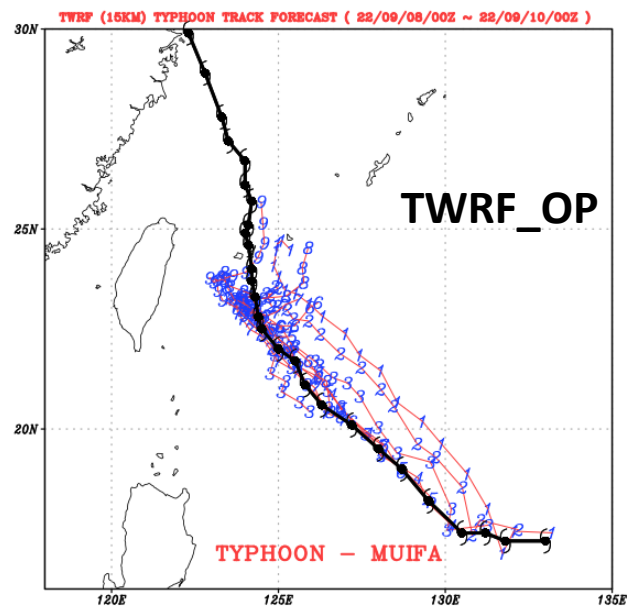


Absolute Intensity Error d02



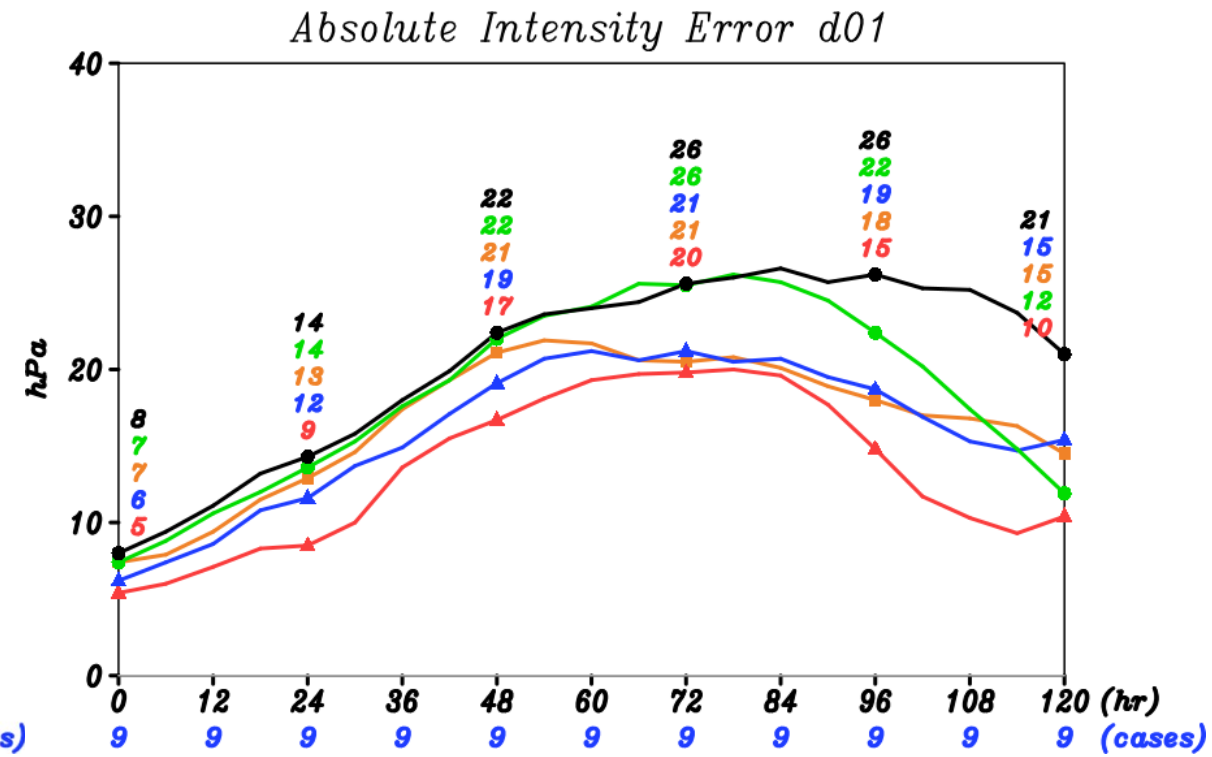
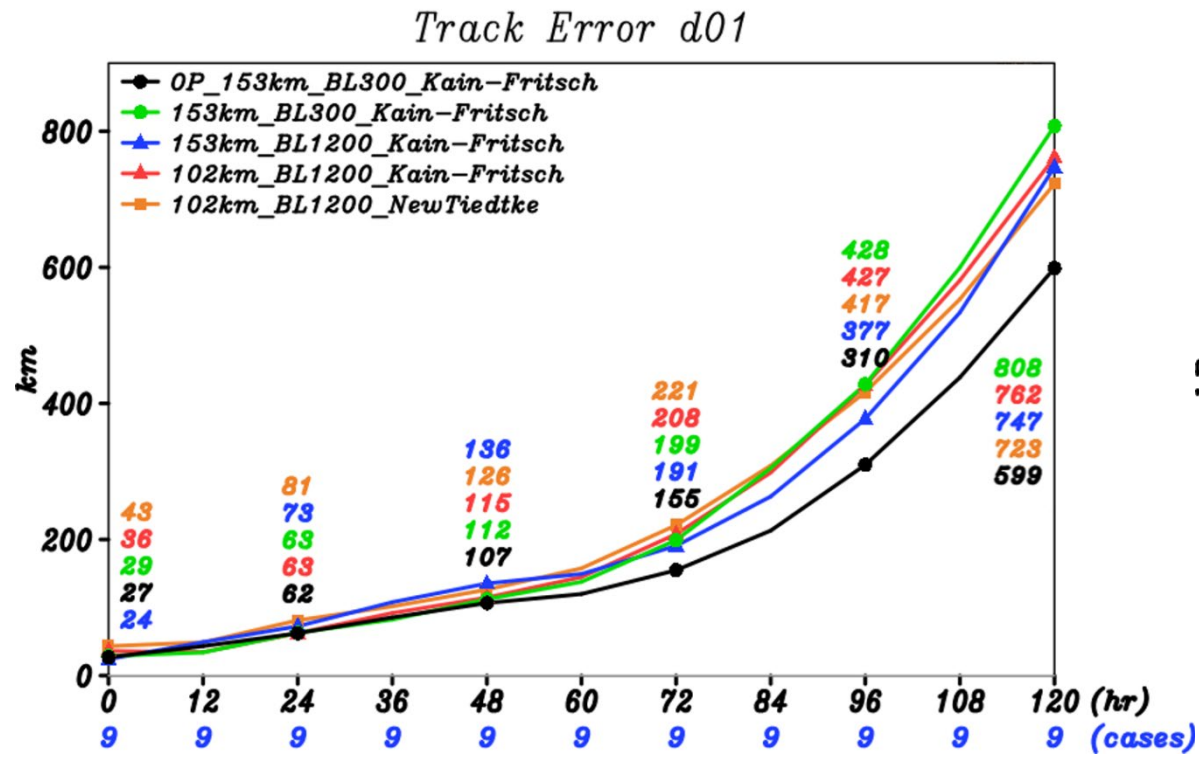
TY MAWAR (2023)

D02: Domain 2
(3 or 2 km)



