Assessing Ozone and $PM_{2.5}$ Air Quality Data for use with Asthma and Cardiovascular Disease Data

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with
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Public
Health
Air
Surveillance
Evaluation

PHASE Project Objective

- Develop, evaluate and demonstrate the advantages and limitations of different methods of generating air quality data that could be used routinely in an EPHT Network.

- The project will help us understand and improve the air quality data needed for a **sustainable** EPHT network.

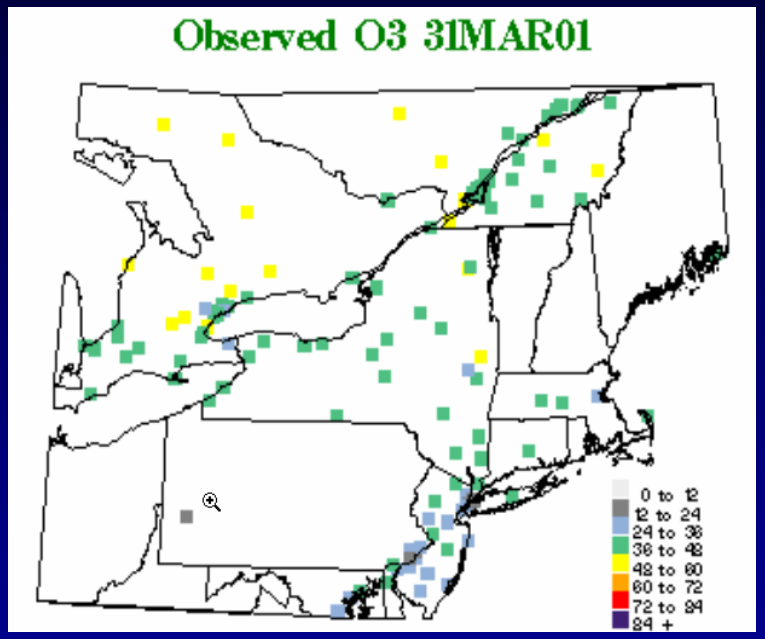
Partnership

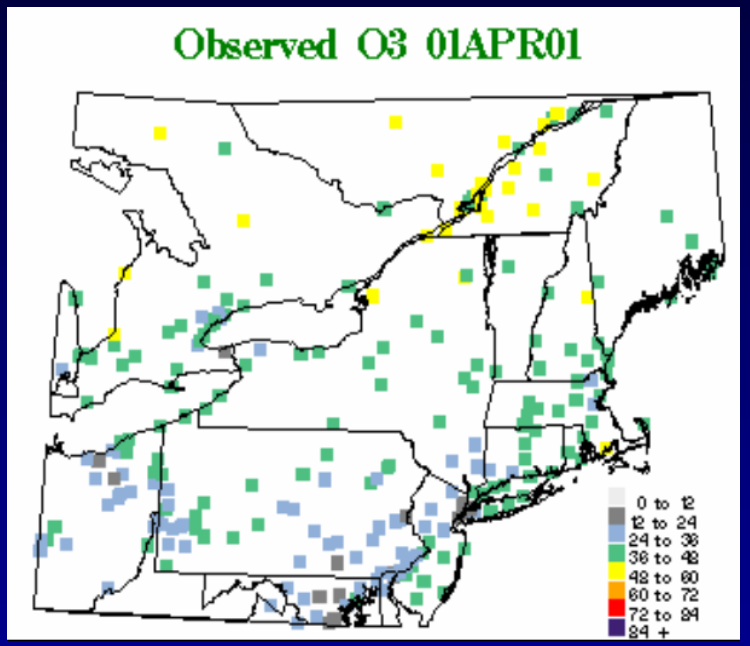
- CDC, EPA, academic, state and local partners.
- NOAA and NASA will assist EPA in developing air quality models.

EPA Role

- Develop and evaluate methods for providing air quality characterization for Maine, New York and Wisconsin.
  - Air monitoring data (limited number of locations)
  - Air monitoring data with spatial-temporal interpolation (Krigging)
  - Air quality modeling using emissions and meteorology data (CMAQ)
  - NASA satellite imagery
  - Combination of the different models (Bayesian)

