JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSINGAND FORECASTING SYSTEMAND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2018

Thai Meteorological Department, THAILAND

1. Summary of highlights

Thai Meteorological Department (TMD) have been running the Weather Research and Forecasting (WRF) Model version 3.8.1 was made fully operational in October 2017. Now, Weather Research and Forecast (WRF) Model is running and generate daily output on Website and utilize daily weather forecast and special weather forecast. Necessary arrangements for the physical parameterization and sensitivity testing on the performance of the Model need to carry out. TMD run WRF with data assimilation technique by Grid point Statistical Interpolation System (GSI) 3DVAR Assimilation, and future plan to run 4DVAR and Hybrid.On 12 April 2017, Thai Meteorological Department (TMD) has been allocated budgets for purchasing the High Performance Computer (HPC) under the "Developmentof Weather Forecasting System with High Performance Computer Project (phase 1)". So, the old project (Unified Model),operated since 1993, has been suspended. TMD choosing the "Weather Research and Forecasting (WRF)" model from "National Center for Atmospheric Research (NCAR)" for processing the weather forecasting system. TMD has brought new products from current project replaces the products from old project from October 2017 onwards.

2. Equipment in use

TMD has changed the processing system for NumericalWeather Prediction (NWP) by using product from HPE brand, Apollo 2000 series Proliant XL170r Generation 9 model. The whole system consists of:

2.1 The front-end computer; HPE Proliant DL380 Generation 9 model.

2.2 The management Server; HPE Proliant DL380 Generation 9 model.

2.3 192 computer nodes; HPE Proliant XL170r Generation 9 model. Total processing peak speed 228 TFLOPs. RAM 128 gigabyte per node.

2.4 High speed storage; HPE 3PAR StoreServ File Controller system 3010 TiB.

2.5 High speed network.

2.6 UPS and monitoring system

3. Data and Products from GTS in use

3.1 Data in use

Now TMD using data from NCEP (GDAS) and TMD is going to improve the data assimilation system by using 3DVAR, 4DVAR, ETKF andHYBRIDtechniques. The initial data are from GTS system and also using assimilated data from NCEP (GDAS). The data assimilation software is WRFDA and Grid point Statistical Interpolation (GSI) systems. data assimilation inGSItechnique)Domain 1) such as.

Satellite	Instrument	Amount of data
metop-a	iasi	2,032,184
metop-a	mhs	32,365
metop-a	hirs4	29,583
metop-a	amsua	10,995
metop-b	iasi	8,965,264
metop-b	mhs	151,190
metop-b	hirs4	139,650
metop-b	amsua	50,805
n19	mhs	216,550
n19	hirs4	201,020
n19	amsua	72,915
n15	amsua	125,190
npp	cris	4,788
npp	atms	22

3.2 Grid Products
   TMD also using the products from ECMWF, NCEP, KMA, JMA and Australia as the additional guidance data for daily weather forecasting and mid range weather forecasting.

4.   Forecasting system

TMD has changed NWP system from Unified Model to WRF model since October 2017. The WRF software version 3.8.1 is processing by the new HPC and the WRF configuration details in Figure 1:
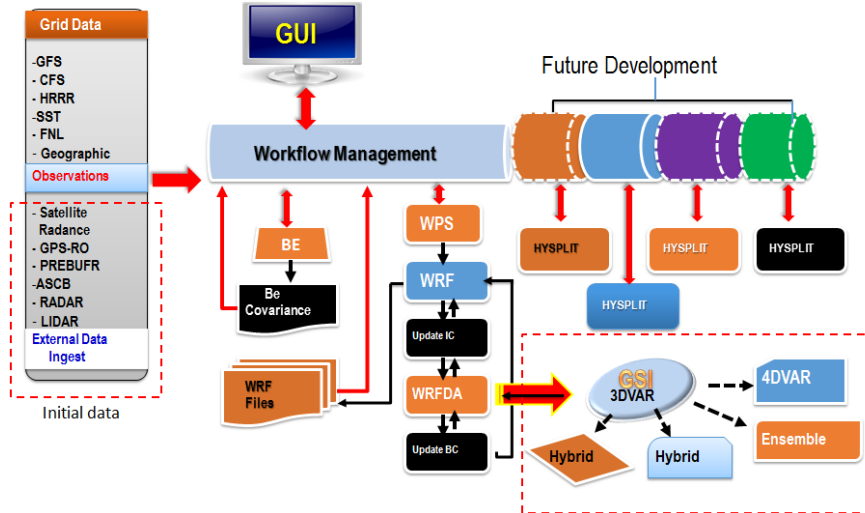

Figure 1 TMD Workflow Management

4.1   System run schedule and forecast range

For run WRF model.				
Type	Model	Data time	Start time	Forecast period
Main run for NWP products	Global	00Z	03:05 UTC	T+397 days
	Asia and Australia			T+10 days
	Southeast Asia			T+3 days
	Thailand			T+2 days
Main run for NWP products	Asia and Australia	06Z	09:05 UTC	T+10 days
	Southeast Asia			T+3 days
	Thailand			T+2 days
Main run for NWP products	Asia and Australia	12Z	15:05 UTC	T+10 days
	Southeast Asia			T+3 days
	Thailand			T+2 days
Main run for NWP products	Asia and Australia	18Z	21:05 UTC	T+10 days
	Southeast Asia			T+3 days
	Thailand			T+2 days

