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No Special Training Required. No need to wait days or even weeks to collect and analyze an air or gas sample. With the VeriAir Flex you can grab a whole air sample, send it to a lab or do on-site analysis in a matter of minutes, anywhere, anytime. Perfect for nuisance aromas, HazMat situations, or any application that requires quick response.

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**VeriAir Flex — the ultimate in sampling flexibility.** It’s versatile, robust, easy to use and transport — no maintenance required. With the Nextteq VeriAir Flex, it’s all in the bag!

<table>
<thead>
<tr>
<th>Sample Method Comparison</th>
<th>NEXTTEQ VERIAIR FLEX</th>
<th>TEDSTAR BAG</th>
<th>STAINLESS STEEL CANISTER</th>
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<tr>
<td>No extra equipment needed to collect sample</td>
<td>yes</td>
<td>no</td>
<td>no</td>
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<tr>
<td>Ready to sample anytime, anywhere - NO preparation needed</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Can be air shipped when filled with sample</td>
<td>yes</td>
<td>no</td>
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<tr>
<td>Ability to sample with a detector tube before sending to lab</td>
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<td>yes</td>
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<tr>
<td>Off-site sample analysis can be performed with no dilution gas or volume calculations</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
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<tr>
<td>Easily reusable with manual flushing capability</td>
<td>yes</td>
<td>no</td>
<td>no</td>
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</tbody>
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FEATURES

Recent Practices and Advances in Air Quality Forecasting
by Prakash Doraiswamy, RTI International
Methodologies and approaches used to forecast daily air quality have improved tremendously in recent years, including the use of single and multiple model-based air quality forecast guidance, near-real-time data post-processing and bias correction using measured data from surface networks and satellite data, and implementation of wildfire emissions for issuing next-day air quality forecasts. This month, EM presents three articles that provide an insight into some of the innovative approaches being implemented and tested to improve air quality forecasts.

A European Global-to-Regional Air Pollution Forecasting System that Combines Modeling with Satellite Observations
by Johannes Flemming, Vincent-Henri Peuch, Richard Engelen, and Johannes W. Kaiser, European Centre for Medium-Range Weather Forecasts

Fires and Air Quality Forecasts: Past, Present, and Future
by M. Talat Odman, Yongtao Hu, Aika Y. Davis, Michael E. Chang, and Armistead G. Russell, Georgia Institute of Technology; and Fernando Garcia-Menerdez, Massachusetts Institute of Technology

Developing Real-Time Emissions Estimates for Enhanced Air Quality Forecasting
by Jeongran Yun, Mark Beauharnois, and Kenneth L. Demerjian, University at Albany; Prakash Doraiswamy, RTI International; Christian Hogrefe, U.S. Environmental Protection Agency; and Eric Zalewsky, Winston Hao, and Jia-Yeong Ku, New York State Department of Environmental Conservation

In Search of an Intelligent Methodology for Designing Sustainable Cities
by Bheegrahul Addepalli, Eric R. Paradiyak, R. Stol, and D.E. Johnson, University of Utah; and P. Willemsen and S.A. Holverson, University of Minnesota-Duluth
A close look at the GEnUSiS (Green Environmental Urban Simulations for Sustainability) project, which aims to empower urban planners, decision-makers, and other stakeholders with the necessary state-of-the-art tools to implement science-based sustainability solutions to achieve better urban designs.
Although the Local Host Committee (LHC) has been forming for the past year, the planning process for the 2014 A&WMA Annual Conference & Exhibition (ACE) to be held in Long Beach, CA, next June officially kicked off in September. At this point, all of the LHC subcommittees (some of which are still looking for volunteers) are jumping into high gear. It takes a lot of hard work and dedication to put one of these annual meetings together, so I very much appreciate the efforts of these volunteers.

Because each year's ACE is a substantial revenue source for our Association, the financial success of these meetings is of critical importance in our being able to bring programs and events to our members. The revenue for ACE comes mostly from attendee registrations and exhibitors, but a substantial portion also comes from sponsorships.

I'm pleased to report that a few sponsors have already signed up, including the South Coast Air Quality Management District (SCAQMD), as the overall general conference sponsor (see list of current confirmed sponsors opposite). The SCAQMD has long been a great supporter and partner of the West Coast Section of A&WMA, my home Section. Kudos to the SCAQMD and the other sponsors for showing their commitment to the environmental profession and environmental leadership. However, we still have a long way to go to meet our budget goals, so I'd like everyone who supports the environmental profession and A&WMA to consider becoming a sponsor of this event.

You might be asking yourself, why should my company or organization sponsor ACE (or any of our other meetings or programs, for that matter)? Is the additional visibility in A&WMA publications and on site at the event worth the cost? I believe it is (and my company, AECOM, has been a sponsor of ACE for the past two years and will be again in 2014), but I would also like you to look beyond the direct advertising benefit and consider how your contributions will be put to good use.

A&WMA offers many opportunities for professional development, including educational courses, webinars, workshops, and conferences, where we are known for providing a neutral forum where regulators, industry, consultants, and public interest groups can come together to express their views and discuss problems and solutions.

In September, for example, we held our biennial Climate Change Conference, which drew several high-level speakers, including keynote speakers, Christopher Smith, Principal Deputy Assistant Secretary of the U.S. Department of Energy, and Thomas Kerr, Principal Climate Policy Officer of the International Finance Corporation, as well as Janet McCabe, Acting Assistant Administrator for the U.S. Environmental Protection Agency’s Office of Air & Radiation, who again (see my September message) spoke highly of A&WMA. Conference Chairs Miriam Lev-On and C. Flint Webb, and the rest of the conference committee and A&WMA staff, did a great job in organizing this conference. As you can see from the caliber of the speakers, this was a great conference in my opinion, and it's unfortunate that more of you did not avail yourselves of this networking and professional development opportunity.

Helping to plan meetings; publishing articles and technical papers; participating in A&WMA activities as officers, directors, or committee members of our local Sections and Chapters; or participating in our various Councils or the Association Board of Directors, provide opportunities to our member volunteers to develop leadership and organizational skills that can lead to career advancement and professional recognition. This has definitely been the case for me in my career.
I believe that A&WMA plays an important role as a source of environmental information, networking opportunities, professional development, leadership skills and training opportunities, and support for students and young professionals. And in fulfilling these needs, A&WMA is a champion for the environmental profession, providing vitality and sustainability. So please decide today to support A&WMA such that we can continue our efforts to pool our resources toward professional development. Maintain your membership, volunteer to help with governance and/or events, and decide to become a sponsor. Has the environmental profession been good to you? If so, it’s time to give back.

And of critical importance to the sustainability of the environmental profession, A&WMA fosters students and young professionals. The Association publishes environmental resource guides for teachers and provides many thousands of dollars in scholarships each year. We also provide subsidies for student memberships and registrations at meetings. This past year, we held several “101” webinars to help our young professionals and others enhance their knowledge and provide training for better job performance.

If A&WMA does not maintain our current membership numbers, have solid registration and exhibitors at our meetings, and also attract sponsors to help us keep our programs more affordable, then we will no longer be able to provide the types of programs and support to our members that we do.

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**Professional Development Course Proposals**

The Air & Waste Management Association is recruiting instructors to be a part of the 2014 Professional Development Courses.

If you are interested in teaching a course prior to the 2014 Annual Conference in Long Beach, California on Sunday, June 23, 2014 and/or on Monday, June 24, 2014 please fill out a Course Proposal Form.

**Deadline for Course Proposal submissions is Monday, December 16, 2013.**

Course Proposal Forms can be found at: [http://ace2014.awma.org/courses/](http://ace2014.awma.org/courses/)

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**Confirmed Sponsors for ACE 2014* General Conference Sponsor – South Coast Air Quality Management District**

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*Confirmed as of October 22

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**A&WMA Student Award Opportunities**

The Air & Waste Management Association is proud to recognize outstanding students who are pursuing courses of study and research leading to careers in air quality, waste management, environmental management/policy/law, and sustainability.

**Don't miss these Student Award Opportunities!**

- **Student Platform Paper Award**
  - Submissions are due by November, 4, 2013

- **Student Poster Award**
  - Submissions are due by December 16, 2013

- **Scholarships**
  - Applications are due by January 10, 2014

- **Master Thesis and Doctoral Dissertation Awards**
  - Submissions are due by January 13, 2014

Recent Practices and Advances in Air Quality Forecasting

State and regional air quality agencies issue short-term air quality forecasts to provide the public with advance warning of possible air quality episodes and actions they might take to protect their health. Air quality forecasts are delivered using an air quality index that converts concentrations of multiple pollutants such as ozone and particulate matter into a simple metric that indicates the quality of the air and the associated health effects for different populations. These forecasts are typically generated based on an analysis of weather patterns, statistical models, human judgment, and more recently, through use of regional photochemical models.

Back in 2002, *EM* featured plans for air quality forecasting in the United States, including a new partnership between the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) to implement a model-based forecasting system. Since then, methodologies and approaches used to forecast daily air quality have improved tremendously, including the use of single and multiple model-based air quality forecast guidance, near-real-time data post-processing and bias correction using measured data from surface networks and possibly satellite data, and the implementation of wild-fire emissions for issuing next-day air quality forecasts. While recent budget cuts have forced these agencies to divert funding away from model-based short-term air quality forecasts, these approaches are still in practice by research groups. In this issue of *EM*, we present three articles that provide an insight into innovative approaches being implemented and tested to improve these air quality forecasts.

**European Global-to-Regional Air Quality Forecasting System**

The first article by Flemming et al. summarizes a novel global-to-regional air quality forecasting system operated by the European Centre for Medium Range Weather Forecasting (page 6). It presents a description of their global forecasting system that incorporates observational data from satellites for gases and aerosols that reduces large-scale model biases. The global forecasts then serve as boundary conditions for their regional ensemble forecasting system.

**Incorporation of Fires in Air Quality Forecasts**

The next article by Odman et al. focuses on the issue of wild fires and their incorporation into air quality forecasts (page 12). Wild fires are a major contributor to poor air quality and are projected to increase in intensity and frequency as a result of climate change. From an air quality forecasting...
perspective, emissions from wild fires are not well-represented. This article presents a description of the approach to model wild fire emissions and prescribed burning emissions. It also describes the utility of information from satellites to incorporate near-real time fire information, particularly for large wild fires.

**Modeling Real-Time Emissions from Electric Generating Units during High Electric Demand Days**

The third and final article by Yun et al. explores approaches to model emissions from electric generating units (EGUs) on hot summer days of high energy demand (page 22). While data from continuous emissions monitors are available for retrospective modeling, air quality forecasts usually use average EGU emissions that may significantly underestimate emissions on some days. This is particularly true for cases where emergency generators are brought online to meet peak demand (and hence are called “peaking units”).

This article examines the relationship between energy load forecasts, ambient temperature, and emissions to develop an improved approach for real-time emission estimates for EGUs that will, in turn, improve the accuracy of air quality forecasts.

The above three articles present examples of approaches used to improve model-based air quality forecasts. Accurate air quality forecasts will translate into more precise warnings to the public. More importantly, they offer potential for use as a dynamic air quality management tool, which can then be used to identify emission intervention strategies that can avoid air quality exceedances. While there are challenges to be overcome, model-based air quality forecasts have enhanced significantly over the past decade and continue to provide hope on a possible transition to a dynamic air quality management framework, as recommended by the National Research Council.1

Reference

A European Global-to-Regional that Combines Modeling

A novel forecasting system for atmospheric composition operates daily to forecast global air pollution.

Atmospheric trace gases and aerosols have been observed from satellites for more than two decades, but only recently have these observations been exploited for air pollution applications. The European Copernicus program (formerly known as GMES—Global Monitoring for Environment and Security) supports the development of operational monitoring capabilities of the environment, which rely strongly on remote-sensing from satellites, as well as in situ observations. A novel forecasting system for atmospheric composition has been developed for the Copernicus atmosphere service in a series of research projects (GEMS, MACC, and MACC-II) funded by the European Commission since 2005. The system is now operated daily to forecast global air pollution, as well as air quality over Europe. The forecasts are an important input to air quality warning systems for protecting human health. Besides air quality, the global forecasts are used to predict ultraviolet exposure, available solar energy, and hazards caused by dust storms.

