Annual WWW Technical Progress Report

On the Global Data Processing and Forecasting System 2004

FINLAND

1. Summary of highlights

This report describes the essential features of the numerical weather prediction (NWP) system operational at The Finnish Meteorological Institute (FMI) during the year 2004. The system is based on the HIRLAM NWP system (Undén et al., 2002), maintained by the international Hirlam consortium, which is formed by the national meteorological agencies of Denmark, Finland, Iceland, Ireland, The Netherlands, Norway, Spain and Sweden. In the year 2004 FMI took up the duties of a lead centre for operational employment of the common reference version of HIRLAM. In this capacity FMI makes operational use of the reference version, and makes all forecast products available to the whole consortium in a common archive at the ECMWF. The lead centre duties also include maintaining a comprehensive technical and meteorological monitoring of the system, that can be followed in real time on the project web pages (Kangas, 2004). Some products of the reference runs are shared within the SRNWP-PEPS project.

The reference HIRLAM currently employs a horizontal grid spacing of 0.2 degrees. Since October 2004 FMI also operates a meso-gamma scale version of HIRLAM with a spacing of 0.08 degrees.

2. Equipment in use for numerical forecasting in Finland

The operational forecasts are run on one IBM pSeries 690 node of the IBM cluster, containing 32 Power 4 processors. There is 32 GB of memory in one node and the clock frequency of the processors is 1.1 GHz. Another node of the same cluster is used as a backup system.

At the Finnish Meteorological Institute the computer configuration of the operational system contains mainly UNIX and Linux workstations and servers.

3. Data and products from GTS used in NWP

SYNOP, SHIP, DRIBU, PILOT, TEMP, AIREP,AMDAR

4. Data input system

Automated

5. Quality control system

Format is checked before transmission to the GTS.

6. Monitoring of the observing system

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

7. Forecasting system

7.1 System run schedule and forecast ranges

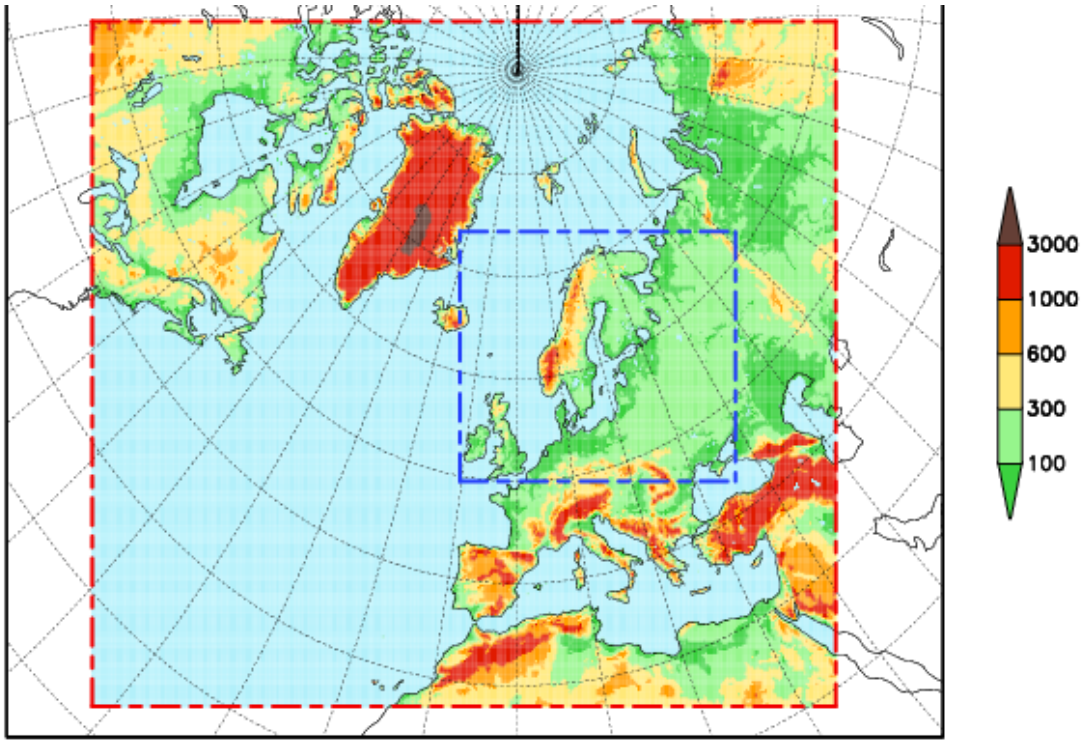

Figure 1. Integration areas of the operational LAM suites.

