

# A Comparison between Hurricane WRF and TWRF in Typhoon Track and Rainfall Forecast over the western North Pacific

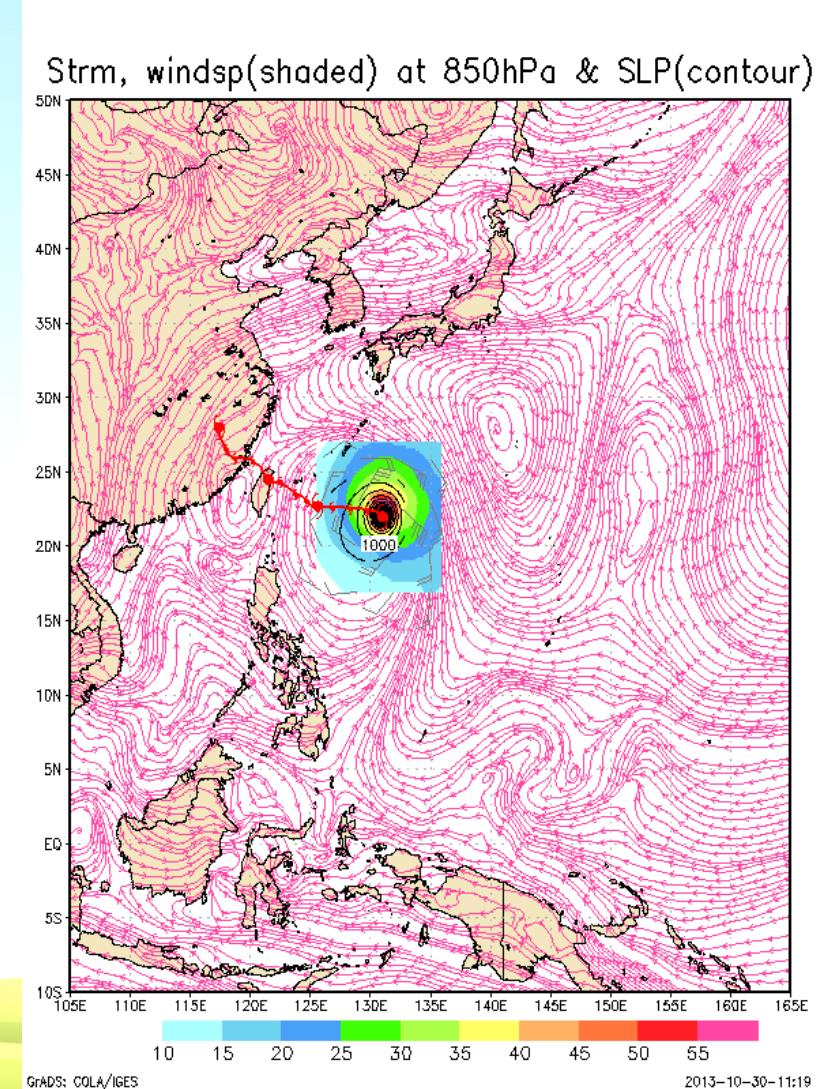
Chin-Cheng TSAI<sup>1</sup>, Ling-Feng HSIAO<sup>1</sup>, Der Song CHEN<sup>2</sup>, Jian-Wen BAO<sup>3</sup>

<sup>1</sup>Taiwan Typhoon and Flood Research Institute, Taiwan, <sup>2</sup>Central Weather Bureau, Taiwan,

<sup>3</sup>NOAA Earth System Research Laboratory, United States

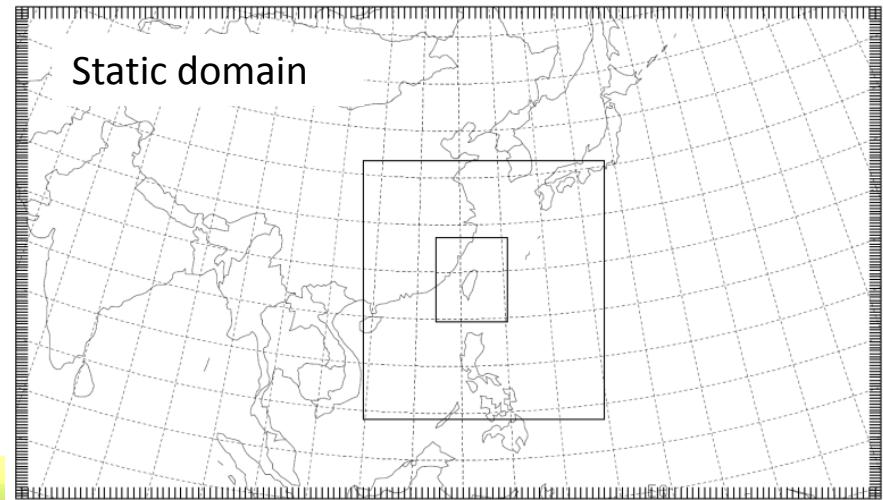
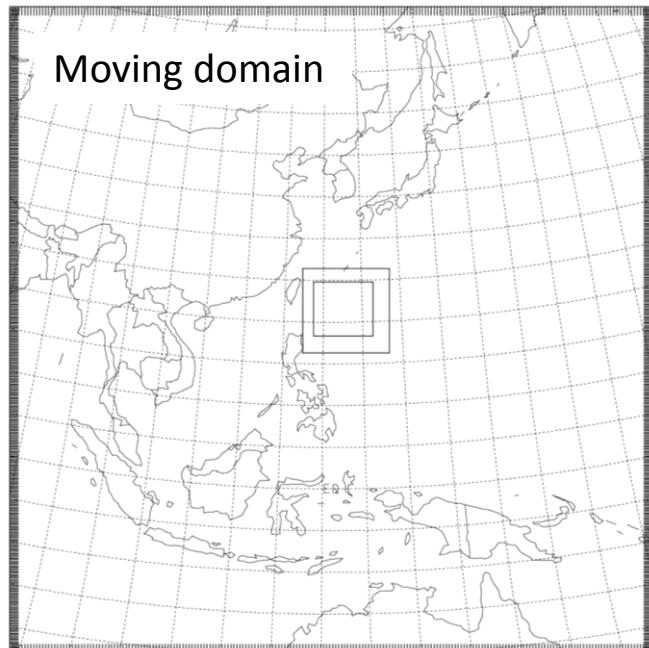
# Hurricane WRF in Taiwan

- **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 2013.
- HWRF 2015 operational version updated in Oct. 2015.



