DISCUSSION OF TALKS BY KIROS BERHANE, ZHULIN HE AND TONY COX

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MY "GRAND CHALLENGE" QUESTION

Is it possible to establish a causal relationship between air pollution and human health outcomes?

EARLY HISTORY

Famous catastrophic air pollution episodes such as Meuse Valley in Belgium (1930s), Donoro, PA (1948) and London (various times in the 1950s but especially December 1952)
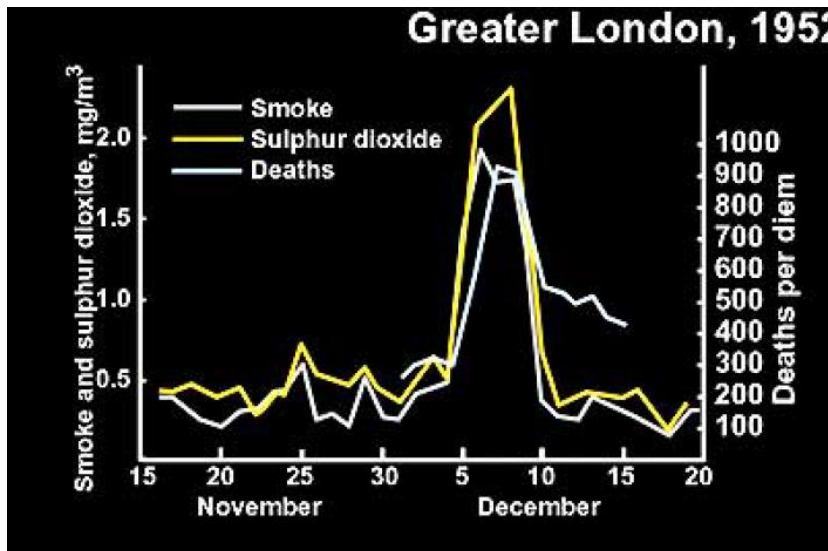
1990s-2000s

Two major approaches:

- *Time Series Methods* (HEI's PEEP study; NMMAPS for multi-city analyses; many individual-city analyses)
  - Focus on short-term effects (<7 days); regress deaths or hospital admissions on air pollution controlling for meteorology, seasonality and long-term trends
  - Combine across cities to increase statistical power
  - Vulnerable to unobserved covariates
 - Results are often inconsistent across large regions

1990s-2000s

Two major approaches:

- *Cohort Methods*, e.g. the Six Cities and American Cancer Society Studies (Dockery et al. 1993, Pope et al. 1995, HEI Reanalysis 2000)
  - Used to assess long-term effects
  - Compute a standardized mortality rate for each city
  - Regress city-wide SMR on a long-term air pollution measure for each city
  - In its simple form, the method ignores possible city-wide confounding variables

EXAMPLE

- Bell et al. (2004) analyzed ozone-mortality effect in a time series analysis of 98 US cities, concluding a statistically significant effect when results were aggregated across all cities

- However Smith et al. (2009) demonstrated considerable regional variation in the response

8H: summer
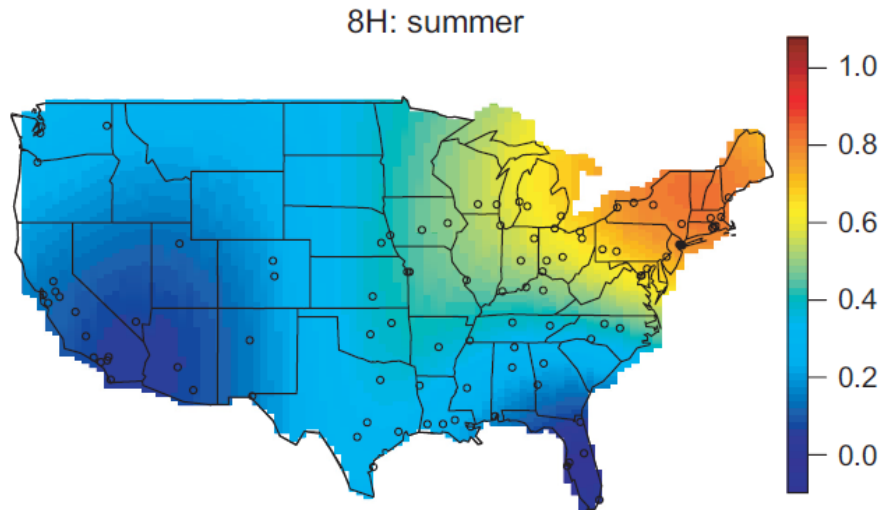
- A more recent paper (Young, Lopiano and Smith, 2017) analyzed California daily mortality data from 2000-2012, finding no association in a time series analysis with either PM2.5 or ozone
- It might seem surprising that there is no effect at all, but in fact the results for ozone are consistent with the NMMAPS results (Smith et al., 2009) when the latter are restricted to California

SO HOW DO PEOPLE GO ABOUT DEMONSTRATING CAUSALITY?

