Stratospheric Ozone: A New Policy Tone

From a Senate hearing to international conferences to papers in NATURE and SCIENCE, ozone and the consequences of its depletion are the talk of the town this month. Scientific uncertainties still exist, but as a recent NASA report on the state of knowledge of the upper atmosphere concludes, "... what was once mainly based on theoretical predictions is now being confirmed by observations." Some feel that the study of stratospheric ozone – the chemical that shields the earth from biologically harmful ultraviolet radiation – has advanced far enough for policymakers to think about altering the course of those human activities that threaten ozone and earth life.

One recent advance has been the development and fine-tuning of ozone measurements from satellites. Satellites are providing, for the first time, global data that are accurate enough "for us to see what we think are real changes in the global distribution of ozone," says atmospheric scientist Donald F. Heath at NASA Goddard Space Flight Center in Greenbelt, Md. "We don't know what is responsible for these long-term changes, but we're certain that they're taking place."

Heath's analysis of data from instruments aboard the Nimbus-4 and Nimbus-7 satellites shows that global ozone levels have been decreasing and, as predicted by ozone models, the depletion rates have been the greatest in the high latitudes and polar regions. He says that from about 1970 through 1981, global ozone levels fell by about 0.15 percent per year. In the 1978-1984 data set, however, the global concentration of ozone dropped by a statistically significant 0.5 percent per year.

Heath thinks the higher recent rates are prompted by changes in the emission of ultraviolet radiation from the sun and by the 1982 eruption of the El Chichón volcano, which most strongly affected atmospheric chemistry in the Northern Hemisphere.

"A lot of people have argued [on the basis of ground-based measurements] that the effect of El Chichón was simply to change the circulation patterns and the distribution of ozone," says Heath. "But the satellite measurements show that the ozone isn't hiding somewhere. It tells you that there's been a real global-scale decrease, although we don't know what the physical mechanism is."

He cautions that these long-term changes are not trends. "Just because over a six-year period it's going down doesn't mean that it will continue to go down," he says. "The important thing is that we've reached a point where the data and the models are good enough so that one can begin to make hard comparisons."

Richard Stolarski, also at NASA Goddard, notes that the satellite data are not entirely consistent with ground-based measurements – some of which do not show any statistically significant ozone changes since the 1970s. Assuming that the satellite observations are correct, Stolarski wonders whether the observed variations mark a new and different kind of behavior for ozone levels, or simply appear significant now because scientists have only recently developed the instruments to monitor global ozone.

Scientists have also had some success at measuring the atmospheric levels of some of the gases that deplete ozone and warm the planet. In the June 27 SCIENCE, Reinhold Rasmussen and Aslam Khalil at Oregon Graduate Center in Beaverton report that the January levels of six of the most important long-lived trace gases have increased over the last decade. In particular, the researchers found that the levels of chlorofluorocarbons CFC-11 and CFC-12 – which release ozone-destroying chlorine into the upper atmosphere – have more than doubled in 10 years. But they also discovered that the annual rates of increase for all of the measured gases, which also include methane, nitrous oxide, methyl chloroform and carbon tetrachloride, have slowed in the last five years.

"This paper shows that we have to be very careful in how we look at what the future will bring," says Khalil, "because the data show a lot of variation and the rates of increase do not remain constant."

The decrease in the growth rate of atmospheric CFC-11 is largely attributable to a U.S. ban, enacted in the late 1970s, on the nonessential use of that chemical in spray cans. Khalil notes, however, that the industrial production of CFC-11 has not diminished, because it is increasingly used for other purposes, especially the blowing of polyurethane foam. "If CFC-11 does harm to the atmosphere, then this is a rather dangerous turn of events," says Khalil, because he and Rasmussen, in other work, have found that the chemical eventually leaks out of the foam and into the atmosphere (about half of the CFC-11 leaks out in 100 years).

Similar concerns motivated Sen. John H. Chafee (R-RI), who chairs the Senate subcommittee on environmental pollution, to hold hearings on ozone depletion and "greenhouse" warming on June 10 and 11. According to a congressional staff member, Chafee intends to introduce legislation before the end of this Congress that would further regulate the use of chlorofluorocarbons. The details of the regulations are still to be worked out. One suggestion made at the hearings was that some chlorofluorocarbons be replaced by other, less harmful kinds; for example, air conditioners in cars could use CFC-22 rather than CFC-12.

Both Chafee and Environmental Protection Agency (EPA) Administrator Lee M. Thomas, who also testified at the hearings, have stressed that the issue is so important that decisions about ozone protection have to be made in spite of the scientific uncertainties. As dictated by the Clean Air Act and a settlement agreement in a suit brought by the Natural Resources Defense Council in 1984, EPA has begun to evaluate whether additional regulation of chlorofluorocarbons is warranted. A final decision is set to be made by November 1987.

Last week, EPA, in conjunction with the United Nations Environment Programme, sponsored a conference on the skin cancers and other biological effects of ozone depletion, as well as climate change, in Crystal City, Va. In July, the agency will host a Washington, D.C., conference examining alternative strategies for protecting stratospheric ozone.

Much of the recent publicity and interest in ozone has been sparked by the discovery that ozone concentrations over the Antarctic dramatically plummet every September, and that this ozone thinning or "hole" has been getting more severe since 1979 (SN: 3/1/86, p. 133). The hole and its progressive worsening were not predicted by any existing ozone model, so a number of scientists have been working feverishly to come up with an explanation.

Two papers appearing in the June 19 NATURE are the first in an upcoming stream of new theories proposed to explain the hole. While each highlights a different chemical pathway, both papers ultimately stress chlorine, which catalytically destroys ozone. Mechanisms suggested in other theories include the enhancement of nitrogen oxides during the solar cycle and the lifting of volcanic aerosols and ozone-poor air from the troposphere into the upper atmosphere.

Each of the many ideas suggested will be put to a test when four U.S. teams leave for Antarctica August 22 to make detailed atmospheric measurements. Researchers say the Antarctic ozone hole may turn out to be only a scientific curiosity. But if the chlorine theories in particular prove correct, the hole may be an ominous sign of what lies in store for the rest of the ozone layer as atmospheric chlorine levels rise. *– S. Weisburd*