National Park Service
Gaseous Pollutant Monitoring Program

The
Monitor

For National Park Service
Air Quality Station Operators

FALL 2003

NETWORK NEWS

New towers, shelters, and more coming to network sites

From time-to-time either a wind, relative humidity, or temperature sensor will fail at an air quality station. When this occurs just prior to an ARS twice-annual maintenance visit, replacement of the sensor is completed by the ARS field specialist and data loss is limited. When a twice-annual or emergency visit by an ARS field specialist is not practical, sensor changing options are limited. Due to lack of training and specialized equipment, and park safety policies, Station operators are not asked to climb towers to replace sensors. Not all meteorological towers fold over, and those that do are not always easy to handle. ARS has recently selected a meteorological tower that incorporates a hinge and winch system that allows for one-person operation to lower the tower to access the top. These towers are being installed at all new monitoring sites, and any site that is being moved or that requires major renovation.

Other changes to monitoring stations will also occur this fall or next spring. A new shelter is being procured for the Yosemite, Turtleback Dome station, and will be installed in Spring 2004. Construction of an Environmental Education Center is displacing the current location of the Mount Rainier monitoring site, and the shelter, meteorological tower, and IMPROVE and NADP equipment will be relocated to a neighboring meadow near the Tahoma Woods administrative area in October 2003.

A meteorological, NADP, MDN, CASTNet, and IMPROVE sampling site located in Ambler, Alaska, was installed this September and October. The site will support Kobuk Valley National Park in the Western Arctic National Parklands. Dave Maxwell of NPS ARD and Andrea Blakesley of Denali NP&P made a presentation to the Ambler community during the installation activities.

New towers *continued on Page 2 ....*

Changes to data reports

Increased demands for a quicker turnaround of validated data is driving a review of the validation and reporting procedures. Currently, the last step in the validation process is to mail monthly data reports to the station operators for final review and comment. After a two-week period, the data are considered final if no corrective comments are received from the field.

Because validation comments are rarely received and because of the desire to provide validated data more quickly, elimination of the two-week delay is being considered by the NPS ARD. In a new approach, monthly data plots would still be available for station operator review, and noted errors could still be corrected, but the two-week waiting period would be eliminated. The format of the monthly reports and annual reports could also change as a result of this procedures review.

We would like to hear from your during this validation and reporting procedures review. What do you think about eliminating the two-week waiting period, and what report products do you find most useful or what new products would you like to see? Please e-mail your comments to *JFaust@air-resource.com.*

NETWORK NEWS *continued on page 2....*

What's inside:

***NETWORK NEWS** continued from page 1....*

Filter packs require prompt mailing

By now you should have received a notice from MACTEC in your CASTNet filter mailing tubes requesting prompt return of filter packs. There are many reasons for this, including, sample degradation with time; the time needed to clean, reload, and reship sampling hardware; and most recently, stricter contractual requirements for data turnaround.

Most operators mail the filters immediately. Some parks may have less frequent mail service than others, or lengthy in-park transfers which contribute to return delays. To those of you who occasionally have trouble getting the tube to the mailroom (or wherever it has to go) please investigate more timely alternatives or be more persistent. If you have old filters lying around the office or shelter, please mail those back immediately so that hardware can get back into circulation. Please post the MACTEC notice in the shelter so subsequent operators are aware of the policy.

Also remember to include both the yellow and white copies of the SSRF in the mailing tube, and always record the time in 24-hour (military) format!

***New towers** continued from Page 1 ....*

An ozone and meteorological monitoring station was installed at Badlands in August 2003. This station represents a return to this park, as previous monitoring was terminated in 1992. Nearby Wind Cave is also scheduled to receive a meteorological and CASTNet dry deposition monitoring site this fall.

Finally, Zion National Park will receive an ozone and meteorological monitoring station this fall. Utility installation delayed the deployment of this station, however, those systems are now in place and installation can now be scheduled. ARS and the NPS ARD welcome these new network sites and station operators.

