Applications of Ensemble Forecasts At Taiwan Central Weather Bureau

Jonq-Gong Chern
Research & Development Center
Central Weather Bureau

Thanks to: CWB Long-range Forecast Branch, SFRD Team, WRF NWP Team, Global NWP Team and ClimateTeam

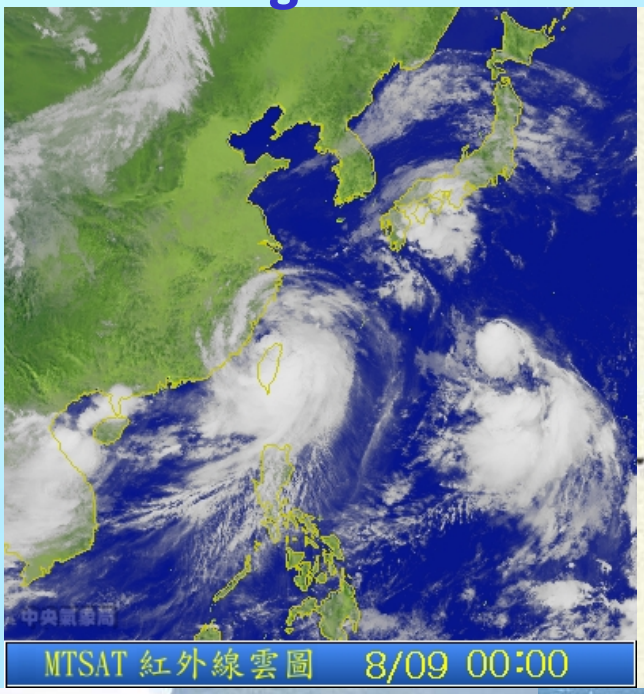
6th NCEP Ensemble User Workshop, October 2014

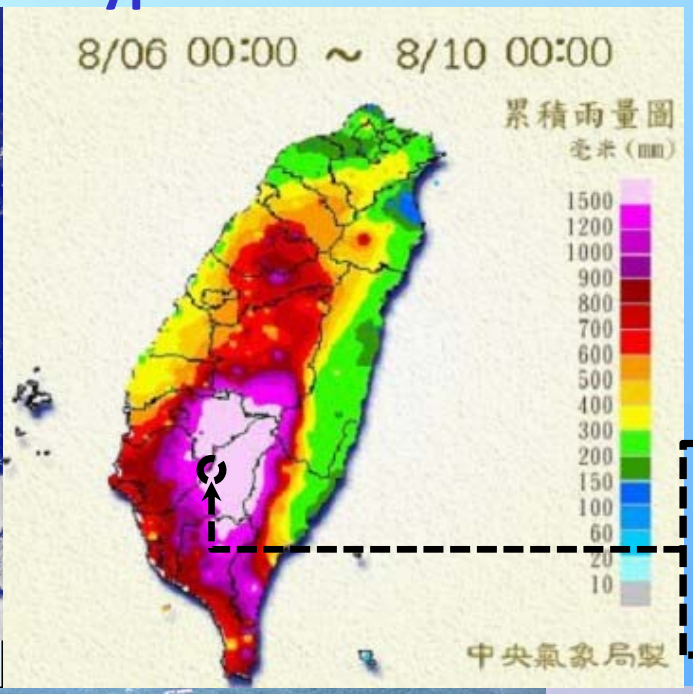
Outline

0. Background
1. Dynamical Guidance
   - 1.1. 1st week, 2nd week and 1~4 weeks
   - 1.2. Typhoon Forecast(CEFS,GEFS,REFS)
2. Dyn.-Stat. Guidance Develop.-MOS
3. CWB Ensemble NWP Develop.
4. Future Plan

0. Sever Disaster: Typhoon Invasion

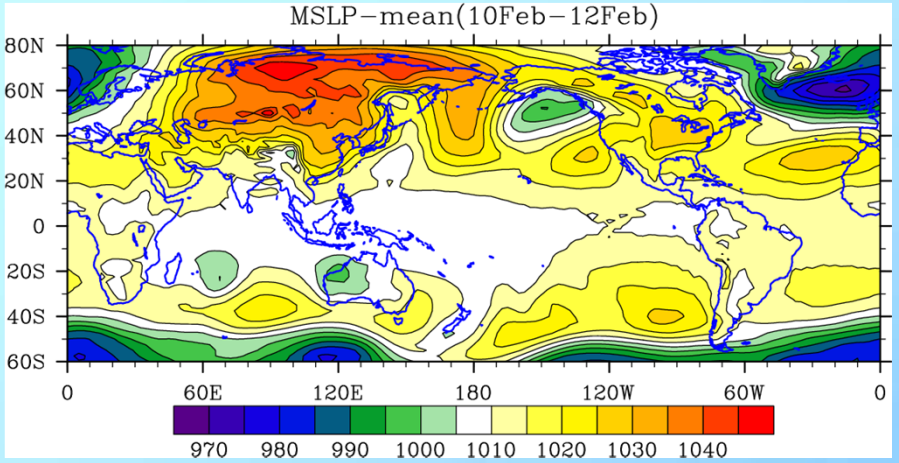
2009-Aug.6~10 Morakot Typhoon - Mudslide and Flash Flood

