



Understanding Episodes of High Airborne Particulate Matter in Iowa

Charles Stanier – University of Iowa

A report commissioned by the private sector and government stakeholders serving Scott and Muscatine Counties



Contributors

- Faculty
 - Gregory Carmichael
 - Charles Stanier
 - Tracey Holloway
- Graduate Students
 - Morgan Brown
 - Aditsuda Jamroensan
 - Sinan Sousan
 - Pallavi Marrapu
- Postdoctoral Researchers
 - Scott Spak
 - Sang Rin Lee
- Undergraduate Students
 - Alex Bender
 - Adam Beranek-Collins

- Particulate Matter (PM)
- Fine Particulate Matter is smaller than 2.5 microns (PM_{2.5})
- Old standard (1997)
 - Annual average of 15 $\mu\text{g m}^{-3}$
 - Daily peak* 65 $\mu\text{g m}^{-3}$
- New standard (2006)
 - Annual average of 15 $\mu\text{g m}^{-3}$
 - Daily peak* 35 $\mu\text{g m}^{-3}$

*Actually the 98th percentile value, which is the 8th worst day for a monitor with a full set of 365 values



Why the decreased standard?

- Between 1997 and 2006, additional science emerged and was reviewed by the EPA and the Clean Air Scientific Advisory Committee (CASAC)
- PM_{2.5} is linked to a wide range of lung and heart diseases, and aggravates asthma and chronic obstructive pulmonary disease (COPD)

What's in our report

Review existing publications on Midwestern air quality	Quantify and catalog regional warm and cold weather episodes	Quantify regional versus local events	Explain conceptual model of Iowa PM formation
Compare background and individual monitor values	Estimate likelihood of future compliance with and without controls	Review IDNR measurements of aerosol chemistry	Identify and quantify directional sources
Determine limiting reagent to ammonium nitrate formation	Examine nitric acid formation pathways	Examine effect of fog	Examine meteorology surrounding episodes
Characterize model performance during episodes	Recommend next steps		

Question 1 – Are Iowa Fine Particulate Matter Episodes Regionally Dominated or Local?



Image courtesy NASA/GSFC/LaRC/JPL, [MISR Team](#).



Donora Pennsylvania 1949. Photo from United States Public Health Service

- Iowa and the entire upper Midwest have a significant number of regional air pollution episodes lasting from 1 to 3 days in time.
- Typical year has 3-5 which are serious enough to influence air quality attainment

Single monitor events

University of Iowa Episode Code	Date	FRM PM _{2.5} (μg m ⁻³)	Monitor	Next 3 Highest PM _{2.5} Levels Measured Statewide on Same Day (μg m ⁻³)		
2002-2	2/12/02	30	Cedar Rapids - Wenig Rd Ne	4	3	
2002-3	2/22/02	29	Council Bluffs	15	13	13
2002-9	7/17/02	35	Davenport - 10th & Vine	28	18	
2002-11	9/27/02	30	Davenport - 10th & Vine	23	15	12
⋮						
2007-17	10/29/07	34	Monitor - Wellman St. Davenport - Blackhawk Foundary	9	9	8
2008-1	1/7/08	32	Monitor - Wellman St.	24	24	24
2008-7	3/17/08	34	Muscatine	19	18	17
2008-8	3/20/08	32	Muscatine	17	11	11
2008-9	3/21/08	33	Muscatine	14	14	14
2008-10	4/23/08	36	Muscatine	11	10	9
2008-11	4/30/08	32	Muscatine	22	19	18
2008-12 ¹	7/4/08	62	Davenport - 10th & Vine	22	18	11

Table 4-3. All Non-regional PM episodes identified by University of Iowa

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- *Question 1 – Are Iowa PM Episodes Regionally Dominated or Local?*
- Answer – Both factors are important. At the current EPA standards, regional episodes are unlikely to put monitors in Eastern Iowa into noncompliance unless they experience additional impact from local sources

(Based on 2002-2008 data)

Question 2 – What controls the cold weather regional episodes?

- Yes – definitely important
 - Regional ammonium nitrate formation
 - Sources < 1 mile from monitors, depending on wind conditions and emission height

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Ultimately from "NO_x" from fuel
combustion (coal, gasoline, oil,
natural gas), but must react in
atmosphere first

- Uncertain influences
 - Role of Quad Cities area NO_x combustion sources during episodes
 - Relative leverage of ammonia versus NO_x controls
 - Geographically, where would the NO_x reductions need to come from?
 - Role of Quad Cities primary emissions (vehicles, industries 1-20 miles from monitors, burning) during episodes
 - Trends in number or severity of episodes

Summary

- Compliance with the $35 \mu\text{g m}^{-3}$ standard can likely be achieved at all existing monitors with source controls
 - Meteorology will still play a role, creating “good” and “bad” years
 - My calculations assumed 100% source controls
- If sources-related emissions are not reduced, sites will go in and out of compliance from year-to-year
 - Davenport Wellman St. / Blackhawk Foundry
 - Muscatine Garfield Elementary
 - Possibly Clinton 23rd and Camanche
- Likely that there are additional hotspots with public exposure $> 35 \mu\text{g m}^{-3}$.

- There is a possibility that the annual and daily standards will eventually be lowered again. This would require a combination of local source controls, county-wide controls, and regional reductions.
- At $30 \mu\text{g m}^{-3}$ attainment probabilities drop to below 75% for
 - Davenport (all three monitors), Muscatine
 - Clinton (both monitors), Iowa City, Cedar Rapids

U of I Plan

- If a “next round” of source controls are needed, it would be difficult to specify what the most effective controls would be
- What is needed is detailed “chemical fingerprint” samples of air during episodes
- It would take multiple years of sample collection to get enough episodes for a valid analysis
- I recommend starting to collect samples in December 2009. To save money, postpone analysis until needed. This approach is being developed into an informal proposal at the University of Iowa.

Thank you

Questions

