National Atmospheric Deposition Program
Atmospheric Mercury Scientists Workshop

Date: Tuesday, June 27th, 2006
Time: 9:00 AM—5:00 PM
Location: Offices of the Lake Michigan Air Directors Consortium (Chicago – See map)
Invitees: Atmospheric Mercury Measurement and Modeling Scientists (see list)

Purpose: Discuss, debate and develop a set of "guiding principles" and "best practices" for monitoring atmospheric mercury species in North America to serve researchers, modelers and network design.

Goal: Consensus Document: *Guiding Principles and Best Practices for Monitoring Atmospheric Mercury Species in North America* (Draft to be sent by 6/13/2006).

Why Attend: Prominent mercury scientists and policymakers have called for a tiered, complimentary structure of routine measurements and intensive studies of atmospheric mercury to provide assessment of new mercury regulations. Currently, there is an opportunity within the changing regulatory landscape for atmospheric mercury scientists to build a coordinated research and monitoring program as called for by recent proposed multi-media mercury monitoring frameworks (see references below). With that in mind, your participation at this meeting is needed to develop a consensus document that can serve as a common reference for existing and future research and monitoring of atmospheric mercury. The document *Guiding Principles and Best Practices for Monitoring Atmospheric Mercury in North America* and the names of the contributing scientists who confirm it, will legitimize research and monitoring that follow these principles and practices. Your knowledge and experience also are needed to formalize and focus a set of monitoring best practices for measuring representative concentrations of atmospheric mercury species and locating monitoring sites. In addition, your input is requested regarding models for estimating mercury deposition using the observations of atmospheric mercury species.

What to Bring: Please bring to share regarding atmospheric mercury speciation 1) modelers data needs 2) site location criteria 3) past, ongoing, and future Hg species measurements sites, dates, summary results 4) quality assurance methods and data for calibration precision, accuracy and blanks 5) instrument maintenance and troubleshooting guides, 6) standard operating procedures 7) information about dry deposition models and estimates, 8) a desire to build consensus.

Agenda: The meeting will be participatory to maximize our effort to find consensus, rather than a series of presentations. The morning will be an introduction and discussion of the guiding principles and best practices. The afternoon will be divided into discussions of the best practices, deposition models, and site location criteria. A set of specific questions has been developed to steer the discussions. (These draft

questions will be sent to you before the meeting.) The meeting organizers will help to guide the discussions.

9:00 – 9:30	Workshop objectives
9:30 – 11:30	Discussion of the guiding principles
11:30- 12:00	Discussion on the best practices
12:00-1:30	Lunch (provided) and continued discussion
1:30 – 3:30	Discussion on modeling mercury deposition
3:30 – 4:30	Discussion of site location criteria for intensive research studies, mercury trends monitoring and hotspots
4:30-5:00	Consensus review and summary
5:00	Thank you and adjourn

Logistics: Plan your travel to the O'Hare Airport in Chicago. Our meeting will be at the Lake Michigan Air Directors Consortium (LADCO) office, 5-10 minutes from the airport. (A map and directions are attached.) The Hyatt Rosemont Hotel (6350 N. River Road, Rosemont, Illinois, 847/518-1234) is a short walk from the LADCO office (see map and directions). The hotel offers a Lake Michigan Air Directors corporate rate of $129. The hotel offers a complimentary shuttle to and from the airport (http://rosemont.hyatt.com/hyatt/hotels/services/transportation/index.jsp). The organizers of this meeting will be at the hotel Monday and Tuesday evenings, June 26-27. Please join us for a meal or refreshments either day if your plans allow.

RSVP: You are encouraged to review the attached list of invited scientists, a majority who have already committed to attend the June 27th meeting. If you have not responded, please RSVP to David Gay (217/244-0462, dgay@uiuc.edu). We need your expertise. Please call so we can keep you involved. Thank you for your response.

Other Info: More information about the scientific planning behind this meeting can be found at the NADP website (http://nadp.sws.uiuc.edu/mdn/mtn.asp).

