Asthma and Particulate Air Pollution: A Spatial Analysis

Tara Negron
UPR, Rio Piedras
ISIB - University of Iowa
Department of Biostatistics

Toni Salvatore
DePaul University
ISIB - University of Iowa
Department of Biostatistics

Emily Simmons
Willamette University
ISIB - University of Iowa
Department of Biostatistics

Dr. Kate Cowles, Associate Professor
Department of Statistics
University of Iowa

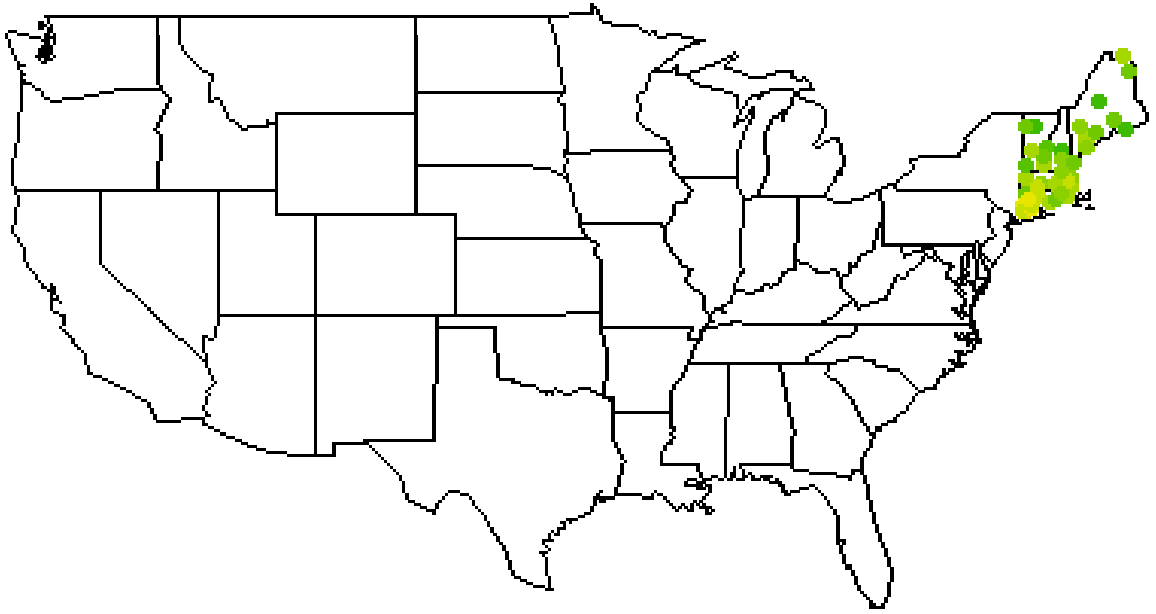
Background Information

- Particulate Matter
  - Mixture of extremely small particles and liquid droplets.
  - Different sizes pose different risks.
- PM 2.5: Why do we care?
  - Emitted from forest fires; also form when gases emitted from power plants, industries and cars react in the air.
  - Health risks
    - Linked to asthma and other respiratory problems.

- Asthma
  - Disease that affects the lungs.
  - Asthma causes repeated episodes of wheezing, breathlessness, chest tightness, and nighttime or early morning coughing.
  - Triggers differ from person to person and consist of house dust mites, tobacco smoke, outdoor air pollution, pets, mold, and other illnesses.

