

HIRLAM work on IFS/ALADIN

-overview-

→ **Evolution of activities 2004 – 2006**

→ **HIRLAM physics in IFS/ALADIN**

- * **Coding strategy**

- * **Problems and questions during work**

- * **Verification**

→ **Other results with IFS/ALADIN/AROME**

→ **Conclusions and suggestions for nearest future**

Evolution of activities (1)

- **First setup** at ECMWF of IFS/ALADIN in July 2004 intended for HIRLAM use (`HIRALD` setup)
- **Autumn 2004**: establish double nested ALADIN systems (~10 km outer Scandinavia, ~2.5 km two inner domains) with forcing from ARPEGE
- **Spring 2005**: First coding of HIRLAM physics (condensation, convection) in cycle 28 + developing of tools, e.g the possibility to force ALADIN with HIRLAM lateral boundary data.

Evolution of activities (2)

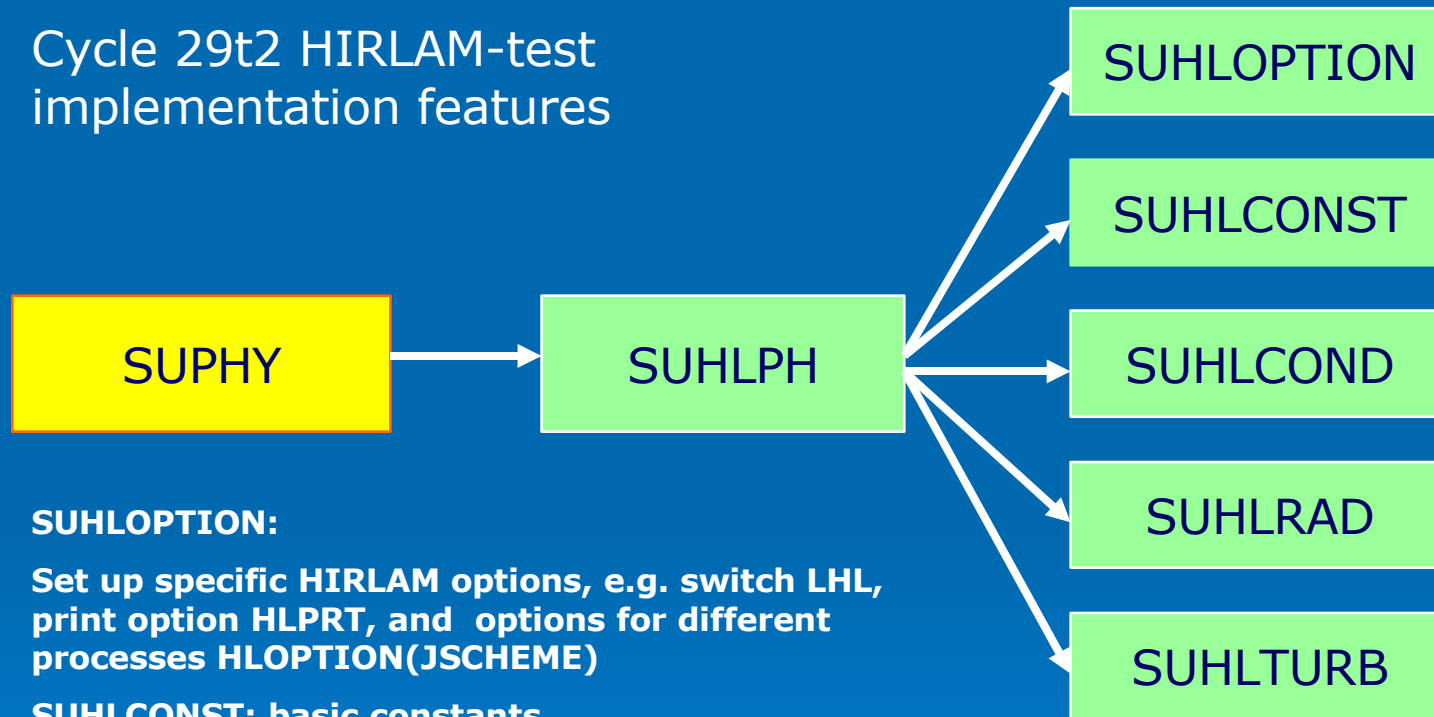
- **Autumn 2005:** Climate generation established, parallel runs every day with ALADIN (SMHI) and HIRLAM physics (DMI) Both radiation, condensation and convection included in double nested setup. –Coding of HIRLAM TKE based turbulence. Other tools, e.g observation verification established and used.
- **Spring 2006:** Implementation of suggested HIRLAM code nomenclature, better norm-checked code, test various combinations of physics. – First implementation of Arome system (cycle 30 at SMHI, FMI). - Participate in phasing exercises (Toulouse) and plan to phase HIRLAM physics in Cycle 31t1

