

# The Monitor

## CASTNET

Clean Air Status and Trends Network

Fall 2007

The Newsletter for Air Quality Station Operators



National Park Service (NPS)  
Gaseous Pollutant Monitoring Program



Environmental Protection Agency (EPA)  
CASTNET program

### In this issue...

- NADP goes digital.....2
- EPA-sponsored sites receive updated ozone analyzers .....2
- Staffing changes around the program..... 2
- Station Operator Focus - Jack Bush of PAL190 ..... 3
- Data Collection Summary .....3
- Feature Article - The third deposition .....4
- Shop Talk: Air quality audits.....6
- Operator's Toolbox - Site conditions, surroundings, and vegetation .....7

### NETWORK NEWS

#### Agate Fossil Beds receives a POMS

Agate Fossil Beds National Monument, Nebraska, is the latest National Park Service unit to receive a portable ozone (POMS) monitoring station. Located in the northwestern part of the state, Agate Fossil Beds received the station in July. National Park Service regional staff requested an ozone monitoring system to complement other air monitoring stations in operation nearby. (See page 2 for photo of the POMS installed at Agate Fossil Beds National Monument.)

#### EPA-sponsored CASTNET sites receive new dataloggers

EPA-sponsored CASTNET sites will soon be receiving new dataloggers. The Campbell Scientific, Inc. (Campbell) Model CR3000 Micrologger® datalogger was chosen over two other models on the basis of a side-by-side comparison study.

Campbell's system is based on a core system that can be programmed to handle a wide range of applications. While the Campbell system requires slightly more user interaction, this does not render the system undesirable – in fact, because flexibility in datalogging, post-processing of data, secondary outputs, and flexibility in control output schemes is desired, the Campbell system was the better choice. The CR3000 Micrologger® is a compact, self-contained datalogger that can measure sensor types via analog or serial inputs. New modems will be installed with the new dataloggers to provide enhanced communication capabilities and control over external devices. Data and programs can be stored in either a non-volatile 2 megabyte (MB) flash memory or a 4 MB battery-backed SRAM. The CR3000 is also backed by Campbell's reputation and more than 30 years experience in the field.

MACTEC recently purchased 30 of the Campbell CR3000 dataloggers for the EPA. The dataloggers and accompanying modems will be installed during the semiannual site calibration visits and/or repair visits starting in late 2007. The CR3000 dataloggers will gradually replace all dataloggers currently in use at EPA-sponsored sites. The move toward increased standardization in the network is desirable and will support the continued successful operation of the CASTNET system well into the future.

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

## NETWORK NEWS continued from page 1....

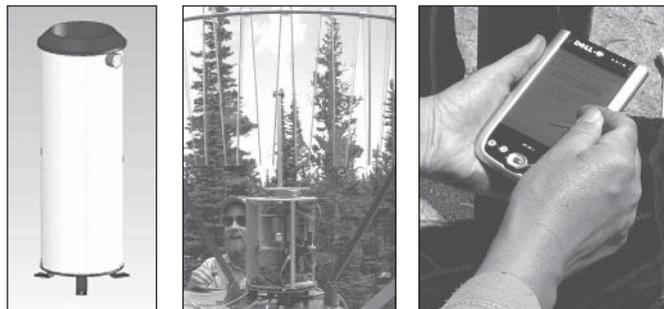
### NADP goes digital

Many technological advances have occurred in rain gauges in the past 30 years and more are yet to come. The National Atmospheric Deposition Program (NADP) investigated several new electronic rain gauges to replace the aging Belfort B5-7809. NADP conducted both bench and field tests over the past five years; the two best performing gauges were subsequently approved for use at NADP sites, with the requirement that all NADP sites be equipped with a new gauge by January 1, 2009. Added to that is a new requirement: for sites with greater than 20% of annual precipitation as snow, to have an Alter-type windscreens on their rain gauge by 2009.