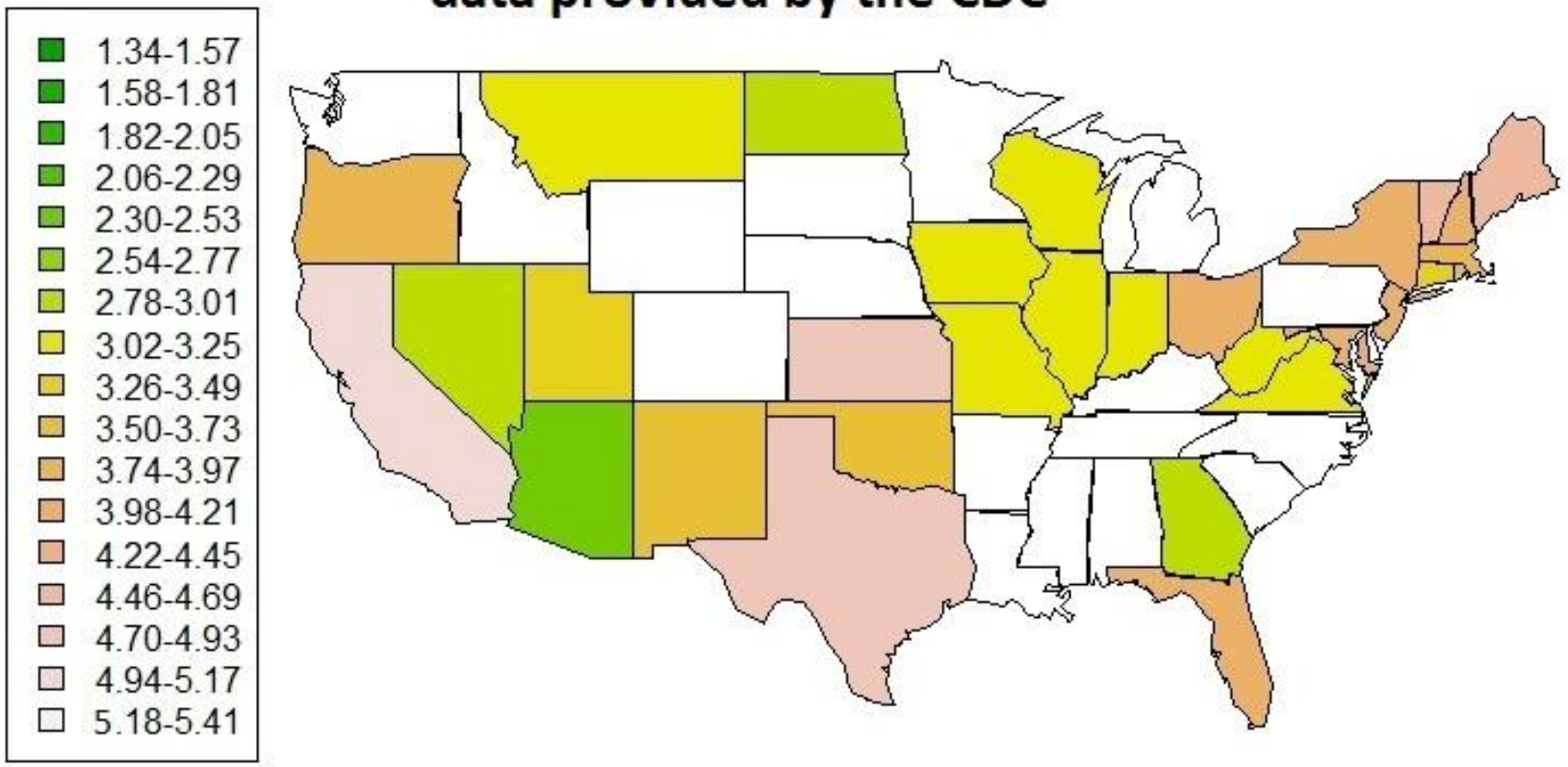
Data

- PM 2.5
  - Monitors at specific sites.
  - Point-source data.
  - Mean annual values for PM 2.5 at these locations.
  - Obtained from Environmental Protection Agency (EPA) website; http://www.epa.gov/air/data/index.html



- Asthma
