Influence of Model Resolution on Uncertainty Associated with Human Health, Part II

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Presentation Outline

- Study Motivation
- Study Approach
  - Previous Work: Resolution Study I
  - Resolution Study II
  - Model Parameters/Domain
- Main Findings
- Discussion
- Questions

Human Health Estimates

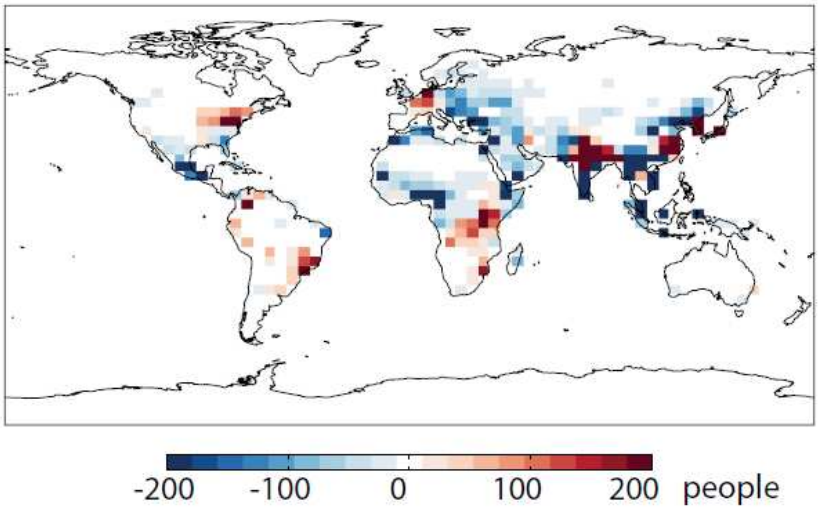
How finely resolved do our models have to be to get meaningful estimates of human health response (relative to finer scale) given the great deal of uncertainty associated with the human health response?

Given that our ultimate goal with air quality modeling is to protect human and environmental health

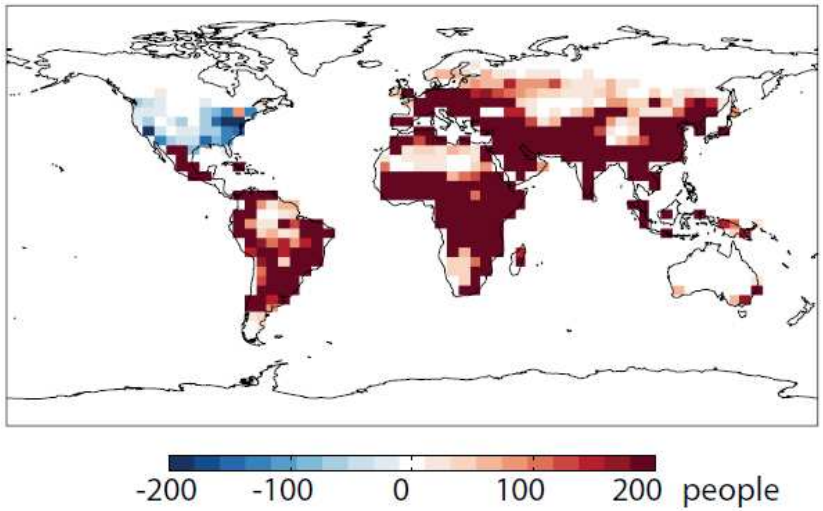
There are data available that define links between pollution concentrations in the atmosphere and human health response

Example: Coarse resolution global scale modeling is commonly used to estimate health impacts from global climate or policy changes (Figures from Wu et al., 2008)

Δ Mortality with 2050 Climate



Δ Mortality with 2050 Emissions



Need for Regional Scale Uncertainty Analyses

How finely resolved do our models have to be to get meaningful estimates of human health response (relative to finer scale) given the great deal of uncertainty associated with the human health response?

Made infeasible by resolution requirements

- Coarse models often miss pollutant minimum and maximum concentrations. This is important for policy analyses.
- Regulatory work is required to be done at 12 km or finer resolution

Versus the climate community who typically work with ensembles in order to capture uncertainty

- Therefore, it is difficult to apply results from global scale analyses to regional scale modeling

