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Numerical simulations of the Ora del Garda wind in the Alps

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High-resolution numerical simulations performed with the WRF model are analyzed to investigate the atmospheric boundary layer (ABL) structures associated with the development of a lake-breeze and valley-wind coupled system developing in the southeastern Italian Alps, the so-called "Ora del Garda" wind. Four nested grids are used, achieving a final horizontal resolution of 0.4 km. High-resolution orography and land use datasets are adopted for the domain initialization, while NCEP reanalysis provides initial and boundary conditions for the meteorological fields. Model results complement an existing dataset composed of a series of measurement flights, performed by means of an instrumented motorglider, and surface observations, which is also adopted to validate model results. The flights explored specific valley sections at key locations in the study area, namely over the lake's shore, at half valley and at the end of the valley where the breeze blows. Air pressure, temperature and relative humidity measurements were recorded. Model results display a good agreement with the experimental dataset. In particular, the surface diurnal cycles of radiation, wind and air temperature are satisfactorily reproduced, despite some discrepancies in the timing of thermally-driven circulation onset and offset. 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, is also qualitatively 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 a well-defined lake breeze front in the lake's shoreline area, as well as the formation of a hydraulic jump structure in the area where the Ora del Garda flows down into an adjacent valley from an elevated saddle.