Linking Asthma Exacerbation with Exposure to particulate matter in the Atlanta metro area: Transforming environmental measurements for data linkage with HMO records

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Overview

- Objectives
- Overview of data assessment
- Exposure estimates
- Limitations
- Next steps

HELIX-Atlanta Respiratory Health Team

- HELIX-Atlanta Respiratory Health Team (RH Team) will contribute to HELIX-Atlanta effort by providing innovative methods for integrating and analyzing respiratory health and environmental data for environmental public health surveillance

Goals

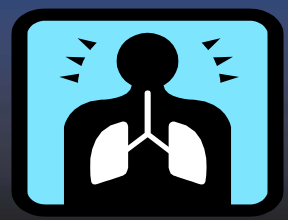
- Provide information on methods for integrating asthma and particulate matter 2.5 microns or less ($PM_{2.5}$) data for environmental public health surveillance
- Generate information and recommendations valuable to sustaining surveillance of asthma and $PM_{2.5}$ in the Metro Atlanta Area





Selection of Measures

- Reviewed literature
  - Studies examining association b/t asthma & air pollution evaluated asthma exacerbation or mortality
    - Suggested positive correlation between criteria air pollutants and asthma exacerbation (Chew, Tolbert, Norris, Galan & Koenig)
- Evaluated data sources containing asthma related health effects and $PM_{2.5}$

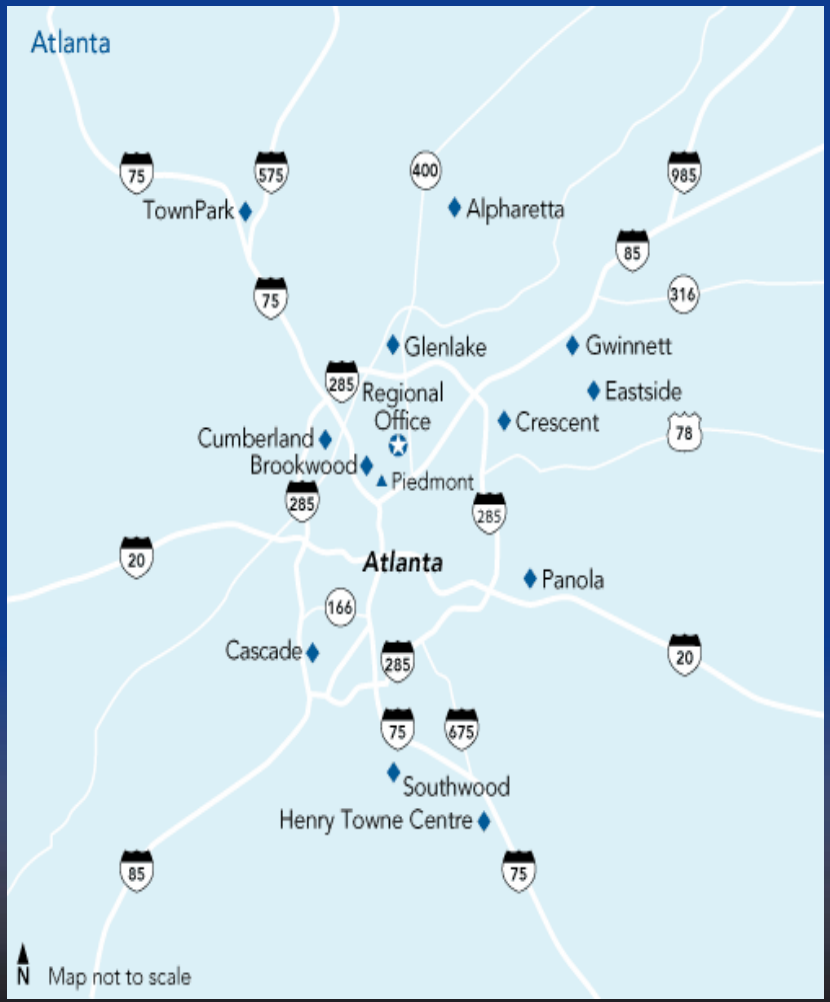


Asthma Measure

Daily acute asthma office visits to a Kaiser Permanente-GA medical facility from 2002-2004

- Acute asthma office visits - appointments made same day and ER visits
- Kaiser IRB has approved the project

Kaiser Permanente Georgia (KP-GA)



- 13 Kaiser facilities
- 264,708 Members (7/04)
- 90% Group Model
- Diverse Membership
- Acute Visit Access
- 20 county metro area coverage
- Contract hospitals for emergency care
- Mean 2.7 primary care visits per member/year
- Mean 17.6 acute child asthma visits/day
- Mean 11.8 acute adult asthma visits/day

