NARSTO News

A North American Consortium for Atmospheric Research in Support of Air-Quality Management

Volume 4, Number 1; Winter/Spring 2000

http://www.cgenv.com/Narsto

NARSTO News Feature: AURAMS

This ***NARSTO News*** edition features the AURAMS project, a multi-year effort at the Meteorological Service of Canada (formerly the Atmospheric Environment Service, or AES) to develop a new regional air-quality modeling system. AURAMS will be used in Canada for studying and managing multiple regional tropospheric air issues, including particulate matter, acid deposition, and photochemical oxidants. This emerging modeling system includes a size-resolved, composition-resolved representation of atmospheric PM.

This feature article provides an overview of the objectives of the AURAMS project, the planned approach, the progress made to date, and the next stages, including performance evaluations and applications. This article is intended as a companion article to the feature article on the EPA's Models-3 project that appeared in our last edition (Summer/Fall 1999) of ***NARSTO News***.

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New York State's New Environmental Monitoring, Evaluation, and Protection Program and First Annual Conference

The move toward competition in the electricity industry means utilities will be less likely to support public-benefit environmental, research and development, and energy efficiency programs. To ensure these kinds of programs continue, New York's Public Service Commission (PSC) named the New York State Energy Research and Development Authority (NYSERDA) the administrator of a number of programs supported by a System Benefits Charge (SBC) on the electricity transmitted and distributed by most of the State's investor-owned utilities. These programs, which NYSERDA designated as **New York Energy $mart**[SM] programs, are funded until June 30, 2001, by which time the PSC will decide on continued funding.

Program Objectives

The **New York Energy $mart**[SM] Environmental Monitoring, Evaluation, and Protection (EMEP) program provides objective and policy-relevant research to:

- Improve the scientific understanding of electricity-related pollutants in the environment;
- Assess the environmental impact of electricity generation relative to other sources of pollution;
- Develop approaches to mitigate impacts of electricity generation and improve environmental quality.

The program also helps New York companies develop and demonstrate better instruments for monitoring ambient air and water affected by power generation.

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In this edition...

The *NARSTO News* is published biannually for the purpose of communicating NARSTO activities and progress to members of the extended NARSTO community. Persons wishing to comment on the newsletter or submit material for publication are invited to do so by contacting either Diane Fleshman or Jake Hales in the NARSTO Management Coordinator's office, at the following address:

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AURAMS, . . . *(Continued)*

PROGRESS REPORT ON AURAMS

AURAMS is a new, size-resolved, chemically-characterized, episodic regional particulate-matter (PM) modeling system being developed in Canada for air quality (AQ) research and management. The acronym AURAMS stands for **A U**nified **R**egional **A**ir-quality **M**odelling **S**ystem. AURAMS consists of three main components: an emission-processing system, a nonhydrostatic meteorological model, and a PM air-quality model. The term "Unified" is used because a comprehensive, size- and composition-resolved, regional PM model must consider emissions of both primary PM components and gaseous PM precursors, atmospheric transport and diffusion, aerosol processes such as nucleation, condensation, coagulation, and activation, gas-phase, aqueous-phase, and heterogeneous chemistry, and wet and dry removal of both particles and trace gases. Such a model is thus by default a multi-pollutant AQ model applicable to other AQ issues such as photochemical oxidants and acidic deposition, since most of the atmospheric processes and PM precursor species important for PM must also be considered for these other AQ issues. The ability to consider multiple air pollutants simultaneously will then permit AURAMS to be applied for integrated AQ planning and management.

