tries could lead to insights about biological processes that operate according to the same dynamical rules that govern the oscillating reactions. "It's just a lot easier to study the chemical systems than the biological systems," he says.

The most studied chemical oscillator — named the Belousov-Zhabotinsky or B-Z reaction after its Russian discoverer and developer, respectively — involves a complex interplay in acidic solutions of organic molecules like malonic acid, inorganic ingredients such as the negatively charged bromate ions, and a metal-containing catalyst that doles out or takes back an electron at different phases of the oscillation. The rapidity of the oscillations depends on the relative concentrations of the solution components, and the specific behavior at a point in the solution reflects variations in the local chemical environment.

Instead of allowing the catalyst to roam the solution freely, the Morgantown scientists load ferroin, an iron-containing catalyst, onto the roughly 1-millimeter beads. The beads' overall negative charge also keeps a major B-Z reactant — bromate ions — from penetrating the beads' interiors. "This forces the reaction to occur at the surface," Showalter explains. "We go from bead to bead looking for interesting behavior." — *I. Amato*

Pacific plankton outdo land pollution

Sulfate pollution generated on land can ride the wind for great distances, eventually dropping into remote reaches of the ocean. Yet long-term measurements on Pacific islands reveal that these well-traveled particles are far less numerous than natural sulfate compounds in the air over the ocean.

This new finding bolsters a recent theory — now attracting considerable scientific attention — that tiny ocean organisms called plankton exert a powerful influence on Earth's climate.

In the June 29 NATURE, researchers describe the sulfate study and a similar study on nitrate. These particles, which form the principal components of acid rain over continents, reach the atmosphere through fossil-fuel combustion and other industrial and natural processes. As part of an international experiment in the early 1980s, Joseph M. Prospero and Dennis L. Savoie of the University of Miami analyzed weekly air samples at 13 island stations for seven years in the North Pacific and five years in the South Pacific.

Data from the network show that the sulfate and nitrate spread unevenly over the oceans, say Prospero and Savoie. Nitrate concentrations were lowest at American Samoa and other stations in the central South Pacific while reaching their highest levels in the North Pacific. Using the southern figures as a measure of "background" nitrate concentrations, the researchers calculated that the North Pacific stations received three times the background amount.

This leads Prospero and Savoie to conclude that 40 to 70 percent of the nitrate over the central North Pacific comes from continental sources. Noting that nitrate amounts swung with the arrival of Asian dust from continental storms, they say this continental nitrate originated in Asia.

Because both sea salt and plankton yield large amounts of natural sulfur compounds, the researchers had to isolate these sources to measure the continental sulfate contribution. In doing so, they showed that biological sulfate greatly outweighed the continental sulfate at the remote stations, even though industry emits more sulfur than do ocean organisms. At Midway, where continental sulfate levels were particularly high, biological sulfate was four times as abundant.

This finding supports the idea that plankton help regulate the climate by emitting key sulfur compounds that convert to sulfate. According to the theory, these sulfates create nuclei for cloud particles and increase cloud reflectivity, limiting the amount of sunlight reaching the ocean (SN: 12/5/87, p.362).

Last year, Stephen E. Schwartz of the Brookhaven National Laboratory in Upton, N.Y., argued that biological sulfate has little climate effect (SN: 12/10/88, p.375). He noted that while industry is concentrated in the Northern Hemisphere, the great amounts of industrial sulfate have produced no noticeable effect on that hemisphere's clouds or climate. The data from the island stations counter Schwartz's argument by showing that marine concentrations of industrial sulfate do not rival biological-sulfate levels. Therefore, Prospero says, the industrial sulfur should not exert as much control over cloud reflectivity as Schwartz supposed. — *R. Monastersky*

Unraveling sleep disorders of the aged

An overactive sympathetic nervous system may prevent elderly people from getting a good night's sleep, according to Seattle researchers who suggest that the sympathetic nervous system, which is responsible for arousal, increases its activity with age. The scientists hope their work will eventually spawn new treatments for an age-old problem.

Michael V. Vitiello of the University of Washington and his colleagues studied nine healthy men aged 22 to 25 who were good sleepers. Participants checked into a sleep laboratory for three 96-hour periods, receiving one of three experimental diets designed to manipulate the sympathetic nervous system. Diets consisted of hospital food altered to contain 500 milligrams of sodium per day (low), 2,000 mg of sodium per day (moderate) or 5,000 mg of sodium per day (high).

The researchers used the low-sodium diet to boost activity of the sympathetic nervous system, hoping to mimic sleep disturbances seen in the elderly. A low-sodium diet triggers water loss from the body, which results in a blood pressure decline, Vitiello explains. The sympathetic nervous system senses the body's water loss and releases norepinephrine, a neurotransmitter that constricts blood vessels, thereby maintaining blood pressure. Vitiello and his colleagues speculated that the increased activity would keep their young subjects tossing and turning at night — a time when the sympathetic nervous system typically slows down.

In studying the sleep patterns of the three groups, the team found that men on the low-sodium diet awoke an average of nine times during the night, while men in the moderate- and high-sodium groups awoke five times. The low-sodium group spent about 53 minutes awake per night, whereas men in the other groups were awake for about 22 minutes. Moderate- or high-sodium subjects spent about 95 percent of their time in bed asleep; low-sodium subjects had a sleep efficiency of only 88 percent.

"Perhaps it is the sympathetic nervous system that is contributing to the disturbed sleep of the elderly," Vitiello reported last week at the annual meeting of the Association of Professional Sleep Societies in Washington, D.C. "But the conclusions aren't that one should go out and eat a lot of salt in order to sleep better. That would be the last thing I would want people to do."

Vitiello points out that the sodium manipulation in his study was for experimental purposes only. There is no evidence showing that a high-salt diet would help elderly people sleep better over the long run, and very salty diets can contribute to other problems such as high blood pressure, he notes.

Vitiello's group has carried the research one step farther by giving elderly men diets with varying sodium contents. The researchers have not yet analyzed the data, but they postulate that elderly men on a low-sodium diet will experience a deterioration of their sleep. Exercise may be one possible remedy, says Vitiello, noting that physical activity is thought to subdue the sympathetic nervous system.

— *K.A. Fackelmann*