The Copernicus prototype forecasting system consists of a single global model and an ensemble of regional air quality models for the European domain, which use the predictions of the global model as boundary conditions to allow for long-range...
Air Pollution Forecasting System
with Satellite Observations

transport of pollutants. Satellite observations are fed into the global model to improve the initial conditions of the forecasts, and also to infer the latest distribution of forest fire emissions. The regional models use surface observations, as well as some satellite data, to correct their initial conditions. Each of the regional models has a different formulation of the chemical processes. The spread of forecasts of the individual regional models is used as an indication of the uncertainty of the predictions, and the ensemble median has a better overall forecast skill than any of the individual models.

A Global Model and Data Assimilation System

The global component of the system has been developed at the European Centre for Medium-Range Weather Forecasts (ECMWF) by extending ECMWF's weather forecasting model to predict the fate of trace gases and aerosols. The atmospheric composition forecasts are currently run over five days at a horizontal resolution of 80 km, which is about five times coarser than the resolution of ECMWF's operational weather forecasts because of the extra computational cost of the representation of chemical processes. Figure 1 shows a schematic of the building blocks and the data flow within the global and regional forecasting systems.

Significant progress in numerical weather prediction in recent decades can be attributed to the improved exploitation of observations, in particular from satellite instruments. The satellite observations, together with in-situ observations, are blended with the model results using a technique called data assimilation. Data assimilation is used in numerical weather prediction to produce a realistic starting point for the model forecast, which is essential for the forecast quality. For the Copernicus atmosphere service, ECMWF's meteorological data assimilation system has been adapted for the assimilation of satellite observations of atmospheric composition.

Observations of atmospheric gases and aerosols by satellites instruments have limitations. The vertical resolution is low and the signal from the boundary layer is often weak. Nevertheless, the assimilation of satellite observations by the Copernicus system is successful in reducing large-scale model biases and introducing the effects of emissions that are not

Figure 2. Forecast of a smoke plume traveling from Asia to North America on July 5, 2012. The plume came from intensive forest fires in Eastern Siberia, which were observed by the MODIS satellite instrument in near-real-time. The corresponding emissions were used in the forecast. The observed fire radiative power (FRP) is shown in a red color scale, aerosol optical depth (AOD) of the forecast plume is shown in a blue color scale. An animated version of the plume is available online at www.copernicus-atmosphere.eu/news/seattle_haze/seattle_haze_details/.
Sea salt emissions are derived based on wind forecasts. Transport events of Sahara dust to Europe and the Middle-East, as well as dust storms in China and Australia, have been correctly predicted by the global forecasts.

A Regional Forecast Ensemble for Europe

Seven state-of-the-art regional air quality models (CHIMERE, EMEP, EURAD, LOTOS, MATCH, MOCAGE, and SILAM)11 are run daily for the European region, as part of the Copernicus atmosphere service. The models have a horizontal resolution of 10–20 km, which is well suited to capture the characteristics of air pollution events such as increased ozone levels in summer.12 The forecasts are provided to a wide range of users, who use the regional results to make air quality forecasts at the urban- or even the street-level scales. The simulated chemistry of the regional models is more comprehensive than that in the global system, in particular for the secondary aerosol formation, which is an important contribution to fine particulate matter (PM2.5). The feasibility to forecast sources and transport of birch pollen over Europe, for example, was demonstrated in spring 2013.

Emissions from Inventories and Observed Forest Fires

Specific inventories of anthropogenic and biogenic emissions at the global8 and the European scale9 have been compiled for the Copernicus atmosphere service. Besides using the inventories, the Copernicus atmosphere service also pursues efforts to capture the day-to-day variability of the emissions in near-real-time. The thermal radiation from large forest fires, which can have a strong effect on air pollution locally or by long-range transport, can be observed from space. The observations are converted to emissions10 of 40 smoke constituents, including black carbon and carbon monoxide, which are then used by the global and regional models.

As an example, Figure 2 shows space-borne observations of forest fires in Siberia and the resulting simulated smoke plume.7 Assimilation of surface observations is a successful approach to correct the initial surface concentration in the regional models, but may have limited impact on the forecasts if the emissions remain uncorrected. Therefore, the correct knowledge of the emissions, the manifold chemical conversions, and the removal processes, together with a good representation of the transport, remains decisive for air pollution forecasting at the global and regional scale.

Figure 3. Presentation of a four-day forecast (June 16–19, 2013) for Paris, including an ensemble of seven regional air quality models for ozone, nitrogen dioxide, sulfur dioxide, and PM10. The size of the boxes represents the range of the predicted values. The median of the ensemble is represented by the line in the middle of the box. The red line indicates the air quality threshold according to European legislation. The latest ensemble forecasts are available online at http://macc-ra.gmes-atmosphere.eu/som_eps.php. Accurately accounted for. It can also help to correct the strength of specific events like dust storms or forest fire plumes.7 Assimilation of surface observations is a successful approach to correct the initial surface concentration in the regional models, but may have limited impact on the forecasts if the emissions remain uncorrected. Therefore, the correct knowledge of the emissions, the manifold chemical conversions, and the removal processes, together with a good representation of the transport, remains decisive for air pollution forecasting at the global and regional scale.

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The regional models use the same emissions, boundary conditions, and meteorological input from the operational ECMWF forecast, but still the results differ owing to different formulations of chemical and physical processes, which is an indication of the uncertainty13 in the forecasts. Following the example in weather prediction, where the spread of an ensemble forecast is used to illustrate forecast uncertainty, the forecasts of the regional models are presented in a common framework.

Figure 3. Presentation of a four-day forecast (June 16–19, 2013) for Paris, including an ensemble of seven regional air quality models for ozone, nitrogen dioxide, sulfur dioxide, and PM10. The size of the boxes represents the range of the predicted values. The median of the ensemble is represented by the line in the middle of the box. The red line indicates the air quality threshold according to European legislation. The latest ensemble forecasts are available online at http://macc-ra.gmes-atmosphere.eu/som_eps.php.
As an example, Figure 3 shows the air quality ensemble forecast for Paris during a period with increased ozone concentrations in June 2013. The regional models predict a similar variability, but the individual differences can be large. In contrast to an ensemble of weather forecasts, in which the ensemble spread tends to increase for longer forecast times, the spread of the “chemical ensemble” does not steadily increase with forecast lead time, but often shows a diurnal variability.

Running, Evaluating, and Presenting Operational Air Pollution Forecasts
The routine operation of the air pollution forecast benefits greatly from the operational infrastructure offered by ECMWF. All meteorological data, as well
as satellite observations of forest fires (MODIS), aerosol optical depth (MODIS), carbon monoxide (MOPITT and IASI), nitrogen dioxide (OMI), and ozone (MLS, SBUV-2, IASI), are received, processed, and fed into the global system. The regional models are run by their owners once the global forecast is completed.

The evaluation of the global and regional forecasts is at the heart of the Copernicus atmospheric service. In-situ observations available shortly after the forecast are used for the evaluation of the latest forecast. These observations come from the operational air quality networks in the European countries collated by the European Environment Agency of images on the Copernicus Web site at www.copernicus-atmosphere.eu.

References
1. The European Copernicus Programme. See http://www.copernicus.eu/

Transport events of Sahara dust to Europe and the Middle-East, as well as dust storms in China and Australia, have been correctly predicted by the global forecasts.
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A look at the evolution of methods for forecasting wildfire and prescribed burn impacts on air quality.

Wildfires threaten our lives not only through their destructive power, but also with their significant impact on air quality. Local- and regional-scale impacts of fires on atmospheric composition are apparent in the concentrations of trace gases and aerosols, including carbon monoxide, nitrogen oxides, ozone, black carbon, and particulate matter. Emissions from fires impair visibility and adversely affect public health. Poor visibility has led to fatal highway accidents, and several epidemiological analyses have identified statistically significant associations between fire-related smoke and respiratory- and asthma-related hospital admissions.

In the United States, a considerable fraction of air pollution can be attributed to fire-related emissions. At present, wildfires largely drive the variability in summertime organic carbon aerosol concentrations in the western United States. Though less common, emissions from wildfires in the eastern United States, such as the Florida-Georgia fires of 2007 and North Carolina peat fires of 2008, can endanger the lives of larger populations in urban areas. In addition, wildfire activity may strengthen under a changing climate. Studies suggest that a warmer and drier climate increase the area burned by wildfires and their severity. The response of plants and vegetation to climate is not necessarily considered in these studies, but fuel loads may also increase in the future leading to more intense fires with larger emissions. Considerable increases to organic and elemental carbon aerosol concentrations can be expected to occur by mid-century as fire-related emissions intensify.

Controlled fires, also known as prescribed burns, can also be a major contributor to air pollution.
Prescribed burns are frequently used as a land-management strategy and have proven to be effective toward accomplishing different objectives, such as habitat restoration, wildfire prevention, endangered species protection, site preparation for seeding and planting, and disease control. In the past decade, more than 30% of the area burned by fires within the contiguous United States corresponded to prescribed burns. In the southeastern United States, where prescribed burning is a preferred method of land management, more than 8 million acres of land are treated by fire every year, and this amount could easily double if there were no limiting air quality concerns. Source apportionment modeling of fine particulate matter (PM2.5) measurements from 24 Speciation Trend Network sites in the southeastern United States suggests that prescribed burning may be contributing more than 30% of the annual PM2.5 mass. Recent studies show that prescribed burning can significantly impact air quality in neighboring urban communities, contributing significantly not just to PM2.5, but ozone as well. For example, on February 28, 2007, due to a prescribed burn, 1-hr PM2.5 concentrations at several monitors in Atlanta, GA, reached 145 μg m⁻³ (the NAAQS for 24-hr PM2.5 is 35 μg m⁻³), increasing by more than 100 μg m⁻³ in just two hours. In addition, 1-hr average ozone concentrations increased markedly from 63 parts per billion (ppb) to 95 ppb at one of the monitors.

The concern over fires in air quality planning efforts is expected to grow as air quality standards become more stringent and emissions from other anthropogenic sources are better controlled. Because prescribed burn impacts on air quality can be exacerbated or diluted, depending on ambient meteorological conditions and interactions with other emissions in and around large metropolitan areas, integrating air quality forecasting in prescribed burn management can avoid creating serious air quality problems. This article was made possible by grants from the Joint Fire Science Program (12-3-01-60), NASA (NNX11AI55G), and U.S. Environmental Protection Agency (RD83521701), and a contract with the Georgia Department of Natural Resources (773-120170). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the supporting agencies. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement or recommendation by the authors.
pollution incidents. Further, a dynamic air quality management approach based on forecasting would not only mitigate the undesirable impacts of fire emissions, but may also increase burning capacity by allowing additional emissions when conditions are favorable. However, such an approach would require more accurate predictive tools for forecasting fire emissions and their air quality impacts.

Models for Forecasting

Weather forecasting is the first step in predicting the impacts of fires. Since numerical weather prediction models are relatively well developed, we will not discuss them here. Using the weather forecast simply as an input to fire impact simulations is a common approach and is appropriate, as long as the fire does not interfere with the weather. However, some fire plumes are known to create their own local weather. Models currently under development to capture the feedback of fire plumes on weather should be considered for fire impact forecasting in the future.

Estimation of fire emissions usually consists of approximating the amounts of different types of fuels consumed and multiplying them with emission factors derived from field studies or laboratory experiments measuring the amounts of various pollutants emitted per unit mass of consumed fuels. The fuel consumption estimation typically begins by characterizing the fuel loads. For wildfires, fuel loads can be obtained from National Fire Danger Rating System (NFDRS) or similar maps. For prescribed burns, fuels can be surveyed and matched with the closest depiction in a catalog where each photograph has corresponding fuel loads. A consumption model can then be used to calculate the fractions of fuels that would be consumed under predicted fire conditions. Several fire emission modeling tools are available through the BlueSky framework, including the consumption model CONSUME which considers fuel loads, fuel moistures, and intensity of the fire to calculate fuel consumptions. BlueSky also compiles emission factors from various sources.

