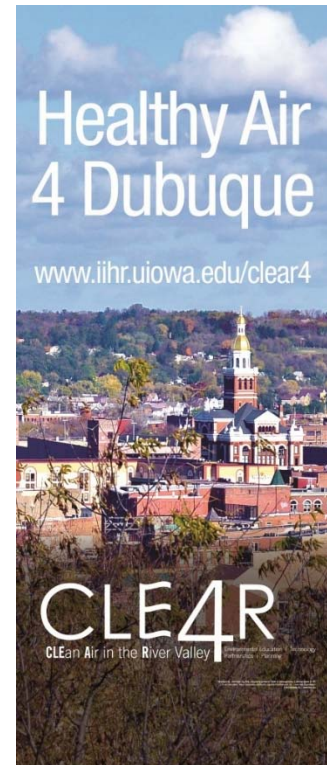


# CLE4R Partner Training Segment 2. Dubuque Air Quality

Can Dong [can-dong@uiowa.edu](mailto:can-dong@uiowa.edu)

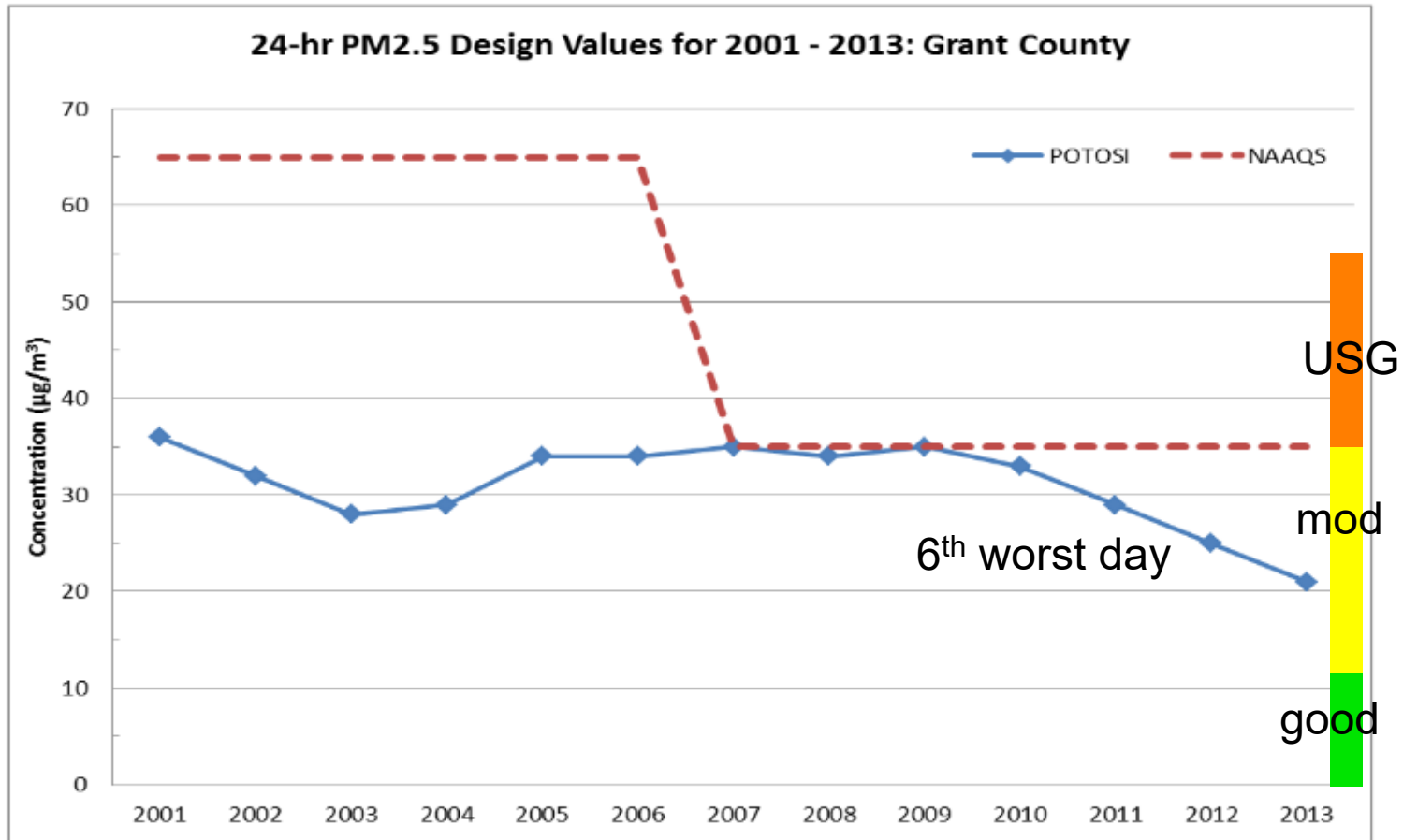
Charles Stanier [charles-stanier@uiowa.edu](mailto:charles-stanier@uiowa.edu)



- Nearest monitor Potosi Wisconsin
- 13 miles away, 21 km
  - Monitor elevation: 975 ft
  - 338 ft above river level
- Concentrations from regional contributions will be very close to one another
- Difference – will depend on local source strengths, and local (topographic) winds
- Pollution can accumulate in the river valley if there is a strong inversion, and pollution can travel up/down the river valley

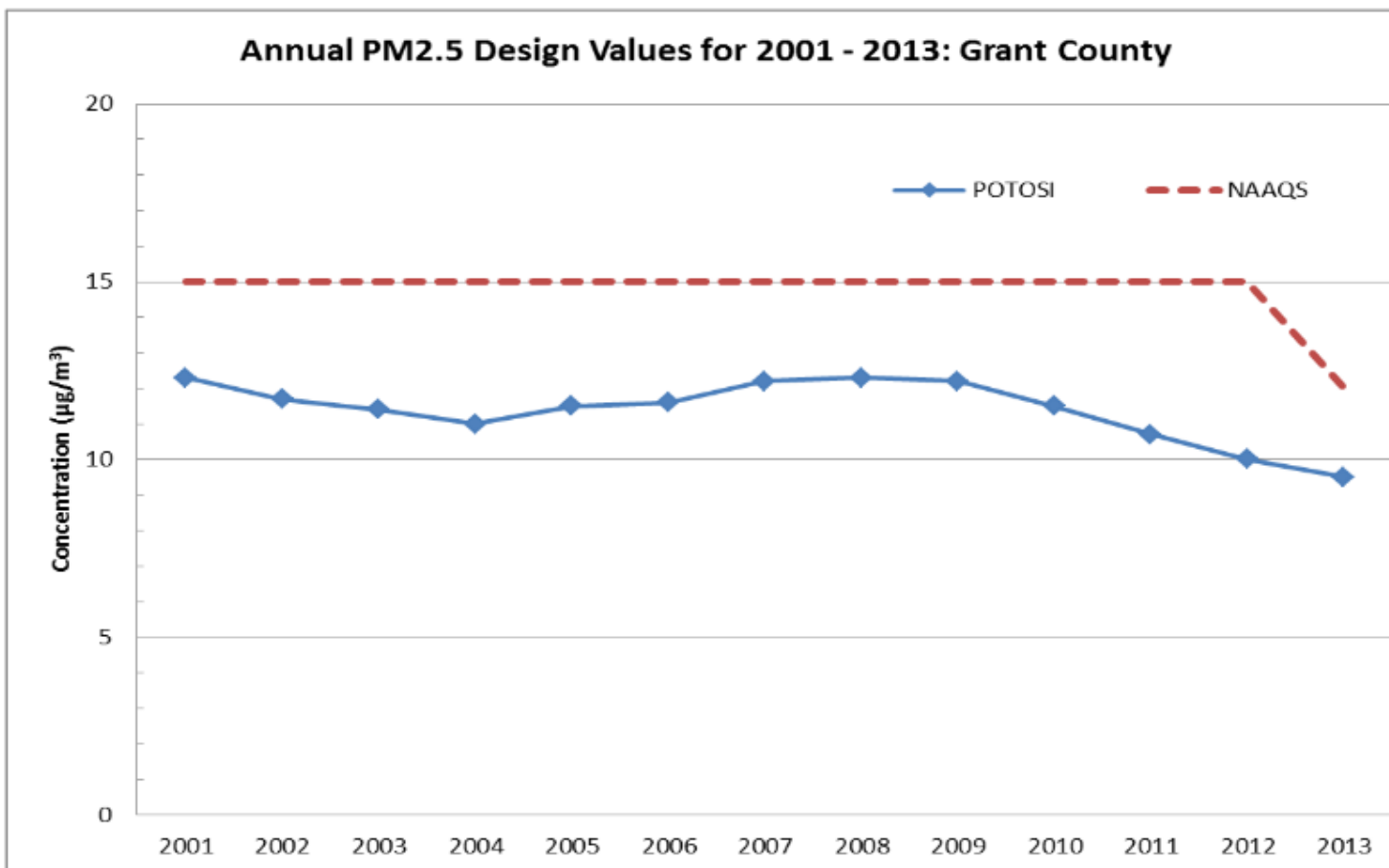
# POTOSI 98<sup>th</sup> Percentile Concentration “Design Value”

