Air Pollution at Northern Mid-latitudes in a Future Climate

Arlene M. Fiore (Arlene.Fiore@noaa.gov), Larry W. Horowitz, Hiram Levy II, Yuanjuan Fang, Gabriel A. Vecchi, Yi Ming
NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ

1. Introduction
Studies examining the impact of climate change on future air quality disagree on the sign of the changes in many northern mid-latitude regions. Previous studies have typically used 3-10 year simulations from climate models (e.g., Chen et al., 2009; Dawson et al., 2009; Horst et al., 2004; Huang et al., 2008; Mickley et al., 2004; Murakami and Hess, 2006; Nolte et al., 2008; Racherla and Adams 2006, 2008; Wu et al., 2008), making it difficult to distinguish whether the meteorological changes driving the air quality changes arise from a true climate change signal or internal (inter-annual or decadal) variability. In a review of how a warmer climate will influence air pollution at northern mid-latitudes, Jacob and Winner (2009) conclude: Ozone (O_3) pollution in urban areas will worsen as temperature and climate models consistently project for the northeastern U.S. and southern and central Europe (Christensen et al., 2007).

2. Simulations of the GFDL AM3 Chemistry-Climate Model

PRESENT Simulation (20 years completed)
- Greenhouse gases at 1990 values
- Climatology of observed SSTs and sea ice (HadISST):
  - annually repeating monthly mean values averaged over 1981-2000

FUTURE Simulation (20 years completed)
- Greenhouse gases at 2090 values
- Climatology of observed SSTs and sea ice from PRESENT simulation:
  - mean changes using the A1B scenario from 19 IPCC A1R-M models, averaged over 2081-2100

All simulations use annually-invariant emissions of ozone and aerosol precursors (except for lightning NOx) representative of the 1990s as in Horowitz (2006). We will also test the sensitivity of our conclusions after updating to the IPCC AR5 emissions for the year 2000.

3. Changes in Air Quality at Northern Mid-latitudes

Change in summer air quality (June-July-August, Future minus Base)

4. Mechanisms by which Meteorological Changes Affect Air Quality

5. Next Steps
(1) Include climate feedback on isoprene emissions

(2) Evaluate air quality – meteorology relationships

6. References


We acknowledge Steve Howard and Jenise Swall (U.S.EPA) for the CASTNet observations and Isaac Held (NOAA-GFDL) for insightful conversations.