

Review of the Potential Health Impacts of Climate Change-Related Effects on Air Quality

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Outline

- Review of the impacts of poor air quality on human health
 - Air pollutants
 - Aeroallergens
 - Long-range transport of dust and other particles
- Projections of the potential health impacts of climate change-related effects on air quality

Climate Change Could Affect Air Quality

- Directly
 - Changes in chemical reaction rates
 - Boundary layer heights that affect vertical mixing of pollutants
 - Changes in synoptic air flow patterns
- Indirectly
 - Changes in biogenic emissions
 - Increased frequency and intensity of drought, leading to more dust and other fine particles

Ground-Level Ozone

- Primary constituent of urban smog
 - Secondary pollutant formed through photochemical reactions involving NO_x and VOCs in the presence of bright sunshine with high temperatures
- Exposure to elevated concentrations associated with
 - Increased hospital admissions for pneumonia, chronic obstructive pulmonary disease, asthma, allergic rhinitis, other respiratory diseases
 - Increased mortality
- Outdoor ozone concentrations, activity patterns, and housing characteristics are the primary determinants of ozone exposure

Trends in Ozone Concentrations

- Background concentrations have risen since pre-industrial times, and this trend is expected to continue over the next 50 years
- Future concentrations depend on future emissions and weather patterns
 - Emissions depend on assumptions of population growth, economic development, and energy use
 - Fraction attributable to climate change is the portion that is the consequence of climate change on local temperature & UV
 - Assuming no change in the concentration of precursor emissions, the frequency of future ozone episodes will depend on the occurrence of the requisite meteorological conditions

Projections of Attributable Premature Mortality

New York Metro Region <i>Knowlton et al. 2004</i>	Ozone-attributable deaths	Concentration / response / function model	GISS GCM linked to RCM; A2 population	By 2050s under A2 climate, 4.5% increase in ozone deaths
England and Wales <i>Anderson 2002</i>	Ozone exceedance days	Statistical model based on met factors	UKCIP scenarios 2000s, 2050s, 2080s	Large decreases in days with high particulates

