Operational NWP Activities at the Finnish Meteorological Institute

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1. Introduction

Duties as the lead centre for maintaining a regular cycle of the HIRLAM reference system (RCR) and implementation of a new nested meso-β-scale (0.08^{o}) HIRLAM system have dominated the operational NWP activities at FMI. After an extensive testing the RCR system was updated to the HIRLAM reference system version 6.4 [Jär05b][JEF+04]. The new nested meso-β-scale system gained operational status on November 2005 [Jär05a]. A significant effort has also been devoted to the upgrades of the on-line monitoring interface accessible to the whole HIRLAM community. On the computational side, after FMI's decision to move to the utilisation of an in-house high performance computing facility, the long-standing operational co-operation with the CSC (Finnish IT center for science) has been discontinued.

Figure 1 shows the development of peak computing performance in FMI's NWP over the years. In the early years the full computing power of the CSC's supercomputers was utilized in the FMI's operational NWP runs, later only a part of the full power has been used for the operational LAM modelling. The ECMWF performance figures have been given for reference.

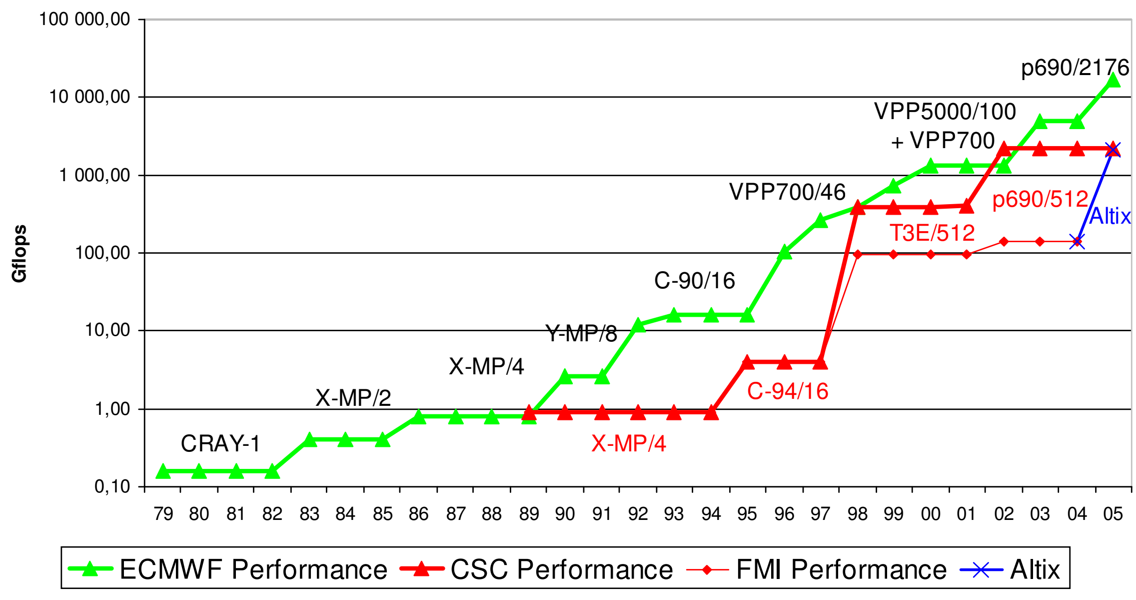

Fig.1 : Development of the peak computing power in FMI's NWP.

2. Technical Environment

The high performance computing parts of the operational LAMs were executed at CSC until June 2005 as before. One IBM p690 node (32 Power4 1.1 GHz CPUs, 32 GB memory) was dedicated to FMI's operational runs only. Since the first of June 2005 an in-house SGI Altix 350 consisting of 16 Itanium2 1.5 GHz processors and offering 64 GB of shared memory has been used for operational runs.

Starting from October 2005, a bigger HPC system, SGI Altix BX2, will be taken into use. The system will consist of 304 1.5 GHz Itanium2 processors with 304 GB of shared memory. With the introduction of the new HPC system, the wall clock time used in the RCR suite will decrease from the 73 minutes spent on IBM system to less than 4 minutes on SGI (3 min for forecast, 30 sec for analysis).

