Report of stay in CHMI
June 2016, Prague

Álvaro Subías Díaz-Blanco
Agencia Estatal de METerología (AEMET), Spain
asubiasd@aemet.es

September 26, 2016

The purpose of the stay has been to put in common the work made separately on one side by Petra Smolikova (CHMI) and Jozef Vivoda (SHMU) and on other side by Alvaro Subias (AEMET) in the topic of vertical finite elements (VFE) in the non-hydrostic (NH) model of the ALADIN-HIRLAM numerical weather prediction system.

The VFE was developed by Untch and Hortal (2004) in the hydrostatic model to work with full-levels in the vertical, instead of the staggered grid of half-levels and full-levels present in the finite difference case which requires some extra interpolations in the semi-lagrangian due to the staggering. The scope of the current work in VFE is to develop an analog for the non-hydrostatic model. The implementation in the NH-model is by far more complex than in the hydrostatic model and the reason is that the semi-implicit (SI) set of equations is written as a $L \times L$ linear system (being L the number of vertical levels) only if a constraint (C1) involving the vertical integral operators is satisfied, if the C1-constraint is not solved then the SI linear system is $2L \times 2L$ and consequently much more expensive in computational terms.

The two codes of Alvaro Subias, and of Petra and Jozef Vivoda constitute different strategies to introduce VFE in the NH model, specially for the C1-constraint. The code of Alvaro Subias gives good scores in tests made in HARMONIE configuration, these tests consists in 3D model over the iberian domain and with the default set of 65 levels in the HARMONIE configuration. During the stay in Prague this code was tested in a 2D idealized case with a set of 150 regular levels with wrong results in the setup of the model and also in 3D test. This needs a revision of the code because the algorithm developed in the setup of the vertical operators is very sensitive to the choice of vertical levels, even aborting in the setup of the model.

Both codes are based on cycles cy40t1 and cy40h1 respectively and will be merged in a version which should clean some repeated parts. The merged code will be considered for future phasing in MeteoFrance, this code will consist mainly of two parts with the two separate developments and which will be revised by each author. Furthermore, the merged code will be provided by a small interface to call the proper VFE method. For clarity purposes there will be considered several matrix of integration and derivation with implicit and explicit boundary conditions and who will be different for both codes, being only allocated if the proper switch is on. The first goal of the merged code will be the reproducibility of the results of the two separate versions.

References

A. Subias. B-splines as a Tool to Solve Constraints in Non-Hydrostatic Forecast Model *https://arxiv.org/abs/1601.03446*

P. Smolíková and J. Vivoda. Finite elements used in the vertical discretization of the fully compressible forecast model aladin-nh. *ALADIN-HIRLAM Newsletter*, 1:31–46, 2013.

A. Untch and M. Hortal. A finite-element scheme for the vertical discretization in the semi-langrangian version of the ecmwf forecast model. *Q. J. R. Meteorol. Soc.*, 130:1505–1530, 2004. doi: 10.1256/qj.03.173.