Source: Wisconsin Dept. Natural Resources; Wisconsin Air Quality Trends - April 2015



# POTOSI Annual Avg. Concentration “Design Value”

Source: Wisconsin Dept. Natural Resources; Wisconsin Air Quality Trends - April 2015



# Changes in emissions since 2011

Percent Change in Emissions

	1980 vs 2014	1990 vs 2014	2000 vs 2014
Carbon Monoxide (CO)	-69	-62	-46
Lead (Pb)	-99	-80	-50
Nitrogen Oxides (NO <sub>x</sub> )	-55	-51	-45
Volatile Organic Compounds (VOC)	-53	-38	-16
Direct PM <sub>10</sub>	-58	-19	-16
Direct PM <sub>2.5</sub>	---	-25	-33
Sulfur Dioxide (SO <sub>2</sub> )	-81	-79	-70

Notes:

1. --- Trend data not available
2. Direct PM10 emissions for 1980 are based on data since 1985
3. Negative numbers indicate reductions in emissions
4. Percent change in emissions based on thousand tons units

Source: <http://www3.epa.gov/airtrends/aqtrends.html#emission>

**DEMOGRAPHIC INFORMATION (DUBUQUE COUNTY)**

Population (2013): 95,697

Population (2010): 93,653

Population under 18 (2013 percent): 23.1 percent

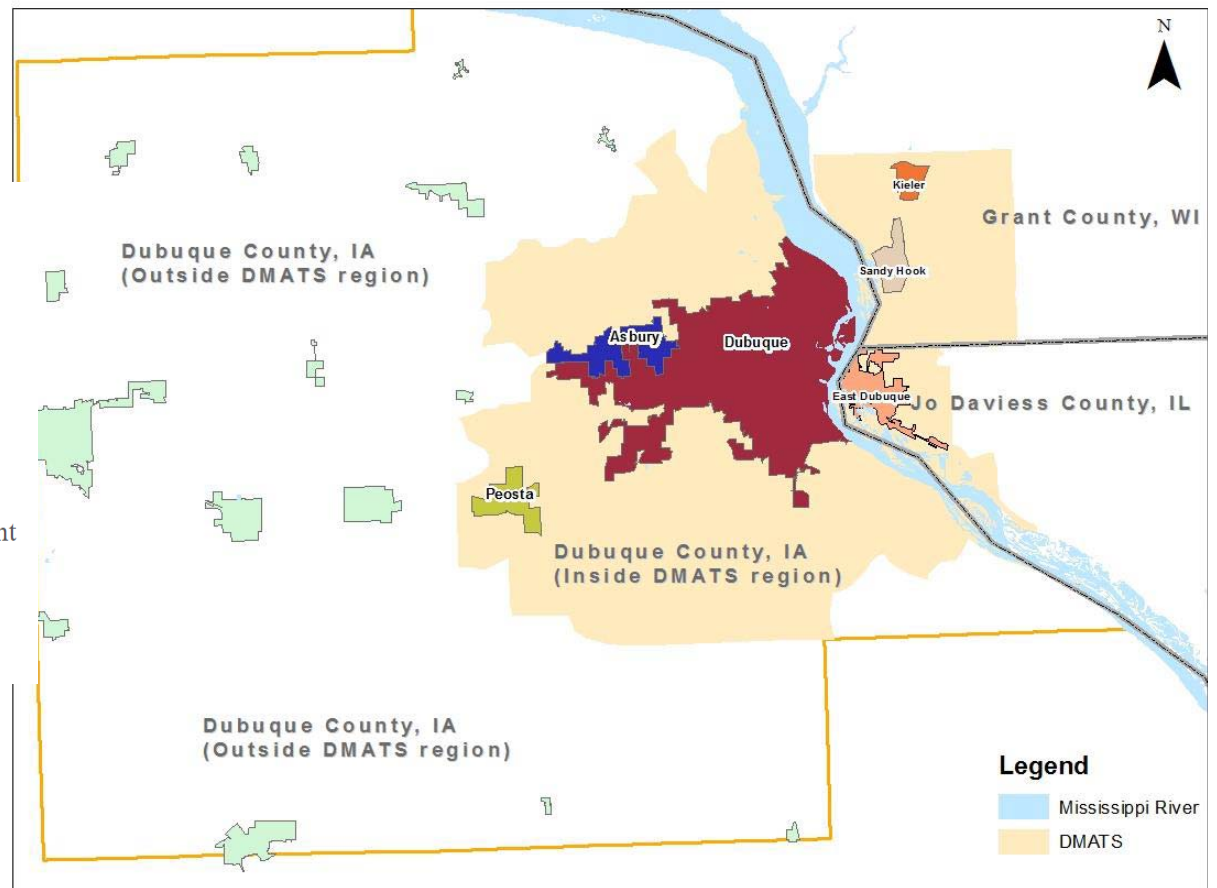
Population over 65 (2013 percent): 15.9 percent