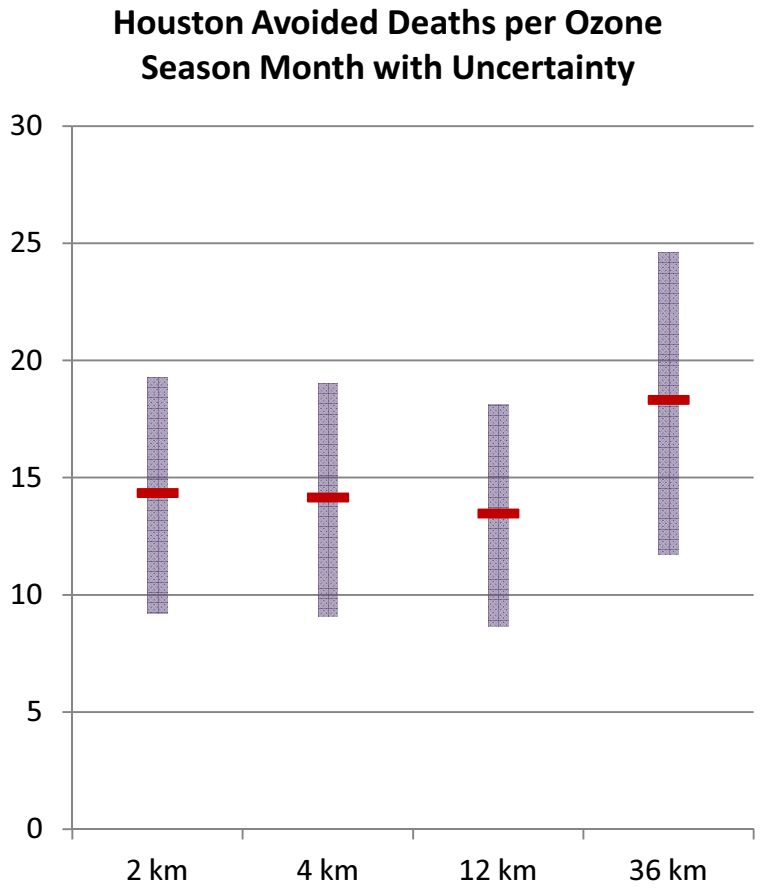
Study Approach

In order to evaluate the impact of Model Resolution on the Uncertainty Associated with Human Health:

1. Conduct air quality modeling with same inputs at multiple resolutions
2. Calculate changes in population-weighted concentrations of ozone and fine Particulate Matter ($PM_{2.5}$)
3. Estimate avoided mortality with 95% confidence interval

Model Resolution Study Part I

- Finding: 36 km Resolution has the potential to over-estimate human health benefits
- Proof of Concept: However, this study only looked at one location, Houston, and one pollutant, Ozone, therefore limited result applicability



Thompson, T.M., N.E. Selin: Influence of air quality model resolution on uncertainty associated with health impacts, ACPD, 12, 14525–14549, 2012.
*Forthcoming in ACP

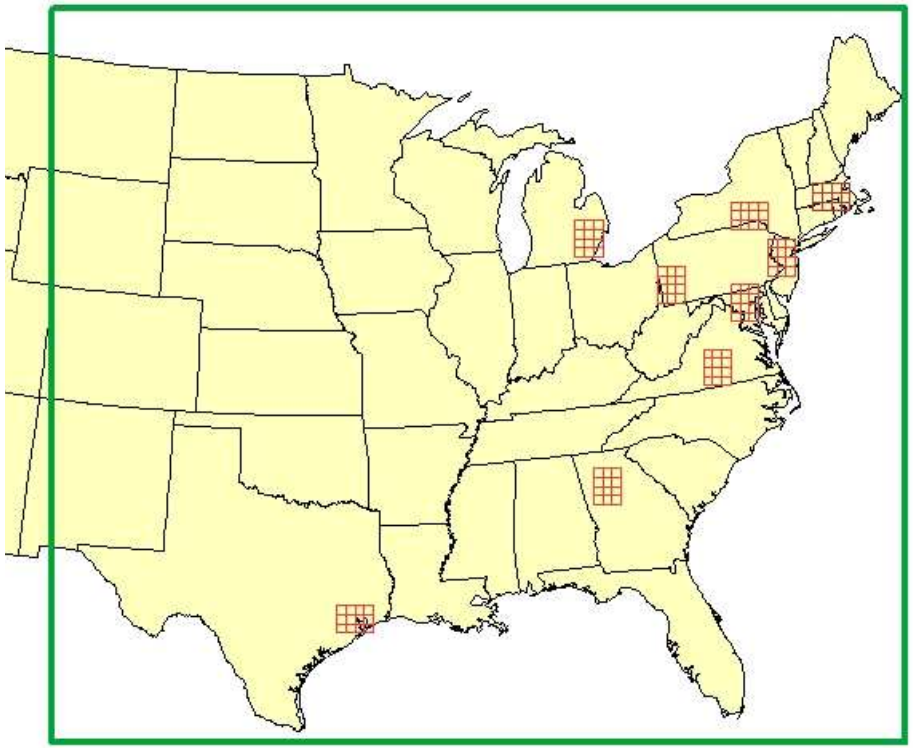
Model Resolution Study part II

1. Expand analysis to include $PM_{2.5}$
2. Model nine regions of the US
3. Model a full year
4. Utilize BenMAP

Model Parameters:

- CAMx version 5.3
- SMOKE version 2.7
- Episode Developed by US EPA for evaluation of CSAPR
  - 36 km, 12 km, and 4 km Resolution
  - 2005 Base Case Emissions
  - 2014 Control Case Emissions
  - MM5 developed meteorological inputs representing conditions as they occurred during the full year 2005 (4 km met data is interpolated from 12 km resolution)

Domains Selected for Variability



4 km Regions
Varied Meteorological and Emissions Characteristics:

Coastal/Inland
Rural/Urban
Attainment/Non-Attainment

1. Houston
2. Detroit
3. Atlanta
4. Washington DC
5. New York City
6. Boston
7. Western Pennsylvania
8. Virginia
9. New York

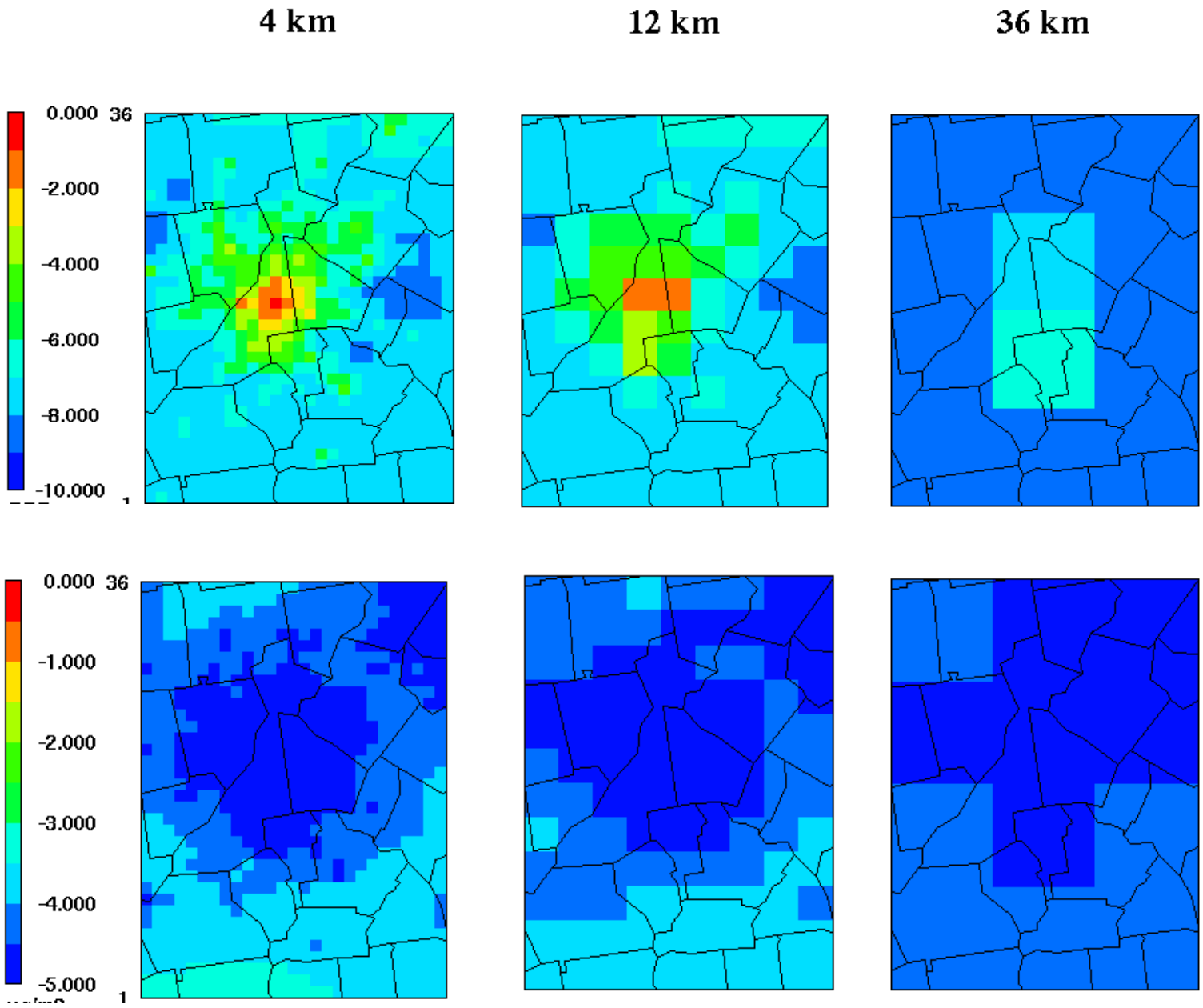
Main Findings

- With respect to Mortality Estimations:
  - Ozone is more sensitive to resolution than $PM_{2.5}$
  - Urban areas are more sensitive to resolution than rural areas
  - Results are more sensitive to concentration response function selection than model resolution

