Environmental Overkill

Whatever Happened to Common Sense?

Dixy Lee Ray
with Lou Guzzo

REGNERY GATEWAY
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CHAPTER 3

Stratospheric Ozone and the "Hole"

Now You See It; Now You Don't

"The world now knows that danger is shining through the sky. The evidence is overwhelming that the earth's stratospheric ozone layer—our shield against the sun's hazardous ultraviolet rays—is being eaten away by man-made chemicals far faster than any scientist had predicted. No longer is the threat just to our future; the threat is here and now. . . ."

NONSENSE, but so began *Time* magazine's cover story, "The Ozone Vanishes," in the February 17, 1992, edition.[1] Typical of the sort of "scientific" information available to the public, this article is so full of emotional hype, exaggeration, half-truths, and unsupported dogma that it is more propaganda than reporting. The only evidence that is referenced comes from the press releases of the National Aeronautics and Space Administration. And NASA, despite all our sentimentality about it, is hardly a reliable source. Like any other government agency, it is interested primarily only in those facts that justify more research and more federal dollars. The only scientists quoted in the *Time* magazine story are those who support the ozone-depletion-by-chlorofluorocarbons (CFCs) theory. No dissenting opinions, although there are plenty of them among reputable scientists, are mentioned.

By contrast, another cover story, "The Ozone Scare," appearing in the April 6, 1992, issue of *Insight* magazine, quotes many scientists who dispute the fashionable theory of ozone depletion.[2] Even more dissenting scientists were featured in a June 1992 article, "The Hole Story—The Science Behind the Scare," published in *Reason*.[3]

But it's typical of so much science reporting today that every issue is presented as one side of a great debate—a fundamental misreading of the nature of science. Lawyers might sway juries with rhetorical genius, ministers might inspire their flocks, and political talk shows might be enlivened by the cut and thrust of debate. But science is about the sober weighing of evidence. To the scientific mind, argument seems to have replaced reason in our public discourse—as if important questions of science or technology could be resolved by which scientific celebrities have the most charisma and media appeal. But science isn't a popularity poll, and sincere and impassioned rhetoric won't change reality. Only evidence counts. Eventually, the facts, clearly established and independently verified, will prevail. But until that time, the public is not well served by the airing of conflicting and untested scientific theories—especially when the theories amount to scaremongering, a vocation that can be quite profitable for those who manipulate it.

No wonder thoughtful people ask: "Who should we believe?" My only advice is this: Look for evidence, not for arguments; discount any unsupported assertions, even if they come from an eminent authority, and then make up your own mind based on what facts you can assemble and on your own common sense.

Now, in an effort to follow my own advice, let's look at ozone.

The issue of stratospheric ozone depletion comes down to just two basic, very simple questions: (1) Is ozone really disappearing from the stratosphere? (2) If it is, is the ozone loss caused by CFCs?[4] These questions are important, especially since freon-12, probably the most widely used CFC, is used extensively in refrigerators and air-conditioners.

Many atmospheric scientists uphold a theory that the answer is "yes" to both questions, and their theory has been widely reported as *fact* in the media. But according to a significant body of scientific opinion that is based on evidence and measurements, the answer is "no." Who is right? And does it matter?

To answer the second question first, it does indeed matter. It matters a great deal, because our entire food transportation and marketing system depends upon refrigeration, which, in turn, depends upon CFCs. The integrity of many medicines, vaccines, inoculations, and the entire supply of blood for surgery and transfusions also depends upon refrigeration.

It matters, too, because of the importance of air-conditioning in most modern buildings—a convenience that makes healthful living possible in the hotter parts of our country. These two industries, refrigeration and air-conditioning, will be affected drastically by political decisions regarding the use of CFCs and related substances. But so will other industries. Halon, a related substance, is, for instance, an agent used by firefighters across the country. If decisions about CFCs and halons are not based on good, solid scientific evidence, the result will be a tragic mistake that could cost the jobs and endanger the lives of countless Americans.

But the lives of many people could also be affected if CFCs are drilling a hole in the ozone layer and flooding the Earth with ultraviolet radiation, which we know can cause skin cancer.

So let's start at the beginning. Is ozone disappearing or isn't it?[5] Why the difference of opinion among scientists? The easy answer is that everyone is partly right, because ozone is being formed and destroyed all the time; the important question is whether there is a long-term trend that could ultimately lead to serious loss. Much of the answer to that question depends upon exactly when, where, and by what means ozone is measured.

Increasingly in modern research, scientists tend to divide themselves into two groups, each with a different way of analyzing natural phenomena. On the one hand, there are the theorists. They develop intellectual models of how nature is believed to work and then, using very highly sophisticated (and expensive) supercomputers, they make computer simulations from which conclusions and predictions are derived. On the other hand, there are the realists; these are the data-collecting and data-measuring people. They believe that natural phenomena can best be understood by gathering evidence from nature itself. They believe in studying what actually happens in the natural world.

There is no unanimity, no universal agreement about which is the better way to explain natural phenomena.[6] My obvious bias is toward direct evidence and measurement. So let's see what data are available, and then compare them with the conclusions drawn from computer models.

What do we know for sure about stratospheric ozone?*

First, we know that ozone is formed from oxygen. The oxygen molecule is very stable; it consists of two atoms of oxygen and hence is always referred to as O_2. Ozone, on the other hand, is not stable. It consists of three oxygen atoms, O_3, any one of which can easily react with either another ozone molecule to form three oxygen molecules or with other substances to form an oxygen molecule and some other oxygenated molecule.[7]

Now for some simple, common sense chemistry. It is the presence of oxygen in the high atmosphere and in the stratosphere that really protects us from ultraviolet radiation. In a very simplified manner, it works this way: Incoming ultraviolet radiation strikes and divides an oxygen molecule (O_2). The two separate oxygen atoms are very reactive and quickly combine with other oxygen molecules to form ozone (O_3). Ultraviolet energy is thereby absorbed by oxygen and prevented from penetrating to the Earth's surface. As long as there is sufficient oxygen in the stratosphere and as long as the sun puts out ultraviolet radiation at the right wavelength, ozone will be produced. Several tons of ozone are produced every second, mainly in that part of the stratosphere that is 10 to 40 kilometers above the earth's surface.

