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Local and regional characterisation of the diurnal mountain wind systems in the Guadarrama mountain range (Spain)

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Diurnal mountain wind systems that develop in the surroundings of the Guadarrama mountain range (Spain) are studied in this work. This area is highly interesting: the city of Madrid is located at approximately 50 km towards the SE; and on the other hand, unlike in other mountainous regions, the summers are characterised to be significantly dry, providing an interesting case study of energy balance in the context of complex orography. Slope and basin circulations formed play an important role in the development of fog and pollution episodes in the whole region. On top of that, when upslope basin winds strengthened by diurnal convection exceed 10 m s-1, the runway configuration at the airport of Madrid needs to be modified.

Continuous meteorological data and turbulent fluxes of carbon dioxide, water vapour, momentum and heat are provided since June 2016 from measurements at a 10 m tower at La Herrería site, which is located at the foot of the Guadarrama mountain range. Besides, a 4 m high portable station is available for complementary measurements. La Herrería is part of the Guadarrama Monitoring Network (GuMNet; www.ucm.es/gumnet/), an atmospheric and subsurface observational facility distributed over the Guadarrama mountain range. As a support for the analysis, data from conventional meteorological stations within the region and a wind profiler at the airport are also employed.

The wind roses for the period analysed (summer 2016) show how the diurnal cycle of the flows is influenced by local slopes and by the configuration of the basin. The irruption of the downslope flow in the evening produces a significant increase of the turbulence intensity and the eventual breakdown of the surface-based thermal inversion. However, the severe drying out of the soil throughout the summer, evident from the evolution of the surface latent and sensible heat fluxes, seems to play a role in altering the characteristics of the mountain-breeze system and its impact on turbulence. For instance, the evening secondary maximum of the friction velocity is almost non-existent at the end of the season. Downslope winds, indeed, present a weaker intensity than at the beginning of the summer, when the soil is wetter, whereas anabatic winds are stronger. Physical mechanisms responsible for differences in the diurnal mountain winds are investigated as well as their potential impacts on Madrid airport.