Ozone Monitoring data is sometimes only available during the Ozone Season

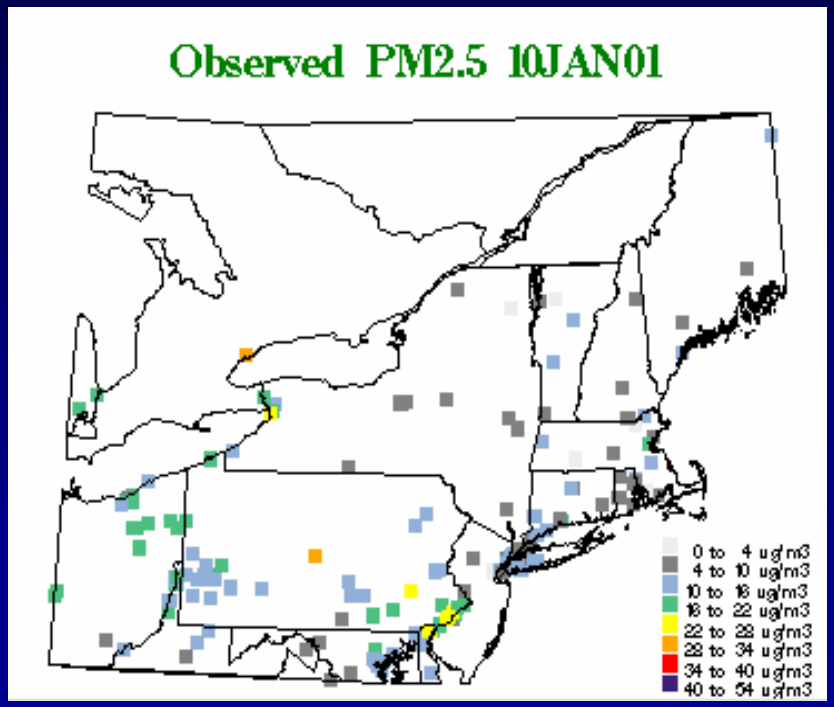


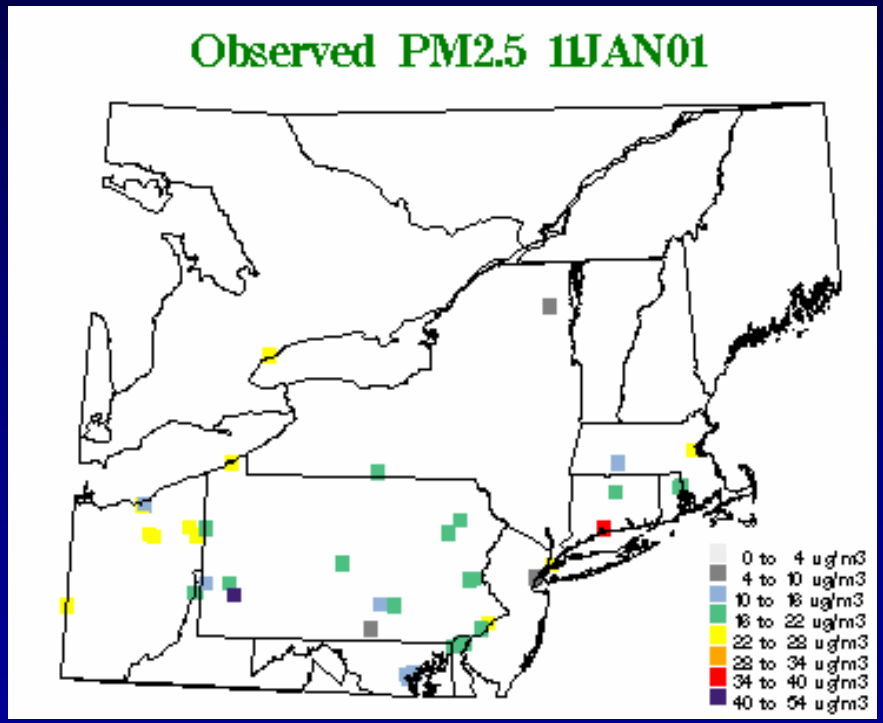


More Ozone stations come on-line April 1

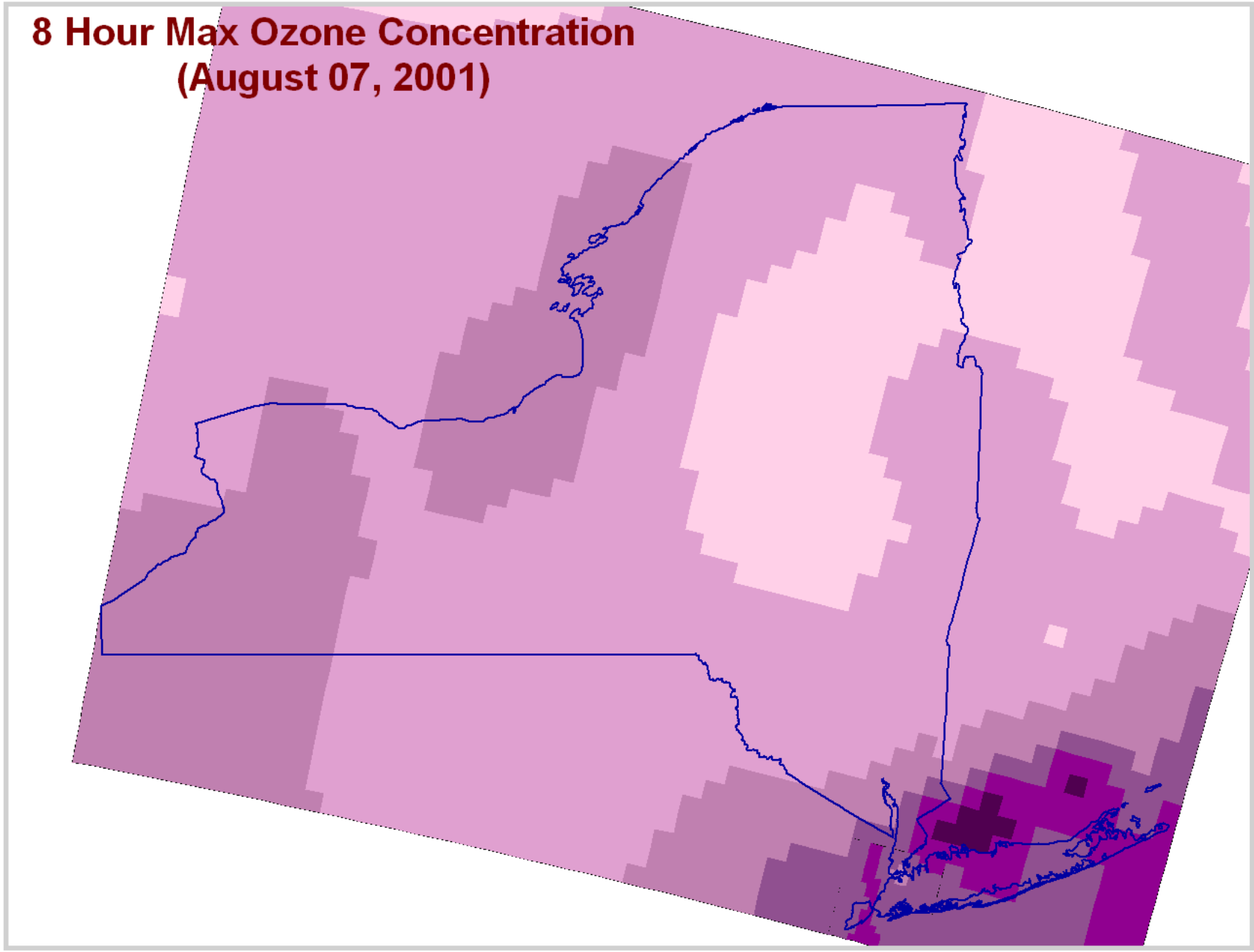
From USEPA

PM Monitoring data only available every third day





From USEPA


8 Hour Max Ozone Concentration
(August 07, 2001)

Air Quality Data

- Daily estimates are provided for each model for 2001.
  - Particulate matter$_{2.5}$ (daily mean)
  - Ozone (daily 8 hour maximum)
- Different scales (depending on model)
  - 4, 12, 36 KM grids
  - Census ZIP Code Tabulation Areas (ZCTA)

Maine, New York, Wisconsin

- Link health data for cardiovascular disease and asthma with the air quality data from the different models.
- Health data from hospitalization and death certificate records.
- Each state will analyze the linked data.
- Assist in evaluating the air data from the perspective of the data user.

