

# JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA PROCESSING AND FORECASTING SYSTEM AND NUMERICAL WEATHER PREDICTION RESEARCH ACTIVITIES FOR 2006

Country – Poland Centre – Institute of Meteorology and Water Management

## 1. Summary of highlights

The modeling suite at IMWM consists of the non-hydrostatic limited-area “Lokal-Modell” COSMO (resolution ~ 14 km, mesh size - 193 x 161 gridpoints / 35 layers) and of hydrostatic version of ALADIN model (resolution - 13.5 km, mesh size - 169 x 169 gridpoints / 31 layers). Operational configuration of the system is shown in the Fig. 1 below.

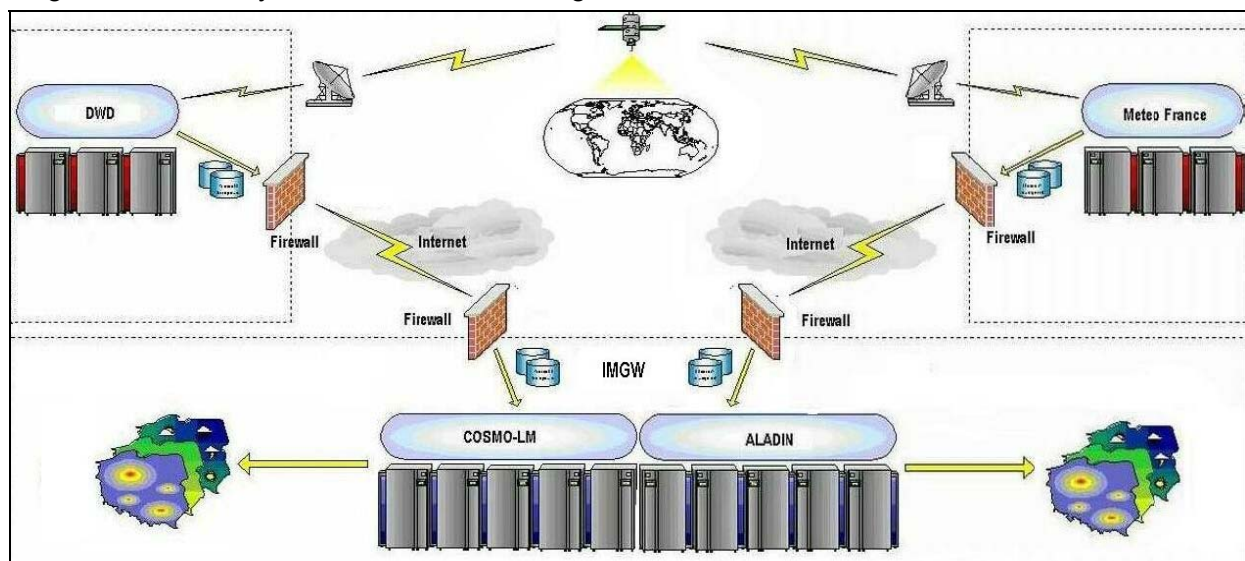


Fig. 1 Operational configuration of meteorological models at IMWM in Warsaw.

## 2. Equipment in use

SGI Origin 3800, 100CPUs peak performance 100GFlops + test machine SGI 3200 4 CPUs

## 3. Data and Products from GTS in use

For NWP – boundary and initial conditions from global models of DWD and MeteoFrance

For Forecast Offices - Almost all observational data from the GTS are used (SYNOP, SHIP, TEMP, METAR, PILOT, AIREP, AMDAR, SATEM, SATOB, GRIB, BUFR)

## 4. Forecasting system

### 4.1 System run schedule and forecast ranges

Run schedule consists of twice-a-day models run. Forecast runs with a data cut-off of approx. 4h after the main synoptic hours 00 and 12 UTC consist of 78h forecasts of COSMO and 54h forecasts of ALADIN.

## **4.2 Medium range forecasting system (4-10 days)**

Medium- and extended range forecasts up to now are prepared basing on external sources (mainly, available results of global models). They consist of decade (10-day) forecast prepared every ten days. In special situation it is required to prepare a long-term forecast (for one or three months). This is mainly done using available global models combined with climatological resources.

