Working paper on physics overhaul
Based on the results of the "Physics cleaning week"
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draft/LR

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Motivation and definition of the goals

Our goal is to formulate clean and well structured building blocks of HIRLAM physical parametrization schemes, suitable for implementation and further development in the IFS framework.

Overhaul of the HIRLAM code for physical parametrizations is needed in order to make possible its implementation to the common AROME framework. Implementation has been started and may be done even without the overhaul. However, handling of the historically developed spaghetti of overlapping and illogical subroutines and structures creates unnecessary limitations for the further development of the potentially valuable schemes and approaches of HIRLAM physics.

We want to use our experience and expertise contained in the present HIRLAM-made physics and develop it for AROME. We want to formulate our parametrizations so that their further development and comparison with others is possible. We accept IFS as the framework for further developments in physics and are aware that each group in HIRLAM-ALADIN cooperation aimed towards AROME is responsible for making its own code compatible with IFS standards.

In the process of overhaul, the following steps are considered necessary:

1. Define the goals
2. Summarise the experience of the related work done until now
3. Understand the IFS framework and standards
4. Analyse the present physics code in order to formulate a detailed recoding plan
5. Do the cleaning/recoding of the HIRLAM physics code, according to the IFS standards

In the following, HIRLAM physics means the minimum package of radiation, turbulence, clouds (STRACO) and orography-related momentum flux parametrizations. HIRLAM surface code means the package of climate generation, surface assimilation and soil/surface-layer parametrizations.

References to the related work done until now

c.f. Bent's document "Implementation of HIRLAM physics in ALADIN"

Review of the IFS framework and standards

The IFS-compatible F90 code should be written according the "Coding standards for Arpege/IFS/Aladin" (R. El Khatib, 2003). This document should be updated to take into account HIRLAM-specific features. New naming conventions will be suggested.

Principles and methods of the overhaul

- How deep cleaning do we need? What components of the present physics components should be included? Where should the resulting code work: in the classical HIRLAM (synoptic scale) system and/or in the common mesoscale model - HFS and/or IFS?

  Suggested answers:

  1. Include first the three main components: radiation, turbulence, STRACO. For HFS, include upper level PHCALL-PHTASK-PHYS cleaning and related handling of input/output where needed. The upper level recoding may touch physics-dynamics interface problems.
  2. Finish the implementation of the renewed snow-surface scheme into HIRLAM. Use that as basis for externalization and recoding of the surface scheme.
  3. Add the new orography-related parametrizations (SSO/MSO) into HIRLAM, continue next with their F90 recoding.
  4. Clean as well as possible and include/anticipate existing new developments (snow surface code, cloud ice, moist CBR, radiation for sloping surfaces, SSO/MSO parametrizations).
  5. The resulting code should work both in IFS and HFS, with simple interface routines for IFS where needed. Results should be compared in between the systems.

- Where to start: from the first version of the restructured F90 ALADIN-compatible components written by the HIRLAM mesogroup and/or from the basic HIRLAM F77 code? Is the goal a clean and restructured F90 code directly or first a clean classic F77 code?

  Suggested answers:

  1. Start from the F90 code where possible (radiation, turbulence, STRACO). Combine cleaning with writing F90 when handling the surface and orography-related code.
  2. Clean classical F77 code may be a intermediate step where needed (climate generation based on ECOCLIMAP for the surface scheme).

- What are the relations of physics overhaul to (1) the ongoing mesomodel recoding of HIRLAM physics for ALADIN framework, (2) the starting work with externalized surface scheme, (3) the HIRLAM integration project and new ways of code handling, (4) ongoing developments of the contents of HIRLAM physics: new snow-surface scheme, development of orography-related parametrizations etc., (5) importing of Meso-NH physics to AROME.

  Suggested answers:

  1. Integrated to mesomodel work
  2. Integrated to externalized surface work
  3. Using the CVS tools

4. Including the existing at the moment developments, but not aiming to include more new inventions during the work.
5. Keeping separated but being aware and possibly learning from Meso-NH physics work

- Should the rewritten physics code produce results identical to those of the RCR HIRLAM? How should the diagnostics/verification/comparison be performed? Is it necessary to agree about test cases and comparison procedures for the validation? From which version of the reference HIRLAM physics/system should we start?

  Suggested answers:

  1. Not identical to present RCR (6.4.0 based or later) until new developments are included to RCR also.
  2. Diagnostics and verification should be agreed, together with the HIRLAM mesogroup and ALADIN colleagues. 1D tools may provide good way to evaluate the changes in physics.
  3. Start from 6.4.0 + new developments.

