SMHI operational HIRLAM system

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1. Computer system

HIRLAM at SMHI is run on computers at the National Supercomputer Centre (NSC) at Linköping university.
Hirlam is run on both a shared memory SGI, and a distributed memory PC-Cluster.

In 2002 NSC replaced their distributed memory machine, a CRAY T3E with 272 PE's with two self-built PC-Cluster where one, BRIS, is dedicated entirely to SMHI's operational models, HIRLAM and the oceanographic model HIROMB. The other, MONOLITH, is for SMHI development work, including HIRLAM, dispersion models and ROSSBY climate centre use. MONOLITH is also a general university computing resource.

BRIS is a PC-cluster with 1+16+2 nodes, each with 2 Intel Xeon 2.2 GHz processors. Each node has 2 GB memory and 60 MB local disk. One node act as a login node and for interactive work and is connected to the other nodes with Ethernet. The other PE's are also connected to each other with Ethernet and 16 of the PE's are connected with a fast SCALI network. There are also 1 TB of disk to the system.

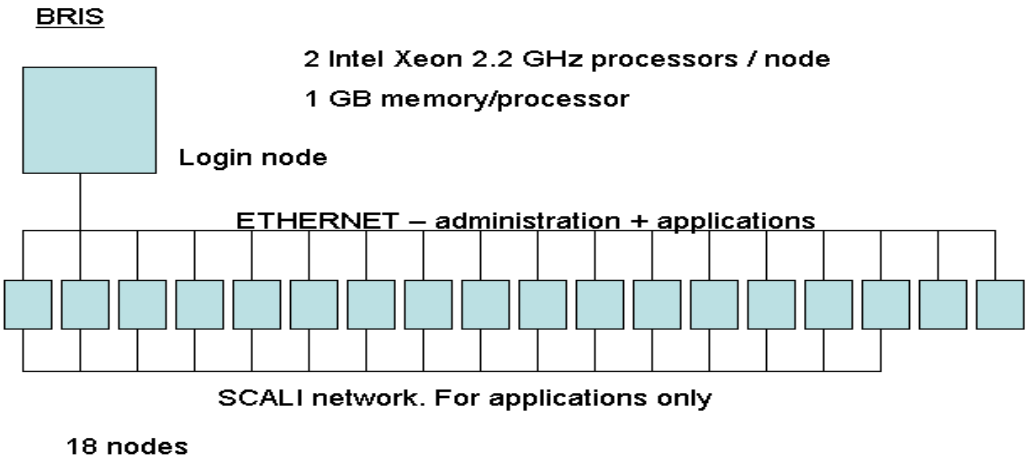
BRIS is using Redhat Linux operating system and have:

- PGI, GNU and Intel compilers
- ScaMPI, MPICH and LAM MPI-libraries
- Intel Math Kernel Library
- OPEN PBS queue system

The SGI 3800 at NSC has 128 PE's with 128 GB shared memory, 128 Gflops peak performance, IRIX operating system and LSF batch system. For operational Hirlam only 16 PE are used due to bad speed-up on more PE when using MPI for parallellization.

Preprocessing are run at SMHI on high availability DEC/Alpha servers.

Communication between NSC SGI and SMHI Unix system is provided through a dedicated ATM link with 10 MB capacity.



2. HIRLAM system

Up until the end of 2002 SMHI had been running a rather old HIRLAM version mainly based on version 2.5 physics and during 2002 we put in a rather big effort in upgrading the operational HIRLAM system in a form of a project, Hirlam X. The new version was thoroughly tested both in near real time and through running it in 4 monthly periods in all seasons.

The new operational Hirlam model is now based on HIRLAM 5.1.4 with certain modifications:

- Kain-Fritsch convection
- Rasch-Kristjansen condensation
- Soil freezing removed in forest and low vegetation (ktyp = 4 and 5)
- Modified CBR
- 40 levels that differs from the one in Vineta. Mainly the lowest level is higher (c:a 28 meter in stead of 10)
- smooth orography

In the surface analysis SMHI also merge the icefield from the Baltic ice model BOBA.

