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Air Quality Data Use, Issues, and Value in Missouri

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October 2013

© 2013 The Research Foundation of State University of New York
This report was funded by a subcontract agreement under Environmental Protection Agency Contract EP-D-09-097 with Sonoma Technology, Inc. (STI) Project # 910306, Improve EPA's AIRNow Air Quality Index Maps with NASA Satellite Data.
CTG grants permission to reprint this report, provided that this cover page is included.

Acknowledgements

We gratefully acknowledge the case study interviewees listed in the appendix for their willingness to participate, their deep appreciation for their communities, and their diverse expertise. We also thank our three graduate students: Nancy Cowan for assistance in organizing and analyzing the interviews, Norman Gervais for background research on methods for valuing air quality improvements, and Roger Gans for research on communicating science information to the public.

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Executive Summary

This case describes the air quality conditions and related programs and issues centered in the area around Kansas City, Missouri and is part of a larger study to assess the potential benefits of enhancing air quality monitoring data from ground sensor networks with data gathered by satellites.

MISSOURI AIR QUALITY CHARACTERISTICS AND DATA

The State of Missouri has been monitoring air quality statewide since the mid-1960s. Today, the Air Pollution Control Program of the Missouri Department of Natural Resources (MDNR) operates monitors at 52 locations. Stations are concentrated around the four largest population areas of St. Louis, Kansas City, Springfield and Columbia. Extensive rural and agricultural areas of the state are not covered by the monitoring network. The five-county Kansas City metro area spans both Missouri and Kansas and was one of the earliest non-attainment areas for ozone, designated in the 1980s. The area is still operating a 20-year improvement and maintenance plan, and has been in attainment for most of that period.

Today, Kansas City maintains good air quality for PM2.5 and falls just within the NAAQS standard for ozone. However, ongoing emissions from both industry and vehicles plus periodic tightening of the NAAQS put the Kansas City region at risk for non-attainment of ozone in the future. The St. Louis area is out of attainment for both PM2.5 and ozone. Specific local sites are out of attainment for sulfur dioxide and lead. Oil and gas exploration in southwestern Kansas may further contribute to increased levels of ozone and particulate matter. Agricultural dust from grain processing and farm operations is another source of particle pollution, although there are few monitoring sites in agricultural regions to assess the extent of the problem. Environmental justice concerns pertain to neighborhoods that border highways and rail lines regarding both ozone precursors and particulates.

The State of Missouri has been monitoring air quality statewide since the mid-1960s. The five-county Kansas City metro area spans both Missouri and Kansas and was one of the earliest non-attainment areas for ozone, designated in the 1980s. The area is still operating a 20-year improvement and maintenance plan, and has been in attainment for most of that period.

Air quality monitoring data are used in several different ways in Missouri and the Kansas City region. MDNR maintains a public website that reports actual pollutant concentrations and near real-time ambient air monitoring data. The department also does pollution forecasting for internal management information and planning, but does not produce daily pollution forecasts or public alerts. Instead, it relies on community-based organizations like the Mid-America Regional Council (MARC), the American Lung Association, or local governments like the Kansas City Department of Health for these activities. In addition, MARC and EPA Region 7 conduct a variety of public education and outreach activities using the web, social media, TV and radio, community meetings, corporate challenges, and other strategies.

GAPS AND WEAKNESS IN EXISTING MONITORING DATA

Existing air quality data are extensive, meets applicable EPA monitoring requirements, but results in spatial gaps that affect the ability to report air quality data in some areas. Interviewees discussed the following gaps and weaknesses that affect their work:

- **Gaps in the monitoring network.** The most obvious and important gap in existing AQ data are a consequence of the monitoring network itself: large portions of Missouri are long distances from the ground-based monitors in the regulatory network.
- **Interpolation of ground monitor data to describe larger geographic areas.** AirNow uses mathematical interpolation of the ground sensor readings to estimate pollution concentrations in surrounding areas. Because the region has relatively simple topography, this can often be a reasonably good way to fill the data gap. However, long distances and un-monitored activities, especially in agricultural areas, can make these estimates unreliable for local use.
- **Inability to target special audiences with public health messages.** Federal government funding is no longer available for environmental health outreach or education programs. Some funding is available through the Federal Highway Administration Congestion Mitigation and Air Quality Improvement Program (CMAQ) the but it cannot be used to advise about human health effects. Despite creative use of these limited resources, interviewees expressed serious concerns that the lack of fine-grained data jeopardizes the ability of state and local governments to address environmental health concerns directly.
- **Competing data sources and interpretations.** The availability and promotion of public air quality information such as AirNow has stimulated public interest in consumer-oriented monitoring tools that present new kinds of challenges regarding data validity and consistency. Government experts need to engage these individuals in a detailed discussion about different data sources, monitoring instruments, and measures in a way that holds their interest but does not oversimplify the science or the data.

POTENTIAL VALUE OF SATELLITE-ENHANCED DATA

Satellite data and related products that record particulate pollution in a 4 km grid are becoming available for regular use. If fully exploited, this new data resource could potentially deliver the following benefits:

- **Filling gaps in the ground sensor network.** Satellite data products could fill coverage gaps in the existing network to support routine forecasts and advisories to the public. They could also be used to identify potential air quality hot spots that warrant additional attention from a planning or regulatory perspective.
- **Supporting design and deployment of the regulatory monitoring network.** While satellite data and fusion product are not intended for regulatory decisions, they ultimately might improve performance of the state's regulatory mission by optimizing network design.
- **Improving understanding of the potential impact of new industrial development.** In the Kansas City region, BNSF is building a new intermodal facility to open in late 2013. While this move and the associated modern capabilities of the new facility will help reduce overall air pollution in the metro area, pollution will increase around the facility itself. Satellite data could help monitor and assess the local impact.
- **Improving regional and local analysis of air quality conditions.** Satellite data could provide localized analysis of air quality conditions for a variety of stakeholders ranging from local health departments interested in better information about the air quality of their specific county or area of responsibility, to local

communities concerned with industrial development. Where modeling is used to predict the dispersion of air pollution and to assess its impact and potential control strategies, satellite data would provide additional detail with greater geographic coverage for use in these models.

- **Improving data for local public health functions.** Satellite data could help support the public health mission of local governments. The satellite products could potentially provide an important information resource that could be used by the agency or by researchers to investigate the link between poor air quality and health effects.

STAKEHOLDER RECOMMENDATIONS FOR FURTHER DEVELOPING SATELLITE DATA PRODUCTS

Interviewees represented different stakeholder groups and consequently offered different kinds of recommendations regarding the future development and use of satellite data and fused data products. Substantial differences are associated with different users and uses of the data, which together indicate its versatility and value for different purposes. Some of the recommendations focus on the regulatory environment and the need for precise data to demonstrate attainment and progress toward attainment of the NAAQS. Others reflect scientific and technical viewpoints about how more or different data can inform analysis, forecasting, planning, policy making, or enforcement. The recommendations include:

- Use satellite data to “ground truth” the monitors and vice-versa to assure data quality and credibility.
- Invest in technologies that allow data from ground sensors and from satellite sensing to be gathered, compared and fused for the same time periods.
- Support research in satellite sensing technologies that permit measurement of other pollutants, especially ozone.
- Provide training and technical support to both scientific and administrative users of ground sensor data, satellite data and fusion products
- Take special care in designing satellite products for non-experts.
- Improve the organization and usability of the existing AirNow.gov website.

