Joint Operational Model Monitoring and Inter-Comparison in HIRLAM

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Abstract

This review describes briefly the ongoing effort in the HIRLAM-A programme on development of a joint monitoring interface for inter-comparison of operational systems.

1 Motivation

HIRLAM (HIgh Resolution Limited Area Model) is a cooperation among many European weather services with an aim to develop and maintain a short-range limited area numerical weather prediction system suitable for research and operational use at member services. As a main form of deliverable, the so-called reference HIRLAM system is regularly assembled and, upon satisfactory technical and meteorological evaluation, released for implementation at member services.

In terms of operational implementation of HFS in routine NWP, it is primarily the task of each HIRLAM member service. A substantial diversity concerning various aspects of operational configurations for HFS exist, such as the differences in terms of

- models (synoptic scale system HIRLAM or meso-scale model HARMONIE);
- version/cycle associated with different models;
- grid resolution, domain coverage;
- operational scheduling;
- model coupling appraochs;
- data assimilation methods;
- assimilated observation data;
- dynamics or physics options and local deviation in forecast model;
- post-processing method.

Traditionally, routine monitoring of operational HFS is the task at individual member services. In the current phase of HIRLAM cooperation, HIRLAM-A programme, sigficant efforts have been devoted to develop a joint operational system monitoring during the last few years. This is motivated by a number of reasons. First, HIRLAM-A programme needs objective, harmonised and convenient means to measure, in a timely manner, status and progress in both operational implementation and in research development. Such monitoring is especially interesting in view of the wide diversity in models and their characteristics. Secondly, a direct inter-comparison of models, if done carefully with harmonised tools, has proven to be very useful to help exposing various irregularities and problems associated with widely varying causes. Furthermore, HIRLAM, as a collaboration between many European NWS of medium or small scales, has a research community that collectively has a wide range of expertise covering different areas. Such large but distributed expertise may be best utilised for model monitoring with help of a common and easy-to-use interface.

It shall be pointed out that joint monitoring activity is a strengthening, but not replacement, of the regular monitoring activities routinely conducted at individual weather services. The idea is, through the common platform, comparison of different models can help to identify both common and individual trends, features and irregularities in an easy manner. For HIRLAM development community, such a joint monitoring package also provides an enhanced tool for new research development, especially in sensitivity or impact studies and in general validation.

2 Development of the Joint Monitoring Interface

Hirlam data portal on model inter-comparison

During the past few years, a mechanism has been established to collect, on near real time basis, monitoring data from HIRLAM operational services. Through centralised processing, these monitoring information are made available for inter-comparison at the web-portal of the internal HIRLAM communication network, HeXnet at hirlam.org (http://hirlam.org/portal/oprint). The arrangement is participated on a voluntary basis. So far all operational services have contributed on data contribution.

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At present, the collected monitoring data consists of main forecasts for a selected list of parameters and at certain spatial/time intervals, as well as monitoring information, such as observation verification, field verification (against verifying analyses), diagnosis and statistics related to observation data assimilation and forecasts.

Harmonising efforts in monitoring tool

Presenting monitoring information from different operational HFS on same web interface provides an unprecedented opportunity for the HIRLAM community on many inter-comparison applications associated with monitoring. Thanks to many years of efforts in the HIRLAM community, there is a rich availability of tools which can be used for various monitoring purposes. Meanwhile, to fully utilise the potential of inter-comparison on a single presentation platform, it is necessary to choose tools that are appropriate and easy to use, both in terms of data processing, graphics and presentation. This also involved, in some applications, harmonisation efforts for application in the joint monitoring.

One such example of the needs for harmonisation is on selection and further development of algorithms and procedures used in observation verification. An inventory study on observation verification among HIRLAM member services revealed existence of many verification packages, but the information derived from these packages are difficult for usage in a inter-comparison. Differences involve data format; methodology; selection of verification parameters; sources of observation data (run-time or delayed cutoff data); selection of parameter for surface temperature (averages over grid-point or for land fraction only) and for humidity (dew point temperature, or relative humidity, or specific humidity); different parameter definition (e.g., use of saturation table with full water phase or liquid water only for humidity data); different model analyses used for observation data rejection, different data rejection limit and criterion, etc. Clearly, a harmonisation in production chain leading to the final inter-comparison of verification results is necessary. The verification package based on utilities GL and MONITOR, developed mainly by Ulf Andrae (SMHI) within the framework of the HIRLAM mesoscale system (HARMONIE), was selected for production in the common verification.

