Ozone hole starts strong, fades quickly

The ozone hole currently hovering over Antarctica has once again forced scientists to gulp down a strong dose of humility. Confounding expectations, the hole didn't even come close to record depths this month.

The lowest ozone concentrations above Antarctica this year measured 111 Dobson units, according to data collected by the Total Ozone Mapping Spectrometer (TOMS) on NASA's recently launched Earth Probe satellite. "That is nowhere close to a record," says Arlin J. Krueger of NASA's Goddard Space Flight Center in Greenbelt, Md.

The stratospheric ozone hole—a patch of sky marked by extremely low concentrations of ozone—has formed over Antarctica each August and September since the late 1970s. During these months, springtime sunlight returns to the cold polar skies and powers chemical reactions in which chlorine and bromine pollution destroy ozone.

As atmospheric chlorine and bromine have grown more abundant over the last 2 decades, the ozone hole has gradually worsened. In 1993, a TOMS device on a Russian satellite measured an all-time low of 85 Dobson units. In 1995, that instrument was no longer working, but balloon-borne instruments measured near-record values below 100 Dobson units in the atmosphere above the South Pole.

David J. Hofmann of the National Oceanic and Atmospheric Administration in Boulder, Colo., predicted earlier this year that ozone amounts in 1996 would drop below those of 1995.

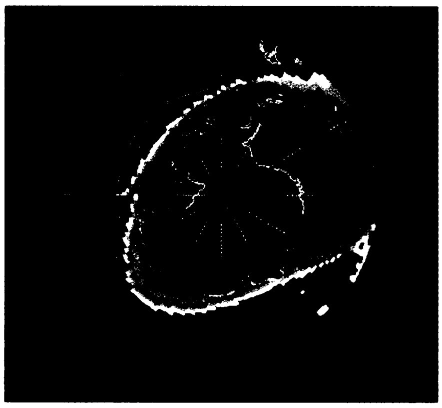
"He blew it," says Krueger.

Hofmann based his prediction on the status of upper atmosphere winds above the equator. When the winds shift toward the west—as they did this year—more air tends to blow toward the poles. This influx of air would bring more pollution and exacerbate Antarctic ozone loss, he suggested in the Sept. 12 NATURE.

The prediction showed promise when the 1996 hole first formed. At that time, the area of ozone depletion was growing extremely rapidly. Then, in the first week of September, the situation began to change. Stratospheric pressure patterns buffeted the giant vortex of winds that normally isolates the Antarctic atmosphere. With this vortex pushed off center and weakened, the process of ozone destruction slowed.

The inability to forecast the ozone hole is nothing new. Scientists failed to anticipate the hole when it first appeared in the 1970s and have since had little success in predicting its annual variability. Still, atmospheric chemists are confident that pollution controls will allow the ozone layer to recuperate after the year 2000. — *R. Monastersky*

NASA



The ozone hole over Antarctica extends outward to the blue bands.

Research funds increase in federal budget

Bruised by last year's government shutdown, Congress approved the 1997 budget on Sept. 30, hours ahead of the new fiscal year. Legislators granted science a respite, increasing funding slightly while backing away from earlier threats to cut research.

The 3,000-page spending bill provides $74 billion for research and development (R&D) in FY 1997, a $3 billion boost over last year, according to the American Association for the Advancement of Science in Washington, D.C. (SN: 10/12/96, p. 235). However, the AAAS contends that the increases fail to make up for cuts during the last 3 years.

"Had Congress followed the budget resolution that called for extensive cuts. . . the news would have been much worse," said Al Teich, AAAS director for science policy. "Science dodged a bullet this year."

Teich says that only the National Institutes of Health and the National Science Foundation have received enough support in recent years to beat inflation. NIH, which funds biomedical studies, won a 6.9 percent hike, raising its research budget to more than $12 billion in FY 1997. Basic research, spread over all federal agencies, including NIH, received a 2.7 percent raise, reaching nearly $15 billion in FY 1997.

Among major research agencies, only the National Aeronautics and Space Administration suffered cuts. Its research budget, declining for most of the decade, fell 1.6 percent, to a little over $9 billion in FY 1997.

