The HIRLAM-6 Project and HIRLAM-A Programme

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Introduction

The HIRLAM-6 Project is in its 3rd and final year. During the last year there have been intensive preparations and investigations for continuing HIRLAM co-operation between the existing members (Denmark, Finland, Norway, Sweden, Iceland, Ireland, the Netherlands, Spain and France for research co-operation). Following an Evaluation of the HIRLAM Projects and of the options for the future, there is a definite intention to enter into a new HIRLAM Programme. It will be set up for a longer period than before under a quite general Memorandum of Understanding. Projects may be changed during the course of the Programme and the scope of the Programme will probably extend with new Projects or optional Projects. The meso-scale modelling at the km scale will become more and more the highest priority and collaboration with the ALADIN consortium and Météo-France around the AROME system will be the focus of this work.

The Evaluation pointed out major advantages of HIRLAM for its members and that the institutes really depended on HIRLAM a lot. There were a number of weaknesses, both in the modelling development and in the organisation. Many major achievements have been met but some forecasting problems have been difficult to solve. The lack of authority and clearly dedicated resources has been a problem. This will be addressed in the new HIRLAM-A Programme to a great deal. Increased resources will be needed because we will continue to need a synoptical modelling system while we also need to develop the meso-scale system quickly. Furthermore, probabilistic forecasting and ensembles are important. There are synergy effects across the scales, but the convergence with ALADIN will help and it was supported by the Evaluation (without taking any position that this was the only alternative or that is guaranteed to be the best model).

A significant work on both the ALADIN and HIRLAM sides has taken place to form a co-operation between the two consortia. It is foremost based on the meso-scale modelling and activities on both formal and practical coordination has taken place. There is a common research plan for the areas that are agreed to share the work on (whereas there will still be individual scientific plans for each consortium and areas that are worked on separately). The cooperation is based on a code collaboration, so the meso-scale modelling is done with common code, IFS based, but with individual options for ALADIN and HIRLAM (at least optionally).

Operational co-operation may become established in the future between some HIRLAM members, but so far and also in future, the role of a quality assured Reference System release of HIRLAM is paramount. Members are striving to use the latest Reference system as far as possible and as fast as they can implement it after own testing. The Reference system is run as one of the operational HIRLAM installations, at FMI currently. It can also be run at ECMWF,

where the Reference is installed and maintained. Data from this Regular Cycle of the Reference system (RCR) are mirrored at ECMWF for HIRLAM members to use for research in diagnostics and for Data Assimilation statistics e.g.

Data Assimilation

The work on enhancing the background error statistics used in 3D-VAR (and 4D) has continued. Several options have been explored and different HIRLAM implementations used. New statistics have been derived for analytical and for statistical balance and for the statistical one more advanced balance is being developed. Ensemble assimilations also give good or better estimates as the new methods from innovation and observation statistics. Flow dependency has been tried through an Eady index normalisation and at least the climatological flow should be represented through a horizontal index. The new control variable based on first guess relative humidity has been developed following ECMWF.

4D-VAR has been run extensively over the last year using the earlier developments with semi-Lagrangian and multi-incremental schemes. It is rather efficient although some further optimisation for vector processors still is done. It is feasible to start pre-operational or parallel runs in some configurations in some of the HIRLAM institutes. Several of the institutes use ATOVS AMSU-A data with a clear positive impact and research is ongoing to use AMSU-B. There is research on radar VAD and radial winds with a novel de-aliasing teqnique. Scatterometer winds are also possible to use. GPS zenith delay data can now be used slant-wise since the operators have been implemented for this.

For the surface analysis, the activities are mainly for snow and ice and SST. A new snow OI analysis was implemented and work is ongoing to introduce the data from the Ocean Sea Ice SAF into HIRLAM (already used in some countries).

Forecast modelling

A large number of changes to the physics parameterisation of the HIRLAM model have been implemented in the Reference system during the period. The combined set results in significantly improved forecast parameters and particularly of temperature and humidity. (Also wind direction and pressure are much improved). There has been a lot of attention to the turbulence scheme for many years and extensive work on tuning of both surface roughness (increase) and stable stratification mixing (increase but not as much as first tried) and a turning of the surface stress vector have all contributed to an improved performance. For the surface fluxes, the effective roughness length for heat and moisture is now much smaller than for momentum, as it should be, and this reduces systematic errors particularly for spring and summer situations, where too much evaporation held the day time temperatures down.

An explicit snow modelling for the tiled surface scheme has been developed and tested over several years. It has now also a treatment for forest and snow, which is dominating in Scandinavia. This is important to cure the frequently poorly simulated cold episodes with clear skies over snow in the Nordic countries. A lot of work has also gone into investigations and diagnostics and the use of 1D simulations is very effective. The formulation of evaporation, condensation and radiation all interact in this problem. The Rash-Kristjanssen

condensation scheme has less cloud water and shows less of a problem than the Reference. The Kain-Fritsch and the Reference Straco scheme have both been developed somewhat, e.g. with statistical cloud formulation. The KF scheme needs considerable optimisation in order to be used on vector machines and it is planned that experts from NEC will do this for HIRLAM.

The dynamics has also been enhanced with some earlier developments to the semi-Lagrangian scheme implemented and also a new coupling to the physics. (Both fairly similar to what has been done at ECMWF). The work on the transparent lateral boundary conditions has progressed well with a few important issues solved. It is based on normal mode and eigenfunction decomposition and proper treatment of incoming or outgoing waves. With the normal modes it has now been done in a multi-level (z) model, although a simpler one than HIRLAM.

A meso-scale modelling group was set up in 2004 in order to work with the ALADIN dynamics and implement it with HIRLAM physics and later with the AROME physics. This work has concentrated on a setup of ALADIN at ECMWF, which has been convenient for symmetrical access from the different HIRLAM institutes and Météo-France (a current drawback is that only some ALADIN members are full members of ECMWF since there is considerable interest of the work also in these other ALADIN countries). The ALADIN model is now possible to run coupled with HIRLAM and a number of runs and relatively long tests have been performed. Some of the HIRLAM physics is interfaced and HIRLAM takes part in the design of the general physics interfaces for ALADIN.

Probabilistic forecasting is carried out in some HIRLAM institutes through ensemble runs with HIRLAM either using perturbations from ECMWF or using a multi-model technique.

System developments

The hitherto very different set-ups in the HIRLAM variational system (HIRVDA) and the rest of the HIRLAM system have now been unified around a CVS bases source code maintenance. New procedures to make the libraries and executables have been developed in a consistent way and this work is almost ready for full implementation.