

Operational HIRLAM at DMI - Status and plans for 2003

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1 Introduction

This is a short overview of the operational HIRLAM set-up at DMI with emphasis on the upgrades made since the 2002 HIRLAM all-staff meeting.

2 Upgrades to DMI's operational HIRLAM system since the 2002 HIRLAM all-staff meeting

In the period between the HIRLAM all-staff meeting 2002 and the HIRLAM all-staff meeting 2003 there has been a total of five upgrades to the operational HIRLAM set-up at DMI. A brief account of each upgrade is as follows:

2.1 April 17, 2002:

The advection scheme for humidity, turbulent kinetic energy and cloud water was changed from centered differences to upstream.

2.2 September 10, 2002:

The operational HIRLAM set-up was moved from the old NEC SX-4 to the first phase of the new NEC SX-6 system with a minimum of changes.

2.3 September 24, 2002:

A special HIRLAM suite for Afghanistan was created in order to support operations of the Danish air force in the area.

2.4 December 9, 2002:

This was the largest upgrade since the last all-staff meeting. The upgrade consisted of the following changes:

1. Use of NOAA16 AMSU-A data in the 3D-VAR analysis.

2. The number of vertical levels were increased from 31 to 40.
3. The explicit horizontal diffusion scheme was replaced with the implicit horizontal diffusion.
4. The STRACO convection scheme was updated. For details about the new STRACO scheme see (Sass, 2002).
5. The time-step was reduces in order to solve stability problems with 40 levels.
6. The advection scheme for q and CW was changed back to centered differences.

Before the upgrade several parallel tests were made as described in (Amstrup *et al.*, 2003).

2.5 March 20, 2003:

The long forecasts per day for DMI-HIRLAM-D was changed from 2 (0 and 12 UTC runs) to 4 (0, 6, 12 and 18 UTC runs).

3 The primary DMI-HIRLAM suite

Below follows a brief overview of the primary suite of the DMI-HIRLAM system. More details can be found in (Sass *et al.*, 2002) with updated information in (Amstrup *et al.*, 2003).

The primary operational DMI-HIRLAM suite is a triply nested system with a coarse resolution model covering all of Europe, the northern Atlantic and some of North America (DMI-HIRLAM-G), finer resolution models over Europe (DMI-HIRLAM-E) and Greenland (DMI-HIRLAM-N) and a high resolution model over Denmark (DMI-HIRLAM-D). The domains of the models are shown in figure 1.

3.1 Analysis set-up

The upper air data assimilation system is HIRLAM 3D-VAR with conventional observations (SYNOP, SHIP, DRIBU, AIREP (with AMDAR/ACARS), PILOT, TEMP) and NOAA-16 AMSU-A data with 3 hour cycling with large scales from ECMWF twice per day for the outer-most models (Sass *et al.*, 2002).

Sea surface temperature and ice coverage is updated from fields received from ECMWF twice a day. Currently we are not running any surface analysis schemes.

3.2 Forecast model set-up

In our operational runs we use Eulerian time integration. We use longer physics time steps compared to dynamics time steps as described by Sass *et al* (2002). For physics parameterization we use the CBR turbulence scheme and the STRACO convection/condensation scheme.

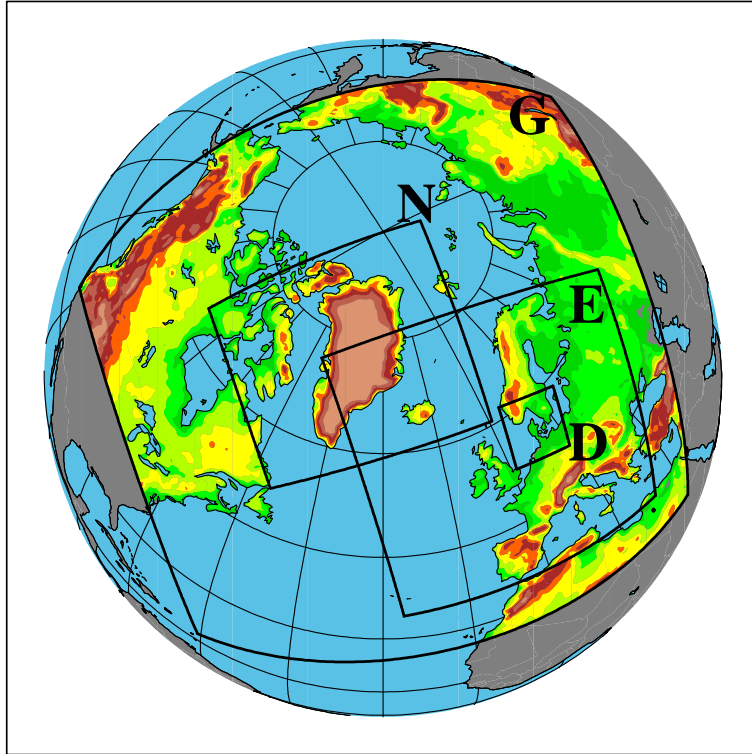


Figure 1: Operational domains (primary suite)

3.3 Operational set-up and schedule

The operational set-up (in form of grid points, number of levels, resolutions *etc*) is summarized in table 1.