That's the basic reaction, but the reality is somewhat more complex. As already noted, ozone molecules are very unstable and reactive. Once formed, they can react with other substances commonly present in the stratosphere like chlorine monoxide, which is formed by oxygen atoms from ozone combining with the chloride ion.

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* Note that here we are concerned with ozone *in the stratosphere*. Ozone that forms at ground level is a different problem and will be considered separately, as a factor in urban air pollution.

Technically, that makes chlorine monoxide an "ozone destroyer." There is always a certain amount of chlorine present in the stratosphere, but it is believed by some atmospheric scientists that the stratospheric chloride that starts this process comes from chlorofluorocarbons. That's why some scientists support a ban on CFCs (more about this important topic later).

The important thing to remember is that ozone is constantly being formed and constantly being broken down. The *amount* that is present at any one time is the result of these reactions, and they can be influenced by many factors.

For example, the amount of ultraviolet radiation reaching the stratosphere—and affecting ozone production—depends upon the season, latitude, and solar cycle.[8]

Given the many chemical and photochemical reactions constantly taking place in the stratosphere, the expression, "ozone layer," is misleading. Ozone does not stratify into a discrete band. It is simply more abundant in the 10 to 40 kilometer area of the stratosphere than in the atmosphere below, because that is where the ultraviolet radiation at a wavelength of 240 nanometers is intercepted. Nevertheless, since the phrase, "ozone layer," is so commonly used, we will continue the practice.

It should also be noted that the amount of ozone can change rapidly. The amount present on any particular day may differ dramatically from the next. These changes in ozone concentration occur naturally and can vary by as much as 50 percent, depending on the weather. In the northern latitudes, ozone concentrations differ as much as 40 percent, even within a few days, while in equatorial regions, there is almost no annual variation in the amount of ozone.[9]

By convention, a decrease in the amount of ozone of 50 percent or more is called a "hole," even though there is no ozone "gap." The regular, annual ozone "hole" that appears over Antarctica was first measured and described in 1956–57, long before CFCs were in common use.[10] The "hole" appears at the end of the dark, cold Antarctic winter, lasts about three to five weeks, and then disappears. There is no overall or permanent depletion of ozone. Among other likely causes, the appearance of the Antarctic ozone hole requires intense cold (−80 degrees Centigrade) and is closely correlated with the onset of the annual Polar Vortex, a severe, late winter cyclonic storm. A similar but less severe storm occurs over the North Pole, with accompanying, though much smaller, temporary reduction in the amount of ozone.

Conclusions about long-term trends in the amount of stratospheric ozone cannot be based on single-day or short-term measurements. Even so, that is exactly what the U.S. Congress did.

A recent announcement by NASA, the U.S. space agency, that an aircraft-borne instrument had detected a high reading of chlorine stampeded the U.S. Senate into passing an amendment, 96 to 0, calling for an accelerated phaseout of the manufacture of chlorofluorocarbons. A week later, the White House ordered a phaseout of CFCs by 1995, five years ahead of schedule.

All this was accomplished by two NASA press releases and a lot of attention from the news media. It is discouraging to see public policy driven by press releases, rather than proved science.

What really happened? As best as one can tell—absent any published information that can be checked by independent scientists—a chlorine detector instrument, flying on a NASA research aircraft in the northern stratosphere, encountered high concentrations of an active form of chlorine, *capable* of attacking ozone.

But, of course, it required careful reading of the artfully worded document to discover that nothing at all was happening to ozone.

The NASA announcement was based on a peak chlorine reading, which occurred on January 20. "Peak" implies, however, that readings were lower—perhaps much lower—both before and after that date. The document was silent on this important point. Nor did it reveal that similar measurements in 1989, the date of the last such experiment, also encountered high chlorine values. Although widely anticipated and discussed at the time, there was no Arctic ozone "hole" in 1989, nor in any other year. Nor did one occur in 1992.[12] Research conducted, not by NASA but by Scandinavian scientists, tells an important story: No Arctic or high northern ozone "hole."[13]

The NASA press release may have told the truth, but it didn't tell the whole truth. It did not reveal that chlorine atoms cycle back and forth between an active and inactive form, depending on the presence of stratospheric ice particles, which, in turn, depend on whatever happens to be the temperature.

In spite of the facts concerning constant fluctuations in the amount of stratospheric ozone, Congress and the White House have accepted the ozone depletion theory that ozone is disappearing over time. This has not been established.

It is known that in addition to ultraviolet radiation and chloride, intense cold, ice particles, nitrogen compounds, and other factors might be involved in the oxygen-ozone interactions. Although the presence of chloride appears to be directly involved in ozone breakdown, the origin of that chloride is open to question. The assumption that it comes from CFCs is based upon hypothesis only. No breakdown products of freon have been identified in the stratosphere.

Chloride is one of nature's most abundant ions. Sea water evaporation provides the atmosphere with 600 million tons of chloride per year. Volcanic eruptions emit millions of tons of chloride. And at least another million tons of chloride are produced naturally every year. Now let's put this in perspective. World production of CFCs at its peak reached 1.1 million tons per year. At this rate there would be roughly 750,000 tons of chloride available from CFCs annually.

When Mount Tambora in Indonesia erupted in 1813, it ejected 211 million tons of chloride. At the highest rate of worldwide CFC production, it would have taken about 282 years to produce as much chloride-yielding CFCs as this one eruption.