A variety of models have been developed and used for predicting the dispersion and transport of fire-related emissions. Simple Gaussian plume models have been developed to assist land managers in planning prescribed burns, such as VSMOKE and the Simple Approach Smoke Estimation Model. Puff models, which simulate fire emissions as a series of continuously emitted parcels, can be used to model dispersion under space- and time-varying meteorological fields over detailed terrain. Calpuff, a widely used puff model, has been applied to simulate the transport of fire plumes. The Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) is a component of the Smoke Forecasting System used by the U.S. National Weather Service to produce daily smoke forecasts. Other Lagrangian particle models, such as FLEXPART, have been used to simulate biomass burning plumes. Daysmoke, another member of the Lagrangian family, has been specifically developed for modeling the dispersion and transport of prescribed burn plumes.

All these models lack the chemical detail that would be needed to predict the air quality impacts of fires, particularly the formation of secondary pollutants such as ozone and a potentially large fraction of organic aerosols. Some do not include any representation of chemistry (e.g., VSMOKE, Daysmoke) and simply treat the fire plume as a mixture of inert gases or particles. Others may have characterizations of chemical reactions in the atmosphere, but generally in a very simplistic way (e.g., Calpuff and HYSPLIT). This is not surprising given the fact that these models are used in forecasts mainly concerned with primary smoke impacts and not secondary air pollution or the interactions with emissions from other sources over large geographic regions.

An alternative approach to simulating the transport and transformation of fire emissions is to use Eulerian chemical transport models (CTMs). These models use weather forecasts, emissions estimates, and mathematical representations of atmospheric processes to predict the evolution of pollutant concentrations over large geographic regions. Today, CTMs are extensively applied in North America and Europe to design environmental policy, generate air quality forecasts, and study atmospheric physics and chemistry. In contrast to Lagrangian dispersion models, Eulerian CTMs include state-of-the science representations of chemical and physical atmospheric transformations.
Previous applications of Eulerian CTMs for predicting the impacts of wildland fires have achieved greater understanding of the atmospheric processes affecting fire-related emissions. However, there are limitations associated with the current generation of models because of their relatively coarse resolution. Eulerian CTMs operate by dividing an atmospheric domain into a number of discrete cells and simulating atmospheric processes for every cell. Computational requirements typically restrict grid resolution in regional-scale applications to a few kilometers. Emissions are immediately diluted upon injection into a grid cell, losing potentially important information about the subgrid-scale structure of a plume. As pollutants are dispersed, coarse grid resolution causes artificial diffusion by uniformly mixing pollutants within each cell. This leads to a loss of accuracy, especially in the modeling of nonlinear chemical transformations. Processes occurring at scales smaller than those captured by the grid resolution must be parameterized in CTMs. Some CTMs offer subgrid-scale plume treatments for emissions from industrial stacks, but not for fire-related emissions.

The vertical distribution of fire emissions is an important component of air quality simulations centered on smoke transport. Theoretical or empirical plume rise representations, with varying levels of complexity, are often used to approximate vertical plume structures. The fraction of fire emissions penetrating into the free troposphere is a key model parameter. Pollutant concentrations predicted by CTMs are highly sensitive to the altitude at which fire emissions are injected relative to the planetary boundary layer (PBL). For instance, Figure 1 shows a prescribed burn smoke plume simulated by the Community Multiscale Air Quality (CMAQ) model, an Eulerian CTM, using different vertical distribution profiles. The vertical profile that retains flaming-stage fire emissions within the PBL (Figure 1a) produces a concentrated smoke plume. In contrast, allocating the majority of fire emissions into the free troposphere leads to a weaker and highly diffused plume (Figure 1b). The air quality impacts predicted by the model at downwind receptors in each case differ significantly.

Air quality forecasting requires emission forecasts as one of its inputs. One approach to projecting fire emissions to the future has been to develop a typical fire emissions inventory by averaging several years’ fires. The rationale is that since the locations, frequencies, and strengths of future fires cannot be predicted accurately, a typical year’s fires would be a reasonable representation of future years’ fires. In this manner, the probability of introducing large uncertainties by using a single year’s high or low fire activity is reduced. In the past, this approach has been used by the U.S. Environmental Protection Agency (EPA) and regional planning organizations (RPOs) for regulatory purposes, and adopted by operational air quality forecasting systems such as Hi-Res.
As an example of the typical year approach, the Fire Averaging Tool (FAT) developed by EPA generates day-specific fire emissions for each county by taking the rolling average over a specified period of daily fire emissions in that county for the years being included in the average. For example, if the selected averaging period is 29 days (+/- 14 days) and the years included are 2003–2009, then for July 15 the tool averages all the fires in that county from July 1 to July 29 for 2003–2009. Figure 2 illustrates how a 29-day averaging period leads to emissions smoother than those produced by 15- or 7-day averaging periods and how the use of multi-year data greatly reduced day-to-day variability compared to the actual 2007 point fire inventory.34 FAT also smoothed the fires spatially by averaging multiple years of fire emissions over each county. All these effects of averaging ultimately lead to a typical year with more frequent but less intense fires over larger spans.

The Hi-Res operational air quality forecasting system35,36 used a typical year inventory developed by averaging fire emissions of years 1999–2003 in its 2007–2008 forecasting.37 Figure 3 shows how using typical fire emissions in the Hi-Res system caused forecasted PM2.5 concentrations to deviate from observations in Atlanta. Due to CMAQ’s tendency to underestimate organic carbon concentrations, the forecasted summertime PM2.5 concentrations were low compared to the observations. In May 2007, the forecasts were extremely low compared to observations, having missed several hits by smoke plumes from the Florida-Georgia fires absent in the typical inventory. During winter, the frequency of fires was larger in the typical inventory than in reality, leading to an over-prediction of PM2.5 concentrations on most days. These results reveal that it is not appropriate for an operational air quality forecasting system to rely on typical year fire emissions averaged from historical multi-year data.

**Satellite Products**

In recent years, satellites have been used for fire detection, and satellite fire products allow for derivation of biomass fire emissions. The Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) system38 provides a satellite-based fire emissions inventory. SMARTFIRE uses the National Oceanic and Atmospheric Administration (NOAA) Hazard Mapping System fire location information combined with the Fuel Characteristic Classification System and CONSUME to estimate fire emissions from wildfires and prescribed burns on a daily basis. The SMARTFIRE emissions inventory is now being widely used by the EPA and RPOs for their regulatory modeling efforts. However, for reasons stated above, such historical fire emissions inventories are inadequate for operational air quality forecasting.
Japan Meteorological Agency. FRP is a function of Multifunctional Transport Satellite operated by the Environmental Satellites (GOES), the European including NOAA’s two Geostationary Operational from a network of multiple geostationary satellites, wildfire automated biomass burning algorithm approximately 4-km resolution. FRP is retrieved using the approximately 1-km spatial resolution. Daily open burning emissions estimates at approx-

Anomalies Product and the MODIS Collection 5 Imaging Spectroradiometer’s (MODIS) Thermal fire detections from the Moderate Resolution Assimilated into modeled concentration fields to more accurately forecast fire impacts. Both the FINN and GBBEP-Geo products could potentially be used in operational air quality forecasting to track emissions from large wildfires and predict their near-future trends. In addition, aerosol optical depth (AOD) available in near-real-time from MODIS and GOES, as well as carbon monoxide concentrations from Measurements of Pollution in the Troposphere (MOPITT) can be assimilated into modeled concentration fields to more accurately forecast fire impacts.

A recent comparison of satellite-based biomass burning emissions products revealed inconsistencies between the different methods used with various satellite instruments and large discrepancies in the emissions estimates. Whenever possible, satellite-based biomass burning emissions products should be calibrated using data from alternative sources. For example, SMARTFIRE uses ground-based incident reports to reconcile its satellite fire detections.

There are also near-real-time biomass burning emissions products derived from satellites such as the Fire Inventory of NCAR (FINN) and Global Biomass Burning Emission Product from geostationary satellites (GBBEP-Geo). FINN uses active fire detections from the Moderate Resolution Imaging Spectroradiometer’s (MODIS) Thermal Anomalies Product and the MODIS Collection 5 Land Cover Type product, together with estimated fuel consumptions and emission factors to obtain daily open burning emissions estimates at approximately 1-km spatial resolution.

GBBEP-Geo produces hourly biomass burning emissions using satellite-derived fire radiative power (FRP) for individual fire pixels at approximately 4-km resolution. FRP is retrieved using the wildfire automated biomass burning algorithm from a network of multiple geostationary satellites, including NOAA’s two Geostationary Operational Environmental Satellites (GOES), the European Meteosat second-generation satellites, and the Multifunctional Transport Satellite operated by the Japan Meteorological Agency. FRP is a function of area burned, fuel loading, and combustion efficiency that provides a means to directly derive biomass consumption from satellite data.

Abstract Details:
Abstracts of 300 words or less must be submitted by December 16, 2013 to siteclosure@awma.org.

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The Air & Waste Management Association is accepting abstracts for the Vapor Intrusion, Remediation, and Site Closure Conference to be held in Cherry Hill, New Jersey (near Philadelphia) on September 10-11, 2014.

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FRP used in GBBEP-Geo as a proxy for the rate of biomass consumption is derived from limited experiments. Satellite products also can be evaluated using various ground-based emission inventories such as the U.S. National Wildfire Emission Inventory.

Aircraft measurements taken in fire plumes can be used as another source of independent data to calibrate satellite retrievals and reconcile with ground-based emissions data. To illustrate this concept, emissions from a prescribed burn were estimated using both ground-based information and satellite observations. The ground-based information was fed into a series of models for fuel loads, fuel consumptions, and emissions, as in the BlueSky framework. The satellite-based emissions estimate was derived from GBBEP. In this case, the ground-based estimate is significantly larger than the satellite-based emissions estimate (Figure 4a). The temporal profiles were also significantly different: satellite-based emissions ramped up, reached their peak toward the middle of the burn, and then tapered off, while the ground-based emissions were more level during the flaming phase followed by two hours of smoldering.

The burn was then simulated using both sets of emission estimates and meteorological parameters predicted by a numerical weather prediction model as inputs to the Daysmoke plume rise and dispersion model. During this burn, an aircraft tracked the smoke plume and measured carbon dioxide and light scattering along with meteorological parameters. Concentrations of smoke predicted by using both ground- and satellite-based emissions estimates were compared along the trajectory of the aircraft to corresponding measurements. This type of comparison is one of the most challenging evaluations for a model where the predictions are paired with measurements both in space and time. While the concentration peaks were generally synchronized, there were large differences between the magnitudes of modeled and measured maxima (Figure 4b).

Since the differences from the measurements are larger than the differences between the two sets of model-predicted concentrations, it is not possible to determine which emissions estimate is more accurate for this case. A comparison of predicted winds to those measured by the aircraft revealed differences both in speed and direction that could easily lead Daysmoke to divert the smoke plume from its observed trajectory. Since modeled concentrations can be very sensitive to uncertainties in predicted wind fields, a less strict pairing of predicted and measured concentrations, for example one with pairing in time but not in space, is recommended.

**Toward a Better Fire Impact Forecasting System**

Once properly calibrated, near-real-time biomass burning emissions products derived from satellites may be beneficial for air quality forecasting. For example, when a large wildfire is detected by...
satellite, its emissions can be input to the next forecast cycle and Eulerian CTMs with sufficiently high resolution can track those emissions. However, these satellite products are not as useful with prescribed burns for several reasons. First, prescribed burns are of short duration; they may be ignited and extinguished between satellite scans and go completely undetected. Second, their radiative power is much weaker than large wildfires, making them more difficult to detect and estimating their emissions more prone to uncertainties. Finally, it is difficult to incorporate prescribed burns detected by satellites into the forecast because of their short duration. However, there are some applications like the forecasting of the extremely dangerous super-fog where the tracking of prescribed burn emissions overnight would be beneficial.