Figure 2 illustrates the technical environment used in the CSC-based RCR system. The observations as well as the Baltic SST/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, 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 available to all HIRLAM members by archiving the data to the ECMWF's ECFS using the ecaccess gateway. A graphical interface for monitoring is provided to the whole HIRLAM community through the HeXnet facility [KS05].

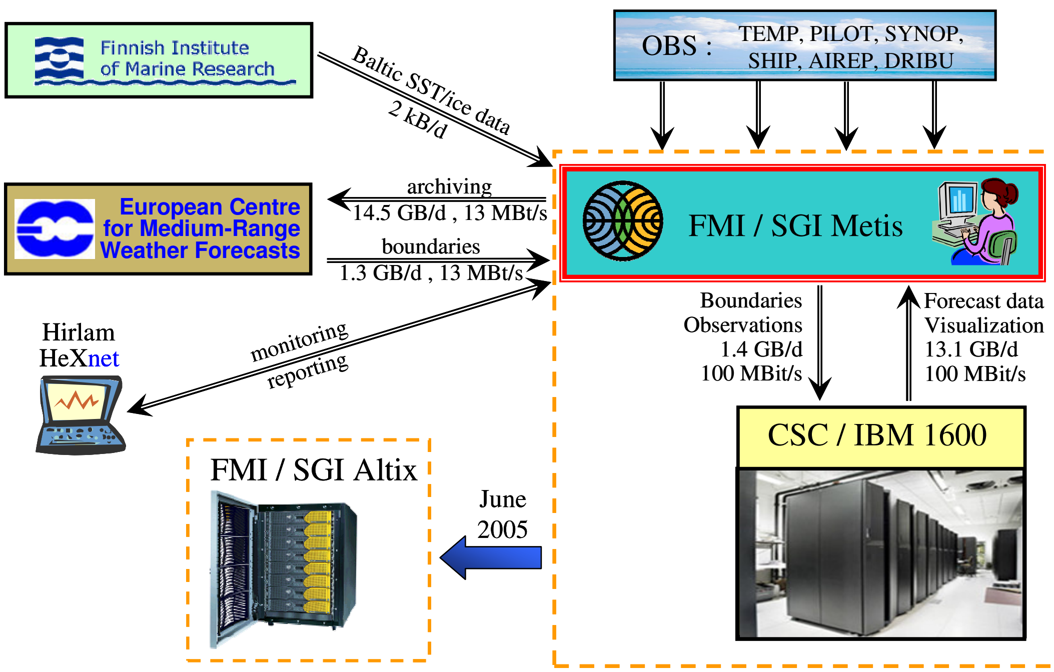

Fig.2 : FMI NWP technical environment.

3. Meteorological Implementation

Starting from June 2005, the HIRLAM 6.3 based RCR suite was replaced by the HIRLAM reference system version 6.4 with default settings (e.g. 0.2^o horizontal resolution), featuring the HIRLAM 3DVAR analysis scheme and the ISBA surface scheme. The main features of the RCR suite are listed in Table 1, and the integration area is shown in Figure 3.