Although measurements of chloride are not available for many modern volcanic eruptions, we know that Mount Erebus in Antarctica has been producing 1,000 tons of chloride daily since 1972.[14] Mount Erebus is located 10 kilometers upwind of McMurdo Sound, where ozone measurements are made. The volcano pumps out 50 times more chlorine annually than an entire year's production of CFCs. And, interestingly enough, the amount of chloride calculated to be in the stratosphere at any one time is 50 to 60 times higher than the chloride that comes from CFCs every year.[15]

If chloride is in fact necessary to the stratospheric breakdown of ozone, whose chloride is it? Man's or nature's?

Some scientists believe that ozone-destroying chloride must come from freon and related substances because CFCs rise through the atmosphere until they encounter stratospheric ultraviolet radiation at 20 to 40 kilometers. There they release their chlorides. Most natural chloride, on the other hand, is in the air and dissolves easily in water droplets and is rained out. But if this theory is true and if freon breaks down and releases its chlorine in the stratosphere, what happens to the rest of the molecule?[16] At least 192 chemical reactions and another 48 photochemical reactions have been identified in the stratosphere, but none involves CFCs.

Several questions are obvious: How does CFC rise when its molecules are four to eight times heavier than air? All experience with freon and related CFCs shows that they are non-volatile and so heavy that you can pour CFCs from a container and if some of them spill, they will collect at the lowest point on the ground, where soil bacteria will decompose them. Of course, some molecules will be caught in upward air eddies or otherwise carried upwards, but this is a very small fraction of the total.

We do not know how these heavier-than-air molecules cross the equatorial counter currents to accumulate at the South Pole and do the most ozone destruction there. And until the transport mechanism for CFC molecules is explained and until the full spectrum of CFC breakdown products is identified and measured *in the stratosphere*, the case for CFC destruction of ozone has not been made.

Again, what about the chloride coming from volcanoes? Chloride is hard to measure in the atmosphere and even harder in the eruptive plumes from volcanoes. Even so, David A. Johnston (who died at Mount St. Helens), in a posthumously published paper (*Science*, July, 1980), brought many previous estimates up to date and refined the measuring techniques for chloride in volcanic emissions.[17] He pointed out that a single eruption of Mount Augustine in Alaska in 1976 put more chlorine into the stratosphere than was contained in the worldwide production of CFCs for the entire year 1975.

Johnston also claimed that chlorine in many volcanic emissions is 20 to 40 times more concentrated than formerly believed. "Volcanic contribution of chlorine to the stratosphere [is] more significant to ozone than previously estimated," he wrote. "Clearly volcanic sources of stratospheric chlorine may be significant in comparison with anthropogenic sources."

Also, recent work has added emphasis to the important role of the sun in altering the ozone layer.[18] Solar flares play a major role, as do planetary waves, and even a major storm crossing the United States on the jet stream can result in a large, temporary ozone reduction.

The occurrence or absence of the El Niño warm current in the Eastern tropical Pacific Ocean is also related to the amount of ozone; any or all of these natural phenomena may reinforce or cancel each other out.

We also know that ozone was at a lower level in 1962 than it is today. An analysis of recent satellite data shows the overall amount of ozone in the stratosphere hit a high in 1969–70 and then dropped. It has been increasing steadily at 0.28 percent annually since 1986. It becomes more and more clear that to discern any real trend beyond normal fluctuations requires measurements that continue over a period of at least 20 to 30 years.[19]

In contrast to the press release publicity from NASA, the Norwegian scientists, Larsen and Henrickson in a January 1990 paper, published in *Nature*, discuss the ozone variations in the Arctic and point out that their work in the North Polar region going back to 1935 reveals "that anthropogenic gases, such as CFCs, have, up to the summer of 1989, had a negligible influence on the Arctic ozone layer. The general balance between formation and destruction of ozone has not changed, at least not to an extent that is apparent in the long-term observations."[20]

We conclude that measurement data do not support the theory that stratospheric ozone is being depleted by human-produced freons or any other CFCs. The theoretical computer models, however, tell a different story.

After ten years of computer predictions about depletion of ozone, it's time to look back and see how accurate these warnings have been.

If models—computer simulations—have any practical usefulness, it would be in their ability to predict phenomena or trends before they are revealed by measurements. In this they have failed dismally. For example, they failed to predict the Antarctic ozone "hole" that appeared in 1985—even though the phenomenon had been discovered and described on several occasions by a number of atmospheric scientists going back to 1956. When it was finally recognized, "new" chemistry had to be invented to explain the phenomenon so that it would fit the CFC theory.[21]

Moreover, in 1980, the National Academy of Sciences conducted a study based on the model developed by Rowland-Molina, the originators of the CFC-caused ozone destruction theory. This model predicted an 18 percent ozone decrease. By 1984, this prediction dropped to 7 percent and shortly thereafter to 2 percent. Recently, the best models now claim that ozone will decline by 5 percent over the next 100 years. After measurements in January 1990, the predicted ozone loss was announced by NASA and the Environmental Protection Agency as proceeding "faster than expected." Note that all of these dire predictions fall well within normal annual variations of 20 to 40 percent.[22]

Maybe it's time to remember that unexpected thinning of ozone in the Antarctic was first described not in 1985 but in 1956 by Gordon Dobson of Oxford University during the International Geophysical Year. CFCs had been developed but were not in widespread use. Not only was Dobson the first scientist to measure and describe the late winter formation of the Antarctic ozone "hole" and its sharp recovery with the onset of spring, but he also devised the instruments and system for measuring and quantifying the ozone amounts (Dobson units). He is recognized as the founder of research on ozone in the stratosphere. At first, he considered the Antarctic phenomenon to be an anomaly, but when it was repeated in 1957, Dobson concluded that it was a natural phenomenon.[23] Moreover, in 1958, the French scientists, P. Rigaud and B. Leroy, described the "hole" and concluded, "the thinning [is] related to the Polar Vortex . . . and the recovery is sharp and complete."[24]

Since the ozone depletion enthusiasts claim that the Antarctic "hole" dates only from 1985, these French scientists reviewed their earlier work, verified the results, and published it again in 1990. They also related the ozone "depletion" to increased solar activity.