Resolution Impacts: Ozone vs $PM_{2.5}$

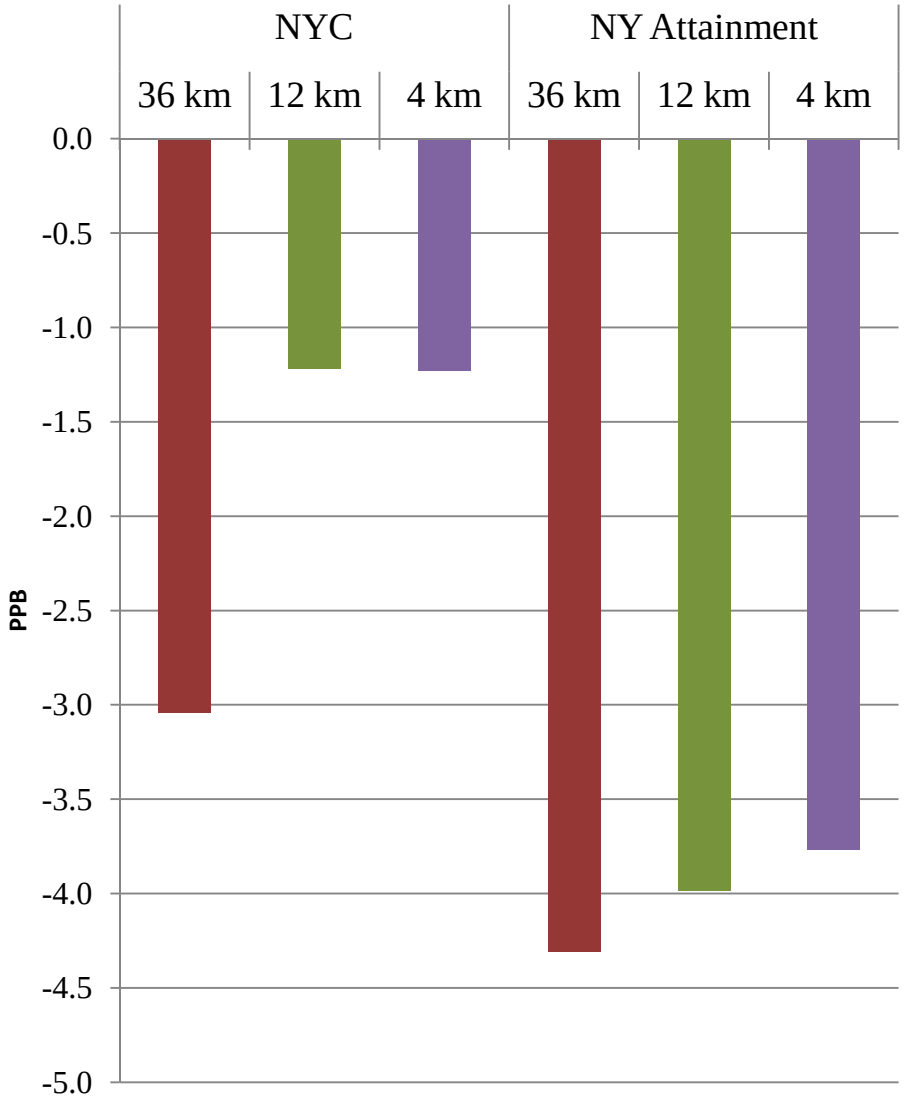
Change in Seasonal Average, Daily Max 8 Hour Ozone (ppb)

Change in Annual Average $PM_{2.5}$ (ug/m^3)