While the use of satellite products is not a current option for forecasting the air quality impacts of prescribed burns, the use of typical fire emissions can lead to poor air quality forecasts, as shown above. What is needed is a better way of estimating prescribed burn emissions. Since weather plays an important role in the decision of the prescribed burner, weather forecasts can be used in predicting prescribed burning activity, at least on a burn/no-burn decision level. One can also assume that if the conditions are perfect, there would be more acres burned. Burners are primarily concerned with the conditions of the fuel and soil: the fuel must be dry enough to burn, but the soil should be damp enough to protect trees from the burn. Wind speed, wind direction, and atmospheric stability are other factors that would be considered to conduct the burn safely, effectively, and without hitting any sensitive targets with smoke. Precipitation, temperature, humidity, and winds are the primary weather parameters determining the fuel and soil moistures. These can be combined with other factors, such as the fuel/soil type, to predict fuel/soil moisture. Alternatively, simple rule-based decision trees can be used to determine whether the prescribed burner would attempt to burn or not. We will illustrate this with the following example.

**Forecasting Prescribed Burn Emissions**

Figure 5 shows the acreage of the burns permitted in northern Bryan County, GA, for each day in March 2010. Bryan County is home to Ft. Stewart, a large training base for the U.S. Army. Also shown in Figure 5 is the daily precipitation measured at Ft. Stewart. In Georgia, burning permits are requested and granted by telephone or online, typically on the morning of the burn. Therefore, the area permitted to be burned is a good indication of the intent for burning on that day. Note that no burns were attempted on a rainy day or the following day. The large rain event on March 11 (2 inches) is followed by three days of inactivity. Burn/no-burn decisions are made based on the rain forecast, not actual precipitation. On days with no precipitation, a high probability of rain in the forecast could have deterred the prescribed burners. For example, March 26 could be one of those days. However, it is more likely that high winds in the forecast influenced the decision against the burns as the maximum wind speed recorded at Ft. Stewart was 22 mph on that day. Another deterrent may have been a westerly wind forecast, which could have put highly populated areas to the east in Chatham County and Savannah at risk of smoke.

The next challenge in forecasting prescribed burn emissions is to predict the location and size of the burns. One approach is to keep an inventory of the managed lands, their frequency of treatment, and the last time they were burned. The Georgia Forestry Commission (GFC) electronically tracks all

![Figure 5. Daily maximum/minimum temperatures and relative humidities, maximum wind speed, and 1-hr accumulated precipitation (top to bottom) recorded at Ft. Steward and total areas of land permitted for prescribed burning in northern Bryan County, GA, in March 2010.](image-url)
burn permits issued since 2005. Databases such as this one can be mined to identify all burners, analyze their burning patterns, and identify their burning frequency and last burning year. Burners whose burning cycles intersect with the current year can be put in a “likely burners” list. For example, a plot on a three-year rotation that was last treated three years ago is likely to be burned this year. At the start of the burning season, it can be assumed that all likely burners would burn over a typical number of days with favorable weather conditions.

The burning season in Georgia is limited to October 1 through April 30 owing to a burning ban during the ozone season (May 1 through September 30). Suppose, on average, there are 20 days favorable for burning in a season. Then, for forecasting purposes, a randomly selected 1/20 of the likely burners could be assumed to be burning on the first occurrence of favorable weather conditions. As the season progresses, the list of likely burners can be updated by dropping those who have already burned and adjusting the number of average burning days based on the days remaining in the season. If the season has been extremely wet thus far, it can be assumed that a larger than average fraction of the burners would be burning on the next chance they get. The GFC database also describes the purpose of the burn. Burns may be conducted early or later in the season, depending on the intent. Burns aimed at site preparation are conducted in early fall, while silviculture burns are conducted at specific times during the growing season. Burns aimed at hazard reduction may be scheduled later in the season. After burners are given priority according to their objectives, the daily allocation can be filled by randomly drawing from the pool of remaining likely burners.

The next step is to estimate prescribed burn emissions from the selected burn plots. The BlueSky modeling framework can be used for this purpose. The most recent NFDRS maps or fuel information derived from satellites can be used to determine the fuel loads. In the future, permit databases like GFCs can be expanded with information on the stand, such as its composition, age, and condition. This information can then be used in vegetation dynamics models to estimate the changes in fuel loads over time. Fuel consumption can be estimated using CONSUME. Finally, emission factors from a recently compiled nationwide database or the Fire Emission Production Simulator can be applied to the amount of fuels consumed in order to estimate total emissions.

The improved forecast can be used as part of the prescribed burn permitting system for dynamic air quality management. The benefit of such a system is that instead of a blanket burning ban, such as the one imposed in Georgia during the ozone season, burns could be banned only on days when it is imminent that air quality would not meet the standards. Alternatively, burns can be selectively allowed on days when air quality standards likely would be met. The modeling technology exists for calculating the increment of pollutant concentrations downwind receptors due to emissions from specific sources. It is feasible to use this technology to discern fires from other emissions sources, such as power plants, industries, and transportation, and forecast the amount of fire emissions that can be allowed without exceeding air quality standards for a given day’s meteorological capacity to assimilate air pollutants.

The allowable amount of fire emissions can be turned into more useful information for air quality conscious prescribed burn management, such as locations and sizes of burns that can be permitted. To achieve this, the inverse of the emission estimation model described above is needed. The inverse model would start with the emissions and calculate the amount of fuels that would lead to those emissions when consumed by fire. The calculation can be performed on a district- or county-level spatial resolution. The list of likely-to-be-burned plots can then be searched by looking at their estimated fuel loads to fill the allowable emission quotas for each county. Finally, the land managers of the selected plots can be called upon to burn on a given day. Such a dynamic system can significantly increase the capacity of land management by prescribed burns, while also maintaining acceptable air quality.

Summary

Wildfires are intensifying and increasing in frequency as a result of global climate change. At the same time, dependence on prescribed burns is growing both for ecosystem management and

A recent comparison of satellite-based biomass burning emissions products revealed inconsistencies between the different methods used with various satellite instruments and large discrepancies in the emissions estimates.
hazard reduction purposes. Meanwhile, air quality standards are tightening and other emission sources such as electricity generation and transportation are being heavily controlled. These dynamics will soon leave fire emissions as the major source of air pollution in many areas of the United States. The increasing demand for prescribed burning, combined with increased air quality pressure due to tighter regulatory constraints, necessitates management approaches that require significantly improved fire impact forecasting capability.

Recently, there has been a notable increase in the use of Eulerian CTMs for air quality impact forecasting. Despite significant strides in model development, limitations remain. One limitation is the heavy computational needs imposed by high grid resolutions needed to adequately track fire plumes. Another limitation is the lack of rapid fire emission forecasting capability. Typical fire emissions used in regulatory modeling are too inaccurate for reliable air quality forecasting. The averaging processes involved in developing typical fire inventories spread the fires in space and increase their frequency without considering the weather conditions.

Satellite retrievals, after calibration with ground-based data, can be used to estimate biomass burning emissions for forecasting the impacts of wildfires. Prescribed burns, on the other hand, are of short duration and smaller size, which makes them more difficult to detect with satellites. A new approach is needed to forecast the impacts of prescribed burns. One is proposed here to forecast burn activity based on weather and past burning patterns in well-managed tracts.

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Note: For a complete list of references associated with this article, please refer to the online version published at www.awma.org/em.


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Developing Real-Time Emissions Estimates for Enhanced Air Quality Forecasting

Exploring the relationship between ambient temperature, energy demand, and electric generating unit point source emissions and potential techniques for incorporating real-time information on the modulating effects of these variables using the Mid-Atlantic/Northeast Visibility Union region as an example.

The operation of air quality forecast models (AQFMs) based on coupling a numerical weather prediction (NWP) model to an emissions processor and a chemical transport model (CTM) are now common within the United States.¹⁻⁸ Health professionals and air quality managers utilize these forecasts to alert susceptible populations and the public at large of poor air quality conditions and recommended actions to minimize exposures. In addition, air quality forecasts have the potential of guiding emission interventions designed to mitigate episodic events and exceedances of National Ambient Air Quality Standards (NAAQS).

While the NWP component incorporates a large amount of real-time information in the form of initial conditions and analysis fields, the emissions processor often relies on simplifying assumptions about the magnitude and temporal-spatial variation of emissions. Emissions of nitrogen oxides (NOₓ) and sulfur dioxide (SO₂) from major point sources are directly measured, tracked, and archived via the U.S. Environmental Protection Agency’s (EPA) continuous emissions monitoring (CEM) network in support of the Clean Air Markets Division for emissions cap-and-trade programs (see www.epa.gov/captrade). Unfortunately, it is not feasible to incorporate these emission measurements in real-time into AQFMs.

The development of an approach to enhance short-term emissions estimates is expected to improve the overall performance of AQFMs and, specifically, the performance associated with episodic events. The inherent relationships between weather fluctuations, electricity demand, emissions, and air quality are not currently represented in the emissions processing module of AQFMs.

Enhanced Emissions Estimates

The emissions model applied in AQFMs typically derives emissions from annual totals of emitted species by source category that are allocated monthly and then hourly based on averaged temporal profiles. Some source categories, such as
On days of high energy demand, additional generators are brought online for power generation. These units are referred to as “peaking units” and typically operate less than 15% of the time during the year. Figure 3 shows the NOx emissions from peaking units in the MANE-VU region from May to September 2007. It illustrates the significant contribution peaking unit emissions can have on some days. It should be noted that, depending on federal and state reporting requirements, not all peaking units may be equipped with CEM and, therefore, cannot be considered in this analysis.

Preliminary air quality modeling studies indicate that time periods when the actual emissions were larger than the average emissions (i.e., positive difference) usually coincided with days leading to high ozone (O3) concentrations. The impact of differences in point source NOx emissions between the two scenarios on O3 predictions varied by location, with the largest changes at the grid cells adjacent to the affected point sources. The maximum difference in 1-hr or 8-hr daily maximum O3 was typically greater than 4 parts per billion (ppb) around the Ohio River valley, and less than 2.5 ppb in general. Differences as large as 8–10 ppb were noted at selected monitor locations in the MANE-VU region, illustrating the need for refined emissions in air quality modeling. In the following section, we present an example approach of incorporating the relationships between energy demand and emissions into AQFMs.
Energy Demand Forecasts

Regional independent system operators (ISOs) perform daily energy forecasts as part of their mission to ensure efficient generation and flow of power to satisfy energy demand and administer electricity markets. These forecasts are typically available online. ISOs in operation within the eastern United States include the New York ISO (NYISO), the New England ISO, the Midwest ISO, the PJM Interconnection, and the Southeastern Electric Reliability Council. The availability of real-time energy load forecasts in principle provides an opportunity to enhance real-time EGU emissions estimates for AQFMs.

For example, a comparison of 2007 CEM NOx emissions and NYISO forecast energy load data shown in Figure 4 indicates a robust correlation between these variables. In addition, a comparison of actual and forecast energy load data from this region.

Figure 2. Difference in actual daily and average EGU NOx emissions in the MANE-VU region.

Figure 3. NOx emissions from “peaking units” in the MANE-VU region from May to September 2007.
same period (not shown) reports a correlation coefficient of $R^2 = 0.954$, indicating that load forecasts provide an opportunity to improve daily EGU emission estimates.

Incorporating emissions from peaking units on a real-time basis requires taking into account the relationship of between meteorology, energy demand, and EGU unit operation. The dominant meteorological parameter affecting the energy demand forecast is temperature.

Energy Load-Adjusted EGU Emissions Estimates

Historical power load data from the NYISO archive\(^1\) and temperature observations data from the research data archive\(^2\) at the National Center for Atmospheric Research have been analyzed for statistical relationships between daily power load and average temperature in NY State.

Figure 5 shows a quadratic relationship between ozone season temperature data (May–September) from 2007 to 2009 and the actual power load for the NYISO region aggregated over NY State. The regression model is: power load (MW) = 288.6112\(x^2\) - 2.9463E+4\(x\) + 1.1487E+6 Where, \(x\) = average daily temperature (which ranged from 45 to 81 °F) and $R^2 = 0.7554$.

