

# Hurricane WRF(HWRF) 與Typhoon WRF(TWRF) 於西北太平洋颱風路徑及降雨預報表現之評估

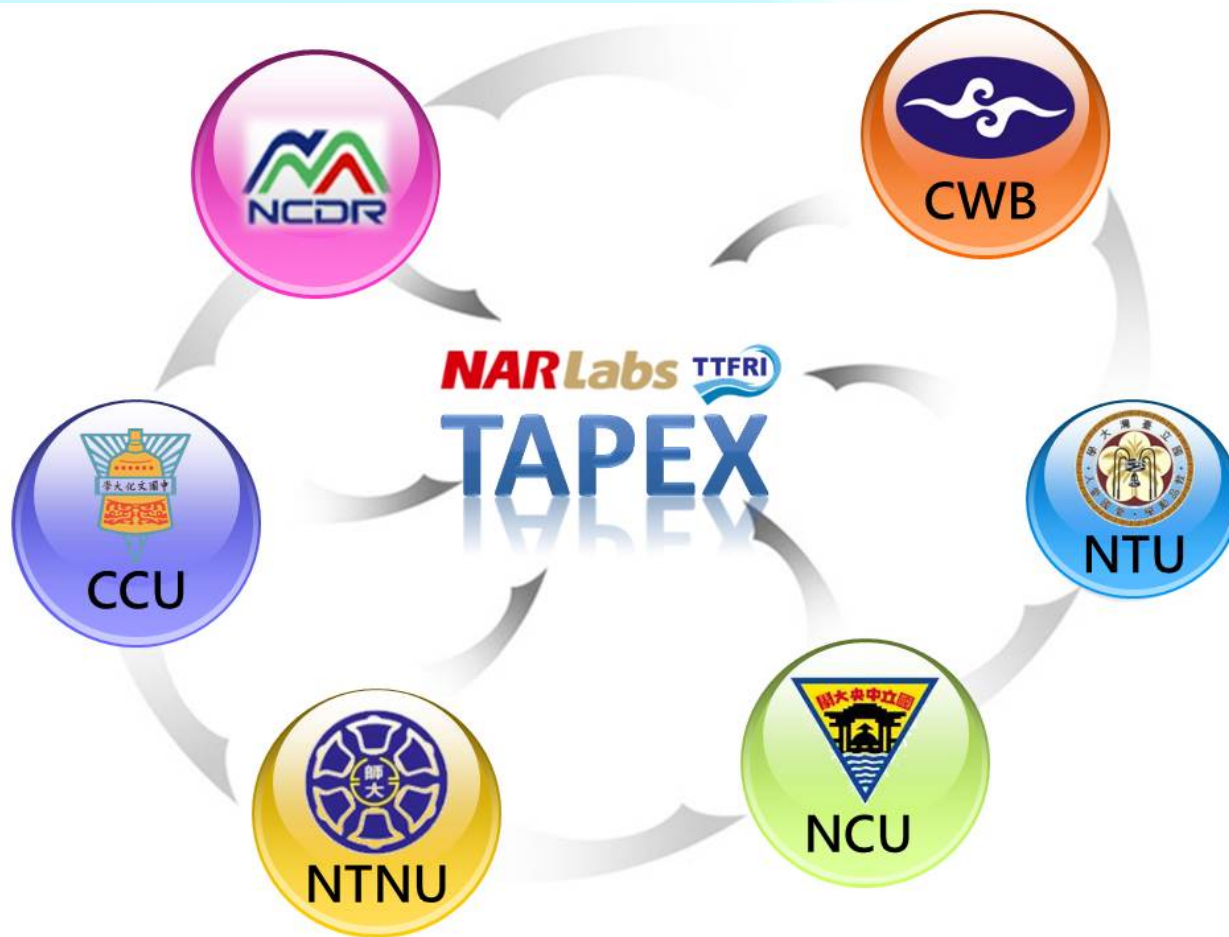
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# Introduction of TAPEX

