JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2015

MYANMAR, DEPARTMENT OF METEROLOGICAL AND HYDROLOGY

1. Summary of highlights

Department of Meteorology and Hydrology (DMH) have been running the Weather Research and Forecasting (WRF) Model version 3.7 was made fully operational in March 2012. Now, Weather Research and Forecast (WRF) Model is running and generate daily output in 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. DMH have plan to do the data assimilation system after installation of Radar and (30) Automatic weather observation stations.

2. Equipments in use

There are five computer systems for NWP purpose. One is CPU - Intel® Xeon ® E5-4607 @ 2.20GHZ machines, four are CPU - Intel® Xeon ® E-3430 @ 2.40GHZ a System with 296.8 GB storage capacity consisting with the same specifications being used for operational NWP. The specifications are given in Table 1.

Data and Products from GTS in use

3.1 Observations
The total number of observations processing is available in 24 hour period

RA II Region

- SYNOP is 175.
- TTAA is 47.

Myanmar Region

- SYNOP is 51.

Table 1: Hardware and Software Specifications for WRF Model

Hardware specifications
Intel® Xeon® CPU E5-4607 @ 2.20GHZ ,   (19 processors) Intel® Xeon ® CPU E-3430 @ 2.40GHZ,   (4 processors)
31.3 GB memory 2.9 GB memory
TP-link Interconnect
System with 1856.7 GB storage capacity consisting System with 296.8 GB storage capacity consisting
Operating system
Red Hat Enterprise Linux Server
Compilers
Intel C++ 10.0 Compiler Professional Edition
Intel FORTRAN 10.0 Compiler Professional Edition
Post-processing utilities
GrADS Version 2.1.0
NCAR GRAPHICS version 6.3.0
NWP models
WRF version 3.7.1

Diana Tool technical details

Combined visualisation of:	• Field data from the NWP models • Observations (synops, ships etc) • Satellite images (still, animation) • Radar composite images (still, animation)
Separate viewers available for:	• Vertical prognosis from NWP data/radio soundings • Vertical cross sections from NWP data • Time series plots
Editing tools:	• Production/editing/drawing tools for issuing surface analysis charts, prognosis charts, significant weather charts etc
Other features:	• Highly customizable with setup files • Batch version for non-interactive production available
Programming environment:	• Linux (At Met Norway we are at the moment using Ubuntu 12.04) • C++ (g++) • Qt 4 for GUI and window handling, platform independent • Mesa3D OpenGL and native drivers for hardware-accelerated 2D graphics • SQL databases (including PostgreSQL and MySQL) • A few other Free and Open Source libraries (fonts etc.) • Connections between applications by Qt QSocket
Formats:	• Field format: NetCDF (CF-1.1 compliant), OpenDAP, Grib1&2, WDB • In-house Met Norway formats • Observation format: BUFR (rdb and WMO

	standard templates), Ascii
	• Satellite and radar images: geotiff, mitiff (tiff with geographical header), HDF5
	• Maps: shape, Ascii

3. Forecasting system

3.1 System run schedule and forecasting ranges

One run per day at 00UTC with forecast range of +72 hours for the deterministic forecasts of WRF V3.7.1. Diana Tools System is running with a forecast range of +72 hours forecast for visualization. The forecast intervals are hourly, 3-hourly, 12-hourly and 24-hourly.

3.2 Medium range forecasting system (4 – 10 days)

For official forecasting purposes, European Centre for Medium-Range Weather Forecasts (ECMWF), Japan Meteorological Agency (JMA), UK Met Office (UKMO), NWP output are used. Data are available on password-protected websites. No research is performed in this field.

3.3 Short-range forecasting system (0 – 72 hours)

3.3.1 Model

3.3.1.1 In operation

- There are three operational NWP models which are the the **WRFV3.7.1** and Diana Tools. The WRF models are configured to run on 1 domains. The model domains are configured with a resolution of 30-km.

- The horizontal domain coverage of the WRF models for the domain is from 80°E – 102°E and 6°N – 30°NThe time step used for the 60 seconds for the 30-km domains. The Diana Tools for the domain is from 65°E – 130°E and 5°N – 40°N.