Although for many practical applications the radiance from the sun is considered to be "constant," there are detectable variations. It is important to measure both long- and short-term variations in the total solar irradiance, as well as changes in solar output at specific wavelengths, particularly in the ultraviolet and X-ray components. Long-term variations in total irradiance and in high-energy output take place over the years-long solar cycle, while short-term variations occur on a days-long time frame. Both these cycles and types of variations can have important effects on the temperature and chemical composition of the upper atmosphere and the stratosphere.

Although total solar irradiance is thought to be relatively constant over time, recent measurements have determined that it can vary by nearly 0.1 percent during an 11-year solar cycle, the period during which the occurrence of solar flares, sun spots, and other magnetic activity on the sun changes from one extreme to the other and back.

We are now living in a period of greater solar flares and larger sun spots than at any time since measurements began. In addition to Dobson and Rigaud and Leroy, several Japanese scientists have described and discussed the annual Antarctic ozone "hole" as a natural phenomenon.[25] None of these investigations is cited by the ozone depletion theorists, nor are these earlier workers given credit for their discoveries. Yet their research puts the whole "CFC-caused-ozone-depletion" theory into question.

But as far as the news media are concerned, what makes a better story: "Man-Made Chemicals Punch Deadly Hole in the Sky" or "Sun Spots Lead to Natural Fluctuation of the Ozone in the Stratosphere"? It all began with Chicken Little.

CHAPTER 4

The Ozone and Ultraviolet Rays

Why the Fuss?

IF we are losing stratospheric ozone and being bombarded with ultraviolet radiation, the fear is that we'll endure higher rates of skin cancer.

The problem with this theory is that ultraviolet radiation levels at the earth's surface are going down, not up.[1]

According to scientists from the National Oceanic and Atmospheric Administration (NOAA), the University of Colorado, and the National Center for Atmospheric Research, the amount of ultraviolet radiation reaching the earth has, in some urban areas, decreased by 5 to 18 percent. How has this happened? Probably because of industrial sulfur dioxides, which, the scientists believe, might scatter the incoming ultraviolet radiation.[2]

Measuring instruments set up across the U.S. in 1974 by the National Cancer Institute show that over two test periods—1974–79 and 1980–85—the amount of ultraviolet "B" (UVB) reaching the earth actually decreased by an average of 0.7 percent per year since 1974. In an article in *Science* (1988), the institute also reports that data from Mauna Loa, Hawaii show no increase in UVB radiation from 1974 to 1985. Similar results were obtained by Penkett in East Anglia, England, and Bavaria, Germany. Measurements taken between 1968 and 1982 show UV decreases of from 0.5 to 0.9 percent. During this period, the ozone layer should have thinned 1.5 percent, causing a 3.0 percent increase in ultraviolet radiation—if the ozone depletion theory were correct.

To explain the significance of these results, we need to consider some more detail about UV radiation. Nothing in nature is simple. This certainly applies to ultraviolet radiation.[3] In the heat, light, and other radiation that flow outward from the sun, UV radiation comprises about 5 percent of the total energy radiated and is itself a spectrum of wavelengths. This spectrum is separated arbitrarily into three groups, A, B, and C. UVA is the longest, with wavelengths from 400 to 320 nm, UVB from 320 to 286 nm, and UVC, the shortest and most energetic, with wavelengths from 286 to 40 nm.

As already described, it is mainly UVC at wavelength 242 nm that splits oxygen molecules (O_2) into two oxygen atoms that immediately combine with other oxygen molecules to form ozone (O_3). There is also a similar interaction of oxygen with UVB at 293 nm. This reaction results in the production of billions of tons of ozone every second. The ozone molecules they create then become the "shield" that blocks nearly all of the remaining UVC and much of the UVB radiation. UVA, by contrast, is not absorbed by either oxygen or ozone, and it passes through the stratosphere virtually unaffected, nearly all of it reaching the Earth's surface. Since it is UVB that is believed to cause sunburn and, presumably, also the most common kinds of skin cancer, most attention has been focused on it. Available evidence does not, however, link UVB directly to malignant melanoma, and there is a growing suspicion that UVA may be implicated in this most serious type of skin cancer. As noted below, there are other possible causes of malignant melanoma, casting doubt on whether the amount of ozone in the stratosphere influences the incidence of this disease.

Even so, William Reilly, administrator of the Environmental Protection Agency, claimed on April 4, 1991, that ozone depletion of 4 to 5 percent would permit increased UV radiation to reach the earth so that "over the next 50 years about 12 million Americans will develop skin cancer and 200,000 of them will die." Such scare statements by a high government official are utterly irresponsible.[4]

Of course, overexposure to ultraviolet radiation can cause skin cancer; this is well established. But that's not the whole story. Two basic types of skin cancer are apparently related to too much ultraviolet exposure, presumably UVB. People who sunbathe or who frequent tanning salons increase their risk of acquiring these cancers. The most common skin cancer is *basal cell carcinoma.* It affects about 400,000 light-skinned individuals a year. The tumors are small, fleshy bumps or nodules that do not spread quickly. They generally occur on the face, neck, trunk, or hands, and, with treatment, basal cell carcinoma is curable in 99 percent of the cases. Then there is *squamous cell carcinoma.* It affects about 100,000 light-skinned people annually. Typically, this type of skin cancer occurs on the ear rim, face, nose, or lips. It can spread and often forms large masses of cells. These common skin cancers may be unsightly, irritating, and annoying, but they are curable.