  - How many adults who have been diagnosed with asthma had one or more asthmatic episodes (periods of worsening) in the past year.
  - Obtained from the Center for Disease Control and Prevention (CDC).
  - Collected as survey.

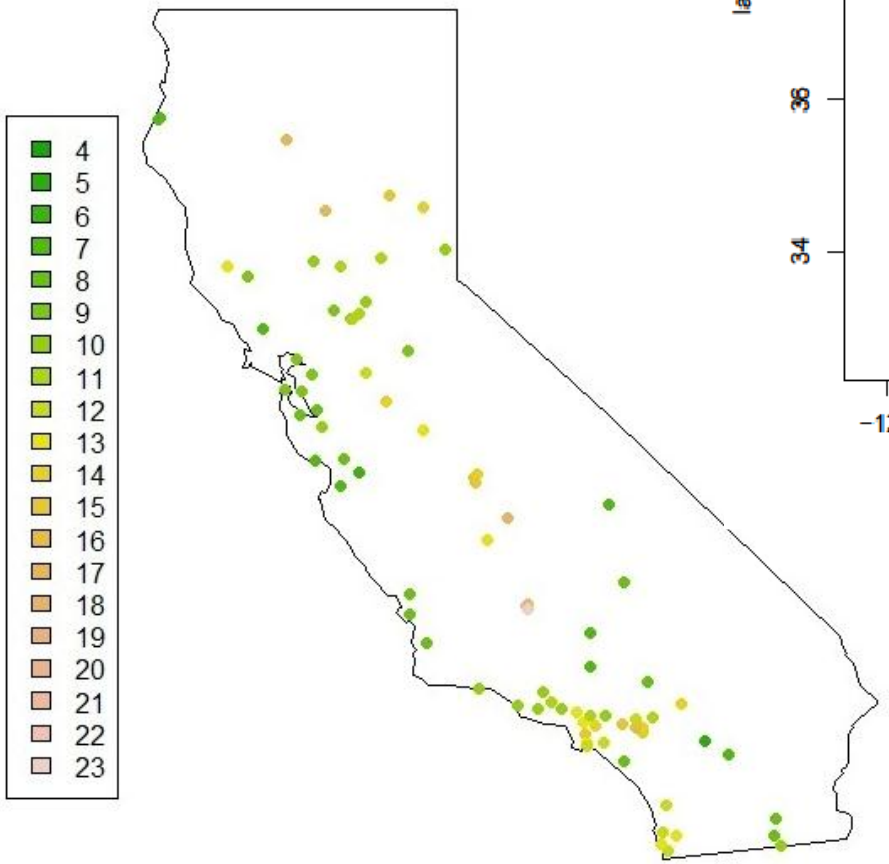
Percent of Episodes Within the Asthmatic Population in 2008 data provided by the CDC

