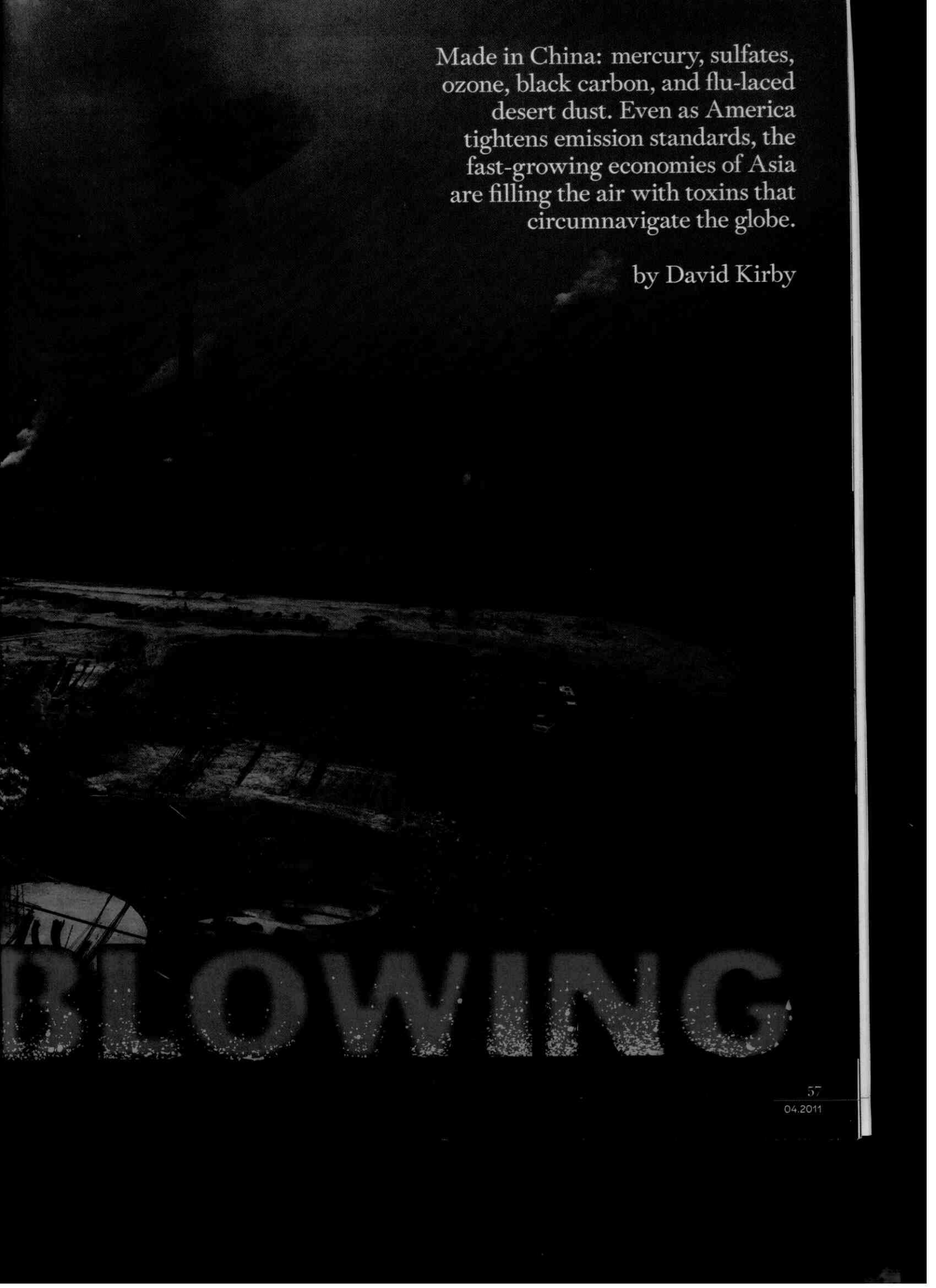


# ILL WIND



Made in China: mercury, sulfates,  
ozone, black carbon, and flu-laced  
desert dust. Even as America  
tightens emission standards, the  
fast-growing economies of Asia  
are filling the air with toxins that  
circumnavigate the globe.

by David Kirby

BLOWING

**T**HERE IS NO PLACE CALLED AWAY." IT IS A STATEMENT WORTHY OF Gertrude Stein, but University of Washington atmospheric chemist Dan Jaffe says it with conviction: None of the contamination we pump into the air just disappears. It might get diluted, blended, or chemically transformed, but it has to go somewhere. And when it comes to pollutants produced by the booming economies of East Asia, that *somewhere* often means right here, the mainland of the United States. Jaffe and a new breed of global air detectives are delivering a sobering message to policy makers everywhere: Carbon dioxide, the predominant driver of global warming, is not the only industrial by-product whose effects can be felt around the world. Prevailing winds across the Pacific are pushing thousands of tons of other contaminants—including mercury, sulfates, ozone, black carbon, and desert dust—over the ocean each year. Some of this atmospheric junk settles into the cold waters of the North Pacific, but much of it eventually merges

with the global air pollution pool that circumnavigates the planet.