These new rain gauges will benefit the site operators as there will be no more charts to read or messy ink pens to deal with. The rain gauge will increase the completeness of valid precipitation measurements by reducing equipment malfunctions and failures, and improve precipitation measurement efficiency by reducing the time required to interpret charts and manually transcribe measurements. The NADP expects that there will be a decrease in operational costs for the network.

The two approved rain gauges are the ETI Instrument Systems, Inc. (<http://www.etisensors.com/noahiv.htm>) NOAH IV Total Precipitation Gauge, and the HACH Environmental, Inc. (<http://www.hachenvironmental.com/beta/products/precipitationgauge.asp>) NADP Ott Pluvio Precipitation Gauge. The gauges cost approximately \$6,000 and a windscreens costs an additional \$1,000. The data are downloaded wirelessly from the gauge datalogger to a hand-held PDA (\$300) with NADP software that provides full records of all rain events and totals.

Several parks and NPS ARD came up with end-of-year funds to purchase new rain gauges. Contact Kristi Morris (303-987-6941), Deposition Program Manager, for more information or help in ordering the new gauges.



The ETI NOAH IV rain gauge, with cover removed and clear Alter-type windscreens, and a wireless PDA used to read the gauge data.



Portable ozone monitoring station with solar panels and battery box, in operation at Agate Fossil Beds National Monument, NE.

### EPA-sponsored CASTNET sites receive updated ozone analyzers

MACTEC and EPA continued to move forward to replace the older ozone analyzers at the sites by recently purchasing 15 additional Thermo Fisher Scientific, Inc. (Thermo) Model 49i ozone analyzers. As CASTNET ozone measurements begin to be used for regulatory purposes, the ozone analyzers must meet stringent requirements, including frequent quality assurance (QA) tests to verify the accuracy and precision of the measurements. The sites that will be receiving the new Model 49i will be evaluated prior to having a new analyzer installed, with some sites being considered "priority" sites. Eventually, all sites will receive a Model 49i analyzer.

### Staffing changes around the program

Four staff members are currently assigned to the CASTNET project at EPA. Brian Lee, who we met in the spring issue of *The Monitor*, manages the day-to-day operations of the network, and ensures both the scientific integrity of the data and the monitoring instrumentation. Gary Lear performs in-depth data analyses and data interpolation and develops air quality models using CASTNET data. Melissa Rury updates and compiles various CASTNET communications, and is beginning to work with data management and analysis. Finally, Michael Cohen performs the CASTNET data upload from MACTEC and manages the database.

At MACTEC's Newberry Office, Dave Dickens, Senior Environmental Technician, has been named Field Coordinator. Dave will be responsible for scheduling of calibrations and repairs throughout the MACTEC portion of the CASTNET program, and assignment of calibration and support tasks to members of the Ambient Air Quality Department, CASTNET Field Operations group.

## STATION OPERATOR FOCUS

### Texas experiment station performs an assortment of air quality research

The Palo Duro Canyon State Park, Texas, air quality site (PAL190) joined CASTNET in April, and is operated by two technicians from the Texas A&M Agricultural Experiment Station in Amarillo. The station performs agricultural and life sciences research across the state, and participates in various federal and state programs.

Jack Bush and Lanny McDonald share the servicing duties at the Palo Duro site. Alongside the CASTNET instrumentation, wet/dry deposition is collected, sponsored by the National Atmospheric Deposition Program. Another site monitors Amarillo's compliance with EPA's ambient air quality standard for PM<sub>2.5</sub>, under contract to the Texas Commission on Environmental Quality. "Much of my day involves traveling from one site to another to maintain and service the instrumentation," said Jack, "so I don't spend a lot of time in the office."

The experiment station also conducts air quality research in various agricultural settings in the Texas panhandle. "The research I am most involved with deals with particulate matter measurement," Jack said. "In conjunction with university graduate students, we are researching the use

of transmissometry as a surrogate for PM monitoring." Visibility measurements are compared to PM concentrations to examine the relationship between the two.