WRFBangkok model.				
Type	Model	Data time	Start time	Forecast period
Main run for NWP products	Bangkok	00Z	04:05 UTC	T+24 hours
Main run for NWP products	Bangkok	12Z	18:05 UTC	T+24 hours

4.2   Medium range forecasting system (4-10 days)

4.2.1   Data assimilation, objective analysis and initialization

4.2.1.1 In operation
   Using 3DVAR on Grid point Statistical Interpolation (GSI) data assimilation system and GDAS datafrom NCEP.The Grid point Statistical Interpolation System (GSI) is a unified data assimilation system for both global and regional applications. GSI is the next generation analysis system developed by the National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC) and is based directly off of the Spectral Statistical Interpolation(SSI) operational analysis system.

4.2.1.2 Research performed in this field

Run WRF in high resolution for water management,agriculture, tourist and so on.

4.2.2 Model

4.2.2.1 In operation

Weather Research and Forecasting (WRF) model version 3.8.1 and plan to update to WRF 4.0. Configuration domains for run WRF on HPC(Phase 1). Used data from GFS 0.25 Initial & Boundary Conditions.Data Assimilated use GSI Technique (3DVAR) inresolution 18,6 and 2 km^2 Horizontal Grid Spacing (18 kmouter grid)52 Vertical Levels. Non-hydrostatic Dynamics, Cumulus Parameterization use New Tiedtkescheme (16), Options *(cu_physics)* No CU Scheme in 2 km^2, In Microphysics Scheme use WSM 6-class graupelscheme ; Scheme Yonsei University Scheme (YSU) PBL Scheme Long Wave and short wave Radiation Scheme Rapid Radiative Transfer Model (RRTMG) Land Surface use options: Unified Noah Land Surface Model *(sf_surface_physics)*Shortwave Radiation Scheme useDudhia

4.2.2.2 Research performed in this field

WRF has been run for Bangkok model research.

4.2.3 Operationally available Numerical Weather Prediction Products

Precipitation, Wind, Pressure, Temperature, Relative humidity and Geopotential height at standard pressure levels products are available in TMD website.

4.2.4 Operational techniques for application of NWP products *(MOS, PPM, KF, Expert Systems, etc..)*

4.2.4.1 In operation

QPE and QPF technique

4.2.4.2 Research performed in this field

Radar data for data assimilation in very short range forecast.

4.2.5 Ensemble Prediction System (EPS)

4.2.5.1 In operation

Plan in the future.

4.2.5.2 Research performed in this field

Plan in the future.

4.2.5.3 Operationally available EPS Products

Long range forecast(397 days) run 2 ensemble

4.3 Short-range forecasting system (0-72 hrs)

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 In operation

Using 3DVAR on Grid point Statistical Interpolation (GSI) data assimilation system and using GDAS data from NCEP as boundary conditions.

4.3.1.2 Research performed in this field

None of activity.

4.3.2 Model

4.3.2.1 In operation

The Cycle run four time per day at 00, 06, 12 and 18UTC with forecast. There are 3 domains for operational which are the WRFV3.8.1 (changing to WRFV 4.0) and . 1 domain for climate model.

   a) 397 days forecast, 27 km. resolution, West-East: 1,483 grid points, South-North: 741 grid points and 31 level Bottom-Top.

b) 10 days forecast, 18 km. resolution, West-East: 485 grid points, South-North: 555 grid points and 52 level Bottom-Top.
c) 72 hours forecast, 6 km. resolution, West-East: 547 grid points, South-North: 544 grid points and 52 level Bottom-Top.
d) 48 hours forecast, 2 km. resolution, West-East: 547 grid points, South-North: 913 grid points and 52 level Bottom-Top.
e) 24 hours forecast for Bangkok model, 1.5 km. resolution. (Processing on PC for research)

4.3.2.2 Research performed in this field
24 hours forecast for Bangkok model, 3 km. resolution (processing on PC for research).

4.3.3 Operationally available NWP products
Wind, Pressure, Temperature, Relative humidity and Geopotential height at standard pressure levels and Precipitation products are available in TMD website.API service and mobile application.

4.3.4 Operational techniques for application of NWP products
4.3.4.1 In operation
None of activity.

4.3.4.2 Research performed in this field
None of activity.

4.3.5 Ensemble Prediction System
4.3.5.1 In operation
None of activity.

4.3.5.2 Research performed in this field
None of activity.

4.3.5.3 Operationally available EPS Products
None of activity.

4.4 Nowcasting and Very Short-range Forecasting Systems (0-12hrs)

4.4.1 Nowcasting system
4.4.1.1 In operation
None of activity.

4.4.1.2 Research performed in this field
None of activity.
4.4.2 Models for Very Short-range Forecasting Systems
4.4.2.1 In operation
None of activity.

