Annual WWW Technical Progress Report

On the Global Data Processing and Forecasting System 2004

ROMANIA

1. Summary of highlights

During 2004 there were no major changes concerning the used equipment for operational purposes.

A Linux cluster (6 nodes with 2 Intel XEON processors each) was entirely designed and built in our institute. The ALADIN and LM (Local Model developed by COSMO consortium) were implemented and tested for high-resolution (up to 2.5 km) simulations.

Since at the end of 2003, Romania became an associate member of ECMWF, more complete information is available with benefits especially for medium range forecasts.

2. Equipment in use at the Centre

SUN platforms (for the LAMs and specialized models integrations: E4500-8 processors, E3500 –4 processors, Blade1000 – 1 processor, DEC-ALPHA 500), 4 SUN-ULTRA (2 processors) for visualization system, HP servers (Message Switching System, database), Linux servers (FTP, mail, web, DNS).

3. Data and products from GTS in use

Average number of messages, by day:

SYNOP:	5300
SHIP:	1000
TEMP:	1300
PILOT:	24
METAR:	6600
AIREP:	66
AMDAR:	1030
SPECI:	3700
TAF:	6370
AIRMET:	110
SIGMET:	330

Daily statistics of products:

GRID

EGRR (00,12):	52
KWBC(00.12):	90
ECMF(12):	50

GRIB:

ECMF (00,12):	1152
EDZW (00,12):	904
EGRR (00, 06, 12, 18)	7776
LFPW (00,12):	1530

FAX(T4 code):
        EGRR: 397
        EDZW: 84
        LFPW: 213

4. Data input system

Automated.

5. Quality control system

The quality control system for the incoming data concerns the format checking of the reports.

Surface observation data quality from the national network is checked trough the Surface Observation Processing (SOP) application, implemented within the SIMIN (National Integrated Meteorological System) Project which includes message structure checking and correlations between measured and observed data.

6. Monitoring of he observing system

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

7. Forecasting system

For short range forecast limited area ALADIN, HRM and MM5 models are daily integrated.

7.1 System run schedule and forecast ranges

7.2 Medium range forecast system

No medium range NWP forecasts are carried out in ANM.

7.2.4 Operational techniques for application of NWP products
The ECMWF 10 days forecast and ensemble prediction are operationally used The Nex-REAP visualization system automatically generates products for every 6 hour forecast. The statistical adaptation procedure is applied for minimum and maximum temperature, wind, cloudiness and precipitation for the surface observation stations in Romania up to 7 day. The results are automatically plotted on maps.

7.3 Short-range forecasting system

7.3.1 ALADIN-Romania model
7.3.1.1 Data assimilation, analysis and initialization
The ALADIN-Romania is run operational in dynamical adaptation mode; the initial state is obtained by interpolation of the ARPEGE global model analysis and digital filter initialization.
7.3.1.2 Model
The operational ALADIN-Romania is a version of the ALADIN model for a region covering Romania.

The main characteristics of ALADIN-Romania are:
- Domain: 100 x 100 points horizontally and 41 levels on vertical
- Horizontal resolution: 10 km (Lambert conformal projection)

- Two integrations per day (00,12) up to 48 hours
- Boundary condition: from the ARPEGE global model, every 6 hours
- Post-processed products every 3 hours

7.3.1.3 Numerical weather prediction products
- 2 D fields: mean sea level pressure, surface and 2m temperature, minimum and maximum 2m temperature, 10m wind, convective and large scale precipitation (water and snow), cloudiness (total, low, medium and high), wind gust, CAPE, temperature and pressure of ICAO tropopause, wind and temperature at maximum wind level.
- 3 D fields: geopotential, relative and specific humidity, temperature, pseudo-potential temperature, wind components, vertical velocity at pressure levels (1000, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 200, 100 hPa)

7.3.1.4 Operational techniques for application of NWP products
- Statistical models (MOS, Kalman filter) are applied to the direct model output for minimum and maximum temperature, wind cloudiness and precipitations
- Computation of stability indexes for each grid point
- Automatic generation of pseudo-TEMP messages
- Automatic generation of meteograms

7.3.2 HRM

7.3.2.1 Data assimilation, analysis and initialization
HRM (High resolution Regional Model, developed by the German Meteorological Service) is run operationally in dynamic adaptation mode, the initial state is obtained by interpolation of the GME analysis followed by a normal mode initialization.

