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The Register

It is still winter in Antarctica. The darkness of the long polar night will not recede until September. Average daily temperatures hover around 40 degrees below zero. Winds whip the snow in blinding sheets.

These are the conditions that will greet 13 American scientists this week as they begin arriving on ski-equipped planes at McMurdo Sound on Antarctica, where the United States maintains a scientific base. The perilous and unusual journey into the polar night was approved by the National Science Foundation in April for a very compelling reason: Researchers will try to determine why a large area in the Earth's protective ozone layer has become precariously thin over Antarctica and whether the hole signals trouble for planet Earth.

"The plane will land on skis on unprepared ice in McMurdo in the darkness," says F. Sherwood Rowland, a professor of chemistry at the University of California, Irvine. "The weather conditions are often very bad. About half the time, the plane can stop only long enough to let the people off (because of sudden changes in visibility). If they have equipment, they throw it to the ground as they take off again. So they've been told their equipment has to be able to bounce and sit on the ice for 12 hours at minus 40 degrees. A lot of equipment won't withstand that. It is certainly dangerous. ...The biggest downside is that the plane (could) crash."

While Rowland will not participate in this unusual expedition to the Antarctic, he has a very special interest in what happens there. It was 12 years ago that he and former UCI colleague Mario Molina first suggested that the ozone layer, an unstable, gaseous air mass seven to 30 miles above the Earth which helps protect humans from the intensity of the sun's ultraviolet light, is being slowly destroyed by man-made chemicals.

The culprits, stated Rowland and Molina in their renowned 1974 paper, were chlorofluorocarbons (also called CFCs or Freon), synthetic chemicals which contribute to modern comforts but which Rowland and others fear may also contribute to the eventual destruction of human life. The UCI researchers' findings led to the 1978 U.S. ban of chlorofluorocarbons in aerosol spray cans. But the clear liquids are still used to keep refrigerators and air conditioners cold and in the making of polyurethane foam containers to keep fast-food orders hot.

Since suggesting that CFC molecules are eroding the ozone layer, Rowland has seen the concern of the public, press, government, industry and others in the scientific community go hot and cold on the issue. Now the ozone-CFCs debate is sizzling again with the evidence of thinning ozone over Antarctica. While there is intense disagreement over what may be causing the hole, Rowland is convinced CFCs are to blame.

"The hole changes everything," says Rowland, sitting in his fifth-floor office at UCI's Physical Science Building. "In one sense, it is sad because the reason for the resurgence of interest is that the problem is much worse. The question is, do conditions in the Antarctic have any relevance to the rest of the world? We think they do."

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Fears over the Earth's precious ozone cover were reawakened last year when a British research team announced that a 40 percent decline in ozone appeared each September and October in a large area over Antarctica. While Rowland and others had predicted a slow decline of global ozone, the science community was shocked by the sharp imbalance in an obscure location.

"No one predicted it," says Rowland, who directs a 15-person research team that monitors air composition from samples gathered around the world. "Almost all of the calculations that were done over many years were done on the basis of an average (ozone loss) for the entire world."

About 90 percent of the atmosphere's ozone is in the stratosphere, or upper atmosphere, where it absorbs most of the sun's ultraviolet rays. According to the Environmental Protection Agency, a 1 percent decrease in ozone could cause an additional 20,000 cases of skin cancer each year. And even in the chill of Antarctica, the 40 percent ozone loss is enough to produce a suntan. Increased ultraviolet light striking the Earth's surface could set off environmental changes as well, Rowland says. Some scientists suggest that even minor increases of ultraviolet light could reduce crop yields and destroy some of the plankton and fish larvae that subsist on the surface of the oceans.

While there is agreement that continued ozone loss would have grave consequences, there is no consensus on whether the hole is a warning for the future. Some scientists suggest that the hole is a temporary, natural phenomenon caused by solar cycles and weather patterns over the South Pole.