New York State Plan

- Geocode Health Data
  - Childhood asthma hospitalizations
    15,000 / year
  - Adult cardiovascular hospitalizations
    Ischemic heart disease, congestive heart failure, stroke
    350,000 / year
  - Adult cardiovascular death certificates
    70,000 / year

New York State Plan

- Link health data to the PM and ozone air quality data for each EPA model.
- Conduct case-crossover analysis to determine the strength of association for each model
- Determine how the strength of association varies between models

New York State Plan

- Evaluate ease of use of the data
- Geographic Resolution
- Temporal Resolution
- Spatial Coverage
- Describe how the strength of association varies between geographic scales (4,12,36 km grid, ZCTA)

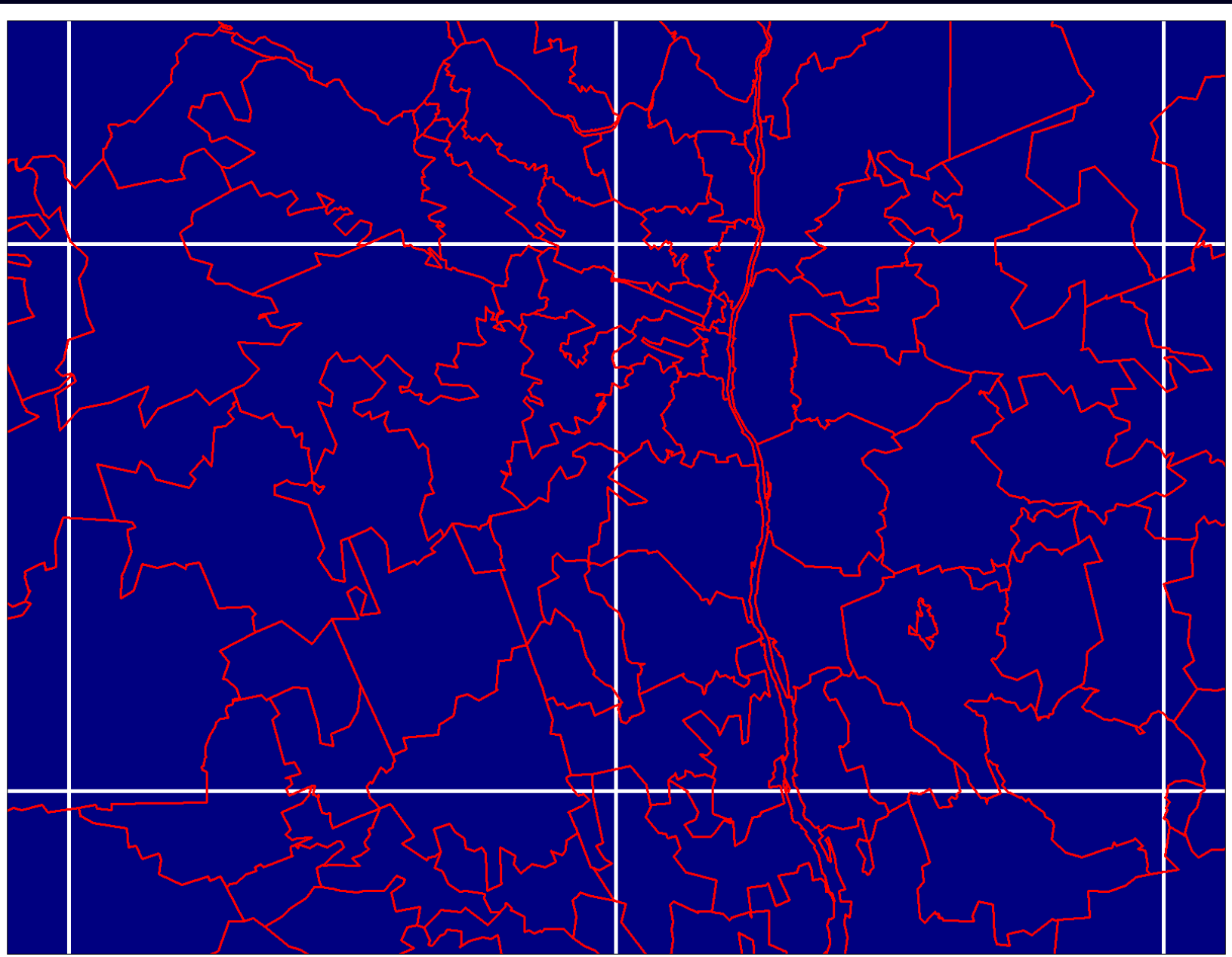
Assigning Grid Cells to Cases

- Grid Cells are assigned to cases by automated geocoding using street addresses
  - 71% Hospitalizations geocoded
  - 79% Deaths geocoded

Assigning Ungeocoded Cases to Grid Cells based on ZIP Code.