7.3.2.2 Model
The main characteristics of the model implementation
- Domain: 41 x 37 points, rotated latitude/longitude grid, 20 vertical levels
- Horizontal resolution: 0.25° (~ 20 km);
- Two integration per day (00, 12) up 78 hours
- Split semi-implicit time stepping: Δt=300 s
- Boundary conditions: from GME, every 3 hours
- Post-processed products: every 3 hours

7.3.2.3 Numerical weather prediction products
- 2D: mean sea level pressure, 2m temperature, 10m wind, precipitation
- 3D: geopotential, temperature, relative humidity, wind, vertical velocity at 5 pressure levels (1000, 925, 850, 700, 500 hPa).

7.3.3 MM5

7.3.3.1 Data assimilation, analysis and initialization
The first-guess is enhanced by wind, temperature, dew-point and sea-level pressure observations at pressure levels, without vertical and time interpolation to additional levels/time periods.

7.3.3.2 Model
The main characteristics of the model implementation
- Domain: 103 x 79 (polar stereographic projection), 25 levels
- Horizontal resolution: 15 km
- Four integration per day (00, 06, 12, 18) up 24 hour
- Boundary conditions: from AVN, every 6 hours;
- Post-processed products: every 3 hours

7.3.3.3 Numerical weather prediction products
- 2D: mean sea level pressure, 2m temperature, 10m wind, precipitation

- 3D: geopotential, temperature, relative humidity, wind at pressure levels (1000, 925, 900, 850, 800, 750, 700, 650, 600, 550, 500, 450, 400, 350, 300, 350, 300, 250, 200, 150, 100 hPa)

7.4 Specialized forecast
   7.4.1   Sea wave forecast
      7.4.1.1 VAGROM Model
         The VAGROM wave model is a version of the French VAGUES wave model adapted for the Black Sea. It is run operational for two domains: the whole basin of the Black Sea and a coastal zone in the western part of the Black Sea.
         7.4.1.1.1   Data assimilation, analysis and initialization
            The initial state is the 24 hours forecast of the wave spectrum from the previous day.
         7.4.1.1.2   Model
            The main characteristics of VAGROM model for the whole basin of the Black Sea are:
            - Domain: 60 x 28 points
            - Horizontal resolution: 0.25°x0.25° latitude-longitude
            - Spectral discretization: 18 directions of propagation and 23 frequencies
            - One integration per day up to 48 hours
            - Input data: 10 m wind field from the NWP global model Arpege every 6 hours
            - Post-processed products every 6 hours

            The main characteristics of VAGROM model for the coastal zone are:
            - Domain: 49 x 61 points
            - Horizontal resolution: 5' x 5' latitude-longitude
            - Spectral discretization: 18 directions of propagation and 23 frequencies
            - One integration per day up to 48 hours
            - Input data: 10 m wind field from the LAM model Aladin-Romania every 3 hours
            - Boundary condition: wave spectrum from the whole basin integration, every time step
            - Post-processed products every 6 hours
         7.4.1.1.3   Numerical weather prediction products
            - 2D wave spectrum
            - 2D integrated parameters for total wave, wind-sea, primary, secondary and total swell: significant wave height, mean direction of propagation and mean period.
      7.4.1.2 WAM Model
         7.4.1.2.1   Data assimilation, analysis and initialization
            The WAM wave model is run operationally, the initial state is the 24 hours forecast of the wave spectrum from the previous day.
         7.4.1.2.2   Model
            - Domain: 60 x 28 points
            - Horizontal resolution: 0.25°x0.25°latitude-longitude
            - Spectral discretization: 12 directions of propagation and 24 frequencies
            - One integration per day up to 48 hours
            - Input data: 10 m wind field from the NWP global model Arpege every 6 hours
            - Post-processed products every 6 hours

7.4.1.2.3 Numerical weather prediction products
- 2D wave spectrum
- 2D integrated parameters for total wave, wind-sea and total swell: significant wave height, mean direction of propagation and mean frequency

7.4.2 Pollution transport and dispersion
7.4.2.1 MEDIA model
MEDIA model is a 3D Eulerian French model used in forecast of the transport and dispersion of the atmospheric pollutant. It is coupled with the Romanian ALADIN model and runs once a day
7.4.2.1.1 Initial state
Atmospheric parameters (temperature, specific humidity, wind, convective and large scale precipitation) at surface and 9 pressure levels are obtained from the ALADIN model.
A prescribed scenario is giving the information about pollutant sources (number, position, type and amount of pollutant) with the possibility to use real time information in the accident case.
7.4.2.1.2 Model
- Crank Nickolson Galerkin technique combined with the splitting, which allows to use different numerical schemes for different physical phenomena
- geographical grid (121 x 71 points) for two domains with approximate 10 (for Romania) and 5 km (for the north-eastern part of Romania, 13 sigma levels
- boundary conditions from ALADIN every 6 and 3 hours depending on the domain
- Post-processing: each 6 respectively 3 hours
7.4.2.1.3 Numerical prediction products
- distribution of the forecast pollutant concentration

