

# Le noyau dynamique Non-Hydrostatique

## The Non-Hydrostatic dynamical core

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Toulouse 6 February 2020

# Genesis...

## Fall of the Berlin Wall (Rostropovitch *et al.* , 1989)

- Mysteriously, 'DMN' federates common willingness of Eastern Europe Countries to access to Western 'modern' NWP
- The "ALADIN Project", and its delicious now forgotten acronyms (MICECO visitors, K-MEMBER...)

## Mass-based vertical coordinate for NH Equations (Laprise, 1992)

- (1991 ?) Receipt of the manuscript by J-F, purportedly hand-dedicated by René Laprise: "...*ceci pourrait vous intéresser...*"
- J-F immediately excited by this new idea, coming at the right time
- J-F on phone the morning after, proposing me to try the adventure "... Yes, of course I'm interested by this !"
- a small kick-off team is constituted (with Radmila, Gwenaëlle)

from "three lines of code" ...  
to "a decade of sweat"

## As little change as possible from HPE models (IFS/ARPEGE)

- A-grid, Spectral (biperiodic), Lorenz-grid on vertical, etc.
- same kind of physics interface, data assimilation
  - ⇒ "just" add two new prognostic variables

## Same ambitious dynamical options as HPE models

- Semi-implicit treatment for both types of fast waves
- semi-Lagrangian capability (i.o. Eulerian)
- and later, 2TL capability i.o. 3TL (Leap-Frog) time-scheme.

... each of these three functionalities will appear to be an issue

## First formulation...

- spectral makes life quite easy for horizontal space-discretisation of SI
- but vertical discretisation was not so obvious (finite-differences)
- Guideline followed : design discretisation so as to be able to construct a discrete wave equation with the same canvas as in space-continuous case
- these 'discretization constraints' led to 'discretisation choices' (similar but slightly different from HPE ones)

## ... first instabilities

- required iteration of 'non-linear' orographic terms (attempting to approach the Crank-Nicolson scheme for these terms)

## ... first article

Bubnová *et al.* (MWR, 1995)

## Making the SI-NH working took 7 years !

- Absolutely unstable (larger  $\Delta t$  than Eulerian)
- Try iterating all the non-linear part (M. Charron's visit 1996)  
even more unstable !!!

## ... a 3-4 years break (1996-1998)

- Indeed, we did not understand at all what we were doing/coding
- discouragement / leaving space for Meso-NH development

## That's enough! (1999)

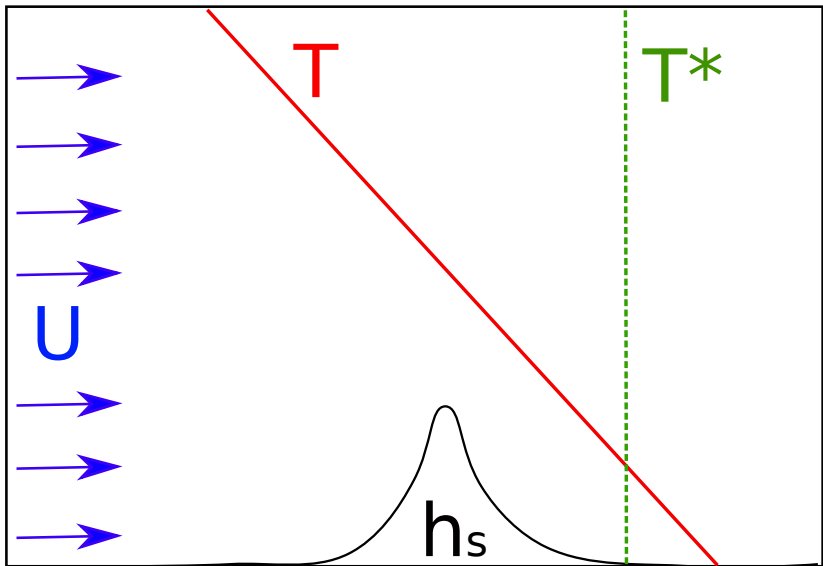
- restart from scratch : try to really understand what we are doing
  - > abandon blind "trial/error" approach typical of early GMAP
  - > change for "mathematical analysis" approach

## Traditional GMAP investigation method

- Eliminate (i.e. force to zero) one by one each of the source terms in a **realistic** forecast, to try to find the "culprit(s)"

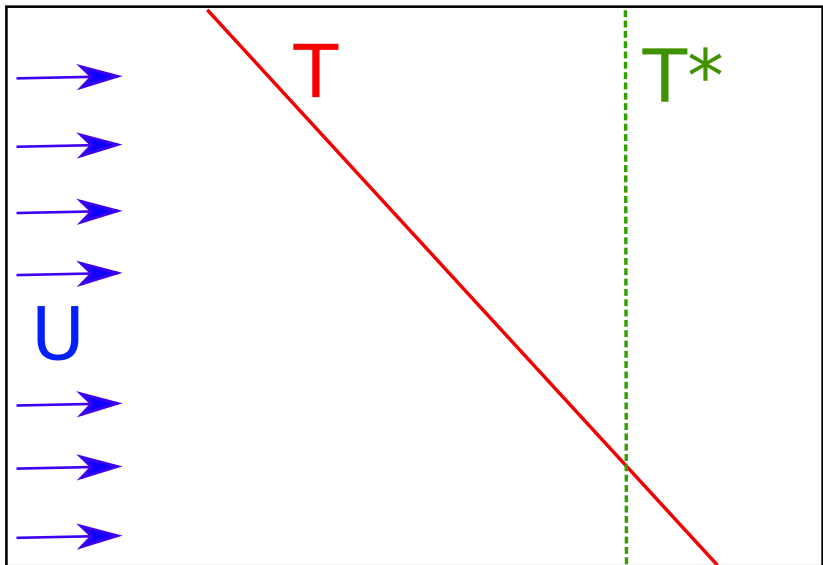
## Numerical analysis, a break in GMAP's philosophy