HIRLAM physics in IFS/ALADIN coding (1)

- Adapt to IFS coding practice (implying recoding from f77 to f90)
- Adapt to interface structure of Arpege/Aladin
- Develop a nomenclature specific to HIRLAM (a "HL"-rule suggested)
- Implement at first the HIRLAM default schemes for turbulence (TKE based), condensation, convection and radiation.

HIRLAM physics in IFS/ALADIN coding (2)

Cycle 29t2 HIRLAM-test
implementation features



SUHLOPTION:

Set up specific HIRLAM options, e.g. switch LHL, print option HLPRT, and options for different processes HLOPTION(JSCHEME)

SUHLCONST: basic constants

SUHLCOND : constants used in condensation

SUHLRAD : setup of HIRLAM radiation

SUHLTURB : setup of constants for turbulence

HIRLAM physics in IFS/ALADIN coding (3)

Additional features of the setup (Cycle 29t2):

Modified setup routines: SUFA, SUGFL, SUDYN, SUDIM1

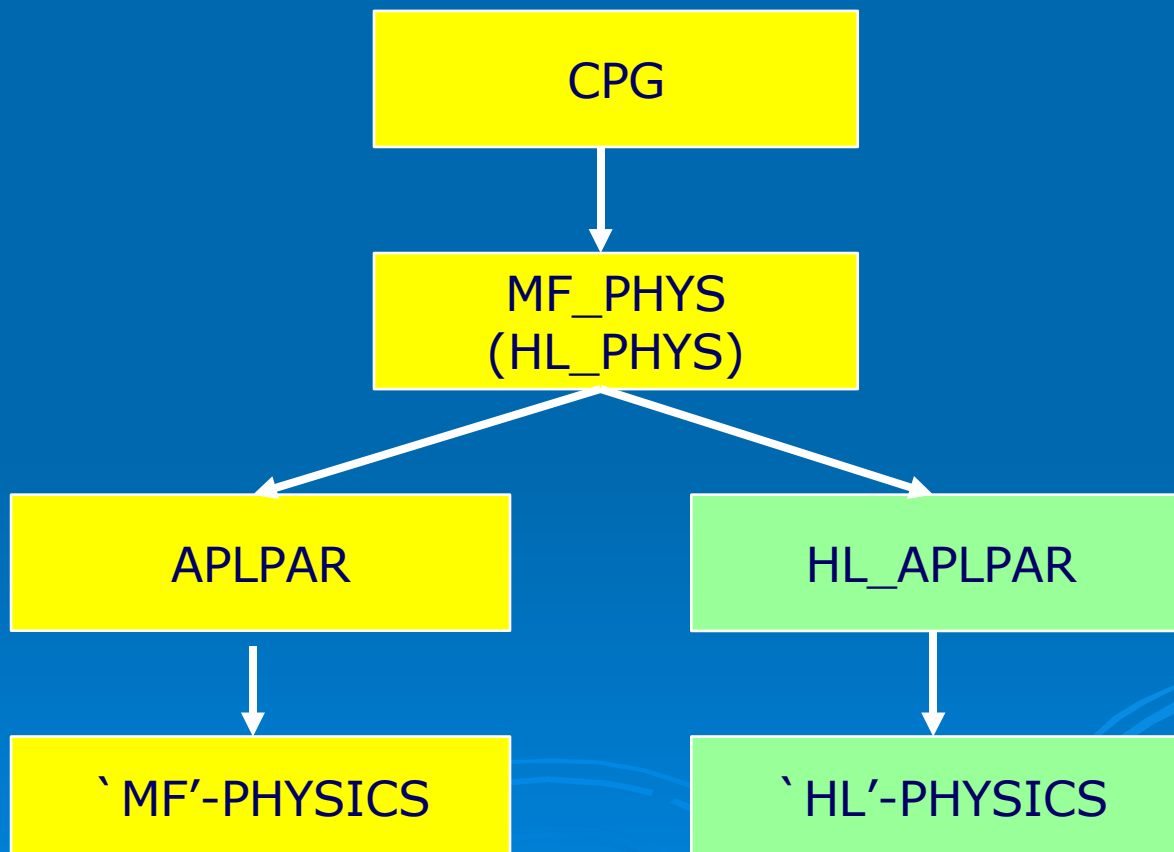
Modified modules: YOMFA, YOM_YGFL

(connected to the definition of a new pseudo prognostic variable)

Modified routines computing tendencies and updating variables due to physics (CPTEND , CPUTQY)

New modules: YHLOPTION, YHLCONST, YHLCOND, YHLRAD, YHLTURB

HIRLAM physics in IFS/ALADIN interface coding (4)



Problems and questions during work (1)

- 1) The ALADIN system cycle 29t2 has not been completely ready for using TKE as a prognostic variable:
 - TKE namelist could not be used in general without source code modifications.
 - Subroutines `cptend` and `cputqy` needed modification to provide updates of variables due to TKE scheme
- 2) Parameters used in interface to physics do not always have the same meaning in `ALADIN world` and in `HIRLAM world`.
 - **EXAMPLE:** Geopotential as argument to physics in HIRLAM is computed relative to local orography, but in ALADIN it is relative to MSL (misinterpretation causes a disaster)

Problems and questions during work (2)

- 3) In order to comply with ARPEGE / ALADIN methodology it has been necessary to compute a number of pseudo-fluxes implying some coding effort.
