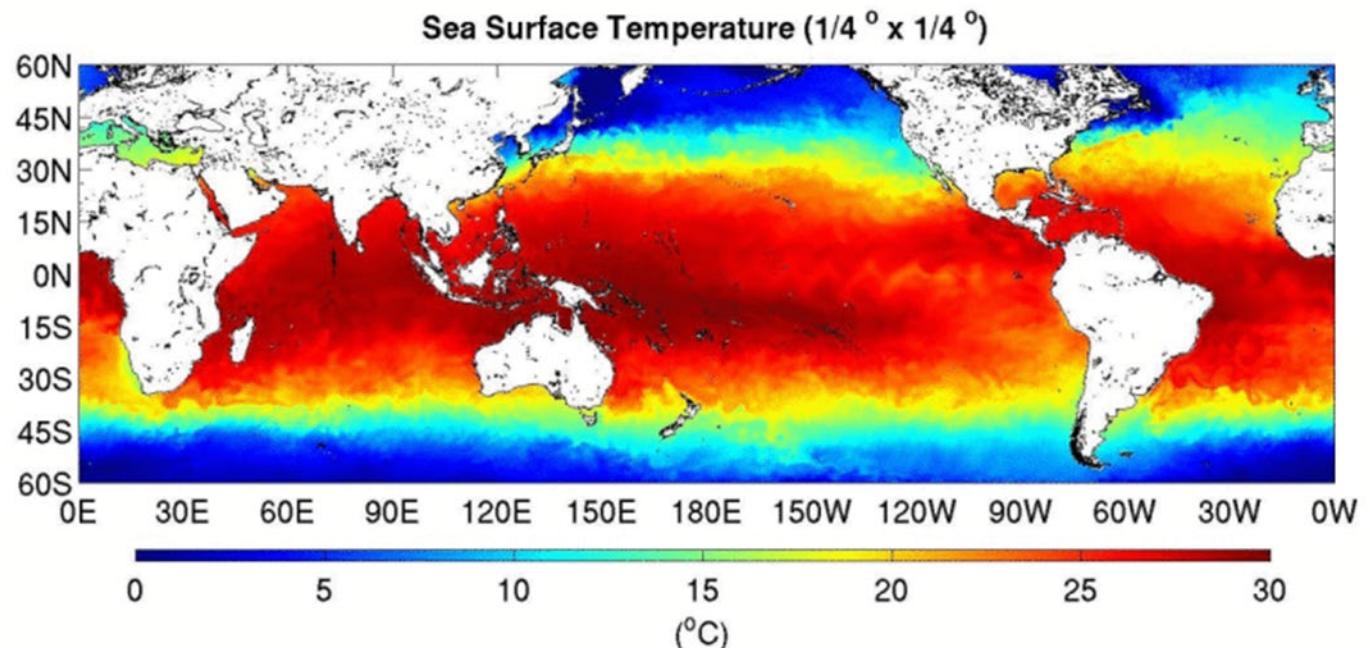


# 台灣跨尺度海氣耦合模式之中長期校驗與應用

Day 000



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<sup>3</sup> 中央氣象署海象氣候組

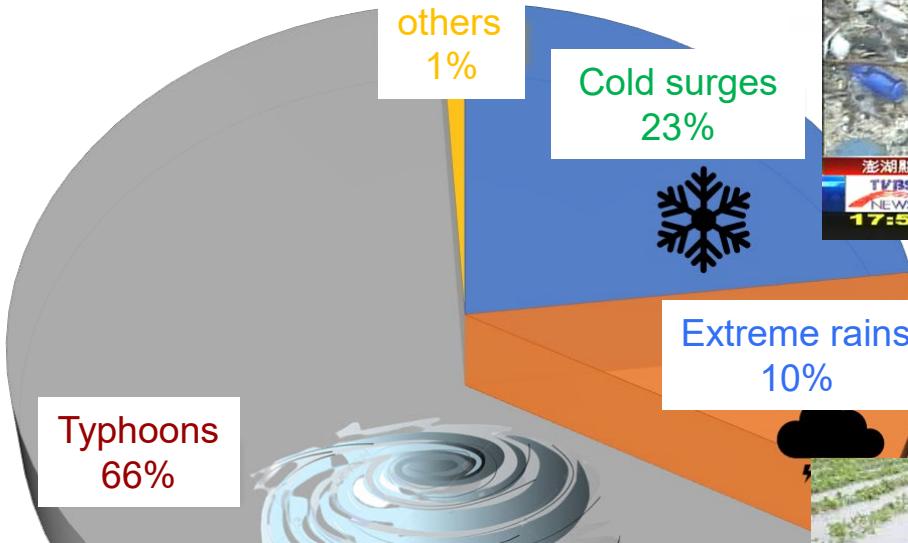
# Motivation



AG. STATISTICS YEARBOOK 2018 279						
3. 重大農業災害產物估計損失 (83-107年)						
Estimated Production Loss of Major Agricultural Disasters (1994-2018)						
單位：千元						
災害別		農林漁牧業產物損失 Products loss				
		合計	農作物	畜產	漁產	林產
Disaster		Total	Crop	Livestock	Fishery	Forestry
<b>颱風</b>						
98年8月莫拉克颱風		19 081 502	10 109 283	1 551 051	4 314 333	3 106 835
85年8月賀伯颱風		18 543 463	14 779 276	467 235	2 430 296	866 656
105年梅姬颱風及9月風災雨害		18 411 548	16 929 138	57 936	105 192	1 319 283
104年8月蘇迪勒颱風		9 981 659	9 673 773	21 695	229 633	56 558
96年10月柯羅莎颱風		7 642 586	7 576 684	7 974	42 141	15 787
94年7月海燕颱風		7 592 991	6 678 433	74 110	634 321	206 127
99年9月凡那比颱風		7 529 266	6 544 674	181 010	768 954	34 628
87年10月瑞伯颱風		6 669 671	6 168 219	25 445	451 635	24 372
97年9月薑蜜颱風		6 421 790	6 328 303	8 266	81 886	3 335
89年8月碧利斯颱風		6 119 063	5 719 063	76 783	140 381	182 836
<b>豪雨</b>						
94年6月豪雨		4 846 084	3 648 782	219 416	962 763	15 123
107年0823熱帶低壓水災		3 453 766	2 765 547	176 562	510 714	943
100年11月豪雨		2 368 718	2 368 718	-	-	-
102年4月霪雨		2 305 494	2 305 494	-	-	-
95年5月豪雨(0609水災)		2 231 320	2 204 480	20 261	4 850	1 729
106年0601豪雨		2 209 991	2 193 939	8 114	5 641	2 297
87年6月豪雨		1 913 308	1 883 263	-	28 100	1 945
<b>地震</b>						
88年921集集大地震		2 061 854	1 288 243	478 263	12 070	283 278
<b>寒害</b>						
105年1月寒流		10 840 267	4 207 867	897	6 631 498	6
88年12月寒害		3 143 387	1 930 372	-	1 213 015	-
94年1~3月低溫		2 817 382	2 670 357	-	147 025	-
<b>冰雹</b>						
87年2月冰雹						Hailstone
91年12月冰雹						ne,1998
						ne,2002
<b>乾旱</b>						
85年7月乾旱		452 313	452 313	-	-	Drought
91年4月乾旱		341 291	341 291	-	-	July Drought,1996
						Apr. Drought,2002
備註：農作物損失金額係以產地價格計算。						
資料來源：行政院農委會畜牧處、農糧署、漁業署、林務局。						
Note : The products loss by farm prices of production areas.						
Source : Department of Animal Industry, Agriculture and Food Agency, Fisheries Agency, Forestry Bureau, COA, Executive Yuan.						