### **4.2.1 Data assimilation, objective analysis and initialization**

#### 4.2.1.1 In operation

n/a

#### 4.2.1.2 Research performed in this field

n/a

### **4.2.2 Model**

#### 4.2.2.1 In operation

n/a

#### 4.2.2.2 Research performed in this field

n/a

### **4.2.3 Operationally available Numerical Weather Prediction Products**

n/a

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

#### 4.2.4.1 In operation

n/a

#### 4.2.4.2 Research performed in this field

n/a

### **4.2.5 Ensemble Prediction System (EPS)**

#### 4.2.5.1 In operation

n/a

#### 4.2.5.2 Research performed in this field

n/a

#### 4.2.5.3 Operationally available EPS Products

n/a

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

### **4.3.1 Data assimilation, objective analysis and initialization**

#### 4.3.1.1 In operation

n/a

#### 4.3.1.2 Research performed in this field

In 2006 – active participation in COSMO priority project on “1D-Var” assimilation and some other projects related mainly to remote-sensing data retrieval for assimilation purposes.

### 4.3.2 Model

#### 4.3.2.1 In operation

##### a) COSMO

- Domain: Central Europe, 2700 x 2200 km, initial data time: 00 and 12 UTC, forecast range: 78h;
- Prognostic variables: p, T, u, v, w, q<sub>v</sub>, q<sub>c</sub>, TKE, vertical co-ordinate: generalized terrain-following, 35 layers, horizontal- and vertical discretization: finite-difference, second order, time integration: three-time-level, leapfrog, split explicit scheme, time step 80 s, horizontal diffusion: linear, fourth order;
- Horizontal grid: 193 x 161 points on a rotated latitude/longitude grid, mesh size 14 km; Arakawa- C grid, orography: grid-scale average based on a 1-km data set.
- Parameterizations: surface fluxes based on local roughness length and stability, free atmosphere turbulent fluxes based on a level-2.5 scheme with prognostic TKE, full cloud radiation feedback based on predicted clouds, mass flux convection scheme, grid-scale precipitation scheme with parameterised cloud, microphysics, two-layer soil model including simple vegetation and snow cover.

##### b) ALADIN

ALADIN is a limited area model being developed in a frame of ALADIN Consortium and exploited at IMWM since 1998. Initial and lateral boundary conditions are taken from ARPEGE.

- Domain: Central Europe (2270x2270km)
- Basic equations: primitive equation system
- Independent variables: horizontal wind, temperature, specific humidity and surface pressure
- Numerical technique spectral, semi-implicit semi-lagrangian scheme, DFI initialization
- Resolution & time step: 169x169 grid points, 31 levels, time step 600s, forecast range 54 hours

#### 4.3.2.2 Research performed in this field

Active participation in modeling consortia in both research and development fields

### 4.3.3 Operationally available NWP products

- u- and v- component of wind and vertical velocity at model hybrid levels and at standard pressure levels and at 10m agl.,
- temperature at levels and at 2m agl.,
- specific humidity, specific cloud water content at levels
- pressure at levels
- snow temperature
- soil temperature at 0 and at 9cm down.
- water equivalent of accumulated snow depth
- soil moisture content at 0-10 and at 10-100 cm down
- water content of interception store

- surface precipitation amount, rain, grid scale and convective
- large scale and convective snow
- dew-point temperature at 2m agl.
- minimum and maximum temperature at 2m agl.
- maximum wind velocity at 10m agl.
- drag coefficient
- transfer coefficient (sensible heat)
- total, high, medium and low cloud cover,
- albedo
- net short-wave radiation (surface and top of atmosphere)
- net long-wave radiation (surface and top of atmosphere)
- downward photosynthetic active radiant flux density
- total precipitation
- surface roughness
- momentum flux, u and v component
- sensible and latent heat flux
- convection base and top index
- top of dry convection (above MSL)
- water run-off
- pressure reduced to MSL
- cloud cover, grid scale and convective at levels

#### **4.3.4 Operational techniques for application of NWP products**

##### 4.3.4.1 In operation

Short-range forecasts from Main Forecast Office are based on direct model output (DMO) of the LM.