4.4.2.2 Research performed in this field
None of activity.

4.5 Specialized numerical predictions
None of activity.

4.5.1 Assimilation of specific data, analysis and initialization (where applicable)
4.5.1.1 In operation
None of activity.

4.5.1.2 Research performed in this field
None of activity.

4.5.2   Specific Models (as appropriate related to 4.5)

4.5.2.1 In operation
None of activity.

4.5.2.2 Research performed in this field
None of activity.

4.5.3   Specific products operationally available
None of activity.

4.5.4   Operational techniques for application of specialized numerical prediction products *(MOS, PPM, KF, Expert Systems, etc..)*(as appropriate related to 4.5)

4.5.4.1 In operation
Plan in the future..

4.5.4.2 Research performed in this field
None of activity.

4.5.5   Probabilistic predictions (where applicable)

4.5.5.1 In operation
None of activity.

4.5.5.2 Research performed in this field
None of activity.

4.5.5.3 Operationally available probabilistic prediction products
None of activity.

4.6   Extended range forecasts (ERF) *(10 days to 30 days)*

4.6.1   Models

4.6.1.1 In operation
None of activity.

4.6.1.2 Research performed in this field
None of activity.

4.6.2   Operationally available NWP model and EPS ERF **products**
None of activity.

4.7   Long range forecasts (LRF) *(30 days up to two years)*

4.7.1   In operation
None of activity.

4.7.2   Research performed in this field
None of activity.

4.7.2   Operationally available EPS LRF products
None of activity.

5.   Verification of prognostic products

5.1   "[annual verification summary to be inserted here]"
Use contingency table for verification quantitative precipitation Forecast (predict rainfall 24hrs) thresholds of 10mm. Percent correct (PC), Hits rate andFalse Alarms Rate (FAR) of quantitative precipitation
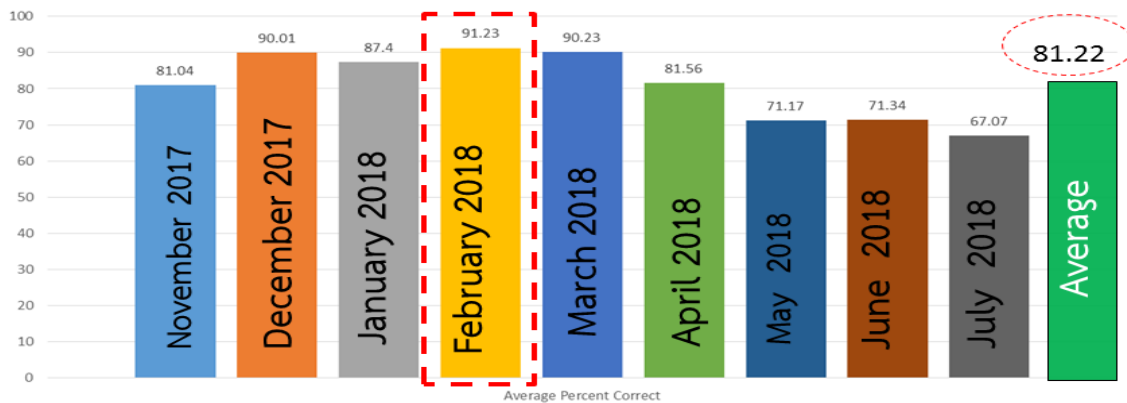Forecast

Figure 2 Percent correct (PC) forecast total precipitation 24 hrs.

5.2 Research performed in this field
"[Summary of research and development efforts in the area]"
> None of activity.

6. Plans for the future *(next 4 years)*

6.1 Development of the GDPFS

6.1.1 "[major changes in the Operational DPFS which are expected in the next year]"
> 1. Assimilate observation data from TMD Automatic Weather Stations into operational WRF-GSI model.

6.1.2 "[major changes in the Operational DPFS which are envisaged within the next 4 years]"
> 1. Using the data from exist GTS system as initial data.
> 2. Research the ensemble prediction system.
> 3. Perform HPC project phase II to extend model resolution and supporting ensemble data assimilation system.

6.2 Planned research Activities in NWP, Nowcasting, Long-range Forecasting and Specialized Numerical Predictions
"[Summary of planned research and development efforts in NWP, Nowcasting, LRF and Specialized Numerical Predictions for the next 4 years]"

6.2.1 Planned Research Activities in NWP
> None of activity.

6.2.2 Planned Research Activities in Nowcasting
> None of activity.

6.2.3 Planned Research Activities in Long-range Forecasting
> None of activity.

6.2.4 Planned Research Activities in Specialized Numerical Predictions
> None of activity.

7. References
"[information on where more detailed descriptions of different components of the DPFS can be found]"
 (Indicate related Internet Web sites also)
Met Office. Scientific & Technical Papers: Unified Model & Observation Processing System.Bracknell, 1998.
http://www.tmd.go.th/
http://www.dtcenter.org/
http://www.cawcr.gov.au/projects/verification/
http://www2.mmm.ucar.edu/