A comparison between the model-predicted power load using the above relationship and the actual power load for 2010 is shown in Figure 6 with an $R^2$ of 0.8039. A similar comparison for 2011 (not shown) had an $R^2$ of 0.8113. Since the results indicate reasonable performance of the regression model, the correlations can be employed to support a better forecast. As the range of daily average temperatures during 2007 to 2009 for the model development was up to 81 °F, predictions of power load at temperatures above 81 °F suggest possible over prediction and the potentially greater influence of EGU peaking units.

Although energy load is distributed across ISO regions and across states, energy use within a region does not necessary reflect where the power is generated and thus where emissions occur. If a significant portion of the electric generation to meet load demand occurs outside of the aggregated ISO domains, the relationship between forecasted load and EGU emissions will be more uncertain. In addition, EGU emissions will vary over the years due to emission controls and changes in electric generation capacity and load demand; the latter very likely affecting the operating frequency of peaking units.

Methodologies for Incorporating Real-Time EGU Emissions Estimates in AQFMs

Current analyses indicate that two methodologies look feasible for incorporating real-time EGU emissions estimates in AQFMs. The first approach...
The second approach draws from the relationship between temperature–energy load and EGU emissions and is more indirect, but also does not rely on the ISOs real-time energy load forecasts. In this case, forecasted temperatures used to process other emission components in the SMOKE emissions model will be applied to the statistical relationship between previous years’ energy load and emissions data.

Figure 5. Regression model between NYISO actual power load (MW) and NY state wide daily average temperature (°F) developed using ozone season data (May–September) from 2007 to 2009.

Figure 6. Prediction of 2010 power load with the regression model vs. 2010 NYISO actual power load (MW).
perature has been shown to be a reasonable surrogate for energy load, using a direct relationship between temperature and EGU emissions is also feasible. In either case, similar procedures for the SMOKE preprocessing of the ISO energy load in relation to emissions would be followed.

**Future Challenges and Outlook**

AQFMs are being used by air quality managers and health officials to issue air quality advisories. Improving the accuracy of air quality forecasts will translate into providing more precise warnings to the public. In this article, we presented an example of possible approaches to refine the characterization of emissions from power plants in AQFMs. We explored relationships between ambient temperature, energy demand and EGU point source emissions and suggested methodologies for applying these relationships to enhance real-time EGU emissions estimates for use in AQFMs. However, there are some limitations.

While the relationships presented here are robust, they were developed based on aggregated emissions sources in NY State, and as such, may be best suited to improve regional-scale predictions.

Developing unit-specific relationships will be much more challenging because load forecasts are not available at that level, and economic and operational constraints likely are at least as important as meteorology in determining which unit runs on which day at which level.

Finally, depending on federal and state reporting rules, some of the peaking units with relatively small annual emissions may not be required to have CEM. Therefore, their annual total emissions are currently included in the miscellaneous point source category inventory and no further information on their temporal variation is readily available. Getting a better representation of their temporal variability may be important for finer scale applications, but is a challenge that may need to be addressed in the future.

The potential of an air quality forecast system is its possible utility as a dynamic air quality management tool that can provide information on likely emission intervention strategies that can avoid air quality exceedances. Improving the accuracy of the model predictions through refinements such as that discussed in this article is an important step toward achieving that goal.

### References


In Search of an Intelligent Methodology for Designing Sustainable Cities

The GEnUSiS (Green Environmental Urban Simulations for Sustainability) project aims to empower urban planners, decision-makers, and other stakeholders with the necessary state-of-the-art tools to implement science-based sustainability solutions to better urban designs.


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The concept of a good urban design means different things to different people—from walkable communities to aesthetically pleasing building layouts to green and clean communities, or a healthy combination of such factors. If it were ever to be undertaken, the task of building consensus on what constitutes a good urban design would be an unenviable one. The problem is especially challenging not only due to the multiple conflicting objectives of the various stakeholders, but also because the stakeholders need the opportunity to experience the various possible solutions (urban forms or layouts) before being asked to choose one of the several alternatives. Moreover, the infrastructure decisions that planners must make have economic, social, and environmental repercussions that entire communities must live with for many years to come.

While a wide variety of approaches to decision-making exist, trying to bring science into the process along the way can be extremely challenging. The GEnUSiS (Green Environmental Urban Simulations for Sustainability) project at the University of Utah and University of Minnesota, Duluth is attempting to meet these challenges by equipping and empowering urban planners, decision-makers, and other stakeholders with the necessary state-of-the-art tools to assess the impact of and implement science-based sustainability solutions.

Problems with complex interacting physical, chemical, biological, and social components often result in unintended consequences that can really only be forecasted by planners with extensive experience or by computer modeling tools that include these interactions. Any approach identifying good urban design should be multi-disciplinary. It should include interactions amongst engineers, biologists, chemists, atmospheric scientists, computer scientists, planners, and social scientists.

A potential methodology for attacking these types of problems is illustrated in Figure 1. The process shown should be based on sound, well-validated computational models that are regional and site-specific. The problems that one might face in New York, for example, are different than those that a manager might be dealing with in Phoenix. Hence, the models should be generalizable. Even with an appropriate modeling strategy, finding good urban designs is extremely daunting due to the number of variables that are at play.

Another more realistic option is to use design optimization strategies. Optimization strategies have been used for a long time in engineering design to find minima or maxima of some desired outcome. For example, finding the optimal thickness of insulation on a pipe or an optimal pipe diameter that minimizes annual costs. These simple types of optimization problems often utilize classical gradient descent methods that follow the slope of simple functions to its minima or maxima. Urban problems, however, are more complex and have mathematical quirks that prevent such simple solutions. Hence, more sophisticated techniques are needed.

A key component of the process is experiencing the urban design. While multi-criteria methodologies allow for flexibility in determining what a manager...
of the GEnUSiS project. To achieve the element of fast and accurate physical modeling, the GEnUSiS project methodology employs the Quick Urban and Industrial Complex (QUIC) dispersion modeling system.\textsuperscript{1-3} QUIC has been jointly developed at Los Alamos National Laboratory and the University of Utah and consists of a diagnostic wind model (QUIC-URB),\textsuperscript{1} a random-walk dispersion model (QUIC-PLUME),\textsuperscript{3} and a graphical user-interface (QUIC-GUI). QUIC-URB computes spatially resolved 3D mean wind fields in urban domains (see Figure 2).

The standard QUIC dispersion model runs extremely fast. When compared to other models used to simulate flow and urban dispersion, QUIC runs two to three orders of magnitude faster, and produces similar results.\textsuperscript{4} However, QUIC is still not fast enough to be used in the solution of realistic UFOPs, which require simulation of many thousands of urban configurations. Therefore to use QUIC to solve UFOPs, it has been adapted to graphics processing units (GPUs) to take advantage of the massive low-cost parallelism afforded by GPUs. Using GPUs, we have been able to speed-up particle dispersion computations by two orders of magnitude.\textsuperscript{3}

To identify optimum solutions under various objectives simultaneously, GEnUSiS utilizes well-established techniques from the field of multiple criteria decision-making.\textsuperscript{5,6} Specifically, to identify the set of all possible trade-off solutions (formally might want, the results may have “surprises” or may produce results that are not practical within the constraints of a real city. Interactive and immersive visualization tools can enable the stakeholder or manager to experience the impact of multiple optimum urban layouts to select the ones that best suit their needs. In the following text, we describe how this methodology has been applied to a simple urban air quality problem to optimize urban design.

**Illustrating Urban Form Optimization**

The process of hunting for good urban designs or desired outcomes for a city can also be called an urban form optimization problem, or UFOP. The outcome may be reduced emissions, lower pollution concentrations, reduced building energy use, and so forth. To illustrate the process, a simplistic real-world UFOP is considered within the framework of the GEnUSiS project.
referred to as Pareto optimal solutions in the literature) we have tested non-dominated sorting genetic algorithms (NSGA). All of the trade-off solutions produced by the NSGA can be visualized through a virtual environment platform developed by the GEnUSiS team (see Figure 3 and the background image on page 28).3

Consider the fictitious 2x2 urban design problem shown in Figure 2, where planners would like to determine the building positions leading to the best air quality in the mock city. After considering a list of objectives, the stakeholders narrow down the problem to two end-goals, but are unable to decide which among the two is better. The stakeholders decide that minimizing the average and maximum pollutant concentrations at breathing height are the two objectives that they would like to achieve. For our simulations, each building is allowed to explore the lot space around the intersection. In particular, each building is allowed to move to four unique locations in each coordinate direction within its quadrant. The relatively simple-looking problem is, in fact, eight-dimensional (8D), with $4^8 (= 65,536)$ possibilities, for a single objective!

Figure 3 illustrates some of the trade-off solutions. If the stakeholders were to choose one of the trade-off solutions, it would implicitly indicate the relative importance of the two objectives (minimizing average and maximum pollutant concentrations). Figure 3 and the the background image on page 28 indicate how the GEnUSiS project provides end-users with an opportunity to explore and experience potential trade-off solutions before arriving at a consensus.

From the 2x2 building array example, it should be clear that in real cities, where each urban object can have several degrees of freedom, trying to determine the optimum configurations through exhaustive enumeration soon becomes infeasible, and optimization techniques are the only hope. The infeasibility is compounded by the fact that any scientifically sound urban flow and dispersion model employed would only increase the computational
complexity of the problem, and thereby its overall execution time.

Our experience has unearthed the following urban optimization challenges that really should be addressed by any UFOP system:

- real-life UFOPs are comprised of high-dimensional decision variable spaces, and an astronomical number of urban layouts to choose from;
- high-fidelity results require sound physics-based urban models, which are computationally expensive;
- optimization procedures must take into account multiple (and possibly) conflicting objectives is needed; and
- stakeholders should be given the opportunity to experience optimum solutions under various objectives before they decide on a final design.

**Current and Future Directions**

Our current work includes developing and integrating urban energy-use physics into QUIC via GPUs. For example, ray-tracing tools (e.g., NVIDIA’s OptiX software development kit) are being used to rapidly compute radiation transfer. Sky view factors, which are critical to understanding urban heat island dynamics (see Figure 4), are easily computed using this framework. This system allows vegetation (which is often neglected in urban simulations) to be included. For example, we are currently adding the ability to spatially resolve trees so that their impact on pollution and microclimate can be evaluated. QUIC is also being coupled with the Weather Research and Forecasting (WRF) model to provide QUIC with more realistic meteorological forcing conditions. Ultimately, the goal of this current work is to provide decision-makers with tools that can take into account place specific characteristics (e.g., local climate) to optimize green infrastructure (e.g., urban vegetation) for their own cities to meet environmental needs.

**References**


Figure 4. Illustration of contours representing sky view factors or the fraction of the sky that each surface can radiate to in downtown Salt Lake City, UT. Sky view factors were computed for Salt Lake City using NVIDIA’s OptiX ray-tracing engine and are critical to understanding urban heat island characteristics. Regions of low sky view are unable to easily radiate heat to space and hence tend to trap heat locally.
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10 Years in Asia
Environmental Lessons Learned in the Developing World

Asia’s population and economic growth goes hand in hand with the increasing demand for resources and environmental impacts. Electricity shortages, dwindling water supplies, air and water pollution, and natural disasters exacerbated by global warming are among the many challenges that Asia’s politicians and the public meet daily. The reality kicks in that development without consideration for the environment is no longer an option. Finding solutions is a challenge but critical because global sustainability will depend on whether we get it right in Asia. Here are some insights from 10 years of working in Asia and with Asians on environment and development.
I first set foot in Asia, in India to be precise, as a 21-year-old. After two months of backpacking on a shoestring budget, I had fallen in love with this fascinating country. Back home in the Netherlands, I realized how deeply consumption patterns had penetrated our lives in the West, but also grew scared of the environmental consequences if India and the rest of the developing world followed our bad example. It was then that I decided to complete my master's degree in environmental management, but it would take another 12 years before I would return to Asia; this time not as a tourist, but as a program manager with the United Nations Environment Programme (UNEP) in Bangkok in 2003.