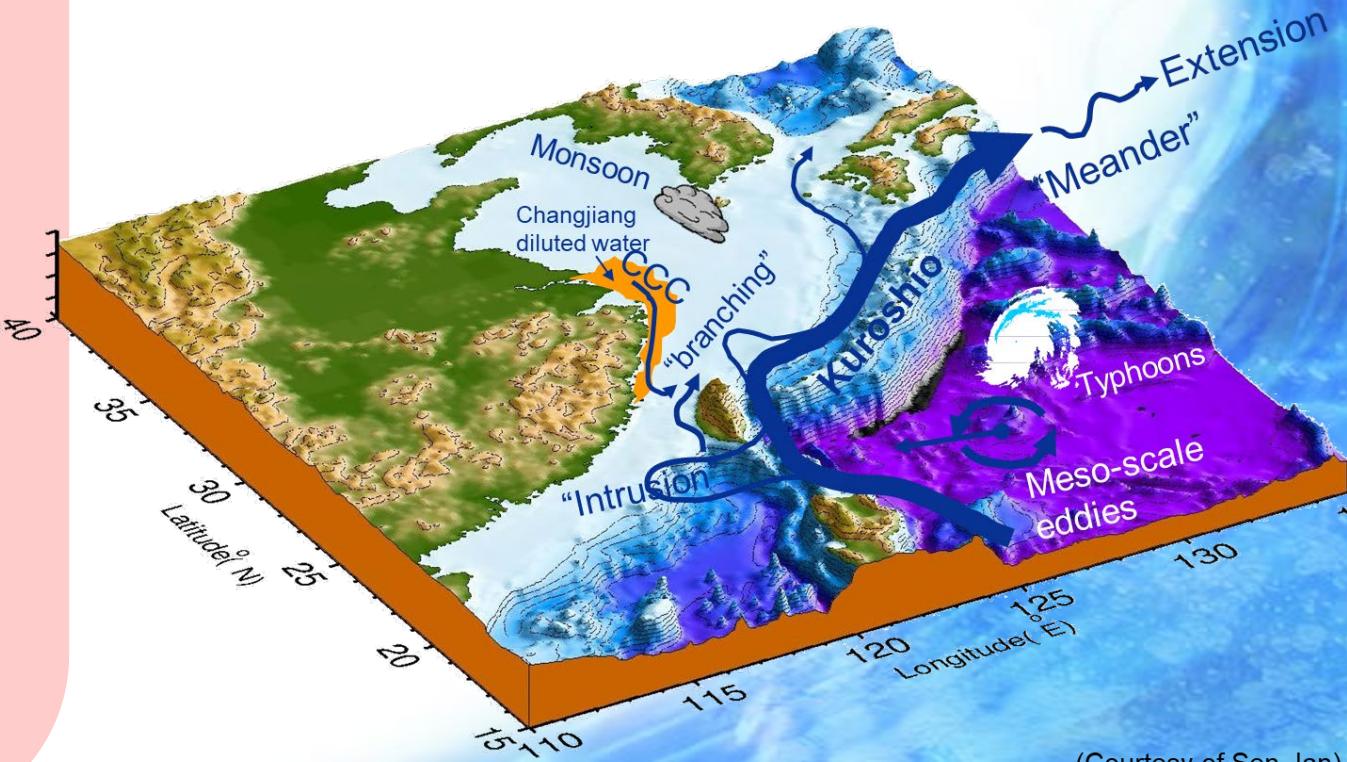
More than 100 million dollar loss

## Major natural disasters in Taiwan



# Objective

- Build a multi-scales, high-resolution and accurate extend weather/climate forecast system
- Dynamical downscaling of regional ocean-atmosphere coupled model online driven by a global coupled model framework
  - Ocean and atmosphere
  - Extend weather forecast
  - Enhance short-term to long-term climate predictability skill
  - Benefit agriculture and fishery
  - Reduce the risks of natural disaster



(Courtesy of Sen Jan)

# Ocean-atmosphere coupled system

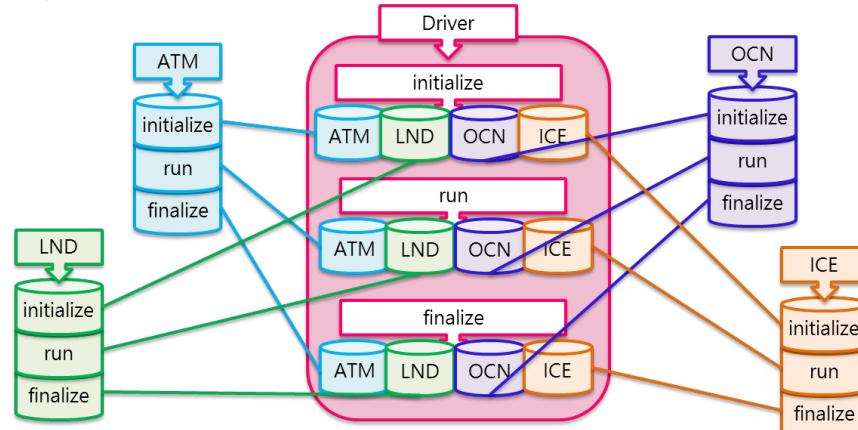
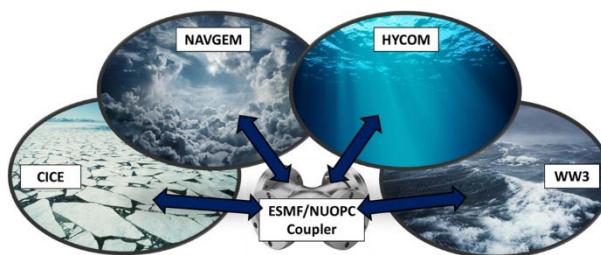
**Coupler is critical**

ESMF coupler

Decomposition and Reorganization

Advantage:

1. Flexible
2. Division



Disadvantage:

1. steep learning/developing curve

NTU&CWA coupler  
Collection and Connection

Advantage:

1. Customization
2. Easy to use
3. Efficiency

Disadvantage:

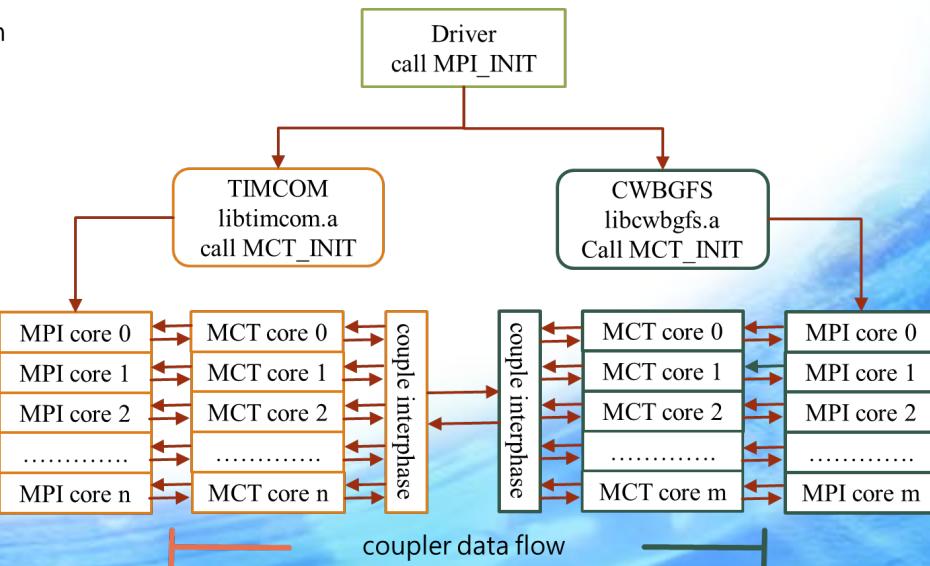
1. Complicated if there are many components

MULTI-Scale Ocean and Atmosphere Coupled modelling System(MUSOACS)

