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AIR MONITORING FOR WILDLAND FIRE OPERATIONS

J. Kennedy and G. Guay

The following are recommendations for conducting an ambient air monitoring program in support of wildland fire operations. These guidelines are designed to assist public land management agencies, Tribal authorities, and private land owners in the assessment of smoke impacts from wildland fire activities. It generally describes important differences between wildland fire monitoring and monitoring for compliance with national ambient air quality standards (NAAQS), how air monitoring can support development and assessment of smoke management plans, and how air agencies and fire/land management agencies can collaborate to conduct monitoring where needed. Information on types of monitors available, cost estimates, and suggestions for operational guidelines are also provided.

What are the differences between wildland fire and NAAQS compliance monitoring?

The primary purpose for monitoring wildland fire impacts is to support the smoke management planning process, primarily in wildland-urban interface and Class 1 areas. Uses include: 1) as a tool in assessing smoke management program effectiveness, 2) to assess smoke impacts on sensitive receptors, including firefighter safety, and visibility impacts to Class 1 areas, and 3) for input and validation of modeling studies and other research on smoke behavior. These additional points will help to further clarify the differences between recommended wildland fire air monitoring and monitoring for compliance with the NAAQS:

NAAQS Monitoring

- Monitoring for NAAQS compliance requires a long-term fixed network which meets the State and Local Air Monitoring Station (SLAMS) criteria of 40 CFR Part 58 and appendices; Criteria include: quality assurance, monitoring methodology, siting, etc.

- Monitoring for NAAQS compliance requires the use of federal reference or equivalent methods pursuant to 40 CFR Parts 50 and 53;

- Monitoring for NAAQS compliance is generally done in high population areas and is primarily filter-based. Data from filter-based monitors is collected every 24 hours and then must be weighed. This delay is obviously an impediment to providing burn managers and air quality managers with the information they need to respond in a timely manner to unacceptable smoke impacts.

Fire Monitoring

* States are responsible for deployment of SLAMS networks. A state may decide to locate a SLAMS or special purpose monitor (SPM) in any populated area where repeated or anticipated levels of smoke exposure from fires is high. Should the NAAQS be violated at a fixed SLAMS or SPM site (that meets CFR guidelines) due to smoke impacts, that violation is considered valid under the Clean Air Act.

* Monitoring for smoke impacts from wildland fire will, in most cases, include short-term monitoring of fire events with portable, or semi-portable instruments. While such short-term monitoring should follow established protocols (e.g., siting design, operational procedures, quality assurance, etc.), federal reference method and SLAMS requirements would not need to be strictly adhered to. Therefore, except in cases where SLAMS and federal reference methods are being utilized, this program cannot be used to determine compliance with the NAAQS.

• Monitoring of wildland fire is usually done to measure smoke impacts in a quantitative sense without regard to comparisons with the NAAQS. One example of such monitoring is a real-time nephelometer network established by the State of Oregon to monitor burning activity in the Blue Mountains. This method is far more effective than filter-based monitoring since the feedback from the monitors is instantaneous and so burning can be modified or terminated where unacceptable smoke impacts are occurring.

Monitoring to support smoke management programs

Air monitoring can be used to support a number of objectives in the smoke management planning process. For a small project where smoke sensitive receptors are not expected to be impacted and the NAAQS is not approached, visual monitoring of the direction of the smoke plume may be sufficient. Posting personnel on potentially affected roadways to monitor for smoke and to initiate safety measures for motorists, using aircraft to track the progress of the smoke plume, continued tracking of meteorological conditions during the fire, and a network of persons at the various sensitive receptors visually monitoring for smoke impacts are examples of monitoring techniques. Ambient monitoring may be warranted for projects which are expected to be multiple day events and/or may potentially cause the NAAQS to be approached in smoke sensitive areas.