TAiwan cooperative PRecipitation E nsemble forecast eXperiment



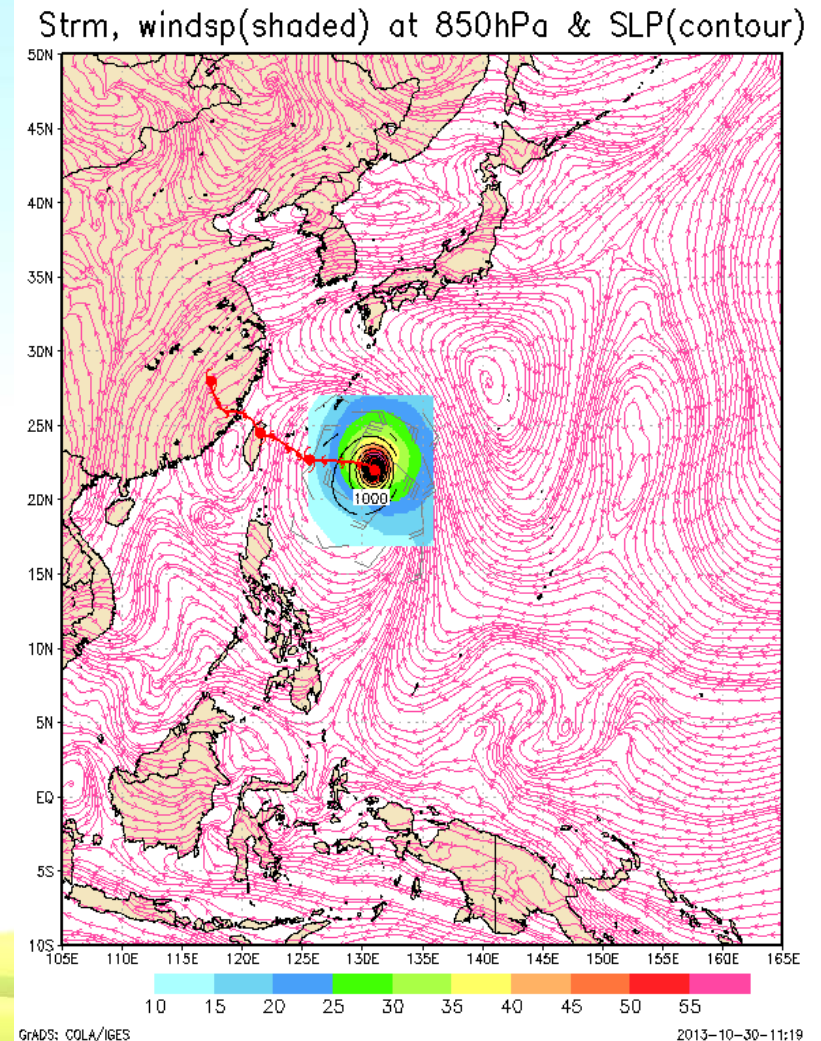


# Model configuration for ensemble members in TAPEX, 2015

編號-群組	model		ICs		LBCs	Cumulus scheme	Microphysics scheme	Boundary Layer	note
11-C1	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	with blending, 2way
01-C2	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	GD	Goddard	YSU	
02-C3	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	G3	Goddard	YSU	
03-C4	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	BMJ	Goddard	YSU	
06-C5	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	KF(1)	Goddard	YSU	
07-C6	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	GD(3)	Goddard	YSU	
08-C7	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	G3(5)	Goddard	YSU	
09-C8	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	BMJ	Goddard	YSU	
10-I1	WRF	partial cycle	3DVAR (CV3)		NCEPGFS	KF	Goddard	YSU	with blending
12-I2	WRF	partial cycle	3DVAR (CV3)		CWBGFS	KF	Goddard	YSU	with blending
04-I3	WRF	partial cycle	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	
05-I4	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	no RO data; VS 11 with blending, 2way
13-I5	WRF	cold start	3DVAR (CV3)		NCEPGFS	KF	Goddard	YSU	
14-I6	WRF	cold start	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	
15-I7	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	no RO data; VS 06
16-O1	CreSS	cold start	NODA		NCEPGFS	No CPS	Cold rain	Mellor and Yamada	grid size 5km
17-O2	CreSS	cold start	NODA		NCEPGFS	No CPS	Cold rain	Mellor and Yamada	grid size 2.5 km
18-O3	WRF	cold start	NODA		NCEPGFS	KF	WSM5	YSU	e_vert=28,two way,d03cu
19-O4	MM5	cold start	NODA		NCEPGFS	Grell	Goddard	MRF	
20-O5	MM5	cold start	4DVAR	bogus	NCEPGFS	Grell	Goddard	MRF	
<b>21-H1</b>	<b>HWRF</b>	<b>cold start</b>	<b>NODA</b>		<b>NCEPGFS</b>	<b>SAS</b>	<b>Ferrier</b>	<b>NCEP GFS</b>	<b>27/9/3</b>
<b>22-H2</b>	<b>HWRF</b>	<b>cold start</b>	<b>NODA</b>	<b>HWRF bogus</b>	<b>NCEPGFS</b>	<b>SAS</b>	<b>Ferrier</b>	<b>NCEP GFS</b>	<b>27/9/3, moving nested</b>
23-C9	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	Tiedtke	Goddard	YSU	cu=Tiedtke
24-C10	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	Tiedtke	Goddard	YSU	cu=Tiedtke
25-R1	WRF	cold start	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	Radar, 30 hrs, d03NOcu
26-O6	WRF	cold start	NODA		NCEPGFS	KF	Goddard	YSU	Large d03:301*241
27-R2	WRF	cold start	3DVAR (CV7)	15/3km	NCEPGFS	KF	Goddard	YSU	Radar, 30 hrs, d02NOcu,CV7
28-R3	WRF	cold start	3DVAR (CV5)	15/3km	NCEPGFS	KF	Goddard	YSU	No Radar, 30 hrs, d02NOcu