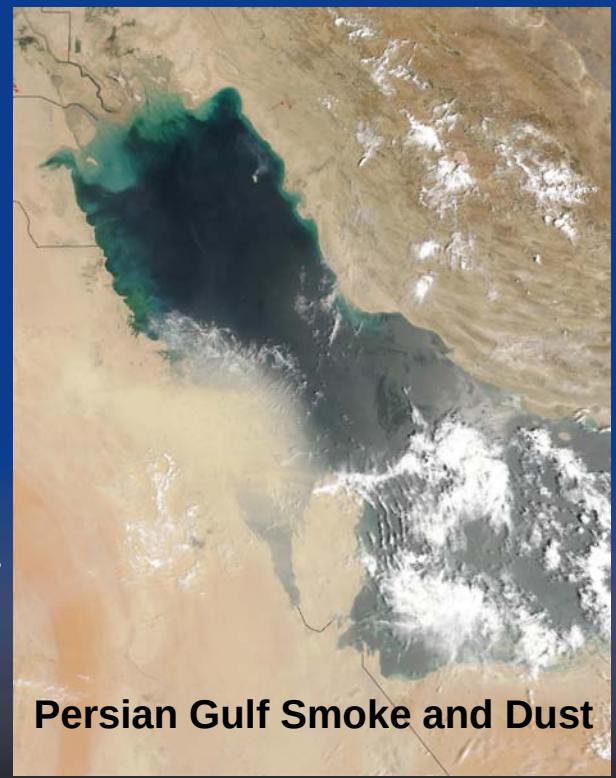
Environmental Hazard Measure

- Daily $PM_{2.5}$ (2002-2004)
  - Studies in Atlanta examining relationship between criteria air pollutants and asthma exacerbation focus on ozone and/or PM_{10}
  - In 1997 EPA strengthened health protection standards for PM by adding $PM_{2.5}$

Exposure Assessment Methods

NASA Satellite Data

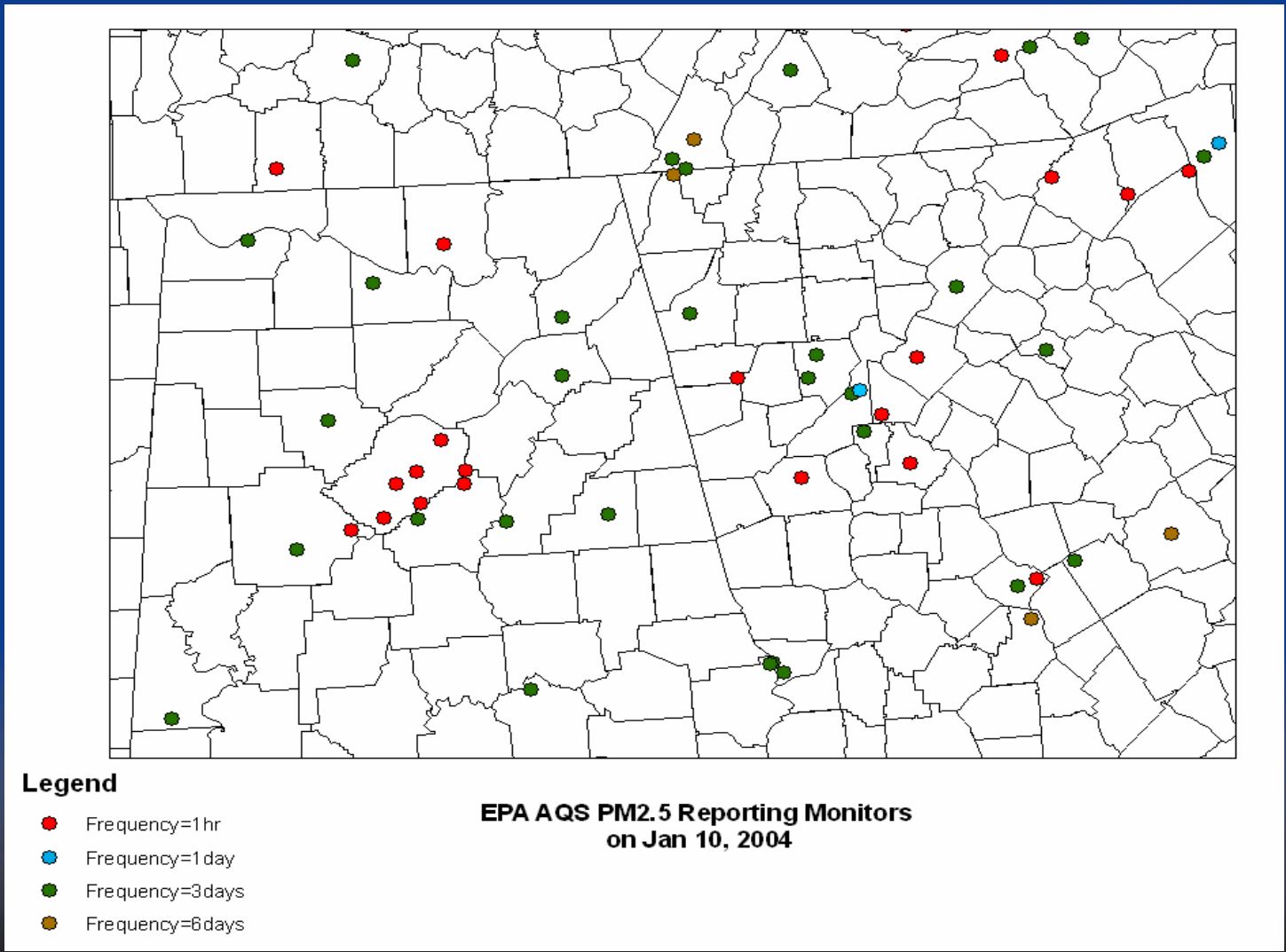
- Why? Satellite data provide enhanced spatial coverage
- NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) sensors flying on two satellites measure Aerosol Optical Depth (AOD) in the morning and afternoon when clouds are not present.
  - AOD is a measure of the total particulate mass in the atmosphere
  - If atmosphere is well mixed, AOD is a good indicator of surface $PM_{2.5}$
  - MODIS AOD is provided on a 10x10 km grid



