Annual WWW Technical Progress Report

On the Global Data Processing and Forecasting System 2004

GERMANY

Country: Germany Centre: NMC Offenbach

1. Summary of highlights

The modelling suite at DWD consists of the global icosahedral-hexagonal gridpoint model GME (average mesh size ~ 40 km, i.e. 368642 gridpoints/layer, 40 layers) and the nonhydrostatic limited-area "Lokal-Modell" LM (mesh size ~ 7 km, 325 x 325 gridpoints/layer, 35 layers). LM is used operationally at the national meteorological services of Greece, Poland and Switzerland and at the regional meteorological service in Bologna (Italy), too. The military weather service of Germany operates a relocatable version of LM, called RLM, for world-wide applications.
The hydrostatic high-resolution regional model HRM of the DWD is being used as operational model at twelve national/regional meteorological services, namely Brazil-INMET, Brazil-Navy, Bulgaria, China, Israel, Italy, Kenya, Oman, Romania, Spain, United Arab Emirates and Vietnam. For lateral boundary conditions, GME data are sent via the Internet to the HRM and LM users.
During the year 2003 the main improvements of the NWP suite included:

- *31/03/04: A sea ice model including a prognostic treatment of ice thickness and temperature has been introduced in the global model GME,*
- *26/04/04: The precipitation phases rain and snow are treated fully prognostically, including the horizontal and vertical advection of the hydrometeors, in the local model LM,*
- *26/04/04: Synthetic satellite pictures are derived from the forecasts of the local model LM,*
- *14/07/04: European wind profiler data are being used in the LM data assimilation,*
- *27/09/04: The grid spacing of GME has been reduced from 60 to 40 km, the number of layers increased from 31 to 40, and a new 7-layer soil model has been introduced.*

2. Equipment in use

2.1 Main computers

2.1.1 IBM RS6000 SP

Operating System AIX 5.1
120 Power3-II Nodes (1920 Processors, 375 MHz)
Peak performance 1.5 Gflops per processor
8 or 16 GB Memory per processor
SP Switch 2
7,6 TB disk space

Used for operational forecasts and research

2.1.2 IBM p690 Server / p615 Server

Operating System AIX 5.2
2 Power4 Nodes (64 Processors, 1.7 GHz)
128 GB Memory per Node

3 Power4 Nodes (6 Processors, 1.7 GHz, 6 GB Memory)

3x13.5 TB Disk space (SAN attached)

This logically partitioned high availability cluster hosts datamanagement (Oracle Database), operational pre/postprocessing and development systems

2.1.3 SGI Origin 2000 Server

Operating System IRIX 6.5.
12 Processors, 275 MHz
Access to StorageTek ACS silos

Used for archiving and as Hierarchical Storage Management system

2.1.4 Storage Tek ACS Silo (3 components)

Attached are
9840 drives: 16
9940 drives: 24

2.2 Networks

The main computers are interconnected via Gigabit Ethernet (Etherchannel) and connected to the LAN via Fast Ethernet

2.3 Special systems

2.3.1 Satellite data system

Windows 2000 Server
Used for preparation of satellite pictures (from METEOSAT and NOAA and FENGYUN), vertical profiles of temperature and humidity (from NOAA).

2.3.2 Interactive graphical system

A number of SGI workstations and colour plotters are used for presentation of satellite- and radar data as well as model output, surface forecast charts significant weather charts, and other interactive graphics,
The MAP (Meteorological Application and Presentation System) Workstation is used to display and animate all available meteorological data sources.

2.3.3 Telecommunication system

The Meteorological Telecommunications System Offenbach (MTSO) is realized on a High-Availability-Primecluster with two Primepower 400 Computers (Fujitsu Siemens Computers) running on Sun-Solaris systemsoftware and RMS clustersoftware.
The belonging MSS and AFD Applications are communicating in real time via the GTS (RMDCN and leased lines), national and international PTT networks and the Internet with WMO-Partners and global customers like ESOC, EUMETSAT, ECMWF and DFS.

3. Data and products from GTS in use

At present nearly all observational data from the GTS are used. GRIB data from France and GRIB data from the UK, the US and the ECMWF are used. In addition most of the OPMET data are used.

SYNOP (AUTO)	47.000
SYNOP (manned)	39.000
BUOY	15.000
SHIP	13.000
TEMP A	1.400
METAR	215.000
PILOT A	400
AIREP	21.000
AMDAR	23.000
SATEM A	11.000
SATOB, section 2	6.700
SATOB, section 3	600
SATOB, section 4	800
SATOB, section 5	1.100
SATOB, section 7	1.000
GRIB	14.000
BUFR	26.000

4. Data input

Fully automated system. Incoming reports in character oriented code forms are converted into BUFR before storing them into a data base.

5. Quality control system

There is no quality control system in use regarding outgoing data to the GTS except for formal structure.

5.1 Quality control of incoming data

The formats of all coded reports are checked and if necessary and possible corrected. Surface and upper air reports are checked for internal consistency before storing them into a data base.

6. Monitoring of the observing system

Surface observations and upper air observations are monitored quantitatively only on the national level. DWD acts as a lead centre for monitoring the surface observations in Region VI. At present, only the surface pressure observational data are checked.

7. Forecasting systems

7.1 System run schedule and forecast ranges

Preprocessing of GTS-data runs on a quasi-real-time basis about every 6 minutes on the ORIGIN 2000.

Independent 4-dim. data assimilation suites are performed for both models, GME and LM. For GME, analyses are derived for the eight analysis times 00, 03, 06, 09, 12, 15, 18 and 21 UTC based on an intermittent optimum interpolation scheme. For LM, a continuous data assimilation system based on the nudging approach provides analyses at hourly intervals.
Forecast runs of GME and LM with a data cut-off of 2h 14 min after the main synoptic hours 00, 12 and 18 UTC consist of 48-h forecasts for LM and 174-h forecasts (48-h for 18 UTC) of the GME. Additionally, three ocean wave models (3rd generation WAM), the global GSM, Mediterranean MSM and local wave model (North, Baltic and Adriatic Sea areas) LSM provide guidance about wind sea and swell based on 00 and 12 UTC wind forecasts of GME and LM.