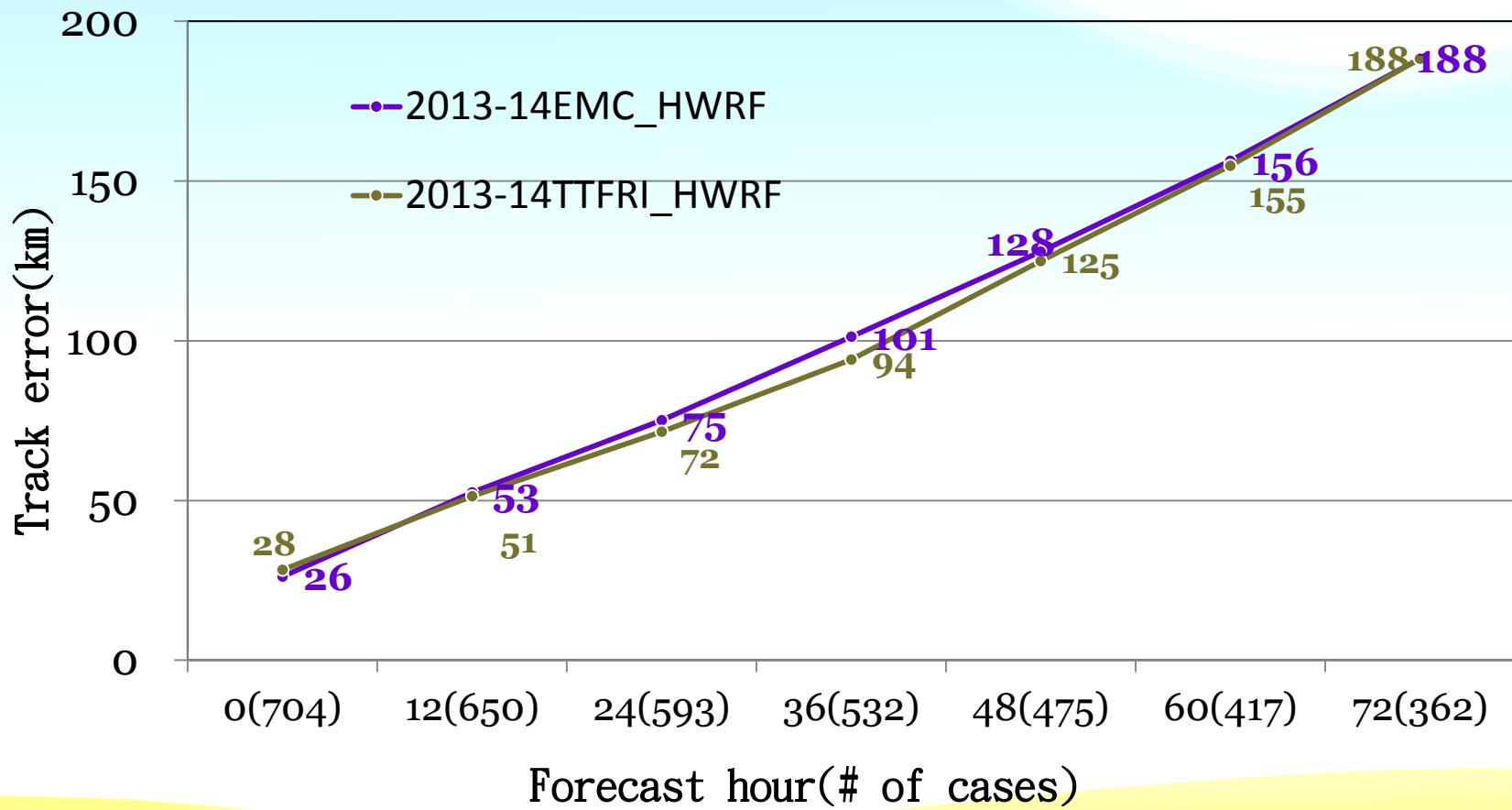
# Configuration of HWRF

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;</b> <b>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; 45/15/5km; static; no ocean couple & no GSI; IC&BC from NCEP 0.5deg data.



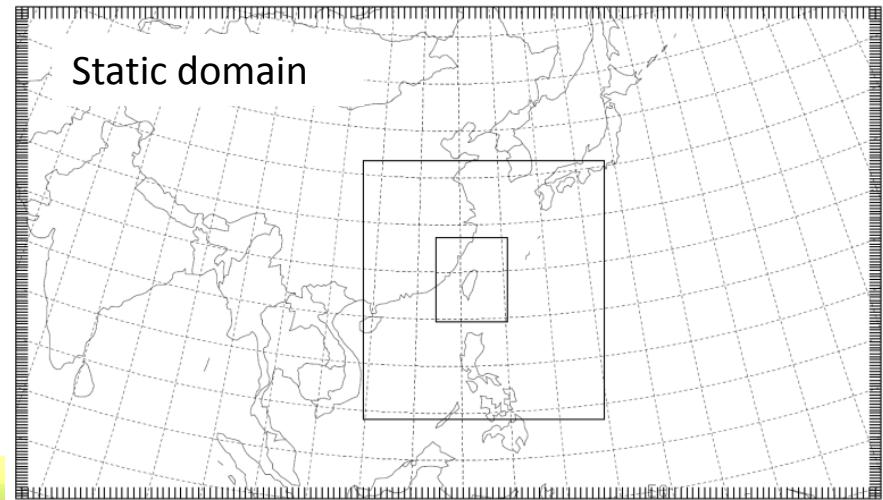
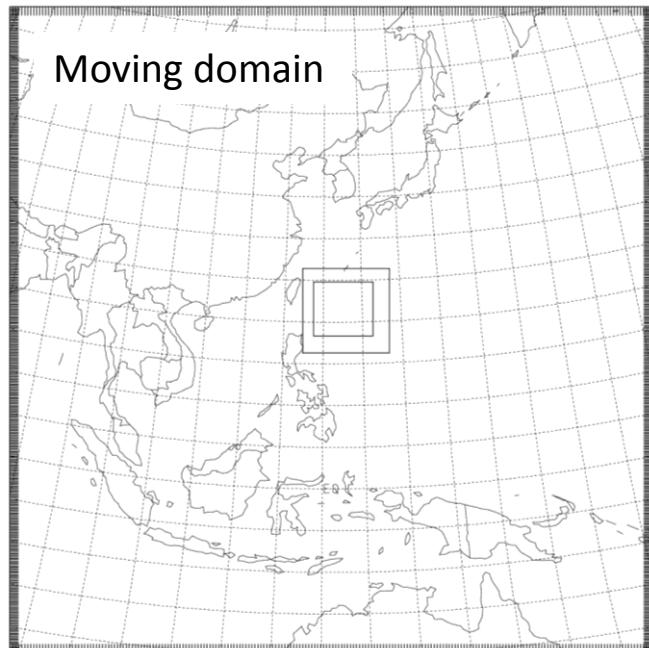
# 2013-2014