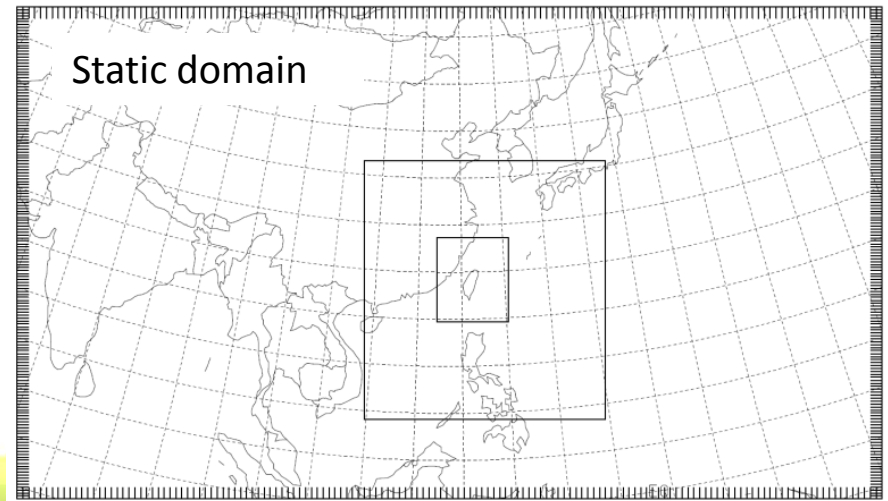
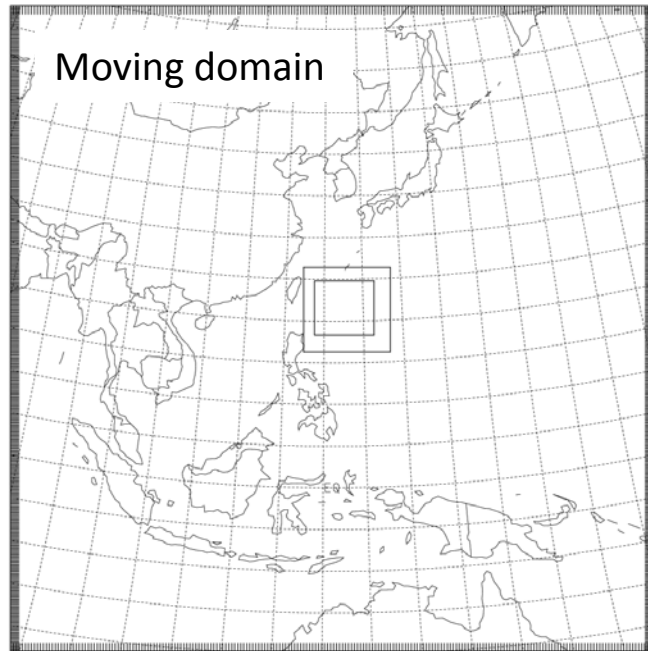
# Hurricane WRF in Taiwan

- **TTFRI and CWB** collaborated with **ESRL/NOAA** and had successfully implemented the Hurricane WRF(HWRF) model in Taiwan since 2012.
- In Apr. 2013, **TTFRI and CWB** had the operational version of HWRF from **EMC**.
- TTFRI had added **2 HWRF members** into Taiwan Cooperative Precipitation Ensemble Forecast Experiment (**TAPEX**) from 2012 to 2014.