- One method is *intervention analysis* – look for response to an external intervention

- Earliest example is paper on Utah Valley (Pope et al., 1992) that analyzed effect of a steel mill being closed for 13 months in 1986-7

- Many more recent examples of interventions, e.g. Irish coal ban, London congestion charge, traffic measures during Beijing Olympics

- But even when there is an effect associated with the intervention, it can be hard to separate from long-term trends

UP TO THE PRESENT DAY …

- HEI Accountability Program – recent set of studies led by Zigler, Gilliland, Russell, Meng (first two published, others presumably forthcoming)

- The report by Zigler and co-authors comes closest to being a true implementation of causal inference, but they were only partially successful

- I applaud the efforts of the authors of all three talks in this session for their development of new methodological approaches to these problems

- Much remains to be done…

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Richard L. Smith
Director

The Statistical and Applied Mathematical Sciences Institute

WHAT IS SAMSI?

- One of 8 NSF funded Math institutes
- A NSF grant awarded to Duke, NCState, and UNC

WHAT IS SAMSI?

Established in 2002

Current NSF funding period: 2012-2017

Renewal expected for 2017-2020

SAMSI'S MISSION

- Forge a synthesis of the statistical sciences and the applied mathematical sciences

- with disciplinary science

- to confront the very hardest and most important data- and model-driven scientific challenges

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RESEARCH PROGRAMS

Year-long collection of focused research activities

- Working groups   (remote access)
- Research workshops
- Summer schools
- Participants

  Visitors (few days – a year)

  SAMSI Postdocs & Graduate Fellows

  National and international participants

Future SAMSI Programs 2017 - 2018

Quasi-Monte Carlo & High Dimensional Sampling Methods for Applied Mathematics
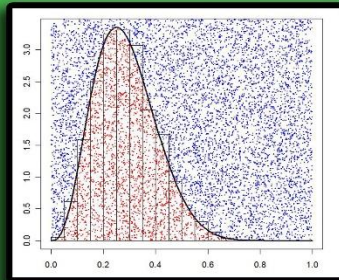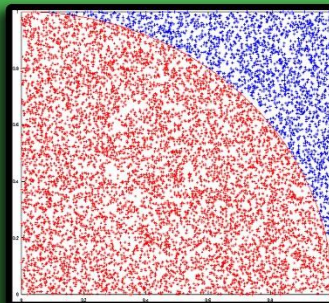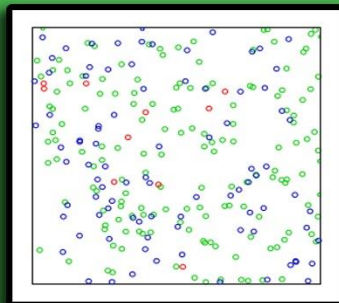
Mathematical and Statistical Methods for Climate & Earth Systems

FUTURE RESEARCH PROGRAMS

2018-19:

- Model Uncertainty: Mathematical & Statistical (confirmed)

- Precision Medicine (confirmed)

2019-20:

- Causal Inference ???

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POSSIBLE CAUSAL INFERENCE PROGRAM FOR 2019-2020

- Potential Organizers (Local)
- Steve Cole
- Michael Hudgens
- Eric Laber
- Fan Li
- Cynthia Rudin
- Alex Volfovsky

- Potential Organizers (Non-Local)
- Jamie Robins
- Ilya Shpitser
- Dylan Small
- Eric Tchetgen
- Jose Zubizarreta

NEXT STEPS

- National Advisory Committee: next meeting in November 2017

- Schedule of Workshops

- Tentative Schedule of Working Groups

- Tentative List of Visitors

- If this goes ahead we will have visitor slots, postdoc appointments, other opportunities to participate

- Feel free to contact me (rls @ samsi.info) with your comments and questions

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THANK YOU!

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