These contaminants are implicated in a long list of health problems, including neurodegenerative disease, cancer, emphysema, and perhaps even pandemics like avian flu. And when wind and weather conditions are right, they reach North America within days. Dust, ozone, and carbon can accumulate in valleys and basins, and mercury can be pulled to earth through atmospheric sinks that deposit it across large swaths of land.

Pollution and production have gone hand in hand at least since the Industrial Revolution, and it is not unusual for a developing nation to value economic growth over environmental regulation. "Pollute first, clean up later" can be the general attitude, says Jennifer Turner, director of the China Environment Forum at the Woodrow Wilson International Center for Scholars. The intensity of the current change is truly new, however.

China in particular stands out because of its sudden role as the world's factory, its enormous population, and the mass migration of that population to urban centers; 350 million people, equivalent to the entire U.S. population, will be moving to its cities over the next 10 years. China

now emits more mercury than the United States, India, and Europe combined. "What's different about China is the scale and speed of pollution and environmental degradation," Turner says. "It's like nothing the world has ever seen."

Development there is racing far ahead of environmental regulation. "Standards in the United States have gotten tighter because we've learned that ever-lower levels of air pollution affect health, especially in babies and the elderly," Jaffe says. As pollutants coming from Asia increase, though, it becomes harder to meet the stricter standards that our new laws impose.

The incoming pollution has sparked a fractious international debate. Officials in the United States and Europe have embraced the warnings of the soft-spoken Jaffe, who, with flecks of red and gray in his trim beard, looks every bit the part of a sober environmental watchdog. In China, where economic expansion has run at 8 to 14 percent a year since 2001, the same facts are seen through a different lens.

China's smog-filled cities are ringed with heavy industry, metal smelters, and coal-fired power plants, all crucial to that fast-growing economy even as they spew tons of carbon, metals, gases, and soot into the air. China's

highways are crawling with the newly acquired cars of a burgeoning middle class. Still, "it's unfair to put all the blame on China or Asia," says Xinbin Feng of the Institute of Geochemistry at the Chinese Academy of Sciences, a government-associated research facility. All regions of the world contribute pollutants, he notes. And much of the emissions are generated from making products consumed by the West.

Our economic link with China makes all the headlines, but Jaffe's work shows that we are environmentally bound to the world's fastest-rising nation as well.

DAN JAFFE HAS BEEN WORRYING about air pollution since childhood. Growing up near Boston, he liked to fish in local wetlands, where he first learned about acid rain. "I had a great science teacher, and we did a project in the Blue Hills area. We found that the acidity of the lake was rising," he recalls. The fledgling environmental investigator began chatting with fishermen around New England. "All these old-timers kept telling me the lakes had been full of fish that were now gone. That mobilized me to think about when we burn fossil fuels or dump garbage, there is no way it just goes somewhere else."

By 1997 Jaffe was living in Seattle, and his interest had taken a slant: Could pollution reaching his city be blowing in from somewhere else? "We had a hunch that pollutants could be carried across the ocean, and we had satellite imagery to show that," Jaffe says. "And we noticed our upstream neighbors in Asia were developing very rapidly. I asked the question: Could we see those pollutants coming over to the United States?"

Jaffe's colleagues considered it improbable that a concentration of pollutants high enough to significantly impact American air quality could travel thousands of miles across the Pacific Ocean; they expected he would find just insignificant traces. Despite their skepticism, Jaffe set out to find the proof. First he gathered the necessary equipment.

Devices to measure carbon monoxide, aerosols, sulfur dioxide, and hydrocarbons could all be bought off the shelf. He loaded the equipment into some university trucks and set out for the school's weather observatory at Cheeka Peak. The little mountain was an arduous five-hour drive northwest of Seattle, but it was also known for the cleanest air in the Northern Hemisphere. He reckoned that if he tested this reputedly pristine air when a westerly wind was blowing in from the Pacific, the Asian pollutants might show up.

Jaffe's monitors quickly captured evidence of carbon monoxide, nitrogen oxides, ozone, hydrocarbons, radon, and particulates. Since air from North America could not have contaminated Cheeka Peak with winds blowing from the west, the next step was identifying the true source of the pollutants. Jaffe found

his answer in atmospheric circulation models, created with the help of data from Earth-imaging satellites, that allowed him to trace the pollutants' path backward in time. A paper he published two years later summarized his conclusions succinctly. The pollutants "were all statistically elevated... when the trajectory originated over Asia."

Officials at the U.S. Environmental Protection Agency took note, and by 1999 they were calling Jaffe to talk. They were not calling about aerosols or hydrocarbons, however, as concerning as those pollutants might be. Instead, they were interested in a pollutant that Jaffe had not looked for in his air samples: mercury.

Mercury is a common heavy metal, ubiquitous in solid material on the earth's surface. While it is trapped it is of little consequence to human health. But whenever metal is smelted

or coal is burned, some mercury is released. It gets into the food chain and diffuses deep into the ocean. It eventually finds its way into fish, rice, vegetables, and fruit.

