The Importance of Air Quality Data for Public Health Applications

WISCONSIN'S ENVIRONMENTAL PUBLIC HEALTH TRACKING PROGRAM

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Environmental Public Health Tracking

Pew Environmental Health Commission
Environmental Health Review 2001 Report

America's Environmental Health Gap: Lack of basic information linking environment and chronic disease that undermines intervention and prevention.

- Environmental health system is inadequate & fragmented
- Responsibilities are scattered among multiple agencies
- Unable to link environmental and health databases

Recommended a "Nationwide Health Tracking Network for diseases and exposures"

Environmental Public Health Tracking

Hazard

Exposure

Health Effect

Data

Ongoing Evaluation

COLLECTION → INTEGRATION → ANALYSIS → INTERPRETATION

Tracking Network

Dissemination

Assessment • Research • Intervention • Policy

Stakeholders*

Prevention

Improved Public Health

Ongoing Evaluation

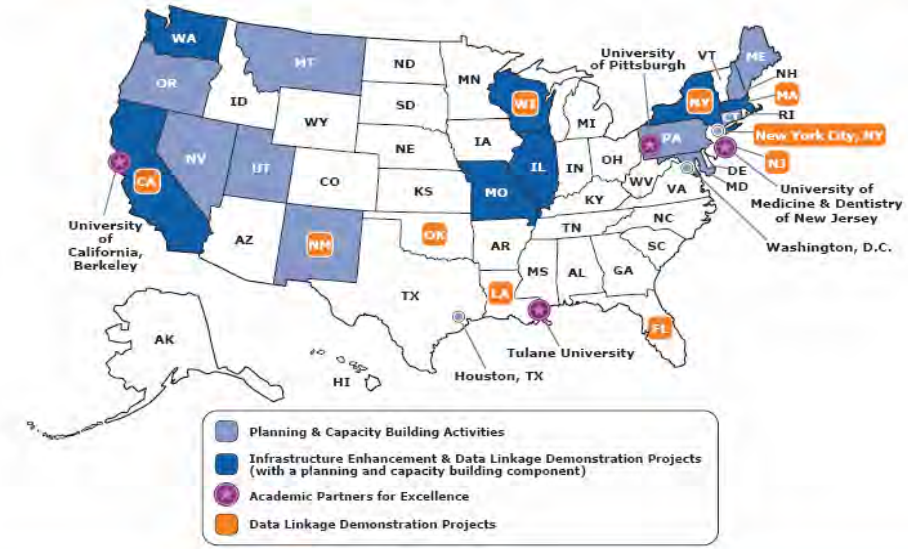
*Stakeholders Include	
Federal Agencies	Business and Industry
State and Local Agencies	Policy Makers
Academia	Media
Health Care System	Public
Non-Governmental Organizations	

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION
SAFER • HEALTHIER • PEOPLE

CDC
SAFER • HEALTHIER • PEOPLE™

Environmental Public Health Tracking Grantees

CDC's Environmental Public Health Tracking Program Grantees FY 2006



Summary

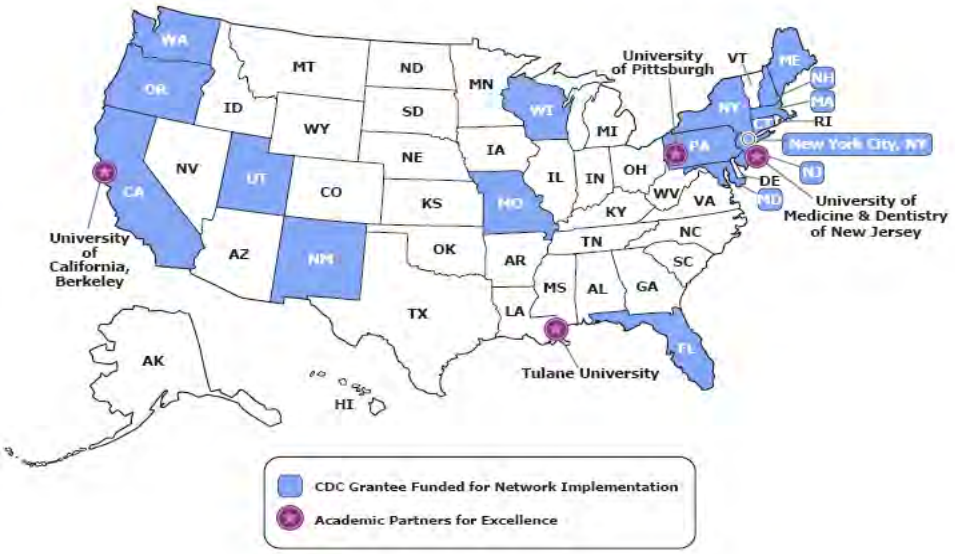
Planning & Capacity Building Activities			
Connecticut	Nevada	Pennsylvania	CITIES:
Maine	New Hampshire	Utah	Houston, TX
Maryland	New Mexico		New York City, NY
Montana	Oregon		Washington, D.C.

Infrastructure Enhancement & Data Linkage Demonstration Projects			
California	Massachusetts	New York	Wisconsin
Illinois	Missouri	Washington	

Academic Partners for Excellence			
Tulane University	University of California, Berkeley	University of Pittsburgh	University of Medicine and Dentistry of New Jersey

Data Linkage Demonstration Projects			
California	Massachusetts	New York	CITIES:
Florida	New Jersey	Oklahoma	New York City, NY
Louisiana	New Mexico	Wisconsin	

CDC's Environmental Public Health Tracking Program Grantees FY 2006



Summary

Funded for Network Implementation			
California	Massachusetts	New York City	Washington
Connecticut	Missouri	New York State	Wisconsin
Florida	New Hampshire	Oregon	
Maine	New Jersey	Pennsylvania	
Maryland	New Mexico	Utah	

Academic Partners for Excellence			
Tulane University	University of California, Berkeley	University of Pittsburgh	University of Medicine and Dentistry of New Jersey

What is Environmental Public Health Tracking?

- Surveillance
  - Systematic, coordinated tracking of hazards, exposures and health outcomes
- Data linkage
  - Examine potential relationships
  - Develop screening level tools to generate future hypotheses
- Integrating environment and health
  - improve understanding of relationships between environmental exposures and public health outcomes to guide action

Making Data and Information Accessible

A. Find relevant data and assess utility for surveillance
B. Prioritize surveillance topics
C. Complete linkage projects
D. Create internet-based portals at national and state levels

A. Find relevant data and assess utility for surveillance

- Wisconsin is rich with environmental and health data
- Wisconsin already has a strong environmental health partnership infrastructure

- The data have limitations for use in surveillance
- The databases are not designed for linkages
- Resources for modifying data infrastructure are limited

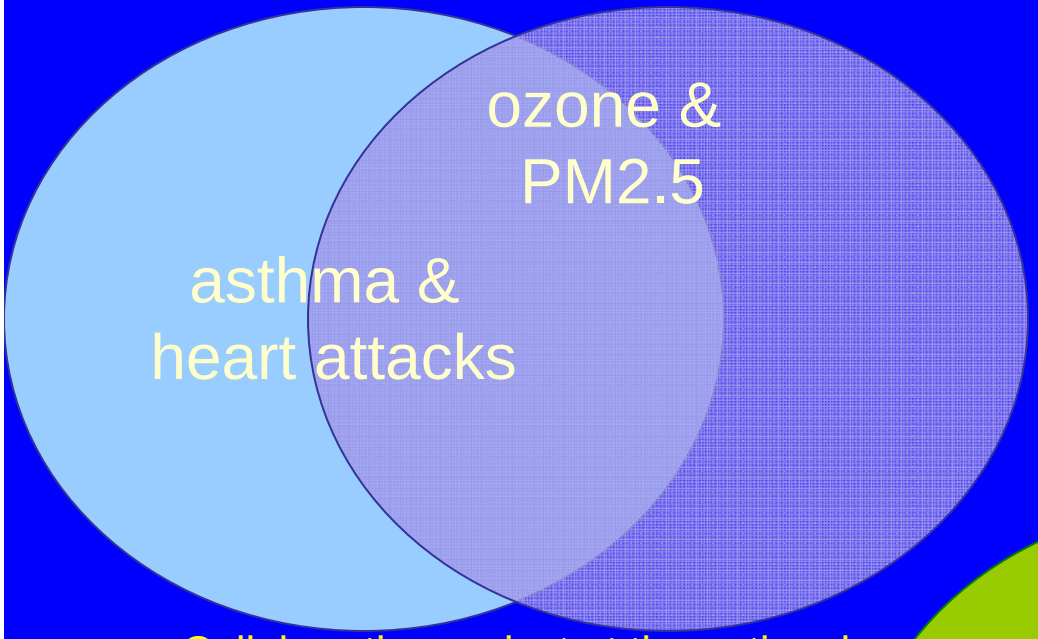
THE STRENGTHS OFTEN COUNTER THE LIMITATIONS

B. Prioritize surveillance topics

- What data are available?
- Which contaminants and health effects are relevant?
  - Biological plausibility
- Is it an issue that is important in Wisconsin?

