ALADIN NH

Recent progress

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Vertical Coordinate Story

- In the beginning of the 90th (last century): most of the research NH models are cast in z-type of coordinate; (NWP models use p-type for quite practical reasons)
- 1992: idea to use hydrostatic pressure coordinate (Laprise; mass-type coordinate)
- Trial in ALADIN despite some voices: it cannot work!
- 4 mousquetaires (1993-1994): and why not?

Conception of ALADIN NH: collection of NWP choices

- Spectral
- Semi-implicit
- Semi-Lagrangian
- P-type coordinate
- Fully compressible

not very common for high resolution LAM

…And yet it runs; to get it wasn't so easy

Period 1995-2000

- 1995: end of first PhD network financing;
- 1996: first NH prototype in semi-Lagrangian (Embassy support);
- 1997-1999: 2 time-level scheme unstable, model is not robust enough; small actions all around with little results; need to work on the iterated time schemes but who?
- 2000: ALATNET financing with two positions on NH topics: revival

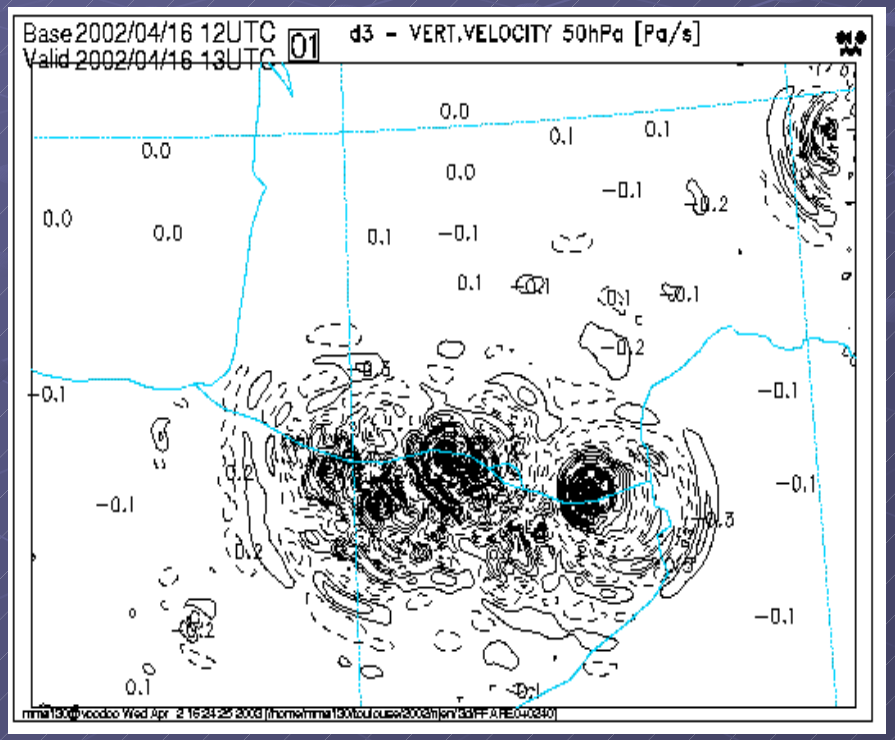
Stability aspects

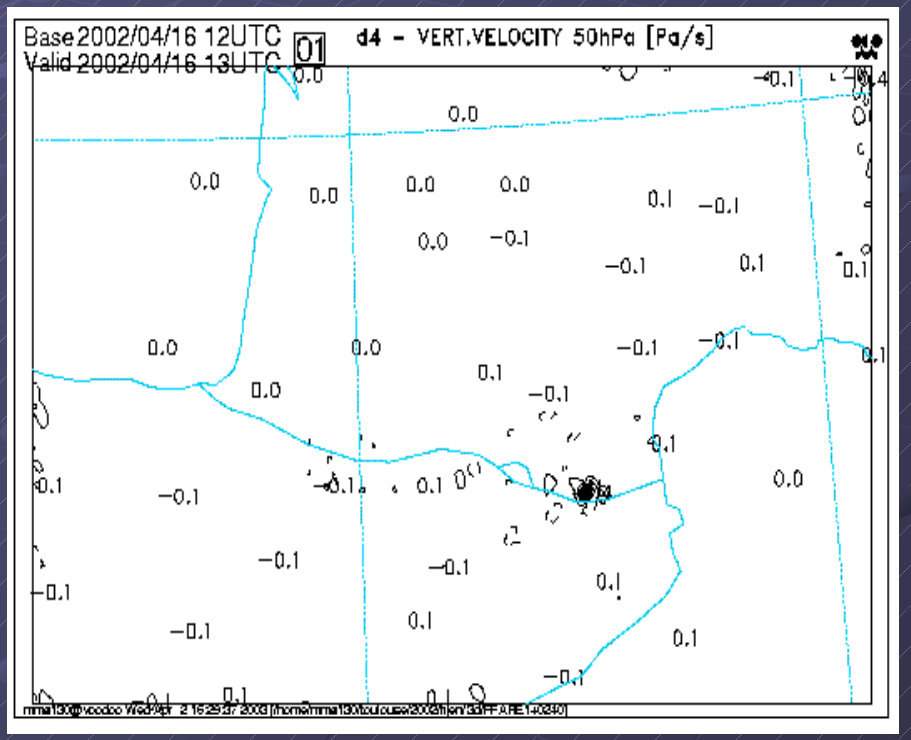
- Concern: numerical control of both acoustic and gravity waves;
- Traditional semi-implicit approach seems insufficient; but why …
- Iterated scheme: predictor-corrector (PC), where the SI step is the predictor part
- To get fast convergence and efficiency, improvements in the SI step are necessary

