LACE Working Group for Dynamics & Coupling: Research plan for the year 2005

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Introduction

This paper summarise the planned research for the year 2005 covered by the RC LACE in dynamics & coupling. Contrary to the previous plans. It tries to give more freedom to the research topics. Objects of main importance are mainly the subjects and the available manpower. The proposed areas of research are still the same as it used to be in the last:

- I. Non-hydrostatic dynamics
- II. Dynamics - more general topics
- III. Coupling

This structure is kept mainly to keep some long term consistency even when there are possibly overlaps between the first two groups and nearly no research at all planned for the third one within the LACE community.

1 Non-hydrostatic dynamics

- **Iterative schemes**

  Description and objectives: The 2TL P/C (more generally called ICI) scheme has been developed, implemented and already cleaned in the model. During Feb-March 2005 the 3TL Eulerian scheme is planned to be phased into the CY29T2 to have more flexibility for the further research. Anyway to achieve full consistency the 3TL semi-Lagrangian part is still missing. Up to now a lack of validation and/or experience with this scheme is felt especially for configuration when no direct operational integration is performed. Within them the main importance seems to be testing this scheme with DFI and SLHD.

  Planned actions:

  1. Phase and validate the 3TL Eulerian ICI scheme into CY29T2
  2. Test the ICI status with DFI
  3. Justify the proposed solution for SLHD with ICI scheme
  4. Extend the ICI scheme for 3TL SL advection

  Risk evaluation: 1

  Priority: 1

  Means: 1.5 man $\times$ months of local work

  Contributors: Jozef Vivoda, Radmila Brožková, Filip Váňa

- **Choice of the NH prognostic variable**

  Description and objectives: During evaluation tests of P/C scheme a pathological behaviour of d variable was observed in the bubble experiment. When w is advected instead of d itself the problem disappears. However, this mixed solution is not a preferable option for the future operational exploitation. Some effort should be invested to analyse source of problem and possibly improve the "pure d" solution. If not successful, mixed solution with advection of w will probably be unavoidable.

  There exists also alternative approach proposing radical change of NH prognostic variables. Stability analysis indicates that the new pair of such prognostic variables should be as stable as the current one. However, all aspects of the new choice and its feasibility within ALADIN framework were not fully analysed yet. Moreover, any such radical step should be preceded by wide discussion inside ALADIN-NH community in order to avoid choosing dead branch and wasting manpower.

  Planned actions:

  1. Improve the performance of clear d_4 variable
  2. Analyse (and possibly test) the radical approach

  Risk evaluation: 2-3

  Priority: 2

  Means: ???

  Contributors: Ján Mašek, Radmila Brožková

- **Bottom boundary condition**

  Description and objectives: The so called HD chimney problem of the NH model has been analysed and explained. However a solution to get rid of it is not trivial. There are basically two streams proposed to avoid it:

  – Implement extra computation in spectral space to treat exactly the current BBC formulation.
  – To withdraw the problem replacing spectral HD by SLHD.

  It is evident that none of the solution is ideal. One imply some advanced work with the code introducing a potential danger for the next model evolution, the other is not solving the problem completely since even together with SLHD some weak and selective spectral diffusion is applied. Anyway both solution are viable and should be further investigated in order to find the best solution of the problem.

  Planned actions:

  1. Test the impact to the chimney when the spectral horizontal diffusion would be replaced by SLHD.
  2. Implement the exact treatment of BBC using some additional spectral computation.
  3. Issuing paper analysing the chimney origin.

  Risk evaluation: 1-2

  Priority: 2

  Means: 3.5 person × month (3 person × month by LACE funding)

  Contributors: Ján Mašek, Radmila Brožková, Miklos Vörös, Filip Váňa

- **Stabilisation and cleaning of d_4 variable**

  Description and objectives: Although the model prognostic variables for the AROME prototype were chosen long time ago, there are still few unsolved topics linked to this set of preferred variables. One of them is given by code option `ND4SYS` defining the prognostic variable called d_4. All four coded options should be analysed with respect to the model stability and the optimal one should be found. The code for d_4 variable is also desirable to be regularised. Especially the part linked to the biperiodization should be at least optimised if not rewritten. Another task stabilising further

the current NH dynamics would be the implementation of non isothermal SI background temperature (SITR) and acoustic temperature (SITRA) in order to further reduce the difference between linear state and the reality.

Planned actions:

1. Select the appropriate setting for `ND4SYS` model variable.
2. Regularise the d_4 code.
3. Implement non isothermal background temperature and acoustic temperature profiles to SI scheme.

Risk evaluation: 1 (2 for SI background)

Priority: 1

Means: 3 person × months (1 person × month of LACE funding)

Contributors: Radmila Brožková, Jozef Vivoda

- **Diabatic forcing in fully compressible model**

  Description and objectives: Diabatic terms in the model are currently modified in order to fulfil the so called hydrostatic adjustment parametrisation. The idea behind is to avoid direct generation of the acoustic waves. This arrangement creates some inconsistency in the model equation. Thus it can be a source of the potential problems. Logically more consistent would be to implement the diabatic terms in agreement with the theory. In the framework of the 2D academic and 3D real case experiments the exact implementation was studied. The results were quite promising but no real profit from exact solution implementation has been detected (despite the fact, that diabatic term can be implemented without any simplificating assumptions). More various tests has to be performed in order to give clean material for the final decision. The final solution rely on the clear phys/dyn interface. Hence the final solution for diabatic forcing is entirely linked to the progress reached on the field of phys/dyn interface.