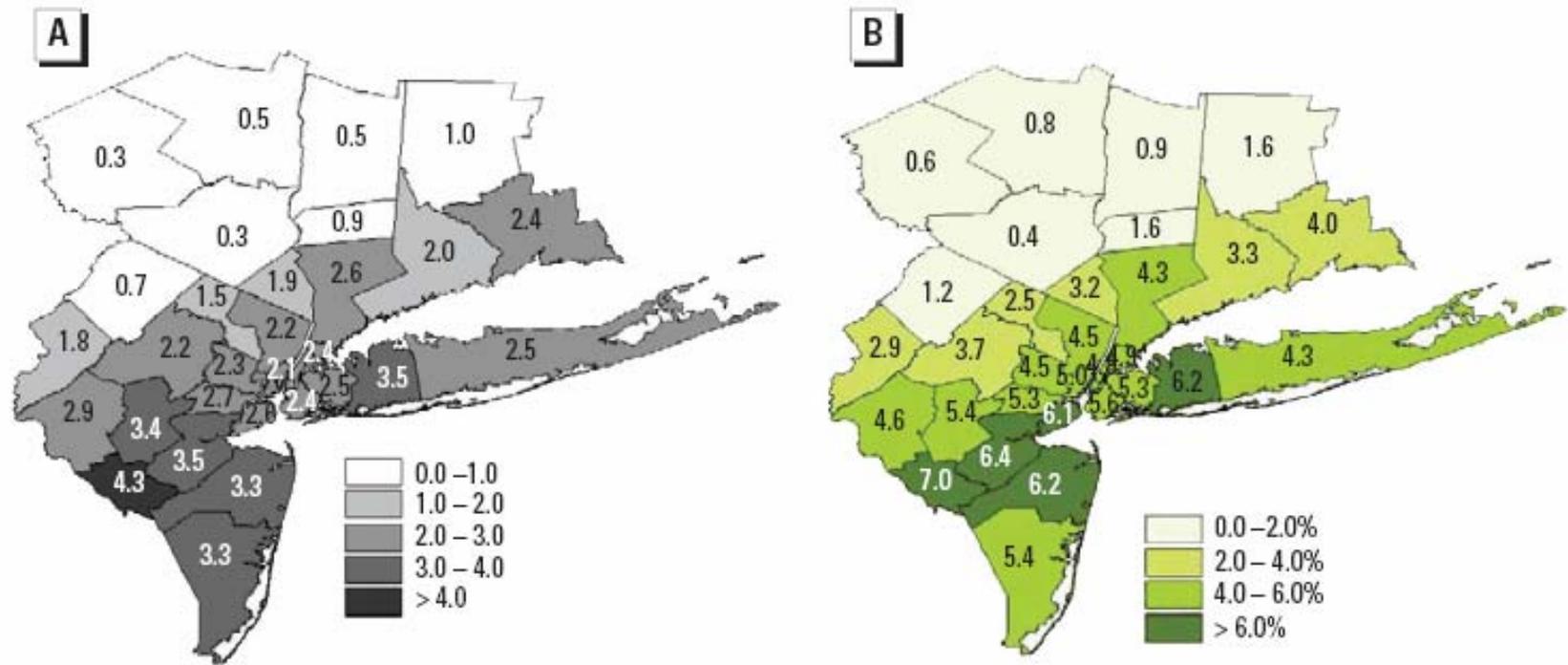


Figure 2. Estimated changes in O₃ and associated summertime mortality in the 2050s compared with those in the 1990s for M1, where climate change alone drives changes in air quality. (A) Changes in mean 1-hr daily maximum O₃ concentrations (ppb). (B) Percent changes in O₃-related mortality.

Other Air Pollutants

- Local conditions and emissions are of primary importance when determining human exposures
 - Transboundary transport also plays a significant role
- Some locations, because of their general climate and topographical setting, are predisposed to poor air quality
- Modeling results vary by region
 - US study projected an increase in the severity and duration of regional air pollution episodes in the Northeast and Midwest (Mickley et al. 2004)
 - UK study projected a large decrease in days with high particulate concentrations due to changes in meteorological conditions (UK Department of Health 2002)

Aeroallergens

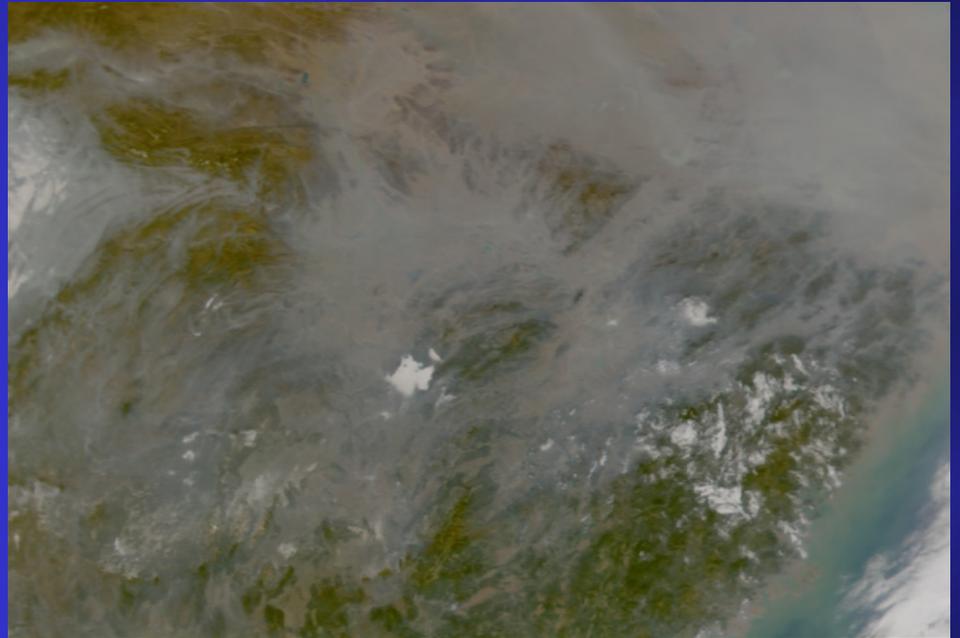
- Strong evidence that observed higher temperatures are associated with an earlier onset of spring in the Northern Hemisphere, with an earlier onset of pollen production, particularly for late-winter and spring flowering plants
- Trend is reversed at higher altitudes
- It is not known whether the allergenic component of pollen also is changing

