LACE Working Group on Dynamics & Coupling

Research plan for 2012

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Introduction

Research in dynamics is rather long-term. It has been already pointed out several times, that the present under-staffed situation is not really favorable to this kind of research: People are rather used for some quick-win tasks offering more benefits for the routine operational.

Still the strategic importance of the longer term plans and research should not be regarded with less priority. Without clear plan for model dynamics it may easily happen that there is an obstacle in the future for further resolution increase with consequences for the forecast quality.

Aiming the available manpower, AL for dynamics asked the national representatives (members of LSC) to involved people from academia. So far, no concrete answer to this request is registered. There is also a hope that the joint research on dynamics would be contributed by people from Hirlam community. But again it is perhaps too early to precise any such eventuality for the next year.

During the last LSC it was agreed that the future focus in LACE for the dynamics should be as follows (considering the existing tradition and the available workforce):

- NH VFE (+stabilization of SETTLS)
- Physics-dynamics interface
- 3D turbulence

The following plan then tries to reflect this intention by putting it into more formal subjects:

1 VFE NH

Description and objectives: This topic is explored for quite some time with minimum manpower usually just enough to keep track with the relatively quickly evolving code of the model dynamics and dataflow. The abundant trials or approaches to complete the scheme led so far to no success in achieving stable and accurate scheme reliable for the operational application. The great complexity of this subject certainly requires that a sort of working team is established working more systematically on the subject than around 2 months per year. There were already some attempts to establish a team but none of them was really successful, mostly from the reason that the allocated staff was not fully devoted to the subject. This is felt as a pity, especially after so much effort was already invested to the subject.

The prolongation of this important subject is thus only meaningful if there is a chance to create a compact team devoted enough to the subject. With the widening cooperation in Europe, there seems to be a chance to join our forces with the advanced people from AEMET working on their own version of NH VFE (different set of prognostic variables, height-based vertical coordinate). Still although there are some differences between the two attitudes there are many common points with possibility to joint fertilization of the two approaches to this subject.

Proposed contributors: J. Vivoda (Sk) provided there are some other people to cooperate
Estimated efforts: up to 4 months (with LACE support: 2 months – JV, 0.5 month – Juan Simarro (Hirlam))
Location: CHMI, AEMET ?
Deliverable in 2012: report

2 Physics-dynamics interface

Description and objectives: This subject covers several different issues - organization of the timestep (recently questioned in connection to OOPS redesign of the model), higher order phys-dyn coupling, providing the physical tendencies to the prognostic quantity of vertical velocity (*w* or *d4*), finding optimal ratio (smoothing) for the computational mesh for physics and dynamics, defining a share between the physical diffusion (turbulence) and numerical diffusion, increasing the lateral communication in presently mostly vertical column physical parameterizations or promoting the full elasticity also to the way the physics is coupled with the model dynamics etc... Indeed there are more issues related to this very general model part.

The present work anticipated for 2012 in LACE is focusing to:

a. Higher accuracy time scheme

The SETTLS technique is successfully used for the extrapolation of the non-linear residual of the model, here this technique is applied on physical tendencies to get a second order accurate coupling of physics to dynamics. The modification was already coded and tested with the Alaro physics. Despite the promising theory, if applied on the physical tendency of moisture short time oscillations are induced in the fields of the model variables which seem to deteriorate the solution and even provoke the instable behavior in some cases. The topic has to be finished probably with the conclusion that we abide by the current status.