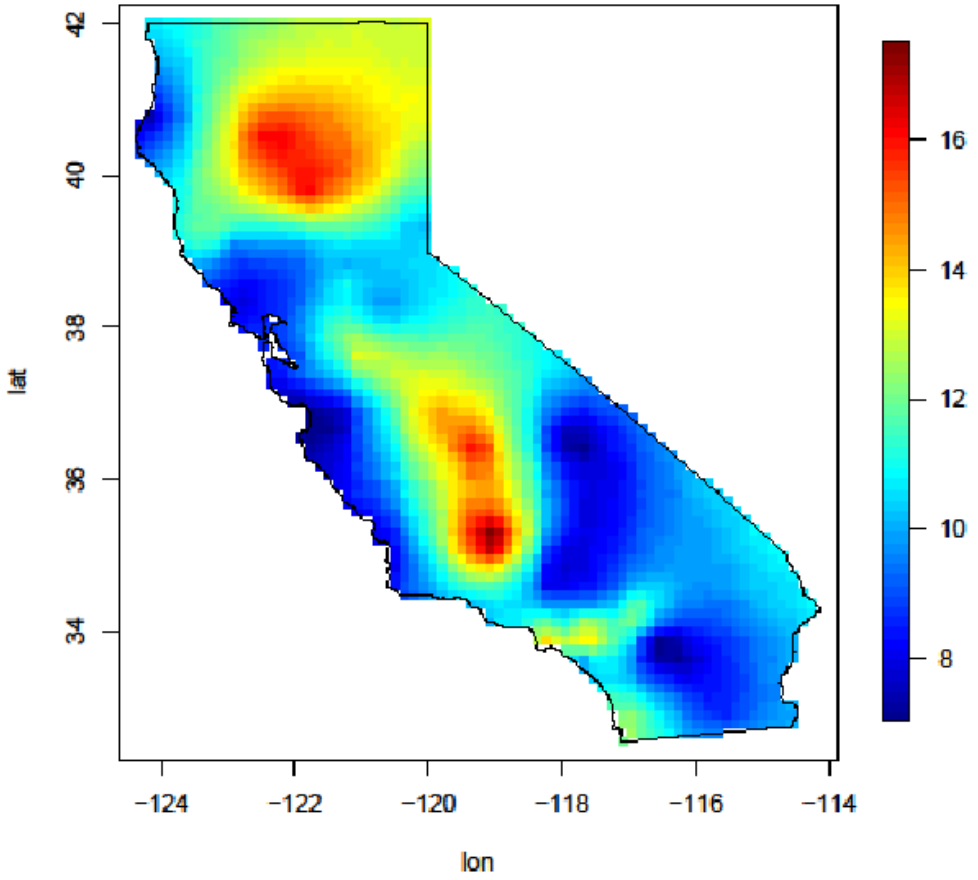


Research Questions

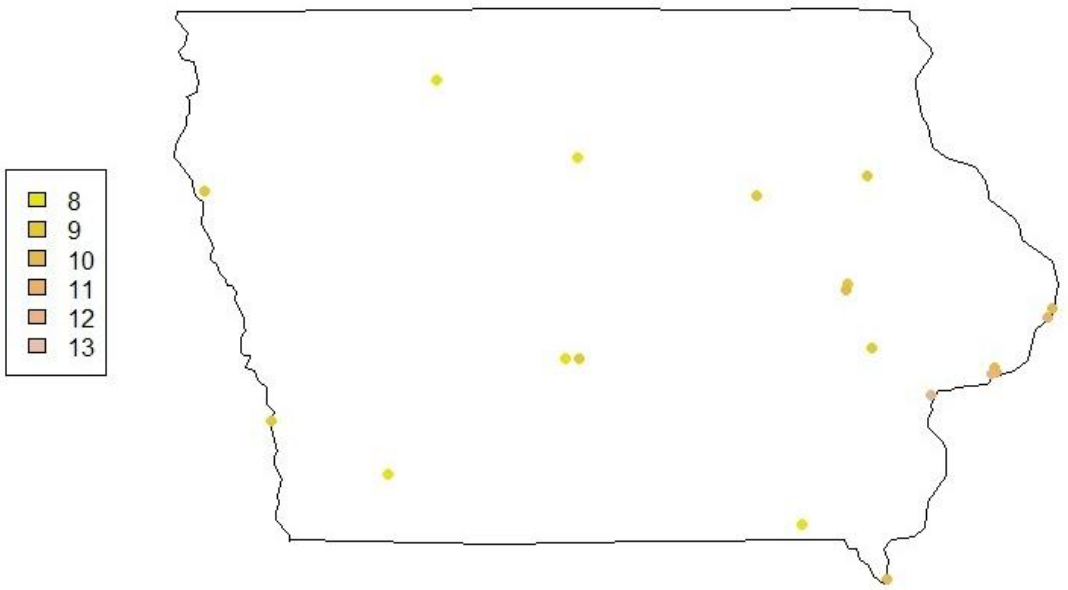
- How can we take the PM 2.5 point source data and produce an estimated surface?
- Are states with more industry more prone to air pollution-according to our maps?
- What does the whole surface of predicted PM 2.5 values look like?
- Is there a visible correlation between the asthma and the particulate matter data?

