JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR "[*2007*]"

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1. Summary of highlights

No major hardware and software changes were done during the year. Upon verification, explicit moisture physics of simple ice was used in place of the previously used warm rain scheme within the MM5 framework.

2. Equipment in use

The High Performance Computing Cluster consist of the following main components

- Two units of Dual Processor Head Management
- Nine units of Quad Processor Compute Node
- Two units of High Capacity Storage (2.4Tb and 8Tb) with raid 6 configuration
- One unit of Gigabit Ethernet Switch
- One KVM (Keyboard, Video and Mouse) Switch

The two head management nodes are Transport GX28 servers and the nine compute nodes are Transport TX48 servers. Processors used in the Head Management and Compute nodes are single core 2.2GHz AMD Opteron.

3. Data and Products from GTS in use

- SYNOP
- SHIP
- METAR
- SATOB
- SOUND

4. Forecasting system

4.1 System run schedule and forecast ranges

Run schedule consists of twice a day model runs at 00UTC and 12UTC. Forecast ranges are hourly, 3 hourly, 6 hourly, 12 hourly and 24 hourly up to a period of 72 hours.

4.2 Medium range forecasting system (4-10 days)

Medium and extended range forecasting are mainly done using available global models combined with climatological resources.

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

4.3.1 Data assimilation, objective analysis and initialization

4.3.1.1 Operational

- Method of Analysis: 3D-VAR
- Analyzed Variable: wind, temperature, relative humidity and pressure
- Vertical Levels: 1000hPa, 850ha, 700hPa, 500hPa, 400hPa, 300hPa, 250hPa, 200hPa

4.3.2 Model

4.3.2.1 Operational

- Basic Equations: Primitive Equation System
- Independent Variable: Horizontal Wind, Pressure, Temperature, Relative Humidity and Geopotential Height
- Numerical Technique: Non Hydrostatic, Finite Difference Second Order horizontal and vertical discretization, Second Order Leapfrog time-step scheme though some terms like the sound-wave terms and planetary boundary layer tendencies are handled using a time splitting scheme.
- Horizontal Resolution: Larger domain is 36km and smaller domain is 12km. Larger domain consists of 154 by 154 grid points and the smaller domain consists of 220 by 130 grid points. 23 vertical levels.
- Time step: 108 seconds
- Shallow convection
- Radiation: Accounts for long wave and short wave interactions with explicit cloud and clear air
- Atmospheric Moisture: Predicts cloud and rain water fields explicitly. Ice phase processes also considered.
- Cumulus Parameterization: The basis for the larger domain is moisture convergence, tending to produce more convective precipitation compared to resolved scale precipitation and moistening dependent on relative humidity. The basis for the smaller domain is rate of destabilization or quasi-equilibrium, single-cloud scheme with updraft and downdraft fluxes, tends to allow a balance between resolved scale precipitation and convective precipitation and considers shear effects on precipitation.

4.3.2.2 Research performed in this field

- Testing of different cumulus parameterization schemes, different moisture schemes and time steps while simultaneously increasing the horizontal resolution up to 4km.

4.3.3 Operationally available NWP products

- Temperature: 2m, 1000hPa, 850hPa, 700hPa, 500hPa, 200hPa
- Wind: 10m, 1000hPa, 850hPa, 700hPa, 500hPa, 200hPa
- Mean Sea Level Pressure
- Vorticity: 1000hPa, 850hPa, 700hPa, 500hPa, 200hPa
- Relative Vorticity: 1000hPa, 850hPa, 700hPa, 500hPa, 200hPa
- Geopotential Height
- Precipitation

4.3.4 Operational techniques for application of NWP products

4.3.4.1 Operational

- Short range forecasts from the Main Forecast Office and Regional Forecast Office are based upon direct operational model output together with output of other global models.

5. Verification of prognostic products

The Root Mean Square wind vector error and predictability skill score for the 850hPa, 500hPa and 200hPa levels done 4 times a year corresponding to different weather seasons in the region of South East Asia.

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

- Improving hardware and software technology in regard to the total system is to be done. Two SGI Altix 4700 systems have been planned to run operationally to replace the presently operational Numerical Weather Forecasting system. 128 dual core Intel Itanium Series 9000 processors using blade technology and Numalink interconnect which has extremely low latency are to be used for each system with a possible maximum performance of 800GFlops.
- The two systems will be used to run the MM5 (Mesoscale Model) and WRF (Weather Research and Forecasting) respectively using 3domains with the third domain having the finest resolution of 4km

6.1.2 Major changes in the Operational DPFS which are envisaged within the next 4 years

- Increasing the finest resolution of both the systems above to 1km.
- In addition to the Short Range Weather Forecasting (3 days) being done, extending the forecast period to Medium Range Weather Forecasting (7 days).
- Using 4DVAR to do data assimilation

6.2 Planned research Activities in NWP, Nowcasting and Long-range Forecasting

6.2.1 Planned Research Activities in NWP

- Testing out the various physics schemes available in both MM5 and WRF to determine the suitable one to be used especially at the fine 12km and 4km resolution domains.
- To improve the 3DVAR data assimilation scheme by integrating more observations like the ATOVS data.
- To test in regard to running the models for Medium Range Weather Forecasting
- To test in regard to running the models up to 1km resolution
- Investigating various severe whether events by doing simulations using reanalysis lateral boundary conditions from NCEP and JMA especially.
- Testing the usage of lateral boundary data from JMA and the Australian Bureau of Meteorology for operational Numerical Weather Prediction purposes
- Conducting data assimilation using 4DVAR