Single execution driver

components

infrastructure

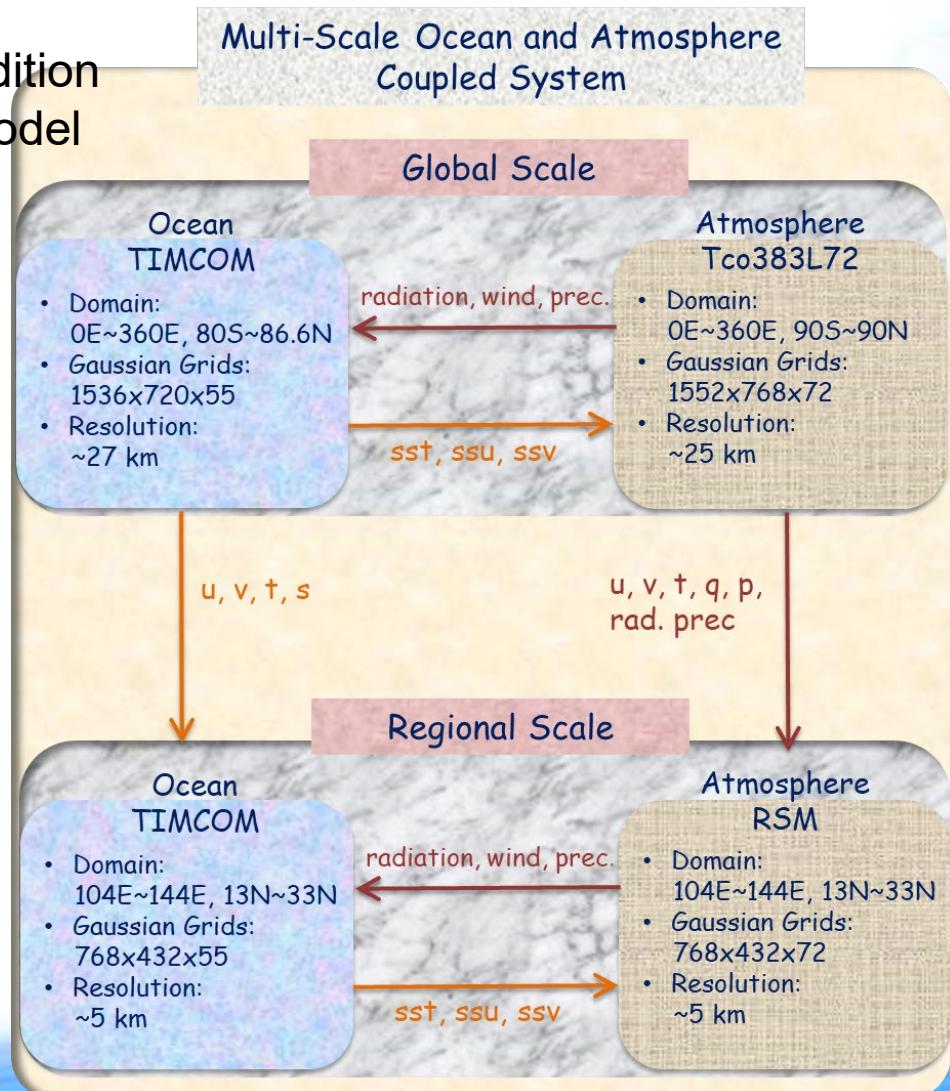
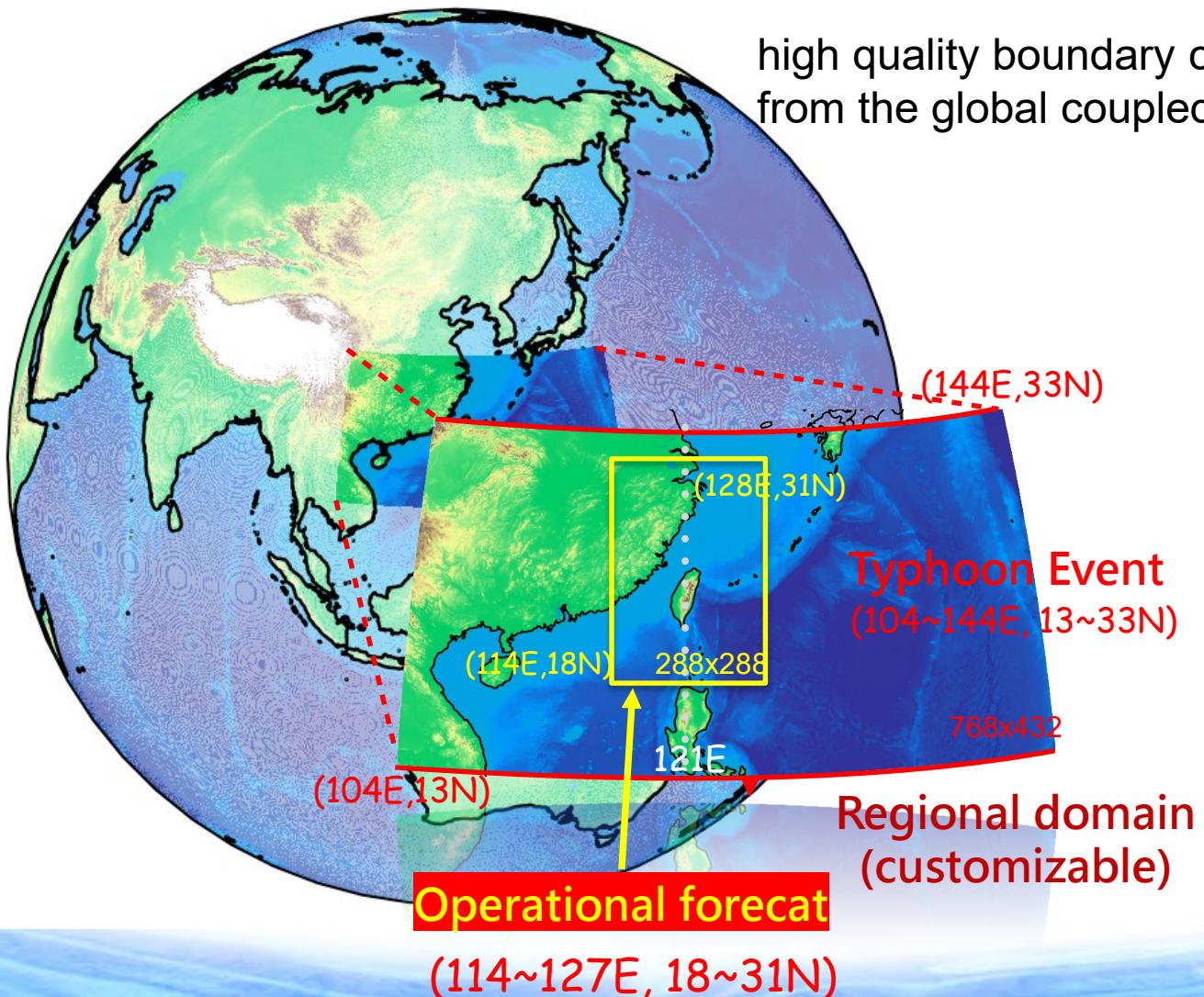


# CWA Global Ensemble Prediction System (GEPSv2)

Model configuration of CWAGFS-TCO	
Dynamic	
Dynamical core	Semi-Lagrangian(NDSL) + Semi-implicit (Juang 2007, 2008) 2-time-level, single precision. timestep=600s
Horizontal resolution and coordinate	~28km (1552x768) Octahedral Reduced Gaussian grid 72 sigma-P layers, Model top: 0.1 hPa
Physics	
Radiation	RRTMG (Iacono et al., 2008)
LSM	Noah LSM
PBL	Monin Eddy-Diffusivity Mass-Flux (Han et al., 2016)
Orographic gravity wave drag	Kim and Arakawa (1995), Lott and Miller (1997) Turbulent Orographic Form Drag (Beljaars et al. 2004)
Convective gravity wave drag	Scinocca (2002, 2003)
Cumulus	KH-SAS Deep/Shallow Convection (Han et al., 2017; Arakawa and Wu, 2013, )
Microphysics	GFDL cloud microphysics V2
SST	Tendence of SST : ± 30°N : SIT (a one-column sea model) ± 30-40°N : SIT & CWBCFS/MOM3 weighting(>1day) ± 40-90°N : CWBCFS/MOM3 (1-25 day) +OISST climatology weighting (after 25 day)

Model configuration of RSM	
Dy-Core	
Dynamical core	Semi-Lagrangian(NDSL) + Semi-implicit (Juang 2007, 2008) 3-time-level timestep=45s
Domain and coordinate	5km (288x216) Taiwan area Mercator projection 72 sigma-P layers Model top: 0.1 hPa
Physics	
Radiation	RRTM
LSM	Noah LSM
PBL	YSU
Orographic gravity wave drag	Kim and Arakawa (1995) Lott and Miller (1997)
Cumulus	SAMF Scale-Aware Mass-Flux Deep/Shallow Convection
Microphysics	GFDL cloud microphysics V2

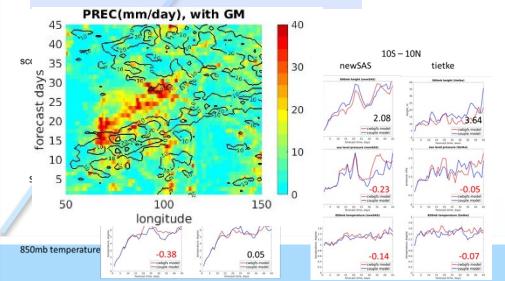
# CWA Global Ensemble Prediction System (GEPSv3)



# Evolution of coupled system in CWA

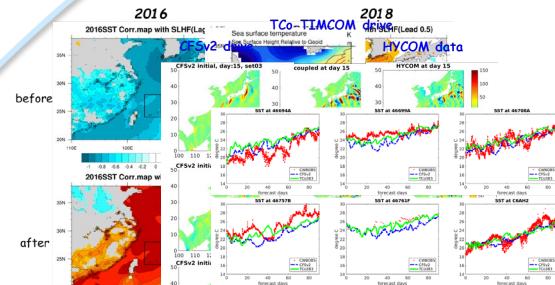
# Completeness

TL319L60( $0.375^\circ$ )  
TIMCOMv1.9( $1.125^\circ$ )



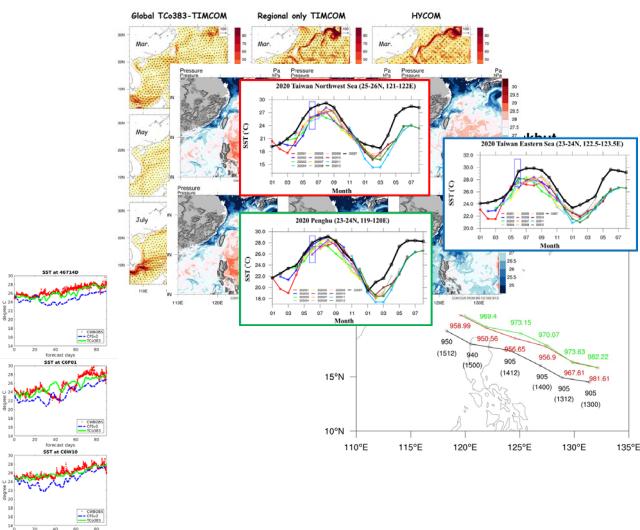
TL319L60(0.375°)  
TIMCOMv1.9(0.375°)

TIMCOMv1.8(0.125°)



Tco383L72( $0.235^\circ$ )  
TIMCOMv2.1( $0.237^\circ$ )