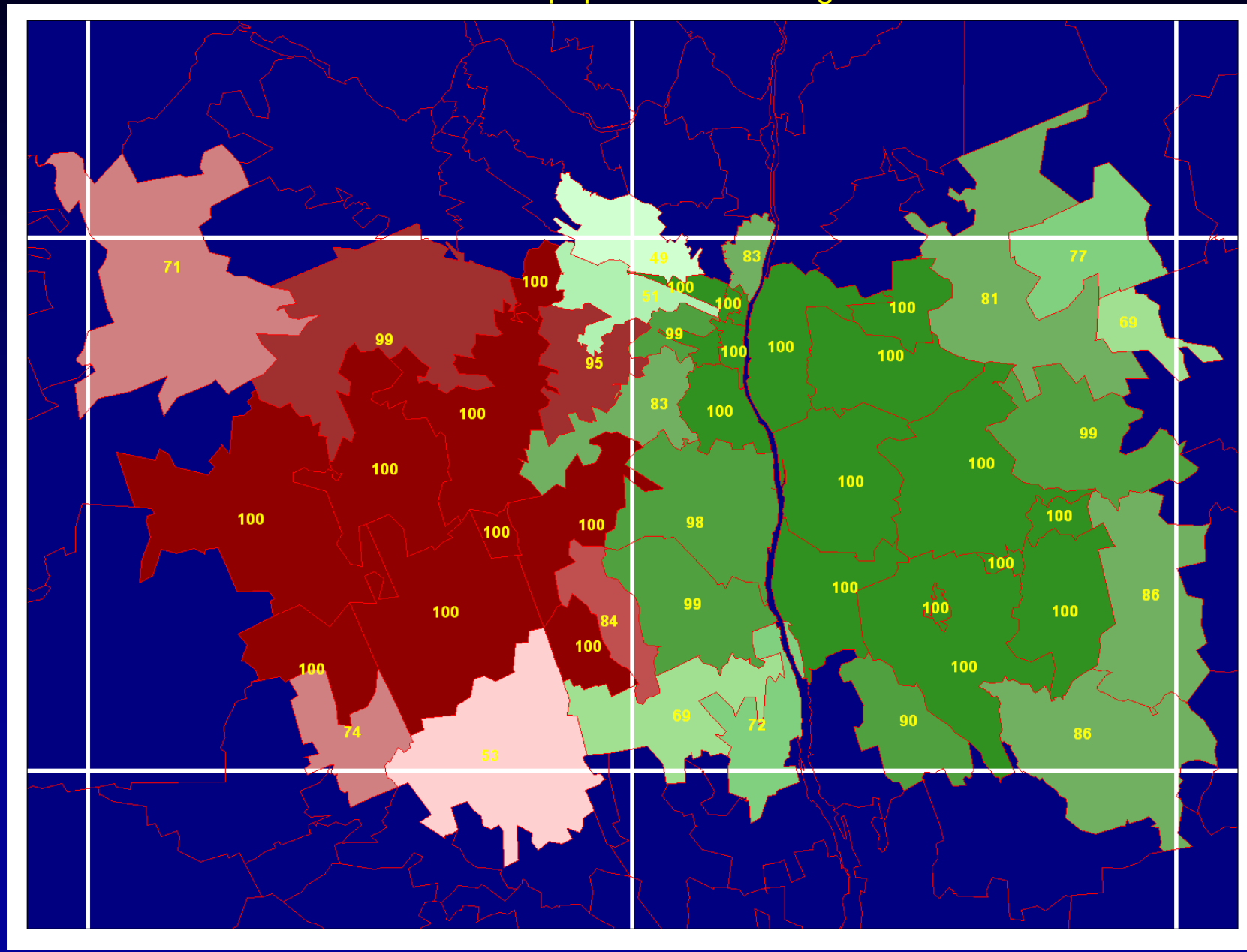
- Ungeocoded cases are assigned to grid cells based on their ZIP Code.
- Over 95% of the cases have valid ZIP codes
- For example: If a majority of the population in a ZIP Code live in in Grid Cell #1. Then any ungeocoded case with that ZIP code will be assigned to Grid Cell #1.
- This operation is performed using a GIS to overlay ZIP code and grid boundaries with census data at the census block level.

ZIP Codes and Air Quality Grids



Assigning Cases to Grid Cells based on Population Overlap

Percent of ZIP population in each grid cell



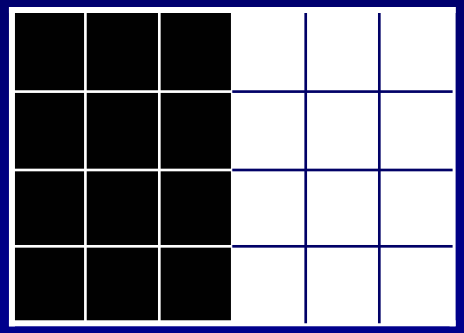
Assigning cases to the wrong cell

- Misclassification will depend on scale.
  - Larger the grid cells less misclassification
  - Smaller the ZIP codes less misclassification
- Impact of incorrect cell assignment will depend on spatial autocorrelation of air quality.
  - How similar is air quality in neighboring cells?
  - How does air quality vary locally for the same period?

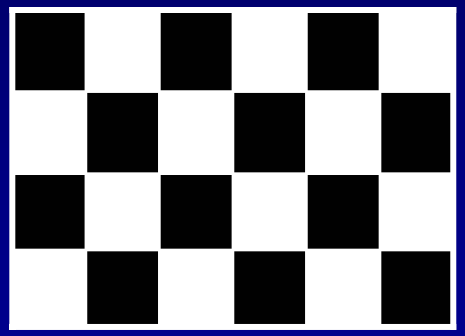
Spatial Autocorrelation

"Everything is related to everything else, but near things are more related than distant things."

- Tobler's first law of geography



Positive autocorrelation



Negative autocorrelation

What is a case-crossover study?

- Method to answer question 'Was this event triggered by something that happened just before?'
- Each case serves as his/her own control