## TTFRI HWRF vs. EMC HWRF



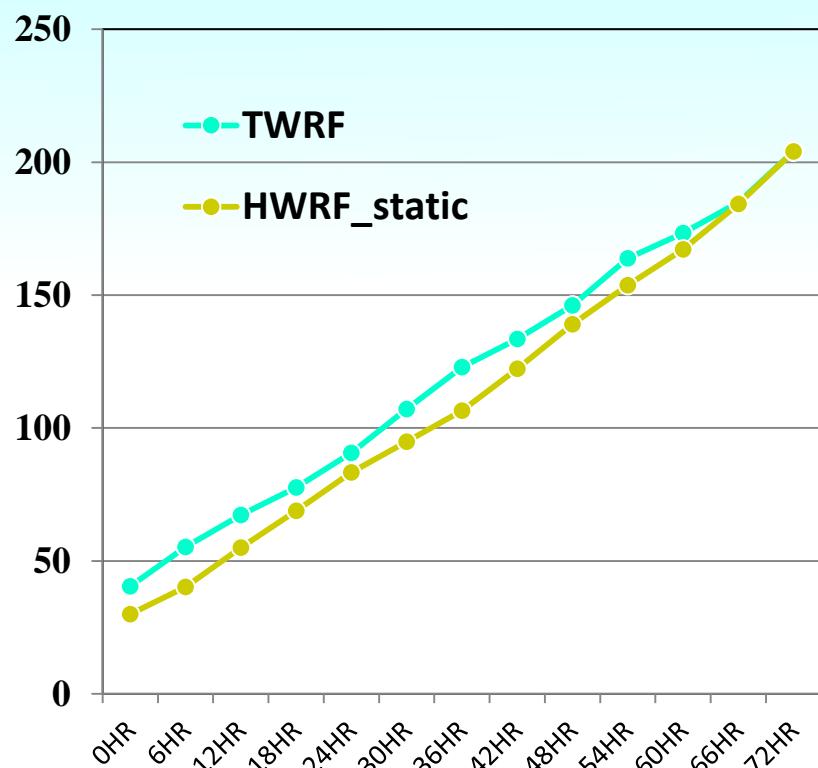
# Configuration of HWRF

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<b>HWRF (M22)</b>	cold start	NODA	HWRF bogus	SAS	Ferrier	NCEP GFS	43levels; P_top 50hPa; 2 way; 27/9/3km; moving; no ocean couple & no GSI; IC&BC from NCEP T574 atmospheric spectral data and include NCEP 0.5deg data.
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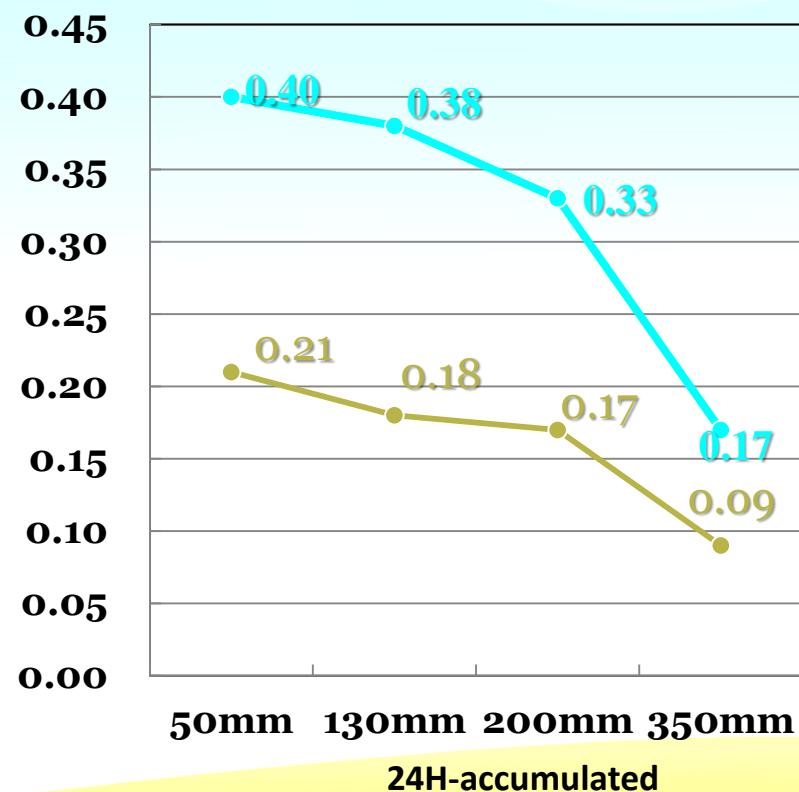


# The Comparison of HWRF and TWRF in 2013

## Track Error



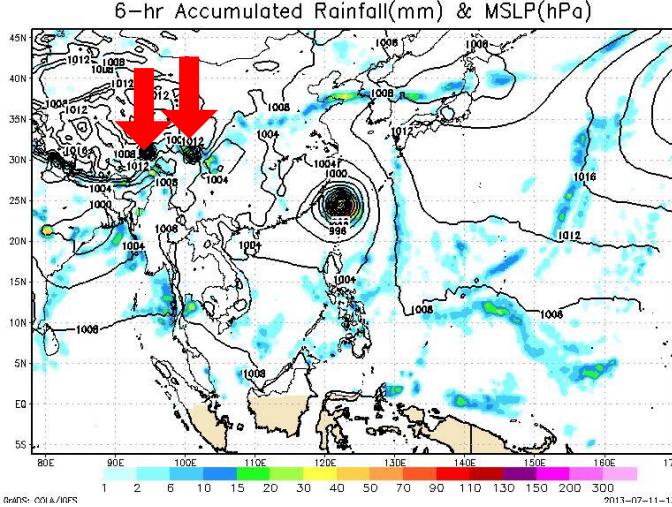
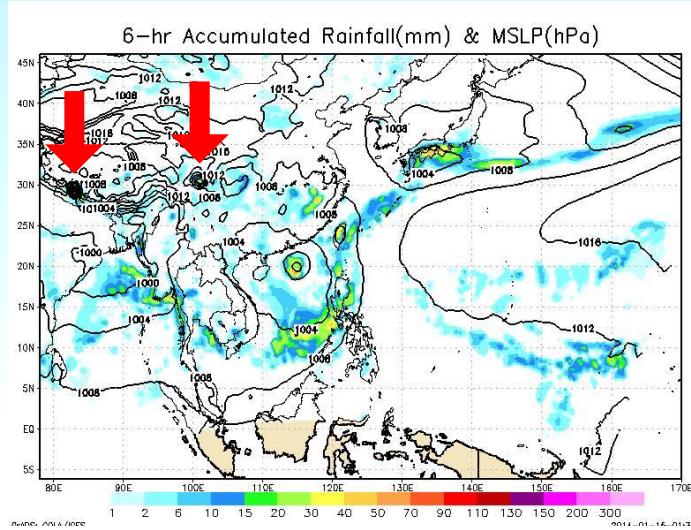
## TS score



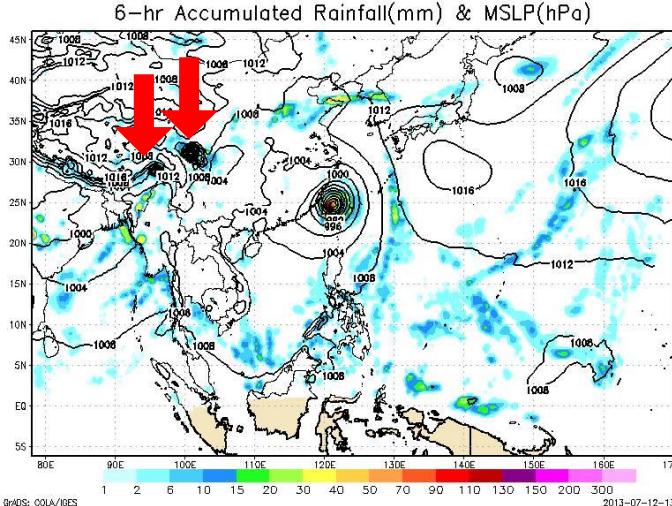
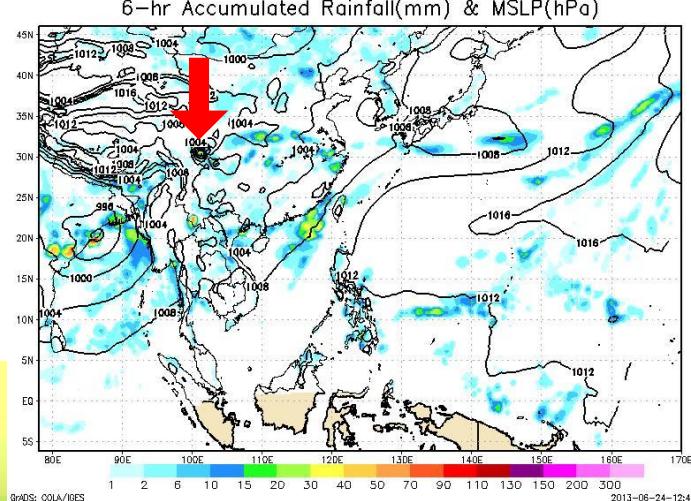
# MSLP of HWRF\_T(45/15/5km) has Bull's eye

