

closer to the earthquake epicenter, was the least affected of the Bay area's three major airports. Damage was confined to a broken water line and concrete tower windows. A new terminal, scheduled to open next year, had been specifically designed to withstand earthquakes, was undamaged, airport officials said.

The airport was an 11:30 p.m. noise curfew but remained open all night Oct. 17 and 18 to handle an influx of disaster relief supplies and news media. San Jose Jet Center, a general aviation base operator, handled 230 corporate jets and helicopters between 6 p.m. Oct. 17 and midnight Oct. 18. Ordinarily, the facility would handle about 15 of these aircraft during a comparable period.

Other instances illustrated that proximity to the center did not necessarily affect the extent of damage. United operations at Monterey airport, closer to the epicenter than either SFO or Oakland, suffered no damage, and even had no diversions from the other airports.

Lockheed Datacom, close to the epicenter in hard-hit Los Gatos, sustained only minor damage and is back in service within minutes, providing computerized flight plan and weather information to airlines and other aviation interests. □

# Ozone Hole's Reappearance Linked to Chlorofluorocarbons

WASHINGTON

New data from an old spacecraft offer the strongest case yet that the use of chlorofluorocarbons is to blame for depletion of Earth's protective ozone layer.

The data from a polar orbiting satellite show that the ozone hole that opened over Antarctica in 1987, but vanished last year, has reappeared. These new data are the first to demonstrate "that chlorine destroys the ozone," according to NASA Scientist Arlin Krueger. "Before it was all a modeler's dream in a computer."

Meanwhile, as international concerns about ozone depletion grow, NASA questions the longevity of the instrument that provides the data. The Total Ozone Mapping Spectrometer (TOMS) is one of only two instruments still working on board

the space agency's 11-year-old Nimbus 7 satellite, according to Krueger, who is the principal investigator for the TOMS at NASA's Goddard Space Flight Center in Greenbelt, Md.

The satellite's age has prompted NASA to arrange a succession of polar orbiting ozone mappers to fly on board new spacecraft, including one to be launched by the Soviets in 1991 (AW&ST Mar. 13, p. 44). The instrument, to be flown

on a Soviet Meteor 3 satellite, should provide data at least until mid-1993.

Then, the next device would be launched as a satellite payload on board a Scout-class booster. In addition, the Japanese have accepted a TOMS for the Advanced Earth Observation Satellite (AdEOS) planned for launch in 1995, Krueger said.

Depletion of the ozone layer, which partially blocks ultraviolet radiation from reaching the Earth, has been a concern since the late 1970s.

Seasonal variations in polar ozone concentrations have been observed since the early 1980s, with the most severe destruction seen in 1987.

However, when observations last year showed significantly higher ozone concentrations than in 1987, the data raised hopes that the deep hole observed in 1987 might have been an anomaly, possibly due to influences of the solar cycle, rather than human activity. This year's data dash those hopes, NASA scientists said.

"This certainly rules out a solar cycle mechanism and strongly supports a chlorine mechanism," Krueger said. "It's becoming clear that the ozone hole is not going away in the near future, although the depth will vary from year to year."

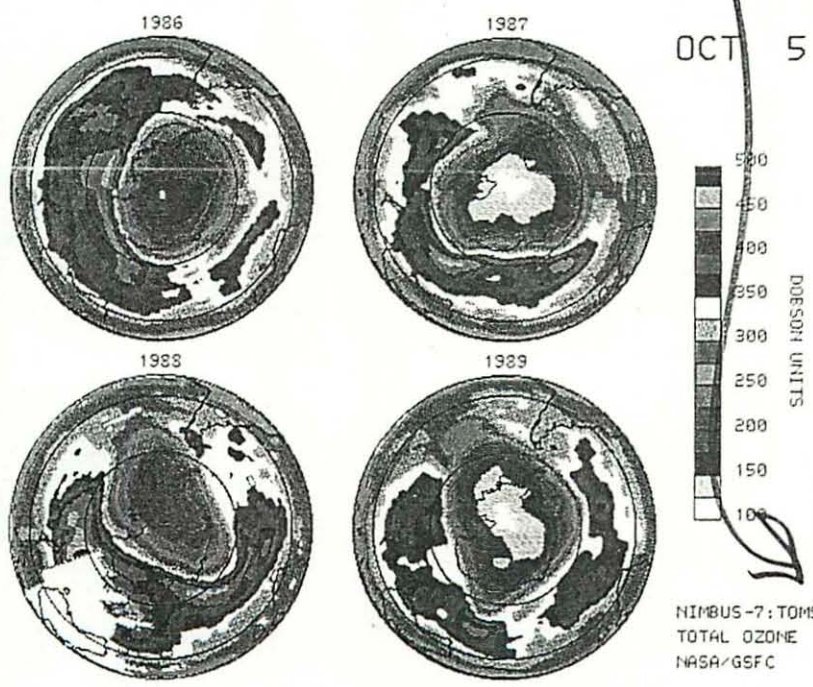
## POLAR NIGHT

Krueger said the depth of the hole each year will vary with meteorological conditions, such as temperature and winds.

The hole is an area roughly equivalent to that covered by the polar night, in which 90% of the normal ozone concentration is gone. The hole drifts somewhat and could extend over some populated areas, Krueger said.