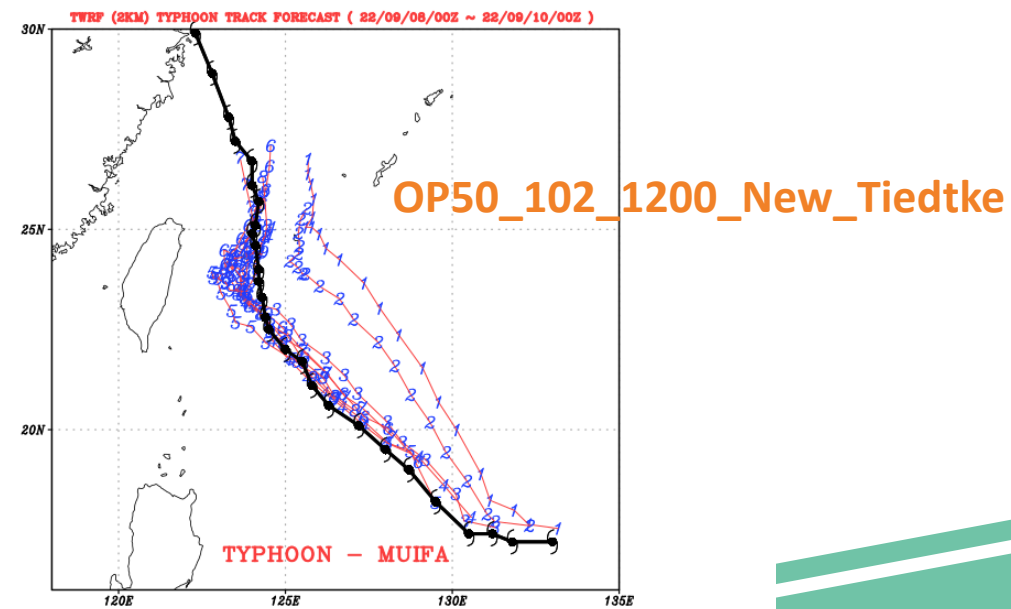
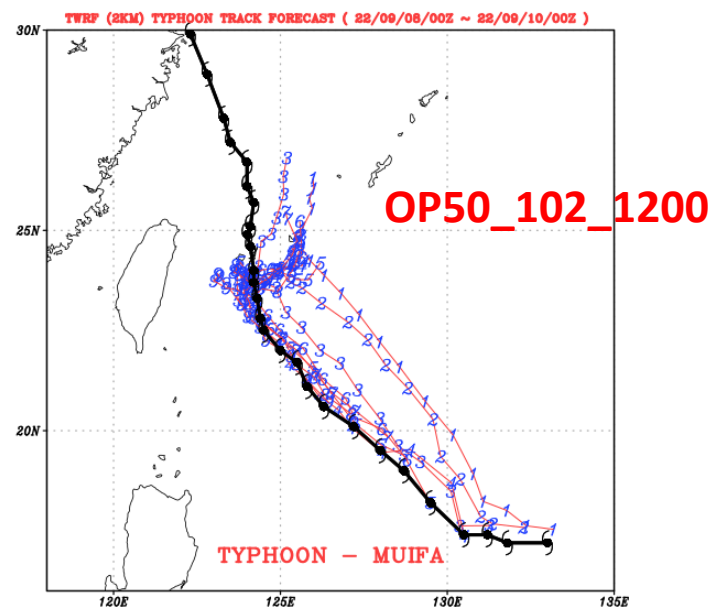
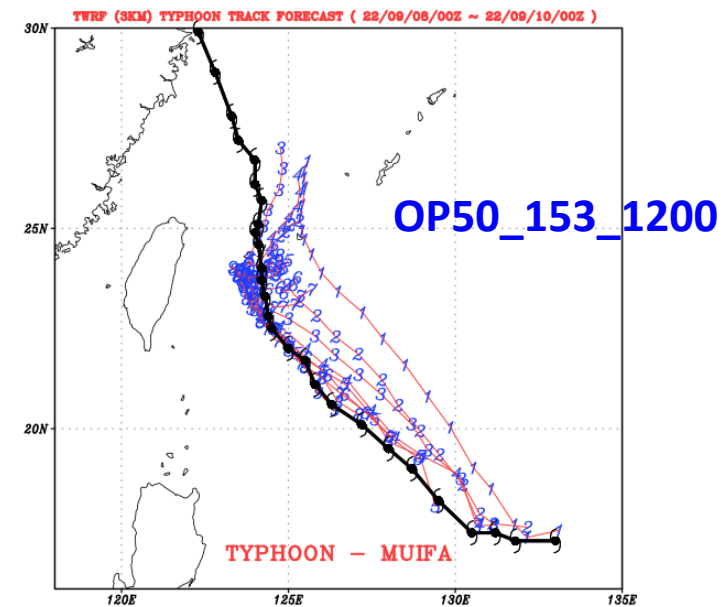
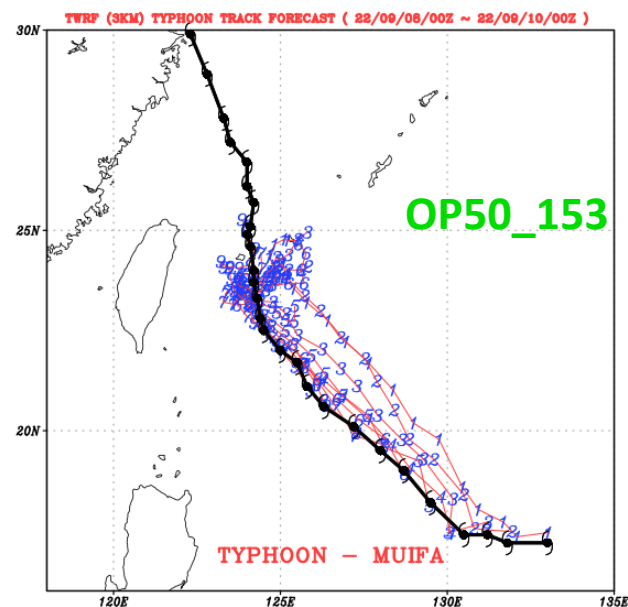
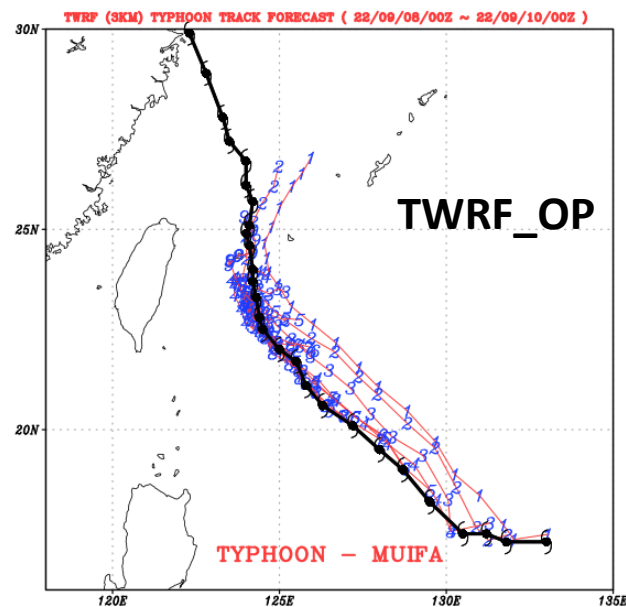
TY MUIFA (2022)

D01: Domain 1
(15 or 10 km)



TY MUIFA (2022)

D01: Domain 1
(15 or 10 km)