Jack holds BS and MS degrees in wildlife biology from West Texas A&M University. He has worked at Texas A&M for three years and is involved with various air quality research studies at the experiment facility.

In his free time, Jack treks about the countryside hiking, backpacking, hunting, and fishing. He grew up not far from Amarillo, and both his and his wife's extended families all live nearby as well.

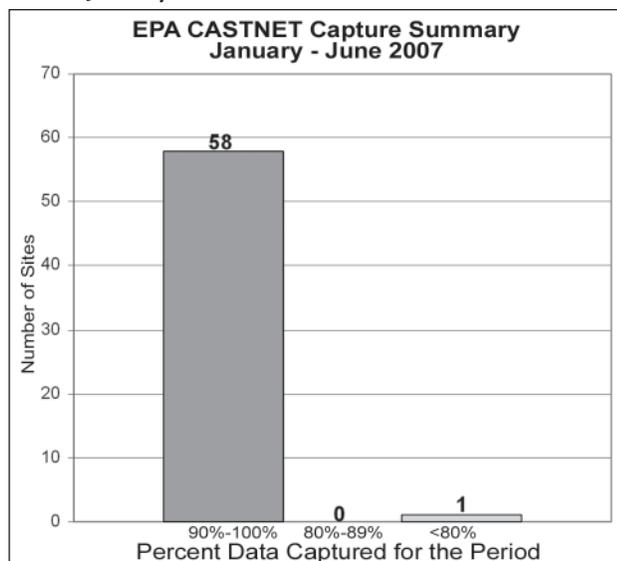


Jack Bush (left) and Lanny McDonald (right) share CASTNET servicing duties at the Palo Duro Canyon State Park, TX, site (background).

## DATA COLLECTION SUMMARY

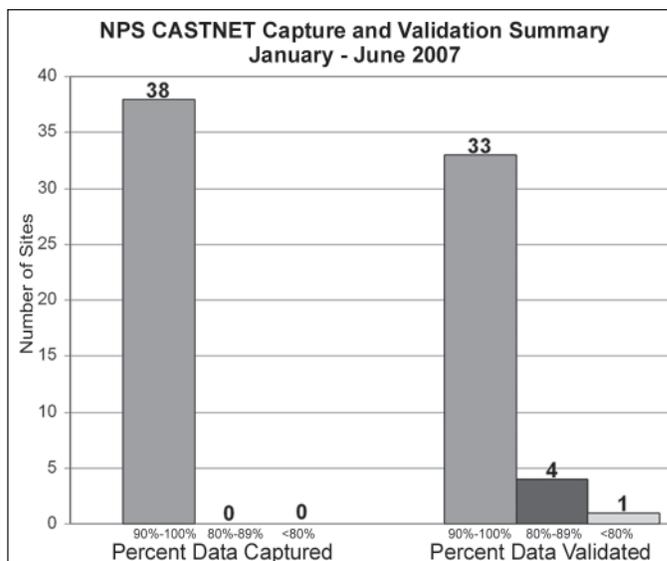
### EPA Site Data Capture Summary

Ozone data capture for the EPA CASTNET sites for January through June 2007 is summarized in the graph below. The network achieved an average 98% collection for the period. Data validation statistics for the period will not be available until mid-January 2008.



### NPS Data Capture and Validation Summary

Ozone data capture for the NPS CASTNET and GPMP sites for January through June 2007 achieved an average of 98% collection as illustrated in the graph below. Data validation for the same sites and period are also shown. The network achieved an average 94% final validation for the period.