FMI maintains two nested data-assimilation/forecasting suites for limited area short range forecasting: an outer "Atlantic suite" (RCR) and an inner "European suite" (MBE). The outer **RCR**-suite serves as a reference run for the whole HIRLAM consortium in addition to serving domestic needs. Integration areas of these suites are shown in figure 1, while the run schedule and forecast ranges are shown in table 1.

Table 1. Run schedule and forecast ranges of the FMI LAM suites.

Available UTC	*RCR*	*MBE*
03:15:00 am	00+54 h	
09:15:00 am	06+54 h	
11:10:00 am		06+54 h
03:15:00 pm	12+54 h	
09:15:00 pm	18+54 h	
11:10:00 pm		18+54 h

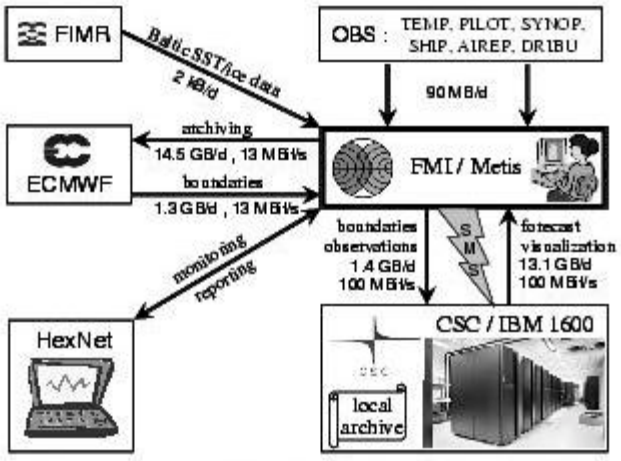

Figure 1. Computers and data flows of the FMI LAM system

Figure 1 illustrates the computers and data flows of the LAM system. The observations as well as the Baltic ice data from the Finnish Institute of Marine Research are first collected to the operational UNIX server, Metis, processed, and then transferred to the CSC for the actual computations. The same applies to the boundary data obtained from the ECMWF. After computations at the CSC supercomputer, the numerical results as well as graphical products are transferred back to the Metis server to be loaded into the real time data base for different uses by duty forecasters, researchers, and automated forecast products. At CSC, an extensive local archiving also takes place. Finally, input and output data are made availabe to the HIRLAM community by archiving the data to the ECMWF's ECFS using the ecaccess gateway. A graphical interface for monitoring the system is provided to the HIRLAM community through the HeXnet facility.

7.2 The RCR forecasting system (short range forecasts)

7.2.1 Data assimilation, objective analysis and initialisation

Upper air analysis:

3-dimensional variational data assimilation
Version: HIRVDA 6.2.1, FGAT option
Parameters: surface pressure, temperature, wind components, relative humidity

Surface analysis:

Univariate statistical interpolation cosistent with the mosaic approach of the surface/soil scheme.
Parameters: SST, fraction of ice, snow depth, screenlevel temperature and humidity, soil temperature and humidity in two layers

Levels:

40 hybrid levels defined by A's and B's. Levels are (assuming a surface pressure of 1013 hPa): 1009.2, 1008.9, 991 980, 967, 953, 937, 919, 899, 878, 855, 829, 803, 774, 744, 713, 680, 646, 612, 577, 541, 506, 470, 435, 400, 366, 333, 300, 270, 240, 212, 185, 160, 136, 113, 91, 70, 50, 30, 10 hPa

Observation types:

TEMP, PILOT, SYNOP, SHIP, BUOY, SATOB, AMDAR and AIREP

First guess:

three hour forecast of the previous cycle

Initialisation:

Digital filter

Cut-off time:

00, 06, 12, 18 UTC: 2h

03, 09, 15, 21 UTC: 4h 20 min

Cycling:

3h cycle

7.2.2 Model

Basic equations:

primitive equations in flux form

Independent variables:

λ,θ (transformed latitude-longitude co-ordinates, with the south pole at 30° S, 0°E), η, t

Dependent variables:

T, u, v, q, p_s, cloud condensate, turbulent kinetic energy

Integration domain:

438 x 336 gridpoints in transformed latitude-longitude grid, 40 vertical levels (as in the analysis)

Grid length:

0.2° (~22 km)

Grid:

staggered grid (Arakawa C)

Time-integration:

2 time level semi lagrangean semi-implicit (time step=6 min)

Orography:

HIRLAM physiographic data base, filtered

Physical parameterisation:

Savijärvi radiation scheme
STRACO- condensation/convection scheme
turbulence based on turbulent kinetic energy and diagnostic mixing length
surface fluxes based on a drag formulation
surface and soil processes using a tiling scheme

Horizontal diffusion:

implicit fourth order

Forecast length:

54 hours at 00, 06, 12, 18 UTC, forecasts available after 3h 15 min

Output frequency:

1 hour

Boundaries:

time dependent lateral boundary conditions from the ECMWF received four times each day on the RCR grid with a temporal resolution of 3 hrs, obtained via the ECMWF boundary conditions optional project .

