Physics Organization: Cleaning and Convergence

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1. Context and motivation

2. A view from outside: convergence of two physics packages

3. A view from inside: convergence of individual parameterizations?

4. Discussion

- Inside HARMONIE, two physics packages exist:
  - ◆ ARPEGE/ALADIN/ALARO, in the routine APLPAR.
  - ◆ AROME, in the routine APL_AROME.

- Scientific ideas are spilling over between these two (e.g. SURFEX, ACRANEB2, EDKF), but in a rather heuristic way.

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- Scientific ideas are spilling over between these two (e.g. SURFEX, ACRANEB2, EDKF), but in a rather heuristic way.

- Coexistence of APLPAR and APL_AROME is demanding from maintenance point of view.

- Can we improve this unfortunate situation?

What's visible from outside the physics is:

- the effect on prognostic variables, as determined by the *physics-dynamics interface*

- (diagnostic output)
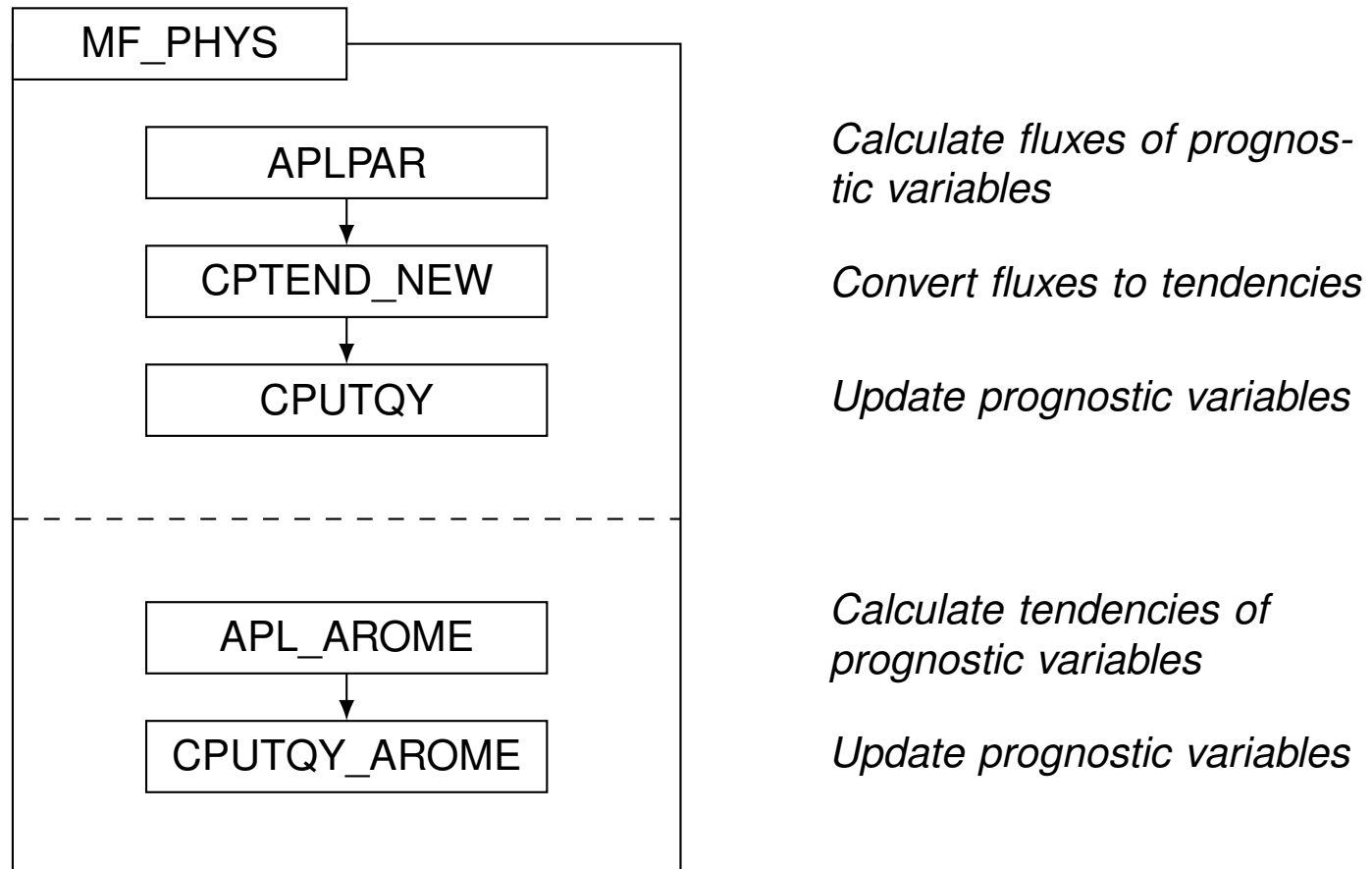
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The two packages use different physics-dynamics interfaces:

MF_PHYS	
APLPAR	Calculate fluxes of prognostic variables
CPTEND_NEW	Convert fluxes to tendencies
CPUTQY	Update prognostic variables
APL_AROME	Calculate tendencies of prognostic variables
CPUTQY_AROME	Update prognostic variables

Context

Physics-dynamics interface

Physics cleaning

Discussion

■ There are some differences in convention:

   ◆ ARPEGE and ALARO use an enthalpy-flux-based interface

   ◆ AROME uses a temperature-tendency-based interface

■ The AROME interface makes some approximations:

   ◆ neglecting the heat transport by precipitation

   ◆ neglecting the heat capacity change by turbulence and shallow convection

   ◆ use of c_{pd} instead of c_p for radiative heating

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- A new *flexible* interface was developed which suits the needs of both packages:
  - ◆ arbitrary number of hydrometeors
  - ◆ all conversions between hydrometeors are possible
  - ◆ guarantee for conservation and consistency
  - ◆ phased in cy40t1 (many thanks to Jan!)
  - ◆ also useful for future ALARO/ARPEGE developments!

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Physics
cleaning

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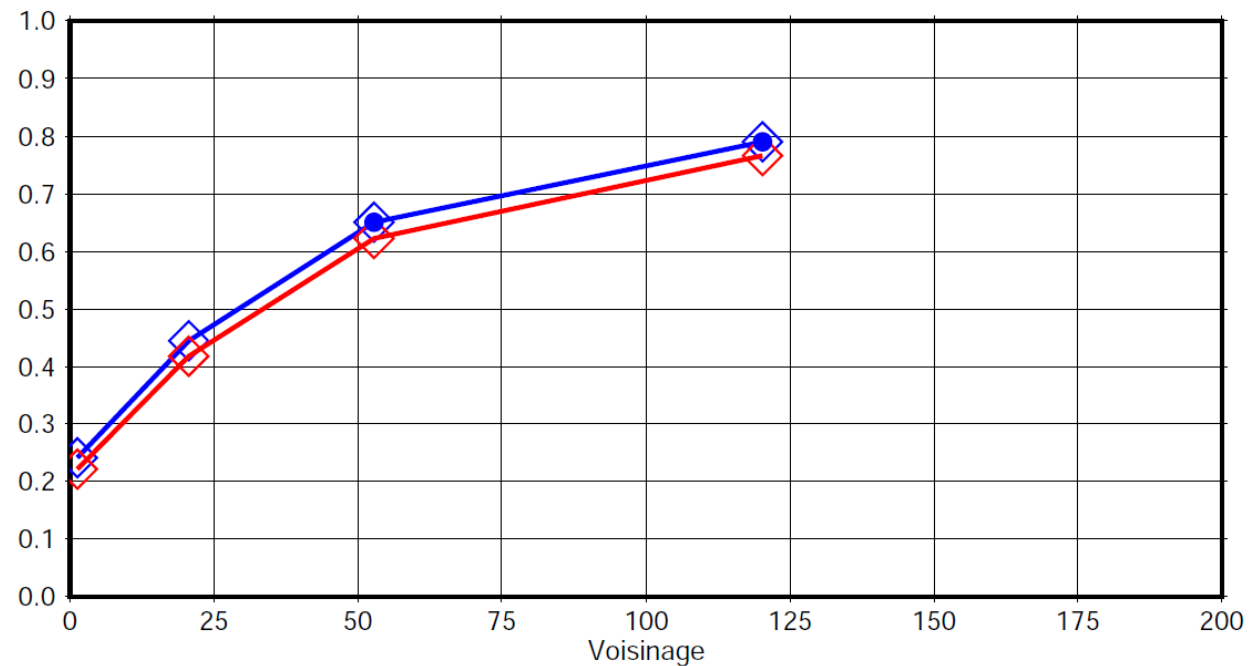interface