7.2 Medium range forecasting system (4-10 days)

7.2.1 Data assimilation, objective analysis and initialization

As far as GME is in use for medium range forecasting, the same procedures are applied as for short range forecasting described in item 7.3.1.

7.2.2 Model

Medium range forecasts at the DWD are mainly based on the ECMWF system (deterministic model and EPS). Additionally, GME (see 7.3) forecasts up to 7 days augment the model guidance available.

7.2.3 Numerical weather prediction products

ECMWF and GME global forecasts are available up to day 7. The ECOMET catalogue of the DWD global model products is given in annex 1.

7.2.4 Operational techniques for application of NWP products

ECMWF-EPS-data and MOS applied to the GME and ECM are in use to produce medium-range forecasts up to day 7. A statistical PPM-based interpretation scheme applied to both ECMWF and GME forecasts is still in use also. Forecasts are provided for the public both in tabular form and in plain language. The forecasts in tabular form comprise the parameters daily maximum and minimum temperatures, relative sunshine duration, daily precipitation amount and probability, wind speed and direction, probability of thunderstorm, probability of fog.

Medium-range forecast activity has moved to the Central Forecast Office in Offenbach in 2004. Forecasts in plain language for the public are created by a particular software developed by DWD. It produces texts automatically from MOS data. At present texts are produced for 7 Areas in Germany according to user requirements. Every day in the beginning of the forecast business the meteorologist examines and – where necessary – modifies the texts taking into account additional model results (for example external models which are not part of the initial data base. The automatically produced texts comprise all significant weather parameters like cloud cover, precipitation, wind and extreme temperatures. In addition to this the automatic text production is in use for worldwide forecasts, which are available by dialling a premium rate number on a fax machine, on a telephone answering device or on mobile telephones using short message system (SMS). The latter ones are produced however without forecasters' intervention.
Progress was made in medium range forecasting concerning the risk assessment of extreme weather for the forecast interval 120 hours down to 36 hours by synoptic interpretation of model results in combination with the evaluation of the COSMO-LEPS and EFI- (extreme forecast index) charts, provided by ECMWF. LEPS means Limited Area Ensemble Prediction System and was developed by the COSMO-Consortium (Members are Germany, Greece, Italy, Poland and Switzerland). LEPS is a combination of the EPS with the Limited Area Model LM and allows for utilising the benefits of EPS for the regional Scale. The Risk-Assessment is made available as a bulletin called "5 day forecast of weather risks". There will be given statements on the probability of certain weather events like storm, heavy precipitation, severe thunderstorm-situations, widespread snowfall or freezing precipitation,

heat and cold waves. The bulletin is produced once a day in the late morning with actualisation according to new model results in the evening or night hours if necessary. It is available for the regional offices within DWD and for the public via the internet.

Agrometeorological forecasts cover a wide span of applications aiming at a reduction of the use of insecticides and fungicides or at an optimization of the water supply to plants. NWP results are combined with additional models which calculate the drying of leaves or the temperature and water balance in the ground.

7.3 Short-range forecasting system (0-72 hrs)

Operational short-range forecasting is based on the products available from GME and LM, where LM covers the time period up to 48 h only.
The short-range forecasts for Central Europe up to 48 hours are derived from the limited-area “Lokal-Modell” LM. Fig. 1 shows the model domain of LM and Fig. 2 the model levels. The LM is designed as a flexible tool for forecasts on the meso-ß and on the meso-γ scale as well as for various scientific applications down to grid spacings of about 100 m. For operational numerical weather prediction, LM is nested in the GME.

Figure 1 Model domain of the “Lokal-Modell” LM mesh size ~ 7 km, 325 x 325 gridpoints.

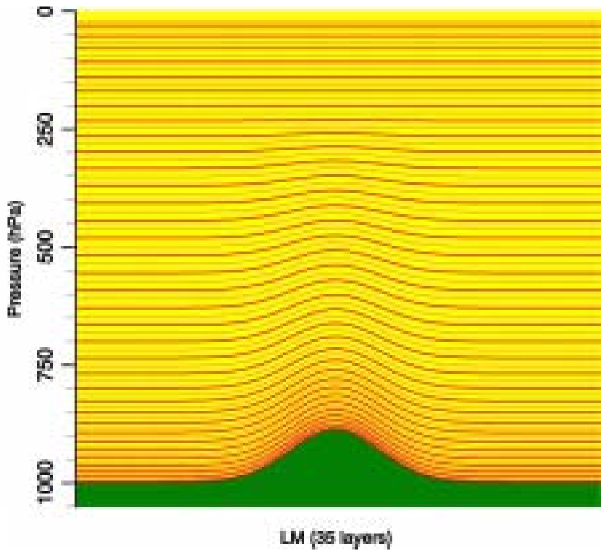

Figure 2 Model layers of LM.

7.3.1 Data assimilation, objective analysis and initialization

Global Model (GME)

a) Global analysis of mass, wind field and humidity

The program for the global analysis of mass and wind field, formerly developed by ECMWF, was ported to MPP systems by DWD with the support of the PALLAS software house.

Analysis method	3-dimensional multivariate optimal interpolation (humidity 2-dimensional). Direct use of thickness data. Box method.
Analysed variables	Φ, u, v, Rel. Hum.; Ozone from ECMWF analysis (12 UTC)
Horizontal anal. grid	Icosahedral grid of the GME (average mesh size of 40 km)
Vertical resolution	40 hybrid layers (see GME)
Products	a) On icosahedral-hexagonal grid of the GME (163842 gridpoints/layer, 31 layers) Variables: p_s, T, u, v, q_v, q_c, q_i, o_3 b) On a regular geographical grid, 480 x 361 points (0.75° x 0.5°) 12 pressure levels 1000, 950, 850, 700, 500, ..., 50 hPa Variables: p_{msl}, T, Φ, u, v, Rel. Hum.
Assimilation scheme	Intermittent data assimilation. Insertion of data every 3 hours. 3-h forecast used as first guess. All observations within a ± 1.5-h window used as synoptic. Cut-off time 2 h 14 min.
Initialization	Incremental digital filtering initialization (*Lynch, 1997*) consisting of a 3-h adiabatic backward run and a 3-h diabatic forward run centered at the initial time. The filtering is performed in vertical mode space; only the external mode plus the first nine internal ones are filtered.

b) Global analysis of surface parameters

Analysis method	Correction method	
Analysed variables	Sea surface temperature (SST) and snow cover	
Horizontal anal. grid	On icosahedral-hexagonal grid of the GME (average mesh size of 40 km)	
Data used	SST:	Synop-Ship, NCEP-SST analysis as background, NCEP-data of ice border.
	Snow cover:	Snow depth, present and past weather, precipitation amount, temperature analysis. History taken into account. NCEP-data of ice border.

