Building a Regional Climate Program: Collaborations and Partnerships

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Climate Change and Air Quality Interactions

Environmental Issue

Future climate change is broadly recognized as a risk of national and international importance by the scientific community (IPCC, 2007). As climate protection becomes more integral to EPA's mission to protect human health and the environment, modeling tools are needed to assess the effectiveness of programs and the potential climate impacts on health and ecosystems.

Research Objectives

The Climate Impact on Regional Air Quality (CIRAQ) project (Poster 4.1) provided an opportunity to test the linkages between regional air quality modeling tools and global climate and chemistry models. Through this experience, collaborations have developed with global climate modeling experts. Two key products from these collaborations are summarized here:

• The USEPA ORD assessment of the impacts of global change on regional U.S. air quality (NCEA, 2007; Weaver et al., in review).

• The Climate Change Science Program (CCSP) Synthesis and Assessment Product 3.2 (Levy et al., 2008).

Establishing these partnerships and working across EPA/ORD, other government agencies, and academia is critical to a program that depends on expertise in both climate and air quality modeling.

With these partners, efforts will continue to:

• Develop advanced modeling tools that link global climate trends to regional meteorology and air quality models

• Provide modeling tools for EPA assessment of climate impacts on air quality, human health, water availability, and ecosystem stress

USEPA ORD Climate and Air Quality Assessment

The EPA Global Change Research Program's climate impacts on air quality assessment program was developed as a cross-ORD collaboration:

• **National Center for Environmental Research (NCER)** awarded grants for study of climate impacts on U.S. air quality.

• **National Exposure Research Laboratory (AMAD)** developed regional scale air quality simulations under current and future climate through collaborations with global climate and chemistry modeling experts and regional climate downscaling experts.

• **National Center for Environmental Assessment (NCEA)** completed the report on NERL and NCER grantee results (NCEA, 2007; Weaver et al., in review).

These collaborative efforts led to four parallel climate impacts on air quality studies using regional downscaling modeling approaches (e.g., Poster 4.1). Using different greenhouse gas (GHG) scenarios and varied modeling approaches, each showed substantial regional O_3 increases.

(Results presented in Poster 4.1)

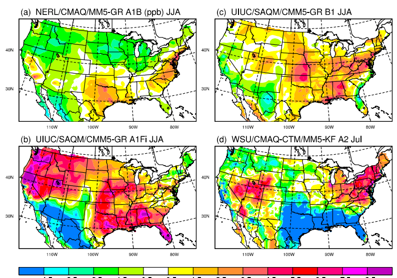

Figure 1. Summer (JJA) mean differences in Maximum Daily 8-h Average (MDA8) O_3 from four separate regional climate and air quality simulations. (Weaver et al., in review)

The spatial variations across these four studies were influenced by differences in factors including convective schemes, IPCC GHG scenarios, chemical mechanisms, and future temperature changes.

Even with these differences, all of the studies suggested mean summer O_3 increases under future climate (Figure 2). Many of the spatially averaged regions had increases of approximately 2-5 ppb under 2050 climate scenarios.

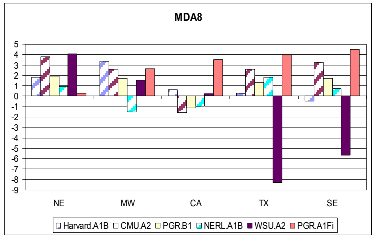

Figure 2. Mean MDA8 O_3 differences (ppb) for subregions. Results from the four downscaling studies (WSU, Ill A1F1, Ill B1, and NERL A1B) and two global chemistry and climate studies (Harvard, CMU) are shown.

CCSP Synthesis and Assessment Product 3.2

NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) led the development of the CCSP Synthesis and Assessment Product (SAP) 3.2, "Climate Projections Based on Emissions Scenarios for Long-lived and Short-lived Radiatively Active Gases and Aerosols." AMAD contributed to this document on the regional scale impacts of climate on air quality, and summary results from the CIRAQ project (Poster 4.1) were included.

The SAP 3.2 report (Levy et al., 2008) highlighted findings from three GCMs (GFDL CM2.1, NASA GISS ModelE, and NCAR's CCSM) regarding the potential impact of short-lived pollutants including sulfate, black carbon, and ozone on climate trends:

- Emission trend uncertainties for black carbon, and SO_2 to a lesser extent, are very large, even for a particular IPCC storyline.
- By 2050, changing levels of short-lived pollutants contribute 20% of global warming in two of three climate models (emission trends strongly affect results).

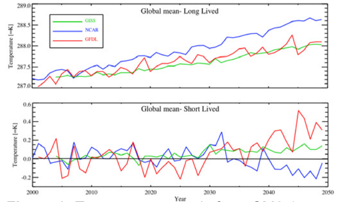

Figure 3. Temperature trends from CM2.1, ModelE, and CCSM based on GHGs only (top) and the additional change simulated from short-lived air pollutants (bottom). (Levy et al., 2008)

- Both short-lived and long-lived gases and aerosols cause enhanced climate responses in the same regions. The spatial distribution of radiative forcing does not correlate with the spatial distribution of climate response.

AMAD's participation in CCSP SAP 3.2 provided an opportunity to better understand how to collaborate with the global climate and chemistry modeling community to study air quality impacts on climate change and how linkages between global and regional models could be used to coordinate air quality and climate management.

New efforts are underway to develop regional downscaling linkages with both the NOAA CM2.1 and the NASA ModelE GCMs (see example results below from both models at 2050). Using similar approaches as in SAP 3.2, these models can be used along with the integrated WRF-CMAQ (Poster 4.3) to study air quality impacts on climate as well as develop regional climate scenarios to assess climate impacts on air quality scenarios.

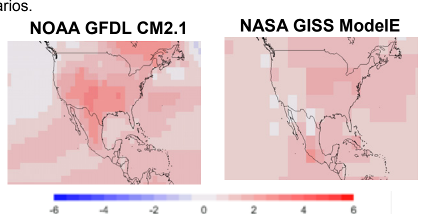

Figure 4. Average temperature changes at 2050 from CM2.1 and ModelE under IPCC A2 GHG scenario (long-lived pollutants only). CM2.1 is at 2° × 2.5° and ModelE 4° × 5° here, but both models will be 2° × 2.5° for the AMAD downscaling work.

Conclusions

- Careful coordination and linkage between global-scale climate/chemistry models and regional-scale models is required to assess potential climate change impacts on regional air quality.
- Effective partnerships among global and regional modeling groups can lead to most efficient use of expertise and resources in studying global-to-regional downscaling issues.
- Large uncertainties exist in GCM predictions of future climate leading to significant differences among models.
- Regional downscaling for air quality projections can benefit from using GCM projections from several models.

Future Directions

- Regional downscaling of present climate (with evaluation) and future climate from NOAA CM2.1, NASA ModelE, and other GCMs
- Studying future regional climate and emissions change impacts on regional air quality with multiple GCM and emissions scenario drivers
- Using integrated two-way model (WRF-CMAQ) to study the regional air quality change impacts on climate

Impact

This research has contributed to two high-profile scientific reports (NCEA assessment of global change impacts on air quality and CCSP Synthesis and Assessment Product 3.2).

Contributors/Collaborators

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