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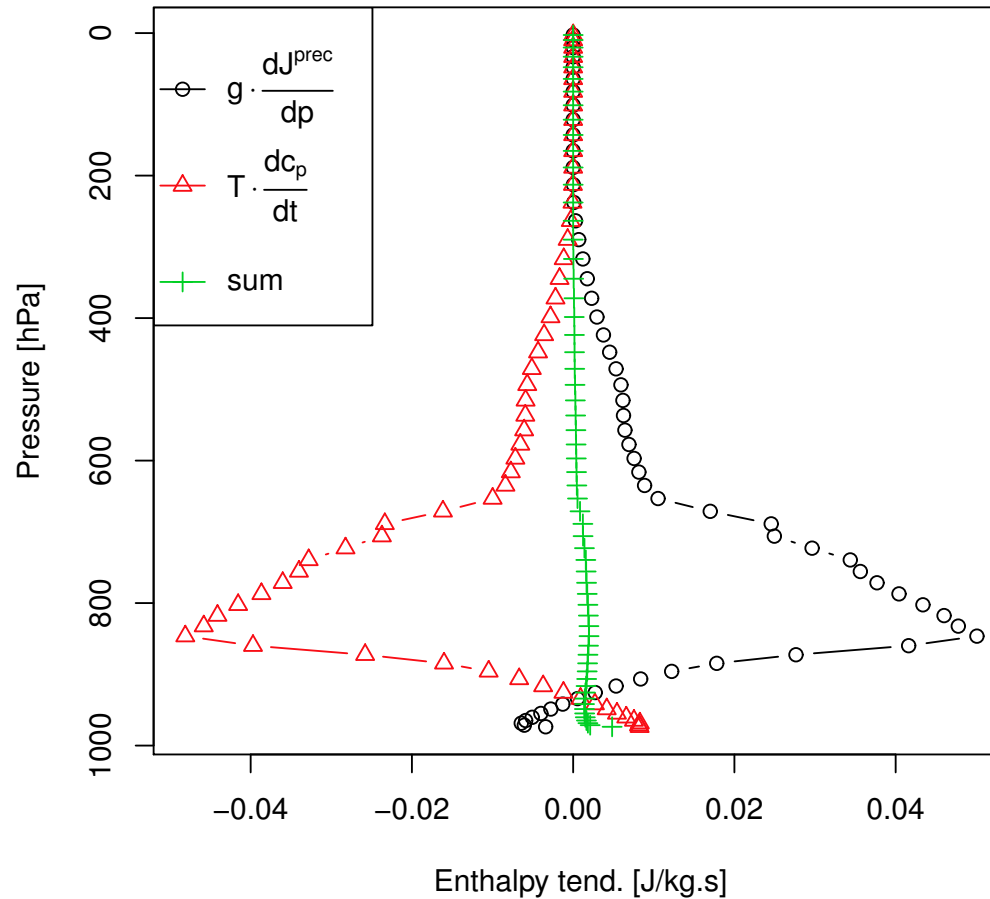
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- Compensation in AROME between neglecting dc_p/dt and neglecting heat transport by precipitation

- Accounting for heat transport by precipitation improves the scores for heavy precipitation

Neighbourhood Observation Brier Skill Score for precipitation $> 10\,\mathrm{mm}$

(Courtesy of Y. Seity)