INTRODUCTION

This case is part of a larger study to assess the potential benefits of enhancing air quality monitoring data from ground sensor networks with data gathered by satellites. The study considers this question from the community-level view through three case studies in Denver, Atlanta, and Kansas City. This case begins with an overview of US air quality policy and regulatory programs and the companion AirNow Program for public outreach. In the subsequent sections we describe the air quality conditions, issues, and stakeholders in the Kansas City, Missouri-area case. We summarize current uses of air quality data as well as its benefits, gaps, and weaknesses. We conclude with a discussion of ways that satellite-sensed data can expand the uses and enhance the socio-economic value of this kind of information.

NATIONAL AIR QUALITY MONITORING AND AIRNOW

The Clean Air Act, last amended in 1990, requires EPA to set standards for six criteria pollutants that make up the National Ambient Air Quality Standards (NAAQS): carbon monoxide, nitrogen dioxide, ozone, particle pollution, sulfur dioxide, and lead. All are considered harmful to public health and the environment. The NAAQS sets two kinds of standards:

- **Primary standards** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.
- **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

This study is concerned with two criteria pollutants: ozone and fine particulate matter with a diameter less than 2.5 microns (called PM2.5). NAAQS for ozone is 0.075 parts per million (ppm) by volume (measured as an 8-hour average), and for PM2.5 the standard is 35 micrograms per cubic meter of air (μg/m3) for the 24-hour, and 12 μg/m3 for the annual average[i].

The Clean Air Act, last amended in 1990, requires EPA to set standards for six criteria pollutants that make up the National Ambient Air Quality Standards (NAAQS): carbon monoxide, nitrogen dioxide, ozone, particle pollution, sulfur dioxide, and lead. All are considered harmful to public health and the environment.

State-operated networks of more than 2000 monitors located throughout the United States measure ozone and fine particle pollution. These networks were established as part of the implementation of the Clean Air Act and are in place for the primary purposes of determining compliance with the NAAQS and for informing both state and national level assessments and policy decisions related to air quality improvement. States perform extensive quality checks on these data and report data quarterly to EPA to be used to assess compliance with, or "attainment" of, the NAAQS.

EPA operate the AirNow program to provide Air Quality Index (AQI) information to the public and the media in real-time. Data from the monitoring networks flow directly from the monitors to AirNow. As the national repository of real-time air quality data and forecasts for the United States, AirNow simplifies air quality reporting to the general public by combining concentrations of five criteria pollutants (all except lead) into a single index available to the public every day. As illustrated below, the AQI is divided into six categories associated with different levels of threat to human health. For example, an AQI of 50 or less indicates "good" air quality and is indicated by the color green in maps

or scales. An AQI of 151-200 is labeled "unhealthy" and indicated by orange. Each level beyond "good" includes recommendations for reducing exposure.

The AirNow program obtains its data from the same state-operated monitoring networks used for regulatory compliance with the NAAQS. The regulatory data go through a painstaking and time-consuming quality assurance process and are reported to EPA by the states every quarter. However, while accuracy is the most critical feature of the data for compliance purposes, timeliness is equally important for the purposes of AirNow. Consequently, the AirNow program applies a less extensive quality control process (dealing with missing data, grossly out of range readings, etc.) in order to provide hourly updates on ozone and PM2.5. These hourly reports support daily pollution forecasts to the media and other stakeholders and are intended to be timely enough to influence individual behavior. For example, declaration of community-level action or awareness days based on air quality forecasts trigger voluntary programs, such as carpooling, to reduce pollution and improve local air quality. The same forecasts coupled with public health messages help individuals, especially those with high sensitivity to pollution such as asthmatics or young children, avoid or limit their exposure.

AirNow also maintains an informational website (http://airnow.gov, left) where near real-time ozone and particulate matter maps and city air quality forecasts are posted for public access. In addition, the AirNow program offers a password-protected website, called AIRNow-Tech, which allows the organizations that contribute data to have direct access to the full national database for research, analysis, and planning. States use this same daily data, either through AirNow-Tech or directly from their own EPA-approved monitoring networks, for similar but more localized forecasting, analysis, and public reporting.

EXISTING SENSOR NETWORKS

The ground sensors and the data they collect about ambient air-quality are governed by federal regulations in 40 CFR Part 58[ii]. These regulations establish data standards such as timeliness and validation as well as requirements for the scientific precision of the instruments that collect the data, and specifications for quality assurance processes to assure data quality. Monitoring stations in the networks may house single or multiple sensors specialized for measuring different pollutants. The networks are designed and operated by the states (and some tribal and local agencies and federal installations) with the advice and approval of EPA.

The placement of sensors in the state monitoring networks follows a set of complex design criteria that specify detailed factors for each type of pollutant, with special consideration for measuring exposure in large population centers. The federal regulations further require an annual monitoring network plan and periodic network assessment to continually consider updates that respond to changing conditions[iii]. Subject to public comment and EPA approval, states may move, add, or decommission monitoring stations or sensors in response to changing needs.

Monitoring networks that meet these extensive regulatory requirements, however, do not necessarily provide full geographic coverage due to the expense of designing, installing, and maintaining monitors of exacting scientific quality. Rough estimates of the cost are around $100,000 to deploy a monitoring station, and about $50,000 per year to maintain one, although the costs can vary widely according to the specific pollutant(s) to be measured, the complexity of the monitoring station, its distance from the home base of the organization that maintains it, and other factors. As a result, sensors are deployed as strategically as possible and their actual readings are used to demonstrate compliance with the NAAQS. When reported to AirNow, however, the monitoring data are interpolated using complex algorithms to estimate conditions in surrounding geographic areas in order to provide forecasts for most communities. In some areas, however, no reasonable estimates are possible due to distance, topography, and other factors, so AirNow does not report conditions for these areas.

The AirNow Satellite Data Processor (ASDP)[iv] system is currently under development to partially compensate for these gaps in the ground sensor network for fine particles, which enables the blending or fusing of surface PM2.5 measurements and satellite-estimated PM2.5 concentrations, providing additional spatial air quality information to AirNow in areas without existing surface monitoring networks. The ASDP system, while currently working only with satellite estimated PM2.5, is building the capability necessary to implement a wider range of remote sensing capabilities for additional pollutants. At present, data are available from two daily satellite passes over the US at mid-morning and early afternoon. The satellites gather data within a 4 km grid for all areas in the US where atmospheric and other conditions allow. Dense cloud cover, snow cover, and desert landscapes prevent the satellites from taking readings in those conditions.