Local Model (LM)

a) Limited-area analysis of atmospheric fields

The data assimilation system for the LM is based on the observation nudging technique (*Schraff, 1997)*. The variables nudged are the horizontal wind, temperature, and humidity at all model layers, and pressure at the lowest model level. The lateral spreading of the observational information is horizontal, or optionally along model layers or isentropic surfaces. At present, the scheme uses only conventional data of type TEMP, PILOT, SYNOP, BUOY, AIRCRAFT and AMDAR.

Analysis method	Observation nudging technique
Analysed variables	p, T, u, v, Rel. Hum.
Horizontal anal. grid	325 x 325 points (0.0625° x 0.0625°) on a rotated latitude/longitude grid
Vertical resolution	35 hybrid layers (see LM)
Products	All analysis products are given on the 325 x 325 grid and available at hourly intervals. a) On the 35 LM layers Variables: p, T, u, v, w, q_v, q_c, q_i, TKE b) On 10 pressure levels (1000, 950, 850, 700, 500, ..., 200 hPa) Variables: p_{msl}, Φ, T, u, v, ω, Rel. Hum. c) On 4 constant height levels (1000, 2000, 3000, 5000 m) Variables: p, T, u, v, w, Rel. Hum.
Assimilation scheme	Continuous data assimilation. Insertion of data in 3-h cycles. Cut-off time 2 h 14 min for LM runs.
Initialization	None

b) Limited-area analysis of soil moisture

Analysis method	2-dimensional (vertical and temporal) variational technique
Analysed variables	Soil moisture of two soil layers at 00 UTC
Horizontal anal. grid	325 x 325 points (0.0625° x 0.0625°) on a rotated latitude/longitude grid
Data used	2-m temperature analyses at 12 and 15 UTC

c) Limited-area analysis of other surface parameters

Analysis method	Correction methods
Analysed variables	Sea surface temperature (SST) and sea ice cover, snow cover
Horizontal anal. grid	325 x 325 points (0.0625° x 0.0625°) on a rotated latitude/longitude grid

Data used	SST: Synop-Ship, US-data of ice border, sea ice cover analysis from BSH (German Institute for shipping and hydrology) for the Baltic Sea and indirectly satellite data (via NCEP-SST and GME_SST analyses). Snow cover: Snow depth, present and past weather, precipitation amount, 2-m temperature analysis (plus model prediction).

Additionally, the plant cover is derived on a weekly basis by evaluation of satellite data (NDVI index).

7.3.2 Model

7.3.2.1 Schematic summary of the global model GME

Domain	Global
Initial data time	00, 12, 18 UTC
Forecast range	174 h (from 00 and 12 UTC), 48 h (from 18 UTC)
Prognostic variables	p_s, T, u, v, q_v, q_c, q_i, o_3
Vertical coordinate	hybrid sigma/pressure (*Simmons and Burridge, 1981*), 40 layers
Vertical discretization	Finite-difference, energy and angular-momentum conserving
Horizontal grid	Icosahedral-hexagonal (*Sadourny et al., 1968*), mesh size between 37 and 43 km, average mesh size 40 km; Arakawa-A grid
Horiz. discretization	Finite-difference, second order
Time integration	3-time-level, leapfrog, split semi-implicit scheme, $\Delta t = 133.33$ s, time filter. For moisture variables (water vapour, cloud water, cloud ice): Positive-definite, shape-preserving horizontal advection (SL-scheme).
Horizontal diffusion	Linear, fourth order
Orography	Grid-scale average based on a 1-km data set
Parameterizations	Surface fluxes based on local roughness length and stability (*Louis, 1979*) Free-atmosphere turbulent fluxes based on a level-two scheme (*Mellor and Yamada, 1974*) Sub-grid scale orographic effects (blocking and gravity wave drag) based on *Lott and Miller, 1997* Radiation scheme (two-stream with two solar and five longwave intervals) after *Ritter and Geleyn (1992)*, full cloud-radiation feedback based on predicted clouds Mass flux convection scheme after *Tiedtke (1989)* Kessler-type grid-scale precipitation scheme with parameterized cloud microphysics 7-layer soil model *(Heise and Schrodin, 2002)* including simple vegetation and snow cover; prescribed climatological value for temperature at about

	14 m depth.
	Over water: Fixed SST from SST analysis over open water; for ice-covered Ocean areas a sea ice model provides ice thickness and temperature; roughness length according to Charnock´s formula in ice-free areas.

Analyses and forecasts (up to 78 h) data of GME are sent twice daily (for 00 and 12 UTC) via the Internet to several other national weather services (Brazil, Bulgaria, China, Greece, Israel, Italy, Kenya, Oman, Poland, Romania, Spain, Switzerland, United Arab Emirates, Vietnam, Yugoslavia). These data serve as initial and lateral boundary data for regional modelling. For a detailed description of GME, see *Majewski, 1998* and *Majewski et al., 2002*.