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

06/20 18Z  
+18fhr

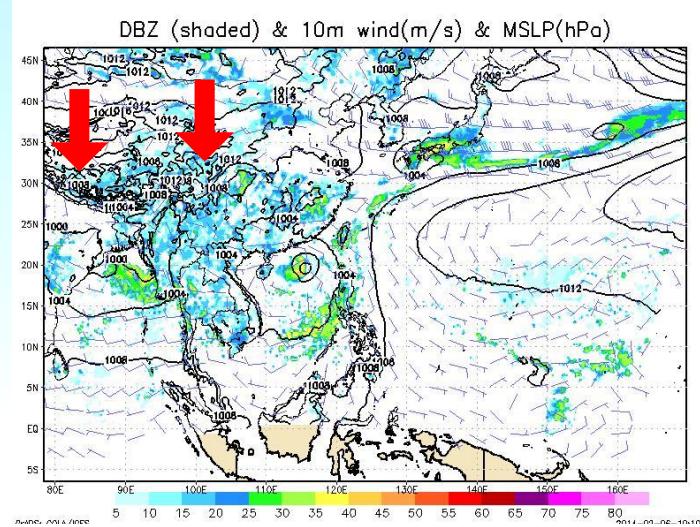


06/24 00Z  
+12fhr

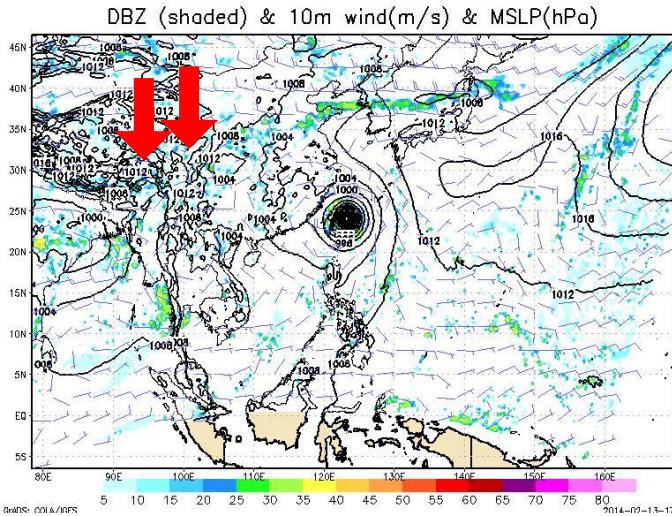


# Bull's eye of MSLP had significantly reduced when increasing the resolution(27/9/3km)

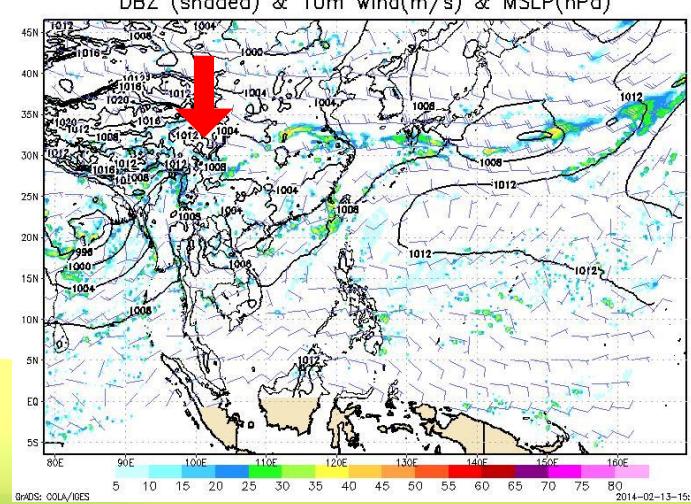
06/20 18Z  
+18fhr



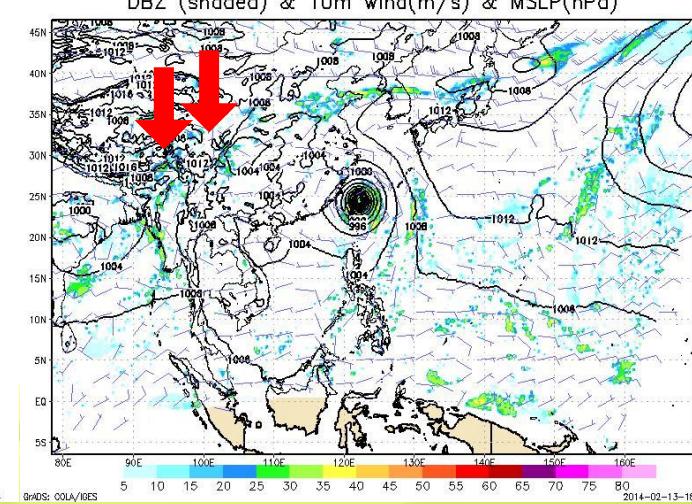
07/11 00Z  
+42fhr



06/24 00Z  
+12fhr

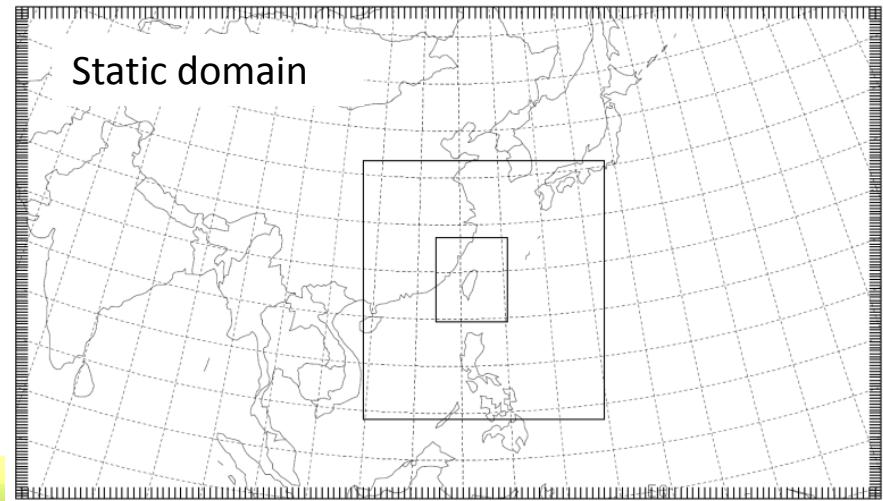
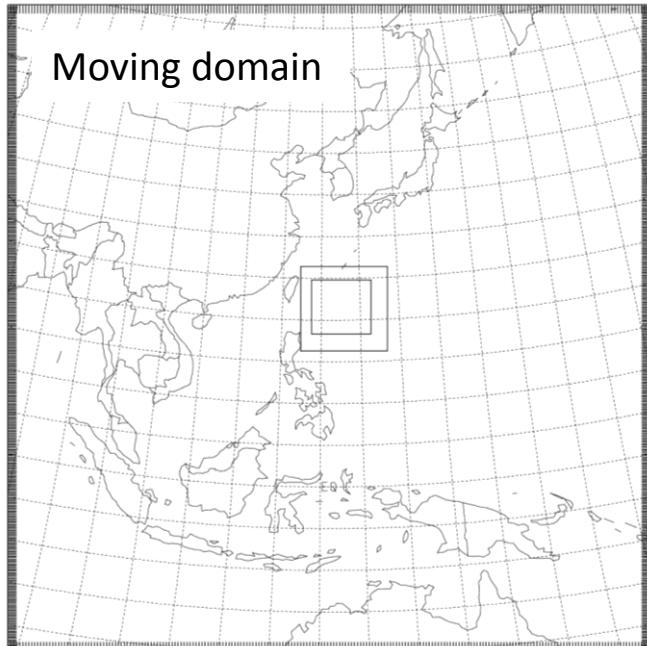


07/12 00Z  
+24fhr



# 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>45/15/5km →27/9/3km; static</b> ; no ocean couple & no GSI; IC&BC from NCEP 0.5deg data.