Some analysts suggest that Congress passed the 1997 budget quickly so members could resume campaigning for reelection. Eager to avoid an unpopular budget showdown like last year's, legislators decided to fund projects in amounts about halfway between their earlier proposals and agency requests.

"The budget agreement reflects political priorities more than scientific priorities," says Steven Aftergood of the Federation of American Scientists in Washington, D.C.

"We didn't do that bad and we didn't do that great," said Robert L. Park of the American Physical Society's Washington, D.C., office. He adds that budget reductions now being planned for FY 1998 offer a bleak outlook for science, regardless of the results of November's elections. "We haven't hit the cliff yet on the budget projections."

Despite a reversal of past budget cutting, some habits proved hard to change. Park notes that three retiring senators slipped $30 million of science earmarks, projects not subject to peer review, into this year's budget. "It's nothing new. Get the budget up against a deadline and they slip anything they want in there." — *D. Vergano*

A hormone's reputation takes a beating

Composed of just nine amino acids, oxytocin is a small hormone with a big reputation. Used for decades to induce labor in women, it has been thought essential for female mammals to give birth and provide milk to their young.

On the behavioral front, animal studies have indicated that oxytocin drives the chemistry of mating, triggering the arching of females' bodies in readiness for copulation and the erections and ejaculations of males. Research on prairie voles and rats also offered a persuasive case that the hormone inspires maternal behaviors, such as nest building and licking of newborns.

Much of the conventional wisdom about oxytocin now lies in ruins. Mice deprived of the hormone mate naturally, and the females give birth on time and without apparent problems. The mothers also seem to care for their young as normal mothers do.

"This was one of those papers you hope never to have to write," jokes Thomas R. Insel, head of a research group at Emory University in Atlanta that for years has studied oxytocin's influence on mammalian behavior.

Insel and his colleagues, in collaboration with a group headed by Martin M. Matzuk of the Baylor College of Medicine in Houston, form one of three research teams that have recently created so-called knockout mice, which lack a working gene for oxytocin. The Houston-Atlanta team describes its animals in the Oct. 15 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

"There's no question the females are fully maternal," says Insel. "It's also startling to find out that mice that have no oxytocin whatsoever seem to have pretty normal reproductive behavior. I found it very difficult to accept at first."

The knockout mice aren't completely normal. Confirming the hormone's role in lactation, mothers deprived of oxytocin can't nurse their young. Mouse pups die within a day unless researchers inject the mothers with oxytocin.

"The milk is there. They just don't let it down in response to suckling," says W. Scott Young III of the National Institute of Mental Health in Bethesda, Md. Young and his colleagues will describe their oxytocin-knockout mice in the November JOURNAL OF NEUROENDOCRINOLOGY.

In retrospect, some researchers say, it shouldn't be surprising that oxytocin-deficient mice can still mate and bear young.

"Reproduction is just too important to have one mechanism for ensuring parturition [giving birth]. There's bound to be redundancy in the system," says Louis J. Muglia of the Washington University School of Medicine in St. Louis. Muglia and Christina E. Luedke of Children's Hospital in Boston head the third group that has recently produced oxytocin-knockout mice.

Determining whether other hormones step in to compensate for the missing oxytocin is high on the investigators' agenda. Oxytocin, secreted by the pituitary gland into the bloodstream, triggers responses within animals by binding to cell surface proteins called receptors. The hormone vasopressin, several studies have suggested, can latch onto the same receptor that oxytocin uses.

Researchers are now racing to create mice lacking the oxytocin receptor. "If you knock out the receptor [and see no changes in behavior], that would really put the nail in the coffin of a behavioral role for oxytocin," says Harold Gainer of the National Institute of Neurological Disorders and Stroke in Bethesda.

More recent tests on the knockout mice have uncovered subtle behavioral changes. "There are clear differences in behavior, mostly centering around aggression and social investigation," says Insel. "It appears the knockout mice don't investigate other mice as much."

What about oxytocin's role in people? Women who have trouble nursing their babies may have a deficiency of the hormone, speculates Insel. *— J. Travis*

Superfluidity finding earns physics Nobel

A report in the April 3, 1972 PHYSICAL REVIEW LETTERS described the discovery of a new phase of solid helium (SN: 4/15/72, p. 249). It took several more months for the report's authors, Douglas D. Osheroff, Robert C. Richardson, and David M. Lee of Cornell University, to realize that they had instead transformed liquid helium-3 into a superfluid, a state of matter in which atoms move in a coordinated manner, allowing the liquid to flow without resistance.