Community Context

This case presents a summary of air quality conditions and related programs and issues centered in the area around Kansas City, Missouri. However, because air quality conditions are affected by natural processes, layers of government policies, and human and organizational activity, the case is not limited to the Kansas City Metro Area. The case also includes information reflecting three larger contexts: the State of Missouri, EPA Region 7, and a five-county ozone region that is located in Kansas and Missouri. Interviewees for this case represented EPA Region 7; several units of the Missouri Department of Natural Resources (MDNR), including the Air Pollution Control Program (APCP) and Environmental Services Program; City of Kansas City, Missouri Department of Health (including the Air Quality Program and Office of Environmental Quality); and the Environmental Services Department of the Mid-American Regional Council.

Source: Ezilon.com

PHYSICAL AND SOCIO-ECONOMIC CHARACTERISTICS OF THE REGION

The State of Missouri is one of 4 central states that comprise EPA Region 7; the others are Iowa, Kansas, and Nebraska. As shown on the map below, northern Missouri including the area around Kansas City is predominately made up of flat plains and the southern region of Missouri comprises a mix of plains and plateaus. The topographic features in the region do not significantly limit intra- or interstate transport of pollutants across the area.

With a population of about 465,000, Kansas City is the largest city in Missouri; is located at the core of a metropolitan region that straddles Kansas and Missouri that is home to approximately 2 million residents. Kansas City is geographically one of the largest cities in the country, approximately 320 square miles covering five counties. Forty percent of the city is undeveloped. Low population density compared to other cities of its size result in more than 6,000 miles of roads and few options for public transport. The metro area is crisscrossed by three interstates (I-29, I-35, and I-70) and a number of major state highways. Kansas City is also the location of nation's second largest rail hub (after Chicago).

Missouri's other major cities include St. Louis, Missouri's largest metropolitan region, located opposite Kansas City on the eastern edge of the state near the Illinois boarder and Springfield, located in the southern part of the state near the Arkansas border. The rest of the state is mainly rural. Missouri's mixed economy has industrial concentrations in each of the three major cities, but the state is predominately agricultural.

In Kansas City, federal, state, and local governments employ the largest number of workers, followed by health care systems. In addition, the metro area is home to major corporations including Cerner Corporation, DST Systems, Hallmark Cards, Black & Veatch, United Parcel Service, Farmers Insurance Group, and Home Depot, as well as Ford General Motors assembly plants and 15 colleges and universities.

HISTORY OF AIR QUALITY IN THE STATE AND REGION

The five-county air quality area around Kansas City was one of the earliest non-attainment areas for ozone, designated in the 1980s. This area is still operating a 20-year improvement and maintenance plan, and the area has been in attainment for most of that period. Today, Kansas City maintains good air quality for PM2.5 and generally falls just within the NAAQS standard for ozone. Since the area is generally in attainment, the region has focused on lowering its levels in advance of changes to the air quality standards, through an EPA-sponsored program called Ozone Advance which addresses activities and strategies to reduce emissions. Jackson County, which comprises about 50% of the population of Kansas City, has been in nonattainment for sulfur dioxide since the last re-designation of the NAAQS for SO2 in 2010. Historically, St. Louis has had the most problem with air quality and is currently out of attainment for both ozone and PM2.5.

An EPA expert characterized the three main pollution sources in the four-state region as transportation associated with the urban environment, large industrial sources such as power plants and grain operations, interstate transport of pollutants. In certain areas of Nebraska and Iowa, source-specific issues such as emissions of particulate matter from the grain industry, have led to poor air quality. Seasonally, burning is a major contributor to air pollution. In April each year, monitors in Kansas City tend to exceed the NAAQS when controlled burns take place over nearly two million acres of the Flint Hills in Kansas to regenerate the natural ecosystem. Additionally, officials estimate that up to a third of ambient ground-level ozone pollutants in Missouri are imported from Texas and Oklahoma.

In addition to urban, industrial, and transport sources, dust associated with agriculture is also a significant, but mostly unmonitored, source of particulate pollution.

CURRENT AIR QUALITY ATTAINMENT ISSUES

The Kansas City region is currently in attainment of the NAAQS. The St. Louis area (comprising St. Louis City and St. Louis, St. Charles, Jefferson, and Franklin Counties) is out of attainment for PM2.5 and ozone, and Herculaneum, the site of a decommissioning lead smelter, is out of attainment for lead. Kansas City, Wichita, and Omaha are all close to violating the current ozone standards. However since the NAAQS were recently tightened and further strengthening is expected, other areas in Missouri and EPA Region 7 near Kansas City are in currently in violation or close to falling out of attainment for ozone and PM2.5. In addition, specific counties within Missouri are addressing problems with sulfur dioxide (SO2) and PM10.

For the Kansas City region, the biggest concern is ground-level ozone. In the next few years, interviewees expect Kansas City will likely be in nonattainment with the NAAQS for ozone primarily because the national ozone standards are periodically tightened. However, ongoing emissions from both industry and vehicles also contribute to the problem. Environmental justice concerns pertain to neighborhoods that border highways and rail lines regarding both ozone precursors and particulates. Oil and gas exploration in southwestern Kansas may further contribute to increased levels of ozone and particulate matter.

Agricultural dust from grain processing and farm operations is another source of particle pollution, although there are few monitoring sites in agricultural regions to assess the extent of the problem. Strong political and cultural opposition to regulation in agriculture and lower population levels in farming regions make it difficult to justify the placement of monitors in these areas.

MISSOURI AQ MONITORING NETWORK AND OTHER AQ DATA SOURCES

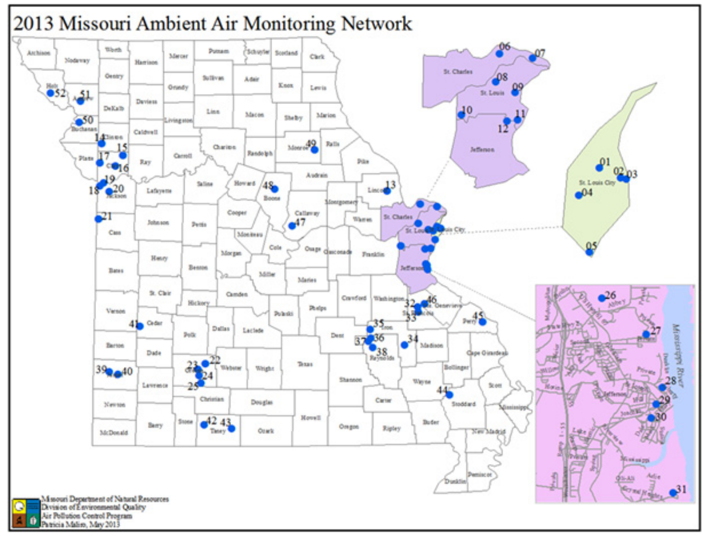
The State of Missouri has been monitoring air quality statewide since the mid-1960s. Today, the Air Pollution Control Program of the Missouri Department of Natural Resources (MDNR) operates monitors at 52 locations. Monitoring stations measure the criteria pollutants in the NAAQS to document attainment or non-attainment of the standards for each pollutant. Particulate monitors, including PM10 and PM2.5, and ozone monitors are the most abundant and widespread types, but monitors are also in place to measure the other pollutants in NAAQS. The map below shows the locations of monitoring stations around the state. Stations are concentrated around the four largest population areas of St. Louis, Kansas City, Springfield and Columbia. Extensive rural and agricultural areas of the state are not covered by the monitoring network.

