WWW TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS), AND THE ANNUAL NUMERICAL WEATHER PREDICTION (NWP) PROGRESS REPORT FOR THE YEAR 2005

Hellenic National Meteorological Service (HNMS)
GREECE

1. Summary of highlights

Migration of the local weather and wave prediction model runs to two high-performance computing systems (HP based on Itanium-type and IBM based on Power4-type processors). A high level visualization tool (Visual Weather) as well as data storage systems and software (MARS and Web-MARS) are in the process of being operationally integrated. Based on the experience from the Athens Olympic Games, WEB-based technology for the meteorological support of events of relevant significance has been developed.

2. Equipment in use at the center

- **Message Switching System (MSS)**
  Servers 2 x RX2600 2 x Itanium 1,3 Ghz
  Gb RAM 2 x 36 Gb HD, 1Gb 2 x FC Connection
  Cluster configuration Service Guard
  O.S. Linux Red Hat A.S. 3.0
- **Preprocessing**
  Servers 2 x RX 2600 2 x Itanium 1,3 Ghz
  4 Gb RAM 2 x 36 Gb HD, 1Gb 2 x FC Connection
  Cluster configuration Service Guard
  O.S. Linux Red Hat A.S. 3.0
- **Web Mars Intranet**
  Servers 2 x RX 2600 2 x Itanium 1,3 Ghz
  4 Gb RAM 2 x 36 Gb HD, 1Gb 2 x FC Connection
  Cluster configuration Service Guard
  O.S. Linux Red Hat A.S. 3.0
- **MARS**
  Servers 2 x RX 5670 4 x Itanium 1,3 Ghz
  16 Gb RAM 2 x 36 Gb HD, 1Gb 2 x FC Connection
  Cluster configuration Service Guard
  O.S. HPUX 11.22
- **Graphical Servers**
  Servers 2 x RX 5670 4 x Itanium 1,3 Ghz
  16 Gb RAM 2 x 36 Gb HD, 1Gb 2 x FC Connection
  Cluster configuration Service Guard
  O.S. HPUX 11.22
- **MSG Processing**
  5 x Intel Based Servers
  DELL.NAS 1Tb
  O.S. Linux Red Hat 9.0

- **Radar Processing**
  2 x Intel Based Servers
  O.S. Linux Red Hat 9.0
  SuSe Linux
- **Web Server Farm**
  24 Servers Intel Based Xeon
  1 Gb RAM 1 x 36 Gb HD
  O.S. Linux Red Hat 9.0
  2 x SUN480
  4 Gb RAM 2x36 Gb HD
  NAS Storage
  80 Gb HD
  Sun Cluster 3.0
  4 X SUN V120
- **High Performance Facilites**
  - **Current System HP Cluster**
    - **Computer Nodes**
      28 x RX2600 2 CPUs Itanium 1.3 Ghz
      4 Gb RAM
      2 x 36 Gb Internal Disks (Mirroring)
      1 Myrinet Card
      O.S. HPUX
    - **I/O Nodes**
      2 x RX2600 2 CPUs Itanium 1.3 Ghz
      4 Gb RAM
      2 x 36 Gb Internal Disks (Mirroring)
      1 Myrinet Card
      2 x Gb Copper Ports
      2 x Fiber Channel Cards
      O.S. HPUX
    - **Parallel Environment**
      MPI
      HP Cluster Pack
    - **Interconnection Switch**
      Myrinet 32 Ports
    - **Control Nodes**
      1 x RX2600 2 CPUs Itanium 1.3 Ghz
      4 Gb RAM
      3 x 36 Gb Internal Disks
      1 Myrinet Card
      2 x Gb Copper Ports
      2 x Fiber Channel Cards
      O.S. HPUX
  - **New System IBM Cluster 1600**
    - **28 Compute Nodes 7039-651 pSeries 655**
      8-way 1.7 Gh power 4+
      16 Gb Memory
      2 Link Switch Interface

