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Can statistical models provide valid estimates for future ozone exceedance days under climate change?

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One of the major challenges in present day atmospheric research studies is to provide estimates on future air-quality under the framework of climate change. Tropospheric ozone is a pollutant that is expected to be affected by changes in climate. The majority of the studies assess climate change impact on tropospheric ozone using coupled chemical transport models to climate ones, in an off-line mode, for various horizontal resolutions and different present and future time slices. In this study we develop a statistical model to examine the potential impact of increasing future temperatures due to climate change on ozone exceedance days in Europe. We employ observed daily maximum temperatures and hourly ozone observations from non-urban stations across Europe, as well as daily maximum temperatures for 2021-2050 and 2071-2100 from three regional climate models, based on the IPCC SRES A1B scenario. A rotated principal components analysis is applied yielding 5 principal components which delineate regions of homogeneous concentrations. To reduce our dataset further, different selection criteria are used based on PCA's products and statistically significant correlation between daily maximum 8-h average concentrations and daily maximum temperatures. To provide estimates of future ozone exceedance days for the periods 2021-2050 and 2071-2100 the present day ozone temperature relationship is examined and then extrapolated to the future with the implementation of a pseudorandom generator combined with the daily maximum temperatures from the regional climate models. Results suggest that increases in the upper temperature percentiles increase ozone exceedances for both future periods compared to the present with the greatest increases seen in Southern Europe for both future periods respectively. Finally the results of the statistical approach are evaluated against the results from the GISS/GEOS-CHEM coupled climate chemistry modeling system as well to studies existing in literature.