Our operational schedule is given in table 2. For reasons of efficiency we run our 06/18 UTC DMI-HIRLAM-G and DMI-HIRLAM-E runs with a 6 hour old first guess in order to save some analysis runs. The second 00/12 UTC DMI-HIRLAM-G run with an ECMWF restart is done after receiving the 00/12 UTC ECMWF analysis followed by 3 hour cycling to provide a good first-guess for the 12/00 UTC runs.

4 The special DMI-HIRLAM suite for Afghanistan

The special operational DMI-HIRLAM suite is a double nested system with a 0.3° resolution outer model and a 0.15° resolution inner model. The outer model uses 3D-VAR as analysis scheme whereas the inner model does not run it's own analysis. The set-up for the special suite is similar to the primary set-up before the upgrade on December 9, 2002. The schedule of the special suite is such that the special suite runs after the primary suite.

Model Identification	G	N	E	D
grid points (mlon)	202	194	272	182
grid points (mlat)	190	210	282	170
no. of vertical levels	40	40	40	40
horizontal resolution	0.45°	0.15°	0.15°	0.05°
hor. res. (assimilation)	0.45°	0.45°	0.45°	—
time step (dynamics)	150 s	60 s	60 s	25 s
time step (physics)	450 s	360 s	360 s	150 s
boundary age (in forec.)	6 h	0 h	0 h	0 h
boundary age (in ass.)	0 h–6 h	–3 h–0 h	–3 h–0 h	–3 h–0 h
host model	ECMWF	G	G	E
boundary frequency	1/(3 h)	1/(1 h)	1/(1 h)	1/(1 h)
data assimilation cycle	3 h	3 h	3 h	3 h
forecast length (long)	60 h	36 h	54 h	36 h
long forecasts per day	4	2	4	4
pole lon.	80.0°	80.0°	80.0°	80.0°
pole lat.	0.0°	0.0°	0.0°	0.0°
west (in rot. grid)	–63.725°	–28.677°	–15.177°	–5.277°
south (in rot. grid)	–37.527°	–54.275°	–36.675°	–29.075°

Table 1: Summary of DMI’s operational HIRLAM set-up

UTC	G	N	E	D
1:40 1:50 2:30 2:55	G00+60h		E00+54h	D00+36h
ECMWF 00 UTC				
7:37 7:50 8:16	G06+60h		E06+54h	D06+36h
ECMWF 06 UTC				
11:50	G_E00+03h G03+03h G06+03h G09+03h			
11:59			E03+03h E06+03h E09+03h	
12:08				D03+03h D06+03h D09+03h
12:13		N03+03h N06+03h N09+03h		
UTC	G	N	E	D
13:40 13:50 14:30 14:55	G12+60h		E12+54h	D12+36h
ECMWF 12 UTC				
19:40 19:50 20:16	G18+60h		E18+54h	D18+36h
ECMWF 18 UTC				
23:45	G_E12+03h G15+03h G18+03h G21+03h			
24:00			E15+03h E18+03h E21+03h	
24:15				D15+03h D18+03h D21+03h
24:20		N15+03h N18+03h N21+03h		

Table 2: Operational schedule: primary suite

5 New NEC SX-6 computer installation

During the last year a new computer system has been installed at DMI replacing the old NEC SX-4 with a new NEC SX-6 system. The installation has been done in two phases with an initial installation of two SX-6 nodes with totally 16 CPU's in April 2002 and a final installation in April 2003 with eight SX-6 nodes with totally 60 CPU's. Details about the amount of hardware installed can be found in table 3. A schematic overview of the final installation can be found on figure 2.

Installation date	April 2002	April 2003
SX-6 vector CPU's on IXS	2×8	$7 \times 8 + 1 \times 4$
Memory	96 Gbyte	320 Gbyte
SX-6 vector CPU's not on IXS	2	2
Peak speed (GFLOPS)	$128 + 16$	$480 + 16$
Increase relative to SX-4	4	15
Front-end system	2 AzusA's	2 AzusA's + 2 AsAmA's
Front-end CPU's	2×4 Itanium	2×4 Itanium + 2×4 Itanium2
Front-end memory	2×4 Gbyte	$2 \times 4 + 2 \times 8$ Gbyte
Front-end total peak (GFLOPS)	25.6	$25.6 + 32$
Shared disks	1 Tbyte	4 Tbyte

Table 3: Details of the new NEC installation at DMI.