Persian Gulf Smoke and Dust

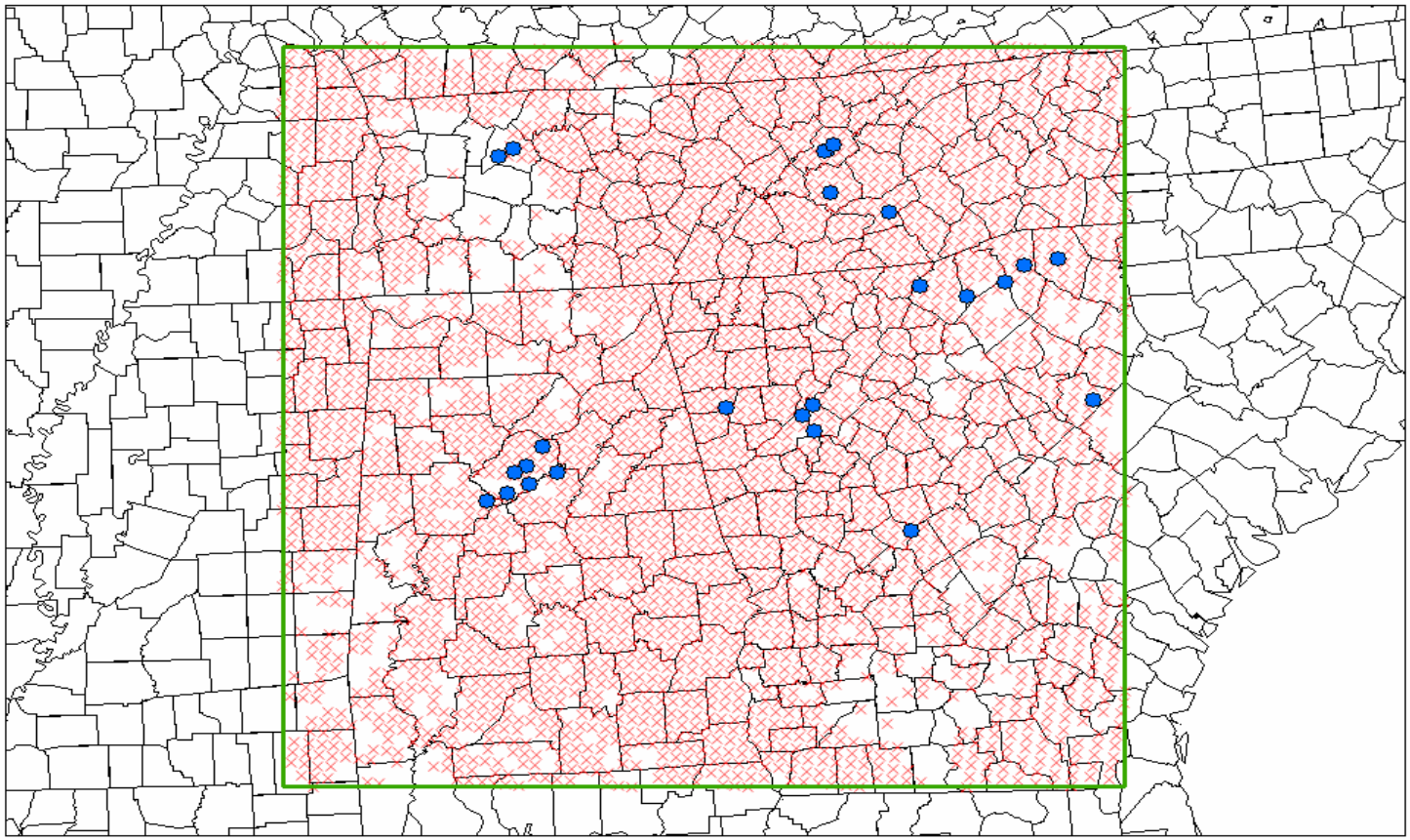
EPA PM $_{2.5}$ Reporting Monitors

- AQS monitors reporting $PM_{2.5}$ on 10 January 2004.
- Reporting frequency ranges from 1 hour to 6 days.
- This represents best possible spatial coverage; on most days there are many fewer reporting monitors.