- 4) It has been necessary to learn how new prognostic/ pseudo-prognostic arrays are introduced in IFS in order to implement HIRLAM physics.
- 5) There is a danger that some parameters of diagnostic nature are 'forgotten' at first, e.g. diagnostic cloud covers

Example: At some stage the verification indicated very large errors in cloud cover - - - the diagnostic cloud cover was indeed zero in that version because the HIRLAM diagnostic total cloud cover was not yet implemented !

Problems and questions during work (3)

6) Problematic implementation of the HIRLAM turbulence scheme in cycle 29t2:

A straightforward implementation of the HIRLAM TKE-based turbulence scheme (keeping the scheme `intact`) means that the ALADIN turbulence scheme is called first and using only surface fluxes of momentum, heat and moisture as input to the HIRLAM turbulence scheme which then `overrules' the previous fluxes computed by the ALADIN scheme (output from ACDIFUS)

The approach outlined is not ideal. It seems advantageous that only one turbulence scheme is involved and that a call is made to the externalised surface scheme to provide the surface fluxes (possible in cycle 31)

Problems and questions during work (4)

- 7) Wrong (sub-optimal) namelist has been used for a long time (a discussion issue as late as May 2006 in a HIRLAM miniworkshop) !
- 8) It might be problematic to implement a physics package only partially (e.g. disregarding surface processes). To what extent is the surface parameterization 'tuned' to give good results with a specific atmospheric physics ?
- 9) It has been confirmed that numerically stable daily runs does not necessarily means correct implementations. As a consequence there is a need for both verification and diagnostics linked to the implementation !
- 10) Is a mixture of physical parameterizations between two different packages numerically stable ? - - -

Answer: NOT necessarily !

