Report of HIRLAM Management Group Visit to SMHI 9 - 10 September, 2002.

Introduction.

The last in the series of visits to member institutes was to SMHI, 9-10 September 2002. It was combined with a Management Group meeting, as usual, and the timing of the visit was constrained by the need of a Management Group Meeting. This was not optimal for SMHI, since some of the staff were at the ECMWF workshop. Still, most of the recent work could be covered.

Assimilation of MODIS near infrared radiance and GPS atmospheric total delay data in HIRLAM. Martin Ridal and Nils Gustafsson.

The MODIS instrument is used for moisture retrievals from the TERRA satellite. There are 40-50 GPS surface stations in the Nordic area which provide data every 15 minutes. Their advantage is that they are all-weather stations and provide cheap data since the stations have to be there for geodesic purposes. Our moisture signal is noise to them. The disadvantage is that it is a single column measurement. Furthermore the data have biases and correlated errors. Nils made impact studies for June 2000 with neutral results. The MODIS data are assimilated in a similar way. The delay in the GPS signals has one ionospheric frequency dependent part, which is well known. For the troposphere, the main delay is related to the pressure and then there is the moisture effect. The wet delay can be used for the retrieval. Data are processed to Zenith. In the assimilation there is QC and bias removal. Zenith total delay is assimilated, thus having also a (small) pressure coupling. The MODIS data are physical retrievals that are assimilated in cloud free areas over land. The moisture background error structures will be developed better through ensemble assimilations. GPS and MODIS data will be compared in the EU-project CLOUDMAP-2.

Assimilation of ATOVS radiances in HIRLAM. Tomas Landelius, Sigurdur Thorsteinsson and Per Dahlgren.

The AMSU-A channels 5-10 are the ones selected for assimilation. December 1999 has been assimilated with ECMWF MARS data. The impact was good for two of the storms, even though there was a non-functional cloud mask at that time (since corrected). It is documented in a Technical Report soon to be issued. The observation errors are going to be varied as well as better background errors will be used. Furthermore, the latitude dependent bias corrections will be implemented. FGAT will be tested. The impact of a non-linear observation operator will be checked. Other work is to use both AMSU-A and AMSU-B, not only over sea but also over ice, land and snow. At SMHI the test system, HIRLAM-X will include ATOVS data. Per Dahlgren is working on this. The EUMETSAT data will eventually be used, but for now the local data are automatically prepared, coded, extracted and bias calculated. The data are in passive mode in HIRLAM-X.

Introduction of spatially varying background error standard deviations in HIRLAM 3D-VAR. Nils Gustafsson.

Nils described how the background error term was formulated and in particular the need of some background error standard deviations. These have been determined with the NMC method. There is a re-scaling (0.6) and a seasonal dependence but the horizontal variation was not built in before. An index field has since been derived from innovation vector values and processed to be smooth. This modulates the background errors. The errors for all variables are provided by randomisation. A special modification had to be done to reduce the errors of geostrophic winds at low latitudes. The use of the index field has the expected effect, increased increments over the ocean. A further modification in the computation of the geostrophic wind error is to use only the linear terms when going from T and lnps, to avoid noise. These changes shall now be tested. Then the statistical balance statistics will be derived at 0.3 degrees resolution. Furthermore, the length scales are going to be determined through perturbed observations assimilations. Nils also presented some material from Anders Persson about observation monitoring. The observation bias can be well estimated through a filtering procedure. Bias correction, observation monitoring and blacklisting could be a common HIRLAM activity.

Effect of the free-flow stability on near-surface turbulent fluxes in stable stratifications in HIRLAM. Veniamin Perov.

The surface fluxes are quite well described by theory in neutral and unstable situations. In stable stratifications they are underestimated. Above the surface layer there may be a layer of near neutrality. In current theory the fluxes almost vanish when the Richardson number exceeds 0.3. The theory developed addresses this problem and fits data better. In HIRLAM assimilations one sees impacts on 2m temperatures, over many areas and generally a bit warmer (in winter, 2 weeks). Veniamin has also worked on calculation of z0 for scalars and on estimation of PBL top.

