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Neutral and stably-stratified turbulent boundary layer flows past topography

J. L. Argain (1), M. A. C. Teixeira (2), and P. M. A. Miranda (2)

(1) Physics Department, University of Algarve, Campus de Gambelas, Faro, Portugal, jargain@ualg.pt, (2) University of Lisbon, CGUL, IDL, Lisbon, Portugal, mateixeira@fc.ul.pt, pmiranda@fc.ul.pt

In this work, we study neutral and stably-stratified turbulent boundary layer flows over orography using a non-hydrostatic microscale-mesoscale numerical model, which has been validated previously with observations. To allow for a simulation of flows over complex topography, the numerical model includes a number of features such as the use of generalized orthogonal coordinates and a new local grid refinement technique. The numerical model is also used for assessing the performance of a theoretical model based on a combination of the linear model of Hunt et al. (1988a) and the Hunt et al. (1988b) modification, which includes stability effects. Simulations show a significant dependence of the flow speed-up on atmospheric stability and orography characteristics. In the case of symmetric orography, an increase in the stability produces a corresponding increase in the speed-up. With regard to highly-asymmetric orography, such as escarpments, the same behaviour is observed only if the escarpment descends on the lee side. Comparisons of the theoretical and numerical model results allow us to conclude that the theoretical model describes the behaviour of the speed-up poorly for high stability cases.