Physics & its interfacing – the AROME case

J.-F. Geleyn & L. Gérard

I) Generalities

II) Challenges & likely problems

V) Prognostic convection for the 5-km target?

VII) The time-stepping issue

V) Summing-up

Physics & its interfacing – generalities

- AROME will merge (for its 2.5-km version) the ALADIN-NH dynamics and the Meso-NH physics
- There will also exist a so-called '10-km version' with a more flexible view of the physics (mix of «new» and «classical») especially for moist convection
- ALADIN-NH dynamics uses the Laprise system of equations while Meso-NH is an anelastic model. Both physics package are adapted to their dynamics, especially in the second case. How to intelligently merge differing concepts, especially for the time-stepping ?
- Convection is also a specific issue (half resolved / half parameterised) for the so-called 'grey-zone' (7-3km)

Physics & its interfacing – challenges and likely problems

- Splitting the content of the Meso-NH physics (3D-turbulence, sophisticated microphysics, etc.) into **A**daptative, **E**volutive and **H**orizontal parts; making the **H**-part semi-Lagrangian-compatible
- Making the **E**-part and the current ALADIN interface compatible: equations and implementation
- Testing the new time-stepping concept; making the step from leap-frog to predictor-corrector => surprises ?
- Extending the merged concept to the 10km scale: reintroducing convection (and drag?) & testing the other schemes at long time steps
- Pursuing current tracks for a possible grey-zone solution

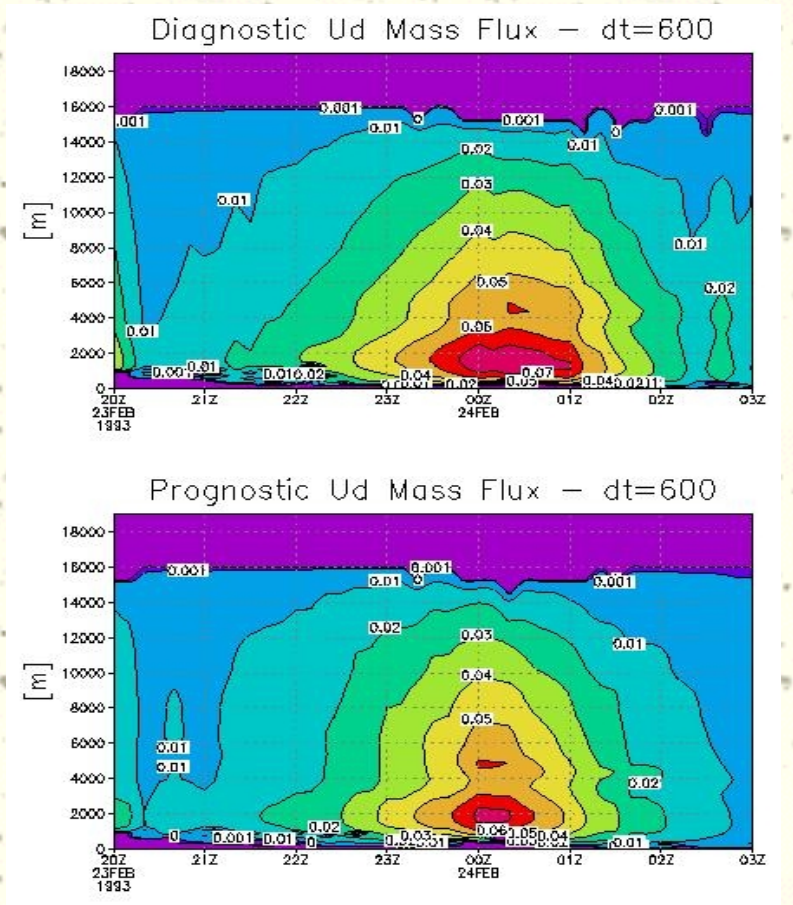
Physics for grid meshes between 7 and 3 km
Current state in Aladin

- Resolved precipitation: vertical velocity → grid-scale saturation
  ⇒ Grid scale dependency
- Subgrid precipitation → mass flux scheme for deep convection.
  vertical motion is channeled into a narrow updraught
- Closure hypothesis: quasi equilibrium
  forcing by moisture convergence ↔ consumption by convection
  diagnostic mass flux ⇒ realised in 1 time step
- Conflict addressed by modulating the forcing