Last week, Osheroff, Richardson, and Lee won the 1996 Nobel Prize in Physics for this finding. "It was a tremendous discovery made by extremely careful experimentalists," says physicist Russell J. Donnelly of the University of Oregon in Eugene.

As liquids and solids are cooled toward absolute zero, they sometimes undergo phase transitions, in which their structure changes. In the late 1930s, researchers found that liquefied helium-4, the most common helium isotope, becomes a superfluid at a temperature of 2.17 kelvins.

Theorists predicted that helium-3 would also become a superfluid but at a lower temperature. However, experimental work couldn't proceed until researchers obtained a supply of helium-3 as a by-product of tritium production in hydrogen bomb experiments of the 1950s. Many research groups started looking for superfluid helium-3, but no one succeeded until Osheroff, then a graduate student at Cornell, noticed a change in the cooling rate of a sample consisting of both solid and liquid helium-3 at a temperature of 2.7 millikelvins.

The Cornell team had expected to find a transition to a particular magnetic state near that temperature. Instead, their measurements suggested that helium-3 had settled into an ordered phase that differed fundamentally from the expected magnetic state.

Initially, the researchers interpreted the result as a phase transition in the solid form of helium-3. Additional measurements indicated that a pair of phase changes had produced two distinct superfluid states of liquid helium-3.

"Though an accidental discovery, it was a very important one," Donnelly notes. It marked the start of intensive research on the peculiarities of quantum effects in liquids.

Osheroff, now at Stanford University, has continued the work, studying transitions between two forms of superfluid helium-3 (SN: 7/18/92, p. 38). Richardson and Lee are investigating the behavior of thin metal films and other materials at low temperatures. *— I. Peterson*

Buckyballs bounce into Nobel history

Eleven years ago, a group of researchers discovered that 60 carbon atoms can roll themselves up into a pattern similar to the patchwork of a soccer ball. The researchers dubbed the molecule buckminsterfullerene for its resemblance to the domes designed by architect R. Buckminster Fuller.

For their perceptive elucidation of the molecular structure of these buckyballs, Robert F. Curl Jr. and Richard E. Smalley of Rice University in Houston and Harold W. Kroto of the University of Sussex in Brighton, England, were awarded the 1996 Nobel Prize in Chemistry last week.

The real boom in buckyball research came 5 years after the original discovery (SN: 11/23/85, p. 325), when scientists determined how to make the molecules in large quantities (SN: 10/13/90, p. 238). Buckyballs can superconduct, lubricate, and absorb light, promising many applications.

Investigations have since expanded to include the larger class of compounds called fullerenes—hollow, cagelike molecules that have pentagons and hexagons in their structures. Researchers have filled them with other atoms, chemically modified their surfaces, and elongated them into tubes and rods.

Behind the first experiments that produced buckyballs was Kroto's theory that long carbon chains formed in interstellar gas clouds. Kroto urged the Rice group to put carbon in one of its instruments, designed for making clusters of atoms. With students Jim Heath and Sean O'Brien, the researchers found they could produce stable carbon-60 and carbon-70 molecules. "The fullerene development was just completely unexpected," Curl says.

Despite earlier evidence of the existence of large carbon clusters, Curl, Kroto, and Smalley were the first to focus on the unusual stability of carbon-60, says Mildred S. Dresselhaus of the Massachusetts Institute of Technology.

"The soccer-ball-shaped structure is so compellingly unique and so satisfying chemically, we decided it must be the correct explanation," Curl says. "In the years that followed, we got some probably well-deserved flak for jumping to a conclusion like that."

Dresselhaus agrees, saying the researchers "had very flimsy evidence when they came up with that hypothesis." Still, she adds, most scientists at the time accepted the structure because "it explained a whole lot of things. It was consistent with everything that was known, and it was not inconsistent with anything."

Eventually, other experiments confirmed that intuitive leap, giving fullerenes their place in scientific history. *— C. Wu*