- **2 I/O – Front - End Compute Nodes 7039-651 pSeries 655**
  8-way 1.7 Gh power 4+
  16 Gb Memory
  2 Link Switch Interface
  Shared 7040-61D I/O drawer with 1 Gb Ethernet/Server and
  2 FC/Server
- **Disk SubSystem**
  1 FASt600 Server
  14 146.8 Gb Disks
  2 links FC Switches
- **6 Hight Performance Swithes (HPS) 7045-SW4 Federation Switches**
- **Total 240 Power 4+ Processors**
- **Parallel Environment**
  MPI
  GPFS V2.1.0
  Loadleveler V3.1
- **Operating System**
  AIX 5L V5.2

3. **Data and Products from GTS in use along with their average number of messages by day**
   SYNOP 14541
   TEMP 294
   SHIP 1207
   GRID from DWD 942
   GRIB aero from EXETER 9408
   GRIB from ECMWF 10160
   Aeronautical Charts from Exeter (T4 code) 208

4. **Data input system.**
   The system is fully automated.

5. **Quality control system**

There is no quality control system in use regarding outgoing data to the GTS, except for formal structure. The format of all coded reports is checked and if is necessary and possible corrected. Surface and upper air reports are checked for internal consistency before storing them into a database.

6. **Monitoring of the observing system.**

Surface observations and upper air observations are monitored quantitatively only on the national level.

7. Forecasting System

7.1 System run schedule

Following a strong commitment towards a forecasting system of high standards as it stems from the raising need to the quality of meteorological products for the highly complex bas-relief of Greece, the Hellenic National Meteorological Service (HNMS) follows up-to-date developments for the three local numerical weather prediction models that run in operational mode using local computational resources as well as those of the European Center of Medium Range Forecasts (ECMWF).

The first Local Model is a modified version of the Yugoslavian ETA model (hydrostatic) that was set in operation in 1995 under the project "SKIRON" in collaboration with the University of Athens. It runs twice a day with a prognostic range of 72 hours.

Next, is the Non-Hydrostatic Local Model (LM) that has been developed by the German Meteorological Service (DWD). LM is in operational use since 1998 through the Consortium for Small Scale Modeling (COSMO) that includes the National Meteorological Services of Germany, Greece, Italy, Poland and Switzerland. It runs 4 times a day locally and 2 times a day using computational resources at ECMWF with a prognostic range of 48 hours. Third is the Non-Hydrostatic RAMS model that has been operationally available under the "NHREAS" project in collaboration with the University of Athens. Within this project there is also the operation of a sea-wave model (WAM) that uses the results of RAMS model. RAMS and WAM run once a day with a prognostic range of 36 hours.

7.2 Medium range forecasting system

As a founding member of ECMWF, HNMS makes full operational use of all the ECMWF meteorological products both for its operational mesoscale weather forecasting as well as for data assimilation, objective analysis and initialization of the local models in use.

7.3 Short range forecasting

7.3.1 Data assimilation, objective analysis and initialization

Regarding Local Models, data assimilation for the LM is based on 6-hour cycle Nudging Analysis Scheme developed at DWD. Correspondingly, for RAMS, the Local Analysis and Prediction Section (LAPS) is used. SYNOP, SHIP and TEMP type of messages are currently assimilated.

7.3.3 Numerical weather prediction products

Numerical Weather Prediction Model ETA (Hydrostatic)	
Time prediction range and step	Initialization from ECMWF analysis of 00 UTC and 12 UTC with prediction range of 72 hours from analysis hour. Data production every 3 prediction hours.
Computer system	HP cluster based on Itanium Processor
Surface data parameters	Mean Sea Level Pressure Wind 10m Temperature 2m Specific Humidity Precipitation

Upper-level data parameters	Geopotential height Temperature Wind Specific Humidity
Vertical Resolution (hPa)	100, 150, 200, 250, 300, 400, 500, 700, 850, 1000 and Surface
Horizontal Resolution	0.1^{o}X0.1^{o} in rotated grid with geographical center (22.0, 39.5), and width 16 degrees in longitude and 12 degrees in latitude.
Covered area	Part of Italy, Adriatic Sea, Balkan peninsula and west part of Asia Minor
Results form	Binary which are converted to ASCII and GRIB