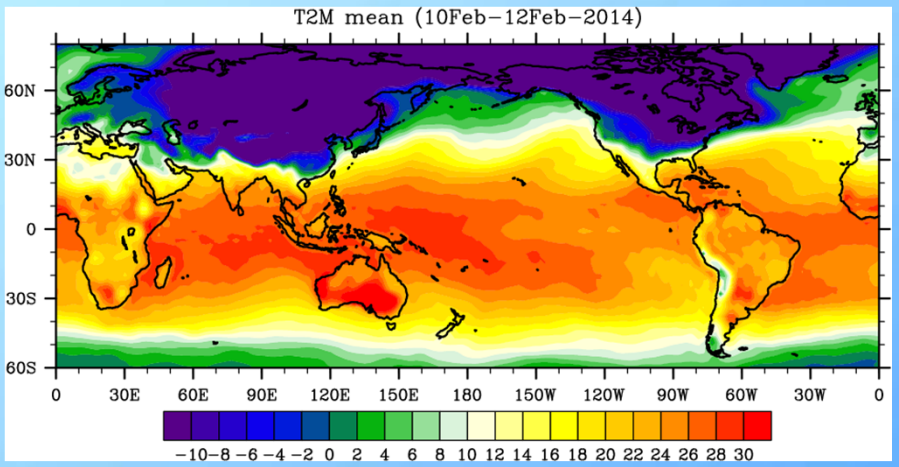


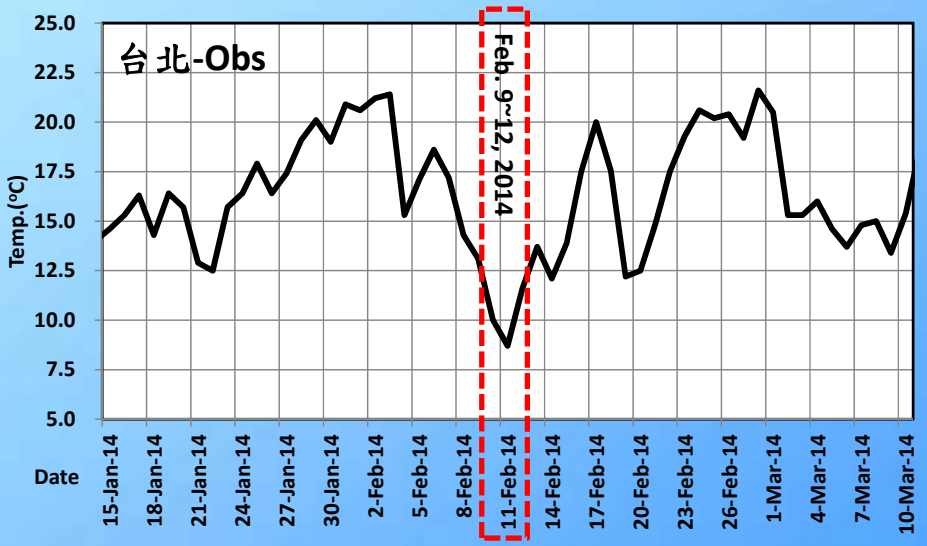


Disaster Damage Cost	3000 million
Death -total	673
Death -Shiao Lin village	474

0. Sever Disaster: Polar Outbeak

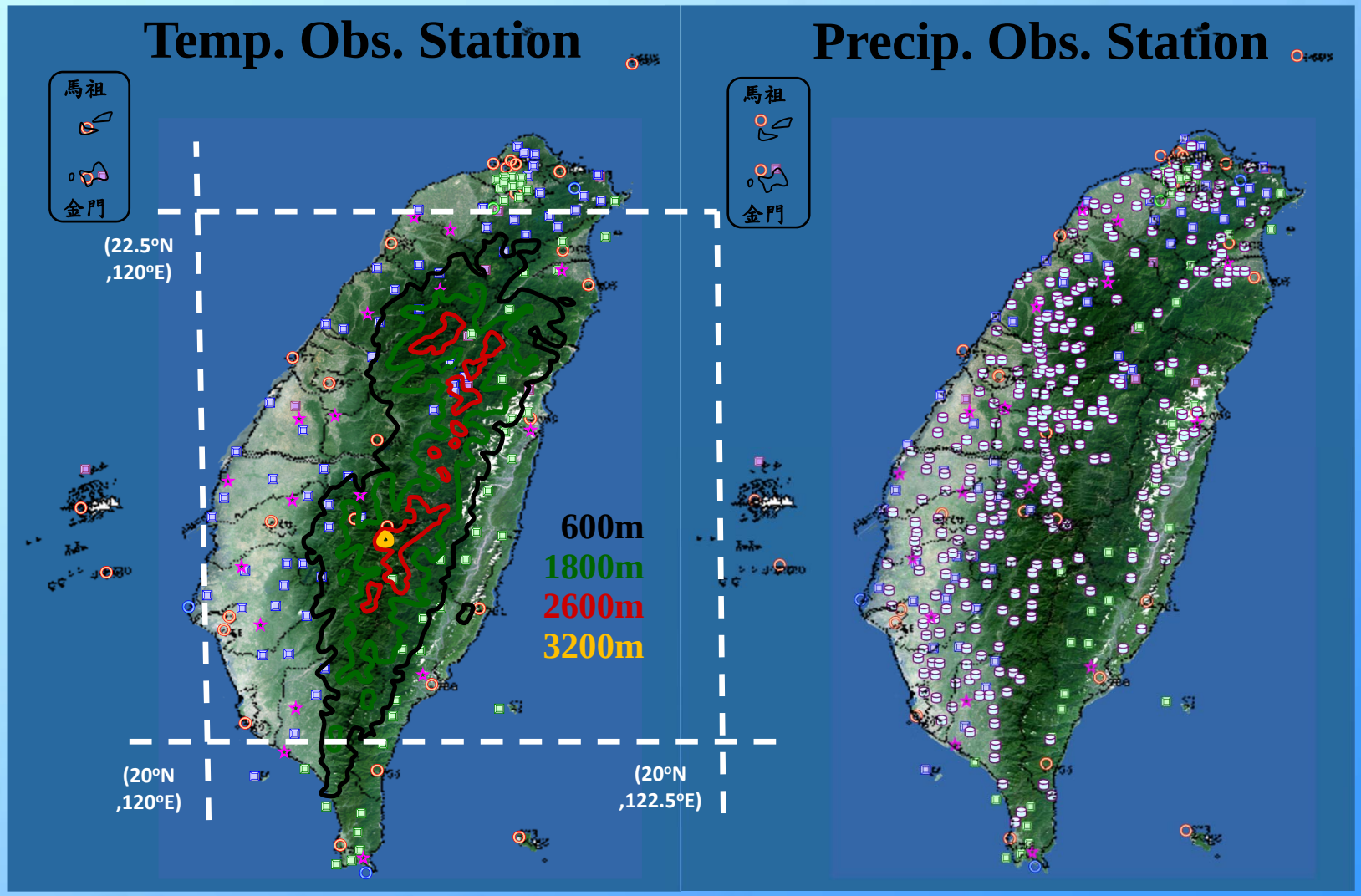






Serious temperature drop
During Feb. 9~12, 2014
152 Deaths
(mainly caused by
Cardiovascular Disease)

0. Obs. Station & Topography



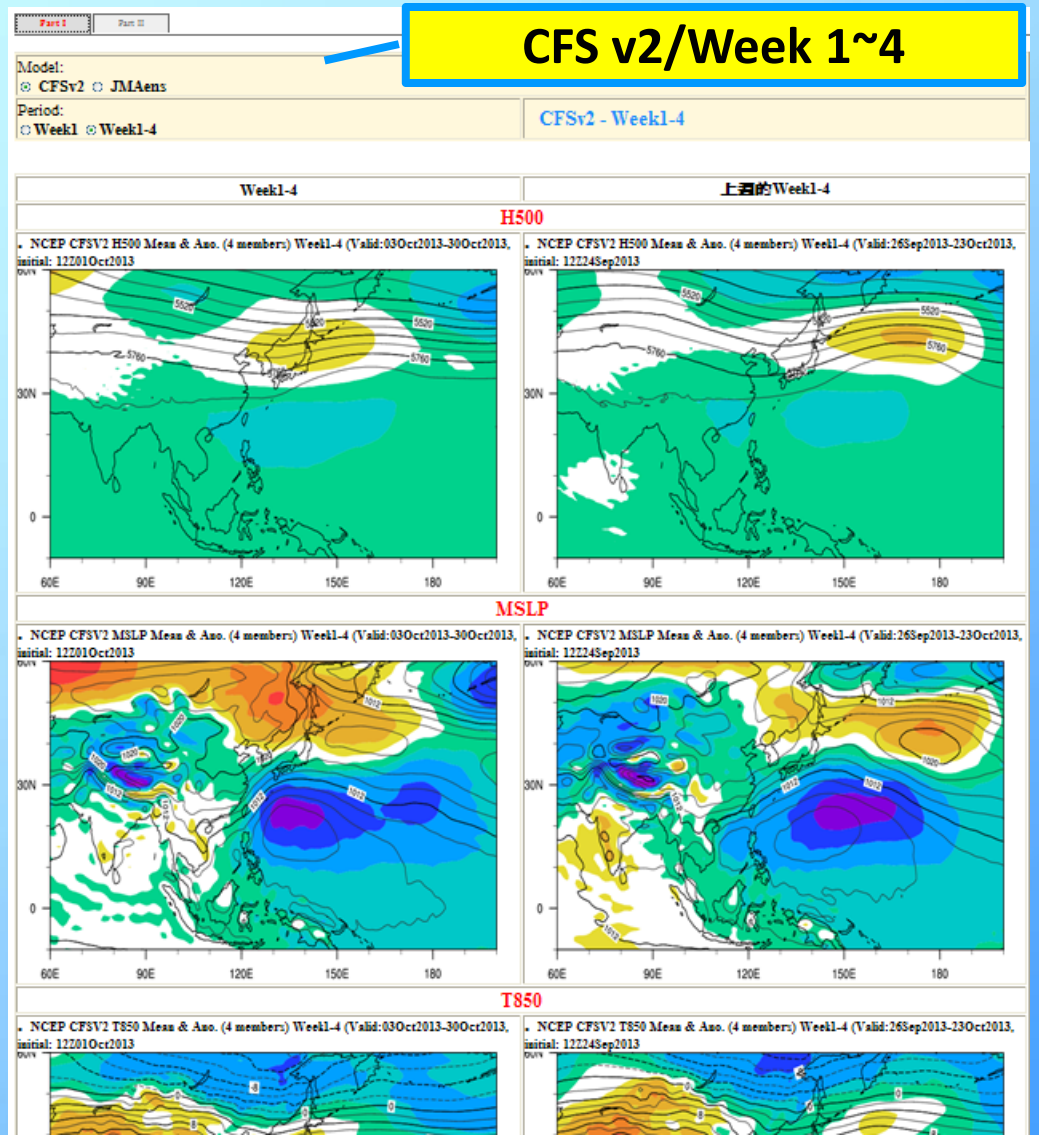
1.1. 1st , 2nd and 1~4th Week

– Temp. & Precip. 3-Categ. Probabilistic forecast –

Model	Target periods
NAEFS	Week1, week2
GEFS	Week1, week2
GFS	Week1, week2
CFSv2	Wee1, week2, week1-4

1.1. 1st , 2nd and 1~4th Week

– Dynamical 1st month Circulations –



H500, MSLP, T850, W850, Precip.