## FEATURE ARTICLE

### The third deposition: Acid in the clouds (by S. Isil, MACTEC)

#### Deposition defined

Acidic deposition is a health threat to the flora and fauna of forest and aquatic ecosystems. Most of you are familiar with the processes of dry and wet deposition, since many monitoring sites participate in the Clean Air Status and Trends Network (CASTNET) (dry deposition) and National Atmospheric Deposition Program (NADP) (wet deposition) programs. Dry deposition is the transfer of particles and gases to land and water through various atmospheric processes in the absence of precipitation, whereas wet deposition is the transfer of particles and gases to land and water through precipitation events such as rain and snow. CASTNET estimates dry deposition using data from weekly 3-stage filter packs, and NADP estimates wet deposition through analysis of weekly precipitation via collection buckets. The combination of dry and wet deposition estimates are obtained from either collocated dry and wet sites or dry and wet sites located within 50 kilometers of each other, and provides a reasonable estimate of the total atmospheric deposition for a defined region. However, a third type of deposition exists that readers may not be familiar with: cloud deposition.

Cloud deposition is the transfer of particles and gases to the environment through cloud impaction. As clouds impact the terrain, their droplets are efficiently collected on all surfaces including trees, shrubs, grasses, rocks, soils, etc. Cloud impaction generally is most common at elevations of 800

meters or higher. While elevations above 800 meters are more common in the western U.S., elevations at or above this level can be found in the eastern U.S. along the Appalachian and Adirondack mountain ranges, where people can experience clouds “down to their noses.” These higher elevations are usually remote areas that see little human intrusion except during vacation trips. People may not be aware of or be affected by cloud deposition, but the ecosystems at these locations are extremely susceptible to damage from acidic conditions. In the mid-1980s, scientists found high-elevation spruce/fir forests from Maine to North Carolina were showing symptoms of injury, decreased radial growth, and increased mortality. Research showed cloud water can be much more acidic than precipitation and substantial sulfur and nitrogen deposition could impact the forest canopy and the soils below from cloud droplet formation.

#### Research projects

Two research projects initiated in the 1980s characterized cloud water chemistry and the impacts of cloud deposition on sensitive ecosystems:

- The Chemistry of High Elevation Fog Project measured cloud chemistry on three mountains in southern Quebec from 1985 through 1991.
- The Mountain Cloud Chemistry Project monitored cloud water chemistry at six locations along the Appalachian and Adirondack Mountains, from Maine to North Carolina, from 1986 through 1989.



Figure 1. The deposition sampling tower at the Clingmans Dome monitoring site in Great Smoky Mountains National Park, TN, displays a particle volume monitor on the left and a cloud collector on the right.

Results from these two projects were used by the National Acid Precipitation and Assessment Program (NAPAP) to assess the role of airborne chemicals on the changing conditions of forests. One of the major conclusions from this research was that cloud water is typically 5 to 20 times more acidic than rain water. Therefore, clouds can be the primary pathway for exposure and deposition of acidic compounds to high-elevation ecosystems. Additionally, the high frequency of cloud immersion, high wind speeds, the upslope cooling of air that results in enhancement of precipitation, and the large leaf surface areas typical of high-elevation tree species (e.g., spruce, fir, etc.) all combine to produce the largest loading of air pollutants to these subalpine forests of the eastern U.S.

As a result of the 1990 Clean Air Act Amendments (CAAA), the EPA activated the Mountain Acid Deposition Program (MADPro) in 1993 as part of the research necessary to support the objectives of CASTNET. Three MADPro sites were operational from 1994 through 1999 during May through October: Whiteface Mountain, NY; Clingmans Dome, TN; and Whitetop Mountain, VA. Due to budget cutbacks since 2000, cloud water has been collected from only two sites: Clingmans Dome and Whiteface Mountain.

**Recent data**

Cloud water monitoring at the Great Smoky Mountains National Park site at Clingmans Dome currently includes the following:

- An automated cloud water collector for bulk (24-hour) cloud water sampling
- A particle volume monitor for continuous determination of cloud liquid water content (LWC)
- Temperature, precipitation, and rain gauge sensors, and
- A data acquisition system for collection and storage of electronic information from the various monitors and sensors (see Figure 1).

