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Diagnosing changes in European tropospheric ozone: A model study of past and future changes

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ecosystem health have led to policy changes aimed at reducing emissions of ozone precursor gases such as nitrogen oxides (NOx) and carbon monoxide (CO). Although emissions of these species have significantly decreased in Europe and North America since the early 1990s, observational data indicate that free tropospheric ozone over Europe has not decreased as expected. Uncertainty remains as to how much of a role the transport of stratospheric ozone has played in recent trends, as well as to how this will evolve in a changing climate.

The global chemistry-climate model SOCOL (SOlar Chemistry Ozone Links) is used to investigate tropospheric ozone trends over Europe from 1960 to 2100. To fully disentangle the effects of both long-range transport and input from the stratosphere, three simulations are run with ozone tracers from 21 different atmospheric regions. In addition to a standard reference run, two sensitivity simulations are run: one with emissions of NOx and CO held constant at 1960 levels, and one with methane (CH4) held at constant 1960 levels, in addition to the NOx and CO. Results suggest that the influence of stratospheric ozone transport is small in all three simulations and remains largely constant over time, except for the contribution from the tropical lower stratosphere, which decreases over the entire simulation period. In contrast, the contributions from the tropical and northern mid-latitude boundary layer and free troposphere increase over time, indicating that changes in source gas emissions have affected ozone concentrations in the European free troposphere most strongly.