Numerical Weather Prediction Model LM (Non-Hydrostatic)	
Time prediction range and step	***Locally (4 runs a day)***: Initialization from the Global Model (GME) of DWD based on analysis of 00 UTC and 12 UTC. Data assimilation is included every six hours by using the Nudging Analysis scheme developed at DWD. The prognostic range is 48 hours and data production is available every prediction hour. ***ECMWF (2 runs a day)***: Initialization from the Global Model of ECMWF based on analysis of 12 UTC and from the Global Model (GME) of DWD based on analysis of 00 UTC. The prognostic range is 48 hours and data production is available every 3 prediction hours.
Computer system	***Locally***: HP Itanium-based system ***ECMWF***: IBM Power4-based system
Surface data parameters	Mean Sea Level Pressure Wind 10m Maximum wind 10 m Temperature 2m Dew point temperature 2m Maximum temperature 2m Minimum temperature 2m Total cloud cover High cloud cover (0-400 hPa) Medium cloud cover (400-800 hPa) Low cloud cover (800 hPa-Surface) Specific humidity Precipitation Convective precipitation Snowfall

Upper-level data parameters	Geopotential height Temperature Omega parameter of vertical motion Wind Specific Humidity
Vertical Resolution (hPa)	200, 250, 300, 400, 500, 600, 700, 850, 950, 1000
Horizontal Resolution	0.0625^{o}X0.0625^{o} in rotated grid with North Pole (32.5, 170.9), and width 12 degrees in longitude and 14 degrees in latitude.
Covered area	Part of Italy, Adriatic Sea, Balkan pen-insula and west part of Asia Minor
Results form	GRIB

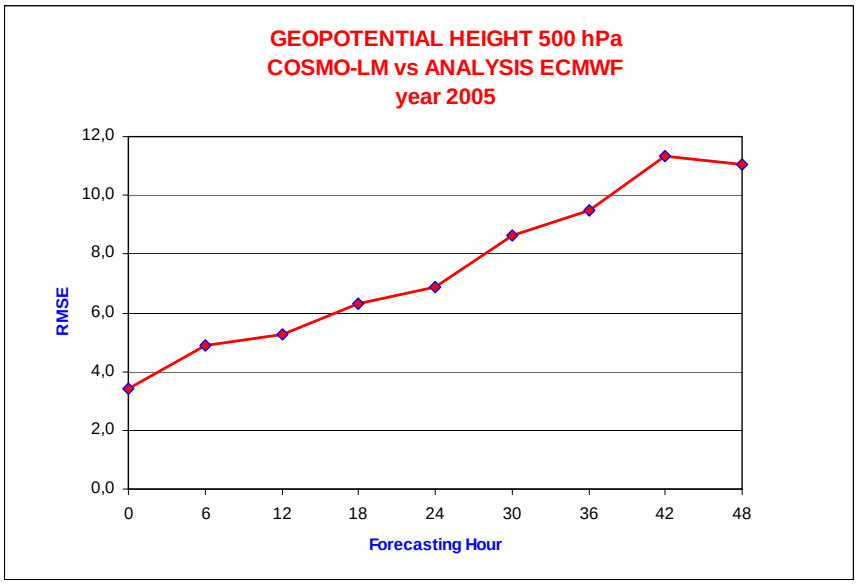
Numerical Weather Prediction Model RAMS (Non-Hydrostatic) & WAM	
Time prediction range and step	Initialization from ECMWF analysis of 12 UTC and corrected with LAPS. Prediction range of 36 hours from analysis hour. Data are displayed for every prediction hour.
Computer system	HP cluster based on Itanium Processor
Surface data parameters	Mean Sea Level Pressure Wind 10m Temperature 2m Total cloud cover Precipitation Wave height and direction (WAM)
Upper-level data parameters	Geopotential height Temperature Wind Relative humidity Specific humidity
Vertical Resolution (hPa)	100, 150, 200, 250, 300, 400, 500, 700, 850, 1000
Horizontal Resolution (Three nested Grids)	Grid 1: 48 Km Grid 2: 12 Km Grid 3: 3 Km
Covered area	Grid 1: Europe, North Africa, Turkey, Middle East, Black Sea Grid 2: Greece, Asia Minor, Albania, FYROM and South Bulgaria Grid 3: Central Aegean, East Sterea Hellas, East Peloponnese and South Evia.
Results form	Packed ASCII, GRIB

7.2.4 Operational techniques for application of NWP products

The 2-meter temperatures forecasted from the Local Models are used to derive daily maximum and minimum temperatures via the method of Kalman filtering.

