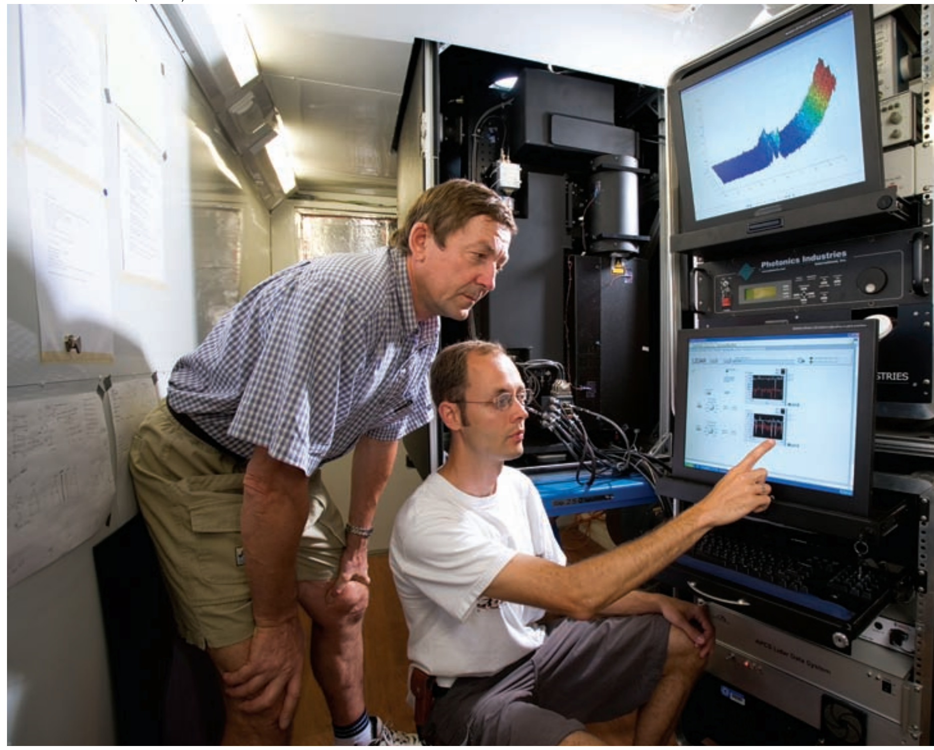
Improving Our Atmosphere

Ground-to-Air Coverage at Ames

STEPHEN AUSMUS (D399-1)



Senior scientist Vladimir Zavyalov (left), electrical engineer Jason Swasey (middle), and senior scientist Tom Wilkerson (right) of the Space Dynamics Laboratory monitor data measurements of particulates in a soybean field in Ames, Iowa, from inside their mobile LiDAR trailer.

The carbon budget, air quality around agricultural operations, and management strategies for soil and water are among the environmental issues being tackled at ARS's National Soil Tilth Laboratory (NSTL) in Ames, Iowa.

"Ames is known worldwide for its animal-disease research," says NSTL director Jerry Hatfield. "But it's also home to a wide range of ARS work aimed at conserving and improving the environment—particularly in the Corn Belt, which is one of the most crop- and livestock-intensive areas in the world."

A major goal at NSTL is to enhance air and water quality in agricultural landscapes through such practical strategies as keeping unused crop nutrients from seeping into waterways and by effectively using animal waste.

STEPHEN AUSMUS (D400-1)

A laser beam from the University of Iowa mobile facility lab is positioned to track the particulate plume from a swine facility.

Lately, NSTL scientists have paid increasing attention to the global impacts of agriculture. An example of this can be found in work related to the world's "carbon budget," which is an assessment of carbon amounts in the atmosphere relative to those being absorbed by soil.

