Quality Assurance in HIRLAM-C

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6) Early achievements in HIRLAM-C (CY40) to improve model quality.
7) Future challenges: Code modernization relevant to high resolution NWP to secure scalability

”Quality Assurance” in general terms (1):
Prerequisites for succesful NWP

International Organisations

WMO

EUMETSAT

EUMETNET

ECMWF

Météo-France/ALADIN/HIRLAM LAM NWP system (Harmonie)

1) High quality and sophistication of the forecast model including LAMEPS

2) High quality of data-assmillation

3) Stable NWP setup producing timely operational NWP forecasts

4) Evolution of modern code structures to secure portability and scalability on relevant platforms

5) Real time monitoring- and verification system adequate for high resolution NWP

6) Output products relevant to end-users and an adequate communication with NWP users in general

Quality Assurance in HIRLAM-C

Known model defifiencies of Harmonie at the end of 2015

- Forecasting of fog, low clouds and intense precipitation due to deep convection
- Poor screen level temperatures in stable conditions
- 10m wind bias , e.g. occasional overprediction of strong winds over sea.
- Overprediction of extreme precipitation
- Systematic errors in surface fluxes, e.g. moisture- and radiation fluxes

Quality Assurance in HIRLAM-C
Addressing model deficiencies

Preliminary HIRLAM-C strategy plan tries to address the identified issues, with special focus on

- **Model improvements on boundary layer physics including turbulence, microphysics, aerosols and radiation**
- **Improved surface schemes and databases**
- **More advanced data-assimilation techniques , e.g. using new promising observation types**
- **Extensive verification e.g. using more surface- and satellite data as a basis for alleviating model problems and diagnosing new deficiencies**
- **New advanced diagnostics**

Adequate common objective verification tools (1)

High resolution NWP requires adequate tools:

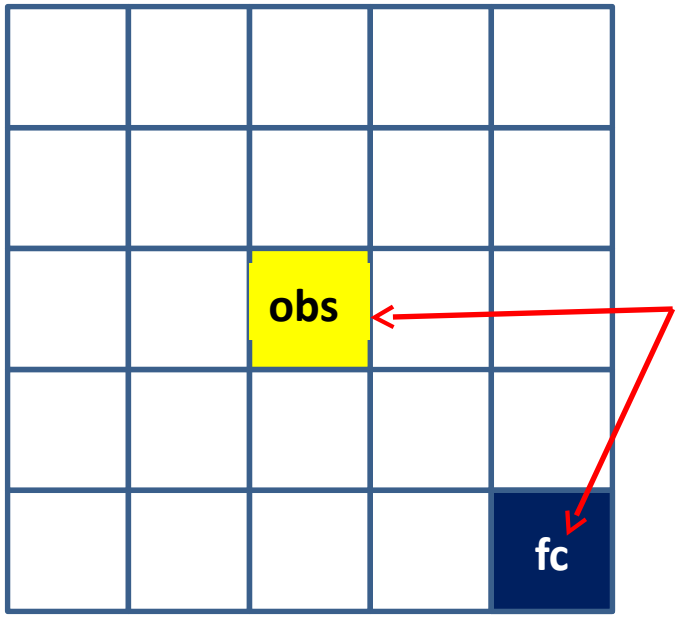
- **Realize that ”Double penalty” issue requires availability of new verification methods for high resolution NWP compared with traditional ”point verification”:**
- **”Point verifications”, i.e. verifications for a specific time and location are no longer sufficient in Quality Assurance due to the ”double penalty issue” where high-resolution models are ”punished” :**
- **First a high resolution model tends to be punished for not predicting a significant weather event exactly on the spot, secondly it is punished for predicting the event at a (slightly) different position.**

Diagnosing predictable spatial- and time scales

”SPATIAL WINDOW” matters
especially when predicting extremes

SUGGESTION:

For a given threshold to be forecasted look for ”optimal” upscaling distance to be used. This may be determined on the basis of verification using different upscaling.