7.2.3.2 Schematic summary of the "Lokal-Modell" LM

Domain	Central Europe
Initial data time	00, 12, 18 UTC
Forecast range	48 h
Prognostic variables	p, T, u, v, w, q_v, q_c, q_i, TKE, rain, snow
Vertical coordinate	Generalized terrain-following, 35 layers (see Fig. 2)
Vertical discretization	Finite-difference, second order
Horizontal grid	325 x 325 points (0.0625° x 0.0625°) on a rotated latitude/longitude grid, mesh size 7 km; Arakawa-C grid, see Fig. 1.
Horiz. discretization	Finite-difference, second order
Time integration	Three-time-level, leapfrog, split explicit scheme (*Klemp and Wilhelmson, 1978*) with the extensions proposed by *Skamarock and Klemp* (*1992*), $\Delta t = 40$ s, time filter. Optionally, a two-time-level split-explicit scheme (*Wicker and Skamarock, 1998*) and a 3-d semi-implicit scheme (*Skamarock et al., 1997*) are available.
Horizontal diffusion	Linear, fourth order
Orography	Grid-scale average based on a 1-km data set. Topography has been filtered to remove grid-scale structures
Parameterizations	Surface fluxes based on local roughness length and stability (*Louis, 1979*)
	Free-atmosphere turbulent fluxes based on a level-2.5 scheme with prognostic TKE (*Mellor and Yamada, 1974*)
	Radiation scheme (two-stream with two solar and five longwave intervals) after *Ritter and Geleyn (1992)*, full cloud-radiation feedback based on predicted clouds
	Mass flux convection scheme after *Tiedtke (1989)*
	Kessler-type grid-scale precipitation scheme with parameterized cloud microphysics

Two-layer soil model *(Jacobsen and Heise, 1982)* including simple vegetation and snow cover; prescribed climatological values at about 40 cm depth for temperature and at 100 cm depth for soil moisture.

Over water: Fixed SST from SST analysis; roughness length according to Charnock´s formula

7.3.3 Numerical weather prediction products

Short-range forecasts are based on direct model output (DMO) of the LM and on statistically corrected values (simple Kalman filtering). MOS-Mix guidance based on GME and ECM data is provided, too. The ECOMET catalogue of the LM is given in annex 2.

7.3.4 Operational techniques for application of NWP products

Forecast are produced partly automatically, based on the data listed in 7.3.3. Forecasts in plain language and warnings for the public and for aviation are produced by meteorologists. Any kinds of fields, DMO and MOS-date are available and used in combination with nowcasting techniques. Forecasts of significant weather (SWC) for Middle Europe are produced on the base of LM and special techniques. NWP results are used for a variety of further applications. Some of these applications are briefly described below.

DMO is used for the production of any weather situation imaginable in 2-D or 3-D modules as still picture, dynamic graphics, or as a complete film. A graphics system developed for the visualization of meteorological data supports the interactive or automatic presentation of DMO in single images or image sequences.

Short range forecasts of weather and temperature in pictorial form are automatically produced for on-line presentation on the Internet using MOS forecasts of GME (worldwide and national) and Kalman filtered LM (national).
The state of road surfaces is predicted by a road weather forecast system (SWIS – Strassenzustands- und Wetter-Informations-System) using MOS data based on GME and an energy balance model of the road surface.
The influence of weather on human health is forecasted using a bio-synoptical weather classification scheme and the predicted vorticity, temperature and humidity in the surfaces 900, 850, 700 and 500 hPa. The thermal strain on a prototype human being is calculated by a physiologically relevant energy balance model which employs forecasted temperature, humidity, wind and short- and long-range irradiances derived from predicted cloudiness. Both weather classification and thermal strain data are calculated for all pixels of the Local Model LM of DWD. UV Index is forecasted within LM derived from the large scale UV Index forecasts by GME and adapted to LM predicted cloudiness and snow cover.

The aviation needs for its planning and safe management of flights beside the wind and temperature forecasts of different flight levels specific forecasts, which are offered as *Direct Model Output.*
Cross sections are vertical sections along defined flight routes. The cross sections contain the distribution of cloudiness, temperature and wind between the surface and FL 240 at different time steps until H+30.
For the planning of gliding flights in Germany, the Alpine area and the eastern part of France the software package TOPTHERM is used. TOPTHERM is able to calculate the development of thermal lift for small scaled areas. The output of LM is used as data input for the TOPTHERM model. TOPTHERM calculations are visualised by the selfbriefing software pc_met.
Significant weather charts which are in use as general guidance for the aeronautical consulting business in the regional forecasting offices and which are issued as products for general aviation cover the middle european area in a layer from surface up to 24 500 ft. As additional information jet-axes and cat areas are included if within the layer. Icing conditions and turbulence areas are described. The

charts are produced interactively on work stations using LM results in combination with conventional synoptic methods.

During the season an advice for gliding pilots is prepared which may be received via facsimile. It presents charts of the lowest cloud base or the height of thermal activity, precipitation, wind direction and wind speed for several times during the day. It is based on LM data.

Further the LM model output is the data base for the visualisation software SkyView and the icing forecast model ADWICE.

SkyView presents for variable sections of areas in Middle Europe precipitation, convection cloudiness and wind of different levels on grid points. The results are presented every two hours. The flash viewer allows overlapping of several parameters. Therewith a common analysis of the requested parameters is possible.

The model ADWICE forecasts the atmospheric icing between surface and FL 300 for a forecast period of 48 hours. At the moment results are visualised in the DWD-Intranet. With the adoption of the visualisation system NinJo ADWICE icing maps will be visualised by NinJo.

All aviation meteorological products except of the model ADWICE are offered to a closed user group over the web site: www.flugwetter.de.

Agrometeorological forecasts cover a wide span of applications aiming at a reduction of the use of insecticides and fungicides or at an optimization of the water supply to plants. NWP results are combined with additional models which calculate the drying of leaves or the temperature and water balance in the ground. These forecasts are presented in www. Agrowetter.de

7.4 Specialized forecasts

7.4.2 Models

7.4.2.1 Trajectory Models

Trajectory model:

Forecast variables	r (λ, φ, p or z, t)
Data supply	u, v, w, p_s from NWP forecasts (or analyses)
Numerical scheme	1st order Euler-Cauchy with iteration (2nd order accuracy)
Interpolation	1st order in time, 2nd (GME) or 3rd (LM) order in space

a) Daily routine (ca. 1500 trajectories)

Trajectories based on LM forecasts:

Domain	Domain of LM (see Fig. 1)
Resolution	0.0625° (as LM)
Initial data time	00, 12 UTC
Trajectory type	Forward trajectories for 36 German, Czech, Swiss, and French nuclear and chemical installations, backward trajectories for scientific investigations
Forecast range	48-h trajectories, optional start/arrival levels

Trajectories based on GME forecasts:

Domain	Global
Resolution	~ 40 km (as GME)
Initial data time	00, 12 UTC
Trajectory type	72-h forward trajectories for ca. 60 European nuclear sites and 8 German regional forecast centers, backward trajectories for 37 German radioactivity measuring sites and 8 forecast centers using consecutive +6h to +18h forecast segments.

