Ozone Depletion: Estimates Halved

A summary report about the decrease of protective ozone in the earth's atmosphere, says Joseph M. Steed, is like a snapshot — a static view "of what's going on at the time the report is written." Usually, says the Du Pont chemist, a newer picture already is forming by the time such a report is released.

Steed is referring to the recent National Academy of Sciences ozone depletion report released the very day he helped chair in Las Vegas a 19-report American Chemical Society session on the same topic. In the NAS report — with which Steed says the chemical industry cautiously concurs — panel members cut in half earlier estimates of how much ozone is being stripped from the stratosphere by reactions with various gases. The NAS panel members also report stronger evidence that increased human exposure to ultraviolet light — which would result from ozone depletion — is associated with the occurrence of non-melanoma cancers. While the data presented at ACS are largely compatible with this NAS report, researchers are far from unraveling the mysteries of ozone chemistry.

Atmospheric ozone (O_3) shields harmful ultraviolet radiation from the earth's surface. Its abundance in the stratosphere is determined by a complex, balanced set of chemical processes that produce and destroy it. In 1979, a NAS report indicated that chlorofluorocarbons (CFCs) — released into the atmosphere due to their previous use as aerosol spray propellants and continued use as foam-blowing agents and refrigeration system additives — offset that balance. The report predicted a CFC-related 15 to 18 percent reduction of ozone (SN: 11/17/79, p. 340). In 1980, the U.S. Environmental Protection Agency considered mandating a ceiling on CFC production (SN: 10/18/80, p. 249). The agency already had banned the use of CFCs in nonessential aerosols; now it considered limiting all other uses.

Such a consideration warranted the gathering of more data, so the agency asked the NAS National Research Council to assemble another report. This latest NAS report relies mostly on a World Meteorological Organization/National Aeronautics and Space Administration study for its lowered prediction of ozone depletion, says Robert Watson of NASA's Jet Propulsion Laboratory. The WMO/NASA report predicts a 5 to 9 percent reduction in stratospheric ozone over the next decade if the production of two specific CFCs remain at 1977 levels.

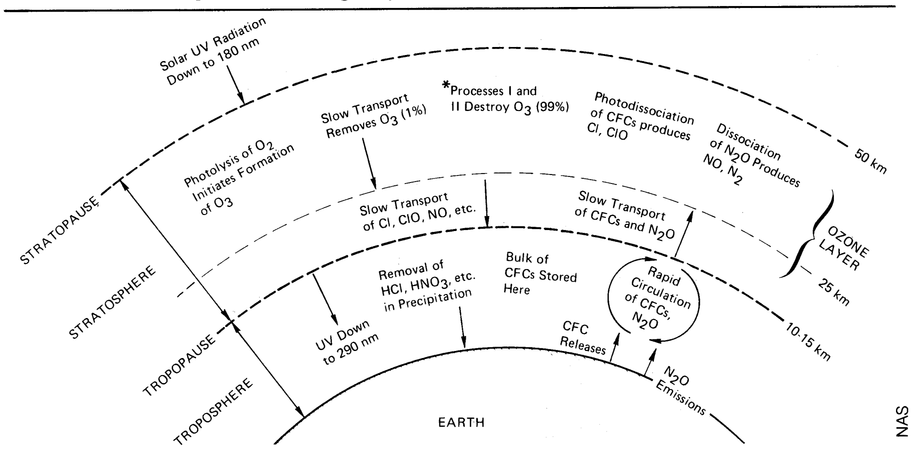
This adjusted forecast can be attributed to an increased understanding of the role of hydroxy (OH) radicals in atmospheric chemistry, says Watson, co-chairperson of the ACS session on ozone. Previously, it was shown that this radical can convert relatively harmless species of chlorine-containing molecules into ozone-destroying ones. (Sunlight decomposes CFCs into various chlorine-containing molecules.) The WMO/NASA study indicated less OH in the lower stratosphere than was previously predicted — thus, the lower estimate of ozone destruction.

An even lower estimate results when taking into account the effect of other gases, reported Don Wuebbles at the ACS meeting. Wuebbles and colleagues of Lawrence Livermore National Laboratory in Livermore, Calif., conducted a comprehensive computer analysis of ozone chemistry. Results suggest that ozone levels would drop just 2 percent by the year 2000 if emissions of CFCs continued at 1980 levels. Moreover, Wuebbles reported, "When we include the possible effect of other anthropogenic perturbations on the ozone — including the effect of carbon dioxide [CO_2], nitrous oxide and nitrogen oxides [NO_x] — little change in ozone is predicted." For instance, explains Wuebbles, an increase in atmospheric CO_2 resulting from fossil fuel and wood combustion is expected to cause a near-surface global warming but to reduce stratospheric temperatures. That cooling would slow ozone-destroying processes.

"Given these relatively low figures for ozone destruction," says Watson, "I personally would not enact any further regulations — as long as we keep doing science on the matter.... Remember," he says, "it's all predictions; these are all theoretical calculations.... We've learned a helluva a lot, but there is still uncertainty."

NAS panel members are uncertain, for example, why three specific discrepancies exist between actual measurements and theoretical models of ozone depletion. First, 35 kilometers above the earth where ozone is most sensitive to chlorine reactions, measured concentrations of chlorine monoxide (ClO) — a key ozone destroyer — are twice as great as those predicted by theoretical calculations. Second, observations over a range of latitudes reveal sharp discontinuities in NO_x concentrations in winter that have yet to be explained by the models. Finally, measured concentrations of CFCs in the lower stratosphere are much lower than those mathematically predicted. Current studies are attempting to explain these discrepancies.

Researchers are striving to learn what is happening to the ozone layer because the implications of its depletion are grave. For each 1 percent decrease in stratospheric ozone, according to the NAS report, incidence of basal cell skin cancer will increase 2 to 5 percent, while incidence of squamous cell skin cancer will rise by about 4 percent. Cancers of the squamous and basal cells — which are found in two different layers of the epidermis — are the most common malignancies in humans. (It is unclear whether ozone depletion would contribute to an increase in cases of the less common but more dangerous form of skin cancer — malignant melanoma.) The exact health effects, the report goes on to state, would depend on such factors as location, sex, skin type and lifestyle. For example, the report notes that white males living in lower latitudes would be much more vulnerable than their higher latitude counterparts to the effects of increased exposure to ultraviolet B rays — radiation that falls in the range of short-wave lengths most damaging to human skin. The NAS report also mentions recent findings suggesting that ultraviolet radiation can alter animal and human immune systems. —*L. Garmon, C. Simon*



The net effects of processes I and II are $O + O_3 \rightarrow 2O_2$ and $O_3 + O_3 \rightarrow 3O_2$, respectively. The process I effect can be mediated by the OH radical and various nitrogen- and chlorine-containing molecules. All of these molecules have natural sources, but their concentrations can be altered by human activity.