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Synoptic control of particulate matter pollution in Barcelona during the 21th century

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The aim of this study is to analyse the influence of synoptic and local atmospheric patterns on PM10 (particulate matter of 10 micrometers or less) pollution levels in Barcelona over the 2006-2100 period. To achieve it, a multivariate analysis (MVA) integrating different atmospheric levels (sea level pressure, the temperature at 850 hPa and geopotential at 500 hPa) was undertaken. The observed data used was the 20th Century Reanalysis. The Max Planck Institute Earth system model was used to study two scenarios (RCP 4.5 and RCP 8.5) during the 21st century. The model was calibrated given the climate variability in the future scenario, using the Quantile-Quantile mapping transformation (Q-Q).

An air pollution episode is defined as a day with levels of PM10 greater than 40 μg/m3. In the observed period (2006-2015), 594 episodes have been detected. The MVA applied to these episodes distinguish three main synoptic patterns related to a quasi-stationary Atlantic anticyclone. The first pattern, named Mild Pattern, occurs during the equinoctial period; the second pattern, the Cold Pattern, is more frequent in winter and the third pattern, the Warm Pattern, takes place during the summer. It is worthy to highlight that the highest values of PM10 in Barcelona are observed during episodes related to the Mild pattern.

These patterns were identified in the simulated period (2016-2100) after the Q-Q calibration. In the RCP 4.5 scenario, a positive a significant trend of synoptic patterns provoking PM10 episodes in Barcelona could be seen, especially in the Warm and Mild pattern, showing a relaxation of the Cold pattern during the last decades of the 21st century. A similar evolution is observed in the RCP 8.5 scenario but the relaxation at the end of the century is also observed in the Warm pattern.