



Every Breath You Take

by Gary Galluzzo

When the winds kick up, there's no telling where the dust they blow will come to rest. More than likely, it will be thousands of miles away.

The research of Iowa scientists is proving that. If you look at the images they study from satellites and the information generated by their computers, you can see brown swirls over the Pacific drifting off the coast of Asia and heading straight for the western coast of the United States.

Gregory Carmichael, a professor in the College of Engineering, says those are not clouds; that is dust mixing with pollution from factories and cars in industrial centers like Hong Kong, Shanghai, and Tokyo.



Last year, Carmichael and his colleagues followed the formation of what came to be called the Asian Brown Cloud, a mass of dust and pollutants born in the Gobi Desert and so filled with pollutants and harmful chemicals that people in Seoul, South Korea, had to wear face masks when they went outdoors. These pollutants routinely end up hitching a ride on California-bound air currents over the Pacific Ocean.

"It shows we're all linked together in one way or the other, that's for sure," says Carmichael, the University's Karl Kammemeyer Professor of Chemical and Biochemical Engineering and codirector of the Center for Global and Regional Environmental Research.

It is a global phenomenon. Windstorms in China have darkened cities in Taiwan, Korea, and Japan; pollutants from Hong Kong have turned up in Denver and even over the farmlands of Iowa.

Chemical Soup

Carmichael has made it his life's work to find out what's in that dust, and what it does to us. You would be surprised, he says.

"It's a complete chemical soup," Carmichael says. "It has everything from mercury to a variety of combustion byproducts, including elemental carbon and polycyclic aromatic hydrocarbons. You name it, it's in there."

The consequences for human health could be serious. Carmichael points out that aerosols—the tiny particles that form from combustion and attach to pieces of dust—can easily enter the lungs with every breath we take, contributing to heart and lung disease, among other serious illnesses. He and other scientists further suspect that the dust may be responsible for damage to forests, the acidification of waterways and killing of fish, and other environmental problems.

"This is a bit complicated," Carmichael says. "Dust is an organic substance that actually counteracts acids in rain. So, this is a benefit. At the same time, dust does reduce the amount of energy available for photosynthesis, thereby reducing the yields of crops and inhibiting the growth of forests. Also, by interacting with radiation, dust perturbs regional climates."

Carmichael and his colleagues surprised their fellow scientists two years ago when they found that rapid industrialization in Asia is affecting California air quality. Carmichael notes that while people for some time have been concerned about the pollution spewing out of the factories near their own homes, they've been slow to recognize the global threat posed by that pollution. In the early 1970s, the solution to a cleaner environment seemed to be to build smokestacks 300 to 600 feet tall. That idea began to break down by the 1980s when people came to see that all that smoke had to go somewhere—and where it was going was into the mid-troposphere, where the weather moved it over thousands of miles and returned it to the surface as acid rain.

Carmichael remembers being impressed when he first saw as a child the NASA photos from space that showed the Earth as a big blue globe. The images should have made people aware that the atmosphere over the continents is interconnected, but it's taken a while for that idea to sink in, says Carmichael, who's fond of the oft-heard environmentalist's mantra that we are all downwind from somebody.