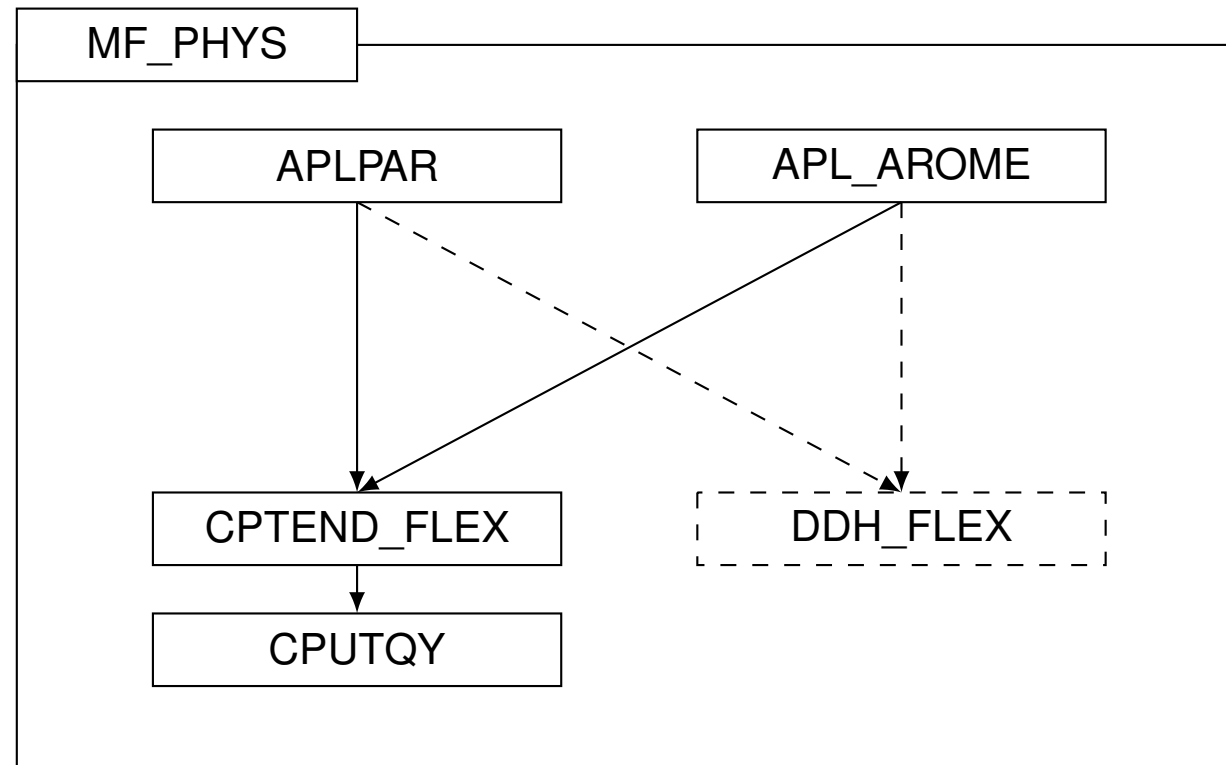- In parallel to the flexible interface, a uniformization of the diagnostics has been developed (DDHFLEX).