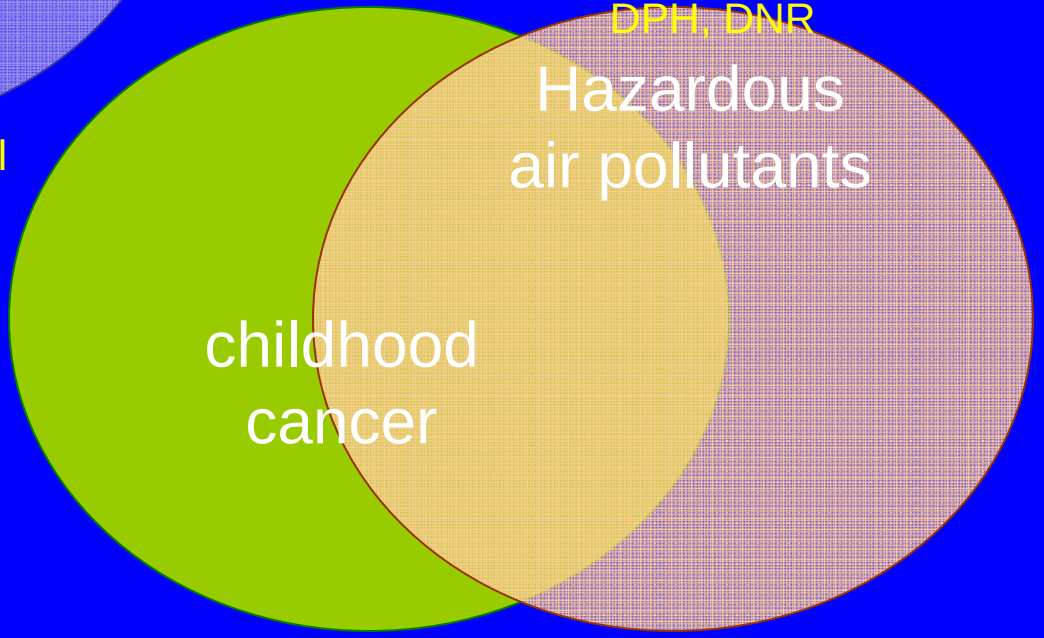
C. Complete Linkage Projects

Current Foci



Collaborative project at the national level:
CDC, EPA Maine, New York, Wisconsin

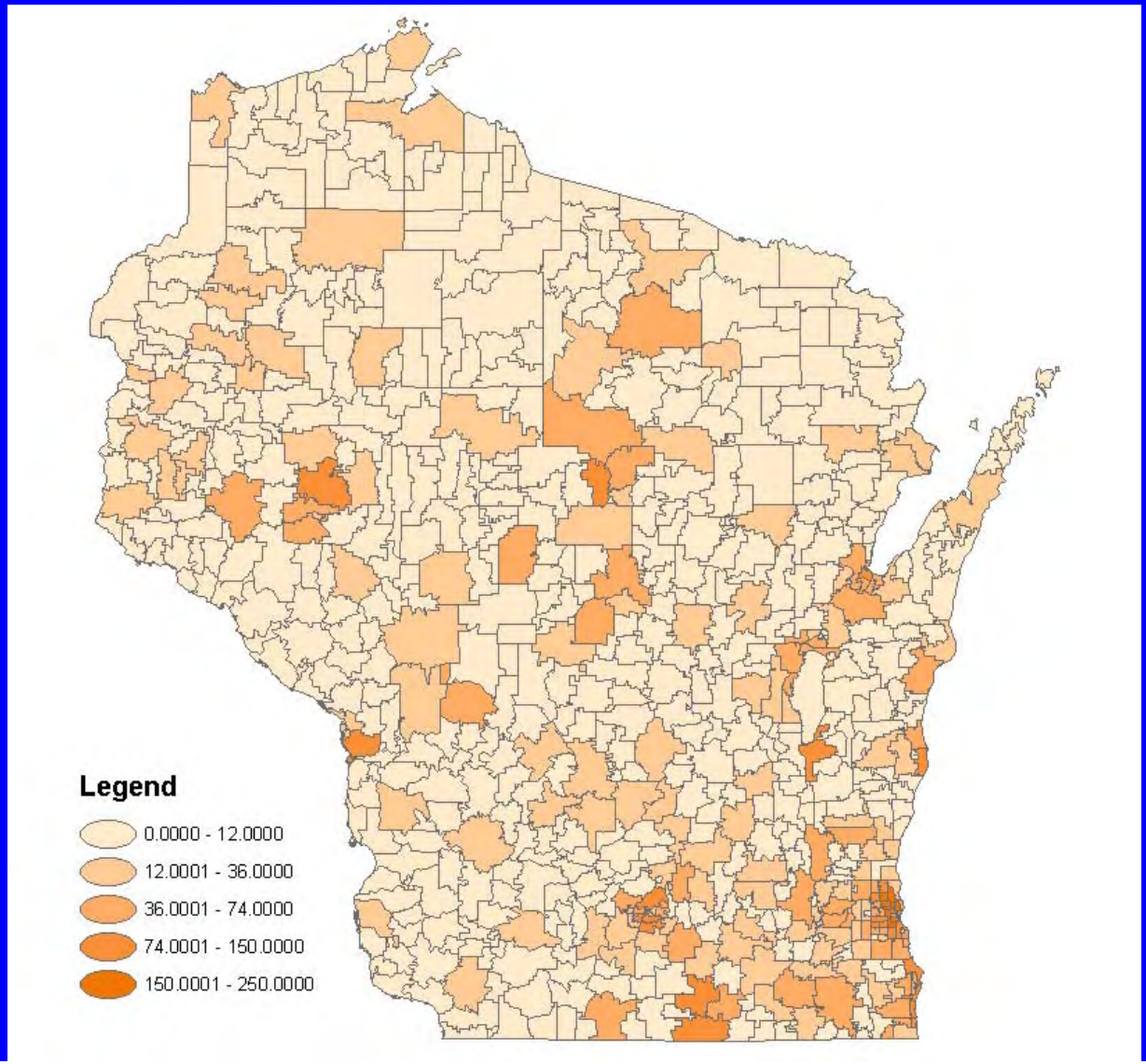
Collaborative project at the state level
DPH, DNR



Linking Asthma Hospitalizations with Ozone and $PM_{2.5}$

BURDEN OF ASTHMA (2001)