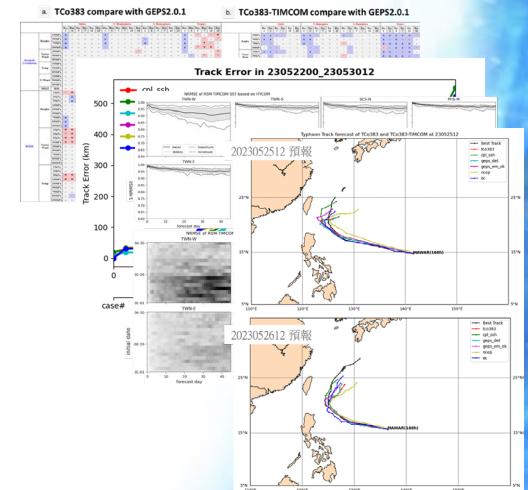
RSM(8km)  
TIMCOMv1.8(8km)



Tco383L72( $0.235^\circ$ )  
TIMCOMv3.1( $0.237^\circ$ )

RSM(5km)  
TIMCOMv3.1(5km)

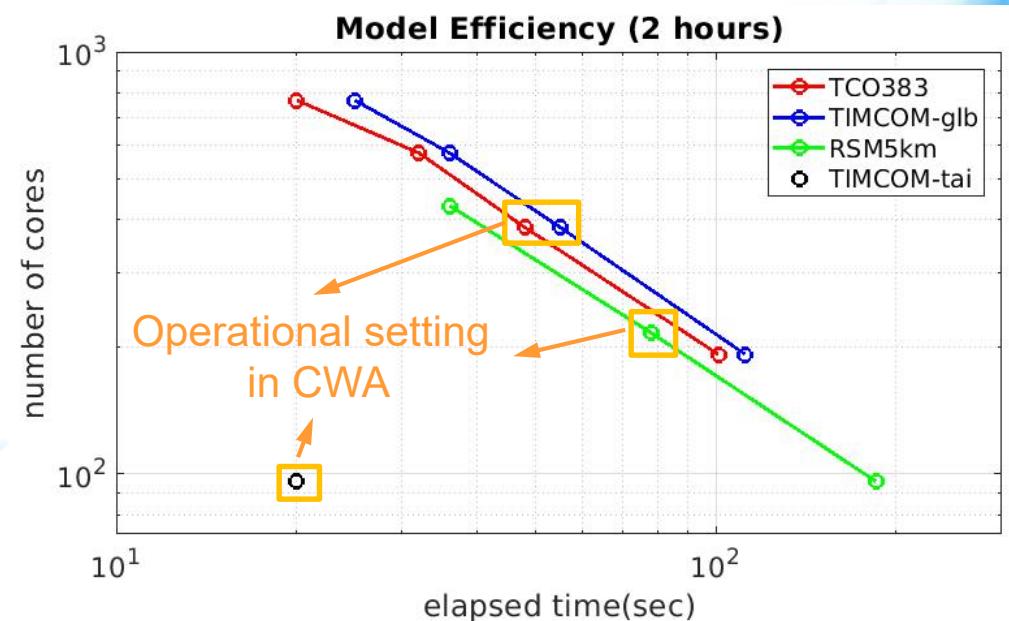
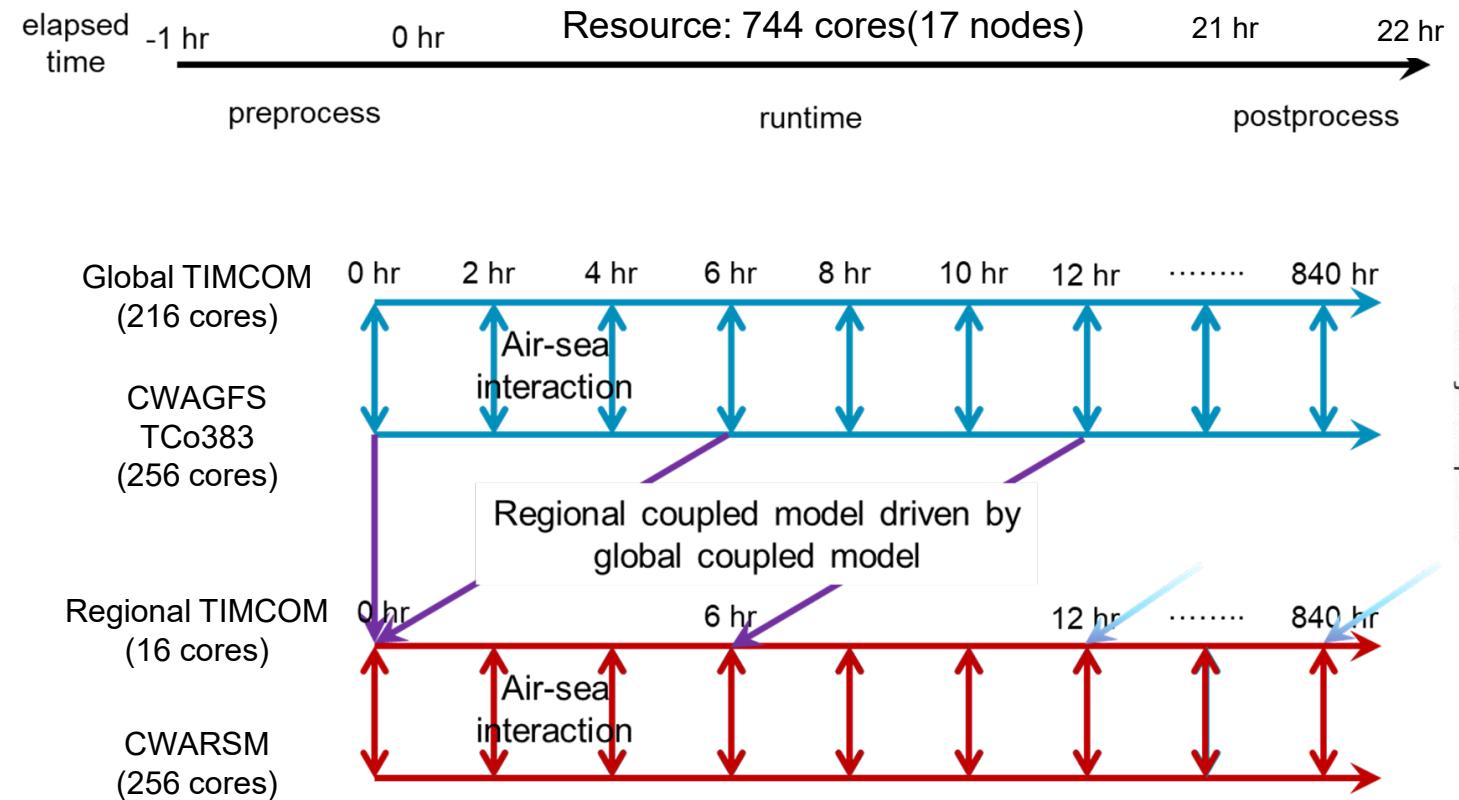
GVER: EMC Verification Scorecard



