Recent trends and 21st Century projections of ozone pollution extremes over the Northeastern USA during summer

Arlene M. Fiore1 (amfiore@ldeo.columbia.edu), Harald Rieder1, Larry W. Horowitz2, Vaishali Naik3

1Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA 2Geophysical Fluid Dynamics Lab, NOAA, Princeton, NJ, USA 3UCAR/Geophysical Fluid Dynamics Lab, NOAA, Princeton, NJ, USA

**Motivation**

- Nitrogen Oxide (NOx) emissions from eastern U.S. point sources decreased by ~50% between 1999 and 2004 [Frost et al., 2006], leading to decreases in surface ozone (O3) documented in several recent studies [e.g., Cooper et al., 2009; 2010; Cooper, 2012].
- U.S. NOx emissions are projected to decline further in the coming decades [e.g., van Vuuren et al., 2011], but rising global emissions, including methane, could offset air quality improvements attained with domestic controls on ozone precursor emissions [e.g., Jacob et al., 1999; Fiore et al., 2003].
- Wu et al. (2008) point out that a warming climate could exacerbate ozone pollution (a ‘climate penalty’), with several modeling systems robustly indicating that the northeastern United States (NE USA) is particularly susceptible [e.g., Cohan et al., 2008; Frost et al., 2012].

**How do changes in emissions and climate influence the distribution of surface ozone (O3) – including extreme pollution events, over the NE USA? How should we communicate such changes in extreme O3 pollution events?**

**Describing Recent Changes in Extreme O3 Events**

**Summer (JJA) MDA8 O3 1987-2009 Observed at Pennsylvania State CASTNet site**

- High tail poorly fit with a Gaussian
- Better fit with Extreme Value Theory (EVT) Approach

**Sharp decline in return levels between early and later periods (NOx SIP call)**

**21st Century Changes in Extreme O3 Events**

**Representative Concentration Pathway Scenarios (RCPs) [van Vuuren et al., 2011]**

**Global Methane Abundance**

**Global NOx Emissions**

**NE USA NOx Emissions**

- We use RCP4.5 (moderate), RCP8.5 (extreme), and RCP4.5 WMGG (moderate); greenhouse gases follow RCP4.5 but pollutants emissions are held at 2005 levels

**1-year Return Levels in CM3 (bias-corrected) Summer (JJA) MDA8 Surface O3**

**INFLUENCE OF CLIMATE CHANGE ON SURFACE O3**

**Influence of climate change on surface O3**


**Climate penalty** [Wu et al., 2008]**

- Moderate climate change increases NE USA surface O3 1-4 ppb in JJA (agreement in sign for NE USA across prior modeling studies [Weaver et al., 2009])

**Similar impacts throughout the O3 distribution**

- Several models find larger impacts at high tail; e.g., >50% [Weaver et al., 2009]

**1-year Return Levels in CM3 (bias-corrected) Summer (JJA) MDA8 Surface O3**

**Influence of changes in emissions and climate on surface O3**

- Distributions are constructed from 10 years of JJA MDA8 O3 (92 days) in surface air over the NE USA

**Large regional NO decreases in RCP4.5**

- Nearly all at or below 70 ppb
- All at or below 60 ppb

**Doubting of CH4 in RCP8.5 raises baseline surface O3, offsetting some of NOX-driven decreases (as seen in RCP4.5)**

**References**


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