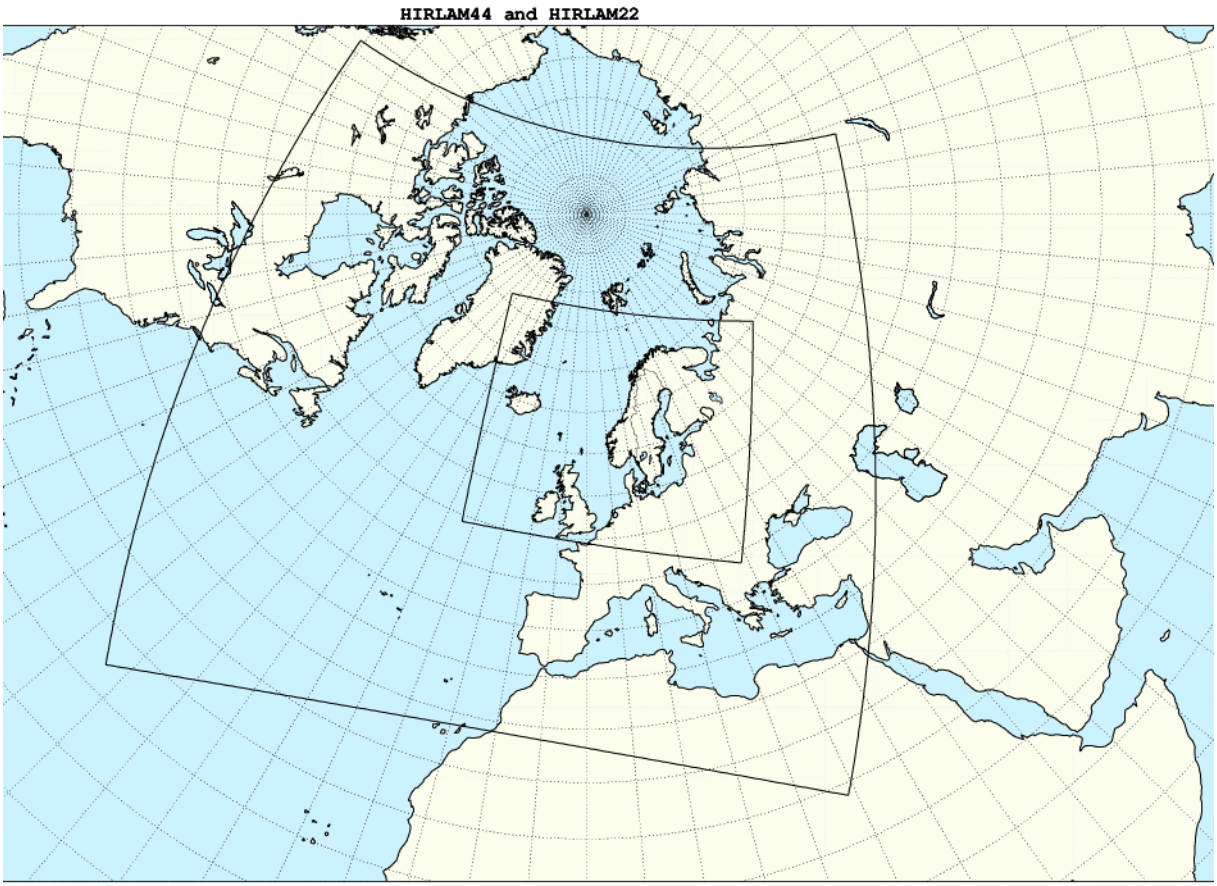
The analysis is HIRVDA version 5.1.1

3. Operational setup

SMHI has for many years operationally been running two completely separate suits of the HIRLAM setup on two computers. Many forecast products are now being generated directly from model output which makes it crucial that the models are run without interruption and in time. SMHI has solved this by running an operational suite and at the same time run a backup suite on an other machine. To switch between the two suits is a simple operator command. At

present the PC-Cluster, BRIS, is normally the operational machine and SGI works as the backup machine mainly because faster communication links to BRIS as it physically is placed in the computer room at SMHI althought it is still a NSC resource.

