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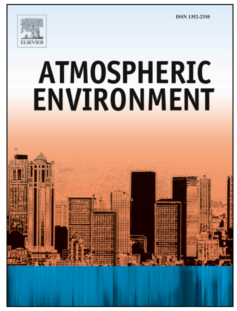

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Spatial clustering and meteorological drivers of summer ozone in Europe

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Abstract. We have applied the k-means clustering technique on a maximum daily 8-hour running average near-surface ozone (MDA8 O_3) gridded dataset over Europe at 1° x 1° resolution for summer 1998–2012. This has resulted in a spatial division of nine regions where ozone presents coherent spatiotemporal patterns. The role of meteorology in the variability of ozone at different time scales has been investigated by using daily meteorological fields from the NCEP-NCAR meteorological reanalysis. In the five regions of central-southern Europe ozone extremes (exceedances of the summer 95th percentile) occur mostly under anticyclonic circulation or weak sea level pressure gradients which trigger elevated temperatures and the recirculation of air masses. In the four northern regions extremes are associated with high-latitude anticyclones that divert the typical westerly flow at those latitudes and cause the advection of aged air masses from the south. The impact of meteorology on the day-to-day variability of ozone has been assessed by means of two different types of multiple linear models. These include as predictors meteorological fields averaged within the regions ("region-based" approach) or synoptic indices indicating the degree of resemblance between the daily meteorological fields over a large domain (25°–70° N, 35° W – 35° E) and their corresponding composites for extreme ozone days ("index-based" approach). With the first approach, a reduced set of variables, always including daily maximum temperature within the region, explains 47–66 % of the variability (adjusted R^2) in central-southern Europe, while more complex models are needed to explain 27–49 % of the variability in the northern regions. The index-based approach yields better results for the regions of northern Europe, with adjusted R^2=40–57 %. Finally, both methodologies have also been applied to reproduce the interannual variability of ozone, with the best models explaining 66–88 % of the variance in central-southern Europe and 45–66 % in the north. Thus, the regionalisation carried out in this work has allowed establishing clear distinctions between the meteorological drivers of ozone in northern Europe and in the rest of the continent. These drivers are consistent across the different time scales examined (extremes, day-to-day and interannual), which gives confidence in the robustness of the results.