High ozone in park units - 2003 season

The table below displays the number and values of 8-hr ozone exceedences in national parks during the 2003 season. This and prior years' ozone "hit lists" can also be found at *http://www2.nature.nps.gov/ard/gas/exceed.htm.*

Month	April	May	June	July	August	Sept.	2003 Season		
Validation Level * (Level 0 indicates raw data. Counts of days may change after the data are fully validated).	2	2	2	2	1	0	Total Count	Max 8-hr O3 (ppb)	4th highest maximum 8hr O3 (ppb)
National Park	Count	Count	Count	Count	Count	Count			
Acadia - McFarland Hill	0	0	2	#	#	#	2	91	--
Great Smoky Mountains - Cades Cove	0	0	1	0	0	0	1	88	--
Great Smoky Mountains - Clingman's Dome	0	0	3	0	0	0	3	98	--
Great Smoky Mountains - Cove Mountain	0	0	3	0	0	0	3	93	--
Great Smoky Mountains - Look Rock	2	0	4	2	1	0	9	96	90
Joshua Tree - Yucca Valley	0	8	10	15	4	1	38	119	111
Lake Mead - Meadview	0	0	1	0	0	0	1	87	--
Mammoth Cave - Houchin Meadow	1	0	0	0	0	0	1	90	--
Pinnacles	0	0	1	0	0	1	2	88	--
Rocky Mountain	0	1	0	1	5	0	7	92	86
Sequoia-Kings Canyon - Ash Mountain	0	2	15	24	15	14	67	115	110
Sequoia-Kings Canyon - Lower Kaweah	0	5	17	9	4	1	42	102	100
Sequoia-Kings Canyon - Lookout Point	0	4	16	9	9	10	48	109	104
Shenandoah - Big Meadows	2	0	4	0	0	0	6	105	86
Yosemite - Turtleback Dome	0	1	1	4	2	2	10	102	90

- Not Available

***NETWORK NEWS** continued on page 6....*

STATION OPERATOR FOCUS

Pat Sampson feels at home in Badlands NP

Pat Sampson has lived most of her life in and near southwestern South Dakota, so it just seemed natural to work at Badlands National Park. For the past 18 years she has been a park ranger for the National Park Service working solely at Badlands. She left the National Park Service at the end of September, but will continue work at Badlands on a contract basis.

Pat's primary responsibilities as a park ranger involved visitor services in the Interpretation Division, assisting the Resource Management Division with plant and wildlife surveys, and serving as ambient air quality site operator. It is the station operator duties that she has continued to perform.

The Badlands monitoring station rejoined the NPS Gaseous Pollutant Monitoring Program in July 2003. The park previously operated an ambient air monitoring station from 1987 to 1992. The new station monitors ozone and meteorological parameters (air temperature, relative humidity, wind speed, wind direction, solar radiation, and precipitation). The park also is equipped with an IMPROVE aerosol sampler and a transmissometer to measure particulates and visibility. In addition to servicing all this instrumentation, Pat also is station operator at an air monitoring station a short distance from Badlands, operated by the state of South Dakota.

Pat came to the NPS after graduating from Kearney State University in Nebraska. "I graduated with a medical technologies degree, minoring in chemistry and biology," said Pat. When not working, she and her husband operate a cattle ranch that keeps them both pretty busy. "With horses, cattle, and a ranch dog (that mostly gets in the way) I don't need any other pets," said Pat. "Now that my daughter and sons are grown, most of my free time is spent travelling on small trips with my husband." Pat also travels out onto the prairie for cross-country skiing or out toward a mountain for a downhill run. In the summer she prefers to hike or bike. "I also travel the rodeo circuit," said Pat, "where my son performs professionally."

Park Ranger Pat Sampson logs into the DataView computer, to begin weekly a station check at Badlands National Park.

DATA COLLECTION SUMMARY

Data collection statistics for January 2003 through July 2003 are listed below.

