

Report of HIRLAM Management Group Visit to Met Éireann, 27 - 28 February 28, 2002.

Introduction.

The time had come for the Management Group to visit Met Éireann. Wise from the experience of earlier visit, the length has now been extended to 2.5 days, to allow enough time for discussions with the HIRLAM research staff as well as for the Management Group Meeting. We were received by Denis Fitzgerald, who is the Head of the Research division. The programme commenced with presentations from some of the staff and one from the Project Leader.

Lateral boundary conditions, Aidan McDonald.

Aidan reviewed the background for his work in this area. In 1995 Erland Källen, the then Project Leader asked Aidan for putting efforts into the lateral boundary conditions issue, since it was deemed to be crucial for LAM forecasting. In 1996 Aidan made a review of the existing literature and pointed out suggestions from e.g. Baumhefner and Perkey. This compares a coarse global host model with a limited area fine scale and a global fine scale model. Such experiments have been performed with HIRLAM (although not global, but a large area versus a small area) and can be used to verify the success of the LBC formulation. A suggestion for better consistency is to use the coarse model orography in the boundary zone (in case of the Davies' relaxation scheme, which is what is used by all operational LAMs). One could argue that the orography might be more optimal with a mixture of the host and guest model's. Another consideration is to use a reduced physical forcing in the boundary zone.

A problem with the Davies' relaxation scheme in HIRLAM is that it is used with fixed coefficients irrespective of resolution. At some other places (NCEP) it is depending on resolution.

Initialising the boundaries does have a large effect on improving the results, as remaining gravity waves cause quite large errors, even though the fields are not noisy. It may be a bit expensive in the HIRLAM context, though. An alternative to LAMs may be the stretched coordinate, but it may be seemingly attractive only. The resolution varies widely, although over a large distance and smoothly, but it will affect wave propagation.

The Davies' relaxation scheme has many advantages: It is stable, robust, easy to implement and computationally inexpensive. The disadvantages are: It does not conserve mass, the overspecification introduces unnecessary errors, it destroys balance, there are undefined parameters and it is mathematically disreputable.

The transparent boundary conditions, which distinguish between inflow and outflow are not easy to implement. The robustness is questionable. They can be expensive. The advantages are that they conserve mass, respect balance, etc. and are mathematically well justified.

Aidan has worked with a number of proposals for well posed boundary conditions. Opaque, characteristic, first order transparent, "semi-Lagrangian" and compared with HIRLAM's. The results are in TR54. Most of them are quite deficient in testing with real data and have little predictability and only one or possibly two beat the Davies one. The characteristic boundary conditions appear to have quite an advantage for the wind forecasts. Admittedly it is all for one situation, but thought to be typical anyway.

Incidentally, Aidan saw some very strong effects of too simple horizontal interpolations. Interpolating winds bi-linearly creates enormous grid-scale noise in divergence/vorticity. If the initial field is not balanced (initialised) one gets this initial shock in the errors, which was prevalent in older studies, when presumably the initialisation was poor.

HIRLAM input to Foot and Mouth disease model, Klara Finkele.

A Gaussian dispersion model is used for estimating the concentration of the bacteria. It needs as input the wind speed, present weather, relative humidity and cloud amounts. This is to estimate stability and boundary layer height very crudely. First SYNOPs were used to provide these inputs, but the stations are rather few and far apart. HIRLAM (at 15 km resolution) can represent local conditions better. Also diagnostic parameters such as boundary layer height, roughness length and surface sensible heat flux are available from HIRLAM and replace the crude empirical estimation from SYNOPs. The results when using HIRLAM were at least as good as before, and this then replaced the use of the SYNOPs. This meant actually also a substantial cost saving, since initially the stations had to be manned additionally on a 24 hour basis.

Recent progress and plans in HIRLAM-5, Per Undén.

Per Undén gave an overview of the main areas of activity and recent developments and the areas which are planned. The plan for the remainder of the year has yet to be updated, but the longer term activities for a HIRLAM-6 are just being discussed by the members, for the Council and HAC to discuss and decide in April.

Per stressed that the most important purpose of HIRLAM was to provide an operational forecasting system providing a comprehensive set of forecasting variables and of best available quality.

3D-VAR is available as an option and has been implemented operationally by four members. It means some general forecast improvement, particularly of large scales and upper levels. The variational development has provided the tools for the 4D-VAR developments, feasibility studies have started with 4D-VAR. It provides good results and runs in a reasonable time, with convergence e.g. after 50 iterations. A very important application of the variational system is for the assimilation of non-conventional data. ATOVS, radar doppler winds and GPS humidities (total delays) have been assimilated as well as Quikscat data. The data availability will be improved by the EUMETSAT re-transmission service due to start during this year.