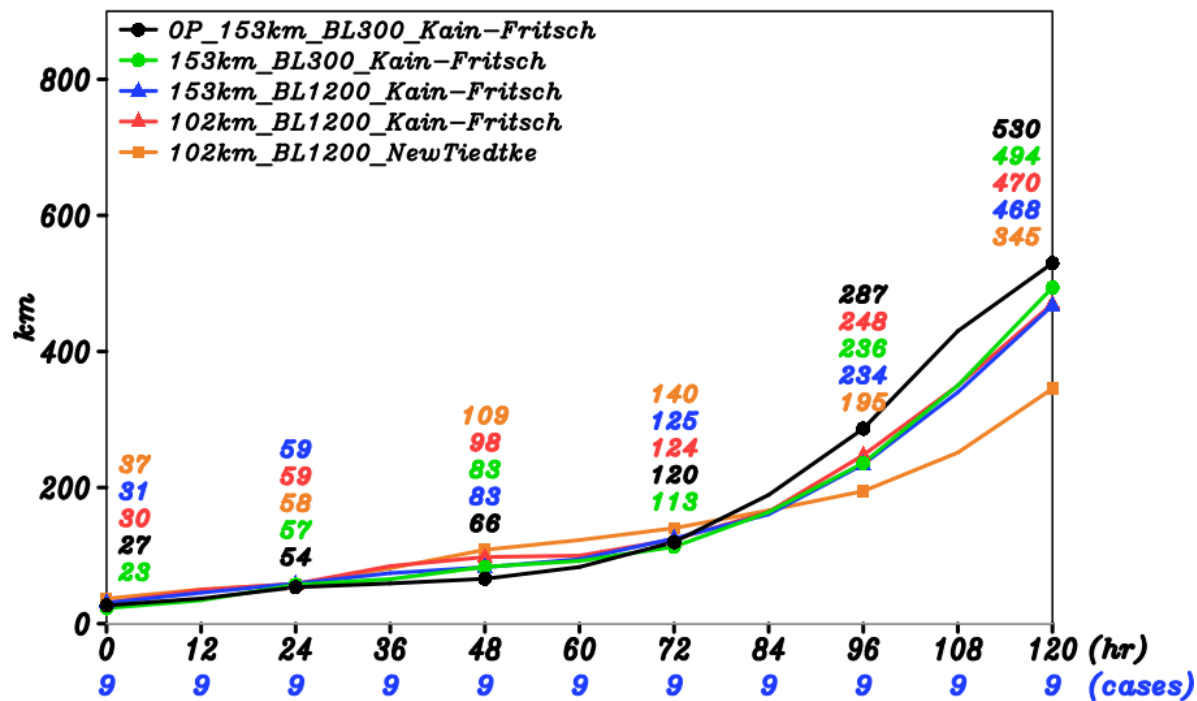


TY MUIFA (2022)

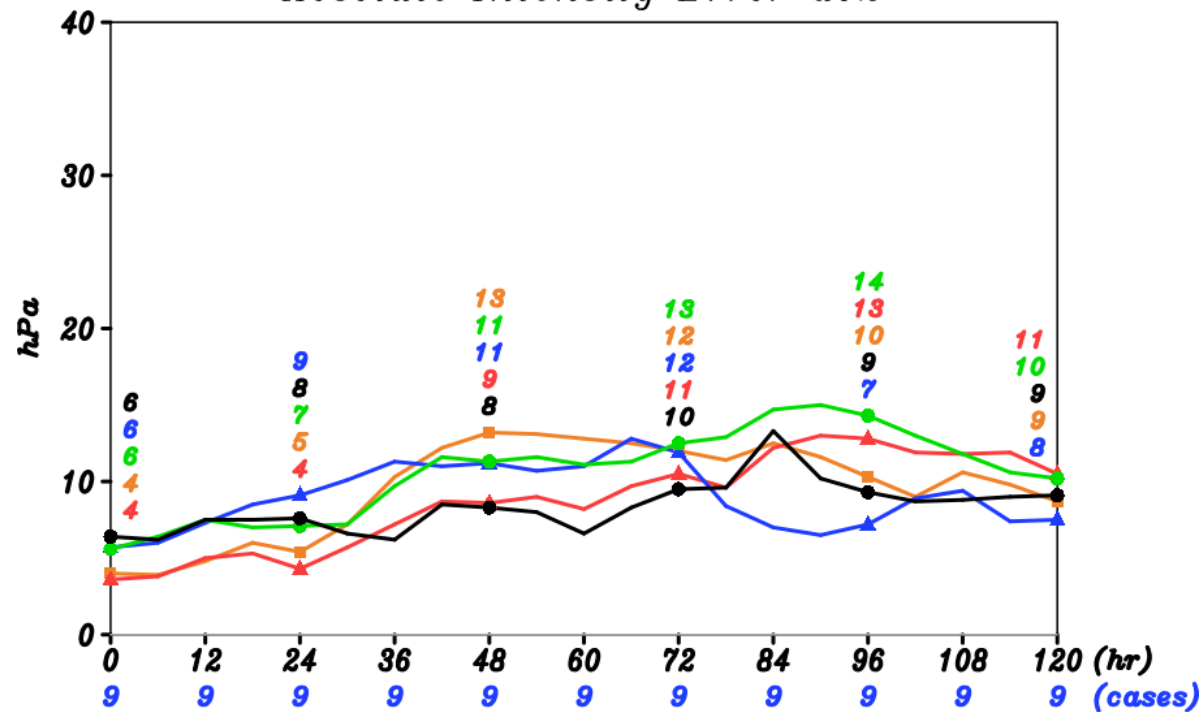
D02: Domain 2
(3 or 2 km)

颱風路徑及強度預報校驗

Track Error d02



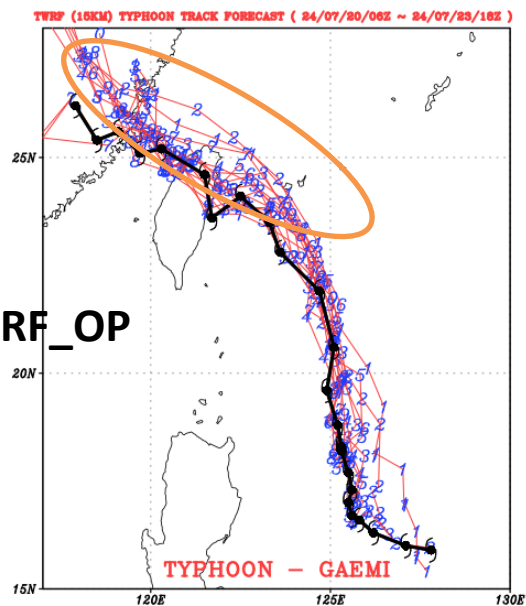
Absolute Intensity Error d02



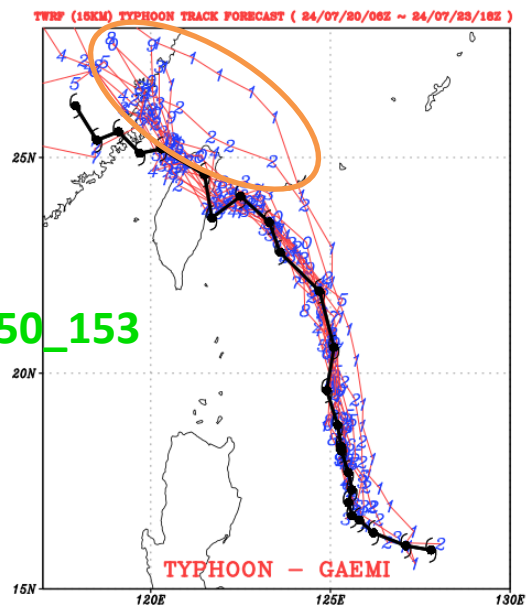
TY MUIFA (2022)

D02: Domain 2
(3 or 2 km)