- Sites with at least 90% collection (final validation of ambient air quality parameters) include:

Acadia	Mammoth Cave
Canyonlands	Mesa Verde
Chiricahua	Mount Rainier
Denali	North Cascades
Death Valley	Pinnacles
Glacier	Rocky Mountain
Grand Canyon	Shenandoah
Great Basin	Theodore Roosevelt
Great Smoky Mountains	Virgin Islands
Clingman's Dome	Voyageurs
Cove Mountain	Yellowstone
Look Rock	Yosemite
Hawaii Volcanoes Observatory	Merced River
Lassen Volcanic	Turtleback Dome

- Sites with at least 80% collection (final validation of ambient air quality parameters) include:

Big Bend	Hawaii Volcanoes Visitor's Center
Craters of the Moon	Joshua Tree
Everglades	Olympic
Great Smoky Mountains Cades Cove	Petrified Forest
Hawaii Volcanoes Thurston Lava Tubes	Sequoia-Kings Canyon Lower Kaweah

- Sites less than 80% collection (final validation of ambient air quality parameters) include:

Sequoia-Kings Canyon Ash Mountain	Sequoia-Kings Canyon Lookout Point

- The entire network achieved an average of 90.9% final validation of ambient air quality parameters.

FEATURE ARTICLE

Mercury: A new monitoring and resource issue

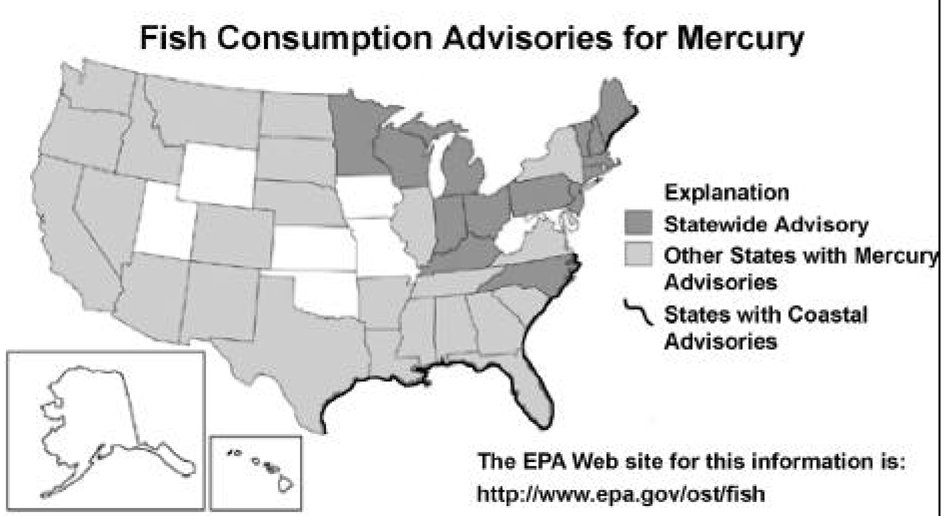
by Tamara Blett and John Ray, Air Resources Division

Except for residual mercury from historical gold mining, one might not expect mercury contamination to be a problem in the national parks. Yet human activities have greatly increased the amount of mercury (Hg) cycling in the global atmosphere, recently estimated to be 6,500 tons. Coal-fired power plants account for about half (41 tons/yr) of the U.S. emissions. Closer to park activities, wildfires and controlled burns are estimated to release about 4 tons/yr of Hg back into the atmosphere. Globally, biomass burning accounts for a total of 800 tons/yr. Mercury is transported in the atmosphere as elemental vapor (Hg^0), reactive gases (Hg^{+2}), or as particulates. Elemental mercury may remain in the atmosphere for a year or more while it circles the globe, but the more reactive gaseous and particle forms are deposited by precipitation or dry deposition closer to the sources where they are produced. Biological processes can change deposited mercury into the more soluble and organic methylmercury, which is concentrated and toxic in the food chain.

The National Park Service (NPS) is concerned about deposition of mercury in park ecosystems because of its ability to bioaccumulate. Significant amounts of Hg have been found in aquatic ecosystems of the Everglades, Acadia, Voyageurs, and Isle Royale National Parks, for example. In aquatic ecosystems, mercury is readily transformed into methylmercury, which can reach toxic levels in organisms at the top of the food web, like predatory fish, birds, and mammals. The concentration of dissolved organic carbon (DOC), dissolved sulfate, and pH have a strong effect on the ultimate fate of mercury in an ecosystem. Studies have shown that increasing the acidity of the water (decreasing pH and/or increasing the DOC content) generally results in higher mercury levels in fish, an indicator of greater net methylation. In addition, sulfate increases methylmercury by stimulating productivity of bacteria theylation. Higher acidity, sulfate, and DOC levels enhance the mobility of mercury in the environment, thus making it more likely to enter the food chain. Fish consumption is the most important pathway for human and for wildlife exposure to methylmercury. Toxic effects of methylmercury include reduced reproductive success, impaired growth and development, behavioral abnormalities, reduced immune response, and other effects including death.

