

全球天氣與氣候預報模式系統發展



全球天氣與氣候預報小組

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系集預報分組：分組長曾建翰 組員：賴永鑫、孫于力

作業控制分組：分組長張庭槐 組員：黃文豪、鄭凱傑

1. 計畫的具體目標
2. 計畫的工作重點
3. 計畫的現況與成果
4. CWB/GFS未來的發展

Weather⁺

Service Observation Climate Forecasts Satellite Earthquakes Marine Radar Astronomy





1. 具體目標

- 改進預報模式的動力架構、模式物理過程、提高模式解析度、更新海氣耦合模式預報系統等方向，並發展全球系集預報系統、模式後置處理及統計預報系統等，**提升2週以上之天氣與短期氣候預報的技術與作業能力。**

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2. 工作重點



- 提高天氣與氣候模式解析度、更新模式的動力架構與物理參數化
- 強化資料同化技術與同化更多衛星資料
- 發展全球系集預報系統
- 引進國際新一代海洋模式，銜接本局全球大氣預報模式的發展，建立自主性的海氣偶合模式
- 同時建構全球與區域氣候預測一體適用之模式系統，健全短期氣候動力預報作業能力。

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3. 現況(105年)與成果



- 更新全球預報系統的動力架構及增加模式的解析度
- 更新全球預報系統的輻射參數化(RRTMG)及增加臭氧預報
- 建立全球系集預報系統
 - 全球模式颱風系集預報系統(CWB/GET)
 - 全球模式45天系集預報系統(CWB/GEPS)

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國際各作業中心模式現況



名稱	解析度	水平	垂直	模式架構
ECMWF (2016/3)	O1280L137	9km	S-P 137	SISL + spectrum
JMA (2007/11)	TL959L60	20km	S-P 60	SISL + spectrum
NCEP(2015)	TL1500L64	13km	S-P 64	SISL + spectrum
UKM (2010/5)	N512L70	25km	S-P 70	Finite difference
KMA (韓國2010/5)	N512L70	25km	S-P 70	Finite difference
CMA (中國2008/1)	TL639L60	32km	S-P 60	SISL + spectrum
CMC (加拿大2006/8)	(800X600)	34km	S-P 80	SISL + finite element
NAVGEM (2015/10)	TL425L60	31km	S-P 60	SISL + spectrum
CWB (2016/4)	T511L60	25km	S-P 60	spectrum

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Present and Past of CWBGFS



Present

Past

	T511L60	T319L40
DA	Hybrid GSI	Hybrid GSI
Dynamic	Horizontal grid : reduced gaussian grid (~25KM) Vertical grid: S-P hybrid 60 layers Model top: 0.1MB	Horizontal grid: regular gaussian grid (~40KM) Vertical grid: Sigma 40 layers Model top: 1MB
Physics	<p>Soil model : Noah Land Surface model</p> <p>Vertical turbulence : Hong and Pan (2011)</p> <p>* Cumulus convection : NSAS Han and Pan(2011)</p> <p>Grid scale precipitation: Zhao and Carr (1997)</p> <p>* Shallow convection: Han and Pan(2011)</p> <p>Topographic gravity wave drag: palmer (1986)</p> <p>Radiation : Fu et.al. (1997) 、 Fu an Liou (1992 ; 1993)</p> <p>* nonorographic gravity wave drag: Scinocca (2003)</p>	<p>Soil model : Noah Land Surface model</p> <p>Vertical turbulence: Mahrt and Pan (1984)</p> <p>Cumulus convection : NSAS Han and Pan(2011)</p> <p>Grid scale precipitation: Zhao and Carr (1997)</p> <p>Shallow convection: Li and Wang (2000)</p> <p>Topographic gravity wave drag: palmer (1986)</p> <p>Radiation : Fu et.al. (1997) 、 Fu an Liou (1992 ; 1993)</p>

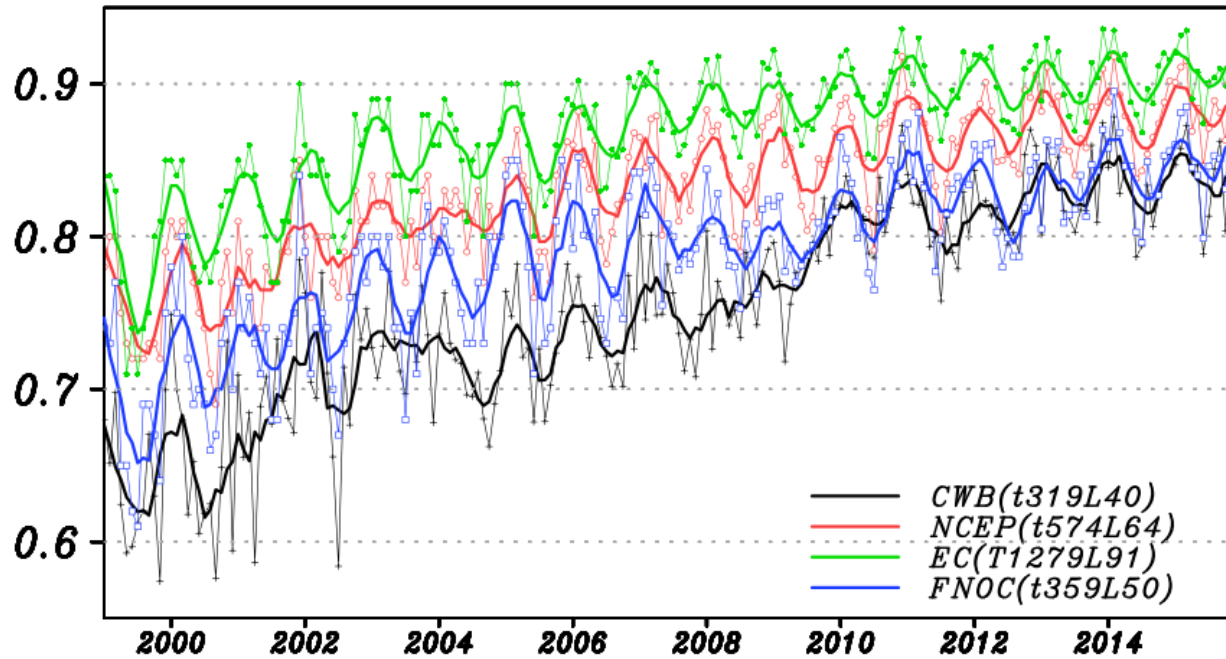
Weather

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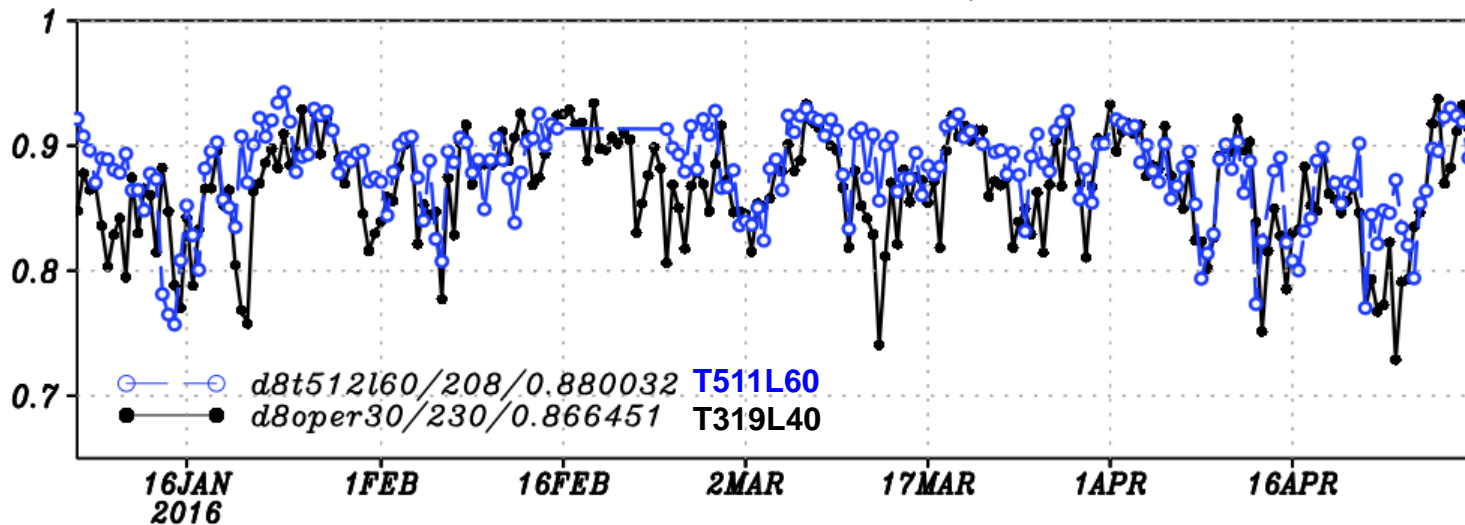
Past

day 5 forecast, 500hPa H AC - N.Hemis.