Then the model developments were reviewed. The CBR turbulence scheme has been revised with a more realistic length scale formulation, which gives a much more realistic wind profile. Due to less mixing, some decrease in low cloud cover can be seen. Also the 2m temperature is slightly higher. Unfortunately, there has been an increase of the negative pressure bias, due to less mixing, at least for some periods.

The ISBA scheme with its very important soil assimilation has been made available in the most recent beta-release (5.1.3) and shows a remarkable positive impact for the times of the year (mainly spring-summer) when temperature biases are large. Both the INM, FMI and very recent SMHI (also involving KF) show an almost elimination of those long standing 2m bias problems.

The cloud cover has been deficient in the Reference system in winter in the Northern half of Europe, at least, and the priority is to introduce the Kain-Fritsch convection, which does not have this low cloud cover excess problem. Also its meso-scale representation provides more realistic distribution of precipitation events (as verified against radar data).

Other areas of activity are in meso-scale orography (GWD) parameterisation where the Météo-France one has been adopted and works, but the impact is not large. Tuning of this one together with turbulence and physiography will be done. The coupling between the physics and dynamics, both how to average over the semi-Lagrangian trajectory and the time order and time scheme for the individual physical processes is the focus of quite a lot of attention and will be brought up at the forthcoming ASM. The non-hydrostatic version of HIRLAM has been developed at Tartu and has been run successfully also at FMI and SMHI. The LBCs will continue to be worked on.

The Hirlam system has undergone a big development in that the mini-SMS has been implemented for a significant efficiency improvement, particularly at ECMWF. Discussions and proposals for an overhaul of the HIRLAM System have taken place and, in particular, a common framework for NWP systems will be considered at a forthcoming workshop in May at Météo-France. Also the verification system has been developed further.

Discussions with the Director, Declan Murphy, Denis Fitzgerald and the Management Group.

Declan first mentioned that the HIRLAM-6 options paper was under discussion and Met Éireann will be very supportive. In general he likes to take a quite pragmatic view on the HIRLAM cooperation, and e.g. the financing of some of the staff through the Project Leader is a good idea. The employment procedures at Met Éireann are very rigid and it is difficult to get extra or temporary staff. Also various ways of operational cooperation are of interest to Met Éireann.

For the staffing of the Project, Jim Hamilton would contribute more in the verification area and Klara Finkle was more interested in the products or to improve them (see also later discussion). Aidan and Ray would continue more or less as at present. The validation efforts for new releases is a continuing task of increasing importance and the Management Group is very pleased that Ray has undertaken quite a bit of this.

HIRLAM input to the road-ice model, Philip Brown.

The prediction of road icing conditions is very important in Ireland since the conditions are very marginal during the winter half year. When there are ridges or weak flow and clear skies, road surface temperatures (RST) often cool close to or below freezing with resultant hoar frost or ice problems on the roads. Even though HIRLAM generally provides a good first guess for the road-ice model input variables, the minimum temperature and cloud cover are more problematic and the normal verifications do not include this short-lived measure of so great importance for the road-ice forecast conditions. Philip showed a couple of detailed cases of forecasts and verifying observations. For quite a lot of the time during the night the 2m temperature of HIRLAM tracked the observations closely except when it came close to freezing. Generally the relative humidity was too high in the model and the temperature did not continue to fall as it should. Even more importantly, there was a tendency to forecast too much cloud in the model and far too often it was overcast when it should have been clear skies. Too much cloud cover resulted in RST and 2m air temperature forecasts being too high.

In the discussion it was the conviction of the Management Group that the cloudiness problem was the main cause for the failure to predict frost on marginal nights. The forecast error was often of 3-4 degrees, especially in dewpoint temperature, and caused a lot of manual editing of the road-ice model input by the forecasters. The Kain-Fritsch scheme is known not to have this cloud problem, and it was decided to use the results from test runs with KF to verify if the products are improved. Probably one of the periods of the test runs could coincide with an interesting forecasting period over Ireland. Sander Tijm will be asked to provide some station

location model data when the runs are done. The soil moisture is another possible/probable cause, but not as important as the cloudiness. The ISBA scheme probably has better soil moisture, both from the assimilation but also due to a better physiography over Ireland (to be verified). The cooling rate is much dependent on the different soil types. It was recommended to Met Éireann try out the latest beta-release with ISBA or to look at results from the runs that have been done with ISBA. Another problem seen is the inconsistency in that the forecasters are presented with precipitation amounts while the cloudiness is 0/8 or 1/8. It is known that there is a certain inconsistency between the cloudiness formulation and the liquid water content, but it was thought that a lot of it stems from different concepts of the integrated precipitation amounts during the three hours and the instantaneous cloudiness picture. It was agreed that Jim Hamilton would dig further in how these products were derived from their hourly HIRLAM runs and try to trace the problem further.

Aidan McDonald suggested that verification should be stratified in temperature bands when it mattered. There is a difference between the customer oriented verification and the scientific model validation one.