Surface parameterizations in SWECLIM. Patrick Samuelsson and Stefan Gollvik.

The new SWECLIM surface scheme has been developed from the present Rossby Centre RCA surface scheme which includes one surface temperature and a snowpack. The new surface scheme contains 5 energy balances, 6 liquid water storages, 3 aerodynamic resistances, and two snow storages. The soil freezing follows the Viterbo approach. A deep climate temperature is used. The snow pack can contain up to 10 % of water. Snow cover is parameterised based on snow depth and its maximum. A particular problem was a too quick wilting in S Europe. This is improved by doubling the depth of the lower layer to 1.6m, however, further work on this problem is needed. They are now working on the code structure for integration with the ISBA Reference. The physiography data are very important.

Stefan has changed the force-restore approach in the soil in ISBA to heat conduction and an additional layer, particularly needed for the snow (over open land) fraction that he has added to ISBA. This will be introduced for the Reference. Next step is to introduce snow on the forest canopy and then have a canopy temperature. More layers in the soil will be needed. The sea ice interaction will also be considered. A general problem when adding these new variables is how to do the analysis updating, and this will be an important part of the work. He has also worked with inclusion of Veniamin's surface fluxes.
Currently the temperature is unrealistic over the arctic snow, but otherwise the scheme performs very similar to ISBA; maybe some worse T bias. The albedo of the snow when

starting is too low.
Stefan and Patrick want to rewrite the surface physics and use the same model system for NWP and climate. The tiling structure of ISBA should be kept, but there will be parameters defining variables and levels. The Rossby Centre RCAO scheme will be in the same code and the analysis system will be adjusted consistently.

Use of regional climate models for parameterization development. Colin Jones.

It is important to isolate the physical processes in the parameterisation. One should be aware of that 2m temperature and humidity values are computed from model parameters and are results of many processes. In evaluating RMS and mean errors, one should be aware of that timing errors hit RMS. One should try to evaluate the parameterisation at process level and evaluate statistical relationships, the PDF e.g. and compare with observed statistics. Observations can often underestimate values. LES models are useful to evaluate non-observable parameters.
Colin described some bias caused by cloud interaction in the long wave radiation. The overlap is not maximum and there is too much long wave radiation in the current HIRLAM code. For short wave there is too large reflectivity due to that radiation is not plane parallel. The short wave radiation is too low, when verified against the SHEBA site.
The cloud particles are not well modelled. There is vast difference between the properties of ice and water; with ice there are fewer and larger particles than for water. Ice has lower reflectivity and more transmittivity. Colin was of the view that a new, more complex, radiation scheme is needed. Some discussion ensued about the ECMWF one, which is much more comprehensive but expensive and run in a thinned way in space and time.

Evaluation of the vertical structure of clouds in SWECLIM/HIRLAM using cloud radar. Ulrika Willén.

Ulrika has used cloud radar data from different European sites collected during the CLIWA-NET campaigns. The KNMI radar at Cabauw provides a cloud mask at 150 m vertical resolution and 10 s in time. A cloud fraction was obtained by averaging in the vertical corresponding to the model vertical resolution and averaging 15 minutes in time to mimic to model horizontal resolution of 18 km. The nearest grid column from RCA HIRLAM model with 24 and 40 levels, ECMWF 40 levels and RACMO 24 levels were compared with the data for a 10 day period. ECMWF was the best model, but the 40 level HIRLAM was fairly close. (The 24 level version looked quite different and did not capture the cloud structures very well.) The high clouds may be overestimated in the model but there are also uncertainties due to radar thresholds. The Xu-Randall cloud fraction parametrization based on relative humidity and cloud water had a more binary structure similar to the observations. The comparison will be done for the whole two month campaign period and the sensitivity to different cloud parametrizations, the cloud overlap and the vertical and horizontal resolution will be evaluated.

Use of regional climate models for projection of future climate changes. Jouni Räsänen.