  Planned actions:

  1. Perform more various tests with both treatments.
  2. Coordinate with actions organised within phys/dyn interface development.

  Risk evaluation: 1

  Priority: 3

  Means: 2-3 person × months of local work

  Contributors: Alena Trojáková

- **Theoretical studies linked to the vertical discretization in high resolution**

  Description and objectives: With the intention to run operational model on kilometric horizontal mesh, the model considerations should be carefully revisited. Within many of them the vertical discretization (possible usage of more precise approximation, study of problems caused by terrain following coordinate above steep orographic features,....) should be verified for such scales. The work has just started by performing some analyses (PB).

  Planned actions:

  1. Vertical finite elements in NH.

  Risk evaluation: 3

  Priority: 2

  Means: ???

  Contributors: Mark Žagar, Ján Mašek, Jozef Vivoda

2 Dynamics - other topics

- **Semi-Lagrangian horizontal diffusion**

  Description and objectives: Since the CY29T1 SLHD is implemented with its full power to the common model source. The scheme should be further extended in order to allow more freedom in the setup part. Wide experience with this unique scheme is still missing. The scheme should be tuned as well in order to be general with respect to all possible model configurations. A guide for the users is also missing for the time being.

  Planned actions:

  1. Introduce more flexible setup of SLHD to CY29T2
  2. Tuning of SLHD.
  3. Producing user's guide for the model users.
  4. Perform various tests with different model configurations
  5. Issuing paper about SLHD

  Risk evaluation: 1 (2 for reaching unique tuning for all model configuration)

  Priority: 1

  Means: 2.5 person $\times$ months of local work

  Contributors: Filip Váňa, Martina Tudor, possible entry for a newcomer

- **Radiative upper boundary condition**

  Description and objectives: An analysis of the recursive filter based on the non-reflecting upper boundary condition (RUBC) for gravity and acoustic waves interaction with the semi-implicit temporal scheme was carried on. The main concern was to influence of the modification of phase speed of the waves caused by a SI scheme on the radiative performance of RUBC. It was suggested that RUBC should be kept in an explicit form in order to properly handle wave radiation.
  The work on this topic had started and then was frozen for long time. It is felt that we should not wait much longer for restarting the work on it.

  Planned actions:

  1. Implementation to 2D vertical plane version of ALADIN
  2. Merging with P/C scheme to get a stable solution
  3. 2D and 3D experiments (SCANIA case)

  Risk evaluation: 2-3

  Priority: 2

  Means: ???

  Contributors: Martin Janoušek, ???

- **Physics / dynamics interface**

  Description and objectives: A wide range of different topics should be treated bellow this subject. There are lot of various topics with different priorities reflecting that this subject is very actual with respect to the current ALADIN-2 project development. The LACE research intends to be fully harmonised with the proposed common action within the wider ALADIN community (stream approach by JFG). The work on equation is successfully in progress (MT), there is also link to quasi-dynamical questions (AT,FV?) and miscellaneous topics like the non spectral treatment of GFL fields and 3D turbulence in the semi-Lagrangian stencil (FV).

  Planned actions:

1. Model equations
2. Quasi-dynamical questions
3. Miscellaneous topics

Risk evaluation: 1-2 (3)

Priority: 1-3 with respect to various subjects

Means: ???

Contributors: Martina Tudor, Ján Mašek, Alena Trojáková, Filip Váňa

- **Case study in high resolution**

  Description and objectives: A comparison of the performance of 2-km resolution hydrostatic dynamical adaptation with the same based on NH dynamics. The aim is to diagnose whether the NH dynamics would have some positive impact for such severe effects like a bura formation.

  Planned actions:

  1. prepared the NH dynamical adaptation
  2. compare the performances of hydrostatic and NH dynamical adaptations for selected cases

  Risk evaluation: 1

  Priority: 3

  Means: 1 person × months of local work

  Contributors: Martina Tudor

3 Coupling

- **Checking the ability of DFI to perform correctly for short coupling intervals**

  Description and objectives: DFI initialisation technique was designed a time ago when probably no one was really seriously thinking about filter cut-off interval longer than the interval between coupling files update. Since that time coupling has been reduced from 6 hours frequency to 3 hours and it is further planed to be reduced to 1 hour interval in the future. Hence the validity of DFI code has to be revisited for coupling frequency 1 hour and typical DFI configurations using extrapolation of coupling files from +N (and 0) to -N.

  Planned actions:

  1. Test the result of extrapolation of the "past" time-steps and DFI reliability for cut-off longer than offered by coupling frequency.

  Risk evaluation: 1

  Priority: 2

  Means: 0.25 person × months of local work

  Contributors: Stjepan Ivatek-Šahdan