NASA MODIS Data Importance

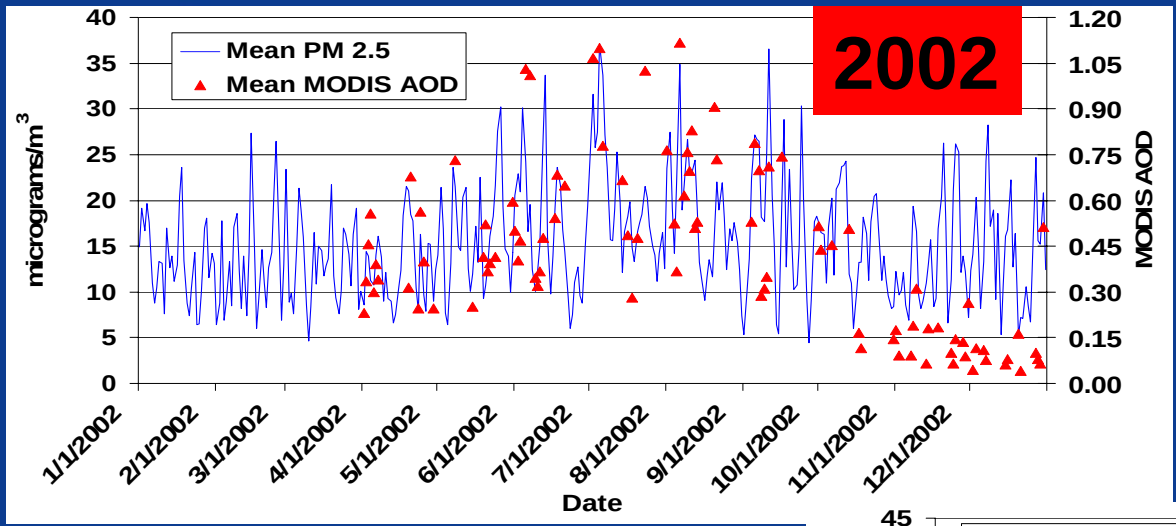
MODIS and AQS data will be merged to create the final spatio-temporal exposure assessment



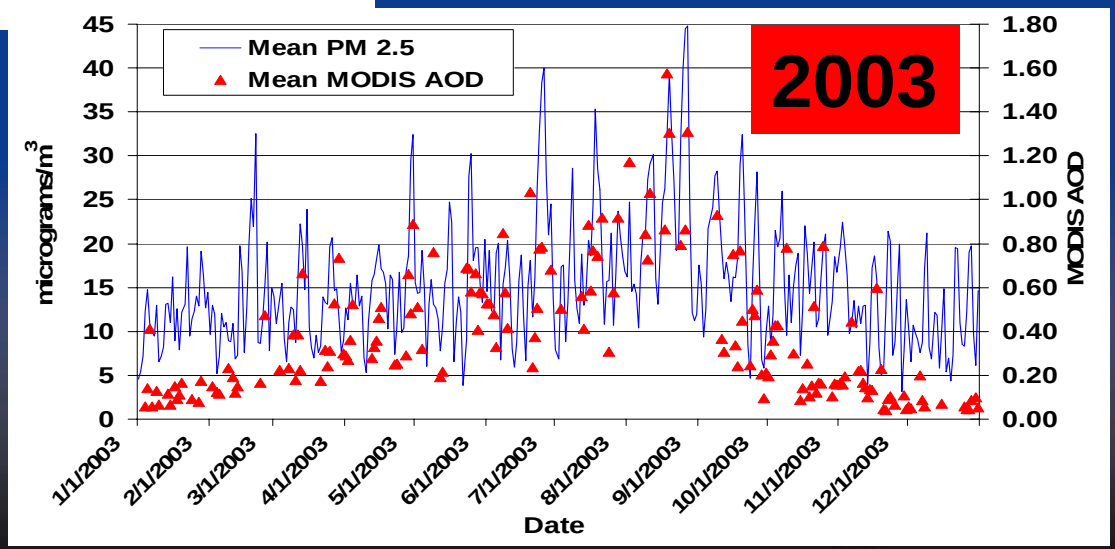
Assessment of Correlation Between Ground Monitors and Satellite data