BASIC CHALLENGE :

No predictability on GRID SCALE

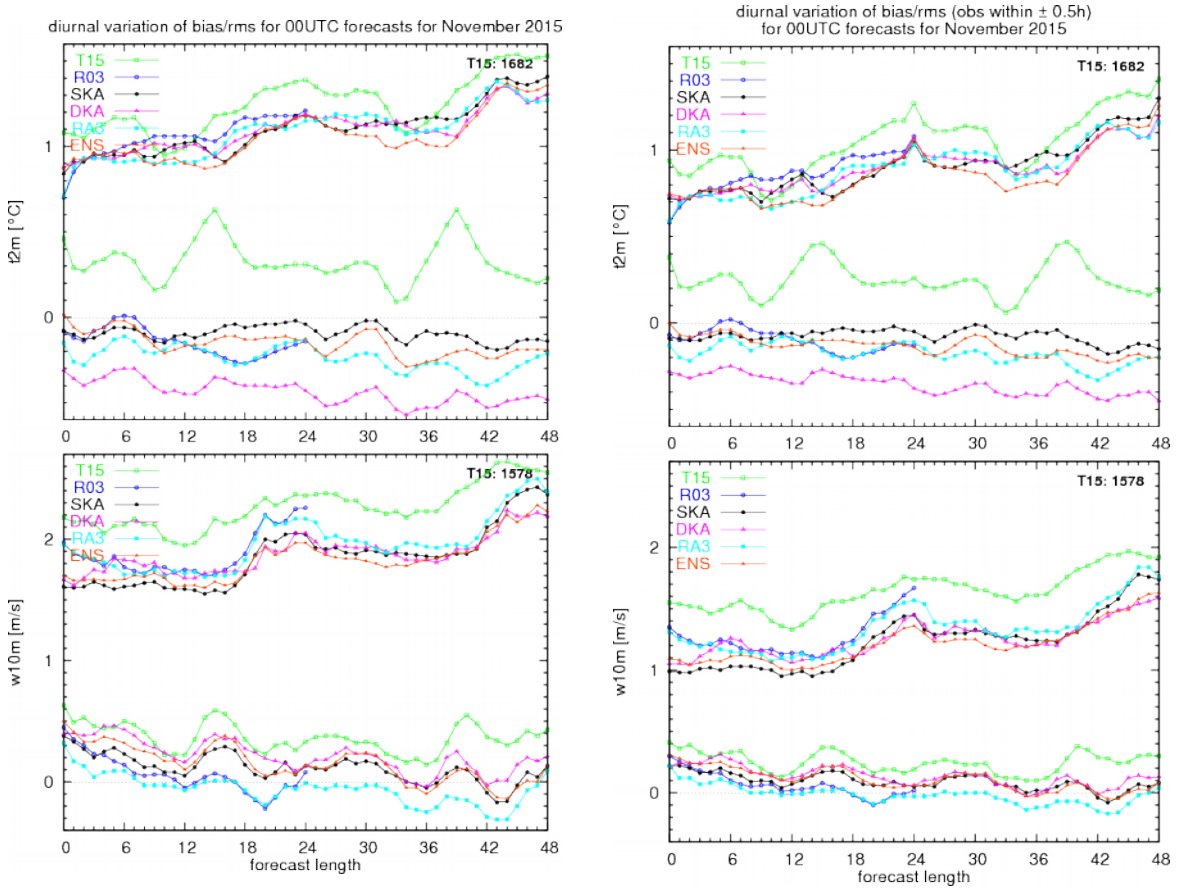
Forecasting ”obs” correctly on gridscale is not likely to happen, but operating on predictable scales gives better chance

Statistical Quality Assessment at DMI :

"TIME WINDOW" matters

Sensitivity of DMI models to verification time window
verification at precise time (left)
allowing a time window of +/- 0,5 hours (right)

Temperature and wind predictions in November 2015:
CONCLUSION : observation time window matters !



Adequate objective verification and validation tools (2)
- Suggestions for Development Strategy -

- **Develop and use common tools in order to avoid unnecessary difficulties with comparing results**
- **For HIRLAM-C project: Use ”Monitor”, later taken over by HARP shared with ALADIN**
- **Further development of HARP , especially regarding spatial verification methods (e.g. FSS, SAL, SWS and other measures) , in collaboration with ALADIN - to be adapted for EPS**

Adequate objective verification and validation tools (2)
- Suggestions for Development Strategy -

- **Get additional info from national verification results until HARP might take over verification (completely)**
- **Use special surface obervations to monitor and validate models: compare model output against special observations from e.g. CABAUW, Sodankylä, Cloudnet supersites**
- **In parallel follow experience from EUMETNET-partners and from other systems, e.g. MODE (System at NCEP)**

Proposed short term actions to promote common tools:

- **SPATIAL verification: A spatial verification package is already available in HARP (software from NCAR), but some last steps prior to general use need to be finalized : transfer of satellite-data, radar derived precipitation and model data to a common grid ! (side meeting at ASM2016)**

- **COMMON verification and validation tools to be discussed further in strategy meeting(s) between HIRLAM and ALADIN (and Météo France) ?**

- **HIRLAM-C Managent plans to arrange a meeting (demonstration and tutorial) in fall 2016 to promote use and development of common verification and validation tools , e.g. `Monitor' , `HARP' , `ObsMon' .**

Communication with Users:

Initiative to start new communication practice with users (1)

Required:

- **According to the preliminary strategy for HIRLAM-C it should be a priority of HIRLAM-C to improve the communication with users, e.g. related with model performance : An initiative is being prepared to start a new improved feedback between users (forecasters) and the HMG.**

Idea:

- **Make a templet to HIRLAM member services to be filled in quarterly with input from operational forecast services. A contact person in each service will secure the regular communication. The templet will be agreed on in the HIRLAM-C management soon.**

Goals:

- **Identify model deficiencies which would otherwise be difficult to reveal, - and to enable mutual communication between operational users of Harmonie and the developers, e.g. the developers may communicate back what is being done to alleviate or cure identified weaknesses.**

Initiative to start new communication practice with users (2)

- **Maintain a list of `top 5' or `top 10 ' issues to work on with priority**

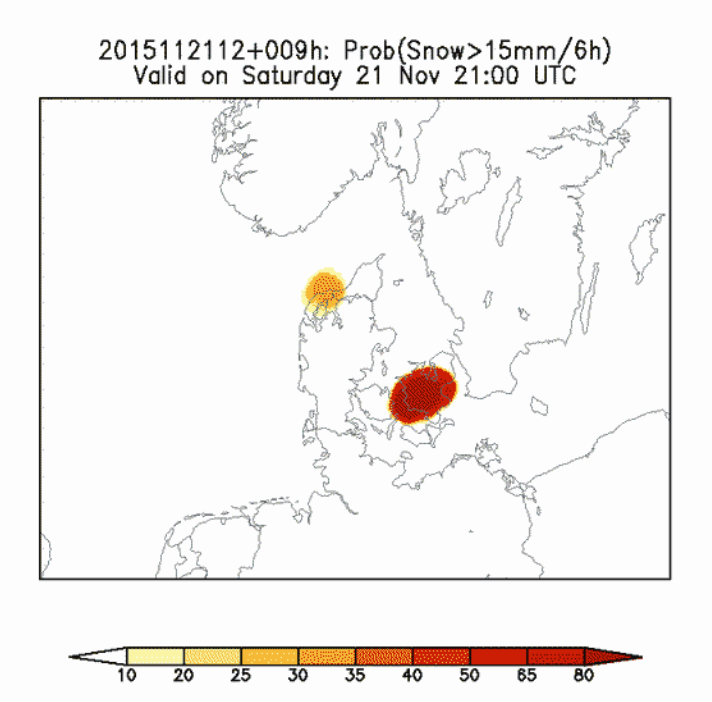
Inspiration for the templet may be gained from a link to ECMWF :

https://software.ecmwf.int/wiki/display/FCST/Known+IFS+forecasting+issues

- **This link contains information exchange in 3 columns: The first column essentially contains a headlines of the topic, the second column describes the model issue (problem) that the user has identified. A third column is reserved for the developers , in our case the HMG , to inform about current actions to alleviate the problem(s). Possibly links to preliminary progress could be included.**

How can we communicate products to users , e.g. forecasters in a form which is easily understood :

Forecasters often complain about too much information to ”grasp” on their busy operational duties. - Hence there appears to be a need to develop condensed and relevant output, especially in the context of EPS



EXAMPLE: Well predicted heavy snow fall with HIRLAM-EPS at DMI, using ”probability” of Snowfall > 15 mm/6h: Easy to ”grasp” for a user

Achievements in CY 40 (1)

The Hirlam-B management

(Jeanette Onvlee, Ulf Andrae, Xiaohua Yang, Mariano Hortal, Laura Rontu, Ingerlise Frogner)

developed new components of CY40 together with Hirlam staff, defined and executed a comprehensive set of tests validating CY40, see (http://www.hirlam.org/trac/wiki/Harmonie_40h1/ValidationTests)

