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Towards the Parametrization od the Atmospheric Surface Layer over Inclined Terrain for use in Non-hydrostatic Models

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One of the outstanding problems in the atmospheric surface layer theory is the inclusion of terrain inclination effects. The gravitational/buoyancy force component along the slope constitutes a source term in the equations of motion that is excluded by the assumptions of the classic Monin-Obukhov similarity. The action of this force is responsible for density flows. While the mesoscale non-hydrostatic models are generally capable of reproducing mean density flows with reasonable accuracy, the estimation of surface fluxes requires some attention.

Typically, models employ empirical Monin-Obukhov similarity functions in order to specify boundary conditions at the surface, or to calculate mass, momentum and energy transfer through the lowermost atmospheric model layer. To address this problem over the inclined terrain, we have implemented a bulk formulation of surface fluxes, derived from a Reynolds-stress model (Łobocki, 1993), into the wideband fluid dynamics model, EULAG (Prusa et al., 2008). The principal concept of solution stems from a hypothesis that the possible near-ground density flows would develop in resolvable scales, while the surface fluxes would remain a subgrid phenomenon, arising in response to the flow (either boundary-layer or density) and to the thermal forcing. While the heat flux is essentially vertical due to the direction of the buoyancy force, the momentum flux is perpendicular to the terrain, as the surface stress is tangent to the surface. The wall proximity effects measured along perpendicular direction to the wall are included in the turbulence master-length scale specification.

Preliminary results involving both idealized situations and simulations of field experiments, are presented. It is anticipated, recalling the promising results of Cuxart et al (2000), that the outcome of this development would be a subgrid transport model, applicable to a wide range of scales, from LES to mesoscale and the global, with a consistent bulk-type solution for parameterizing wall effects.