Median Household Income (2012): \$50,885

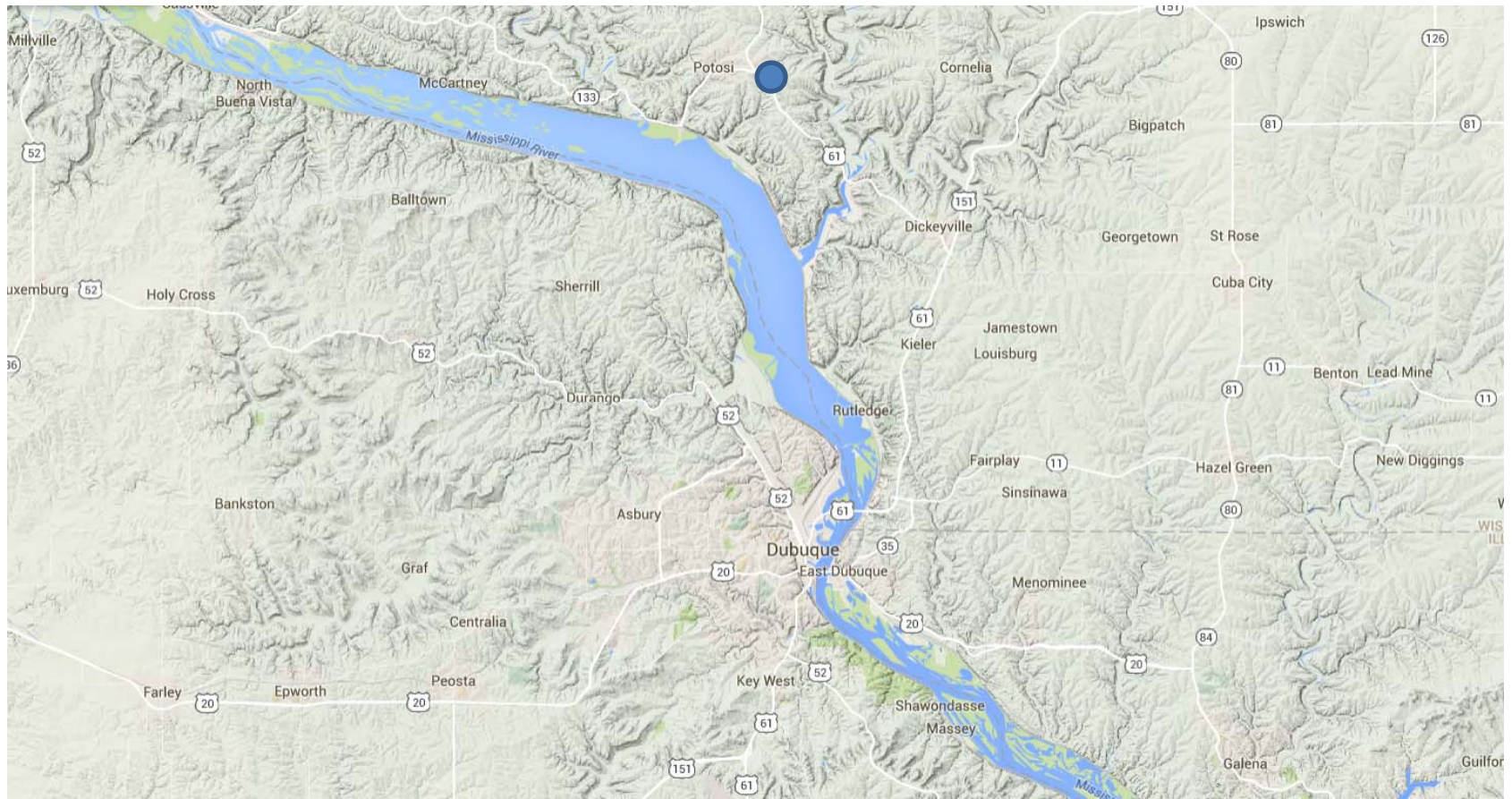
Persons below Poverty Level (2012 percent): 10.3 percent

Unemployment Rate (2013): 4.5 percent

Average Hourly Wage (2013 Private Sector): \$23.38



Source: DMAT: Dubuque Metropolitan Area Transportation Study



## Cases with highest PM2.5 concentration in the study

- Most (but not all) occur in colder months
- All have a contribution of atmospheric stability
- Winds are often from the south but that doesn't mean there is a single "source" to the south – it is that stable conditions and low winds coincide with southerly winds, and sources are to the south and east (but not to the north and west)

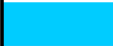

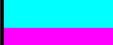

2006 – Highest PM2.5		
Case	Date	PM2.5
1	11/25/2006	41.2
2	8/18/2006	31.2
3	3/9/2006	30.0
4	3/6/2006	29.6
5	3/30/2006	29.6
6	1/11/2006	26.5
7	6/16/2006	25.5
8	1/20/2006	24.8
9	8/6/2006	23.7

2007 – Highest PM2.5		
Case	Date	PM2.5
1	12/20/2007	45.9
2	12/11/2007	39.0
3	11/20/2007	36.4
4	12/17/2007	32.7
5	1/21/2007	27.9
6	1/24/2007	27.5
7	5/30/2007	26.8
8	7/26/2007	26.4
9	10/15/2007	25.6
10	12/29/2007	25.4
11	2/11/2007	24.5
12	11/11/2007	24.0
13	3/7/2007	23.4
14	1/18/2007	22.7
15	12/26/2007	22.7
16	8/1/2007	21.7
17	9/24/2007	21.6

2008 – Highest PM2.5		
Case	Date	PM2.5
1	2/24/2008	52.6
2	2/3/2008	41.2
3	3/10/2008	35.2
4	2/9/2008	28.0
5	5/1/2008	26.9
6	1/25/2008	24.7
7	7/27/2008	24.7
8	1/16/2008	24.3

2009 – Highest PM2.5		
Case	Date	PM2.5
1	1/22/2009	52.2
2	2/6/2009	36.2
3	2/9/2009	33.0
4	1/28/2009	32.1
5	1/7/2009	31.7
6	12/18/2009	31.4
7	11/24/2009	27.7
8	12/21/2009	27.0
9	3/23/2009	25.4
10	10/28/2009	23.0

PM2.5 concentrations have units of  $\mu\text{g}/\text{m}^3$ .