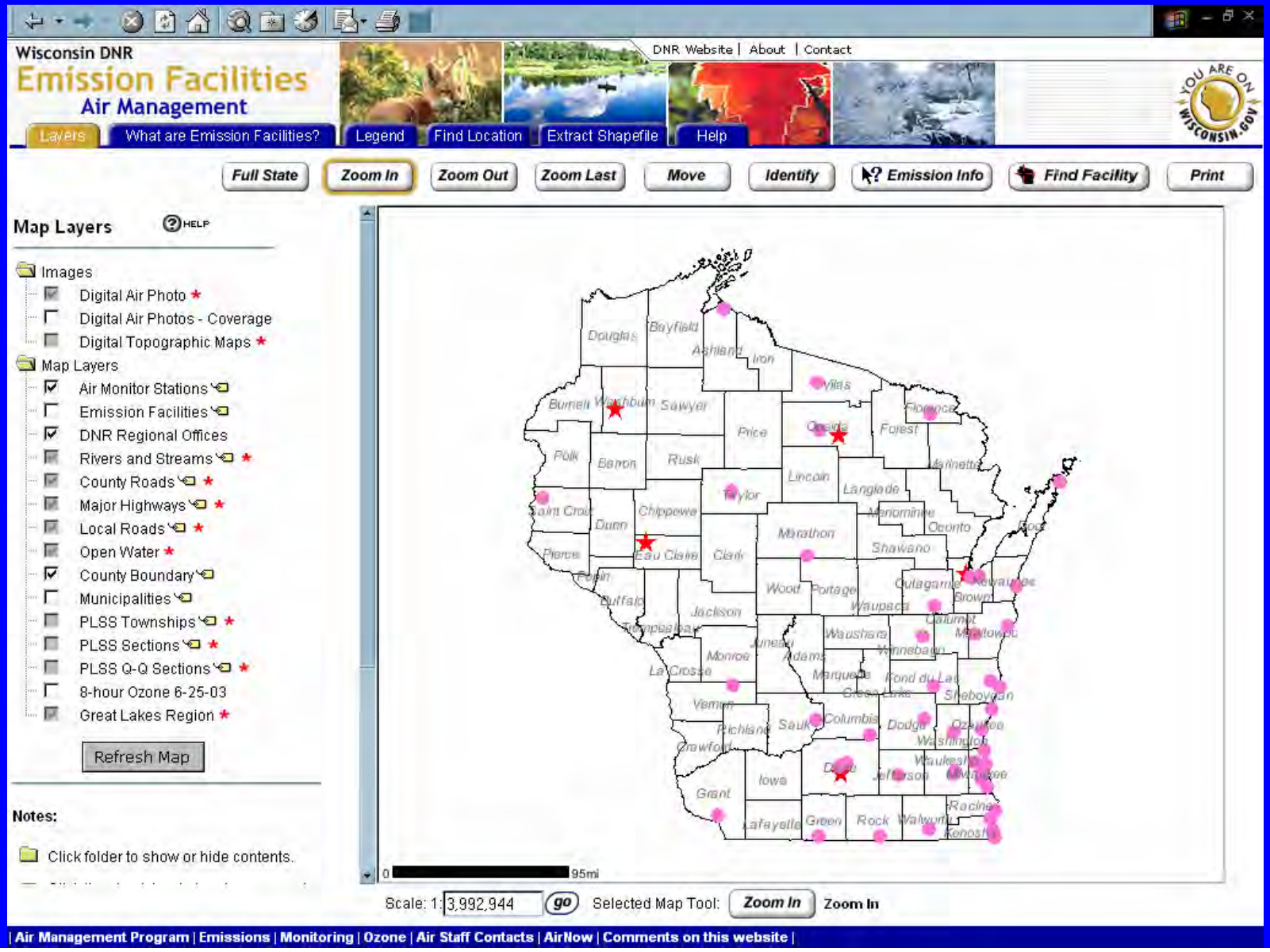
Defined as ICD code 493 in primary or first other diagnosis fields for hospital discharge.



