Strengthening the Connection between Air Quality and Health Effects Science: Summary of an Expert Panel Discussion

NARSTO Executive Assembly

April 11, 2005

Background

As part of the 2005 NARSTO Executive Assembly, a panel discussion was organized to explore how NARSTO might facilitate improved collaboration between the air quality and health science research communities in order to improve scientific understanding of the health effects of ambient particulate matter (PM) and other atmospheric pollutants. The panel was charged to address three questions:

1. What additional collaborations among the air quality and health science communities would be useful in advancing understanding of the relationships between air pollution (specifically, its physical-chemical composition), the sources of air pollution, and its potential health effects?

2. Could such knowledge lead to more effective air-quality management?

3. What actions might NARSTO take to further these objectives?

The format consisted of a series of brief presentations by the panel members followed by a roundtable discussion involving panel members and the Executive Assembly. This summary, however, only reflects the observations and suggestions of the panel. Panel member presentations can be found at the NARSTO web site: http://www.narsto.org

Members of the panel were:

Joe Mauderly (Director, National Environmental Respiratory Center, Lovelace Respiratory Research Institute)

Ron Wyzga (Technical Executive, Air Quality, EPRI)

Constantinos Sioutas (Professor of Civil and Environmental Engineering, Southern California PM Center and Supersite, University of Southern California)

Ted Russell (Georgia Power Distinguished Professor, Department of Civil and Environmental Engineering, Georgia Institute of Technology)

Jeff Brook (Senior Research Scientist, Environment Canada and Adjunct Professor, Department of Public Heath Sciences and Department of Chemical Engineering, University of Toronto)

Pat Mastin (Chief, Cellular, Organs and Systems Pathobiology Branch, Division of Environmental Research and Training, NIEHS)

Andy Miller (Senior Research Engineer, Office of Research and Development, U.S. Environmental Protection Agency)
Daniel Greenbaum (Director, Health Effects Research Institute)
Mark Raizenne (Associate Director General, Safe Environments Program, Health Canada)
Carlos Santos-Burgoa (Director General de Promoción de la Salud)

The panel participants reached a robust set of consensus conclusions and recommendations. These conclusions and recommendations are summarized in this brief report.

Observations and Findings

Panel members felt very strongly that continued progress in understanding the health effects of air pollutants will require innovative research designs that employ multi-disciplinary research teams that include air-quality scientists in addition to other disciplines. The emphasis is on the word "team". These groups must be actual functioning teams that communicate and collaborate in both the design and analysis of experiments.[1] They cannot be just collections of individuals representing different scientific disciplines. Panel members urged research funding agencies in all three NARSTO countries to recognize this requirement and to focus increased fractions of their resources on funding well-designed research proposals that follow this approach.

There was also a consensus among the panel members that the design of health-effects research studies has not kept pace with the advances in scientific knowledge. Although PM is frequently shown to have the strongest association with health effects among the few pollutants measured routinely, individuals in the real world are exposed to multiple pollutants – both particles and gases. Agencies must adopt a "one-atmosphere" approach for research and regulation.[2] Experiments need to identify what chemical components and what types of exposures are most important in initiating adverse health effects in sensitive populations. Toxicological studies should use realistic exposures, consider multiple pollutants, and employ pollutants – especially PM – that mimic what is really in the atmosphere.

Traditional epidemiological studies have focused on identifying associations among air-quality metrics (both chemical and meteorological) and health endpoints. Some studies have begun to focus on associating specific sources of air pollutants with health effects. Continuing research using both approaches is needed. Exposure of sensitive populations to specific chemical components or combinations of components (both PM and gases) – along with coincident environmental conditions including each individual's current health status – is what exacerbates or possibly initiates disease. Thus, if we are to

[1] The nature of this collaboration will depend upon the specific objectives of the health study being undertaken. Examples are given below.

[2] In the United States, adopting a true one-atmosphere approach to air-quality management presents some challenges. The current language of the Clean Air Act forces the Environmental Protection Agency towards regulating air pollutants separately – even though standards may be set with the effects of multiple-pollutant exposure in mind.

understand the mechanisms of environmentally induced disease, we must understand to what, how much, and under what conditions people are exposed, as well as how such exposures interact with medical/public health and socioeconomic factors. However, there is an attraction to understanding health effects with respect to specific sources. First, we regulate sources. If adverse health impacts can be attributed to a select set of sources, we might be able to craft more focused and effective air-quality management strategies. Sorting out the health impacts of individual chemical components is extremely difficult. Various pollutant components tend to be highly correlated, and some pollutant combinations tend to be identified with specific source types. Determining whether or not there are clear relationships between specific source types and adverse health outcomes could prove to be an achievable research objective; however, we need to go further and understand the aspects of source emissions that are responsible for health impacts.[3]