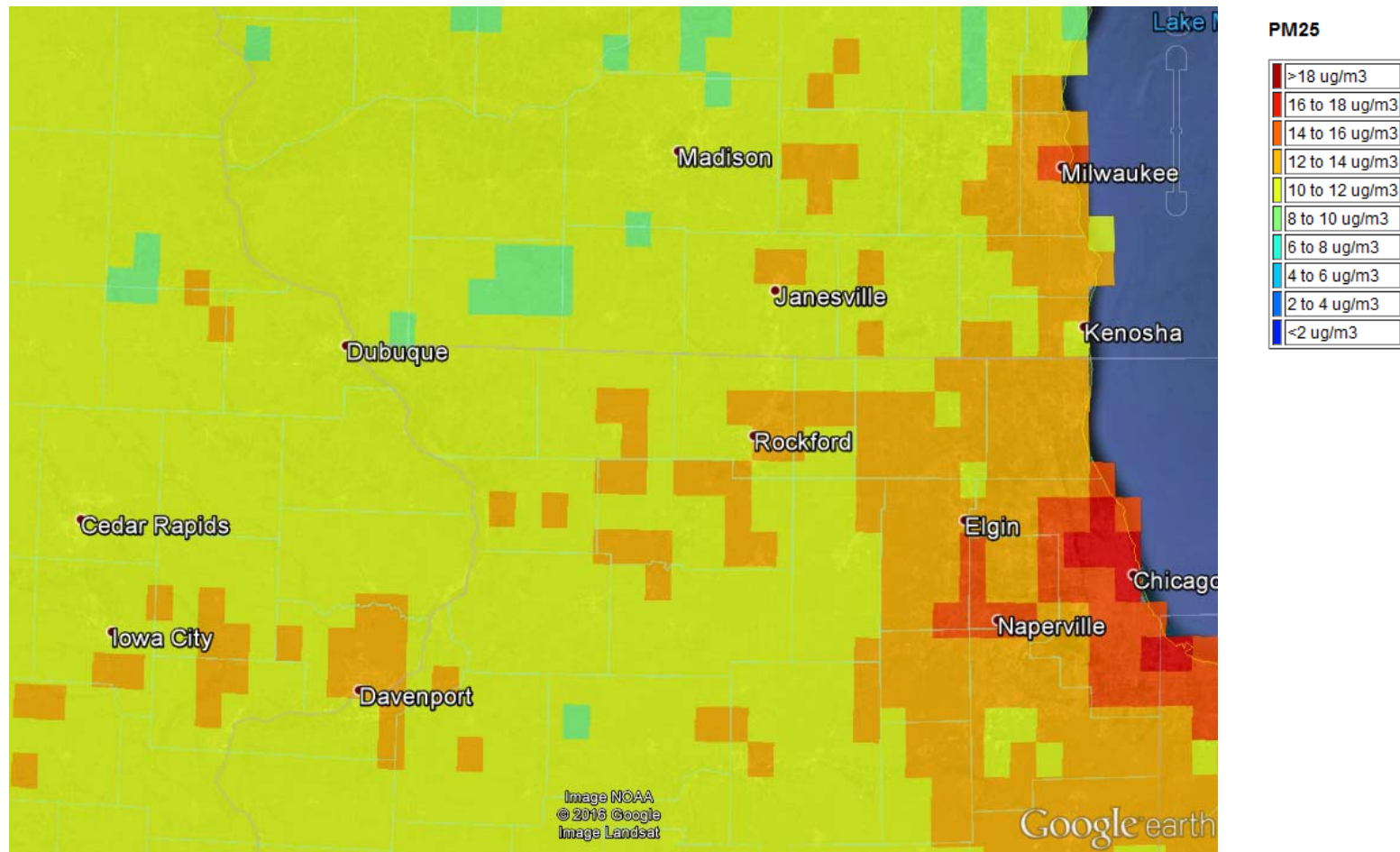
Color Key	
	Quarter 1 (January, February, March)
	Quarter 2 (April, May, June)
	Quarter 3 (July, August, September)
	Quarter 4 (October, November, December)
	98th Percentile Ranking