LINKAGE TOOLS

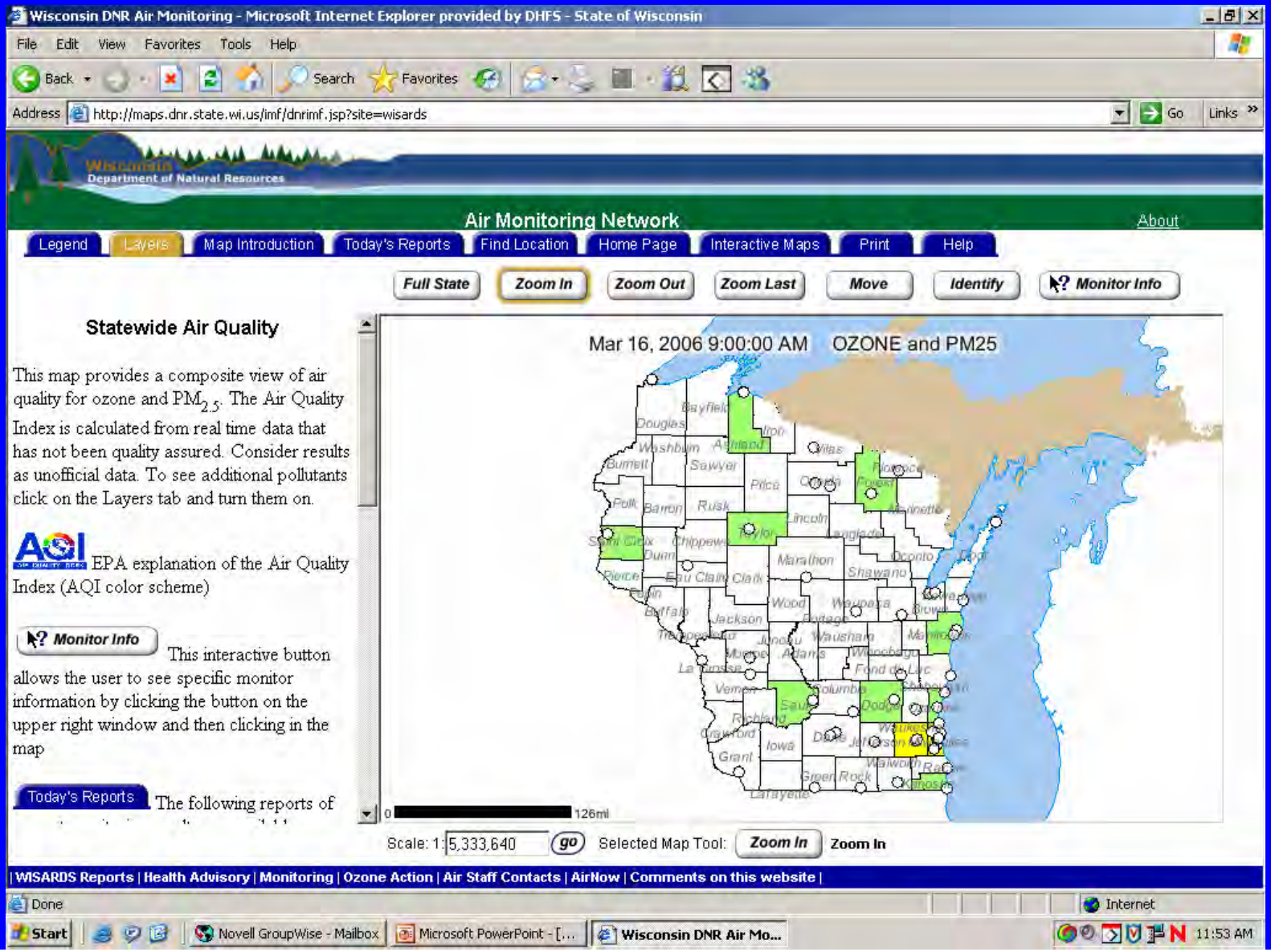
Limited number of monitors

http://maps.dnr.state.wi.us/imf/dnrimf.jsp?site=wisards



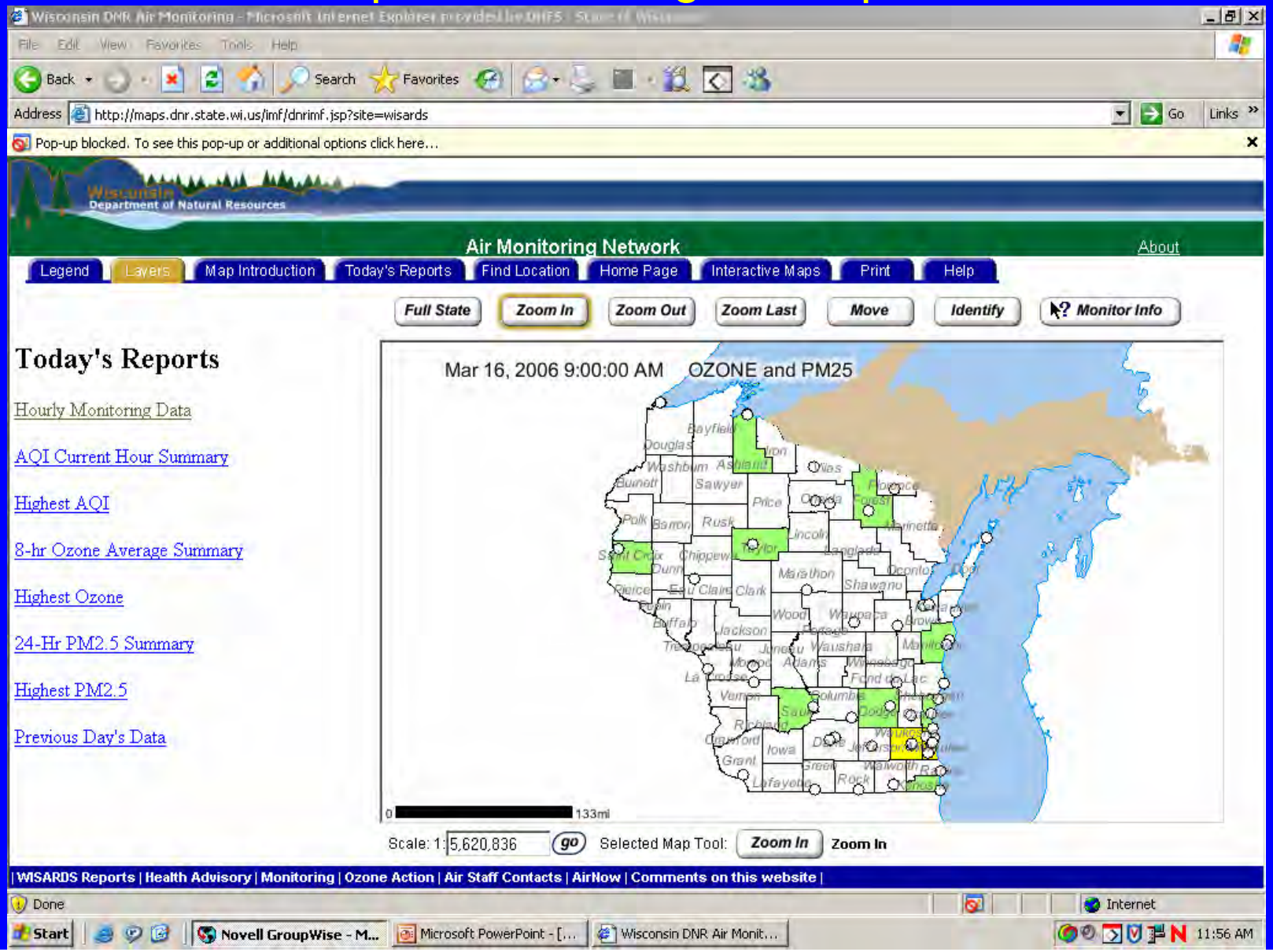
LINKAGE TOOLS

Data from single monitor applied to geopolitical boundary



LINKAGE TOOLS

Temporal matching is complex



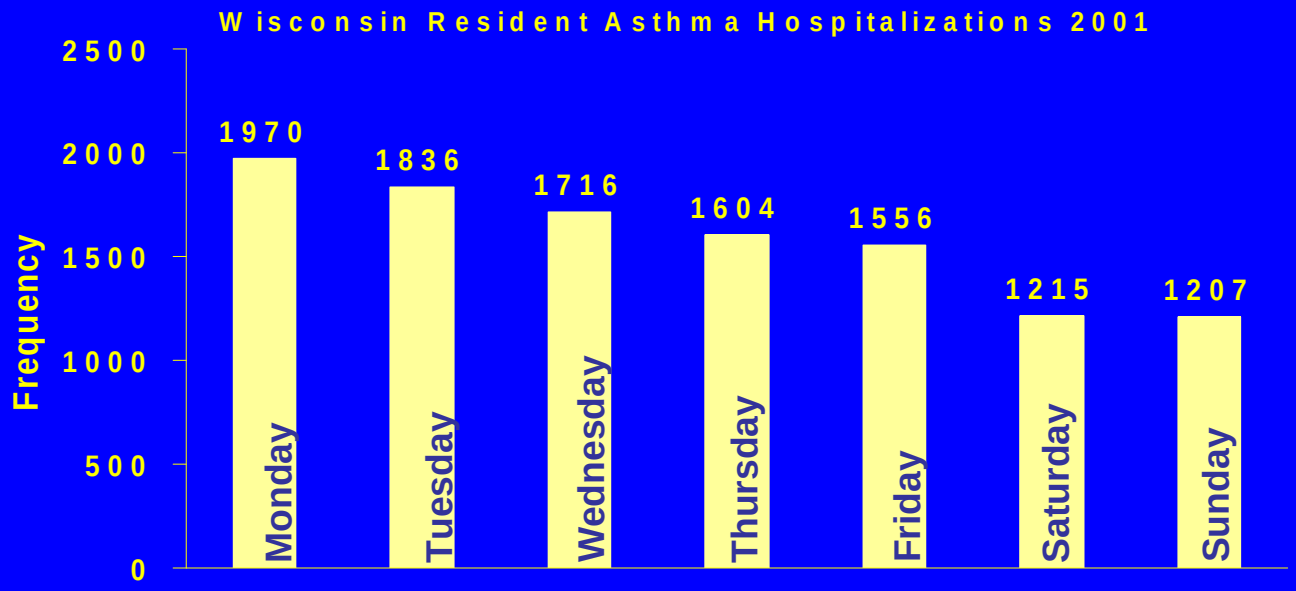
Expanding Work to a National Level

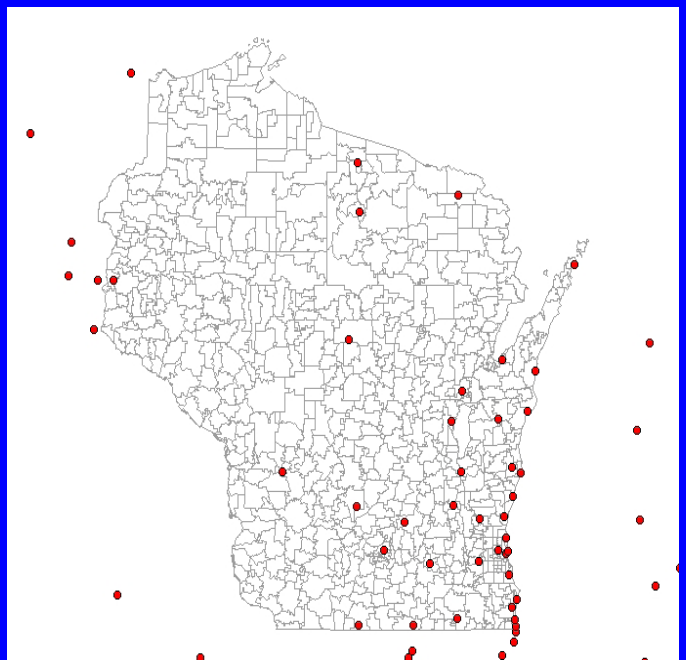
- Public Health Air Surveillance Evaluation (PHASE) project
  - Multi-state (ME-NY-WI)
  - Multi-agency (CDC, EPA)
  - Air Quality characterization evaluation
    - How to apply regulatory data to public health
  - Methods development
    - How to link health and hazard data for analysis