Other meteorological data required for calculation of cloud deposition estimates are obtained from the NPS instruments adjacent to the cloud collection tower. Collected bulk

cloud water samples are analyzed in a laboratory for pH and conductivity, and for concentrations of acid anions and basic cations. The concentrations for each cloud sample are then used, along with the associated sample LWC and meteorological parameters, to calculate sample depositions. These depositions are summed to produce monthly and seasonal deposition estimates.

Acidic deposition at Clingmans Dome shows a trend of approximately 45 percent decrease in sulfur and 62 percent decrease in nitrogen cloud water deposition between 2001 and 2006. Although there has been an overall decline in cloud water deposition at Clingmans Dome since 2001, the data in Figure 2 demonstrate that the sensitive, high-elevation ecosystems are still receiving pollutant loadings on the order of 4 to 8 times greater than ecosystems at lower elevations. The park has the highest total acid deposition of any monitored national park or location in North America. Cloud water inputs contribute significantly to the total deposition that is both chronically and episodically acidifying high elevation streams and soils. This is reflected in the cloud water acidity (pH 3.65) compared to the lower elevation Elkmont (pH 4.7) or the mean pH for sites in TN and NC of 4.7. Such exposure to acidic cloud water can reduce cold tolerance, cause extensive leaching of cations and amino acids from the forest canopies, and contribute to nitrogen saturation as well as aluminum toxicity in these high elevation forests.