Long Range Transport

- Under certain conditions, aerosols, carbon monoxide, ozone, desert dust, mold spores, and pesticides may be transported over large distances and over timescales of typically 4-6 days
- Dust can carry large concentrations of PM_{2.5-10}, trace minerals, fungal spores, and bacteria

China Haze 10 January 2003

- Windblown dust originating in desert regions of Africa, Mongolia, Central Asia, and China can affect air quality and population health over wide regions
- Mortality, particularly from cardiovascular and respiratory diseases, is increased on days following a dust storm



NASA

Climate Change vs. Urban Air Pollution

Millions of DALYs

Climate change

Urban Air Pollution

Africa Region

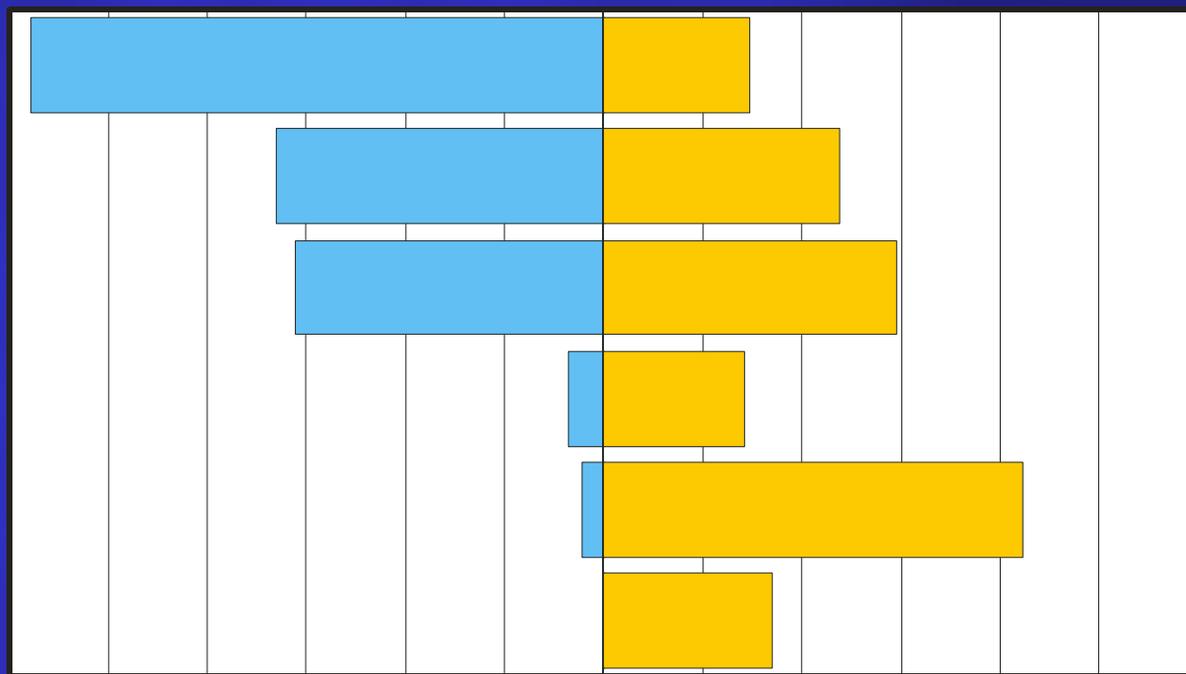
South-East Asia Region

Eastern Mediterranean Region

Latin America and Caribbean Region

Western Pacific Region

Developed Countries



3000 2500 2000 1500 1000 500 0 500 1000 1500 2000 2500 3000

Burden of disease by region: Climate change and urban air pollution. Disability Adjusted Life Year per million. World Health Report 2002.

Key Areas for Further Research: Air Pollutants

- Extensive, and growing, literature on the health impacts of air pollutants in developed countries
 - Fewer studies on the health impacts in developing countries, which experience higher concentrations of air pollutants
- Better understanding is needed of how climate change might affect air pollution concentrations
 - Cloud cover particularly important for ozone formation
- Additional modeling studies, incorporating relevant factors, is needed to assess whether climate change could add to future disease burdens
 - For both ozone and other air pollutants

Key Areas for Further Research

- Aeroallergens:
 - Need projections of the seasonal distribution of pollen under a changing climate
 - Need to understand whether the allergenic components of pollen will change with changing phenology
- Long-range transport
 - Very little research has been conducted on health impacts

Thank you