


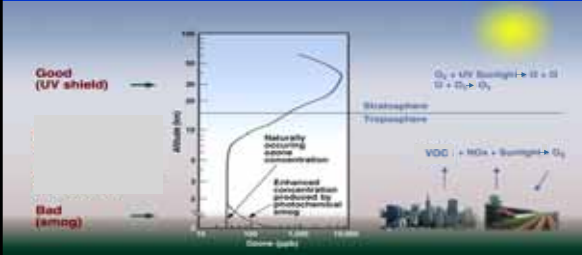
OVERVIEW OF ATMOSPHERIC PROCESSES:

Ozone and particulate matter (PM) with a global change perspective

Daniel J. Jacob



GOOD (STRATOSPHERIC) vs. BAD (SURFACE) OZONE

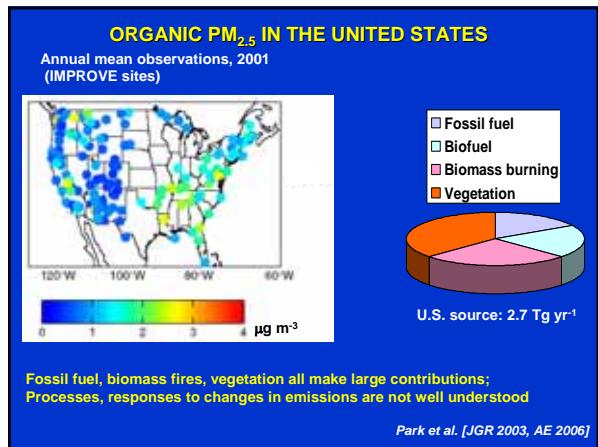
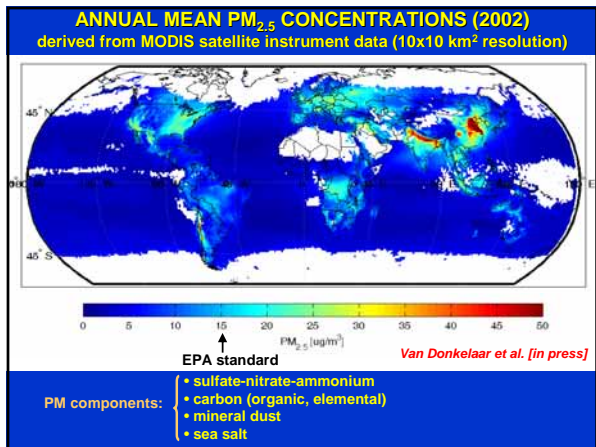
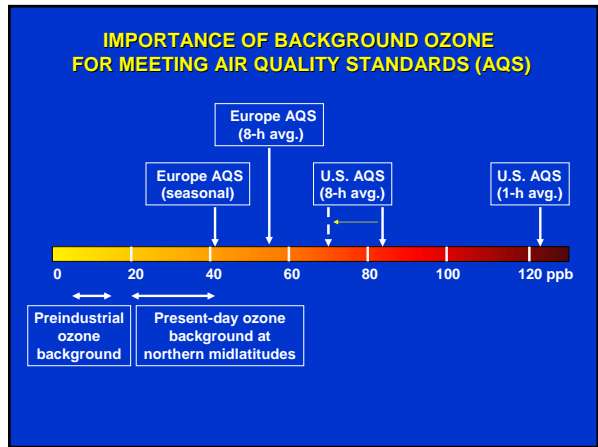
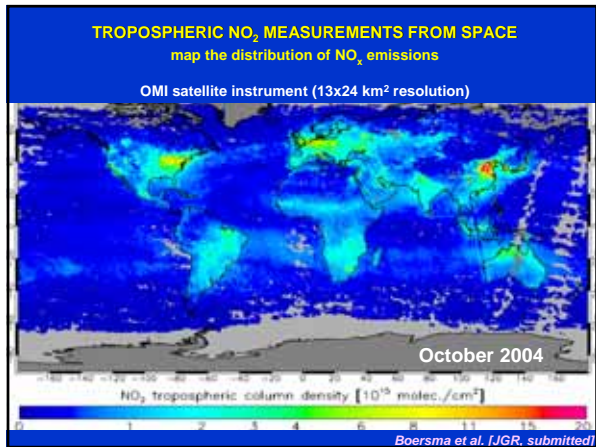