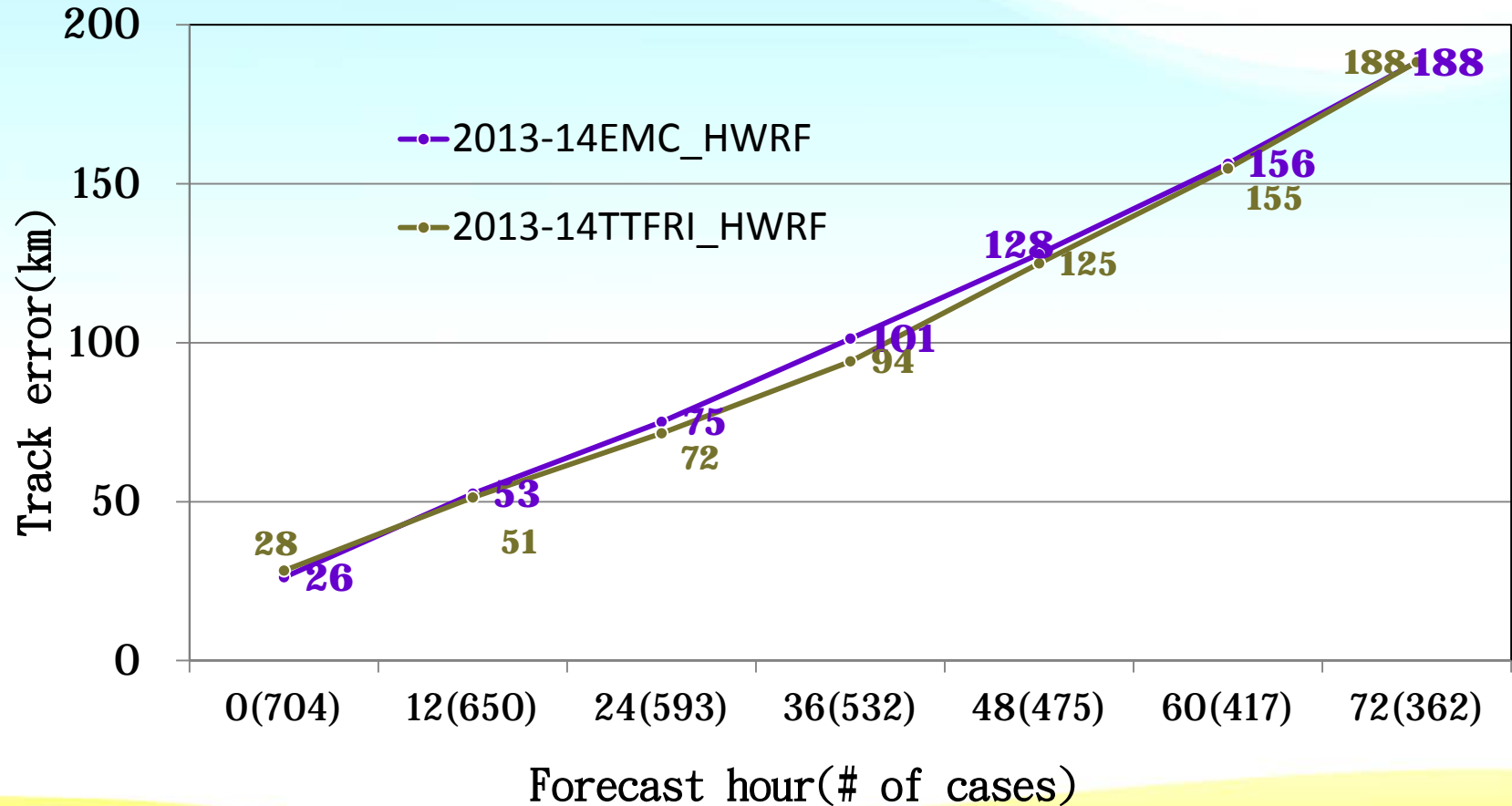
# Configuration of HWRF

Experiment	cold/warm	analysis	bogus	Cu.	M.P.	PBL	Note
<b>HWRF (M22)</b>	cold start	NODA	HWRF bogus	SAS	Ferrier	NCEP GFS	43levels; P_top 50hPa; 2 way; <b>27/9/3km; moving</b> ; no ocean couple & no GSI; IC&BC from NCEP T574 atmospheric spectral data and include NCEP 0.5deg data.
<b>HWRF_T (M21)</b>	cold start	NODA	no bogus	SAS	Ferrier	NCEP GFS	43levels; P_top 50hPa; 1 way; <b>45/15/5 → 27/9/3km; static</b> ; no ocean couple & no GSI; IC&BC from NCEP 0.5deg data.





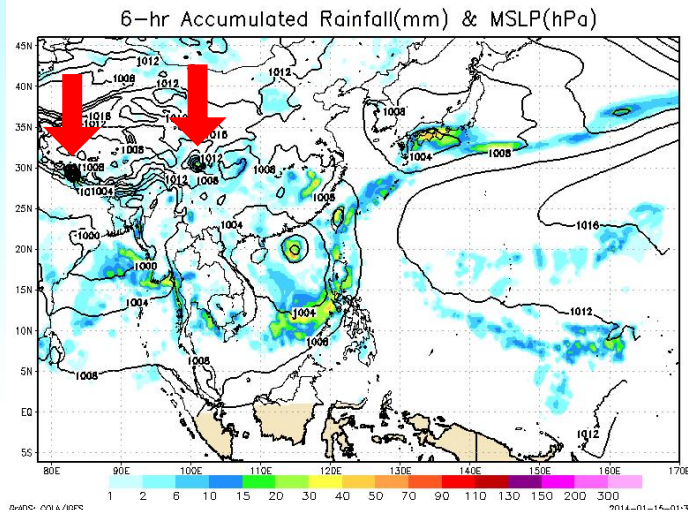
# 2013-2014 TTFRI HWRF vs. EMC HWRF



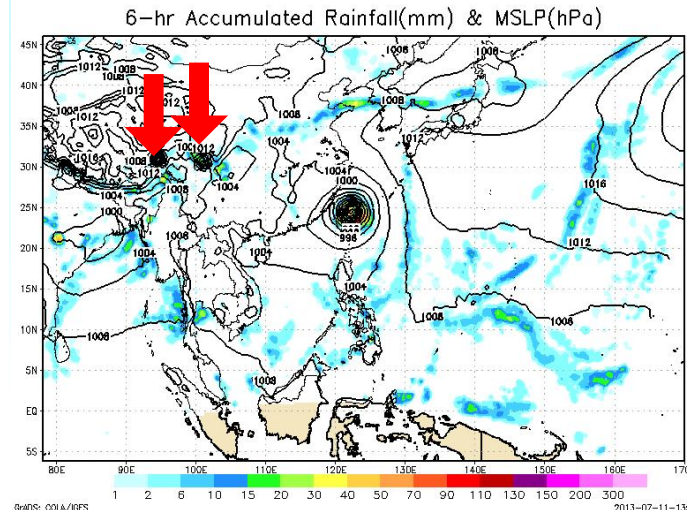
# MSLP of HWRF\_T(45/15/5km) has Bull's eye

Reduce terrain resolution >> adjust ptsgm level from 200hPa to 420hPa(HWRF)