Mean & Anomaly Circulation

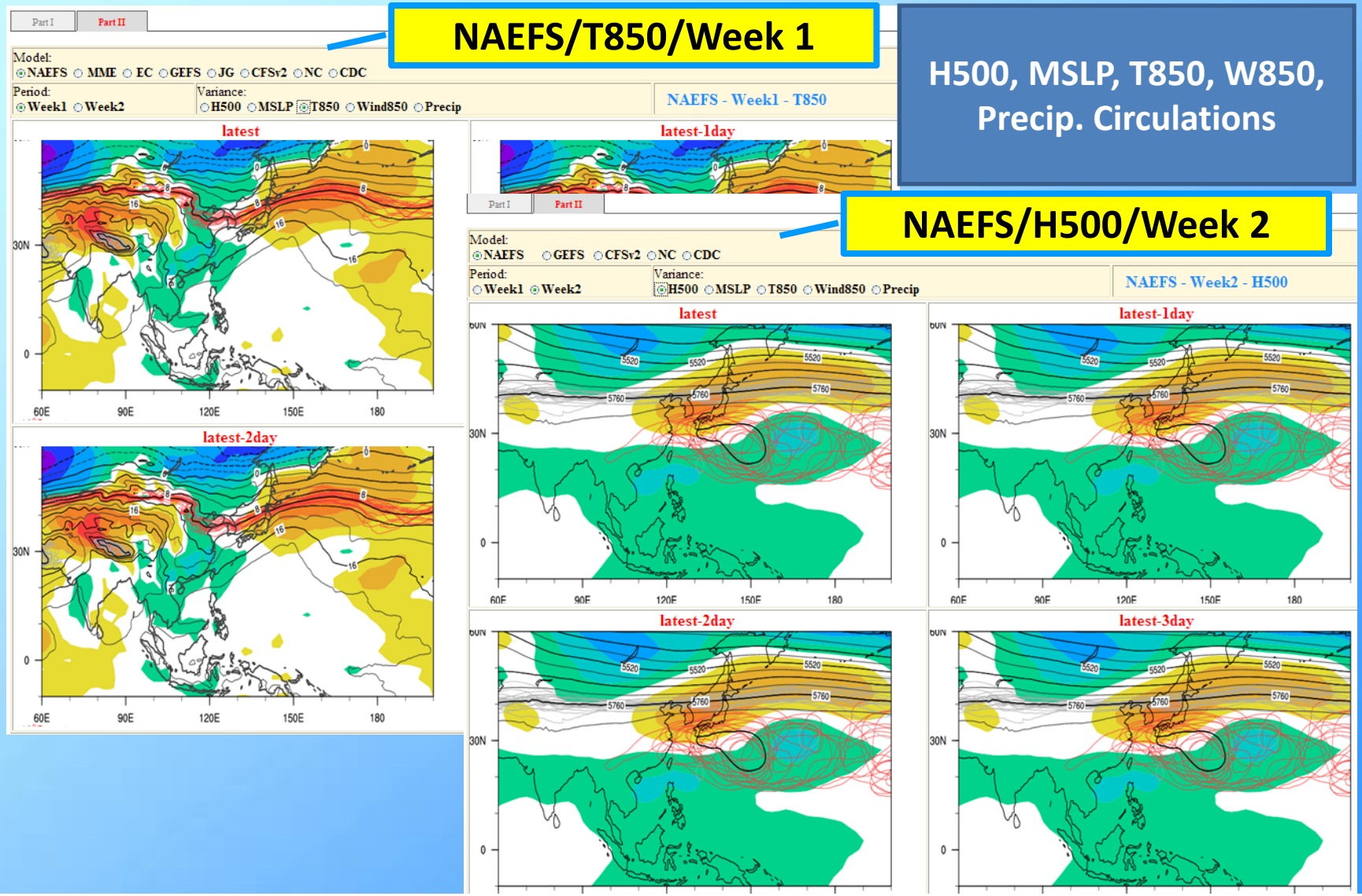
1.1. 1st , 2nd and 1~4th Week

– Dynamical 1st & 2nd Weeks Circulations –

NAEFS/T850/Week 1

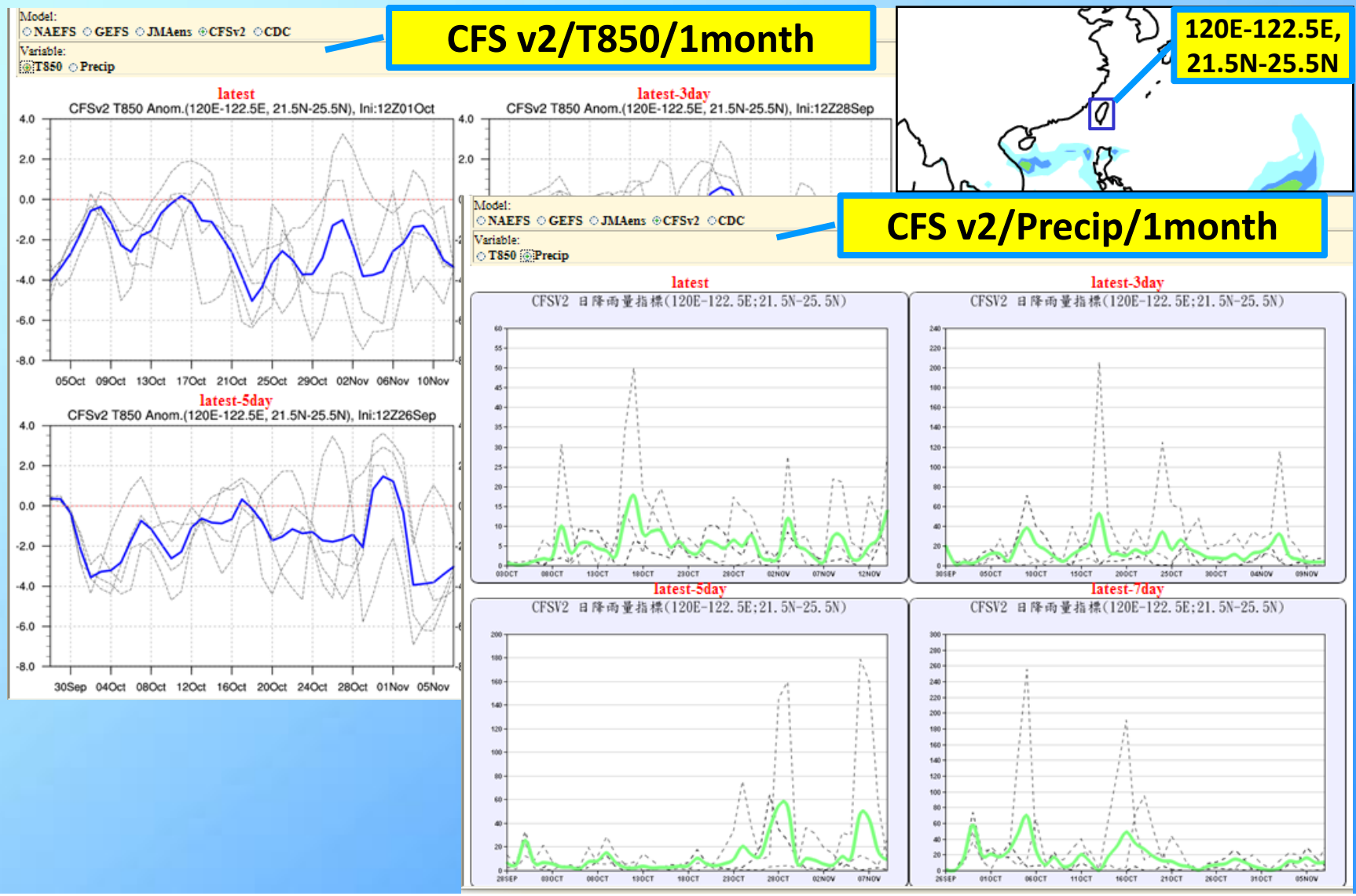
H500, MSLP, T850, W850, Precip. Circulations

NAEFS/H500/Week 2



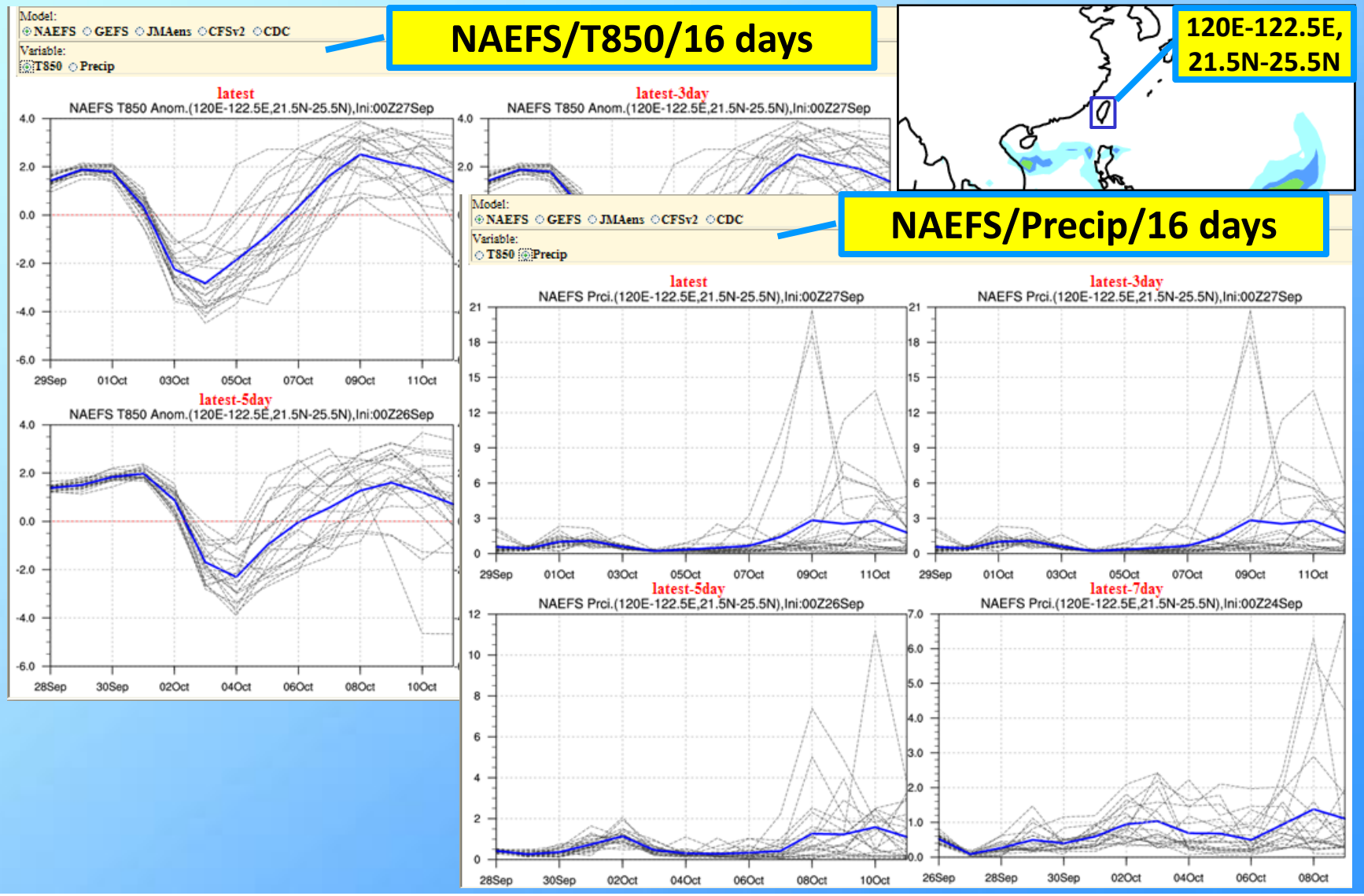
1.1. 1st , 2nd and 1~4th Week

– Dynamical CFS v2 1~30days time series at Taiwan area –



1.1. 1st , 2nd and 1~4th Week

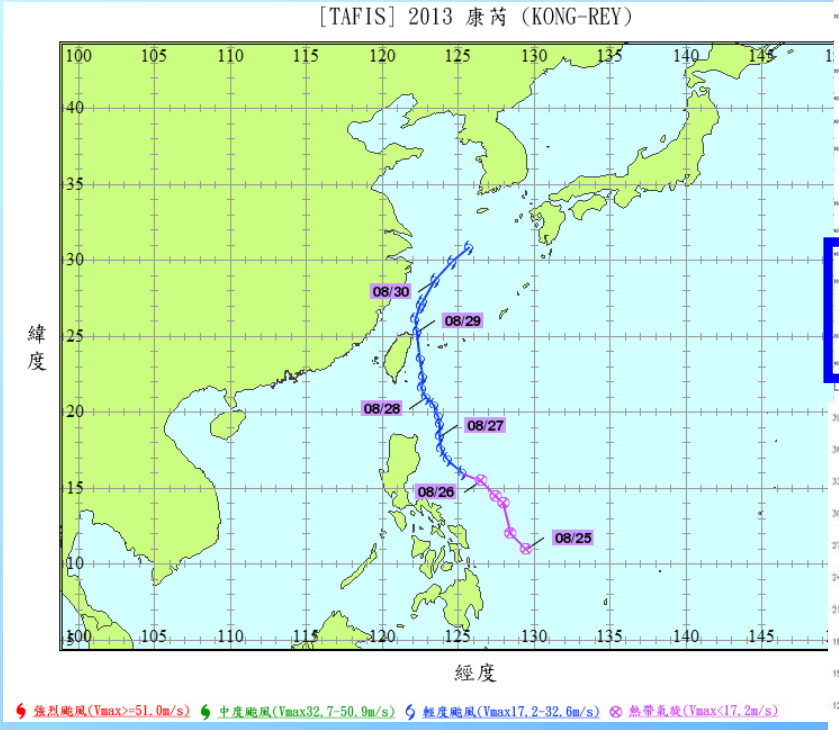
– Dynamical CFS v2 16 days time series at Taiwan area –



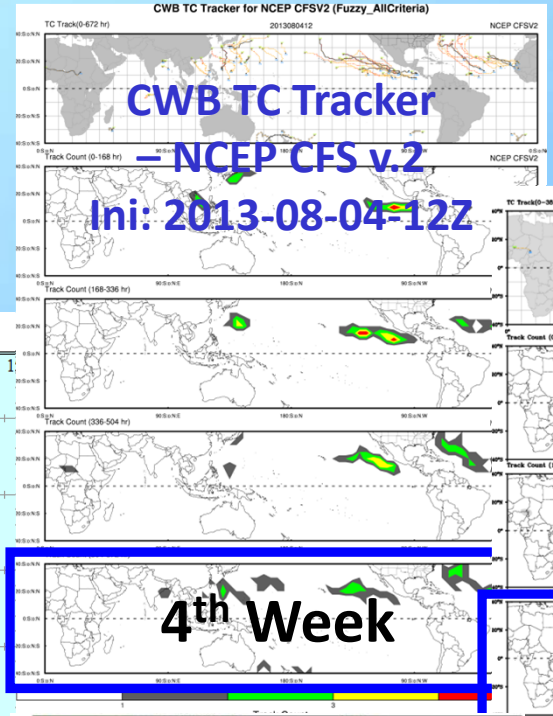
1.2. Typhoon Forecast

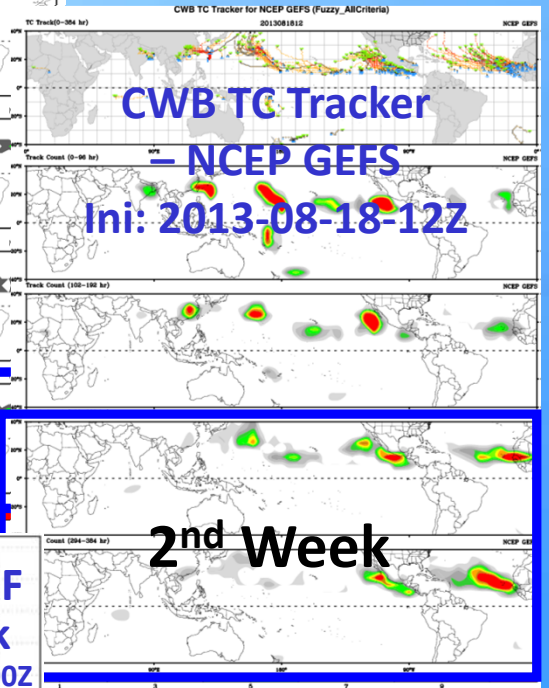
Typhoon Kong-Rey - light
August 25~30, 2013

