A short summary of the HIRLAM work on IFS/ALADIN during the Meso-Scale Project 2004 - 2006

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1. Evolution of activities

The main activities are summarized below. Further details can be found in HIRLAM reports (Sass 2005, Andrae 2005)

- A first setup of IFS/ALADIN intended for HIRLAM use has been established in July 2004
- Double nested ALADIN model systems have been established in Autumn 2004 ($\approx$ 10 km grid size model domain over Scandinavia , including two $\approx$ 2.5 km grid size inner domains) with forcing from ARPEGE outer model fields.
- In Spring 2005 the first recoding of HIRLAM physics was made (condensation, convection) in cycle 28. Also other necessary developments were started, e.g. the feature to force ALADIN with HIRLAM lateral boundary data.
- In Autumn 2005 a climate generation was established. Parallel runs every day was set up at SMHI (ALADIN physics) and at DMI (using recoded HIRLAM physics of radiation, condensation and convection). Coding of the HIRLAM TKE-based turbulence scheme started. Other tools, e.g., observation verification was established and used.
- In Spring 2006 a full implementation of HIRLAM recoded physics was done (radiation, condensation, convection and turbulence). The code was better complying with the norm-checker demands than previously. - HIRLAM staff participated in phasing excercises in Toulouse. The HIRLAM physics was phased into cycle 31t1 in early June 2006. - A first implementation of the Arome code was done at SMHI and at FMI.

2. Coding of HIRLAM physics in IFS/ALADIN

The coding strategy is briefly described below. Further details are provided in Sass (2006).

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

The basic constants used for physics in the context of IFS are initialized in setup routines called from subroutine **SUPHY**. The subroutines initializing HIRLAM physics are called through the following sequence :

SUPHY ⟶ **SUHLPH** ⟶ ”HIRLAM initializing routines”

The following subroutines are called:

SUHLOPTION (Basic HIRLAM options)
SUHLCONST (Basic physics constants)
SUHLCOND (Constants related to condensation processes)
SUHLRAD (Constants related to radiative processes)
SUHLTURB (Constants related to turbulence).

The related modules are respectively **YHLOPTION**, **YHLCONST**, **YHLCOND**, **YHLRAD** and **YHLTURB**.

It is also necessary to modify a few existing setup routines and modules in IFS (**SUFA**, **SUGFL**, **SUDYN**, **SUDIM1**, **YOMFA**, **YOM_YGFL**) Furthermore, the routines computing tendencies and updating variables due to physics (**CPTEND** , **CPUTQY**) need to be updated.

The basic physics interface routines in the case of pure ARPEGE-ALADIN physics call are

CPG ⟶ MF_PHYS ⟶ APLPAR ⟶ ‘MF’ physics routines

In the case of activation of HIRLAM physics (constituting only a part of the total physics) the physics calling routines are

CPG ⟶ MF_PHYS ⟶ HL_APLPAR ⟶ ‘HL’ physics routines

3. Problems during work

The implementation of HIRLAM physics has taken longer time than originally anticipated, for various reasons. First, the ARPEGE system was not completely ready for using TKE as a prognostic variable in cycle 29.

Also some model variables had different meaning in ALADIN compared to HIRLAM. For example, geopotential in ALADIN physics is computed relative to MSL whereas in HIRLAM it is computed relative to the local topography height.

In ARPEGE a number of pseudo fluxes are computed before constructing the tendencies from physics. The computation of these fluxes were not in all cases trivial when implementing HIRLAM physics.

For some time there was, for various reasons, uncertainty related to the use of namelists.

The mixture of HIRLAM physics (with cloud condensate variables) and ALADIN physics without cloud condensates appears to be sometimes problematic implying the risk of model instabilities. A stable integration system has been obtained when a bug-free implementation of the HIRLAM turbulence scheme was ready. A more optimal implementation of HIRLAM physics is expected when the interface to turbulence is governed by a call to the externalised surface scheme.

4. Status by mid 2006

It is now possible to make daily runs on different computer systems (e.g., a Linux cluster, IBM, NEC) with ALADIN systems forced by HIRLAM boundary fields. A limitation is that the HIRLAM fields cannot yet be used directly as forcing to a non-hydrostatic ALADIN system. The physics may me either Arome based (cycle 30) or ARPEGE cycle 30), or mainly HIRLAM based (cycle 29 or 30 or 31). The official cycle 31t1 release, with HIRLAM physics as an option, is expected soon. As regards HIRLAM physics the quality of results in a broad sense appears at this stage to be comparable to the ALADIN counterpart. No comparisons have yet been done to the corresponding tests with Arome physics. A more optimal implementation of HIRLAM physics requires a coupling to the externalised surface scheme.

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