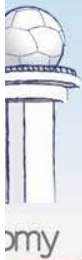


Present

500hPa ach 5 day fcst - NA
07JAN2016-30APR2016, 0012Z



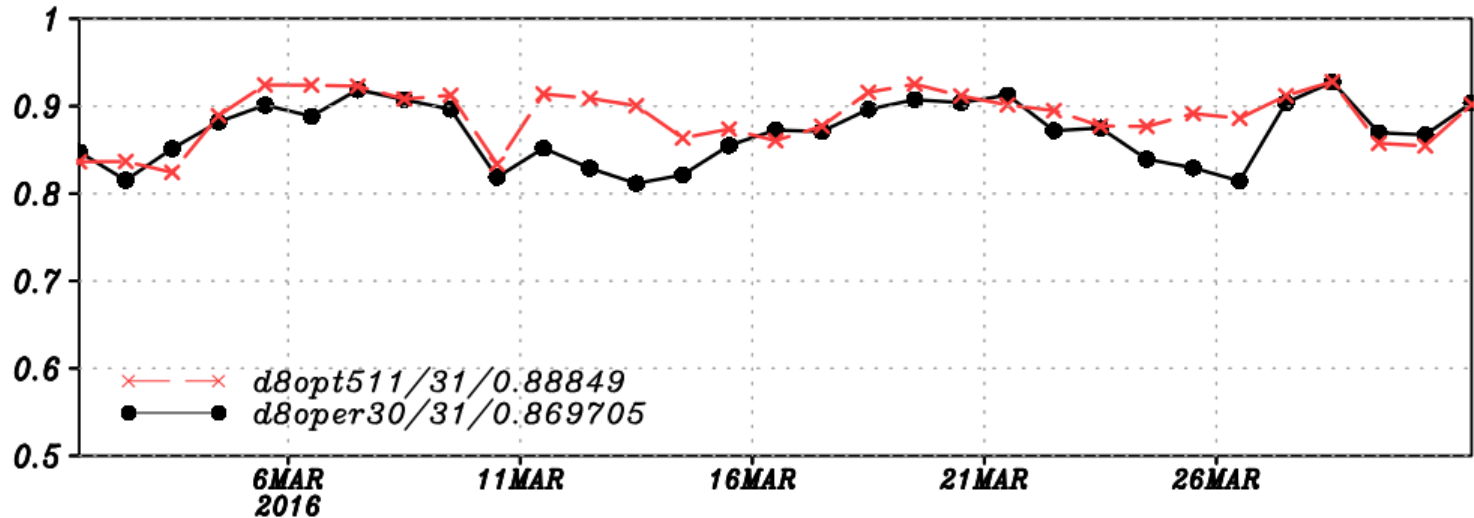
Ueo



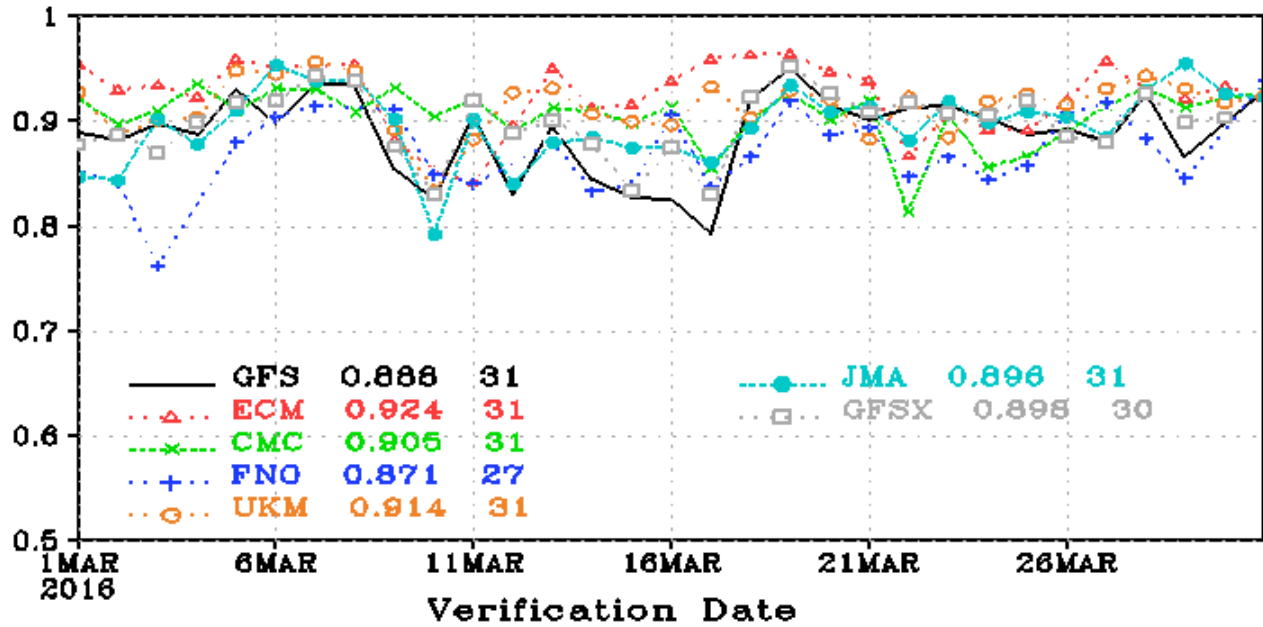
omy

500hPa AC, 16030100-16033100,12Z

500hPa ach 5 day fcst - NA
01MAR2016-31MAR2016, 12Z



Anomaly Correl: HGT P500 G2/NHX 12Z, fh120

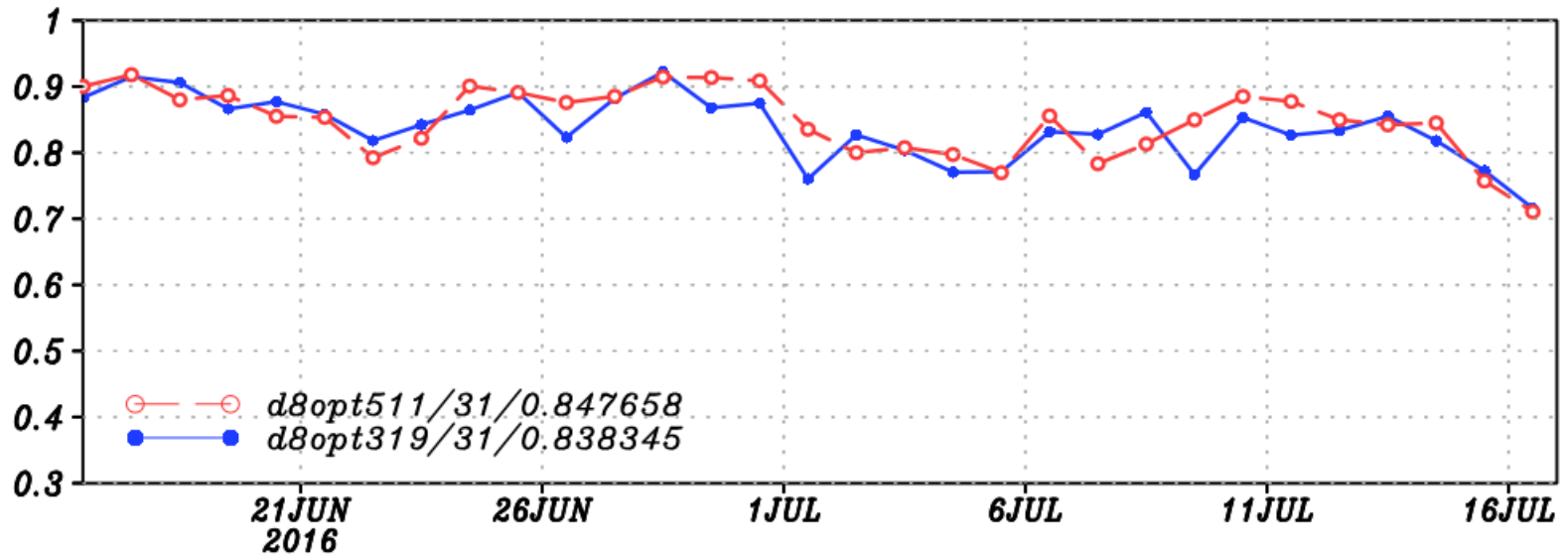


Weat

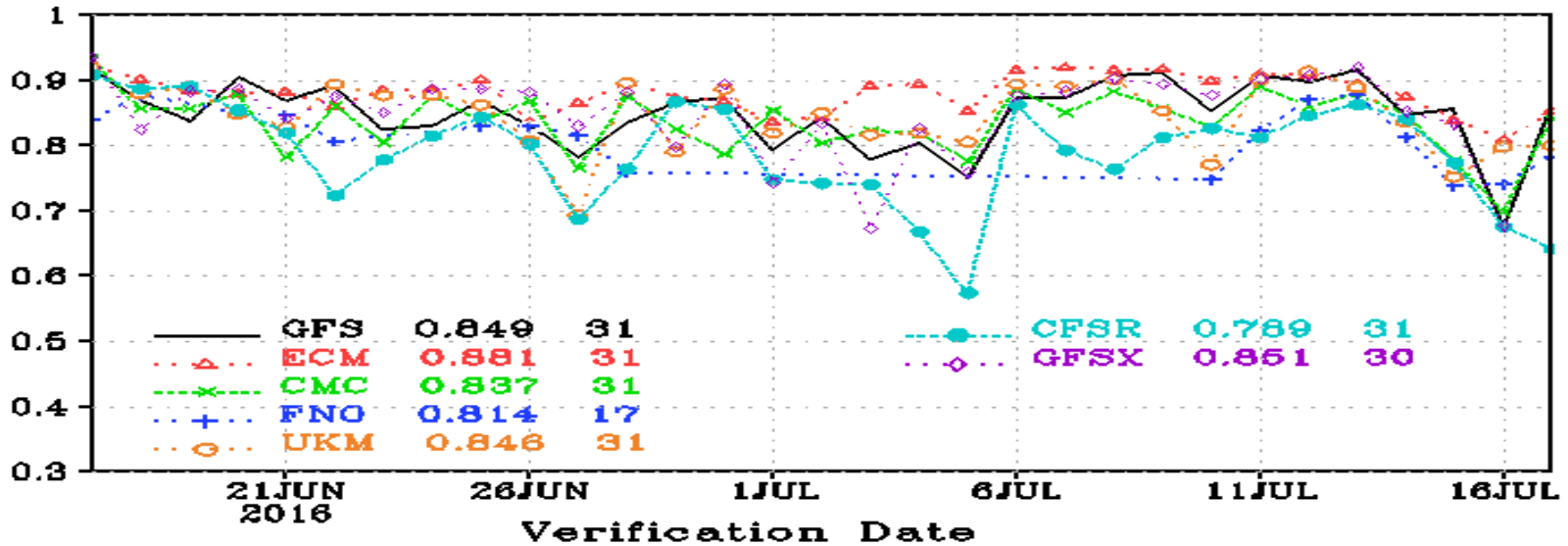


500hPa AC, 16061600-16071700,00Z

500hPa ach 5 day fcst - NA
16JUN2016-17JUL2016, 00Z



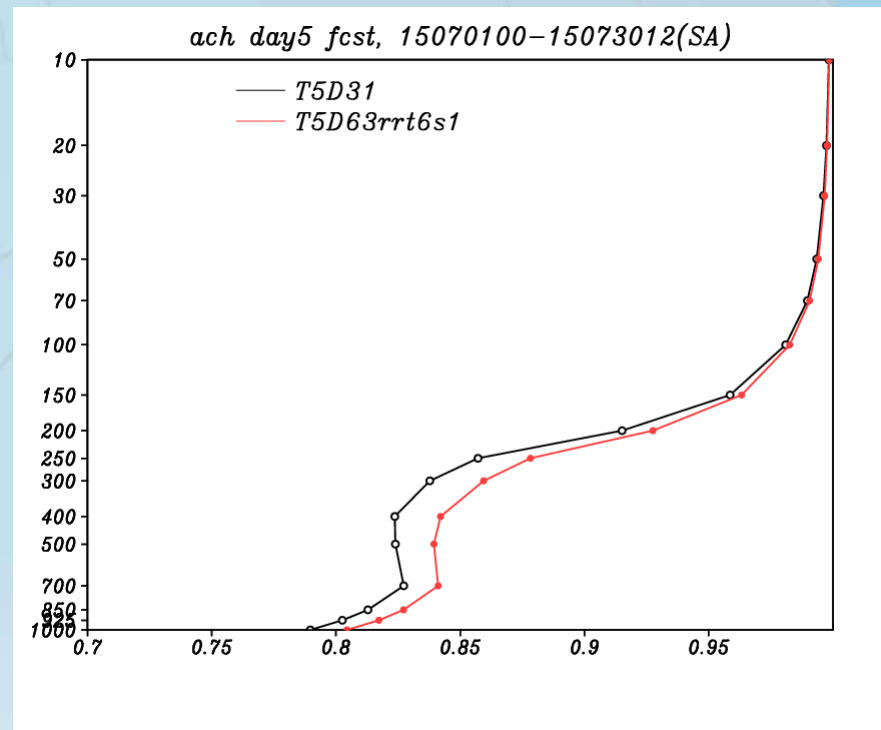
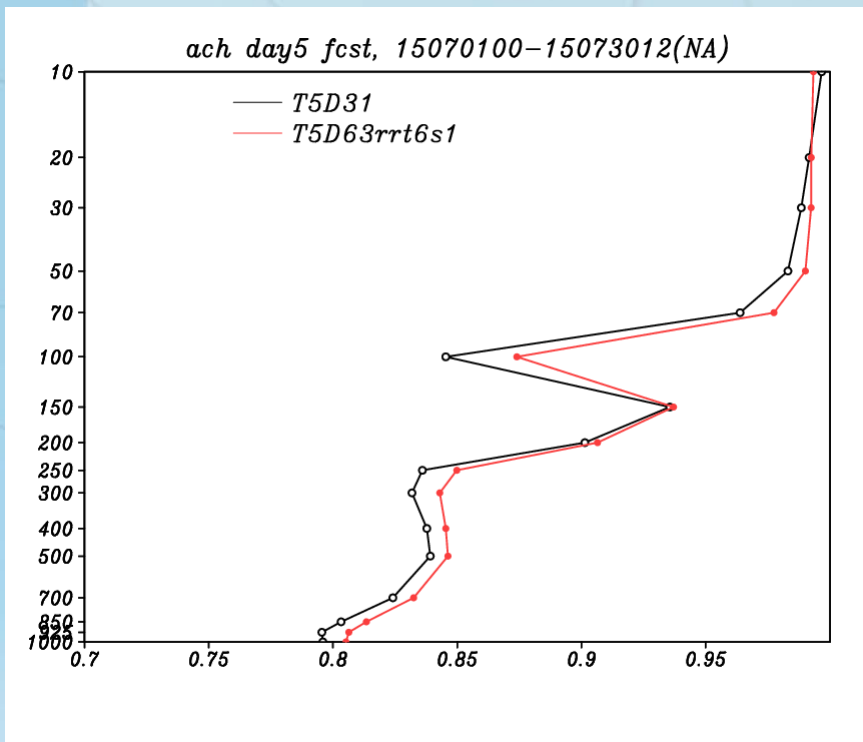
Anomaly Correl: HGT P500 G2/NHX 00Z, fh120