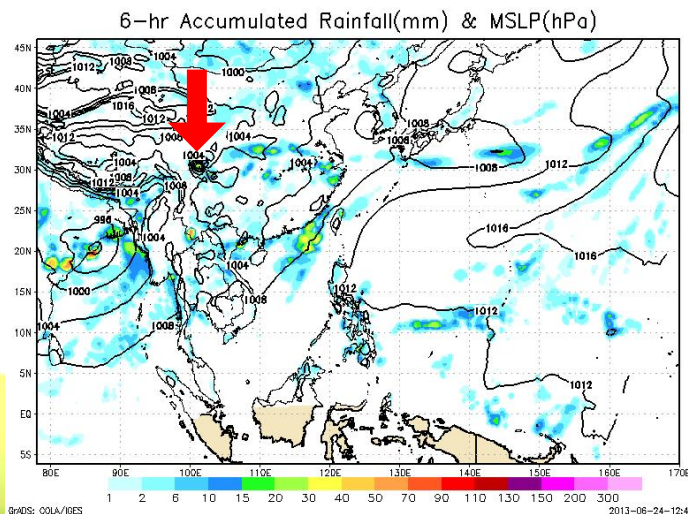
06/20 18Z  
+18hr



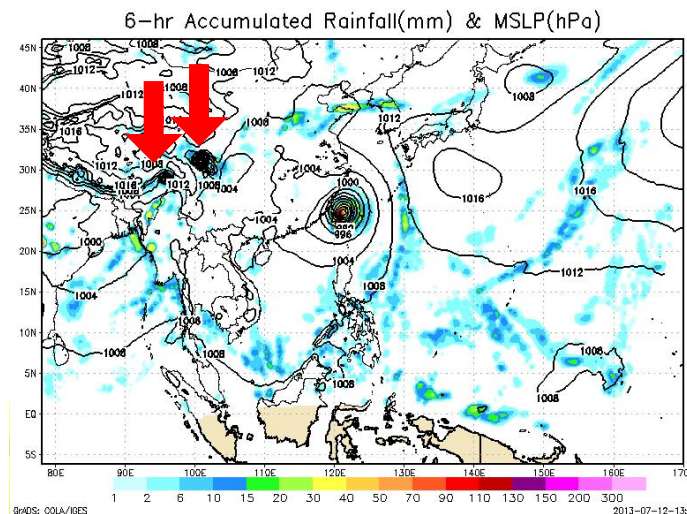
07/11 00Z  
+42hr



06/24 00Z  
+12hr



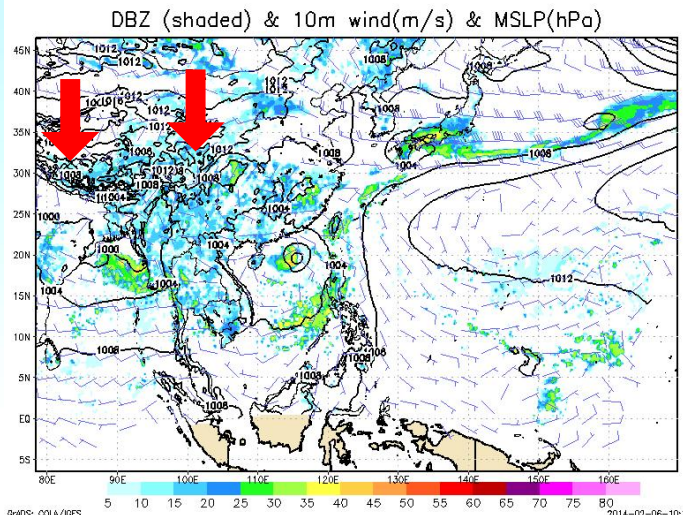
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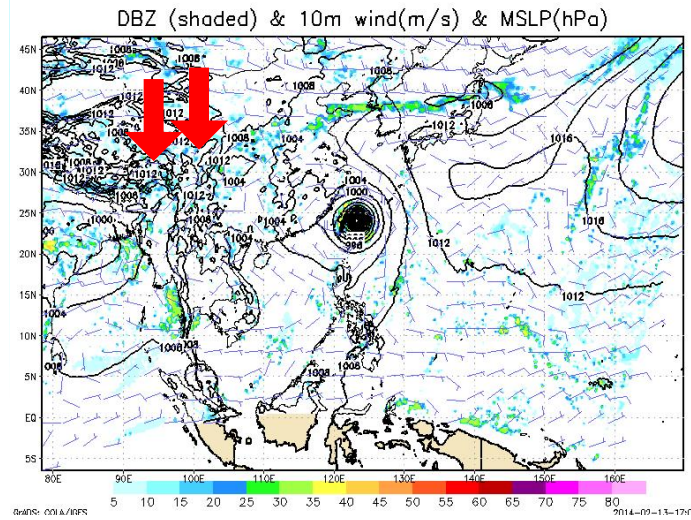