Stability aspects, continuation

- The best predictor: good pre-conditioning
  - Choice of prognostic variables: influences the shape of still explicitly treated residuals;
  - Good choice may be verified by numerical analysis tool (not really by hand with a pencil and piece of paper)
  - Stability criteria : opposite for the two types of waves (gravity and acoustic); this makes a huge difference compared to hydrostatic equations

Example of the Predictor gain (change of variable, PYREX)

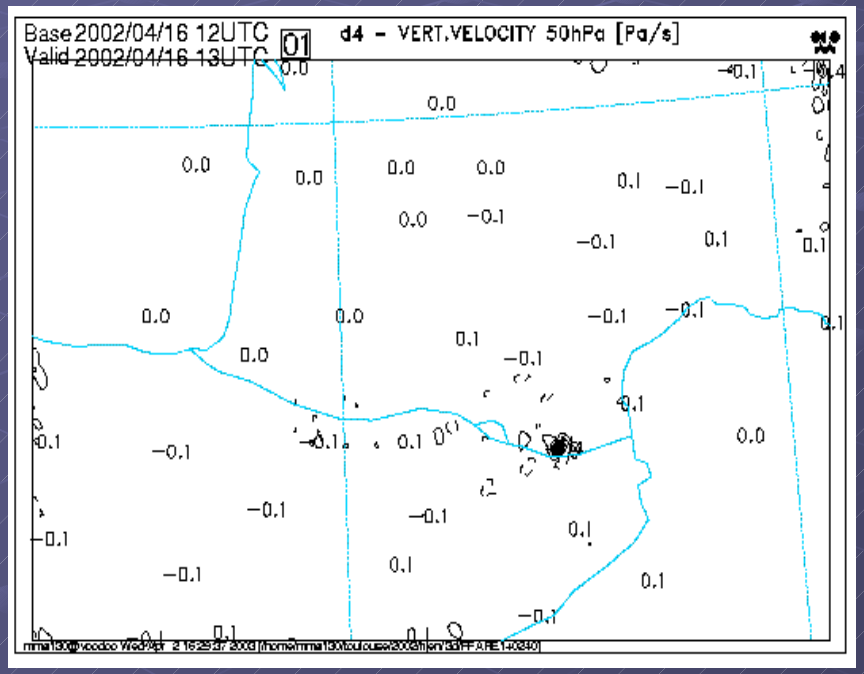




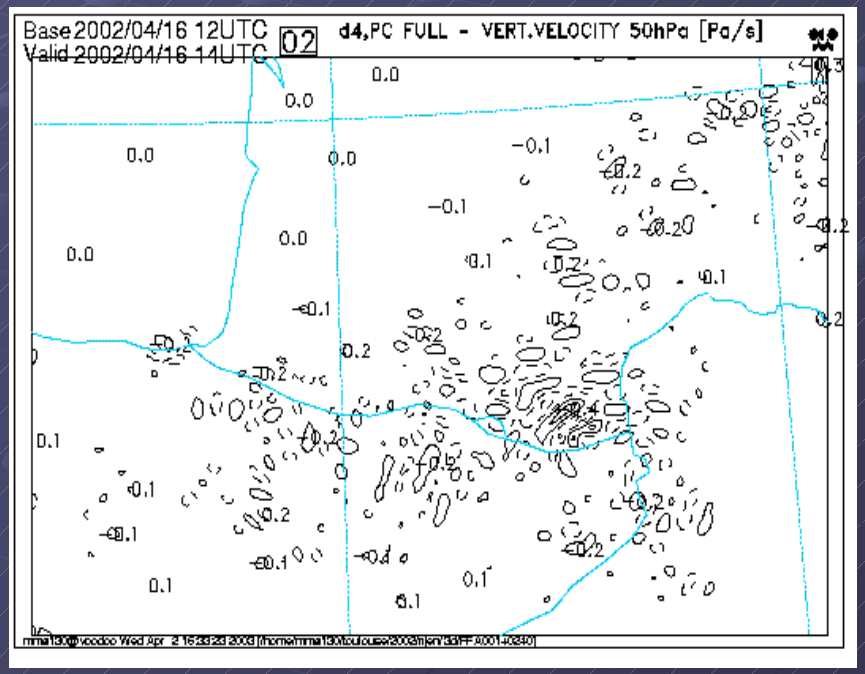
"natural" variable, simple corrector added

"numerical" variable, SI step only

Example of the Predictor-Corrector gain (1 full iteration, PYREX)