Source: Dubuque's Path Forward to Improved Air Quality, July 15, 2015

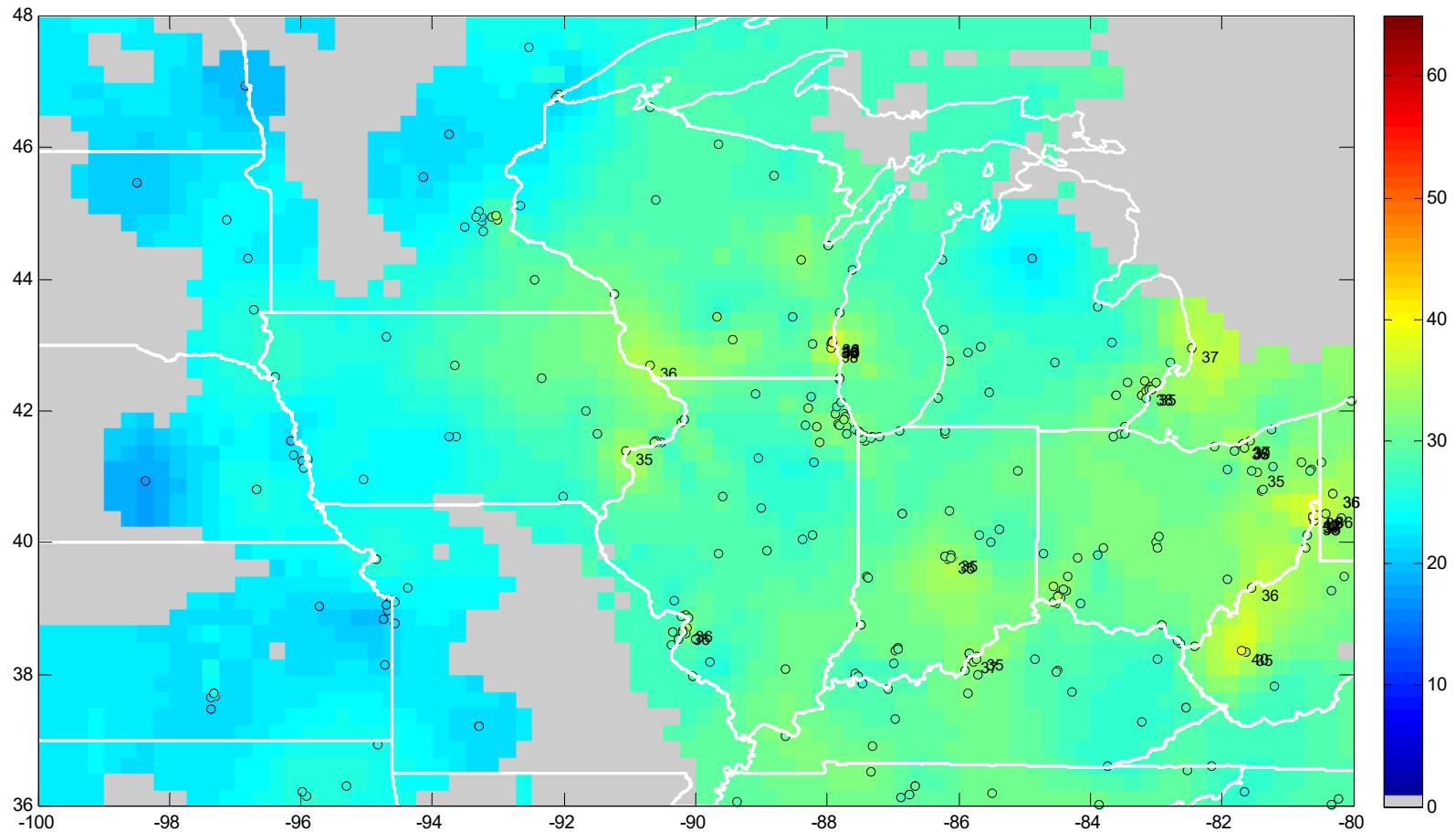


# But there's no monitor in Dubuque – how can we estimate the concentration in Dubuque?

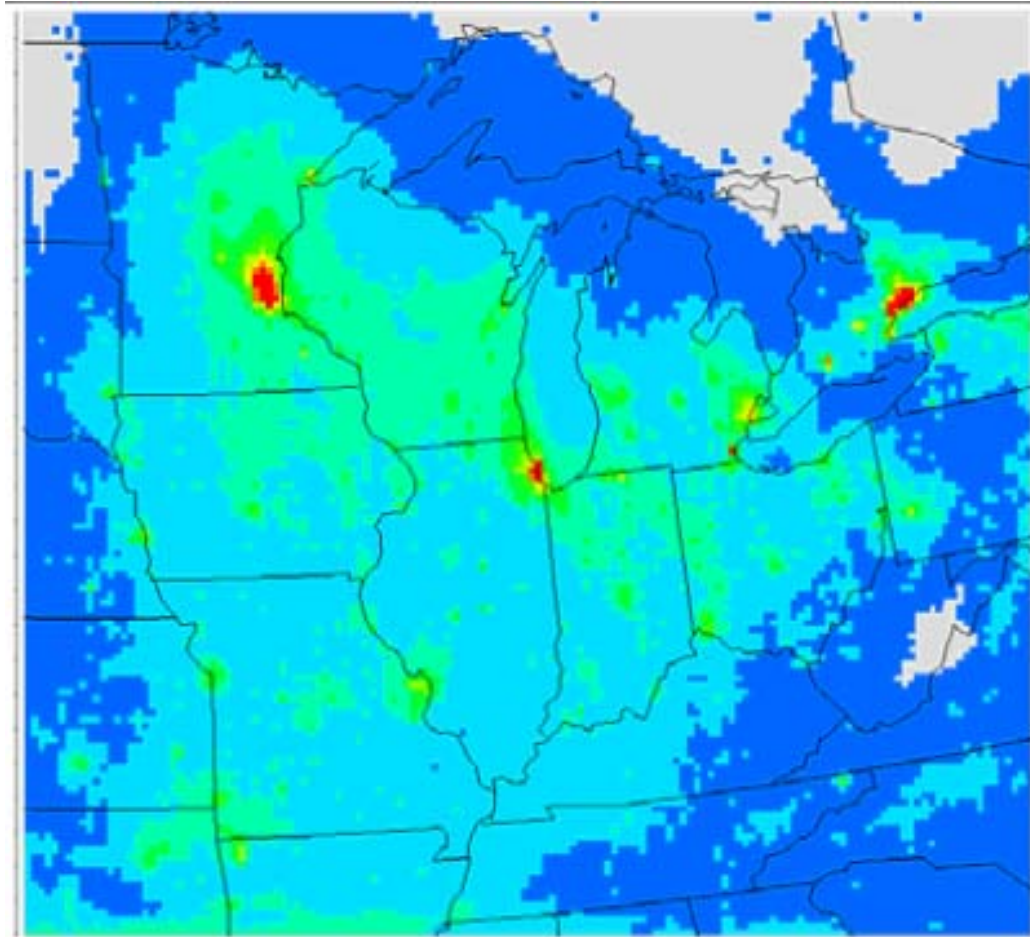
- Satellite-derived estimates van Donkelaar, A., R. V. Martin, M. Brauer and B. L. Boys, **Global fine particulate matter concentrations from satellite for long-term exposure assessment**, *Environmental Health Perspectives*, DOI:10.1289/ehp.1408646. ~14 km resolution – so same pixel for Dubuque and Potosi – 10–12 ug/m<sup>3</sup>



Statistical smoothing of monitor values @ 25 km resolution.  
Potosi and Dubuque in same grid cell. But high concentrations are reasonably smooth even at ~100 km length scales.



## 12 km model of PM episodes – no Dubuque hotspot

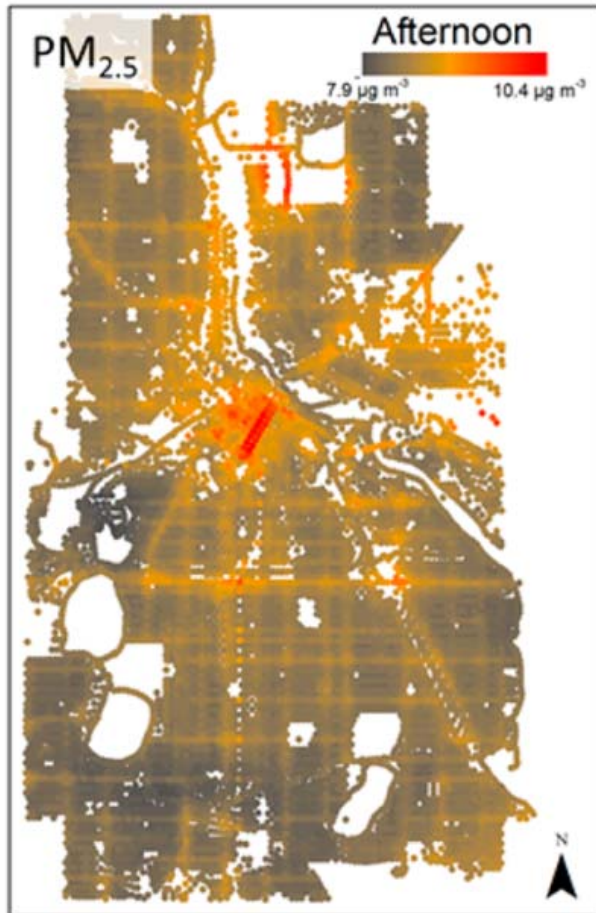


Spak, S et al. "Episodic Air Pollution in Wisconsin (LADCO Winter Nitrate Study) and Georgia (SEARCH Network) During Jan-Mar 2009. Phase II Report: Three Dimensional Modeling, Process Analysis and Emissions Sensitivity." Lake Michigan Air Directors Consortium. May 2012.

## “Urban Excess” Studies

- Potosi with population less than 1000 people is like a rural background monitor
- Milwaukee vs. Rural Site about 100 km away
  - During AQ Episodes, Milwaukee higher by  $10 \mu\text{g}/\text{m}^3$
- Iowa DNR Monitoring
  - Average of 98<sup>th</sup> percentiles for Backbone State Park, 2012-2014
    - $21.3 \mu\text{g}/\text{m}^3$
  - Average of same statistic for Waterloo, Cedar Rapids, and Iowa City
    - $21.8 \mu\text{g}/\text{m}^3$
  - Average of three monitors in Davenport
    - $24.0 \mu\text{g}/\text{m}^3$
  - An urban excess of  $0.5 \text{ ug}/\text{m}^3$  (Waterloo, Cedar Rapids, Iowa City vs. Backbone)
  - An urban excess of  $2.7 \text{ ug}/\text{m}^3$  (Davenport vs. Backbone)
- Scaling the Milwaukee urban excess to Dubuque assuming urban excess scales as population density x physical size of city (square root of area), we would expect Dubuque’s increment to be 11% of that of Milwaukee, or  $1.1 \text{ ug}/\text{m}^3$
- SUMMARY ... we might expect Dubuque to be  $0.5$  to  $2.7 \text{ ug}/\text{m}^3$  above the Potosi monitor under peak PM conditions. So using 2010 to 2013 ...  $20\text{-}30 \text{ ug}/\text{m}^3 + 0.5$  to  $2.7 = 20.5$  to  $32.7 \text{ ug}/\text{m}^3$

# What if you sample directly on roads or at roadside? On road increment from traffic



<http://pubs.acs.org/doi/pdf/10.1021/acs.est.5b01209>

Hankey and Marshall. *Environ. Sci. Technol.*, 2015, 49 (15), pp 9194–9202

Minneapolis – busiest streets 3 µg/m<sup>3</sup> over background during an afternoon. Effect can be larger at night