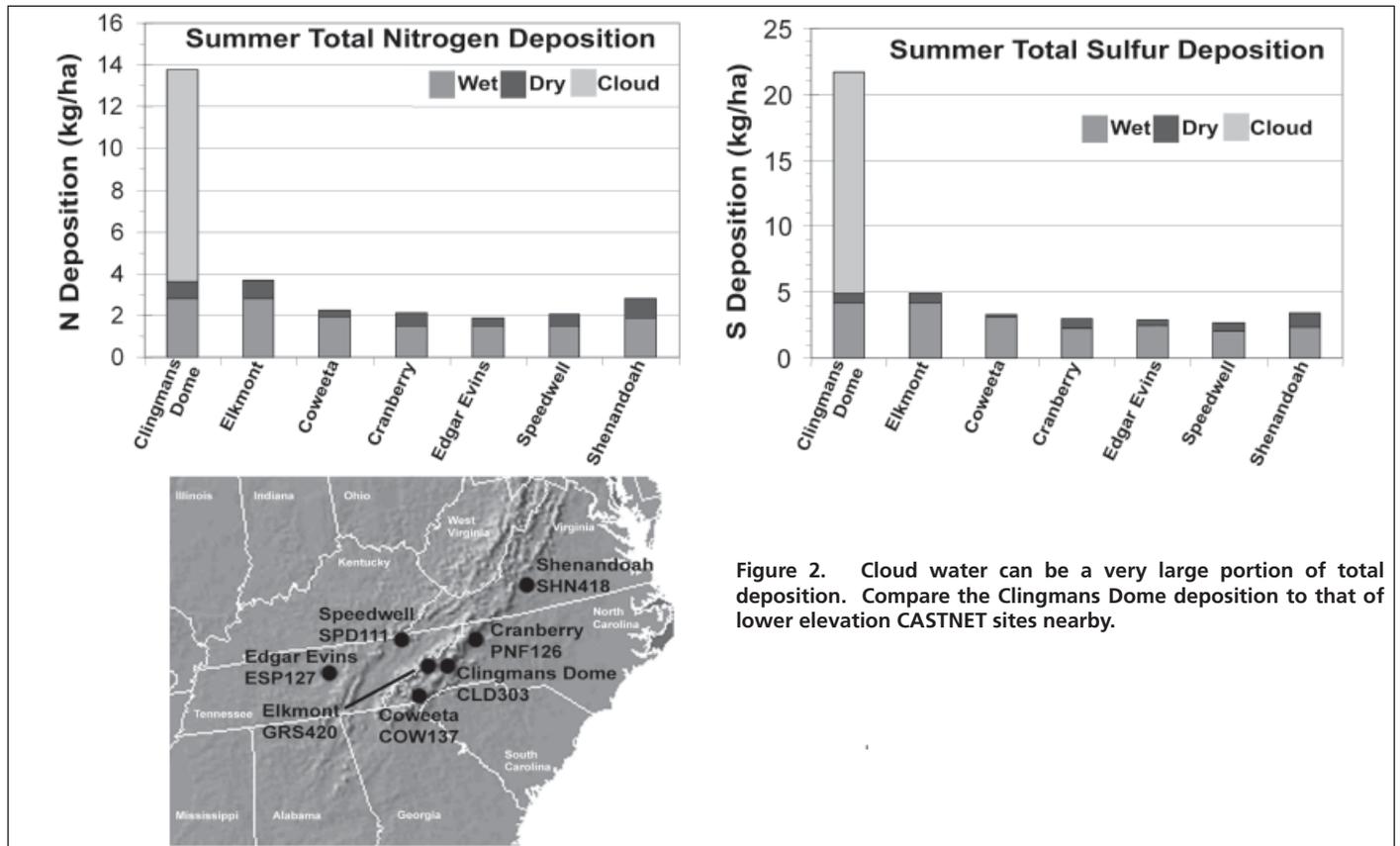


Figure 2. Cloud water can be a very large portion of total deposition. Compare the Clingmans Dome deposition to that of lower elevation CASTNET sites nearby.

## SHOP TALK

### Air quality audits of CASTNET monitoring stations



To assess the accuracy of CASTNET field measurements, the instruments must be periodically compared against known quality assurance standards. This is performed during station audits. Two types of audits are common in the CASTNET program; internal field performance audits and independent field performance audits. Internal audits refer to accuracy assessments performed by the operating agency or contractor; ARS and MACTEC for the NPS and EPA sites, respectively. They are referred to as internal audits because the operating program is internally checking its own measurements. Independent (or external) audits are performed by an organization not directly involved with network operations and are expected to provide an independent, unbiased assessment of measurement accuracy.

Internal field performance audits: Field staff from ARS or MACTEC visit NPS or EPA CASTNET sites twice each year. Upon arrival, the first task the field staff perform is an “as found” internal field performance audit. The field staff assesses the accuracy of each measurement including filter pack flow, ozone measurements, and each meteorological parameter. The on-site instruments are compared to calibration standards that the field staff bring with them to the site. The accuracies of these standards are certified and traceable to measurement standards recognized by the National Institute of Standards and Technology (NIST). The field staff document all audit findings and these results are used in the data validation process. Once the “as found” audit is performed, the field staff continue with instrument maintenance and calibration and finally document the “as left” status of all instrumentation.

Independent field performance audits: Several agencies and contractors provide independent field performance audits of CASTNET sites. These auditors also assess the accuracy of site measurements with certified and traceable standards and prepare audit reports. Independent auditors include:

- CASTNET independent auditor - Environmental, Engineering & Measurement Services, Inc. (EE&MS) currently has a contract to independently audit each CASTNET site every 2 years.
- State and local air quality agencies - Several agencies that regularly use CASTNET site data to supplement their measurement networks will audit CASTNET sites periodically (quarterly, annually, or other frequency) to ensure the quality of the measurements. For example all NPS sites in California are audited by state or local agencies.

- National Performance Audit Program (NPAP) - This EPA program offers independent audits to participating organizations. A fully instrumented EPA van will travel to sites to conduct field performance audits. The NPS hopes to negotiate an agreement with the EPA to provide this service to sites that are not independently audited by other agencies.

