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# Observations of gravity waves on the top of a katabatic flow

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In absence of strong synoptic-scale forcing, the structure and evolution of the nocturnal atmospheric boundary layer is dominated by mesoscale or even microscale conditions. Especially with weakly to moderately stable stratification, both regional and local circulations are mainly driven by surface heterogeneities and katabatic flows are very common anywhere with a non-completely horizontal earth's surface. The different topographically-induced circulations usually become organized at the scale of a basin and drainage flows originated by topographical features in the vicinity may be observed even over flat terrain. In specific areas, the coexistence of circulations of different scales induces important horizontal mass divergence (convergence) and, consequently, relatively large values of downward (upward) vertical velocity. Consequently, katabatic flows have to be considered fully three-dimensional circulations.

Observations of katabatic winds indicate a generally unsteady nature, even in the most quiescent conditions. The initial irruption of the flow and sudden shifts in speed or direction may induce vertical displacements of air parcels from their equilibrium position, becoming a frequent source of internal gravity waves.

The SABLES-2006 field campaign was carried out in the northern part of the Iberian Peninsula, at the CIBA atmospheric laboratory, over relatively flat and homogeneous terrain. The site is located in the Duero basin, an extensive surface with a light slope descending westwards almost surrounded by mountains. The current work describes the main features of the katabatic winds observed at the site, highlights the formation of gravity waves at the top of the drainage flow and analyzes the main characteristics of such perturbations. Special emphasis is placed on the vertical transport of momentum and heat induced by the gravity waves. In situations with important wave activity, this vertical transport may become a key factor to force the vertical profiles of wind and temperature.

The description of the vertical fluxes and the vertical structure of perturbations is based on the analysis of data gathered by a set of sonic anemometers and microbarometers installed on a 100-m mast, a sodar device and tethered balloon releases. On the other hand, knowledge on the horizontal structure and motion mainly follows from the analysis of data gathered by an array of microbarometers set on the vertices of a 200-m side triangle.