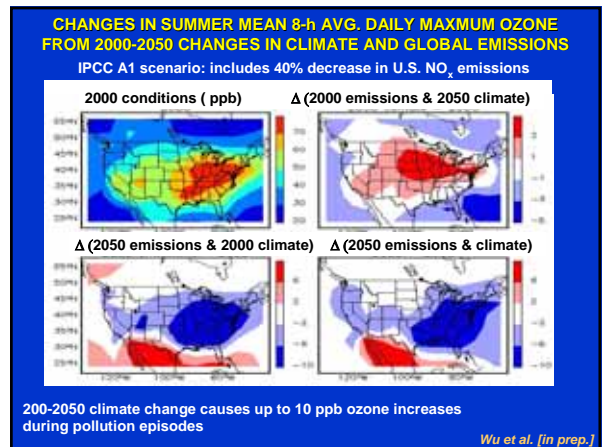
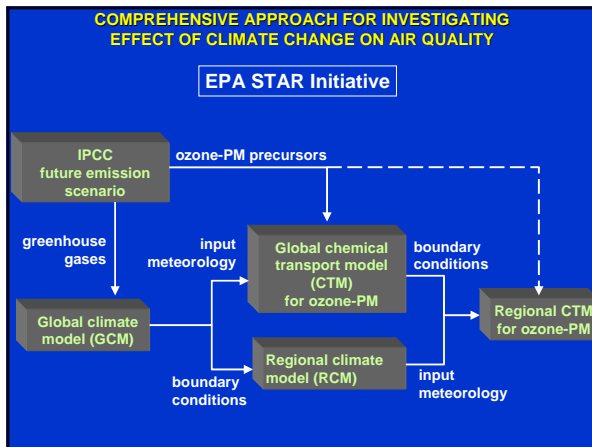
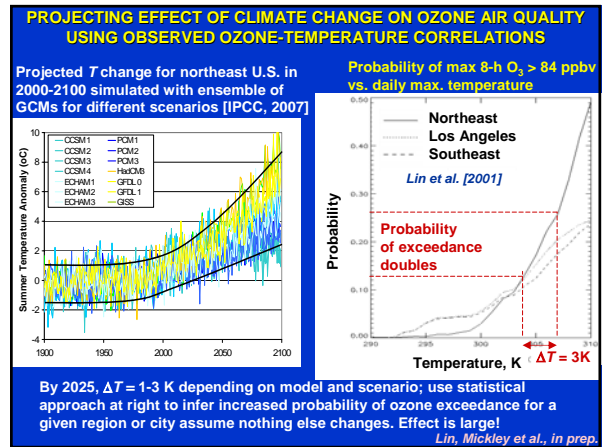
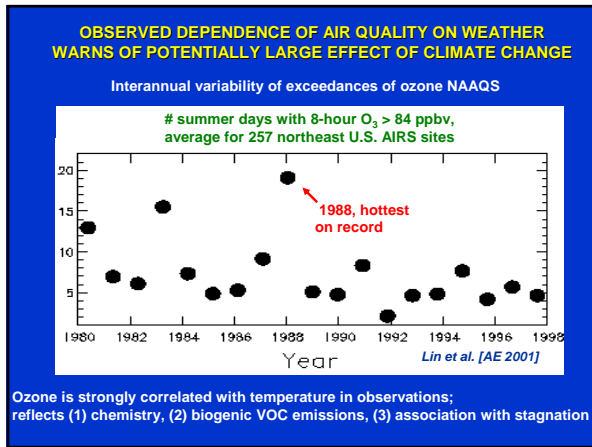
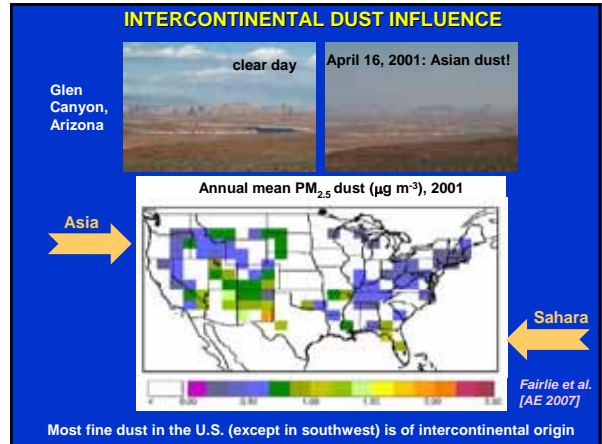
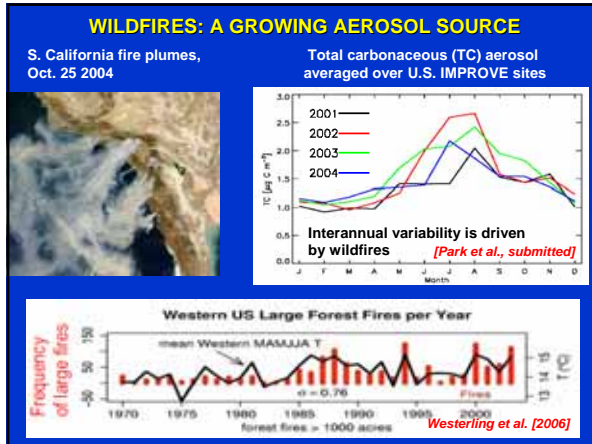
Good (UV shield) → Stratosphere