	96-h backward trajectories for the GAW mountain stations Zugspitze, Jungfraujoch, Sonnblick and Hohenpeißenberg, and to the German meteorological observatories. 72-h backward trajectories for 5 African cities in the framework of the METEOSAT-MDD program, disseminated daily via satellite from Bracknell. 120-h backward trajectories for the German polar stations Neumayer (Spitzbergen) and Koldewey (Antarctica) and the research ships Polarstern and Meteor, disseminated daily. 168-h forward trajectories for 14 Eastern European nuclear power plants. Mainly backward trajectories for various scientific investigations.
Forecast range	168h forward and backward trajectories, optional start/arrival levels

b) Operational emergency trajectory system, trajectory system for scientific investigations:

Models	LM or GME trajectory models
Domain	LM or global
Data supply	u, v, w, p_s from LM or GME forecasts or analyses, from current data base or archives
Trajectory type	Forward and backward trajectories for a choice of offered or freely eligible stations at optional heights and times in the current period of 7 to 14 days.
Forecast range	48-h (LM) or 168-h (GME)
Mode	Interactive menu to be executed by forecasters

7.4.2.2 Sea wave models

Domain	Global	Mediterranean	North, Baltic and Adriatic Sea Areas
Numerical scheme	Shallow water, 3rd generation WAM		
Wind data supply	GME: u, v at 10 m		LM/GME: u, v at 10 m
Grid	geographical (regular lat/lon)		
Resolution	0.75° x 0.75°	0.25° x 0.25°	0.10° x 0.167°
Initial data time	00 and 12 UTC		
Forecast range	174 h		48 h
Model output	significant wave height, peak period, direction		
Initial state	sea state adapted to predicted wind field over last 12 h		
Verification	Available on request		

7.4.3. Numerical Weather Prediction Products

The forward and backward trajectories are an important tool for emergency response activities. In addition to these forecasts for concentration and deposition of radionuclides are produced using a Lagrangian Particle Dispersion Model.
Based on the Sea wave models charts are produced for swell and significant wave height, frequency and direction .

7.4.4 Operational techniques for applications of NWP results

Forecasts of the optimal (shortest and/or safest) route of ships are evaluated using the results of the global sea wave model and of NWP in the ship routing modelling system of the DWD. The system calculates isochrones taking into account the impact of wave and wind on different types of ships.

A very special application of the NWP result is a hydrological one. A model-system called SNOW-D allows for estimating and forecasting snow-cover development and areal melt water release. The model enables a daily calculation and forecast of grid-point values of the water equivalent of the snow cover and meltingwater release. The snow cover development is computed with the help of physically-based model components which describe accumulation (build-up, increase), metamorphosis (conversion, change) and ablation (decrease, melting).
The model input data are

- 6-hour interval averages of air temperature and vapour pressure
- global radiation/duration of sunshine and precipitation totals of the last 24 h
- three times a week additional data from a part-time network (depth of snow cover, water equivalent of snow cover)
- output data of the „Lokal-Modell“

The model output contains

- current values of the snow cover (reference point 06.00 UTC)
    - snow depth (in cm)
    - water equivalent (in mm)
- specific water equivalent (in mm/cm)

- forecast values of snow cover development (forecast interval maximum 48 hours, forecasting for 6-h-intervals)
    - water equivalent (in mm)
    - precipitation supply, defined as the sum of meltwater release and rain (in mm)

The results are provided grid-oriented and with a blanket coverage for Germany. A summary of the grid values can be made for any area required.

In addition to SNOW-D, a new model-system called SNOW2 was developed for Baden-Württemberg and Rhineland-Palatinate and will be extended to Bavaria. This model is similar to SNOW-D but it runs every 6 hours and has a higher temporal resolution (1 hour). Not only DWD measurements but also data from regional networks are integrated in the data sampling procedure. Universal Kriging is used for regionalization of measured values to the computational grid.

The strongly improved physics uses wind speed (which is neglected in SNOW-D) for computation of turbulent transfer of heat and moisture taking into account the atmospheric static stability.
The model output contains the quantities of SNOW-D but in addition forecast values of snow depth, snow temperature, ice content and so on can be derived.

The operational UV Index forecast has been upgraded to a physically based fully deterministic global system. It is based on the dynamic prediction of ozone within DWD's global model GME and uses ECMW forecasts +12 h for initialisation. The model comprises modifications for clouds, snow albedo, and since the end of 2003 seasonal variations of aerosol optical depth derived from NASA MODIS MOD08_M3 data. The “large-scale UV-Index” forecasts are suited to interpolation to the grids of national higher resolution models (HRM). They can then be adjusted to the HRM topography and HRM forecasts of snow cover and cloudiness. All forecasts are supplied to the interested WMO member states by the RSMC Offenbach via ist server ftp.dwd.de. For more information see http://www.uv-index.de.

