

NWP at Met Éireann - ASM 2008

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Introduction

The Hirlam system is used at Met Éireann – the Irish Meteorological Service – to produce operational forecasts out to 48-hours. The model (version 7.0rc1 with 3DVAR) is run four times per day using 32 dual-CPU nodes of the walton cluster at ICHEC [Irish Centre for High-End Computing].

Met Éireann and ICHEC [www.ichec.ie] signed a collaboration agreement in early 2007. As part of this collaboration, ICHEC provides computational facilities and support to Met Éireann to enable it to run its operational high-resolution forecast models on ICHEC's flagship supercomputer, walton [IBM eServer cluster 1350 consisting of 476 IBM e326 compute nodes with 20 TB of tightly integrated high-performance SAN based around an IBM DS4500].

Data Assimilation

Observations: SYNOP, SHIP, BUOY, AIREP, AMDAR, ACARS TEMP, TEMPSHIP, PILOT observations are used. The data are packed into BUFR format both for storage and for input to Hirlam.

Analysis: Hirlam 3DVAR [3-dimensional variational assimilation]. The analysis runs on 60 hybrid [eta] levels. Upper-air observational data is accepted on all standard and significant levels (10 hPa to 1000 hPa) and interpolated to eta levels.

Assimilation Cycle: Three-hour cycle using the forecast from the previous cycle as a first-guess. The LSMIX option was switched on in late January 2008. A *re-forecast* is carried out every cycle. [It is also possible to use an ECMWF forecast as a first-guess].

Analysed Variables: Wind components (u,v), geopotential and specific humidity.

I

Lateral Boundary Treatment: Davies-Kallberg relaxation scheme using a cosine dependent relaxation function over a boundary zone of 8-lines. The latest available ECMWF 'frame' files are used [based on 4 ECMWF runs per day at 00Z, 06Z, 12Z and 18Z, respectively]. ECMWF data, received on a $0.3^\circ \times 0.3^\circ$ rotated latitude-longitude grid and on ECMWF eta levels, is interpolated both horizontally and vertically to the Hirlam $0.15^\circ \times 0.15^\circ$ rotated latitude-longitude grid with 60 [Hirlam] eta levels. [The selected $0.3^\circ \times 0.3^\circ$ grid corresponds to half the resolution of the $0.15^\circ \times 0.15^\circ$ grid; we may upgrade to full resolution in the future if the line-speed proves fast enough].

In general the ECMWF boundary files are just provided as 'frame' boundaries where the data is not defined in the central section of the grid. The following diagram shows such a grid:

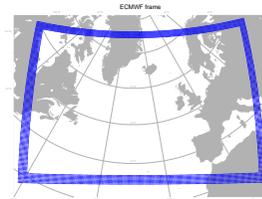


Figure 2: ECMWF frame

However, the ECMWF analysis fields are received on a 'full' grid and so can be used as a 'first-guess' in the case of a 'cold-start'.

III

Nested Hirlam - Hourly Setup

A separate nested version of Hirlam is run every hour on a high-performance PC running Linux. The run has a cutoff time of 20-minutes and provides an hourly analysis and a short range [6-hour] local forecast. The following diagram shows the area:

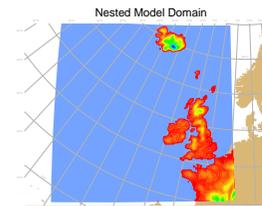


Figure 4: Hourly orography

Forecast Model: Hirlam 7 forecast model.

Vertical grid: A set of 40 hybrid [eta] levels.

Horizontal grid: A rotated latitude-longitude grid is used with 166 x 163 grid points with a resolution of $0.15^\circ \times 0.15^\circ$.

Data Monitoring

The analysis departures/flags are fed back to the original BUFR reports to create 'feedback' files which are used to monitor the quality of the data on an ongoing basis and to identify problems [e.g. station elevation errors].

V

Backup Linux Cluster

Met Éireann started to experiment with running Hirlam on a Linux cluster in early 2004. The experiences have been generally good. The cluster performance is similar to our old IBM RS/6000 SP mainframe [a system with 9 nodes each with 4 processors sharing 2 Gbytes of memory i.e. a total of 36 CPU's and 18 Gbytes of memory]. We use the cluster to run a backup version of the operational Hirlam-7 model but with 31 levels rather than the 60 used at ICHEC.