U.S. EPA Persistent Bioaccumulative Strategy for Mercury
http://www.deq.state.mi.us/documents/deq-aqd-toxics-HgWorkshop-Attach2.pps
http://www.epa.gov/pbt/pubs/resources.htm

Mason, R.P., Abbott, M.L., Bodaly, R.A., Bullock, O.R., Driscoll, C.T., Evers, D., Lindberg, S.E., Murray, M., Swain, E.B., (2005) Monitoring the response to changing mercury deposition, ES&T Vol. 39, Issue 1, pp. 14A-22A
http://pubs.acs.org/subscribe/journals/esthag-a/39/i01/toc/toc_i01.html

Canadian Atmospheric Mercury Measurement Network (CAMNet)
http://www.msc.ec.gc.ca/arqp/camnet_e.cfm

Minutes and Notes from Organizers of the NADP Mercury Dry Deposition Initiative

Atmospheric Mercury Scientists Workshop

Tuesday, June 27th, 2006

9:00 AM—5:00 PM

LADCO Offices, Chicago IL

MINUTES
NADP / Mercury Trends Network Planning Meeting
Lake Michigan Air Directors Consortium (LADCO)
Rosemont, IL
27 June 2006

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A. Introductions / Workshop Objectives

The meeting began with introductions. Each participant identified needs for mercury dry deposition research. Some introductory comments are listed below.

- There is a need for dry deposition data to estimate wet and dry Hg deposition from domestic and global sources.
- The modeling community uses MDN mercury wet deposition data. Despite current measurement uncertainty, data for estimating mercury dry deposition is critically needed for model development (especially mercury speciation data).
- High quality and spatially representative measurements of ambient air mercury fractions (Hg^0, RGM and Hg_p) are the most important for understanding dry deposition fluxes. Measurements of atmospheric mercury will also improve our understanding of mercury cycling and source-receptor relationships.
- There is a need for ambient air mercury monitoring to measure the efficacy of the Clean Air Mercury Rule (CAIR) and the Clean Air Interstate Rule (CAIR).

B. Discussion of Guiding Principles

The document "Guiding Scientific Principles for Atmospheric–Mercury Monitoring in North America" (attached below) was distributed to participants before the meeting. Feedback from participants is summarized after each discussion point.

1. A program of coordinated atmospheric-mercury monitoring and research stations in North America, with common protocols for sampling and analysis and a centralized data archive, would provide information needed for mercury deposition models, mercury research, and mercury policy assessment in the United States and Canada. This network is needed soon, to coincide with implementation of national and state regulations that will affect mercury emissions to the atmosphere.

The consensus of the group was that coincident measurements of meteorological parameters and other air quality data (CO, aerosol, NO_x, etc) would make any mercury monitoring data much more useable. Such data (particularly the meteorological measurements) should be distributed in the common data set with mercury monitoring data.

Some participants noted that speciated mercury measurement methods are still considered research measurements, not routine monitoring, and are at this point many times more difficult than TGM measurements: Significant skill and experience is required to operate Hg speciation instruments. Mercury concentrations are episodic, and episodes can be missed if the record is not continuous.

Data quality assurance (QA) must be evaluated consistently and continuously for Tekran measurements by a qualified technician. Such evaluations can be somewhat automated in a database. It will not be sufficient to perform QA at the end of a month's measurements. The Canadian CAMNET has developed a QC protocol to create a public Hg data base.

2. A program of coordinated atmospheric-mercury monitoring and research stations would provide concentrations of three mercury species: reactive gaseous mercury (RGM), particulate-bound mercury (PHg), and elemental mercury (Hg^0). These concentrations should be quantified to a standard level (proposed to be at least 2 picograms/m^3 for RGM and PHg and less than 0.1 nanograms/m^3 for Hg^0).

Mercury monitoring and research may be or will be separated by specific objectives: A "cookie-cutter" approach to coordinated monitoring and research won't work.

There was concern that individual sites and operators may not be able to operate Tekrans long-term for solely monitoring purposes due to funding limitations and the need to use the instruments for research purposes.

Some participants noted that measurement variability between collocated Tekrans is very large ($\pm$ 5% for TGM, $\pm$ 15% for RGM, $\pm$ 40% for PHg). They noted that such measurements are at this point very much research-quality. Others disagreed, arguing that variability exists, but is not as high. Collocated measurements, comparing Tekran measurements and SOPs, have been done but have not been published. Protocols and guidance need to be developed for intercomparison of Tekran measurements. Results should be reported with estimates of error.