Others suggest that the hole could be caused by sulfur compounds released into the atmosphere from the 1982 eruption of the El Chichon volcano in Mexico. But Rowland maintains that if El Chichon was the cause, ozone levels should have returned to normal by now.

The explanation most popular among scientists — and most dreaded — is based on Rowland and Molina's studies on how man-made chemicals react in the ozone layer. And even the CFC industry, anchored by such corporate giants as DuPont Co. and Allied-Signal Inc., is concerned about that possibility. One industry group is helping fund the Antarctic expedition.

"That phenomenon is large, unexplained and of great concern to everyone," says Kevin Fay, executive director of the Alliance for Responsible CFC Policy, a lobbying group working for the CFC industry. "It's got everybody attentive because the models don't predict it. And, yes, it's a concern of ours. We have to get some answers."

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Chlorofluorocarbons were synthesized 50 years ago and were heralded as a non-toxic, effective refrigerant to replace iceboxes. But in the early '70s, Rowland and Molina's studies revealed that CFCs drift slowly into the stratosphere, where ultraviolet light breaks the molecules down to release chlorine. The chlorine then seeks out molecules of ozone and destroys them. Like a wild game of Pac-Man, one chlorine atom can gobble up countless ozone molecules, contributing to a rapid overall decrease of the ozone layer. The researchers predicted that total ozone would be depleted by 7 to 13 percent by 2075 if CFCs continued to be released in the atmosphere at the 1974 rate.

The UCI chemists' data has proved accurate so far. The National Aeronautics and Space Administration estimates that worldwide ozone levels have dipped 2.5 percent over the past seven years. Based on recent studies, 5 to 9 percent of the ozone layer will be destroyed in the next 50 years if current CFC production rates continue; the ozone layer could not be naturally replenished against such rapid destruction. As for the unpredicted hole, an article by Harvard chemist Dr. Michael B. McElroy published in Nature magazine in May, suggests that conditions are ripe in Antarctica for accelerated ozone destruction due to the presence of CFCs and other man-made gases.

According to this theory, the cold and stagnant air over Antarctica during the winter, called the polar vortex, sets up light-sensitive chemical reactions on ice crystals in the atmosphere. CFCs, while produced mostly in industrialized areas, are mixed throughout the atmosphere by weather patterns.

"What we think happens is chemical reactions occur on those ice crystals," Rowland says. "And these chemical reactions change the distribution of the (CFCs). They do it in such a way that when the first sunlight comes up, the chain reaction starts. The usual steps that would cause it to slow down aren't there. And so the chain runs with much less impedance than it does in other places."

When the sun finally rises high enough, Rowland says, the polar vortex breaks up, bringing in air from the Southern Hemisphere and filling the hole with ozone-rich air from elsewhere. The hole disappears again until the next year. But the average annual ozone loss above Antarctica is still about 6 to 10 percent, Rowland says, far greater than losses found elsewhere.

"There's still an overall ozone loss compared to what there was in the 1960s," he says. "It's just not as concentrated as it is in the hole."

Normally, research expeditions to Antarctica take place in October, after the icy runways have been properly prepared for planeloads of scientists and the sun has warmed the area. But to understand how and why the hole forms, Rowland says, scientists must set up experiments in Antarctica now while the hole is forming.

"The hole will be there, we think, all through October, but the chemistry takes place in September," Rowland says. "What the scientific community wants to do is understand the chemistry during the time you're losing the ozone, not after you've already lost it. It's very, very difficult to measure the rates of particle reactions, so I think all the experiments have to be done there."

The research team, which includes a group from the Jet Propulsion Laboratory in Pasadena, will use ground-based and balloon devices to analyze the atmosphere. The JPL team will make use of an instrument originally designed for use aboard the space shuttle.

The instrument, called Atmospheric Trace Molecule Spectroscopy Experiment, measures the composition of the upper atmosphere. Different chemical elements absorb different wavelengths of sunlight. The instrument identifies specific chemicals in the atmosphere based on the wavelengths of sunlight that have been absorbed. When compared to sunlight that has been filtered through the atmosphere, scientists can determine which chemicals are present in the region.