The HIRLAM-C management

(Jeanette Onvlee, Daniel Santos-Munoz, Roger Randriamampianina, Ingerlise Frogner, Lisa Bengtsson, Patrick Samuelsson and Bent Hansen Sass)

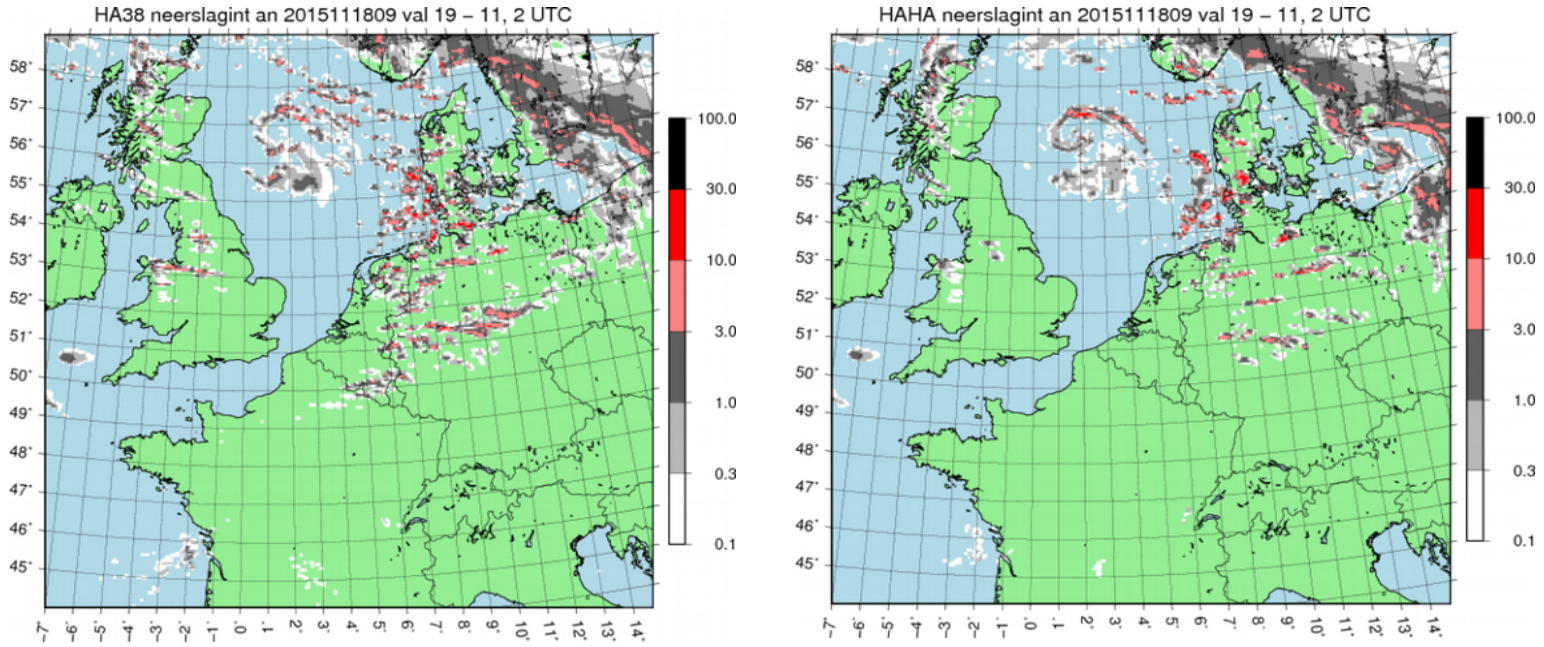
now finalizes tests and documentation

Achievements in CY 40 (2)

- **The new components in Cy40h1 for consideration as default are: HARATU (upgrade), LLCRIT (snow from shallow convective precipitating clouds), radiation updates, new spectral grid options, GMTED2010, prognostic sea ice scheme.**

- **Conclusions: Significant improvements have started in CY40 to alleviated known model deficiencies.**

Results: precipitation
default versus upgraded HARATU



(a) (b)

The ”spottiness” of precipitation field is reduced with updated HARATU (b), containing more coherent structures compared with default ”non-HARATU” scheme (a). (Version 38 test ! , made available by Wim de Roy)

”Scalability”(1)

- When producing operational high quality short range forecasts it is not enough that model and data-assimilation are sophisticated. Results also need to be produced efficiently at new HPC architectures.