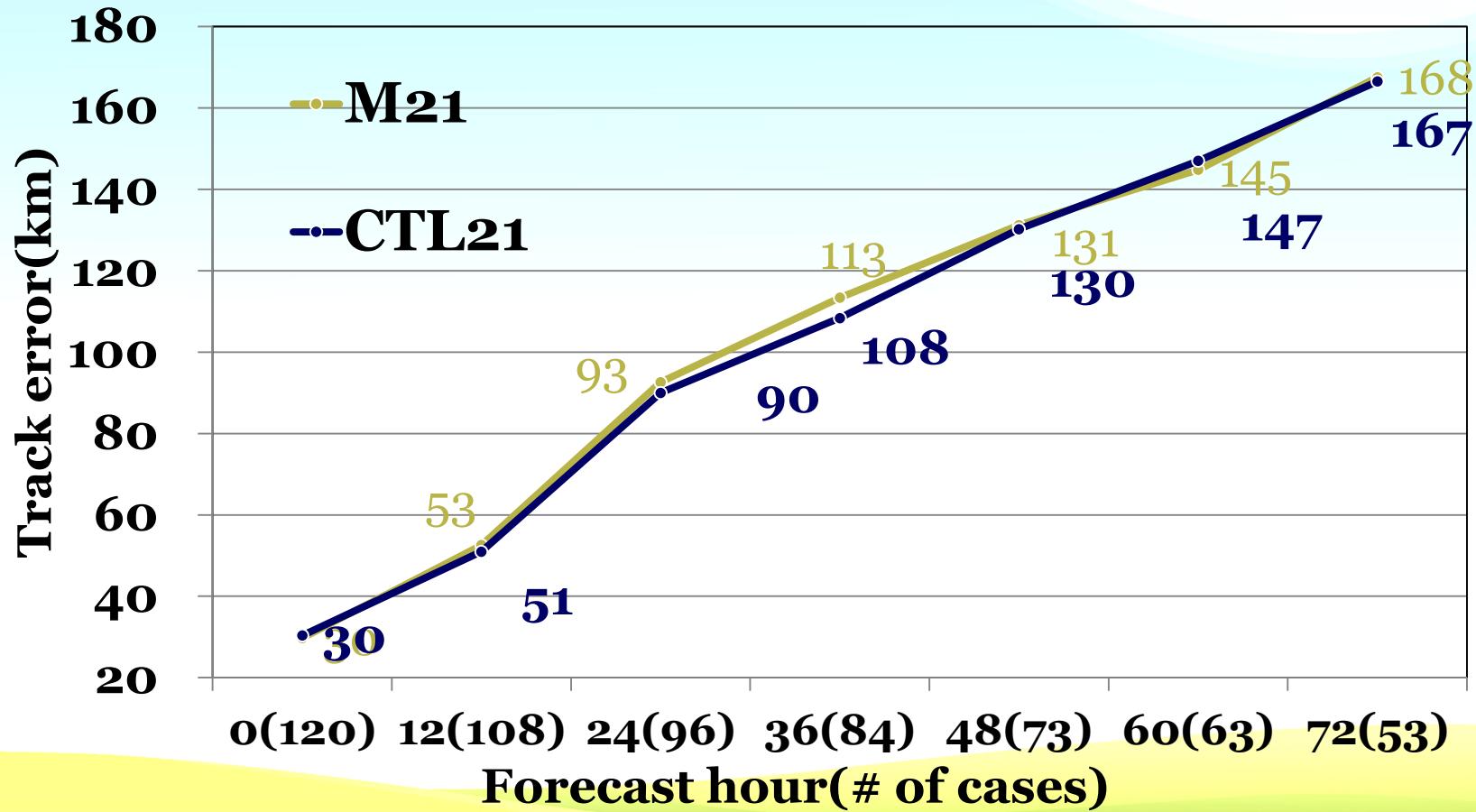


# Cases study for HWRF\_T(27/9/3km)

- **Experiments**
  - M21 : 45/15/05 km,e\_vert=43
  - CTL21 : 27/09/03 km, e\_vert=43
- **Cases with warning issued by CWB,2013**
  - Soulik 07W : TRK:070800-1318Z,RAN:1200-1212Z
  - Cimaron 08W : TRK:071700-1812Z,RAN:1800-1812Z
  - Trami 12W : TRK:081800-2206Z,RAN:2100-2112Z
  - Kong-rey 14W : TRK:082606-3012Z,RAN:2806-2818Z
  - Usagi 17W : TRK:091618-2300Z,RAN:2018Z-2106Z
  - Fitow 22W : TRK:093012-0700Z,RAN:0506-0518Z

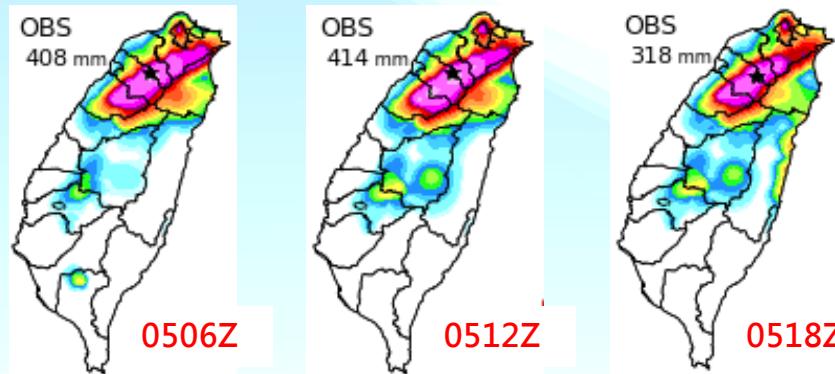
# Track error of 6 warning TCs

120 cases had been finished

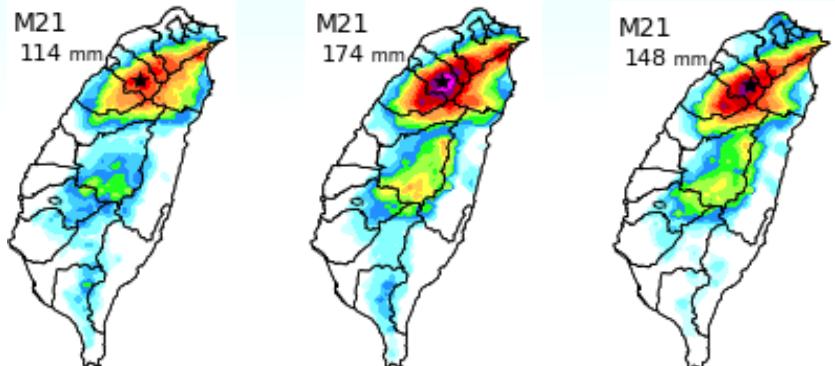


# 24-hour accumulated rainfall for Typhoon FITOW(2013)

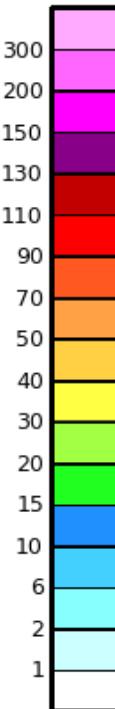
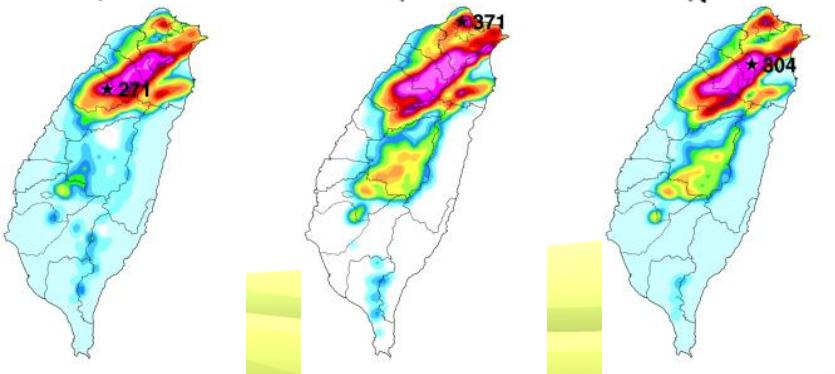
OBS



