Antarctic ozone hole expands in altitude

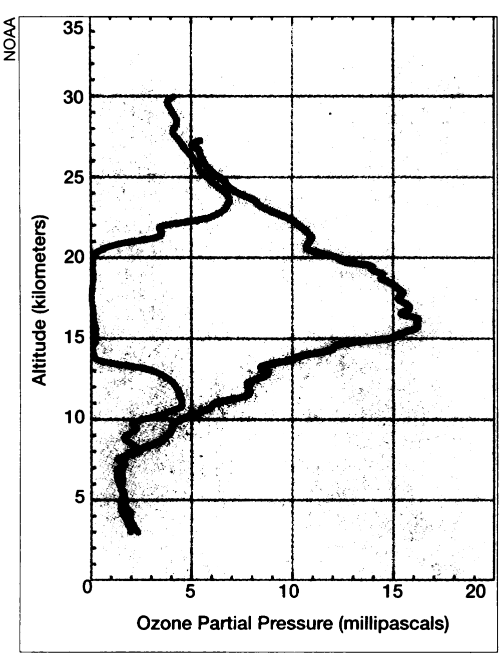
Atmospheric pollution over Antarctica has pushed its assault on the ozone layer to new heights this year, causing a subtle worsening of the so-called ozone hole over the southern continent.

The zone of total ozone destruction, which had reached from 14 to 19 kilometers in altitude, crept up to 20.5 km this month, reports David Hofmann of the National Oceanic and Atmospheric Administration in Boulder, Colo. The shift may have resulted from increased chlorine- and bromine-containing pollution in the atmosphere, he says. Fluctuations in atmospheric temperatures may also have contributed to the rise.

The ozone hole develops in the extremely cold Antarctic stratosphere each August, when sunlight returns after the darkness of the polar winter. The light drives reactions in which chemical pollutants rapidly destroy ozone, usually reaching a peak during the first 2 weeks of October. During the next 2 months, the hole fills in over Antarctica, and the ozone-depleted air spreads throughout the Southern Hemisphere.

In the past, ozone at an altitude of 20 km has escaped total destruction. This year, however, balloons launched from the South Pole in early October could not detect any ozone at that altitude.

While the vertical extension of the hole was big enough to catch the attention of scientists, it had little effect on the total concentration of ozone in the sky above Antarctica, says Hofmann. The minimum value recorded this year, 112 Dobson units, matched the minimum of the last few years. The record low, 91 Dobson units, came in 1993, when volcanic acid particles from the 1991 eruption of Mount Pinatubo enhanced ozone loss in the Antarctic.



Amounts of ozone measured Aug. 7 (blue), before formation of the ozone hole, and Oct. 8 (red), at its peak.

Satellite measurements confirm the balloon data. In terms of size and severity, the 1997 hole roughly equals last year's, according to Paul Newman of NASA's Goddard Space Flight Center in Greenbelt, Md. "This wasn't an outstanding ozone hole year," he says.

International limits on ozone-destroying chemicals have sharply slowed the release of additional chlorine and bromine into the atmosphere. Concentrations of such chemicals have already peaked in the lower atmosphere, but they are still increasing in the stratosphere: It takes 5 years for air to drift up that far.

Calculations suggest that the stratospheric concentrations should level off by the year 2000 and begin to decline sometime around 2010. Scientists will monitor the yearly ozone hole for signs of ozone's recovery.

Hofmann proposes that the uppermost altitude of total ozone destruction provides a sensitive measure of the atmosphere's health. "The extension at the top, which we have seen this year, is significant. This is where we can look for recovery in the next 10 to 15 years to see if the top starts coming back down."

Satellite image shows ozone hole in purple and blue.

Another indicator may be the average area of the hole, which expanded dramatically in the late 1980s and early 1990s but has remained constant recently, says Newman. *—R. Monastersky*

Enzyme mechanics win chemistry Nobel

People often refer to enzymes as part of a cell's biochemical "machinery" because their hard labor keeps the cell in working order. Three scientists share this year's Nobel Prize in Chemistry for their insights into just how apt that comparison is.

Paul D. Boyer of the University of California, Los Angeles and John E. Walker of the Medical Research Council Laboratory of Molecular Biology in Cambridge, England, were recognized for their research on an enzyme that acts as a molecular motor, and Jens C. Skou of Aarhus University in Denmark was honored for his discovery of an enzyme that works as a molecular pump.

Boyer and Walker study the enzyme ATP synthase, which manufactures ATP, the energy-storing molecule that fuels numerous biochemical reactions in the cell. In a series of studies in the 1970s, Boyer proposed an unusual mechanism for ATP synthase before its complete structure was known. He suggested that the enzyme rotates like a wheel, causing structural changes during each turn. These changes influence the enzyme's ability to bind the chemical precursors of ATP, catalyze their reaction, and release ATP into the cell (SN: 3/22/97, p. 173).

The mechanism "was extremely controversial when it was first enunciated, and now we take it in stride," says Steven M. Block of Princeton University. "I'm absolutely thrilled for Paul Boyer, who was a voice in the wilderness for a long time about this."

Walker's research on ATP synthase, begun in 1980 and reported in 1994, helped verify Boyer's model. "Walker accomplished the Herculean task of sequencing all the genes for the proteins in the enzyme and also determined the structure for part of it," says Richard L. Cross of the State University of New York Health Science Center at Syracuse. The catalytic part of the enzyme resembles a pumpkin with a stalk protruding from its center; a cylindrical part guides the flow of protons that powers rotation of the stalk.

Skou was recognized for his 1957 discovery of sodium- and potassium-stimulated ATPase, an enzyme that pumps those ions across cell membranes. The enzyme maintains different ion concentrations on either side of a membrane, a crucial factor in keeping the volume of a cell constant and propagating nerve signals. Many other ion pumps have since been discovered, including the enzymes responsible for muscle contraction and the production of stomach acid.

"These people are richly deserving of the prize," says Block. Regarding ATP synthase, he notes that "man, in his hubris, thought that he had invented the wheel. In fact, the wheel was one of nature's earliest inventions. It wasn't until the 1970s that we discovered that rotary mechanisms exist in biology." *—C. Wu*