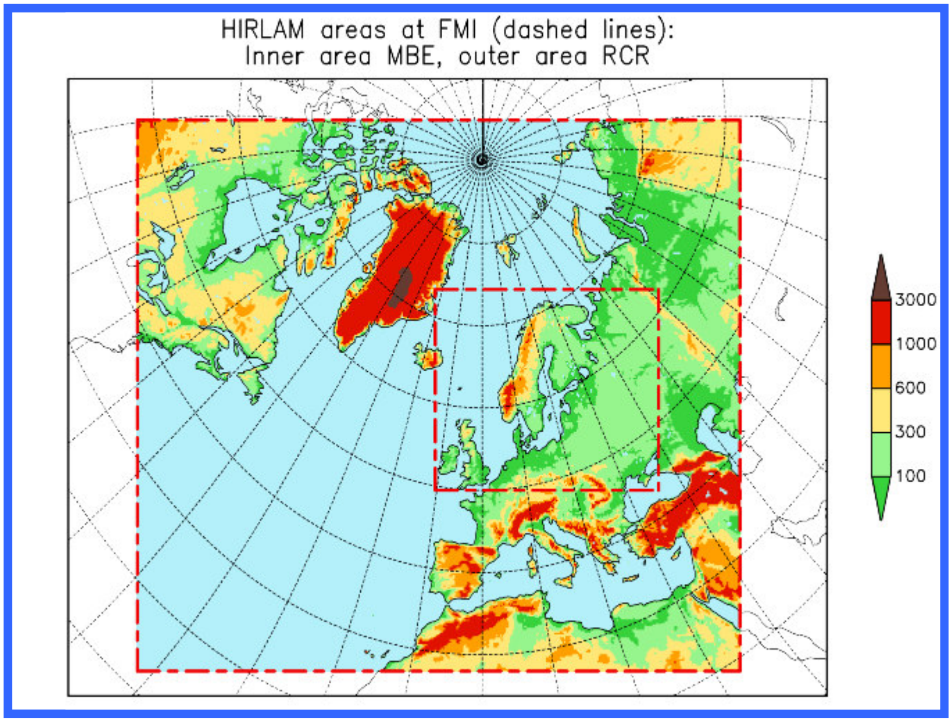

Fig.3 : Integration areas of the operational models at FMI.

In data assimilation, conventional observations are used. The cut-off time of observations is 2 hours for the main synoptical hours (00, 06, 12, and 18 UTC) and 4 hours 20 minutes for the intermediate hours (03, 09, 15, and 21 UTC). Incremental digital filter is used for initialization. The forecast length is 54 hours for 00, 06, 12, and 18 UTC runs. Between them, additional 6 hour forecasts are run to provide an improved first guess for the main runs.

Table 1 : Model configuration

Data assimilation	
Upper air analysis	3-dimensional variational data assimilation
Version	HIRDVA 6.3.2, FGAT option
Parameters	Surface pressure, temperature, wind components, humidity
Surface analysis	Separate analysis, consistent with the mosaic approach for surface/soil processes of - SST, fraction of ice - snow depth - screen level temperature, humidity - soil temperature/humidity (2 layers)
Grid length	0.2^o in the horizontal
Integration domain	438 x 336 grid points in a rotated lat/lon grid
Levels	40 hybrid levels defined by A and B
Observation types	TEMP, PILOT, SYNOP, SHIP, BUOY, AIREP
First guess	3 h forecast, 3h cycle
Initialization	Digital filter (IDF)
Cut-off time	2 h for main cycles, 4 h 20 min for intermediate cycles
Assimilation cycle	3 h cycle

Forecast model	
Forecast model	Limited area grid point model
Version	Hirlam 6.4.0
Basic equations	Primitive equations
Independent variables	T, u, v, q, p(s), cloud water, turbulent kinetic energy (TKE)
Discretization	Arakawa C grid
Grid length	0.2^o in the horizontal
Integration domain	438 x 336 grid points in a rotated lat/lon grid
Orography	Hirlam physiographic data base, filtered
Physics	- Savijärvi radiation scheme - Turbulence based on TKE - STRACO condensation scheme - Surface fluxes using the drag formulation - Surface/soil processes using mosaic tiles - No gravity wave drag
Horizontal diffusion	Implicit fourth order
Forecast length	54 hours
Output frequency	1 hour
Boundaries	- 0.2^o "frame" boundaries from ECMWF - received four times a day - 3h temporal resolutions

A second operational suite, MBE, a meso-β-scale (0.08^o) nested HIRLAM model, having been in pre-operational test since 7 May 2004 became operational during the month of November 2004. The integration area of the MBE suite is also shown in Figure 3. The meteorological set-up is close to identical with the hosting RCR suite.