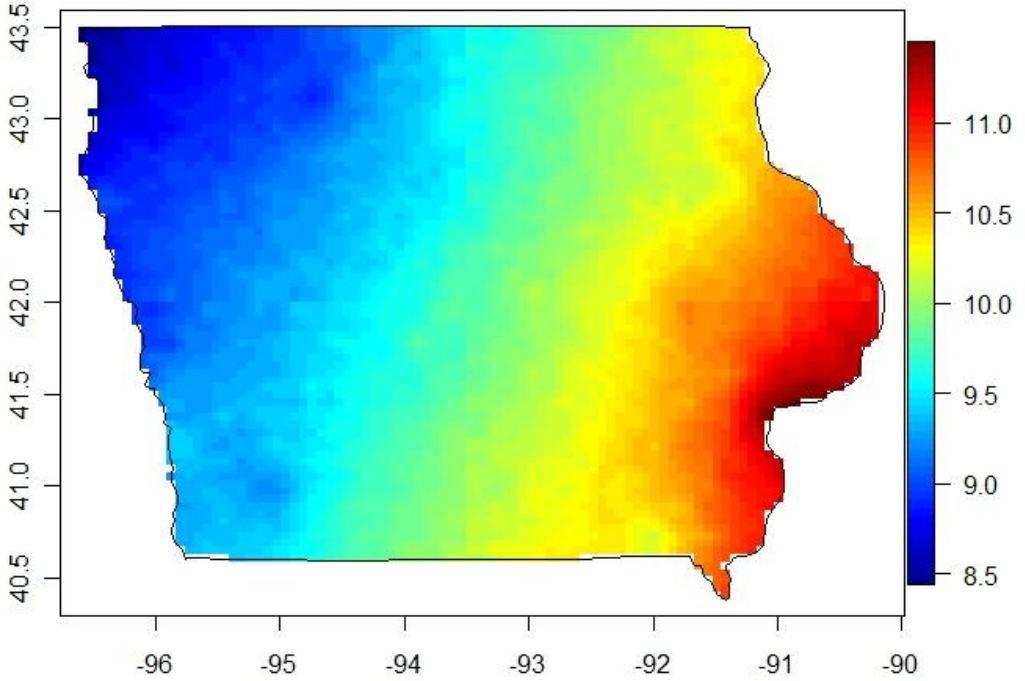
California


4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

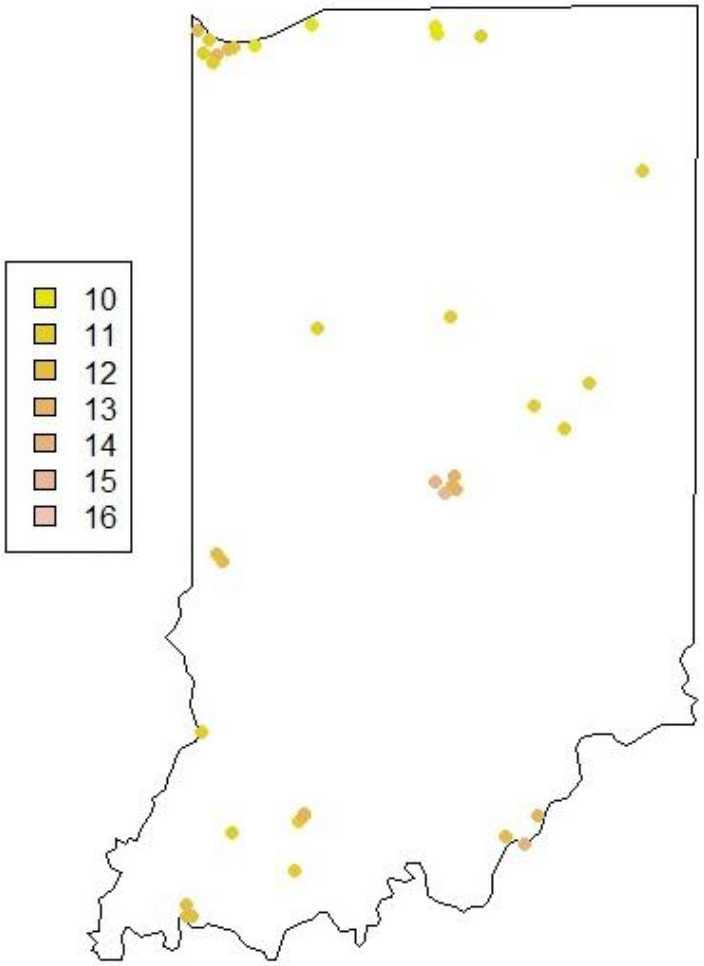

42
40
38
36
34
lat
−124
−122
−120
−118
−116
−114
lon
16