Problems and questions during work (5)

EXAMPLE:

The HIRLAM default condensation scheme (using prognostic condensate) is not always stable when coupled to the ALADIN turbulence scheme. It is stable at a 'traditional' synoptic scale resolution (10 km and upwards), but unstable at high horizontal resolution (e.g. at 2.5 km grid size studied)

In ALADIN physics it is customary to relate precipitation release to condensation in the flux forms :

$$PFPLCL = K^* PFCCQL$$

$$PFPLCS = K^* PFCCQN$$

$$PFPLSL = K^* PFCSQL$$

$$PFPLSN = K^* PFCSQN \quad , \text{ With } K=1.$$

Problems and questions during work (6)

This relates precipitation fluxes of rain and snow (stratiform or convective) to the associated condensation fluxes.

In HIRLAM the precipitation release is more complicated as in other schemes with cloud condensates.

However if the precipitation release of HIRLAM is overruled by the abovementioned simple relationship it is found that runs at 2.5 km grid size are stable for

$K \rightarrow 1$, but becoming unstable for decreasing K .

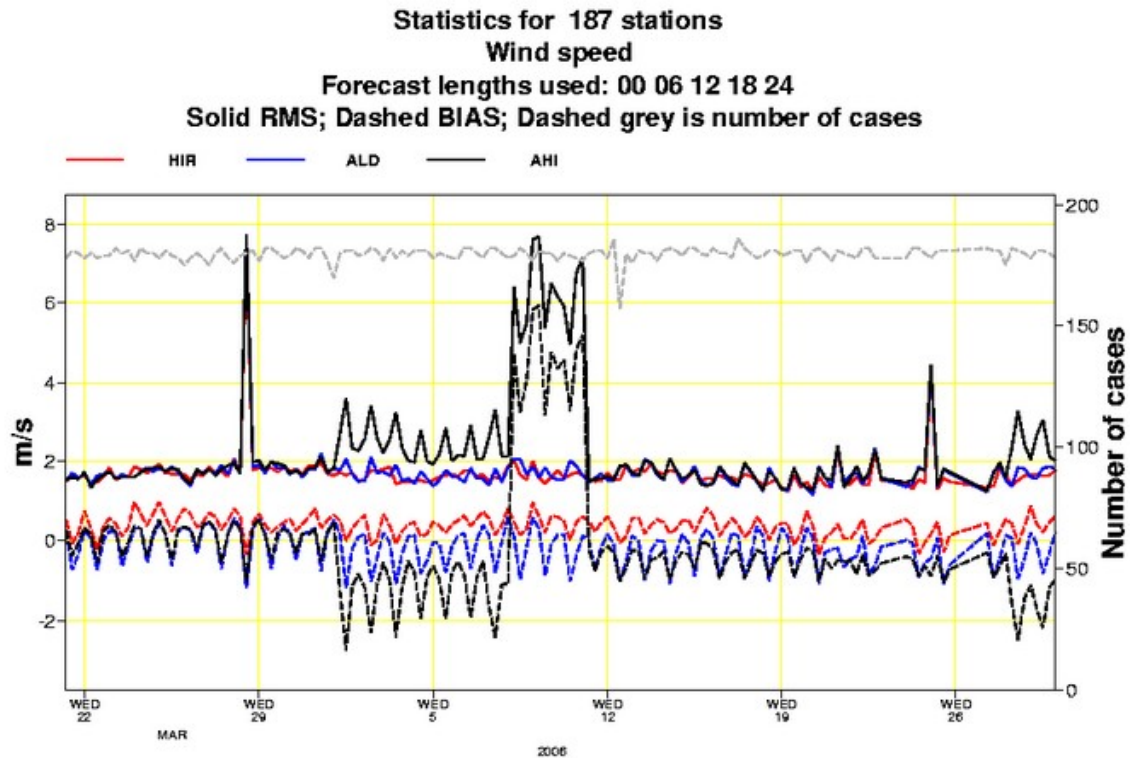
When K increases towards 1 it means that less cloud condensate is accumulated in the atmosphere which appears 'less dangerous' for the model.