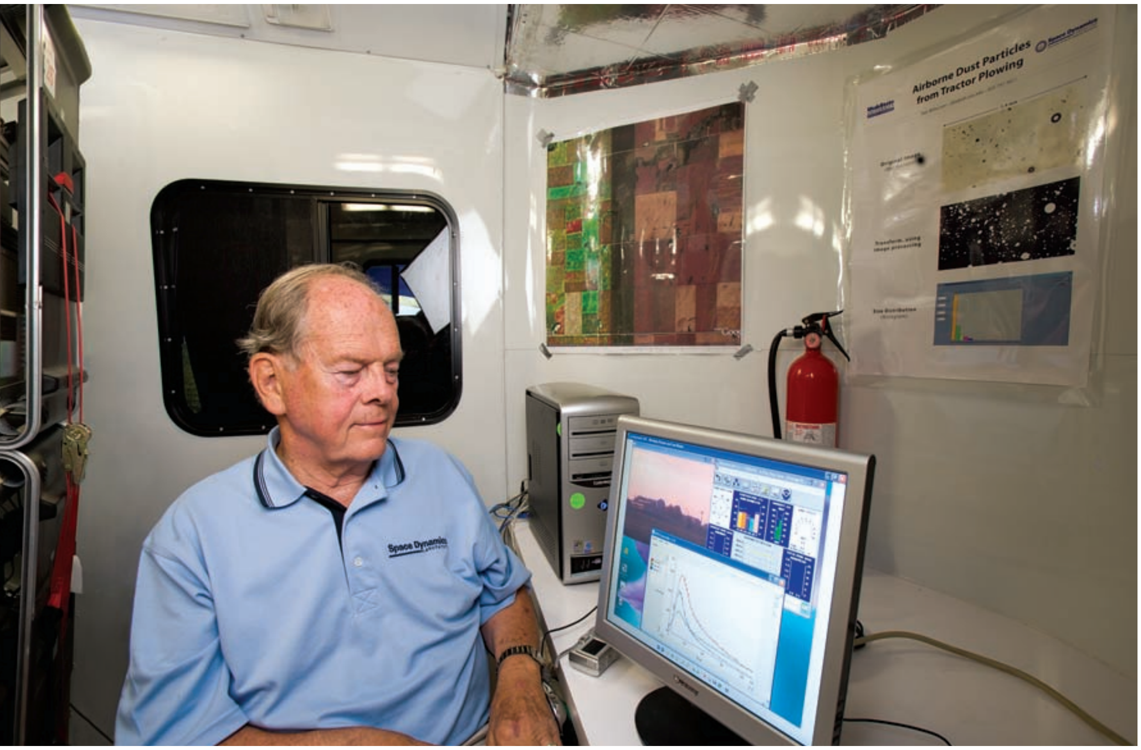
Carbon is a hot topic in agricultural and climate-change circles because carbon dioxide is among the major greenhouse gases in our atmosphere that are linked to human activity. ARS is working on a national estimate of how much carbon U.S. farm and grazingland soils are currently storing. (See "Depositing Carbon in the Bank: The Soil Bank, That Is," *Agricultural Research,* February 2001, pp. 4-7.)

Hatfield says NSTL is taking part in the North American Carbon Program (NACP), a U.S. Climate Change Science Program initiative directing experimental and field campaigns related to the carbon budget.

Carbon and the Corn Belt

"We're involved in NACP's Mid-Continent Carbon Program, which will help researchers understand the Corn Belt's role in the global carbon cycle," says Hatfield. "We'll study how farming-management systems interact with energy and carbon exchanges. A goal is to measure the amount of carbon dioxide, methane, nitrous oxide, and other greenhouse gases released from soil into the atmosphere and determine how different crop- and soil-management methods affect these exchanges."

This task will be done in part through comparisons of how regional carbon budgets are determined for a portion of the Midwest that includes Iowa, Minnesota, Wisconsin, Illinois, and parts of North Dakota, South Dakota, Nebraska, Kansas, Missouri, and Indiana.



"We'll examine the atmosphere from two perspectives: top down and bottom up," Hatfield says. "We'll work toward developing an atmospheric budget of carbon dioxide and methane based on measurements from tall towers and aircraft. It will be applied at a regional scale." The other approach, he says, "will be carried out at much smaller, watershed, field, or plot scales and will couple experimental observations with computer models."

Working within NACP are federal entities such as the U.S. Departments of Agriculture, Energy, and Defense; the National Oceanic and Atmospheric Administration; the National Aeronautics and Space Administration; the National Science Foundation; and the U.S. Geological Survey, as well as several universities.

A New LiDAR

Meanwhile, NSTL scientists seek innovative ways to measure particulates and gases emitted from crop- and livestock-production areas. Hatfield and colleagues are expanding landmark work on the use of LiDAR.

LiDAR—for Light Detection and Ranging—is a technology that's similar to radar but uses light waves instead of radio waves. Its tight beam of light can be tweaked to detect objects ranging in size from large, like cars or submarines, to tiny, like dust particles. (See "Seeing Air in a New Light with LiDAR," *Agricultural Research,* October 2004, pp. 20-21.)

Through a cooperative research agreement with the Utah-based Space Dynamics Laboratory, Hatfield and colleagues are now deploying a new, multiwavelength LiDAR developed to track and map particle emissions. Other collaborators include agricultural engineer Michael Buser of ARS's Cropping Systems Research Laboratory in Lubbock, Texas; agricultural engineer David Bjorneberg and soil scientist Dale Westermann at ARS's Northwest Irrigation and Soils Research Laboratory in Kimberley, Idaho; Space Dynamics scientist Gail Bingham; NSTL soil scientist John Prueger; and scientists from Utah State University and the University of Iowa.

