National Park Service
Gaseous Pollutant Monitoring Program

The Monitor

For National Park Service
Air Quality Station Operators

FALL 2004

NETWORK NEWS

Portable stations complete second year

The NPS ARD has deployed nine portable ozone stations in the past two years. They have just completed their second summer season of operation and have yielded much needed ozone and meteorological data in NPS units where no information exists or where additional spatial data are needed. Stations added this season include:

- Gulf Islands National Seashore, FL/MS
- Mammoth Cave National Park, KY
- Mount Rainier National Park, WA
- Olympic National Park, WA

These new stations are all tripod-mount designs, which are smaller and less expensive than the original, platform-mount configuration. Installation of additional stations are scheduled for Padre Island National Seashore, TX, and four other NPS locations.

Cooperative monitoring begins in South Dakota parks

An agreement was recently reached among the NPS ARD, the South Dakota Department of Environment and Natural Resources (DENR), and Badlands and Wind Cave National Parks, to expand air monitoring in the southwestern part of the state. Both parks will increase their monitoring instrumentation and monitor additional air quality parameters.

The ambient air quality station at Badlands currently monitors ozone, meteorological parameters, and particulates with an IMPROVE sampler. The station at Wind Cave currently monitors meteorological parameters, sulfates and nitrates with a CASTNet particle sampler, and particulates with an IMPROVE sampler. South Dakota's DENR purchased additional monitoring equipment that will operate with existing dataloggers and other support systems. Additional equipment at Badlands NP includes: NO_x, SO_2, and continuous PM_{10} and $PM_{2.5}$; and at Wind Cave NP, a new shelter, O_3, NO_x, SO_2, continuous PM_{10} and $PM_{2.5}$, and integrated $PM_{2.5}$ monitors.

The DENR and Air Resource Specialists, Inc. cooperatively installed the additional equipment in early October.

Yosemite Turtleback Dome gets new shelter

The Yosemite Turtleback Dome site received a new monitoring shelter in August. Installation of the new shelter was delayed several times due to helicopter availability, location of endangered plants, and ARS field schedules.

Yosemite's site location is inaccessible by vehicle; station operators must walk into the station from a nearby parking area, or ski or snowshoe a kilometer up a steep grade in the winter. The previous shelter, installed many years ago by the California Air Resources Board, was carried in one wall at a time and assembled on-site. The station was too small from the start, and became smaller with the addition of other air quality measurement programs.

A helicopter was used to transport the new 8' x 10' EKTO shelter to its new location near the existing shelter. ARS field specialists Dave Meisters and Dave Beichley spent a week leveling the shelter, installing a meteorological tower, and moving and reinstalling the ozone and meteorological sampling equipment. Thanks to Katy Warner, David Rains, and Yosemite maintenance staff for their assistance with moving the shelter and wiring the power and telephone. The new shelter is a welcome improvement to the program.

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

What's inside:

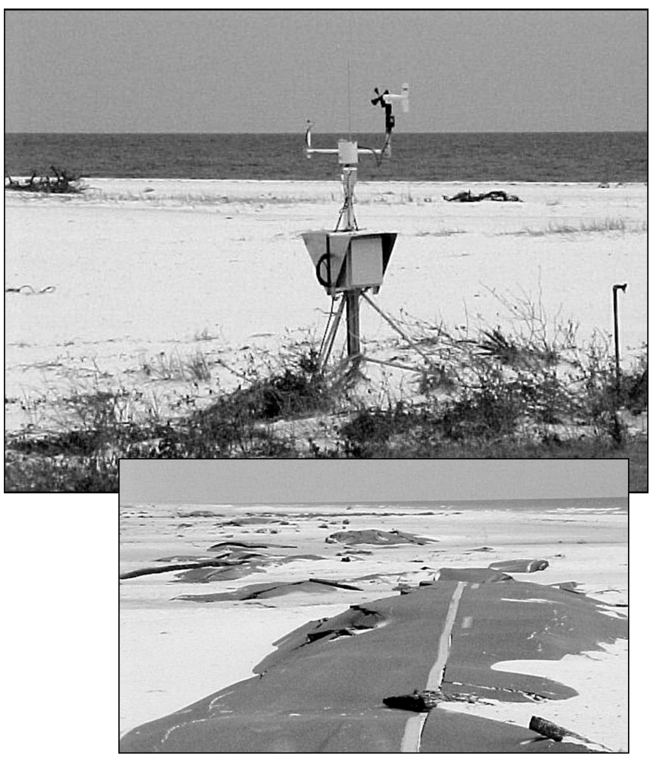
NETWORK NEWS *continued from page 1....*

GPMP stations affected by hurricanes

After an active hurricane season, several ambient air monitoring stations have been affected by strong winds, heavy rains, and storm surges.