# Resolution

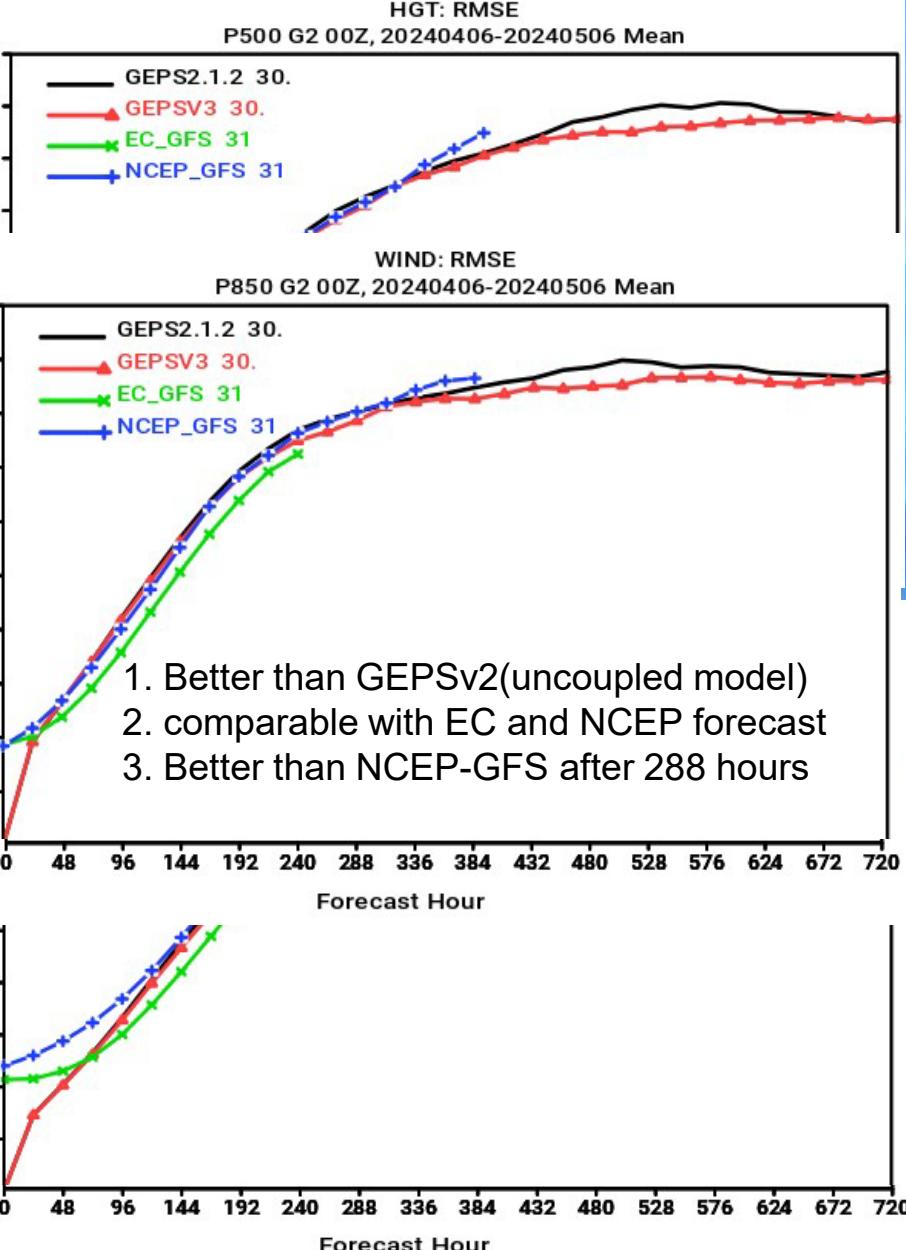
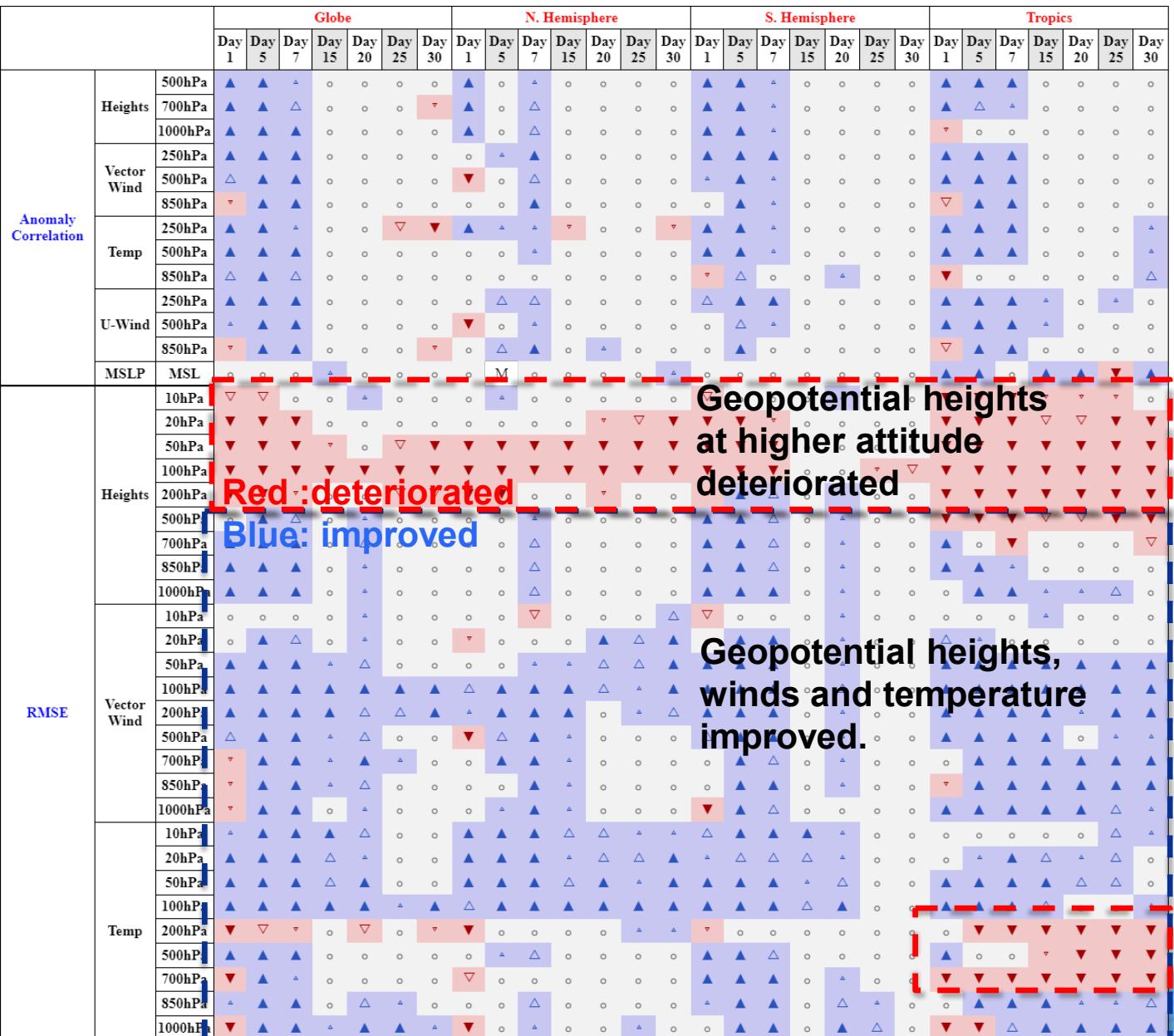
# Operational Parallel Run in CWA

**(CWAGEPSv3)**

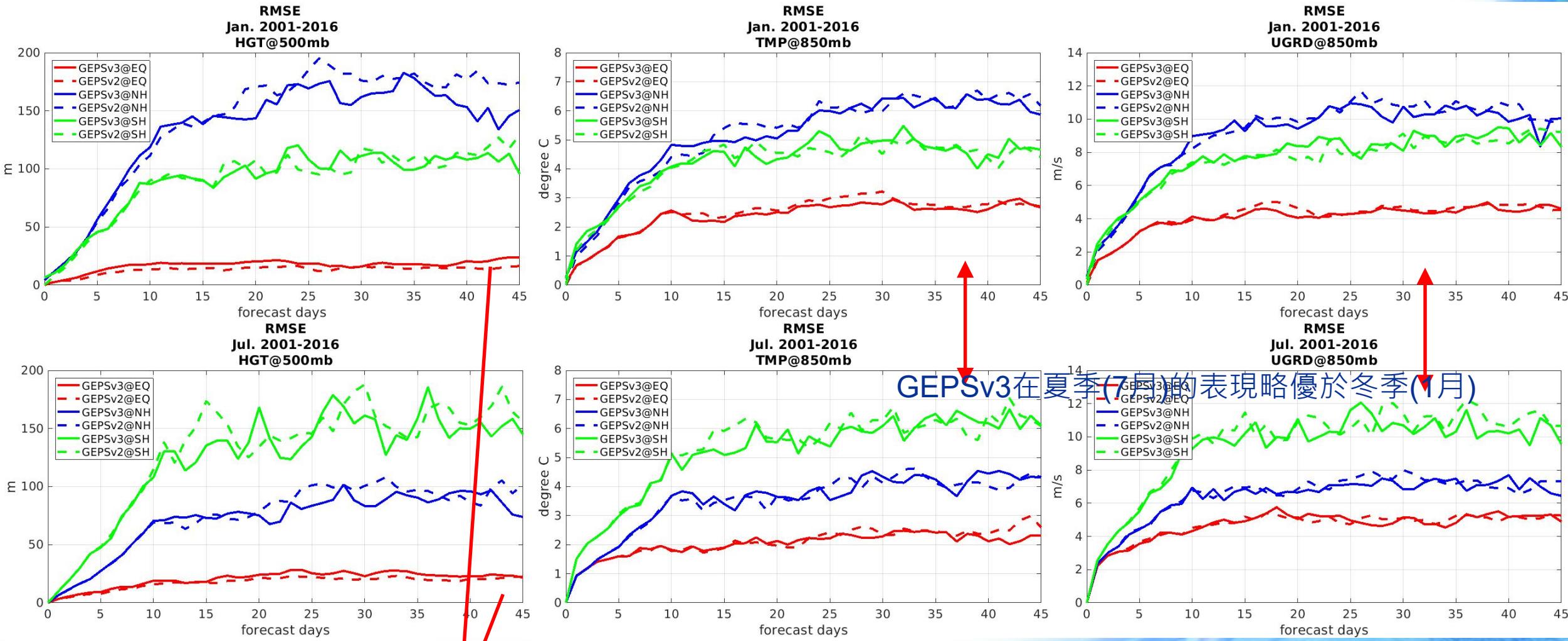


# Forecast Skill with GVER

GEPSv3 V.S. GEPSv2

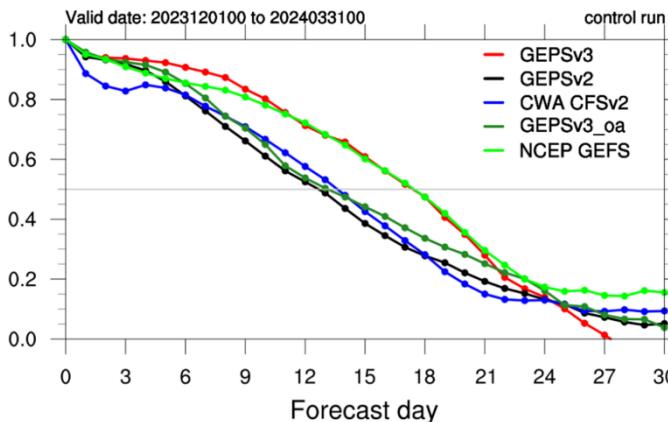


# Forecast Skill of long-term hindcast



GEPSv3的500hPa HGT表現在赤道比GEPSv2差

MJO RMM index (bivariate correlation)

