Action on physical interfaces

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Plan

- Status and proposals for the « physical interfaces »
- Status and proposals for the « physics/dynamics interface(s) »
- Conclusions and perspectives

Status and proposals for the physical interfaces

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What is a physical interface ?

- Preparatory computations needed for calling physical parameterisations (initialisations, new variables (potential temperature, moisture convergence…), securities, interactions between parameterisations)

- Calling physical parameterizations (radiation, surface, gwd, turbulence, clouds, microphysics, convection schemes)

- Interactions between parameterisations (parallel/sequentiel calling, turbulence for convection triggering, convection for subgrid variability, clouds, …)

Current status

- The physical interfaces are different for AROME ("APL_AROME"), for ARPEGE/ALARO ("APLPAR"), for HIRLAM ("HL_APLPAR"), for ECMWF ("CALLPAR")

- The creation of "HL_APLPAR" was motivated by the complexity of "APLPAR" interface and by the existing differences between Meso-Nh and ARPEGE parameterisations :

  - use of differing variables in input of physical parameterisations

  - an opposite convention for describing the vertical dimension

  - the description of the horizontal dimension by 1D arrays in ARPEGE and 2D arrays in Meso-NH (for 3D parameterizations)

These differences are currently treated by conversions performed at each time step within "APL_AROME" physical interface

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Need of improvment of physical interfaces

- **Little effort was devoted in the last years to the improvement of our physical interfaces "APLPAR" and "APL_AROME", priority being rather given to the improvement of physical parameterisations**

  Exemple: APLPAR physical interface contains 3400 lines, 240 input/output arguments, 55 "Call" to physical routines

- **With the "operational use" of ALARO+3MT, AROME and "CBR+KFB" in ARPEGE/ALADIN-MF, it is time to devote more attention to improving physical interfaces**

Proposals (1)

- Cleaning of the physical interfaces "APLPAR" and "APL_AROME" :

    - forbidding physical computations

    - removing obsolete parameterisations

    - should contain only the initialisation of variables, the calls of "preparatory" routines, the call to physical parameterisations

    - study the overhead associated to the conversions currently performed in "APL_AROME" ("reshaping", invversion of the vertical levels). Study of the suppression of these conversions (F. Vana proposal)

- For the particular case of radiative computations, development of a general interface within which would be called the radiative parameterisations currently used in IFS, ARPEGE, ALARO, AROME and HIRLAM.

Proposals (2)

- Analysis of the possibility to use a common code for the correction of negative moisture values within the ARPEGE, ALARO and AROME physics
- Feasibility study concerning the use of FORTRAN “structures” in order to substantially reduce the number of input/output arguments of the physical interfaces. (Link with DDH action)
- Feasibility study concerning an increased flexibility of the physical interface handling the sequence of calls to physical parameterisations, the pseudo-historic variables and the choice between sequential and parallel calls to physical parameterisations.

Interoperability of physical parameterisations

- The schemes “p-TKE”, “3MT” and “APLMPHYS” are physical parameterisations rather than interfaces. The algorithmic and scientific aspects are very tightly linked when developing physical parameterizations and it seems hopeless that a specific algorithmic framework could fit all scientific ideas

- Interoperability between physical parameterisations is a common target, but it should be obtained via modern physical interfaces, rather than by fixing the algorithmics of physical parameterisations

WRF model physics (V3)

Microphysics
* Kessler
* WRF Single Moment (WSM) 3, 5 and 6 class
* Lin et al.
* Eta Ferrier
* Thompson
* Goddard 6 class
* Morrison 2-moment

Cumulus parameterization
* Kain-Fritsch with shallow convection
* Betts-Miller-Janjic
* Grell-Devenyi ensemble scheme
* New Grell 3D ensemble scheme

Planetary boundary layer
* Yonsei University (S. Korea) with improved stable BL
* Mellor-Yamada-Janjic
* Asymmetric Convective Model (ACM2)
* MRF

Surface layer
* similarity theory MM5 - may be run with a 1-D ocean mixed layer model
* Eta or MYJ