A third, rarer form of skin cancer is malignant melanoma. Despite considerable investigation, this type of skin cancer has not been correlated with exposure to UVB. It has also been increasing. It is usually fatal and may be, to some extent, genetically determined. There is clear evidence that cases of malignant melanoma occur more frequently among people living close to the Equator.[5]

Melanoma is increasing at about 5 percent per year, and, curiously, its incidence is much greater in the higher social classes. This suggests that a person's lifestyle might have a significant influence on susceptibility to the disease. Studies in Australia, for example, show that melanoma is considerably more common in indoor workers than in outdoor workers.

Malignant melanoma starts with a black mole or a lesion that usually appears on the trunk, buttocks, or other parts of the body that are not often exposed to sunlight. To imply that ozone loss (even if it has occurred) would lead to an increase in malignant melanoma is obviously false.

The extent of ozone loss that EPA Director Reilly called "grim" would result in a 4 to 5 percent increase in exposure to ultraviolet radiation. This is, in fact, far less than normal, annual variations in ultraviolet radiation, and far less than the increased dosage one would absorb if one made a simple move to a lower latitude.

For every six miles that one goes closer to the Equator, one's ultraviolet exposure increases by 1 percent. Humans accommodate very well to these changes. And if one moves from either the North or South Polar region to the Equator, ultraviolet penetration and consequent exposure increases 5,000 percent.[6]

Who would refuse a vacation in Hawaii, or Florida, or to the South Seas, or along the French Riviera because of such increases in the ultraviolet exposure? Yet these trips mean exposures many times in excess of the amounts that the EPA and NASA are using to frighten Americans. When people from Scandinavia go to Spain's Costa del Sol or the English and Scottish move to Australia, they subject their lightly pigmented skins to amounts of UV radiation to which they are not adapted by nature. The intensity of UV radiation in northern Australia is 300 percent greater than in England.

It is not surprising, given the sunbathing fad of the past few decades, that there is an increase in common skin cancer among white people. The same phenomenon has not appeared among brown or darkly pigmented peoples or among those who are native to more tropical climates.

UV radiation can be very damaging to unpigmented cells; this is the basis for the long-known sterilizing properties of direct sunlight—it kills bacteria. And UV radiation has many positive effects. Exposure to UV rays from sunlight is absolutely essential for young children in order to develop a normal, strong skeleton. Absence of sufficient ultraviolet exposure results in a dreadful childhood disease, rickets. It is UV radiation acting to catalyze a chemical reaction in the skin that leads to the formation of Vitamin D, which is required for the growth of strong bones. Provision of synthetic Vitamin D can help to overcome lack of UV exposure, but some UV exposure remains important.

While rickets is the expression of severe lack of Vitamin D, less extreme reactions may include the onset of adult osteomalacia (also known as osteoporosis or "brittle bones"), particularly prevalent in women.*

It is worth noting that although the EPA speaks pompously and probably erroneously of 400,000 to 800,000 new cases of common skin cancer in the U.S., there are 1,200,000 bone fractures annually among the elderly—many of them are hip or legbone breaks—and 20,000,000 Americans are afflicted with osteomalacia. It's likely *more* exposure to UV would have helped. Recent research has revealed a strong possibility that both colon cancer and breast cancer are inversely related to exposure to sunlight.[7]

Further, those who would protect us from UV rays by banning the production and use of CFCs on the basis of computer simulations and undocumented theory overlook the reasons CFCs were developed and put into use in the first place. CFCs are non-volatile and non-toxic and present no direct hazards to living organisms. Until CFCs were developed, many people died from the toxic fumes of ammonia, methyl chloride, and sulfur dioxide, which were often used as refrigerants.

In 1929, more than 100 people died in a Cleveland hospital from a leak in the refrigeration system. The dangers of home refrigerants stimulated the search for a safe substitute. It was a division of General Motors—Frigidaire—whose scientists, led by the chemist, Thomas Midgley, succeeded. The CFC now called "freon" was introduced in 1930.[8]

Not only are CFCs safe, but all of the proposed substitutes have turned out to be very expensive, and some are toxic, flammable, and corrosive. All are inefficient compared to freon. Use of any of them or a return to cumbersome, ineffective refrigerants like ammonia or sulfur dioxide would require a thorough redesign of home, commercial, and industrial equipment.

In the U.S. alone, there are thousands of companies that use CFCs. They produce billions of dollars' worth of goods every year. There are millions of individual and commercial refrigerators, air-conditioning units, refrigerated transport trucks, rail cars, and ships.

Replacing *just* the refrigerated transport for food moving to market would cost more than $150 *billion*. Some estimate the cost of banning CFCs for refrigeration at $800 per person per year.[9]

Melvyn Shapiro, an atmospheric scientist at the National Oceanic and Atmospheric Administration, has said that President Bush's decision to speed up the phaseout of CFCs by five years (1995, instead of 2000) was "A terrible thing. . . . The President

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* Question: Could this be related to the "little girls don't romp half-naked in the sunshine as much as little boys do" phenomenon?

reduced the time scale for the elimination of CFCs based on the politics of the day. . . . The costs to the country for the termination of CFCs are going to be phenomenal. Globally, it will cost hundreds of billions of dollars."