It was noted that RGM, PHg, and Hg^0 should be termed "fractions," not "species." Researchers are currently investigating the individual species within the RGM fraction. The fractions are now operationally defined as individual Hg compounds and are not specifically identified. It is difficult to calibrate instruments for RGM measurements.

3. A program of coordinated atmospheric-mercury monitoring and research stations would apply a standard method for sampling the three atmospheric mercury species. The method would be one that has been widely used, documented, and quality assured. (A proposed sampling method uses a 2.5-micrometer impactor, KCl-coated annular denuder (for RGM), thermally-

desorbed, regenerable particulate filter (for PHg), and gold traps (for Hg^0). This sampling method can be applied in an automated or manual system, as described by Landis et al., 2002[a].)

Some were concerned about the comparability of manual denuder measurements with Tekran measurements. There are also concerns with the precision of replicate manual denuder measurements. Replicate measurements would be needed in each run given the high expected variability. Others disagreed, noting that comparison studies have been done, and concluded that measurements are sufficiently comparable for monitoring purposes.

A suggestion was made that for full comparability, the manual system would need to be operated for a full 24 hours, or for two 12-hour samples in a week. An integrated sample would be preferable in a 1-in-6 day schedule, and would be used for long-term trends. If a 1-in-6 day protocol is adopted, 24 hour samples should be taken because of diurnal Hg patterns. It was noted that day/night diurnal patterns may not fall 12 hours apart. (Note by Prestbo: A 12-hour sample has been shown to be the maximum sample time for a KCl-denuder)

Atmospheric modelers need temporal resolution in the data (more frequent than 24 hour samples), and information on data error. The modelers would likely accept fewer measurements of higher quality. Long-term average concentrations are adequate for regional assessments, but data of greater temporal resolution is needed to investigate atmospheric Hg processes. Daily average concentrations are the finest resolution used by current mercury models.

One person suggested that they were concerned about PHg denuder measurements in anything more than a 3-hour sample, as Hg can be gained or lost on trapped particulates. Manual systems have not shown passive contamination from leaving inoperative samplers.

It was suggested that a throughfall collector with an ion exchange column paired with a wet deposition collector could be a very inexpensive way to determine dry deposition (via difference) to a canopy.

4. A program of coordinated atmospheric-mercury monitoring and research stations would apply a standard method for analysis of three atmospheric mercury species. The method would be one that has been widely, used, documented, and quality assured. (A proposed analytical method uses thermal desorption of the mercury from the denuder, particulate filter, or trap into a calibrated mercury analyzer for quantification by cold vapor atomic fluorescence spectroscopy (CVAFS). This analysis method can be applied in an automated or manual approach, as described by Landis et al., 2002.)

Some noted that when automated systems have operations issues, it may take days to determine the cause and fix the instrument. Because Hg concentrations are episodic, it will be important for

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[a] Landis, M.S., Stevens, R.K., Schaedlich, F., and Prestbo, E.M., 2002, Development and characterization of an annular denuder methodology for the measurement of divalent inorganic reactive gaseous mercury in ambient air: Environmental Science and Technology, vol. 36, no. 13, p. 3000-3009.

a monitoring station to have a ready stock of replacement parts or a duplicate instrument to reduce time without data collection.

Some noted that automated systems will require daily checks. Others suggested weekly checks and monthly in-depth service, unless there's a specific problem. Continuous measurements at a site will likely require a dedicated technician.

A follow-up survey will be sent out as follow-up to determine current measurement practices. This survey will be used to develop standard operating procedures for a proposed program of coordinated monitoring and research.

5. A program of coordinated atmospheric-mercury monitoring and research stations would always include measurements of mercury wet deposition. These stations would provide additional benefits if acid-rain constituents, trace elements, or criteria air pollutants (nitrogen oxides, sulfur oxides, particulates, and ozone) also are measured. All stations would include measurements of meteorological parameters (at the minimum: wind speed, wind direction, precipitation, air temperature, relative humidity, and net radiation.)

All were in agreement that collocated measurements (especially meteorological parameters) are highly desirable. Some questioned whether collocated wet deposition measurements should be "required," perhaps they should be just "desirable." (More discussion of wet deposition measurements follow in Part C.)