##### 4.3.4.2 Research performed in this field

n/a

#### **4.3.5 Ensemble Prediction System**

n/a

##### 4.3.5.2 Research performed in this field

n/a

##### 4.3.5.3 Operationally available EPS Products

n/a

#### **4.4 Nowcasting and Very Short-range Forecasting Systems (0-6 hrs)**

##### 4.4.1 Nowcasting system

###### 4.4.1.1 In operation

NIMROD (license and support from UK Meteorological Office) – a nowcasting system using satellite, radar and NWP model data to provide short-period forecasts up to six hours ahead.

#### 4.4.1.2 Research performed in this field

n/a

#### 4.4.2 Models for Very Short-range Forecasting Systems

##### 4.4.2.1 In operation

n/a

##### 4.4.2.2 Research performed in this field

n/a

### 4.5 Specialized numerical predictions

DMO is used for the production of any weather situation with the aid of LEADS (Leading Environmental Analysis and Display System) to produce single images or image sequences for Forecast Offices. Short-range forecasts of weather, wind, temperature, pressure and sensible temperature in pictorial form are automatically produced for online presentation on the Intranet and on the Internet. The state of road surfaces and – in general – on-road conditions are on-line predicted by a road weather forecast system using data based on model results and the energy balance model (SHAWrt) of the road surface, together with visibility and type of precipitation (FOGMOD\_PL). Data from COSMO runs are available for National Atomic Agency in case of nuclear emergencies and/or accidents (RODOS system – Real Time On-line Decision and Support System). The possible influence of weather on human health (“bio-meteorology”) is forecasted using COSMO results. Forecasts of QNH pressure are prepared for aviation purposes. Also, system for dispersion of pollutants is working in an operational way at IMWM, based on COSMO results processed for needs of dispersion modeling.

#### 4.5.1 Assimilation of specific data, analysis and initialization (where applicable)

##### 4.5.1.1 In operation

n/a

##### 4.5.1.2 Research performed in this field

n/a

#### 4.5.2 Specific Models

##### 4.5.2.1 In operation

SHAWrt – Simultaneous Heat and Water Transfer (road temperature) model

FOGMOD\_PL – visibility and type precipitation type model

REMOTA – Regional Model for Atmospheric Transport of pollutants

QNH – calculations of QNH pressure for aviation.

##### 4.5.2.2 Research performed in this field

Further development of SHAWrt/FOGMOD\_PL based on Adaptive Regression Method; development of dispersion modeling in the frame of REMOTA modeling system.

#### 4.5.3 Specific products operationally available

- road temperature and possibility of occurrence of “black ice”

- visibility, precipitation type
- depth of snow cover
- forecasts and diagnoses of common pollutants' concentration and deposition patterns

#### **4.6 Extended range forecasts (ERF) (10 days to 30 days) – see 4.2**

#### **4.7 Long range forecasts (LRF) (30 days up to two years) – see 4.2**

### **5. Verification of prognostic products**

5.1 Products are verified against both surface and upper air observations. Verification has become operational in 2004. List of verified products includes cloud cover, wind speed, temperature, dew point and ground pressure (for surface observations) and wind speed, temperature, pressure and relative humidity (for upper air soundings).

#### 5.2 Research performed in this field

Continuous verification helped in description of common problems with quality of forecasts and possibilities of improvement. Some clarifications concerning stability of forecasts was also introduced via chosen approach of verification.

### **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]"

- introduction of new reference version of COSMO model
- introduction of full analysis cycle and data assimilation scheme
- introduction of "lagged-EPS" approach

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

##### 6.2.1 Planned Research Activities in NWP:

- active participation in COSMO research efforts (research projects of high priority, mainly on data assimilation, verification and physical processes)
- active participation in ALADIN research efforts (as above)
- involvement in national/regional researches and studies

##### 6.2.2 Planned Research Activities in Nowcasting

n/a

##### 6.2.3 Planned Research Activities in Long-range Forecasting

n/a

### **7. References**

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