Ozone Destruction Worsens

Don't look up now, but new satellite data show that the ozone shield over the United States is eroding twice as fast as had been assumed. Indeed, the ozone layer is disappearing so quickly that it now looks as if current plans to reduce the losses may be too little, too late. "I find it very disturbing that the ozone layer is peeling away this quickly," says atmospheric chemist Michael Oppenheimer of the Environmental Defense Fund in New York. "Now it looks like the strong measures we're about to take won't be enough."

Those measures are embodied in the Montreal Protocol, which aims to eliminate the release of the manmade chlorofluorocarbon chemicals (CFCs) thought to underlie stratospheric ozone losses. When first signed back in 1987, with the newly recognized Antarctic ozone hole—the first tipoff to a deteriorating ozone layer—hanging over the negotiators, the protocol mandated a 50% reduction of CFC production by the year 1998. The fear was that stratospheric ozone depletion, if it continued, would allow increased amounts of ultraviolet radiation to strike Earth, increasing the rate of human skin cancer and also harming plants and animals.

The original provisions for controlling CFCs looked strong enough to buy plenty of time for ozone scientists to study the problem further—or so the treaty negotiators hoped. Then the Antarctic hole deepened, evidence mounted for similar ozone destruction over the Arctic, and signs appeared of possible ozone destruction over the mid-latitudes of the Northern Hemisphere (*Science*, 12 August 1988, p. 785). In response to these ominous developments, the Protocol was revised last June to phase out CFC production by 2000. Now, even that may fall short of what's necessary to hold ozone depletion to tolerable levels.

The latest ominous development comes from NASA's satellite-borne Total Ozone Mapping Spectrometer (TOMS). Three years ago, the international Ozone Trends Panel (*Science*, 25 March 1988, p. 1489) analyzed 17 years of ground-based ozone measurements and concluded that the northern mid-latitudes (roughly between Seattle and New Orleans) were losing ozone at a rate of about 1% to 3% per decade. But the new TOMS results, which were released on 4 April by William Reilly, who heads the Environmental Protection Agency (EPA), indicate ozone losses there of 4% to 5% per decade. During the winter months, the rate goes as high as 8% per decade. And the enhanced losses are now dragging into April and May, when both plants and people are more exposed—and therefore more vulnerable—to ultraviolet radiation. Globally, ozone is decreasing 2.3% per decade. The EPA estimates that in the United States alone such ozone depletion may cause 200,000 additional deaths from skin cancer over the next 50 years.

Although Reilly called the new depletion rates "stunning," the difference between the loss rate found by TOMS and that estimated 3 years ago by the Ozone Trends Panel may not be as great as it appears, says Richard Stolarski of NASA's Goddard Space Flight Center in Greenbelt, Maryland, who analyzed the TOMS data with his Goddard colleagues. The panel analyzed data only through 1986, while the new satellite analysis includes the years since then, when ozone losses were, if anything, greater than those in the early 1980s, Stolarski says. And the satellite analysis did not have data from the 1970s, when there was little or no downward trend in ozone.

But even if the new satellite data were overdramatized a bit, they confirm that the downward trend has continued since 1986. And that's having a sobering effect in the scientific community. Few researchers are arguing very strenuously anymore that the trend might be a natural one; the assumption is that CFCs are behind the decline. And even under the revised protocol provisions, atmospheric chlorine is expected to reach 25% to 30% above present values.

Researchers are now assuming that the mid-latitude ozone losses originate at least in part in CFC-induced chemical reactions far to the north. The Arctic has its own version of the Antarctic ozone hole contained within a wintertime vortex of swirling stratospheric winds. Here the ozone-destroying chlorine of CFCs is released through reactions on icy cloud particles unique to the polar regions. But the chlorine needn't stay penned within the vortex. It and any air already depleted of ozone can escape to lower latitudes to make mischief there, too. Great streamers of air can peel off the vortex, the vortex itself can break up (as it always does by March), and chemically altered air might simply leak out the bottom of the vortex.

In addition to the ozone losses imported from the Arctic, some ozone destruction may occur locally in the mid-latitudes. Lab experiments have shown that some of the ice-mediated reactions of the Antarctic ozone hole can also occur on sulfuric acid droplets, which pervade the stratosphere at all latitudes.

The higher quoted rates of ozone loss come as scientists are preparing for another reassessment of ozone trends under the auspices of the Montreal Protocol, which is due by the end of the year. That leaves time for more bad news, perhaps from a 6-month-long airborne expedition into the Arctic to be mounted this fall from Bangor, Maine. After all, in the ozone business, bad news seems to be the only news. ■ RICHARD A. KERR

Greenhouse Policy: A Bargain?

Ever since people began to take the greenhouse effect seriously, it has been widely assumed that it would be horrendously costly to make a significant dent in the amount of carbon dioxide and other greenhouse gases that industrial society pours into the atmosphere each year. Both the Reagan and Bush Administrations seem to have accepted that notion in declining, so far, to join several other countries in pledging to control CO_2 emissions (*Science*, 22 February, p. 868). A committee of the National Academies of Science and Engineering and the Institute of Medicine politely, but firmly, disagrees with this conventional wisdom, however.

In a report* published this week, the Committee on Science, Engineering, and Public Policy concludes that the United States could cut emissions of greenhouse gases by 10% to 40% for little or no cost. "Some reductions may even be at a net savings if the proper policies are implemented," says the panel, which was chaired by former U.S. senator and civil engineer Daniel Evans, a Republican from Washington state. The committee urges the Administration and Congress to start now in cutting greenhouse gases "as insurance protection against the great uncertainties and the possibility of dramatic surprises" inherent in global warming. "Insurance," it says, "is cheap."

The Administration may not regard some of the panel's recommendations as "proper policies," however. In essence, the panel calls for an energy program that relies on a combination of regulations and price incentives (including taxes) to encourage conservation and efficiency, stepped-up efforts to reduce deforestation, and—of course—more research on energy technologies, climate modeling, and the ecological and economic effects of global warming. In contrast, the Administration recently sent Congress a package of legislation for an energy strategy that studiously avoids addi-

**Policy Implications of Greenhouse Warming*, National Academy Press, 1991.