SMHI runs HIRLAM at two domains with different horizontal resolution. H44 has a resolution of 0.4° over a rotated grid with 202x178 horizontal gridpoints. It uses ECMWF boundary conditions 4 times a day from ECMWF BC project with a temporal resolution of 3 hours. A nested H22 is run at 0.2° resolution over 162x142 gridpoints and with boundaries from the 44 model. Both versions have the same 40 model levels.



Model files are written every hour and sent to SMHI UNIX system. The postprocessing used to be at SMHI but in the new setup it is done inside the ordinary HIRLAM run.

MPI parallellisation is used both for the forecast model and for the analysis.

The BOBA sea ice model and pseudo SST observations from manually analysed Baltic SSTs are used in the surface analysis.

The statistics files are produced operationally and they are converted to formatted files so that they can be used on the workstations for a graphical monitoring tool and for accumulating and plotting RMS observation statistics. These are essential tools for monitoring of the operational runs and for evaluating modifications.

SYNOP, AIREP, AMDAR, BUOY, TEMP and PILOT observations enter the analysis using a version of the ECMWF observation pre-processing system to convert from the WMO alphamuneric code forms used on GTS to BUFR format.

TOVS AMSU-A and VAD wind profiles are used in passive mode.

Operational schedule

At every 3 hours +0h25m a preliminary H44 analysis is run using mainly SYNOP data. The output is mainly used for automated analysis of weather charts.
Every 6 hours, HIRLAM 44 is run with a cut off of 1h55m. The forecast is run out to 48 hours and then HIRLAM 22 is started, and the forecast is run to 48 hours.

HIRLAM operational runs and other things like available diskspace on involved systems, availability of resources, the automatic product generation from HIRLAM data and communication links are continuously supervised by SMHI general supervising system KARO.

4. Events

During last year many resources were allocated at SMHI in the project Hirlam X which had as a goal to upgrade our operational version with new physics and new surface analysis. This led directly to changes in the operational runs and other things were an indirct result of the upgrade. Further there was other changes that just coincided in time but the result was that almost everything in SMHI operational Hirlam was changed and we also took the opportunity to refresh a lot of scripts that controlled the system.
So in the beginning of December 2002 a lot of changes took place:

- New Hirlam model
- New computer – PC-cluster
- Higher vertical resolution – 40 levels in stead of 31
- New fileserver at SMHI – for storing model output
- New execution of Hirlam – SMS, which not has been used at SMHI before
- TOVS AMSU-A and VAD in passive mode
- Postprocessing inside the model – stand alone at SMHI before
- New framework for operational system
- Test of FGAT – first guess at appropriate time

All this led to a major revision of all applications at SMHI that is using Hirlam output.

In addition to have a model upgrade Hirlam X also had the aim at reaching a concenpt to introduce changes to the operational model version and make thorough testing and validation. An additional aim was to strenghten the cooperation between developers/researchers and people that operated and also use the models.

5. Coming work

Even after a major update of the operational setup the plans are very ambitious for the coming year:

- Set up a ‘research’ model in near real-time to compete with the present operational. This should be the next operational model
- TOVS and VAD in active mode
- FGAT operational
- GPS data in passive mode
- Test vith 4DVAR
- Inclusion of asynchronous I/O
- Higher horizontal resolution - 0.2° resolution on the H44 area. And also higher vertical resolution. Possibly also an even higher relolution , 0.1°

Discussion will also start with NSC for the next generation of PC-cluster and upgrading of SGI for in particular be able to handle 4DVAR analysis.