The Gulf Islands portable station weathered Hurricane Ivan, as he came ashore near Pensacola, Florida. Station operator Riley Hoggard removed the 2B ozone analyzer before evacuating the area. Many park structures were lost during the storm, but as seen in the photographs below, the station remains standing. The station may have been underwater for a time; the datalogger will be retrieved to see if any useful data were logged during this period.

Strong winds, heavy rain, and falling barometric pressure was reported at the Great Smokies and Mammoth Cave stations as Ivan traveled northward. Operators at the Everglades station shut down ozone measurements and took other precautions during Hurricanes Charley and Frances, but were spared any significant damage as both hurricanes missed the Everglades area. The Everglades station was destroyed along with many park structures and most of neighboring Homestead, Florida, during Hurricane Andrew in 1992.



The portable ozone station at Gulf Islands, Florida/Mississippi, remained standing after Hurricane Ivan. The storm caused major road damage, as seen in the lower photograph.

2003 annual reports feature different look, different format

The Gaseous Pollutant Monitoring Program's 2003 annual reports are expected to be delivered later this year. The reports will feature a different look and a different format than previous years' reports.

Instead of individual site reports, the 2003 report will be a comprehensive, united report for the entire network. The 60+ page report will include:

- Network and data summary descriptions
- Map of network sites and parameters monitored
- Site specifications table
- Table of data collection statistics by site
- Tables of ozone data statistics by site
- Ozone maps
- Long-term ozone trends plots
- Summary of ozone indices for resource injury
- Tables of sulfur dioxide data statistics by site
- Tables of meteorological data statistics by site

Reports will be delivered via e-mail. Some program participants will receive a hardcopy report.

GPMP's quality assurance plan complete

The quality assurance project plan (QAPP) for the Gaseous Pollutant Monitoring Program (GPMP) is now complete and has been submitted to the Environmental Protection Agency. The QAPP is part of a mandatory agency-wide quality system that requires all monitoring programs that submit their data to the EPA to formally document their operational and quality assurance processes to ensure that data or information collected are of the needed and expected quality for their desired use.

The GPMP's QAPP explains how quality assurance and quality control activities will be implemented during the life of the program. It allows project managers and planners to better understand the type and quality of data available for environmental decisions and provides a blueprint for collecting and assessing those data.

The document will be posted on the GPMP Web site after EPA approval, expected later this year.

NETWORK NEWS *continued on page 5....*

STATION OPERATOR FOCUS

Heather Dumais pulls air monitoring together at Sequoia-Kings Canyon NPs

A year and a half ago at Sequoia-Kings Canyon National Parks, Heather Dumais stepped up to the challenges of running the air monitoring program. The two adjacent parks, in central California, have three ambient air monitoring stations that document very high pollution levels.

Originally from Maine, Heather prepared herself for environmental work by earning a B.S. degree in environmental science and policy, from the University of Southern Maine. After graduation she served the National Park Service at Death Valley, Acadia, and Everglades National Parks before moving to Sequoia-Kings Canyon. Sequoia-Kings Canyon National Parks' superlative resources are threatened by stifling pollution. The parks are a living laboratory to study pollution's affects on a premier resource. "As hard as it is, I'm willing to be apart from my family in Maine to experience this unique environmental opportunity in the Sierra Nevada," said Heather.

Heather heads the air monitoring programs at three main stations in Sequoia-Kings Canyon: Ash Mountain, Lookout Point, and Lower Kaweah. She trains seasonal and volunteer operators, ensures all systems are functional, performs site visits and troubleshoots systems, and coordinates with various agencies who sponsor the monitoring networks. The National Park Service' Gaseous Pollutant Monitoring Program monitors ozone and meteorology. Other agencies that perform air monitoring include the CASTNet Program, IMPROVE Program, the National Acid Deposition Program, and the Mercury Deposition Program. Passive ozone monitoring is also performed in many remote areas in the two parks.