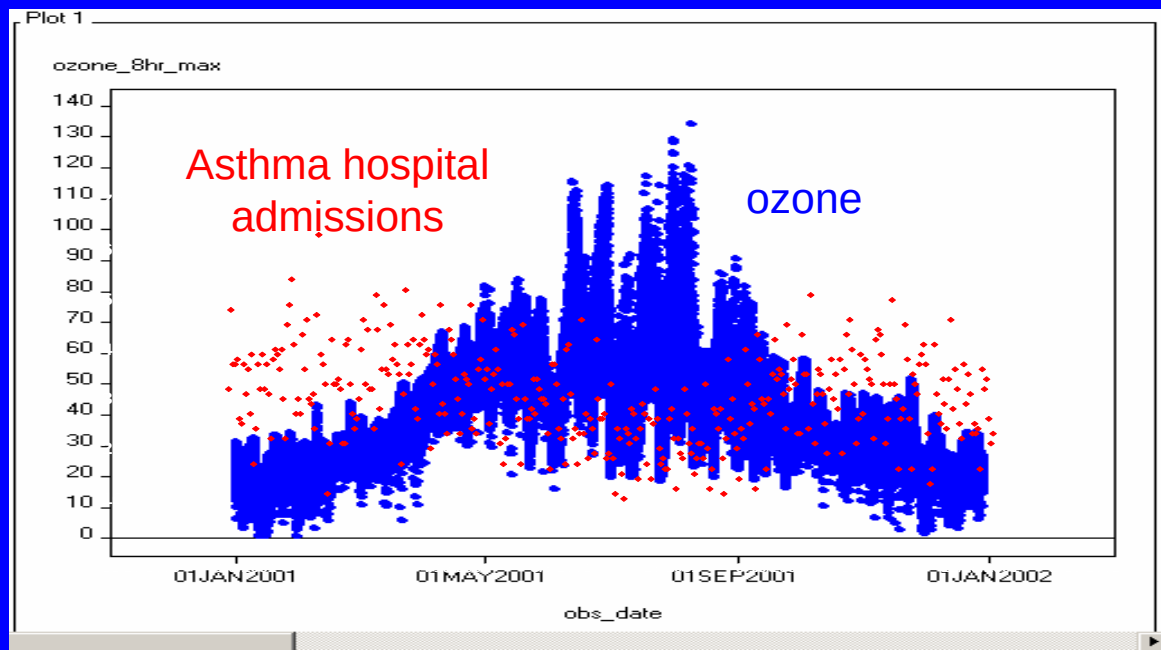
PHASE Project Tasks

1. Selecting and Defining health outcomes
2. Estimating and Assigning exposures
3. Calculating the relationship between the health outcome and estimated exposure
4. Evaluating air quality characterization methods for their utility in public health

1. Selecting & Defining Health Outcomes



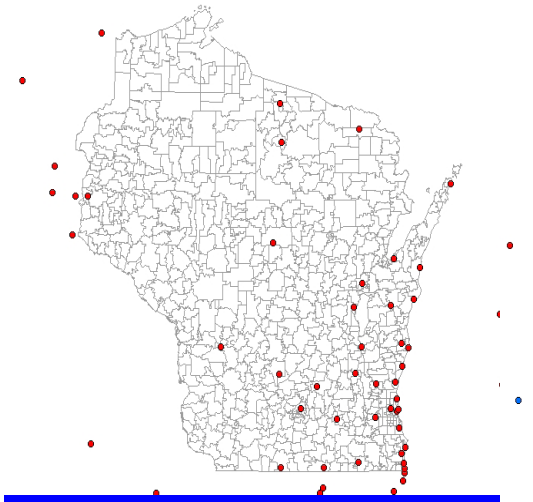


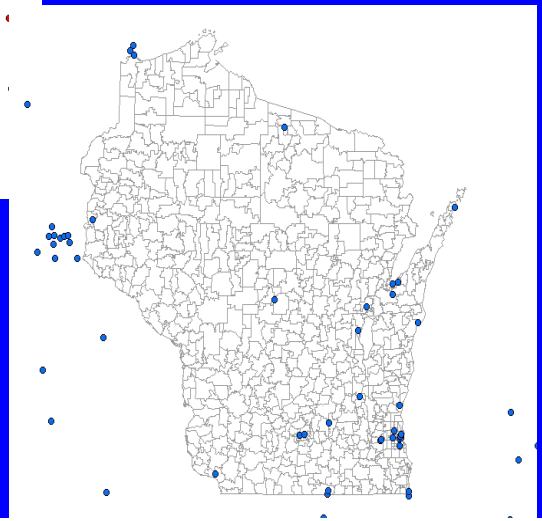


2. Estimating and Assigning exposures

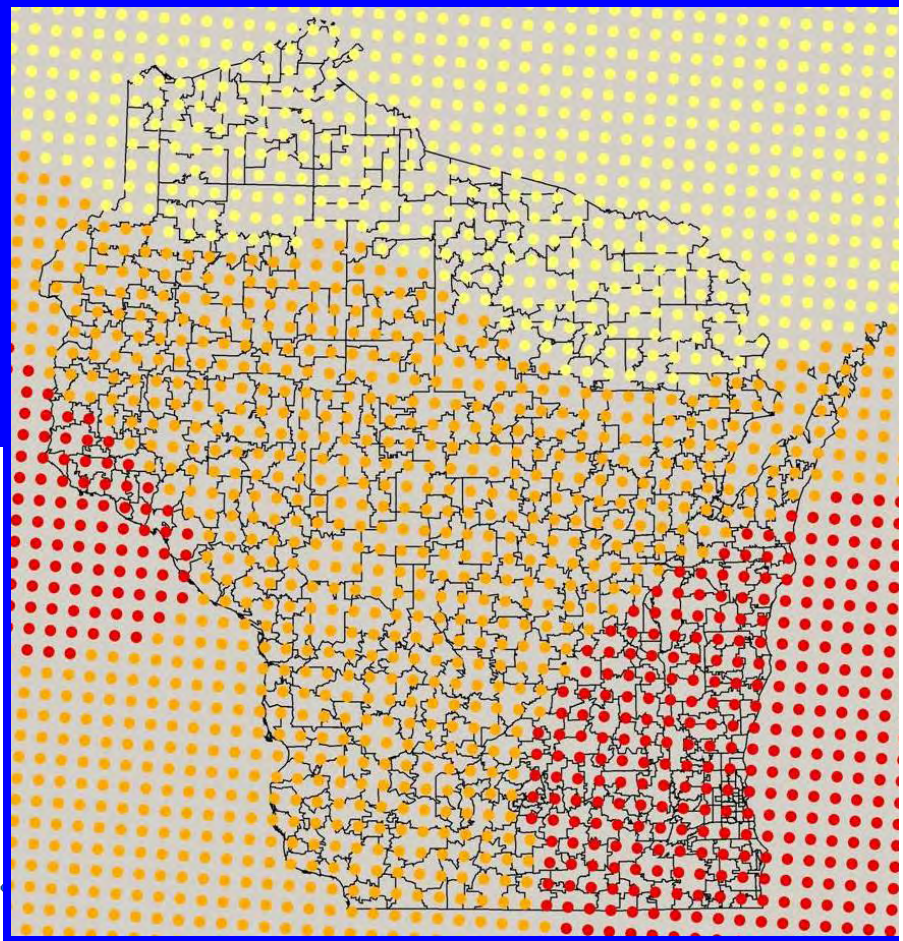
- Raw monitor data
  - Ozone collected daily from April15-October 15
  - PM collected every 3 days (all year round)

http://maps.dnr.state.wi.us/wisards/



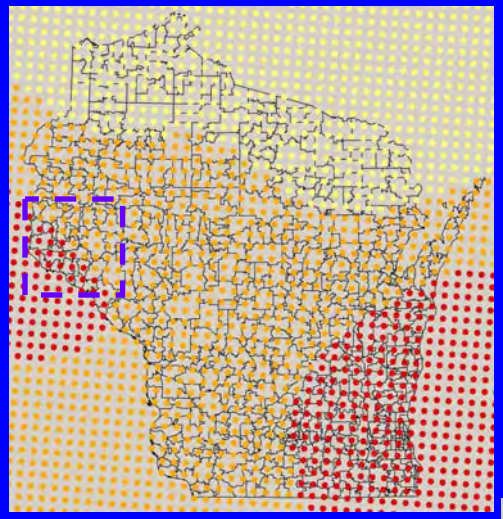


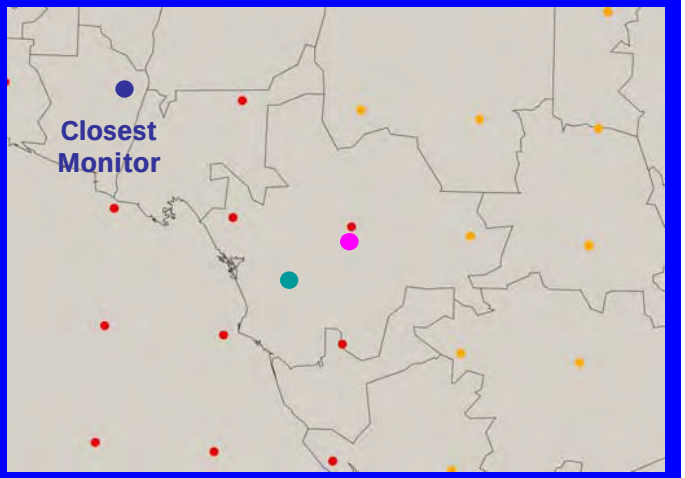
- EPA Interpolated data (4km, 12km, 36km)
  - Daily Ozone & PM2.5
- CMAQ & Hierarchical Bayesian (36km only)
  - Jan 1 - Dec 29 Ozone and PM 2.5