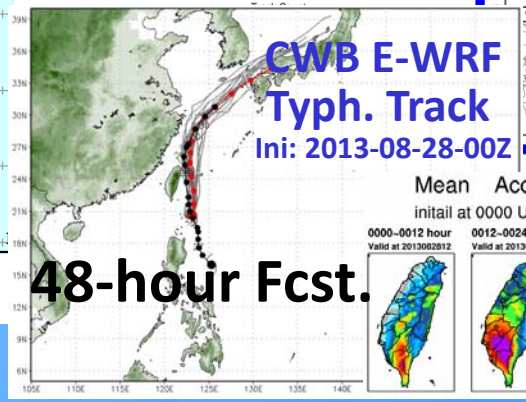
- JTWC/Joint Typhoon Warning Center -

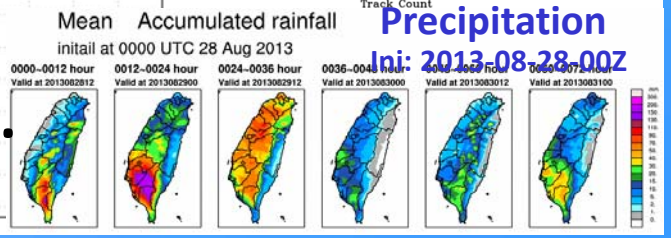


CWB TC Tracker
– Dr. Tsai, Hsiao-Chung



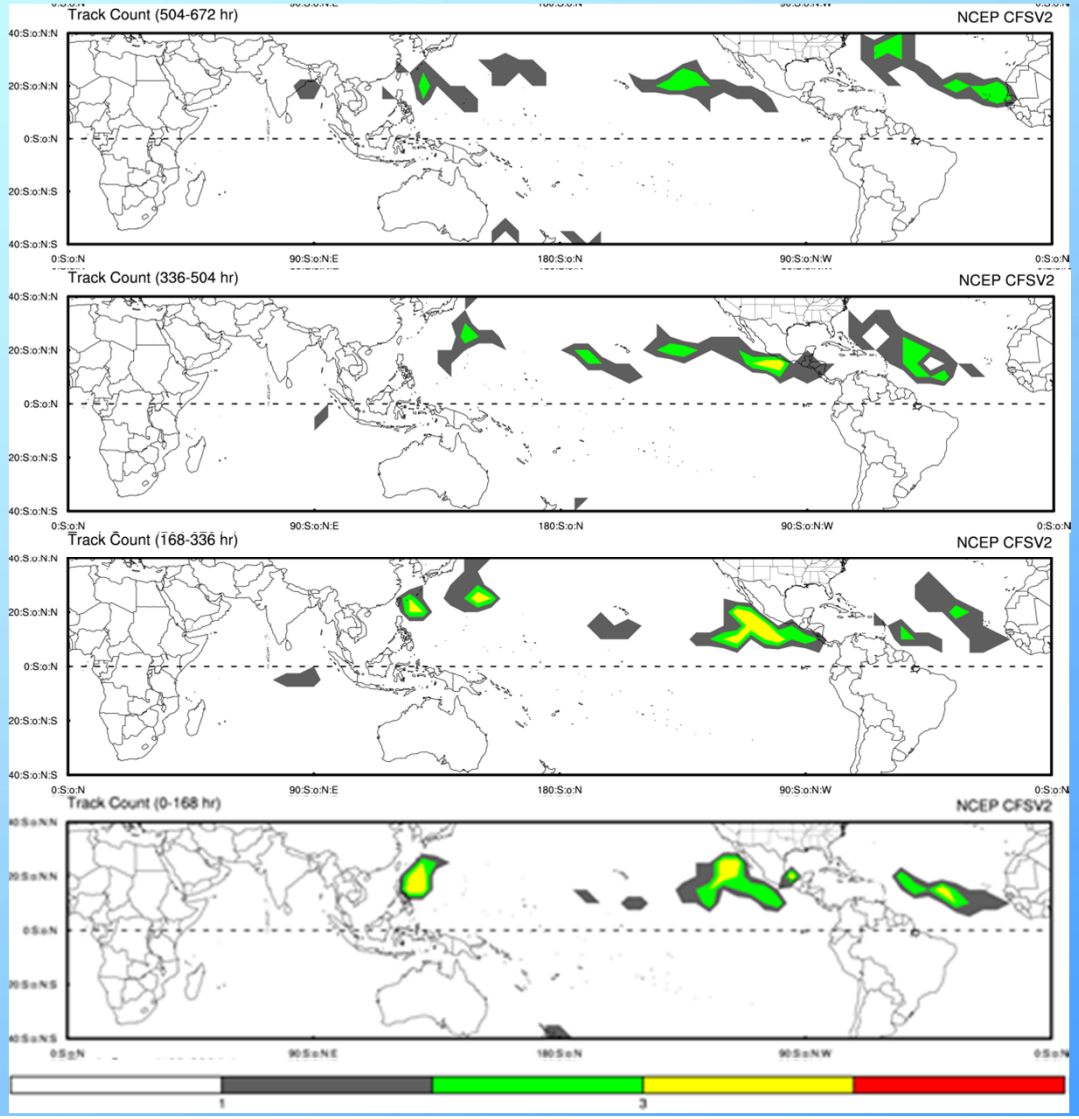






1.2. Typhoon Forecast – 1

– 1st~4th Weeks CWB TC Tracker – NCEP CFS v.2 –



2013-08-04 12Z
4th Week
504~672 hr

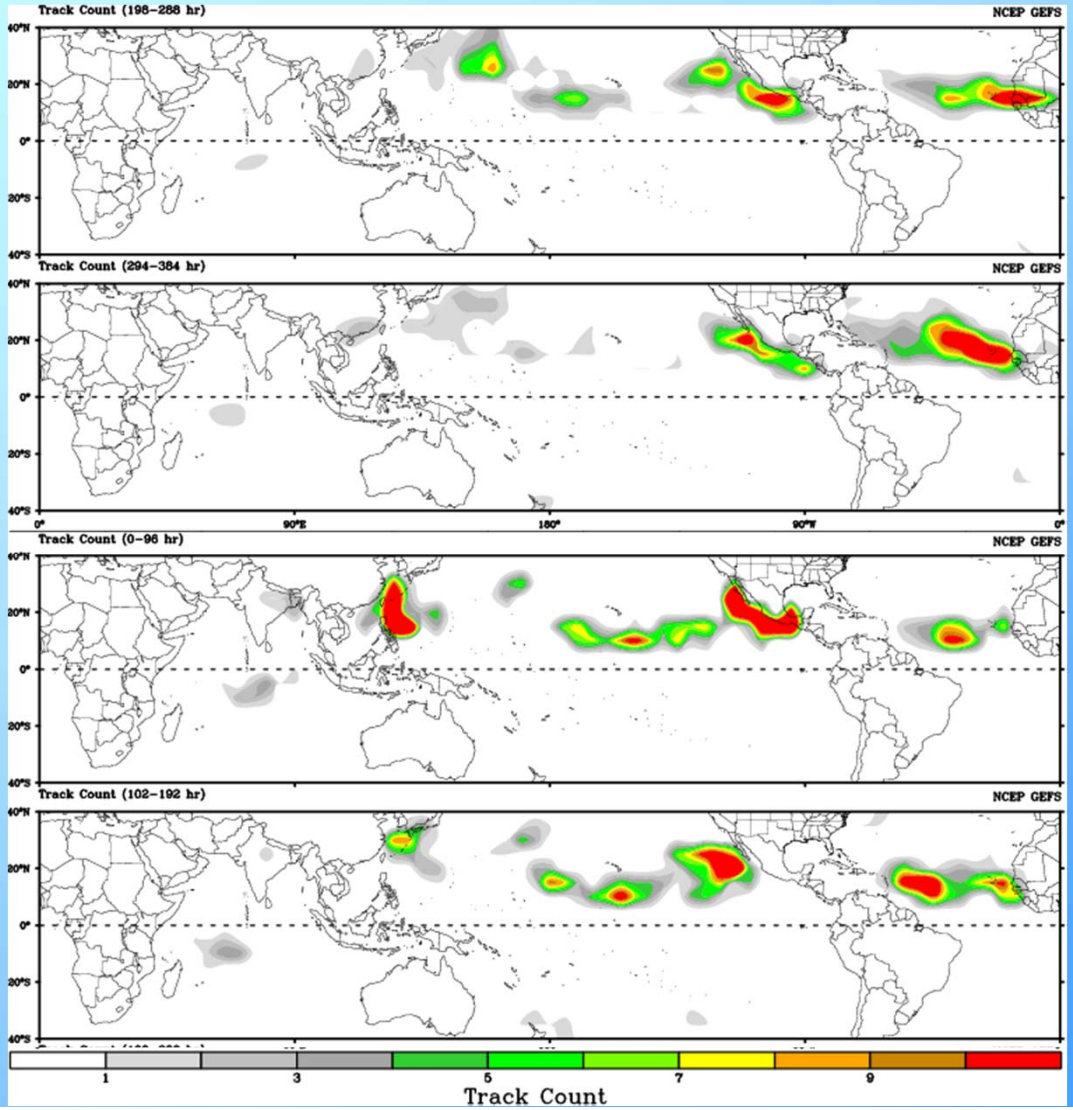
2013-08-11 12Z
3rd Week
336~504 hr

2013-0818 12Z
2nd Week
168~336 hr

2013-08-25 12Z
1st Week
000~168 hr

1.2. Typhoon Forecast - 2

– 1st and 2nd Weeks CWB TC Tracker – NCEP GEFS –



2013-08-18 12Z
Day 08~12
198~288 hr

2013-08-18 12Z
Day 12~16
294~384 hr

2013-0825 12Z
Day 00~04
