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# Asian pollution ill wind for U.S.

## Giant brown cloud blows in from China

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TRINIDAD, Calif.—There are storms you can see here on California's far northern coast, and storms you can't.

When a big gale comes ashore at Trinidad, it's hard to miss. The heaving gray waters of the Pacific Ocean crash against the house-size boulders that litter the coastline, then shatter into white spray. A buoy lurches in the waves, its bell tolling a mournful warning, and a curtain of rain sweeps in from the sea.

But when a plume of pollution, known as the Asian brown cloud, blows in from China, nobody in Trinidad even knows it's happening. Add one more item to the long list of things

Asia exports to the United States: air pollution.

The contaminated air that rides the jet stream to Trinidad is laced with the sulfates and soot from Asia's industrial smokestacks, and nitrogen oxides that emerge from tailpipes of Asia's rapidly growing fleet of automobiles. It contains particles from fires set to clear jungles for farming, and from the millions of households that burn coal, wood or animal dung for heating and cooking.

Scientists identified the phenomenon five years ago. The Asian brown cloud, researchers now know, routinely climbs high enough into the atmosphere to hitch a ride on the fast-moving jet stream heading east to North America. In April and May, when seasonal winds are strongest, the high-altitude pollution can cross the Pacific in as little as four days.

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## CLOUD: Researchers track plume of pollutants

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So far, the increase in ground-level pollution that the Asian brown cloud causes in the United States is "not catastrophic, or even critical," said David Parrish, a research chemist with the National Oceanic and Atmospheric Administration's Aeronomy Lab in Boulder, Colo.

Still, he said, imported Asian pollution obviously works to undercut initiatives, such as cleaner-burning gasoline or improved auto mileage, intended to clean up the West Coast's air.

### Collecting data on cloud

Looming larger, however, is a growing suspicion in the scientific community that these brown clouds may be starting to warp weather patterns across much of the U.S., threatening to reduce the amount of rain that falls from the forests of the Northwest to the cornfields of the nation's midsection.

But to prove or disprove that suspicion, scientists need a lot more data. And that's where a group of scientists led by V. Ramanathan, a one-time professor at the University of Chicago, comes in.

Ramanathan is a professor of climate and atmospheric sciences at the University of California in San Diego's Scripps Institution of Oceanography. He also was a leading scientist in the 1999 Indian Ocean study that discovered that Asia's pollution, far from being localized, was transforming itself into a sprawling, semi-permanent haze.

"Show me where the plume is now," said Ramanathan, as he and the half-dozen scientists in his group stare at a computer

image projected onto the wall of a tourist cabin just outside of Trinidad.

"Step it forward," directs the 59-year-old Indian-born atmosphere scientist known as Ram. The computer displays a tendril of bright red marching across the Pacific Ocean and approaching the California coast.

### Tracking ribbons of dirt

The ribbon of red represents a stream of heavily polluted air that left Asia a few days ago. The scientists use computer modeling to help them guess where the dirty cloud will come ashore the next day, so that they can fly into it and study it.

When the right combination of low- and high-pressure systems comes together across the ocean, a meteorological "conveyor belt" forms, creating an efficient mechanism for transporting pollution and dust from Asian. Once it makes landfall, the particulates mingle with home-grown dirty air and becomes harder to study.

"If we don't leave early," warns one scientist, "we're going to lose all that pollution. That sulfate is going to be gone."

The stream of incoming pollution has divided into layers, or strata, like seams of underground coal, with clean air in between. And because the wind is moving at different speeds at different altitudes, the layers are moving at dissimilar speeds and headings.

"The one-K level is coming more to the south," said Ramanathan, watching the projected path; he's referring to a stratum 3,280 feet above the sea.

"Closer ... closer ... touch-down," he said. "It's right over our heads."

When China's dirty air begins its trip across the Pacific, fallout is bad enough to cause health problems for people on the Korea peninsula and in Japan.