14
12
10
8

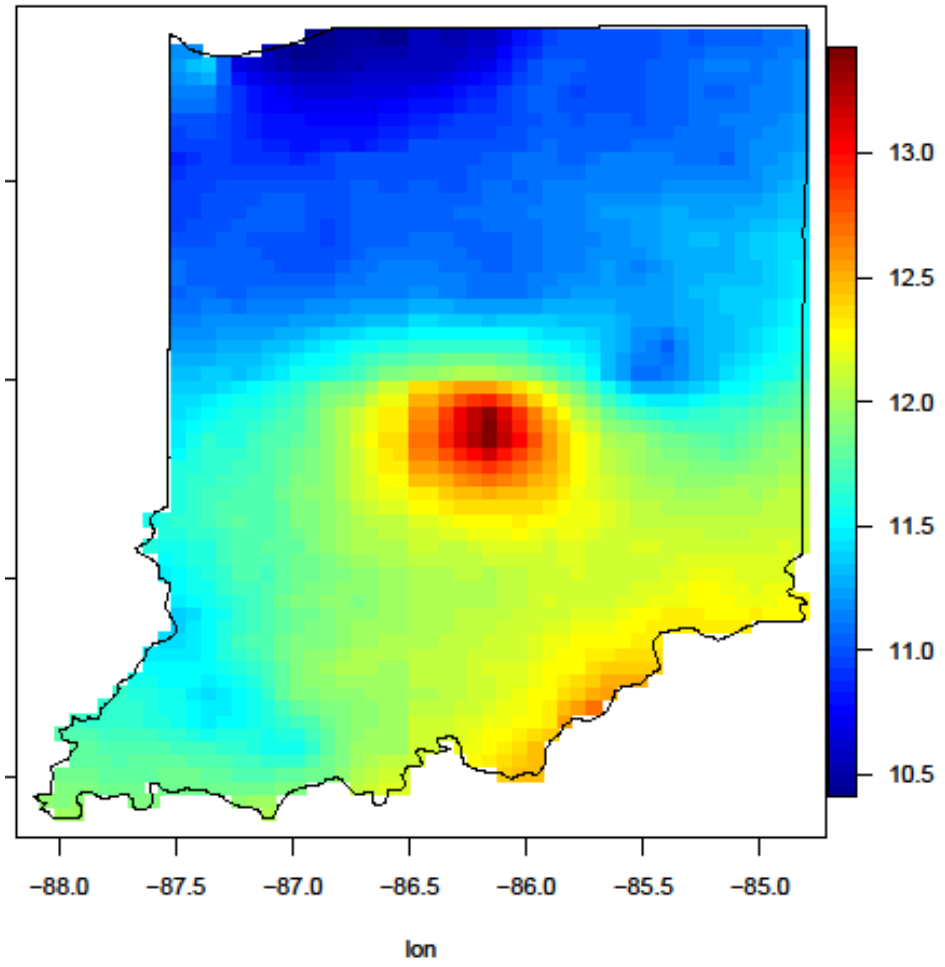
Iowa


8
9
10
11
12
13

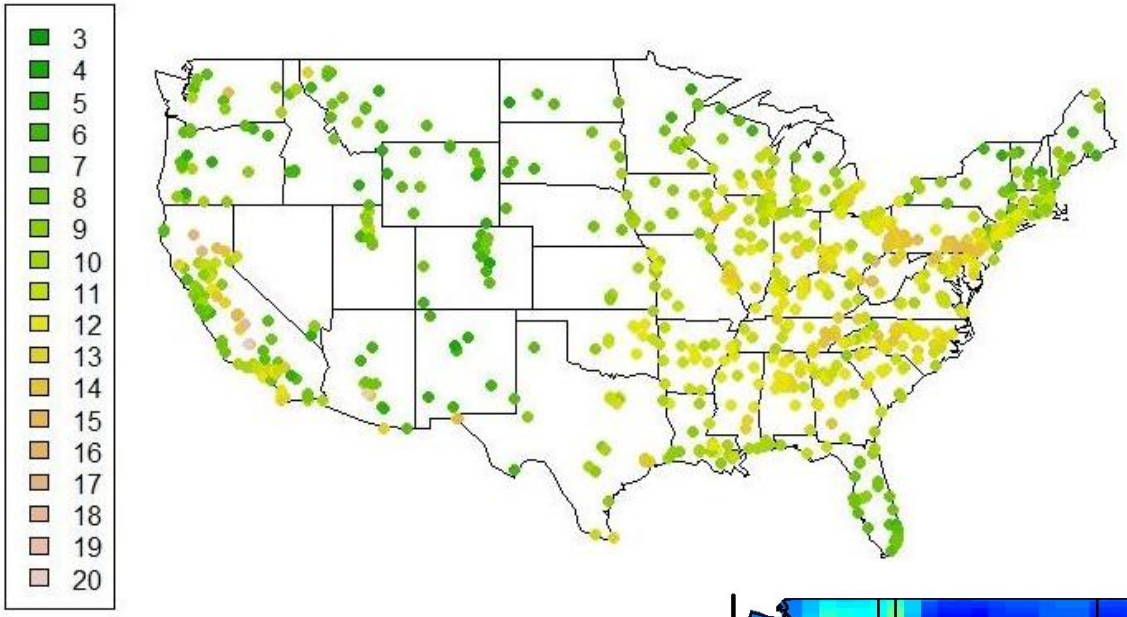

43.5
43.0
42.5
42.0
41.5
41.0
40.5
-96
-95
-94
-93
-92
-91
-90
11.0
10.5
10.0
9.5
9.0
8.5