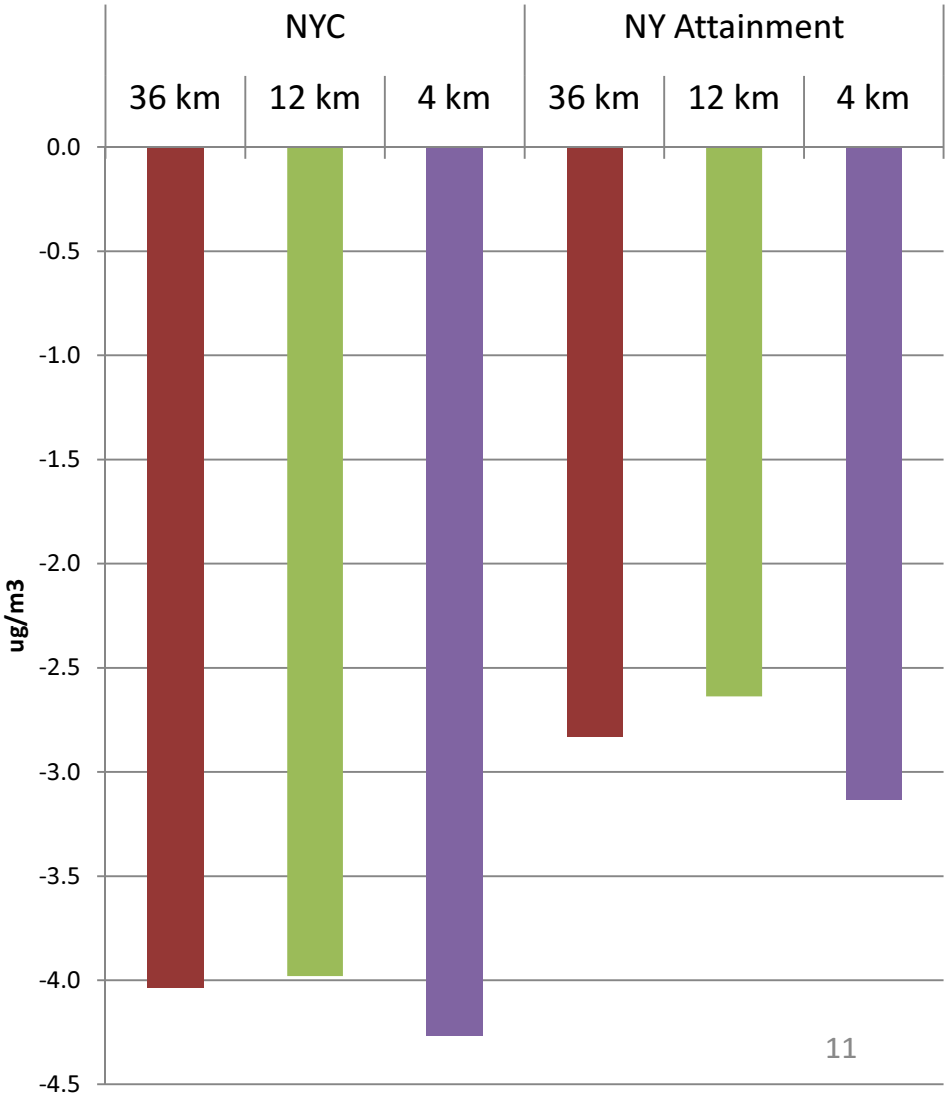


Urban vs Rural

Seasonal Average Change: Population Weighted Daily Max 8-hour Ozone



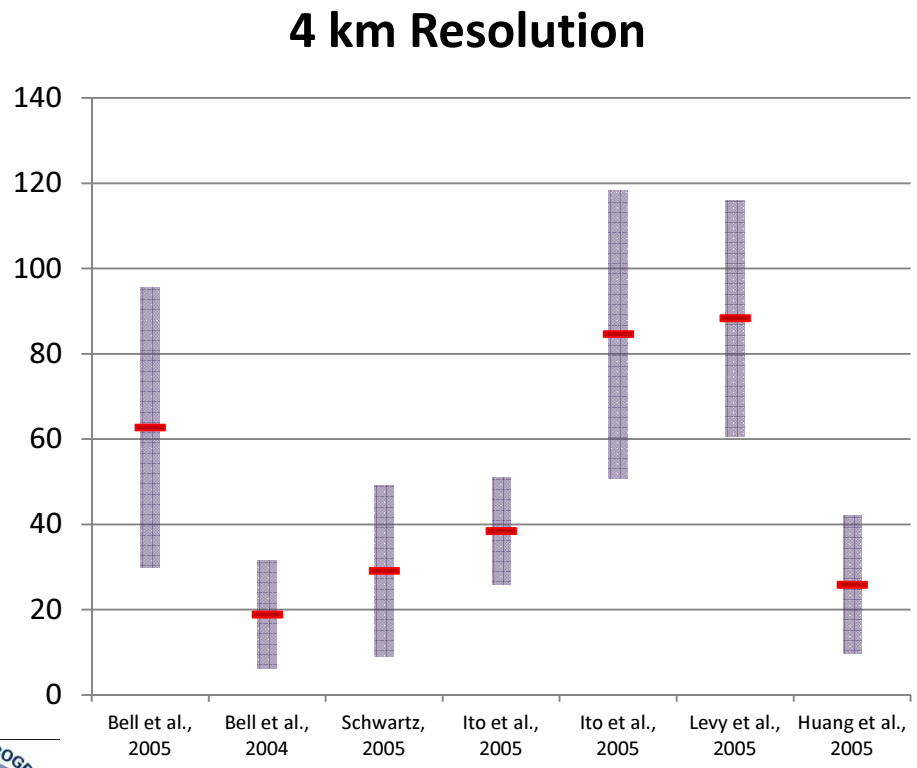
Annual Average Change: Population Weighted 24-hour $PM_{2.5}$