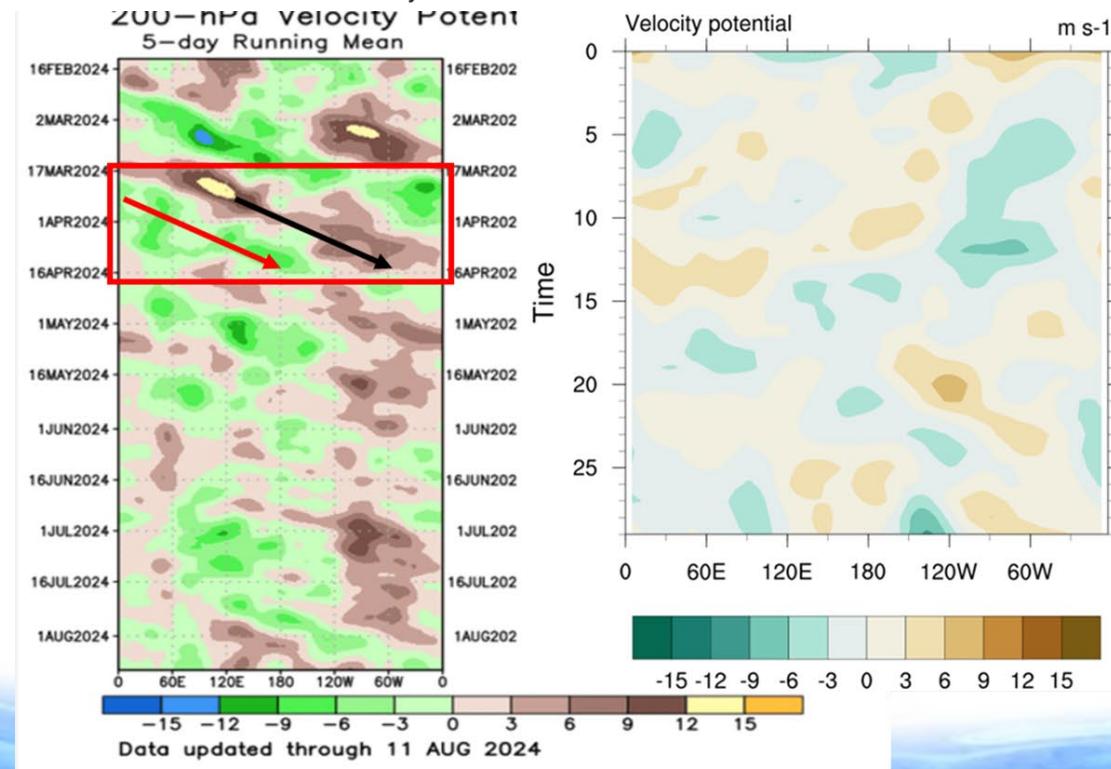


# Intraseasonal Oscillation- MJO

**GEPSv2 CHI200  
(5-day running mean)**

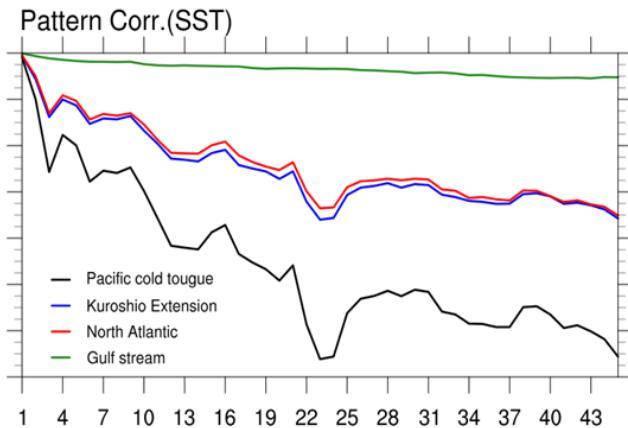
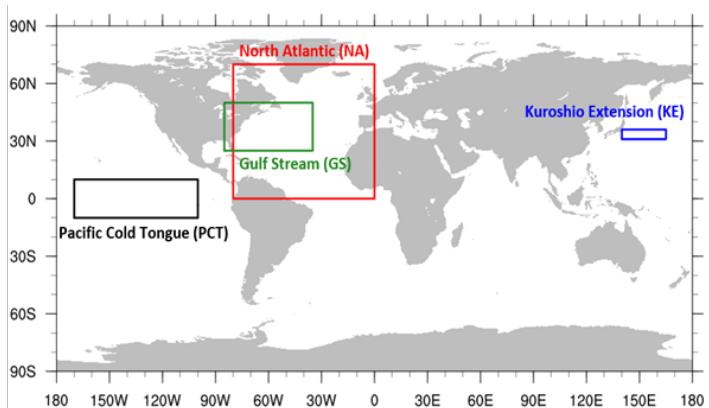
**GEPSv3 CHI200  
(5-day running mean)**

**GEFS CHI200  
(5-day running mean)**

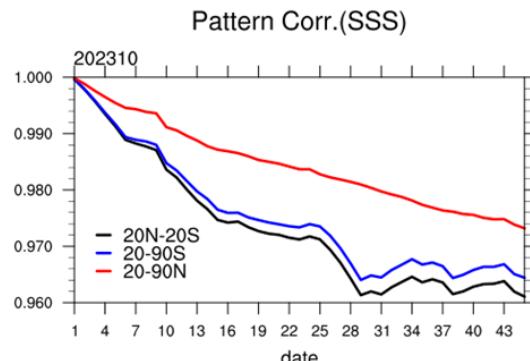
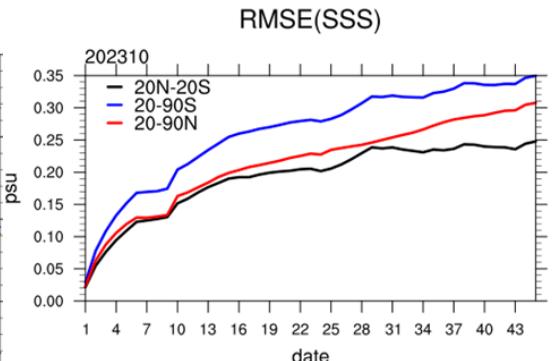
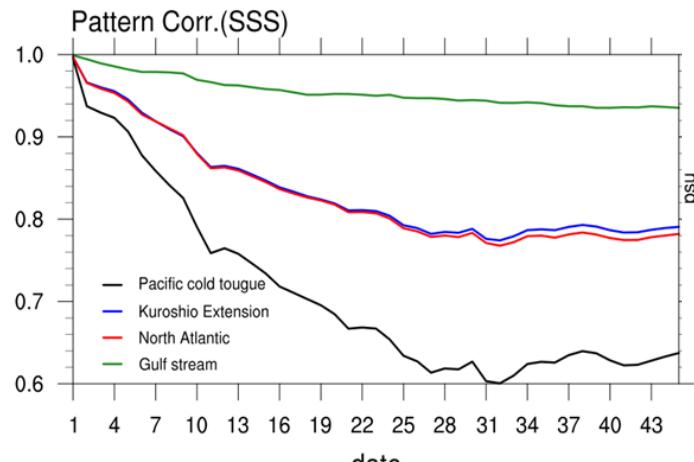
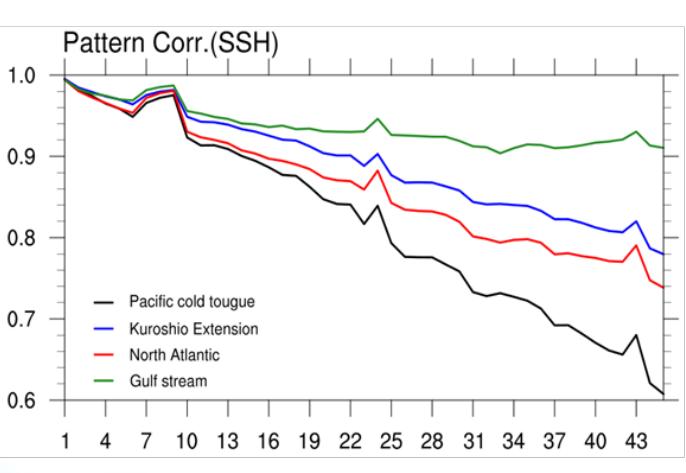
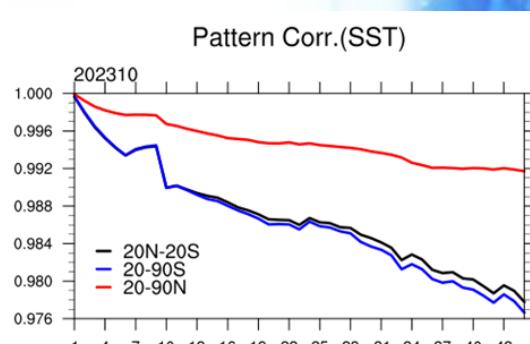
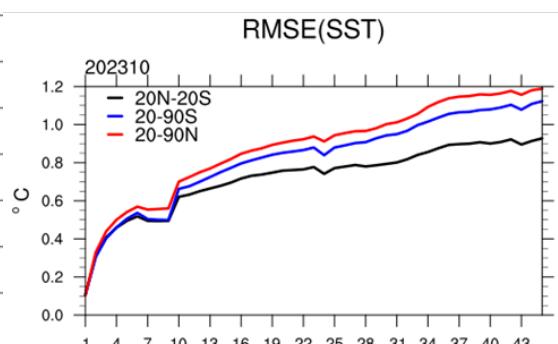


