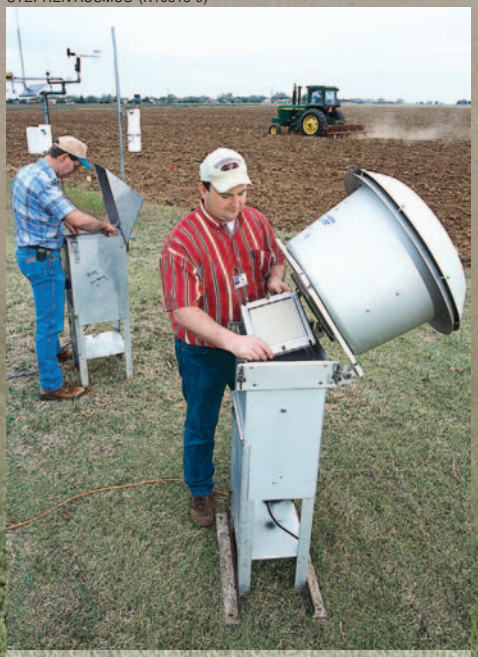
STEPHEN AUSMUS (K10519-6)

A Bum Rap for Agricultural Dust?

Look at those dust clouds kicked up by a plow in West Texas! Is that dust affecting public health as much as public perception and dust samplers would indicate?

"No," says Michael Buser, an agricultural engineer in the Cotton Production and Processing Research Unit at ARS's Cropping Systems Research Laboratory in Lubbock, Texas. Why not? Because current sampling methods tend to overestimate the amount of very small particles in agricultural dust, his research shows.

STEPHEN AUSMUS (K10513-9)



Inset: Agricultural engineers Greg Holt (left) and Michael Buser change filters from PM10 (foreground) and TSP samplers and collect meteorology data while sampling dust generated by a rolling cultivator (background).

An ambient PM10 sampler in a West Texas dust storm. A storm like this exposes samplers to dust particles greater than 10 micrometers, and larger dust particles increase the overall error associated with ambient air samples.

MICHAEL BUSER (K11169-3)

A disk bedder throwing up beds in preparation for planting can generate a lot of dust.

Buser's lab is located in the heart of Dust Bowl country. Scientists there and at the Texas A&M Center for Agricultural Air Quality Engineering and Science have been working on characterizing and defining dust emitted from agricultural sources. They also want to develop economically feasible ways to reduce dust emissions to comply with federal and state air quality regulations.

"In agriculture," says Buser, "we're typically dealing with 'boulders,' in comparison to the particle sizes that the EPA (U.S. Environmental Protection Agency) is concerned about from a health-risk standpoint." Agricultural activities will generate some dust particles in the size range that EPA is concerned with, but the amounts are greatly overestimated in most situations because of inherent sampler errors, he says.

EPA is concerned with particulate matter 10 micrometers (μm) or less in diameter (PM10), with a special concern for particles 2.5 μm or less in diameter (PM2.5).

"To put these particle sizes in perspective, the average diameter of a human hair is 75 μm," Buser says.

Complying With the Law

Through the authority of the Federal Clean Air Act, EPA has established National Ambient Air Quality Standards, or concentration limits, for PM10 and PM2.5. Multiple violations of these standards can lead to a "nonattainment" designation for an area, with a corresponding reduction in allowable emission rates for all sources of particulate matter in that area.

State air pollution regulatory agencies have authority to set or limit emissions from individual businesses through use of operating permits. If an agency determines that a business is exceeding limits set in the permit—or if it becomes necessary to reduce emissions in a region—the agency could require the business to cut its emissions by adopting alternative management techniques or incorporating additional control devices.

Buser and his colleagues are evaluating samplers and sampling methods regulatory agencies use to determine particulate matter levels emitted by agricultural sources, such as cotton gins, cattle feedlots, dairy operations, grain elevators, and tillage and harvesting operations. They have found that sampler measurements can indicate that agricultural sources are emitting much more PM10 or PM2.5 than they actually are. This is because the preseparator in the samplers blocks some of the smaller particles from passing through it and being deposited on the filter, but lets some of the bigger particles pass through.

Basically, the sampler has two errors: one causing oversampling and another causing undersampling. A common assumption made in the regulatory community to circumvent this problem is that one error offsets the other. In other words, the mass of smaller particles prevented from reaching the filter is equal to the mass of larger particles that mistakenly make it to the filter. But this assumption is not valid outside of a laboratory setting where there is a uniform distribution of particle sizes. Outdoors, the distribution of particle sizes in dust from most agricultural operations is far more uneven, with larger particles tending to predominate.