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新輻射參數化(RRTMG)+臭氧 2016年9月30日上線作業



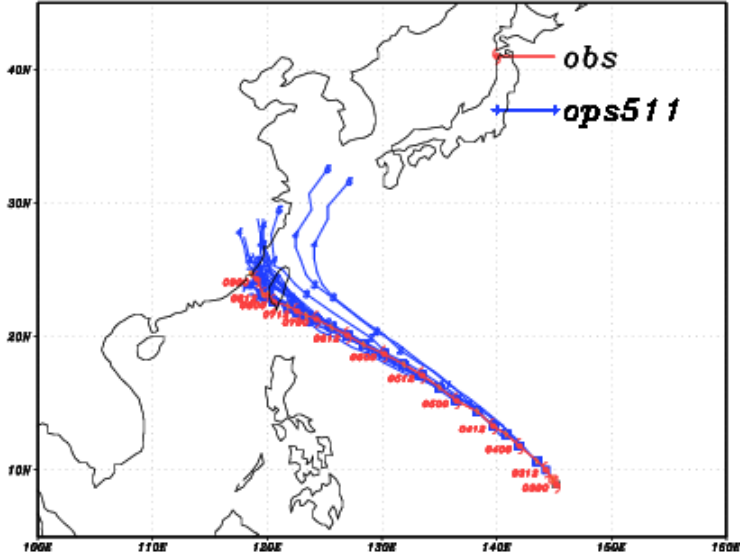
Weather⁺

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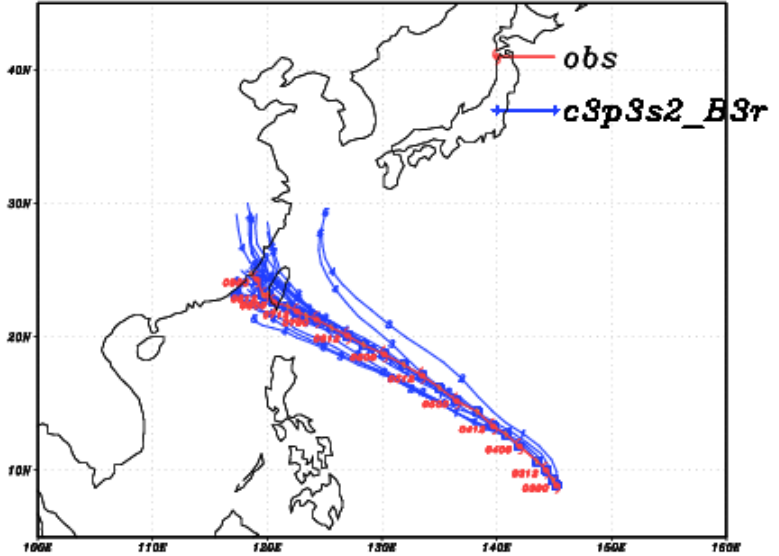




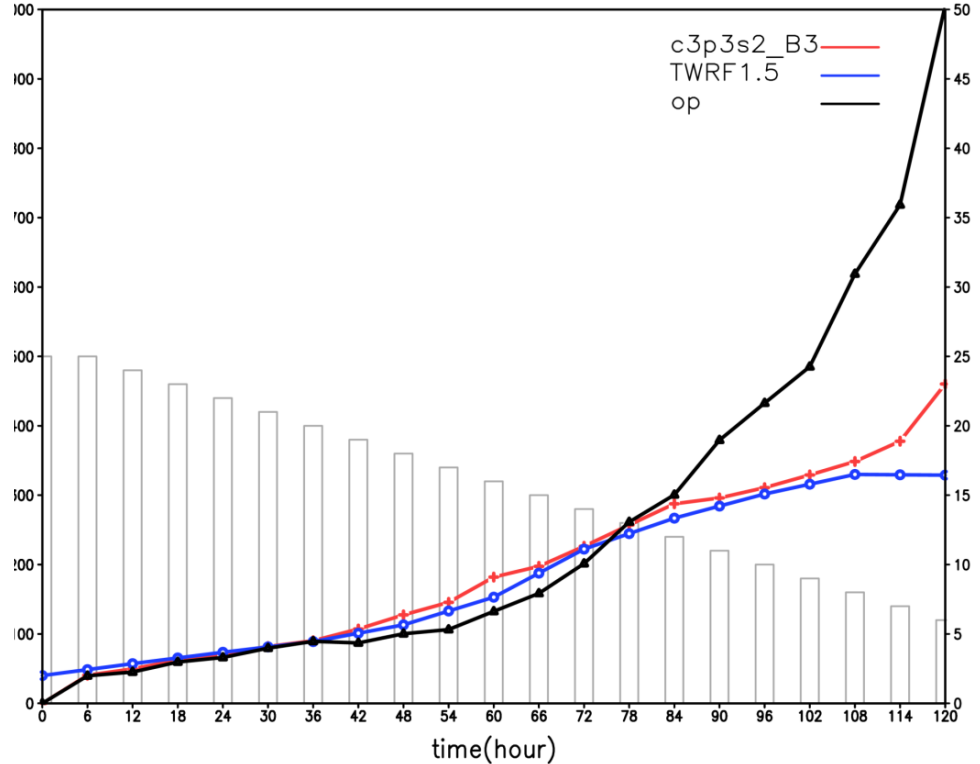
NEPARTAK 2016:7:3:0-2016:7:9:0 (050H)



NEPARTAK 2016:7:3:0-2016:7:9:0 (050H)

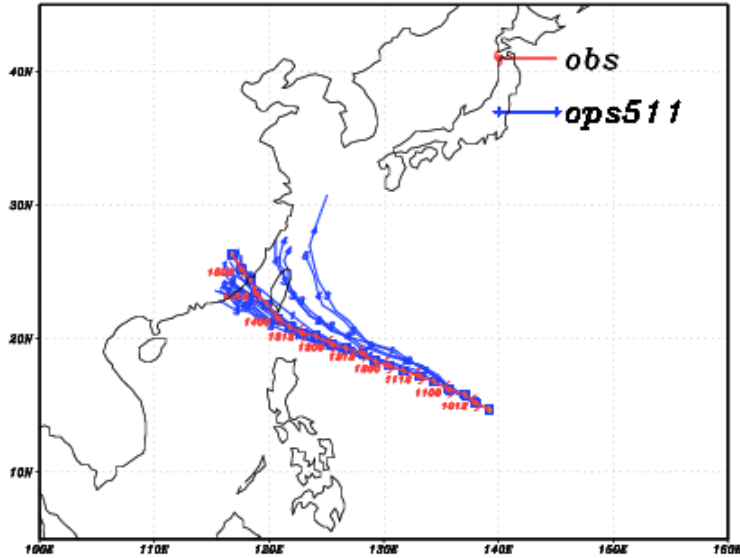


2016070300-2016070900 track error

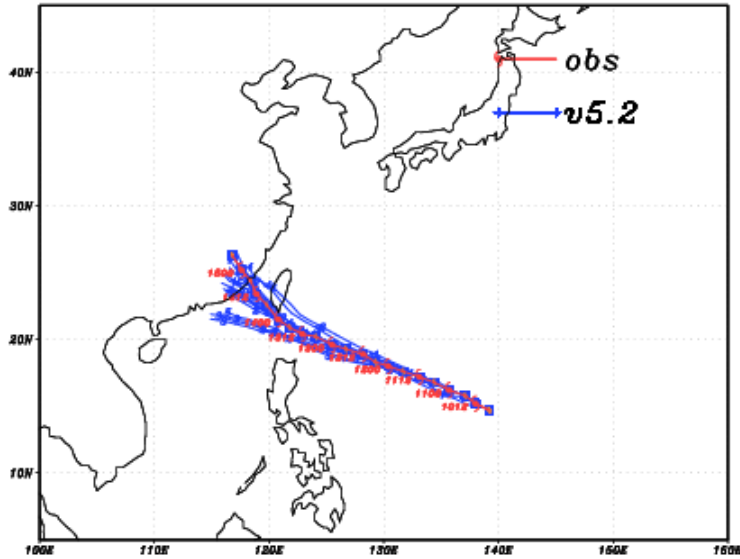




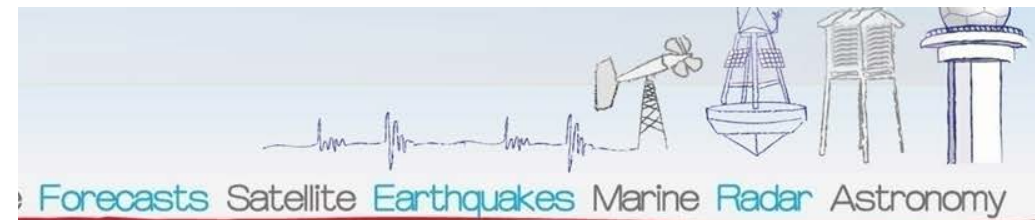
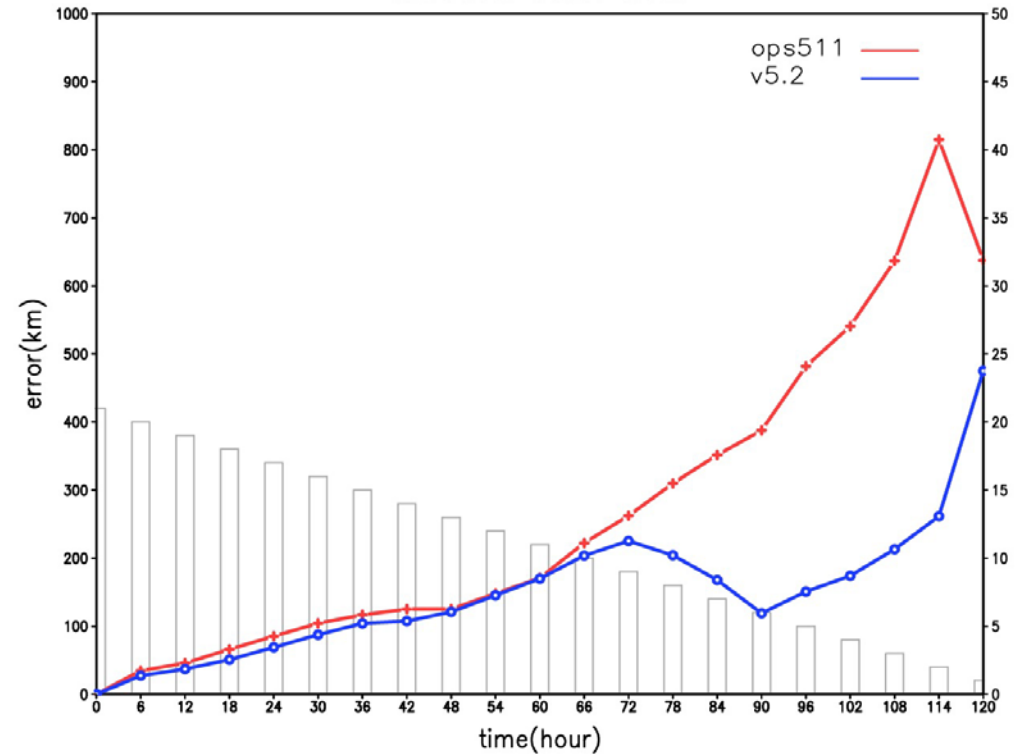
MERANTI 2016:9:10:6-2016:9:15:6 (850H)