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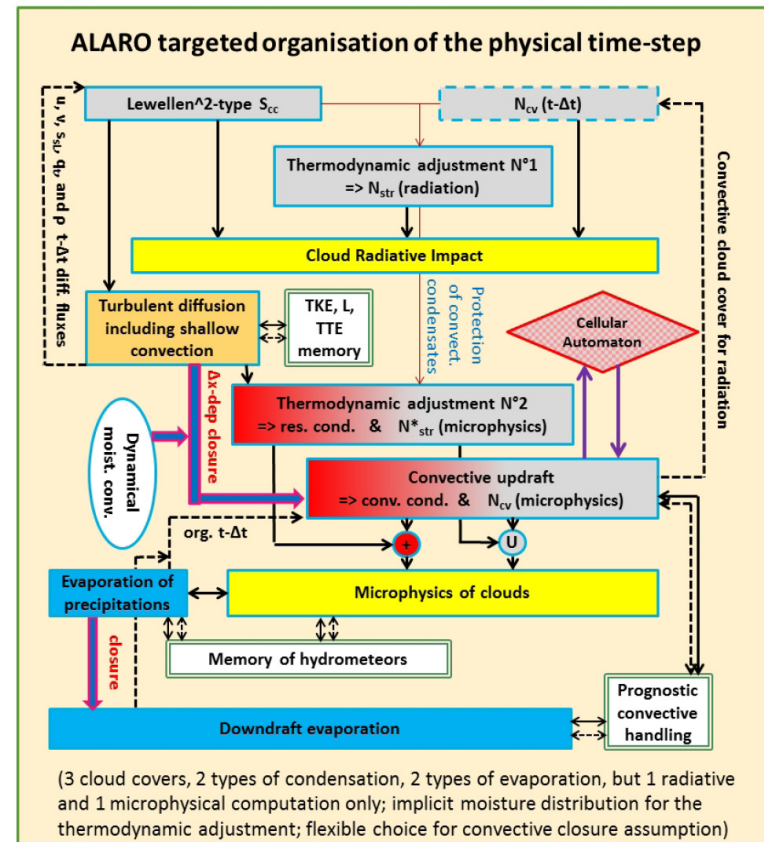■ So from the broad perspective, things have converged quite well:
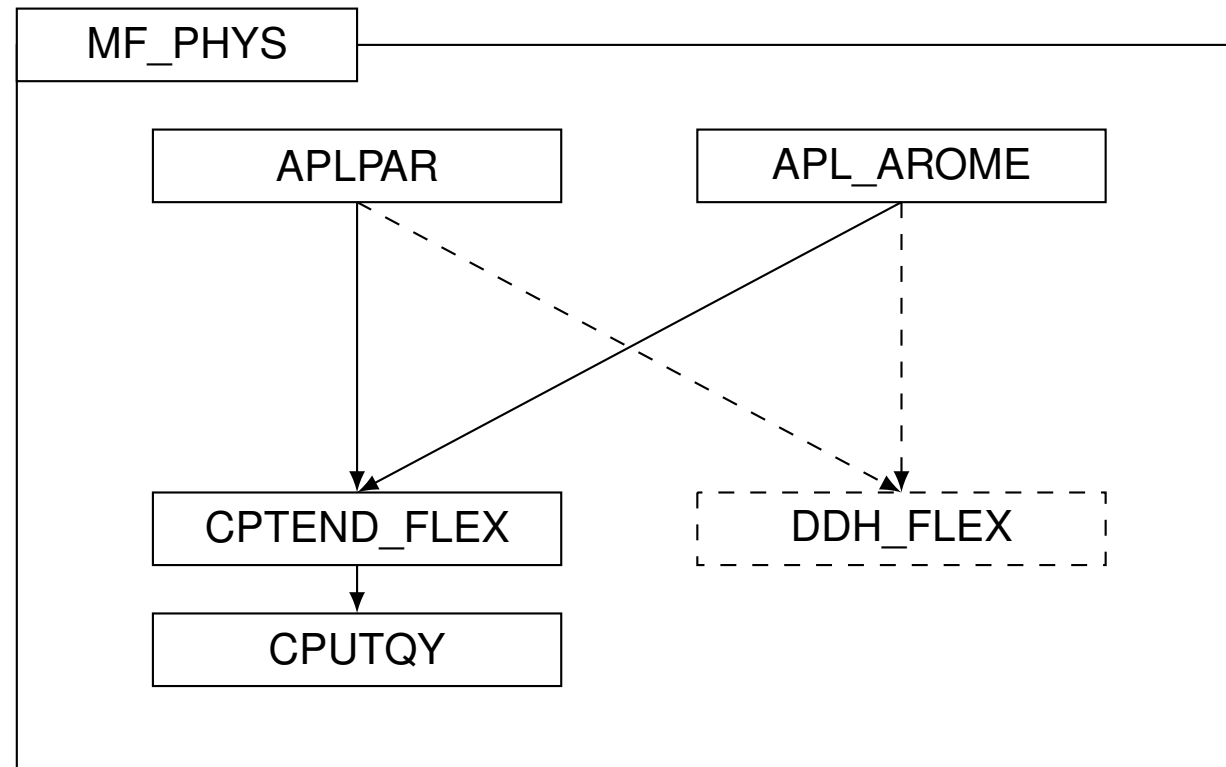
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■ Can we take this convergence a step further, to the level of individual parameterizations?

