The Impact of Climate Change on Regional Air Quality

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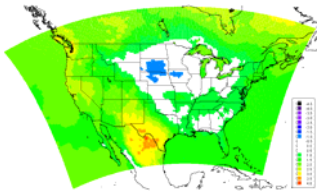
Introduction

- The Climate Impact on Regional Air Quality (CIRAQ) project seeks to assess how near-term (ca. 2050) climate change will affect air quality in the U.S.
- A Global Climate Model (GCM) simulation for the period 1950-2050 has been linked with regional scale models to simulate regional climate and air quality.
- A principal goal of CIRAQ is to determine the relative importance of climate change and changes in anthropogenic emissions to future U.S. air quality. In this first phase of the project, anthropogenic emissions are held constant. In subsequent work changes to anthropogenic emissions will be considered.

1. Global and Regional Climate Modeling

•NASA Goddard Institute for Space Studies GISS II' GCM downscaled to 36 km grid covering continental U.S. using Penn State/NCAR Mesoscale Model (MM5).

•CO_2 consistent with IPCC greenhouse gas emissions scenario A1B, corresponding to high economic growth with balance between fossil fuel and alternative energy sources.



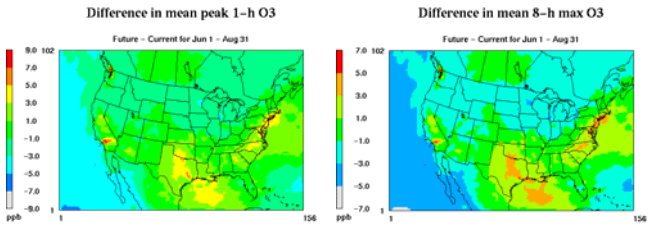
Modeled differences (Future – Current) in mean summer (JJA) 2-m temperature (K) for the ten year meteorology simulations. The largest increases are seen in southern Texas and New Mexico and the Pacific Northwest, while the Upper Midwest is predicted to cool slightly.

2. Air Quality Modeling

•Regional air quality simulations conducted using EPA Community Multiscale Air Quality (CMAQ) model version 4.5 for two 5-year periods (1999-2003 and 2048-2052).

•Monthly averaged outputs from Harvard/Carnegie Mellon global tropospheric chemistry models coupled to GISS II' provided chemical boundary conditions.

•Anthropogenic emissions held constant at 2001 levels; biogenic emissions and response to temperature simulated using Biogenic Emissions Inventory System (BEIS) 3.13.



Modeled differences (Future – Current) in maximum 1-h and 8-h ozone (O_3) concentrations (ppb), averaged over summer (JJA) for the two 5-year periods. The largest increases are seen in Southern CA, Seattle, east central Texas, and a strip from North Carolina through New Jersey.

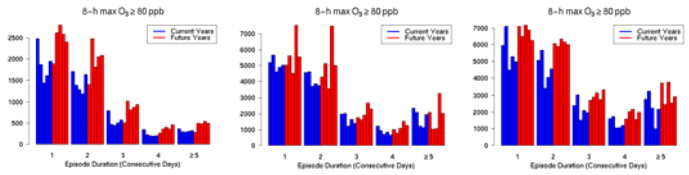
3. Change in Frequency and Duration of Ozone Episodes

•The bar charts below show the number and duration of ozone episodes (8-h max > 80 ppb) for current (1999-2003) and future (2048-2052) years, broken down by geographic region.

• The number of high ozone episodes increases in the future simulations in both the Western and Southeastern U.S.

• Additionally, the duration of ozone episodes increases in the future simulations in the Western and Southeastern U.S.

• The number of future ozone episodes in the future simulations does not increase substantially in the Northeast U.S., if interannual variability is considered



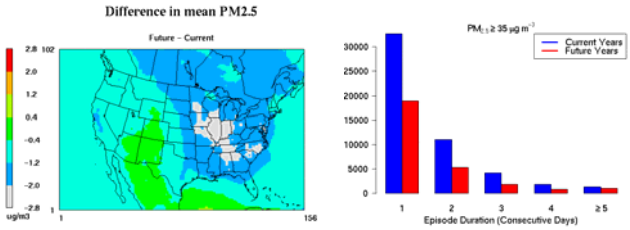
West **Northeast** **Southeast**

4. Changes in Particulate Matter ($PM_{2.5}$) Concentrations

•The differences between modeled $PM_{2.5}$ concentrations averaged over the two 5-year periods and the frequency and duration of $PM_{2.5}$ episodes are shown below.

•Compared to the current period, concentrations are broadly lower and the frequency of PM episodes decreases in the future.

•Subsequent work will investigate the change in concentration of the individual components of $PM_{2.5}$ (sulfate, nitrate, ammonium, and organic and elemental carbon).



Summary and Future Work

•Regional climate and air quality simulations have been developed for both the current climate and under one future greenhouse gas emissions scenario.

•For this modeling system, summer ozone concentrations are predicted to increase in California and much of the Southern and Eastern U.S., with a greater frequency of ozone episodes. The spatial pattern of this change appears to be consistent with the pattern of the temperature increase predicted by the regional climate model, though a more quantitative analysis is needed.

•These modeling results will be evaluated against observations for the current climate to assess the degree of uncertainty in the air quality predictions for the future climate period.

References

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