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Sensitivity analysis of high-resolution WRF model for high Ozone episodes in coastal area and complex terrain

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The importance of meteorological representation on regional air quality modelling has been clearly established and, consequently, the sensitivity and performance evaluation of meteorological models is a mandatory step for any air quality simulation. Many studies have comprehensively assessed and compared the performance of several meteorological models in the scope of air quality modelling. Nevertheless, only few studies focused on model evaluation during heat wave episodes, that quite often produce the condition for high Ozone accumulation.
The study region (Liguria) is a narrow strip of land located in the north-western Italy and bordered by the Ligurian Sea. The area, almost mountainous, is characterized by a long coastline that produces, during the summertime, the condition for the Thermally Induced Circulations (TICs) to occur. Moreover, the complex orography is likely to strongly influence the TICs, that are known to play an important role in producing Ozone accumulation.
The present study focuses on a 10-day event characterized by high Ozone concentrations during stable conditions and high air temperature. The data analysis shows that the evolution of the Ozone episode highly correlates with specifics of the coastal local circulations. To understand critical atmospheric conditions relevant to the Ozone episode, an extensive sensitivity analysis was performed using the Weather and Forecasting (WRF) model. The model was forced using the ERA-Interim reanalysis dataset from the European Centre for Medium-Range Weather Forecasts. Four nested grids were used, achieving a final horizontal resolution of 1 km over the entire Liguria region. Up to 12 alternative model configurations were tested, including 4 Planetary Boundary Layer schemes, 2 Land-Surface Model and 2 Radiation schemes. The impact of vertical and horizontal spatial resolution, as well as of the use of a subgrid-scale orography parametrization, was evaluated. Model results for the most significant meteorological variables were evaluated using an extensive surface observation network. Particular attention was given on assessing the model ability to reproduce the evolution of the TICs. The optimal model configuration to be used for high Ozone episodes over coastal areas characterized by complex orography was finally identified.