Introduction

Future air quality is likely to be affected by changes in global and regional climate through processes such as the change of chemical reaction rates and modifications of synoptic flow patterns.

In addition, local-scale changes such as urbanization and associated changes in the magnitude and spatial allocation of emissions also may affect future air quality.

The aim of this study is to establish a modeling framework to simulate the effects of regional climate change on pollutant concentrations and the frequency of high pollution events over the northeastern U.S.

Assesses the potential air quality impacts of changes in global and regional climate and takes in initial and boundary conditions from the GISS GCM.

Future urban land use distributions consistent with the pessimistic A2 scenario were simulated with the SLEUTH model.

Using output from MM5 and SMOKE, the CMAQ photochemical model was run at 36 km over the eastern U.S. to simulate ozone and particulate matter.

Simulations were performed for two selected three-week periods at a horizontal grid spacing of 4 km, nested inside the larger domain shown above.

Changes in Pollutant Concentrations and the Frequency and Duration of Extreme Pollution Events as a Result of Regional Climate Change

Changes in Summertime Average Daily Maximum 8-hr O3

- Left: Maps of a) summertime daily maximum 8-hr O3 for the 1990s, b) Difference 2020s – 1990s, c) Difference 2050s – 1990s, and d) Difference 2080s – 1990s.

- These results suggest that climate change could cause an increase in sulfate and primary components and a decrease in nitrate and organic carbon during summertime.

Changes in Haze Ozone Events

- Left: The number of high ozone events (8-hr daily maximum concentration > 84 ppb) determined from the simulations with current and future regional climate scenarios.

- Simulated regional climate change may cause an increase in the frequency of high ozone events over the eastern U.S.

Impact of Land Use and Emission Changes on Simulated Ozone Concentrations

Civerolo et al. (2007) investigated the potential effects of increased urbanization and associated changes in emissions under the pessimistic A2 scenario on O3 in the greater NYC area.

Simulations were performed for two selected three-week periods at a horizontal grid spacing of 4 km, nested inside the larger domain shown above.

Changes in Temperature

- Left: Differences in summertime average PM2.5 species concentrations for the 2050s A2 and 1990s simulations.

- These results show that simulated changes in PM2.5 concentrations vary by species and across space.

Changes in High Ozone

- Left: Maps of differences between summertime average O3, CO, and PM2.5 species concentrations for the 2050s A2 and 1990s simulations.

- These results show that high ozone events are driven by high nitrogen oxides and particulate matter emissions, primarily from vehicles and industrial processes.

References


Changes in Deposition and a Result of Regional Climate Change

Above: Simulated N deposition, air concentrations, and precipitation over the nine eastern watersheds depicted on the right during the summer seasons of the 1990s and 2050s under the A2 scenario. (a) Wet deposition (kg N/ha), (b) dry deposition (kg N/ha), (c) air concentrations (ng N/m3), and (d) precipitation (cm).

- Over the eastern U.S., the modeling system simulated 3%-14% increases in summertime N deposition as a result of climate change.

- Summertime wet N deposition is predicted to increase primarily as a result of increased precipitation, while dry N deposition is predicted to increase as higher surface temperatures favor gas-phase nitric acid over particulate nitrate.

Model Evaluations

Left: Cumulative Distribution Functions of summertime daily maximum 8-hr ozone concentrations for the observed and modeled summers of 1993–1997 over the entire modeling domain. Each individual curve represents ozone concentrations from one summer.

Changes in Land Use

Daily total emissions roadway

Changes in Averaged Ozone

- Left: Episode-average surface ozone concentrations for a) Run 1 and b) Run 4.


- These sensitivity simulations suggest that strong increases in low-density urban land use as simulated under the pessimistic A2 scenario, along with associated changes in emissions, may have local air quality impacts of comparable magnitude as climate change.

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