"What you have to understand," Shapiro added, "is that this is about money. If there were no dollars attached to this game, you'd see it played in a very different way. It would be played on intellect and integrity. When you say that the ozone threat is a scam, you're not only attacking people's scientific integrity, you're going after their pocketbook, as well. It's money, purely money."[10]

The manufacturers of CFC have glibly assured everyone that substitutes for freons and halons can and will be found, because they hope to make a killing on new, more expensive products. One possible replacement for freon, being touted by DuPont, is Suva (CFC 134a). But it has a few problems. It is inefficient, compared to freon. It cannot be used in existing equipment. Tools that have been used in units containing freon cannot be used with Suva. It is toxic and hazardous to handle. It reacts with the desiccant used to keep water out of air-conditioning units; no solution to this problem has been found. It is corrosive and attacks lubricants, leading to early failure of compressors; it requires a specially fabricated lubricant. And its use will be temporary, because Suva is a hydro-chlorofluorocarbon and will come under the hydro-chlorofluorocarbon ban by the year 2000. And, of course, it will cost a lot more than freon; it is about ten times more expensive. Is it worth it?

Suva will require the complete redesign and re-engineering of all existing refrigeration and air-conditioning equipment. Given the flimsy and dubious scientific basis for banning CFCs, it doesn't make good sense to throw away all our present refrigeration and air-conditioning equipment just to accommodate environmental bureaucrats. If leaking freon *is* a problem, it would be simpler and wiser merely to improve the sealing of refrigerators and air-conditioning units. But simple solutions and common sense aren't the point. News media play and big dollars are, even if human lives are endangered in the process.

The effects on human health should also be considered. Loss of food through spoilage will increase if the use of refrigeration is reduced, and at the same time cases of food poisoning will also increase. U.S. health statistics show a dramatic decline in stomach cancer deaths when refrigeration was introduced. Robert Watson, head of the Ozone Trends Panel (a strong supporter of banning CFCs), has admitted that "probably more people would die from food poisoning as a consequence of inadequate refrigeration than would die from depleting ozone."[11]

There is also an international health consequence. International refrigeration experts estimate that should the world's "cold chain" for food transportation collapse because of the ban on CFCs, hundreds of millions of people could die. Preventing Third World countries from building modern refrigeration systems is one of the stated purposes of the population-control environmentalists.

EPA chief William Reilly said in 1989: "The prospect of seeing countries move forward with major development plans involving, as we heard in China, a proposal for 300 million new refrigerators possibly based on CFCs, makes [it] very clear that we must engage them in the process [to ban CFCs]."[12]

Remember that CFCs also play a role in firefighting. These CFCs are called halons and are nonflammable. Their molecules are so heavy, they can be incorporated into foams that instantly smother fires. Countless lives have been saved by using halons to put out fires in aircraft, in ships and submarines, and in many industrial facilities. What will replace halon? The Montreal-London Treaty requires that production of Halons 1211, 1301, and 2402 be frozen at the 1986 level by 1992, reduced 50 percent by 1995, and phased out completely in the year 2000. It might have been helpful if the treaty also banned fires, or at least came up with a replacement for halon.[13]

Even though CFCs have been impugned only because of theories, computer models, simulations, and forecasts of disaster that are not substantiated by either the evidence or the measurements gathered in nature over the past 35 years, CFCs have already been effectively banned. Their production is being phased out by 1995, the price of freon has already gone up by 40 percent, and further increases are coming. The costs are enormous. The question is, again, is all this justified? Is the evidence of an irreversible loss of stratospheric ozone so overwhelming and the likelihood of worldwide damage so great that billions of taxpayer dollars must be spent? All the evidence points the other way.

Yet 59 nations signed an international treaty usually referred to as the "Montreal Protocol on Substances that Deplete the Ozone Layer." It was adopted in 1987 and revised, to cover more substances and make the restrictions and penalties more severe, in 1990.

Richard Benedick, deputy assistant secretary of state for environment—an unelected population-control bureaucrat—was the chief negotiator for America in forging the ozone treaty. In his account of the events leading to the treaty, recorded in his book, *Ozone Diplomacy*, Benedick writes with astonishing candor of how the treaty was agreed to even though a scientific basis for it had not been established.[14]

Ozone Diplomacy reveals how science can be, and has been, politicized; it is a clear example of how a little dubious science and zealously held theory can overwhelm available evidence.

"Perhaps," Benedick wrote, "the most extraordinary aspect of the treaty was its imposition of short-term economic costs to protect human health and the environment against *unproved future dangers* . . . dangers that *rested on scientific theories, rather than on firm data*. At the time of the negotiations and signing, *no measurable evidence of damage existed*."*

No such evidence exists today.

"By their action," Benedick added, "the signatory countries sounded the death knell for an important part of the international chemical industry, with implications for billions of dollars in investment and hundreds of thousands of jobs in related sectors. The protocol did not simply prescribe limits on these chemicals based on 'best available technology'. . . . Rather, the negotiators established target dates for replacing products that had become synonymous with modern standards of living, *even though the requisite technologies did not yet exist*."†[15]

Not only does the protocol require replacement substances; the negotiators also established procedures for enforcement, including severe penalties and fines for noncompliance. Who gave the negotiators the authority to establish police power?

Yet the treaty is in effect; it has the force of law. In the last analysis, it is based on two unproved assumptions: (1) that CFCs destroy ozone, which is not replaced, and (2) that CFCs are so resistant to change that nothing except ultraviolet radiation in the stratosphere breaks down the molecule. Neither of these assumptions has been corroborated. Many people believe them only because "everyone says so."

We have seen that the evidence for CFCs destroying ozone is flimsy and scant, and now it has been discovered that soil bacteria destroy CFCs very effectively.[16] This fact has not been taken into account in calculating the persistence of CFCs, whose *estimated* lifetimes range from 20 years to 1,000 years. For freons, the estimates are 75 to 120 years, or an average of 100 years, which is the figure most often quoted. These estimates are all based on the assumption that nothing disintegrates the CFC molecules. Enter the microbes. As already pointed out, CFC molecules are (depending on which CFC is considered) four to eight times heavier than air molecules; most CFC that escapes into the atmosphere falls to the earth. There, soil bacteria decompose CFCs within a few days or weeks. The history of this discovery is interesting.