The continuous monitors in the network transmit data hourly to AirNow after it has been subjected to initial automated data screening. After this initial hourly screening, these data also go through an extensive quality assurance process to ensure accuracy before being reported to EPA quarterly for compliance purposes. Conversely, the near-real time data reported to AirNow is subjected to a much less rigorous validation process and includes some sources that may not meet the EPA instrumentation requirements.

USERS AND USES OF AQ DATA

During the interviews in Kansas City, Missouri with staff from the respective federal, state, and local air quality responsible agencies, and the Mid America Regional Council we learned about the different users and uses of existing air quality data and other sources of information. Below is a summary of those users and uses.

The ***EPA Regional Office (Region 7)*** monitors air quality conditions in the four state region and works with the state and local communities on strategies for dealing with current or emerging problems.



Source: Missouri Department of Natural Resources

The EPA technical staff that work on State Implementation Plans (SIPs) use raw AQS data to model the sources of pollution and various strategies to maintain or reach attainment. The raw data consists of the real-time monitoring data from the state network, although the data are typically used to assess historical trends or to project future scenarios, rather than to do any real-time assessment or near term forecasting. This same data eventually feeds into AirNow for those purposes. EPA modelers focus on (1) ensuring that proposed state actions, if implemented as planned, will not cause a region to fall out of attainment; and (2) developing a SIP to bring a region back into attainment with the NAAQS. While the primary burden for developing the plans for proposed state action and SIPs fall on the state agencies, the EPA consults with them and signs off on a plan before a state is allowed to proceed. The EPA region also has a limited monitoring program of its own for conducting special studies. Generally these models and studies are retrospective or looking ahead to find ways to bring an area into attainment by modeling control strategies and longer-term forecasts. They seldom require real-time data and therefore AirNow and AirNow Tech are only used occasionally to support this work.

AirNow products are used mainly for public outreach and education in those areas that have had historic problems with air quality, such as St. Louis, or high potential for non-attainment, such as Kansas City. The Region's education and outreach initiatives usually involve face-to-face discussions with concerned parties. Starting with the dominate voices in particular environmental groups or communities, the Regional staff speak personally with those individuals prior to meeting with the larger group or holding a public information session. Detailed knowledge of the region provides critical context for this work– for example, understanding the tensions and complexities of sharp urban-rural differences makes it possible to appropriately address the potential for nonattainment not only in Kansas City but also in surrounding rural counties encountering air quality issues for the first time. Staff respond to this situation by focusing on educating the population regarding the sources for pollution, what it means to be out of attainment, and what kinds of steps are meaningful in different communities. Contextual knowledge of the Region is also important in advising EPA headquarters as it develops or refines national rules and guidelines.

Source: Missouri Department of Natural Resources, Air Pollution Control Program Website (MDNR APC 2).

Within the ***Missouri Department of Natural Resources (MDNR)***, the ***Air Pollution Control Program (APCP)*** and ***Ambient Air Monitoring Unit*** are responsible for ensuring that the State of Missouri's monitoring network satisfies the requirements set forth in 40 C.F.R. § 58. Staff use air quality data supplied by Missouri's analytics lab to establish and maintain the official monitoring sites. As necessary, the unit also works with industrial representatives to establish monitoring networks around particular stationary sources of concern. The State's Environmental Services Program manages the data the State receives from its monitors and is responsible for quality assurance and reporting to AirNow and APCP for uploading data to AQS.

The APCP maintains a website that reports air quality and near real-time ambient air monitoring data, focusing less "on reporting the AQI and more on reporting the pollutant concentrations, primarily because a lot of stakeholders the air program works with are the regulated community and… [this data] is actually of more interest to those stakeholders than the AQI," which would be of greater interest to the general public. Accordingly, while it does maintain a public website, the Program does not produce daily pollution forecasts or focus on outreach to the general public, instead deferring to community-based organizations like the Mid-America Regional Council, the American Lung Association, or local governments like the Kansas City Department of Health for these activities. Some internal forecasting is performed for management information and planning.

The ***Air Quality Program (AQP)*** within the ***Kansas City Department of Health Office of Environmental Quality*** regulates pollution sources by issuing construction and operating permits, enforcing air quality policies; and working with state, local and federal agencies to plan and implement air quality improvement strategies . These activities include

Kansas City Air Quality Program Website (CKC MHD)

an extensive program directed at City government agencies and employees. Every city department is required to submit an ozone action plan to the Office of Environmental Quality that details the steps the department plans to take to reduce relevant emissions including plans for mowing, painting, and other activities that contribute precursors of ozone in the summer months. The Office reviews these plans and provides departments with feedback regarding additional ways reduce emissions.

Additionally, forecasted Orange or Red days prompt the Office to issue ozone alerts to the City's 4000 employees that include mitigation recommendations that pertain to individual driving and commuting habits. The program also provides transit programs for city employees such as reduced cost transit and bus passes. While it does maintain a public website that includes limited air quality alert data, the AQP does not conduct direct outreach targeted to specific populations. Instead, it works with community-based organizations like the ***Mid-American Regional Council*** and the ***Air Forum*** to conduct broad-based public outreach and education.

The AQP regulatory program focuses on construction and burning permits and asbestos mitigation along with a regular program of permitting and inspections of small regulated entities. The staff make use of emission data required to be provided by the facilities in making their reviews and determinations; they generally do not use air quality information from AirNow or similar sources to support this work.

Over the past 10-12 years, the environmental program in the Kansas City Health Department has been drastically cut from about 12 staff, who operated a full monitoring and inspection program, plus some research and an analytical lab, to the current staffing level of three professionals. Permitting and inspection responsibility for large facilities was transferred to MDNR but ongoing cuts at the state level have resulted in a significant diminution of proactive health-oriented air quality programs at the both the state and local levels.

The ***Mid-America Regional Council (MARC)*** is a nonprofit association of city and county governments and serves as the metropolitan planning organization (MPO) for the bi-state Kansas City region. MARC serves nine counties and 119 cities in the region. Governed by a board of local elected officials., it provides a forum for regional cooperation on social, economic, and environmental issues. MARC is funded by federal, state and private grants, local contributions and earned income. Its main activities include transportation planning, environmental planning for both air and water quality, solid waste management, and other areas.