- Choose an unstable **simple** case in the academic version of the model
- Eliminate physical features to find the "minimal" unstable situation ...until the unstable situation becomes analysable (if lucky)
- Build and exploit the analysis :  
explain observed instability, identify causes, and imagine solutions

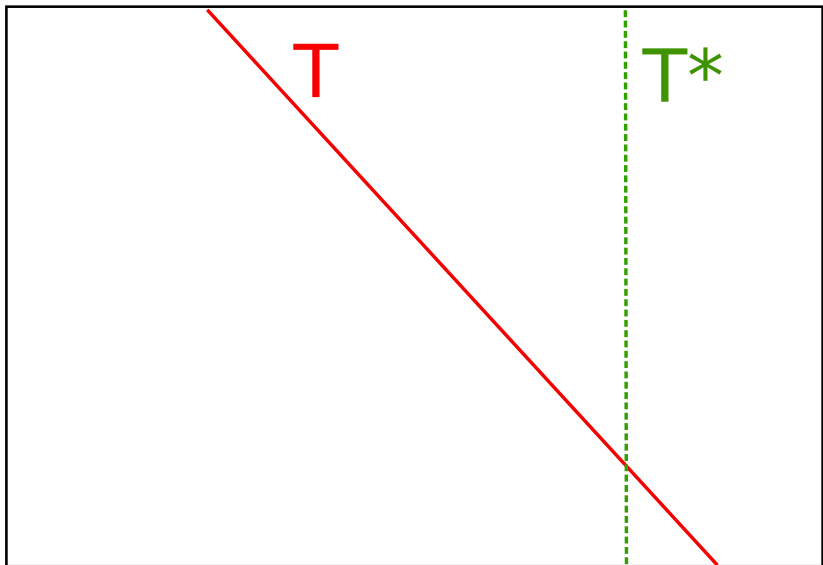


Unstable





Unstable !



Unstable !!



Unstable !!!

memo 08 sept 2000:

I) THEORY

1) Summary

The SHB81 analysis is ready:

- Larger instability domain for NH than for Hyd.
- For some modes, Dt,... instability can occur for small values of alpha (i.e. less than 0.2).

■ ■ ■

2) Continuing to simplify context

It is found that in fact  $U=0$  also leads to instability, with no discontinuity at all in the behaviour.  $U=0$  is thus not a special case for this instability.

This simpler case is now studied more in detail.

### After that, things became algebraically clear

- The model could not be stable with these prognostic variables
  - > new progn. variables proposed for flat terrain (2001)
  - > new progn. variables proposed for real terrain (2003)
- The 2TL model could not be stable as it was
  - > introduce a second reference temperature (2004)

### Back-look on this period

- "Trial-error" strategy had absolutely no chance to succeed
- New names actively emerging (Jozef Vivoda, Jan Mašek, Petra Smolíková...) thanks to ALATNET funding European project

# Links with Jean-François

- Initially J.-F. was not comfortable at all with people under his authority, questioning solid dogmas :  
"... no, it MUST work ..." (kind of: "you have introduced a bug")
- First crack : Karim's work on map factor in stretched SI model (1996)
- These three successes in NH modelling (2001-2004) made him turn completely his mind
- He became the warmest supporter, and blindly leaved us doing what we wanted, with new methods of work.
- He was always pleased to read /discuss new ideas, and check all boring computations.

# From Aladin-NH to AROME (2001-2008)

- 2001, two candidates for the dynamical core of the planned future NWP-NH model : Aladin-NH and Meso-NH
- Meso-NH was more close to readiness, Aladin-NH was more promising in terms of governing equations and efficiency
- "Titans fights" far far above our heads (one of the titans was J-F)
- The CIPN meeting on 13 December 2002 decided for Aladin-NH (with end 2008 target for operational release).  
Aladin-NH Dyn Core + Meso-NH physics + Aladin Data Assimilation
- J-F had fiercely "wetted his shirt" for Aladin-NH.
- He was of a disappeared generation, with clear views, able to strongly defend his personal credo against the rest of the world

- Big efforts for Physics (Yann Seity) and Assimilation (Pierre Brousseau)
- Thanks to François Bouttier's iron hand, the project went in due time
- First AROME operational forecast : 18 December 2008

# This was the genesis...

## A "second generation" of problems and researchers

- The problem of VFE-NH : Jozef vivoda, Petra Smolikova...
- Bunches of new ideas (maybe even too many) : Fabrice Voitus  
Theoretical views on formulations, conservation of invariants, SI discretizations, new variables...
- Non-spectral NH : Steven Caluwaerts, Thomas Burgot, Ludovic Auger, Daan Degrauwe



## JFG, a giant

## JFG, a fragile giant. Open questions

- Why never Head of Research ?
- The "double crisis" of 2003 ? (top-down vs. bottom-up pressures)

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## JFG, a giant, but of the same clay as us all