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Observed ozone exceedances in Italy: statistical analysis and modelling in the period 2002-2015

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Local ambient air quality is strongly influenced by anthropogenic emissions and meteorological conditions. The year 2015 is considered by NASA scientists as one of the hottest at the global scale since 1880. Furthermore, in Europe it was the first summer after the introduction of Euro6 regulation, the latest emission standard for passenger vehicles.
The goal of this study is twofold: (1) the investigation of the impact of the heat wave occurred in the summer of 2015 on ozone levels and (2) the exploration of the weight of temperature as driver of high-level ozone events with respect to other variables.
We performed a quantitative examination of the ozone seasons (May-September) for the period 2002-2015 using ozone concentration and weather data from 24 stations across Italy. The number of exceedances of limit values set by the European directive was calculated for each year, and compared with the trend of ozone concentration and temperature. Furthermore, the data were grouped in clusters of consecutive days of ozone exceedances in order to characterize the duration and the intensity of high ozone events. Finally, we developed a multivariate logistic regression model to investigate the role of a set of independent variables (meteorological, and temporal variables, altitude, number of inhabitants, vehicle emission standard) on the probability of exceedances.
Results show that 2015 is one of the hottest years after 2003. During the period 2002-2015, the average number of exceedances per station of the daily maximum 8-hour average is often higher than the limit established by the European directive (25 per year). The highest number of exceedances was 65 per station, reached in 2003. The Po Valley is confirmed as a hot spot for pollution, with more frequent exceedances and a higher sensitivity to temperature, especially at urban sites. Ozone events in 2015 were fewer than recent years, but of longer duration (on average 4 days against 3 days), and with similar mean concentrations. On the other hand, high-temperature events have similar duration and higher mean temperature with respect to recent years, pointing out that temperature is not the only driver of high-ozone events.

The statistical model confirms a significant impact of the meteorological variables (positive for temperature and pressure, negative for humidity and wind speed) on the probability of ozone events. Significant predictors are also the altitude (negative) and the number of inhabitants (positive). The decreasing observed recent trend is explained by the introduction of the Euro regulations, rather than natural variability. However, we find an inversion of trend for the more recent period under Euro6 (from September 2014), but we cautionary wait a confirmation from additional data at least for the year 2016.