4. Road weather model

The road weather model is a 1-dimensional energy balance model that calculates vertical heat transfer in the ground and at the ground-atmosphere interface, taking into account the special conditions prevailing at road surface and below it. The effect of traffic is also accounted for. Output from a weather forecast model, either directly or with duty meteorologist's corrections, is used as a forcing at upper boundary.

In addition to calculating ground and surface temperature, the model also makes a road condition interpretation. At present, eight different road surface classes, or descriptions, are used: dry, damp, wet, frost, dry snow, wet snow, and partly icy. Additionally, a three-valued index describing the driving conditions more generally is calculated.

The model is run operationally once an hour using the latest available data, including weather radar precipitation. A model version for pedestrian conditions has also been developed and is in operational use. Further, enhanced versions of the model including also road maintenance measures as well as advanced on-line warning system and traffic routing are being developed.

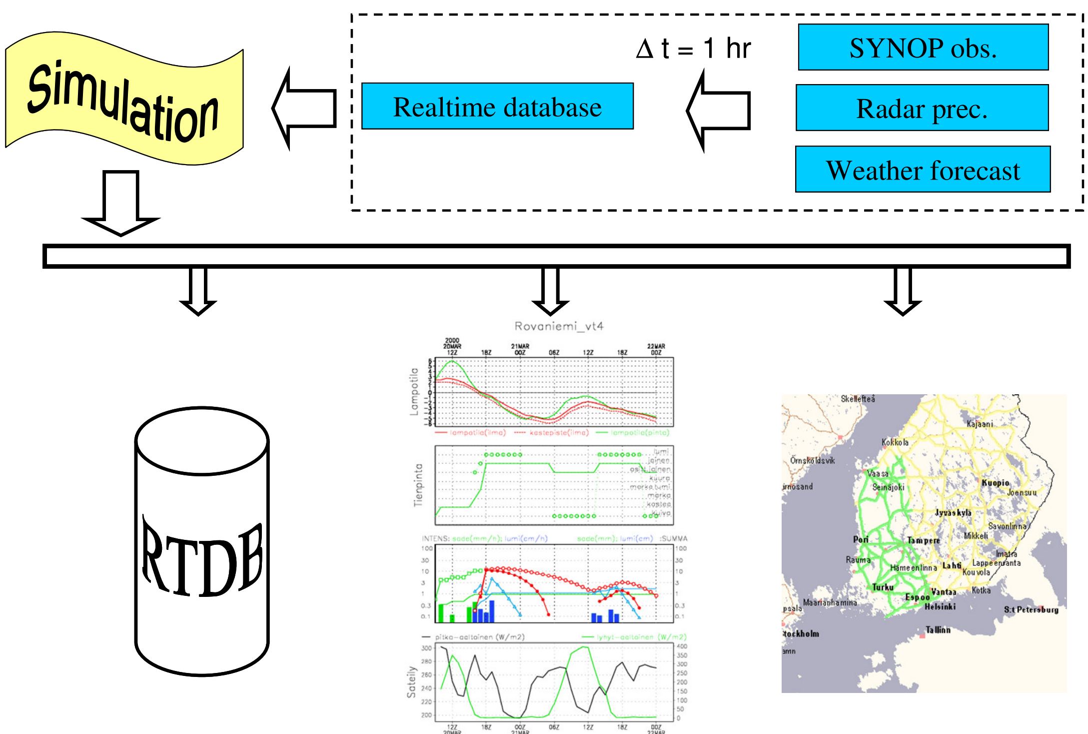

Fig.4: Road weather model operational system.

References

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[Jär05b] S. Järvenoja. Tests with the HIRLAM 6.3.5 version - comparison to some earlier versions and RCR. Hirlam Newsletter, 47, 2005.

[JEF+04] S. Järvenoja, K. Eerola, C. Fortelius, M. Kangas, S.Niemelä and N. Sokka. Validation of RCR for spring and summer 2004. Hirlam Newsletter, 46, 2004.

[KS05] M. Kangas and N. Sokka. Operational RCR HIRLAM at FMI. Hirlam Newsletter, 48, 2005.