A New Kind of Weather News

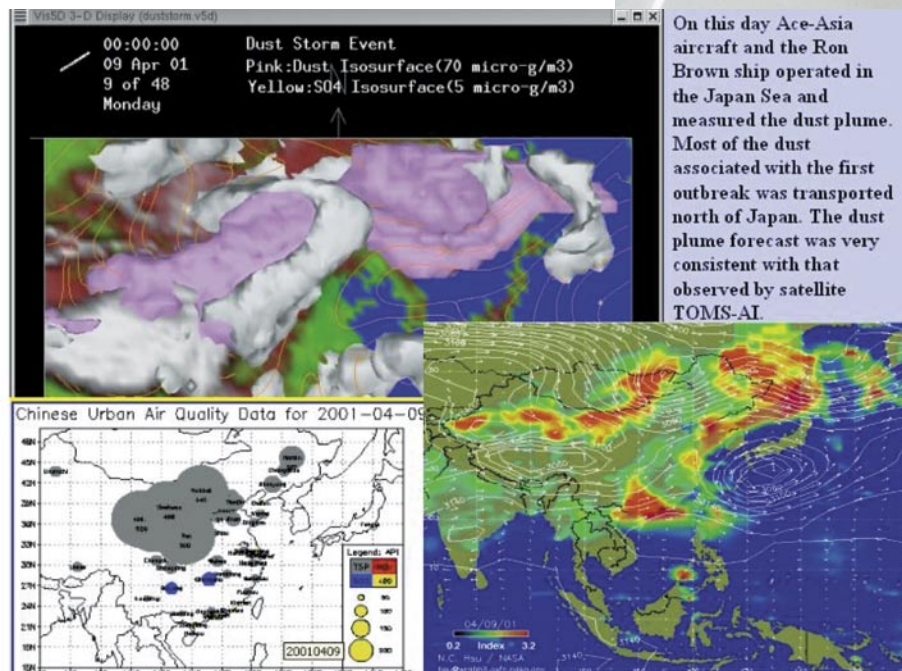
Carmichael is interested in developing a new kind of weather forecast—a chemical pollution prediction. Someday soon, on the regular nightly news, people may watch a pollution forecast based on measurements made by a network of specially equipped aircraft, satellites, and ground stations dedicated to monitoring the quality of the air. This kind of forecast would tell people not only what they can expect in the air they breathe but also how to become better stewards of the planet's environment.

The chemical weather forecast might come in two parts. The first part might show what the air quality would be like if people continued to operate their cars, air conditioners, and factories as usual. The second part might show what the air quality would be like if enough people discontinued or modified their use of those things.

"There is a societal need to know whether tomorrow will bring dangerous levels of pollution to a certain region," says Carmichael, who recently received a five-year, \$2.3 million grant from the National Science Foundation to build computer models that would facilitate the kind of pollution forecasting he has in mind. "We need to know when we should be alert to the danger, and we need to know what we can do to prevent the danger from occurring again."

On the Horizon

It would be easy to paint a pessimistic picture. But Carmichael, inspired with purpose as a high school student by the first Earth Day in 1970, feels optimistic about the changes he sees. Not only are people generally becoming more concerned about doing something about global pollution but those in charge of industry and technology also are starting to see the light, he believes.



On this day Ace-Asia aircraft and the Ron Brown ship operated in the Japan Sea and measured the dust plume. Most of the dust associated with the first outbreak was transported north of Japan. The dust plume forecast was very consistent with that observed by satellite TOMS-AI

Above: At the Center for Global and Regional Environmental Research (CGRER), director Gregory Carmichael uses satellite imagery to keep track of big dust storms like the April 2001 storm that blotted the sun from view in parts of Asia and crossed the Pacific to create air-quality problems in much of the western half of the United States.

Right: A team of researchers at the CGRER design daily experiments aimed at developing forecasts of dust storms and ways of predicting chemical pollution in the Earth's atmosphere. Among those assisting Iowa professor Gregory Carmichael are those pictured in photo at right (from left to right): Young Sunwoo, Jeremie Moen, Narisara Thongboonchoo, (Carmichael), Youhua Tang, Li Pan, Tianfeng Chai, Chao Wei, and Brian Elliott.

Carmichael recently made estimates of Asian factory emissions and urban air quality for the World Bank. They've been surprising, he says. Ten years ago, he would have predicted that a rapidly industrializing China would create a geometrically rising level of pollution. Now, Carmichael sees China making outstanding strides along the path toward a cleaner environment.

"Decisions are being made in China to leapfrog over older Western technology that was harmful to the environment," he says.

As Carmichael likes to point out, the whole planet is intermixing. If you wake up tomorrow morning to see a clear blue sky, you might thank a cleaner factory an ocean away.

