Rumor and Confusion Follow Ozone Theory Revision

Ruth Reck has been restructuring the earth's atmosphere again—a preoccupation not nearly as implausible as it sounds for a General Motors physicist. With commands typed neatly on key-punched computer cards, she wipes out massive amounts of ozone from the stratosphere or shifts the bluish gas around to different levels. Her latest set of models predicts some very interesting atmospheric behavior, and, moreover, promises to restructure another system—the current morass of confusion and uncertainty that was once an orderly theory of ozone destruction by fluorocarbons.

That theory and the supporting evidence, gathered by balloon, jet and infrared spectrometer, seemed so airtight last month that rumor ran wild in Washington of an imminent ban on nonessential uses of fluorocarbons 11 and 12. Rumor is running rampant again this month, that the theory was wrong, industry was right, the ozone layer is saved and fluorocarbons deserve an official reprieve. Or the inverse of all those statements, depending on who's talking. Committees impaneled by the National Academy of Sciences and a federal interagency task force called "IMOS" are meeting hastily to reconsider tentative recommendations. Scientists are shuttling in and out of the city to testify before the committees on new theories, models and evidence. And the founder of the original fluorocarbon-ozone destruction theory, F. Sherwood Rowland, nervously churns out yet more equations.

Rowland and co-worker Mario Molina proposed the now famous theory two years ago and, like the fluorocarbons themselves in the lower atmosphere, it had remained inert to serious attack until now. True to innovative form, Rowland, Molina and John E. Spencer of the University of California at Irvine made the first substantive revision in the theory themselves earlier this year (SN: 3/20/76, p. 180).

Analyses, models and projections made since have touched off the latest paroxysm of speculation. Ruth Reck's study, reported in the May 7 SCIENCE, was begun and submitted before Rowland revised the theory, but, coming at this point, may shed considerable light on the murky situation as well as add force to the argument that all is *not* well with the ozone layer, theory revision notwithstanding.

Reck wanted to calculate the effects of ozone depletion on earth surface temperatures. Previous researchers had predicted that complete removal of ozone wouldn't really change the earth's surface temperature much (less than 1°C) but would completely eliminate the tropopause. The boundary between the troposphere and the stratosphere divides cold air below from warmer air above. This layering effect, in large part, controls weather and climate. Reck used a more sophisticated model of the atmosphere for her study. Plugging in ozone depletion rates from 10 percent to 100 percent, she, too, observed only a small surface temperature change up to 90 percent ozone depletion. Only at 100 percent was the tropopause eliminated.

This model, she told SCIENCE NEWS, was "reassuring"; not even large ozone depletions—and certainly not the small ones estimated for current fluorocarbon release rates—would likely lead to drastic changes in surface temperature. But then Reck did a second, and ultimately disquieting, experiment. She lifted the "ozone profile" in her model. This profile, she explains, is the amount of ozone at each altitude. By arbitrarily changing the height of the maximum amount of ozone (the "bulge" in the ozone profile) but without removing any of the ozone, she saw a larger change in surface temperature than before.

Such a shift in the ozone profile, unfortunately, is predicted by both the old and new Rowland theories. And herein lies the importance of Reck's study for the current confusion. In Rowland's new theory, chlorine nitrate ($ClONO_2$) would be formed after reactive chlorine is kicked loose from fluorocarbons. It would then tie up the chlorine and prevent it from destroying as much ozone as originally predicted. Just how much prevention is afforded by $ClONO_2$, however, is a major point of contention now. Some industry-funded "modelers" calculate that with $ClONO_2$ in the picture, 90 percent less ozone would be destroyed. This practically exonerates the fluorocarbons. Others, however, like Rowland and Paul Crutzen of the National Center for Atmospheric Research in Boulder, Colo., calculate a 50-60 percent reduction in ozone depletion—less disastrous, but still a problem. The solution to this is still up in the air, so to speak.

The change in ozone profile, however, remains in the new model. $ClONO_2$ would not function effectively as a chlorine-atom-catcher at high altitudes (above 35 kilometers) due to the penetration of strong ultraviolet light. Thus, fluorocarbons reaching that height might break down a predicted 35 to 40 percent of the ozone above 35 km. Looking at a graph of the new ozone profile, were this upper stratospheric depletion to occur, Crutzen said, "This looks like the profile from another planet." And as Ruth Reck found, ozone profile changes theoretically could influence temperatures more strongly than even severe ozone depletion.

This new emphasis suddenly makes the fluorocarbons potential villains on the climatic scene to a greater extent, and villains on the skin cancer-crop damage scene to a lesser extent. And the uncertainty of the new theory and calculations now places a large part of the prediction problem in the hands of meteorologists—a group already saddled with such a complex, dynamic and poorly understood system that reliable prediction won't be forthcoming for a decade.

The co-chairman of the IMOS task force, Carol Pegler, told SCIENCE NEWS that reevaluation is going on now and that the "troubling uncertainties raise new questions and research needs. But," she says, "as far as I am personally concerned right now, nothing in the new information removes the seriousness of the old."

Crutzen, one of the most highly regarded ozone researchers, told SCIENCE NEWS, "I am sure that this industry will be phased out—if not for biological reasons, then climatological ones. There is no doubt that fluorocarbons will alter the ozone in some way; the longer we go on, the more it will be altered. Perhaps a two to three year phase-out is a reasonable compromise, I don't know. That's not my area. But I would be happiest if it were to go as soon as possible." □

Mental abilities: Sex or maturation rate

Males and females differ in many ways, including performance on certain tests of mental ability. Males tend to excel on tests of spatial skills while females usually score better on tests of verbal ability (fluency, articulation and perceptual speed). The most obvious reason for these differences would seem to be gender, but there may be another explanation. In the May 7 SCIENCE Deborah P. Waber of the department of psychiatry at Children's Hospital Medical Center in Boston suggests that rate of maturation, rather than sex, might be responsible for some of the observed differences between the sexes in mental abilities.

Females generally attain physical maturity at an earlier age than males. And this biological fact could be related to mental abilities. Waber hypothesized that early maturers, whether male or female, would tend to score higher on verbal tests, and late maturers would do better on spatial tests. Girls 10 and 13 years old and boys 13 and 16 years old from a middle-class white population were examined medically and rated as early or late maturers according to secondary sex characteristics