Unhealthy concentrations of mercury are known to be widespread in the U.S., because the states currently monitor mercury in fish in selected water bodies, in order to develop public fish consumption advisories. In the U.S., 28% of water bodies (79,119 individual lakes monitored in 2001) are currently under such advisories. In the Great Lakes area, 100% of the waters are currently under fish consumption advisories. The EPA recommends that pregnant women, nursing mothers, and young children, limit consumption of many types of fish to **one** meal per week, to avoid complications from toxic bioaccumulation of mercury. Much less is known about the Hg levels in the fish and lakes within the parks and at what concentration of Hg that species begin to be affected.

The Environmental Protection Agency offers mercury information on its Web site, including news and events, a national listing of advisories, consumption advise, reports and chemical fact sheets, and more.



Individual parks have conducted or funded some limited sampling for mercury in air, water, snow, sediments, fish, and wildlife in the past. The Air Resources Division has become more active in mercury monitoring recently. The Western Airborne Contaminants Assessment Program (WACAP) is an NPS-sponsored research effort to measure toxics, including Hg, in lakes, biota, and snow within 8 parks. Also, NPS now funds and operates 5 of the approximate 70 sites in the Mercury Deposition Network (MDN). Another 6 sites in the network are in or near NPS units. The MDN program assesses mercury in wet deposition, but does not measure dry deposition of mercury or address methylmercury in the food chain. The transformation of mercury to methylmercury in an ecosystem is not consistent or predictable, because it is controlled by microorganisms that thrive or decline under varying environmental conditions. Therefore it can be valuable to obtain information about methylmercury accumulation in fish or other target species, in conjunction with deposition measurements to determine whether or not mercury is actually entering the food chain and having an ecosystem effect.

The Hg deposition from rainfall at MDN sites for 2001 is provided in the map below. New NPS Hg monitoring sites are shown with stars. In 2002 the Mesa Verde deposition was 3.3 ug/m^2 and the Yellowstone deposition was 1.5. Only low rainfall keeps the deposition down at these sites, because the Hg concentrations in the rain at these sites are higher than most eastern sites at 18.3 and 15.1 ng/L. Since mercury is only slowed, when tied up into geological formations (the only true "removal" process), the problem with Hg in the environment is likely to get worse and be a very long-term issue. Continued research and monitoring will be needed to understand its actual effect on park resources.