- The APLPAR routine has become overly complex: 4500+ lines, 300 arguments, 150+ IF statements, . . .

- e.g. ALARO data flow between parameterizations:

(Courtesy of R. Brožková)
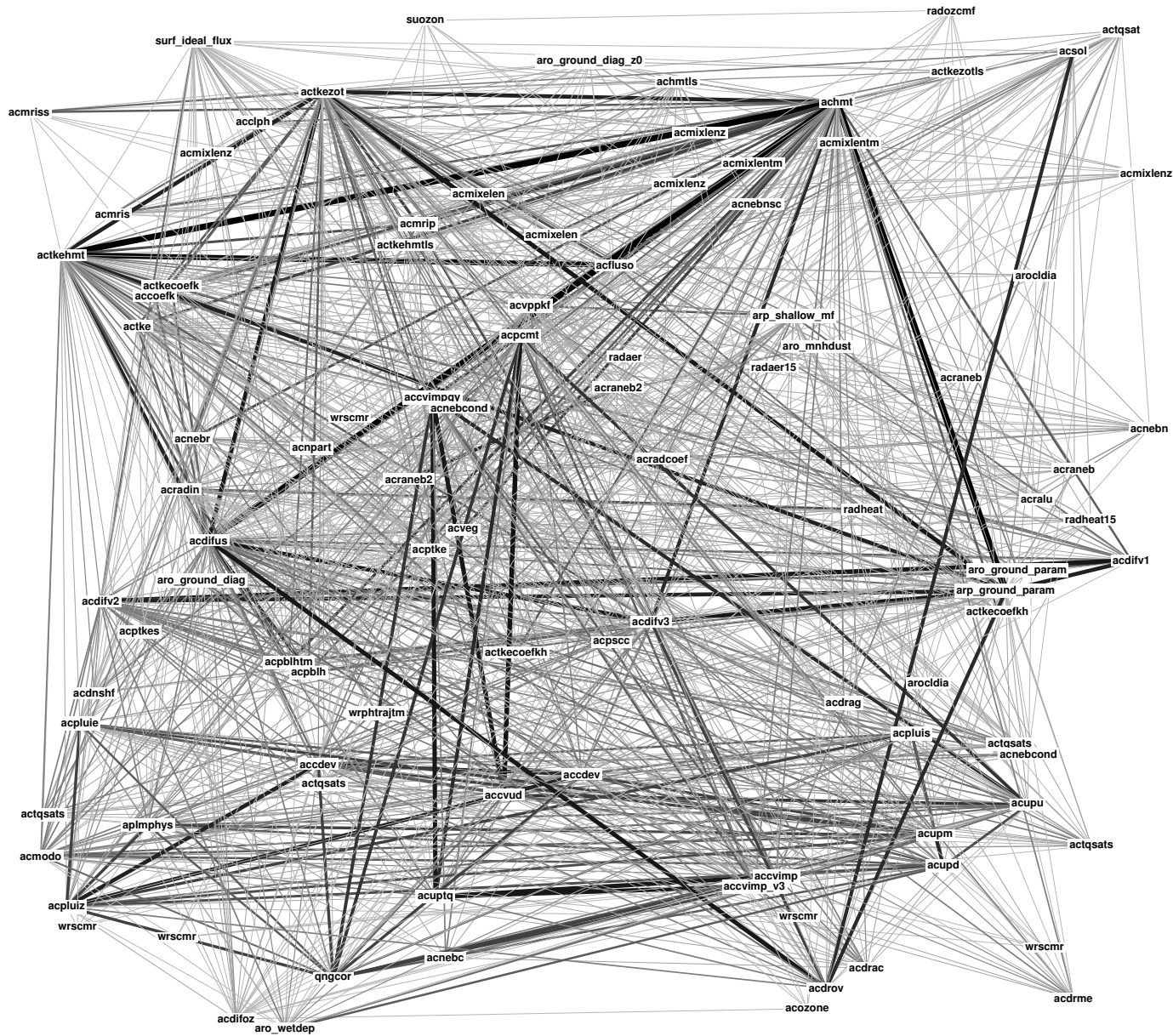