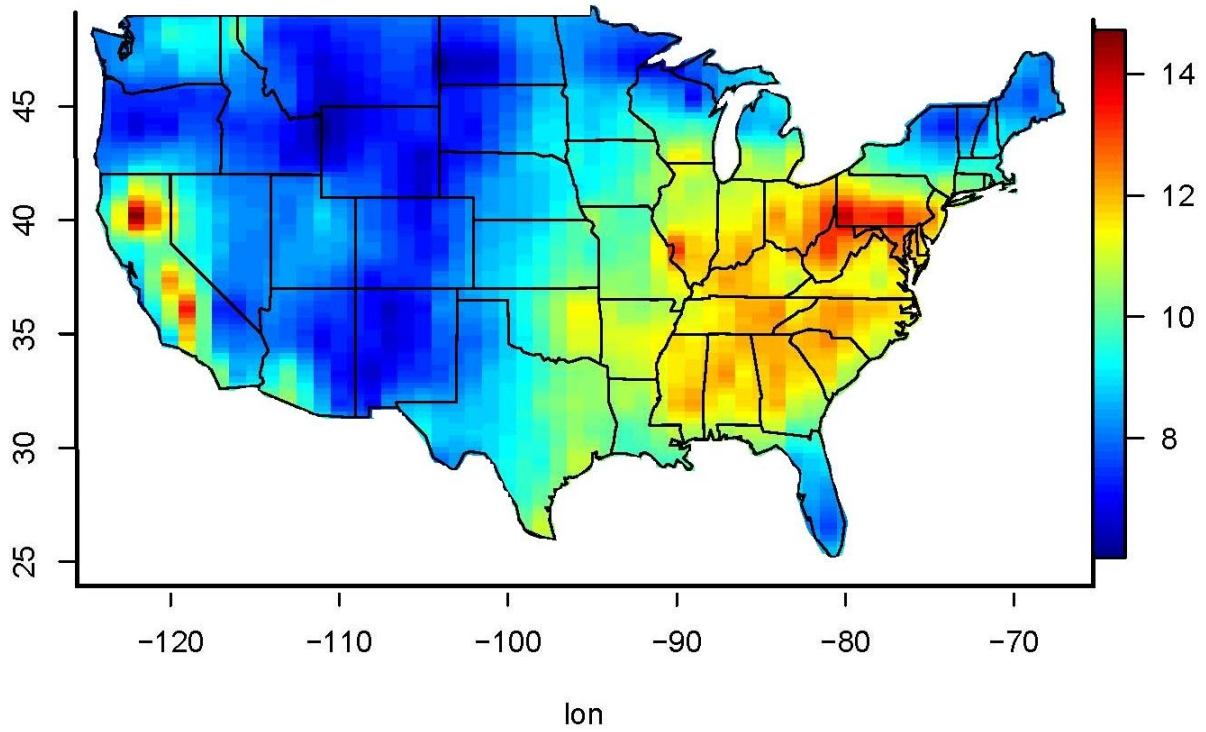
Indiana


10
11
12
13
14
15
16

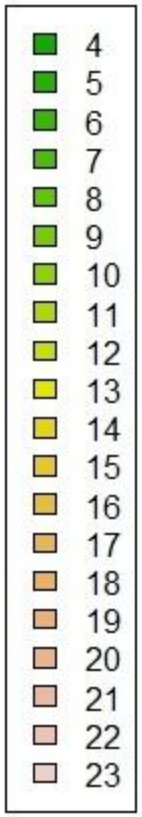

13.0
12.5
12.0
11.5
11.0
10.5
−88.0
−87.5
−87.0
−86.5
−86.0
−85.5
−85.0
lon

United States





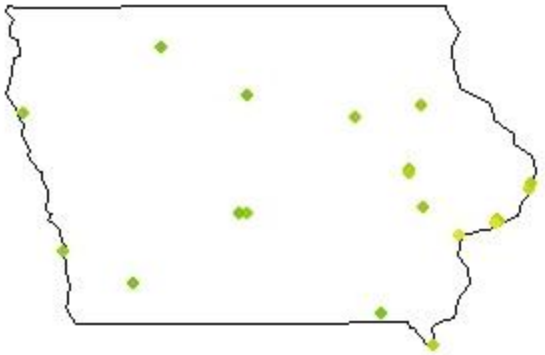
Point Source Maps for 2.5µg/m3
Particulate Matter in 2008 from EPA