- Used hourly and daily EPA-AQS surface monitor measurements to determine daily mean $PM_{2.5}$
- Extracted MODIS satellite data for locations corresponding to each of the surface monitoring sites
- Paired observed $PM_{2.5}$ values with corresponding MODIS AOD data to calculate correlations and regression equations from April - September (warm season) and from October - March (cool season) for 2002-2003

MODIS AOD - Monitor Relationship



- Daily all-site means of observed $PM_{2.5}$ and MODIS AOD
- MODIS data not available every day due to clouds



- MODIS AOD follows seasonal patterns of $PM_{2.5}$ but not the day-to-day variability in fall and winter

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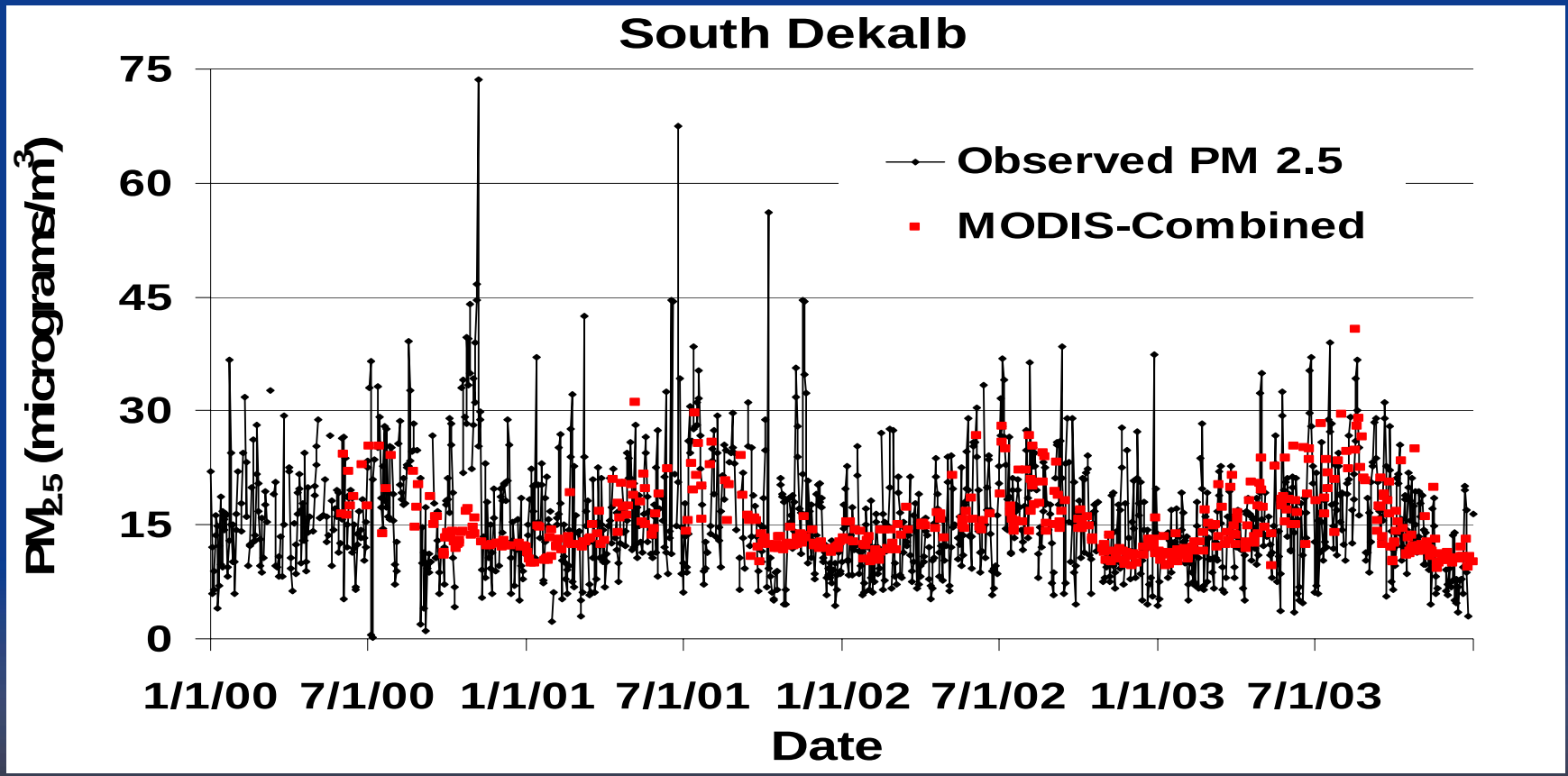
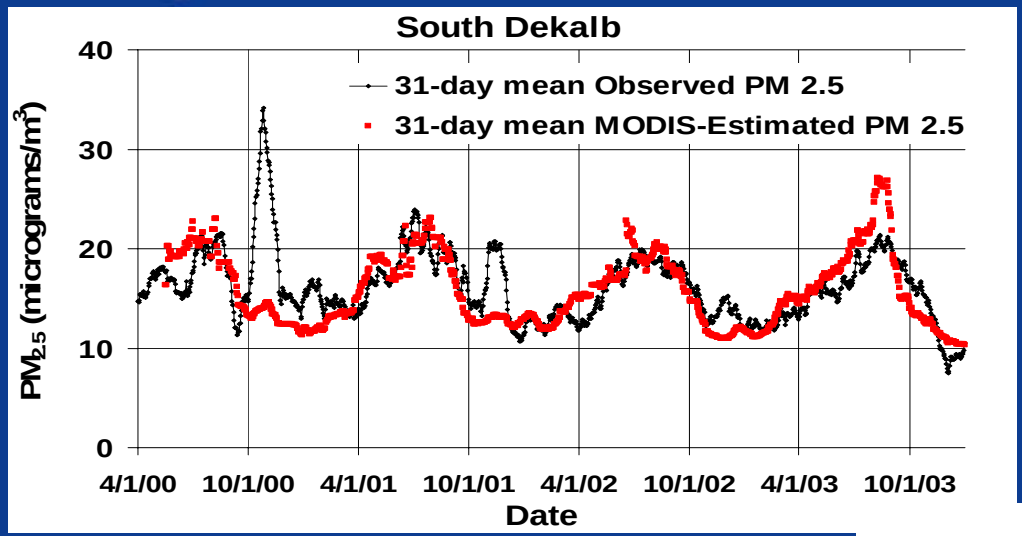
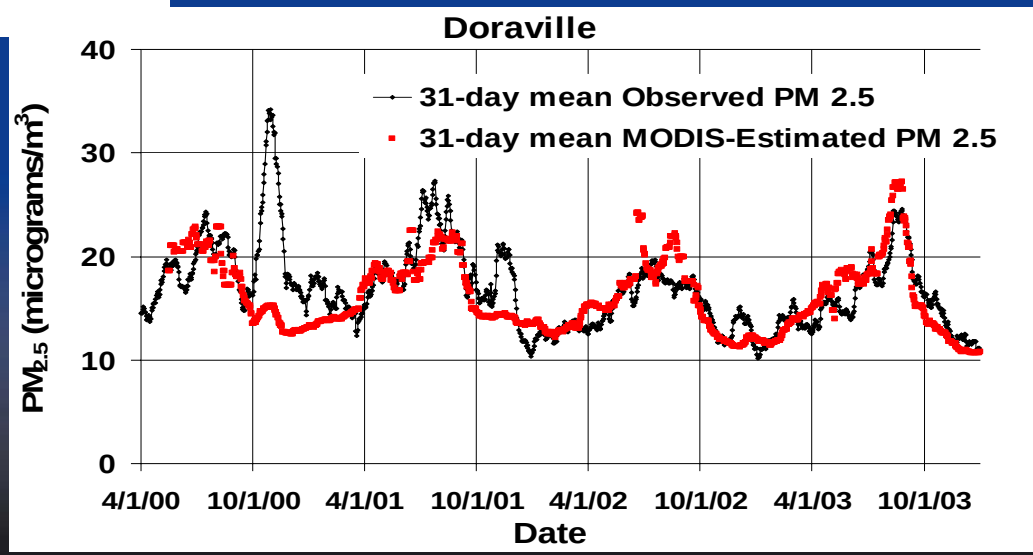
Observed and MODIS-Estimated $PM_{2.5}$ 2000 - 2003