7.4.2.2 Trajectory model
The trajectory model is a French model for calculate direct and backward forecasted trajectories of a pollutant release from a source (real or fictive)

The principle of computation is based on successively horizontal, vertical and temporal interpolations of the wind forecast of the ALADIN model at 10 km resolution, in a regular latitude-longitude grid, each five minutes. The input file for the trajectory model contains, each hour the horizontal components and vertical velocity, at five pressure levels. The results are saved into files (geographical position and pressure at the trajectory height) and maps with forward and backward trajectories are generated.

7.4.2.3 INPUFF model
The INPUFF model is run daily using the HRM output and a prescribed scenario with 3 sources localized in the potential aria of nuclear and chemical pollution (Cernavoda, Kozlodui, Turnu Magurele). The results are visualized by GRADS graphical package.

7.5 Extended range forecast
A statistical model is used to forecast the anomalies with respect to the mean climatological state, on the basis of analogy principle. A score matrix is computing for 16 analogy criteria including:
- Hess Brezovschi circulation type,
- monthly average geopotential at 500 hPa and mean sea level pressure for Northern Hemisphere and Atlantic-Europe Region

- monthly average of temperature, minimum and maximum temperature, of monthly cumulated precipitation, number of precipitation days, for 32 Romanian stations
- SST anomalies for North Atlantic and Equatorial Pacific
- Quasi-biannual oscillation
- Solar activity phase
- Debits for 17 rivers

The main results consist in map of temperature and precipitation forecasted variances with respect to the climatological norm.

7.6 Long-range forecast

The seasonal forecast in Romania is not operationally.

The research on seasonal forecast in Romania with various lead-times (up to three seasons) is based on statistical methods. It refers to the analysis of the predictability of the large-scale circulation indices influencing the European climate including Romania (such as NAO index), obtaining of some predictive information related to seasonal temperature and precipitation anomalies in Romania using statistical models based on direct connection with climate anomalies in previous seasons or on analogue climate states in the past, as well as to extract the climate signal by the statistical analysis of long term climatological time series. The statistical models used are: multivariate linear models based on canonical correlation analysis (CCA), multi-field analogy approach, univariate autoregressive models (AR) and approaches based on conditional probabilities.

The methodologies consist in:
- estimation on the NAO phase using: the link between November temperature anomalies over the Central Europe and the NAO phase in the following January; the linkage between snow frequency anomalies over Asia in the warm season and the NAO phase in the next winter; estimation of winter temperature and precipitation characteristics in Romania using the significant link with the NAO phases;
- estimation of the temperature and precipitation anomalies over Romania in the next cold season using the SST anomalies over the North Atlantic in May;
- estimation of the seasonal temperature and precipitation anomalies over Romania using geopotential heights at 500 hPa (H500) over Europe in previous seasons; the most significant result was obtained for the summer temperature anomalies using the H500 anomalies in the previous autumn;
- estimation of the temperature and precipitation anomalies in Romania using a multi-field analogy approach based on a climate state vector with following components: anomalies of the air surface temperature, precipitation and geopotential height at the 500 hPa over the Atlantic-European region, and sea surface temperature over the Atlantic;
  estimation of the temperature and precipitation states (normal, below normal, above normal) for the succession of four seasons at 14 stations in Romania by integration the information obtained through various approaches

Products:
- Predicted value of standardized NAO index anomaly for the cold season (December-March);
- Predicted standardized anomalies of temperature and precipitation at 104 Romanian stations for the winter interval (December-February);
- Predicted seasonal states (normal, below normal, above normal) for temperature and precipitation for four Romanian regions with zero, 1, 2 and 3 seasons in advance.
- Predicted seasonal states (normal, below normal, above normal) for temperature and precipitation at 14 Romanian stations with zero, 1, 2 and 3 seasons in advance.

8. Verification of prognostic products

The direct output of the ALADIN model and statistical adaptation results for ALADIN, ARPEGE and ECMWF models are operationally verified against the SYNOP observations for the Romanian surface stations (~160 stations) computing statistical measures like bias and RMS.

9. Plans for the future

The main objectives for 2005 concern:
- implementation of 3D-VAR data assimilation for the ALADIN model
- improvement of the mesoscale forecast by using the non-hydrostatic version of the ALADIN model and LM at very high resolution

10. References

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