In 1986, while measuring the production of carbon dioxide and methane in termite colonies in Australia, scientists Khalil and Rasmussen ran into an unexpected problem. Believing, as everyone did, that CFCs were indestructible outside the stratosphere, they were using this material to calibrate their instruments. To their surprise, they found that the calibration kept changing and concluded that something in the soil was destroying the CFC. Study of the soil microbes established that there was rapid breakdown of freon and many other man-made chlorofluorocarbons, including methylchloroform and carbon tetrachloride (both targeted for banning by the Montreal Protocol). Khalil and Rasmussen reported on the microbial removal of CFCs in 1989; their research has been substantiated by field work in China's rice fields and by considerable laboratory experimentation. These results have been largely ignored in the ozone controversy.

Further evidence that CFCs sink to the earth and are sequestered

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* Emphasis added.

† Emphasis added.

in soil or on plant materials comes from the results of testing the smoke from forest fires. Dean Hegg, et al, from the University of Washington report large amounts of CFCs in wood smoke—an amount equal to as much as 50 percent of all freon likely to have been released to the atmosphere.[17]

When all the research on CFCs is taken into account, the idea that all these molecules end up in the stratosphere and destroy ozone has less and less to recommend it. Yet millions of dollars have been spent to examine the minuscule amounts of CFC that do reach the ozone and very little has been spent to look at the real environmental sink—the ground and the oceans.

It is from the marine environment that information on the *natural* production of CFCs may be obtained. Indeed, nature does produce CFCs, as well as the bacteria that destroy them. What are we to make of the macroalgae and the invertebrates that produce and use halogenated organic compounds in the sea?[18]

The current fuss about ozone "depletion" is not the first. It is only the most recent, and judging by the degree of clamor and emotionalism engendered, the most successful. Some senior citizens may remember the public outcry during the 1950s about testing nuclear warheads (atom bombs, as they were then called) in the high atmosphere. Besides fallout of radioactive isotopes, the nuclear explosions were claimed to disrupt the stratosphere and destroy the ozone. They didn't.

Then in the 1960s came plans for a commercial supersonic transport plane. This development was vigorously opposed by environmentalists, who charged—among other supposed effects—that the exhaust gases would destroy the stratospheric ozone. The United States SST program was terminated, giving the activist environmentalists one of their early victories. France and Great Britain went ahead with their own program, the Concorde. Today there are hundreds of supersonic military aircraft flying. Their exhaust has not been shown to affect the ozone or the stratosphere.

Then in the 1970s came the Space Shuttle. Here, too, the ozone depletion enthusiasts attacked.

But NASA's political clout was sufficient to squelch them and, of course, the shuttle program has not depleted ozone or perturbed the stratosphere. And then, also in the 1970s, along came Sherwood Rowland and his postdoctoral student Molina with their theory that man-made chemicals—CFCs—somehow found their way into the stratosphere and destroyed ozone.

This time the charge was widely reported in the popular press and soon received broad public support. Even such claims as increased UV radiation due to the Antarctic "ozone hole" causing cataracts and blindness in sheep and rabbits in New Zealand and South Chile received uncritical acceptance. Veterinarians have examined the afflicted animals and report that the eye problems are caused by an epidemic of the highly contagious bacterial infection commonly known as "pink eye."[19]

Meanwhile, we're stuck with the Montreal Protocol that bans human production and use of CFCs. If one adds up all the estimated costs from the different affected industries, it may be as high as $5 trillion worldwide by the year 2005. Because of the severe effect on transportation and storage of food due to the loss or greatly increased cost of refrigeration, estimates indicate that between 20 to 40 million people will die yearly from hunger, starvation, and food-borne diseases.

Why have so many nations signed the protocol? One reason could be Article 4, which imposes a total trade ban on any nation that does not abide by the protocol conditions. This amounts to very effective "persuasion." Also, all the countries that sign the treaty are prohibited from exporting or importing CFCs, and the penalties, in addition to the trade sanctions, are severe. "Illegal" use of freon carries a $25,000 per day fine, and five years in prison can be imposed on anyone who transports a refilled cylinder.[20] To counter the loss of refrigeration technology, many developing countries are, of course, demanding payment from the industrialized nations, mainly the USA, and free access to all manner of other development technology. Maneka Gandhi, India's environmental minister, delegate to the Montreal conference, and the daughter-in-law of former Prime Minister Indira Gandhi, has said, "The whole 21st Century's survival will be based . . . on knowledge . . . . Either you sell us the technology [at an acceptable price] or you change your laws or you change your patent rights. . . . Start working on it."[21]

Responding to this sentiment, expressed by many developing countries, the protocol proclaims, "Industrialized countries affirmed their commitment to 'take every practicable step' . . . to ensure that the best available, environmentally safe substitutes and related technologies are expeditiously transferred . . . under fair and most favorable conditions."

Who pays? Especially since DuPont and others will patent their substances and processes? And, as Robert Watson said, commenting on the prospects of DuPont making so much money from substitutes, "Of course, they are going to make enormous profits."[22]

Since there was never an informed public discussion of the obligations undertaken by the U.S. under this treaty, it seems fair to ask the question: Precisely what is meant by the statements quoted above? Does this "protocol" override normal commercial practices in international trade? What about patent law? Benedick writes:

> The parties and non-parties to the Montreal Protocol had accomplished far more than significantly strengthening controls over ozone depleting substances: they had created the first financial mechanism dedicated to protection of the global environment, and, for the first time, the governments of industrialized nations had accepted a responsibility to help developing countries with modern technology.[23]

The president of the London conference, United Kingdom environmental secretary Patten, concluded that the Montreal Protocol "would become 'the model for . . . future environmental diplomacy.'"