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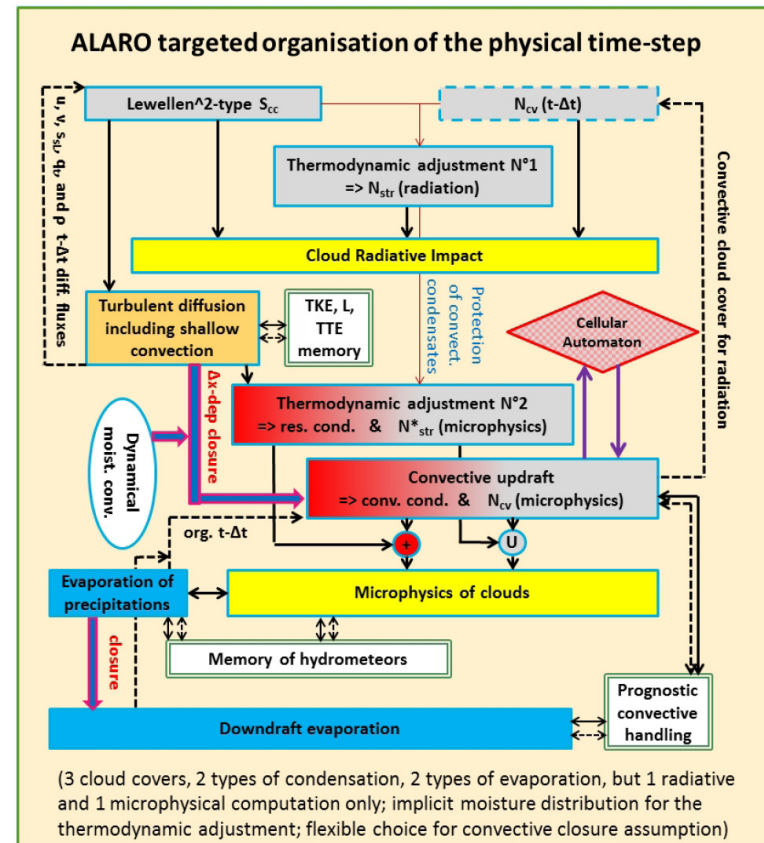
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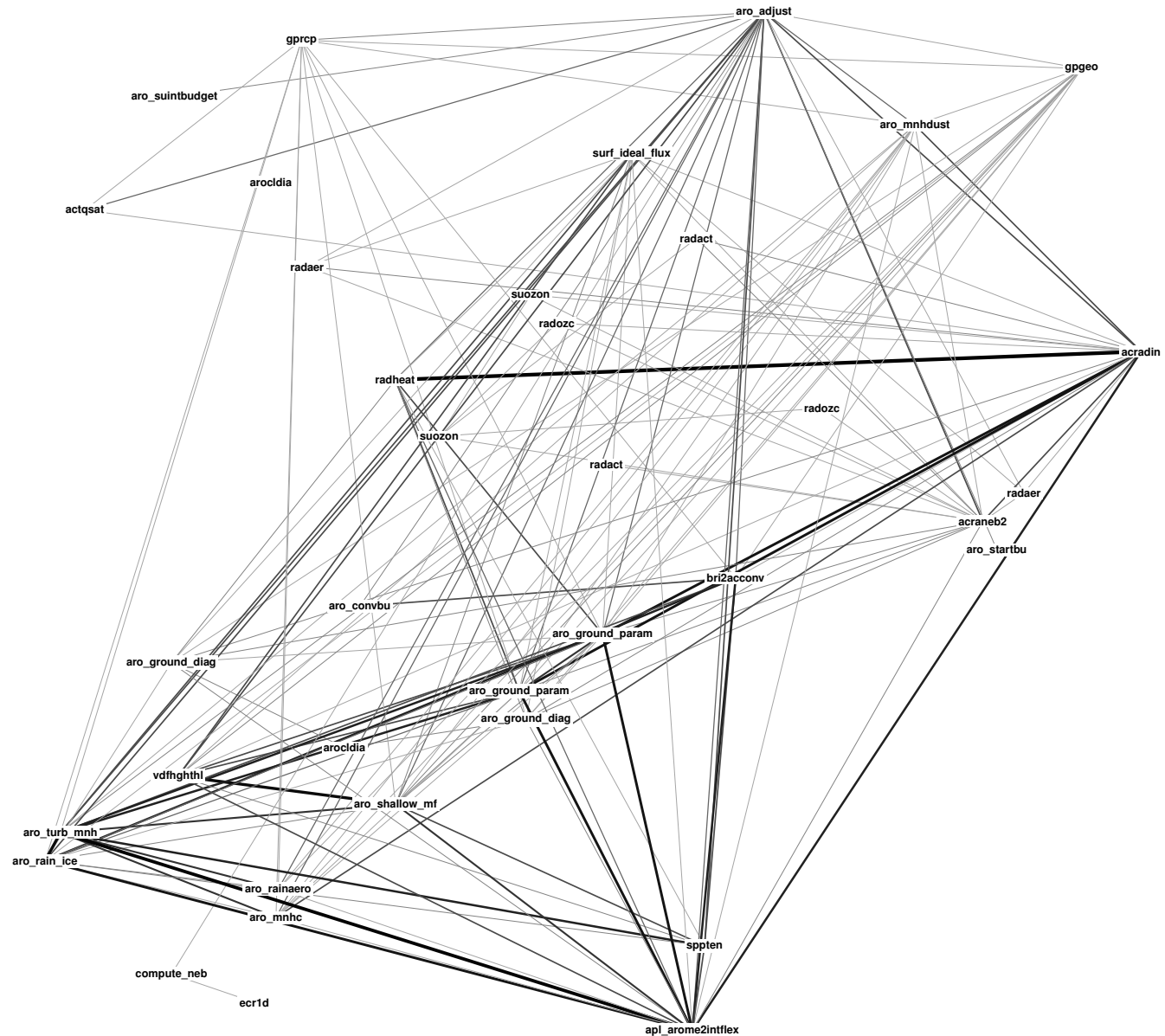
. . . and this is only a subset of APLPAR!