- Challenges to utilize current IFS/Harmonie codes on future HPCs efficiently with respect to many cores per node.

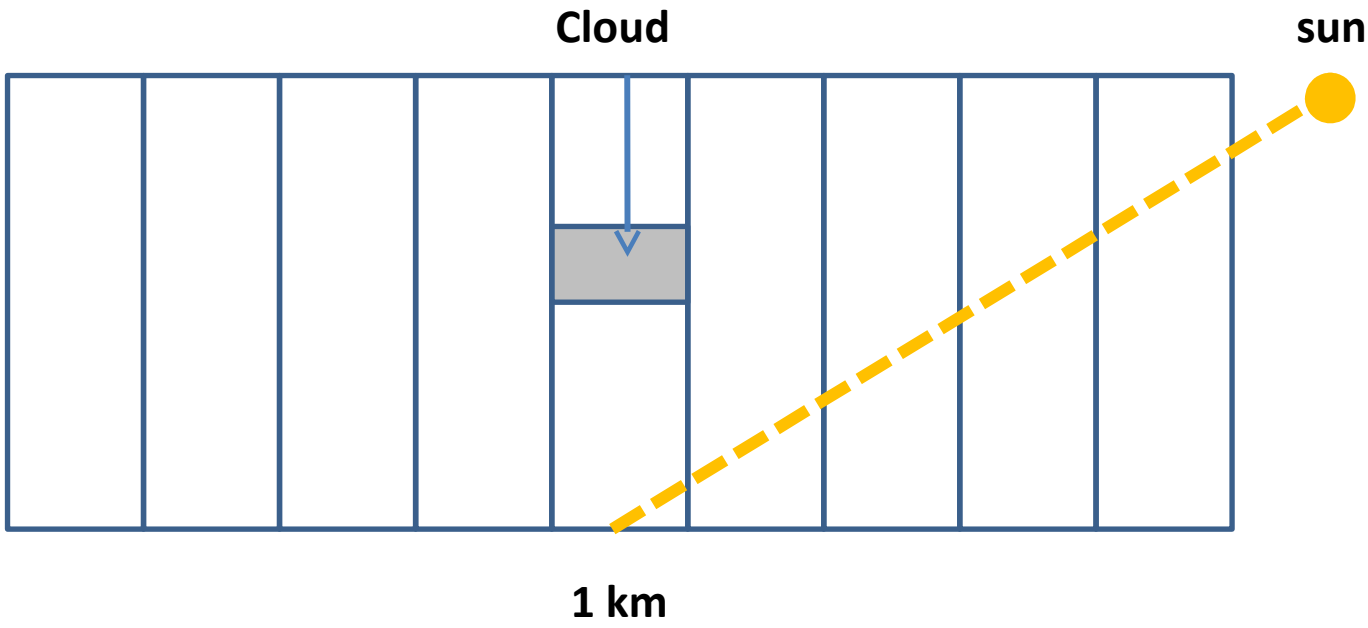
- Fortunately, ”Scalability” projects have been financed and started involving ECMWF and European partners, e.g. the ESCAPE project.

- Expensive physics such as radiation and aerosol physics in high resolution potentially benefit a lot from developments in ESCAPE, e.g. through ”multigrid options”

”Scalability ”(2)

Instantaneous solar fluxes in the model based on high horizontal resolution becomes inherently inaccurate if only data in the local vertical column is used. As a consequence (partial) use of coarse mesh computations could be highly beneficial in the future . This may lead to substantial computational savings (an order of magnitude faster computations) . This idea (multigrid option) is assumed to be realizable via ATLAS framework at ECMWF in the future.

Figure: Example illustrating that using local vertical column cloud cover will occasionally lead to completely wrong flux to the ground. The tendencies in the vertical column will in general depend on neighboring columns !



”Scalability”(3)

BUT at a time scale of next few years :

Do we risk big problems with scalability due to HPC architectures, e.g. from new many-core nodes delivered by vendors ?

- **Suggestion for consideration: Establish a group of experts (e-mail list ?) in the IFS community discussing means of alleviating scalability issues on short to medium term**

- **Keep close relations to scientific computing centres and vendors willing to test our codes on new HPCs**

”Quality Assurance” in general terms
Prerequisites for succesful NWP (2)

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LAM NWP system
(HARMONIE)

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Valuable products and happy users

Meteorological scientists are wonderful people, and now we understand their forecasts !