7.2.3 Numerical weather prediction products

All the HIRLAM products on model and constant pressure levels are available for applications in the FMI real-time data base with the frequency of one hour.

HIRLAM forecasts are available to duty forecasters on workstations. The geopotential, temperature, relative humidity and three dimensional wind fields are available on constant pressure levels (1000, 925, 850, 700, 500, 400, 300 and 250 hPa). In addition, surface pressure, 10-metre wind, 2-metre temperature, intensity of precipitation and accumulated large-scale and convective precipitation, surface fluxes of sensible and latent heat and net radiation are available. Also several derived parameters such as type of precipitation, stability index, fog, cloudiness etc. are computed from every forecast.

Nearest gridpoint values are picked up to produce forecasted vertical soundings of temperature, dewpoint deficit and wind at selected points.

7.2.4 Operational techniques

HIRLAM forecasts provide guidance to duty forecasters, and can be used as a basis for a large number of automated forecasts distributed to the general public and various authorities. They are also used as input (forcing) to many specialized applications forecasting road conditions, waves and currents in the Baltic Sea, potential dispersion of radioactive pollutants, or air quality.

7.3 The MBE forecasting system (short range weather forecasts)

7.3.1 Data assimilation, objective analysis and initialisation

Same as in RCR, except for six-hourly cycling

7.3.2 Model:

Same as in RCR with the following exceptions:

Integration domain:

406 x 306 gridpoints in transformed latitude-longitude grid, 40 vertical levels (as in the analysis)

Grid length:

0.08° (~9 km)

Time-integration:

2 time level semi lagrangean semi-implicit (time step = 3 min)

Forecast length:

54 hours at 06 and 18 UTC, forecasts available after 5 h 10 min

Boundaries:

boundary values with hourly resolution are interpolated horizontally from the forecasts of the RCR suite.

7.3.3 Numerical weather prediction products

As in 7.2.3

7.3.4 Operational techniques

As in 7.2.4

7.4 Specialized forecasts

FMI operates a set of air-quality/pollution dispersion models. Forecasts of sea-waves and sea-ice, water levels and currents as well as river runoff are produced in cooperation with the Finnsih Institute of Marine research and the Finnish Environment Institute.

7.4.1. Data assimilation etc.. (as applicalble)

A variational data assimilation technique 4DVAR for a passive tracer has been developed for the emergency dispersion model SILAM and applied to a full-scale 3D inverse dispersion problem based on European Tracer Experiment ETEX (Sofiev & Atlaskin, 2004).

7.4.2. Models

Meso-to-hemispheric scale dispersion models at FMI (alphabetical order):

DMAT. Eulerian, regional-to-hemispheric, research; SOx, NOx, NHx, toxic metals and organic pollutants, long-living multi-media pollutants, mineral dust, size-segregated aerosol. (Sofiev, 2000)

HILATAR. Eulerian, regional, research; SOx, NOx, NHx, toxic metals, mineral dust. (Hongisto, 2002)

SILAM. Lagrangian, meso-to-continental, research and operational; size-segregated aerosol, up to 496 radioactive nuclides, natural pollen, probabilities (Sofiev & Siljamo, 2003).

7.4.4. Operational techniques for application of NWP products

Operational 4-times a day 48-hours forecasts of probabilities and potential areas of risk in case of nuclear accidents at 5 nuclear power plants in Finland and the nearest surrounding; made on the basis of HIRLAM and/or ECMWF NWP forecasts.

8. Verification of prognostic products

Due to the limited computational area of the operational forecast model, no verification summaries are computed for the areas suggested. However, standardized verification scores based on surface observations and upper air soundings are being provided operationally for the HIRLAM consortium.

9. Plans for the year 2005

Extended (54 hour) forecasts from the high resolution MBE suite will be made available four times a day early in 2005. Assimilation of ATOVS AMSU-A data and doppler radar wind data will start during the year. The monitoring facility will be further developed.

10. References

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