Full of optimism, I embarked, through UNEP, to help 44 industrial companies in nine countries improve their energy efficiency and reduce their greenhouse gas (GHG) emissions and costs along the way. I joined Clean Air Asia in 2007, first as deputy executive director and later as executive director, to support cities and governments in developing policies and programs that reduce air pollution and GHG emissions and make cities more livable. In the ensuing years, I have not lost my optimism, but I have changed my conviction on what is needed to get Asia on the right track. The lessons I have learned over the past 10 years are many, so I will pick a few that affected me the deepest.

**Find Local Success Stories**

An energy audit of an Indian cement factory 300 km from Hyderabad was a humbling experience. The three brothers who owned the plant brought in trucks of water to the drought stricken area daily, had a simple savings and loan scheme for employees to cover medical and dowry costs, and set up a village school to give employees’ kids a chance to work their way up the social ladder. Corporate social responsibility is as much present in small companies as it is in global multinationals, they just have never heard of the term and it stems from a genuine interest in the wellbeing of employees and the environment they live in. Therefore, finding local examples of what already works and preserving them is equally important to transferring successes from developed countries to Asia.

**Consider Local Conditions and Needs**

Technology transfer absolutely must consider local conditions and needs if we want to see technology adoption at scale. As part of a pilot project in Guangzhou, China, we tested low rolling resistance (LRR) tires on garbage trucks that reduce the friction with the road surface. This resulted in an unexpected and astonishing 18% in fuel savings. The reason: The cheap tube tires were of such poor quality that they caused the truck to destabilize when driving. The LRR tires contributed to more stability on the road, which explained the lower fuel consumption. Interestingly, slightly better quality tires (and much less costly than the LRR tires) would have also resulted in significant fuel reductions.

The worst example of technology transfer I personally have come across was at a paper plant that had been shipped from Germany (because of tightening environmental regulations there) and rebuilt in Bangladesh. The capacity of the boiler and several other machineries was twice what was needed for the plant’s current production, resulting in massive energy wastage. I was greeted with smiles when I arrived with a team of engineers and was asked if I could please translate some sections from the German equipment manuals needed to operate the plant properly (never mind that I am Dutch!).

**Look at Asia as a Whole**

I have always been proud that Clean Air Asia works across Asia. It is a gross misconception by many development agencies and foundations that the “biggest bang for the buck” approach that focuses on BRICs—Brazil, Russia, India, and China—will do the trick to save the environment. Ironically, this is mostly applied to climate change funding—a
global problem. Globalization has meant that the economies of countries and the environmental impacts that come with them are interlinked.

Trumpeting successes like cleaning up steel factories or phasing out pre-Euro buses in China falls partly flat if factories and vehicles are pushed across the border to poorer neighboring countries. Southeast Asian countries may be relatively small individually, but their combined number of vehicles is comparable to India and China. At least part of the funding should go toward replicating successes across Asia and avoiding environmental spill over.

Local presence through our country networks has allowed Clean Air Asia to build capacity from the ground up, while also bringing in experts from the United States and elsewhere. Our Air Quality Management City Network in China, for example, empowered cities to learn from one another and provide active input into national policies, thus neatly supplementing top-down policies by the Ministry of Environmental Protection. The past year’s air pollution emergencies have solidified the topic on China’s policy agenda through the recently announced Action Plan for Air Pollution Prevention and Control issued by the State Council, and this city network can now be expanded on to deliver solutions at scale.

Add Local to Global Climate Change

Related to this is the need to approach environmental challenges from the local context. Climate change may be a hot topic in Western governments, but in Asia climate change programs are often met with suspicion of Western self-interest. For example, I was quick to change the words “greenhouse gas” to “energy efficiency” in my UNEP program to bring businesses on board, and even then the director of a Thai steel plant told me his priority was to expand production to meet demand, which would earn him a magnitude more than the potential savings from energy efficiency projects.

Car Free Sundays in Jakarta and Manila and a walkability publicity campaign in India have done more to bring climate change and air quality issues to the public’s attention than more direct routes. Hong Kong’s phase-out scheme for old buses and trucks was founded on air pollution concerns, and much less by climate change. It is such a unique opportunity to tackle local impacts and global climate change under one banner. Why not make the most of that instead of labeling local benefits as secondary co-benefits, or worse, omitting them all together?

Build Relationships and Trust

Showing an interest in the country and its people certainly helps build relationships and trust. Clean Air Asia’s Chair, a professor at Tsinghua University, recommended two options to increase acceptance in China: Learn the language or learn to eat with sticks the proper way (understandably, I chose the latter option). While I never had the stomach to eat a “balut”, an embryo chick complete with feathers and bones in an egg, I did surrender to karaoke and mall-hopping in the Philippines, present business cards with two hands like the Japanese, and can swing my head in circles in South Asia that seems to imply “no” but means “yes”.

That may be the biggest lesson I learned and would like to pass on to anyone wanting to make a difference here: Immerse yourself in Asia’s culture and people and try to look at the challenge from their perspective. You’ll go a long way.
Ontario Tweaking EASR Regulations

The Ontario Ministry of the Environment is proposing a number of amendments to its Environmental Activity and Sector Registry (EASR) regulations. The amendments would expand EASR eligibility, delineate between EASR and Environmental Compliance Approval, modify requirements for standby power systems, and extend the deadline for mandatory transition to EASR.

EASR is a public, Web-based registry system intended for activities that are routine, well understood, and with minimal environmental impacts when complying with standard regulatory requirements. It allows businesses to register prescribed activities instead of seeking an Environmental Compliance Approval through the normal application and review process.

The main amendments would be to the Registrations under Part II.2 of the Act—Heating Systems and Standby Power Systems Regulation (O. Reg. 346/12), which defines the eligibility criteria for heating systems and standby power systems. The amendments would expand the types of systems that would be eligible for EASR and would also remove the requirement that EASR-eligible activities be registered on EASR if a site has both EASR and Environmental Compliance Approval activities.

The draft amendments are available on the Environmental Bill of Rights (EBR) Registry at www.ebr.gov.on.ca, EBR Registry Number: 011-9631.

BC to Investigate Environmental Impact of LNG Emissions

British Columbia (BC) is contracting out a massive liquefied natural gas (LNG) study to help inform regulatory oversight for the future of the industry.

Requests for proposals have been issued for the study, currently scheduled for completion by March 2014. The quick turnaround time highlights BC’s eagerness to get started on its ambitious plan to mine some 1,400 trillion cubic meters of natural gas on its land over the next century.

Investors across the LNG sector are exploring the idea of developing export facilities in BC, with the first commercial LNG export facility in Canada scheduled to open in Kitimat, BC, by 2015, and two more expected to be operational by 2020.

The study will consider the impact of emissions from gas-turbine powered electrical generation facilities used to create LNG. It will focus on sulfur dioxide and nitrogen dioxide emissions and will examine the impact of LNG emissions through a number of scenarios, including effects on water and soil, vegetation, and human health.

New Brunswick Government, Public, Fractured Over Shale Rock Drilling

As anti-fracking protests ramp up in New Brunswick, the province’s Minister of Energy wants Canadians to consider the “facts” about the controversial underground drilling practice, and not be swept away by environmental ideology.

At a speech during the Maritimes Energy Association conference in Halifax, October 1–2, 2013, Energy Minister Craig Leonard hailed a tightly-regulated shale gas industry as a huge financial opportunity for the people of New Brunswick. That is, he said, if they’re willing to listen to a reasoned argument for fracking.

“There is a sector of the population, they do everything in their power to try to stop these projects, they focus on the environmental concerns to raise opposition within the population,” Leonard told conference delegates. “Much of it, as we know, takes the form of an ideological stance, as opposed to any that is fact-driven or has anything to do with the details of a particular project.”

Fracking has drawn a firestorm of criticism from environmental groups around the world. They warn that the process itself and the wastewater it generates can pollute drinking water.
Effective communications are the foundation for successful project management. In fact, communication problems are often cited as a primary reason projects fail.

Previous columns have addressed the use of communication tools (see “Simple Communication Tools Drive Project Success,” EM April 2007), communication planning (see “Project Success Depends on Communication Success,” EM January 2011), and management of communication channels (see “Channeling Project Success,” EM March 2011). While these are all important aspects of project communications, poor messaging will undermine the best use of communication planning and communication tools. Accordingly, careful attention should be given to framing our communications.

As environment, health, and safety (EH&S) project managers, we are often asked to identify multiple solutions and recommend the best option. Not that it is easy or straightforward, but our detailed knowledge of the project requirements and solutions provides us a unique perspective to identify the best solution. So why is it that a project sponsor or client will select an option that we have not identified as best? Likely, our recommendation was not selected because we did not effectively frame our message.

Communication Framing Theory
Framing theory is rooted in mass communications and simply states that the same situation will be perceived differently based on the way it is presented. Tversky and Kahneman argue that choices associated with framing effects are influenced by
Project Decision-Making

attitudes toward risks (The Framing of Decisions and the Psychology of Choice, *Science* 1981, 211, pp. 453-458). Specifically, the authors argue that people will choose a certain gain more than a probable gain with an equal or greater expected value; however, the opposite is true when people are faced with losses. The following study, cited in the article, is used to illustrate the point.

**Probability Problem**
Problem for consideration: The United States is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Study participants were asked to select a preferred program.

If Program A is adopted, 200 people will be saved. If Program B is adopted, there is a one-third probability that 600 people will be saved and two-thirds probability that no one will be saved. Although there is no quantitative difference in the outcome of the two programs, 72% of the study participants chose Program A and 28% of the study participants chose Program B. The authors argue that the prospect of certainty of saving 200 lives (i.e., the "certain gain") is more attractive than a one-in-three chance of saving 600 lives (i.e., the "probable gain with an equal value"). When framed in terms of gains, we'll choose the risk-averse option that offers certainty.

A second group of study participants were given the same problem with the following alternative programs: If Program C is adopted, 400 people will die. If Program D is adopted, there is a one-third probability that no one will die and two-thirds probability that 600 people will die. In this case, 22% of the study participants chose Program C and 78% chose Program D. In this case, the authors argue that the certain death of 400 people (i.e., the "certain loss") is less acceptable than the two-in-three chance that 600 will die (i.e., the "probable loss with an equal value"). When framed in terms of losses, we'll take the chance and accept the option that appears riskier.

**Mixed Message**
In a previous issue, I described the case of an EH&S manager at a facility subject to Good Manufacturing Process (GMP) requirements who wanted to reduce solvent usage in manufacturing to avoid Title V permitting (see “Laying the Groundwork for Environmental Project Success,” *EM* February 2007). The EH&S manager reasoned that management would readily revert to a previously successful formulation that would reduce solvent consumption and thus, eliminate the need for a Title V permit.

The EH&S manager presented the proposed reformulation project without an analysis of costs or benefits, emphasizing instead the difficulty in obtaining and complying with a Title V permit. However, management was more familiar with GMP management and compliance than it was with the challenges of Title V permitting and compliance. As a result, the EH&S manager was instructed to proceed with Title V permitting for the facility.

Had the EH&S manager taken the time to frame the reformulation project in terms of guaranteed GMP compliance without the risk of operational constraints (i.e., the "certain gain") instead of the complexities of Title V compliance (i.e., the "certain loss"), plant management may have decided to accept the reformulation alternative. Instead, management perceived operation under a Title V permit as less risky than reformulation, when in fact reformulation was the less risky option.

Some may argue that framing a recommendation to influence a decision is manipulative; it isn’t. If we believe that we have a solution that effectively satisfies project budget and schedule requirements, we should make the effort to present the solution in terms that resonate with the decision maker. When we have been trusted to evaluate options and make a recommendation, we are simply providing excellent service when we frame our recommendations in terms that reflect an understanding of stakeholder needs and concerns. *em*
Despite its name, Waste 101 resists a narrow focus and tackles many of the non-air-related issues driving today’s industry, including waste, water, and remediation. This month’s column has broad application to all environmental fields.

by Cindy Smiley

Cindy Smiley is an environmental attorney with Smiley Law Firm P.C., Austin, TX. E-mail: cindy@smileylawfirm.com.

