NASA Air Quality Applied Sciences Team Quarterly Newsletter

November 2014 "Earth science serving air quality management needs"

Register Today for AQAST8 in Atlanta!

AQAST's 8th biannual meeting (AQAST8) will be held December 2-4, 2014 (Tuesday-Thursday) at Georgia Tech University in Atlanta. Go to the meeting website for more detailed information and to **register**. Air quality managers are encouraged to attend as the meeting will feature a special session on air quality management issues in Southeastern states. We look forward to seeing you in Atlanta in December!

AQAST Spotlights: Russell Dickerson & Daniel Cohan

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This month's AQAST spotlight is focused on the collaborative efforts of Russell Dickerson in Maryland, and Daniel Cohan in Texas. These AQAST members have assisted state air quality managers with a variety of complex issues that have improved their understanding of the factors that contribute to poor air quality.

FRAPPÉ Enjoys Media Support

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The Front Range Air Pollution and Photochemistry Experiment (FRAPPÉ) enjoyed sustained media coverage and public interest during the summer of 2014. Read more **here**.

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EM September Issue Features AQAST Work

Environmental Manager, the monthly magazine of the Air & Waste Management Association, devoted its September 2014 issue (**available here**) to AQAST's involvement with the DISCOVER-AQ project. The issue features a cover story co-authored by Russell Dickerson and other articles written by AQAST members Bryan Duncan, Anne Thompson, Pius Lee, and James Syzkman. It is the second time this year that *EM* has dedicated an issue to AQAST's research activities.

DISCOVER-AQ has helped scientists improve the accuracy of satellite data to create better estimates of emissions sources, inventories, and forecasts. The first campaign took place in the Baltimore-Washington metro area in July 2011, followed by campaigns in California's San Joaquin Valley, and the Houston-Galveston region in October 2013.

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This photo shows visitors waiting to take a tour of one the aircraft used to collect air quality measurements during the FRAPPE campaign. The open house drew several hundred visitors to Rocky Mountain Metropolitan Airport in Broomfield, CO, on August 2nd (Image provided by NCAR).

FRAPPÉ Campaign Receiver High Public Interest

Several AQAST members played integral roles in supporting the groundbreaking campaign aimed at improving scientific understanding of the factors that affect air quality in Colorado's Front Range region.

The Front Range Air Pollution and Photochemistry Experiment (FRAPPÉ) launched on July 16th and concluded on August 16th. The campaign coordinated ground-based measurements with aircraft sample and satellite observations. These three air quality measurement techniques are expected to produce a vivid portrait of the complex factors that contribute to air quality problems in the Front Range.

Project leader and AQAST member Gabrielle Pfister said early results of the far-reaching campaign found ozone and ozone precursors at high elevations in the Rocky Mountains, which are typically associated with very clean air. The pollutants were pushed in to the mountains by wind and rising air masses that were heated at lower elevations.

The unprecedented FRAPPÉ campaign garnered consistent coverage in local and national media for several months, ranging from local television newscasts to coverage in The Denver Post and Lab Manager Magazine.

Selected FRAPPÉ media coverage can be found **here.**

<<Recently published

Clifton, O.E., A.M. Fiore, G. Correa, L.W. Horowitz, and V. Naik, 21st Century Reversal of the Surface Ozone Seasonal Cycle over the Northeastern United States, *Geophysical Research Letters*, in press, 2014. Article

de Foy, B., J.L. Wilkins, Z. Lu, D.G. Streets, and B.N. Duncan. Model evaluation of methods for estimating surface emissions and chemical lifetimes from satellite data. *Atmospheric Environment*, 98, 66–77, 2014. Article

de Foy, B., Cui, Y. Y., Schauer, J. J., Janssen, M., Turner, J. R., and Wiedinmyer, C., Estimating sources of elemental and organic carbon and their temporal emission patterns using a Least Squares Inverse model and hourly measurements from the St. Louis-Midwest Supersite, *Atmospheric Chemistry & Physics Discussions*, 14, 12019-12070, doi:10.5194/acpd-14-12019-2014, 2014. Article

Fishman, J., K.M. Belina, and C.H Encarnaciòn, The St. Louis Ozone Gardens: Visualizing the impact of a changing atmosphere, *Bulletin of the American Meteorological Society*, 85, 1171-1176, 2014. Article