When inorganic mercury (whether from industry or nature) gets into wet soil or a waterway, sulfate-reducing bacteria begin incorporating it into an organic and far more absorbable compound called methylmercury. As microorganisms consume the methylmercury, the metal accumulates and migrates up the food chain; that is why the largest predator fish (sharks and swordfish, for example) typically have the highest concentrations. Nine-tenths of the mercury found in Americans' blood is the methyl form, and most comes from fish, especially Pacific fish. About 40 percent of all mercury exposure in the United States comes from Pacific tuna that has been touched by pollution.

**A factory worker covered with coal dust in Inner Mongolia. Previous pages: Tianjin Steel Plant, in China's Hebei Province.**



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In pregnant women, methylmercury can cross the placenta and negatively affect fetal brain development. Other pollutants that the fetus is exposed to can also cause toxic effects, "potentially leading to neurological, immunological, and other disorders," says Harvard epidemiologist Philippe Grandjean, a leading authority on the risks associated with chemical exposure during early development. Prenatal exposure to mercury and other pollutants can lead to lower IQ in children—even at today's lower levels, achieved in the United States after lead paint and leaded gasoline were banned.

Among adults, University of California, Los Angeles, neuroscience researcher Dan Laks has identified an alarming rise in mercury exposure. He analyzed data on 6,000 American women collected by the Centers for Disease Control and Prevention and found that concentrations of mercury in the human population had increased over time. Especially notable, Laks detected inorganic mercury (the kind that doesn't come from seafood) in the blood of 30 percent of the women tested in 2005–2006, up from just 2 percent of women tested six years earlier. "Mercury's neurotoxicity is irrefutable, and there is strong evidence for an association with Alzheimer's and Parkinson's disease and amyotrophic lateral sclerosis," Laks adds.

CIRCUMSTANTIAL EVIDENCE STRONGLY pointed to China as the primary origin of the mercury; the industrial processes that produce the kinds of pollutants Jaffe was seeing on Cheeka Peak should release mercury as well. Still, he could not prove it from his data. To confirm the China connection, and to understand the exact sources of the pollution, researchers had to get snapshots of what was happening inside that country.

One of the first scientists with feet on the ground in China was David Streets, a senior energy and environmental policy scientist at Argonne National Laboratory in Illinois. In the 1980s he was at the forefront of the study of acid rain, and in the 1990s he turned his attention to carbon dioxide and global warming as part of the Intergovernmental Panel on Climate Change. Streets began focusing on emissions from China about 15 years ago and has since become such a noted expert that he helped the Chinese government clean up the smoke-clogged skies over Beijing before the Olympics in 2008.

In 2004, spurred by increased attention to mercury in the atmosphere, Streets decided to create an inventory of China's mercury emissions. It was a formidable undertaking. Nobody had ever come up with a precise estimate, and the Chinese government was not exactly known for its transparency.

Nevertheless, Streets considered the endeavor important because China is full of the two biggest contributors to human-generated mercury, metal smelting and coal combustion. Smelting facilities heat metal ores to eliminate contaminants and extract the desired metal, such as zinc, lead, copper, or gold. Unfortunately, one of the consistent contaminants is mercury, and the heating process allows it to escape into the atmosphere in gaseous form. Similarly, coal contains trace amounts of mercury, which is set free during combustion at power plants.

Streets began by studying reports from China's National Bureau of Statistics. China's provinces provide the

central government with detailed data on industrial production: how much coal they burn, how much zinc they produce, and so on. "China is very good at producing statistical data. It's not always 100 percent reliable, but at least it's a start," he says. Those statistics help the Chinese government monitor the economy, but for Streets they also quantified China's mercury-laden raw materials.

The numbers from the statistics bureau told Streets the total amount of mercury that might be emitted, but he also needed to know how much actually made it into the air. To obtain that information, he turned to pollution detectives—a group of professional contacts he had met at conferences, along with graduate students who spent time in his lab. Most of the time, Chinese factories turned these "spies" away. "Factory owners had nothing to gain and a lot to lose," Streets says. "They were nervous that the results would get leaked to the government."

Yet some of Streets's moles got through by guaranteeing that the data would stay anonymous. Once inside, they took samples of raw materials—zinc ore in a smelting facility, for example—and installed chemical detectors in smokestacks. After a few days of data collection, they passed the information to Streets.

The statistics Streets collected were hardly airtight. Factory foremen and provincial officials were not above providing inflated data to make themselves look more productive, and the managers who were willing to let his inspectors take measurements were often the very ones with nothing to hide. "There's still a lot of uncertainty," Streets concedes, "but we know more than we did before."

In 2005 Streets and his team reported their first tally of human-generated mercury emissions in China, for the year 1999. The scientists estimated the amount at 590 tons (the United States emitted 117 tons). Almost half resulted from the smelting of metals—especially zinc, because its ores contain a high concentration of

**He sent his spies into Chinese factories to determine how much mercury was entering the atmosphere. Usually they were turned away, but every so often a manager let them in with the promise of anonymity.**