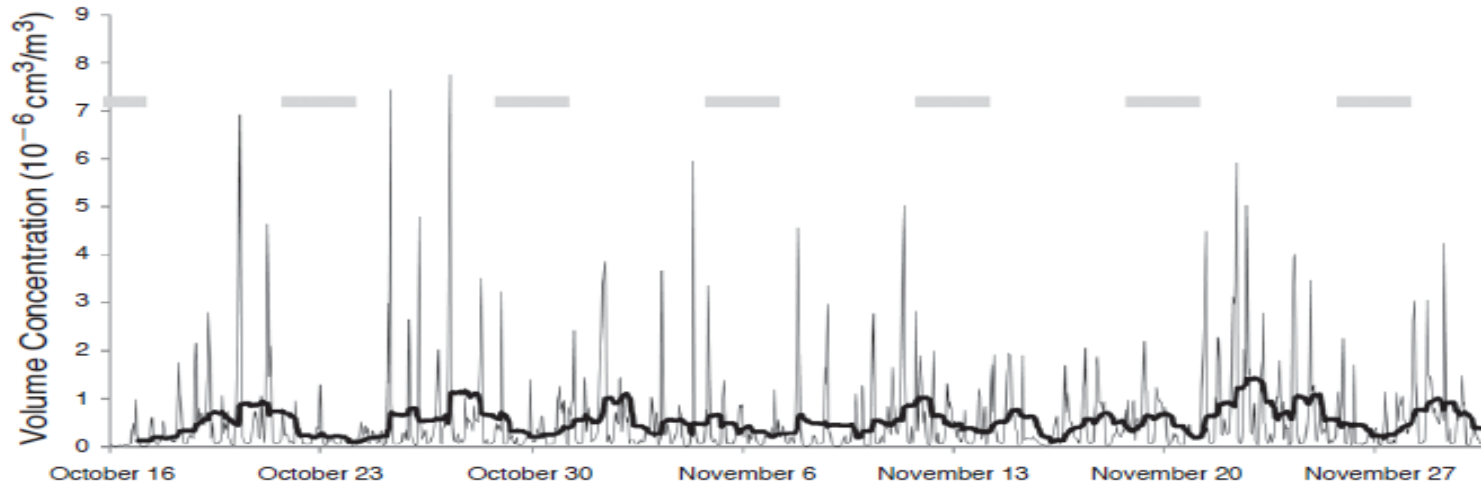
## Maximum on-road increments from traffic

	I-80 at Full Capacity (6200 veh/hr)	Busy arterial (800 veh/hr)
Stable conditions, no wind	Up to 100 $\mu\text{g}/\text{m}^3$ on-road increment	Up to 12 $\mu\text{g}/\text{m}^3$ on-road increment
Normal conditions, moderate wind	Up to 12 $\mu\text{g}/\text{m}^3$ on-road increment	Up to 1.6 $\mu\text{g}/\text{m}^3$ on-road increment

Will depend on high-emitter vehicles, and on number of pre-2007 heavy duty diesels (no particulate trap)

Source: Stanier and Lee, HEI Report 179 (2014)

# Impact of traffic on neighborhood concentrations



Los Angeles – contribution of traffic within 4km to a residential location not far from freeways: about 0.5  $\mu\text{g}/\text{m}^3$  on average but peaking to 7  $\mu\text{g}/\text{m}^3$  during some hours

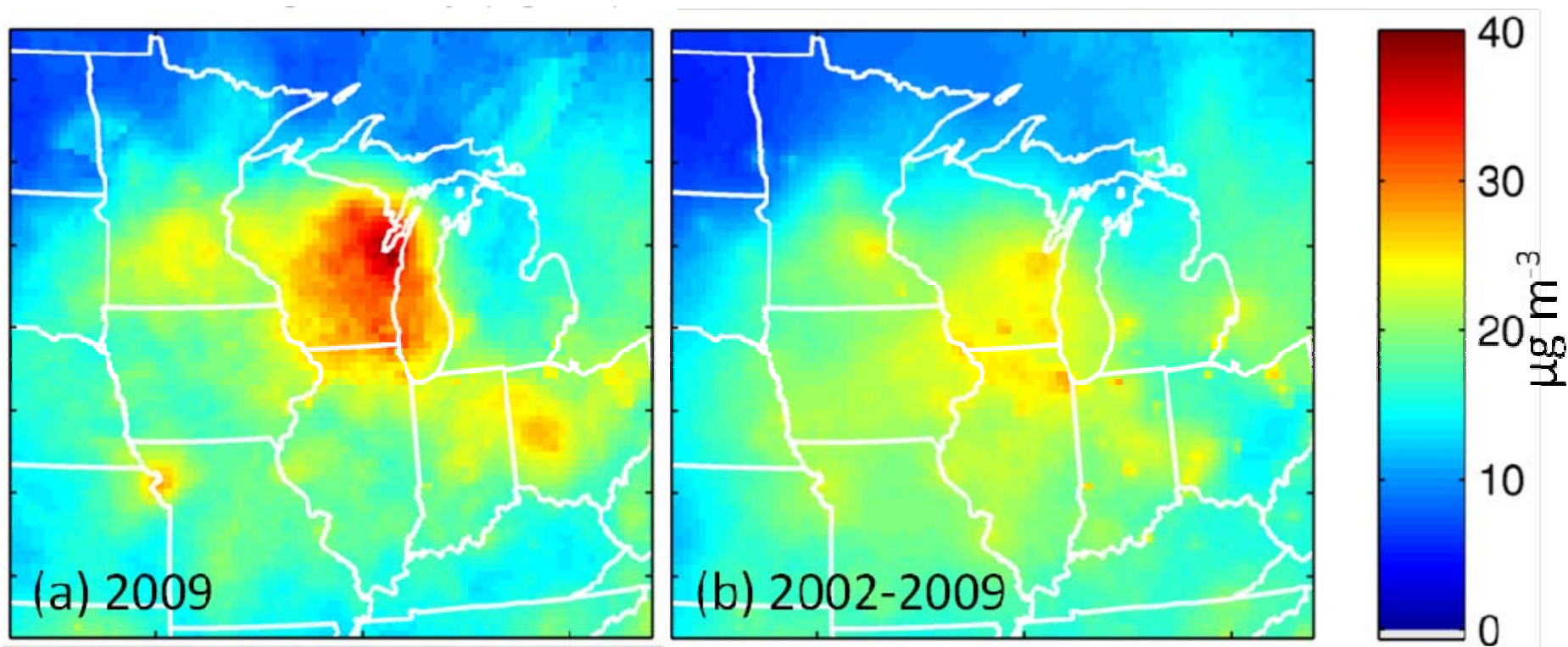
Source: Stanier and Lee, HEI Report 179 (2014)

## Other local contributions of importance?

- Food cooking (restaurants)
- Biomass burning (fireplaces, bonfires, firepits)
- Anthropogenic secondary organic aerosol
- Non-catalyzed gasoline engines (lawn mowers, boats, mopeds, leaf blowers, string trimmers)

