Atmospheric Boundary Layer simulations with a LES model nested in a regional atmospheric simulation.

M. Bove*, A. Vignolo*, , M. Mendina*, G. Usera* and G. Cazes*,**
Corresponding author: mbove@fing.edu.uy

* Facultad de Ingeniería, Universidad de la República

Abstract:
This proposal aims to improve the ability of the caffa3d-CFD model by incorporating realistic climate information from a mesoscale meteorological model (WRF). An unidirectional strategy was implemented for the nesting of the models. Once generated the tool will be used to evaluate the flow over a simple geometry in an easy access region selected for which promissing results were obteined.

Keywords: WRF, CFD, Nesting.

1 Introduction

Numerical simulations carried out with models that solve relatively large-scale turbulent vortices (Large Eddies Simulation models, LES) can be very appropriate to study atmospheric processes near the ground, specifically in the atmospheric boundary layer. On the other hand, these processes are also determined by movements of the atmosphere of relatively larger scales than the domains of the LES models can resolve, particularly by the mesoscale and the synoptic scale [1]. The boundary and initial conditions of these simulations allow incorporating this information. The prescription of idealized wind or temperature conditions allows valuable studies for many purposes. In any case, realistically prescribing atmospheric circulation variables larger than the LES domain significantly enhances the usefulness of the LES models. In this sense, short-term regional numerical forecast information can be prescribed, as well as interpolation to regular field data grids by assimilating them to short-term numerical forecasts. This paper describes a method for prescribing initial and boundary conditions to a in-house CFD model caffa3d.MBR [2] from the regional WRF model, which may or may not include assimilation of field data.

2 Experimental Setup

In this work an unidirectional strategy was implemented for the nesting of the models. The information generated by the WRF is provided to the caffa3d model as boundary and initial conditions.Three nested domains of successive higher resolution and smaller size (D1, D2 and D3) were used in CFD simulations. A horizontal mesh was used for each domain with square section cells vertically expanded. In order to increase topography in D2 and D3 data of ASTER Global Digital Elevation Model (GDEM) from NASA was added.

Velocity, temperature and humidity fields were linearly interpolated in order to transform the horizontal system used by the prescribed WRF data (Arakawa C) to the horizontal grid used by caffa3d model [3]. Following the Monin-Obukhov theory an extrapolation was implemented in order to obtain velocity boundary and initial conditions on near ground zones whereas second-order polynomial extrapolation was used for others fields. WRF data were interpolated between two successive WRF time steps for each caffa3d time step to be prescribed en D1, while the flow in domains D2 and D3 was explicitly resolved by caffa model using an overlapping domain strategy.

3 Results and Conclusions

An adequately representation of WRF conditions were reflected in D1 caffa reproduction and a good representation of resolved fields were also observed according to the represented topography and the boundary / initials conditions imposed. The inclusion of turbulence on these conditions, which is generally not included in the information from regional simulations is discussed in a companion paper of this conference.

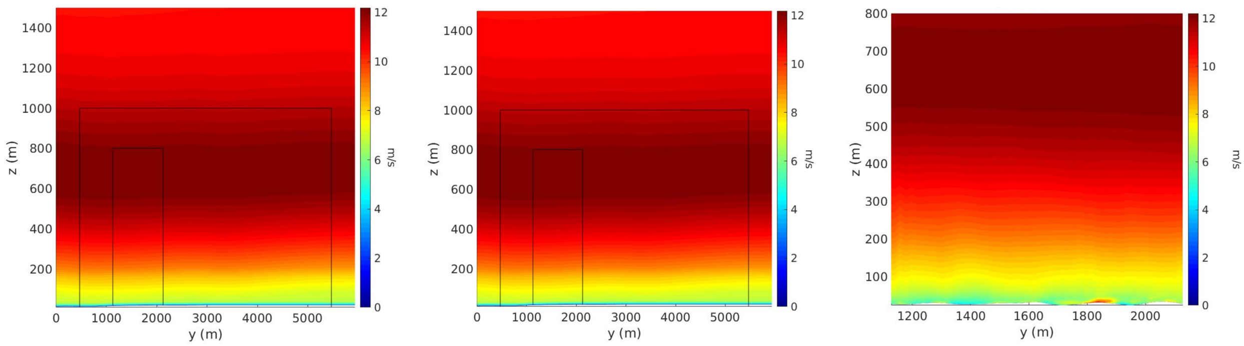

Figure 1: Instantaneous velocity modules at a vertical plane $3000m$ from the inflow. Black lines represents D3 and D3 domains. Left) WRF data; Center) caffa D1 results; Right) caffa D3 results

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