Problems and questions during work (7)

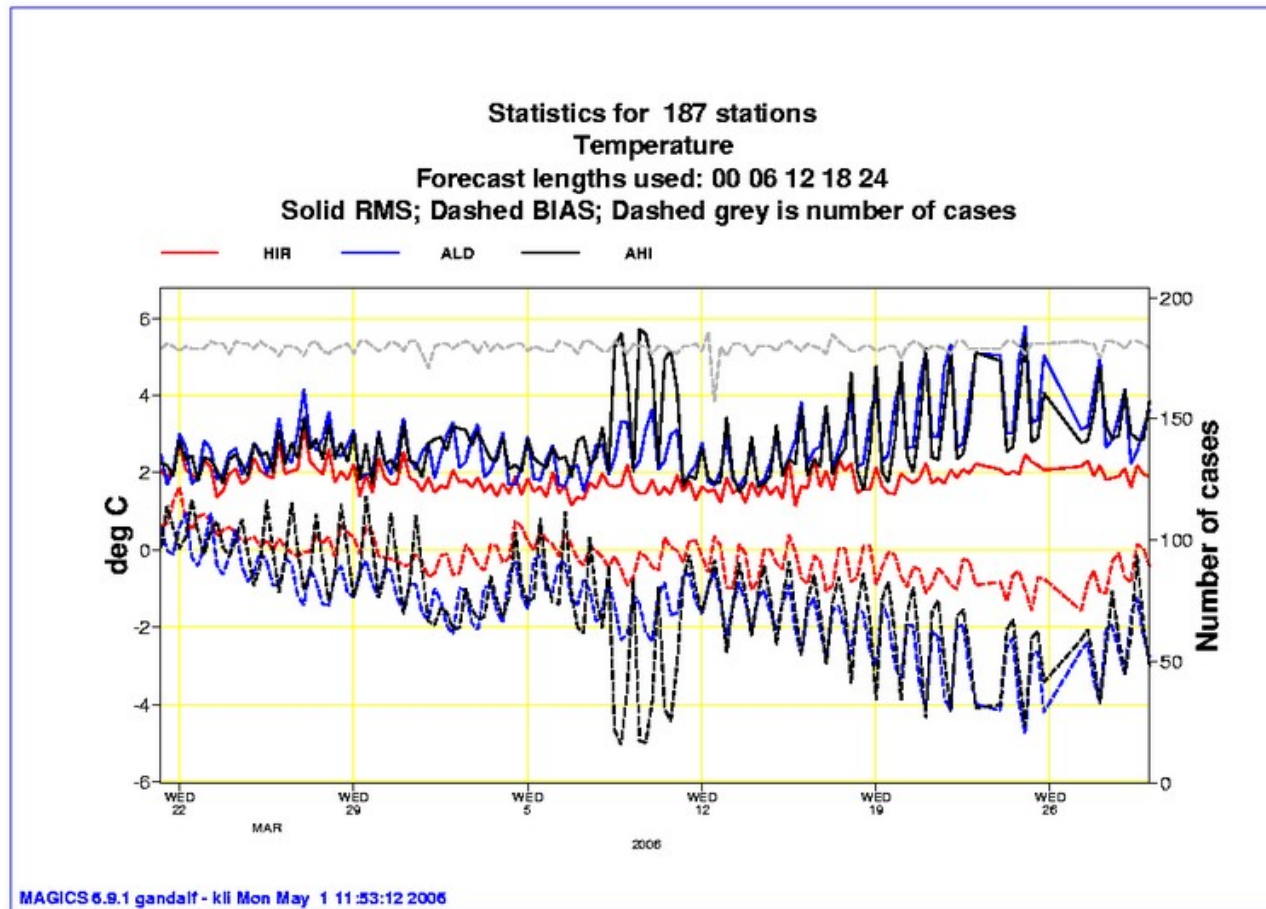
Fortunately ,

it has been found that the HIRLAM physics is stable when using the HIRLAM turbulence scheme also at high resolution in the IFS/ALADIN environment (at 2.5 km).