Land-surface
* slab soil model (5-layer thermal diffusion)
* Unified Noah land-surface model
* Urban canopy model (works with Noah LSM, new in V2.2)
* RUC LSM

Longwave radiation
* RRTM
* CAM

Shortwave radiation
* simple MM5 scheme, with Zaengl radiation/topography (slope and shadowing) effects
* Goddard
* CAM

Sub-grid turbulence
* constant K diffusion
* 2-D Smagorinsky
* predicted TKE

3MT may not be an interface but it can be used as such

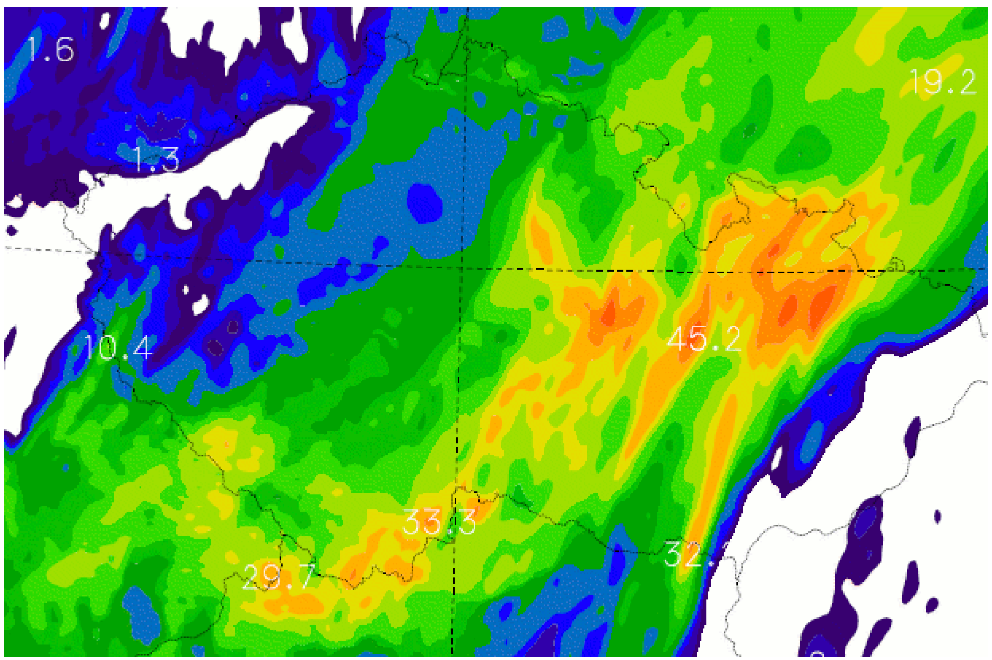
- Basically 3MT is a way to do ‘***as if***’ deep convection was resolved but ***without*** needing to go to scales where this is true, thanks to:
  - Prognostic and diagnostic ‘memory’ of convection;
  - A single microphysical treatment beyond all sources of condensation.

- It can work with several levels of scientific sophistication for:
  - Convective entrainement and closure specifications,
  - Microphysics,
  - Thermodynamic adjustment.