Desirable measurements (in addition to standard meteorological parameters listed above) would include:

- Incident solar radiation (pyranometer) – for inferential dry deposition model
- Sonic anemometer – Can be used for three-dimensional wind profiles, and can be used to evaluate vertical mixing and flux measurements
- SO_2, NO_y, CO – Criteria pollutants
- Nephelometer – Provides total atmospheric particulate burden
- Surface wetness – Important for inferential model for use in dry deposition estimation models

6. A program of coordinated atmospheric-mercury monitoring and research would integrate two kinds of stations:

(1) those at which atmospheric mercury is measured at a frequency and level of complexity to support:
(a) calibration and verification of mercury fate and transport models, and
(b) assessment of long-term trends in atmospheric mercury concentrations and deposition;
(2) those at which atmospheric mercury and other constituents are measured at a frequency and level of complexity to support evaluation of mercury source and receptor relationships.

This generated some discussion about the need for long-term monitoring sites to asses spatial and temporal trends versus sites established to better understand atmospheric processes and for direct

source-apportionment estimates. Some noted that both types of sites are needed, one set to look at trends over time and the other to research atmospheric Hg processes. It was also noted that each station can't be all things: It may be difficult to follow network measurement protocols while performing scientific research and investigations.

It was noted that only a few sites are needed to investigate atmospheric processes; only one site would be needed for the most detailed measurements. Monitoring locations downwind of emissions sources would be useful, but such sites may not contribute significantly to model development.

For model development, surface measurements are need, but so are higher altitude data. The Mt. Bachelor and Mt. Washington sites allow occasional measurements of free tropospheric Hg to evaluate long-range transport.

7. A program of coordinated atmospheric-mercury monitoring and research stations would be at locations that have one or more of the following characteristics:

- *(a) susceptible to impacts of total atmospheric-mercury deposition because of the proximity of mercury emissions sources;*
- *(b) vulnerable ecologically to total atmospheric-mercury deposition because of the high potential for mercury methylation and bioaccumulation/bioconcentration;*
- *(c) representative of local, regional, continental, or global-scale mercury sources;*
- *(d) representative of the hydrologic units and eco-regions in North America;*
- *(e) representative of boundary conditions for atmospheric transport and deposition models of North America; and*
- *(f) adjoining studies of mercury concentrations and processes involving atmospheric deposition, water, sediment, and fish.*

Several suggested that there is a need for more West Coast stations upwind of U.S. sources to determine global mercury inputs to the U.S. As noted in the previous point, there is also a need for more measurements at high altitudes in the free troposphere.

It was also noted that there is a need for a mix of urban and rural sites. Urban sites can be located in emissions source gradients. However, measurements should not be located too close to sources, ideally 25 km downwind to allow plume spread. Locations should be based on the questions to be answered, such as the influence of coal fired power plants or of urban sources.

There is a need to distinguish natural from anthropogenic sources as there is evidence of regional natural sources of mercury. Information is needed on oceanic emissions and deposition, including modeled results for the Atlantic and Pacific. Coastal sites and islands will provide these data.

Finally, one scientist noted that a principal component analysis of Canada's data indicated that the following factors explained most of the variance in the data: seasonality, local emissions influence, Eastern vs. Western Canada site location.

8. A program of coordinated atmospheric-mercury monitoring and research stations would provide for a centralized, publicly accessible, permanent data base to archive atmospheric mercury concentrations, meteorological data, and ancillary data. A quality-assurance protocol and standardized format would achieve a common framework for storing, retrieving, manipulating, and comparing the data. The data would be accessible for free over the Internet. The structure of this data-sharing system would protect the rights of researchers who wish to be the first to publish their data, if there is a legitimate reason.

It was generally agreed that meteorological measurements be associated with the observations. However, estimates of dry deposition should be included with the observations in a separate part of the data base.

All data should follow the same QC protocols to qualify data released on the Web. Environment Canada has done this for TGM and RGM measurements. Some flagging could be automatic. A simple system of valid / questionable / invalid data flags would be a start. Although some data flags can be automated, all data will need to be manually reviewed to find episodes. It was suggested that QC be done on the local level, with a second level done by network coordinators before release to the public.

Most seemed comfortable with restricting immediate public distribution of data on a web site to allow researchers to publish the data. It was suggested that this holdback time be no longer than two years. Network data could have a shorter holdback time.