"We're all very hopeful we'll be able to measure the composition of the atmosphere," says Molina, who now works at JPL and will help interpret results of the Antarctic experiment. "Right now, all we really have is an ozone measurement there. We need badly to measure a few other components.

"I think (the hole) is most likely a chemical effect and it's of man-made origin. But we have so little evidence, that's why we need to explore it. We can't rule out the solar activity theory."

But conditions in the Antarctic may make experiments difficult, Rowland says. And conclusive results may not emerge from this expedition.

"When they get back, there is going to be demand for a yes or no answer," he says. "But the people who go to Antarctica don't usually get anything the first time they go."

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Whatever researchers find — or fail to find — in the Antarctic, the issue of man-made destruction of the ozone is back on the agenda at the U.S. Environmental Protection Agency.

Following Rowland and Molina's paper in the '70s, the EPA called for a two-part solution to protect the ozone layer. Phase One was the 1978 ban of CFCs used in spray cans. Phase Two called for reductions in the non-aerosol uses of CFCs, such as those used in refrigerators and air conditioners. But Phase Two was never enacted.

"There was intense interest in 1974," says Rowland, a patient man who has given countless interviews and testified before many government and scientific committees on ozone depletion. "The interest dropped off with the thinking that we've solved the aerosol problem with Phase One and we'd work on Phase Two. The problem is Phase Two never arrived and most countries have never gotten to Phase One."

As part of the settlement of a lawsuit brought against the EPA by an environmental group, the EPA must put Phase Two CFC regulations in effect by November 1987. But future restrictions will be bitterly opposed by industry unless there is overwhelming scientific proof that CFCs are to blame. Industry representatives say the rate of global ozone depletion, and the role of CFCs in the process, is still unclear.

"There is an enormous amount of scientific uncertainty involved in this issue," says lobbyist Fay, of the Alliance for Responsible CFC Policy. "We definitely support continued research. But the scientific consensus we hear is that there is no imminent danger, that there is time to reach an international consensus. We do not concede that there is an environmental problem in terms of the imminent threat to civilization or human health."

According to Fay, the CFC industry is currently taking voluntary measures to reduce CFC emissions and substitute less harmful chemicals "where technologically and economically feasible." But, Fay says, further domestic restrictions will only cripple U.S. industry and will do little to affect the environment since half of all CFC emissions are produced in other countries. Only three countries followed the United States' ban on CFCs in spray cans.

"People say, 'The U.S. has to be a leader.' Well, no one followed us on the aerosol ban," says Fay. "Only about three countries followed us. If we set new standards (to regulate domestic use of CFCs) it may provide other countries with an incentive to sit back and say 'Well, the U.S. is handling the problem.' It's truly a global problem. What we're saying is let's not commit suicide here in the U.S. from an economic standpoint."

Some 28 nations are scheduled to meet next month to discuss a global policy on CFCs, but a consensus isn't likely, says Rowland. And unlike the strong consumer boycott of aerosol spray products in the '70s, it won't be as easy for consumers to express concern now — unless they are willing to forgo air conditioning in their houses and automobiles and give up burgers-to-go.

"In the '70s the individual consumer had a vote," Rowland says. "You don't have that now because you can't go to an automobile dealer and say I want an automobile with an air conditioner that doesn't use fluorocarbon 12."

Rowland maintains there is enough scientific evidence to justify a worldwide ban on all CFC production; he says adequate substitutes for harmful CFCs are available. But he fears the international agreement will be to "wait and see" if global ozone levels continue to decline. By then, Rowland says, it may be too late.

"My own somewhat cynical view is that, on average, people in the United States don't worry about what will happen to their grandchildren," Rowland says. "They worry about what will happen to their children somewhat, but they expect their children to worry about what will happen to *their* children. And as far as industry is concerned, they have great difficulty looking more than 10 years down the road."