  Cases: asthma hospitalizations
  cardiovascular deaths and hospitalizations

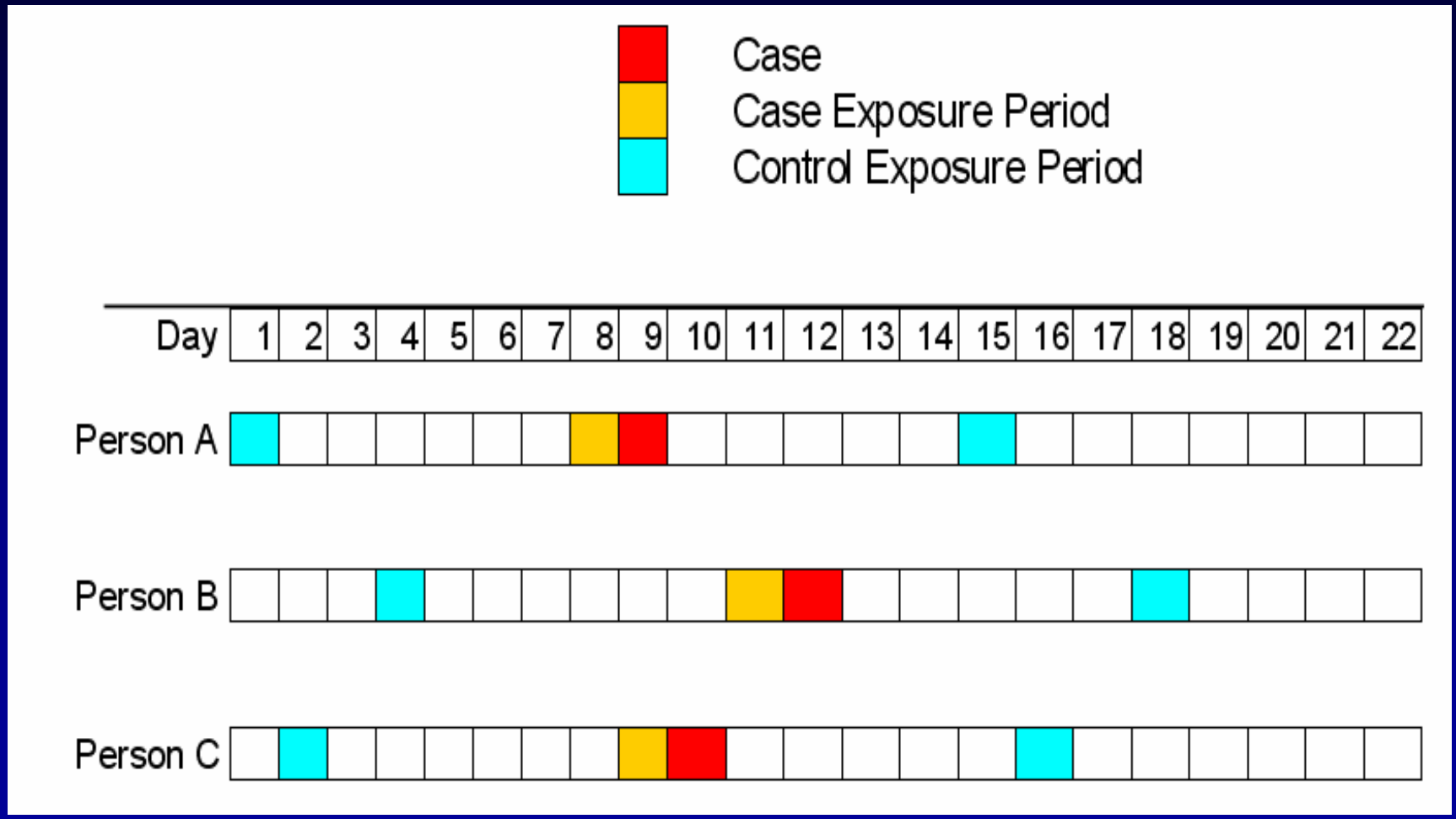
  Controls: what was air pollution like on days that the cases were not hospitalized

- Conditional logistic regression

Bi-directional Case Cross Over

with 1 day lag period

control days are one week from case exposure period



Modified from Johns Hopkins training materials from Thomas Bateson

We can consider various lags and exposure periods

Pollutant	OR	p-value
Current day	1.05	0.03
Previous day	1.20	<0.0001
2 days ago	1.10	0.01
3 days ago	1.00	0.80
Average of past 2 days	1.06	0.02
Average of past 3 days	1.01	0.30

Main Questions

- Do the odds ratios change among the 5 different methods of estimating ozone and pm?

  Asthma
  Cardiovascular disease

- Does the strength of association between air quality and disease events change at different scales?

  4 km cells
  12 km cells
  36 km cells
  ZCTA (ZIP Codes)

Software Considerations

There are many permutations of the case-crossover models we are exploring.

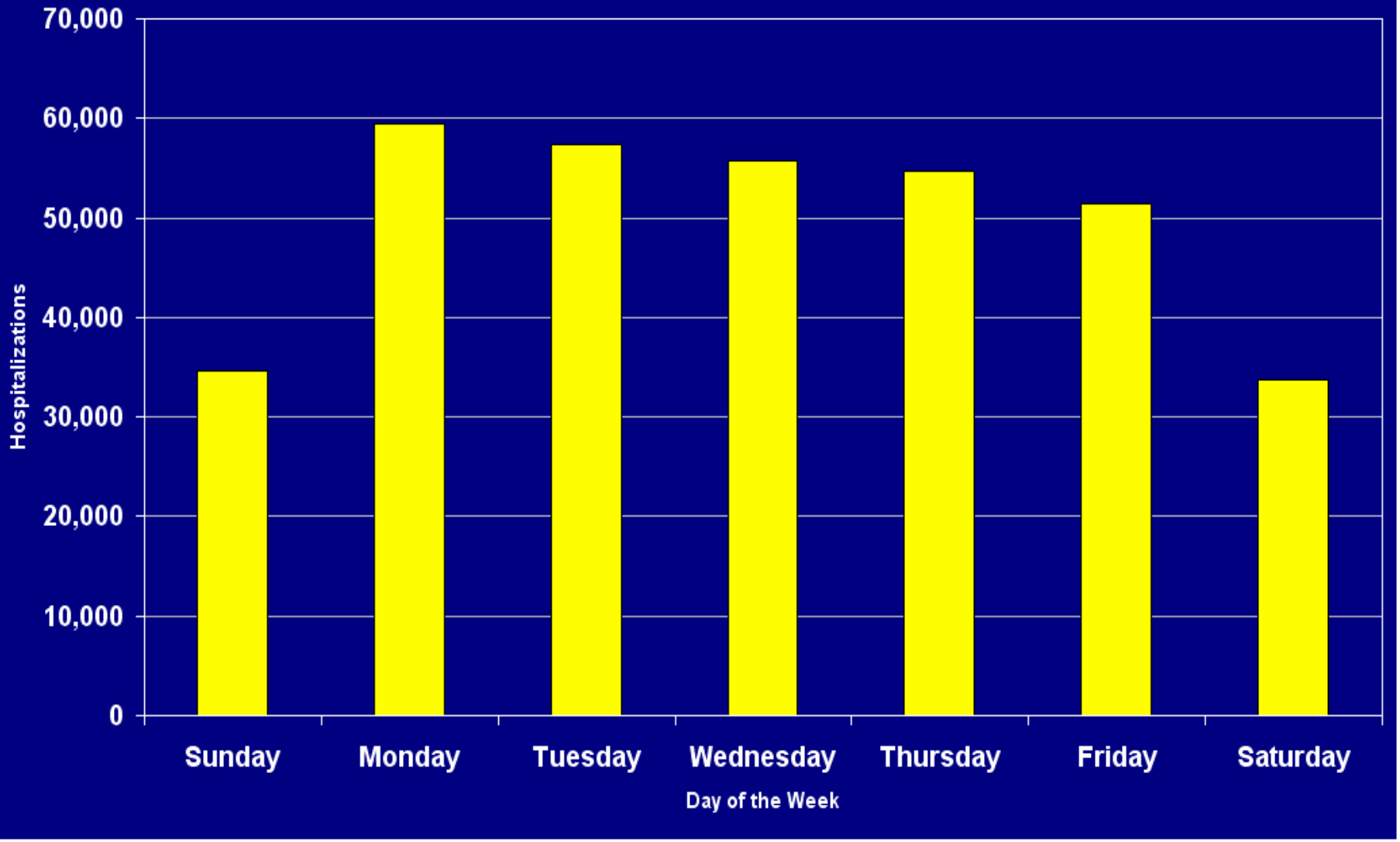
The software we use needs to be flexible easy to use.