Lead physical science technician Heather Dumais heads the air monitoring program in Sequoia-Kings Canyon NPs.

"The monitoring stations in Sequoia-Kings Canyon are about an hour's drive from each other, so site visits involve a jeep ride in the summer and snowshoeing or cross-country skiing in the winter," said Heather. She enjoys just about any type of outdoor activity, including rock climbing, kayaking, and snow sports in general. Yoga is also a big part of her life.

Heather also loves to travel. She's driven cross-country over 10 times, and plans on being in Costa Rica this winter. Her family is back in Maine, and she visits them often. She recently completed a 100-mile, 6-day trek in the Sierra Nevada mountains. Heather is no stranger to strenuous outdoor activity and understands firsthand the importance of good air quality. No matter where you go, air is an important resource. Heather does her part to try to improve it.

AIR QUALITY GLOSSARY

Attainment area - a geographic area in which levels of a criteria air pollutant meet the health-based National Ambient Air Quality Standards (NAAQS) for that specific pollutant. An area may have an acceptable level for one criteria pollutant, but may have unacceptable levels for others. Thus, an area could be attainment and non-attainment at the same time. Attainment areas are defined using federal pollutant limits defined by the EPA.

Criteria air pollutants - a group of very common air pollutants regulated by the EPA on the basis of criteria, for which an NAAQS is established. Criteria air pollutants are: SO_2, NO_2, PM_{10}, Pb, CO, and O_3.

Dose-response - the relationship between the dose of a pollutant and its effect on a biological system.

Mixing layer - an unstable layer of air that has turbulent mixing, usually due to solar heating of the ground. It is often capped by a stable layer of air.

Nonattainment area - a geographic area in which levels of a certain criteria air pollutant are higher than the level allowed by federal standards. For the NAAQS, where the pattern of "violations of standard" is sufficient to require remedial action, a boundary is determined around the location of the violations. The area within that boundary is designated to be in nonattainment of the particular NAAQS standard and an enforceable plan is developed to prevent additional violations.

FEATURE ARTICLE
Understanding wind flows in the mountains

Many of our air quality monitoring stations are in mountain areas, which brings up the question about how representative are they for the broad area that comprises the park. Let's look at what wind measurements tell us. Air is a fluid that flows from high pressure areas to low pressure areas -- what we call wind. Two overriding forces create wind over very broad areas: 1) winds between highs and lows of weather systems, and 2) the rotation of the earth beneath the air. When these winds are strong they will dominate local effect winds.

We all know that mountains create their own winds and that it seems to be constantly changing and complex. In general, these local winds are from a process called convection, caused by the heating of air near warm surfaces that rises through slightly cooler air surrounding it. When the sun warms a south-facing slope, the air begins to rise up the slope. These upslope winds build during the day and can be turbulent (see Figure 1). In the afternoon when the solar radiation is less, the heating decreases, the surfaces cool, and the winds reverse, starting a flow settling down the hill (a downslope wind).

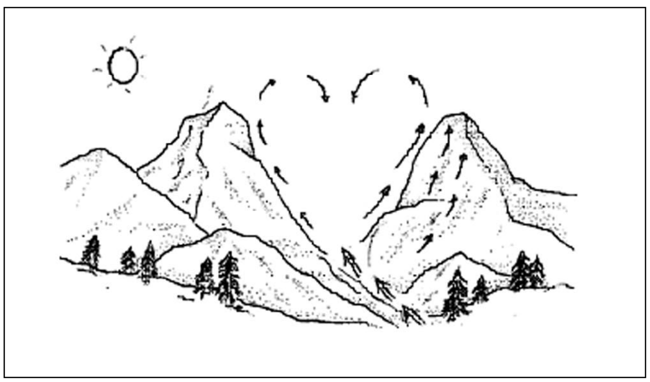


Figure 1. Both upslope winds from solar heated mountain surfaces and a general up-valley wind are indicated in this drawing. At night, the wind patterns reverse.