Fiore, A.M., J.T. Oberman, M.Y. Lin, L. Zhang, O.E. Clifton, D.J. Jacob, V. Naik, L.W. Horowitz, J.P. Pinto, G.P. Milly, Estimating North American background ozone in U.S. surface air with two independent global models: Variability, uncertainties and recommendations, *Atmospheric Environment*, 96, 284-300, 2014. Article

Flynn, C. M., Pickering, E. K., Szykman, J., Knepp, T., Silverman, M., Long, R., and Lee, P., Can surface air quality be estimated from satellite observations of trace gases, *Environmental Manager*, 28-33, September 2014. Article

Pickering, E. K., and Lee, P., Air quality forecasting guides flight plans, *Environmental Manager*, 39-43, September 2014. Article

Schneising, O., J. P. Burrows, R. Dickerson, M. Buchwitz, M. Reuter, and H. Bovensmann, Remote sensing of fugitive methane emissions from oil and gas production in North American tight geologic formations, *Earth's Future*, 2, doi:10.1002/2014EF000265, 2014. Article

Tang, W., D.S. Cohan, A. Pour-Biazar, L.N. Lamsal, X. Xiao, W. Zhou, B.H. Henderson, and B. Lash. Influence of satellite-derived photolysis rates and NOx emissions on Texas ozone modeling. *Atmospheric Chemistry & Physics Discussions*, 14, 24475-24522, 2014. Article

Yue, X., L.J. Mickley, and J.A. Logan, Projection of wildfire activity in southern California in the mid-21st century, in press, *Climate Dynamics*, 2014. Article

NASA Air Quality Applied Sciences Team update, presented by Daniel Cohan to the Southeast Texas Photochemical Modeling Technical Committee, July 22, 2014. Presentation

Visit aqast.org for a full list of AQAST publications.

EM September Issue Highlights

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Dickerson, a professor of atmospheric science at the University of Maryland, led a team that provided critical support for the Baltimore-Washington DISCOVER-AQ campaign. Measurements collected by NASA's P3-B aircraft were supplemented by lower altitude measurements taken by a smaller Cessna aircraft provided by the University of Maryland. The Maryland team also offered a unique historical perspective because they have been flying solo missions for the past 15 years.

Dickerson's research during and after the DISCOVER-AQ campaign has helped the Maryland Department of Environment (MDE) with important policy issues, such as quantifying emissions from motor vehicle emissions, and addressing interstate pollution transport. The DISCOVER-AQ campaigns have also improved statistical understanding of how satellite observations can complement ground-based monitoring networks. These tools can help improve the accuracy of air quality models that are used to test pollution reduction strategies.

Examining the 'Bay Breeze' Phenomenon

Research by Thompson and Ph.D candidate Ryan Stauffer focused on an important aspect of the complex ozone non-attainment problem in Maryland. Their *EM* article focused on characteristics of the "bay breeze" phenomenon, which re-circulates air with high concentrations of ozone and ozone precursors over the upper Chesapeake Bay. Air that moves offshore during the mid-afternoon tends to creep back over the land in a wind shift caused by the bay breeze phenomenon. The bay breeze caused Maryland's Edgewood monitor to record ozone levels above federal standards. These subtle shifts in airflows can be forecasted with high-resolution models. As ozone violations over Maryland are generally declining, a higher percentage of episodes that do occur are expected to be caused by the bay breeze phenomenon.

Testing the Accuracy of Satellites

Syzkman and Lee contributed to research featured in *EM* that explains the role DISCOVER-AQ played in validating the accuracy and effectiveness of satellite data for air quality modeling and forecasting. Their research investigated the relationship between satellite measurements of trace gases in the regions where DISCOVER-AQ aircraft measured pollution levels, against the actual aircraft and ground-level measurements of several pollutants. Results of their analysis showed that, under summer conditions in Maryland, satellite-derived ozone measurements are capable of estimating surface-level ozone in areas that lack ground-based monitoring equipment. The relationship between satellite measurements of NO_2, a precursor to ozone formation, and ground-level measurements remains weaker and requires further research.

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More AQtivities:

Supporting LADCO

AQAST members Ben de Foy and Jack Fishman from Saint Louis University have been working with Mark Janssen of LADCO on inverse modeling for emissions estimation using surface observations for elemental and organic carbon at the St. Louis-Midwest Supersite. The project led to valuable confirmation of some of the modifications made by LADCO to the National Emissions Inventory and also highlighted areas in need of more analysis. The publication can be accessed at this **web address**.