Proposed contributor: P. Smolíková (Cz)
Estimated efforts: 2 months (PS)
Location: CHMI
Deliverable in 2012: report

b. Feasibility study to add the physical tendency of vertical velocity to the adequate prognostic (NH) variable

For parameterization schemes used in HPE systems, the horizontal momentum 'feels' the sub-grid effects of mountain drag, turbulence and convection. The impact of these processes on the

vertical momentum in the case of NH dynamics has to be reconsidered. The first of the three processes is here of little importance because it is admitted that most of the various shapes of orographic stress upward propagation are fully resolved by the model dynamics when one reaches scales where non-hydrostatism matters. For the turbulence parameterization, the same down-gradient approach as for horizontal momentum can be applied to vertical momentum with an additional attention paid on the vertical staggering. For the third process, the fact that vertical sub-grid convection transports upwards a systematically rising vertical velocity ought to have some direct impact on the model's dynamics via the 3D divergence term, on top of the already considered thermodynamic impact of deep convection in non-hydrostatic conditions.

Proposed contributor: may be suitable for an eventual newcomer, a 1-1.5 month stay might be proposed on LACE support if there is a contingent candidate
Estimated efforts: 1.5 months
Location: CHMI
Deliverable in 2012: problem analysis, solution proposal

c. Design of the ideal share between the horizontal turbulence and numerical diffusion depending on the scale

A numerical diffusion has a significant role among the other mixing parameterizations since it must be present from planetary to viscous scales, mimicking the continuation of the energy cascade at the end of model spectrum and simulating residual processes which are not well captured by other parameterizations, as well as acting to filter-out unwanted discretization noise. The SLHD is a flexible tool to represent the numerical diffusion in the model. On the other side there is the horizontal extension of the scheme for vertical diffusion called TOUCANS as a tool for the horizontal turbulence control. The topic covers the proposal of an experimental setup enabling to test schemes in multiscale environment, developing tools to diagnose energy and entropy in the model system and SLHD tuning to get a consistent and scale invariant parameterization of mixing processes.

Proposed contributor: R. Brožková (Cz) and J. Mašek (Cz)
Estimated efforts: 0.5 month (RB) and 2 months (JM)
Location: CHMI
Deliverable in 2012: problem analysis

3 3D turbulence scheme

Description and objectives: This subject covers development of the specific approach to the 3D turbulence (or perhaps better called 1D+2D turbulence) designed for NWP model (being far from computed with isotropic grid) for anticipated resolutions between 500 m and few km of horizontal mesh. (The particular scheme implemented to the model is a horizontal extension of the TOUCANS/QNSE turbulence scheme available in the Alaro physics.) This range of resolution is being frequently called a gray zone for turbulence as the large anisotropic eddies starts to be partially resolved by the model. To validate and prove the usefulness of any more sophisticated turbulence scheme from the 1D approach then becomes a sort of challenge.

It is assumed that after the validation of the scheme present implementation, some specific (academic) cases will be studied in order to better understand the extra features offered by this new scheme. There are also still some algorithmic options for which the optimal solution should be defined. Apart from the implementation issues, it is also subject of design to define the most appropriate tuning for (numerical) horizontal diffusion in the presence of the horizontal turbulence scheme.

This evaluation should be possibly done in cooperation with the LES community for being able to directly compare the results with reliable reference. It is also desirable if those tests are coordinated with similar tests made in full environment focusing to the role of turbulence in the triggering of convection (see plan for physics).

Proposed contributor: J. Mašek (Cz), I. Bašták-Ďurán (Cz)
Estimated efforts: 2 months
Location: CHMI
Deliverable in 2012: updated code phased to the common source code at the level of CY37T1 bugfix or CY38T1, validation and report on results of intercomparison studies in academic environment

Summary of planned means for 2012

	Estimated effort (in person/months)	Stays supported by LACE (in person/months)
VFE NH	4	2.5
Phys-dyn interface	6	1.5
3D turbulence	2	-
Total	12	4

Unfortunately, it is not feasible to complete the plan by all stays at the moment since there is no certainty in the personal coverage of proposed stays which would induce the choice of the issue to be attacked. There is however intention to spend the remaining available funds on an engagement of a newcomer, some additional invitation of people from Hirlam, or funding a stay establishing a cooperation with the LES community on validation of the 3D turbulence.