Physics for grid meshes between 7 and 3 km

Prognostic Convection

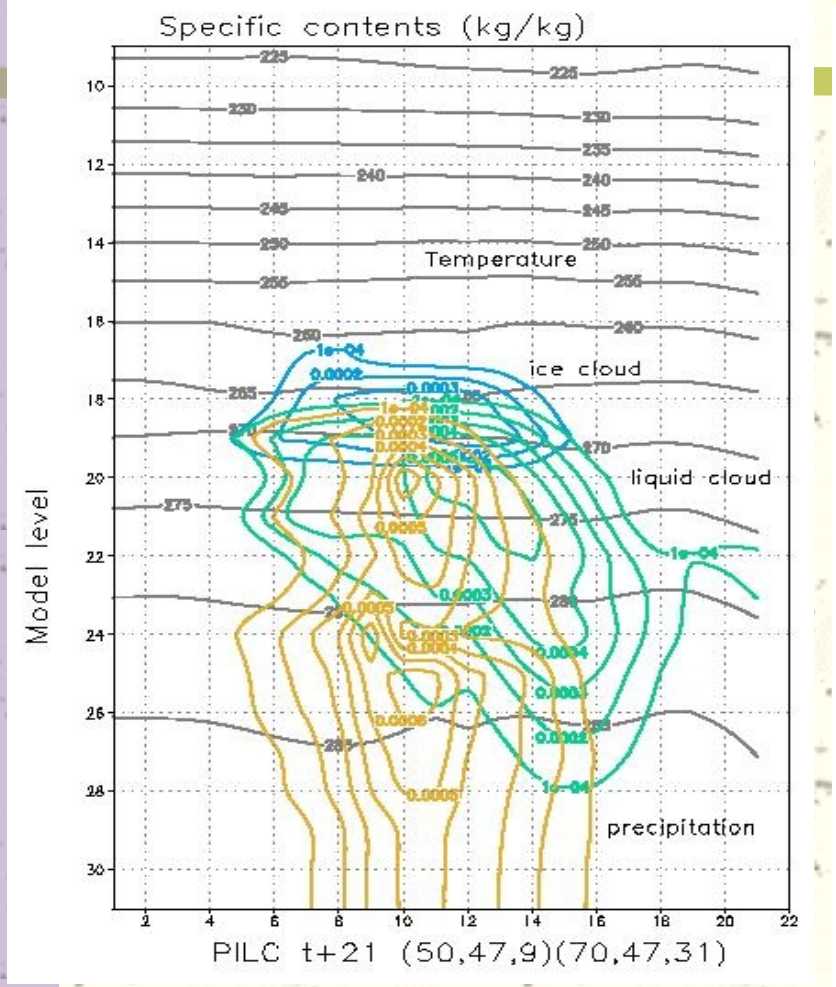
auto extinction behaviour

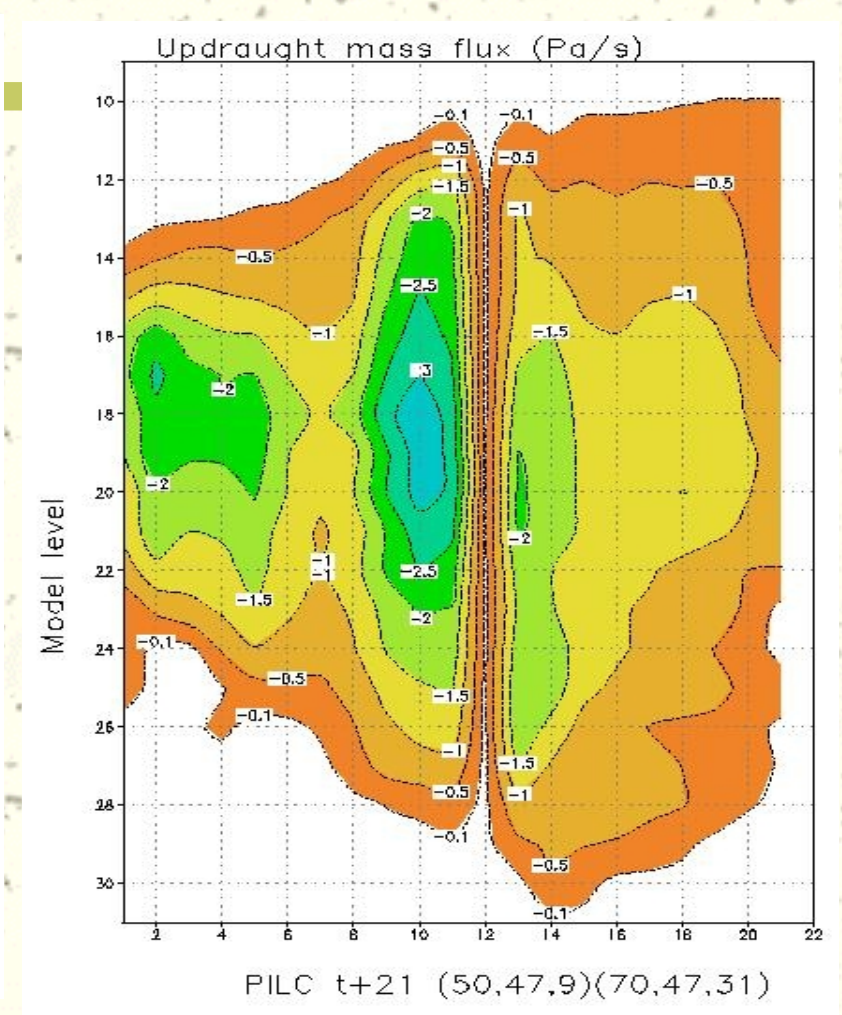


Physics for grid meshes between 7 and 3 km
***Prognostic cloud** condensates*

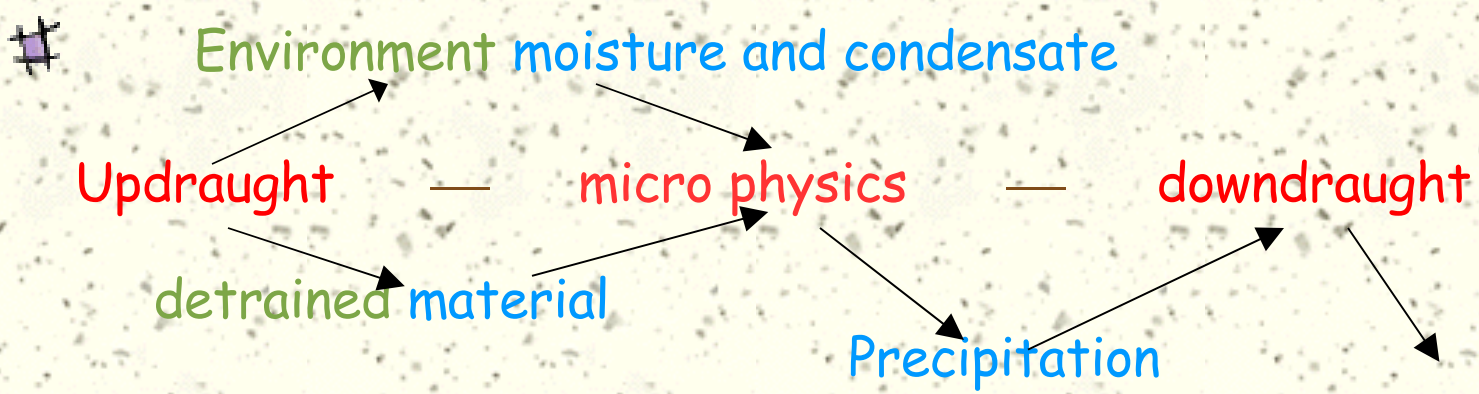
- Micro-physical package developed for the resolved precipitation
- Prognostic suspended liquid water and ice
- Contradicts various hypothesis of the subgrid scheme:
  - Immediate precipitation of all condensate
  - Negligible updraught mesh fraction
- → Need of a more integrated solution