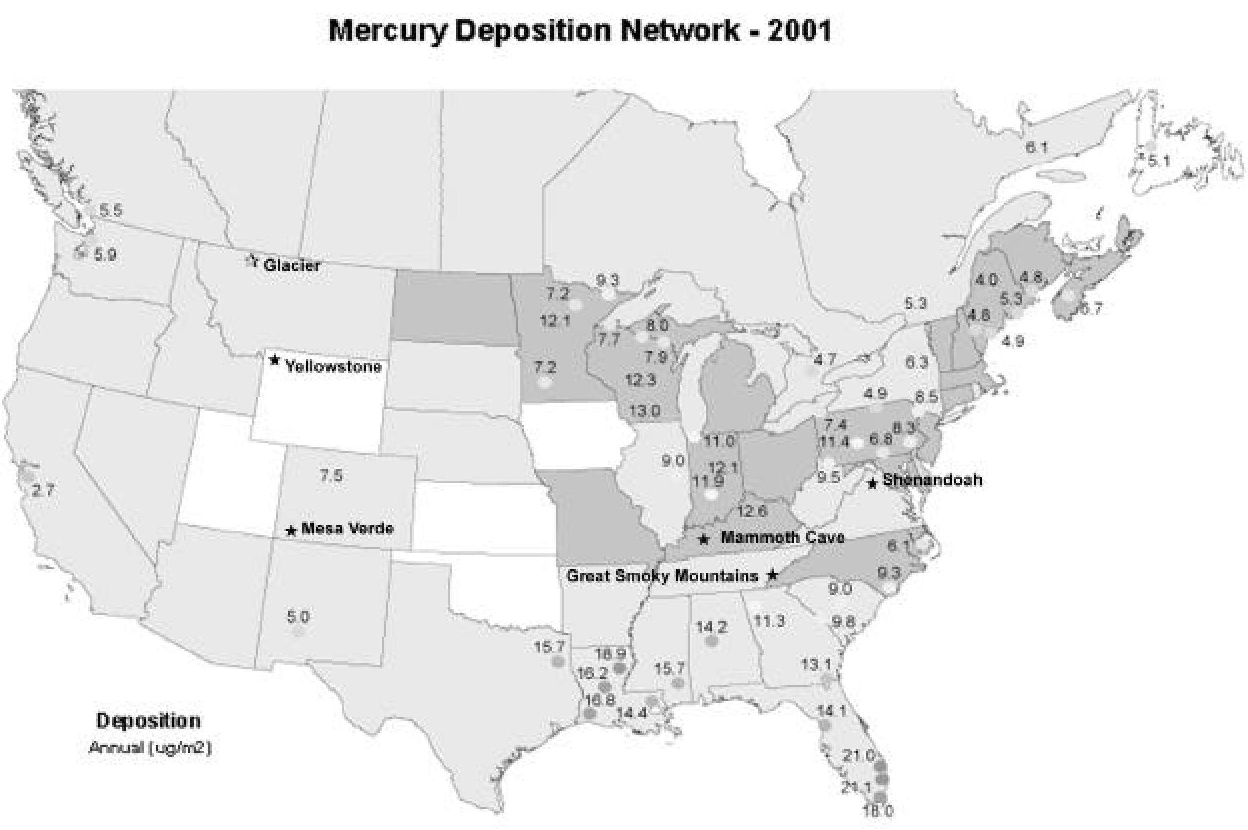
References and information resources

The NPS has a mercury Web site at:
http://www2.nature.nps.gov/ard/aqmon/air_toxics/mercury.htm

EPA mercury information can be found at:
http://www.epa.gov/mercury/

Mercury Deposition Network (MDN) information can be found at:
http://nadp.sws.uiuc.edu/mdn/

Annual deposition measured in the Mercury Deposition in 2001.



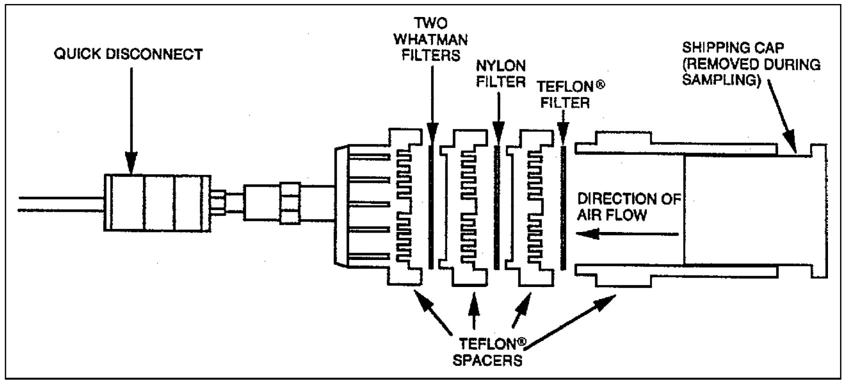
HOW DOES THAT WORK?

CASTNet filter pack systems

Many NPS monitoring stations include a CASTNet filter pack monitoring system. The system consists of a pump, flow controller, tubing, and sampling head. First off, what is CASTNet? The Clean Air Status and Trends Network (CASTNet) is an EPA- and NPS-sponsored monitoring program to measure dry (acid) deposition and ground-level ozone in rural areas. The program was initiated as a result of the 1990 Clean Air Act Amendments, which mandated significant reductions is sulfur dioxide emissions from electric generating plants. As emission reduction strategies are implemented, the CASTNet program is charged with tracking the environmental changes and results.