8. Verifications

GEOPOTENTIAL 500 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	11	10	10	9	8	8	7	7	8	8	9	10	8.8
36. h	19	19	19	17	16	15	13	14	15	15	17	19	16.4
60. h	30	30	30	27	25	24	20	21	23	24	27	29	25.8
84. h	43	41	43	38	35	34	28	30	35	36	40	43	37.1
108. h	56	54	58	51	47	44	37	40	49	49	55	57	49.6
132. h	68	67	73	63	57	55	45	50	61	63	71	72	62.1
156. h	79	82	89	76	66	64	51	59	71	77	85	88	73.9
p156. h	138	148	149	131	115	97	83	91	106	124	133	139	121.0
climate	106	112	114	102	93	81	64	74	78	98	103	109	94.6

GEOPOTENTIAL 500 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	1.00	1.00	1.00	0.995
36. h	0.98	0.98	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.98	0.984
60. h	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.97	0.96	0.96	0.959
84. h	0.92	0.93	0.92	0.92	0.92	0.90	0.90	0.91	0.89	0.93	0.93	0.92	0.915
108. h	0.86	0.88	0.85	0.86	0.85	0.82	0.82	0.84	0.79	0.86	0.86	0.86	0.846
132. h	0.79	0.80	0.76	0.78	0.78	0.73	0.74	0.75	0.67	0.77	0.77	0.78	0.761
156. h	0.72	0.71	0.64	0.69	0.70	0.63	0.66	0.64	0.56	0.67	0.67	0.69	0.665

PRESSURE MSL RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.4	1.3	1.2	1.2	1.1	1.1	1.0	1.1	1.1	1.0	1.1	1.2	1.14
36. h	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.7	1.7	1.8	2.0	2.2	1.92
60. h	3.3	3.2	3.2	2.7	2.5	2.4	2.2	2.4	2.5	2.6	3.0	3.2	2.76
84. h	4.4	4.2	4.3	3.8	3.4	3.1	2.8	3.1	3.5	3.7	4.1	4.5	3.74
108. h	5.5	5.4	5.5	4.9	4.4	4.0	3.5	3.9	4.7	4.9	5.5	5.8	4.82
132. h	6.5	6.6	6.7	5.9	5.1	4.7	4.0	4.6	5.8	6.2	6.8	7.3	5.85
156. h	7.5	7.7	8.0	6.8	5.7	5.4	4.6	5.3	6.7	7.4	7.8	8.6	6.80
p156. h	12.3	12.7	12.4	11.0	9.2	7.7	6.6	7.6	9.7	10.8	11.7	12.7	10.37
climate	9.4	9.5	9.2	7.8	6.5	5.6	4.9	5.9	7.0	8.4	8.9	10.1	7.77

PRESSURE MSL ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.998
36. h	0.97	0.97	0.97	0.97	0.97	0.95	0.94	0.96	0.97	0.98	0.98	0.98	0.967
60. h	0.94	0.94	0.94	0.94	0.93	0.91	0.90	0.92	0.93	0.95	0.95	0.95	0.932
84. h	0.89	0.90	0.88	0.88	0.87	0.85	0.83	0.85	0.87	0.90	0.90	0.90	0.876
108. h	0.82	0.84	0.81	0.80	0.77	0.75	0.74	0.77	0.76	0.82	0.81	0.83	0.793
132. h	0.75	0.75	0.71	0.70	0.67	0.64	0.66	0.67	0.63	0.72	0.71	0.74	0.696
156. h	0.67	0.66	0.59	0.60	0.59	0.53	0.57	0.57	0.50	0.61	0.62	0.63	0.595

TEMPERATURE 850 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.97
36. h	1.7	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.6	1.51
60. h	2.2	2.1	2.1	2.0	2.0	1.9	1.8	1.7	1.8	1.7	1.9	2.1	1.94
84. h	2.7	2.6	2.7	2.4	2.4	2.3	2.1	2.1	2.2	2.2	2.4	2.6	2.38
108. h	3.3	3.1	3.3	2.9	2.8	2.7	2.4	2.4	2.6	2.6	2.9	3.2	2.86
132. h	3.8	3.7	3.9	3.4	3.2	3.1	2.8	2.8	3.0	3.1	3.4	3.7	3.33
156. h	4.2	4.3	4.6	3.9	3.6	3.5	3.0	3.1	3.5	3.6	4.0	4.2	3.77
p156. h	6.5	6.6	6.9	6.1	5.6	4.7	4.4	4.5	5.0	5.8	5.9	6.2	5.67
climate	4.7	4.9	5.1	4.7	4.3	3.8	3.3	3.5	3.9	4.5	4.7	4.8	4.35

TEMPERATURE 850 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.97	0.98	0.98	0.98	0.97	0.96	0.96	0.96	0.96	0.98	0.98	0.98	0.971
36. h	0.93	0.95	0.95	0.94	0.93	0.91	0.91	0.91	0.92	0.95	0.94	0.94	0.932
60. h	0.89	0.91	0.91	0.90	0.89	0.86	0.86	0.86	0.87	0.91	0.91	0.90	0.890
84. h	0.83	0.86	0.86	0.85	0.84	0.80	0.80	0.81	0.81	0.86	0.86	0.85	0.836
108. h	0.75	0.80	0.79	0.79	0.78	0.71	0.73	0.74	0.72	0.80	0.79	0.78	0.766
132. h	0.66	0.72	0.70	0.72	0.71	0.62	0.66	0.66	0.63	0.73	0.71	0.71	0.685
156. h	0.59	0.62	0.64	0.64	0.53	0.59	0.58	0.54	0.64	0.61	0.61	0.63	0.600

Table 3: Verification results of the GME for the extratropical northern hemisphere for different forecast times. (p156.h stands for the rmse-values of persistence and climate for the rmse-values of climate), 2004.