000~096 hr

2013-08-25 12Z
Day 04~08
102~192 hr

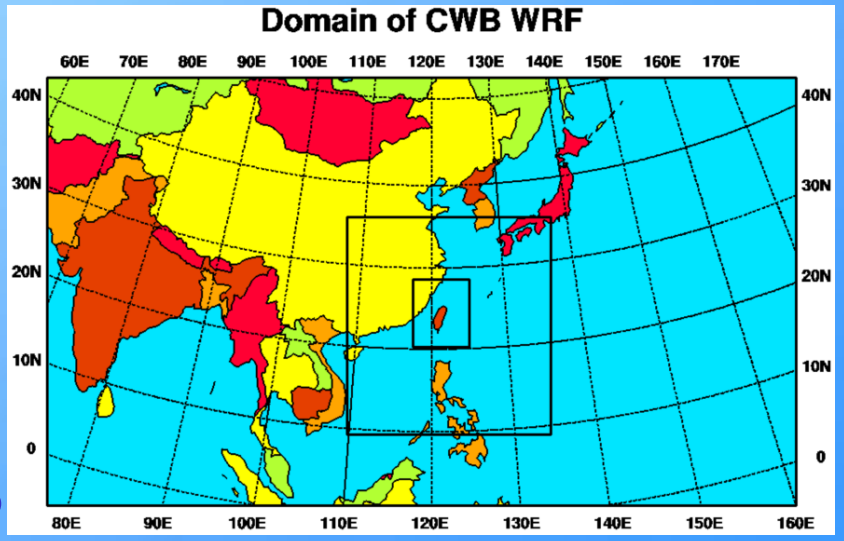
1.2. Typhoon Forecast – 3.0

– Regional Ensemble WRF Forecast –

CWB Regional Ensemble Prediction System

Model Configurations

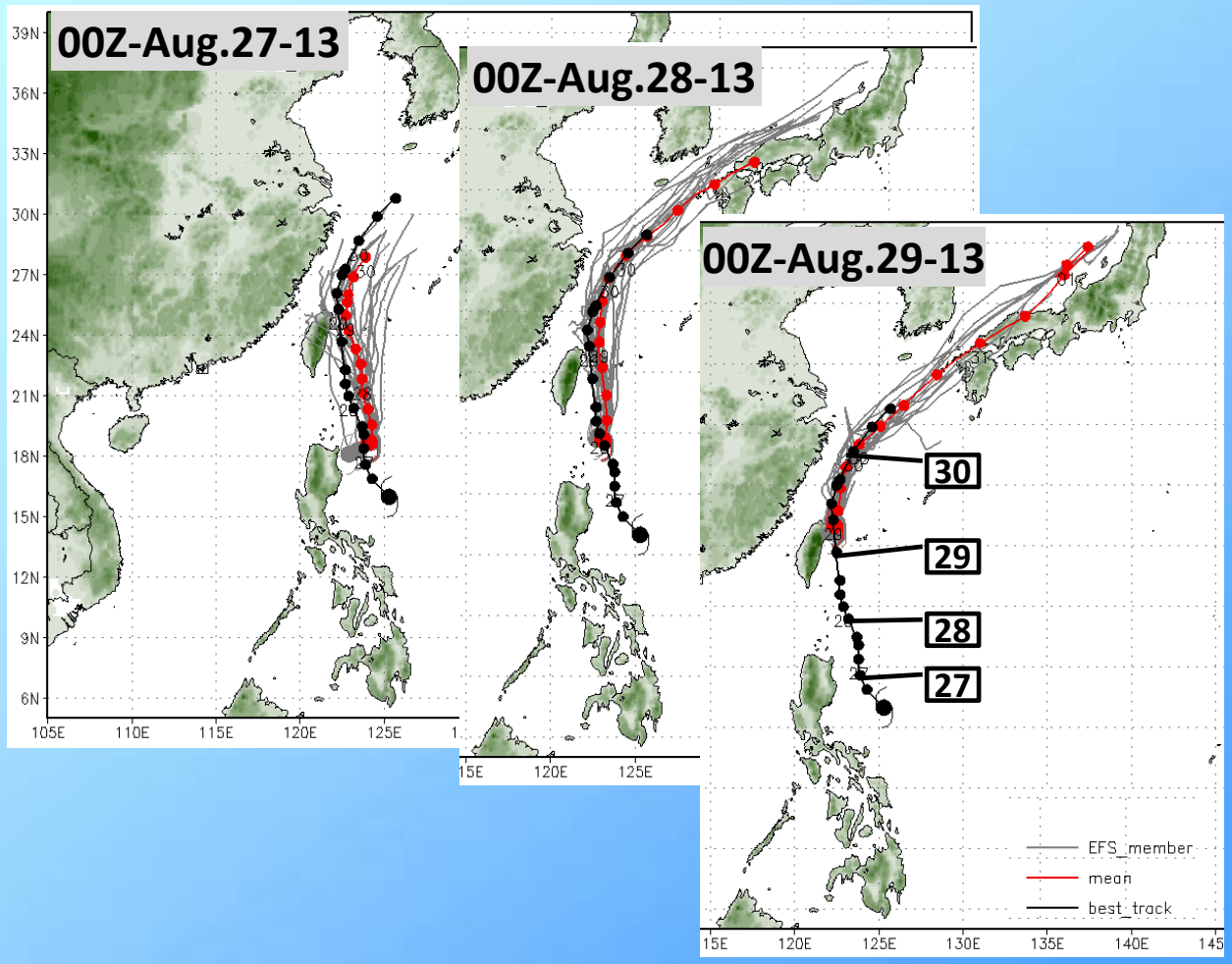
- Model – WRF 3.1.1 – 45km, 15km, 05km
- Vertical level – 45 levels, top: 30hPa
- Operation – 00Z, 12Z
- Ensemble member – 20
  - Perturbation by
    1. Initial
    2. Model physics
    3. Boundary from NCEP GEFS



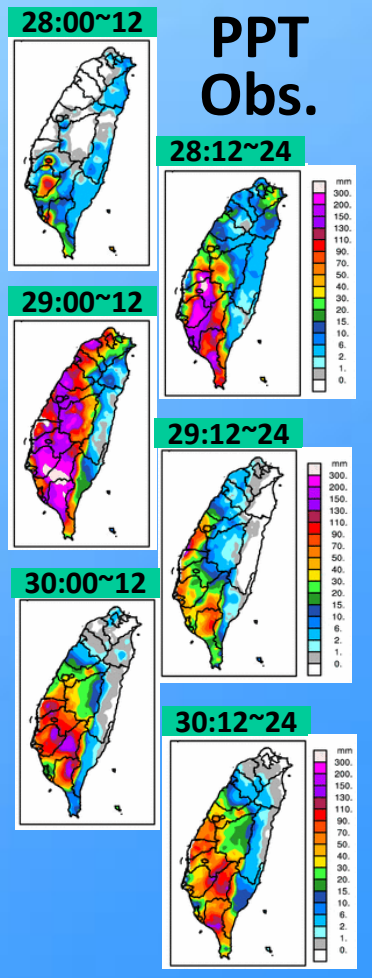
1.2. Typhoon Forecast – 3.1

– Regional Ensemble WRF Forecast –

Typhoon Track Forecast



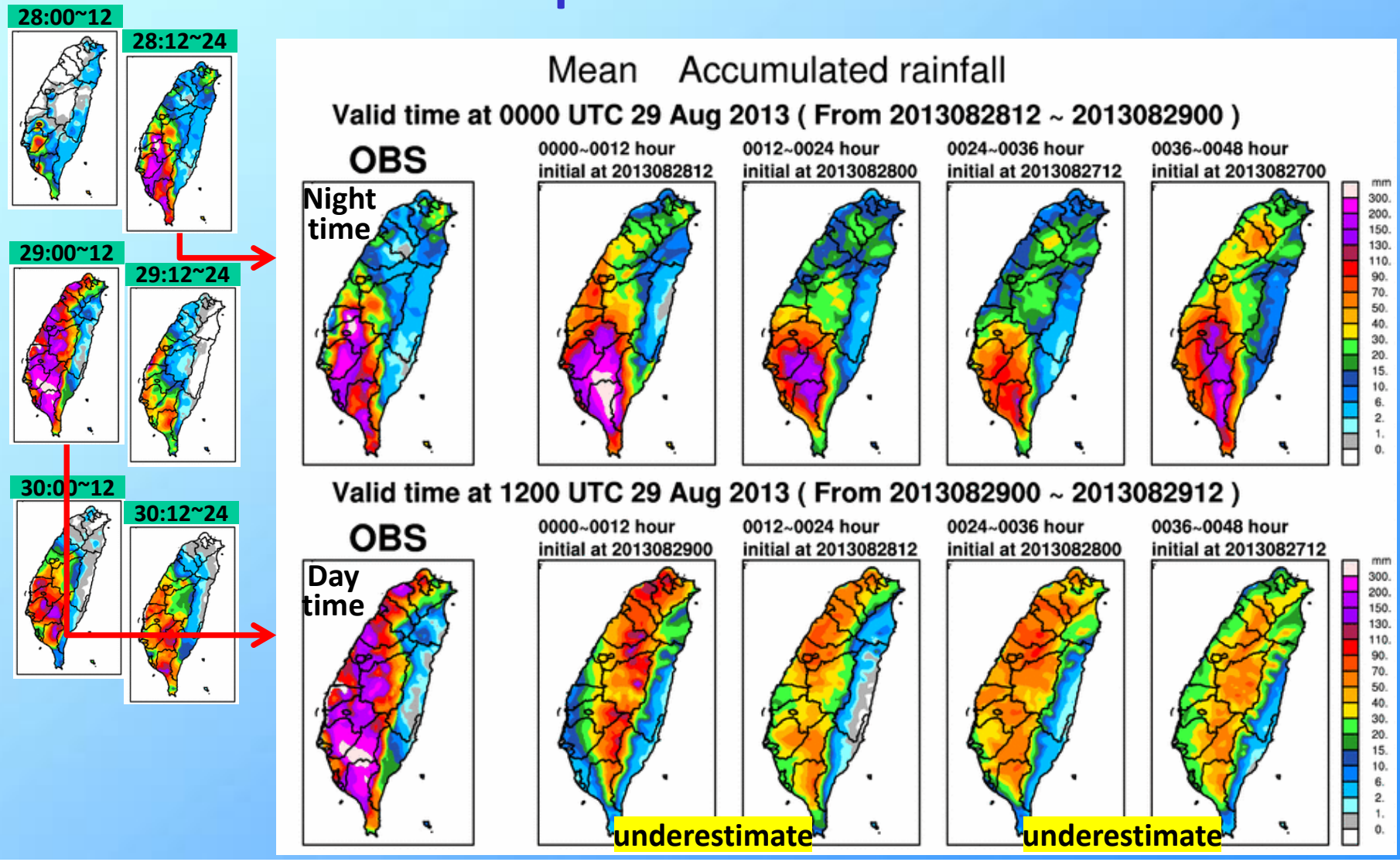
PPT Obs.