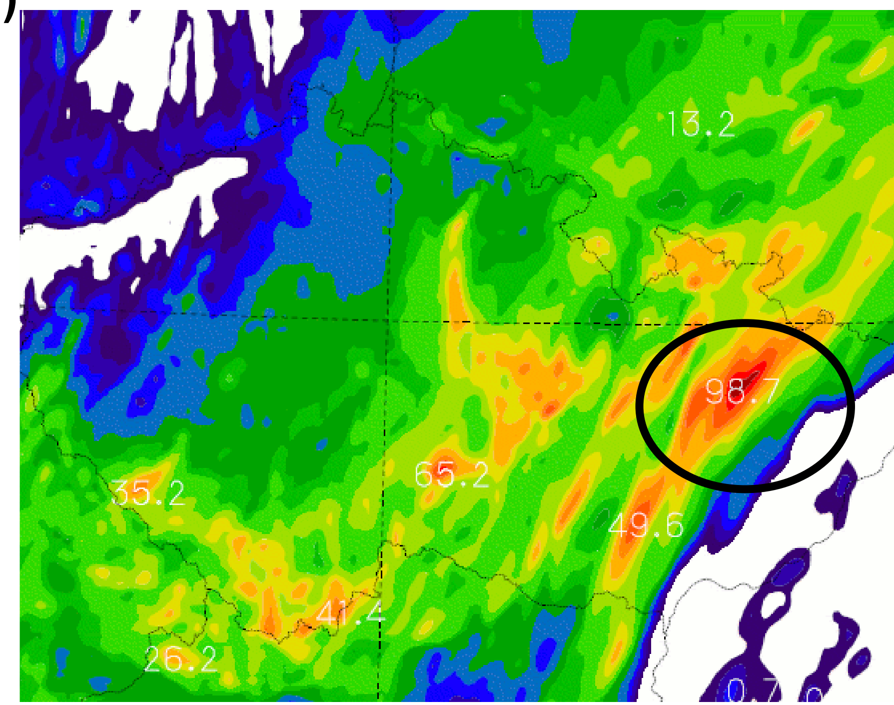
- Because of the ‘*as if*’, 3MT is an interesting way of testing things like they could be in AROME, but without running AROME (see next slides), which makes it then something between a parameterisation and an interface.

Impact of (no) enthalpy evolution (1/2)

ALARO test (with 3MT) on 2.3 km mesh and with 90s time step (set-up ~ AROME)
6h precipitation on 18/05/2008 (00H+18H)