"It's already big enough that it's affecting organisms in the ocean. So there are potential food chain effects," Krueger said. □

*'This certainly rules out a solar cycle mechanism and strongly supports a chlorine mechanism'*



False color images of the Southern Hemisphere compiled from data of the Total Ozone Mapping Spectrometer on NASA's Nimbus 7 satellite show the extent of ozone depletion on Oct. 5 each of the past four years. The values of the colors in Dobson Units of total ozone are shown by the color bar. The areas of lowest ozone concentration are represented in

purple shades. Each 100 Dobson Units equals an ozone density that would be 1 mm. thick at 0C. at 1 atmosphere. Global ozone averages 300 Dobson Units. The plots show a large hole in the protective layer appearing in 1987 and again in 1989, but not in 1988. The white area over the Australian sector in the 1988 plot is missing satellite data. □

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# Ozone hole over Antarctic shuts for year

The Associated Press

*The Register 12/5/89*

WASHINGTON — The Antarctic ozone hole is closed for this year after the window allowing dangerous ultraviolet radiation to reach the Earth was open at near record levels.

The hole, actually a region of depleted ozone levels in the stratosphere over the South Pole, approached record levels in October, the National Oceanic and Atmospheric Administration said Monday.

Ozone levels in that region have returned to normal, said Walter Komhyr of NOAA's Air Resources Laboratory.

Ozone in the upper atmosphere helps screen the Earth from dangerous ultraviolet radiation from the sun.

Scientists are concerned the hole over Antarctica could endanger marine life in that region and, if the depletion spreads, cause increased skin cancer and other health problems.

Scientists measure ozone in Dobson units, with a measurement of 270 to 300 considered normal for the area over the Antarctic.

When the ozone hole forms, levels drop drastically, setting a record at 125 Dobson units in 1987 and falling to 135 units this year.

Levels rebounded to 322 units by mid-November, then declined somewhat and are now estimated at near 300, Komhyr said in a telephone interview.

During the Antarctic spring, a band of winds encircles the continent, preventing the air there from mixing with the atmosphere in other parts of the world.

During that period, temperatures drop to minus 125 degrees Fahrenheit and colder in the upper atmosphere, creating a situation in which manmade chlorofluorocarbon chemicals can mix with and destroy the ozone.

Those reactions cease later in the year, when temperatures warm to minus 70 degrees or so, and the winds break down, allowing polar air to mix once again with air from other areas and thus restore ozone to more normal levels.

The breakup of the polar vortex winds has been occurring quite late in the last few years, Komhyr said, compared with the 1960s and 1970s, when it took place several weeks earlier. The cause of the delay is not well understood, he said.

The period of greatest ozone depletion this year extended from Oct. 6 to Oct. 9, Komhyr said.

The depletion was nearly as deep as in 1987, but didn't last quite as long as that year, he said.

## **Rockets Blamed for Ozone Loss**

Exhaust from space shuttle and other rocket launches makes the government one of the biggest contributors to ozone depletion, an environmental group charged last week.

"Each launch of the space shuttle or the Air Force's Titan IV does more to deplete the fragile ozone layer . . . than the annual ground-level emissions of chlorofluorocarbons from most individual [industrial] plants," the report by the National Toxics Campaign Fund of Boston said.

Shuttle launches are exempt from air safety regulations, and unless they can be brought into compliance, NASA should be forced to abandon solid rocket fuel, the report said. Space shuttles and Titan IV rockets are propelled by solid rocket fuel, which produces exhaust that causes environmental damage.

The European Space Agency's Ariane rocket and the Soviet Energia rocket use liquid fuel, which the report said is less damaging.

*From Times staff and wire service reports*

*LA Times 8/27/90*

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# Scientists boost estimate of arctic ozone loss

*The Register*  
By Adam Friend 9/18/90  
Dallas Morning News

Annual losses of the Earth's protective ozone layer over the North Pole appear to be larger and to last longer than previously believed, researchers have reported.

Scientists said the ozone layer, which protects life from the sun's harmful ultraviolet rays, decreases by an average of 25 percent in the arctic in the winter. They found evidence that the loss begins in early December and extends through February.

They detected the greatest decrease in ozone in regions with the highest levels of chlorine monoxide, a gas associated with the release of chlorofluorocarbons, or CFCs, chemicals already implicated in ozone destruction.

"In the arctic, losses are en-

hanced and occurring earlier in the year," said Michael Proffitt of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado at Boulder. Proffitt and five colleagues published their findings recently in the journal *Nature*.

The arctic findings differ from previous studies done in Antarctica revealing the formation of an ozone hole during spring in the Southern Hemisphere. More ozone is destroyed over Antarctica than over the arctic.

In the arctic, winds form a spiral vortex where ozone-rich winds from the tropics enter the top of the spiral and ozone-poor winds leave from the bottom and return to the tropics. This keeps ozone levels stable.

While conducting tests from an airplane last winter, Proffitt and

his Airborne Arctic Stratospheric Expedition team found losses of ozone ranging from 12 percent to 35 percent throughout the vortex.

Ozone losses already are noticeable globally. Measurements recorded by NASA's Ozone Trends Panel show that compared with 10 years ago, ozone levels have decreased 4.7 percent in the winter over the United States and Europe.

In an accompanying commentary in *Nature*, Alan Plumb of the Massachusetts Institute of Technology said the findings might be met by skepticism from fellow atmospheric scientists.

The team derived its results based on the theory that there is air flowing from outside the vortex to the inside. Some other scientists contend that the air inside the vortex is isolated.