Source-related information could also play a role in developing health studies with innovative designs. One idea would be to use source apportionment methods in selecting sites for health-effects studies. Detailed information on which sources are of greater or lesser importance in different locations could be used to maximize differences in exposure or in the variability of exposure to specific pollutants or combinations of pollutants. Thus, source apportionment and in situ measurements could be used to identify and document different chemical climates. Health researchers could then exploit these differences in designing studies for understanding the source and chemical-physical properties of pollutant mixtures responsible for both acute and chronic effects. Conducting coordinated experiments in all three NARSTO countries could greatly expand the range of chemical and meteorological climates considered in these studies.

A significant problem with the source approach is that we need reliable methods for associating exposure with the specific sources that contribute to it. Associating ambient chemical measurements with the contributing source or sources is not trivial. There is a clear and very important need for improved, reliable source apportionment models for doing this. And there is a need, especially within the health effects research community, for a clear understanding of the capabilities, strengths, weaknesses, and pitfalls of source apportionment methods.

In addition to these overarching observations and findings, panel members offered a number of other suggestions for improving the state-of-the-science in health effects research. Improved health effects research studies will require

- Better characterization of the surface chemistry of PM, and better tools for speciation, especially for semivolatile components.
- Better methods for characterizing complex exposures.
- Funding support for interdisciplinary "resource centers" that house multi-disciplinary teams and research facilities, develop new analysis and measurement methods, and make these capabilities available to a broad spectrum of researchers.

[3] For example, if light-duty, gasoline-fueled vehicles were identified as a problem source, it would be necessary to understand whether or not the emissions of concern were tailpipe emissions, brake wear, tire wear, oil combustion, etc.

- Improved "cross-over training" for graduates and postgraduates: true multi-disciplinary research teams must be composed of scientists who understand the science and the cultures of the key disciplines that make up the team.
- Removal of disincentives, especially within academic institutions, to the pursuit of careers in multi-disciplinary team research, and perhaps even positive incentives for pursuing these lines of research.
- Better designed monitoring programs: Monitoring networks need sufficient longevity to enable complex relationships between exposure and effect to be teased from the data, they need to measure the right chemical components, and they need to document spatial and temporal variability. Monitoring programs need to be better coordinated among sites with different or unique chemical and meteorological climatologies.
- Better measurements of gas-phase and PM-surface organics – bulk chemistry is not sufficient. These technologies will be most useful if they are developed to fill specific needs as identified by better designed or more innovative health studies.
- Better personal exposure monitors, and continuous samplers that provide accurate speciation.
- Proteomic and metabolomic markers of exposure and dose.
- An organization within the health effects research community that could parallel NARSTO.

It is clear from this summary that the panel was not able to address completely all of the questions that were placed before it. This is not surprising given their ambitious scope. However, the action items listed below could provide a start towards more complete answers. In considering these next steps it is useful to remember an important observation from one of the panel members: Each research community – health effects and air quality – actually knows less than the other community thinks it knows. Reducing this misunderstanding may be reason enough for improving collaboration between them.

<u>Actions for NARSTO</u>

The panel members identified a number of actions NARSTO could take in order to promote improved collaboration between the air-quality and health-effects research community.

1. Based on the conclusions of this panel discussion, consider preparation of a summary paper on enhancing collaboration between the two research communities for presentation at appropriate health science research meetings.
2. Building upon this summary paper, consider collaboration with an appropriate organization in the health sciences to develop a recommended research agenda and strategy for collaborative air-quality and health effects research. Such a strategy should capitalize on NARSTO's international connections and take advantage of the diversity in climate, pollution chemistry, population, and exposure that exists in the three NARSTO countries.
3. NARSTO should consider preparation of a critical review or set of critical reviews for publication in an appropriate health sciences journal. This review (or reviews) should focus on how the tools of atmospheric science can be applied to

the problem of identifying which sources are or have contributed to exposures in a given airshed. A critical review of source apportionment methods should be part of such an assessment.

4. Consider NARSTO sponsorship of a biennial conference or workshop on Air-Quality and Health Effects. Such a conference or workshop should include a venue for providing "cross-over" training in health and air-quality sciences for students and researchers.
5. Work with an appropriate organization in the health sciences to develop a joint, pro-active communications strategy to convey current knowledge and expert opinion on the subject of air quality and health science collaboration, including current status and future needs, to the public and decision-makers.