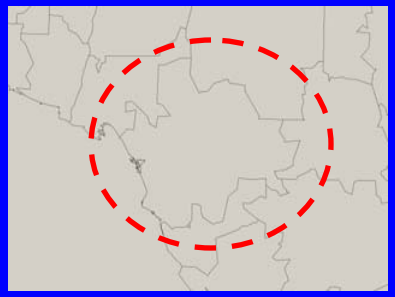


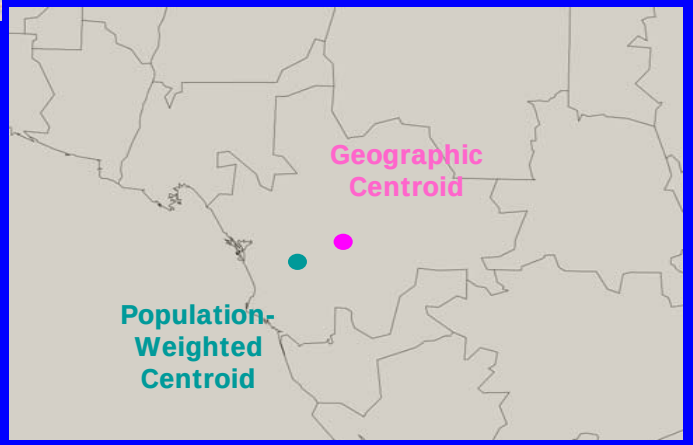
2. Estimating and Assigning exposures

- Zip code of residence at time of event
  - Geographic Centroid of Zip Code (closest value & average of nearest values)
  - Population Weighted Centroid of Zip Code (closest value & average of nearest values)
  - Average of air quality within zip code polygon
  - Use raw monitor data (assign closest monitor data)









Correlations >.97. Used geographic centroid and closest value

3. Calculating the relationship between the health outcome and estimated exposure

- Assign “exposure” based on air quality estimate
- Account for possible delay between exposure and when person arrives at hospital
- Run statistics – Case cross-over vs. Time Series

4. Evaluate air quality characterization methods for public health utility

- Correlate results to see how different they are from one another
- Rate the ease of use and other practical aspects
- Make recommendation
  - Hierarchical Bayesian methodology

Linking Cancer with Hazardous Air Pollutants

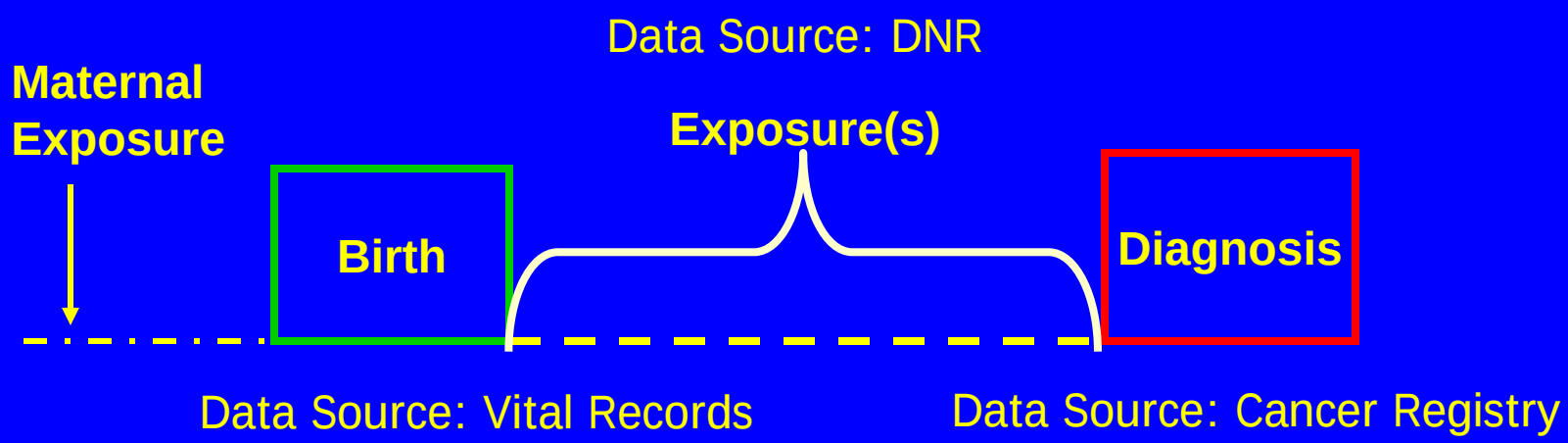
Steps in the Project

1. Selecting and Defining health outcomes
2. Estimating and Assigning exposures
3. Calculating the relationship between the health outcome and estimated exposure
4. Evaluating air quality characterization methods for their utility in public health

1. Selecting and Defining health outcomes

- Childhood cancer
  - Potentially shorter latency
  - Potentially less variability in residential history
  - Priority for our staff
    - Approximately 270 cases diagnosed annually in WI
    - Significant concern from public

2. Estimating and Assigning Exposures



2. Estimating and Assigning Exposures

- Estimate changes in exposure assignments over the exposure period
  - How far do mothers move between time of conception to birth?
    - Do not currently have a way to estimate
  - How far do children move during the time between birth and diagnosis?
    - Linked birth records with cancer records

Distance Moved from Birth Address to Diagnosis Address

Distance Moved (Miles)	% of Cases (N=351)
0	56.4
0.1 -.5	2.9
.6– 1.0	3.7
1.1 – 2.0	8.3
2.1 – 3.0	4.0
3.1 -4.0	2.6
> 4.0	22.2

2. Estimating and Assigning Exposures

1. 1-to-1 Case to Facility/Emissions source
2. Buffer Zone Analysis
3. RAIMI Model