Cluster Details: The cluster consists of 10 rack mounted Dell Poweredge 1750 nodes (i.e. 1 master node and 9 compute nodes). The master node has dual 2.8GHz Xeon processors with 4 Gigabytes of ECC DDR RAM; each compute node has dual 3.2GHz Xeon processors with 2 Gigabytes of memory. The compute nodes are connected as a two-dimensional torus via 4 Port Dolphin SCI HBA cards. The cluster runs RedHat ES 3.0 / WS 2.0 with PGI compilers and Scali MPI software.

Operational Usage

General Forecasting: Hirlam forecasts are used for general forecasting in Met Éireann out to 48-hours. [ECMWF forecasts are used beyond that period]. Hirlam output can be displayed using an interactive graphics system called *xcharts* (developed at Met Éireann).

WAM model: Forecast 10-metre winds from Hirlam are used to drive the ECWAM limited area wave model at a resolution of $0.25^\circ \times 0.25^\circ$.

Roadice Prediction System: Forecast surface parameters [temperature, wind, cloud-cover, humidity and rainfall] are used [after forecaster modification] as input to a roadice model.

SATREP: Hirlam output can be overlaid on satellite plots as part of the ZAMG SATREP analysis scheme.

VII

Forecast Model

Forecast Model: Hirlam 7 reference system grid point model.

Horizontal grid: A rotated latitude-longitude grid is used with the South-Pole at (-30° longitude, -30° latitude). Fields are based on a 438×284 grid corresponding to a $0.15^\circ \times 0.15^\circ$ horizontal Arakara C-grid [see diagram]:

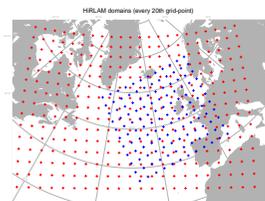


Figure 1: HIRLAM domains: Main - red, Nested - blue

Vertical Grid: Hybrid [eta] coordinate system with 60 levels.

Initialisation: Digital Filter.

Integration Scheme: We use a two time-level three-dimensional semi-Lagrangian semi-implicit scheme with a time-step of 300 seconds.

Filtering: Fourth order implicit horizontal diffusion.

Physics: CBR vertical diffusion scheme; Sundqvist condensation scheme with the 'STRACO' (Soft TRAnSition COndensation scheme) cloud scheme; Savijarvi radiation scheme.

II

Nested Hirlam

A nested version of Hirlam is also run at ICHEC. It runs immediately after the main run has finished and produces 30-hour forecasts. The following diagram shows the area:

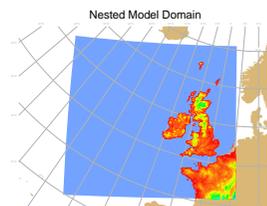


Figure 3: Nested orography

Forecast Model: Hirlam 7 forecast model.

Vertical grid: A set of 60 hybrid [eta] levels.

Horizontal grid: A rotated latitude-longitude grid is used with 438×395 grid points with a resolution of $0.05^\circ \times 0.05^\circ$.

IV

Verification

Verification against Fields: A small number of Hirlam parameters are verified against the corresponding Hirlam analysis fields. [This is to provide continuity with an earlier model which was used before Hirlam became operational].

Verification against Observations: The Hirlam verification system is used to verify forecasts against observations from EGWGLAM stations within the area.

Verification Statistics

The following diagram shows some verification statistics for Hirlam-7 [60-levels], against the EGWGLAM stations, covering the period Apr-Sept 2007:

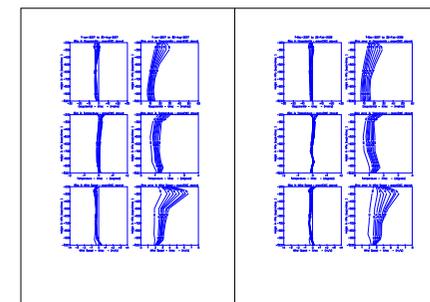


Figure 5: Verification profiles for summer and winter

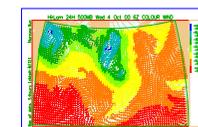
VI

Sample Output

The following are some examples of typical Hirlam output as displayed on the forecaster's workstation [using the *xcharts* graphics program]. The first chart shows accumulated rainfall:



The next chart shows wind-arrows at 500hPa. The colour of each arrow has been chosen to indicate the temperature at that level:



Current Activities

- Better specification of boundary conditions for NWP models
- Operational implementation of ATOVS data
- Testing of 4DVAR
- Operational use of IBL visual weather work station

VIII