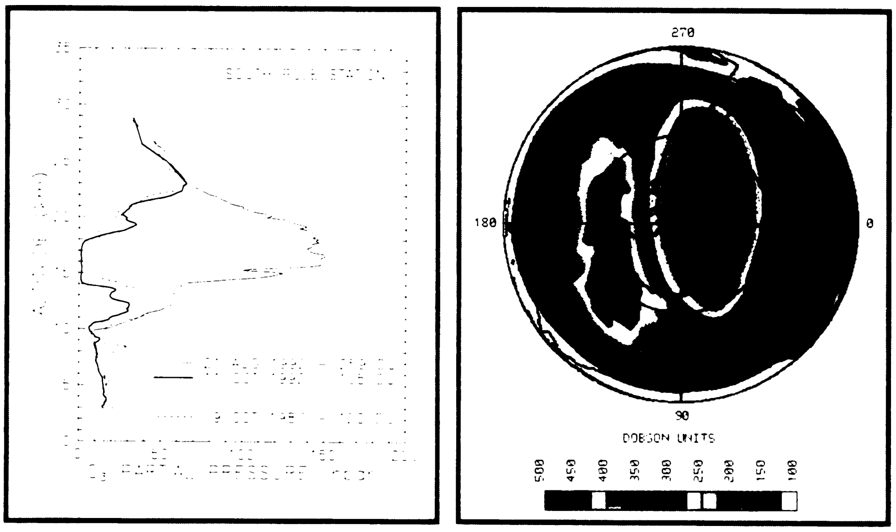

Hofmann/NASA

In graph of balloon data, thin line represents conditions prior to 1992 hole. Thick line shows loss this year. Dotted line indicates loss in 1987. Satellite image shows ozone-rich air (in red and orange) displacing ozone hole (in blue and purple).

ments lies closer to the truth. In either case, though, Earth's protective ozone shield suffered a particularly severe attack this year. In late September, the satellite-borne detector showed that the ozone hole had reached record proportions in terms of aerial extent (SN: 10/10/92, p.229). Atmospheric scientists are currently debating why its breadth grew so large this year.

At the time, the depth of the hole – the ozone levels measured where the shield is weakest – also seemed on the way to a record. But in the last week of September and early October, a huge, ozone-rich patch of air over the South Pacific pushed its way over the edge of the Antarctic continent. The Pacific air distorted the circling vortex of winds that normally encloses the Antarctic stratosphere and helps chlorine destroy ozone there. Weakened by the disturbance, the vortex took on an oblong shape and shifted toward the Atlantic, says Arlin J. Krueger of NASA Goddard in Greenbelt, Md. This event slowed the ozone destruction.

While satellite instruments give a broad aerial view of the hole, balloon measurements can show how much ozone resides at specific levels of the atmosphere. The balloon launches revealed unusually severe ozone loss this year in the lower part of the stratosphere, between 10 and 18 kilometers in altitude, Hofmann says.

Chemical reactions destroyed all ozone in a 4-km-thick layer between the altitudes of 14 and 18 km. This contrasts with the pattern seen in previous years, when total ozone loss occurred in a region only 1 to 2 km thick. Moreover, the chemical attack in years past spared ozone between 10 and 13 km high. This year, that layer lost about a third of its ozone, says Hofmann.

Normally this low region is too warm for the formation of frozen cloud particles that hasten the ozone destruction process. But this year, ground-based and balloon-borne instruments detected a significant number of small particles in the lower stratosphere. Hofmann suggests the particles were droplets of volcanic sulfuric acid that helped chlorine chemicals extend their destructive power even lower in the polar stratosphere than normally possible.

In the Sept. 24 NATURE, Hofmann and colleagues reported seeing a similar – but less severe – phenomenon last year, when the lower stratosphere contained sulfuric acid from the eruption of Mt. Hudson in Chile. These particles should have dropped out of the stratosphere by now, but the droplets from Pinatubo's much higher cloud should still remain up there, says Hofmann.

While the Antarctic ozone hole comes during its spring, balloon launches in May and June suggest that this region also suffered some ozone destruction during the fall season as a result of the volcanic particles, says Hofmann.

– R. Monastersky

Electron chemistry, detector physics

Electron behavior lies at the heart of the research that merited this year's Nobel Prizes in Physics and in Chemistry.

French physicist Georges Charpak of the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, won the physics prize for the invention and development of electronic particle detectors capable of tracking the ephemeral subatomic products of high-energy collisions between particles in accelerators.

Canadian-born physical chemist Rudolph A. Marcus of the California Institute of Technology in Pasadena won the chemistry prize for theoretical work elucidating the intricacy of chemical processes involving the transfer of electrons between molecules in solution.

In the late 1960s, Charpak invented the "multiwire proportional chamber" to cope with the demands of rapidly characterizing the large numbers of extremely short-lived, exotic particles created during high-energy interactions. His device consisted of a flat, closely spaced array of thin, parallel, positively charged wires placed between two negatively charged plates in a gas-filled chamber.

Any charged particle entering the chamber would tear electrons away from the gas atoms or molecules inside. The freed electrons would then stream toward the positively charged wires, producing electrical signals that could be amplified and sent directly to a computer for recording and analysis.

Such an arrangement, which ended reliance on photographed particle tracks in bubble chambers and inaugurated the age of electronic particle detection, allowed physicists to pinpoint individual particle trajectories with improved precision while handling hundreds of thousands of such events per second. Thus, researchers could sift through billions of interactions to focus on rare but particularly interesting examples of exotic particles.

Descendants of this type of detector played key roles in the discoveries of several new particles, including the W and Z particles. The Superconducting Super Collider, under construction near Waxahachie, Texas, will have similar detectors.

In the 1950s and '60s, Marcus, while at the Polytechnic Institute of Brooklyn and later at the University of Illinois at Urbana-Champaign, developed a theory describing how electrons can jump from one molecule to another without breaking chemical bonds. He found simple mathematical expressions for the way changes in the molecular structure of reacting molecules and their neighbors affect the energy of a molecular system. He could then calculate the rates of electron-transfer reactions and explain the surprisingly large differences in the rates at which various reactions occur in terms of these molecular rearrangements.

Initially controversial, Marcus' theory was vindicated by experimental work in the 1980s. His theory illuminates a variety of important chemical processes, from photosynthesis and chemiluminescence to corrosion and the behavior of electrically conducting polymers.

– I. Peterson