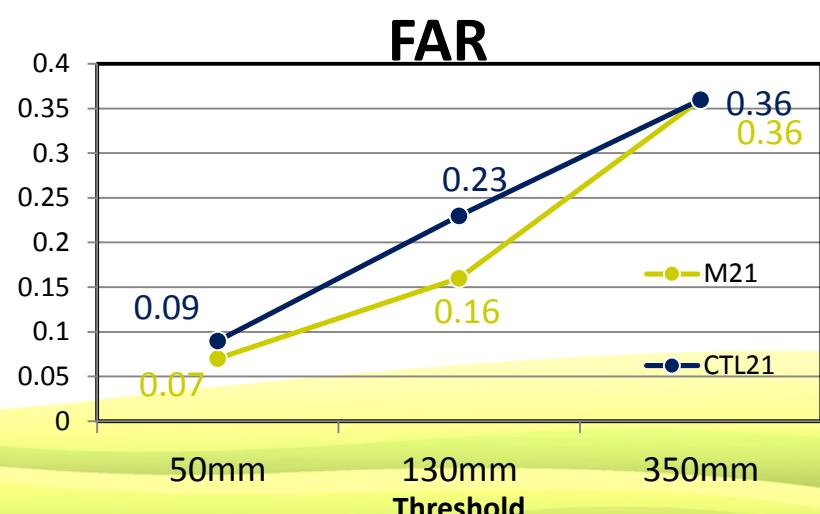
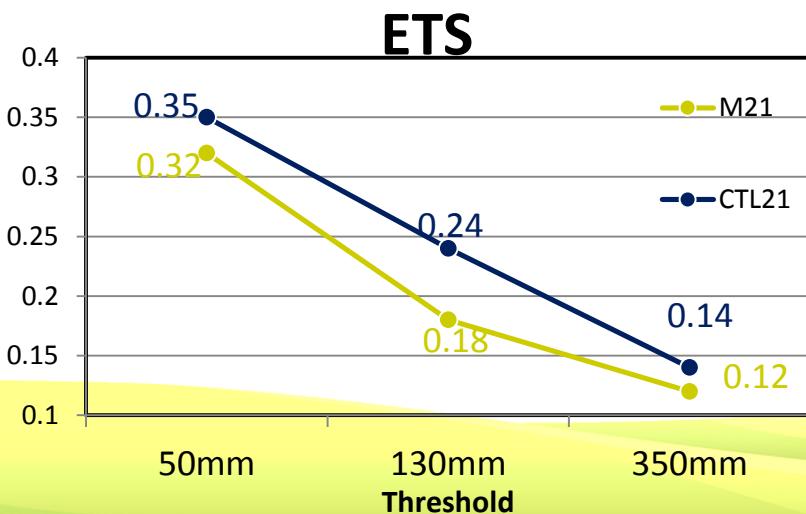
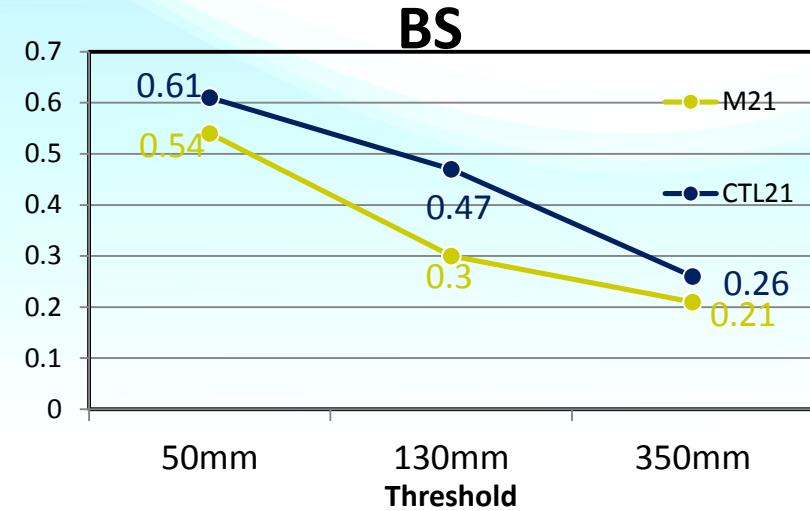
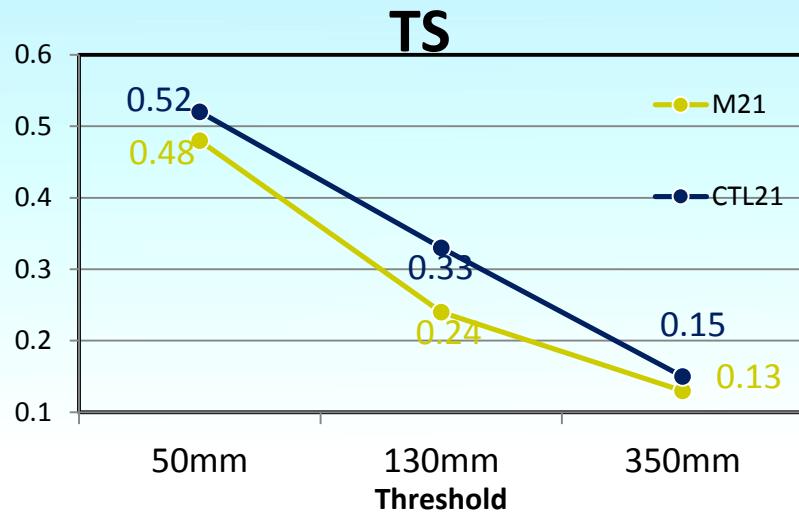
5km