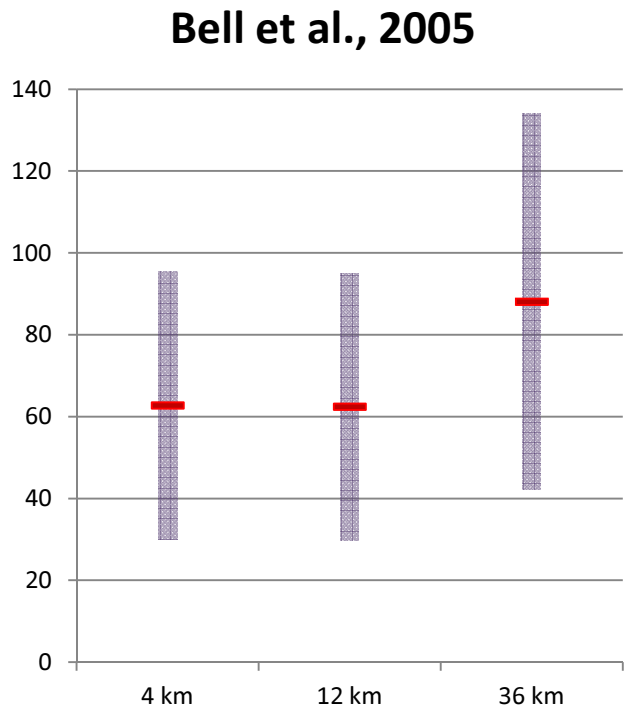


Health Function vs Model Resolution

Ozone season avoided mortalities in Atlanta

- Single resolution, multiple health response functions (left)
- Single health response, multiple resolutions (right)





