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An investigation of the Ora del Garda wind in the Alps from surface and airborne measurements and from high-resolution numerical simulations

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The “Ora del Garda” is a coupled lake and valley breeze, regularly blowing on warm-season, clear-sky days, from the northern shorelines of Lake Garda, in the Italian Alps, and then channeling northward along the Sarca and Lakes Valleys, until reaching the Adige Valley in the area of the city of Trento.
The climatological characteristics of this wind are first investigated through the analysis of 10 years of observations collected at two representative surface weather stations – one at Lake Garda’s shore and the other 30 km further inland, at the Adige Valley’s floor.
A series of targeted measurement flights, performed by means of an instrumented motorglider between 1998 and 2001, allows the exploration of the valley atmosphere thermal structure at selected vertical sections at key locations in the study area, namely over the lake’s shore, at half valley and at the end of the valley. 3D potential temperature fields are mapped over high-resolution regular grids for each explored section, by means of a Residual Kriging technique. In addition, surface observations from a number of weather stations along the valleys where the Ora del Garda wind blows are also available.
Moreover, high-resolution numerical simulations performed with the Weather Research and Forecasting (WRF) model are analyzed to investigate the atmospheric boundary layer (ABL) structures associated with the development of the Ora del Garda. Three mesoscale domains, forced by reanalysis data field, are used to drive the finest domains, in which the large-eddy technique is used, achieving a final horizontal resolution of 80 m over three different target areas.
Model results are validated against the above-mentioned measurement flights and surface observations, displaying a good agreement, In particular, the surface diurnal cycles of radiation, wind and air temperature are satisfactorily reproduced. The typical structure of the valley ABL, characterized by shallow or even absent mixed layers surmounted by slightly stable layers extending up to the lateral crest level, due to compensating subsidence in the valley core, is also well reproduced in the simulated fields. Moreover, the simulations confirm characteristic local-scale features of the thermally-driven wind field suggested by the analysis of the airborne dataset as well as from previous observations in the area. For example, the model shows the development of inhomogeneities in the cross-valley thermal field, caused by the propagation of the lake breeze and by the different heating between the sidewalls of the valley, as well as the formation of a structure resembling a hydraulic jump in the area where the Ora del Garda flows down into the Adige Valley from an elevated saddle.

References

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