FINLAND

FINNISH METEOROLOGICAL INSTITUTE

Helsinki

1. Summary of highlights

This report describes the essential features of the numerical weather prediction (NWP) system operational during the year 2002. The system is based on the use of the results from the international Hirlam project. The other countries, in addition to Finland, in this project are Sweden, Norway, Denmark, Iceland, Ireland, France, Spain and the Netherlands. Meteorologically the system is based on the HIRLAM reference system version 4.6.2.

The operational numerical forecasting system at the Finnish Meteorological Institute (FMI) contains two suites. The “Atlantic suite” (**ATA**) contains a complete data-assimilation/forecasting system. It is run to +54 hours four times a day, based on 00, 06, 12 and 18 UTC data. The resolution is 0.4° x 0.4° in the horizontal and 31 levels in the vertical. The geographical area covers Europe, North Atlantic and parts of North America. Forecasts received from ECMWF are used for lateral boundary values in the Atlantic suite.

The integration area of the other suite (called **ENO**) covers mainly the northern Europe. It contains a full data assimilation/forecast system and uses boundary values from the **ATA** suite with a frequency of three hours. The resolution is 0.2° in the horizontal and there are 31 levels in the vertical. The forecast length is 54 hours.

The T3E and Origin 2000 supercomputers, hosted by the Center for Scientific Computing (CSC), were used for running the HIRLAM system. In December the operational Hirlam was transferred to the new IBM eServer Cluster at CSC.

2. Equipment in use for numerical forecasting in Finland

From January to November Cray T3E system was the main computer used for numerical weather prediction. From December onwards one IBM pSeries 690 node of the IBM cluster , containing 32 Power 4 processors, is used for running Hirlam. There is 32 GB of memory in one node and the clock frequency of the processors is 1.1 GHz. The Origin 2000 is a backup computer.

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

Typical number of observations used daily in the **ATA** suite:

SYNOP, SHIP:	26000
TEMP:	1400
AIREP, AMDAR:	10100
PILOT:	180
DRIBU:	1400
SATOB:	800
SATEM	600

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

The HIRLAM level 4.6.2 system is used for short range, 1-2 days, forecasting. Two versions of the HIRLAM forecasting system is run operationally:

- the “Atlantic suite” (**ATA**): full 6 hour data assimilation cycle four times a day, resolution 0.4° in the horizontal and 31 levels in the vertical, forecast length 54 hours, products available on model and constant pressure levels with the interval of one hour

- the “European suite” (**ENO**): full 6 hour data assimilation cycle four times a day, resolution 0.2° in the horizontal and 31 levels in the vertical, forecast length 48 hours, products available with the interval of one hour

7.2 The ATA forecasting system (short range forecasts)

Four complete data assimilation cycles are run daily with the HIRLAM system to +54 hours. The cut-off time for observations is 2 h 30 min. The elapsed time of one complete forecast run (including analysis, forecast and post-processing) is about 30 min.

7.2.1 Data assimilation, objective analysis and initialisation

Analysis system:

3-dimensional multivariate statistical interpolation, univariate for relative humidity (limited area version of the ECMWF scheme)
A separate univariate analysis for sea surface temperature, ice coverage and snow depth

Parameters:

surface pressure, geopotential, wind components, relative humidity, sea surface temperature, ice coverage and snow depth

Levels:

hybrid levels defined by A’s and B’s. Levels are (assuming the surface pressure of 1000 hPa): 996, 983, 959, 928, 891, 850, 807, 762, 717, 671, 626, 581, 538, 495, 453, 413, 374, 338, 302, 269, 237, 208, 181, 156, 132, 111, 90, 70, 50, 30, 10 hPa

Observation types:

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

First guess:

six hour forecast of the previous cycle

Initialisation:

adiabatic non-linear normal mode initialisation, 4 vertical modes are initialised

Cut-off time:

2 h 30 min.

7.2.2 Model

Basic equations:

primitive equations in flux form

Independent variables:

λ,θ (transformed latitude-longitude co-ordinates), η, t

Dependent variables:

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

Integration domain:

194 x 140 gridpoints in transformed latitude-longitude grid, 31 vertical levels (as in the analysis)

Grid length:

0.4° (~44 km)

Grid:

staggered grid (Arakawa C)

Time-integration:

leapfrog semi-implicit (Δt = 3 min)

Orography:

smoothed US Navy mean orography, no gravity wave drag

Physical parameterisation:

prognostic cloud scheme
turbulence based on turbulent kinetic energy
Hirlam radiation scheme
Hirlam old surface parameterisation scheme

Horizontal diffusion:

implicit fourth order

Boundaries:

time dependent lateral boundary conditions from ECMWF model (on model levels). The boundaries come from a special ECMWF run and are based on six hours older observations.

The integration area covers Europe, the North Atlantic and north-eastern part of Canada. It is a transformed latitude/longitude grid with the north pole moved along the 180° meridian to the latitude of 30° N to avoid the convergence of longitudes towards the pole.

7.2.3 Availability of the numerical weather prediction products

All the HIRLAM products on model and constant pressure levels are available are for applications in the 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.

Hirlam forecasts are used as input in the real-time trajectory model, air pollution models, cloud animations and in the interpretation models of the satellite data and UV-index forecasts. In addition, Hirlam products are used in many other applications.

7.3 The ENO forecasting system (short range weather forecasts)

The mesoscale system is run four times a day to 54 hours. The main difference to the basic system is the horizontal gridlength, which in the ENO suite is system is 0.2°. This forecast suite is run partly in parallel, partly after the ATA HIRLAM run mentioned in the previous chapter. The ENO suite is ready about 30 min. after the ATA suite.

7.3.1 Data assimilation, objective analysis and initialisation

Same as in 7.2.1 with some minor modifications

7.3.2 Model:

Same as in 7.2.2 with the following exceptions:

Grid length:

0.2° (~22 km)

Time-integration:

leapfrog semi-implicit ($\Delta t = 2$ min)

Boundaries:

boundary values are interpolated horizontally and vertically from the forecasts of the ATA suite. Boundaries are updated every three hours.

7.3.3 Numerical weather prediction products

The same fields are available to forecasters as from the ATA suite.

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, standardised verification scores are being provided operationally for internal purposes.

9. Plans for the year 2003

The whole NWP system will be replaced with a new version of the Hirlam system. Especially, 3DVAR analysis will be introduced instead of the present optimal interpolation method. The new system has been run in parallel with the present one since August 2002.

10. Publications

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