Success Continues for Ozone Gardens

AQAST members led by Jack Fishman have developed a network of 13 ozone gardens in botanical gardens and other public venues across the U.S. to demonstrate the damaging impact of ozone on vegetation. Read the 2014 season report by Jack Fishman **here**, and his recent article featured on the cover of the Bulletin of the American Meteorological Society **here**.

Two snap bean cultivars before harvest in August 2014, one ozone-resistant (at left) and one ozone-sensitive (at right). The effect of ozone damage is evident. Ozone levels reached 105 ppb this past season at the SLU garden (Image provided by Saint Louis University).

AQAST Spotlight: Russell Dickerson & MDE

Recipe for Ozone Reductions Cooks Up in Maryland
By: Ben Kaldunski & Tracey Holloway

Ever since the US Environmental Protection Agency (EPA) established limits on ground-level ozone to protect public health in 1970, the state of Maryland has struggled to comply. Unlike the smoke from a backyard barbeque, ozone is not directly emitted from tailpipes, smokestacks, or open burning. Rather, it is "cooked up" when ingredients from human and natural sources combine with heat and sunlight in the air.

Across the US and other countries, a common recipe creates ozone: nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight.

Maryland faces unique challenges in controlling ozone because the state is located near several urban areas, and prevailing winds carry polluted air in from upwind states. Russell Dickerson, a member of NASA's Air Quality Applied Sciences Team (AQAST) and a professor at the University of Maryland, is working with air quality managers at the Maryland Department of the Environment (MDE) to create the ultimate ozone reduction cookbook.

"AQAST has been a catalyst and liaison for communication between states and NASA scientists," Dickerson said. Although he has supported MDE for over 15 years, Dickerson said that the launch of AQAST in 2011 has led to a substantial uptick in connecting NASA science with state air quality agencies like MDE. The collaboration between AQAST and MDE kicked into high gear during the summer of 2011 when Dickerson helped coordinate the first DISCOVER-AQ campaign, a month-long study of air quality in the Baltimore-Washington metro area.

"DISCOVER-AQ was a wonderful opportunity for Maryland because a NASA aircraft laden with state-of-the-art instruments spent an entire month observing our local air quality," Dickerson said. Data collected from the aircraft and satellites proved that ozone in the eastern U.S. is a regional problem, not just local. The hard evidence supports what computer modelers had been arguing for years, that ozone pollution in Maryland is dependent on emissions from surrounding states.

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Russell Dickerson, an AQAST member and professor at the University of Maryland, has worked with the Maryland Department of the Environment (MDE) for over 15 years (Image provided by University of Maryland).

Tad Aburn, Director of MDE's Air & Radiation Division, said his agency has received great benefits from their partnership with AQAST (Image provided by MDE).

AQAST Spotlight: Russell Dickerson & MDE

Tad Aburn, director of MDE's Air & Radiation Division, said Dickerson's work had provided critical insights that have guided the agency's efforts to develop the most effective ozone reduction strategies. "Understanding how emissions behave aloft, and how they are transported into Maryland, is the single most important piece of our partnership with AQAST," Aburn said. "The concentrated efforts by Russ Dickerson and AQAST over the past several years has been a really positive thing," he said. "I truly believe that this collaborative structure is the right way to go about solving local and regional air quality problems."

Power plants that only generate electricity during extremely hot days to meet air conditioning demand, known as "peaking" plants, are one of the major sources of ozone-forming emissions. These peaking units often run without the same NOx emission controls used on standard power plants. Unfortunately, the hottest days are often the most polluted, because of active chemistry in the atmosphere. "It is perfectly legal for power plants to operate without controls under current emissions trading programs," Dickerson said, "but doing this on extremely hot days is very bad for air quality."

The partnership between AQAST and MDE has been successful in several ways. It has provided MDE with access to expert scientists, like Dickerson, who connect their staff with NASA satellite data products, complex modeling simulations, and intensive field campaigns like DISCOVER-AQ. Aburn highlighted AQAST's role in developing tools to simplify the use of satellite data products and best practices for using those datasets to examine pollution source trends and exception events. "Satellite data analysis is a relatively new piece of our process, but I expect it to grow rapidly and produce valuable benefits in the next several years," Aburn said.

