

# Report of the Working Group Discussion on “Physics-Dynamics Interfacing”

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The basis for these discussions was a document prepared by J.-F. Geleyn, B. Catry, B. Hansen-Sass, P. Termonia and M. Tudor after the Workshop on the same topic held in Prague, November 22<sup>nd</sup> to 26<sup>th</sup> 2004. This document synthesises all its proposals within five rules, named from A to E, mainly targeted for the HIRLAM-AROME-ALADIN collaboration. The basic aim of each rule will be recalled thereafter before the account of the discussion concerning it.

Bart Catry made two presentations at the Workshop. The full presentation recalled the spirit and meaning of each of the five rules (in some sense the following thus contains a short abstract of it). The mini-presentation that introduced the WG discussions emphasized the importance of having a clear vertical discretisation strategy cleanly adapted to the models choices (type of coordinate, explicit or implicit physical time-stepping, etc.). Errors of the order of 10% or less on the budget-terms arising when neglecting this constraint were shown to sometimes have a strong impact on individual cases' results (for instance in terms of precipitation maps).

## *Rule A*

Summary: This rule introduces a distinction between (a) options of a general nature that are automatically part of some critical-path interfacing computations and (b) more 'local' options that can in principle be handled independently at the level of some parameterisation computations. The idea is that the latter computations should all have the same positioning with respect to the options of category '(a)' and ideally be written with algorithms that make them completely transparent to the related choices.

### Discussion:

- When following the HIRLAM line of thoughts it was sometimes difficult to separate Rule A from Rule E below. This was sort of a surprise for people used to the IFS/ARPEGE/ALADIN world and this difference of approach is probably linked to a different 'culture' in the use of switches to activate code options.
- The idea to make even the high-level choices routine-dependent was addressed, but rejected because probably leading to an exaggerated complexity.
- Some doubts were raised about the wisdom of using a parallel strategy for calling parameterisation routines concerned with different processes at high resolution, but this remained at the edge of the discussed topic.
- HIRLAM was requested to analyse its current situation and to also set its 'minimum requirements' with respect to the following flexibility issues:
  - physics before of after dynamics;
  - physics and dynamics parallel or sequential;
  - positioning of the physics forcing along the time-space semi-Lagrangian trajectory;
  - which 'physical' information to pass from one time step to the next;
  - the 'spectral model constraints' (e.g. no physics calls after the Helmholtz solver).
- There is a need to know where the combination of the AROME prototype and of the conservation rules will lead in term of practical interfacing constraints. HIRLAM should receive one example as soon as possible. This should not prevent the above-mentioned analysis to start in-between, on the contrary (a first early feed back might indeed help to better target the example).

- HIRLAM will face the problem that its parallelisation structure influences the data-flow of the physics interfacing in the HIRLAM model. Hence there will be a choice between grouping as much as possible the calls from the ALADIN dynamics (which practically amounts to follow for the time being the whole AROME time sequence) or developing a way to use symmetrically the GFL/GMV structure of IFS and the HIRLAM equivalent but without touching too much the low-level physics code (*Remark N°1: this point is transversal to all rules; it is mentioned here because of the chronology of the discussion as it happened in Tartu. Remark N°2: subsequent discussions showed that the 'code-related' starting point of the discussion on this item was erroneous; nevertheless the dilemma between sticking to the AROME time-space arrangement or maintaining HIRLAM's own specificities in this domain remains a true one*).

### **Rule B**

Summary: The link between individual tendencies computed by parameterisation routines and the projection of the total forcing on the evolution of the model's prognostic variables should obey a single set of governing diabatic equations. These equations are derived from first principles (under an agreed set of basic hypotheses) independently of the choice of the dynamical core they are applied to when discretisation takes place. Only at time of this discretisation should the general switches mentioned in Rule A matter.

#### Discussion:

- HIRLAM wishes to see and study all definitive papers about equations, but in principle, like already said in Prague, it is ready to adapt to the proposed choices.

### **Rule C**

Summary: The basis for articulating the "tendencies  $\leftrightarrow$  fluxes" conversions necessary for a smooth application of Rule B will be the DDH-type diagnostics of IFS/ARPEGE/ALADIN with a mandatory minimum of flux-type information to initialise. When this framework will be (temporarily) at odds with some of the choices made in the basic parameterisation routines (which should evolve to match the said conversion rules), the output of those will be re-tailored to deliver a 'dummy output production' technically compatible with this rule 'C' and scientifically close to the previous solution.

#### Discussion:

- Contrary to what will likely happen for the Meso-NH routines in AROME, HIRLAM shall most likely place its 'dummy output production' (for a full thermodynamic interfacing) inside its own codes.
- A first interfacing verification exercise should be based on both 1D models, before going to 3D applications.

### **Rule D**

Summary: In order to simplify the application of the preceding rules (especially for the distinction between 'parallel' and 'sequential' computations of the physical evolutions) parameterisation routines should communicate on the basis of three different statuses (reference, initial and final) rather than on the basis of only the last two ones like generally done. The use of the 'reference' additional input information to the parameterisation routines should allow keeping correct thermodynamic budget calculations within any sequence of evolutions for non-linear conservative quantities like enthalpy.

#### Discussion:

- NB: *this rule should be reassessed following the introduction of the 'dummy output production' proposal that partly overlaps with its own targets.*

- On a matter of principle, HIRLAM is much in favour of the spirit of this rule and asks that its reassessment should be done as soon as possible, in order to avoid a double effort in recoding the interfaces of the HIRLAM physics routines. The ALADIN-2 team will see how and when to satisfy this request in order that HIRLAM can consider Rules A, B and D nearly as a whole when starting its recoding actions.

### **Rule E**

Summary: The application of the above proposed architecture of 'rules' ultimately assumes that some high-level control procedure knows about the type of 'mandatory' budget terms that should be produced given the high-level 'a'-type choices. It should also know about which routines are used and which ones contribute to which 'mandatory' terms. Furthermore some 'cross-checking' could take place to ensure that neither double-accountings nor misses happen inadvertently. This introduces a welcome distinction between 'processes' and 'schemes', but will need time to be fully implemented.

Discussion:

- Symmetrically it was partly mixed with rule A and the idea of the a-priori control was challenged by the possibility of having a running-time control of which routines to call for which 'physical' purpose. Like for a more versatile version of rule A (cf. supra), this was judged too ambitious and it was concluded that one shall stick to high level choices setting of options rather than situation dependent switching between process (which is indeed a modelling rather than interfacing issue).
- HIRLAM supports very much the idea of relying on a distinction between 'processes' and 'schemes' to perform this a-priori control, even if this is not the most immediate priority of the interfacing design and upgrading. It shall find adequate manpower resources to promote this issue (*Remark N°3: preliminary contacts on this issue started shortly after the Tartu meeting*).