# Bull's eye of MSLP had significantly reduced when increasing the resolution(27/9/3km)

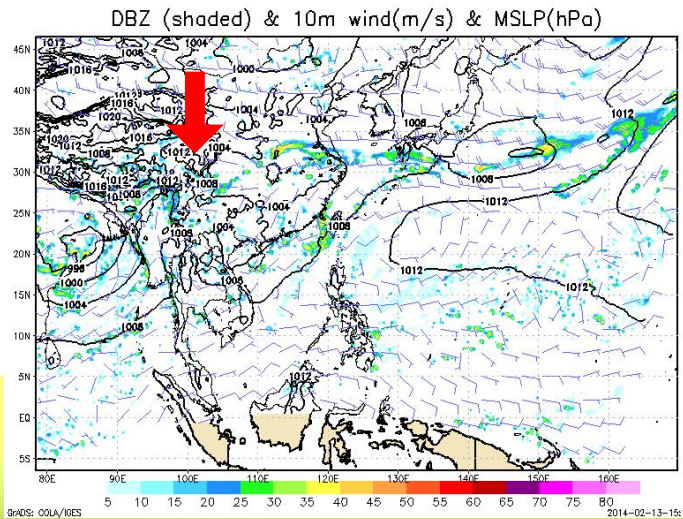
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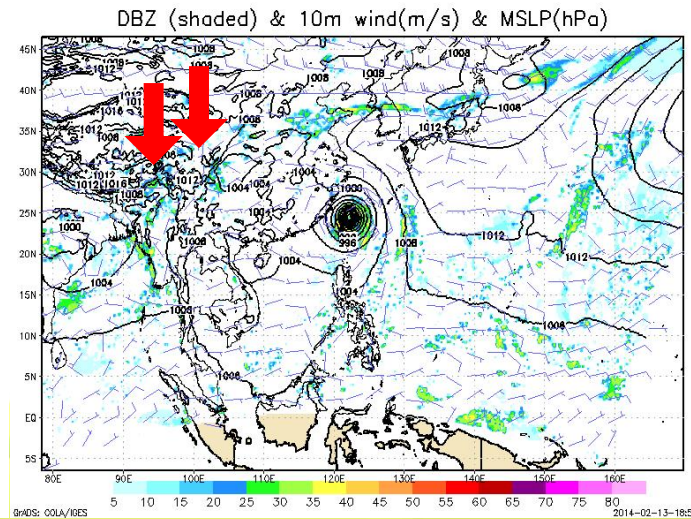
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06/24 00Z  
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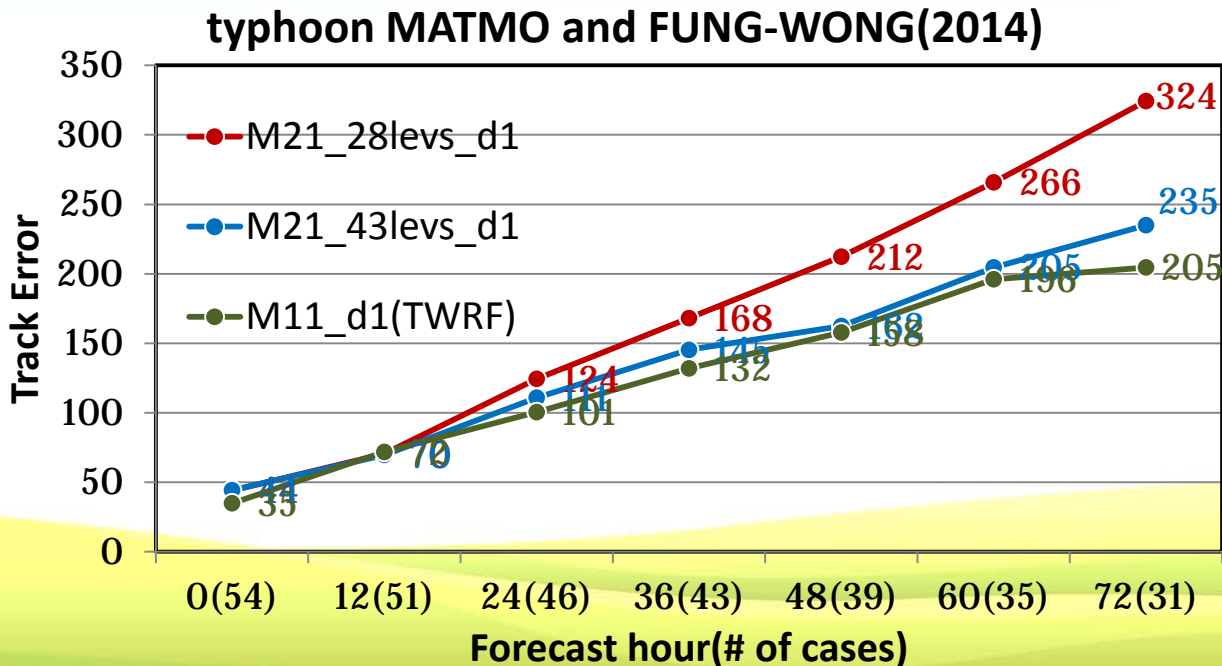
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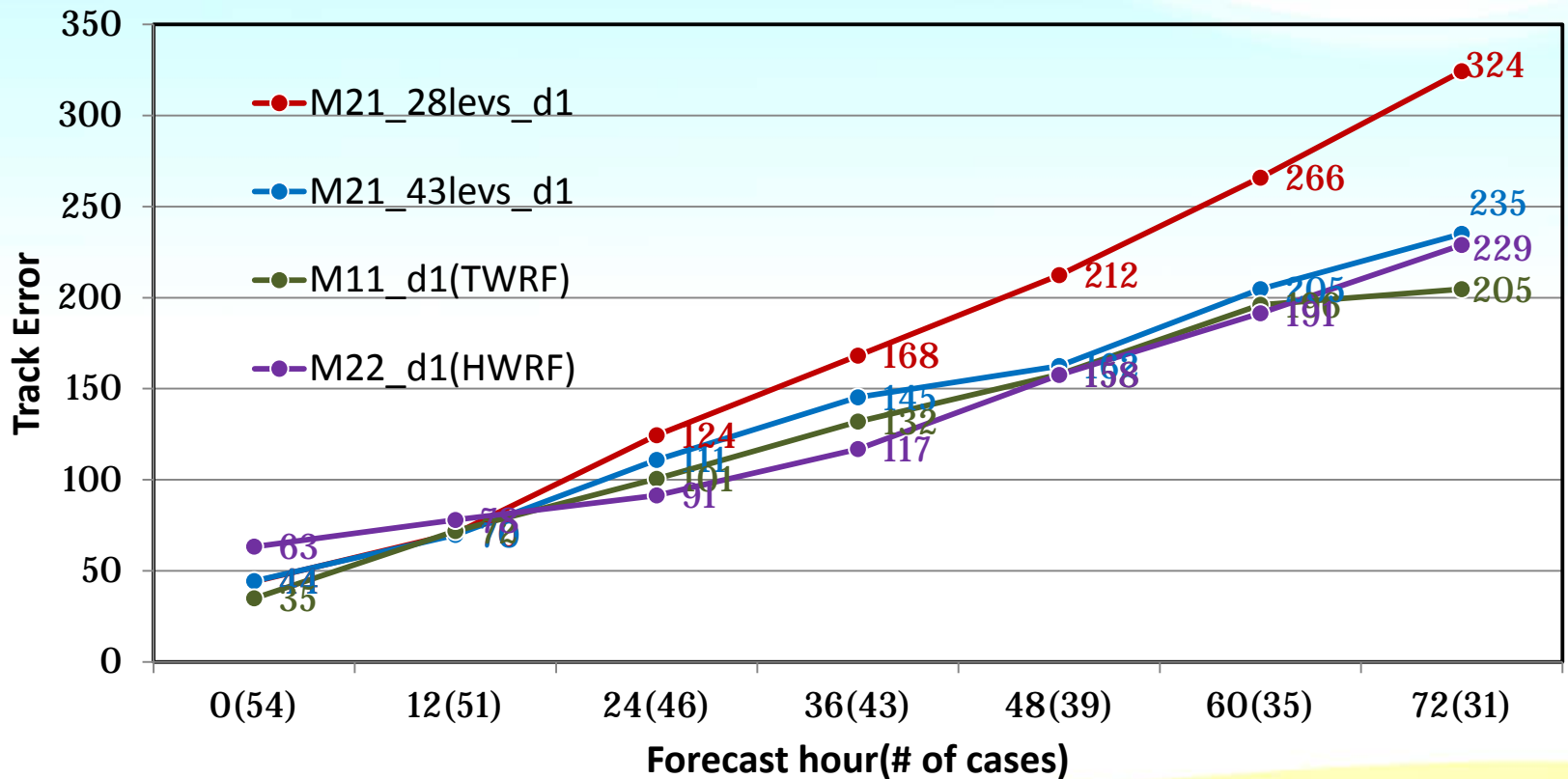
# HWRF with static domain