The Meteorological Service of Canada possesses other regional AQ models that have been used to study and manage acid deposition and photochemical oxidants in Canada, but these models have only rudimentary "bulk" treatments of only some of the chemical components of atmospheric PM. As a first step toward PM modeling, in 1997 MSC organized and hosted an international workshop to review the state of the science of modelling size-distributed aerosol formation and composition (Brook and Moran, 2000). The later decision to commit the significant resources required to develop a new size-resolved, chemically characterized PM model in-house was not an easy one, but several arguments prevailed. First, since regional PM modelling is in its infancy at present, such a model could evolve as new knowledge about atmospheric aerosols becomes available. Second, the characteristics of the Canadian climate and environment could be considered and addressed. And third, as discussed next, MSC's existing regional AQ modeling infrastructure could be built upon, thus ensuring continuity and a "head start" on the new model.

AURAMS Building Blocks

AURAMS is being constructed using four major existing "building blocks": (i) a regional emissions processing system, the Canadian Emissions Processing System (CEPS); (ii) a nonhydrostatic mesoscale meteorological model, the Mesoscale Compressible Community model (MC2); (iii) a gas-phase chemical transport model, the Canadian Hemispheric and Regional Oxidant

and NO_x System (CHRONOS); and (iv) an aerosol module employing a sectional size representation, the Canadian Aerosol Module (CAM). To build the AURAMS regional PM model, CAM has been merged with a restructured version of CHRONOS and additional aerosol chemical components. Process representations are now being added. Figure 1 shows a schematic representation of the building blocks and their interconnections. A short description of each building block follows. For more details see Moran et al. (1998a).

Emissions Processing System

CEPS is a flexible, regional-scale emissions processing/modeling system that is used to process the Canadian and U.S. national annual emission inventories and to generate emission files for regional AQ modeling including PM emissions (Moran *et al.*, 1998b; Scholtz et al., 2000). CEPS considers five primary emissions "streams": major point sources; minor point sources; non-mobile area sources; mobile sources; and biogenic area sources. Of these five processing streams, the emission rates for two, on-road mobile area sources and biogenic area sources, are dependent upon meteorological conditions. The speciation of the criteria VOC gas-phase emissions by CEPS varies with the choice of gas-phase chemistry mechanism employed in AURAMS (two mechanisms are available at present). Figure 2 shows a plot of the annual North American SO_2 emissions for the 1990 emissions year generated by CEPS from the 1990 Canadian and U.S. inventories.

Meteorological Model

The meteorological driver now being used in AURAMS is MC2, which is a flexible, three-dimensional, fully compressible nonhydrostatic atmospheric model that uses a semi-implicit, semi-Lagrangian time-differencing scheme (Benoit *et al.*, 1997). The vertical coordinate is terrain-following and the set of dynamical equations are solved on a polar stereographic map projection. Vertical diffusion is based on a turbulence kinetic energy (TKE) boundary-layer parameterization. MC2 also has a one-way nesting capability, including a self-nesting (or cascade) capability, that allows lateral and upper boundary conditions to be supplied (i) by objective analyses, (ii) by another model run at a coarser scale, or (iii) by MC2 itself run at a coarser scale. As indicated in Figure 1, MC2 meteorological fields are passed to both CEPS and to the regional AQ model.

Gas-Phase Chemical Transport Model

MSC's photochemical oxidant model CHRONOS has been used to date for summertime photochemical modeling over northeastern North America (Pudykiewicz et al., 1997; Sirois et al., 1999) with horizontal grid spacing of 20 to 40 km and 25 terrain-following vertical levels. Over the past two summers it has also been used in an experimental mode to produce real-time predictions of ground-level ozone over eastern Canada. Chemical transport in AURAMS is calculated using the semi-Lagrangian algorithm of Smolarkiewicz and Pudykiewicz (1992). The gas-phase chemistry mechanism employed by CHRONOS is the ADOM-II mechanism (Venkatram et al., 1988) with 114 reactions and 47 species, 29 of which are advected and 16 of which are emitted. The only aerosol species considered in this scheme is bulk particulate sulfate.