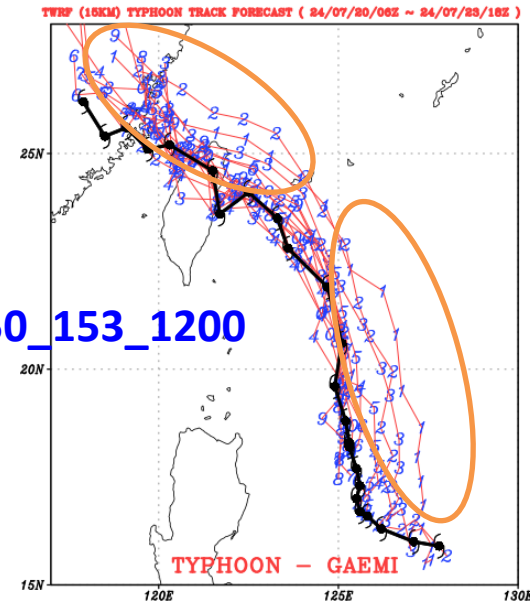
TWRF_OP



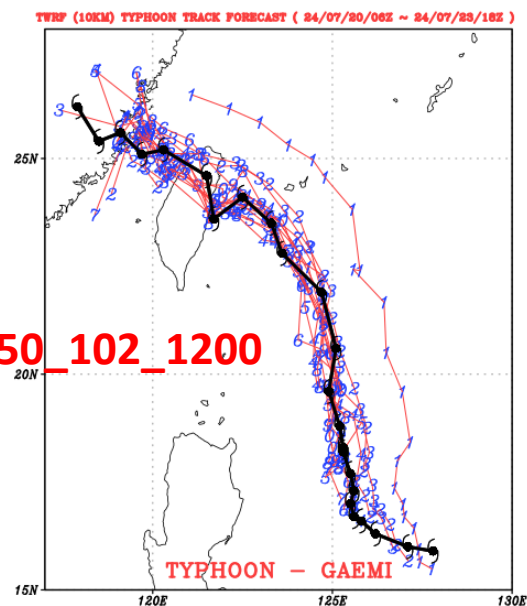
OP50_153



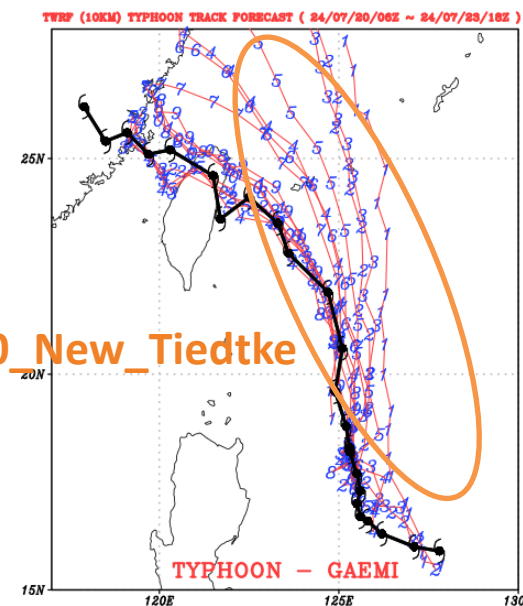
OP50_153_1200



OP50_102_1200



OP50_102_1200_New_Tiedtke

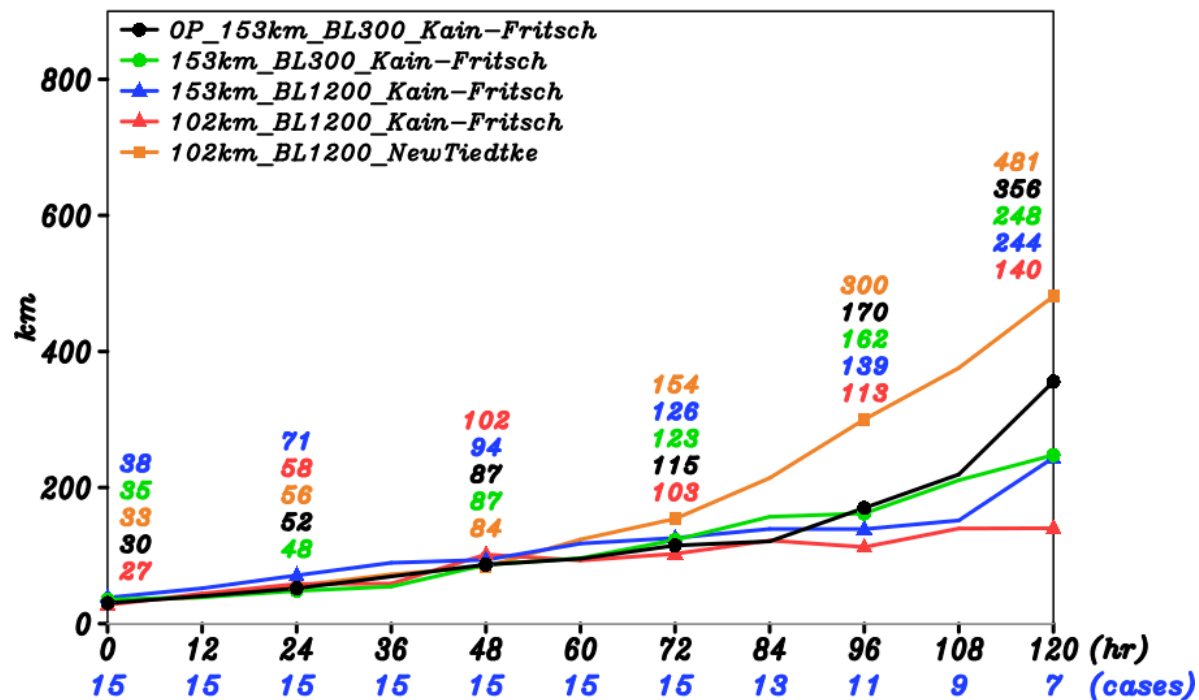


TY GAEMI (2024)

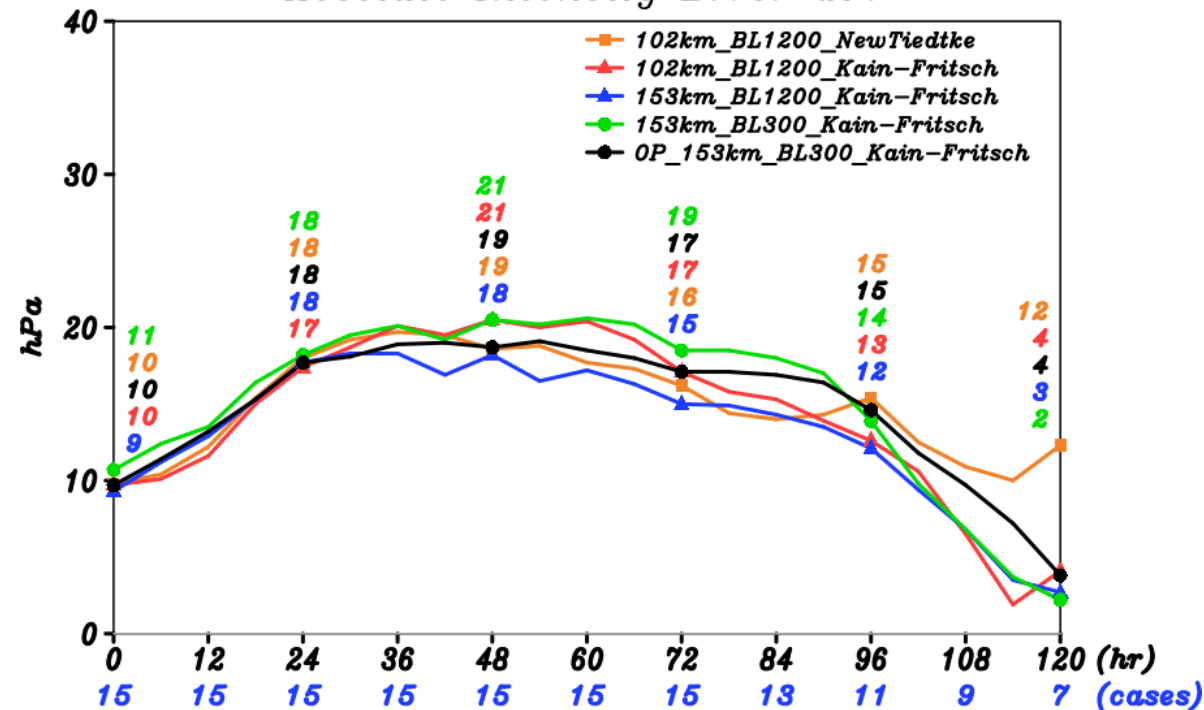
D01: Domain 1
(15 or 10 km)