MERANTI 2016:9:10:6-2016:9:15:6 (850H)

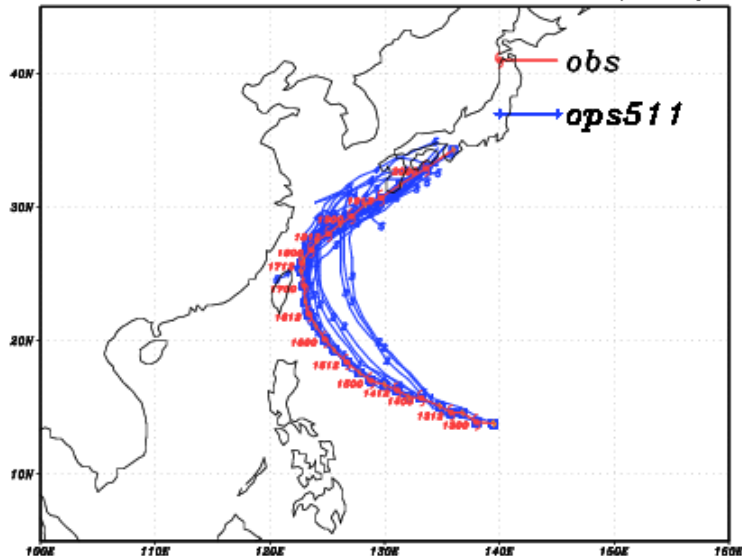


MERANTI track error

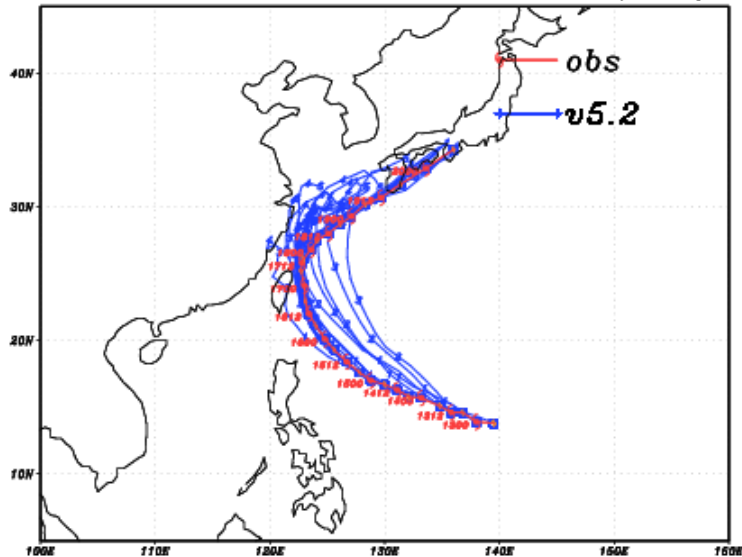




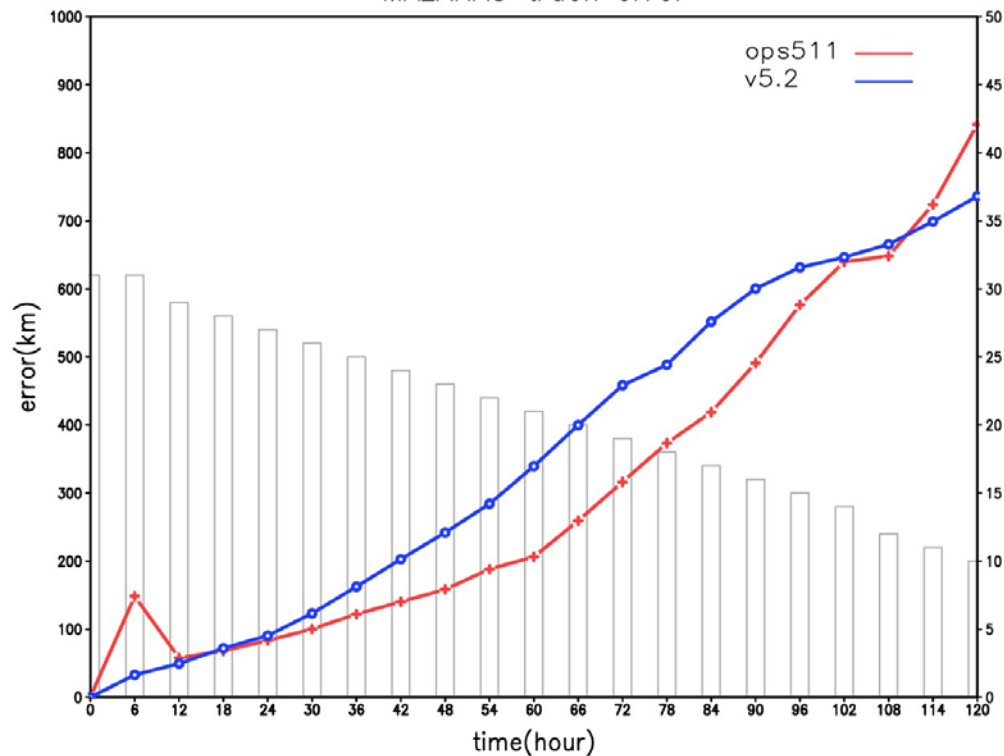
MALAKAS 2016:9:12:18-2016:9:20:6 (850H)



MALAKAS 2016:9:12:18-2016:9:20:6 (850H)

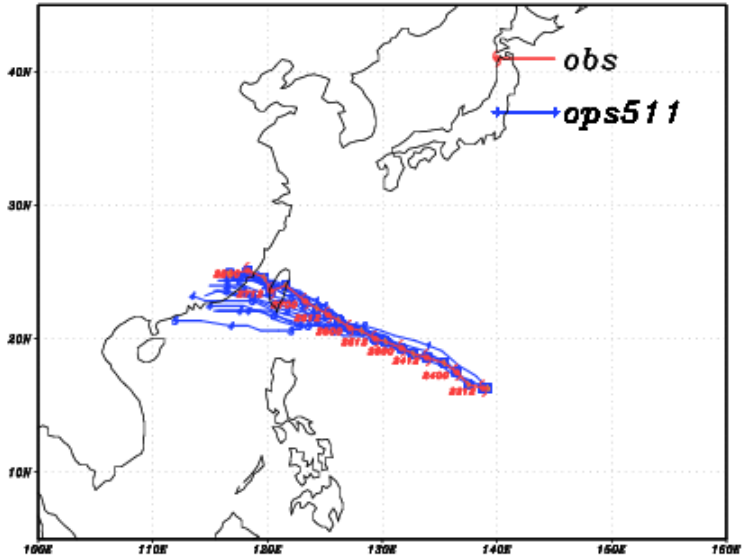


MALAKAS track error

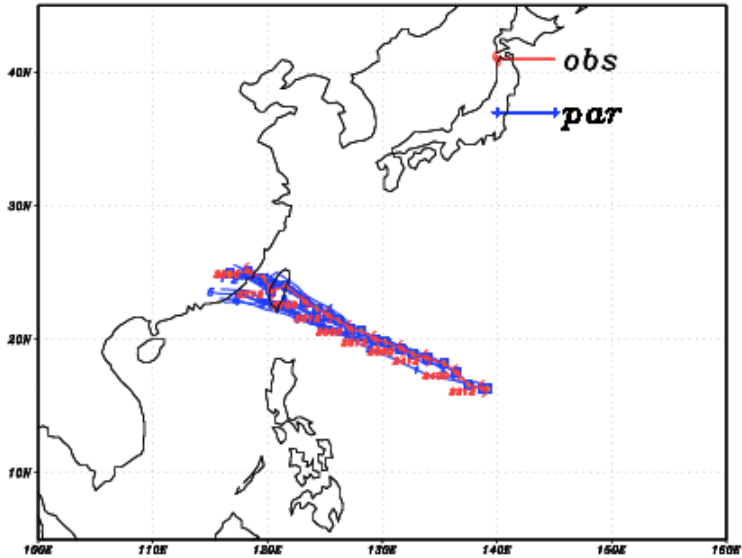




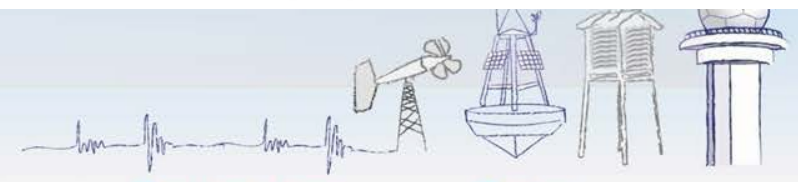
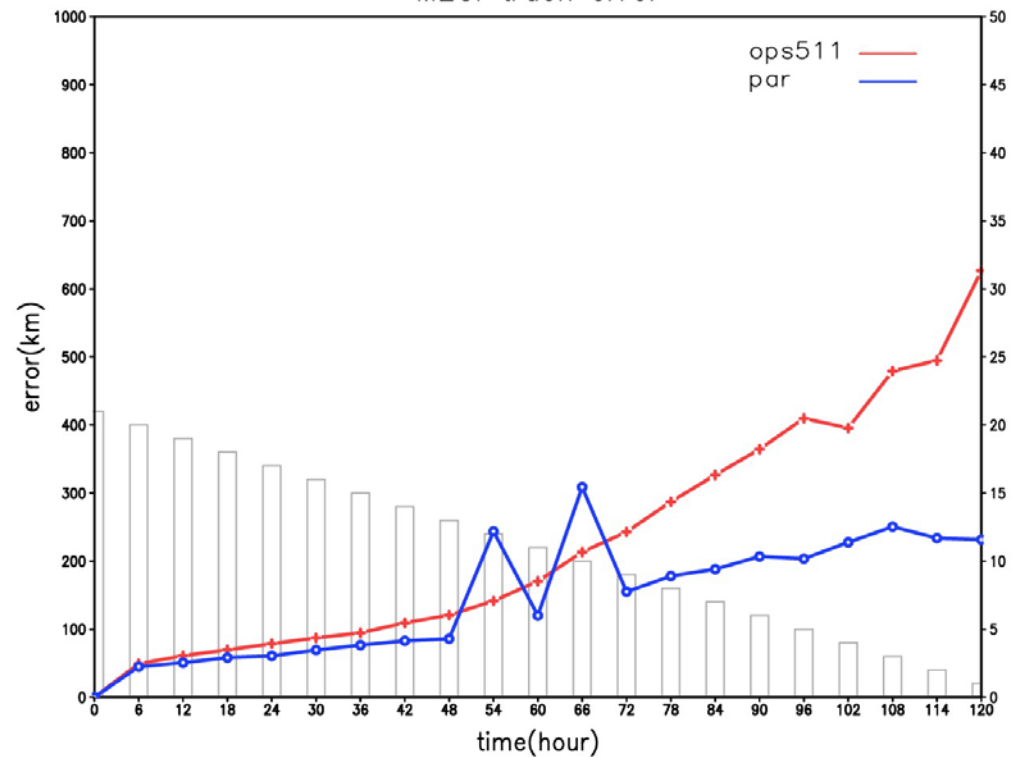
MEGI 2016:9:23:6-2016:9:28:6 (850H)



