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VERY LOW MACH NUMBER PROBLEMS AND THE CBS SCHEME: NON-HYDROSTATIC ATMOSPHERICS MODELLING FOR NUMERICAL WEATHER PREDICTION

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ABSTRACT

What happens in Numerical Weather Prediction (NWP) is a paradigmatic example of how far the lack of communication between different disciplines can go. Although the simulation target (air), the regimes (laminar or turbulent, compressible or incompressible, thermal flows) and the governing equations (Navier-Stokes' or Euler's) are the same, CM researchers and meteorologists seems to speak totally different languages. This paper represents an effort to bridge this gap, in this case from the Computational Mechanics (CM) reserchers side.

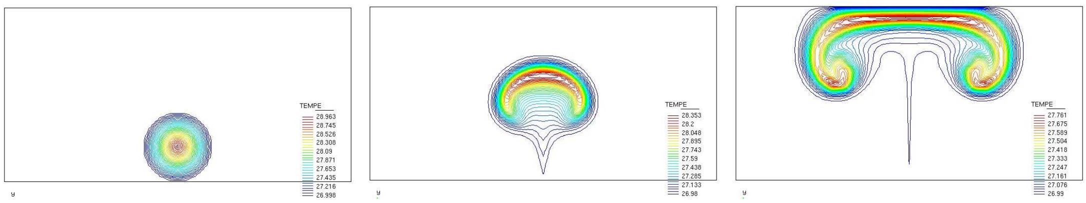

Figure 1: Warm bubble test.

The NWP core should be based in a fast, efficient and accurate solver of the *compressible* Navier-Stokes equations set. By *compressible* we mean that the density field develops variations spread throughout the domain coupled to temperature and main responsible of the dynamics of the system due to buoyancy effects. In this paper we present two different approaches for solving the problem, putting them to test through a benchmark known as Warm Bubble Test in the meso-gamma meteorologic scale (2 to 20km domains) in Euler flow regime. In the one hand, an explicit compressible flow solver based on the CBS method shows its performance to solve this very low Mach number problem. On the other hand, it is worth to mention that the compressible character of the flow does not preclude from solving the problem using different approximations. Therefore, the second CBS-based algorithm we present is an incompressible flow coupled to thermal effects under the Boussinesq approximation. Both formulations are duly compared and tested using Alya, an in-house high performance computational mechanics code of the BSC.

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