- In typhoon season 2014
  - Increase the horizontal resolution of 3-nested domain from **45/15/5** km to **27/9/3** km.
  - Reduce the vertical resolution from **43** to **28 levs** for limited computing resource.
  - But the track performance was poor after 24 forecast hour.



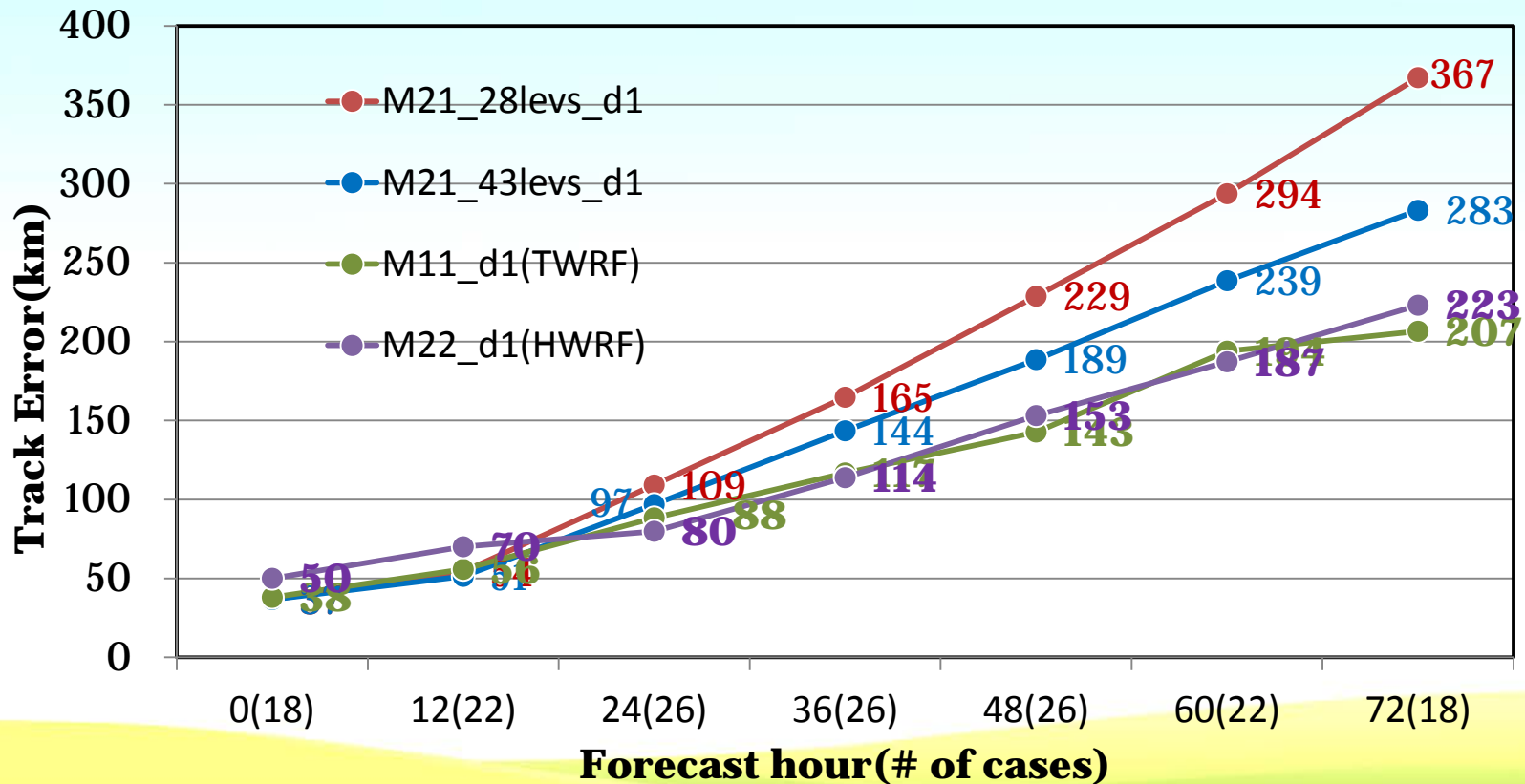
# HWRF with moving nested domain

typhoon MATMO and FUNG-WONG(2014)