The air quality program at MARC focuses on a five-county region (three in Missouri and two in Kansas) that are at risk of non-attainment for ozone. However, all nine member counties are involved in some level of air quality education, outreach, and improvement activity. MARC coordinates a voluntary SIP-type effort under EPA's Ozone Advance program called the Clean Air Action Plan to help in setting short, medium, and long term goals and priorities for both the five-county ozone region and the larger nine-county consortium.

MARC contracts with a private meteorology firm, Weather or Not, to provide daily pollution forecasts during ozone season, using the state's raw monitoring data and feeding the forecasts directly into the AirNow-Tech site which then populates the specific regional forecasts for Kansas City. MARC also uses AirNow-Tech to access raw hourly monitoring data in situations where high levels or exceedances are expected in order to track the readings over region during the course of the day.

MARC's extensive public outreach program is funded mainly by the US Highway Administration Congestion Mitigation and Air Quality Improvement (CMAQ) Program which limits the emphasis of message content to ozone-related transportation and emission reduction topics, rather than to public health issues. MARC communicates to the public through its website, television commercials, YouTube, newspaper and radio advertisements, its Twitter and Facebook accounts, billboards and traffic boards, clinics, as well as through direct messaging to interested parties.

Several employer-focused initiatives aim to communicate with workers and commuters through their workplaces. One employer-focused initiative, the Kansas City Corporate Challenge encourages employers to compete for carpooling awards and other forms of recognition. In addition, when the region experiences an ozone alert day, MARC uses EnviroFlash, an AirNow notification tool, to message between 150 and 175 organizations so they can inform their employees. Another education program is focused on shifting the public's preferred mode of transportation via "30- and 15-second animated [commercials] in both English and Spanish, introducing this cartoon bird, Quinton the Air Quality Bird… [who] good behavior in terms of riding the bus and walking."

Source: Mid-America Regional Council Website

MARC also uses an automated system to send alerts to interested citizens who sign up to receive ozone alerts. Users subscribe to the service and set their personal alert-level preferences (for example to receive a messages with a yellow level or higher) and the system automatically sends out the relevant alerts with little administrative burden.

MARC successfully collaborated with the National Weather Service to issue ozone alerts as a standard National Weather Service product. As a result, "on ozone alert days when someone goes to the National Weather Service website, they see "Air Quality Alert" on the side and they can click on

Source: Mid-America Regional Council Facebook Page, Twitter Feed

it and it links to [MARC's] website… [b]ut the bigger piece is… many websites just pull whatever products the National Weather Service issues, so people will get push notifications or other things on their phones or online" with no additional effort for them or for the MARC. This has allowed MARC to benefit from the National Weather Service's structure and influence, without having to build a mobile app themselves.

Since 2000, MARC has contracted for an annual Public Awareness Survey to determine the effectiveness of specific initiatives. The most recent survey (2011) shows relatively high public awareness of air quality issues, mainly through TV weather reports and radio. Respondents indicated they were more likely to take positive action to reduce emissions when their actions could save money, be sure to "do the right thing" and were easy to do. The survey results help MARC focus future outreach on the specific geographic areas and demographic groups that recorded the lowest awareness scores. Additionally, it allows MARC to target outreach types (e.g., social media, TV spots, etc.) to appeal to particular demographic segments.

GAPS AND WEAKNESS IN EXISTING AQ MONITORING DATA

Gaps in the monitoring network

The most obvious and important gap in existing AQ data are a consequence of the monitoring network itself. Missouri has good coverage in its urban areas but there are gaps in its rural areas. Several interviewees mentioned Southeast Missouri as one specific area with such gaps. One of the main reasons for these gaps is due to the regulatory nature of the placement of the monitors. For PM2.5 in particular, the minimum monitoring requirements do not require monitoring locations to be based on spatial coverage but rather for exposure risk. This approach emphasizes population density so the monitors tend to cluster around cities.

These gaps limit the state's overall ability to provide timely and accurate air quality information to some areas but it is neither economically nor politically feasible to place enough monitoring stations throughout the state to eliminate them.

This results in inadequate information to fully understand both current conditions and longer-term trends.

In addition, the state-based monitoring networks impose an artificial boundary around the data that makes it difficult to track and understand the effects of interstate transport of pollutants.

Interpolation of ground monitor data to describe larger geographic areas

AirNow uses mathematical interpolation of the ground sensor readings to estimate pollution concentrations in surrounding areas. Because the region has relatively simple topography, this can often be a reasonably good way to fill the data gap. However, long distances and weather patterns can also make these estimates unreliable for local use. Thus a two-part problem exists – (1) at times the interpolated data are incorrect and thus it mis-characterizes the exposure in certain areas, or (2) at times the interpolated data are correct, but since it is not verified by direct observations users consider it unreliable. This data gap problem is unlikely to be filled with more ground monitors because of the expense of deployment, operation, and maintenance and some opposition, especially in agricultural areas. However, under the right atmospheric conditions, good quality satellite data could substitute for, or verify, interpolation in some areas to provide more accurate localized readings and forecasts and more confidence in the data.

Inability to target special audiences with public health messages

Federal government funding is no longer available for environmental health outreach or education programs. Some funding is available through the Federal Highway Administration Congestion Mitigation and Air Quality Improvement Program (CMAQ) the but it cannot be used to advise about human health effects. The MARC makes creative use of a variety of resources for public outreach and education, but the Kansas City public health department interviewees expressed serious concerns that the lack of fine-grained data and program funding is jeopardizing the ability of state and local governments to address environmental health concerns directly. This is seen as especially detrimental to poor and minority communities who tend to live and work in areas that are likely to be more polluted but are not well-monitored.

Competing data sources and interpretations

The availability and promotion of public air quality information such as AirNow has stimulated public interest and consumer-oriented monitoring tools that present new kinds of challenges regarding data validity and consistency. Reporting AQ conditions in a way that makes sense to lay people immersed in very specific local situations remains a major challenge. One EPA interviewee described a local "Bucket Brigade" doing citizen monitoring because they are not satisfied with the coverage of the official network. They use handheld devices "that are reasonably priced, but they're not calibrated to the same way that our air monitors would be and they aren't calibrated by the design values the way we calculate it...The first thing we have to do is a comparison of what their readings are getting. They might be getting a one-hour reading or an initial reading of something where the standard is set over a three year time period, an average." Thus, the government experts need to engage these individuals in a detailed discussion about different data sources, monitoring instruments, and measures in a way encourages their interest but does not oversimplify the science or the data.

During each interview we presented examples of the satellite and satellite-enhanced AirNow products produced by the STI team developing the ASDP. Each example focused on the greater Kansas City metro region and was drawn from past dates selected by STI to highlight different daily conditions and the capabilities and limitations of the ASDP. We asked the interviewees to consider how they might use these products in light of their intimate knowledge of the case study region and to suggest the value of these products in their jobs or for the stakeholders they serve. The rest of this section describes the main benefits identified.