When there is a well defined valley, the upslope flows shift from directly up the steep slopes to more generally up the valley. Up-valley winds will twist and turn to follow the valley drainage up to the ridges and peaks. In early evening, cooling begins and the flows reverse to create a more gentle down valley flow, often as a layer below warmer air, a condition called an inversion. These are diurnal (twice a day) winds. Now, add some trees and boulders to disrupt the direct flows, some twists, turns, and changing slopes to get the final wind pattern. Let's look at some monitoring data to see what this looks like in a real situation.

Both the Lower Kaweah and Lookout Point monitors in Sequoia National Park have classic upslope/downslope winds. The vector wind direction has a regular pattern; it looks like a square wave when viewed as a time plot (Figure 2) or as just two directions on a wind rose (Figure 3).

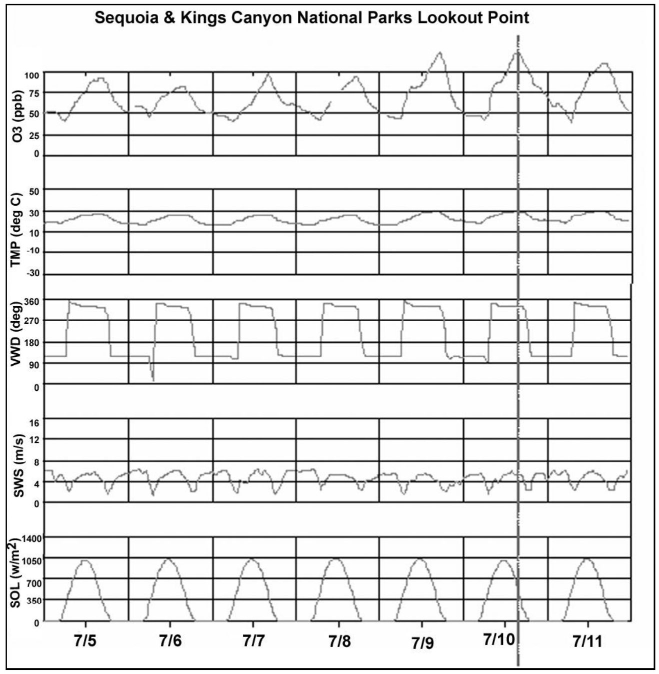


Figure 2. Stackplot of meteorological and ozone data for Sequoia NP showing the upslope winds daily pattern.

During the day winds are from the northwest and at night winds are from the southeast. Notice that wind speed during the daytime and nighttime is very similar and that a lull in the winds exists at the time of the shift. The winds follow the temperature and solar radiation patterns. Ozone seems to be on a downward slide each night until just after sunrise. When the winds reverse, there is often a sudden jump in ozone, then a climb to a peak in mid-afternoon, and a long decline starting at sunset. Residual ozone in a layer above the nighttime boundary layer is mixed downward about the same time that the winds reverse for the day. Newly formed and transported ozone, plus locally formed ozone, combine to reach the afternoon peak.

The square-wave wind direction pattern is seen in many other parks including Joshua Tree, Yosemite, Lassen Volcanic, Chiricahua, and Mesa Verde. Because of this strong local-wind effect, we can expect that daytime upwind sources will have a large affect on the park's air quality. Each drainage might be expected to have slightly

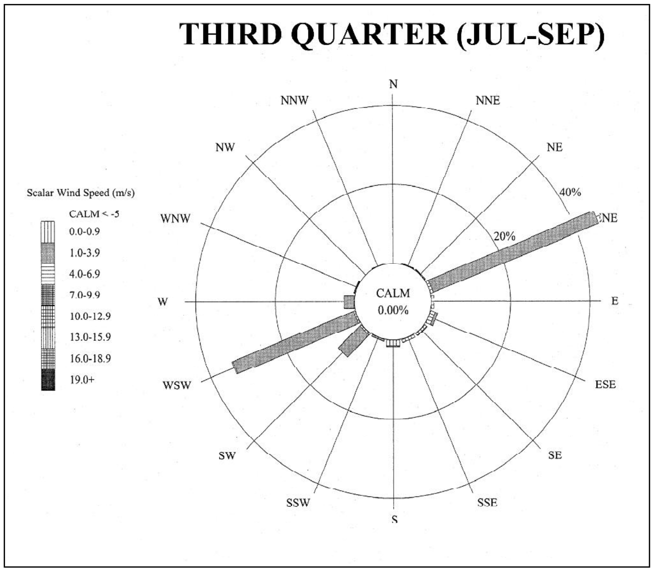


Figure 3. The square wave wind pattern for Sequoia NP looks like this when plotted on a wind rose. Winds are basically from only two directions, west-southwest and east-northeast.