For many environmental professionals, monitoring, record-keeping, and advising on a wide variety of regulatory issues is more than enough to fill their busy days. The environmental laws governing air, waste, and water quality have been in place for several decades. In fact, the earliest versions of the federal Clean Air Act, Solid Waste Disposal Act, and Clean Water Act were passed in 1963, 1965, and 1948, respectively. After all these years, with a multitude of rules now in place, one might wonder whether the role of an environmental professional would have become a routine, hum-drum kind of existence.

The answer is a resounding “NO.” The responsibilities of today’s environmental professionals are certainly not boring or routine. In some ways, the long history of these laws and programs creates a challenge all of its own.

The need to rely upon guidance, rules, and agency decisions dating back to the 1970s, 1980s, and 1990s presents some interesting situations. For example, when looking for guidance on the federal air program, environmental professionals may refer to the U.S. Environmental Protection Agency (EPA) publication dated July 1991, entitled “Guideline for the Regulatory Application of the Urban Airshed Model,” for recommendations on air modeling for certain emissions (see www.epa.gov/ttn/scram/guidance/guide/uamreg.pdf). It seems highly likely, however, that the modeling and other aspects of this guidance have advanced since 1991.

Similarly, EPA’s “Development Documents” for various effluent limitations guidelines have long been an important source for insight into the potential scope and applicability of wastewater discharge limits for various industry categories. Information on these national standards for wastewater discharges from certain types of sources, many of which were written in the 1970s, can be
found by exploring EPA's Web site (see http://water.epa.gov/scitech/wastetech/guide/industry.cfm). Importantly, these standards are technology-based standards. As a result, although practitioners look to these rules and the related documents to determine which effluent limitations may be imposed in a wastewater discharge permit, the technologies that formed the basis for the limitations may now be more than 30 years old.

In years past, practitioners looked to the RCRA “Hotline” or the “RCRA Permit Policy Compendium” for guidance on the interpretation of solid waste issues under the Resource Conservation and Recovery Act (RCRA). To obtain agency guidance, we called an actual “RCRA Hotline” with a toll free phone number and spoke with a real person about our question. Later, the questions and answers from those calls to the Hotline were typed up and made available on paper. Sometimes we were able to obtain them from EPA (and its contractors) by fax transmittal. If we were able to obtain a copy of the RCRA Compendium, we treasured it and kept it safely in our offices. Thankfully, today’s world of online communications has overcome these comparatively archaic ways of communicating and the documents of years past have been captured electronically (see www.epa.gov/epawaste/inforesources/online/index.htm).

Although the volume of guidance and rules has grown substantially through the years, the constantly changing science and technology in the environmental field may not track with the established body of rules and guidance. The following real-world examples illustrate some of these challenges.

Consider a recent discussion between the representatives of a company holding an air permit that authorizes emissions of industrial flue gas and the representatives of an innovative new technology that will remove certain constituents from the authorized flue gas emissions at the industrial facility. In this situation, where should the permittee place its emissions monitoring devices? Should the permittee locate its monitors upstream or downstream of the innovative technology? Which emissions should be monitored for permit compliance and reporting purposes? And what are the regulatory implications for the industrial facility and its permitting limits in the future?

Or consider the continually evolving definitions of solid and hazardous wastes. As people continue to think of creative uses for secondary materials and to invent technologies that affect the generation and management of wastes, the laws may not adapt so quickly. The RCRA statute dates back to 1976, and the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) dates back to 1980, but waste generation, waste management, and the science of risk assessment have evolved and advanced since then. Recent research may provide more facts on the potential consequences of a constituent’s presence in the environment, and it may suggest that risks are lower than anticipated. Conversely, newly emphasized risks may trigger a reopening of waste sites that were “closed” many years ago, and those closed sites may be reassessed.

The clash between the old and new may also be observed in the water quality program. When a company recently reviewed the potential applicability of the federal effluent limitations to its proposed industrial process, it looked back to the industry category’s development document for a description of the technologies subject to the rules. The company observed that the technologies described in the rules are no longer prevalent in the industry, and the rules were found to be irrelevant. EPA appears to be in the process of reviewing and updating these historic documents, so that the technology-based standards can reflect today’s technologies.

What can we learn from these examples? That many of the guidance documents and rules that are in effect today were written several decades ago and may contain outdated information. As a result, today’s environmental professionals are not facing a dull or predictable existence. Instead, thoughtful, proactive, and “forward-looking” professionals in today’s regulatory world are frequently asked to identify, reconcile, and resolve a steady stream of interesting and challenging issues.
Court Told EPA Should Reconsider

Advocating for strengthened National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), environmental groups asked a federal appeals court to remand a U.S. Environmental Protection Agency (EPA) final rule that retains standards first set in 1971 (Comm. for a Better Env't vs. EPA, D.C. Cir., No. 11-1423, oral arguments 9/26/13).

Before the U.S. Court of Appeals for the District of Columbia Circuit, Nicholas Lopez argued on behalf of petitioners Communities for a Better Environment and WildEarth Guardians and intervenor petitioner the Sierra Club, saying EPA issued the rule without providing an adequate explanation as to why it did not give consideration to epidemiological evidence that supports strengthened standards.

Lopez, a law student with the University of Denver Sturm College of Law Environmental Law Clinic, criticized EPA’s primary reliance on a 20-year old study that looks at the health effects of CO exposure on men with certain heart conditions, such as angina, when reaching its conclusion that the standards didn’t need to be revised. Lopez said the study doesn’t represent a diverse population with diverse health effects.

Central to Lopez’s argument is EPA’s alleged disparate treatment of epidemiological studies in the rule-making process. Lopez said that when the agency revised the NAAQS for nitrogen dioxide (NO2) and sulfur dioxide (SO2), it was able to move past concerns related to factors such as confounding variables from other co-pollutants and that EPA gave weight to the epidemiological studies when setting the standards.

At issue is a 2011 final rule in which EPA retained the primary CO standards of 9 parts per million (ppm) measured over eight hours and 35 ppm measured hourly.

The environmental groups filed their challenge Oct. 31, 2011, taking issue with the level of the
primary standards, which protect public health, and the agency's decision not to set a public welfare standard to protect the environment.

**Epidemiological Evidence**

Senior Circuit Judge Stephen F. Williams closely questioned Lopez as to where in the groups' opening brief they had criticized EPA for giving different treatment to epidemiological evidence in this case versus other cases. He said the argument was found in the reply, but that it cannot be raised for the first time there.

Lopez and the petitioners in their arguments pointed to the D.C. Circuit decisions—handed down after the opening brief was filed—that upheld EPA's determinations of which epidemiological studies to use in regulating NO₂ and SO₂. Lopez asked the court to remand the rule to EPA. If the agency looks at the evidence again, it will have to reconsider its conclusion as to the CO standard, he said.

EPA issued revised NAAQS for NO₂ in January 2010, announcing it was the first ever 1-hour standard. The D.C. Circuit in July 2012 upheld that rule against industry challengers who claimed it was more stringent than needed (Am. Petroleum Inst. vs. EPA, 684 F.3d 1342, 74 ERC 2153, 2012 BL 178836 (D.C. Cir. 2012)).

In issuing new standards for SO₂ in June 2010, the agency revoked the previous daily and annual standards, and, for the first time, set an hourly standard. The D.C. Circuit, also in July 2012, upheld a challenge to the SO₂ rule brought by industry groups and states (Nat'l Envtl. Dev. Ass'ns Clean Air Project vs. EPA, 686 F.3d 803, 75 ERC 1396, 2012 BL 184620 (D.C. Cir. 2012)).

In response to questioning from the court, Doyle challenged the petitioners' standing with respect to EPA's decision not to issue a secondary standard to protect the environment from CO levels. Doyle said that CO isn't one of the six greenhouse gases and that petitioners haven't said that a secondary standard would make a difference to climate change.

Petitioners argued before the court and in their reply brief that they had standing to challenge the lack of a secondary standard by linking CO to climate change. To show injury-in-fact, petitioners argued they had established that a certain individual's recreational interests, which included an interest in watching birds adversely affected by climate change, had been harmed due to a link between CO emissions and climate change.

The three-judge panel also included Judge Janice Rogers Brown and Judge Brett M. Kavanaugh.—By Sarah Kunkleman, Bloomberg BNA

**Rule Called Valid**

Andrew Doyle of the Justice Department, arguing for EPA, said the rule should be found valid. Doyle said the petitioners were trying to get the court to review the scientific evidence already considered by EPA during the rule-making process and that is not the role of the court. Doyle also said there was no disparate treatment of the epidemiologic evidence, citing differences between the studies for CO and the studies for SO₂ and NO₂. Doyle also said that the issue was not raised in the petitioners' opening brief.

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EPA Delays Final Tier 3 Auto, Fuel Standards

EPA now anticipates finalizing its Tier 3 vehicle and gasoline standards in February 2014, the agency said Sept. 27. EPA had originally planned to issue the final rule by the end of 2013, but it said it needs the additional time to review the comments it received on its proposal. The agency said the delay isn’t likely to affect the rule’s 2017 compliance date.

“EPA received more than 200,000 public comments on the May proposal,” the agency said in a Sept. 27 statement. “Due to the extensive input we received and the need for thorough analysis of available data, EPA currently intends to issue the final rule in February 2014.”

The rule, which EPA proposed in May, would limit emissions of combined nitrogen oxides (NOx) and volatile organic compounds (VOCs) from light- and medium-duty passenger vehicles to 30 milligrams per mile by 2025, down from 160 milligrams per mile currently. It would set a particulate matter (PM) emissions standard of 3 milligrams per mile for all model-year passenger vehicles, compared with 10 milligrams per mile currently.

The proposal would limit VOC and NOx emissions from heavy-duty pickup trucks and vans to 178 milligrams per mile or 247 milligrams per mile, depending on vehicle type. It would set a PM emissions limit of 8 milligrams per mile or 10 milligrams per mile for heavy-duty trucks, depending on vehicle type. The proposal also would set evaporative emission limits for passenger vehicles and heavy-duty vehicles (78 Fed. Regist. 29,815). The Tier 3 rule would limit the sulfur content in gasoline to 10 parts per million (ppm), down from the current limit of 30 ppm.

Delay Expected to Have Little Impact

Automakers have said reducing the sulfur content in gasoline is necessary to help achieve the EPA and National Highway Traffic Safety Administration’s joint greenhouse gas emissions and fuel economy standards, which require carmakers to achieve the equivalent of 54.5 miles per gallon by 2025. However, a slight delay in issuing the Tier 3 rule isn’t expected to affect manufacturers’ plans to comply with the standards, which also take effect in 2017.

“A delay of a few weeks won’t be a problem,” Gloria Bergquist, a spokeswoman for the Alliance of Automobile Manufacturers, told Bloomberg BNA in an e-mail. Petroleum refiners have pushed EPA to withdraw the Tier 3 rule, calling it expensive and unnecessary.—By Andrew Childers, Bloomberg BNA

Elevate Your Professional Career to the Next Level

The December EM will become a resource that environmental professionals will refer to for years to come, featuring key professional and business etiquettes to follow for new and practicing environmental professionals. The articles will present both positive and negative experiences from supervisors, hiring managers, clients, as well as new and seasoned professionals, and will touch upon topics like “how to attend your first client meeting,” “how to be prepared for interviews,” “how to make sure your web/social media presence helps your professional profile,” “how to perfect your resume,” “pitfalls to avoid in your career,” and so forth.

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Reviewers of National Climate Assessment Seek More Analysis

Members of the National Research Council (NRC) have offered suggestions for how the 2013 National Climate Assessment could provide more analysis of response strategies to climate change without prescribing specific policy decisions.

While the assessment is intended to be only a descriptive account of current climate change science, potential impacts, and current response strategies, NRC members agreed in a meeting on the report’s development that the information in the report should be complete and reliable enough to feed into decision-making to address climate change.