1.2. Typhoon Forecast – 3.2

– Regional Ensemble WRF Forecast –

Precipitation Forecast

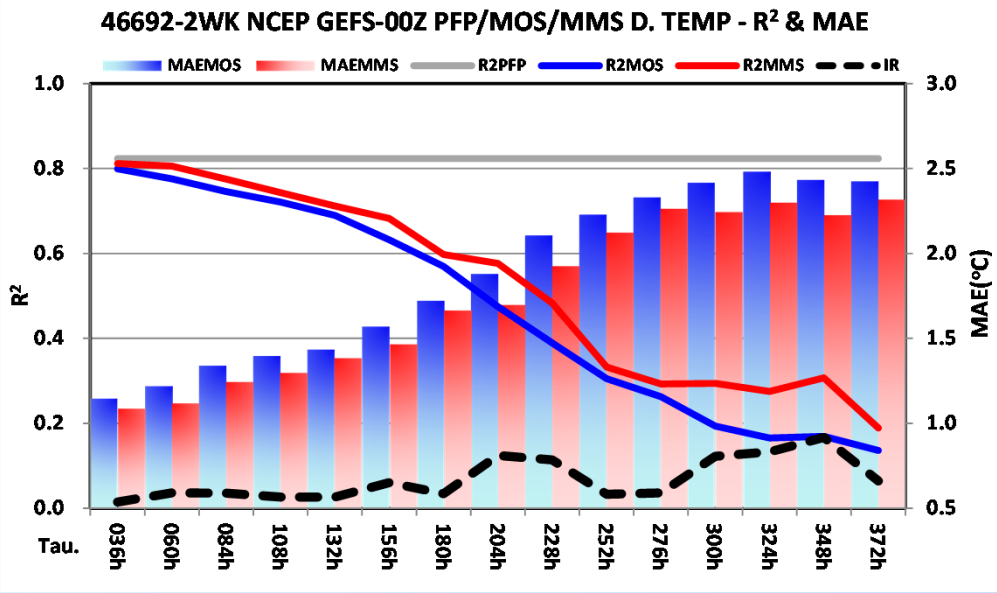


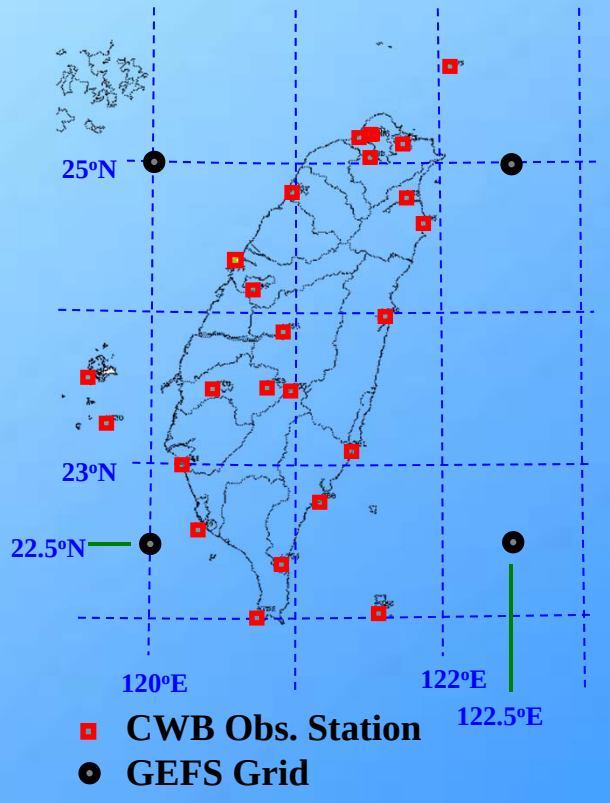
2. Dyn-Statistic Scheme Develop.

– NCEP GEFS Temp. MOS –

GEFS fields:

T850, H700, H500, U250, PPT
U850, Rh700, V250,
V850,





Why MOS: 1. Down Scaling. 2. Bias Correction (Reduce Systematic Error)

Purpose : Examine NWP model potential predictability

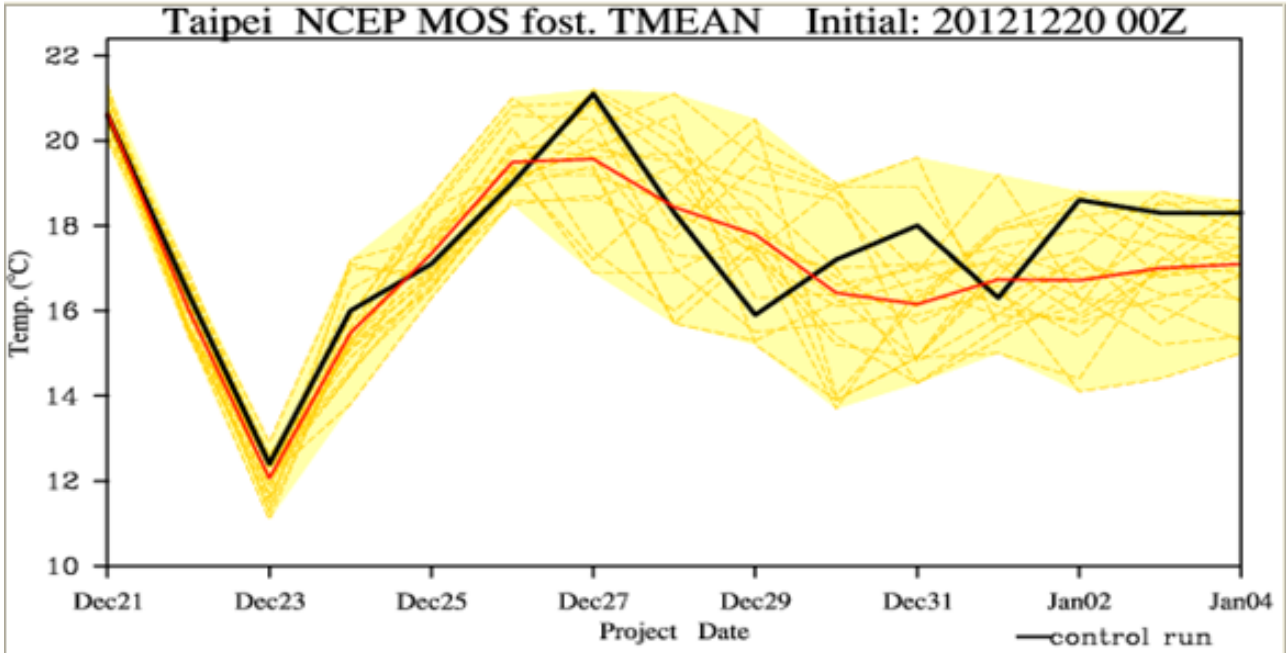
2. Dyn-Statistic Scheme Develop.

– NCEP GEFS Temp. MOS –

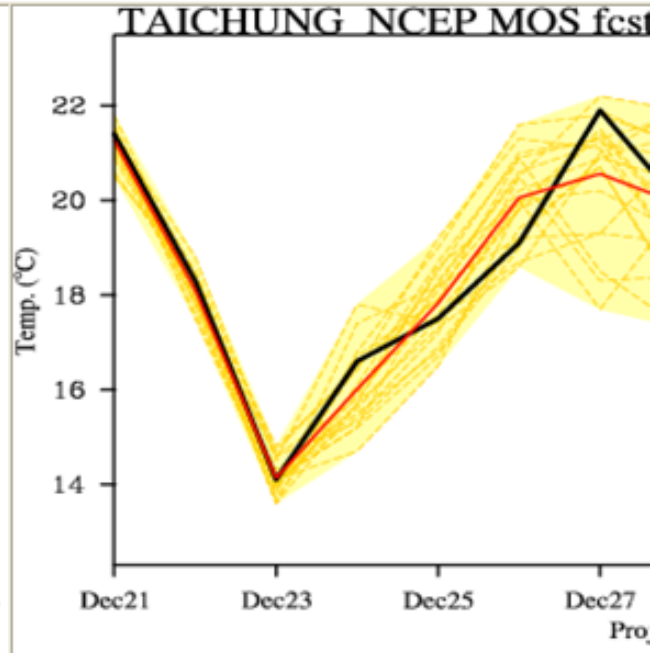
Mean Temperature | QPF | Prob. Precipitation

MOS of NCEPMRF -- Mean Temperature

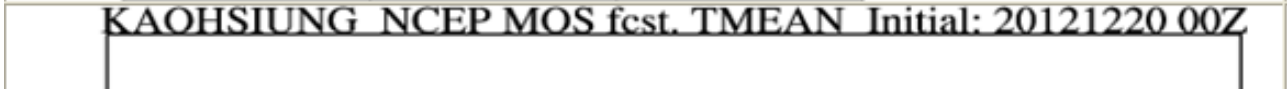
CWB CMF System



	week1	week2
Ensemble mean	16.9	16.8
Control run mean	17.2	17.5
Min ~ Max	15.4 ~ 18.4	14.5 ~ 19.2