CASTNET site operators will always be notified in advance when ARS or MACTEC will be visiting their sites or when the CASTNET independent auditor will be visiting. The schedule for audits by other independent auditors may not always be known. In most cases, the site operator will be given some advance notice by the agency, but often neither ARS, MACTEC, NPS, nor EPA will be aware of the audit. The site operators will generally be asked to provide the following assistance to an independent auditor:

- Provide the auditor access to the site.
- Assist the auditor with procedures that are unfamiliar to the auditor or are most safely or efficiently performed by two people.
- Answer auditor questions about operator duties. The operator may also be asked to demonstrate one or more of these duties.
- Help the auditor navigate through DataView at NPS CASTNET sites to view the results of recent calibrations, data displays, or log entries.
- Provide the auditor with contract information for both ARS and MACTEC and ask that the auditor contact both contractors.

ARS or MACTEC must be made aware that an audit was performed. Since the auditing agency does not always make this notification, the site operator is asked to both contact ARS and MACTEC and to enter the time, date, duration, agency, and auditor’s name and telephone number in the station log. After being informed that an audit occurred, ARS or MACTEC will make sure that they obtain the audit results from the auditor. These results are an integral part of the overall quality assurance documentation for a site.

As always, contact ARS or MACTEC if you have any questions.

#### Monitoring Site Assistance:

NPS CASTNET sites: contact Air Resource Specialists  
telephone: 1-800/344-5423 (Mountain Time)

EPA CASTNET sites: contact MACTEC  
telephone: 1-888/224-5663 ext. 3611 (Eastern Time)

## OPERATOR'S TOOLBOX

### CASTNET site conditions, surroundings, and vegetation



CASTNET program objectives are:

- To monitor the status and trends of air emissions, pollutant deposition, and air quality;
- To determine the effects of emissions on water quality, forests, and other sensitive ecosystems; and
- To assess the effectiveness of emission reduction requirements through operation of a long-term monitoring program.

Filter packs are used at EPA CASTNET sites to obtain regional air quality samples. The filters collect particles and gases during the week that the filter pack is in place. The filters are subsequently removed from the filter pack holder and analyzed for sulfur and nitrogen compounds, sodium, potassium, chloride, magnesium, and calcium. Additionally, continuous measurements of wind speed, wind direction, temperature, relative humidity, solar radiation, precipitation, and ozone are made and electronically reported. Vegetation near the site and at a distance are also observed or estimated and reported as the percent of leaf-out and leaf area index (LAI) on a periodic basis.

The particulate matter and gas data are used in conjunction with meteorological, vegetation, and land use data to perform complex computerized modeling. This modeling estimates the rates that the particles, gases, and their precursors are deposited to the environment. For these

**Table 1. Site-specific siting criteria for CASTNET monitoring sites.**

Potential Interferant	Minimum Distance From Measurement Apparatus
Large point source of SO <sub>2</sub> or NO <sub>x</sub>	20 to 40 km
Major industrial complex	10 to 20 km
City, >50,000 population	40 km
City, 10,000 to 50,000 population	10 km
City, 1,000 to 10,000 population	5 km
Major highway, airport, or rail yard	2 km
Secondary road, heavily traveled	500 m
Secondary road, lightly traveled	200 m
Feedlot operations	500 m
Intensive agricultural operations (including aerial spraying)	500 m
Limited agricultural operations	200 m
Large parking lot	200 m
Small parking lot	100 m
Tree line	50 m
Obstacles to wind	10 times obstacle height

estimates to be accurate and meaningful, the conditions at the site must not interfere with particle, gas, and meteorological measurements. Therefore, each site must be maintained so as to strictly adhere to siting criteria (Table 1).

Maintaining and assuring such operating conditions may seem unimportant, and violations of criteria may develop slowly over time – so slowly as to escape notice unless the site operator and MACTEC or ARS field staff objectively assess site conditions regularly.

On a broader scale CASTNET sites must also satisfy the following criteria:

- Regional representativeness,
- Avoidance of nearby pollution sources,
- Long-term availability,
- Accessibility, and
- Good overall geographic distribution of sites to ensure meaningful nationwide status and trends information.