A draft version of the assessment was released in January by the U.S. Global Change Research Program, which coordinates federal research on changes in the global environment. NRC published a report in April suggesting specific changes to the draft, including expanding efforts to understand climate change impacts in the United States and providing more practical guidance for adapting to climate change. Most of the changes suggested by NRC were incorporated into the draft assessment, but one area identified for improvement was the report’s discussion of response strategies to climate change.

The final report is expected to be released to the public in March 2014.

President’s Climate Plan Could Boost Science Program

President Obama’s climate plan could help raise the value of the foundational climate science produced by the U.S. Global Change Research Program (USGCRP) and better link it to practical objectives, such as adaptation or mitigation efforts, a White House climate official said.

The climate plan, released in June, included a call for research to increase understanding of climate change impacts, establishment of a public-private partnership to explore risk and catastrophe modeling, and development of information and tools needed by decision-makers to respond to both long-term climate change effects and near-term effects of extreme weather.

USGCRP, established in 1990, coordinates efforts among 13 federal agencies to monitor atmospheric, oceanic, land, and space data and to develop predictive models. The program has slowly evolved from concentrating on the science behind climate change to focusing on research to help the government and the public respond to potential risks brought about by climate change, as evidenced by its strategic plan for 2012–2021.

EPA Releases ‘Road Map’ to Revitalize Cities with Large Auto Manufacturing Sectors

The U.S. Environmental Protection Agency (EPA) has released a toolkit to help cities with large auto manufacturing sectors to clean up contamination, revive manufacturing, improve infrastructure, and create more sustainable communities.

EPA’s Roadmap for Auto Community Revitalization provides communities affected by the recent economic struggles of the auto industry with access to information on sources of funding and technical assistance for economic revitalization, and details case studies from cities and towns around the country. Mathy Stanislaus, EPA assistant administrator for solid waste and emergency response, said the document would help communities with automotive brownfields succeed at developing new uses for abandoned or neglected properties.

“Cleaning up and reusing contaminated automotive sites protects human health and the environment, fosters economic revitalization and can pave the way to a more prosperous future for local communities,” Stanislaus said in the introduction to the document. “The Agency is working closely with communities impacted by the downturn in the U.S. auto industry to clean up automotive sites where necessary, and then put those sites back into productive use.” EPA envisions the document being especially helpful to mayors, city managers, economic development directors, and other elected and appointed officials who are working to redevelop struggling communities.
Product Showcase by

The product reviews presented below have been compiled, edited, and shared with permission from Pollution Engineering.

**Acrylic Meter Lines**

Aalborg Instruments’ ACRX line of acrylic flow meters are being offered with any one of the interchangeable direct reading scales for air, water, argon, oxygen, carbon dioxide, nitrogen, helium, and hydrogen. Dual scales display flow rates in both metric and English units.

Optional scales can be developed for diverse flow conditions facilitating OEM applications. The yellow colored back plate enhances readability of scales and helps to minimize eye fatigue.

**Aalborg Instruments and Controls Inc.**
Orangeburg, NY
(800) 866-3837
www.Aalborg.com

**Combustion Gas and Emissions Analyzer**

The E4400 is a portable flue gas analyzer designed for emissions monitoring and maintenance and tuning of combustion processes. Its rugged design and makes the E4400 the ideal industrial analyzer for boiler, engine, furnace, and other combustion applications. It also includes up to four gas sensors: O$_2$, CO, NO/NO$_2$, and SO$_2$. Additionally, the analyzer includes a built-in printer (non-thermal); low NOx and “True NOx” capabilities; unbreakable metal hose connectors; temperature and pressure measurements; and a rechargeable lithium ion battery pack.

**E Instruments International**
Langhorne, PA
(215) 750-1136
www.e-inst.com

**Parts Directory App**

Asahi/America has released a new free app for use with the iPhone, iPad, and Android operating systems. The app is a part number search tool that allows users to locate part numbers and list prices for any of the company’s more than 20,000 thermoplastic fluid flow technologies with the click of a button. Via the app, users can easily locate a part number and list price by entering a brief description of what their search objective. This free app is available via the device’s app store under Asahi/America Part Number Search Tool.

**Asahi/America Inc.**
Malden, MA
(781) 321-5409
www.asahi-americ.com

**Single-Shaft Shredders**

Antares is the name of a new line of compact single-shaft shredders from Lindner that deliver up to one-third more throughput than previous machines in this class, but at the same price level. Available in four sizes and numerous equipment configurations, the units are perfectly adaptable to specific requirements in the plastics processing and recycling industry. Thus, typical applications range from postconsumer materials to special tasks such as in-house recycling of films, filaments, start-up lumps and sheets/plates.

**Lindner America LLC**
Raleigh, NC
(919) 783-7719
www.l-rt.us
Filling and Blending Software

Mettler has introduced a new process weighing software, the IND560 FillPlus, to meet the needs of basic and complex filling and blending applications, while preserving ease of use. Users meet product accuracy goals thanks to programmable spill values and jog functions. To reduce errors, operators no longer need to manually enter formulas; they can be retrieved from memory. FillPlus performs rescaling based on a percentage of the programmed target, percentage of the available amount of material in a formula, or a desired total formula weight. The system enables the storage, retrieval and rescaling of up to 25 formulas.

Mettler Toledo LLC
Columbus, OH
(800) 786-0038
www.mt.com

Optical Gas Imaging

FLIR Systems’ range of GF-Series Optical Gas Imaging cameras provides reliable, top performance leak detection across a variety of applications. The cameras display a gas leak as a plume of vapor in the captured infrared image. Cameras are inherently safe as the technique enables the user to remotely scan for leaks. The technology used offers tangible benefits compared to traditional methods because they scan a broader area rapidly while detecting leaks in areas that are difficult to reach with contact measurement tools.

FLIR Systems Inc.
Boston, MA
(800) GO-INFRA
www.flir.com

Disperser Models

The new Laboratory High Viscosity Disperser from Charles Ross & Son features interchangeable bow-tie and paddle blades driven by a 2 hp explosion-proof, VFD-capable motor. Suitable for use with standard 5-gallon pails, this bench-top mixer is ideal for thorough blending of fluids with very different viscosities, quickly resuspending dense solids that have settled during transport or storage, preparing thick paste-like formulations and other similar applications. Model PBA-2 is offered with either an electro-mechanical lift or an air/oil hydraulic lift. Both options allow the operator to easily raise and lower the mixing blades during or in between batches. All wetted parts are stainless steel 304, as well as the shaft guard and adjustable can lock.

Charles Ross & Son Co.
Hauppauge, NY
(800) 243-ROSS
www.mixers.com

Fluid Control Instruments

The new P65SRN has a maximum operating pressure of 925 psig and is available in either F304 Stainless Steel or A105 Carbon Steel. The P65SRN PowerDyne range features: inline replaceable module; verifiable “zero energy” condition with optional BD blowdown valve; 440c hardened valve trim; the stainless steel version allows higher TMO/TMA (800 °F/1,022 °F at 863 psig) and is corrosion resistant; and air venting for quick startup. It is available in 1/2, 3/4, and 1 inch NPT and socket weld connections, and is available for immediate shipment.

TLV Corporation
Charlotte, NC
(800) TLV-TRAP
www.tlv.com

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Listed here are the papers appearing in the November 2013 issue of EM's sister publication, the Journal of the Air & Waste Management Association. For more information, go to www.tandfonline.com/UAWM.

The 2013 Critical Review Discussion
Stratospheric ozone, global warming and the principle of unintended consequences—An ongoing science and policy story

Technical Papers
Municipal solid waste shear strength parameters defined through laboratory and in situ tests

Aerosol species concentrations and source apportionment of ammonia at Rocky Mountain National Park

Characterization of Halyomorpha halys (brown marmorated stink bug) biogenic volatile organic compound emissions and their role in secondary organic aerosol formation

Radical precursors and related species from traffic as observed and modeled at an urban highway junction

Gaseous pollutants emitted from a municipal solid waste plant: Odor assessment and photochemical reactivity

Greenhouse gas emissions in Morelos, Mexico: A first approximation for establishing mitigation strategies

Biofiltration of odorous fume emitted from recycled nylon melting operations

Improved atmospheric sampling of hexavalent chromium

Calibration of a fugitive emission rate measurement of an area source

Effects of the NOx SIP Call Program on ozone levels in New York

2013

NOVEMBER
5–6 Energy Forum: Environmental And Economic Challenges, Baltimore, MD
5–8 53rd Annual Conference of A&WMA’s Pacific Northwest International Section (PNWIS), Victoria, BC
19–21 Air Quality Measurement Methods and Technology, Sacramento, CA; measurements.awma.org

DECEMBER
5–8 CALPUFF/CALMET General And Advanced Modelling Courses, Calgary, Alberta, Canada
10–11 38th Annual EPA Information Exchange, Research Triangle Park, NC; www.awma.org/infoexchange

2014

FEBRUARY
2–6 American Meteorological Society’s 2014 Annual Meeting, Atlanta, Georgia; http://annual.ametsoc.org/2014/
24–27 4C Environmental Conference, Austin, TX; www.4CConference.com

MARCH
Mar 30 The 29th International Conference on Solid Waste Technology and Management, Philadelphia, PA; www.solid-waste.org
– Apr 2

JUNE
24–27 A&WMA’s 107th Annual Conference & Exhibition, Long Beach, CA; ace2014.awma.org

AUGUST
19–22 2014 Power Plant Pollutant Control “MEGA” Symposium, Baltimore, MD; megasymposium.org

SEPTEMBER
10–11 Vapor Intrusion, Remediation, and Site Closure, Philadelphia, PA; siteclosure.awma.org

Events sponsored and cosponsored by the Air & Waste Management Association (A&WMA) are highlighted in bold. For more information, call A&WMA Member Services at 1-800-270-3444 or visit the A&WMA Events Web site: www.awma.org/events.

To add your events to this calendar, send to: Calendar Listings, Air & Waste Management Association, One Gateway Center, 3rd Floor, 420 Fort Duquesne Blvd., Pittsburgh, PA 15222-1435. Calendar listings are published on a space-available basis and should be received by A&WMA’s editorial offices at least three months in advance of publication.
The 38th Annual A&WMA/EPA Information Exchange
December 10 - 11, 2013 • Research Triangle Park, NC • www.awma.org/infoexchange

Hear the latest research and program news directly from EPA!
Topics will likely include:
• Mercury and Air toxics Standard (MATS)
• Greenhouse Gas Update
• Cross State Air Pollution Rule (CSAPR)
• EGU GHG New Source Performance Standard (NSPS)
• Sector-based rule development
• Air pollution prevention and control research
• Greenhouse gas mitigation - Market Modeling

Registration for the two-day meeting is only $145 for A&WMA members and $170 for nonmembers who pre-register. These discounted prices will increase by $25 after November 19, 2013 – so act now!

Joint Meeting of the Research Triangle Park Chapter
December 10, 2010 • 6:00 – 9:00 p.m.
All attendees of the Information Exchange are invited to attend the Research Triangle Park Chapter Dinner Meeting.
6:00 - 7:00 p.m. Cash bar
7:00 - 8:00 p.m. Dinner
8:00 - 9:00 p.m. Speaker TBD
Cost: $35

Please visit www.awma.org/infoexchange for more information!

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After November 19, 2013
Member $170
Nonmember $195

Research Triangle Park Chapter Dinner
Specify one selection:
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• Roast NY Strip
• Vegetable Stuffed Ravioli

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Name (printed) on Card
Signature

Return registration form to: A&WMA, One Gateway Center, Third Floor, Pittsburgh, PA 15222, or fax to: 412-232-3410. For more information, call 412-232-3441 or 1-800-270-3444. Refund Policy: If written notice of cancellation is received on or before November 20, 2013 payment will be refunded. Substitutions may be made at any time; payment for any difference is due at the time of substitution. This refund policy applies to all occurrences, including weather-related events and other natural disasters. In the unlikely occurrence of event cancellation, the Association is not liable for any expenses incurred by the registrant other than the full refund of registration fees paid.
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