Report from the HIRLAM Management Group Visit to INM 25-26 September 2003.

Introduction.

In the programme of regular visits to member institutes, the HIRLAM MG visited INM during these two days. The first day was used for presentations of HIRLAM work and use of HIRLAM. The Management Group held its MGM(7) the following day (see separate Report on HEXNET).

General meeting with the INM management.

Rosario Díaz-Pabón opened the meeting and welcomed the Management Group. It was a nice opportunity to meet all the staff working with HIRLAM. INM's operational plans would be described. It is envisaged that INM will enter the climate modelling, as there is a clear need expressed from the government department. Bartolomé Orfila asked and discussed about resources for climate model developments. The Management Group thought that the model should be the same as for NWP. The parameterisation is the same, except for the assimilation aspects for ISBA. Ernesto Rodríguez pointed out that this is a difficult issue but Colin Jones mentioned that the aim at SMHI was to have the same surface scheme. It would be beneficial for the Project to include the climate option, both for support and to unify and avoid parallel developments.
One activity in that area that is planned, is to run from ERA boundaries and do statistical downscaling for the current climate.
INM is involved in a number of EU projects like TOUGH, ELDAS, HONEYMOON.
The priority at INM is to get HIRLAM to run on the new Cray X1. There are some compiler/system routines problems when running with 64 bit precision. Furthermore, the short range ensemble system will be run on the X1.
José Antonio García-Moya presented more details of the runs on the X1. The computer was installed at the end of July and has 40 CPUs distributed over 10 nodes. There were also some problems with C routines of the climate system. Even though as a short cut, one could take climate files from runs at ECMWF, José pointed out that they wanted the complete system to be installed and run. The scalability was not so good; it was good up to 16 CPUs or so, but slow benefit at 32 and beyond. CRAY will have to work on it (irrespective of HIRLAM improvements that have since been introduced in the Reference). Archiving is an area of attention, and a new system comes with the CRAY.
The operational plans are to run at 0.15 degrees for the large area and 0.05 for the small one. The Management Group and Colin in particular questioned the choice of 0.05, as this is the "no mans' land" for the physics, even though there are others who run at that resolution. Denmark and Norway are running with such resolutions with the hydrostatic models, as their inner areas, and have find some usefulness for some parameters but there are problems with others (precipitations). The main benefit are the coastal winds and temperatures. INM has not decided exactly which resolution it will be, but there is pressure for high resolution.
Bartolomé Orfila reminded us that INM would like us to maintain OI and also to have the possibility of running with the ECMWF physics option, for the purpose of perturbing the EPS.

Presentation by the Project Leader.

The Project Leader gave an overview of the HIRLAM-6 activities and showed results and examples of progress in a number of areas. The HIRLAM members need a forecasting system first for the synoptic scales, to provide comprehensive data bases nationally, for direct use and to drive other models and, very importantly, to provide boundaries for meso-scale model and, of course, to provide updated forecasts based on the most recent observations. HIRLAM will also work on a meso-scale system and transfer more resources to this.
In the data assimilation areas there will be further developments for 3D-VAR while 4D-VAR is currently being enhanced quite a bit with semi-Lagrangian numerics and incremental loops. It has been demonstrated to provide benefits. The observation use was discussed, then the model physics and particularly the modifications and the problems in the turbulence scheme. The snow scheme is another

important new feature and in the dynamics there are improvements of the boundary scheme and the work on coupling is described below. Verifications from met.no and KNMI were shown, comparing their older operational versions with the new implementations and improvements were demonstrated.

Use of HIRLAM model for the operational forecasting of severe convective storms. Fermin Elizaga.

HIRLAM is used to predict the environment for convective activity. Based on this, a large number of instability measures are computed and displayed, like CAPE, lifting index, potential instability, total column water etc. Techniques have been developed to estimate the possibility of convective systems and downdraugths. A particular severe case of a supercell system with tornado (small scale one) causing much damage had been forecasted and advance warning issued.

Use of HIRLAM in the INM operational environment. Ana Casals.

INM has a central forecasting office with a shift (and a leader) with different positions for the different forecasting ranges and types. There are 15 regional offices, which forecasts are coordinated with the central one. The work starts with diagnosis of the situation, e.g. using WV images to compare with the fields and find the developments. The prognostic products are gridded and sent to regional offices and there are telephone conferences to discuss the forecasts. For the medium range, EPS and objective as well as subjective clustering is used. MCIDAS is used a lot in the forecast production; there are 83 direct forecast output fields and 50 derived ones. Kalman filtering is used as well. There are products for aviation, profiles, ice areas, cloud liquid water and cloud average amount. The wave model uses the high resolution HIRLAM. Derived products are e.g. shear vorticity and pseudo images to compare with satellite ones.
The experience is good for forecasts for the first 24 hours. Particularly the high frequency of forecasts is valuable. There is a tendency for overforcasting some derived products. The model is better inland than along the coast. It overestimates the affected areas and triggers to much convection. Cloudiness is difficult and may be underestimated.