Physics for grid meshes between 7 and 3 km
Prognostic cloud condensates



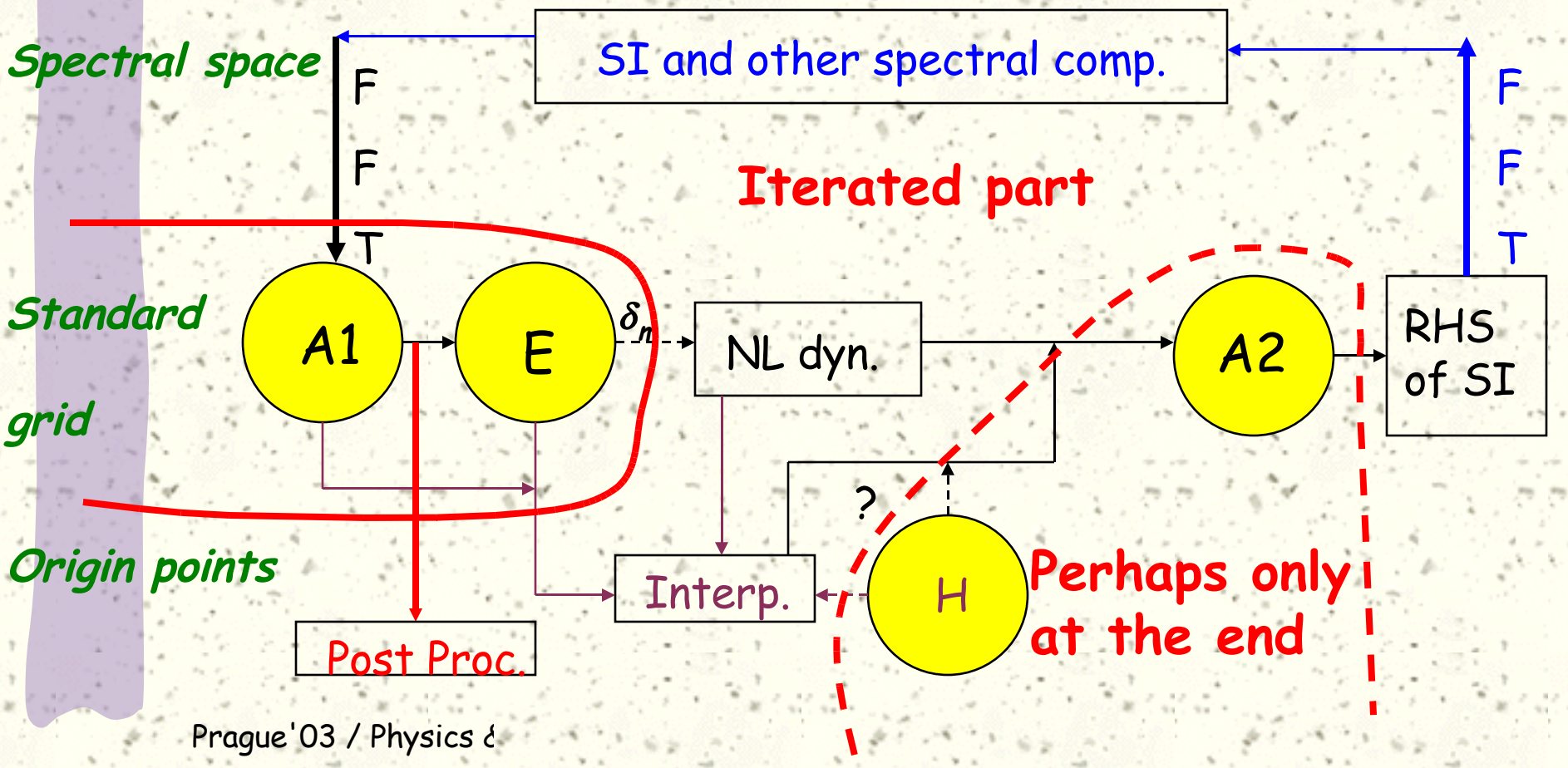


Physics for grid meshes between 7 and 3 km
New advances in Aladin

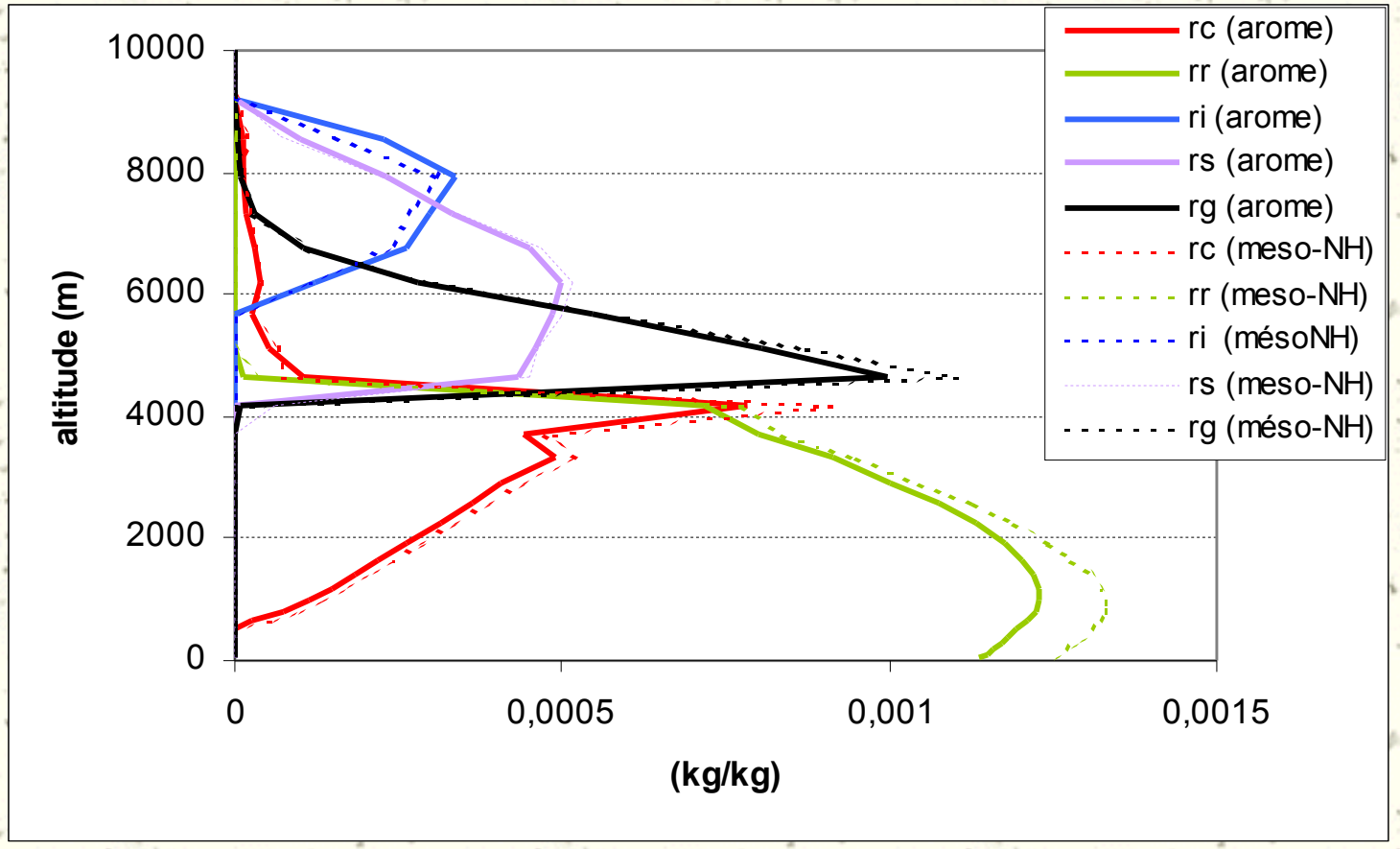


- Environment of the updraught differs from large scale average,
  Detrained material does not mix instantaneously
- CAPE closure with characteristic time or prognostic closure by moisture convergence
- Downdraught's life cycle independent of that of the updraught