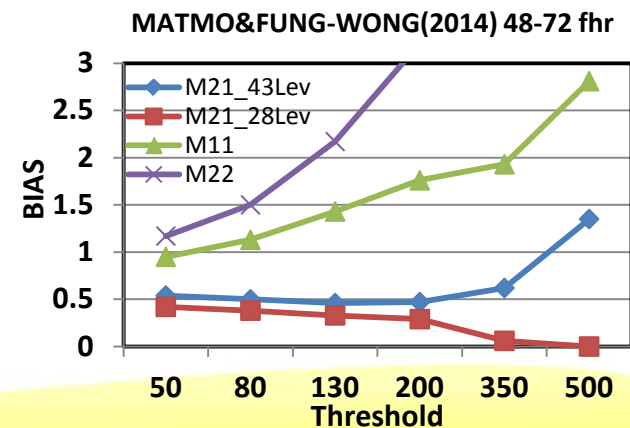
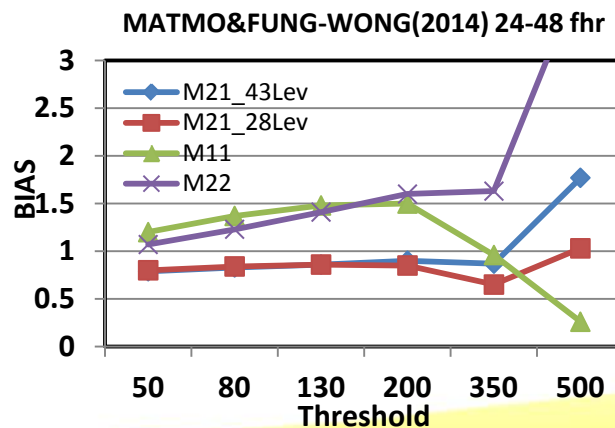
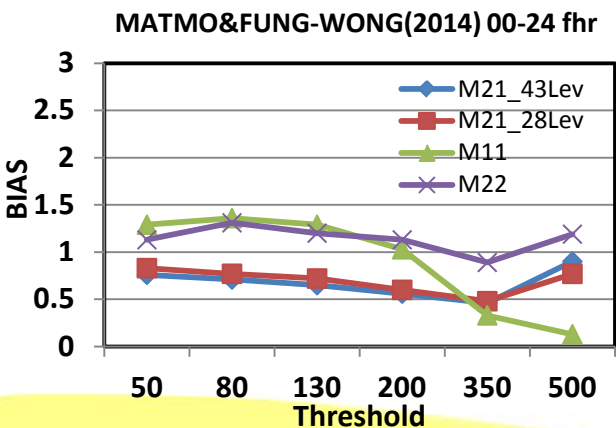
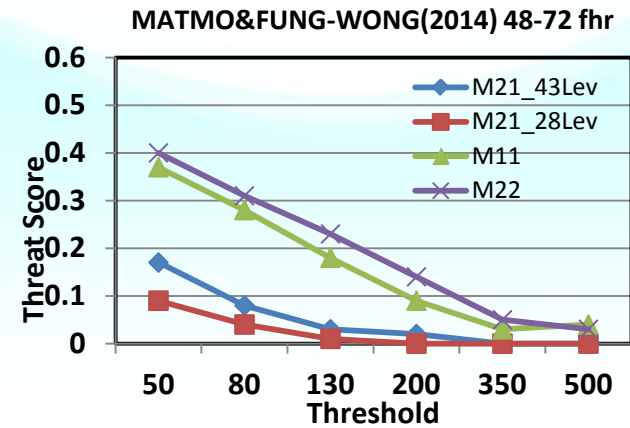
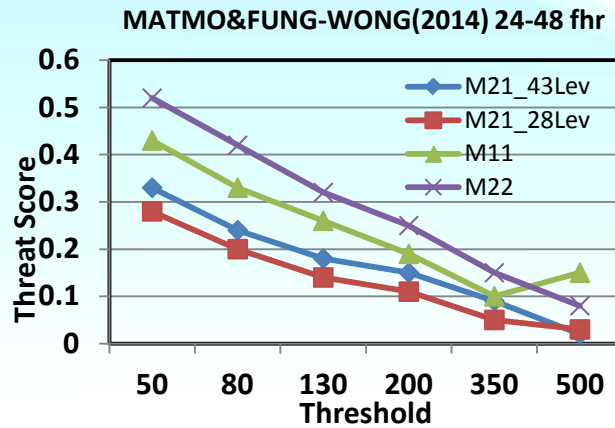
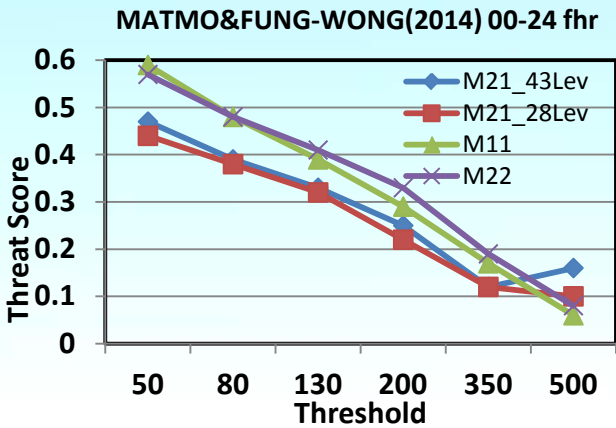
# Track performance of HWRF and TWRF

MATMO and FUNG-WONG(2014), heavy rainfall period





# Rainfall forecast skill score of typhoon FUNG-WONG&MATMO (18 cases)



# Summary & Future work

- We successfully implemented HWRF system in Taiwan and evaluated the track and rainfall forecast performance of HWRF over WNP from 2013-2014.
- For static domain HWRF configuration with higher vertical(43levs) and horizontal(3 km) resolution can have better capabilities in forecasting typhoon track and rainfall.
- To update the 2015 operational HWRF version and continue evaluating the performance over the WNP.

# Data Application of TAPEX