Aerosol Module

CAM was developed for climate applications and is currently being used within both a global and a regional climate model (Gong *et al.*, 1997a,b). It includes size-dependent treatments of nucleation, condensation, coagulation, dry deposition, gravitational settling, in-cloud and below-cloud scavenging, and primary emissions. A sectional approach is used to represent aerosol size distribution. Presently, 12 sections spanning the size range from 0.005 to 20.48 μm are used. Three aerosol chemical components have been considered to date in CAM (sea salt, sulfate, water) but more are being added.

Current Status

"Dry" Prototype

A phased approach has been adopted in building AURAMS. An initial "dry" prototype version of the AURAMS PM model based on the merger of CHRONOS and CAM is currently being tested. This version considers emissions of gas-phase precursors and particulate sulfate, atmospheric transport and vertical diffusion, gas-phase chemistry, sulfuric-acid nucleation, gas-aerosol condensation (including secondary organic aerosol formation), coagulation, sedimentation, and dry deposition of trace gases and particles. The model domain covers much of Eastern North

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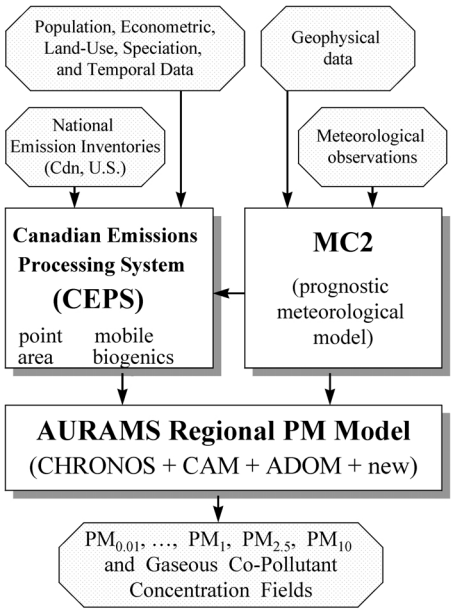

Figure 1 Schematic diagram of AURAMS building blocks.

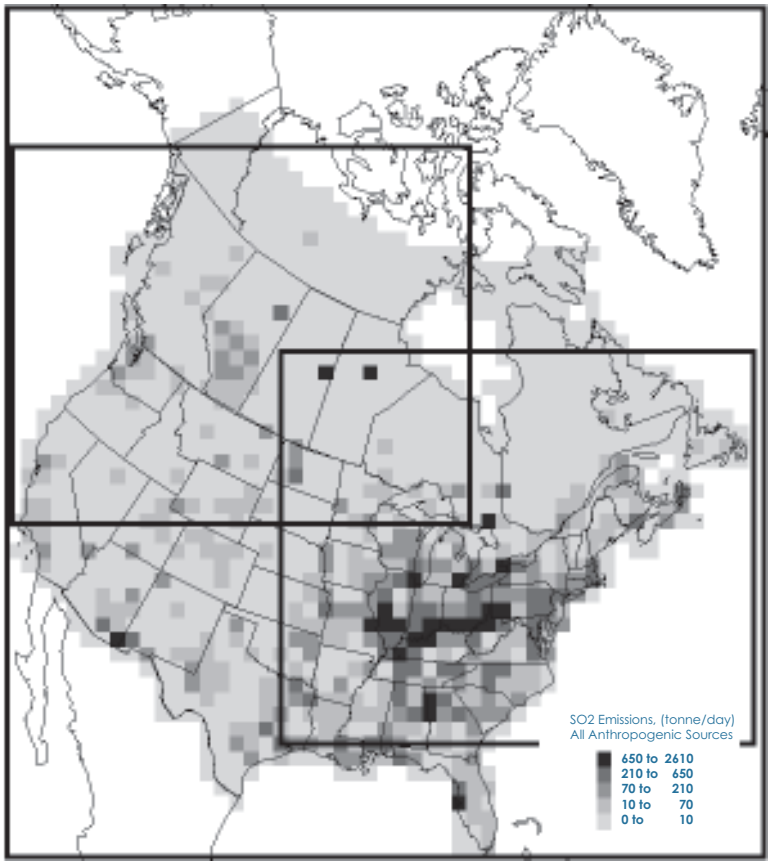

Figure 2 Location of planned western and eastern AURAMS modelling domains superimposed on a CEPS1.0-based plot of annual SO_2 emissions for 1990. The grid-cell size is 127 km by 127 km.