1-to-1 Case to Facility/Emissions Source

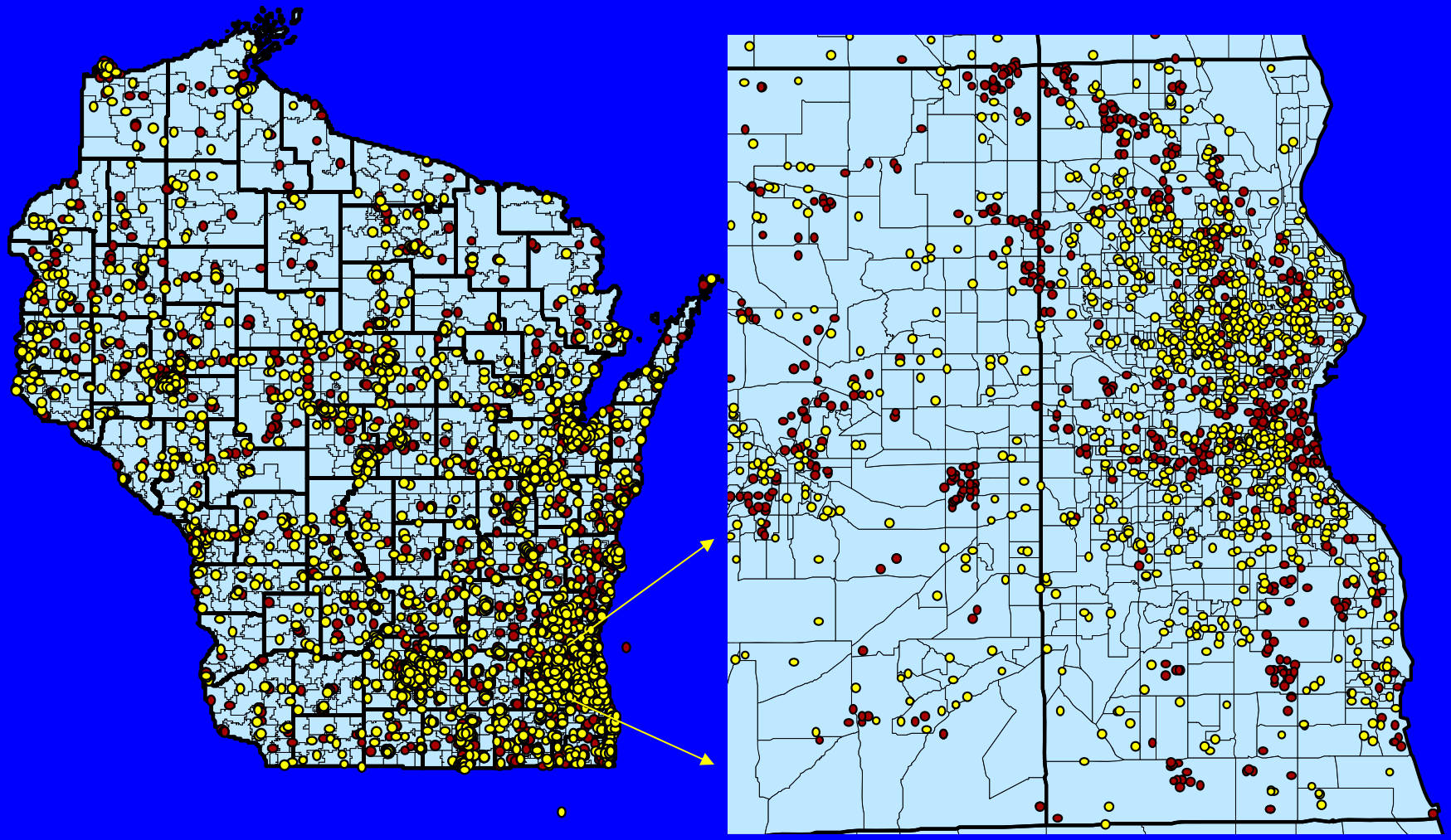
Environmental Monitoring Data (WI DNR)

- BRRTS- remediation sites/land fills/underground storage tanks
- AEMS- air emissions
- SWAP- sources of drinking water contamination

Childhood Cancer Data

- Case birth address
- Case diagnosis address
- Control birth address

1-to-1 Case to Facility/Emissions Source



Linked three files based on closest facility only

Mean Distance (miles) from Closest Contamination Source by Source Type

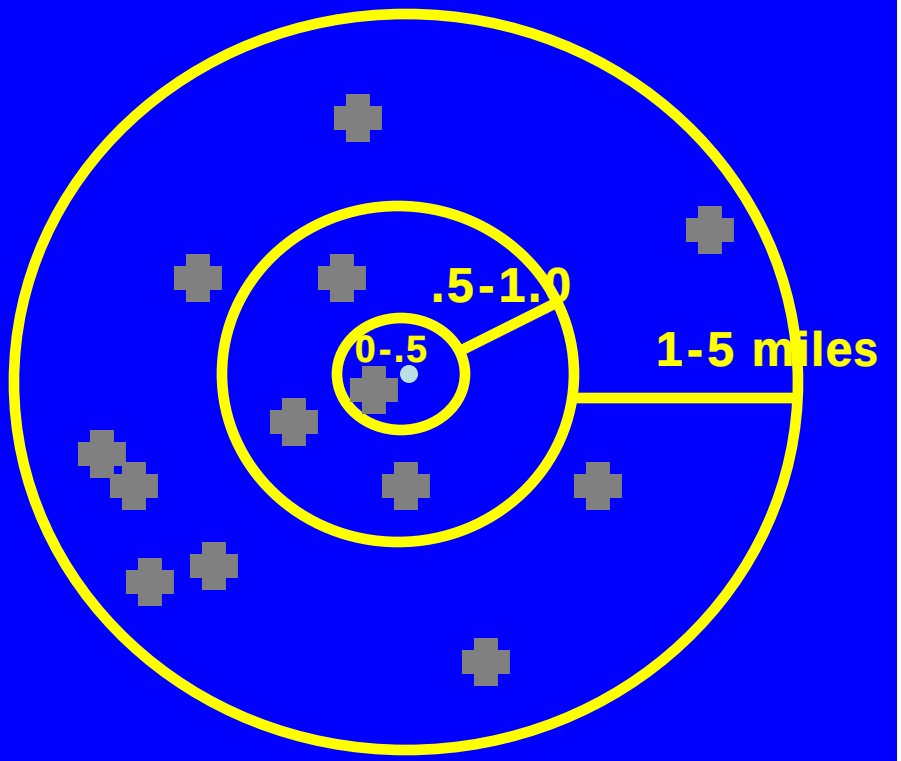
Environmental Hazard/Source	Cases by Birth Address (min-max) N = 357	Cases by Diagnosis Address (min-max) N=357	Controls by Birth Address (min-max) N=3591
BRRTS Sites	0.51 (0-5.13)	.49 (0-19.13)	0.49 (0-19.60)
AEMS Sites	1.32 (0-13.4)	1.34 (.01-10.11)	1.39 (0-21.40)
SWAP Sites (Area)	0.39 (0-4.02)	0.39 (0-3.44)	0.38 (0-19.38)
SWAP Sites (Lines)	3.02 (0-40.96)	3.24 (0-43.49)	3.31 (0-43.40)

1-to-1 Case to Facility/Emissions Source

- Do-able
- Practical
- Value of this linkage method uncertain
  - Helps with understanding how far cases and controls are from facilities
  - Exposure assessment - may not make sense scientifically
    - 1-to-1 linkage does not take into account multiple facilities
    - 1-to-1 linkage does not take into account other sources of exposure
    - Spatial and temporal gaps are an issue

Buffer Zone Analysis

- Case Files
  - Diagnosis Address (n=421)
  - Birth Address (n=421)
- Control File
  - Birth Address (1253)
- 3 buffers
  - 0-.5 miles
  - .5-1.0 miles
  - 1.0-5.0 miles
- Link with emissions data



Buffer Zone Analysis

- Resulting Files:
  - For each case/control file – emissions data for all facilities falling within each of the 3 different buffers
- Case File – 1.4 million records (combines birth address and diagnosis address data), 1.3 GB
- Control file – 1.2 million records, 1.4 GB
- Computing Time (not including time required to set up) – 12 hours

Buffer Zone Analysis

- Do-able?
  - Yes, BUT - Computing time very intensive
- Practical and Feasible?
  - size of dataset is an obstacle
- Value of Linkage Data?
  - Still difficult to determine
    - Approach does take into account emissions from multiple facilities
    - Spatial and temporal gaps remain a major issue