What will happen to this treaty should it turn out, as appears likely, that "ozone depletion" is nothing but an aberration of the research techniques? That perturbations occur in the ozone layer is well established. Some have been correlated with solar activity, and with stratospheric weather patterns, intense cold, and the presence of chloride and/or nitrogen. Of all these, stratospheric weather may be the most important.

Further long-term studies, especially those relying on satellite-based instrumentation, may reveal cyclic patterns and may help to determine what is cause and what is effect among the many phenomena that have been described. Maybe—just maybe—none of the earth-based data are reliable.

This startling statement is based on a 1992 research report by two Belgian meteorologists, D. DeMuer and H. DeBacker (published in the *Journal of Geophysical Research*), who contend that all ground-based measures of stratospheric ozone concentration are influenced by changing amounts of sulfur dioxide (SO_2) in the atmosphere. They conclude that the presence of SO_2—from volcanoes and from industry—produces a "fictitious" ozone depletion and point out that when the data for the past 30 years are corrected for SO_2 interference, all evidence of ozone depletion disappears.[24]

Should this surprising result be confirmed by other independent investigators, it would do away with all the worry over ozone depletion. It would also be an object lesson in the hazards of acting precipitously, before sufficient data are gathered and understood.

So where does that leave us on the question of ozone depletion? The facts do not support the notion that ozone in the stratosphere is being irrevocably destroyed. Nor do they support the supposed dire consequences that would result if the ozone doomsayers should be right.

We also know that the idea that CFCs destroy ozone is long on theory but short on facts. Yet, CFCs, specifically freon (CFC-12), are essential for the proper functioning of today's refrigeration and air-conditioning equipment, and halons are critical for fire suppression. Nevertheless, we're still faced with an early, forced phaseout, accompanied by enormous price increases of this important product. What to do?

Should we succumb to the plans of the duPont Company to introduce Suva (CFC 134a) at great cost to the consumer and great profit to duPont? By no means.

So far, the unsurpassable ingenuity of the human mind has not been taken into account. Faced with the CFC challenge, the proprietor of an automotive air-conditioner repair shop in Florida, Bob Holzknecht, has come up with a replacement for freon that is both inexpensive and effective. Experimenting in his own personally supported research laboratory, Holzknecht has found that a mixture of four parts propane and three parts N-butane is every bit as effective in air-conditioners as freon. The same should be true for refrigeration units.

The beauty of the propane-N-butane combo is that both components are readily available—and they cannot be patented. While it is well known that both of these gases are flammable, that can be controlled by proper sealing. After all, natural gas (which is both flammable and explosive) is safely used in many household appliances and gasoline likewise is safely controlled for use in automobiles. No chemical company, no matter how large, can monopolize this product and hence make enormous profits.

Holzknecht's results are supported by independent work in the former Soviet Union.[25] A report broadcast on the Moscow Home Service said, in part: "In accordance with the International Convention signed two years ago, the Soviet Union is taking steps to cut production of freon, which has a damaging effect on the ozone layer. This year, a large number of aerosols will be manufactured without freon, to be replaced by a mixture of propane and butane. In a year's time, five more Soviet factories will stop using freon in refrigerators."

Information on whether Russia and other countries that were formerly part of the U.S.S.R. will adapt propane-N-butane as a freon substitute is not currently available.

The case for or against freon and other CFCs, substitute refrigerants, and destruction of stratospheric ozone has not been made, and, until it is, we should be suspicious of those with an interest in reaping the profits of doom.

6×10^{15} tons   .02 per cent = 2×10^{-4}

inches. And from #1 that the atmosphere weighs 11.9 billion billion pounds. This is 6 million billion tons. Now take fact #3; 0.04 per cent is 2,400 billion tons of CO_2. Half (the change since 1950) is 1,200 billion tons. Let's call this fact #5:

$12 \times 10^{11} = 1.2 \times 10^{12}$ $\Delta CO_2 = 1 \times 10^{12}$ tons

5. There were 2,400 billion tons of CO_2 in the atmosphere in 1950; 3,600 billion tons now, give or take a sigh or two....
6. Human activity currently releases 6 billion tons of CO_2 per year.
7. Non-human activity (oceans, trees, Pinatubo, Mauna Loa, etc.) releases 200 billion tons of CO_2 per year. . . .

Now compare fact #5 with fact #6. Simple division tells you that if every molecule of human-released CO_2 at the current rate of production stayed in the atmosphere, it would take another 200 years for the post-1950 change to be matched. Or looking backward, since minus 200 years takes us back to before the Industrial Revolution, it means that if every CO_2 molecule from every factory, car, steam engine, barbecue, campfire, and weenie roast that ever was since the first liberal climbed down out of a tree right up until today was still in the atmosphere, it still wouldn't account for the change in CO_2 since 1950.

Fact #7 has been going on for a long time, a lot longer than any piddling 200 years. Comparing #5 and #7 means it takes about 12 years for the average CO_2 molecule to be recycled back out of the atmosphere.

Given the above, here are some conclusions that nobody can argue with and still claim to be a reasoning creature:

8. Human activity, carried out at the present rate indefinitely (more than 12 years) cannot possibly account for more than 6 per cent of the observed change in CO_2 levels.
9. Entirely shutting off civilization—or even killing everybody—could only have a tiny effect on global warming, if there is any such thing. . . .

That leaves two questions that no one knows how to answer:

Q-1. Why do all these supposedly educated, supposedly sane people want to end civilization?

Q-2. Since humanity can't possibly be causing the CO_2 level to go up, isn't it time to start wondering about what *is*?

—S/L. L. Van Zandt, Professor of Physics,
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