America (see Figure 3) and is divided into 71 by 71 horizontal grid cells 40 km on a side with 28 terrain-following vertical layers extending up to 18 km. Five chemical components are treated in this first version (sulfate, nitrate, ammonium, organic carbon, and aerosol-bound water), while two more components will be added in the next version (elemental carbon, crustal material). The chemical components are assumed to be internally mixed within each of the 12 size bins.

Model Evaluation

An important component of the development of any new AQ model is the evaluation of model performance with available observational data. However, very few speciated, size-resolved, regional-scale PM data sets are currently available. The Eulerian Model Evaluation Field Study (EMEFS), which was carried out in 1988-90 in eastern North America to collect a two-year data set suitable for evaluating comprehensive Eulerian acid-deposition models, comes close. The EMEFS data set includes daily, 24-hour concentration measurements of bulk particulate sulfate, nitrate, and ammonium and sulfur dioxide, nitric acid, ammonia (denoted as filter chemistry data in Figure 3), as well as ozone in air at up to 99 sites and sulfate, nitrate, and ammonium concentrations in precipitation at up to 117 sites (McNaughton and Vet, 1996). In addition, daily, 24-hour measurements of $PM_{2.5}$ gravimetric mass concentration and $PM_{2.5}$ sulfur concentration were made during EMEFS in the eastern U.S. at the 41 sites of the U.S. EPA's Fine Particulate Network (FPN) (Bennett et al., 1994), and some noncontinuous 24-hour measurements of $PM_{2.5}$ gravimetric mass and elemental concentrations are available from 13 U.S. National Park Service IMPROVE stations and

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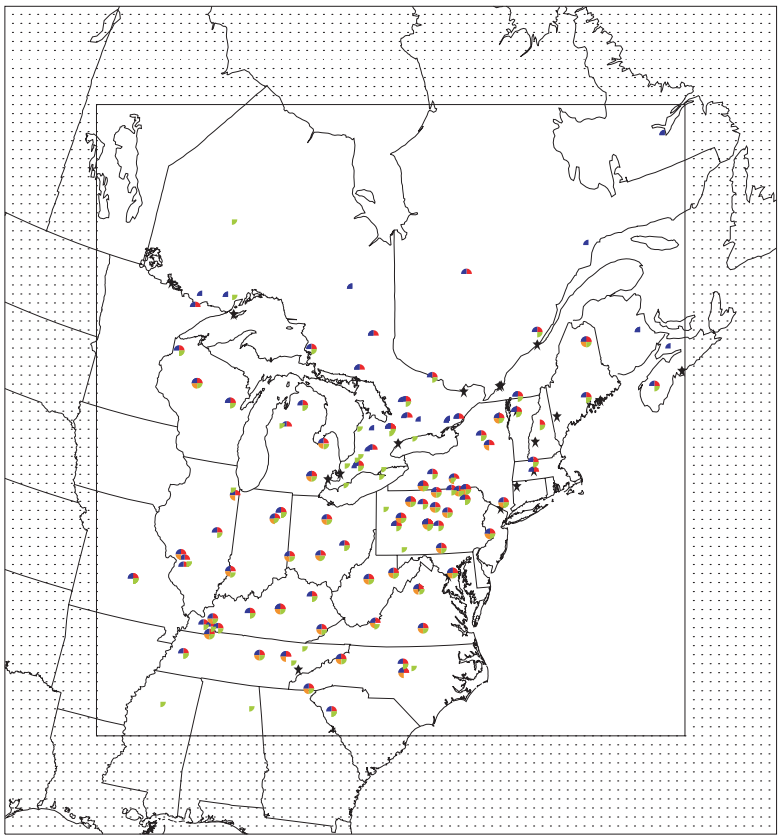

