

Uncertainties in estimating health effects of $PM_{2.5}$ exposure

Bonne Ford, CSU
Colette Heald, MIT

7th International GEOS-Chem User's Meeting
4-7 May 2015

Colorado
State
University



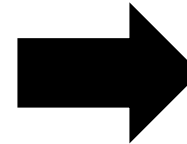
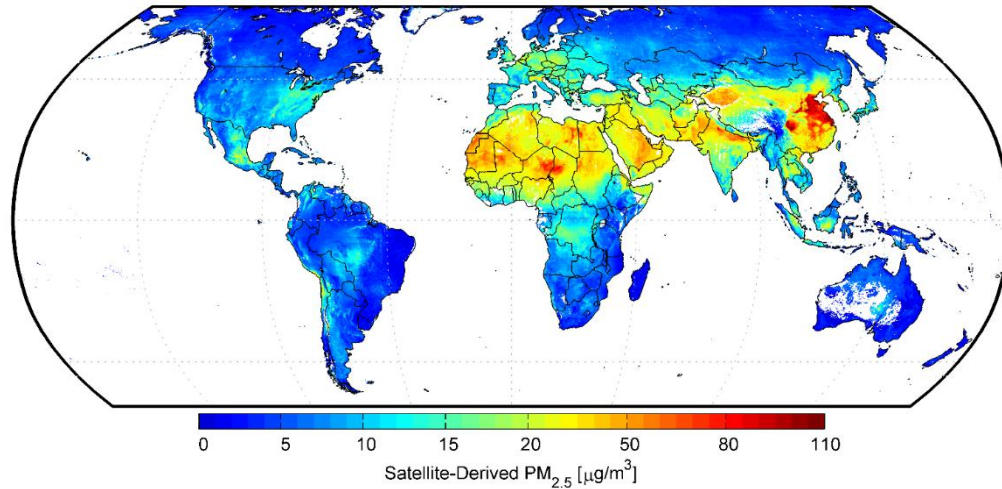
Motivation

Exposure to particulate matter ($PM_{2.5}$) has negative impacts on human health

Motivation

Exposure to particulate matter ($PM_{2.5}$) has negative impacts on human health

“Satellite-based” $PM_{2.5}$



Exposure and Health Effects:

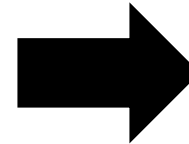
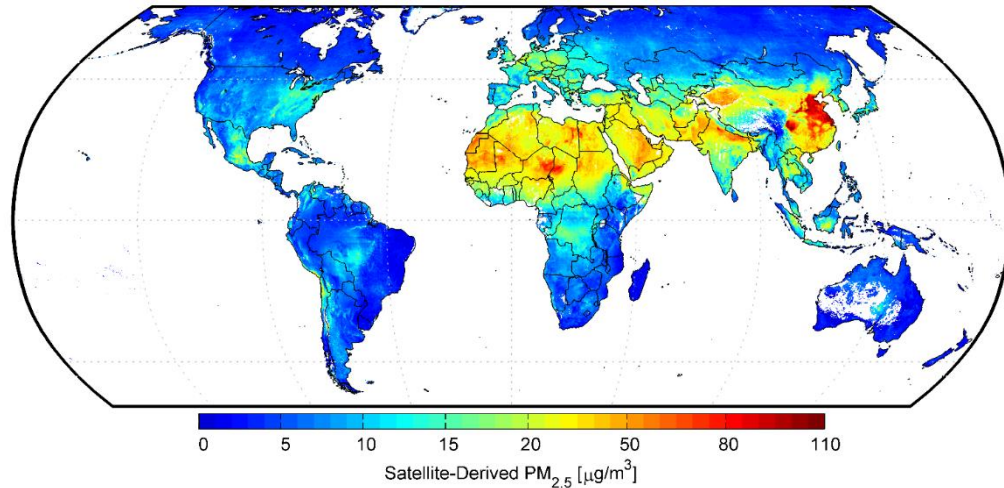
- Burden of disease (Evans *et al.*, 2013)
- Global childhood asthma (Anderson *et al.*, 2012)
- Lung cancer in Canada (Hystad *et al.*, 2012)
- etc.