SI step only, with a good variable

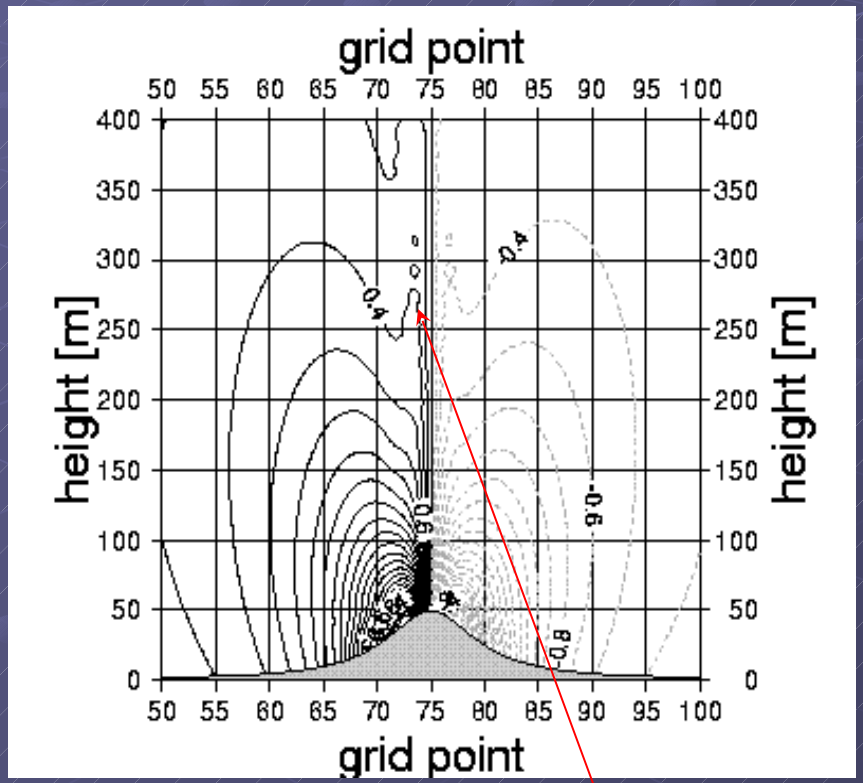


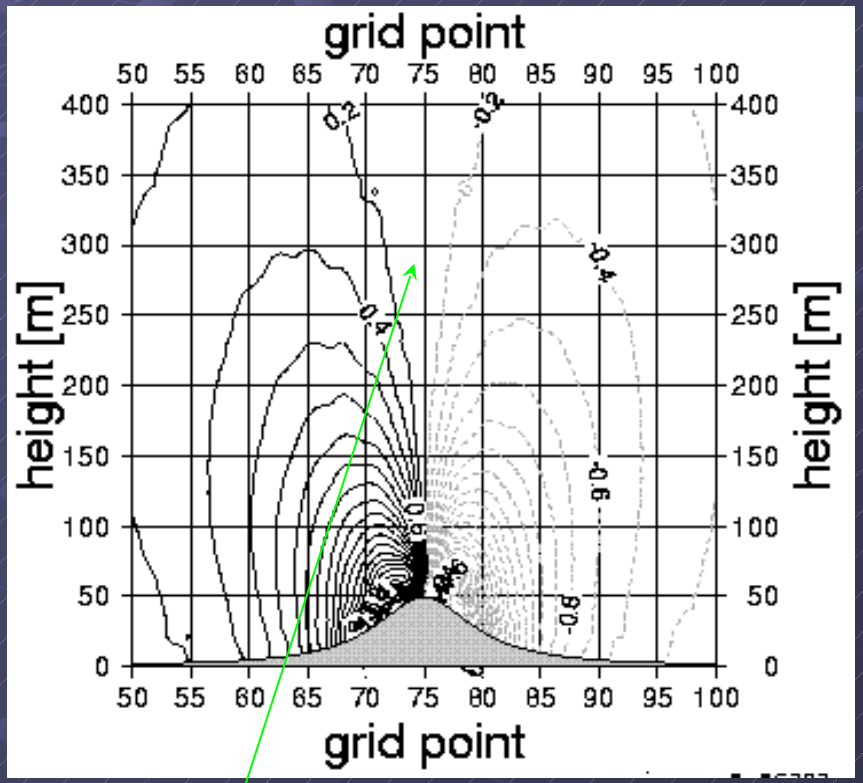
completed by one full corrector step

Discretization Aspects

- Conservation of Energy
- Conservation of Angular Momentum (only for hydrostatic pressure part of the total gradient)
- Consistent treatment of the top and bottom boundary conditions: prescribing the value of the quantity or of its derivative

Example of gain by consistent discretization of the vertical momentum eq. (potential flow)





chimney

clean solution

Conclusions

- ALADIN NH is now a robust dynamical core at rather low cost (one iteration of the dry adiabatic step with a simple solver);
- The length of the time step probably reaches a world record;
- Quality of simulations is very good;
- Lesson 1: seek for understanding and use numerical analysis when facing difficulties
- Lesson 2: don’t believe that something is wrong because it is simple and hence never tried by self-appointed experts on complexity