Figure 3 Locations of EMEFS, FPN, IMPROVE, and NAPS stations operating in 1988-1990 time period. The four possible sets of observations at each location are denoted by the four quadrants of a circle: ozone (SE quadrant), filter chemistry (NE quadrant), precipitation chemistry (NW quadrant) and daily FPN $PM_{2.5}$ mass (SW quadrant). The black stars indicate locations of IMPROVE and NAPS sites with 2-in-7-day and 1-in-6-day $PM_{2.5}$ and PM_{10} measurements. The border of the figure shows the location of the grid centres on the 91x91 MC2 domain that lie outside of the 71x71 AURAMS CTM domain. Grid-cell size is 40 km by 40 km.

AURAMS, . . . *(Continued)*

8 Environment Canada NAPS stations. Figure 3 shows the locations of measurement sites and the types of data that were collected at those sites.

Given the characteristics of the EMEFS data set and the prototype model, the focus of the present preliminary evaluation is on predicted air concentrations of the PM inorganic-ion species sulfate, nitrate, and ammonium. All significant processes for these components, with the exceptions of aqueous-phase sulfate production and wet removal, are represented in the current version of AURAMS. The first evaluation episode being considered is the six-day Aug. 1-6, 1988 period, which had generally hot, hazy, and humid weather over the model domain. The neglect of aqueous-phase chemistry and wet removal in the "dry" prototype should not be too important for this period.

Future Plans

The next version of AURAMS, now under development, will include treatments of size-distributed primary emissions of PM components other than sulphate and moist processes, including aerosol activation, aqueous-phase chemistry, and wet removal. A new gas-phase mechanism containing 81 species and 251 reactions has been developed at MSC and will be incorporated into AURAMS. This more detailed scheme should better resolve VOC species with a significant organic particulate fractionation or formation potential.

Comparisons with results from other PM models currently in use in Canada and elsewhere (e.g., ADOM, REMSAD, CMAQ) are also planned. AURAMS is intended for use in Canadian AQ policy and forecasting applications. In terms of policy, initial model applications will be made to support development of implementation plans to achieve the Canada Wide Standards for $PM_{2.5}$ and ozone and a PM annex to the Canada/U.S. Air Quality Accord. Figure 2 shows the likely size and location of the two grid domains needed to cover the country. Following demonstration of acceptable model performance and attainment of forecast-cycle processing speeds, it is hoped that AURAMS will be also used for real-time forecast applications using GEM, the Canadian operational weather forecast model, as the meteorological driver.

References

Bennett, R.L.; Stockburger, L.; Barnes, H.M. *Atmos. Environ.*, 1994, *28*, 409-419.

Benoit, R.; Desgagné, M.; Pellerin, P.; Pellerin, S.; Chartier, Y.; Desjardins, S. *Mon. Wea. Rev.*, 1997, *125*, 2382-2415.

Brook, J.R.; Moran, M.D. *Atmos. Environ.*, 2000, *34*, 1153-1154.

Gong, S.-L.; Barrie, L.A.; Blanchet, J.-P. *J. Geophys. Res.*, 1997a, *102*, 3805-3818.

Gong, S.-L.; Barrie, L.A.; Prospero, J.M.; Savoie, D.L.; Ayers, G.P.; Blanchet, J.-P.; Spacek, L. *J. Geophys. Res.*, 1997b, *102*, 3819-3830.

McNaughton, D.J.; Vet, R. *Atmos. Environ.*, 1996, *30*, 227-238.

Moran, M.D.; Dastoor, A.P.; Gong, S-L.; Gong, W.; Makar, P.A. "Conceptual design for the AES Unified Regional Air Quality Modelling System". Report of the Air Quality Research Branch, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario M3H 5T4, Canada. 1998a, 100 pp.