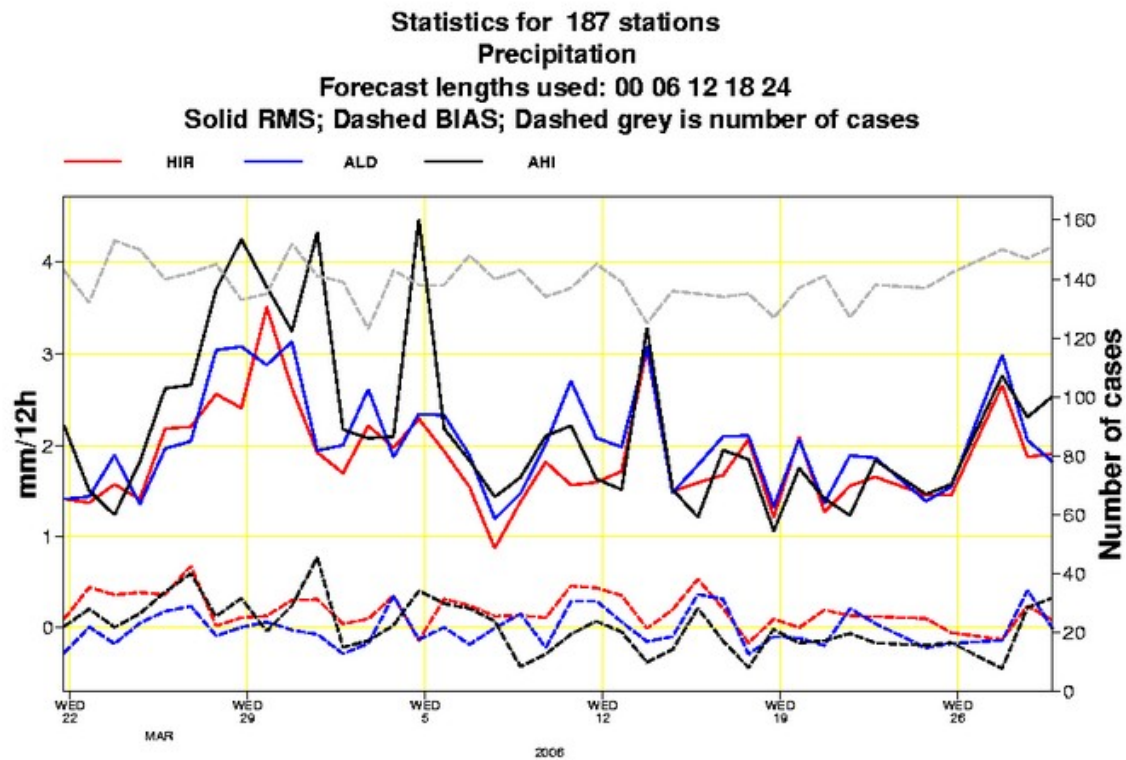
Verification of daily runs(1)