Discussion with Met Éireann HIRLAM staff.

Ray McGrath expressed some dissatisfaction with the convenience of using the ECMWF computer system for HIRLAM. The efficiency of MARS is not so great some days when it is overloaded. The through-put has however increased significantly with mini-SMS and generally an assimilation cycle per hour can be achieved. The interactive slow response is probably due to the use of the RMDCN dissemination line. It was recommended to try the Internet log in instead (tn-gw.ecmwf.int) which gives generally instantaneous response. There was a reluctance to use mini-SMS operationally because of the complications and not necessarily a need when using one machine only. The Management Group pointed out that even on one machine the parallel execution of some tasks increased efficiency, but this may already have been done at Met Éireann. The problem of not using mini-SMS is the difficulty in following the releases of the Reference and also the use of mini-SMS was not a major difficulty in other member institutes who have tried it. There is an initial hurdle to overcome and to get used to the system. The likely life time of mini-SMS was enquired about. The new design of HIRLAM has not yet been done, but it is most likely to use SMS or mini-SMS. SMS is available for ECMWF members and HIRLAM has full rights to mini-SMS, to distribute it as it wishes under rules decided by the HIRLAM Council.

Aidan McDonald asked whether all these technical issues meant a change of direction on HIRLAM, to become less research oriented. In fact, in the views on the HIRLAM-5 Project some member institutes had expressed their view that HIRLAM was too much research oriented. The HIRLAM Project is a research cooperation, but the operational quality and efficiency aspects are of high priority and are likely to be even more emphasised. Still there are important research aspects in the Project (e.g. 4D-VAR, LBCs, forecast reliability-EPS).

Klara Finkle asked about the availability of the ECMWF physics package. Gerard Cats replied that it was implemented for testing at KNMI and was just ready for a first real testing and that it was probably not in such a developed state that it would be safe to disseminate it. It is also a complex task to run it due to different climate files. Klara is interested in the soil hydrology in the ISBA scheme and it was agreed that the limited part she has for HIRLAM-5 would be devoted to validation aspects.

Ray asked about the status of the satellite processing in HIRLAM. Some members have implemented the chain from local reception and AAPP software to HIRVDA, but for complete coverage the EUMETSAT re-transmission service is the best bet. It would require a Digital Video Broadcasting satellite receiver and a dedicated PC, according to the plans,

neither very costly. Otherwise the ATOVS data are ready to be used, but bias correction files will be needed. These will necessarily be produced in a collective manner in HIRLAM. Quikscat data can be acquired but with a 3 hour delay, so mainly for re-analysis cycles. SATOB wind data can be used; Met Éireann uses them from time to time, but do not see any particular positive nor negative impact.

Discussion with Aidan McDonald.

The Management Group then had a dedicated discussion about the LBC work with Aidan McDonald. Aidan has worked for over 5 years now in the area and a lot of the work has been studying the available literature and applying it to the shallow water equations. There is almost no other work in this area in Europe for NWP, so it is felt that HIRLAM should have some responsibility towards the NWP community also for more basic research, as this one is. Furthermore, and more important for the users, the aim towards higher resolution and probably smaller areas mean that there is much more exposure to errors in the LBC formulation. Aidan was almost giving up, had he not found that the characteristic boundary conditions provided a significant improvement compared to the Davies ones. The work now needs to be extended to include orography and then to a multi-level model by projection into mode space. When it comes to a full implementation it will be beneficial and necessary to involve also another scientist who is particularly proficient on the computational aspects. Aidan has also repeated Ivar Lie's large omega cases and produced some runs which blow up, others not. Plots and notes were passed for Isabel Martínez.

The Meso-scale modelling workshop will be hosted by Met Éireann and Aidan is local organiser. It will be organised in October and a hotel in the city will be used. We have to think about suitable invited speakers for the occasion.

Verification discussion with Jim Hamilton.

Jim has provided a lot of input to the survey of verification utilities needed in the Project. In general the separation between level 1 (basic data) utilities and level 2 (presentation) should remain. There is however a virtue in also providing a set of open source level 2 utilities for people not being well acquainted or supported with graphical tools. Jim could help in this area when needed. There is a need for higher time frequency in the verification, as illustrated by the minimum temperature problem. An hourly resolution would be ideal, but probably a 3 hourly would have to suffice for the general system. Precipitation verification needs to be developed, but there is a need for both development of methods and also of data exchange.

Conclusions

The Management Group found the presentations and the quite extensive discussions with the Met Éireann HIRLAM staff very interesting and useful. Some important forecasting problems were aired and important issues for the future HIRLAM work were discussed. We feel also that our comments and information were appreciated by the staff at Met Éireann. The Management Group would like to thank the hosts, Denis Fitzgerald and his staff, for the visit and the meetings that took place.

**Per Undén
6 March 2002**