Moran, M.D.; Scholtz, M.T.; Slama, C.F.; Dorkalam, A.; Taylor, A.; Ting, N.S.; Davies, D.; Makar, P.A.; Venkatesh, S. In *Proc. 7th AWMA Emission Inventory Symp.*, 1998b, VIP-77, Air & Waste Management Association, Pittsburgh.

Pudykiewicz, J.A.; Kallaur, A.; Smolarkiewicz, P.K. *Tellus*, 1997, *49B*, 231-248.

Scholtz, M.T.; Taylor, A.; Ivanoff, A.; Moran, M.D.; Makar, P.A.; Venkatesh, S.; Cheung, P.; Davies, D.; Barton, J. In *Proc. 9th AWMA Emission Inventory Symp.*, 2000, Air & Waste Management Association, Pittsburgh.

Sirois A.; Pudykiewicz, J.; Kallaur, A. *J. Geophys. Res.*, 1999, *104*, 21,397-21,423.

Smolarkiewicz, P.K.; Pudykiewicz, J.A. *J. Atmos. Sci.*, 1992, *49*, 2082-2096.

Venkatram, A; Karamchandani, P.K.; Misra, P.K. *Atmos. Environ.*, 1988, *22*, 737-747.

NARSTO News *contribution by Mike Moran, Véronique Bouchet, Ashu Dastoor, Sunling Gong, Wanmin Gong, Paul Makar, and S. Venkatesh, Meteorological Service of Canada*

Executive Assembly/ESC Meeting Held in March

The 2000 Annual Meeting of NARSTO's Executive Assembly and Executive Steering Committee was held on March 7 and 8 at the White House Conference Center. In addition to reviewing a variety of ongoing and planned NARSTO programs, the attendees updated committee appointments and provided guidance to the Management Coordinators and the ESC for the coming year's operations.

Jim Meagher was confirmed as the new Public-Sector Co-Chair - Elect. Jim Will replace Don McKay when Don's term expires in early 2001. In addition, John Elston was selected as the Public Sector "Co-Chair- Elect -Elect," an action taken because of the very close election results for John and Jim during the ESC's recent selection process. If all goes according to plan, John will replace Jim when Jim's term expires in 2003.

Complete meeting minutes are posted on the NARSTO Web site. The revised membership for the Executive Steering Committee appears immediately below.

NARSTO Executive Steering Committee Members

Federal Members
Alphonso Garcia, Mexican Instituto Nacional de Ecologia
Don McKay, Meteorological Service of Canada
Jim Meagher, U.S. National Oceanic & Atmospheric Administration
Peter Lunn, U.S. Department of Energy

Alternate Federal Members
Dan Albritton, U.S. National Oceanic & Atmospheric Administration
Adrian Fernandez Bremauntz, Instituto Nacional de Ecologia
Gary Foley, Environmental Protection Agency

State Members
John Elston, State of New Jersey Department of Environmental Protection
Bart Croes, California Air Resources Board

Alternate State Members
John Cahill, New York State Department of Environmental Conservation
Cyril Durrenberger, Texas Natural Resource Conservation Commission
P.K. Misra, Ontario Ministry of the Environment
Susan Wierman, MARAMA

Utility Members
Al Ferullo, Pennsylvania Power and Light Company
Peter Mueller, Electric Power Research Institute

Alternate Utility Members
Paul Jacobson, Northeast Utilities System
Janet Joseph, NYSERDA
James Shissias, Public Service Electric & Gas Company
Fred Starheim, First Energy Corporation
Jim Meagher, U.S. National Oceanic & Atmospheric Administration

Industry Members
Howard Feldman, API
Steve Cadle, General Motors

Alternate Industry Members
Robert Wendoll, Dunn-Edwards Corporation
David Chock, Ford Motor Company
Tim Belian, Coordinating Research Council

Ron Patterson, NARSTO Associate Management Coordinator, Retires

On December 31, Ron Patterson ended his long career in atmospheric-pollution research and retired from EPA and from NARSTO. Ron was involved with NARSTO from its early planning stages, and has been a continual pillar of the organization from the onset. Although his leadership and hard work in establishing NARSTO's Quality Assurance and Data Management function was particularly outstanding, we'll remember Ron most for being a friendly, reasonable, and supportive presence throughout the total NARSTO organization.