9. A program of coordinated atmospheric-mercury monitoring and research stations would provide data that can be used to develop, evaluate, and refine atmospheric fate and transport models. The data requirements of these models, to the extent possible, would be part of the data management procedures and system for the network.

It would be useful to measure concentrations at two different heights with fractions measured at each height. This would assist in flux evaluations. Hg concentrations and meteorology will help to estimate dry deposition. Models only look at concentrations, other methods determine the flux.

10. A program of coordinated atmospheric-mercury monitoring and research stations would conform to written standard operating procedures for sampling and analysis, quality assurance, and data management that are periodically reviewed and updated in a systematic manner. The standard operating procedures would be flexible to accommodate a range of scientific efforts, amenable to improvements from creative research studies, and managed so that updates can be communicated and implemented in a timely fashion.

All were in agreement that a best practices SOP should be developed program of coordinated monitoring and research. There are ongoing studies to provide intercomparison between SOP methods in practice. There are also ongoing evaluations using standards additions to determine comparability of instruments, especially for RGM.

An evaluation will be done in the European Union soon at four separate field sites (maritime, urban, etc.) for Tekran measurements for TGM measurements. Environment Canada is planning an intercomparison of TGM and wet deposition measurements for one year starting in September 2006.

Several noted that a guiding principal should be added to address research needs beyond routine monitoring SOPs.

11. A program of coordinated atmospheric-mercury monitoring and research stations would be a voluntary collaboration of public and private entities with shared objectives. These entities would fund and implement their monitoring and research for various reasons and purposes, rather than depending on centralized funding and purpose from a coordinating body. The coordinated program would communicate regularly in an open, structured forum. The coordinated program would assure accountability for data quality at multiple levels—from sampling to analysis to data archival.

SOPs, network coordination, and a central database are definitely needed for the coordinated program of monitoring and research.

C. Best Practices

The document "Questions for Discussion of Atmospheric Mercury Monitoring Best Practices" (attached below) was distributed to participants before the meeting. There was not sufficient time to discuss all points. The NADP coordinating committee will distribute a survey to meeting participants to get their input on recommended monitoring practices, and will be used to develop Standard Operating Procedures for the MTN.

The need for daily mercury wet deposition sampling

One scientist noted that for modeling processes, daily wet deposition data may provide little additional information. Precipitation model predictions are fairly poor, which introduces error when modeling wet deposition.

Weekly wet deposition data is good for model evaluations of long-term trends. However, it does not provide much information regarding modeling of atmospheric cycles. Collocated MDN/NTN measurements provide an extra data comparison opportunity.

It would be good to have fractionated Hg chemistry in wet deposition samples, although it was noted there are technical difficulties to fix species fractionation in precipitation samples.

D. Modeling of Mercury Deposition

To date there are many deposition studies and models that do a fairly good job at estimating particulate deposition, so it is possible to model PHg dry deposition.

For modeling RGM, it was suggested to use half the deposition velocity for nitric acid. There is general consensus that the deposition velocity of RGM is less than HNO_3. The assumption that RGM deposits like HNO_3 provides a reasonable upper limit of flux for RGM. It was suggested that the Big Leaf model would be adequate for this evaluation.

Modeling of Hg^0 deposition is the most difficult, as its flux is bi-directional, and surface resistances are not well characterized. It was suggested to use a series of observational stochastic models to predict net Hg deposition to a surface with different atmospheric concentrations.

CMAQ provides local dry deposition estimates. The best estimate of dry deposition from the the proposed program of monitoring and research would be useful for model comparison.

Inferential dry deposition estimates should be considered provisional and subject to improvement with further research. Receptor surfaces (such as forest or wetland or water) for dry deposition vary around each monitoring site. This needs to be considered (as a percentage of receptor surface type) in the inferential estimate. It is important to state all assumptions about land use. If concentrations and meteorological data are stored, better dry deposition estimates can be made in the future from improved models.

Attendees expressed agreement that more research is needed on better methods to estimate dry deposition. If deposition values are estimated, the MTN must be very clear to state all assumptions and limitations. People are likely to use the numbers despite any warnings.

E. Site Location Criteria

Sites are needed that are regionally-representative based on the model grid size. Locations should be determined to answer research questions, or to assess the impact of CAIR & CAMR. Sites should be located where the greatest change in mercury emissions is estimated in the future (Ohio valley).

