DISCUSSION: UNDERSTANDING COMPLEXITY IN PHYSICAL SYSTEMS

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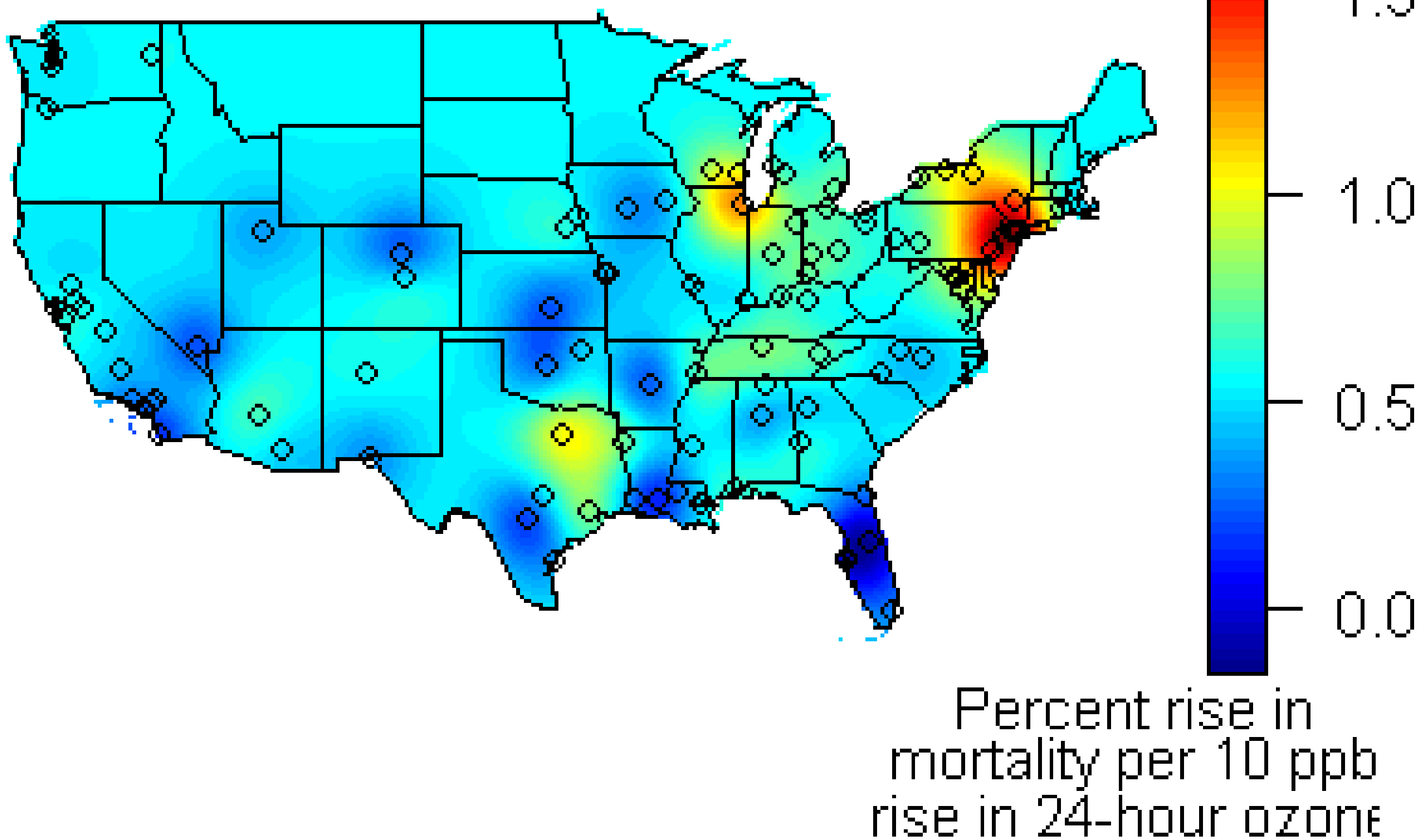
Bell, Dominici and others (2004, 2005, 2006, ...) have argued that there is a strong statistically significant effect between ground-level ozone and mortality.

In one widely cited result (*JAMA 2004*) they have argued that a 10 ppb rise in ozone results in an 0.52% increase in deaths, with a 95% PI from 0.27% to 0.77%.

This result arose from a Bayesian hierarchical analysis in which generalized linear models were first fitted to 95 cities, and then combined across cities.

However, we have found that the results are not homogeneous, but that there is a lot of spatial variability.

OZONE-MORTALITY COEFFICIENT
24-HR OZONE, REG MET MODEL



The result shows a strong concentration of the effect in a number of cities close to New York, in Chicago, and parts of Texas (especially Dallas/Houston). On the other hand there is virtually no effect in traditional ozone-heavy cities such as Atlanta and Los Angeles.

This example raises a number of questions that suggest the need not only for further epidemiological analysis, but also for physical and socioeconomic modeling.

- What is the role of measurement error? It is known that ambient to personal correlations of ozone are very poor.
- Could ozone be acting as a proxy for some other air pollutant? It has been suggested that it could be a proxy for particulate matter.
- Socio-economic effects, e.g. the ozone coefficient by city is highly correlated with the proportion of African Americans in each city
- Could ozone be a proxy for meteorology? (Chicago heatwave effect)
- What could be the role of global warming in future projections of ozone and of ozone-related mortality?
- What other direct or indirect effects might lead to a rise in mortality associated with climate change?

A role for many different kinds of models

- *Statistical* — joint spatial-temporal models for air pollution and for health outcomes
- *Air Quality Modeling* — to understand the formation and spread of ozone in the atmosphere, its dependence on meteorology, and the co-modeling of ozone and particulate matter
- *Exposure Modeling* — the relationship between personal and ambient exposure to air pollution
- *Climate Modeling* — to project future changes in meteorology as they might affect exposure to ozone (and directly, how they could lead to rises in weather-related deaths)
- *Socio-economic* — understanding why some socio-economic groups appear to be more vulnerable than others; also, understanding society's response to extreme air pollution and weather events (California wildfires; Katrina; European heat-wave of 2003)

The bottom line

A comprehensive treatment of this problem requires many different types of expertise. The problems are "complex" in the sense that they require interaction of many different models at a wide range of spatial and temporal scales.