We're gonna miss ya, buddy, and we all wish you the very best for the future!

NARSTO PM 2000 in Mexico

Almost 100 abstracts have been received for the planned NARSTO symposium ***Tropospheric Aerosols: Science and Decisions in an International Community*** to be held in Querétaro, Mexico, October 24-26, 2000. All three NARSTO countries will be well represented in the presentation of technical papers and posters at the meeting. The symposium will provide an opportunity for participation with colleagues from all over North America in discussions on the important scientific issues developing in tropospheric aerosol research. Platform sessions at the symposium include topics such as PM health and exposure, measurements, modeling, field studies, and aerosol satellites.

The meeting also will include prestigious keynote speakers, such as Nobel Prize winner Mario Molina from MIT, and cultural events such as opportunities to visit nearby early colonial towns and local art communities.

Don't miss this important chance to be part of this educational and entertaining NARSTO event. We understand that the Margaritas are very, very good down there. Registration and information regarding the meeting accomodations and special chartered transportation service from Mexico City will be available from the NARSTO web site at http://www.cgenv.com/Narsto by late April.

New York State Program, . . . *(Continued)*

The EMEP program is guided by a steering committee comprised of representatives from the New York State Departments of Environmental Conservation (DEC), Health (DOH), and Public Service (DPS); the U.S. Environmental Protection Agency (U.S. EPA); the New York Academy of Sciences; a utility association; and two environmental/public interest groups. A science advisory committee also provides periodic review in critical disciplines. Upon completion of the research projects, NYSERDA will commission several papers to "translate" research results into a form useful for policy-makers. As research results, papers, and reports become available, NYSERDA and its research partners will make the information available at www.nyserda.org

NYSERDA recently joined NARSTO to ensure that these new programs are coordinated with other national and regional initiatives.

Research Priorities

The $7.1 million EMEP program is currently supporting research on four critical regional environmental issues related to electricity generation: ozone, fine particles, acid deposition, and mercury. The projects currently funded are listed in the table on page 9.

Annual Conference

To facilitate timely exchange of research results, NYSERDA is sponsoring annual conferences to provide a forum for policy-makers and scientists to share information. The first conference was held December 7-8, 1999, co-sponsored by DEC, DOH, DPS, and U.S. EPA. Speakers presented information on environmental research initiatives in New York and the region with the focus on the areas being researched through the EMEP Program: acid deposition, fine particulates, mercury, and ozone.

The Conference covered a wide range of topics from asthma in NYC to mercury in remote regions of the Adirondacks. Technical presentations were given on new research and monitoring initiatives. Critical research and policy needs in New York State were identified by a variety of stakeholders. Many different perspectives were shared from the 200 scientists, government officials, air quality managers, legislative staffers, public interest groups, and utilities participating in the conference.

To support further integration of research efforts and evaluation of creative policy options, NYSERDA anticipates making $750,000 available in the Spring of 2000 for additional environmental monitoring, evaluation, and protection projects.

