Estimation of low-level vertical velocity at Madrid-Barajas airport aimed to improve fog forecast

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During recent years, the Spanish Instituto Nacional de Meteorología (INM) has been using the H1D single-column model (SCM) in the operational short-term fog and low-clouds forecasts for Madrid-Barajas airport. Sensibility tests together with phenomenology studies have proved that the vertical advection has a decisive impact on the fog occurrence. Since the vertical velocity depends, according to the continuity equation, on the horizontal mass convergence that is a consequence of the atmospheric horizontal heterogeneity, it may not be estimated by a SCM. The values of vertical velocity and horizontal gradients are supplied to H1D by the HIRLAM limited-area model (LAM). Nevertheless, because of the non-homogeneous terrain, there is a relative high prevalence of mesoscale circulations that are not correctly simulated by the LAM.

The verification scores of H1D have been substantially improved through the inclusion of a module that somewhat reproduces the nocturnal mountain-breeze circulation. Under certain conditions, several of the external forcings provided by the LAM model, such as horizontal gradients or the profile of vertical velocity, are substituted by values based on climatological knowledge. The upward vertical velocity, that is a the consequence of the low-level convergence of drainage flows coming from two mountain ranges that configure the valley where the airport is located, is the parameter with the most decisive influence in the verification improvement.

In the present work, it is first presented a summary of different methods that have been used to estimate the profile of vertical velocity over the airport. Special emphasis is put on the estimation of mass convergence from the analysis of wind data recorded by an array of anemometers set up on the airport premises. The study of the diurnal and seasonal variation of this mass convergence allows a much better understanding of some common atmospheric circulations over the region and of some mechanisms that are decisive in the fog formation.