A site should be located in a “simplified” location away from significant sources for model evaluation.

Potential locations identified include:

- Steubenville, OH
- Mona Loa – Assess oceanic Hg
- IADN sites
- NCOR sites
- Underhill, VT – Already has MDN, IMPROVE, NTN & AIRMoN
- Frostburg, MD
- Mt. Bachelor, WA
- Canaan Valley, WV
- Grand Bay, MS
- Beltsville, MD
- States and tribes that have purchased Tekrans

F. Review / Consensus

The general consensus was that the NADP organizing committee should proceed and revise the "Guiding Principles" based on participants' input. All showed interest in participating in a survey and compilation of current practices and SOPs.

Participants would like to see a map and information about participation in a potential transitional network.

All agreed that it is a priority to have a network to assess Hg reductions resulting from CAIR and CAMR, so timing is important.

G. Meeting Follow-up

- The NADP organizing committee will distribute a survey to solicit input on best practices for mercury measurement and deposition modeling
- The NADP organizing committee will produce a white paper of best practices that will form the basis of SOPs.
- The NADP organizing committee will obtain and distribute modeling estimates of deposition, with forecasts of impacts due to emissions reductions.

Guiding Scientific Principles for Atmospheric-Mercury Monitoring in North America

1. A program of coordinated atmospheric-mercury monitoring and research stations in North America, with common protocols for sampling and analysis and a centralized data archive, would provide information needed for mercury deposition models, mercury research, and mercury policy assessment in the United States and Canada. This network is needed soon, to coincide with implementation of national and state regulations that will affect mercury emissions to the atmosphere.

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(d) representative of the hydrologic units and eco-regions in North America;
(e) representative of boundary conditions for atmospheric transport and deposition models of North America; and
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11. A program of coordinated atmospheric-mercury monitoring and research stations would be a voluntary collaboration of public and private entities with shared objectives. These entities would fund and implement their monitoring and research for various reasons and purposes, rather than depending on centralized funding and purpose from a coordinating body. The coordinated program would communicate regularly in an open, structured forum. The coordinated program would assure accountability for data quality at multiple levels—from sampling to analysis to data archival.

[a]Landis, M.S., Stevens, R.K., Schaedlich, F., and Prestbo, E.M., 2002, Development and characterization of an annular denuder methodology for the measurement of divalent inorganic reactive gaseous mercury in ambient air: Environmental Science and Technology, vol. 36, no. 13, p. 3000-3009.

Questions for Discussion of Atmospheric Mercury Monitoring Best Practices

Measurements of Atmospheric Mercury Species

1. What should be the standard height for the inlet of the sampling system – 2 m (typical for manual systems on a mast fastened to a raised platform) or 5 m (typical for an automated system fastened to the roof of a trailer or small building) or some other logical height?
2. Specific Operational and Quality Assurance Questions
    a. How frequently should the KCl denuder and regenerable filter pack (RFP) be replaced with newly prepared ones for the automated and manual systems?
    b. How frequently should the filters for the zero air, 1130 and 2537 be changed?
    c. How frequently should the PM2.5 inlet be changed and should the impactor plate be coated with vacuum grease?
    d. What technique is used and how often should a leak check be performed on the automated and manual system?
    e. How often should the internal Hg^0 calibration be done for the automated and the manual analysis system using the Tekran 2537?
    f. Should periodic standard addition injections or permeation source Hg^0 be done and how frequently?
    g. Should inlet standard addition injections of Hg^0 be done and how frequently?
    h. How frequently should field blanks be collected for the manual sampling system (1 per 3 samples)?
    i. What are acceptable sample adsorption times for RGM and PHg?
    j. What are acceptable analysis routines (flush, zero, pyro heat, RFP heat, denuder heat, cool) for the automated and manual analysis
    k. What are acceptable temperatures for the inlet, pyrolyzer, RFP and denuder during automated and manual sampling and analysis?
    l. What are the best practices for routine maintenance of the automated and manual system?
    m. Is a soda-lime cartridge prior to the Tekran 2537 for automated or manual sample analysis required to avoid gold-trap passivation?
    n. What are the best practices for managing the automated zero air system for the automated analysis (pre-drying air, plumbing changes, halogenated carbon canisters, cleaning, etc.)?
3. Is the 1-in-6-day schedule for sampling that is used by USEPA for conventional air pollutants acceptable for use with a manual system for purposes of supporting models and assessments of long-term trends?
4. Is a single 12-hour sample from a manual system acceptable for purposes of supporting models and assessments of long-term trends, or should there be two consecutive 12-hour samples collected at the established interval (i.e. 1-in-6-day schedule) Is a single 24-hour sample acceptable or is some other schedule preferable?