3km

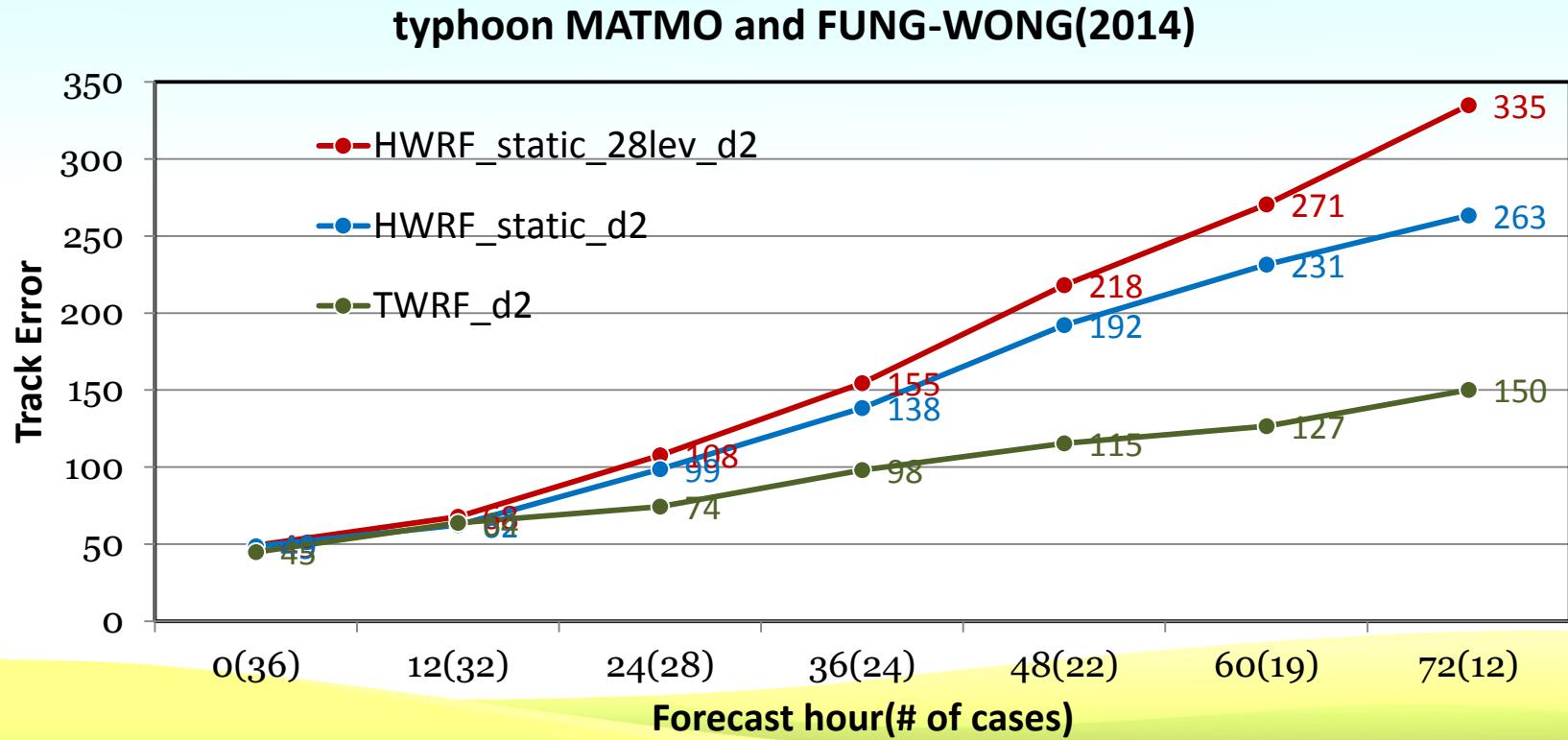


# Precipitation skill score (6 TCs,18cases)

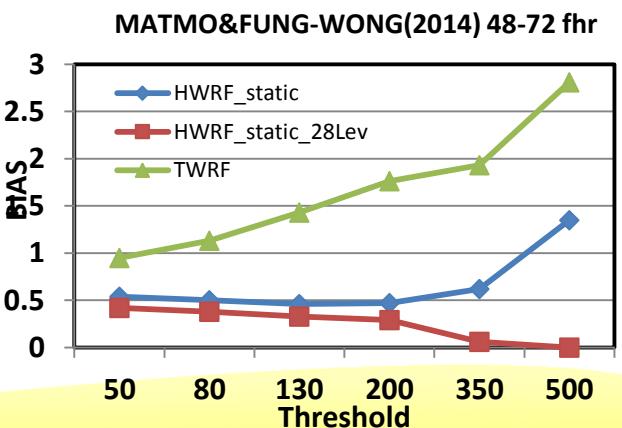
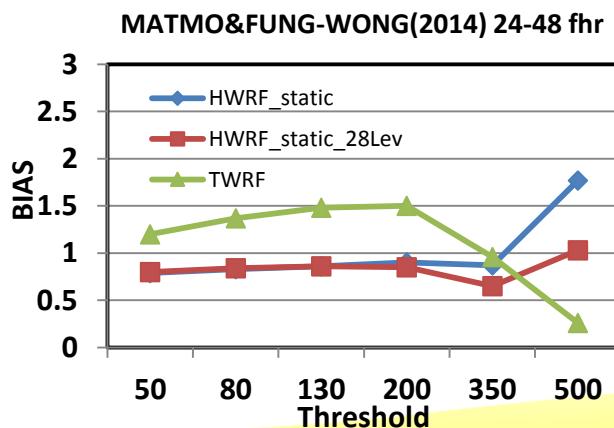
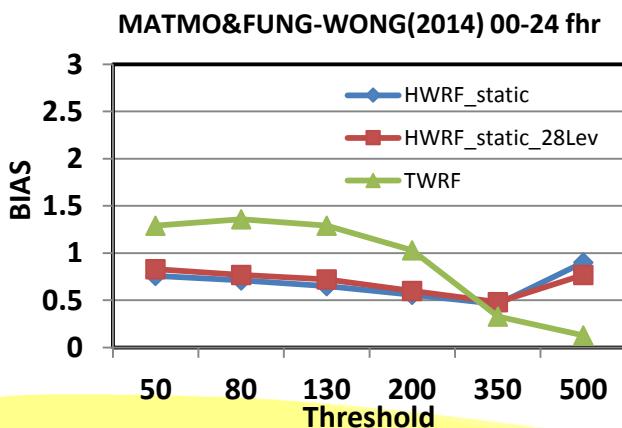
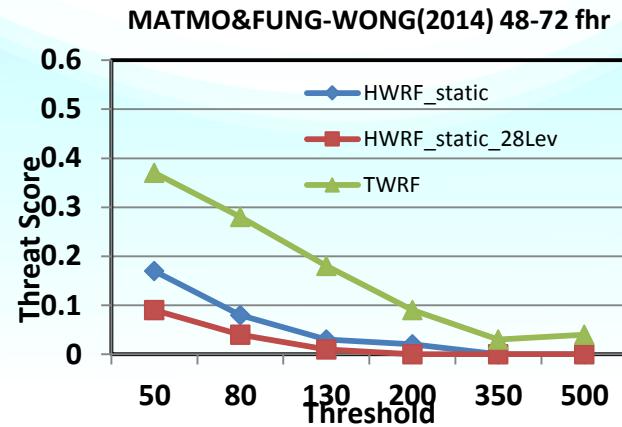
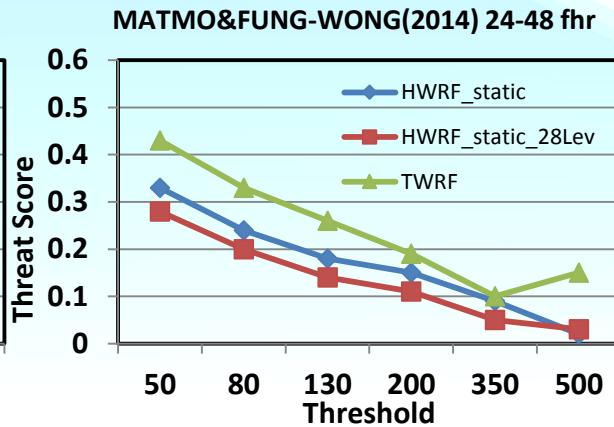
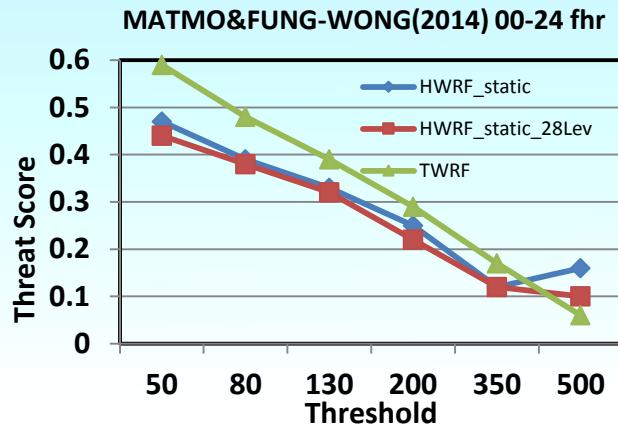


# HWRF with static domain in 2014

- In typhoon season 2014
  - horizontal resolution :**27/9/3** km ; vertical resolution **43 levs**
  - But the track performance was poor after 36 forecast hour.



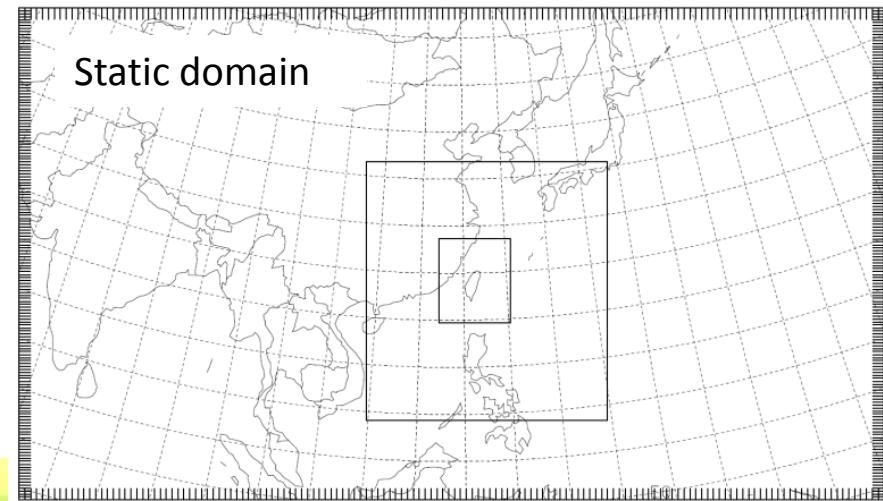
# Rainfall forecast skill score of typhoon FUNG-WONG&MATMO (18 cases)