Acid deposition (pollution that collects in the atmosphere and falls from the sky) occurs as both wet (precipitation) and dry deposition. CASTNet filter pack sampling provides information on the dry component of acid deposition. The wet deposition is assessed by the National Atmospheric Deposition Program (NADP), and many of you participate in that program as well. Together these networks allow for a regional assessment of total (dry and wet) deposition.

The filter pack that you change weekly provides an integrated sample of sulfur and nitrogen species using an open-face, three-stage filter assembly, as shown in the diagram above. A controlled flow rate (1.5 eastern U.S. and 3.0 SLPM western U.S.) of ambient air is drawn through the filter pack, and particles and selected gases are collected on the filters. The Teflon filter collects particulate sulfate (SO_2^{-4}), nitrate (NO^{-3}), ammonium (NH^{+4}), and certain cations. The nylon filter collects nitric acid (HNO_3). The cellulose fiber-based Whatman filter is impregnated with potassium carbonate (K_2CO_3) and is used for collection of sulfur dioxide (SO_2).



The filter pack laboratory, operated by MACTEC E & C in Gainsville, Florida, handles all filter pack assembly and subsequent filter analysis using modern laboratory analysis equipment and techniques. Filter analysis results are combined with flow rate and elapsed time information to calculate atmospheric loading of the targeted pollutants. These and other measured data help characterize deposition levels and identify relationships among emissions, atmospheric loadings, and effects on human health and the environment.

Additional information on CASTNet, NADP, and similar monitoring programs can be found at *http://www.epa.gov/castnet* and *http://nadp.sws.uiuc.edu.*

***NETWORK NEWS** continued from page 2....*

ARS' eye is on you

So, you've been too busy to run a multipoint? Last month too? Some weeks you run through the air quality site and change the CASTNet filter pack and don't go through the DataView station check procedures? Don't enter any log notes either?

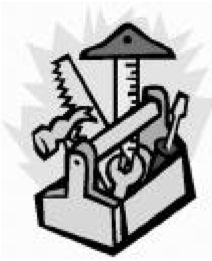
Well, don't think you're going unnoticed. The DataView system brings some advantages to station operators. The system eliminates the need for pencil and paper checklists, but removes the excuse "I *did* my multipoint last week; it must have gotten lost in the mail."

We know who's been good (and not so good) at completing their station servicing duties, and we share this information with NPS ARD staff regularly. Network protocols require station operators to perform weekly station checks and monthly multipoint checks on ozone analyzers. These procedures are necessary and important to assure the quality of the data.

If you have any questions about your responsibilities, or questions about any procedures, please call and speak with any of our field specialists. In addition, make sure to take advantage of their expertise during twice-annual visits. This face-to-face, hands-on experience and training is invaluable. Call ARS toll-free at 1-800-344-5423, or 1-970-484-7941.

***NETWORK NEWS** continued on page 8....*

OPERATOR'S TOOLBOX



Scalar and vector winds

Wind speed and direction is a common parameter measured in the NPS and other meteorological and air quality networks. Should be simple, right? Compared to gaseous analyzers and more complicated devices, figuring out the wind should be easy. Read on for the real story.

The NPS network uses both the traditional "cup anemometer and wind direction vane" manufactured by Climatronics or the combination "propvane" manufactured by R. M. Young. Both styles of instruments measure wind speed and direction and the ESC dataloggers' process and log that data. But why have two wind speed outputs? Scalar and vector?

The dictionary definition of a vector is "a quantity completely specified by a magnitude and a direction." Scalar wind speed is the magnitude of the wind and vector wind speed has the direction component weighted into it. Vector wind speeds can never be greater than scalar wind speeds.

Scalar wind speed is what we typically think of when we consider wind speed, "How fast is the wind blowing?" This measurement is important in industrial meteorology where the force of the wind is critical to the design and construction of buildings, bridges, smokestacks, and similar structures. But in air pollution meteorology, the vector wind speed is of greater use. *Vector* wind speed incorporates the wind direction as well as the speed.