GEOPOTENTIAL 500 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	9	9	10	11	12	12	13	12	12	9	8	8	10.4
36. h	18	20	21	22	24	24	25	25	24	19	18	18	21.5
60. h	27	32	33	34	37	38	39	40	37	31	28	28	33.7
84. h	38	44	46	48	52	52	54	57	51	44	39	39	47.1
108. h	49	57	60	65	68	68	69	76	65	58	51	50	61.4
132. h	62	72	74	81	82	82	83	94	79	70	62	62	75.3
156. h	72	85	88	95	95	97	99	110	91	82	73	74	88.4
p156. h	111	130	132	142	163	158	144	158	149	138	144	116	140.4
climate	89	98	101	106	113	110	110	114	106	103	111	89	104.1

GEOPOTENTIAL 500 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.99	1.00	1.00	1.00	1.00	0.99	0.99	1.00	0.99	1.00	1.00	1.00	0.995
36. h	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.98	0.979
60. h	0.95	0.95	0.94	0.94	0.95	0.94	0.94	0.94	0.94	0.95	0.97	0.95	0.947
84. h	0.90	0.90	0.88	0.89	0.90	0.88	0.89	0.87	0.89	0.91	0.93	0.90	0.895
108. h	0.83	0.82	0.80	0.80	0.82	0.80	0.81	0.77	0.82	0.84	0.88	0.84	0.820
132. h	0.73	0.71	0.69	0.68	0.73	0.71	0.72	0.65	0.73	0.77	0.83	0.76	0.726
156. h	0.63	0.60	0.57	0.58	0.64	0.60	0.60	0.53	0.64	0.67	0.77	0.66	0.624

PRESSURE MSL RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.1	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.2	1.1	1.1	1.27
36. h	1.9	2.2	2.4	2.6	2.7	2.7	2.8	2.8	2.6	2.3	2.1	2.0	2.43
60. h	2.8	3.3	3.5	3.8	4.0	4.0	4.2	4.2	3.9	3.4	3.0	2.9	3.58
84. h	3.8	4.4	4.7	5.1	5.4	5.5	5.6	5.9	5.2	4.5	4.1	3.9	4.84
108. h	4.8	5.5	6.0	6.5	6.7	6.8	7.0	7.5	6.6	5.7	5.1	4.9	6.09
132. h	5.7	6.7	7.2	7.8	8.0	8.0	8.3	9.1	7.8	6.9	6.0	5.8	7.29
156. h	6.6	7.8	8.3	8.8	9.2	9.3	9.7	10.6	9.1	7.9	6.9	6.8	8.41
p156. h	9.5	11.3	11.7	12.5	14.3	14.0	13.3	14.3	13.5	12.0	12.3	9.8	12.38
climate	7.9	8.7	8.7	9.5	10.2	10.3	10.2	10.3	10.3	9.1	9.2	7.4	9.32

PRESSURE MSL ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.991
36. h	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.965
60. h	0.93	0.92	0.91	0.91	0.92	0.92	0.91	0.91	0.93	0.93	0.95	0.92	0.922
84. h	0.87	0.86	0.84	0.84	0.86	0.84	0.84	0.83	0.87	0.87	0.90	0.87	0.858
108. h	0.80	0.79	0.74	0.73	0.78	0.76	0.75	0.72	0.79	0.80	0.84	0.79	0.773
132. h	0.71	0.68	0.62	0.62	0.68	0.67	0.65	0.59	0.70	0.71	0.78	0.69	0.674
156. h	0.62	0.57	0.49	0.52	0.57	0.57	0.53	0.47	0.60	0.61	0.70	0.58	0.569

TEMPERATURE 850 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.04
36. h	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.0	1.9	1.7	1.6	1.6	1.76
60. h	1.9	2.0	2.2	2.3	2.4	2.5	2.6	2.6	2.5	2.2	2.0	2.0	2.27
84. h	2.3	2.4	2.6	2.7	2.9	3.0	3.2	3.2	3.0	2.6	2.4	2.3	2.72
108. h	2.6	2.8	3.1	3.3	3.4	3.4	3.7	3.8	3.4	3.0	2.7	2.7	3.16
132. h	3.0	3.2	3.5	3.7	3.7	3.8	4.1	4.3	3.8	3.4	3.0	3.0	3.55
156. h	3.3	3.6	3.8	4.0	4.1	4.1	4.6	4.8	4.2	3.7	3.3	3.3	3.90
p156. h	4.4	4.7	4.9	5.0	5.4	5.3	5.3	5.9	5.5	5.3	5.1	4.4	5.09
climate	3.4	4.0	4.5	4.8	4.9	4.5	5.2	5.0	4.9	4.0	4.0	3.5	4.40

TEMPERATURE 850 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.96	0.97	097	098	0.98	0.97	0.98	0.98	0.98	0.97	0.97	0.96	0.970
36. h	0.90	0.91	0.92	0.93	0.93	0.92	0.93	0.93	0.94	0.92	0.92	0.90	0.920
60. h	0.85	0.86	0.86	0.88	0.88	0.86	0.88	0.88	0.88	0.87	0.87	0.84	0.869
84. h	0.78	0.79	0.80	0.82	0.83	0.80	0.82	0.81	0.84	0.81	0.82	0.78	0.809
108. h	0.70	0.72	0.73	0.75	0.77	0.73	0.75	0.73	0.78	0.73	0.76	0.72	0.740
132. h	0.60	0.63	0.66	0.68	0.71	0.67	0.69	0.65	0.72	0.66	0.71	0.66	0.671
156. h	0.51	0.55	0.59	0.63	0.65	0.61	0.62	0.57	0.66	0.58	0.66	0.60	0.603

Table 4: Verification results of the GME for the extratropical southern hemisphere for different forecast times. (p156.h stands for the rmse-values of persistence and climate for the rmse-values of climate), 2004.

GEOPOTENTIAL 500 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	10	10	9	9	8	7	7	7	7	7	9	11	8.5
36. h	21	19	18	16	14	13	13	12	15	14	18	21	16.3
60. h	37	34	29	27	23	22	20	20	24	24	31	35	27.2
84. h	53	46	45	40	33	33	30	29	38	37	47	49	39.9
108. h	69	62	63	58	46	45	41	41	59	50	64	65	55.3
132. h	85	83	78	76	60	55	49	55	84	65	83	91	72.0
156. h	100	106	104	88	73	66	57	70	102	86	99	112	88.6
p156. h	176	199	184	152	131	111	104	112	149	143	169	167	149.8
climate	122	138	137	103	117	91	84	88	98	101	126	133	111.4