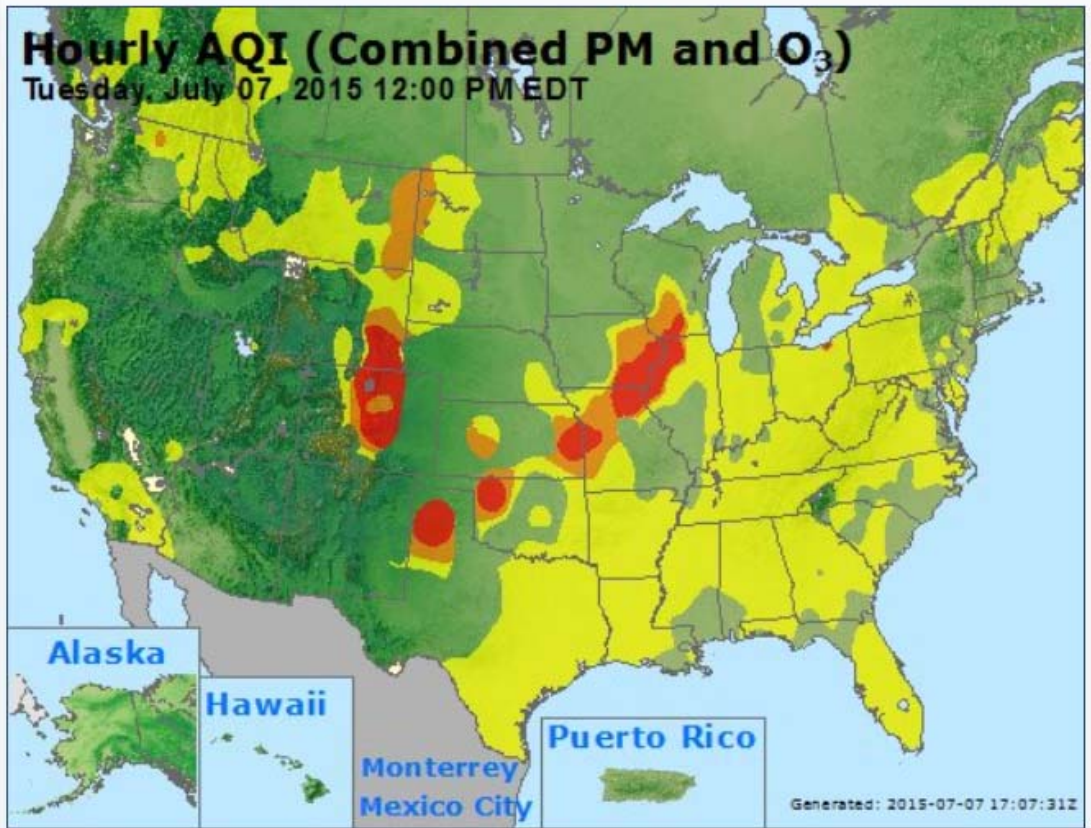


## Wintertime ammonium nitrate episodes (maps show 5<sup>th</sup> highest concentration Jan – Mar)



# Hourly AQI (Combined PM and O<sub>3</sub>)

Tuesday, July 07, 2015 12:00 PM EDT



Good

Moderate

USG

Unhealthy

Very Unhealthy

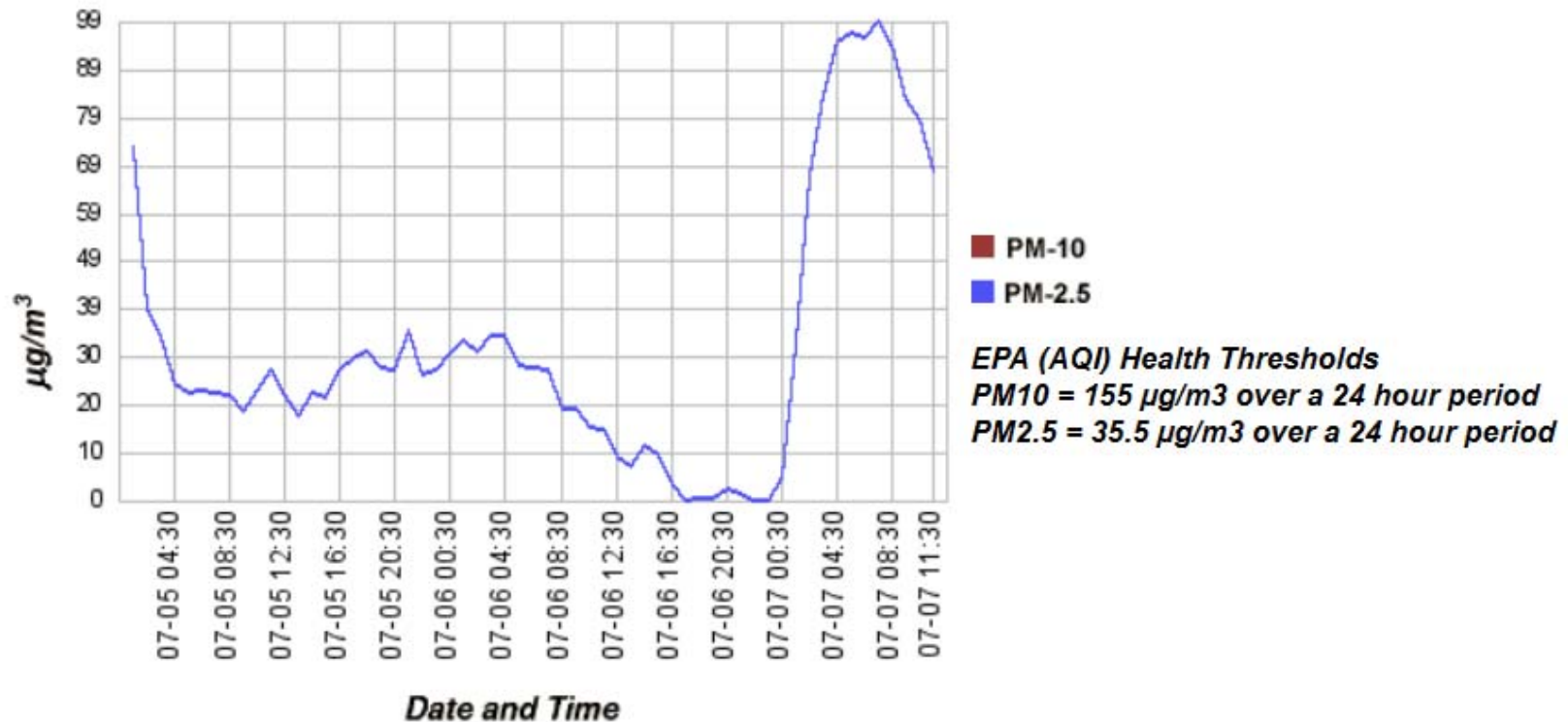
Hazardous

! Action Day

# Current Air Quality Readings

## Iowa State Hygienic Lab

see <http://www.shl.uiowa.edu/env/ambient/realtime.xml>  
and <http://www.iihr.uiowa.edu/clear4/current-air-quality/>



# News Coverage of July 5 Biomass Burning Smoke Event

- <http://www.desmoinesregister.com/story/news/local/2015/07/07/canada-smoke-iowa-air-quality/29806731/>
- <http://www.kcci.com/news/canadian-fires-send-smoke-south-over-iowa/33835870>
- <http://www.kcci.com/weather/dnr-air-quality-unhealthy-in-northwest-iowa/34024398>
- <http://www.kwwl.com/story/29494398/2015/07/07/smoke-from-canadian-wildfires-continue-to-affect-air-quality>
- <http://wqad.com/2015/07/07/quad-cities-has-worst-air-quality-in-the-nation-this-morning>
- We are having one of the worst air quality days in memory, due mainly to long distance transport of smoke.
- [http://www.thonline.com/news/tri-state/article\\_4ee972b2-24a6-11e5-b145-5b77fb6c79ff.html](http://www.thonline.com/news/tri-state/article_4ee972b2-24a6-11e5-b145-5b77fb6c79ff.html)