For more information on the next research solicitation and other elements of the **New York Energy $mart**[SM] Environmental Program, or to get a copy of the conference proceedings, contact: Janet Joseph at (518) 862-1090, ext. 3296, fax (518) 862-1091, e-mail jj2@nyserda.org; or visit NYSERDA on the web at www.nyserda.org

NARSTO News *contribution by Janet Joseph, NYSERDA.*

Highlights of NYSERDA's Environmental Monitoring, Evaluation, and Protection Program

Topic	Research Partners
Clinical Studies of Exposure to Ultrafine Particles	University of Rochester Medical Center (M. Utell)
Source Apportionment of Fine Particles in New York City	New York University Medical Center (G. Thurston)
Impact of Power Plants on Semi-volatile Pollutants and Fine Particles in New York State	Clarkson University (P. Hopke), State University of New York (SUNY) - Fredonia (M. Milligan)
Development and Demonstration of Continuous Ambient Particulate Monitor (R&P 6400 series)	Rupprecht & Patashnick Co., Inc. (H. Patashnick)
Innovative Instrument for an Ambient Air Particulate Matter Mass Measurement Standard	Rupprecht & Patashnick Co., Inc. (H. Patashnick)
Analysis of Ozone and Fine Particles in the Northeast	SUNY - Albany (S.T. Rao)
Enhanced Measurements of Oxidants, Fine Particles, and Precursors	SUNY - Albany (K. Demerjian)
Effects of Atmospheric Deposition of Sulfur, Nitrogen, and Mercury on Adirondack Ecosystems	SUNY College of Environmental Science and Forestry (D. Raynal)
Long-Term Monitoring Program for Evaluating Changes in Water Quality in Adirondack Lakes	Adirondack Lakes Survey Corporation (W. Kretser)
Mercury in Adirondack Wetlands, Lakes and Terrestrial Systems	Tetra Tech, Inc. (R. Munson), Syracuse University (C. Driscoll), Cornell University (C. Schofield), Smith College, (R. Newton)
Evaluation of the Recovery from Acidification of Surface Waters in the Adirondacks	SUNY College of Environmental Science and Forestry (M. Mitchell)
Assessing Effects of Transboundary Pollution on New York' s Air Quality	New York State Department of Environmental Conservation (S.T. Rao)

Under development - Characterization of Fine/Ultrafine Particulate Emissions from Several Different Stationary Combustion Sources in New York State.

Jeff West Appointed NARSTO's Associate Management Coordinator

Jeff West recently joined EPA, and has been appointed Associate Management Coordinator to replace Ron Patterson (See article on Ron on Page 7). Formerly with General Public Utilities, Jeff is most noted locally for his leadership role in the NARSTO-Northeast program. He comes to the Management Coordinator's position with a broad base of experience from this as well as from a variety of past activities in quality management and other air-quality related efforts.

In replacing Ron, Jeff will be responsible for helping facillitate the Oak Ridge - based Quality Systems and Data Management activities, as well has dealing with most aspects of NARSTO's membership records and communications. In addition, Jeff will work closely with Management Coordinator Jake Hales on document preparation, review, and other activities under the general management-coordination purview. We're all looking forward to working with him as NARSTO moves into the future and takes on its new challenges.

Jeff can be reached by phone on 919/541-4635 and by e-mail on west.jeffrey@epa.gov.

The Light at the End of the Tunnel: NARSTO Ozone Assessment Entering the Final Stretch

Very recently NARSTO's Ozone Assessment effort delivered one of its two major products, with publication of the dedicated *Atmospheric Environment* issue (Volume 34, Nos. 12-14 (2000)) containing the majority of the Assessment's Critical Review Papers.

The second product, the Tropospheric Ozone Assessment Document, is currently in the final stages of its page-layout process. We expect to submit the final electronic manuscript to EPRI for printing around May 1, and hope to see the printed copies emerge sometime in June.

A huge amount of work has gone in to this effort, and we thank all of those involved, including the Critical Review Paper authors and the Synthesis Team members, who have been responsible for preparing the Assessment Document. We'd especially like to thank our Assessment Co-Chairs Bill Chameides, Ken Demerjian, George Hidy, and Ken Schere, and . . . last but not least . . . our Technical Editor, Betsy Owczarski for their huge efforts during the past few months.


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