Jouni described the configuration of RCAO with ocean and lake model coupling. The global scenarios are from HADCM3 and ECHAM4. The control is a 30 year slice from 1961 and the scenario 30 years from 2071. The warming is between 3-6 degrees in winter but up to 10 in S Europe in summer. The lowest winter minimum temperatures change much more than the average and highest temperatures in this season. The ECHAM4 forcing gives a very large

decrease in precipitation in southern Europe and a very large increase in northern Europe (especially western Norway) due to a change in the large-scale circulation.

HILRLAM X - tests of a new operational HIRLAM model version for SMHI. Karl-Ivar Ivarsson.

SMHI is implementing a 33 km resolution model replacing the 44 km one and with 40 levels. One month from each of the seasons have been tested against the operational SMHI model. For April there is a major improvement of the 2m temperature and humidity. In some periods there is a marked increase of a (negative) pressure bias with forecast length. In winter there is a problem with too much cloud cover and not low enough 2m temperatures.

Tests of modified CBR turbulence schemes to improve vertical momentum transports and surface pressure verification scores. Colin Jones.

The pressure bias problem was shown by Per Kållberg to be closely related to the lack of filling of cyclones. There is too little Ekman pumping and cross-isobaric flow. The vertical momentum transport in CBR is depending on a mixing length and the TKE. In stable stratification the mixing length is inversely proportional to the Brunt-Vaisala frequency and with increased stability the mixing length gets very small. Furthermore the dissipation of TKE increases with smaller mixing length and makes the exchange coefficient very small.
For the momentum exchange, one can argue that there is additional turbulence due to non-resolved gravity waves and an extra term in the length scale formulation is added. Furthermore, in the boundary layer, there are small non-resolved regions of larger mixing, so the average stability is not the same as the average of all local stabilities. Due to this effect, an additional term is added for heat and momentum in the boundary layer. Most of the effect comes from the momentum part. The scores of pressure as well as upper level geopotential are much improved and with only marginal effects on near surface parameters.
The Management Group thought this work was a very valuable contribution to the HIRLAM Project.

Postprocessing of HIRLAM DMO by a Kalman filter. George Ericsson and Anders Persson.

A very short description of the status was done. The Kalman filter works well for 2m temperatures and wind speed, but there is not so much experience of other parameters yet. It was argued that the trials are for pre-ISBA with well known temperature problems in the model.

Discussion between the HIRLAM Management Group and SMHI (Nils Gustafsson and Stefan Nilsson).

The staffing situation was discussed. The Core group contribution had been less than full time and split between persons. Still there have been some valuable contributions. In HIRLAM-6 SMHI will contribute to the overhaul work, assimilation and data usage, ensemble prediction, and physical parameterisation. Also observation monitoring could be considered. The main problem as seen from SMHI was that the tuning of the physics in HIRLAM has been too slow in the Project.

Overhaul discussions with the Management Group, Nils Gustafsson, Stefan Gollvik and Tomas Wilhelmsson.

First the coding strategy was discussed. From the Toulouse Workshop, (and other discussions), it is quite obvious that F90 will be used. One can then e.g. use Case tools as in WRF or e.g. use derived types in F90. The main complaint against the current (physics) code are the many arrays and possibilities for errors and overwriting.
Code version control is probably better with CVS and is user friendly and good enough. Data bases and file formats should be discussed among an expert group in SRNWP and coordinated by Gerard. The suite control was strongly recommended to be SMS in Toulouse, and it is almost certain that we will use some flavour of this (mini-SMS). Coupling to models could be thought of in data assimilation (4D-VAR) and GRID computing will probably come later.
The overhaul (coding) and I/O design can probably be done in parallel. For MPI, the most urgent task is to increase the message length, as communication will remain a bottle neck. Of course, with higher resolution, the messages will become longer, but the increase in CPU speed demands tight control of the message passing.

Conclusions

The Management Group found that the presentations were very interesting and covered a wide area of HIRLAM activities. Encouraging progress had been made in the implementation of the Reference system (with Kain-Fritsch) and the very recent modifications to the turbulence scheme. Some ideas to test new features for the overhaul were discussed. The Management Group would like to thank the hosts, Nils Gustafsson and Stefan Nilsson and the staff, for the visit, the presentations and the meetings that took place.

Per Undén
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