A More Precise Sampling Tool

EPA and state air quality regulatory agencies now use two basic types of samplers: Ambient air samplers sample air over a wide area, and "stack" samplers measure particulate matter emitted from an individual business or farm operation. EPA has a network of several thousand ambient air samplers permanently in place across the United States. A region's air quality agency may temporarily install a stack sampler at a particular business before issuing an operating permit or to determine whether the business has to reduce emissions.

Buser and his colleagues have found a third, more accurate method to determine PM10 and PM2.5 concentrations from agricultural sources. It uses total suspended particulate (TSP) samplers to obtain a total concentration of dust, followed by laboratory analysis of the filter to determine particle-size distribution and percentage of smaller dust particles.

Buser's research shows that this method would do a better job than stack samplers in measuring dust output from agriculture.

It Saves Money—In the Long Run

This proposed method of determining concentrations emitted from agricultural sources will most likely increase the cost of sampling. But, says Buser, "By improving the samplers and sampling protocol used to regulate agricultural businesses, we could save that sector of the economy a lot of money in the long run, without any harm to air quality."

And though it will go a long way toward correcting errors associated with particulate-matter sampling, it will not eliminate them. "I don't think we're going to have a perfect sampler any time in the near future," he says. "The technology just isn't there to eliminate the two errors. And it's not for a lack of trying, because researchers have been working on improving dust samplers for years. Developing a sampler to accurately measure a pollutant as diverse as particulate matter, with sizes varying from less than 1 μm to over 100 μm, is extremely challenging.

"Results from the ambient samplers set up across the United States to determine whether or not a region is in compliance with air quality standards for PM10 and PM2.5 may be right on the money for urban dust measurements under normal conditions," says Buser.

But if the region where a sampler is located is prone to dust storms like the one seen in Lubbock on April 15, 2003, the sampler most likely will greatly overestimate PM10 concentrations. A storm like that one exposes samplers to dust particles that are mostly larger than 10 µm, and these greatly increase the overall error associated with ambient air samplers. Such dust storms could erroneously place a region in danger of receiving a nonattainment classification for PM10 or PM2.5, or both.

"These sampler errors may prove—and have proven in some instances—to be extremely costly to agriculture," says Buser. "The agricultural community has seen only a small fraction of the impact of future air quality regulations likely to come. For instance, California legislators are proposing a state bill (SB 700) that would establish a comprehensive new definition of the term 'agricultural operations' and require farmers to obtain and maintain an air pollution permit to perform them. Included would be such common practices as disking, irrigation pumping, and harvesting.

"And, as we all know, once a bill like that is passed in one state, other states tend to follow. Though most states currently require agricultural processing operations—such as cotton gins, feed mills, and grain elevators—to obtain and maintain operating permits, the requirement has not yet been extended to individual farmers' tillage and harvesting operations."

Compliance Is Key

While ARS has several researchers working in the wind erosion arena, including at the Wind Erosion and Water Conservation Research Unit in Lubbock, Buser is one of very few dealing with agricultural air quality in terms of compliance.

According to Buser, "The difference between air quality compliance research and wind erosion research can be seen in the goals of each. The fundamental goal of most wind erosion research is to minimize or eliminate soil loss by modifying agricultural practices. But the fundamental goal of compliance research is to ensure that agricultural producers and processors can obtain and maintain the operating permits required to allow them to stay in business.

"Compliance-related research includes rigorous evaluation—using sound science—of regulations applied to agricultural industries and development of abatement strategies and devices to help the agricultural community comply with national air quality standards.

"In my opinion," Buser says, "both areas of research are critical."—By **Don Comis,** ARS.


STEPHEN AUSMUS (K10516-8)

Agricultural engineer Michael Buser (left) and technician Bill Turner prepare to insert an EPA Method 201 stack sampler into candy cane piping attached to a cotton gin exhaust.

This research is part of Air Quality, an ARS National Program (#203) described on the World Wide Web at www.nps.ars.usda.gov.

Michael D. Buser is in the USDA-ARS Cotton Production and Processing Research Unit, Cropping Systems Research Laboratory, Rte. 3, Box 215, Lubbock, TX 79401; phone (806) 746-5353, fax (806) 744-4402, e-mail mbuser@lbk.ars.usda.gov. ★


STEPHEN AUSMUS (K10515-1)

Turner, Holt, and Buser conduct stack sampling on a cotton gin exhaust.