- How to bring the IFS-formatted F90 Hirlam physics and surface code back to HFS?

  Suggested answers:

  1. Code should be formulated in general F90 form so that it is applicable in both systems, possibly using simple interface routines for calculation of additional variables etc. where needed.

Practical tasks and time schedule

A working document on cleaning, based on the Cleaning week results and including notes/plan on subtasks, ready in October 2005.

A guide to coding standards, containing HIRLAM-specific issues plus references to IFS-documents, ready in December 2005.

HIRLAM 6.4.0 physics 1D tool available for testing in October 2005. Common 1D tools for AROME-ALADIN-HIRLAM-comparisons to be developed as agreed with the ALADIN colleagues.

Basic cleaning of HIRLAM physics in F90 format ready and tested for both IFS and HFS in January, 2006. No significant difference of results (in 1D environment?) should be seen. Implementation of recoded physics into a HIRLAM reference beta version in March, 2006.

HIRLAM physics implemented into IFS cycle ... in May, 2006.

HIRLAM surface code externalized (in explicit mode) and implemented to IFS cycle ..., December 2006.

Subtasks and suggested responsible persons. The first task is to provide a short status report and plan till the 15th October. Then, continue the work according to the plan.

1. Radiation : Sami, Laura
2. Turbulence: Sander, Bent

3. STRACO : Bent, Sami
4. Surface : Stefan, Han, Beatriz
5. PHCALL, PHTASK, PHYS : Toon, Han
6. Bring 1D HIRLAM to reference CVS system: Sander, Gerard
7. Guide of coding standards: Han, Toon, Bent
8. coordination of cleaning: Laura, Bent

Communication

- Arrange the “Southern surface meeting”, Madrid, November
- Use web page hirlam.fmi.fi/cleanphys (send new material to Laura) for support documents, plans, reports.
- Use e-mails for discussion: include responsible persons and others needed in the recipient list.
- Meeting where possible for other reasons (Budapest, Poiana Brasov, Oslo etc)
- Arrange a cleaning group during ASM06.

APPENDIX I : Reports/plans concerning subtasks

Technical task: Open a CVS branch for F90 physics development in HIRLAM.

Upper level physics restructuring

Radiation

The F90 version of RADIA and related components has been prepared by Sami and imported back to HIRLAM 6.4.0. Testing shows minor differences between 6.4.0 experiments using updated f77 RADIA (equation of time correction included) and the F90 code. Reasons for the differences are suspected to be related to clouds, but the exact reason is not clear yet. The new code has been run as RCR-parallel over a short test period. Responsible people for further developments: Laura, Nastya Senkova.

Further tasks:

1. Find the reason for the small differences, analyse the RCR-parallel results.
2. Modify output of hlradia to include also diffuse radiation.
3. Add the code for sloping surface radiation (hlororad). Decide if a capping subroutine ARADIA is still needed between PHYS and hlradia and hlororad.
4. Export the code to 1D environment, test and compare there.
5. Export a suitable version of the code (first without the sloping surfaces) to HIRALD. Test it there.
6. Write a technical description/documentation of the recoded radiation for the Newsletter. A journal paper about the sloping surface radiation is under preparation.

Turbulence

The F90 version of VCBR.f already is much cleaner than any previous version of VCBR.f has ever been. It therefore is a good starting point for further development of the turbulence scheme, that will have to be able to run in Hirlam as well as Aladin. To enable this, the following steps have to be taken:

1. Rewrite CBR so that VCBR.f can be called directly from PHYS.f and AVCBR.f can be called by APLPAR (Aladin).
2. Make a switch in CBR between moist and dry CBR, based on the existing noption list. Noption(3)=2 is CBR, Noption(3)=3 will become moist CBR
3. Plugging in the moist CBR changes into the F90 CBR routine, also with the switches based on the choice of noption.
4. Introduction of more cloud condensate species (now cloud ice and cloud water) easily extendable with more cloud condensate species.
5. Calculation of cloud condensate dependent on convection/condensation scheme, as switches dependent on choice of noption(2).
6. Test the cleaned scheme in Hirlam 1D
7. Test the cleaned scheme in Hirlam 3D
8. Test the cleaned scheme in Aladin

Items 1 through 4 already are ready. Item 5 is currently being discussed. Testing in 1D will start shortly, and if successful, can be extended to 3D probably quite easily.

STRACO

Surface

APPENDIX II : Naming suggestions