LACE Working Group on Dynamics & Coupling

research plan for 2011

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Introduction

The NH project is supposed to finish by the early 2011. Contrary to the initial expectation, it seems that for the targeted resolution 4-5 km of numerical models the hydrostatic approach is still capable to deliver reasonable quality model results for significantly lower computational cost. This however doesn't mean that the non-hydrostatic dynamics should be off the RC LACE research interest for the short range period of one-two years perspective. It offers great potential to allow additional sophistication which can't be fully explored in the hydrostatic approach (for example fully elastic interface of diabatic processes, possibility to directly influence the vertical velocity by physical processes or just by offering technically much simpler extension of the shear source to the TKE equation by its horizontal components). Being able to profit from those issues, the NH dynamics could then possibly outperform the present hydrostatic dynamics already at the targeted scales for Alaro operational. Among this, the interest to move into the higher resolutions between 1-2 km is rising, so the model dynamics should be made ready to deliver stable core also for those scales.

Naturally the major focus for the research in dynamics should be related to the NH approach. More generally then to all issues related to increased horizontal and vertical resolution. Among the previous, a continuous interest should be also devoted to an increasing numerical efficiency of the code.

- ### VFE NH

Description and objectives: The subject is very complex. It was agreed to put increased manpower to this subject in order to progress from the current stagnating situation. The target is still remaining the same: to achieve with minimal principal changes of the model dynamics the stable VFE discretization.

Proposed contributors: J. Vivoda (Sk), F. Váňa (Cz) and J. Mašek (Cz)

Estimated efforts: 2+1+1=4 months (2 months with LACE support – JV),

Location: CHMI

Deliverable in 2011: report

- ### Non iterating version of advection of vertical velocity

Description and objectives: The advection of vertical velocity (so called *LGWADV=.T.* option) is so far the most accurate alternative for the model NH dynamics. It is however only available for the ICI scheme as the non iterative scheme using the SETTLS technique haven't been coded. The extra cost of the

iterative scheme with this option is around 49% of the whole model cost (on NEC machine) with respect to the (non iterating) hydrostatic dynamics. From the real simulations it has been found that in the present version of Alaro and Arome models the iterative scheme is not necessary. Like that the existing non-iterative alternative of the *LGWADV=.T.* code seems to be an attractive option for its capability to deliver comparable accuracy for only like 8% of additional model cost with respect to the hydrostatic dynamics.

Proposed contributor: F. Váňa (Cz)

Estimated efforts: 2 months

Location: CHMI

Deliverable in 2011: Report and model branch with code modifications.

- ## Pressure gradient term and optimal treatment of model orography

Description and objectives: An accurate discretization of the pressure gradient is an essential target for corect treatment of model orography. This becomes increasingly important for high resolution simulations. The work already started is supposing to identify the sources of the discretization errors and ideally propose a viable solution improving the present situation.

As the orography representation is also contributing to the pressure gradient force error, the study should also propose a consistent and optimized way to derive model orography.

Proposed contributor: J. Mašek (Cz)

Estimated efforts: 2 months

Location: CHMI

Deliverable in 2011: Report and possibly also model branch with new option for orography tuning in climate files.

- ## Preparation for higher resolution

Description and objectives: By increasing the model resolution (horizontal and vertical) some "sleeping pathological syndromes" can be amplified to an extent when they cause a harm to the model forecast. The aim of this task then should be to revisited schemes responsible for pacifying gravity waves (especially near the model top), the dynamic part of the convection triggering or coherent discretization of physics and dynamics tendencies or anything else possibly overseen at the moment. The target is to have reliable and accurate model results at resolutions bellow 5 km and with more than 60 levels outperforming the worse resolution simulations in every extent. It is also highly desirable to ensure, that

the model dynamics delivers realistic performance also at the scales of around 1-2 km of horizontal mesh.

Proposed contributors: J. Mašek (Cz), R. Brožková (Cz) and F. Váňa (Cz)

Estimated efforts: 2+1+1=4 months

Location: CHMI

Deliverable in 2011: Optimal tuning for model dynamics at scales 4-5 km. Identify possible difficulties for the present model dynamics when used for scales of 1-2 km of horizontal resolution.

- ## Multi-phase aspects

Description and objectives: Revision of the physics-dynamics coupling in the sense it allows fully elastic coupling of diabatic tendencies in pressure based model coordinate. The proposed method should consistently treat the existing water phases in the model atmosphere.

Proposed contributor: R. Brožková (Cz)

Estimated efforts: 2 months

Location: CHMI

Deliverable in 2011: report

- ## Second order accurate coupling of physics to dynamics

Description and objectives: The present coupling of physics to dynamics offers very stable and robust solution. The price to pay for it is however its only first order accuracy in time. Using the SETTLS technique for the physical tendencies the present time-stepping should be relatively easily extensible to a second order accuracy coupling without a need to change timestep organization.

Proposed contributor: P. Smolíková (Cz)

Estimated efforts: 2 months

Location: CHMI

Deliverable in 2011: Report and model branch with code modifications.

- ## 3D turbulence scheme

Description and objectives: The first version of 2D extension (or so called 3D-1D) of the turbulence scheme was made available in summer of 2010. It however still needs to be consistently extended for all options of NH dynamics, to be validated and phased to the common source code, at the level of CY37T1.

After this is completed, the scientific work on evaluation the impact to of this 3D physical scheme and optimal tuning for other model component can start.

Proposed contributor: F. Váňa (Cz)

Estimated efforts: 1 month

Location: CHMI

Deliverable in 2011: Code phased to the common source code at the level of CY37T1 and report with guidelines and first impressions about the horizontal turbulence scheme.

Summary of planned means for 2011:

Estimated total effort	stays supported by LACE
17 person/month	2 person/month – J.Vivoda, CHMI