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The ozone hole over the south pole during September and October, 1989, surprised scientists, who had predicted a mild year for ozone destruction. Instead, this year has been as bad as any previously recorded, matching 1987, which was the worst on record. In the region 10 to 11 miles above the earth, ozone depletion this year is almost 100%.[1] Throughout the entire "hole," the loss averages 50% this year, just as it did in 1987. The extreme losses in 1987 prompted scientists to argue then that it was an unusual occurrence because their theories had not predicted it. This year's recurrence of the 1987 losses has prompted those same scientists to admit that their theories need to be revised because the situation is clearly worse than they thought.

The ozone "hole" is not small; this year it covers 12 million square miles, more than three times the area of the continental United States. Furthermore, the "hole" is not the only place ozone is being depleted; the hole is merely the center of the most severe depletions. The stratospheric ozone depletion over the whole planet is now about 3%, averaged over the entire year; above the heavily populated regions of North America, Europe and Asia, the average ozone depletion is now 5% in winter but less severe in summer.[2]

The ozone layer in the stratosphere--6 to 30 miles above the earth's surface--filters out ultraviolet radiation, shielding the earth from this cancer-causing form of sunlight. Loss of the earth's ozone shield leads to measurable increases in ultraviolet light striking the surface of the earth; each 1% loss of ozone leads to a 2% increase in ultraviolet light striking the earth. The increased ultraviolet light is expected to have several important effects on humans and other forms of life. Increases in skin cancer and eye cataracts are the principal effect on humans. In other creatures the principal effects will be genetic mutations and growth disturbances. For example, phytoplankton, the tiny plants that form the lowest layer of the ocean's food chains by converting sunlight and water into carbohydrates--have their growth reduced by increased ultraviolet light. So do pine trees. Unlike humans, insects see ultraviolet light, so the world will look different to insects as the ozone layer becomes thinner. Several reputable scientists have suggested that the loss of stratospheric ozone will disturb the earth's climate in unpredictable ways, but the only way to tell whether this is true seems to be to wait and see.

The chemicals mainly responsible for destruction of the ozone layer are chlorine released by chlorofluorocarbons or CFCs (Freon 11, 12, 113, 114 and 115, which are used in refrigeration and air conditioning systems, in rigid polyurethane insulation, and as solvents in the computer chip industry), and by carbon tetrachloride and methyl chloroform (with many uses), and bromine released by Halon-1211 and Halon-1301 (fire extinguisher agents).

The U.S. and several other nations signed a treaty in late 1987 (see RHWN #60) to curb ozone destruction. However, the treaty would allow stratospheric chlorine levels to triple during the next decade (from their current 3 parts per billion [ppb] to 10 ppb), so it is now clear to everyone working on this problem that the treaty is inadequate. In Helsinki, Finland, last May, signers of the treaty met again and agreed unofficially to phase out CFCs by the year 2000, and to phase out the other ozonedepleting chemicals (Halons, etc.) as "soon as feasible," though no one seems to know just what that means.

The ozone-depleting chemicals already in the stratosphere have a very long lifetime, ranging from 25 years to 380 years. As a consequence, even if all production of ozone-depleting chemicals stopped today, it would be several centuries before the stratospheric ozone layer returned to normal.

Meanwhile the first treaty restrictions on CFCs went into effect July 1, 1989, and within a month the price of CFCs had risen 30%, while the cost of production remained the same. Before the phaseout is finished, the price of CFCs may rise five-fold. As a result, DuPont and Allied- Signal, the largest producers, are expected to make "several billion" extra dollars in the final years of CFC production--a windfall profit of at least $2 billion during the first two years of the phase-out alone.[3]

The CFC producers are now in a rush to produce alternative products. They seem bent on selling substitutes, called HCFCs, that are highly questionable. Naturally, there will be a big (and rapidly growing) market for CFC substitutes. They are in a rush because they didn't start looking for substitutes until 1986 when it became 100% clear that the U.S. government was seriously promoting a treaty that would curb CFC production.

The first technical paper predicting destruction of the earth's ozone layer by CFCs was published in 1974. It created immediate and intense interest among scientists and among government officials. In the U.S., the National Academy of Sciences immediately convened a blue ribbon panel to study the problem and in a year or so the panel reported that, yes, this appeared to be a very serious problem. Why did the CFC producers not start looking for substitutes in 1976? Why did they wait until 1986? C&EN [Chemical & Engineering News], a publication of the American Chemical Society, has answered that question: "Until it was clear that restrictions would be placed on the existing CFCs, companies had no incentives to invest in more expensive alternatives." The fact that their products were setting the stage for massive increases in cancer and eye cataracts among humans, disrupting the oceans' food chains, causing genetic damage and growth disturbances throughout the animal kingdom, interfering with the ecological balance of insect life, and possibly dislocating the earth's climate and weather-none of these things by itself was sufficient to cause DuPont and Allied-Signal to start a serious search for alternatives. There wasn't enough money to be made until the world situation got really desperate. Then they could cash in.

Such events throw a shaft of intensely revealing light on the nation's chemical companies. An anecdote comes to mind. In 1973, William Walker, a hydrologist with the Illinois State Water Survey, reported a conversation in the journal Ground Water:[4]

A few years ago the plant chemist of a large industry in east-central Illinois requested advice from the Illinois State Water Survey on underground disposal of toxic chemical waste from their manufacturing processes. According to the chemist, the plant, located in a densely populated part of town, had for several years burned about 700 gallons per week of a very toxic chlorinated hydrocarbon (polychlorinated biphenyl [PCB]) in a local garbage dump. Strict antiburning regulations being initiated by the State Department of Public Health were to prohibit further disposal in this fashion.... The plant chemist was hopeful that permission could be obtained to dispose of the toxic material in a pit on the plant property.

...When the chemist was asked if the toxic chemical wastes would blend with native ground water and thereby become diluted to a nontoxic level, he quickly replied, "Oh no, this material is a hydrocarbon--it will not mix with water but will float on top instead." A further question concerning possible deterioration of the toxicity of the material with time was answered, "6000 years from now it will still be as strong as it is today," and, finally, when asked what the effects would be on a person who might drink ground water contaminated with the toxicant several years in the future, the chemist replied, "It would kill him!"

The people who brought you ozone depletion are cut from the same cloth as the people who brought you your neighborhood Superfund dump. And they both did it with eyes open. Our job--and we have only about a decade to do it--is to bring these people under control. It will not be easy.

--Peter Montague

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[1] R. Monastersky, "Arctic ozone hole unexpectedly severe," SCIENCE NEWS Vol. 136 (October 14, 1989), pg. 246.."

[2] Pamela Zurer, "Ozone Layer: Study finds alarming global losses," C&EN [CHEMICAL & ENGINEERING NEWS], March 21, 1989, pgs. 6-7.

[3] Pamela Zurer, "Producers, Users Grapple with Realities of CFC Phaseout," C&EN [CHEMICAL & ENGINEERING NEWS] July 24, 1989, pg. 9.

[4] William H. Walker. "Where Have All the Toxic Chemicals Gone?" GROUND WATER Vol. 11 (March-April, 1973), pgs. 11-20.

Descriptor terms: ozone depletion; atmosphere; cfcs; superfund; landfilling; groundwater; water pollution; air pollution; skin cancer; eye cataracts; health effects; methyl chloroform; bromine; policies; treaties; economics; carbon tetrachloride; hcfcs;