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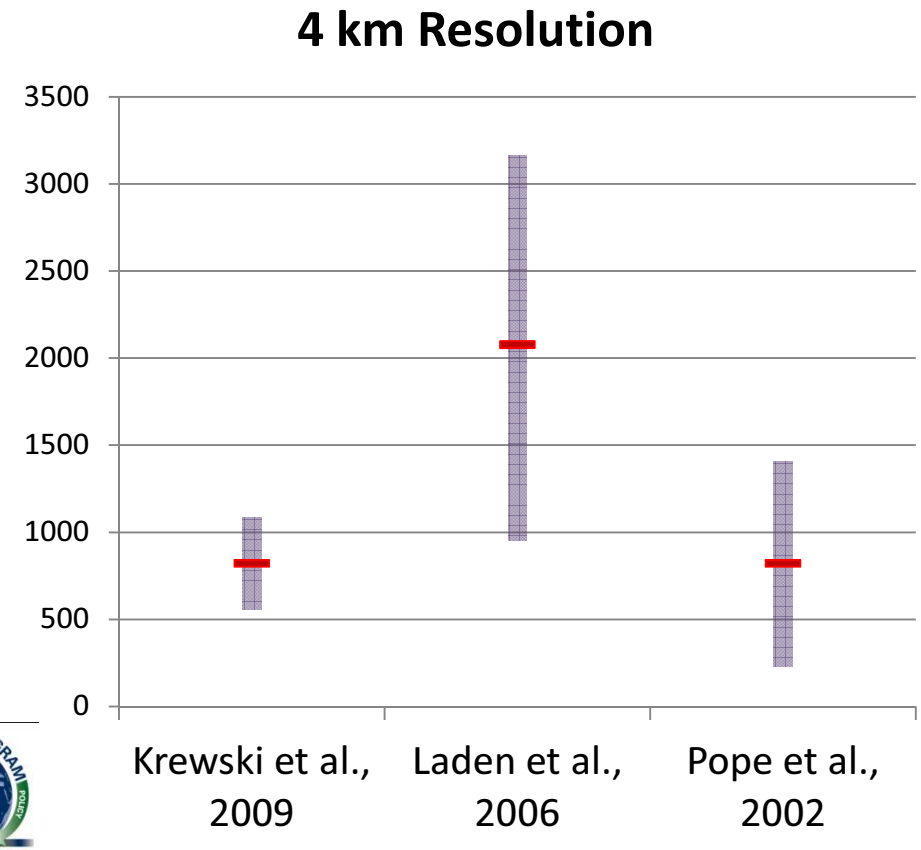
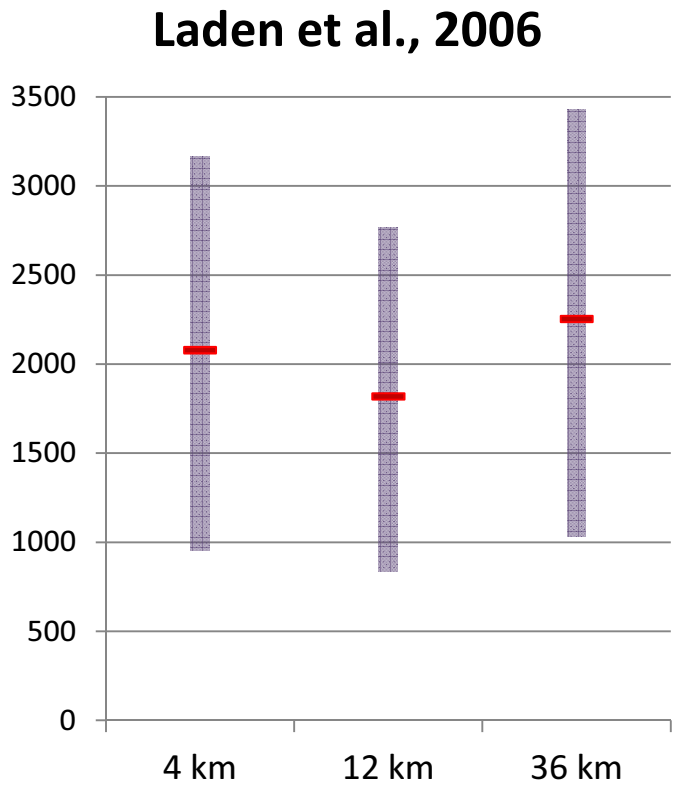
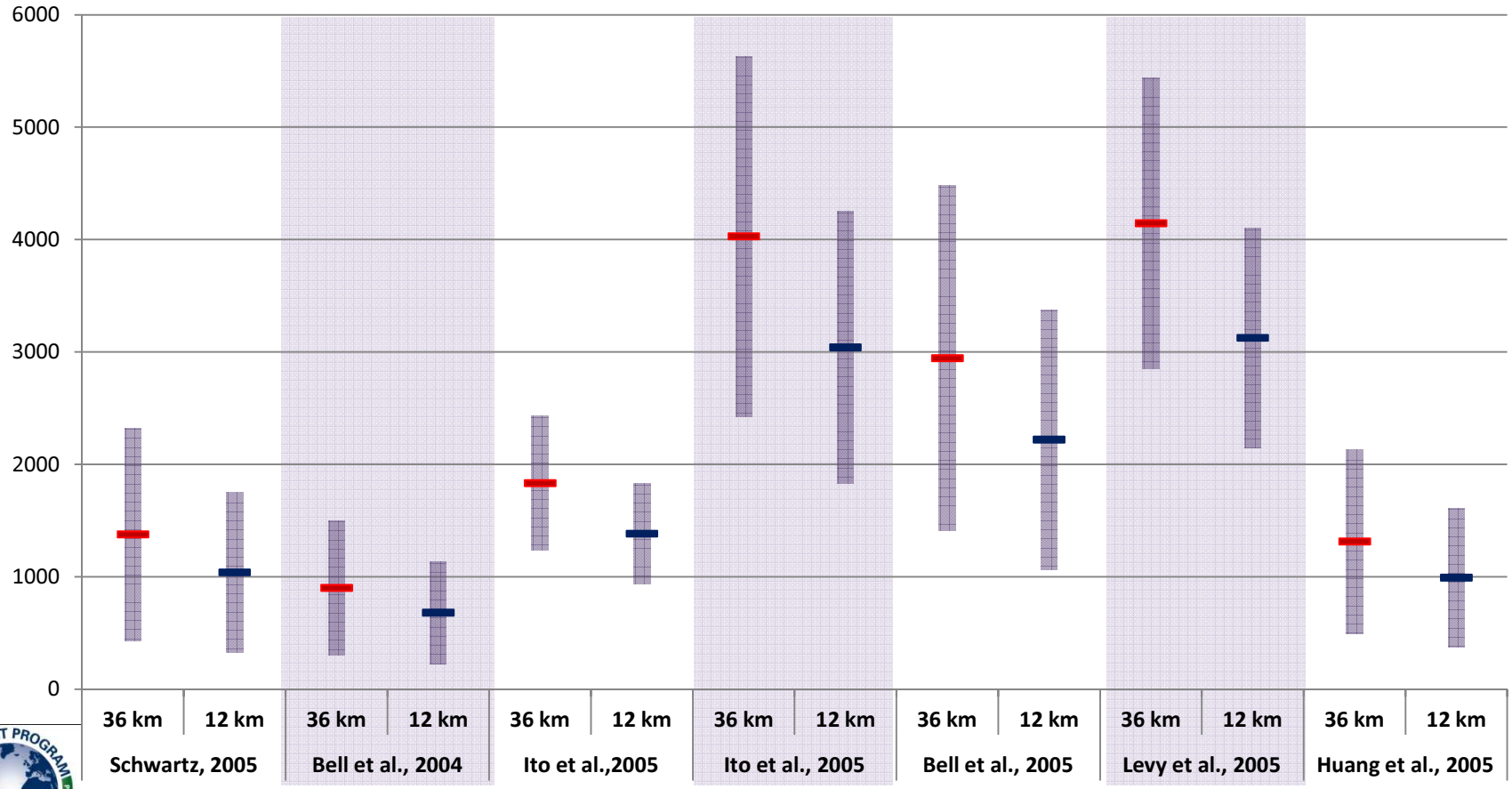