different air quality. Weather fronts and strong winds will disrupt the convection-driven mountain winds, replacing them with different winds without the daily repeating pattern. Rainy or cloudy days also disrupt the solar heating and the regular wind patterns. As we move into winter, there is less solar heating and the daily upslope and valley winds become progressively less likely. These weather changes are readily seen in the wind direction plots.

Parks without daily wind patterns are also telling. Grand Canyon (south rim), Glacier, Shenandoah, Great Smoky Mountains, Rocky Mountain, Theodore Roosevelt, and Everglades have either infrequent patterns or none at all. There may still be dominant wind directions, but the distinctive square wave is missing. These stations have wind contributions from a wider circle and a broader representation. Their stations are on ridges, plateaus, or forested areas that don't have the valley or upslope wind flows.

Look at the wind records in your own park to see if and when upslope winds are present. Study the topography around your monitoring site to better understand how the winds flow and what that might mean about the location of sources of air pollution. In our next column we will show you how to use dominant wind flows to determine where more distant emission sources might be that affect park air quality.

NETWORK NEWS continued from page 2....

NASA launches satellite to study air quality

NASA launched the Earth Observing System (EOS) Aura satellite July 15, 2004, to study the Earth's ozone, air quality, and climate for at least five years. Researchers will use the collected data to study the composition, chemistry, and dynamics of the Earth's upper and lower atmospheres. Aura is the third satellite in a series of EOSs (the first two are Terra and Aqua) to study the environment and climate changes. Aura will make 14 polar orbits each day and repeat its orbit track every 16 days.

Aura has a three-part mission, to provide information that will help answer the following questions.

Is Earth's ozone layer recovering?

The Earth's protective ozone layer is contained in the upper atmosphere, the stratosphere. This layer protects life on Earth from harmful UV radiation. The ozone layer is destroyed through chemical reactions involving nitrogen, hydrogen, and chlorine compounds. Aura will measure ozone and these ozone-destroying compounds. It will also measure the amount of UV radiation that reaches the Earth's surface, and determine whether the stratospheric ozone layer is recovering, as scientific models have predicted.

Is air quality getting worse?

The Aura satellite will make the first space-based comprehensive and near global measurements of ozone in the lower atmosphere, the troposphere. It will map the sources and transport of aerosols on regional and super-regional scales, and collect information regarding chemical changes and chemical pollution in the troposphere.

How is Earth's climate changing?

Aura will collect, quantify, and map the variability of upper tropospheric ozone, water vapor, and aerosols, to provide information about climate change. This information may reveal how these variations affect global temperature increases.

Data products for all the Aura instruments can be accessed through the EOS Data Gateway (EDG) at *http://delenn.gsfc.nasa.gov/~imswww/pub/imswelcome*. For additional information regarding the Aura satellite and its mission, visit: *http://daac.gsfc.nasa.gov/upperatm/aura/data_products/*.

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NETWORK NEWS *continued from page 5....*

Clean air hits Great Smoky Mountains

In an extraordinary sequence, three tropical storms brought clean, pristine air to Great Smoky Mountains National Park in September 2004. These events provide a dramatic demonstration of what the air quality should be for the region. Air quality monitoring and the Webcam at Look Rock captured the effect on air quality as Hurricanes Frances, Ivan, and Jeanne came ashore and proceeded up the Eastern U.S.

Looking at the 24-hour average ozone we can clearly see the effects. The monitoring stations at Great Smoky Mountains recorded about 24 ppb ozone and about 2 $\mu g/m^3$ $PM_{2.5}$ during the period when Frances was passing in early September (Figure 1). Tropical storms carry clean ocean air with them and the high winds and rain tend to dilute and remove air pollution.