# Evaluation of Global TIMCOM

墨西哥灣區域的預報表現最好

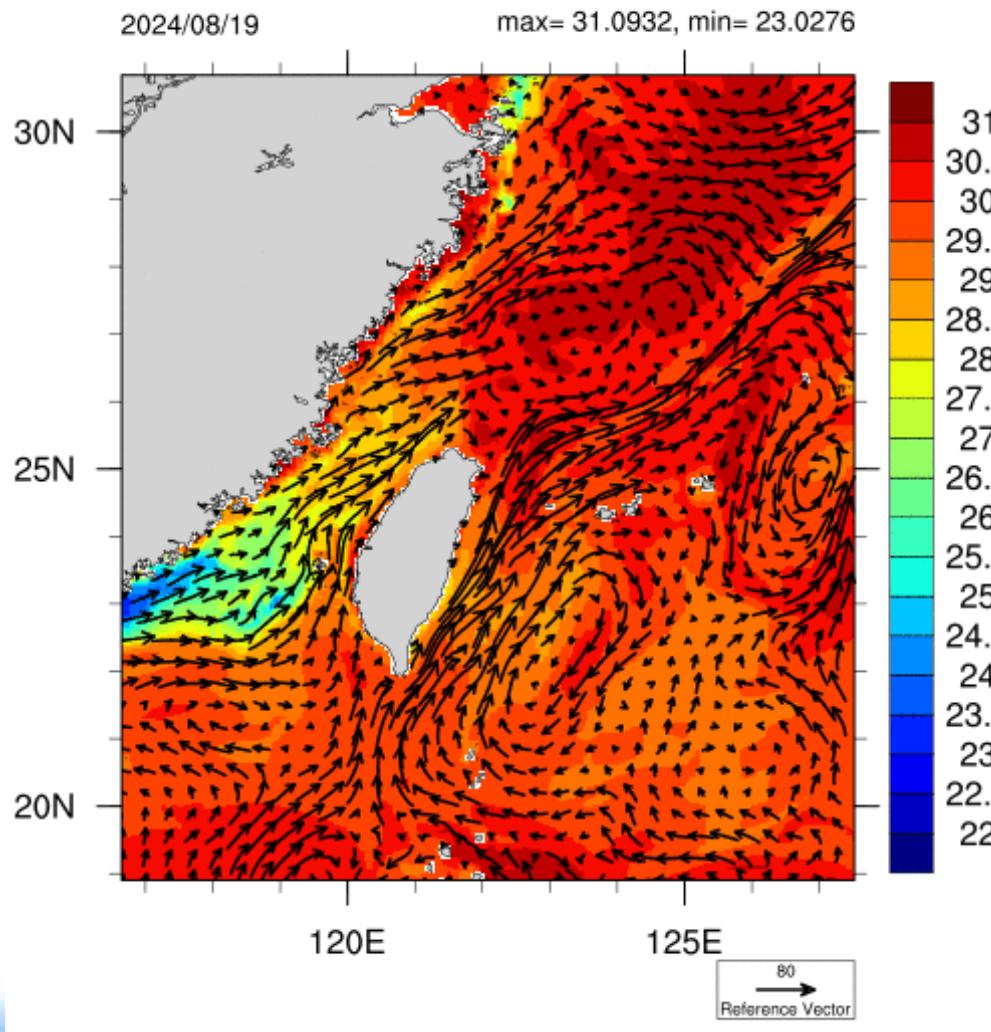


SST在北半球的RMSE與Corr較好

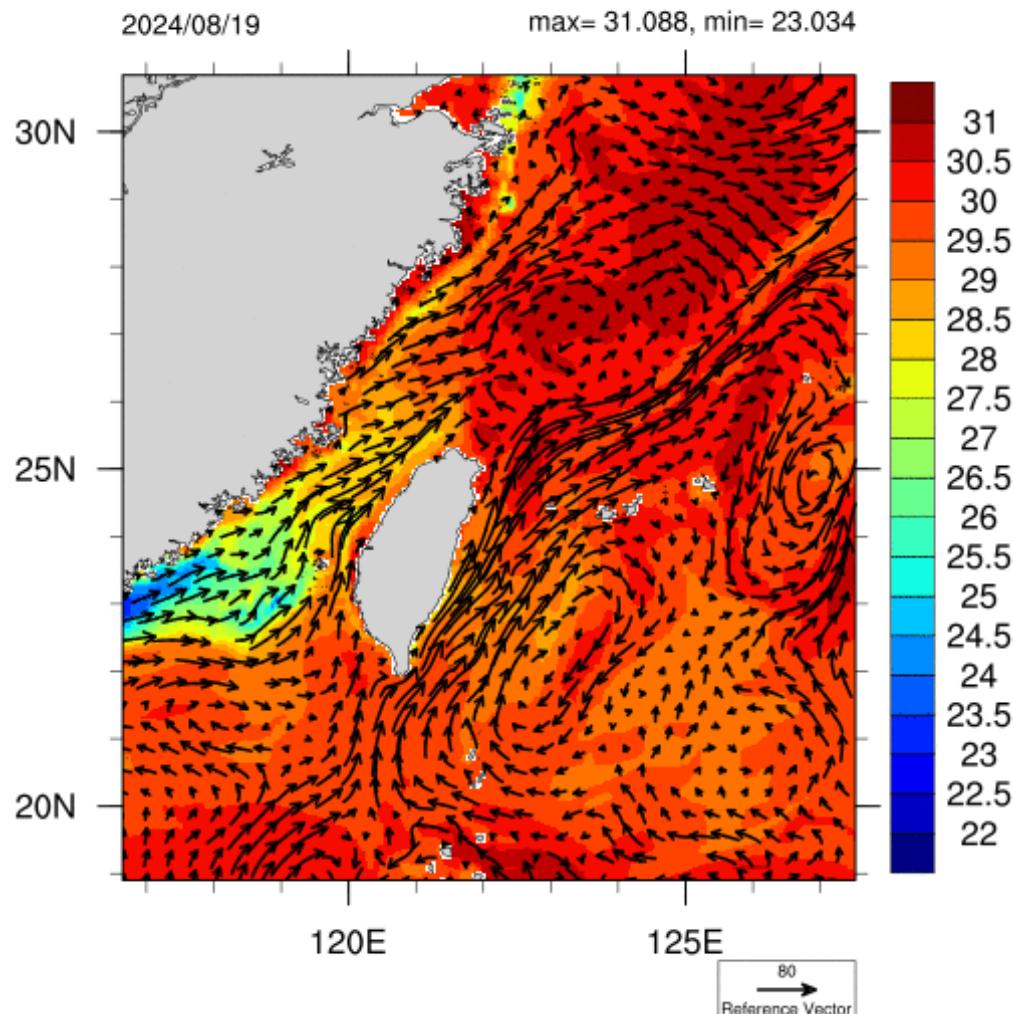


# Regional TIMCOM forecast

**TIMCOM SST of 15°C, 20°C isotherm**



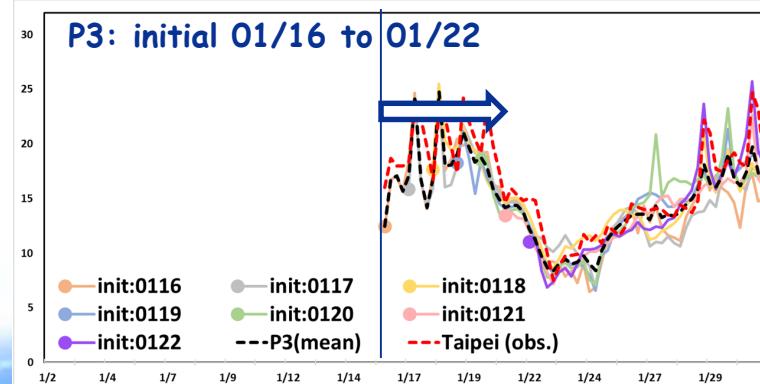
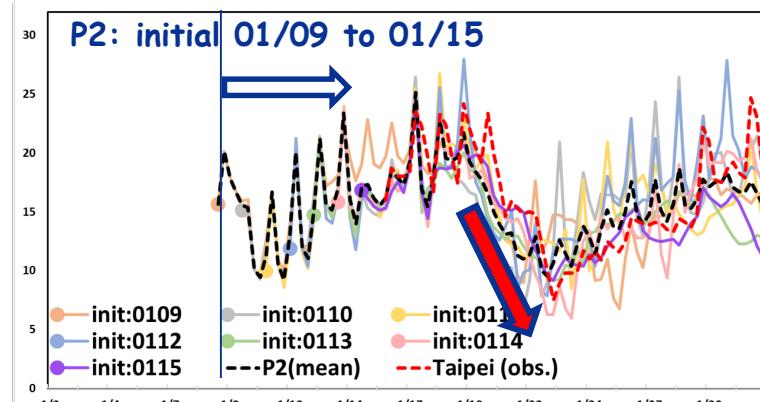
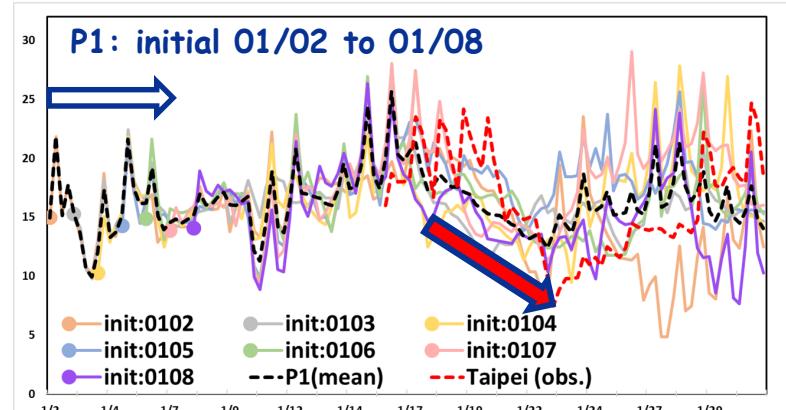
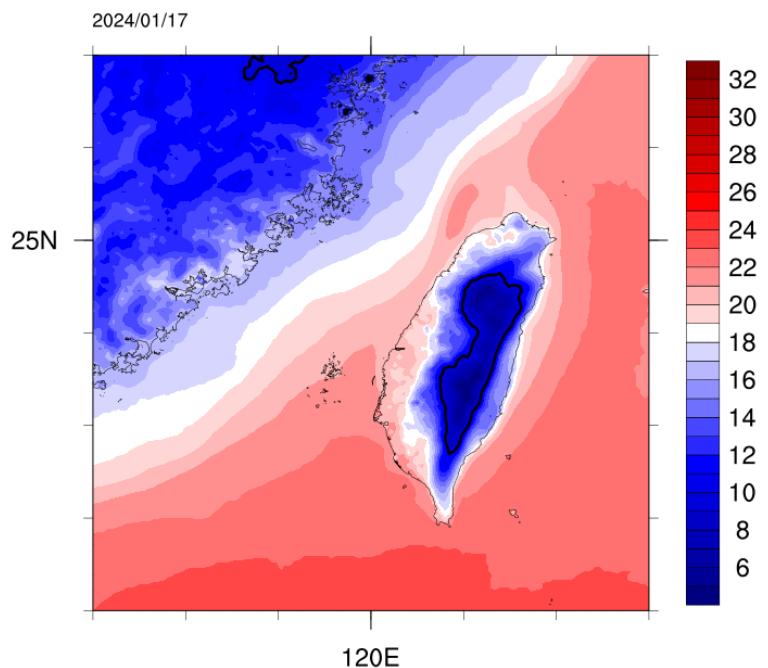
**HYCOM SST of 15°C, 20°C isotherm**



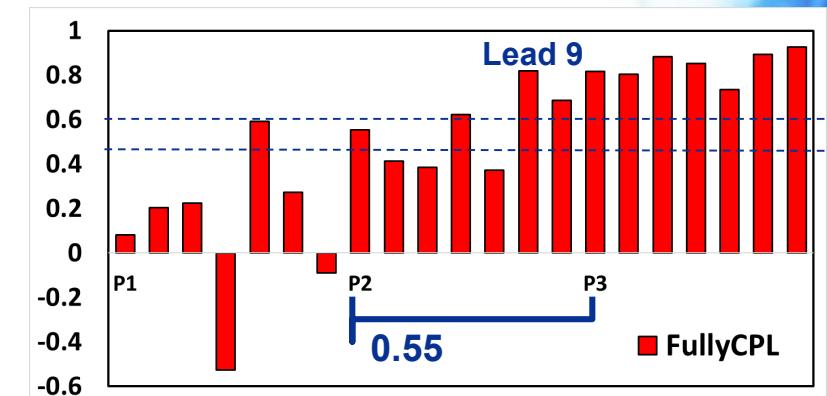
# Cold Surge

Initial time  
2024/01/17 00Z

RSM T2m of 10°C isotherm



Corr: 1/22-1/31



P1 : weak signal  
P2 : signal arise  
P3 : accurately predict

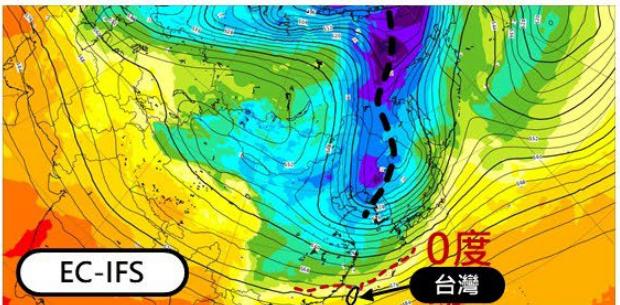
# Cold Surge

[Analysis]: 24/01/22 – 01/25 Cold Surge

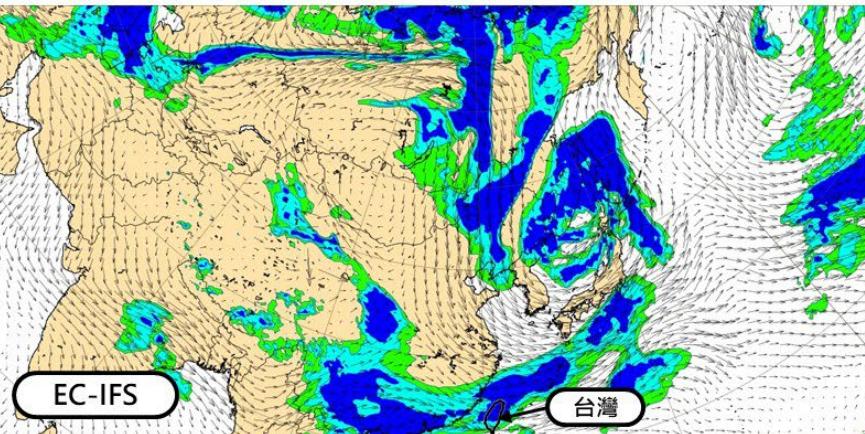
2024.01.23

IFS

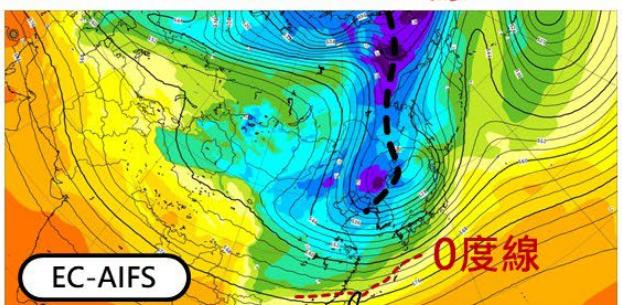
850hPa Temp & 500hPa HGT



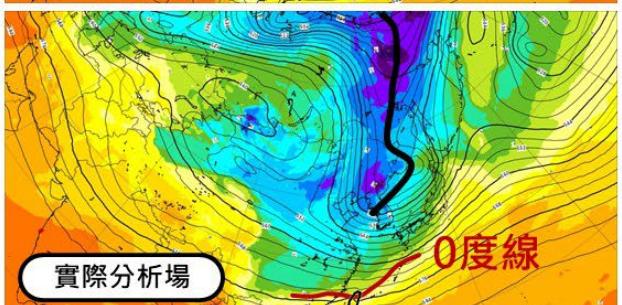
700hPa Wind & Relative Humidity



AIFS



Analysis



The prediction of EC-IFS(NWP) and AIFS(AI) are familiar with analysis data in the position of 0 degree of temperature at 850 hPa height and the trough of geopotential height at 500 hPa.

AI model predict 24/01/23 cold surge well for 5 days in advance.

Initial : 24/01/18 12Z

Forecast: 24/01/23 00Z(+84h)



WCDR  
資料の學習  
研發小組

9 days in advance  
for MUSOACS

## Summary and future work

- A novel Multi-scale Ocean and Atmosphere Coupled Modeling System (GEPSv3) is developed to enhance the predictability of extended-range weather/climate forecasts
- MUSOACS: high-performance global ocean+atmos coupled models + regional coupled model(2+2)
- GEPSv3 surpasses the current operational atmospheric forecast system at CWA(GEPSv2) up to 30 days
- The predictability of MJO is enhanced.
- MUSOACS predict 24/01/23 cold surge for 9 days in advance, performing better forecast skill than AI model.
- Long-term hindcast validation.
- Include wave model and ice model.



# Thanks for Your Attention!