FILLING GAPS IN THE GROUND SENSOR NETWORK

A consistent theme across all of the interviews was that satellite data could be used by local and state governments to supplement the existing ground-based network. Interviewees agreed that both the satellite data and the fused product could fill coverage gaps in the existing network to support routine forecasts and advisories to the public.

Gaps in the monitoring network are addressed as far as possible by AirNow by estimating or extrapolating air quality measurements from sensors at the monitoring sites to areas farther away. However, as described in the previous discussion of gaps and weaknesses, distance from the monitors can make these estimates inaccurate. In these instances, the satellite data could supplement the monitoring data. The accuracy of the satellite measurements is affected by local conditions such as cloud cover, so this supplementation would not always be possible, but in many instances the satellite data could add considerable granularity by providing direct local measurements for forecasting and public information purposes. An air quality monitoring expert from the Missouri Department of Natural Resources Air Pollution Control Program after reviewing the satellite product examples produced for the Kansas City region stated, “I think from what I’ve seen here, the merged product seems to me to be potentially a better solution than some of the interpolation.”

Several interviewees noted that the satellite information could be valuable by providing missing air quality monitoring data for rural sections of Missouri. More specifically, satellite enhanced AirNow data could be used by the state to identify potential air quality hot spots that warrant additional attention from a planning or regulatory perspective. According to one interviewee, “I think that’s something that we’re missing – a better understanding of how much emissions in rural areas and upwind transport impact largely urban nonattainment areas.”

SUPPORTING DESIGN AND DEPLOYMENT OF THE REGULATORY MONITORING NETWORK

While everyone interviewed clearly understood that the satellite data and fusion product are not intended for regulatory decisions, they did recognize how they ultimately might improve performance of the state’s regulatory mission. Due to a combination of economic and political factors, Missouri cannot place ground sensors in all the places needed to provide complete coverage. However, the state constantly evaluates its network against current and emerging air quality conditions in an effort to optimize the network they do have. They occasionally place monitors in new locations, sometimes as part of the regulatory network and sometimes as exploratory efforts to better understand the conditions in a certain location.

Interviewees talked about the large rural areas outside of Kansas City in Missouri and Kansas and lack of air quality monitors in these areas. As a result much less is known about the impact that agriculture has on air quality in these rural areas. Interviewees noted that the satellite information could provide a cost effective strategy for state regulators to learn more about the potential impact of agriculturally-generated sources of air pollution. For example, an EPA interviewee explained how pollution levels in rural areas could potentially be associated with an adjacent urban area. One of the issues the state and EPA may consider, is the connectivity of the rural area to adjacent urban area. The satellite information could prove useful in better understanding these sparsely monitored "in-between areas where we're looking at those connections between rural and city."

IMPROVING UNDERSTANDING OF POTENTIAL IMPACT OF NEW INDUSTRIAL DEVELOPMENT

In the Kansas City region while particulate matter; especially from diesel has decreased significantly over the years, the region still has a lot of locomotive traffic and Kansas City itself currently has a large intermodal facility. However, BNSF is building a new intermodal facility to open in late 2013 in nearby Edgerton, Kansas. As result, existing intermodal operations in Kansas City will move south of the city to the new facility. According to an air quality expert interviewed in Kansas City, this move and the associated modern capabilities of the new facility will help reduce overall air pollution in the area. However, the local impact on the area where the intermodal facility is being developed is an unknown:

> ". . . theoretically, as the air shed is concerned, [the new facility] will reduce the overall emissions because there will be less congestion, less idling of trucks coming in and out, and they're using electric cranes versus diesel cranes, and they're doing a lot of improvements both on process and on technology. But the area they're putting it in is pristine nature. You know, they're not building on a brown field."

Satellite data could help assess the impact on air quality in this situation.

IMPROVING REGIONAL AND LOCAL ANALYSIS OF AIR QUALITY CONDITIONS

All the experts we interviewed recognized the potential value of the satellite data to provide both regional and localized analysis of air quality conditions.

From a regional perspective, several interviewees discussed transport of air pollution across long distances within and across states. Identifying the source and impact of interstate air pollution has become an increasingly important issue because experts in the region estimate as much as one-third of their ambient ground-level ozone is imported from other states, primarily Texas and Oklahoma. According to one Region 7 expert, this recognition has, "Increased the need for larger-scale modeling, figuring out where the stuff is actually coming from versus looking at it within the air quality boundary [of the five-county Kansas City region]. So there's definitely a desire for more information at a wider scale." One interviewee noted "pollution travels quite long distances.. . anything from, say, the fires in the Flint Hills, which have impacts in multiple states away, we've seen that and can verify that based on following the smoke plume in a satellite photo, to, yeah, transport from, say, Oklahoma City, Dallas-Fort Worth area up into Wichita and causing ozone problems there. Transport is definitely a big issue both into our region and from sources within our region impacting downwind areas."

The annual prescribed burning of approximately two million acres of prairie in the Flint Hills area of Kansas "can contribute to impaired air quality in Kansas City, Wichita, Topeka and adjacent downwind states". . "And to be able to get a spatial representation of the ground level PM concentrations would be very intriguing."

From a more localized perspective, interviewees questioned exactly how granular the current 4km resolution of the satellite data would be for local analysis, but they all agreed it would be an improvement from the current network coverage. For example, an EPA interviewee explained how pollution levels in rural areas could potentially be associated with an adjacent urban area. One of the issues the state and EPA may consider is the connection of a rural area to an adjacent urban area. The satellite information could prove useful in better understanding these sparsely monitored "in-between areas where we're looking at those connections between rural and city."

IMPROVING DATA FOR LOCAL PUBLIC HEALTH FUNCTIONS

Satellite data could help support the public health mission of local governments. The deputy director of the Kansas City Health Department summarized the agency's main focus as it relates to air quality: "We're looking at the health outcomes that could be attributed to poor air quality; such as rates of chronic obstructive pulmonary disease, other respiratory disease, and asthma particularly." However, since the 1980s, a combination of political and economic factors caused the local air quality program to shrink from as many as 12 individuals to three, with a variety of responsibilities reverting to the State level where similar cuts have reduced the public health mission in favor of basic regulatory compliance. Reduction and loss of these capabilities have diminished the city health department's ability to make the case to influential stakeholders such as industry and the state legislature about the negative impacts of poor air quality on the residents of Kansas City. Interviewees stated that the satellite products could potentially provide an important information resource that could be used by the agency or by researchers to investigate the link between poor air quality and health effects. More specifically, "what I hope can come from [the satellite products] is the ability to look at more data analysis to allow us to anticipate health impacts, particularly as it relates to emergency room visits, doctor visits, provider visits, related to asthma and upper respiratory illness" and to the impacts on poor and minority neighborhoods that are more exposed to pollution.

