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Sensitivity and uncertainty assessment of global climate change impacts on regional air quality over US

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Global climate change induced by the emissions of gases and particulate matter and human activities has the potential to affect regional air quality. The objective of this study is to assess the impact of global climate change uncertainties on regional air quality (i.e., O_3 and $PM_{2.5}$) over North America and the sensitivities to emission changes (i.e., anthropogenic and biogenic VOC and NO_x, total NH_3 and anthropogenic SO_2). Meteorological fields for both historic (i.e., 2001) and future (i.e., 2050) years are derived by downscaling GISS results using MM5. The simulation followed the SRES-A1B emission scenario. EPA's Models 3 (MM5/SMOKE/CMAQ) is chosen for performing regional air quality simulations while DDM-3D is used to quantify the sensitivities. The MIT IGSM global climate model is used to suggest uncertainty in future climate, which is then incorporated into the modeling through the following steps: the three-dimensional air temperature and absolute humidity simulated from MIT IGSM's outputs are remapped onto MM5 outputs derived from GISS. Intermediate meteorological outputs after remapping air temperature and absolute humidity are used for rerunning MM5 in order to get conservative mesoscale meteorological fields. Three percentiles of MIT IGSM PDF plots, 0.5th, 50th and 99.5th for both meteorological variables, (i.e., three-dimensional temperature and absolute humidity) have been applied: the simulation with 50 percentile of temperature and humidity is used as the base scenario, while the simulations with 0.5th and 99.5th percentiles of temperature and humidity are used for low and high extreme scenarios, respectively. We find that the emission controls have larger impact than climate change and control strategies will be more effective in the future. Uncertainties in O_3 and $PM_{2.5}$ concentrations due to climate change are larger in the higher extreme case: the variations in daily maximum 8-hr ozone concentrations are predicted to be up to 5 ppbV higher while the uncertainty in $PM_{2.5}$ concentrations is predicted to be about 1 μg/m^3.