颱風路徑及強度預報校驗

Track Error d01

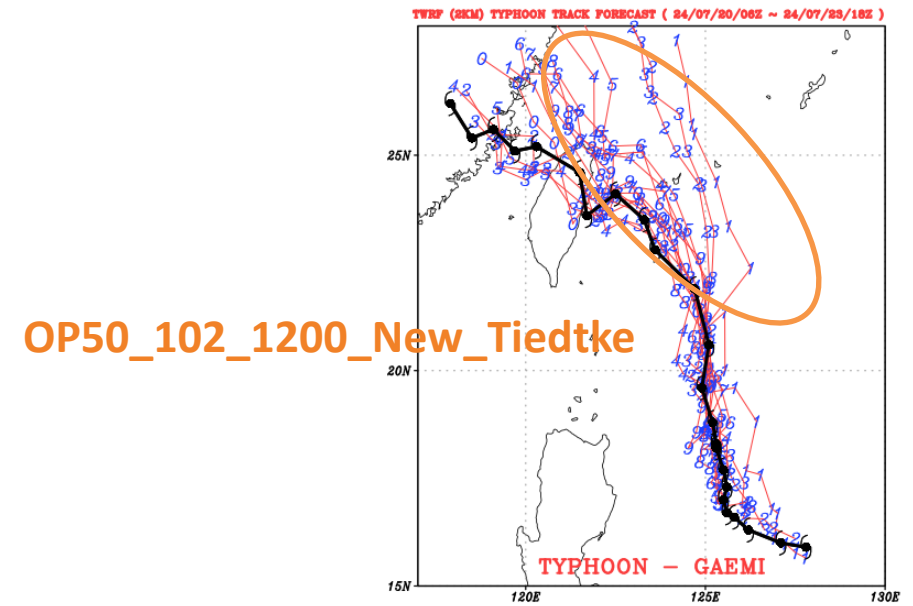
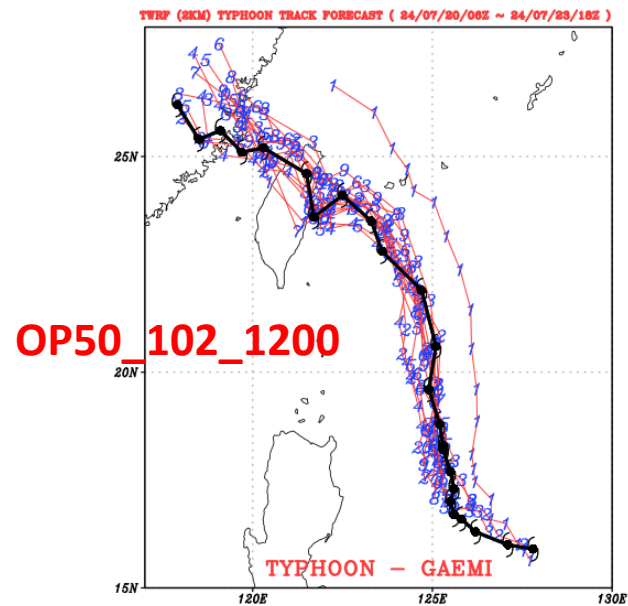
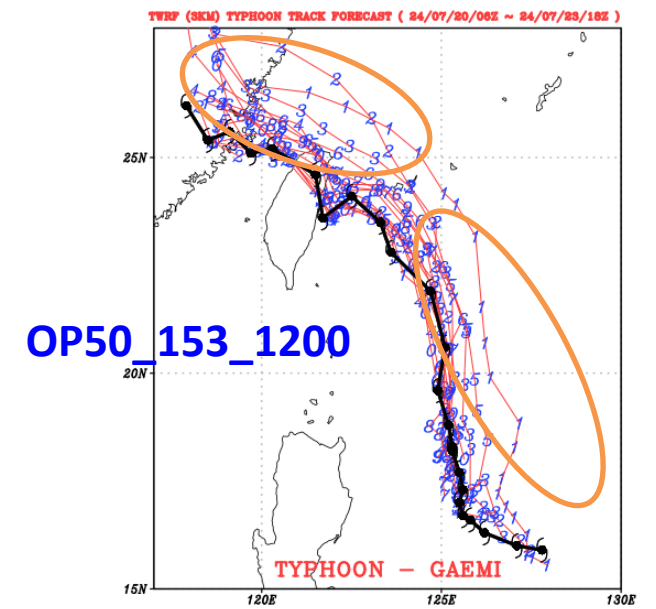
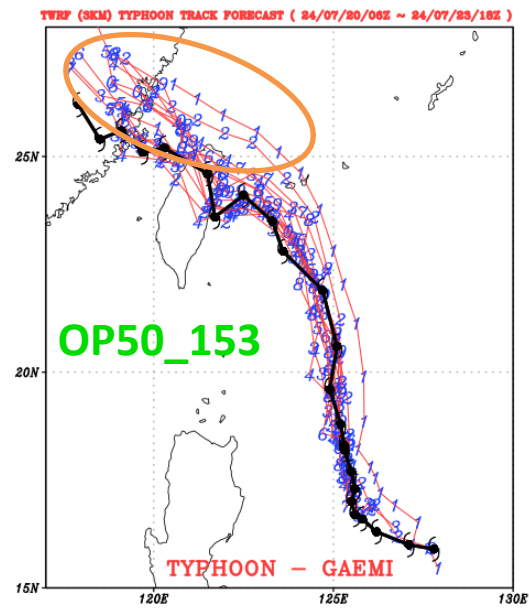
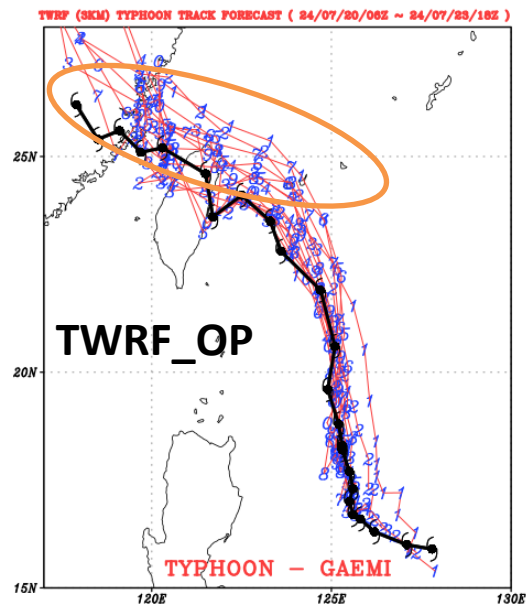


Absolute Intensity Error d01



TY GAEMI (2024)

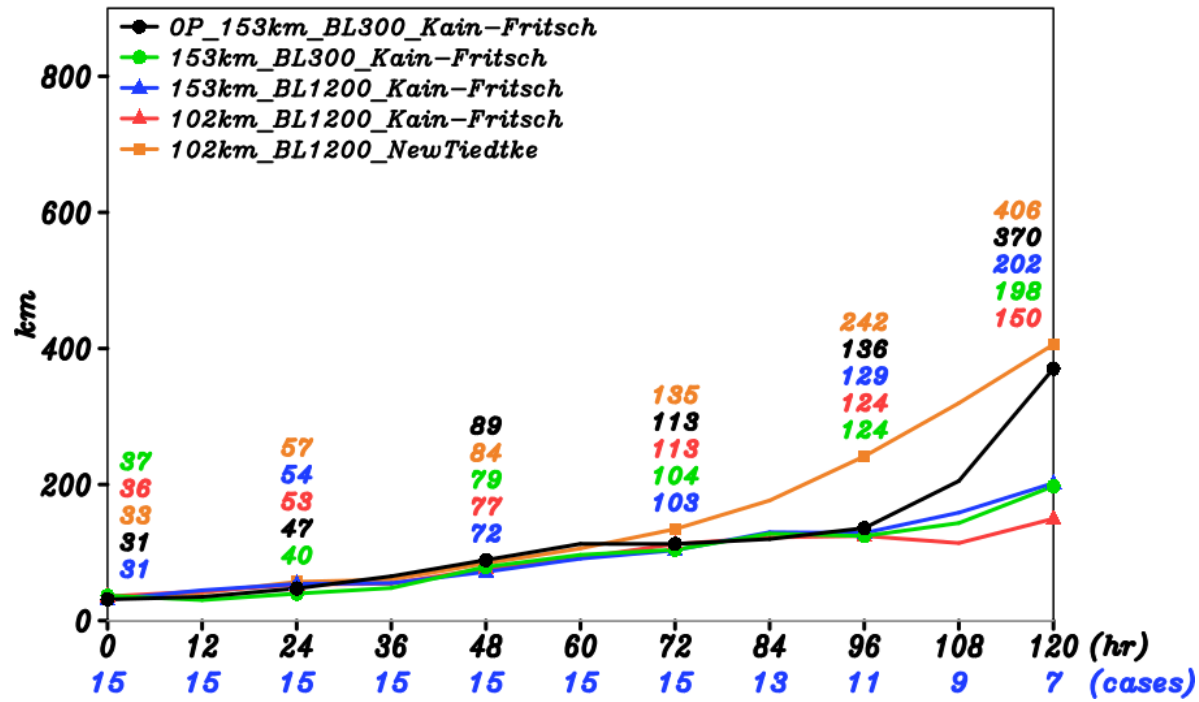
D01: Domain 1
(15 or 10 km)