Interviewees represented different stakeholder groups and consequently offered different kinds of recommendations regarding the future development and use of satellite data and fused data products. A clear tension exists between the desire for more information that is useful but not of regulatory quality and the desire for accuracy and consistency across data sources to demonstrate compliance and avoid unwarranted actions or mixed messages to the public, businesses, or local communities. Some of the recommendations therefore focus on the regulatory environment and the need for precise data to demonstrate attainment and progress toward attainment of the NAAQS. Others reflect scientific and technical viewpoints about how more or different data can inform analysis, forecasting, planning, policy making, or enforcement. A third set addresses public health and education concerns about how scientific information and health "messages" can best be communicated to the lay public.

Use satellite data to "ground truth" the monitors and vice-versa to assure data quality and credibility.

Satellite data would be a new source for most users of AQ information. As such, its quality and reliability need to be assured. One way to do this would be to periodically compare time-matched ground sensor readings on clear days to satellite readings on the same days in the small grid area surrounding each sensor. If the readings are substantially the same, the two sources could be considered equivalent quality for many purposes and satellite readings in areas more distant from the sensors could be considered valid. Another approach would be to test satellite readings in remote areas against readings from good quality mobile ground sensors in the same locations. A third would be to substitute satellite readings for a subset of ground sensor readings and compare the combined results to the results from the full set of ground sensors. All of these would help to establish the validity of satellite data and document its limitations relative to both sensor readings and interpolated results. According to one state expert, "The extent to which the satellite data agrees with monitored data relatively close to the monitors is a good thing."

Invest in technologies that allow data from ground sensors and from satellite sensing to be gathered, compared and fused for the same time periods.

Nearly all interviewees noted that the potential benefits of satellite data and especially of a fused product, depend on finding a way to synchronize the data from the ground and satellite sources. One interviewee explained that "I could see the value potentially of having some satellite-derived data . . . although I'm not sure from a temporal standpoint, that two passes would be super-meaningful." Another air quality expert commented that the current two passes of the satellite that occur in late morning and early afternoon do not capture certain pollutant peaks that occur throughout the day such rush hour and high processing times at factories and other facilities. Ideally, the readings from both sources would be recorded frequently so that information could be compared, fused, or adjusted using measurements from both sources taken at the same time of day. Investments in geosynchronous satellites or other technologies that collect data throughout a 24-hour period seemed far preferable to algorithms that attempt to compensate mathematically for missing data and widely different time frames.

Support research in satellite sensing technologies that permit measurement of other pollutants, especially ozone.

Interviewees could see the definite benefits of satellite data for filling in the gaps and improving the granularity of PM2.5 data gathered in the sensor network, but they also agreed that PM2.5 is less problematic than ozone as an environmental pollutant and health hazard. Better data are needed regarding ozone for two reasons. First, Missouri is generally in attainment with the PM2.5 standard but has a history of non-attainment for ozone. Second, PM2.5 is often accompanied by visible dust, smoke or haze as well as eye and respiratory irritation that cause people to take reasonable precautions, while ozone is invisible and more insidious as a health risk. According to one interviewee from the Mid-America Regional Council while reviewing the satellite product examples, "It really comes back to ozone . .

. these images would absolutely be a thousand times more useful to us here if they were more ozone related but, again, remote sensing of ozone... not here yet."

Provide training and technical support to both scientific and administrative users of ground sensor data, satellite data and fusion products

Data users need information and training about the nature and limitations of the satellite data in order to make informed judgments about whether and how to use it. One question raised several times during the interviews focused on learning how the ASDP integrates the reading from the two passes of the satellites with the PM2.5 standard, which is a 24 hour reading. A standard description of this process would help a technical user understand how the fusion is done and whether the result would be relevant or useful in any given application. Administrative users suggested webinars or other training programs to introduce them to the full range of AQ data available, its pros and cons, and suggestions about how it can be applied to support different responsibilities including outreach, research, and environmental justice studies.

Take special care in designing satellite products for non-experts.

Because of its complexity and limitations, interviewees were cautious about making the satellite data directly available to the public. While they recognized that community groups in Missouri that would be very interested in additional sources of air quality information, they expressed concerns about how these groups would react to multiple and different sources of information that by their nature are not necessarily consistent and are sometimes contradictory. Several interviewees compared the satellite products to mobile and hand held monitors that were emerging in local communities around the United States. Some of these monitors do not meet the EPA standards for instrument and data quality and can provide readings that are substantially different from what the public sees on AirNow or official state or local websites. Interviewees agreed that more and different data sources is a good thing for experts who understand the data, it will be necessary to understand if and how this information could be of value to "non-experts" before making satellite products publicly available. One air quality expert from the MARC compared the challenge to the growing use of community-level monitoring:

"Community-level monitoring, like handheld monitors that people can monitor in their yard, I think those are fantastic [but] I just hesitate a lot on the validity of the data . . . [E] specially when those monitors are monitoring in a different time scale or a different unit than the EPA monitors, you can't compare those results…. [I]f there's not enough outreach and education going on with the people who are actually collecting the data, they just see numbers. They don't see micrograms per cubic meter. They don't see if it's an annual or a 24-hour. All they see is that instantaneous measure. And it's very hard, even for people who work in air quality, it gets complicated really fast. And so I worry a little bit about that data collection and the comparison of results to other monitors, just because they're not calibrated to each other… [I]f the numbers can't be meaningfully compared to one another, is it really that useful or are you just sort of scaring people."

An EPA expert suggested one strategy for making the satellite information available in a useful way would be to present it side by side with the AirNow data on a single web page with an explanation of the differences. This approach could make the satellite data more understandable and useful to members of the public as an additional source of information. Overall, interviewees saw the potential value but cautioned that satellite products would need to be accompanied by outreach and education to help people understand what they were seeing. One interviewee summed up the general consensus, "the idea is awesome, it's just the implementation that needs a lot of focus and work and energy."

Improve the organization and usability of the existing AirNow.gov website.

Several interviewees were not fully aware of the range of information and links on AirNow.gov and others noted that the site is very data-driven and therefore suitable for expert users but not so much for general users. While the information it provides is diverse and valuable, it is not easy to find or use. One interviewee commented that the accessibility, usability, and value of the current AirNow website could be improved for public consumption by an expert evaluation from someone who specializes in user experience.

Appendix 1

List of Interviewees

Missouri Department of Natural Resources, Air Pollution Control Program

- Stephen Hall, Monitoring Unit Chief

Environmental Protection Agency, Region 7

- Andy Hawkins, Environmental Scientist
- Amy Bhesania, Missouri State PM Coordinator

Mid-America Regional Council

- Doug Norsby, Air Quality Manager
- Amanda Graor, Air Quality Program Manager

City of Kansas City Health Department

- Bert Malone, Deputy Director
- Catherine Reid, Air Quality Engineer
- Dennis Murphey, Chief Environmental Officer, Office of Environmental Quality
- Naser Jouhari, Director of Environmental Services

LIST OF ACRONYMS

Items Pertaining to Air Quality Science, EPA, NASA, and National Policies

ASDP: AirNow Satellite Data Processor

40 CFR Part 58: Ambient Air Quality Surveillance Siting Criteria for Open Path Analyzers

CMAQ: Congestion Mitigation and Air Quality Improvement Program

CO: Carbon Monoxide

GASP: Geometric Autonomous Shuttle

GOES: Geostationary Operational Environmental Satellite

MODIS: Moderate Resolution Spectroradiometer

NOx: generic term for mono-nitrogen oxides, NO and NO2

OAPQS: EPA Office of Air Quality Planning and Standards

PIO: Public Information Officer

QA: Quality Assurance

SIP: State Implementation Plan

VOC: Volatile Organic Compounds

Kansas City case-specific items

MARC: Mid America Regional Council

MDNR: Missouri Department of Natural Resources

Appendix 3

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Appendix 4

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Act identifies two types of standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. EPA has set NAAQS for six "criteria" pollutants listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m3). The standards shown in the table below are effective October 2011.