The site operator must remain constantly aware of changes in surroundings, particularly if a change violates criteria for proximity of a secondary road, feedlot operations, agricultural operations, a large or small parking lot, a tree line within 50 m, or obstacles to the wind that are within 10 times the height of the obstacle to the CASTNET monitoring station. Changes in site status, representativeness, and accessibility should be reported to MACTEC (EPA-operated sites) or ARS (NPS-operated sites) immediately.

Locally, the site operator, responsible agency (EPA or NPS) and network contractors (MACTEC or ARS) must assure that site vegetation is controlled and not allowed to cause a violation of siting requirements. If trees or shrubs interfere with normal site operations or violate siting criteria, then permission to trim or remove the vegetation must be obtained, MACTEC or ARS must be advised of the need to have such services conducted.

To document site changes, panoramic photographs are taken over time and a verbal assessment of each site is performed during each biannual calibration.

Please contact MACTEC or ARS field staff should you require additional information or need to report a known or possible violation of siting criteria. Quality data collection depends on the diligence and attention of the site operator(s) responsible for each site. Keep up the good work and thank you!

**Air Resource Specialists, Inc.**  
1901 Sharp Point Drive, Suite E  
Fort Collins, CO 80525

**TO:**

First Class Mail

**The Monitor**

is published in the spring and fall by Air Resource Specialists, Inc. under NPS Contract C2350064024, for air quality site operators in the CASTNET and NPS GPMP air quality programs. For newsletter address corrections, contact:



1901 Sharp Point Drive, Suite E  
Fort Collins, CO 80525  
Telephone: 970/484-7941  
Toll Free: 1-800/344-5423  
Fax: 970/484-3423  
E-mail: [info@air-resource.com](mailto:info@air-resource.com)

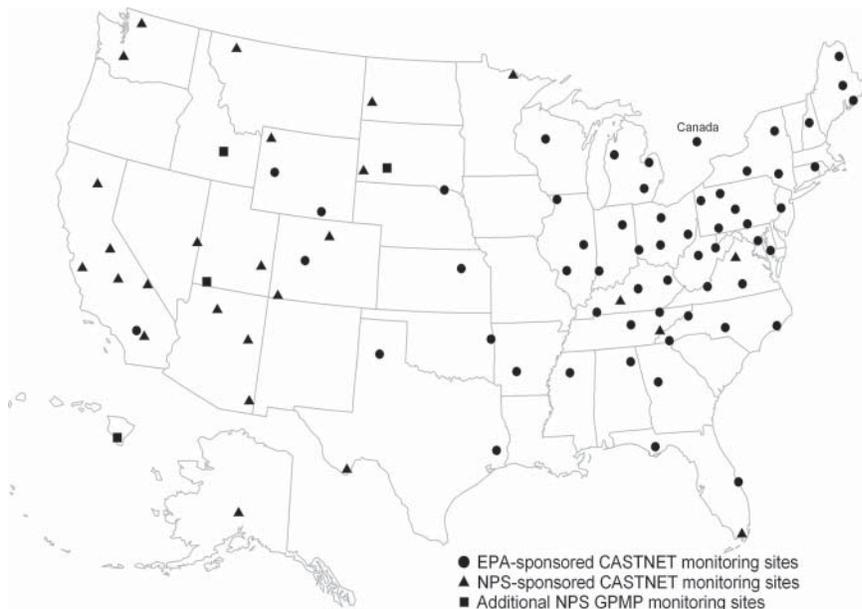
The Monitor is also available on the Internet at <http://www2.nature.nps.gov/air/Pubs/theMonitor.htm>

Newsletter production consultant:  
John D. Ray - Program Manager, NPS ARD  
Telephone: 303/969-2820

Editor:  
Gloria S. Mercer  
Air Resource Specialists, Inc.  
Telephone: 970/484-7941



**CASTNET Monitoring Program Locations**



EPA Clean Air Status and Trends Network  
(<http://www.epa.gov/castnet>)

NPS Gaseous Pollutant Monitoring Program Network  
(<http://www2.nature.nps.gov/air/monitoring/index.cfm>)