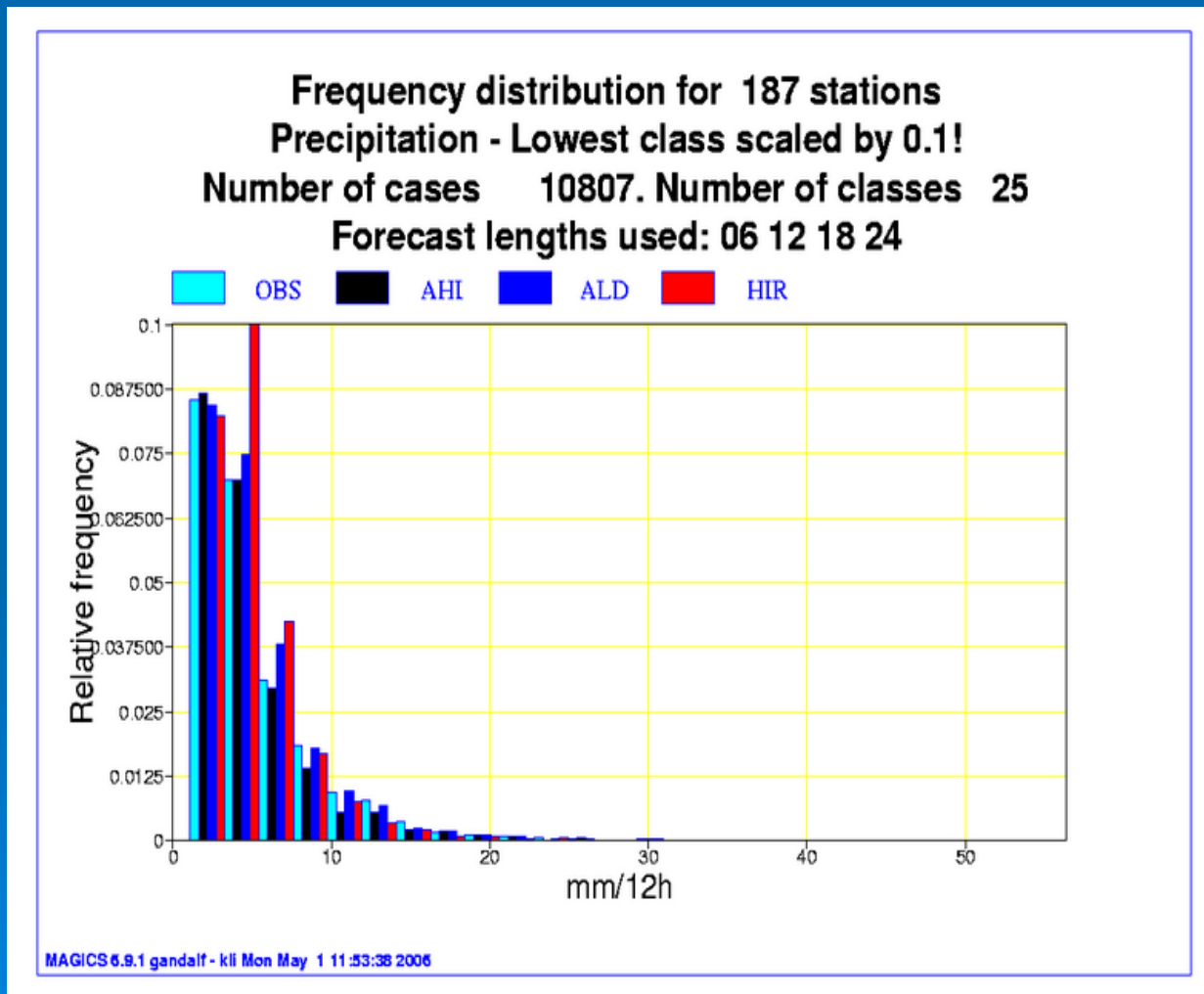
Verification of daily runs(2)



Verification of daily runs(3)



Verification of daily runs(4)



Other results with IFS/ALADIN/AROME

- At SMHI daily runs with `standard' ALADIN physics have also been carried out since Autumn 2005. The results have been described and compared with corresponding SMHI-HIRLAM results in a HIRLAM newsletter
- In Spring 2006 implementation early tests of AROME physics have been carried out at SMHI and at FMI.
- Currently other HIRLAM countries are in a process of setting up new systems of daily runs.

Conclusions and suggestions(1)

Fruitful and efficient code collaboration requires firm procedures about standard namelists linked to a given release ,

ARPEGE-namelist,

ALADIN namelist,

AROME namelist.

Otherwise too much time is spent to understand problems caused by parts of the namelist that a given user cannot be expected to understand

Conclusions and suggestions (2)

It is now possible to make meaningful daily runs at high resolutions with HIRLAM physics implemented in IFS/ALADIN.

BUT

some questions still require attention:

1)

The poor results of surface parameters in the DMI setups in late April (also for standard ALADIN run needs to be understood)

2)

Additional diagnostic investigations, mainly on the CBR scheme implementation, need to be carried out to ensure that the schemes operates as expected.

Near future

- A planned next step is to make an implementation of HIRLAM physics in cycle31-t1
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- A few corrections could possibly be implemented in cycle 32.