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 µg/m3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	PM2.5	primary	Annual	12 µg/m3	annual mean, averaged over 3 years
		secondary	Annual	15 µg/m3	annual mean, averaged over 3 years
		primary and	24-hour	35 µg/m3	98th percentile, averaged over 3 years
	PM10	primary and secondary	24-hour	150 µg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

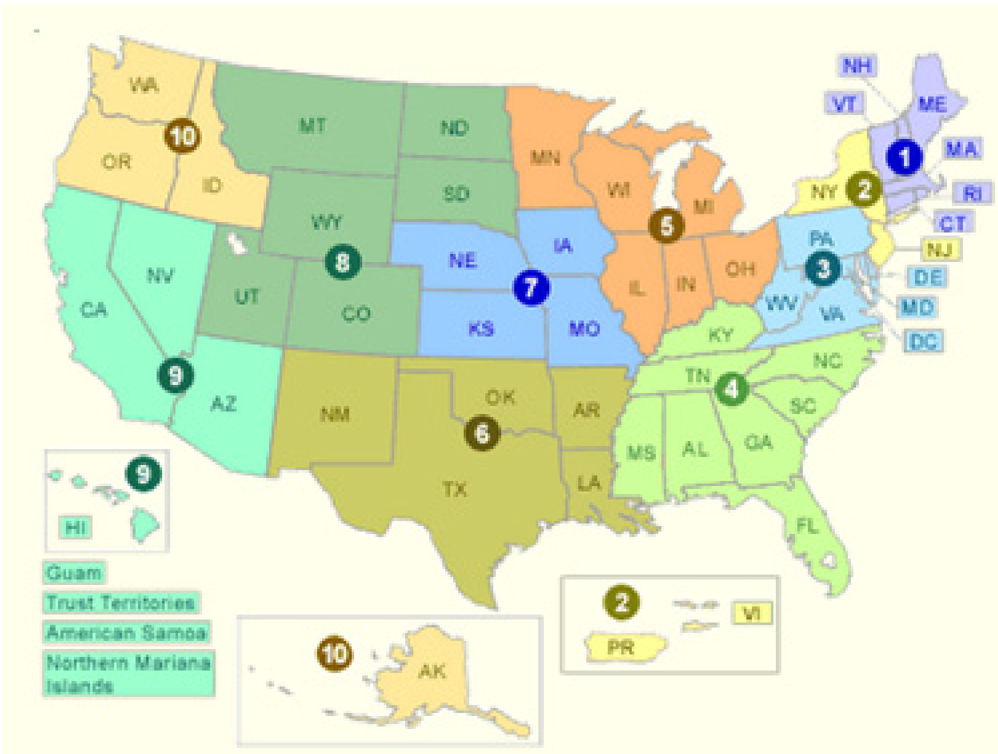
(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Case Study Methodology

This study, funded by NASA and in partnership with EPA and Sonoma Technology, Inc., addresses the ways in which current AirNow source data and data products contribute to socioeconomic benefits today and how satellite-enhanced data might contribute to different or greater benefits in the future.



To understand the potential benefits of adding satellite data to AirNow, we put that data in a larger context including the flow of air quality monitoring data among different stakeholders. Within the regulatory process that requires compliance with the NAAQS established under the Clean Air Act, data are collected hourly but organized and reported quarterly to the US Environmental Protection Agency by the air quality agency in each state. States that do not meet the air quality standard are required to develop and implement action plans to come into compliance. Most of the improvement in air quality in the U.S. can be attributed to the adoption and enforcement of these standards which have influenced both public policy and private enterprises. AirNow uses essentially the same data for non-regulatory purposes, but use this data in near-real time, before extensive quality assurance has been performed. State air quality agencies use AirNow data to forecast air quality conditions for the next day and to inform the public and the media about potentially unhealthy conditions so they can take action to reduce pollution and protect human health.

Most research on the benefits of air quality regulation and information rest on complex mathematical models or surveys that cover extensive regions of the US or the entire country. By contrast, this study attempts to understand the value of monitoring data from a community-level view through three case studies: Denver, Atlanta, and Kansas City located respectively in EPA Regions 4, 7 and 8.

Using these communities as a focus, we take localized contexts into consideration to address the following questions:

- Who are stakeholders in air quality information in the case study area? What are their needs and capabilities?
- Who uses AirNow source data and data products now and how do they use it?
- What techniques or strategies seem to have the most positive effect on public awareness and behavior? What evidence is available on these effects?

- What gaps or weaknesses in current data reduce its usability and usefulness for different kinds of users?
- To what extent could NASA satellite data ameliorate these problems or provide for new or expanded uses?
- What other activities, information, or capabilities would enhance the usability and usefulness of AirNow data for informing and educating the public about air quality and its effects on health and quality of life and for furthering the goals of the Clean Air Act?

We organize the analysis according to a public value framework that assesses the impact of existing AirNow source data and data products along several dimensions including economic, social, strategic, quality of life, stewardship, and mission impacts.

The case studies involved 23 face-to-face and three telephone interviews with responsible officials and leaders in these communities representing EPA, state agencies, local public health authorities, regional planning and outreach organizations, university researchers, and relevant others. Interviews were transcribed and coded to identify factors associated with each of the research questions and the various indicators of public value. The study data also include regulatory documents, news media, local and state websites and reports, and a previous research studies in these three sites.

[i]The full NAAQS is found at http://www.epa.gov/air/criteria.html and in the Appendix.

[ii]For more information about 40 CFR Part 58 see http://www.gpo.gov/fdsys/pkg/CFR-2002-title40-vol5/pdf/CFR-2002-title40-vol5-part58.pdf.

[iii]See Ambient Air Monitoring Network Assessment Guidance. Prepared by STI 2007, pp. 2-1 – 2-3.

[iv]The AirNow Satellite Data Processor Website is located at http://asdp.airnowtech.org/

[v]Missouri Department of Natural Resources. Air Pollution Control Program. 2013 Monitoring Network Plan . May 23, 2013. Available at www.dnr.mo.gov/env/apcp/2013monitoringnetworkplan.pdf.

About

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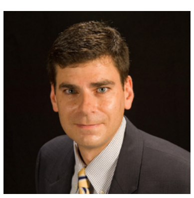

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