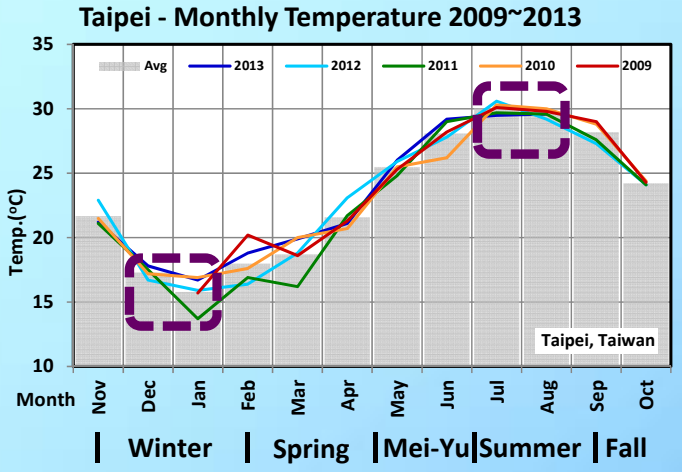


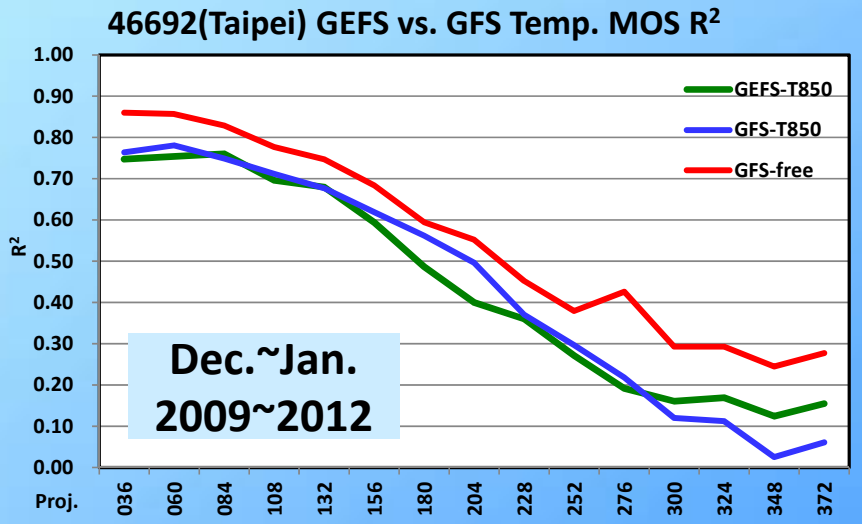
	week1
Ensemble mean	18.1
Control run mean	18.2
Min ~ Max	16.6 ~ 19.5

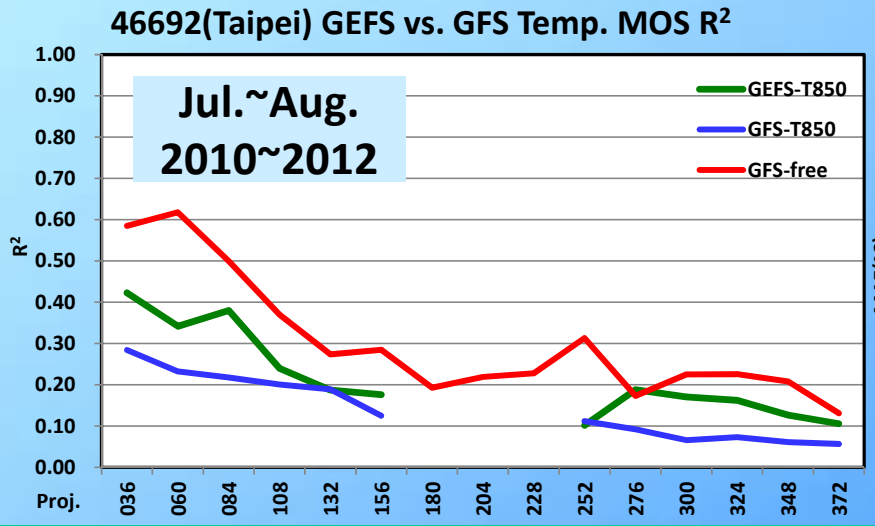


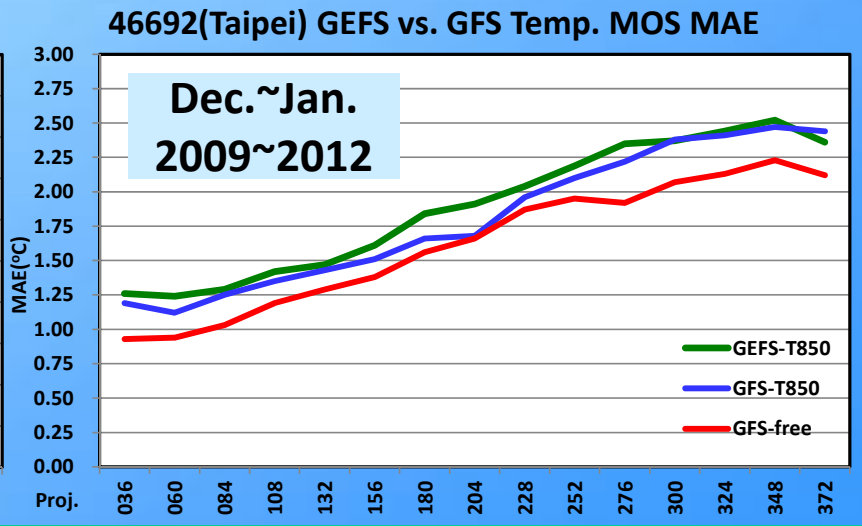
2. Dyn-Statistic Scheme Develop.

– NCEP GFS vs. GEFS Temp. MOS –







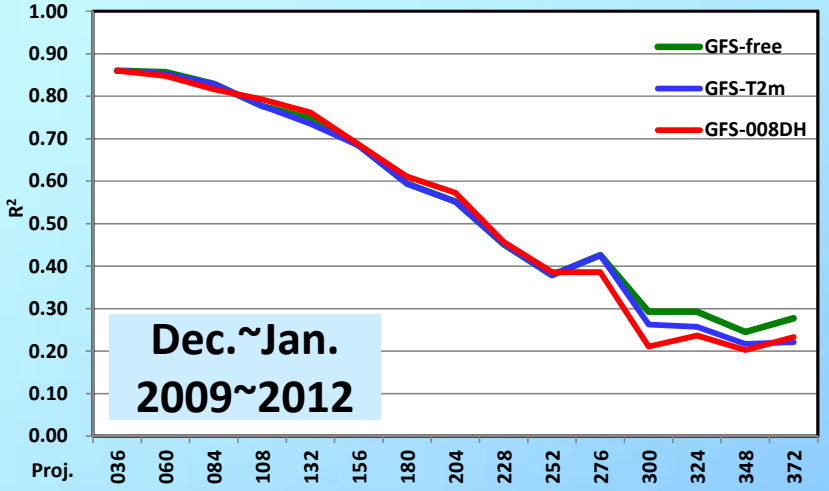


Model request: (a).satisfied under 0.05 significant level, and (2). predictors collinearity thres value 0.4

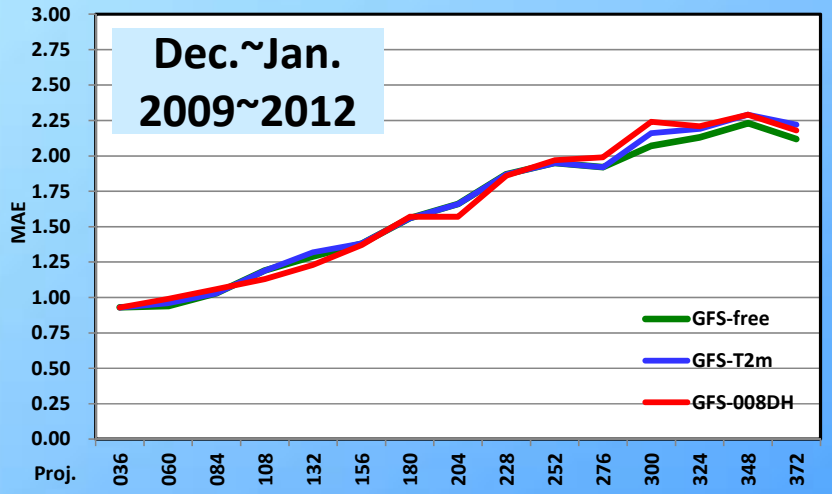
2. Dyn-Statistic Scheme Develop.

–GFS Temp. MOS(T2m,DH850~1000mb,free run) –

46692(Taipei) GFS Temp. MOS R^2



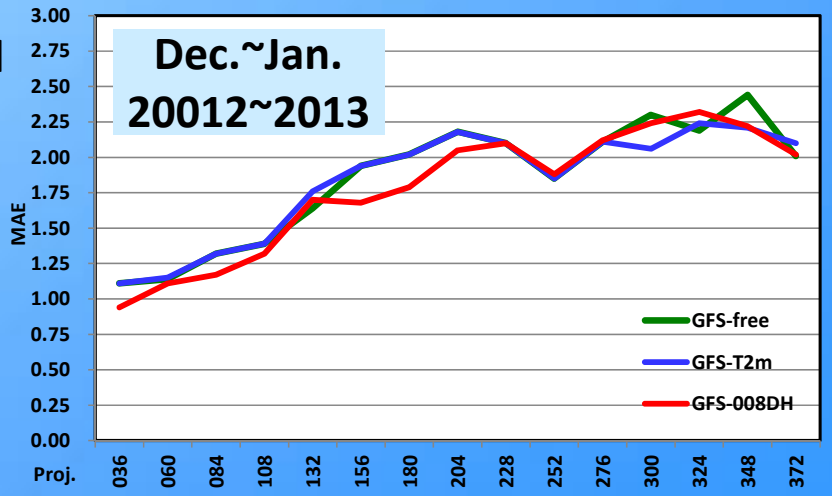
46692(Taipei) GFS Temp. MOS MAE - Fitting



Why GFS:

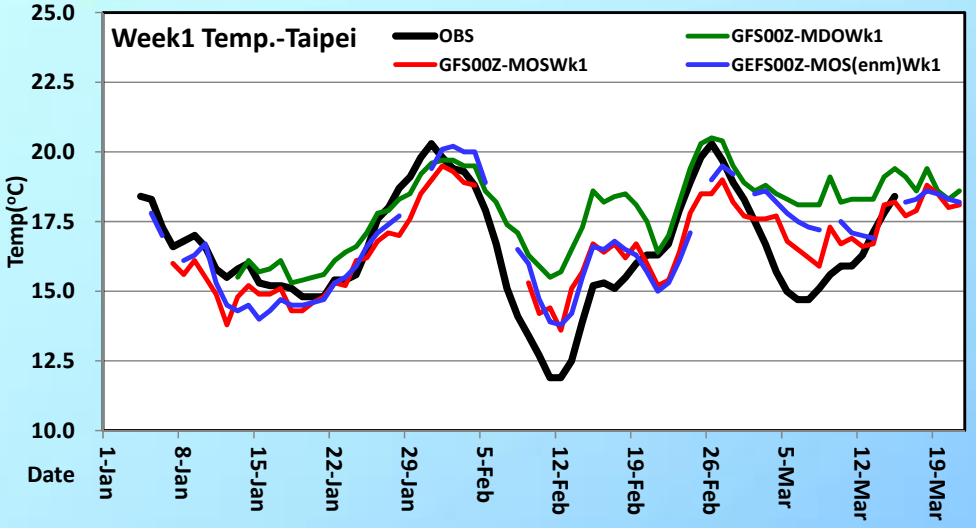
1. NCEP GFS full forecast products collected by CWB MIC from 2008. (5-yaer data)
2. Study the important forecast variable fields, which affected Taiwan' weather.
3. Study the model potential predictability at Taiwan area.
4. Operate with GEFS to generate EnMOS
5. Collect necessary GEFS fields from 2.