(van Donkelaar *et al.*, 2010)

Motivation

Exposure to particulate matter ($PM_{2.5}$) has negative impacts on human health

“Satellite-based” $PM_{2.5}$



Exposure and Health Effects:

- Burden of disease (Evans et al., 2013)
- Global childhood asthma (Anderson et al., 2012)
- Lung cancer in Canada (Hystad et al., 2012)
- etc.

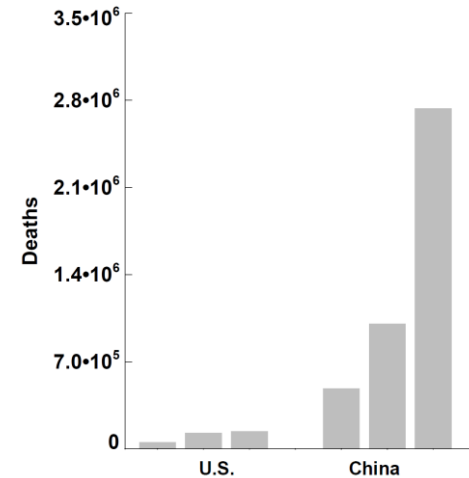
(van Donkelaar et al., 2010)

Questions:

1. How much does potential uncertainty in the model impact these results?
2. How does this model uncertainty compare to other sources of uncertainty?

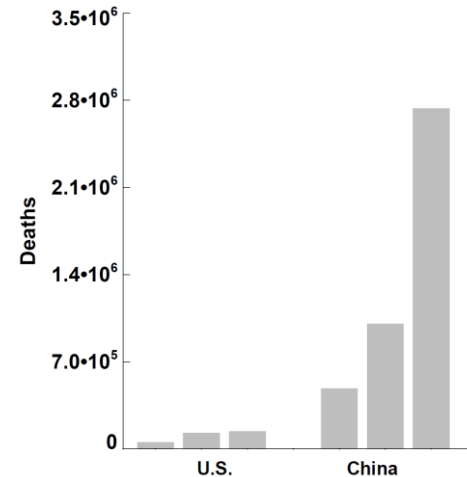
Factors that influence health burden estimates

- $PM_{2.5}$ Concentration
- Risk estimates from epidemiology studies
- Population data



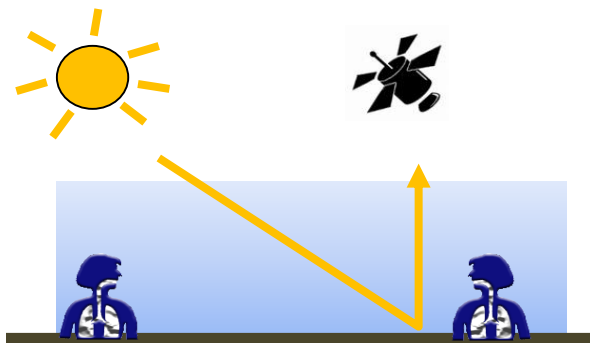
Factors that influence health burden estimates

- $PM_{2.5}$ Concentration
- Risk estimates from epidemiology studies
- Population data



Factors that influence satellite-based $PM_{2.5}$ estimates

$$PM_{2.5} = \Omega \times AOD_{satellite} \text{ where } \Omega = \frac{\text{Model } PM_{2.5}}{\text{Model AOD}}$$

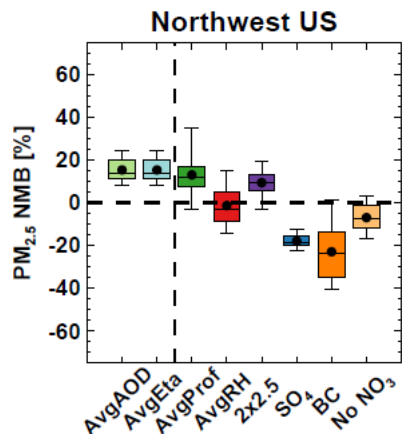


Function of:

- vertical distribution
- aerosol types
- optical properties
- meteorology

Potential Model Uncertainty

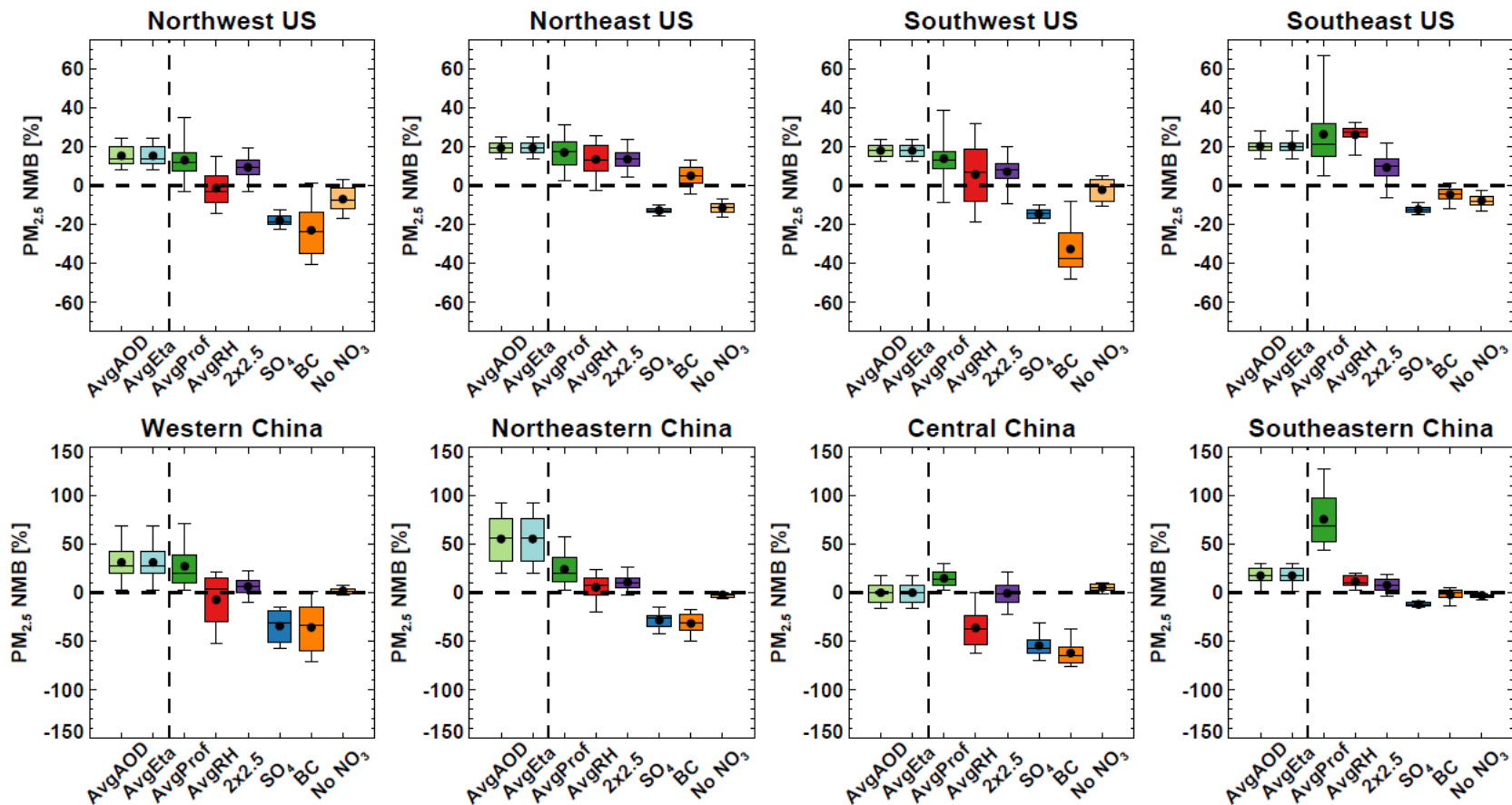
Model-to-Model Comparison



- Variability in AOD and η
- Impact of vertical profile:
 - Seasonally-representative Profile
 - Seasonally-representative Relative Humidity Profile
 - No Nitrate
- Optical Properties
 - Sulfate vs. Hydrophobic Black Carbon
- Model Resolution