Complete data flow between routines called from APLPAR:

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Identification
of blocks?

For comparison: APL_AROME data flow

- Some reasons for this complexity:
  - ◆ Second law of thermodynamics. . .
  - ◆ Physics developers mainly focus on the internals of their set of parameterizations, less on the common ground with other parameterizations.

- Anyway, it's clear that some cleaning/reorganization is necessary if we want to cross-use parameterizations.

■ We started with streamlining radiation:

◆ prepared by exercise of putting ACRANEB2 in APL_AROME.

◆ grouping of aerosol, albedo, cloudiness, ozone, co_2 in dedicated subroutines.

◆ symmetric organization in APL_AROME is possible.

◆ although radiation is considered to be the simplest block, it accounts for about 600 lines of code in APLPAR.

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- Some guidelines derived from this cleaning exercise:

  ◆ Removal of calculations from APLPAR!

  ◆ Use of dedicated structures for different data flows (fluxes of prognostic variables, diagnostic terms, inter-parameterization communication).

  ◆ Avoidance of global variables.

  ◆ Limit IF statements at the APLPAR level: choice between equivalent schemes should be done at a lower level.

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- Consider turbulence as the next block.

- Importance of common validation tools (MUSC?).

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- Consider turbulence as the next block.

- Importance of common validation tools (MUSC?).

- Collaboration is also a way to ensure that developments survive in the longer term!

- Are we (ALARO developers) willing to put effort in this (and maybe make compromises)?

- What level of granularity should we aim at when organizing APL_AROME and APLPAR in blocks?

Thank you !