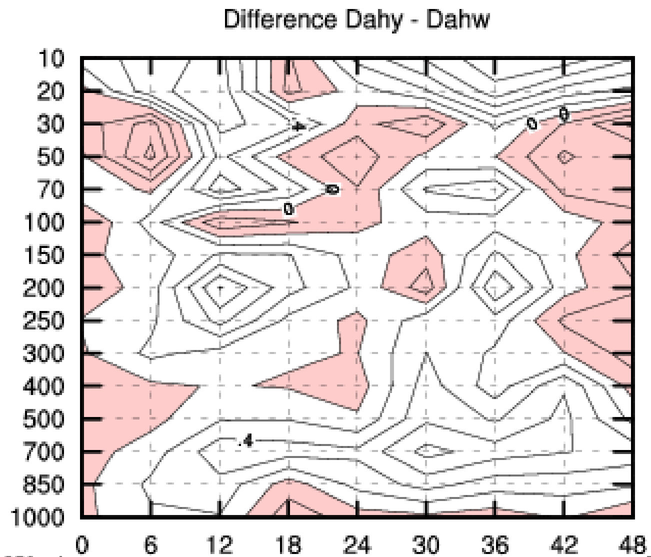
with enthalpy evolution

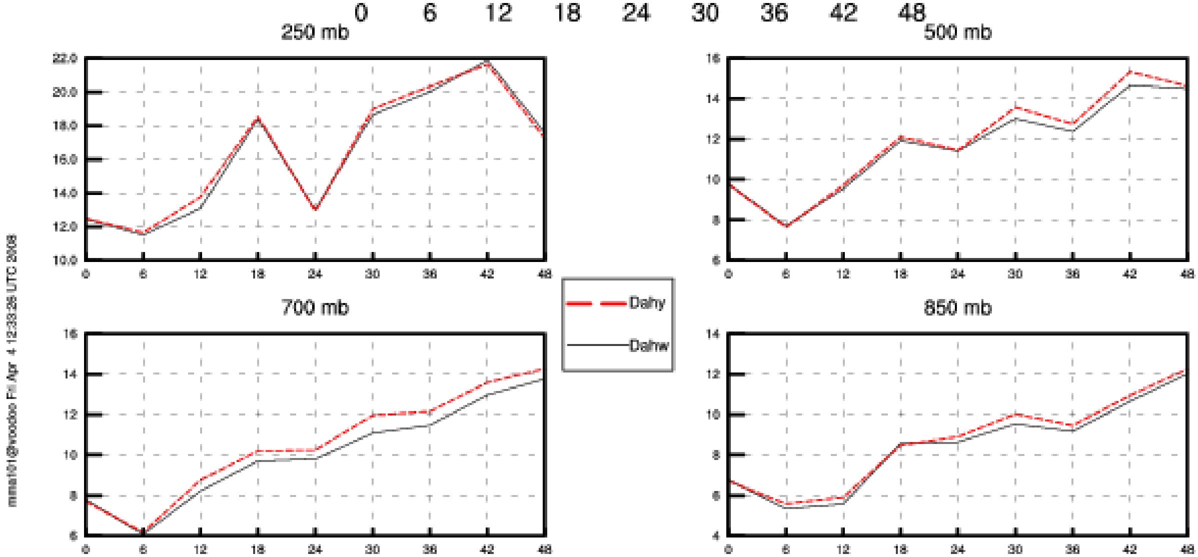


without enthalpy evolution

Precipitation patterns are roughly the same, but the intensity is very different !
(even with this order of magnitude for the time step)

Impact of (no) enthalpy evolution (2/2)





RMS scores of geopotential for a 9km mesh with 3MT

Red = *Cp.dT/dt|phys better than d(Cp.T)/dt|phys*

Transparent = *d(Cp.T)/dt|phys better than Cp.dT/dt|phys*

Similar signals for T, Hu
Neutral for wind

Dahy = *Cp.dT/dt*|phys

Dahw = *d(Cp.T)/dt*|phys

non-neglegible impact !

Improvment of physics/dynamics interface

Physics / Dynamics Interface

- Role: Physical tendencies taken into account in the dynamical equations

- ARPEGE/ALARO interface has evolved continuously. Catry et al. (2007) proposed an extension for prognostic clouds and precipitations compatible with a barycentric compressible hydrostatic equation system, coded by partners and used in ALARO and ARPEGE, but difficult to use within AROME (the first proposition of MAPFI was going in the good direction)

- AROME interface is very simple, but has some weaknesses (non conservation of enthalpie, not available options : conservation of mass, projection on pressure of diabatic terms in case of NH)

Advantages of an intermediate solution: MAPFI

- the AROME prognostic computations can be kept unchanged if wanted
- AROME/ALADIN/ALARO can share the same PDI routine (extended version of CPTEND_NEW)
- options like $_m$ and projection of heat on pressure (compressible case) become easy to test in AROME
- possibility to quantify the associated heat sink/source due to neglecting enthalpy evolutions and to extend towards a consistent enthalpy budget
- could be quickly available
- there is no "trap", it does not prevent any future action on interfacing
- when updating/coding, each side (both ALARO and AROME) will have to take the other side into account => effective collaboration

Proposals

- Evolution of the « Catry et al. » interface for a generalisation to the physics used in ARPEGE, ALARO and AROME (use of the tendencies for hydrometeors in replacement of the pseudo-fluxes, adding graupel and hail, considering non-zero fall speeds for all hydrometeors) : Evolution of MAPFI?

- Writting of a unique general routine « CPUTQY » for ARPEGE, ALARO and AROME

- Possibility to test the dynamics before the physics (ECMWF choice)

Weaknesses/risks of this proposal

- use of tendencies instead of pseudo-fluxes

  BUT the final temperature tendency should not become the sum of separate temperature tendencies; idem for TKE

- non-zero fall speeds of condensates (e.g. for fog)

  the kinetic energy in the NH case includes a vertical component for all vertically moving species. Very small fluxes will lead to a kind of zero/zero computation => the sedimentation effect of cloud species when included should be treated outside this aspect (use of the 'diffusion' framework)

- no consistent enthalpy budget

  options like $_m$ and the projection of a heat source on pressure in the compressible case are not correctly treated without any type of consistent enthalpy budget

- It lacks a 'demo' test version => MAPFI_v0?

Conclusions and Perspectives

- There are many collaborative actions to be done on interfaces:

  - Convergence towards a unique and more flexible physics/dynamics interface (MAPFI evolution ?)

  - Improvments of physical interfaces (cleaning, flexibility, modernisation, …)

  - Which implication of other partners (ECMWF, HIRLAM, IPSL) ?