- The WRF models use the initial and boundary data from the National Centers for Environmental Prediction Global Forecast System (NCEP GFS) at a resolution of 0.5° X 0.5° with an auxiliary initial and boundary data from JMA GSM at a resolution of 0.5° X 0.5°. Diana tool uses the initial and boundary data from the 25-km resolution ECMWF data from Norwegian Meteorological Institute (Met.no).

3.3.2 Operational available NWP products

3.3.2.1 For WRF

- Temperature: 2m, Tmax, Tmin
- Wind: 10m, 850hPa, 700hPa, 500hPa, 300hPa, 250hPa
- Mean Sea Level Pressure
- Relative Humidity: 1000hPa, 850hPa, 700hPa, 500hPa, 300hPa, 200hPa
- Precipitation

3.3.2.2 For WRF

- Temperature: 2m, Tmax, Tmin, Td,
- Wind: 10m, 1000hPa to 10hPa
- Mean Sea Level Pressure
- Relative Humidity: 1000hPa to 10hPa
- Precipitation
- Wave
- Vorticity
- Divergence
- Cloud information
- K-Index, BOYDEN-Index, Showalter -Index, Total-totals
- CAPE, SST, geopotential height at each Level

3.3.3 Operational techniques for application of NWP products

3.3.3.1 Diana Features

Combined visualization of

- Fields
- Satellite and radar images
- Surface observations
- Trajectories in isosurfaces
- Weather charts

Separate viewers available for

- Soundings
- Vertical cross sections
- Time series

Editing tools

- Field modification
- Drawing of fronts, weather symbols etc.

Other features

- Highly customable with setup-files
- Batch version for non-interactive production available

Diana depends on an IT infrastructure, including databases/filesystems for fields, observations and images. There are no acquisition or dissemination tools included.

3.3.3.2 WRF

NWP output visualization graphics are generated using GrADS Tools and NCAR graphics visualization software on the SGI ALTIX 4700 SMP system. The WRF post processor and WRF output to GRIB1 format.

3.3.3.3 Research performed in this field

Table 2.   Experimental Design

Sr.No	PBL Schemes	Cu_physis	Mp_physis
1	YSU	Kain_fritsch	Ferrier(New Eta)
2	YSU	Betts-Miller-Janjic	Ferrier(New Eta)
3	YSU	Grell-Devenyi	Ferrier(New Eta)
4	YSU	Kain_fritsch	Kessler

Table 3.   Summary of WRF Model configuration

Sr.No	Model	WRF3.4.1
1	Number of domain	One
2	Central Point of Domain	20 ºN,95 ºE
3	Horizontal grid size	9km
4	Number of Grid points (with SST Data)	X-direction 200 (86 ºE,104 ºE) Y-direction250 (9 ºN,30 ºN)
5	Number of Grid points (without SST Data)	X-direction 250 (85 ºE,105 ºE) Y-direction250 (9 ºN,30 ºN)
6	Number of Grid points (without SST Data)	X-direction 200 (87.5 ºE,104.5 ºE) Y-direction150 (13 ºN,25.2 ºN)
6	Number of Grid points (without SST Data)	X-direction 110 (91 ºE,101 ºE) Y-direction120 (15 ºN,24 ºN)
7	Map projection	Mercator
8	Initial conditions	3-dimensional real data (NCEP)
9	Radiation Scheme	RRTM scheme long wave radiation Dudhia scheme (ptop > 50 mb) short wave radiation
10	Surface Layer parameterization	Noah Land-surface scheme
11	PBL Scheme	YSU scheme, use

		(sf_sfclay_physics=1) Yonsei University
12	Cumulus Schemes	1.Kain-Fritsch 2.Betts-Miller-Janjic 3.Grell-Devenyi
13	Microphysics Scheme	1.Kessler 5.Eta (Ferrier)

4   **Plans for the future (*next 5 years*)**

- To run the operational NWP models up to 9-km or higher resolution

- To initialize the NWP models with the high resolution Lateral Boundary condition data from Shanghai, China.

- To assimilate Doppler radar reflectivity and AWOS data into the WRF non-hydrostatic version on operational mode

- To create a multi-model ensemble prediction system