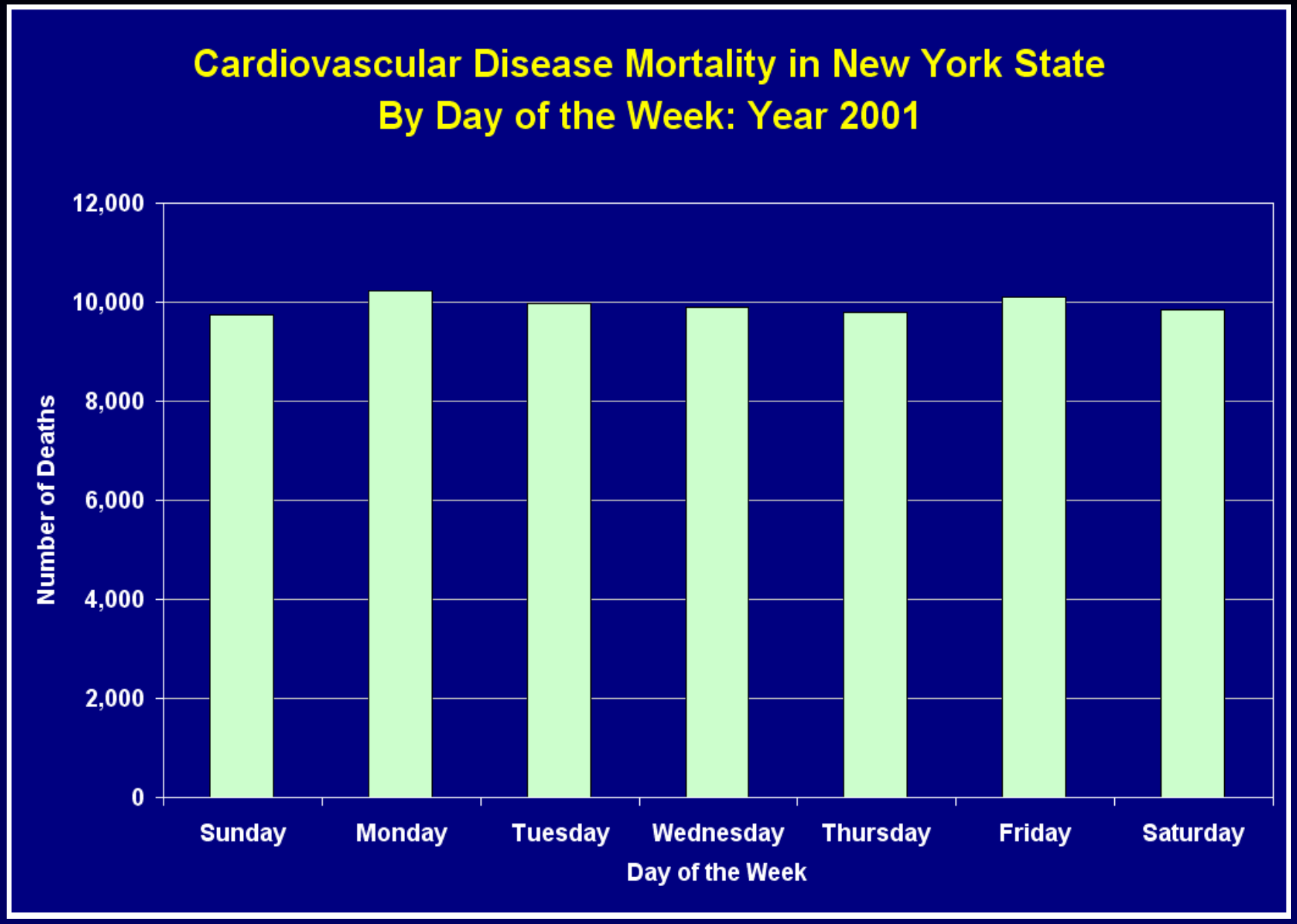
We are currently building front end modules for both our GIS and SAS. Input and output data will pass easily between the two systems.