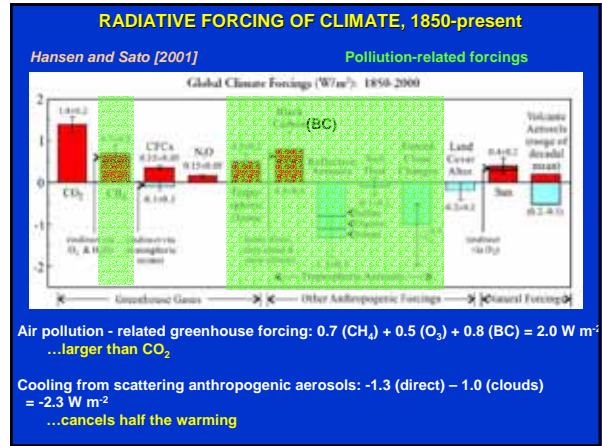
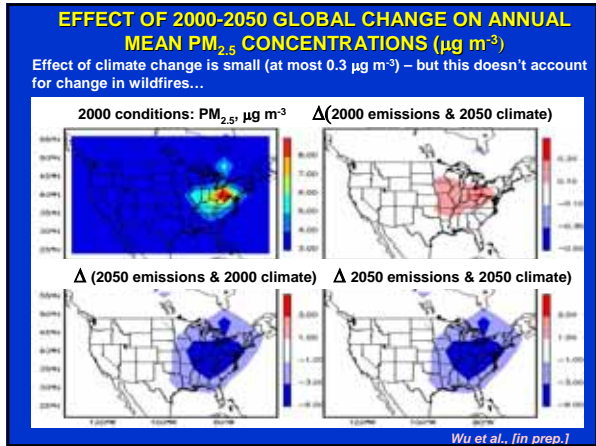
Bad (smog) → Troposphere

Tropospheric ozone precursors:

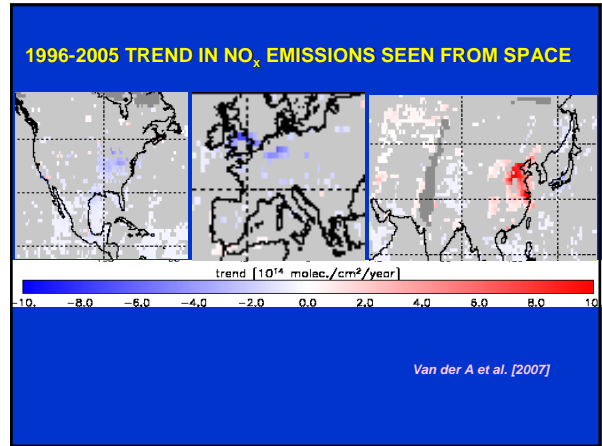
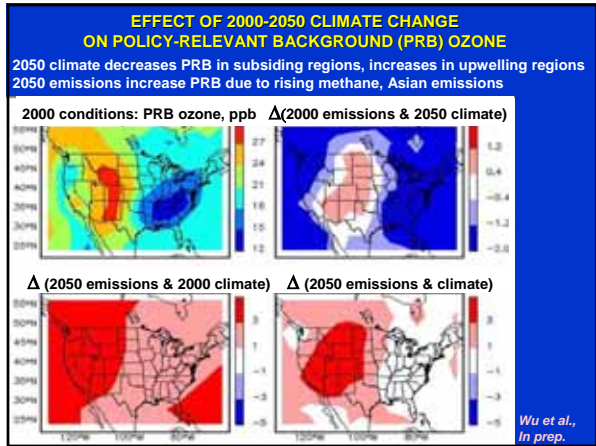
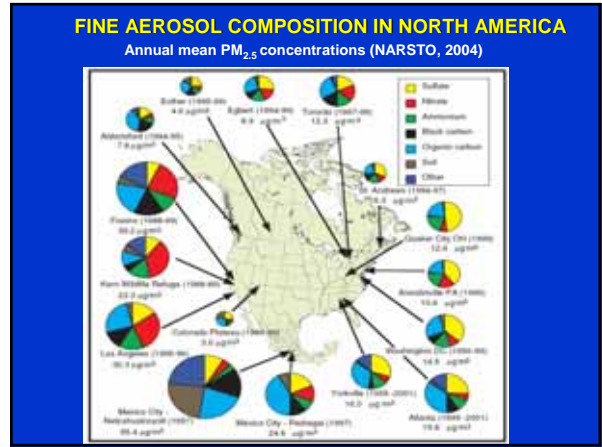
- Nitrogen oxide radicals; $\text{NO}_x = \text{NO} + \text{NO}_2$ ← *NO_x is usually the limiting precursor for ozone formation*
- Sources: combustion, soils, lightning
- Volatile organic compounds (VOCs)
- Methane
- Sources: wetlands, livestock, natural gas...
- Reactive VOCs
- Sources: vegetation, combustion







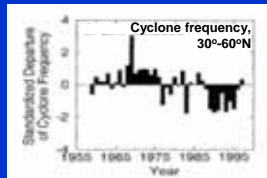
EXTRA SLIDES



EFFECT OF CLIMATE CHANGE ON REGIONAL STAGNATION

Mid-latitudes cyclones tracking across southern Canada are the principal agents for ventilating the northern United States

Frequency of these cyclones has decreased over past 50 years; trend is expected to continue

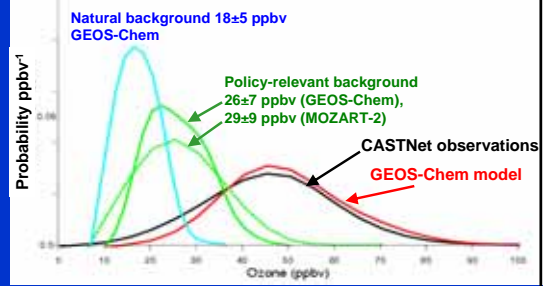


Model simulation for 2050 climate finds that pollution episodes double in duration to decreasing frequency of cyclones ventilating the eastern U.S.; this decrease is an expected consequence of greenhouse warming.

Mickley et al. [2004]

POLICY-RELEVANT BACKGROUND (PRB): ozone that would be present in U.S. surface air in absence of N. American anthropogenic emissions

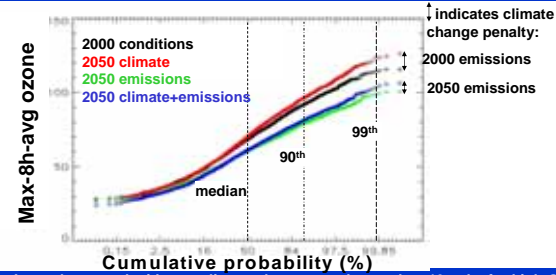
Ozone afternoon frequency distributions at U.S. CASTNet sites



Fiore et al. [JGR 2003]

CLIMATE CHANGE PENALTY FOR POLLUTION EPISODES

Simulated summer probability distribution of daily 8-h max ozone in Northeast



• In northeast and midwest, climate change penalty reaches 10 ppbv for high-O events; longer and more frequent stagnation episodes
 • climate change penalty means that we would need to reduce NOx emissions by 50% instead of 40% to achieve the same air quality goals in the northeast

Wu et al. [2007]