Total Ozone Mortalities Eastern US

Ozone season avoided mortalities in the Eastern US calculated at 36 km (red) and 12 km (blue)



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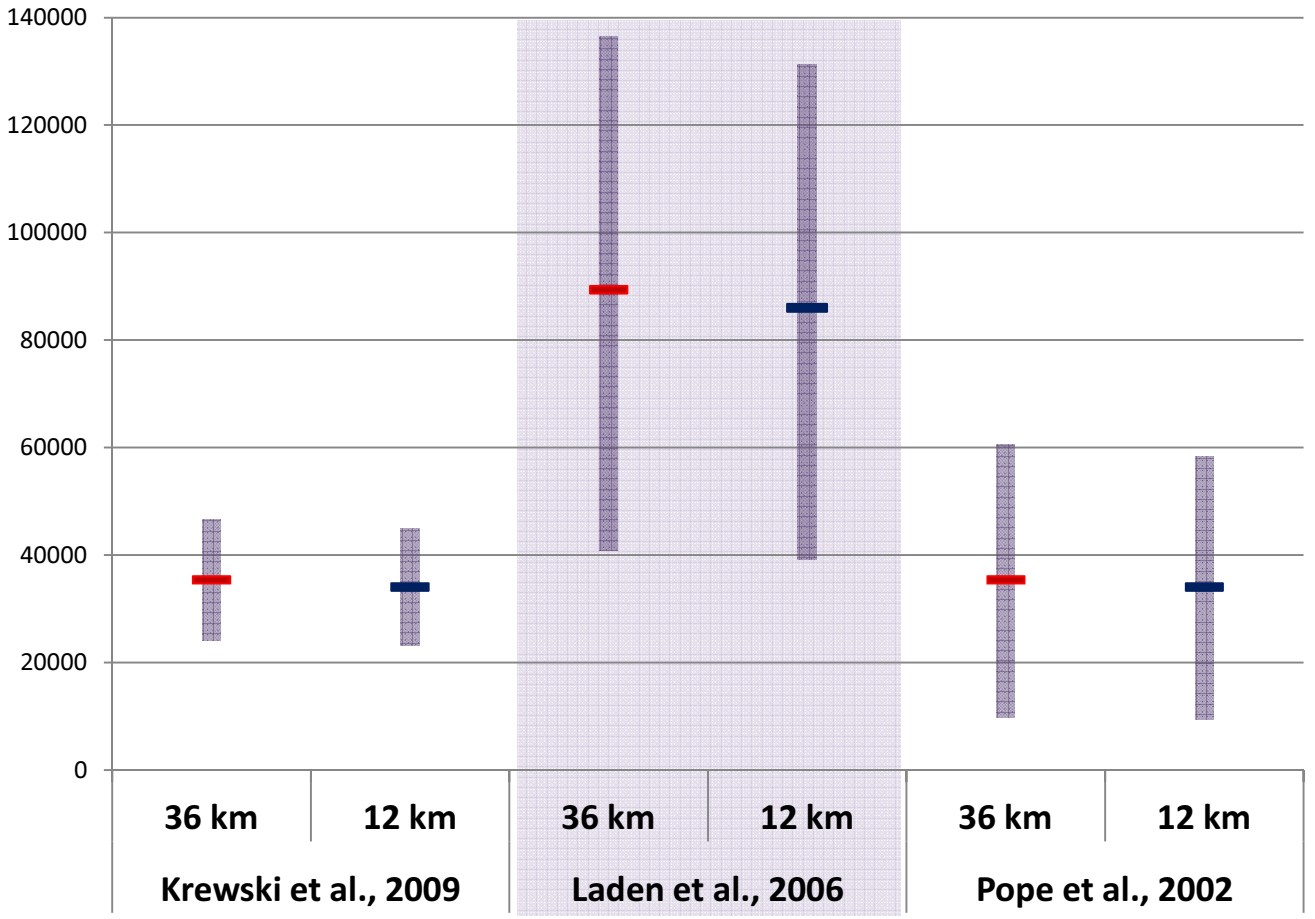

Main Findings Discussion

Mortality Estimations:

- Ozone is more sensitive to resolution than $PM_{2.5}$
  - Likely due to the larger health impacts associated with $PM_{2.5}$ (therefore larger confidence interval) as well as the mix of primary and secondary species
- Urban areas are more sensitive to resolution than rural areas
  - Population and emissions distributions are more homogenous
- Results are more sensitive to concentration response function selection than model resolution

Results

Given the uncertainty ranges provided by *most* concentration response functions, modeling at scales finer than 36 km does not improve the estimations of human mortality due to changes in air quality.

Acknowledgements

The research described has been supported by the U.S. Environmental Protection Agency's STAR program through grant R834279 and by the MIT Joint Program on the Science and Policy of Global Change. It has not been subjected to any EPA review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

Thank you!!!
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Questions??