Data assimilation activities at INM. Beatriz Navascués.

Beatriz presented many results from the work of the people in her group. (Carmen Martin, Alberto Cansado, Jana Sánches, Carlos Geijo, Carmen Salvador and Beatriz). They had worked on improvements to the HIRLAM surface analysis. T2m and RH 2m background errors have been computed and an OI analysis developed for the snow. Then a first version of a variational surface analysis has been developed. They are also working on the upper air analysis and on forecasting tools.
The 2m structure functions use the TOAR functions (following Mitchel). There is no clear latitudinal dependence. There are on the other hand clear annual and diurnal cycles. The horizontal correlations have been modelled with two TOAR functions with shorter and larger scales. Vertical correlations decrease rapidly with separation. Standard deviations have diurnal cycles. Test show a small but consistent improvement.
The variational (SVA) analysis has many advantages. It uses a dynamic estimation of the gain matrices, is portable and has great potential for remotes sensing data. It is integrated with a model and assumes horizontal decoupling and tangent linear behaviour of the model. The SVA code has been ported to HIRLAM in cooperation with Météo-France in the ELDAS project. It has been extended to tiles. The first test showed much improved SWI maps.
The upper air analysis work consisted in testing the new operational configuration for the INM area, use of GPS data and radar winds and assimilation of METEOSAT winds. For the Jb term, the relaxation of geostrophy is important. A period has been evaluated in the DMR area with only conventional observations. OI and 3D-VAR have been compared and 3D-VAR is much better for the humidity. For the surface fields it was not so obvious, OI and statistical Jb had better PMSL scores over Iberia (but OI was worse for whole EWGLAM) and 10m winds were not as good as in OI. There is a need for a new statistical Jb for 40 levels and possibly for the southerly area. (This will be investigated from the data accumulated at SMHI). The initialisation increments were however smallest with the analytical Jb. INM is participating in TOUGH for GPS and is trying with radar wind assimilation.

Frequent surface analysis for diagnostic purposes. Alberto Cansado.

The new surface analysis is used for diagnostic purposes every hour. The wind analysis uses multi-variate OI with FG and OI QC checks. Also 10m wind, T2m and RH 2m as well as PMSL are analysed. OI has been tuned for smaller scales. The data and the analysis are checked with histograms.
The snow depth analysis has been improved by using an OI method. The first guess creation is using previous snow depth, previous snow density, analysed temperature and precipitation following Brasnett. A snow aging (density) and a snow melting model are included. Test show some improvements of T2m and RH in some instances, but above all a more realistic snow cover when inspecting horizontal maps. The only drawback when checking against SSM/I derived data is some spurious snow fall from the model that appears on some mountains. The auto-regressive functions will be used and derived as well.

Physics-dynamics coupling strategies in HIRLAM 6.2. Isabel Martínez.

Isabel described the formulations in the different experiments. The physics tendencies are averaged along the semi-Lagrangian trajectory, first the radiation and convection are averaged only, then those values at the departure point are included in the semi-implicit scheme, thirdly also vdiff is averaged and finally they are included in the semi-implicit scheme.
The evaluation of the accuracy compared with very short time steps has been done. All experiments improve the the total tendency accuracy for temperature, humidity and cloud water and precipitation. The cloud water tendency due to vertical diffusion is worse when vdiff is included in the averaging.
A strong convective case has been tested. The averaging seems to give somewhat smoother precipitation fields. However, after the change to 6.2 and the new boundary treatment, there are stronger differences. This is to be investigated. The "noise" features seem to be a little reduced in 6.2 compared to before. A drawback now, and with 40 levels, is that the maximum time step had to be reduced, but still 450s is used for 0.2 degrees and 40 levels (the level thickness may have had such an impact).

Topics on surface parameterisation. Ernesto Rodríguez.

