2.125 Source attribution of tropospheric ozone in a chemistry-climate model using a novel tagging approach.

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Abstract:

Tropospheric ozone is an important air pollutant, as well as a contributor to anthropogenic radiative forcing. Major sources of ozone in the troposphere are transport from the stratosphere, and photochemical production involving reactions of oxides of nitrogen (NOx) and Volatile Organic Compounds (VOC), including methane. Model intercomparison experiments consistently show that ensembles of global chemistry-climate models produce a very wide spread in their simulation of present-day surface ozone concentration, and are not capable of reproducing observed historical trends in tropospheric ozone. Before these models can be reliably employed to make quantitative projections of future changes in tropospheric ozone, the shortcomings in their ability to simulate past and present ozone must be better understood. Improved diagnostic information about modelled ozone budgets is one way in which this understanding could be improved.

Here we describe and evaluate a novel approach to the attribution of tropospheric ozone to its emitted precursors and production in the stratosphere in a global chemistry-climate model using tagged tracers. We use this approach to attribute the modelled ozone in a number of “receptor regions” to NOx and VOC precursors emitted in several major northern hemispheric “source regions” (East Asia, South Asia, North America, and Europe). Modelled summertime ozone maxima are shown to be due primarily to photochemistry involving locally emitted anthropogenic NOx and biogenic VOCs. Anthropogenic VOCs play a minor role in modelled summertime ozone production, but become much more important in winter and springtime, when long-range transport of remotely-produced ozone becomes the dominant source of ozone in most receptor regions. Methane oxidation contributes to a consistent level of background ozone in all receptor regions. If implemented in more models, the deeper understanding of the provenance of modelled ozone provided by our tagging methodology could yield information about model-model differences, and point the way towards improvements.