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Modeled and observed ozone sensitivity to mobile-source emissions in Mexico City

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Abstract. The emission characteristics of mobile sources in the Mexico City Metropolitan Area (MCMA) have changed significantly over the past few decades in response to emission control policies, advancements in vehicle technologies and improvements in fuel quality, among others. Along with these changes, concurrent non-linear changes in photochemical levels and criteria pollutants have been observed, providing a unique opportunity to understand the effects of perturbations of mobile emission levels on the photochemistry in the region using observational and modeling approaches. The observed historical trends of ozone (O_3), carbon monoxide (CO) and nitrogen oxides (NO_x) suggest that ozone production in the MCMA has changed from a low to a high VOC-sensitive regime over a period of 20 years. Comparison of the historical emission trends of CO, NO_x and hydrocarbons derived from mobile-source emission studies in the MCMA from 1991 to 2006 with the trends of the concentrations of CO, NO_x, and the CO/NO_x ratio during peak traffic hours also indicates that fuel-based fleet average emission factors have significantly decreased for CO and VOCs during this period whereas NO_x emission factors do not show any strong trend, effectively reducing the ambient VOC/NO_x ratio.

This study presents the results of model analyses on the sensitivity of the observed ozone levels to the estimated historical changes in its precursors. The model sensitivity analyses used a well-validated base case simulation of a high pollution episode in the MCMA with the mathematical Decoupled Direct Method (DDM) and the standard Brute Force Method (BFM) in the 3-D CAMx chemical transport model. The model reproduces adequately the observed historical trends and current photochemical levels. Comparison of the BFM and the DDM sensitivity techniques indicates that the model yields ozone values that increase linearly with NO_x emission reductions and decrease linearly with VOC emission reductions only up to 30% from the base case. We further performed emissions perturbations from the gasoline fleet, diesel fleet, all mobile (gasoline plus diesel) and all emission sources (anthropogenic plus biogenic). The results suggest that although large ozone reductions obtained in the past were from changes in emissions from gasoline vehicles, currently significant benefits could be achieved with additional emission control policies directed to regulation of VOC emissions from diesel and area sources that are high emitters of alkenes, aromatics and aldehydes.

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