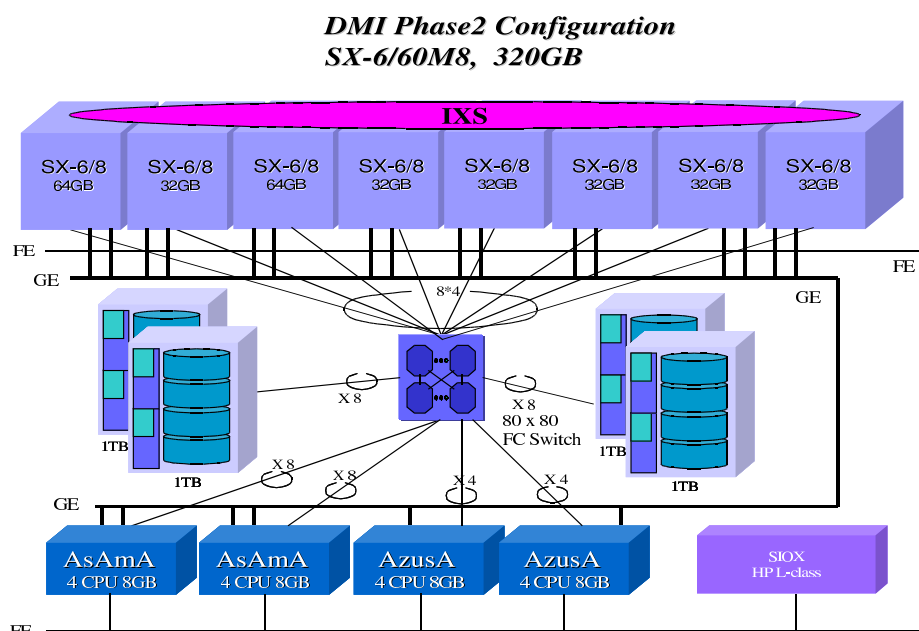


Figure 2: Schematic overview of the SX-6 installation at DMI.

A major difference between the new system and the old SX-4 is that the old NEC SX-4 was a shared memory system whereas the new system is a combination of shared memory (within a node) and distributed memory (across nodes). This means that the current operationally used shared memory parallel versions of 3D-VAR and forecast model

can not fully utilize the full multi-node system. A new set-up is based on a distributed memory programming model (*e.g.* MPI) will be needed in order to fully utilize the system.

An important aspect of the new system is the disk system which allows fast access to data both on the compute SX-6 nodes and on the Itanium based front-ends. This means that computational intensive applications (such as the 3D-VAR analysis and the forecast model) can run on the SX-6 nodes and write data directly to disks seen by the front-ends where I/O intensive applications (such as plotting of maps) will run.

6 Plans

The short term plans is to upgrade the analysis system to use the first guess at appropriate time (FGAT) option and to use more satellite data in form of NOAA-17 AMSU-A data and Quikscat winds.

A more long term plan is the switch from the current model version to the reference version of HIRLAM (with semi-Lagrangian dynamics and the ISBA scheme and surface analysis). The current DMI-HIRLAM system will probably still be maintained for some time in the future for special DMI post-processing and derived products.

When the HIRLAM reference version works satisfactory on the NEC system the plan is to switch to new domains with a simpler set-up with only a double nested with a 0.15° 602×568 grid with 50 (or 60) levels and a yet to be decided larger 0.05° area.

The 3D-VAR analysis system will be continuously upgraded with new observation types such as wind profiler data and possibly MODIS winds.

References

- Amstrup, Bjarne, Mogensen, Kristian Sten, Nielsen, Niels Woetmann, Huess, Vibeke, and Nielsen, Jacob Woge. 2003. *Results from DMI-HIRLAM pre-operational tests prior to the upgrade in December 2002*. Tech. rept. 03-20. Danish Meteorological Institute. Available from <http://www.dmi.dk/f+u/publikation/tekrp/tekniskerap.html>.
- Sass, Bent Hansen. 2002. *A research version of the STRACO cloud scheme*. Tech. rept. 02-10. Danish Meteorological Institut. Available from <http://www.dmi.dk/f+u/publikation/tekrp/tekniskerap.html>.
- Sass, Bent Hansen, Nielsen, Niels Woetmann, Jørgensen, Jess U., Amstrup, Bjarne, Kmit, Maryanne, and Mogensen, Kristian Sten. 2002. *The operational DMI-HIRLAM system - 2002-version*. Tech. rept. 02-05. Danish Meteorological Institut. Available from <http://www.dmi.dk/f+u/publikation/tekrp/tekniskerap.html>.