After each forecast model runs, the predicted key parameters at 6 hour interval are extracted, using GL package, against a comprehensive observation station-lists (compiled from WMO database) which assures complete coverage over the largest operational model domains among HIRLAM weather services. GL package has also been extended to extract model data from ECMWF, HARMONIE/ALADIN, UKMO. The extracted model data with GL package are then collected in near real time centrally (currently at the ECMWF computer platform), and compared, in various grouping form, using the MONITOR package to compute regular verification scores against extracted surface and sonding observation data derived with the same package (GL) and format. The quality control of observation data in MONITOR is done on the fly, i.e.,, through comparison against verifying analyses of models in use and against a namelist-driven rejection limit. The quality check here follows principle of maximum consent from all verifying analysis, thus ensure strict equivalence in observation data samples used for observation. e.g., if observation from a given station is acceptable according to the verifying analysis of model A but erroneous according to model B, this particular observation data will be excluded in computation for verifying forecasts from both of the models.

With algorithm used in GL and MONITOR packages, similar algorithm is used to extract model information to a pre-defined station list, and with the implemented on-the-fly quality control method, the verification package has no dependency on any models.

A large variety of verification products has been implemented in MONITOR package, which can be applied, through name-list switches, to compute, from extracted model and observation data derived from GL, various kinds of error statistics, maps, scatter plots, time series, time/area averages, etc. These results are then converted into various forms suitable for graphical presentation on the HIRLAM web site.

For web presentation, one of the main interface adopted is WebgraF, a tool package as part of MONITOR package. The interface seems quite robust and flexible for a range of inter-comparison applications.

3 Progresses and Outlook

The efforts on the joint operational HIRLAM system inter-comparison are still ongoing. Currently, the web-portal contains near-real time analysis and forecast charts for key parameters of up to 48 hours, with field data from contributing member services and ECMWF. Monitoring of data assimilation and forecast model features are also included in the same web interface, in which analysis increment maps for selected analysis quantities, observation data usage and error statistics plots, minimisation and forecast characteristics in terms of various domain averages, are presented. Some real time comparison between HIRLAM forecasts and observations via meteogramms and mast profiles are also provided via links to web-pages at member services. Currently, the mast profile observation provided by Sodankyla (FMI), Cabauw (KNMI), Valladolid (AEMET) and Lindenberg (DWD) measurement towers are included, compared to a few model forecasts from contributing services and Meteo France.

Using the harmonised GL-based verification package, main operational HIRLAM models at all HIRLAM member services as well as the early delivery BC (Boundary Condition) forecasts from ECMWF are verified against land surface and radiosond observations and inter-compared in near real time. Field verification against verifying analyses for some of the HIRLAM systems has recently also been added.

Similar inter-comparison facilities have also been used to monitor real time, pre-operational forecast suites using the so-called trunk version of the reference HIRLAM model, which is the candidate for the coming official reference HIRLAM version. Meanwhile, tools developed in connection with the joint operational monitoring have also been applied more widely in the HIRLAM research community for regular model inter-comparison, especially the GL and MONITOR-based tools for verification (fldextr, obsextr, verobs and xtools), as well as the web-interface using WebgraF, and plotting package for analysis statistics.

Although still in its development phase, the monitoring package has shown to be a powerful tool to facilitate the HIRLAM community with an improved monitoring work. Since the introduction of the common monitoring interface, numerous examples of timely detection of operational problems have been experienced. e.g., the real time inter-comparison of observation data usage helped in several occasions early detection of missing observation data (sonding, surface synop and ATOVS data), missing data stream (BUOY data, E-amdar data in bufr format), incomplete temporal data coverage, and abnormal observation data rejection. From comparison of analysis diagnosis plots monitoring 4D-VAR minimisation, abnormal cost function behavior in connection with variational quality control has been detected, leading to subsequent bug correction. From observation verification, abrupt deviation of surface verification behavior from other models in comparison revealed erroneous use of sst and ice cover data due to script errors. Finally, inter-comparison of analysis charts for SST/ice over lake area and snow depth during the recent cold winter condition helped to detect analysis problems in the recent version of HIRLAM.

Looking ahead, more emphasis in the work on the joint monitoring interface will be to extend the existing products to cover more real time model systems including those of meso-scale HARMONIE forecasts, and to improve the maintenance work to ensure regular, timely and complete presentation of monitoring information from all contributing models. Another important improvement will be sought for a more active monitoring, through an increased participation of the HIRLAM research community. Participation from communities outside of HIRLAM will also be actively encouraged and promoted.

4 Acknowledgement

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