Ernesto first gave an overview of the recent and current modifications to the surface package. They are: the explicit soil freezing, T2m and RH structure functions, additional snow tile for bare and low vegetation and sub-grid scale run-off. There is work in ELDAS and testing with the new ECOCLIM data base.
ELDAS is primarily intended to provide off-line assimilation from observations.
The SVA variational scheme has been run with HIRLAM at 0.2 degrees but without tiling (tested to show that no tiling gives not to large deterioration). The sub grid-scale may however be important, as there are differences in different vegetation types.
The ECOCLIM (Masson et al.) is a global 1 km data base with 215 eco-systems and very comprehensive with aggregation software included. The differences to the HIRLAM Reference are significant for bare soil part (hardly in the Ref.), forest fraction (too high in Ref.) and albedo (too high in Ref). The data have been tested and give quite a bit of impact on biases, some slightly worse, some better. Further work is going on to update tables.

Assessments and recent developments of the HIRLAM surface scheme. José Antonio Parodi.

José has implemented a sub-grid scale run-off parameterisation, due to the heterogeneous distribution of soil within the box. (from Dümenil & Todini(1992)). It results in more surface run-off and less infiltration in the soil. For the Rhone valley experiment, it shows nice improvements of the run-off. In normal HIRLAM runs, it shows very nice improvements of relative humidity since the soil does not have to be saturated and generally reduces the soil moisture. This is important during days when the assimilation does not work. This is most beneficial for northern areas.

Progress on Kain-Fritsch/Rasch-Kristjánsson. Javier Calvo.

Javier has repeated the questionable periods from the STRACO/KF comparison shown in NL42, with the most recent KF scheme. There have been some updates in mainly the micro-physics due to the EUROCS work and operational experience at SMHI. Javier's results show that the aspect of deteriorated PMSL

scores is gone, while all the positive effects on humidity profiles and cloud cover are still there.
He has also compared single column simulations of STRACO and KF with LES simulations. The diurnal cycle of shallow and deep convection over land is better represented using KF. Trying to assess the representation of the Hadley circulation over the Pacific, HIRLAM has been run in NWP mode with the two schemes and monthly means have been compared to satellite observations. Both schemes produce too much of the very light precipitation over the Sc and shallow Cu regions. In the ITCZ, STRACO has much higher amounts than TRMM observations. Both schemes underestimate cloud cover and vertically integrated liquid water in the Sc regions. KF overestimates cloud cover in the Shallow Cu region.
The KF/RK still takes 20% more to run, but some optimisation may be possible. It should now be provided as an option in the Reference system.

SLAF for SREPS. José Antonio García-Moya.

INM is very keen on Short Range Ensemble Prediction for severe weather (precipitation) events. José has set up a number (5) of SREPS (with 9 members in each) with perturbations of both initial and boundary fields, using forecast errors from different times in the past and multiplied by different factors for scaling. The ensembles have been checked through the Talagrand diagrams. The ones with few outliers and an even distributions should be the best. The spread is also checked and it varies quite a bit among the different perturbations types. Then the probabilistic verification is done using the ROC curves and reliability curves. For low precipitation all methods seem quite good, but at high amounts it becomes a sampling problem.
Most things indicate that the perturbation with 24 hour forecast errors is the best.

Radar reflectivities from the HIRLAM model. Jana Sánches.

Jana has compared the Spanish radar reflectivities with data from HIRLAM with the aid of the Radar Simulation Model of Günther Haase (then from Univ. of Bonn, DWD, and implemented at FMI). The results have been compared for an extreme case at model resolution s of 0.5 and 0.2 degrees. There are 14 radars and 20 elevation angles. There is a lot of processing and both radar reflectivities and the simulated data have been processed in MCIDAS, on the same grid. HIRLAM was modified to write out the 10 min accumulated precipitations at model levels as input to the RSM.
In the Mediterranean cyclone case the simulations were compared with radar. At 0.5 there was only some small similarity, whereas 0.2 was better, but still lacking in detail.

Perfect Prog with HIRLAM. José M. Guiterrez. University of Cantabria (Santander).

At the University of Cantabria, they have been working with statistical down-scaling of forecast models by using re-analysis data and a dense network of about 6000 rain gauges. Instead of regression, a clustering technique is used, in the space of the two leading Principal Components. The kernel of the correlation matrices is used and the method is quite general and generic, can be applied to many problems. The technique has been applied on both precipitation and 10m winds. Probabilities of events are produced and using HIRLAM or ECMWF forecasts. The HIRLAM results seem quite good and at least as good as the ECMWF equivalents. The method looks very attractive.

General.

The Project Leader and the Management Group thanked INM and all the speakers for preparing and presenting their work and for the many interesting presentations. The Project Leader added that there has been an increased activity in the HIRLAM Project related tasks and that INM now is active over a wide range of the Scientific programme, both upper air and surface assimilation, observation use, physics parameterisation, aspects of the dynamics and forecasting methods in terms of e.g. EPS. There are very useful contributions to the Project that have and are being developed.

Per Undén
30 September 2003