Projecting Ozone Response to Precursor Emission Changes Using the HDDM Modeling Tool

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We ran an annual (2006) US-wide ozone simulation at high resolution (12 km) with the CAMx photochemical model using its "High-Order Decoupled Direct Method" (HDDM) of sensitivity analysis. HDDM predicts non-linear ozone responses to changes in precursor emissions from user-selected source categories and/or regions. This approach reduces computing time by replacing potentially hundreds of "brute force" emission scenarios with one to few HDDM runs. Extensive testing of HDDM was conducted to establish the accuracy of the approach compared to brute force runs (Yarwood et al., 2013; http://www.geosci-model-dev.net/6/1601/2013/).

The CAMx modeling employed EPA's 2006 AQMEII-US meteorology and emissions database (Rao et al., 2011), along with WRAP Phase III updates to oil and gas inventory in the Rocky Mountain States, and continental boundary conditions derived from a 2006 simulation with the GEOS-Chem global chemistry model (Emery et al., 2012). The HDDM was run for two annual emission scenarios: 50% and 90% US-wide across-the-board NOx and VOC anthropogenic emission reductions. A post-processing tool was developed that extracts hourly gridded sensitivities at (1) all 2006 active AQS sites in 22 cities (including 12 EPA/REA cities), and (2) all 2006 active CASTNET sites across US, and then projects 1 and 8-hour ozone at those sites over the entire year for any user-selected anthropogenic NOx and VOC level. Results are shown for a single urban area (Denver) and two different rural areas (Mesa Verde and Gothic, CO). Air quality at Mesa Verde is influenced by local power plants and oil/gas fields, whereas Gothic is influenced by high background ozone from the upper troposphere and stratosphere. We show that deep cuts in anthropogenic emissions (>50%) are needed at both urban and rural sites to attain new lower 8-hour ozone standards (60-70 ppb), and that some urban monitoring sites need to get past the "NOx-disbenefit" effect before any ozone reductions can be realized. The ozone response is "stiff" at rural sites because anthropogenic influences are small compared to high background concentrations that often exceed lower ozone standards.

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