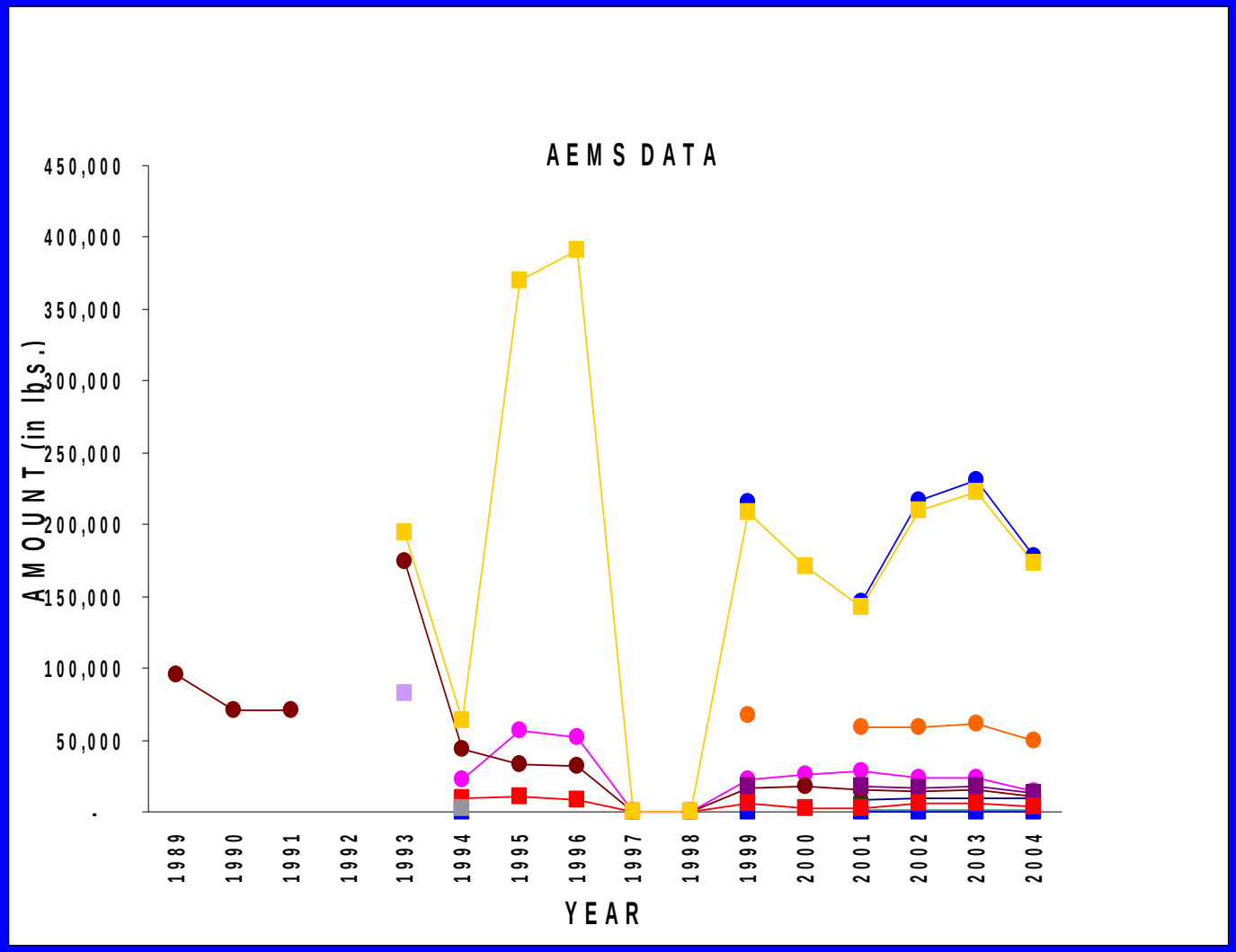
RAIMI Model

- Regional Air Impact Modeling Initiative
- Accounts for multiple contaminants and potency
- Has better geographic resolution than other methods
- Temporal resolution is still poor

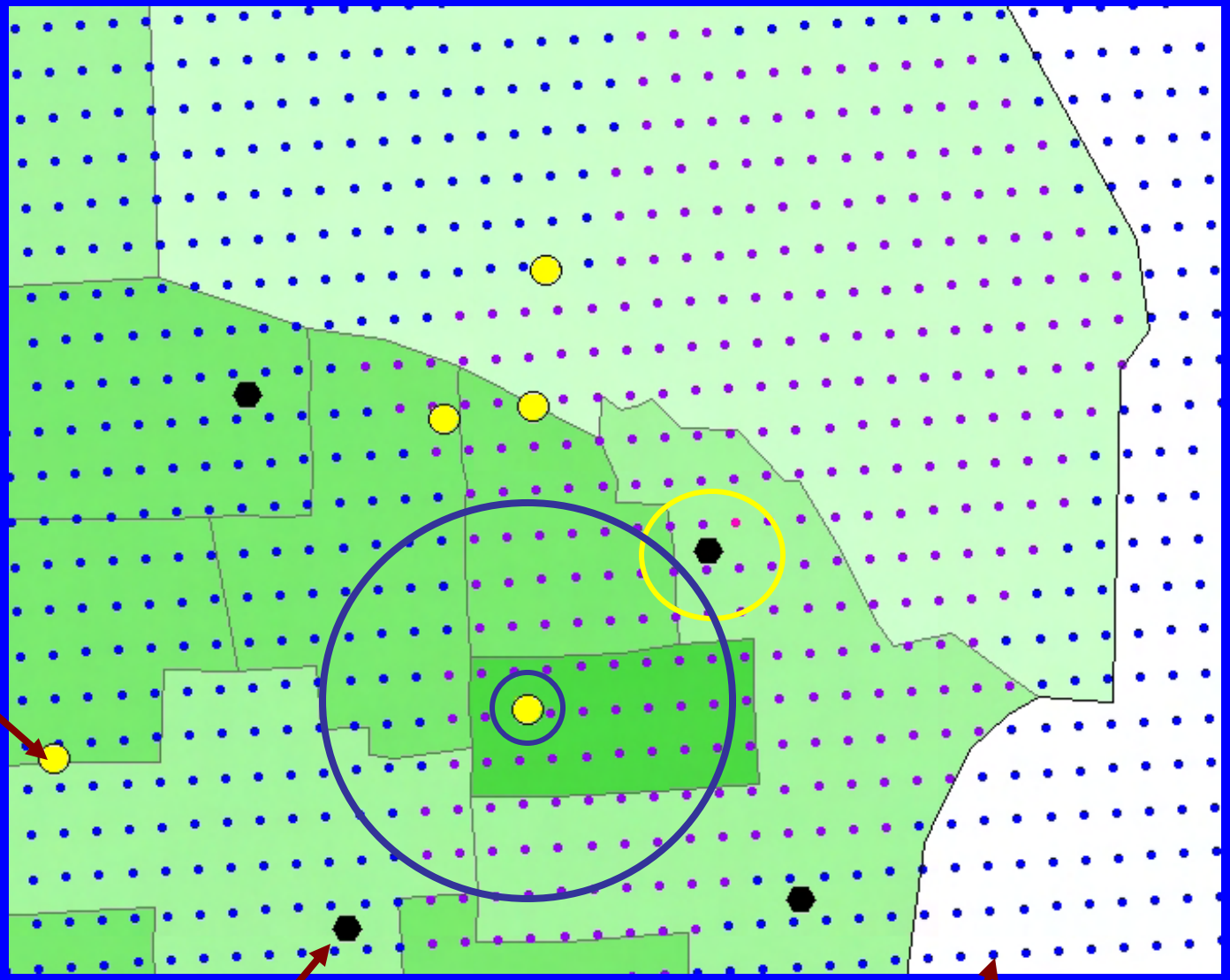
Modeling Hazards: Cumulative Exposure to Hazardous Air Pollutants (HAPS)

Modeling Hazards: Hazardous Air Pollutants (HAPS)

Application of Hazard Data



Exposure Assignment – closest point? Mean? Smoothed?



Cancer Control

Air Emissions Facilities

RAIMI Model Estimates

RAIMI Model

- Is possible and feasible
- Scientifically based
- Exposure Assignment will still be challenging
- Additional sources beyond ambient air emissions are needed- still may underestimate risk
- Validation needed
  - Is hypothesis generation, **NOT** hypothesis testing

Summary of Linkage Projects

Linkage Method	Feasible	Practical	Value added	Scientific	Overall Grade
1) 1-to-1 Linkage	A	B	C	D	C+
2) Buffer Analysis	B	D	C	C	C
3) RAIMI Model	C	C	A	A	B

Future Linkage Work for Wisconsin Environmental Public Health Tracking

- Finalize the analyses for asthma links to ozone and PM2.5
- Repeat asthma project with Emergency Room visits
- Repeat asthma project to include more years
- Incorporate data for cancer cases with RAIMI model information
  - Select cancers and compounds with biologically plausible linkages

Future Directions for Wisconsin Environmental Public Health Tracking

- Repeat asthma project to include more states
- Support inclusion of mobile sources of emissions into RAIMI
- Work with partners to get better exposure estimates for emissions

Making Data and Information Accessible

A. Find relevant data and assess utility for surveillance
B. Prioritize surveillance topics
C. Complete linkage projects
D. Create internet-based portals at national and state levels
    - Secure portal
    - Public portal

Thank you!

Contact information:
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