The combination of these tools, resources, and shared knowledge has resulted in significant improvements in MDE's modeling capabilities, which are critical for developing effective pollution reduction strategies. "Much of the success of this partnership lies in the two-way conversations between MDE and AQAST members," Aburn said. "They listen very closely to the problems we have and help us solve those problems by applying high quality scientific research."

The collaborative effort between AQAST researchers and Maryland's air quality managers has produced significant improvement in air quality over the past decade. The joint effort has led to many more clear skies over Baltimore (above) and other urban areas in Maryland that have struggled to meet federal air quality standards since the 1970's (Image provided by the City of Baltimore).

AQAST Spotlight: Daniel Cohan & TCEQ

AQAST Helps Regulators Tackle Texas-Sized Ozone Problems
By: Ben Kaldunski & Tracey Holloway

Although NASA's work in the Lone Star State is most often associated with rocket launches and the space program, Texas also hosts exciting work connecting space observations with ground-level information needs. Members of NASA's Air Quality Applied Sciences Team (AQAST) have been working with Texas' air quality managers to improve scientific understanding of the complicated factors that contribute to ozone pollution in Houston, Dallas, and other parts of the state.

The health-damaging air pollutant ozone is formed in the atmosphere from a mix of human-caused and natural pollutants. Understanding the role of natural sources, like wildfires, soil, and plants, has been a challenging aspect of ozone science. Human activity is responsible for the majority of ozone-forming emissions in urban areas, but high levels of natural (or "biogenic") emissions can push pollution levels over the limits set by the federal Environmental Protection Agency (EPA). In rural areas where human emissions are low, understanding biogenic emissions is even more critical.

Daniel Cohan, an AQAST member and professor at Rice University in Houston, is using data retrieved from instruments mounted on NASA satellites to improve understanding of these natural emissions. Data collected from satellite instruments that measure solar radiation, cloud cover, and chemicals that lead to ozone formation (such as NO2) can be used to build more accurate estimates of biogenic emissions and improve understanding of ground-level ozone.

Cohan and AQAST colleagues work to ensure that research addresses priority issues to local, state, and federal air quality management agencies. The Texas Commission on Environmental Quality (TCEQ) works to ensure that air in state meets EPA standards to protect public health, and Cohan works with TCEQ to make sure his work serves the state. "The ongoing involvement of air quality managers in AQAST meetings, conference calls, and research collaborations lets us continually adapt our efforts and address emerging needs as policies and conditions evolve," Cohan said.

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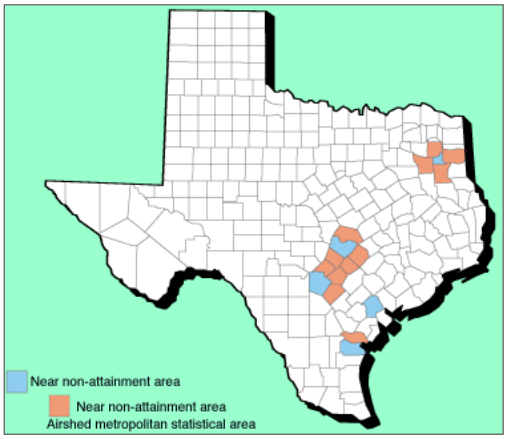
Daniel Cohan, an AQAST member and professor at Rice University in Houston, has worked with the Texas Commission on Environmental Quality (TCEQ) on several projects that have helped the agency improve ozone modeling capabilities (Image provided by Rice University).



This map shows areas in Texas that are in non-attainment, or close to being in non-attainment, with federal ozone standards. TCEQ is responsible for developing strategies to reduce air pollution in these areas. The agency is making progress as a result of their partnership with AQAST (Image provided by the Texas Center for Policy Research).

AQAST Spotlight: Daniel Cohan in Texas

Mark Estes, a member of TCEQ's modeling and data analysis group, said working with Cohan and other AQAST members has been, "kind of like a genie offering us three wishes, and we are trying to find the best wishes to choose."

For the past several years, Cohan has been working closely with Estes and other TCEQ staff to improve the agency's understanding of the different sources and factors that cause ground level ozone problems. Having previously worked for Georgia's environmental agency, Cohan has long focused his research on the priorities of air quality management at the state level.