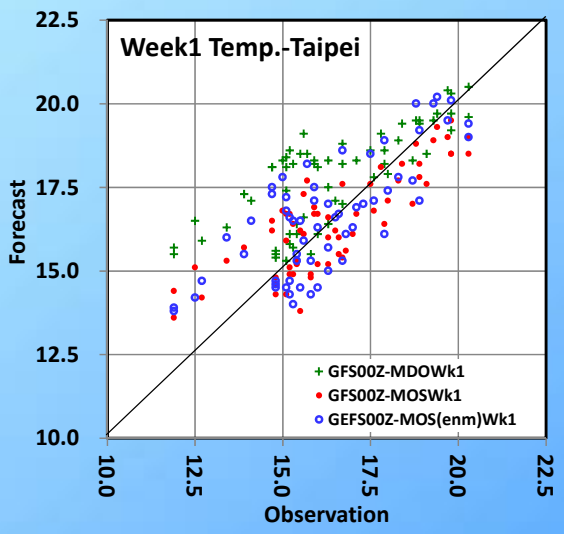
46692(Taipei) GFS Temp. MOS MAE - Verify



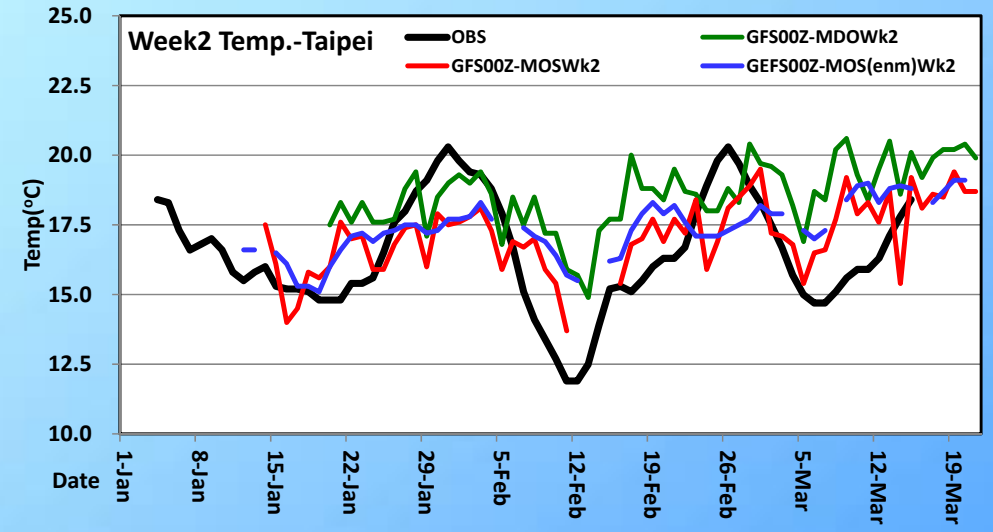
2. Dyn-Statistic Scheme Develop.

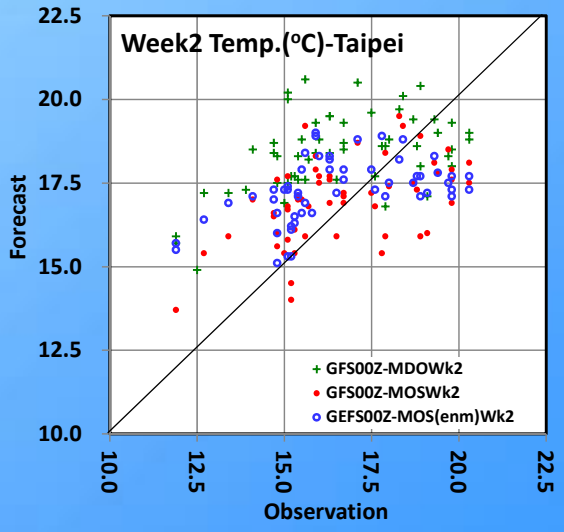
– Verifications of GFS、GEFS MOS & GFS MDO Week 1 & 2 –





Corr.	Week 1	Week 2
GFS-T2M	0.77	0.49
GFS MOS	0.83	0.52
GEFS MOS(EM)	0.76	0.49





MAE	Week 1	Week 2
GFS-T2M	1.50	2.32
GFS MOS	0.96	1.50
GEFS MOS(EM)	1.10	1.71

@ GEFS MOS has less pdr. variables description than GFS MOS (full pdr. Free selection)
@ T2M MDO exists warm bias than GFS MOS and GEFS MOS

3. CWB Ens. NWP Development

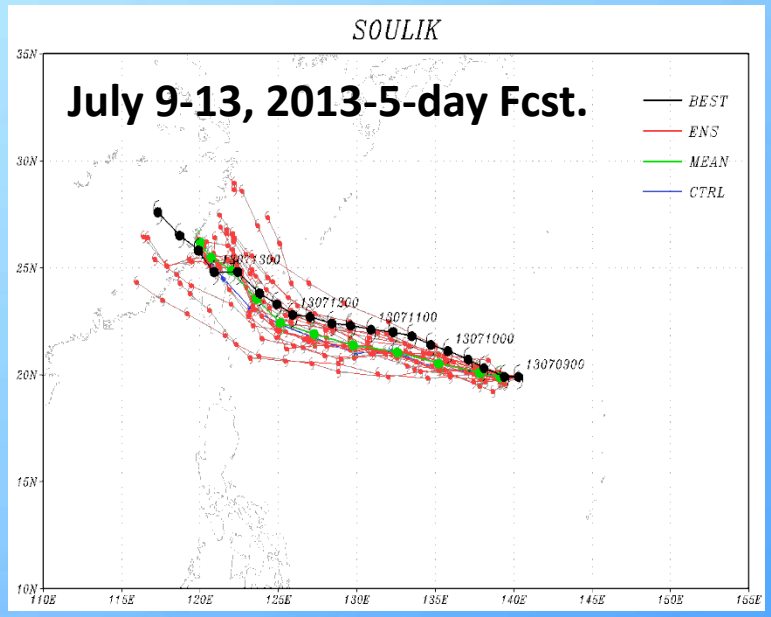
- CWB CFS -

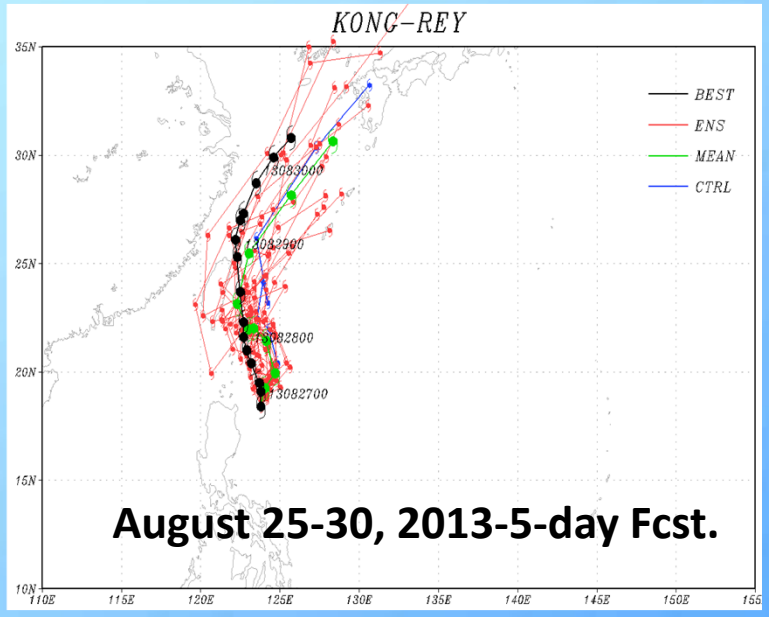
CWB CFS (2-tier)	V2	V1
Operation	2016-daily 12Z	2010-20days*12Z
Model-TCWBGM	T119L40	T42L18
Forecast length	7-month	7-month
Ensemble Size	4-member (TCWBGM & ECHAM) X (OPGSST(v2) & NCEP CFS(v2)-SST)	4-member (TCWBGM & ECHAM) X (OPGSST(v2) & NCEP CFS(v2)-SST)
Model physics improvements	radiation, Cumulus Convection Parameterization, Grid-sale Precipitation, Land model, boundary-layer Parameterization etc.	
Sub-seasonal prediction	More flexibility	No

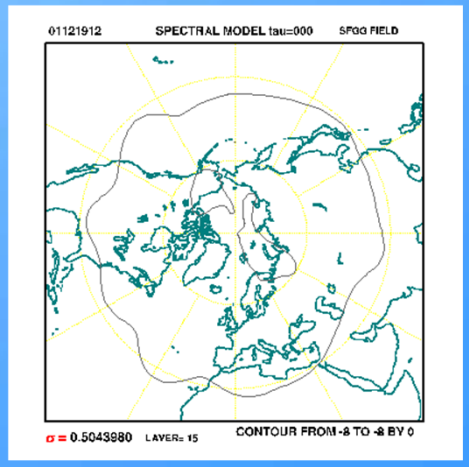
3. CWB Ens. NWP Development

- CWB GEFS -

CWB GEFS 2014			
Resolution	Deterministic		T319L40
	Ensemble		T319L40
Initial Perturbation -Singular Vector-	Global		T42L40
	Nested Typhoon domain	East Asia	20°N-60°N,100°E-180°E
		Typhoon	15°x10° -surround TY Center
Optimization time	48-hour		
Ensemble Size	20		
Forecast length	7-day		







3. CWB Ens. NWP Development

- CWB GEFS Roadmap-

2013-14 establish EPS based on SVs

2014- typhoon track EPS, probability forecast

2015- 14 day EPS based on SVs,
NCEP EnKF (breeding, NMC etc.)

2017- 14-day ~ 30-day
SVs, NCEP EnKF, physical forcing
(e.g. physical parameter and scheme,
ocean couple model scheme etc.)

-by Dr. Tseng C.H. chtseng@rdc.cwb.gov.tw

4. Future Plan of CWB Dyn.-Stat. Develop.

1. MOS Development:
   (1). global scale predictor
   as MJO, Asian Monsoon *etc.* indices
   (2). Predictor's forecast persistence
2. Generate Probabilistic Forecast Guidance
3. Multiple Model Ensemble
4. Application of Reanalysis and Reforecast


The Highest CWB Meteorological Observation Station
– Yushan / 46755 –
Height : 3,844.8 meters;
Total precitation 2855mm, During Typhoon Morakot Invasion
APPRECIATE FOR YOUR ATTENSION