High Altitude Data Confirm Ozone Theory

Using atmospheric test equipment—from mixing bowls to rockets—Government scientists have just finished collecting data that all but eliminates doubt about fluorocarbon-ozone destruction theories.

Two groups have provided the first experimental data 1) confirming the presence of predicted concentrations of fluorocarbons 11 and 12 (CCl_3F and CCl_2F_2) at predicted altitudes in the stratosphere, 2) confirming the important prediction that fluorocarbons are breaking down in the stratosphere and 3) confirming that there are no major sinks for the aerosol propellants in the troposphere. The data points were so close to the predicted numerical values, in fact, that one experimenter calls the agreement "absolutely astounding."

Researchers F. Sherwood Rowland and Mario Molina last summer proposed the now well-known model of ozone (O_3) destruction by fluorocarbon aerosol propellants. These, they predicted, float inert to the stratosphere and are there broken down by ultraviolet light, releasing reactive chlorine atoms that destroy ozone (SN:9/21/74, p. 181). A National Academy of Sciences committee is awaiting data such as those just collected by the two teams to make recommendations to the Government on propellants.

The teams work from the Boulder, Colo., based laboratories of the National Center for Atmospheric Research (NCAR) and the National Oceanic and Atmospheric Administration (NOAA). Both teams finished in June analyzing samples of fluorocarbons 11 and 12 and nitrous oxide (N_2O) retrieved from the stratosphere by rocket and weather balloons. Both have submitted reports of their work to GEOPHYSICAL RESEARCH LETTERS.

John Gille, head of NCAR's Upper Atmosphere Project, described that group's experiments to SCIENCE NEWS. Measurements of the two propellants and N_2O were made at various altitudes in the stratosphere over NCAR's Palestine, Texas, test facility in September 1973, May 1974 and June 1975. Team members launched large weather balloons carrying large-volume collection vessels cooled in liquid neon. Samples were collected at several altitudes, from about 12 kilometers (the lower boundary of the stratosphere) to 35 kilometers (near the upper boundary). The samples, once inside the cryogenic vessels, were frozen and returned to NCAR's atmospheric chemistry laboratory for analysis by gas chromatography. An earlier sample was collected at 45 kilometers by a rocket-borne cryogenic sampler and also analyzed.

Arthur L. Schmeltekopf, a member of the NOAA team, described that agency's similar but slightly less sophisticated test procedures. Small rubber weather balloons were launched on three days in early June from the Laramie, Wyo., airfield. Each balloon carried a 7.5-liter sphere, made, Schmeltekopf says, from two stainless steel mixing bowls welded together. ("Our test sphere cost us a total of $9," he says, "and we tease NASA about that all the time.") Ground-controlled valves admitted samples at 17.7, 22.3 and 26.2 kilometers and these were later analyzed. The NOAA and NCAR samples showed similar concentrations of the chemicals at the similar altitudes.

Several researchers, including Rowland and Molina, Paul Crutzen from NOAA and NCAR, Steven Wofsy and Michael McElroy from Harvard and Ralph Cicerone from the University of Michigan, have predicted the concentrations of the chemicals that should be found if the Rowland-Molina model is correct. All fairly similar, they predicted that the propellants, as they drifted upwards and were broken down by ultraviolet light, would decrease in concentration with increasing altitude. N_2O, the source of the NO that catalytically destroys ozone, would also decrease with altitude as it is broken down by ultraviolet light. This is precisely what both teams found, and at the predicted concentrations.

"We sort of anticipated that some things would have been left out of the models," Schmeltekopf says, but the results absolutely astounded us. Our (NOAA and NCAR's) data show close agreement with all the models and is a nice confirmation of them."

The data show for the first time, Schmeltekopf says, that almost all of the inert fluorocarbons are reaching the stratosphere intact, and are not being washed out into the troposphere first, as suggested by some scientists. Also, the concentration curves for fluorocarbons 11 and 12 are different. If the molecules were inert to the attack of ultraviolet light once in the stratosphere, both molecules would have parallel profiles, Gille says. The fact that fluorocarbon 11 decreased more sharply with altitude supports the prediction of stratospheric destruction of aerosol propellants.

Both the NOAA and NCAR teams plan to make further tests at higher altitudes to confirm that propellant concentrations do fall off rapidly above the photolysis reaction zone (18 to 35 kilometers). But, Gille says, "I think our results have drastically narrowed room for doubt" about the validity of the fluorocarbon-ozone destruction theory. □

A scientific attack on arson

More scientific attention is being paid in recent years to fire chemistry—how fires kill or injure people, ways of improving firefighting equipment and the toxic aspects of fire retardants (SN: 12/1/73, p. 348; 3/1/75, p. 134).

Last week, scientists zeroed in on still another aspect of fires—arson—when some of the nation's top arson authorities met at the National Academy of Sciences in Washington. The investigators are members of the NAS Committee on Fire Research. Although they are not yet ready to make recommendations on the arson problem to the National Bureau of Standards and other Government agencies, they discussed some aspects of the problem with the press.

Arson is claiming an increasing toll of properties and lives, according to Carl W. Walter, a Harvard Medical School surgeon and chairman of the committee. There is "cause for alarm," he says, yet the problem has not been recognized by society. This is why members of the Committee on Fire Research are tackling it. Committee member John E. Stuerwald, editor of *The Fire Commission and Arson Investigator,* agrees. He cites National Fire Protection Association statistics underscoring the rising arson problem.

Incendiary fires (those caused by arsonists) have increased 1,157 percent in the United States during the past two decades. From 1969 to 1973, the United States experienced at least 74,380 incendiary fires annually at an annual loss of at least $213 million.

These statistics can be misleading, though, the committee members agree, because they include fires set not only on purpose but accidentally—say, by children playing with matches or by smokers falling asleep in bed. One recommendation probably will be that better incendiary fire statistics be collected to determine precisely which fires are set on purpose, and by what types of arsonists.

Contrary to common belief, the committee members concur that very few incendiary fires are set by the pyromaniac—the psychopathic individual who gets a sexual thrill out of watching buildings burn. (This is not to say that such persons don't exist, though. According to committee member Walter Moretz, a psychologist with George Mason University, "Occasionally a fire marshall or arson