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Sensitivity of $PM_{2.5}$ to climate in the Eastern US: a modeling case study

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Abstract. The individual effects of various meteorological parameters on $PM_{2.5}$ concentrations in the Eastern US are examined using the PMCAMx chemical transport model so that these effects and their relative magnitudes can be better understood. A suite of perturbations in temperature, wind speed, absolute humidity, mixing height, cloud cover, and precipitation are imposed individually on base case conditions corresponding to periods in July 2001 and January 2002 in order to determine the sensitivities of $PM_{2.5}$ concentrations and composition to these separate meteorological parameters. Temperature had a major effect on average $PM_{2.5}$ in January (-170 ng m^{-3} K^{-1}) due largely to the evaporation of ammonium nitrate and organic aerosol at higher temperatures; increases in sulfate production with increased temperature counteracted much of this decrease in July. Changes in mixing height also had major effects on $PM_{2.5}$ concentrations: 73 ng m^{-3} $(100\ m)^{-1}$ in January and 210 ng m^{-3} $(100\ m)^{-1}$ in July. Changes in wind speed (30 to 55 ng m^{-3} $\%^{-1}$) and absolute humidity (15 to 20 ng m^{-3} $\%^{-1}$) also had appreciable effects on average $PM_{2.5}$ concentrations. Precipitation changes had large impacts on parts of the domain (a consequence of the base case meteorology), with sensitivities to changing area of precipitation in July up to 100 ng m^{-3} $\%^{-1}$. Perturbations in cloud cover had the smallest effects on average $PM_{2.5}$ concentrations. The changes in $PM_{2.5}$ concentrations resulting from changing all eight meteorological parameters simultaneously were approximately within 25% or so of the sum of the changes to the eight individual perturbations. The sensitivities of $PM_{2.5}$ concentrations to changes in these meteorological parameters indicate that changes in climate could potentially have important impacts on $PM_{2.5}$ concentrations.

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