Most wildland and prescribed fires will take place in remote areas, however, some do occur at the wildland/urban interface. Since most ambient air monitoring takes place in urban population centers, States/Tribes should consider establishing monitoring sites, in addition to those in the current monitoring network, near sensitive receptors at the wildland/urban interface during fire seasons. When the State/Tribe determines that additional monitoring is warranted, the following elements should be considered:

- type and size of fires requiring special air monitoring,

- who will purchase and service monitors,
- where monitors should be located,
- type of monitors that will be used at each location,
- sampling time duration and frequency,
- sample analyses required,
- storage and use of monitoring results

Public Notification and Firefighter Safety

There are real limitations on the use of ambient monitoring data for real time decision making for the purpose of protecting public and firefighter health. The 24-hour NAAQS for particulate matter (PM-2.5 and PM-10) Federal reference (or equivalent) monitors operate on a 24-hour schedule and are therefore not appropriate for real time decision making. On the other hand, non-filter based real time samplers provide a instantaneous reading of increasing PM levels and thus can be used for public notification, fire management, or firefighter safety purposes . Ambient monitoring can be useful for multi-day events where mid-stream fire management decisions are possible, either to change the prescription or to issue an air quality advisory to nearby communities. It will be up to the judgement of the burn boss and/or local air quality officials to determine when to issue an air quality advisory. Where smoke impacts to downwind communities may be of concern, measuring air quality levels can help provide assurance to those communities that a fire is being carefully "monitored". Where SLAMS sites exist in downwind communities, compliance with the NAAQS can be tracked.

Evaluating Smoke Management Plan Effectiveness

Monitoring is one tool which can determine how well a smoke management plan is working with regard to the concentration levels of harmful pollutants impacting firefighters or sensitive populations. The design of any given monitoring network depends on the purpose for which it is being conducted. If, for example, the use is to determine the distance or direction of smoke travel for purposes of developing or assessing smoke management plans, a series of monitors at various downwind distances would be appropriate. Monitoring frequency should also be often enough to determine smoke travel under various conditions or to determine the duration of smoke exposure to receptors. Where post-burn analysis is being conducted, the sampling design might call for samplers to gather data at various locations to assess if the smoke management measures are successful. Having good data is essential in post-burn analysis to aid in improving smoke management plans.

Monitoring for smoke management plan effectiveness can be limited by: the vagaries of fire/smoke behavior and monitor siting options; not having enough monitors for the application; budget constraints; coordination with fire managers; inadequate training or knowledge of monitoring methods; unclear monitoring objectives or inadequate network design.

Partnerships

Joint monitoring efforts among stakeholders (including public land management agencies,

Tribal authorities, state/ local air agencies, non-governmental agencies, and private land owners) can greatly increase collaboration, reduce costs, and take more advantage of air monitoring as a useful tool in assessing air quality impacts of smoke. A number of collaborative monitoring arrangements already exist across the country, which can provide useful lessons for future collaborative efforts. For example, the state of Oregon in cooperation with the Forest Service and the Bureau of Land Management entered into an agreement to establish a real-time air quality monitoring network to minimize prescribed burning impacts originating in the Blue Mountains and protect air quality in NE Oregon, SE Washington and Western Idaho.

State/local air agencies play a key role in this process by providing technical assistance, training, and sometimes instrumentation to stakeholders. They can also activate idle network samplers to support smoke tracking efforts. Local air agency personnel are often willing to operate and maintain instrumentation, assist in data analysis and reporting, and issue health advisories when requested. MOU's between stakeholders (such as the one between Oregon and the federal government) can be a good vehicle for detailing what services would be provided and who would pay for salaries and per diem.

Another very important aspect to partnerships is the smoke management planning and negotiation process among stakeholders. The greater the understanding and collaboration that can be achieved among the various governmental agencies in this process, the more sharing of technical assistance, personnel and monitoring resources can take place to achieve mutually desired goals.

What type of monitors are available?

Two general types of ambient air quality monitors are available for use in sampling prescribed fire emissions; those which have been certified as federal reference method monitors (FRMs) and those which show comparable results, but have not been certified. The FRMs are more commonly associated with fixed SLAMS sites. These samplers are large, not easily transportable, require line power and are labor intensive. The current PM-10 and PM-2.5 samplers are available in both continuous and manual configurations. Manual samplers are collect particles on a filter medium and are designed to give 24 hour measurements. The continuous sampler provides data hourly in addition to providing a 24 hour average and is better suited for indicating changing levels of particulate on an hour-by-hour basis. Filter-based samplers allow for speciation analysis of soil, organics (carbon), metals, and other compounds - analyses which also help to validate modeled estimates of these components.