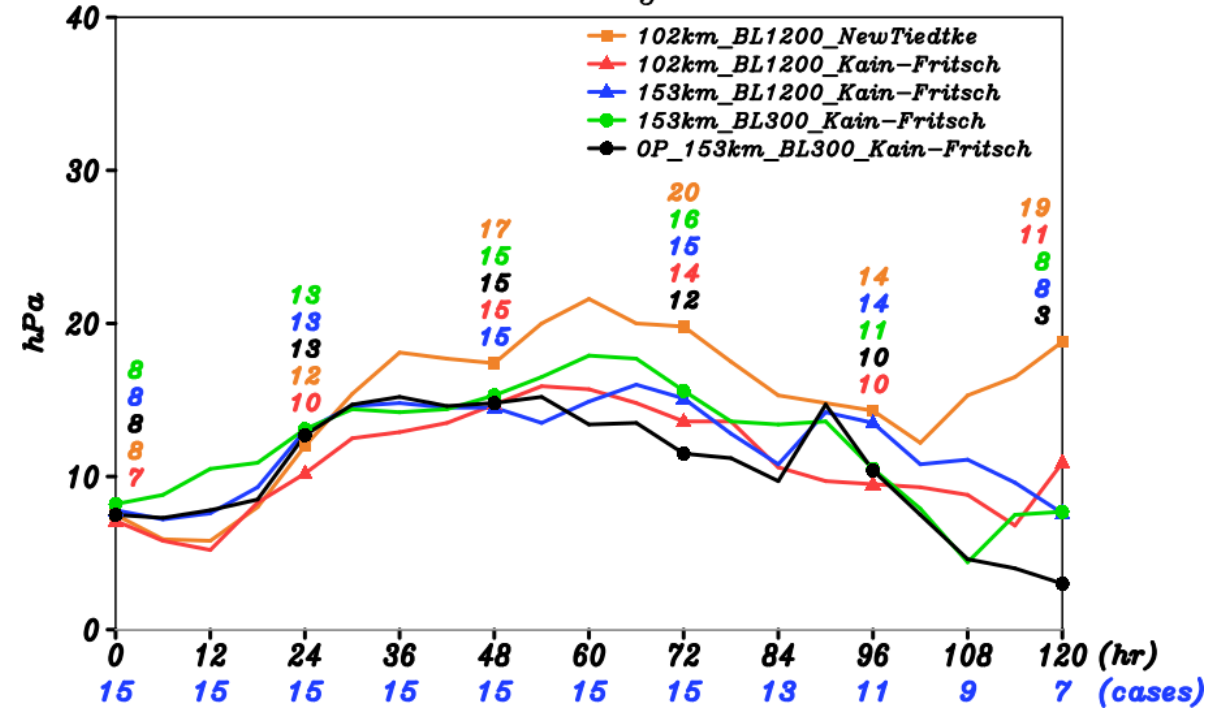
TY GAEMI (2024)

D02: Domain 2
(3 or 2 km)

Track Error d02



Absolute Intensity Error d02

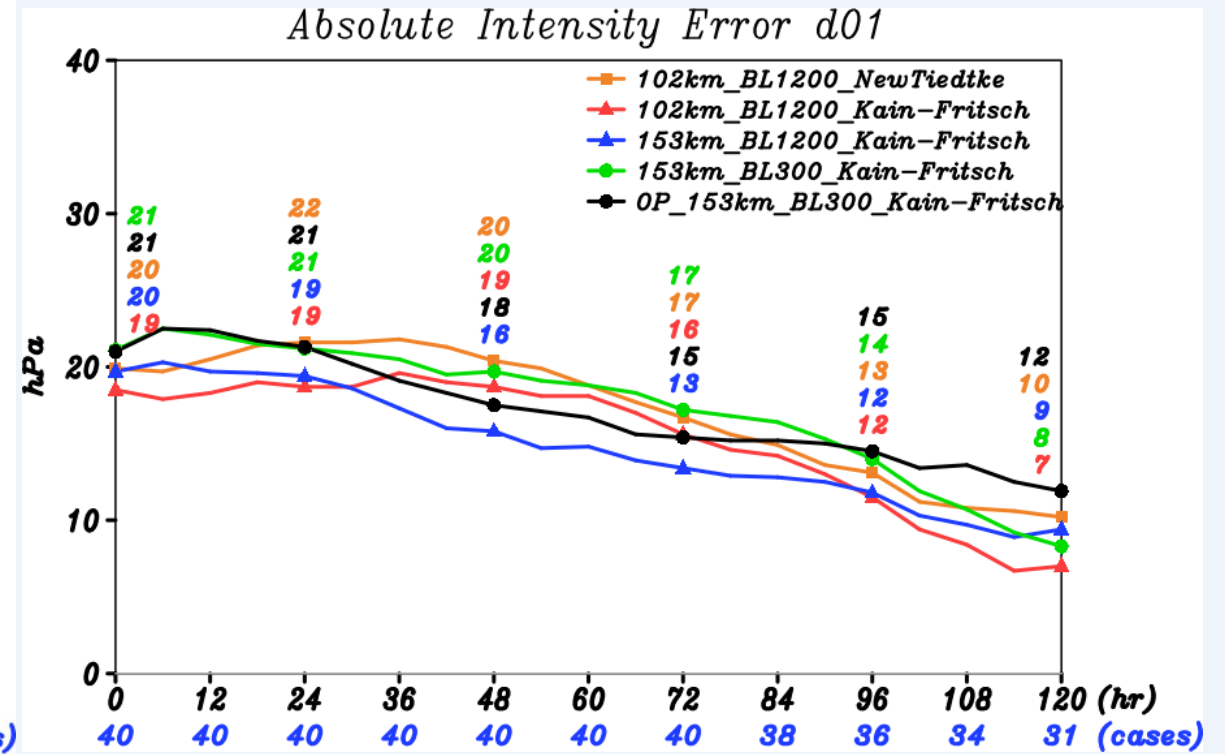
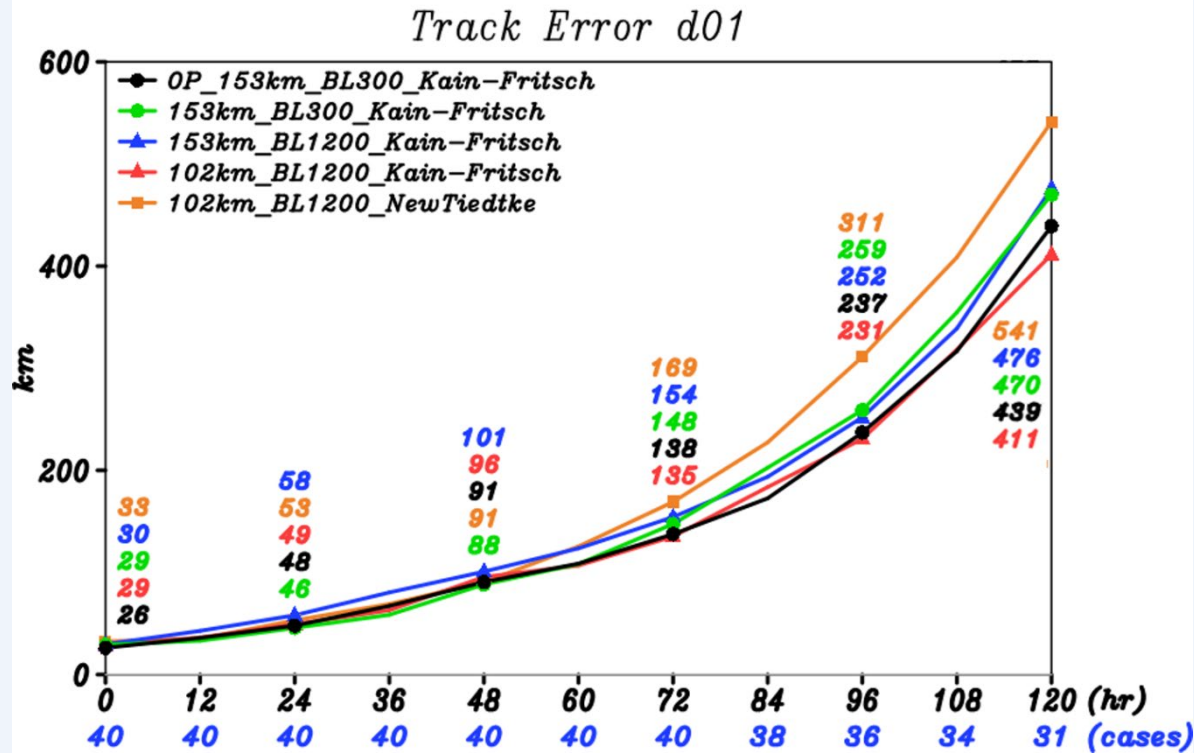