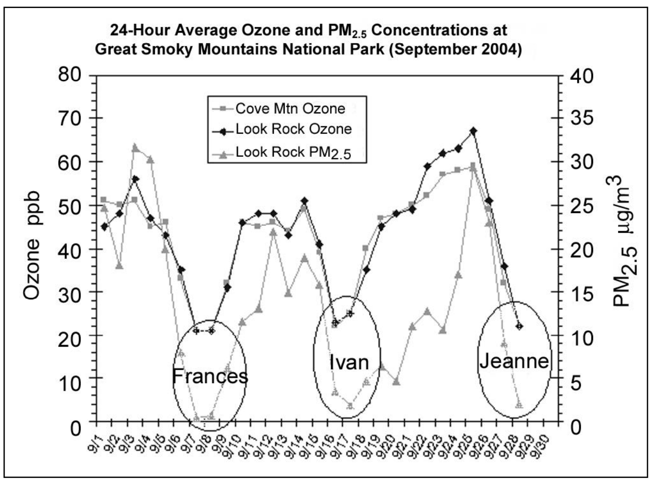

Figure 1. Clean air signatures are shown by the three tropical storm events that hit Great Smoky Mountains NP in September.

Hurricane Ivan was stronger, came ashore over the Gulf Islands, and proceeded to pass over Great Smoky Mountains on September 16-17. Average ozone was about 25 ppb and $PM_{2.5}$ about 4 $\mu g/m^3$ during the storm passage. Ivan dumped about 8 inches of rain in two distinct periods, before and after the eye passed. The three monitoring stations, Look Rock, Cove Mountain, and Cades Cove, had nearly identical daytime ozone in the 18-34 ppb range during the passage (highest during the passage of the eye). It is interesting to note that Cades Cove has nightly low ozone values normally of about 5 ppb, however, the Cades Cove nighttime concentrations increased to 20-30 ppb for several days following Ivan. After the storm, it took 4 days for ozone to return to average values before the storm. $PM_{2.5}$ recovered even more slowly over the next week.

The Webcam at Look Rock (*http://www2.nature.nps.gov/air/WebCams/parks/grsmcam/grsmcam.htm*) captured the improvements in visual range as $PM_{2.5}$ was brought to very low values during the passage of Ivan (Figure 2). Visual range became increasingly worse as $PM_{2.5}$ concentrations rose over the next week.

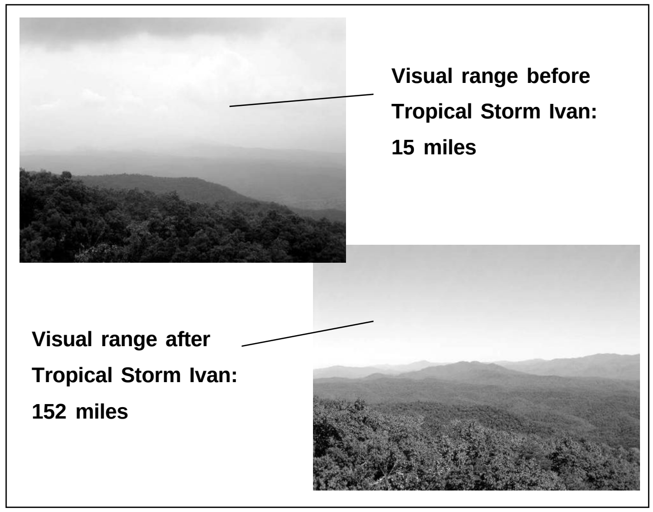

Figure 2. $PM_{2.5}$ decreased dramatically during Tropical Storm Ivan leaving beautifully clean air in the days following. Visual range increased from less than 20 miles to greater than 150 miles.

Rainfall from the storms was also quite high at Great Smoky Mountains, but the presence of cleaner air is evident in the acidity measurements. The pH of rain increased from an average of 4.4 before the storms, to 5.2 afterward -- an important acidity decrease. It will be interesting to see the concentrations of sulfate and nitrate in the storm rainwater once the lab results are back.

Ivan left clean signatures at Great Smoky Mountains, Mammoth Cave, Big South Fork, and Shenandoah. In each case the cleanest air was in the 25-30 ppb ozone range and it took several days for ozone to grow back to the concentrations prior to the storms. We have detailed data of CO, NO_x, and SO_2 from continuous analyzers and filter data from CASTNet and IMPROVE at Great Smoky Mountains that will provide an even more detailed record of these tropical storm events. Further results will be reported as validated data become available.