MEGI 2016:9:23:6-2016:9:28:6 (850H)



MEGI track error

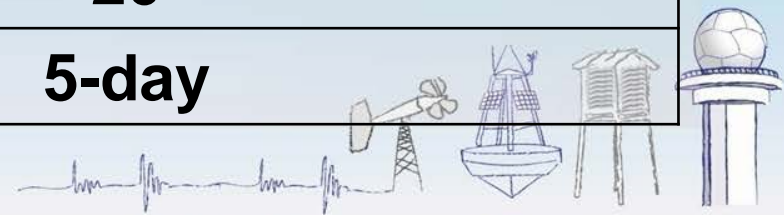


● 全球模式颱風系集預報系統(CWB/GET)



CWB GFS EPS for T yphoon track (GET)			
resolution	deterministic model		T511L60
	ensemble		T511L60
initial perturbation, singular vector	global		T42L60
	nested typhoon domain	east Asia	20 ⁰ N-60 ⁰ N, 100 ⁰ E-180 ⁰ E
		typhoon	15 ⁰ × 10 ⁰
optimization time	48 hrs		
ensemble size	20		
forecast length	5-day		

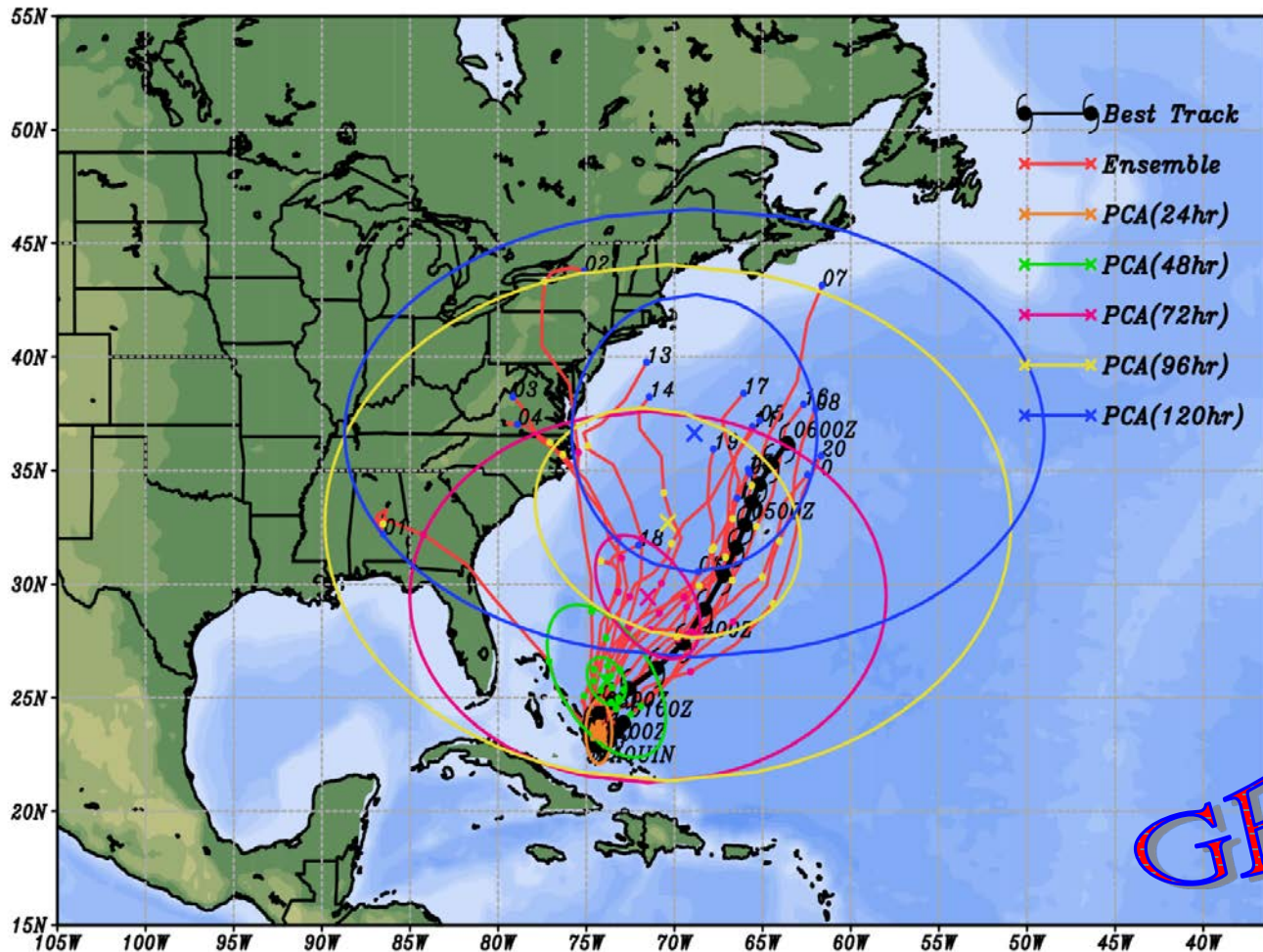
Weather⁺



Probabilistic Estimation (2)



CWB GEps for Typhoon-track (GET)
Initial time = 15100100



GET



Astronomy

Wea

Courtesy of Young-Sin Lai



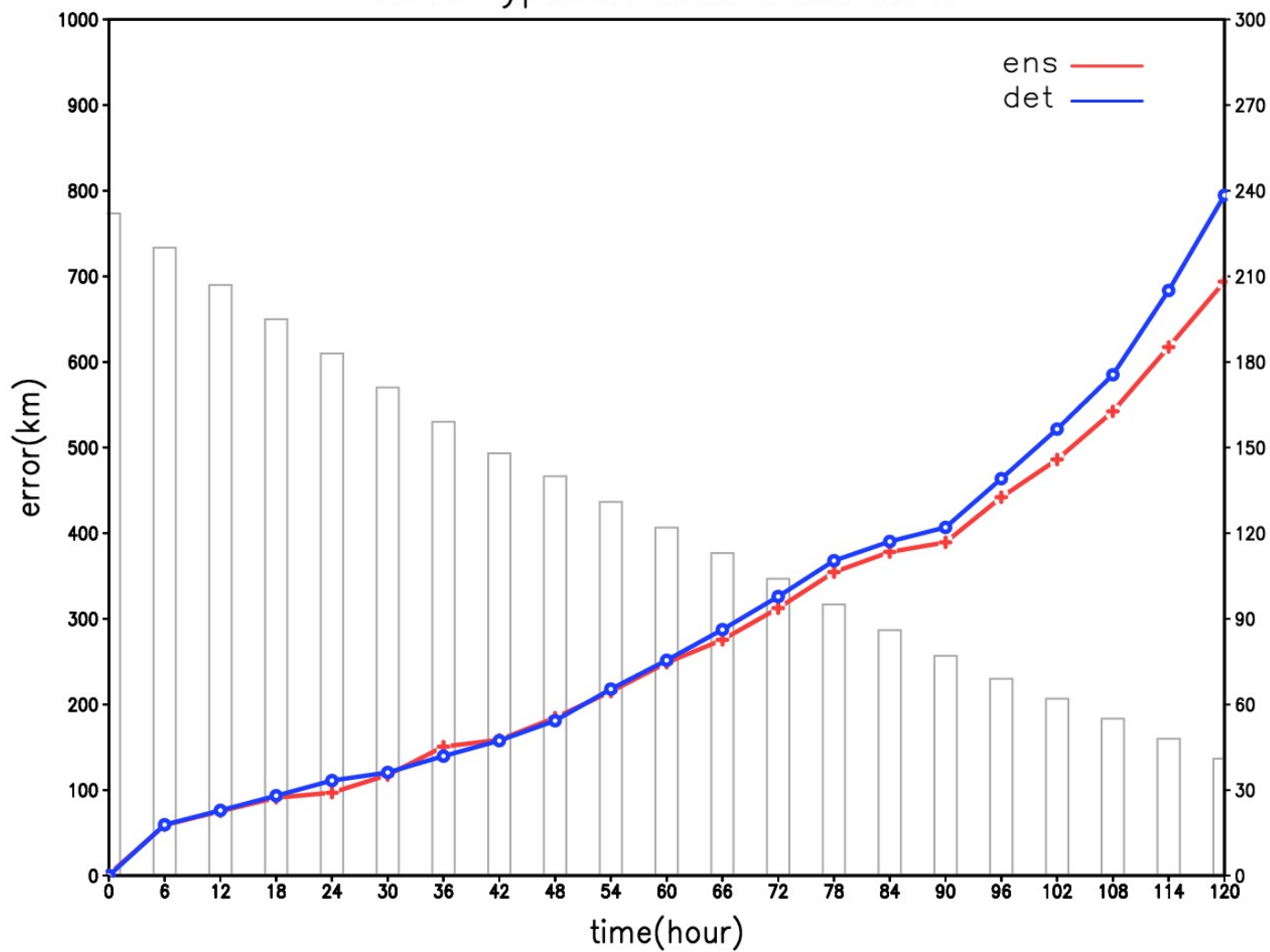
Typhoon	Initial date	End date
NEPARTAK	2016070300	2016070900
LUPIT	2016072318	2016072412
NIDA	2016073018	2016080218
OMAS	2016080406	2016080912
CONSON	2016080818	2016081418
CHANTHU	2016081318	2016081706
DIANMU	2016081800	2016081906
MINDULLE	2016081906	2016082300
LIONROCK	2016081912	2016082812
KOMPASU	2016082000	2016082112
MALAKAS	2016091218	2016092006
MERANTI	2016091006	2016091506
MEGI	2016092300	2016092806