5. What ancillary data need to be measured at monitoring stations for atmospheric mercury species? Is the list in the Guiding Principles complete? What are the most important measurements?

Wet Deposition Measurements for Total Mercury Deposition

1. Is daily mercury wet deposition monitoring needed in conjunction with atmospheric mercury monitoring *to determine a proportion of the wet vs. dry atmospheric mercury deposition*? Can this proportion be estimated with weekly-composite sampling for mercury wet deposition?
2. Is daily mercury wet deposition monitoring needed in conjunction with atmospheric mercury monitoring *to support models and assessments of long-term trends*?
3. Can models and trends assessments be supported with weekly-composite sampling for mercury wet deposition?

Estimating Dry Deposition, Vertical Deposition Velocities

1. Can an inferential model provide acceptable estimates of localized vertical deposition velocities for RGM (based on HNO_3 or similar gas) and PHg (based on fine particulates)? Can localized daily dry deposition of RGM and PHg be estimated with these vertical deposition velocities and the RGM and PHg concentrations? What assumptions and limitations need to be stated for these estimates?
2. Can an inferential model provide acceptable estimates of localized vertical deposition velocities for Hg^0 (based on SO_2 and NO_2)? Can localized daily dry deposition of Hg^0 be estimated with these vertical deposition velocities and the Hg^0concentrations? What assumptions and limitations need to be stated for these estimates?
3. What inferential models should be considered as acceptable methods for calculating an estimate of mercury dry deposition (Big Leaf, Hicks et al., 1985; Multi-Layer, Meyers et al., 1998; others)? What data do they require? What are their strengths and weaknesses? Who has used these other methods?
4. Is it necessary to continue to support specific studies of mercury species flux using methods such as Relaxed-Eddy Accumulation and other advanced methods to provide improved input to the inferential models?

Locations for Atmospheric Mercury Monitoring

1. What locations with ongoing atmospheric mercury monitoring can be integrated into the startup of a monitoring network for North America?
2. Where are the priority locations for new stations in an atmospheric mercury monitoring network for North America?
3. What criteria are important for the location of mercury monitoring stations? Are all the important criteria listed in the Guiding Principles?
4. What locations for mercury monitoring are needed to evaluate fate and transport models?

5. How far away from a source can a monitoring station be located to detect the mercury primarily from that source?
6. Will it be acceptable for placement of a new site to be directed by an overall national strategic plan, rather than the individual programmatic needs of a specific funding agency?

Other Issues

1. To what extent would you be willing to make measurement data publicly accessible through a common, central database in a timely manner?

Invited Scientists

Dwight Atkinson, U.S. EPA
Steve Brooks, NOAA
Mark Castro, U. Maryland
Ashu Dastoor, Environment Canada
Eric Edgerton, Atmospheric Research, Inc.
Tom Holsen, Clarkson U.
Daniel Jacob, Harvard U.
David Krabbenhoft, U.S. GS
Steve Lindberg, Oak Ridge Nat. Lab. (ret.)
Rob Mason, U. Connecticut
Laurier Poissant, Environment Canada
Christian Seigneur, Atm. & Env. Res., Inc.
Sandy Steffen, Environment Canada
Tom Braverman, U.S. EPA
Russ Bullock, NOAA/EPA
Mark Cohen, NOAA
Charles Driscoll, Syracuse U.
Mae Gustin, U. Nevada-Reno
Dan Jaffe, U. Washington-Bothell
Jerry Keeler, U. Michigan
Matt Landis, U.S. EPA
Winston Luke, NOAA
Eric Miller, Ecosystems Research, Inc.
Jamie Schauer, U. Wisconsin
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Rob Tordon, Environment Canada

NADP Organizing Committee

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NADP / Mercury Trends Network Planning Meeting
Lake Michigan Air Directors Consortium (LADCO)
Rosemont, IL
27 June 2006

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