GEOPOTENTIAL 500 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.997
36. h	0.98	0.99	0.99	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.98	0.987
60. h	0.93	0.97	0.96	0.95	0.98	0.96	0.96	0.97	0.97	0.97	0.96	0.96	0.961
84. h	0.86	0.94	0.91	0.88	0.95	0.91	0.91	0.92	0.91	0.92	0.92	0.92	0.913
108. h	0.76	0.89	0.84	0.76	0.91	0.83	0.83	0.84	0.78	0.86	0.83	0.85	0.832
132. h	0.67	0.79	0.75	0.64	0.84	0.76	0.76	0.73	0.58	0.77	0.73	0.72	0.729
156. h	0.59	0.64	0.54	0.53	0.75	0.68	0.68	0.61	0.43	0.63	0.63	0.61	0.610

PRESSURE MSL RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.2	1.2	1.1	1.2	1.0	0.9	0.9	0.9	0.9	0.9	1.1	1.2	1.04
36 .0	2.4	2.0	1.7	1.7	1.5	1.4	1.4	1.3	1.5	1.7	2.0	2.3	1.75
60. h	3.8	3.3	2.8	2.6	2.3	2.2	2.1	2.3	2.5	2.5	3.1	3.4	2.73
84. h	4.9	4.3	4.0	3.8	3.3	3.1	2.8	3.0	3.6	3.6	4.5	4.6	3.78
108. h	6.4	5.6	5.2	5.4	4.4	4.0	3.5	3.9	5.2	4.7	6.1	5.9	5.02
132. h	7.8	7.5	6.5	6.5	5.4	4.8	4.0	4.7	7.4	5.9	7.8	8.3	6.39
156. h	8.9	9.3	8.8	7.5	6.2	5.4	4.8	5.7	9.0	7.8	8.7	9.7	7.65
p156. h	14.7	14.2	14.9	13.7	10.3	8.6	7.5	8.3	12.0	12.4	12.1	13.4	11.84
climate	10.3	10.2	11.1	9.1	7.4	6.0	5.8	7.1	8.4	8.9	9.5	12.0	8.82

PRESSURE MSL ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.99	0.99	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.993
36. h	0.96	0.98	0.98	0.97	0.98	0.96	0.96	0.98	0.98	0.98	0.98	0.98	0.974
60. h	0.91	0.94	0.95	0.93	0.95	0.91	0.92	0.94	0.94	0.95	0.94	0.95	0.937
84. h	0.84	0.90	0.90	0.86	0.90	0.81	0.86	0.89	0.88	0.90	0.87	0.91	0.877
108. h	0.75	0.83	0.82	0.71	0.81	0.72	0.80	0.78	0.76	0.82	0.76	0.86	0.785
132. h	0.67	0.69	0.71	0.61	0.71	0.58	0.74	0.67	0.54	0.72	0.62	0.72	0.665
156. h	0.58	0.53	0.47	0.48	0.60	0.48	0.64	0.57	0.38	0.56	0.54	0.62	0.538

TEMPERATURE 850 hPa RMSE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	1.0	1.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	0.88
36. h	1.6	1.5	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1.5	1.6	1.34
60. h	2.1	2.1	1.8	1.7	1.6	1.6	1.5	1.5	1.6	1.6	1.9	1.9	1.75
84. h	2.5	2.7	2.3	2.1	2.0	2.1	1.9	1.8	2.0	2.0	2.4	2.4	2.17
108. h	3.2	3.3	2.9	2.7	2.4	2.6	2.3	2.1	2.5	2.6	2.9	2.7	2.67
132. h	3.7	3.9	3.4	3.2	2.9	3.0	2.7	2.6	3.1	3.0	3.4	3.2	3.17
156. h	4.0	4.6	4.2	3.7	3.5	3.5	3.0	3.2	3.6	3.7	3.8	3.8	3.72
p156. h	6.5	7.6	6.5	5.7	5.6	4.4	4.7	4.7	5.2	5.5	6.1	5.4	5.65
climate	4.4	5.1	4.6	4.2	4.6	3.7	3.4	3.4	3.8	3.8	4.8	4.0	4.15

TEMPERATURE 850 hPa ANOMALY CORRELATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
12. h	0.97	0.98	0.98	0.98	0.98	0.97	0.97	0.96	0.97	0.97	0.97	0.96	0.972
36. h	0.90	0.96	0.95	0.94	0.96	0.94	0.93	0.92	0.93	0.94	0.94	0.91	0.935
60. h	0.84	0.92	0.92	0.90	0.93	0.89	0.89	0.88	0.89	0.90	0.90	0.87	0.893
84. h	0.77	0.87	0.86	0.83	0.90	0.82	0.82	0.83	0.83	0.85	0.84	0.81	0.836
108. h	0.64	0.81	0.78	0.72	0.85	0.72	0.75	0.76	0.74	0.77	0.76	0.75	0.753
132. h	0.52	0.72	0.69	0.61	0.78	0.64	0.66	0.66	0.59	0.68	0.66	0.64	0.653
156. h	0.44	0.57	0.53	0.47	0.66	0.54	0.57	0.51	0.47	0.56	0.56	0.49	0.530

Table 5: Verification results of the GME for the European region 36° - 72°N, 12°W - 42°E for different forecast times. (p156.h stands for the rmse-values of persistence and climate for the rmse-values of climate), 2004.

9. Plans for the future

In the summer of 2005, the model domain of LM will be increased from 325 x 325 to about 665 x 657 gridpoints with a mesh size of 7 km to cover whole of Europe, the number of layers will be increased from 35 to 40, and the forecast range extended from 48 to 78 hours.
A nowcasting and very short range (up to 18 hours, initialised every three hours) forecast version of LM (named LMK) is under development with a mesh size of 2.8 km and 50 layers. This high a resolution aims mainly at the explicit prediction of deep convection which is a major forecasting problem in Germany during the warm season. The further development of LM is co-ordinated in the Consortium for Small-Scale Modelling (COSMO). Current members of COSMO are the weather services of Germany, Greece, Italy, Poland and Switzerland.
Concerning applications of NWP results it is planned to make a more systematic approach to severe weather forecasting by making use of objective methods based on the EPS provided by the ECMWF. For any kind of post processed specialized forecasts of the parameters temperature, wind and significant weather MOS will be used instead of Kalman Filtering.

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