"This new LiDAR is special in that it allows for point measurements of turbulence and of concentrations of particulates and gases," says Hatfield. "Key to this mission is gaining knowledge of how particles and plumes move." The researchers are currently testing it against other types of particle-detection equipment, including other LiDARs. Hatfield adds that testing LiDARs sensitive enough to detect gases may be in NSTL's future.

STEPHEN AUSMUS (D396-15)

A LiDAR laser from the Space Dynamics Laboratory mobile system is seen tracking across an Iowa landscape to measure the particulate plume at night.

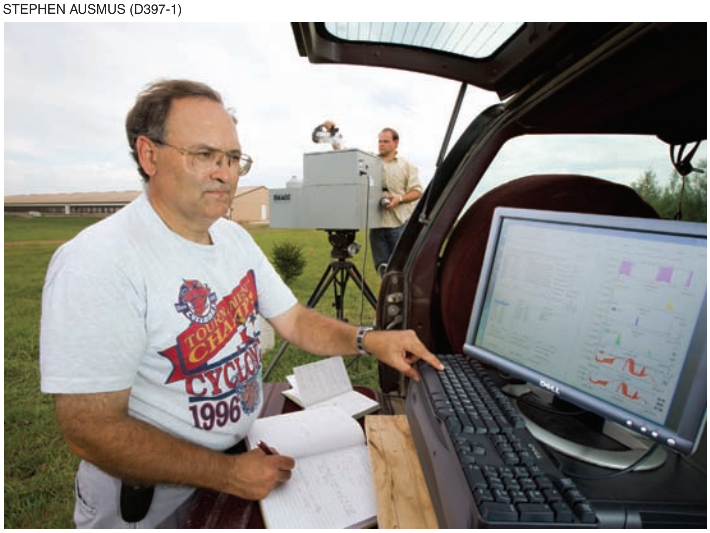
Targeting an Ill Wind

Meanwhile, animal nutritionist Brian Kerr leads a group of five scientists taking a markedly different approach in NSTL's Swine Odor and Manure Management Research Unit.

Phenomena such as housing sprawl into farmland and emergence of large-scale commercial operations have made odor from swine-production facilities a point of contention in many communities.

Kerr's unit evaluates how nutrition, microbial ecology, zoonotic pathogens, and other factors affect how pigs excrete nutrients and produce bad-smelling compounds. "Our nutritional strategy is to formulate diets that will lessen the odor-causing agents," says Kerr. "To control nitrogen-containing compounds such as ammonia, we're reducing the pigs' protein intake by giving them less soybean meal and balancing the diet with crystalline amino acids."

STEPHEN AUSMUS (D397-1)



In an air quality study, chemist Richard Pfeifer observes the spectra of gases obtained from an infrared spectrometer unit positioned adjacent to a swine facility.

Kerr says research has shown that for each 1-percent reduction in dietary crude protein, ammonia emissions are reduced by 8 to 10 percent.

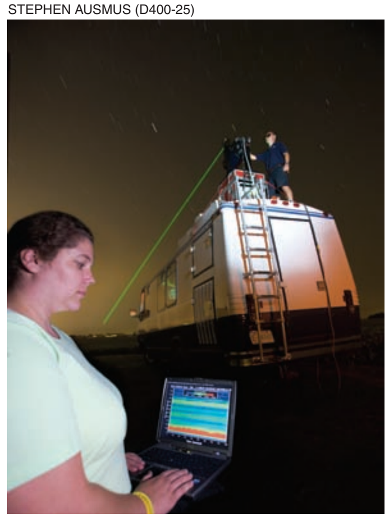
The unit is also exploring how sulfur-containing odorants may be altered to control smells from swine-production facilities. "A third factor we are changing is the fiber type and level fed to the pig," says Kerr. "Not all of the dietary fiber is digested in the pig. We've found that metabolism of these fiber sources leads to increased production of volatile fatty acids that lower manure pH. This helps keep ammonia from being released into the environment, but the effect on odor generation has not been well characterized."

"All these studies provide us with new insights into how agricultural systems can be managed to reduce their environmental impact and how to deliver our findings to crop and livestock producers so they can be incorporated into production systems," says Hatfield. "We want producers to realize that we are working for their benefit."—By **Luis Pons,** ARS.

STEPHEN AUSMUS (D401-73)

In a study to document plume characteristics with LiDAR measurements, soil scientist John Prueger climbs a 30-meter tower positioned between swine production buildings to inspect air-sampling equipment.

STEPHEN AUSMUS (D400-25)



Technician Jennifer Nichols, from the University of Iowa, examines the output from the LiDAR mounted atop the mobile laboratory.

This research is part of Air Quality (#203) and Global Change (#204), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

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