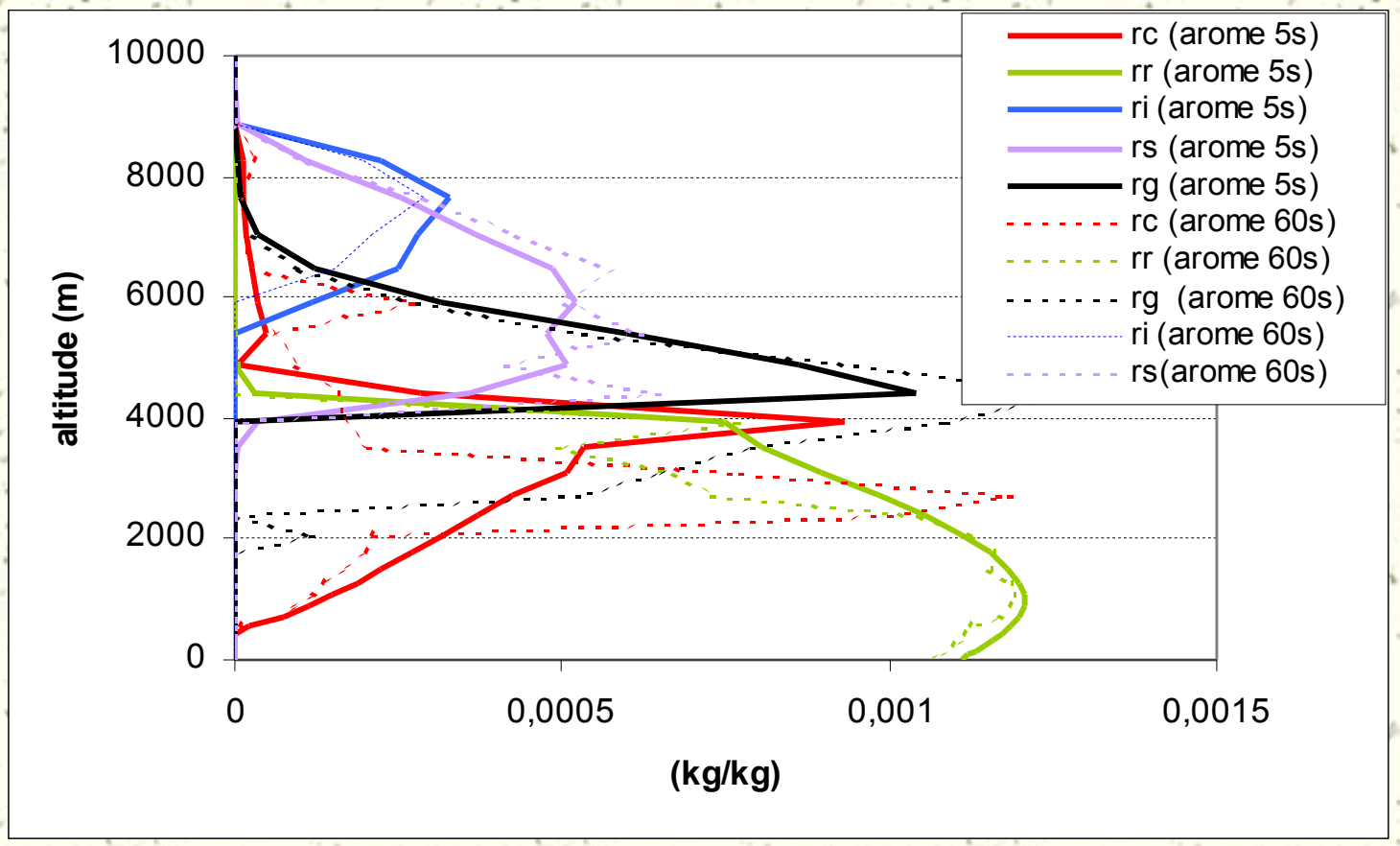
Rough sketch of the AROME target time marching scheme for physics (in P/C case)