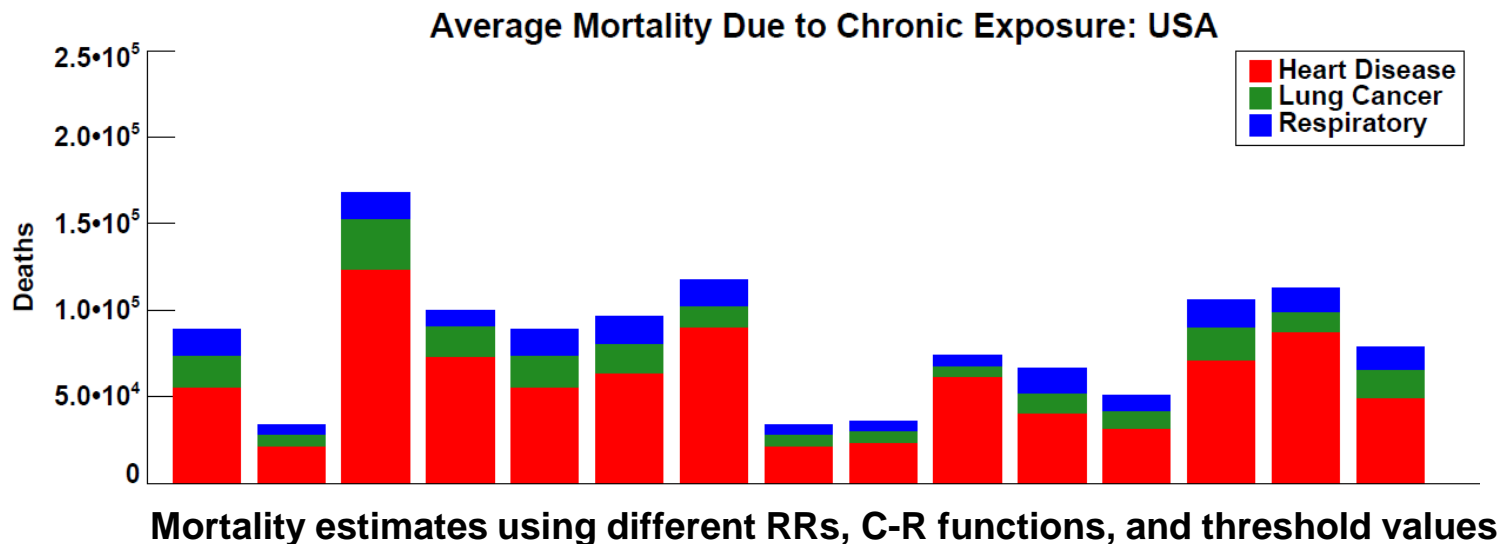
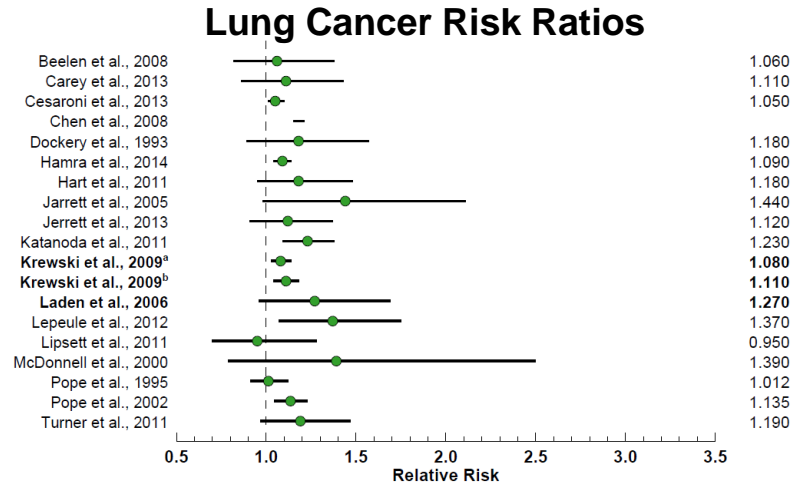
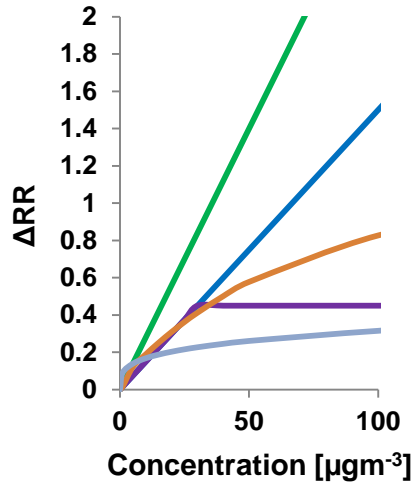
Potential Model Uncertainty