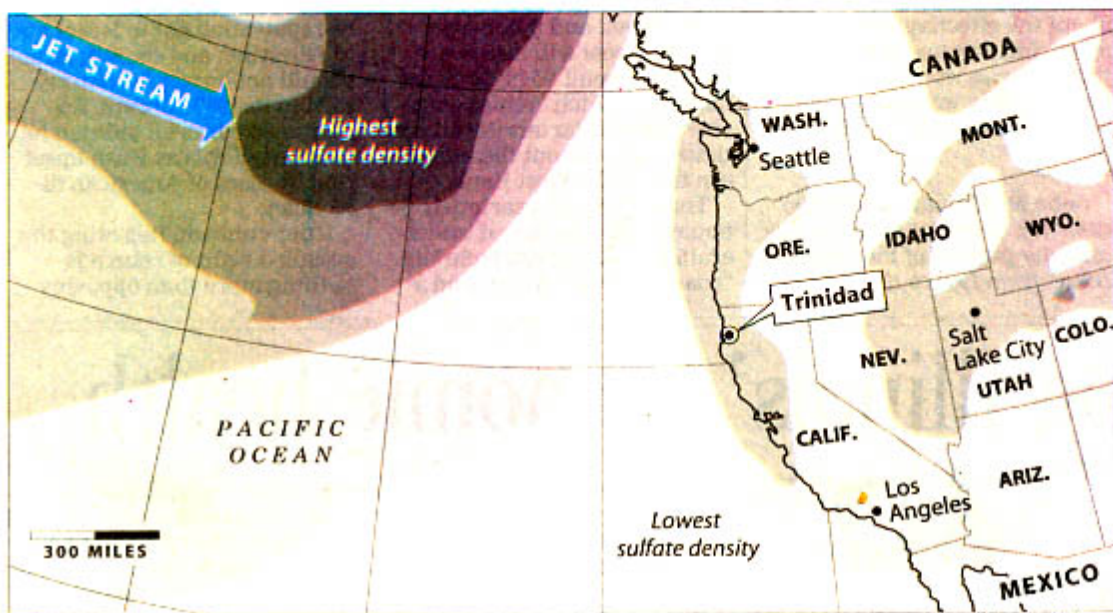
But by the time the Asian brown cloud reaches North America—scientists call the process "long-range aerosol

## Asian brown cloud travels on jet stream

Scientists have learned that high-altitude pollution from East Asia can ride fast-moving winds across the Pacific Ocean to North America, raising West Coast pollution levels and potentially altering weather patterns.

### SULFATE DENSITY ON APRIL 23, 2004, 3.5 kilometer layer

Least dense  Most dense



Source: University of Iowa

Chicago Tribune

transport"—much of its original load has fallen into the sea or has been washed out by rain.

Ozone and air-particulate readings tick only modestly higher in coastal cities like Seattle and Los Angeles.

Ramanathan is in Trinidad, about 240 miles north of San Francisco in the middle of what Californians call the Redwood Empire, because his computer models say the tiny coastal town is statistically in an ideal spot to receive tendrils of Asia's brown clouds.

These days, much of his work involves studying migrating pollution's effect on weather.

### Rainfall adversely affected

Although the greenhouse effect is the major issue for global climate change, Ramanathan contends that "the brown cloud is emerging as a major factor in regional climate changes and in

reductions of regional and global rainfall."

So in late March, he brought a research team to Trinidad to conduct a monthlong field exercise.

With funding from the National Science Foundation, the scientists probed the salty sea air using a twin-engine plane packed with high-tech equipment. Their tools included a green laser that burned straight up into the night sky, and a packet of sophisticated, atmosphere-sniffing sensors atop a 350-foot-high rock known as Trinidad Head.

Their research proposal explained that the work would include measuring "cloud-droplet spectra" in clean and dirty clouds. In other words, they were measuring their brightness.

A cloud heavy with particles of dust or pollution is whiter

than a non-polluted cloud, because water droplets condense around the particles, explained Ramanathan.

"Double the aerosols, double the droplets," he said. That means polluted clouds reflect sunlight more efficiently than a clean cloud. And that, in turn, affects the weather.

When clouds scatter sunlight, ground-level temperature declines. Such unnaturally high reflectivity also can suppress rainfall, or it can hold rain back so long that when it finally does fall to earth, it comes in the form of a damaging downpour, said Ramanathan.

Some researchers, in fact, think the extra-white clouds caused by dirty air are helping to offset the global warming effect. That would offer an explanation for the unsettling fact that "the planet hasn't warmed as much as the models suggest it



should," given the amount of greenhouse gas that humans have released into the atmosphere, the researcher said.

The Asian cloud is only the first and largest of a number of high-atmosphere brown clouds scientists have discovered. This summer, National Oceanic and Atmospheric Administration is funding a major study of a similar blotch found hovering a mile or more above the eastern U.S. (and which sends a plume of dirty air trailing toward Europe.)

### Air pollution has gone global

Europe's polluted air drifts toward Asia. Like the world's economy, air pollution has gone global, scientists contend.

"The westerly winds tie us all together," said Ramanathan.

The recently ended study in Trinidad aimed only to gather more data, not find answers. Usually, that meant two flights a day out over the Pacific, with the scientists aboard the plane watching data streaming into their laptops while trying not to be distracted by the whales surfacing in the water below.

Sometimes the dirty air was clearly visible, and sometimes only the instruments—some sampling the air 4 million times per second—could find the pollutants.

When the yellow-and-brown aircraft rolled to a stop during one of the team's last flights, scientist Greg Roberts emerged looking enthusiastic.

"We got 45 minutes of homogeneous aerosol, a full spectrum," he said.

"Ice in the precipitating clouds?" Ramanathan asked.

"Mixed," Roberts responded.

Although seven or eight laptop computers are crunching weather data inside the hangar's cramped office, Ramanathan peered from the hangar bay at the gray sky. With the study winding down, he wants to make sure he gets as many different weather conditions as possible.

"I need one low-lying cloud," he said.