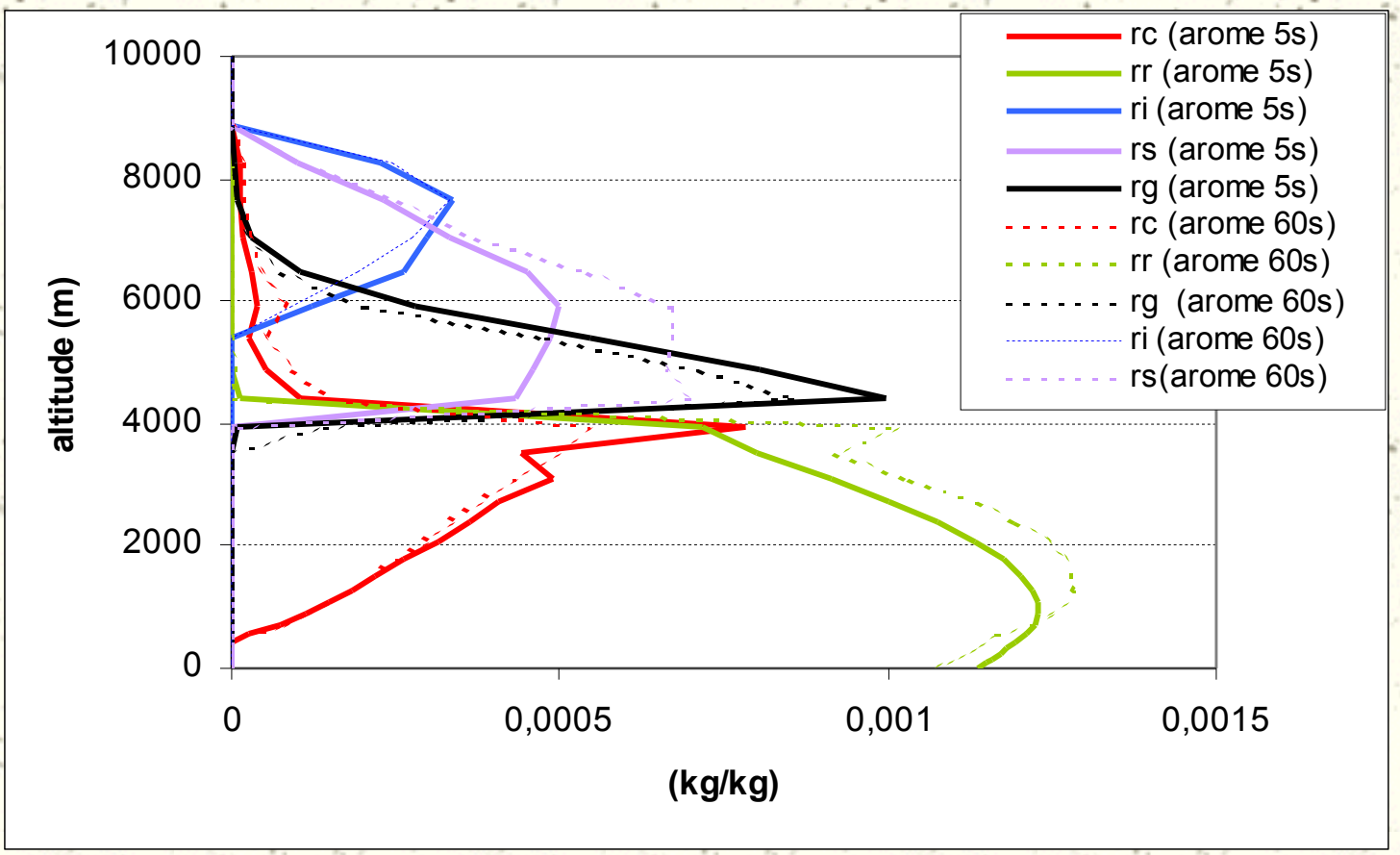
Comparison of AROME and Meso-NH 1D microphysical response to a constant forcing (δt=5s)



Comparison of AROME 5s and 60s time-steps with a «centred» call to parameterisations ('t')



Comparison of AROME 5s and 60s time-steps with a «forward» call to parameterisations ('t-dt')



Conclusions

- This is a rather complex issue. There are even some side-issues that haven't been mentioned here
- Work on the basic equations (not shown) is paramount if one wants good guidelines for long term solutions
- When it comes to arranging the time step structure to be able to run with big time-steps, «NWP rule»
- The problem of convection at the grey-zone scale has not yet been fully attacked with the tools envisaged up to now in ALADIN
- All this work will require coordination, imagination and a bit of patience!