NETWORK NEWS *continued on page 7....*

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

Staff changes in the IMC

ARS has made some staffing changes in the Information Management Center (IMC). The staff of three, headed by a manager, perform data collection and validation for all GPMP sites. They ensure data are collected daily; review daily site summaries, stackplots, and calibration plots; notify field staff of potential site problems; and perform data validation. IMC staff are:

- Joe Adlhoch, IMC section manager
- Jim Baer, IMC data analyst
- Jessica Ward, IMC data analyst
- John Ellis, IMC data analyst

John Ellis joined ARS in September and is a recent graduate of the University of Pittsburgh.

DATA COLLECTION SUMMARY

Data collection statistics for January 2004 through June 2004 are listed below.

- Sites with at least 90% collection (final validation of ambient air quality parameters) include:
  - Acadia
  - Badlands
  - Big Bend
  - Canyonlands
  - Chiricahua
  - Craters of the Moon
  - Denali
  - Everglades
  - Great Basin
  - Grand Canyon
  - Great Smoky Mountains
    - Cades Cove
    - Clingman's Dome
    - Cove Mountain
    - Look Rock
  - Hawaii Volcanoes
    - Observatory
  - Hawaii Volcanoes
    - Visitor's Center
  - Joshua Tree
  - Mammoth Cave
  - Mesa Verde
  - Petrified Forest
  - Pinnacles
  - Rocky Mountain
  - Shenandoah
  - Theodore Roosevelt
  - Voyageurs
  - Wind Cave
  - Yellowstone
  - Yosemite
    - Merced River
    - Turtleback Dome
- Sites with at least 80% collection (final validation of ambient air quality parameters) include:
  - Death Valley
  - Lassen Volcanic
  - Mount Rainier
  - North Cascades
  - Sequoia-Kings Canyon
    - Ash Mountain
    - Lower Kaweah
  - Zion
- Sites less than 80% collection (final validation of ambient air quality parameters) include:
  - Glacier
  - Hawaii Volcanoes
    - Thurston Lava Tubes
  - Olympic
  - Sequoia-Kings Canyon
    - Lookout Point
- The entire network achieved an average of 89.7% final validation of ambient air quality parameters.

OPERATOR'S TOOLBOX

Obtaining validated stackplots from the GPMP Web site

Stackplots may be obtained from your DataView workstation on site. These plots of raw, unvalidated data will tell you at a glance, whether or not all parameters are functional and within normal measurements. If you require a stackplot containing *validated* data, log onto the GPMP Web site. These plots are easily accessible, and are generally available 45 days after the date of data collection.

Obtaining a validated stackplot for viewing, printing, or saving to your own computer is quick and simple:

- Log onto the GPMP Project Web site (*http://ard-aq-request.air-resource.com/project*). Refer to the monthly data reports for login information.
- Click on **Access NPS Gaseous Pollutant and Meteorological Data**.
- Click **Get Plots**. The plots will contain gaseous and meteorological parameters applicable to each site:

  Ozone (ppb)

  Sulfur dioxide (ppb)

  Ambient temperature (^{o}C)

  Relative humidity (%)

  Wind speed (^{o})

  Wind direction (m/s)

  Precipitation (mm/hr)

  Solar radiation (w/m^2)

- Scroll through the list of sites and select the site you want to view.
- Click **Continue**.
- Select a *start date* of the data you wish to view, and the *number of days* to view (1-93 days). The plot may take several minutes to generate, depending on the number of days you have chosen.
- Finally, click **Create Plot**. The output will be a .pdf file that you may print or save to your computer.

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National Park Service
Gaseous Pollutant Monitoring Program

The
Monitor

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NPS Gaseous Pollutant Monitoring Program Network
http://www2.nature.nps.gov/air/monitoring/index.htm

The Gaseous Pollutant Monitoring Program network currently consists of 57 air quality sites that monitor gaseous and meteorological parameters in 45 parks. The network was established as part of a comprehensive NPS air quality program. Data from the program are used to:

- Establish existing or baseline concentrations
- Assess trends in air quality
- Judge compliance with national air quality standards
- Assist in the development of national and regional air pollution control policies
- Provide data for atmospheric research and model development
- Identify and monitor pollutants that have the potential to damage park resources