United States

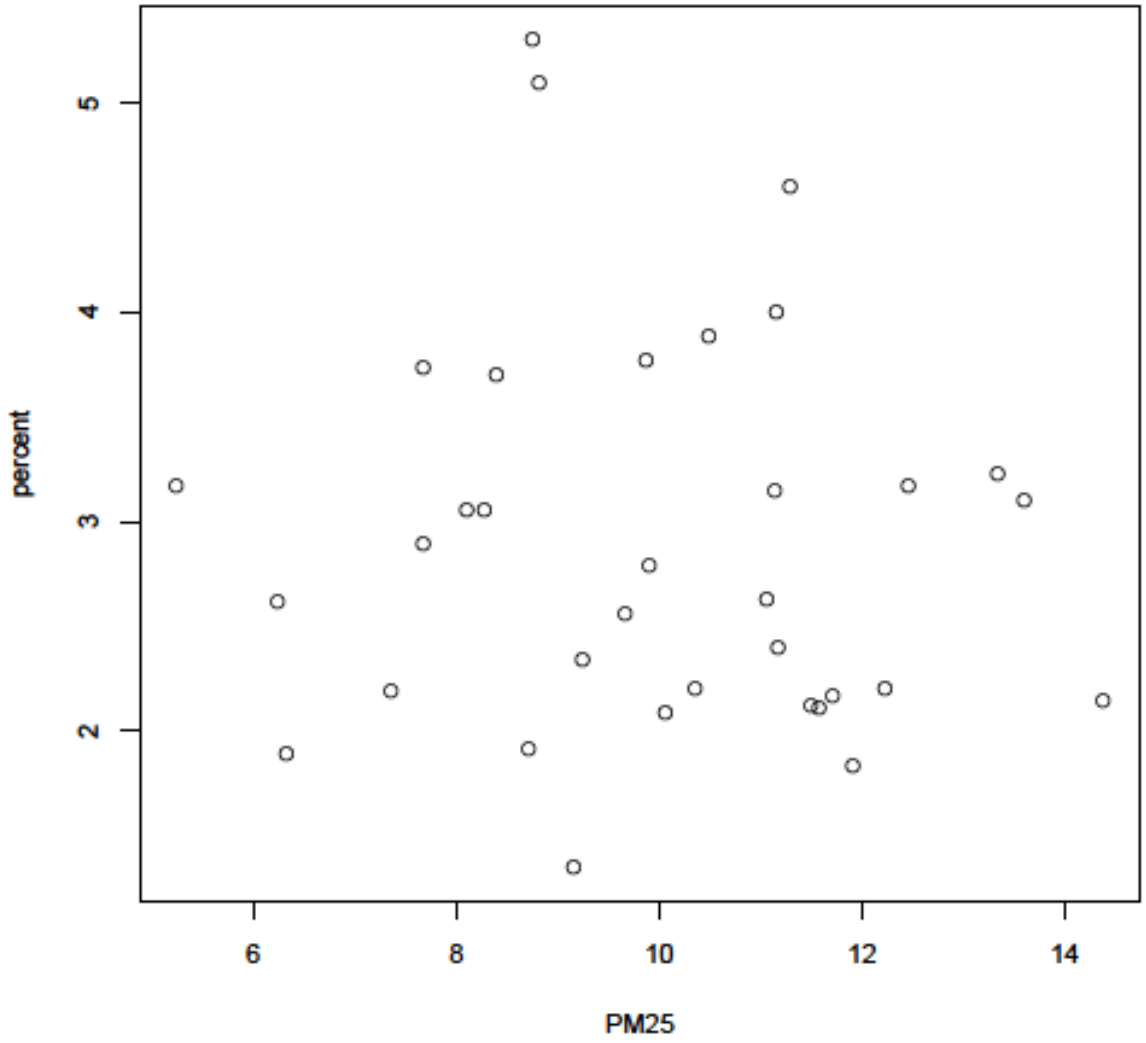
California

Iowa



Indiana

Scatter plot of asthma control percentages vs. PM 2.5 concentration by state



Results

- Trends in PM 2.5 concentration.
  - States with more industry do have more particulate pollution.
- Correlation value of -0.09, 95% confidence interval of (-0.42,0.26) and a p-value of 0.61; thus, no correlation between asthma and PM 2.5.

Conclusions

- No significant correlation between asthma control percentages and PM 2.5 data.
  - Asthma data recollection method (survey vs. state registry).
  - People have variable asthmatic triggers and they can limit their time outside if they know that outdoor air pollution is a trigger, which may be why we did not find a correlation.

Future Work

- Estimate the average level of PM 2.5 for each state using the point source data and the ramps and geoR packages.
- Look at specific occupations which pose an increased exposure to PM 2.5 and find a correlation between these and the ability to control the asthma episodes.
- Since particulate matter has been shown to trigger the development of chronic bronchitis, find a correlation between prevalence of this and the state concentrations of PM 2.5.

Citations and References

- R: R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.
- geoR: Paulo J. Ribeiro Jr & Peter J. Diggle geoR: a package for geostatistical analysis R-NEWS, 1(2):15-18. June, 2001
- Maps: Original S code by Richard A. Becker and Allan R. Wilks. R version by Ray Brownrigg Enhancements by Thomas P Minka (2010). maps: Draw Geographical Maps. R package version 2.1-5. http://CRAN.R-project.org/package=maps

- Ramps: Smith, B. J., Yan, J., and Cowles, M. K. (2008) Unified Geostatistical Modeling for Data Fusion and Spatial Heteroskedasticity with R Package ramps, Journal of Statistical Software, 25(10), 1-21.
- Animation: Yihui Xie (2009). Animation: Demonstrate Animations in Statistics. R package version 1.0-10. http://CRAN.R-project.org/package=animation

- United States Environmental Protection Agency (EPA). “Air Data: Access to Air Pollution Data”. http://www.epa.gov/air/data/index.html
- Center for Disease Control and Prevention (CDC).

- Partly supported by the University of Iowa Department of Biostatistics NHLBI—NCRR—NIH training grant (T15-HL097622-01 NHLBI)