TY GAEMI (2024)

D02: Domain 2
(3 or 2 km)

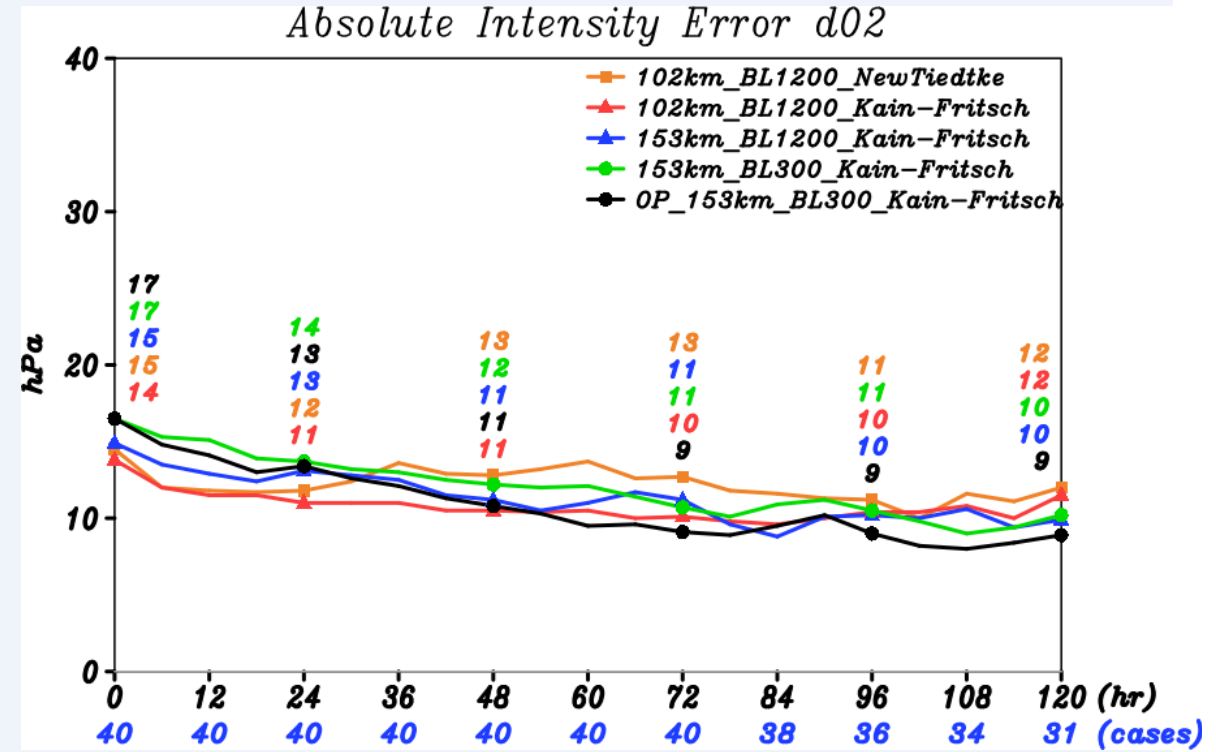
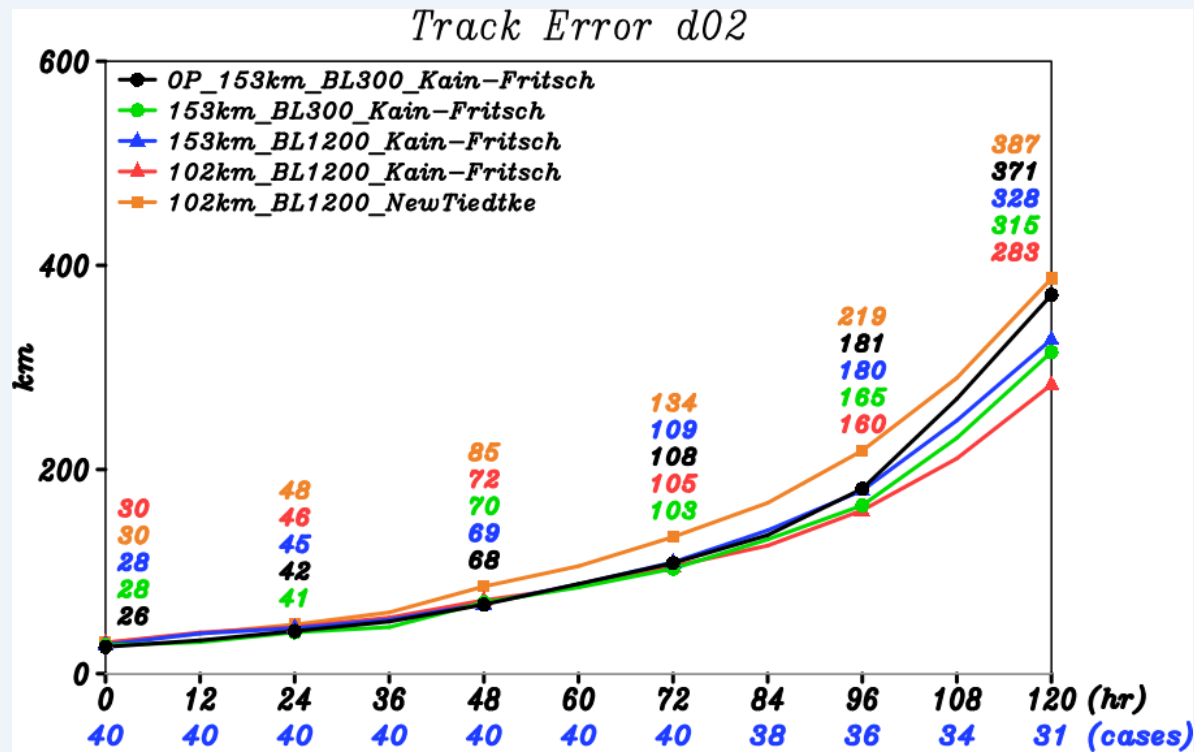
Experiment result for TWRF_D01