8. Verification of prognostic products

A set of algorithms is developed to allow the comprehensive verification of surface and upper-air point forecasts in a systematic fashion. The variables under consideration include 2m temperature, 2m dew point temperature, 10m wind, precipitation, msl pressure, as well as upper air geopotential height, temperature and wind speed.

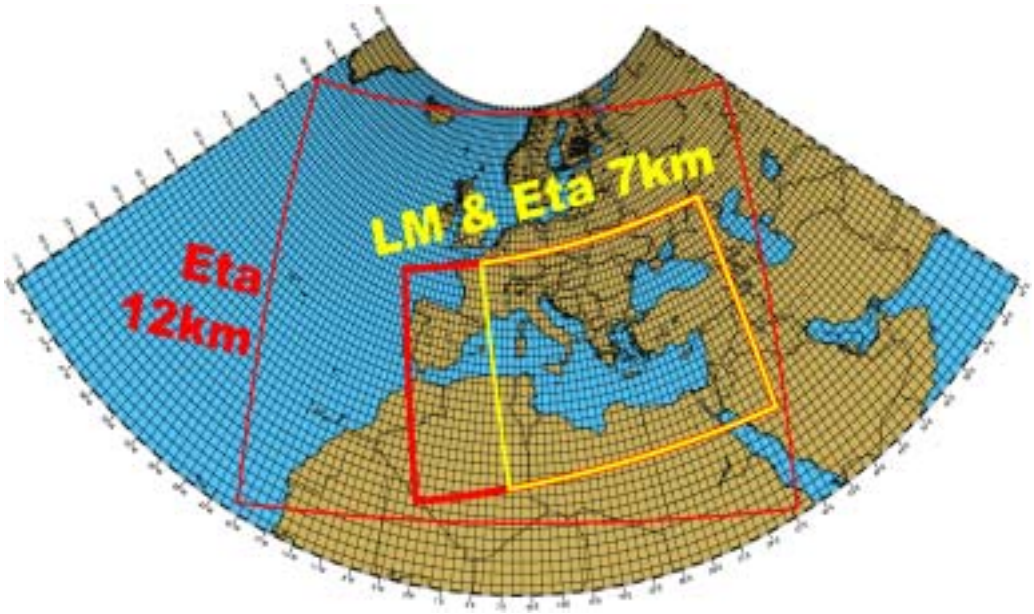


9. Plans for the future.

9.1 Development of GDPFS.

A new IBM High Performance Computing System has been recently acquired and installed at HNMS. The Local Numerical Weather Prediction Models are in the process of installation and test mode runs. Within this new operational framework, the Local Models are estimated to run for extended prognostic ranges as well as significantly larger domains with higher horizontal and vertical resolution.

Current operational domains of ETA and LM.



Future operational domains of ETA and LM

9.2 Research activities in NWP.

The research activities at HNMS are focused in the implementation of statistical methods in order to improve the quality of the forecasted NWP products. There is close collaboration within COSMO community towards the continuous development of LM. In particular, there is contribution to the development of a new version of the model (LM-Z) that uses a numerical scheme based explicitly on height coordinates instead of the terrain following coordinates standard approach. Also the sub-grid scale processes, especially for cloudiness, are investigated. The implementation of nesting techniques is in progress towards the effort of very high resolution NWP (~2km).

Additional issues regarding numerical weather prediction and data manipulation for research purposes are also addressed in collaboration with Greek Universities as well as National Research Organizations.

10. References

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2. "Weather support for Athens Olympic Games 2004 using web-based technology", Alexiou I., Chatziapostolou E., Kamperakis N., Linardi A., Mavroudis A., Mouhassiri E., Pappa G, Sopotinou A., ECMWF Tenth Workshop on Meteorological Operational Systems, ECMWF, 14-18 November 2005, http://www.ecmwf.int/newsevents/meetings/workshops/2005/MOS_10/presentations.
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4. "A Z-Coordinate Version of the Nonhydrostatic Model LM", J. Steppeler, H.-W. Bitzer, S. Janjic, U. Schättler, P. Prohl, J. Parfiniewicz, U. Damrath and E. Avgoustoglou, COSMO Newsletter Nr. 5, April 2005 p. 149-150.