5.020 Diagnosing changes in free tropospheric ozone over Europe: A model study of past and future changes.

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Abstract:

In recent decades, the negative impacts of tropospheric ozone on human and ecosystem health have led to policy changes aimed at reducing emissions of ozone precursor gases such as nitrogen oxides (NO_X) and volatile organic compounds (VOCs). 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 or tropospheric ozone from remote source regions has played in recent trends, as well as how this will evolve in a changing climate.

The global chemistry-climate model SOCOL (SOlar Climate Ozone Links) is used to investigate tropospheric ozone over Europe from 1960 to 2100. To fully disentangle the effects of both long-range transport and input from the stratosphere, simulations are run with ozone tracers from 29 different atmospheric regions. In addition to a standard reference run, two sensitivity simulations are run: one with emissions of NO_X and VOCs held constant at 1960 levels, one with methane (CH_4) held at constant 1960 levels (in addition to the NO_X and VOCs). Results suggest that the largest contributions to European tropospheric ozone originate from the tropical and northern mid-latitude boundary layer and free troposphere. Contributions from these regions increase over the historical period (1960-2010), indicating that changes in source gas emissions have affected ozone concentrations in the European free troposphere most strongly. Contributions from these regions then decrease from 2010-2100, but remain considerably larger than input from the stratosphere, which is relatively small in all simulations. The stratospheric contribution does, however, increase over the 21^{st} century, in tandem with ozone recovery and a simulated strengthening of the Brewer Dobson circulation.