Observed and MODIS-Estimated $PM_{2.5}$ 2000 - 2003



- MODIS predictions follow seasonal $PM_{2.5}$ patterns.
- MODIS AOD is nearly constant in fall and winter, while observed $PM_{2.5}$ is not. Some major events are not captured by MODIS estimates.



- 31-day running averages

Monitor – MODIS AOD Correlations

Warm Season (April – September)

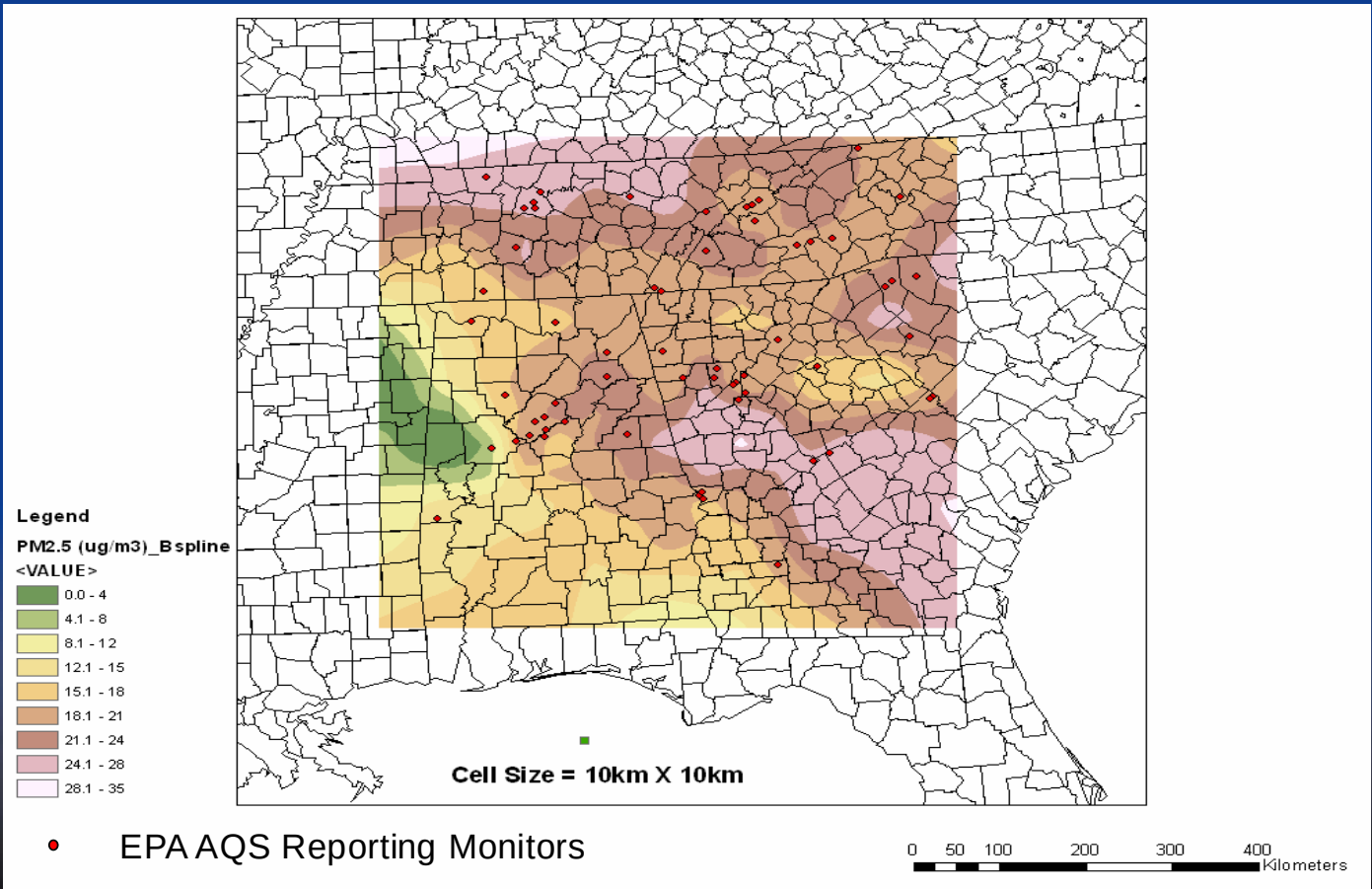
	MODIS-Terra	MODIS-Aqua
2000 -->	0.579	
2001 -->	0.643	
2002 -->	0.559	0.401
2003 -->	0.661	0.727