Weather⁺

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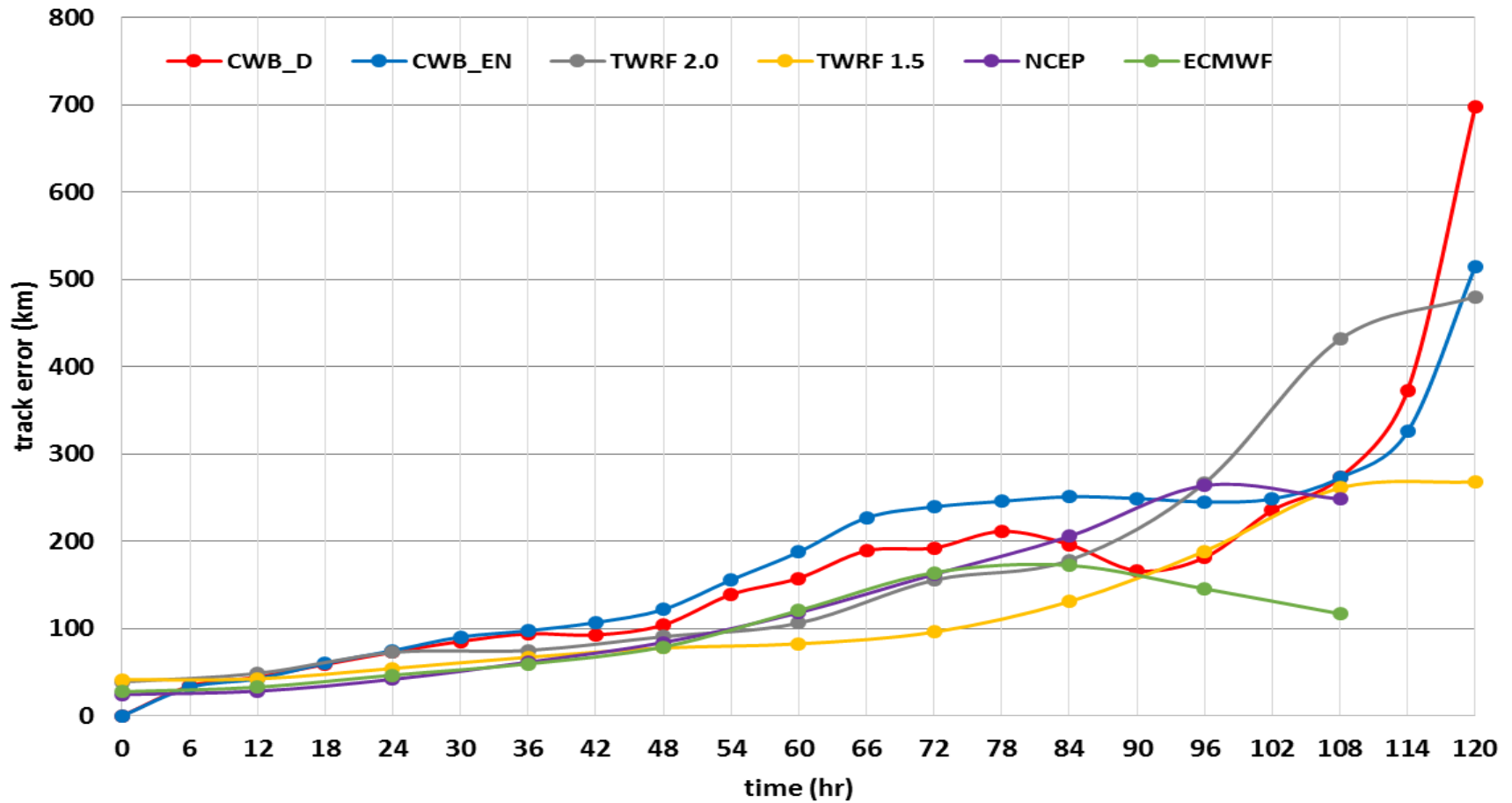


2016 typhoon total track error

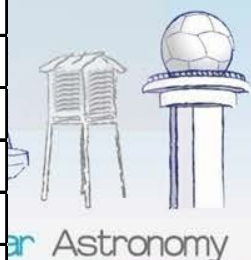


有氣象

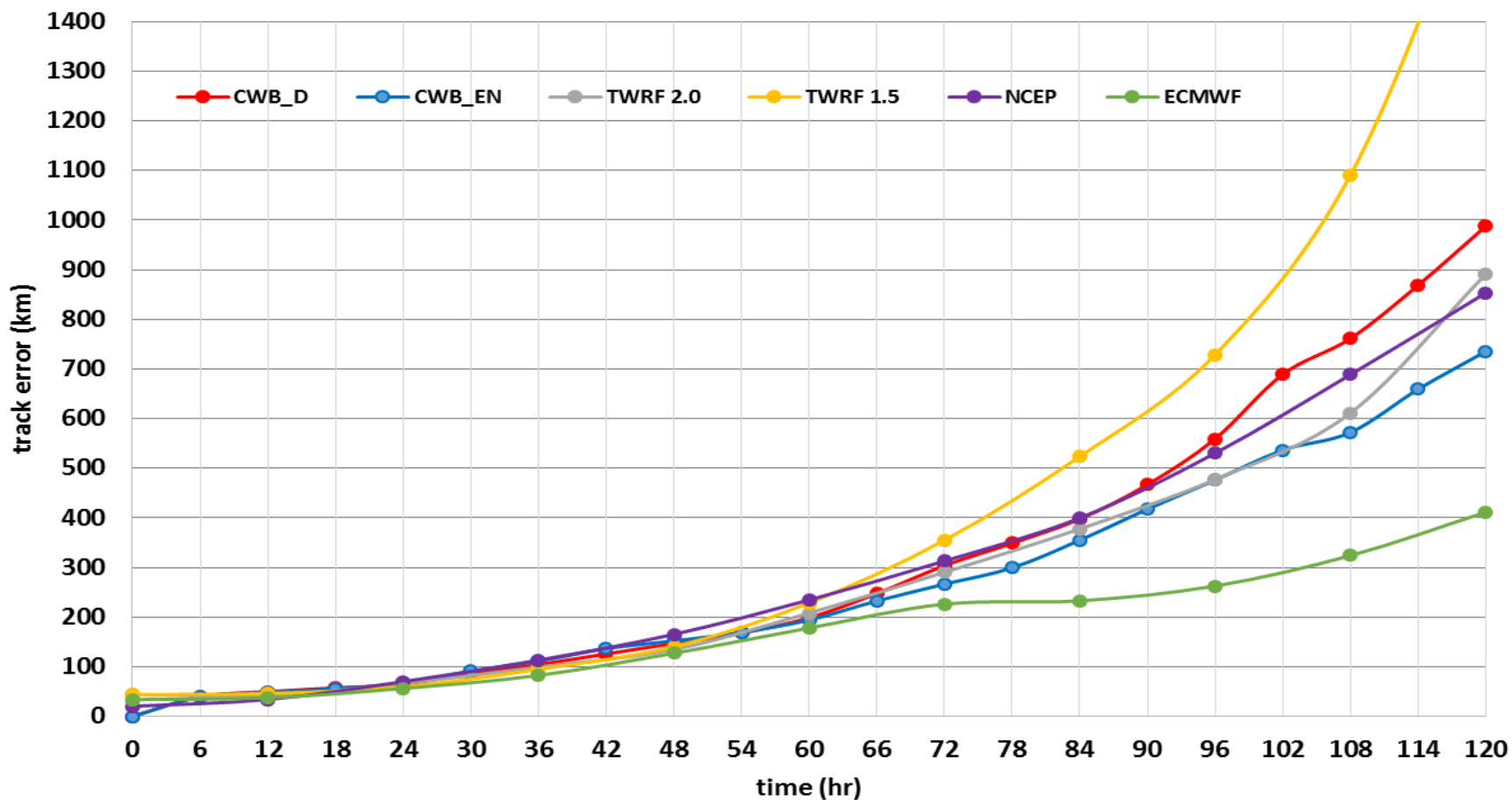
MERANTI track error (16091006-16091506)



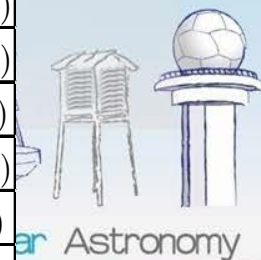
	0	12	24	36	48	60	72	84	96	108	120
CWB det	0 (21)	44.5 (19)	73.0 (17)	94.0 (15)	104.2 (13)	157.7 (11)	192.4 (9)	196.2 (7)	181.4 (5)	272.8 (3)	697.9 (1)
CWB ens	0 (21)	42.5 (19)	74.7 (17)	97.5 (15)	122.0 (13)	187.6 (11)	239.5 (9)	251.0 (7)	245.2 (5)	272.7 (3)	514.9 (1)
TWRf 2.0	38.9 (21)	48.7 (19)	72.7 (17)	75.0 (15)	90.8 (13)	106.3 (11)	155.5 (9)	178.3 (7)	266.8 (5)	431.4 (3)	480.2 (1)
TWRf 1.5	41.4 (21)	42.4 (19)	54.3 (17)	67.2 (15)	77.8 (13)	82.5 (11)	96 (9)	130.9 (7)	188.7 (5)	261 (3)	268.2 (1)
NCEP	24.5 (20)	28.3 (18)	41.9 (16)	61.5 (14)	84.1 (12)	118.2 (10)	162.1 (8)	205.6 (6)	263.8 (4)	248.4 (2)	
ECMWF	27.7 (10)	32.9 (9)	46.7 (8)	59.6 (7)	79 (6)	120.7 (5)	164.1 (4)	172.4 (3)	145.6 (2)	117 (1)	



MALAKAS track error (16091218-16092006)



	0	12	24	36	48	60	72	84	96	108	120
CWB det	0 (31)	49.9 (29)	65.0 (27)	104.4 (25)	147.0 (23)	198.6 (21)	303.8 (19)	397.9 (17)	559.1 (15)	761.4 (13)	987.7 (10)
CWB ens	0 (30)	48.3 (28)	66.4 (26)	111.3 (24)	152.1 (23)	194.1 (21)	266.5 (19)	355.0 (17)	476.2 (15)	572.0 (13)	735.2 (11)
TWRf 1.5	44.1 (31)	46.2 (29)	59.6 (27)	95 (25)	140.3 (23)	228.4 (21)	355 (19)	523.6 (17)	728.7 (15)	1090.4 (12)	1737 (10)
TWRf 2.0	43.8 (30)	42 (28)	66.7 (26)	99.4 (25)	134.8 (23)	208.2 (21)	290.3 (19)	377.7 (17)	477.3 (15)	611.1 (13)	891.1 (11)
NCEP	20.3 (30)	34 (28)	70.2 (26)	113.3 (24)	165.3 (22)	234.5 (20)	313 (18)	399.6 (16)	530.2 (14)	688.5 (12)	853.1 (9)
ECMWF	34 (15)	37.5 (14)	56.2 (13)	82.6 (12)	127.2 (11)	178.1 (10)	226.2 (9)	232.9 (8)	262.7 (7)	323.9 (6)	411.5 (5)



EPS run(t319L60) , 00Z

MASOPS (t511L60 main run)

GEPSHi2lo

gm2gm (t511 -> t319)
read_hires (reformat)
trnf_hi2lo (t319 -> t42)

GEPSsvd

svd(create perturbations,
AREA :
NH(10-80° N)
SH(10-80° S)
TP(depend on typhoon)