Model-to-Model Comparison

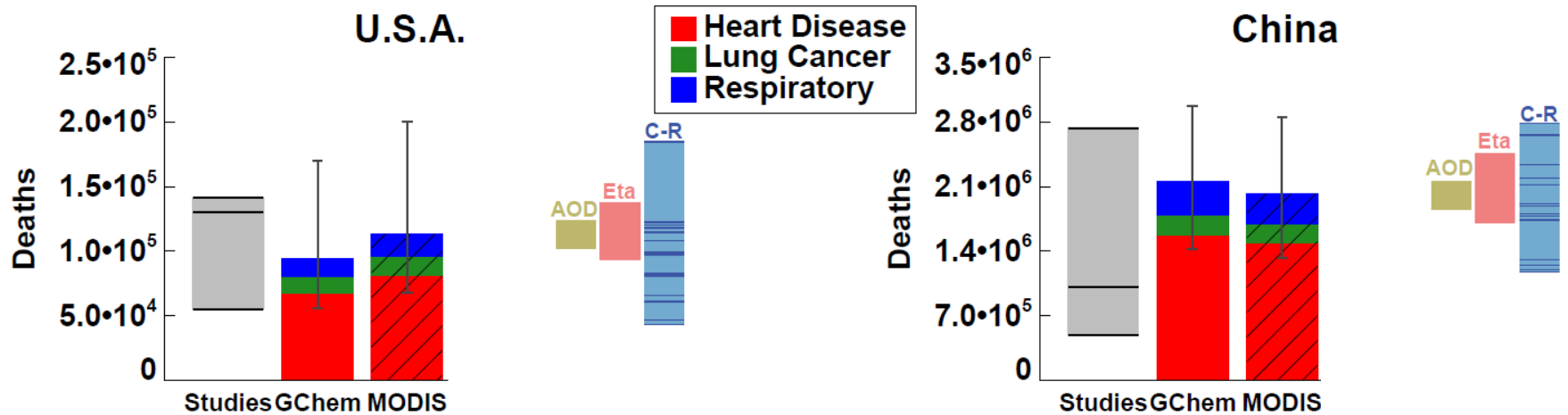


*Substantial regional differences
Important to simulate variability and longer term means*

Concentration-Response Function and Risk Ratio Uncertainty



Uncertainty Comparison



- **4%** of total deaths in the U.S., **22%** in China attributable to PM_{2.5} exposure
- Difference between standard model and satellite-based estimates falls within range of potential model η uncertainty (decreases with less reliance on the model)
- RR and C-R function leads to largest source of uncertainty in burden estimates
- *Uncertainty decrease as product more widely used*