Consider a pollutant released from a single point. Based upon a scalar wind speed measurement of 10 mph, that pollutant would be 10 miles away an hour from now. However, if the wind blew for 30 minutes directly from the north (at 10 mph), and then turned around and blew for 30 minutes directly from the south (at 10 mph), then in an hour from the release, that pollutant would be right back where it started. Obviously this is an extreme case, but it illustrates the need to express and use wind measurements in a vector form for air pollution meteorology and dispersion calculations. So, in summary, scalar wind speed indicates how fast the wind is blowing, vector wind speed incorporates the wind direction and will indicate how far away an air mass is from its release point given a known period of time. Strong steady winds will yield similar scalar and vector wind speeds (and low standard deviations of wind directions (sigma-thetas), while light variable winds will yield different scalar and vector wind speeds (and high sigma-thetas).

Another problem occurs when calculating wind direction averages. Wind direction is commonly displayed in "polar coordinates" where north equals zero degrees, east equals 90 degrees, south equals 180 degrees and so on. The averaging on these numbers would (logically) yield the wind direction over the averaging period. Consider winds that are predominately from the north, with some measurements of 10 degrees (a little east of north) and some measurements at 350 degrees (a little west of north). The arithmetic average of these values is $(350 + 10) / 2 = 180$ or south. Intuition would suggest (correctly) that the average should be north, but the answer comes out south, as wrong as possible. This potential error is often referred to as the *wrap-around* or *cross-over* problem. The dataloggers we use in the network eliminate this potential error, by converting the wind direction measurement to vector coordinates, calculating the average, and then converting back to polar coordinates to display the result in degrees.

Another problem with doing a straight arithmetic average on wind direction is that no account is taken of speed, known as the *unweighted direction* problem. Suppose the wind is calm for 1/2 hour, and then wind is at 10 mph from the south for the remainder of the hour. Clearly, the hourly average, using straight averaging, will be southeast, but the only wind was from the south.

The above problems can be solved by translating the wind speed and wind direction into a X-Y (or Cartesian) coordinate system. Thus each wind direction observation is converted into a vector, that is, an easterly and a westerly component of speed, and the data is accumulated and averaged in vector form. The results are then transformed back into polar coordinates.

One more thing. What do we mean when we say there is a *southwest wind*? That means the wind is **from** the southwest. A wind direction of 225 degrees would indicate the wind is blowing from the southwest. And I'm sure by now all of you have figured out one "meter per second" is about two miles per hour. So wind speeds of 5 meters per second are about 10 miles per hour. The actual conversion is meters per second times 2.237 equals miles per hour.

AIR QUALITY GLOSSARY

Air Quality Related Value (AQRV) - a resource, as identified by the Federal Land Manager for one or more federal areas, that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource identified by the Federal Land Manager for a particular area.

Continuous sampling device - an air analyzer that measures air quality components continuously. Ozone monitors are an example of these devices.

Deciview - a unit of visibility proportional to the logarithm of the atmospheric extinction. Under many circumstances a change of one deciview will be perceived to be the same on clear and hazy days.

Fugitive emission - pollutant emitted from diffuse or ill-defined sources (e.g., other than a stack or chimney). Windblown dust is an example of a fugitive emission.

Integrated sampling device - an air sampling device that allows estimation of air quality components over a period of time (e.g., one week) through laboratory analysis of the sampler's medium. The IMPROVE aerosol sampler and CASTNet filter packs are examples of integrated samplers.

NETWORK NEWS *continued from page 6....*

PRIMENet articles and reports on Web

Many news articles and research reports are available on the PRIMENet Web site. Recent postings include:

- A USGS study on toxic rainfall in the San Joaquin Valley.
- A Western Lake Survey article titled, "Changes in the chemistry of lakes and precipitation in high-elevation national parks in the western United States 1985-1999."
- The World Meteorological Organization June 2003 newsletter *World Climate News* (volume 23). It discusses a review of major events in the world climate in 2002.
- A National Wildlife Federation report, "Cycle of Harm: Mercury's pathway from rain to fish in the environment."

The Web site lists many more articles, reports, news, and more. Log onto *http://www.forestry.umt.edu/research/MFCES/programs/PRIMENet* and click on Announcements. You can also log onto *http://www2.nature.nps.gov/ard/gas* and follow the links to the PRIMENet program.

National Park Service
Gaseous Pollutant Monitoring Program

The
Monitor

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