GEPSlo2hi_addpertb

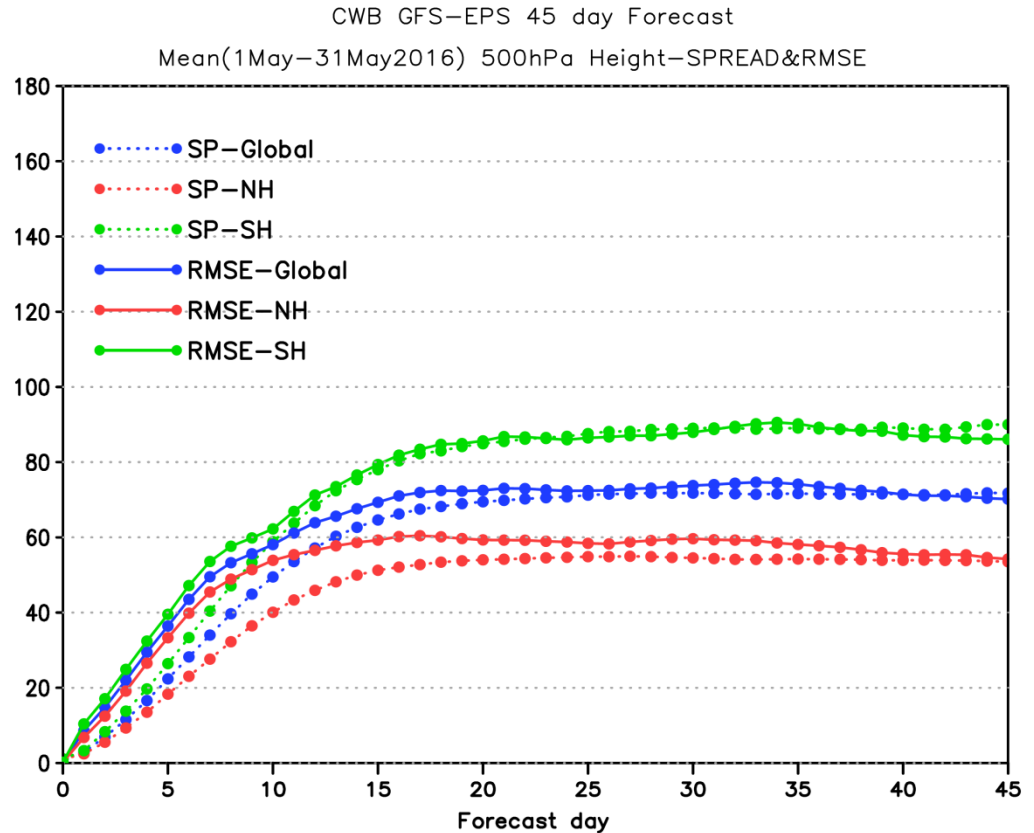
trnf_lo2hi_addpertb
(create analysis for 20 EPS
members)

Gstgfs

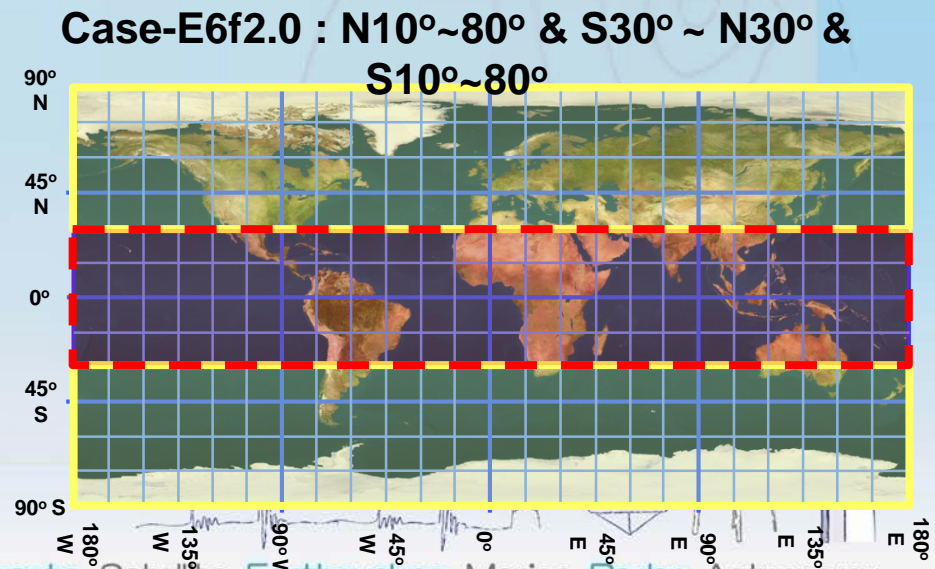
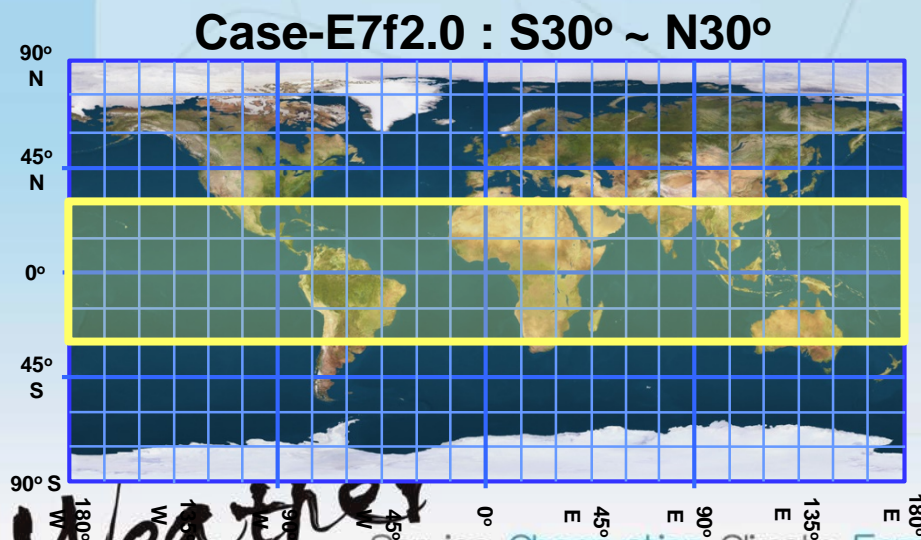
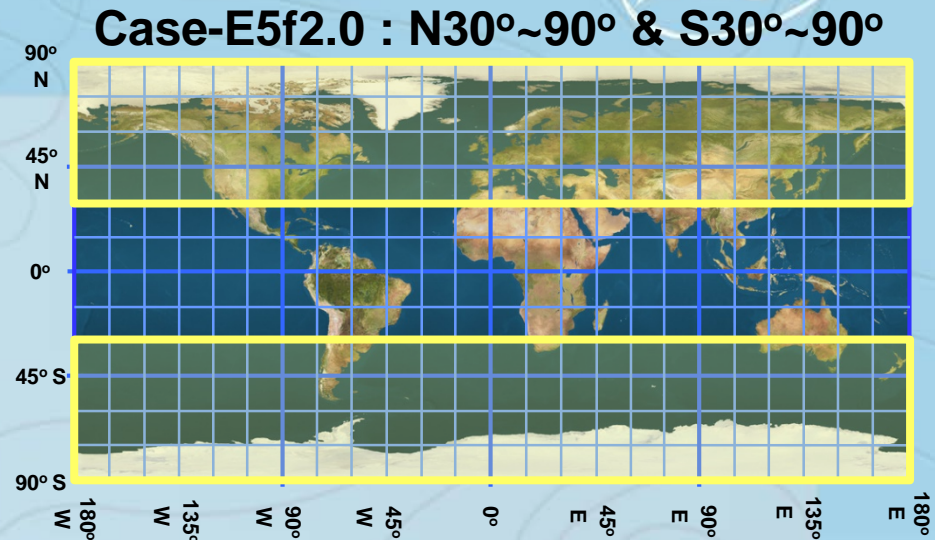
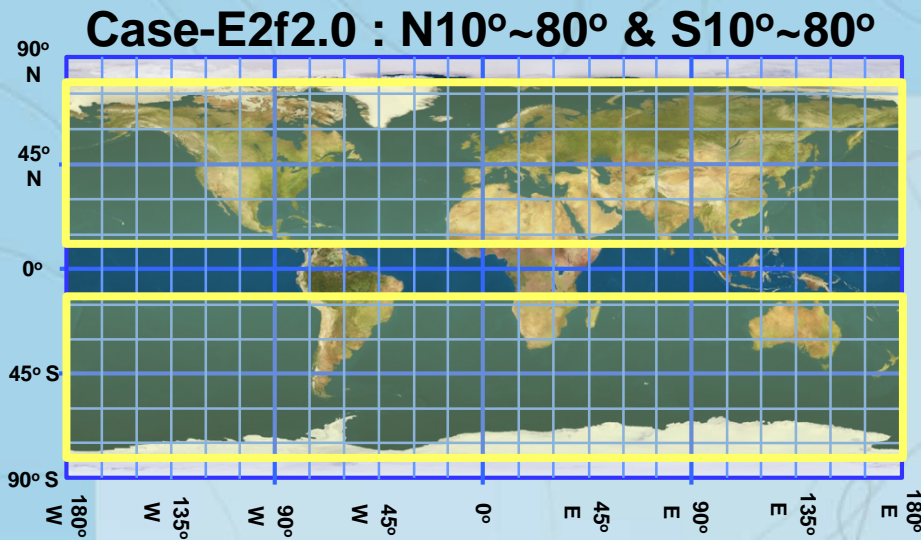
45-day forecast for 20 EPS
members

MASOPS_eps\${cmem}

CWBGFS-EPS(45day forecast) Spread&RMSE



Cases of SV breeding areas



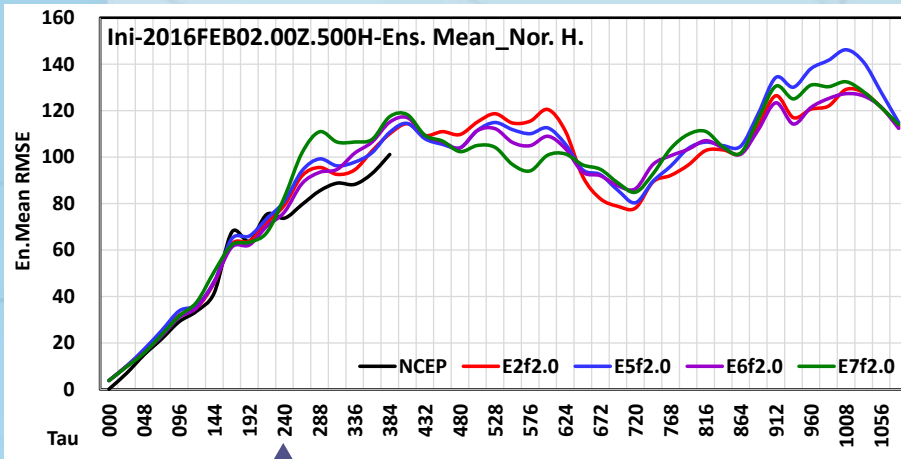
Weather

Global Ensemble Prediction System (**GEPS**) for 45days

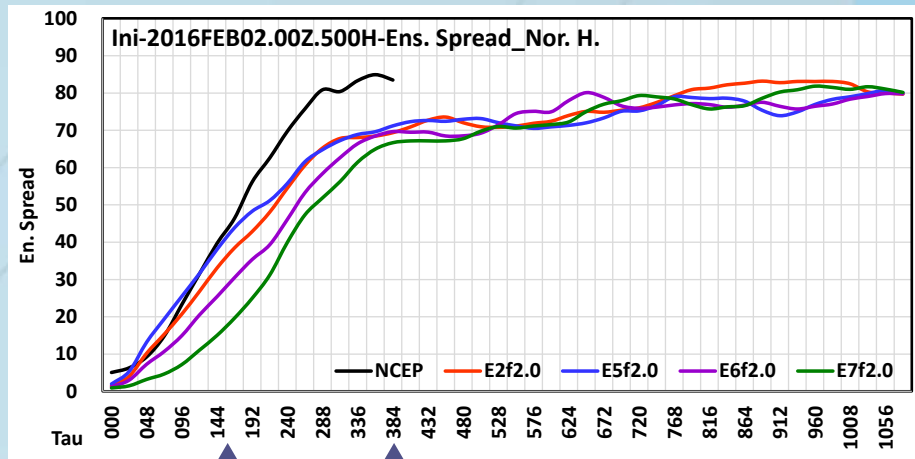


Case: DTG=16/02/02 00Z, 500 MB Height

RMSE



Spread



Weather⁺

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Future development of CWBGFS