For July-September only

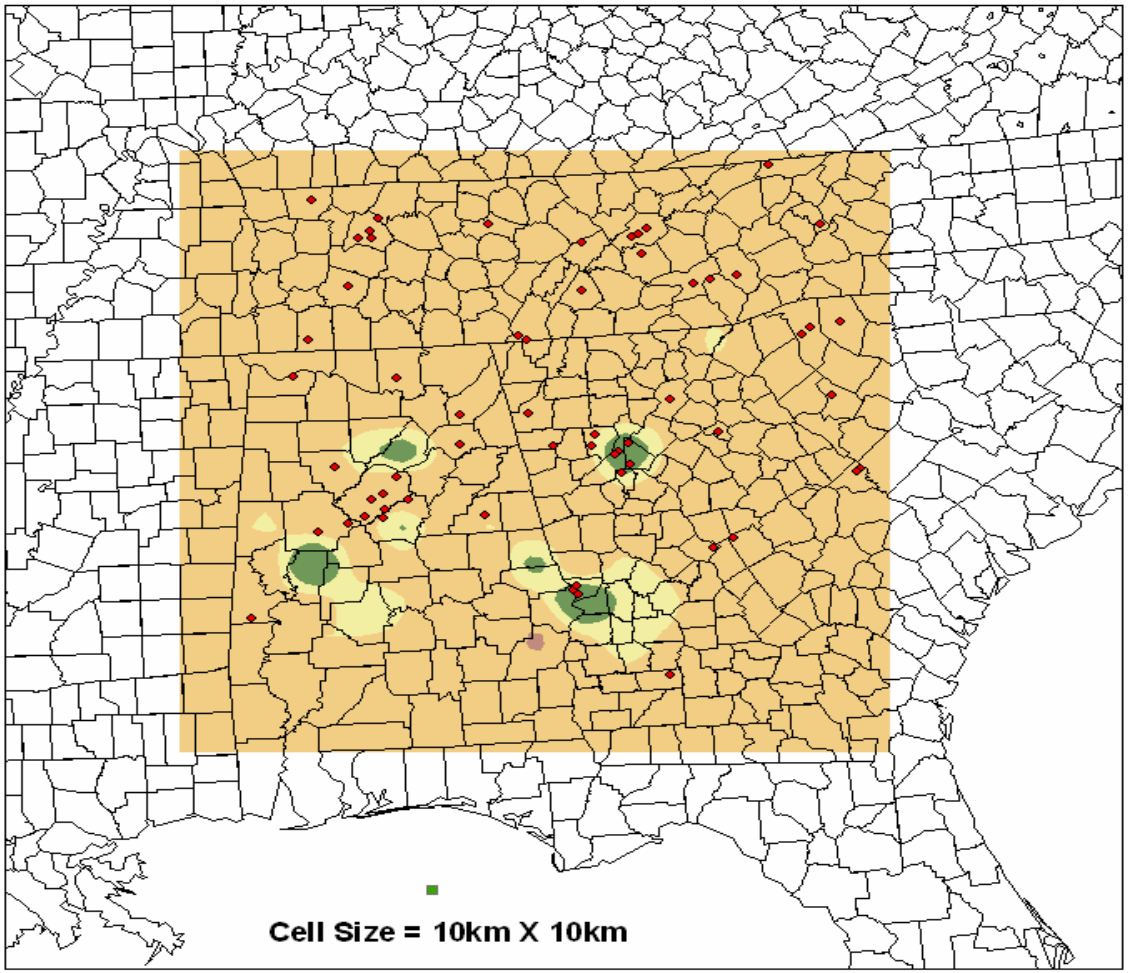
$PM_{2.5}$ Exposure Assessment

- Collect EPA monitor data for study area in GA, AL, TN, NC, SC
- Run B-Spline fitting technique to output daily $PM_{2.5}$ surfaces

17 July 2003 B-spline surface



B-Spline Residuals Surface
(17 July 2003)



Legend

Residuals

Value

- -5 - -1.42
- -1.41 - -0.51
- -0.50 - 1.5
- 1.51 - 2.5

0 50 100 200 300 400 Kilometers

- EPA AQS Reporting Monitors

Conclusions

- Day-to-day variations in $PM_{2.5}$ are large
- Seasonal variations are evident but smaller
- MODIS tracks the seasonal patterns of $PM_{2.5}$
- Correlations between MODIS and $PM_{2.5}$ for the warm season are generally > 0.6 for the means of all sites
- MODIS does not capture day-to-day $PM_{2.5}$ variability in cool season
- There is good agreement between B-Spline $PM_{2.5}$ surfaces and EPA observations at the site locations
- $PM_{2.5}$ concentrations are lower during the cool season than during the warm season
- Spatial and temporal gaps in data can be filled by utilizing NASA MODIS data during the warm season

Limitations

- MODIS AOD does not correlate well with surface $PM_{2.5}$ during the cool season
- Monitors have less than optimal spatial coverage
- Asthma measure selected
  - Does not provide spectrum of asthma chronic and acute measures- project examining asthma exacerbation
  - Capturing subset of population with acute asthma

Next Steps

- Combine EPA and MODIS $PM_{2.5}$ data and apply exposure assessment method
- Develop $PM_{2.5}$ concentration estimates on 10 x 10 km grid within the region for 2002-2004
- Geocode entire KP-GA member data base to obtain latitude/longitude coordinates of each member and every asthma visit for 2002-2004
- Link health and air pollution data
  - Each asthma visit and member in the KP-GA will be assigned $PM_{2.5}$ concentration of the grid cell within which they lie
  - Visits and rates will be determined and stratified by age and gender for spatial-temporal analyses
- Determine analysis plan
  - Evaluate association between daily acute asthma office visits and $PM_{2.5}$

Team Members and Acknowledgements

Member's Name, Affiliation

- (*Co-Chair)* Kafayat Adeniyi, Centers for Disease Control and Prevention,
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- Kristen Mertz, Georgia Division of Public Health
- Amanda Sue Niskar, Centers for Disease Control and Prevention
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- Amber Sinclair, Kaiser Permanente
- Allison Stock, Centers for Disease Control and Prevention
- Denis Tolsma, Kaiser Permanente
- Linda Thomas, Environmental Protection Agency, Region 4
- Ntale Kajumba, Environmental Protection Agency, Region 4
- Carolyn Williams, Georgia Division of Public Health

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