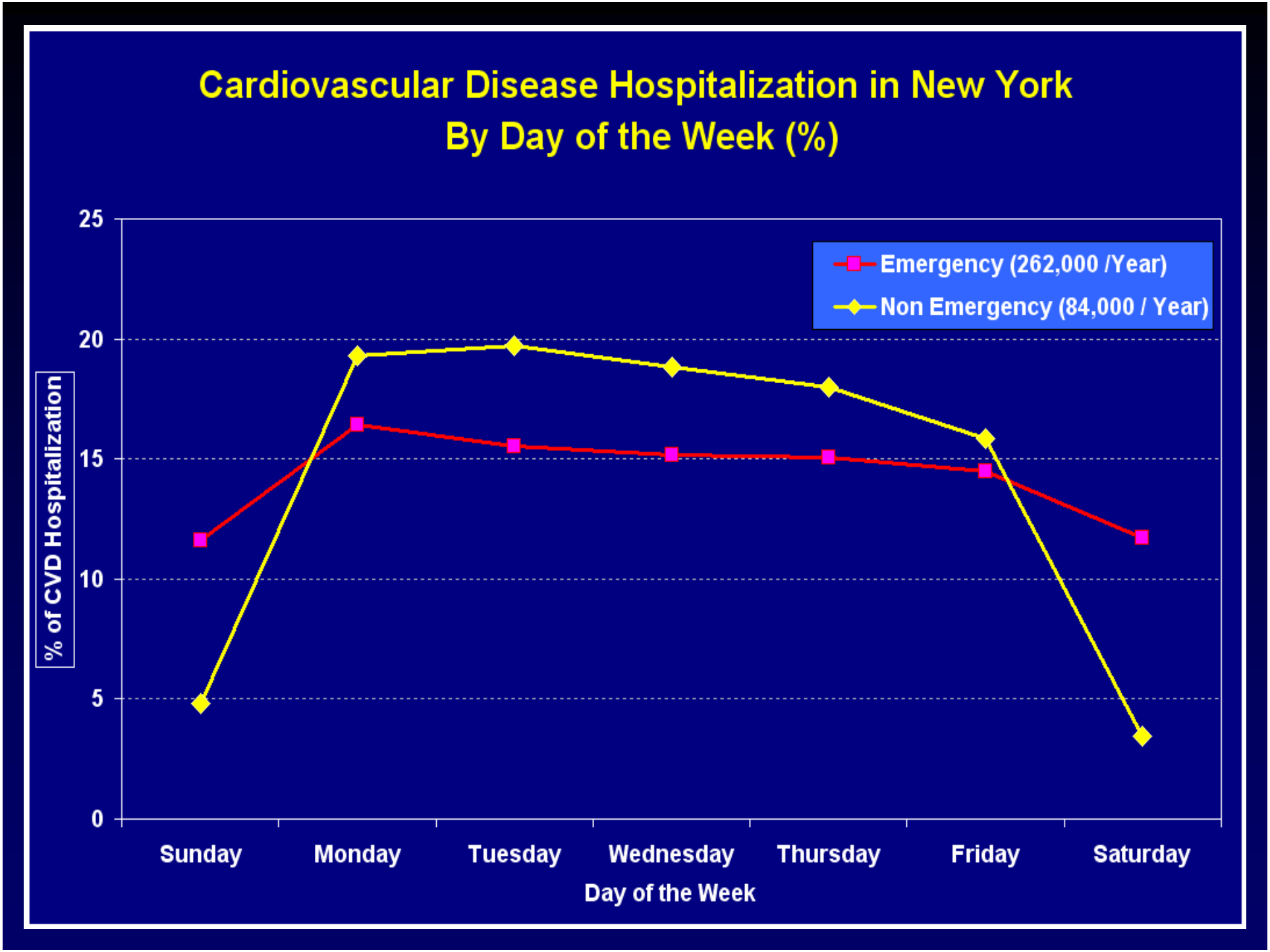
Other Considerations

- Which diagnostic codes should we look at?
- How should the ICD codes be grouped for analyses?
- Can we separate out scheduled admissions from emergency admissions?

Cardiovascular Disease Hospitalizations By Day of the Week :Year 2001




Cardiovascular Disease Mortality in New York State
By Day of the Week: Year 2001
12,000
10,000
8,000
6,000
4,000
2,000
0
Number of Deaths
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Day of the Week


Cardiovascular Disease Hospitalization in New York
By Day of the Week (%)
Emergency (262,000 /Year)
Non Emergency (84,000 / Year)
% of CVD Hospitalization
25
20
15
10
5
0
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Day of the Week

Future Analyses

- Consider the speciation of the particulate matter.
- Control for meteorological conditions (temp, relative humidity)
- Control for other pollutants

Does the strength association vary by regions?