1. Data assimilation

- Use more satellite data (MHS、向日葵)
- 結合奇異向量與隨機物理擾動法之測試 (SV+SPPT)
- 混成同化系統調整與優化 (4-D ensemble-Var、multi scale analysis)

2. Forecast model

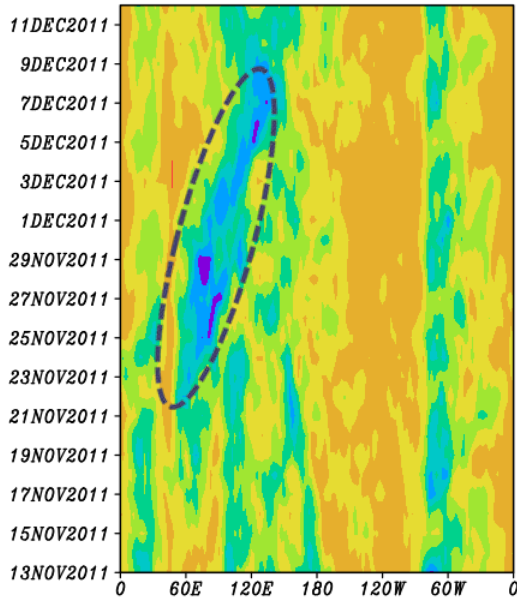
- Improve Physical parameterization
 - 微物理參數化(WSM5)
 - topographic gravity wave drag (Kim and Arakawa,1995)
 - MJO模擬及診斷
 - SIT (Snow/Ice/Thermocline)建置及測試
- Improve CWB **GFS EPS** for Typhoon track (**GET**)
- Improve Global Ensemble Prediction System (**GEPS**) for 45days
- Couple ocean model (MOM3、MOM5) with CWBGFS
- Implement 2-D MPI and linear reduce grid of CWBGFS code
- Develop Semi-Lagrangian model TL1279L80(~15km)
- Unify model (25km/5km)

Weather⁺

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OLR, NCEP,
Time=11111300~11121200

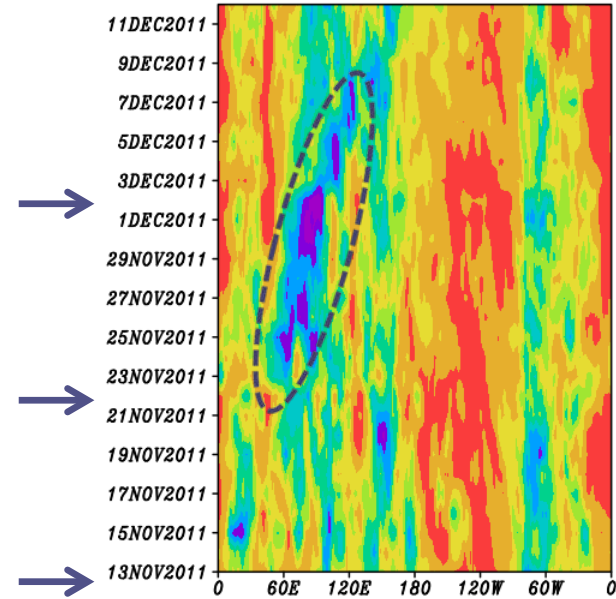


DYNAMO-MJO

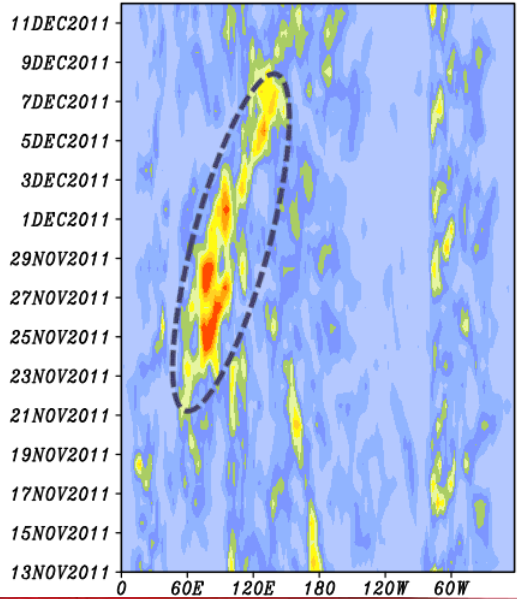
2011 11/13-12/12

OLR

OLR, a361 run, T9s2c4p3
Time=11117300~11121100

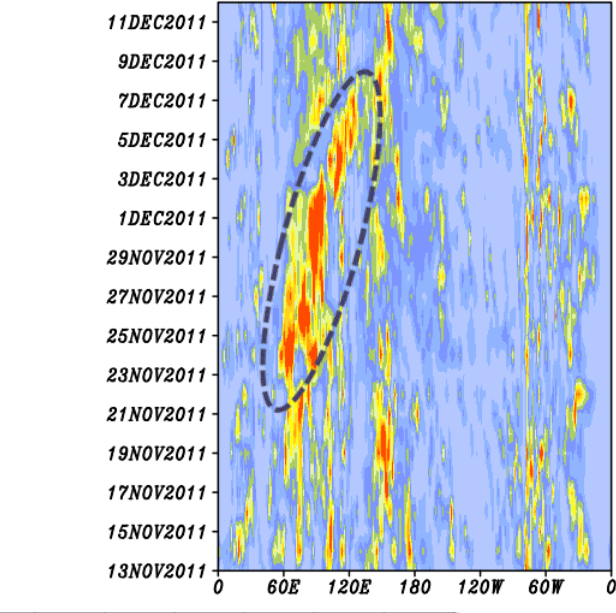


precipitation, NCEP,
Time=11111300~11121200

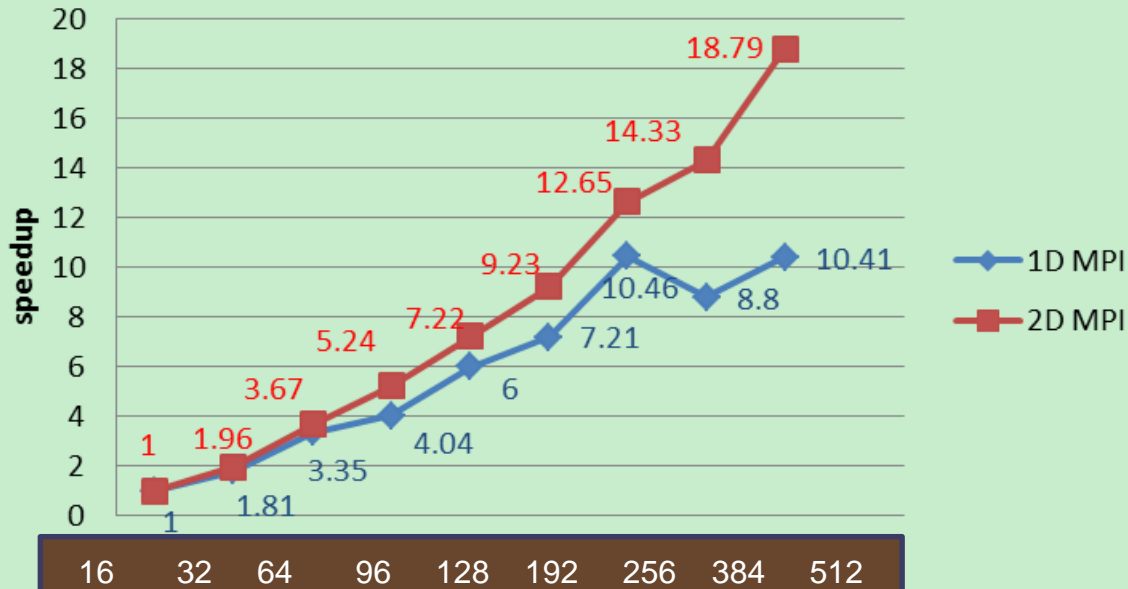


precipitation

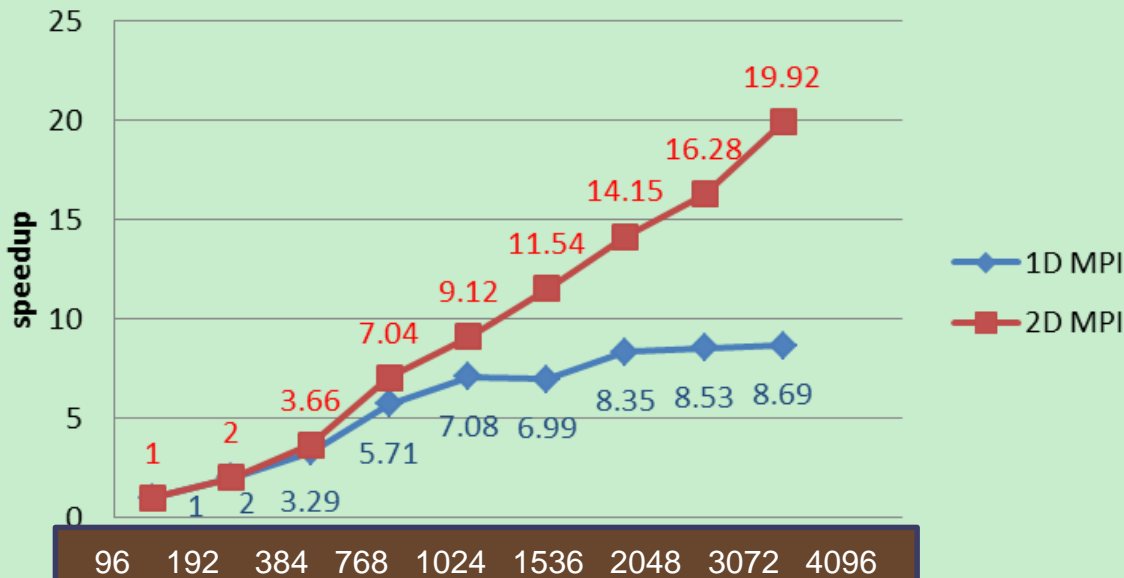
Rain, a361 run, T9s2c4p3
Time=11117300~11121100



gsw T512L60 120 hours fcst on fx100



gfsT512L60(D59) 120 hours on fx100



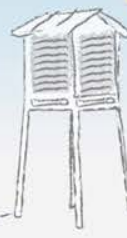
Shallow water model

CWBGFS dynamic core





報告完畢 敬請指導



生活有氣象