For prescribed burns where smoke changes direction frequently or the duration of the burn is short, a portable sampler is more desirable. Two types of portable monitors are currently available, filter based and non filter based. In general, the filter based sampler is similar to the FRM sampler while the non filter based monitor (integrating nephelometers) correlates back scattering of light off the particles in the gas stream to produce a concentration. One of the newer

technologies combines a nephelometer with a portable particulate sampler to provide a real-time continuous monitor with a filter collection capability. The advantage is instantaneous data readout with the ability to do filter speciation later. The limitation of these portable samplers is that they may not be as accurate as the FRMs and their data could not be certified for determining compliance with the particulate standard- shortcomings which are not believed to be critical for this application.

Finally, there are monitors available which combine different measurement parameters such as for aerosols (e.g., nitrates, sulfates and carbon compounds), fine and coarse particulates, some gaseous pollutants, and visual (camera) components . IMPROVE sites are probably the best example, and certainly most widely used, sampler of this type which are used primarily for monitoring visibility impacts in Class 1 areas. The Interagency Monitoring of Protected Visual Environments (IMPROVE) network is a cooperative effort among several agencies, including NPS, EPA, NOAA, USFS, STAPPA, FWS, WESTAR, BLM, and NESCAUM. The IMPROVE program was designed in 1985 and initiated at 20 locations in 1987. The objective of the program is to monitor visibility in Class I visibility protected areas (156 national parks and wilderness areas nationwide). Several additional agencies have adopted the instrumentation and protocols developed for IMPROVE for use in their programs, bringing the number of IMPROVE look-alike sites to more than 40 in this country and nearly 60 worldwide.

How much do samplers cost?

Monitors cost between $2000 and $20,000 with fixed site continuous samplers and remote-operated integrated meteorological/particulate samplers priced at the upper end of the range. Fixed site installations cost approximately $10,000 depending on the type of shelter and local power requirements. A basic portable nephelometer costs around $5000 with the sampler version around $8000-$10,000. The capital costs of filter handling and weighing is approximately $20,000 -30,000 if a microbalance balance is needed to be purchased. Operating and data analysis are in addition to the above capital costs.

How often should sampling be done?

The standard sampling duration for FRMs is a twenty-four hour period starting at midnight and ending at midnight the following evening. For the purpose of smoke management plans, the monitoring times can be adjusted to what makes sense. Start times may be shifted to early in the morning; sampling duration may be adjusted to shorter periods to facilitate advisory updates. When basing action on continuous sampler readings, the recommended sample period should be at least 3-6 hours.

How should data be analyzed?

Data analysis depends on the intended use. Where immediate operational decisions and public notification are being based on the data results, only real time monitoring information

should be used. In a post burn analysis mode, the entire data set, including filter analyses and meteorological data, can be used to assess smoke dispersion patterns, validate air quality models, fine tune action plans to improve public notification systems, and revise smoke management plans. Laboratory support is essential for filter weighing and speciation.

Monitoring Protocols

Protocols should be developed and agreed upon before conducting a monitoring program or project. Protocols should include siting design and rationale for monitor placement; routine quality control check procedures against certifiable standards (traceable to National Bureau of Standards where possible); quality assurance procedures on instruments and data, data analysis procedures, QC and QA; data storage and accessibility, and reporting (to whom, how often, what format, etc). The Federal monitoring guideline in 40 CFR 58 can provide some framework for developing a monitoring protocol, as well as other existing field and research study protocols.

References

1. Code of Federal Regulations, Title 40, Parts 50, 53, 58, and Appendices.

2. Prescribed Fire Understory Burning Smoke Monitoring Plan, USDA Forest Service, Pacific Northwest Region. Prepared by CH2MHill. Contract # 53-82-FT-03-2. *Draft* April 1, 1997.