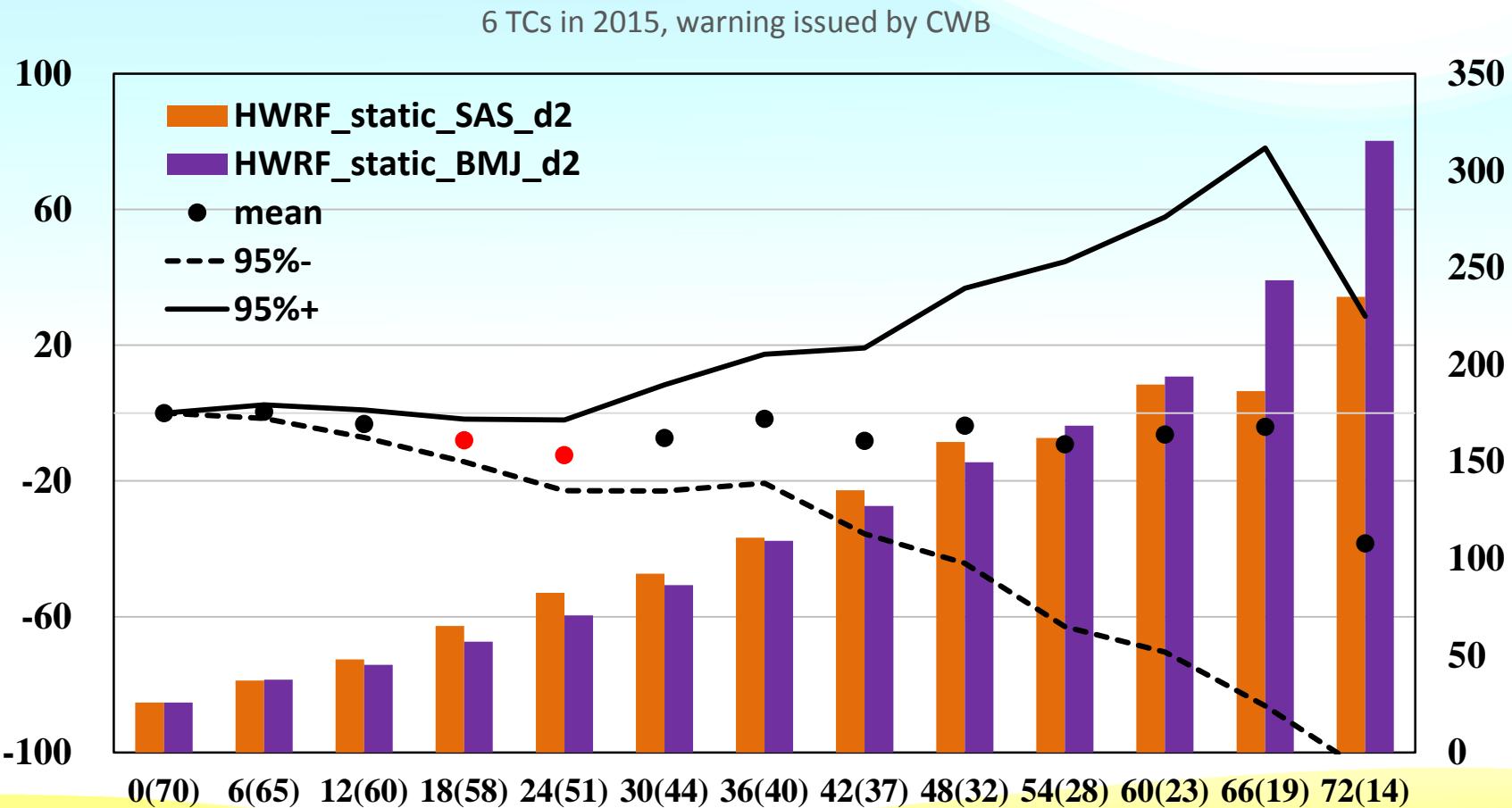
# Configuration of HWRF static

Experiment	cold/warm	analysis	bogus	Cu.	M.P.	PBL	Note
<b>HWRF static</b>	cold start	NODA	no bogus	<b>SAS</b>	Ferrier	NCEP GFS	43levels; P_top 50hPa; 1 way; 27/9/3km; static; no ocean couple & no GSI; IC&BC from NCEP 0.5deg data.
<b>HWRF static</b>	cold start	NODA	no bogus	<b>BMJ</b>	Ferrier	NCEP GFS	43levels; P_top 50hPa; 1 way; 27/9/3km; static; no ocean couple & no GSI; IC&BC from NCEP 0.5deg data.

- **Warning issued by CWB,2015**
  - NOUL
  - CHAN-HOM
  - LINFA
  - SOUDELOR
  - GONI
  - DUJUAN

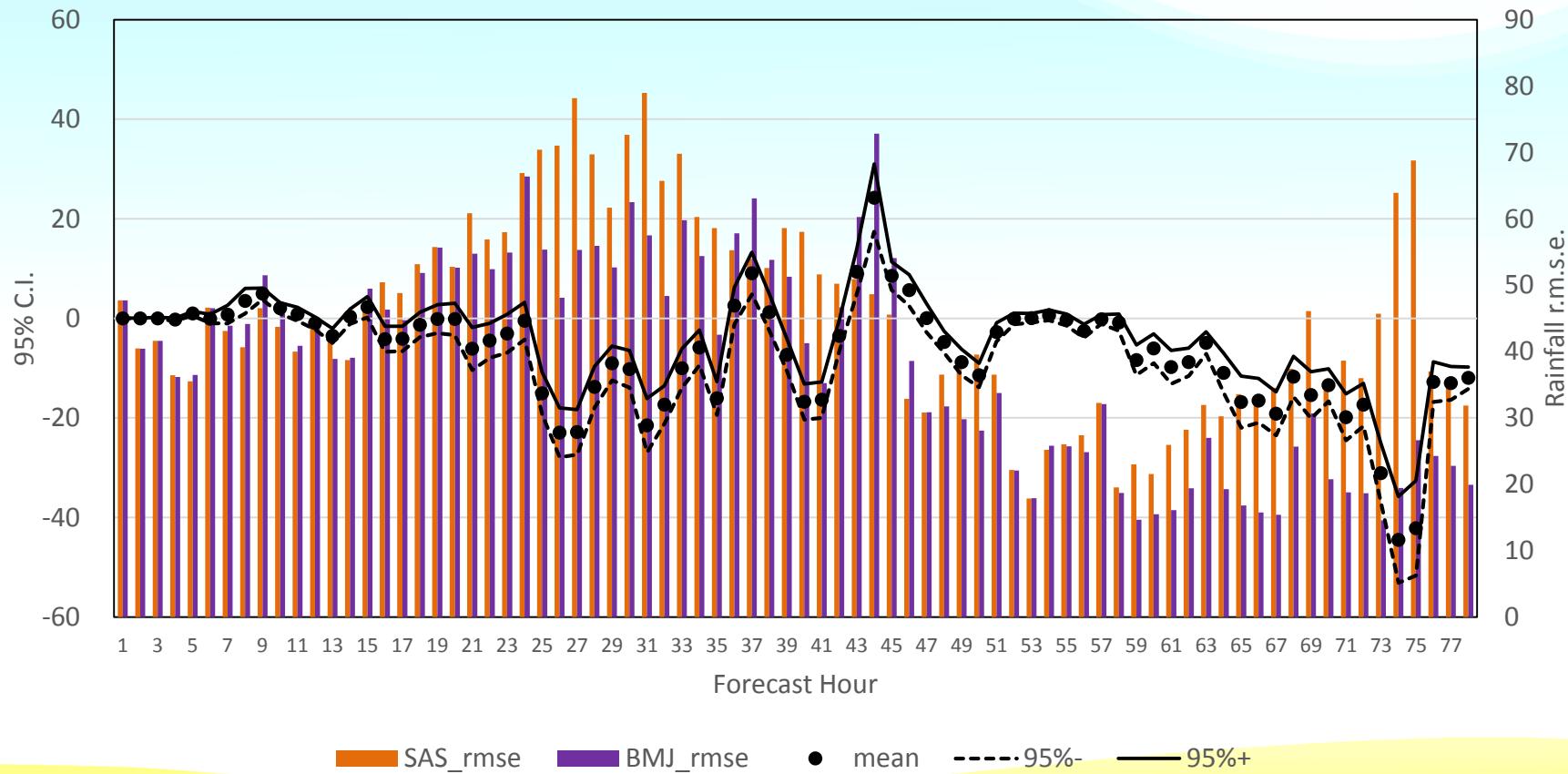


# Forecast Track Error of SAS vs BMJ



# Rainfall forecast ability of SAS and BMJ

766 stations in TAIWAN, 65 initial times



# **Summary & future work of Hurricane WRF**

- 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. But it's rainfall forecast ability still poor than TWRF.
- A sensitivity test of model cumulus scheme had been done to evaluate the track and rainfall forecast ability between SAS and BMJ scheme. 6 TCs cases show that BMJ performs better during 18-24H in track forecast and 25-35H in rainfall forecast.
- To update the 2015 operational HWRF version and continue evaluating the performance over the WNP.

**Thanks for your attention**