3TCs 40cases



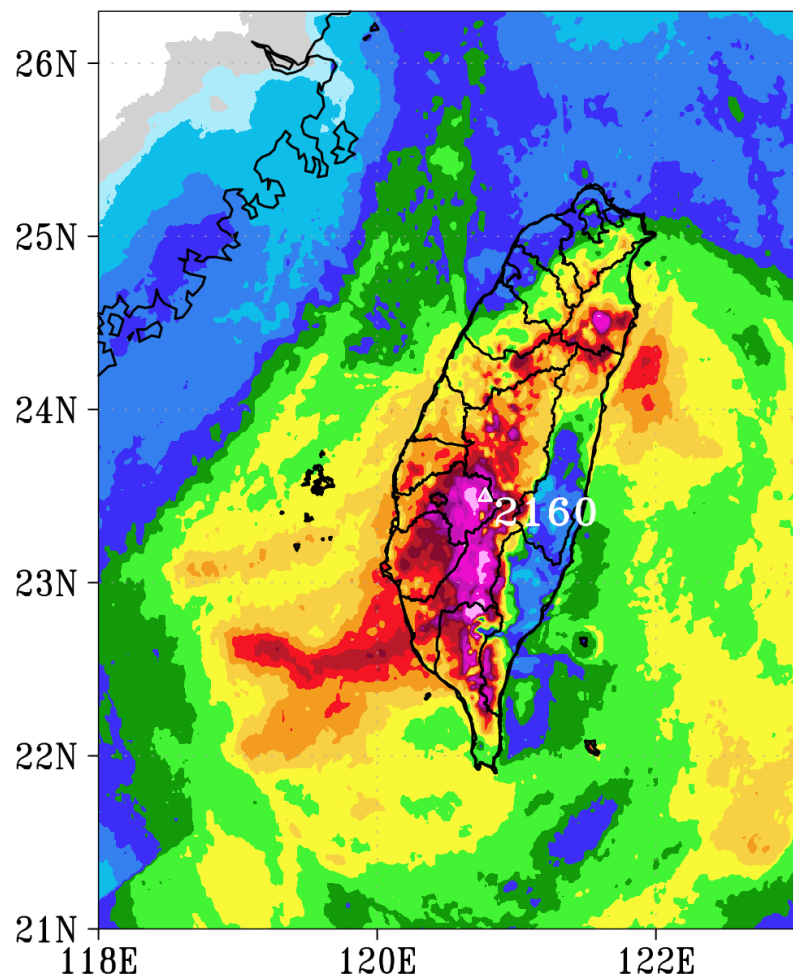
Experiment result for TWRF_D02

3TCs 40cases



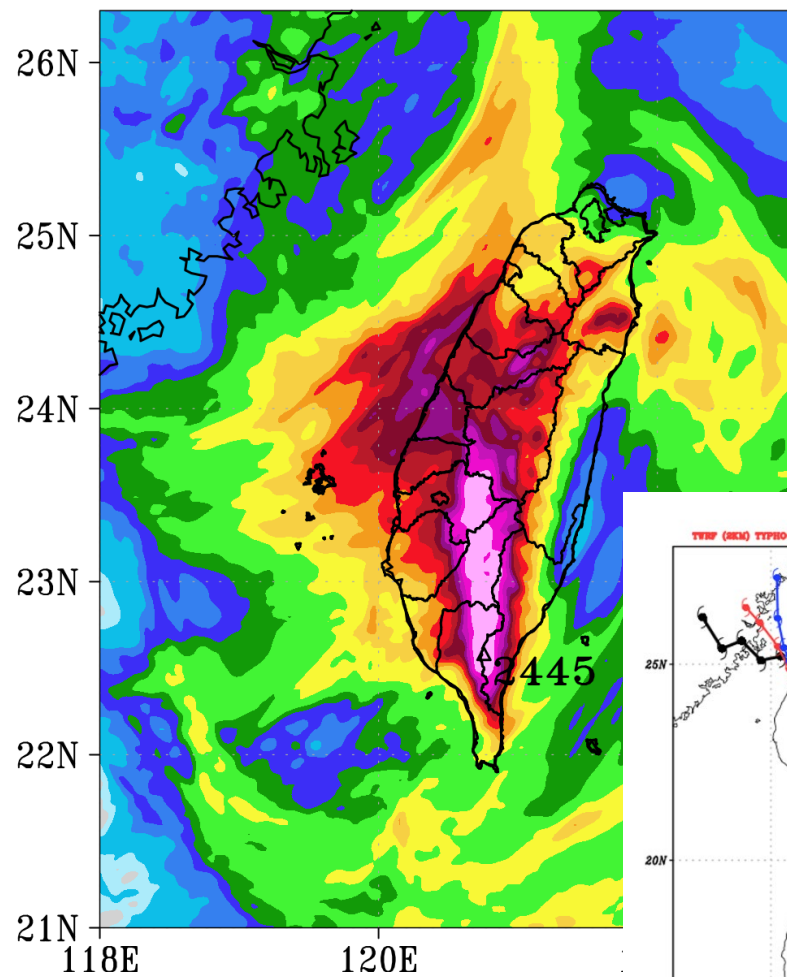
QPESUMS

from 24072312 72h



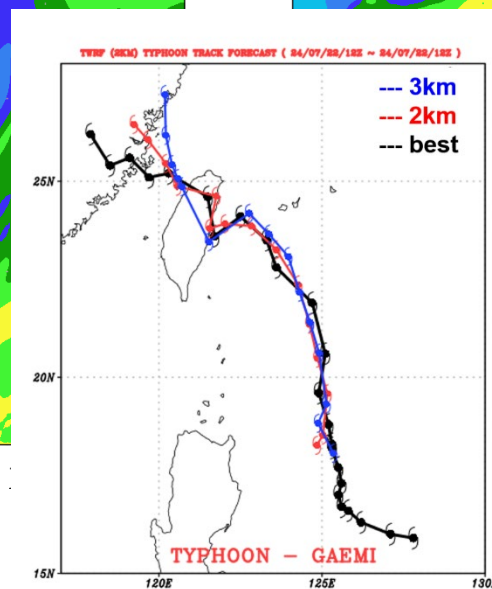
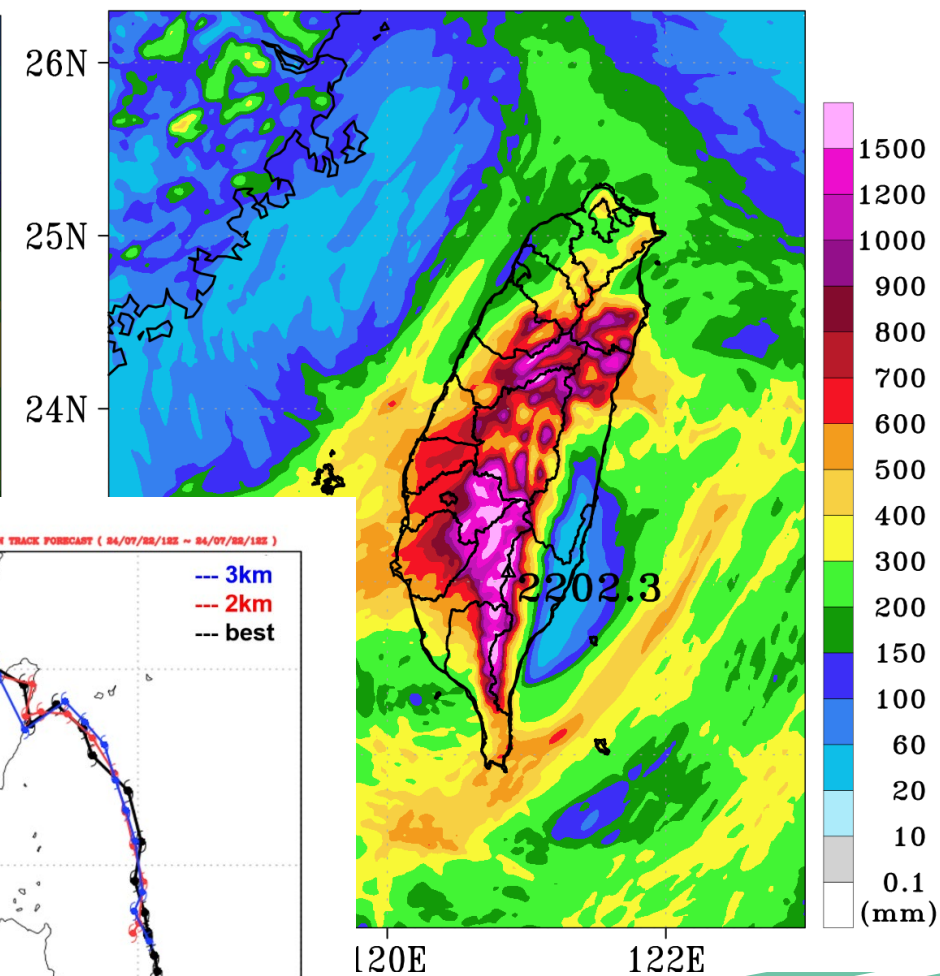
現在作業版本 3 km
cutoff length=300
cumulus scheme=KF

Initial time: 24072212 UTC
2312~2612 UTC accumulated rainfall



2 km
cutoff length=1200
cumulus scheme=KF

Initial time: 24072212 UTC
2312~2612 UTC accumulated rainfall





總結

- 颱風路徑預報校驗結果顯示，提高網格解析度能改進預報誤差，尤其2公里明顯優於3公里。
- 網格解析度由15/3公里提升至10/2 公里，對於颱風強度預報改進幅度不大。
- 在颱風降雨個案中，顯示2公里網格可以模擬出更細緻的雨量分布。

未來工作

- 調整實驗設計，增加一組Blending cut-off length=300 公里。
- 持續累積颱風個案實驗，提出最佳方案，評估上線作業的可行性。



A light blue world map with white outlines of continents, serving as a background for the central text.

謝謝聆聽
敬請指教