2 PM Sunday July 5. Mississippi River Looking South from Effigy Mounds National Monument.

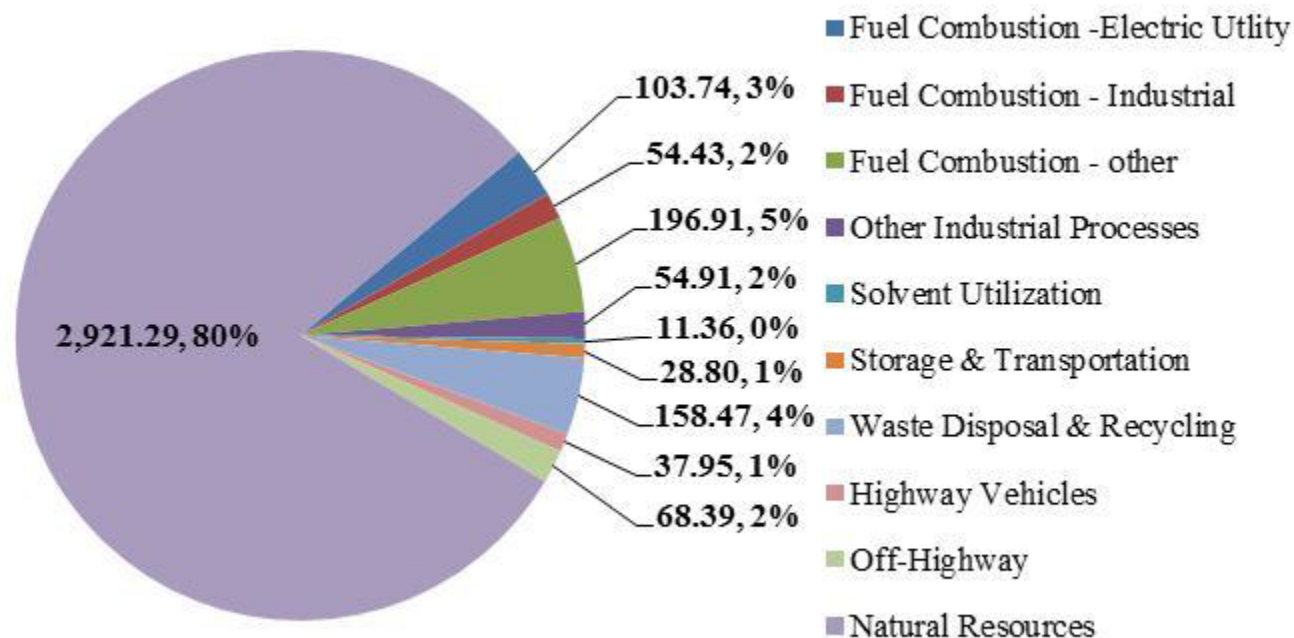


Biomass burning smoke impairs visibility. Photo credit: Charles Stanier

## Your PMA “PM Advance” Planning Document lists your official primary emissions (but most PM is secondary)

- 80% of PM<sub>2.5</sub> emissions are natural (soil and agricultural dust)
- Profile is similar to that of Scott County
- 2011 – active management of PM emissions at Jeld-Wen
- 2011 – coal to natural gas at Alliant
- 2013 – Jeld-Wen ceases operations

**Dubuque County PM 2.5 emissions by source in tons**



Source: EPA 2011 National Emissions Inventory

Source: Dubuque's Path Forward to Improved Air Quality, July 15, 2015

# Protective Actions in USG conditions?

- Important for those with
  - Asthma and other respiratory diseases (COPD, emphysema, bronchitis, lung infections)
  - Cardiovascular disease [(cardiovascular disease, high blood pressure, coronary artery disease, congestive heart failure, cerebrovascular conditions, hardening of the arteries (atherosclerosis)]
    - Reduce their risk of chest pain, heart attack, cardiac arrhythmia, and stroke
  - The elderly
  - Pregnant women
  - Children
  - Smokers

**Wildfire Smoke**  
**A Guide for Public Health Officials**  
Revised July 2008  
(With 2012 AQI Values)

# Protective Actions in USG conditions?

- Shelter indoors
  - Can reduce concentrations significantly
  - Rule of thumb is 1/3 of outdoor for a typical air-conditioned building
  - If windows open, or “leaky” building – then indoor and outdoor concentrations can be similar
  - If any indoor combustion (unvented stove, smoking, candles, incense) then indoor PM > outdoor PM

**Wildfire Smoke**  
**A Guide for Public Health Officials**  
Revised July 2008  
(With 2012 AQI Values)



# Protective Actions in USG conditions?

- Reduce activity
  - Vigorous exercise can increase dose of particles to lung by 10 to 20 times
- Reduce indoor air pollution sources
  - Smoking cigarettes
  - using gas, propane and wood-burning stoves and furnaces
  - spraying aerosol products
  - frying or broiling
  - burning candles & incense

**Wildfire Smoke**  
**A Guide for Public Health Officials**  
Revised July 2008  
(With 2012 AQI Values)

# Protective Actions in USG conditions?

- Pay attention to recirculate vs. “fresh air” settings on air conditioners. Outdoor particle pollution will be minimized by recirculation, but some outdoor air is needed for effective/safe ventilation
- For central HVAC systems, pay attention to filters
  - Install maximum efficiency filter possible (they may have higher pressure drop)
  - Change filters at recommended intervals
  - Consider an ESP (electrostatic precipitator) to remove particles

**Wildfire Smoke**  
**A Guide for Public Health Officials**  
Revised July 2008  
(With 2012 AQI Values)

# Protective Actions in USG conditions?

- Avoid locations that could likely have higher concentrations
  - Roadways
  - Areas of mowing
  - Construction vehicles
  - Dusty areas
  - Areas with recreational vehicles
  - Campfires and camping sites
  - Cookouts

Air cleaners – unlikely this would be needed with the good air quality of eastern Iowa

- Buy certified product with a Association of Home Appliance Manufacturers (AHAM) rating
- Clean Air Delivery Rate (CADR)
- Choose a unit with a tobacco smoke CADR at least 2/3 of the room's area.
  - For example, a 10' x 12' room (120 square feet) would require an air cleaner with a tobacco smoke CADR of at least 80
- See <http://www.arb.ca.gov/research/indoor/cr-12-2007.pdf>

# Air cleaners – avoid those that claim to clean air with ozone

- These products may have “Claims that the devices reduce allergens such as dust, smoke, pollen, germs, and mold using ‘highly activated oxygen or ‘super oxide ions,’ leaving the fresh scents of thunderstorms and waterfalls in their place.”
  - Consumer products, Air Purifiers, Dec 2007 issue



The screenshot shows the Health and MED.com website. The header includes the logo "Health and MED.com" with the tagline "Products for Healthy Living" and a search bar. The navigation menu contains links for HOME, ALL PRODUCTS, BLOG, CONTACT US, REQUEST A CATALOG, and MORE RESOURCES. The main content area features a product listing for an "Ionic Air Purifier & Ozone Generator - Covers 4000 Sq. Ft." with a price of \$174.98 and an "Add to Cart" button. The product image shows a red and black unit with a control panel labeled "FRESH AIR" and "IONIZATION & UV Fan Speed".

# Masks?



- Research is not clear on effectiveness as a health protection measure
- Stanier's gut feeling
  - good idea to protect health and lung capacity in chronically polluted locations (unhealthy and above conditions)
  - Increases effort needed for breathing, so not a good solution for those that are indoors and already have compromised lung function

# Resources

- <http://www.iihr.uiowa.edu/clear4/>
- [https://twitter.com/clear4 air](https://twitter.com/clear4_air)
- <https://www.facebook.com/CLEAR4air>