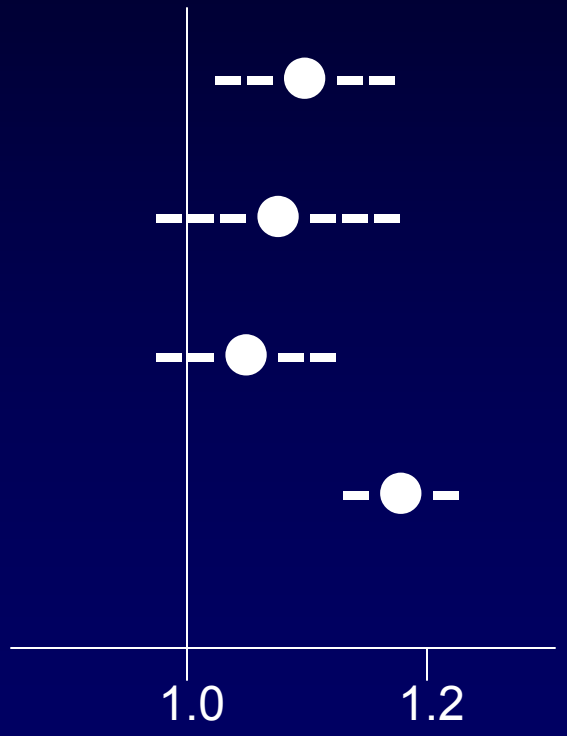
Region

Eastern NY

Western NY

Long Island

New York City

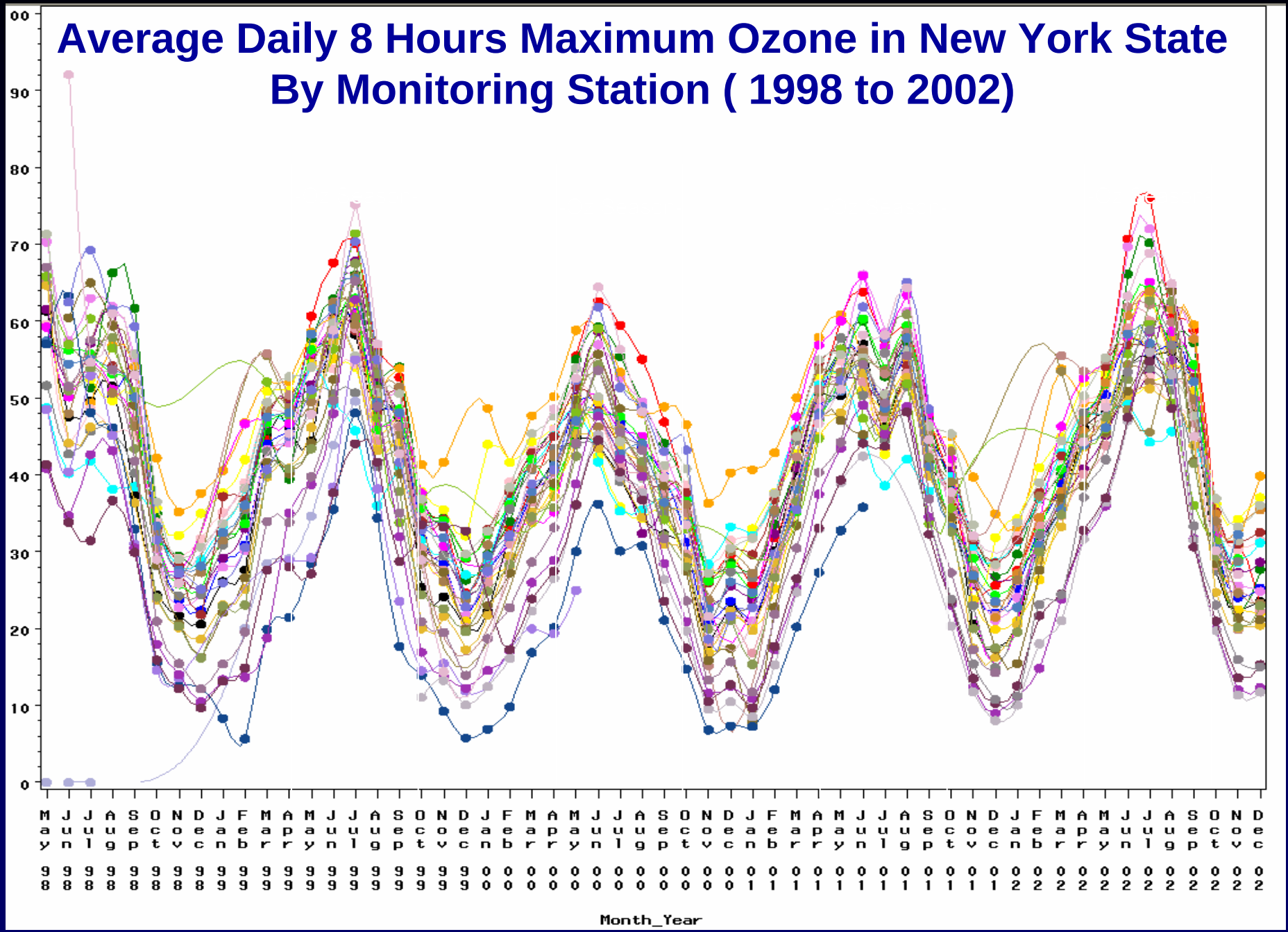


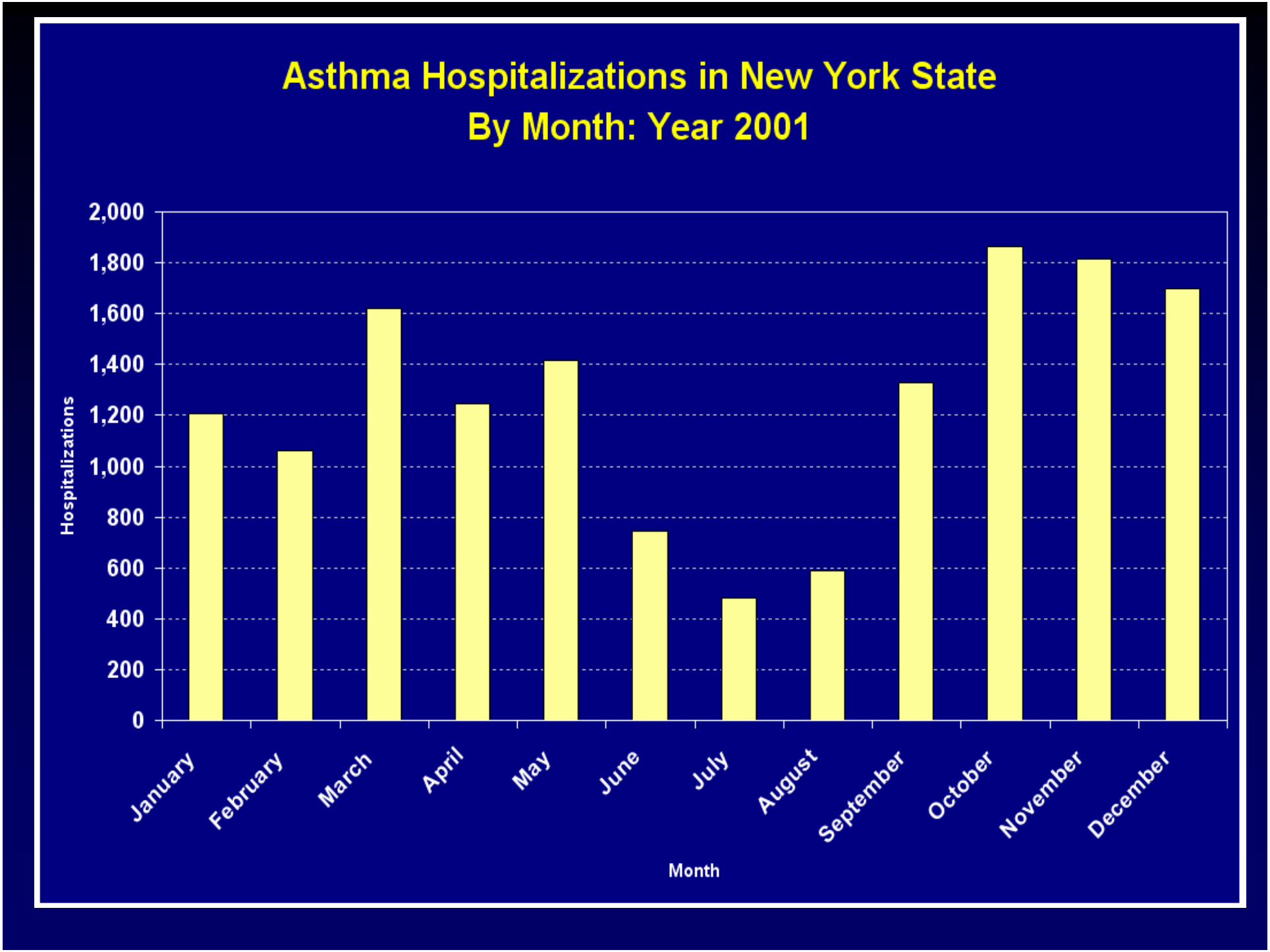
OR and 95% confidence interval

(for hypothetical pollutant)

Does strength of association vary with season?

Average Daily 8 Hours Maximum Ozone in New York State By Monitoring Station (1998 to 2002)




Asthma Hospitalizations in New York State
By Month: Year 2001
Hospitalizations
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
Month