Understanding biogenic emissions is just the type of high-impact research that helps decision-makers. Estes said it is critical to simulate biogenic emissions accurately because over- or under-estimating those emissions could skew the simulations of ozone chemistry in TCEQ's air quality models. Inaccurate modeling could lead to the implementation of less effective emission reduction strategies. Estes explained that the levels of background ozone entering eastern Texas from natural sources, as well as other states or Mexico, can be substantial. In Houston, the average background ozone concentration is about 30 parts per billion (ppb) compared to about 40ppb in Dallas. Cohan's research could help TCEQ incorporate more accurate simulations of background ozone into their models.

Cohan's research has provided TCEQ with improved methods for calculating natural emissions, which in turn affect air quality models used to evaluate different pollution reduction strategies. "TCEQ has an outstanding modeling team that is committed to using the best methods and science to ensure their pollution control strategies are robust." Cohan said.

Cohan's research and collaboration with Estes and TCEQ demonstrates the successful marriage of NASA science with state-level pollution control efforts. Together, AQAST and TCEQ are focusing research efforts to help the agency address Texas-sized air quality problems. "We would like to see AQAST focus all of their efforts on Texas." Estes said. "But that wouldn't be fair to the other states."

The collaborative effort between AQAST researchers and Texas air quality managers has led to improved understanding of the complex chemistry and other factors that cause ozone problems in Houston (left), Dallas (right), and other parts of Texas. Improved modeling produced from AQAST research will help Texas implement the most effective pollution reduction strategies. (Images provided by the University of North Texas Library Archives).

EM September Issue Highlights

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Duncan used the results of the Baltimore-Washington DISCOVER-AQ project as the basis for research aimed at predicting the impact of climate change on air quality. The campaign provided a preview of future air quality problems because pollution measurements were collected during the hottest month on record at Baltimore-Washington International airport. The region experienced fourteen days with 8-hour average ozone concentrations above 75 parts per billion (ppb), and three above 95 ppb. The 1-hour ozone standard was set at 120 ppb in 2002 and was regularly surpassed, but ozone levels never crossed that threshold in July 2011. This highlights the fact that emissions controls are working, Duncan said.

Looking Forward to Future Partnerships

AQAST's research projects provide opportunities for air quality managers to collaborate with leading experts from universities and national laboratories. These collaborations have allowed multiple state air quality agencies to work directly with scientists to solve the most complex challenges identified at AQAST's biannual meetings.

AQAST's nineteen members are dedicated to high quality research across the wide spectrum of air quality and climate topics with the goal of providing new tools and support for local, regional, and federal air quality managers. The scope and impact of these research efforts are described in *EM* magazine's September issue. The team hopes that this media coverage will stimulate further cooperation among AQAST members and air quality stakeholders.

Read the full *EM* September issue **here**.

The 2015 Transboundary Ozone Conference will be held at the Tenaya Lodge (pictured above) just outside Yosemite National Park from March 31 to April 2 (Image provided by Yosemite National Park).

Spring 2015 Conference on Transboundary Ozone Pollution

In partnership with AQAST, the San Joaquin Valley APCD is organizing a scientific conference focusing on transboundary anthropogenic ozone (TAO) in the western U.S. It will be held at the Tenaya Lodge at Yosemite (just outside Yosemite National Park) on March 31-April 2, 2015. Click **here** for more information.

The overall goal of the conference is to provide a forum for researchers to share their latest findings in this field with air quality managers and other atmospheric scientists. In particular, a growing body of research provides clear evidence that transboundary ozone has risen substantially over the past few decades and is currently making non-trivial, episodic or, in some cases, near continuous contributions to ambient ozone levels throughout the western U.S.

Rising scientific awareness of TAO has stimulated questions regarding its' possible contribution to local ozone exceedances of the National Ambient Air Quality Standards (NAAQS). Section 179B of the Clean Air Act empowers the U.S. EPA to provide exemptions for NAAQS exceedances in cases where the exceedance would not have occurred "but for" the incremental contribution from transboundary ozone generated by foreign sources of anthropogenic precursors.

Central questions addressed by the conference include: (1) Based on the current body of evidence derived from observational studies, satellite retrievals, and modeling efforts, how and under what circumstances is it possible to make reasonable estimates of TAO contributions to surface concentrations in the western U.S? And (2), what are the key data limitations that currently constrain the accuracy of these estimates for regulatory applications?

For more information, contact **David Lighthall** of the SJV APCD.

Next AQAST Biannual Meeting (AQAST8)

AQAST8 will be held December 2-4, 2014, at the Georgia Tech University in Atlanta. Our host will be AQAST members **Ted Russell and Yang Liu**. **Click here to register**!