UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

January 14, 1987

Dear Colleague:

At the request of the Science Advisory Board's Stratospheric Ozone Subcommittee, we have redrafted the Executive Summary of the report, "An Assessment of the Risks of Stratospheric Modification." The panel suggested that the Executive Summary be based on the statement of findings from each chapter and we have rewritten the Summary to reflect their suggestions as well as other public comments. We would appreciate your comments. The new Executive summary may be discussed at the upcoming SAB meeting (see attached Federal Register Notice for details). You can also address any comments directly to my office. These remarks should be sent to Maria Tikoff, US EPA, PM 220, 401 M St, SW, Washington, DC 20460, (202) 382-4036.

Sincerely,

John S. Hoffman
Director
Strategic Studies Staff

[SAB-FRL-3139-2]

Science Advisory Board, Stratospheric Ozone Subcommittee; Open Meeting

Under Pub. L. 92-463, notice is hereby given of a meeting of the Stratospheric Ozone Subcommittee of the Science Advisory Board on January 26-27, 1987. The meeting will be held at the U.S. Environmental Protection Agency in Room #2, South Conference Center, 401 M Street, SW., Washington, DC. The meeting will begin at 9:00 am on January 26 and will adjourn no later than 3:00 pm on January 27.

This is the second meeting of the Subcommittee. The purpose of the meeting is to enable the Subcommittee to continue its independent scientific review of the scientific adequacy of the assumptions, interpretations and conclusions of scientific information used by the U.S. Environmental Protection Agency in preparing its draft document "An Assessment of the Risks of Stratospheric Modification." The first day of the meeting will be held in public session; the Subcommittee will write its report on the second day and will meet in executive session. For further information on the draft document, contact Maria Tikoff, U.S. Environmental Protection Agency, PM-220, 401 M Street, SW., Washington, DC 20460, or by calling (202) 382-4036.

The Subcommittee meeting is open to the public. Any member of the public wishing to attend or obtain information about the meeting should notify Dr. Terry F. Yosie, Director, Science Advisory Board or Mrs. Joanna Foellmer, Secretary, at (202) 382-4126. Opportunity will be provided for members of the public to make brief oral presentations to the Subcommittee, and a total time of one hour will be available for this purpose. Written scientific comments will be accepted in any form. Any member of the public wishing to present oral comments should notify Dr. Yosie no late than close of business on January 19, 1987.

Terry F. Yosie,

Director, Science Advisory Board.

December 31, 1986.

[FR Doc. 87-137 Filed 1-5-87; 8:45 am]

BILLING CODE 6560-50-M

The New York Times

U.S. and Soviet to Study Ways to Save the Ozone

A14

By PHILIP SHABECOFF
Special to The New York Times

WASHINGTON, Dec. 18 — United States and Soviet officials agreed today to widen cooperation on environmental issues, including a joint effort to halt depletion of atmospheric ozone.

At a news conference after four days of meetings, Lee M. Thomas, Administrator of the Environmental Protection Agency, said scientists from the two countries would meet in Moscow next month to consider what measures may be needed to halt the destruction of ozone by man-made chemicals.

Yuri A. Izrael, chairman of the Soviet State Committee for Hydrometeorology and Control of the Natural Environment, said his country did not think there was sufficient evidence yet demonstrating the need to limit production of chlorofluorocarbons and other chemicals that destroy ozone in the upper atmosphere. But in response to a question he said such evidence might be presented at next month's meeting.

Mr. Izrael did say that depletion of the ozone layer "is one of the most important global problems" that could lead to higher skin cancer rates because more ultraviolet radiation can reach the earth's surface.

Agreement Is Extended

A joint announcement said that the agreement on environmental cooperation between the United States and the Soviet Union, first signed in 1972, had been extended for five years. The two sides agreed to pursue 38 environmental projects in the coming year.

One project, urged by Mr. Izrael, was a "comprehensive" analysis of the state of the global environment. This will include stepped-up monitoring of such things as climate change, ocean pollution, acid rain and other problems associated with the long-range transportation of air pollution.

A report on the findings will be published at the end of 1988 or the beginning of 1989.

The two sides also agreed to study means of preventing the pollution of major rivers and lakes. The study will concentrate on Lake Michigan and on Lake Baikal in Siberia.

Information will be exchanged on the development of systems for protecting water in large lakes, on methods used to identify major pollution sources, on the effects of pollutants in lake sediment and on ways of dealing with the runoff of agricultural chemicals.

Under another agreement, the United States and Soviet coast guards will develop ways to respond jointly to spills of oil and other pollutants in waters of concern to both countries, such as the Bering Sea.

Among the other new or expanded agreements were these:

¶An exchange of endangered species from zoos.

¶Joint studies on marine mammals and how to protect them.

¶A joint Pacific Ocean expedition aboard a Soviet research ship to study how ocean change affects the climate.

¶More cooperative work in predicting earthquakes, including an exchange of visits by scientists to seismic measuring systems.

¶An exchange of information on the education and training of environmental specialists.

Arms Issue Raised

The Soviet delegation raised the issue of arms control several times at the meetings. At today's new conference, Mr. Izrael said he had noted "as a scientist and as co-chairman that the two most important global problems are, No. 1, the maintenance of peace and the saving of the world from nuclear war and, No. 2, the preservation of the natural environment."

A member of the United States delegation said the Russians liked to use the arms issue as "a stick to beat us with," but added that the subject was brought up only "perfunctorily."

Mr. Izrael complained about air pollution drifting over the Soviet Union from Western Europe. The Soviet Union, he said, was taking steps to control pollution from its territory that moves across the Arctic Circle.

Asked about the lessons the Soviet Union had learned from the accident at the Chernobyl nuclear power plant, he said that Soviet scientists had made "a very serious evaluation" and concluded that the country's energy program "will not be changed."

He added, however, that the scientists had concluded that "nuclear electrical stations demand very strict and serious controls."

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The New York Times DEC 19 1986

Maybe Not Just Soviet Propaganda

A38 Iran-contra affair or not, says the Soviet leader, Mikhail Gorbachev, he still wants a nuclear arms pact with the United States and is prepared to make further compromises. "Propaganda," the State Department was quick to snort. Too quick.

Propaganda or not, Mr. Gorbachev has a powerful incentive to move now on arms control. It could be very much in his interest to lock in a bipartisan American consensus on arms reductions before President Reagan's successor takes over. That's not just a fanciful view; it's also rooted in a realistic Soviet assessment of American politics. The State Department and the Reagan Administration would do well to hear it out, for it could also be very much in America's interest.

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Sure, the Russians are happy when the United States stumbles. Sure, they'll be delighted to exploit the Iran scandal. Posing as peacemaker and compromiser is easy when the other guy is reeling. But propaganda advantages do not strengthen their economy. And that, as conservative and liberal analysts on the Soviet Union agree, is Mr. Gorbachev's top priority. That doesn't mean he'll stop playing the power game. It does indicate, however, how he rates his current interests.

Mr. Gorbachev this week told Senator Gary Hart that he was prepared to be flexible on limiting research on space-based missile defenses. Specifically, he spoke of allowing virtually all testing — as long as it was not done in space. This formulation falls short of Mr. Reagan's demands for essentially no restrictions, but he could accept it and still argue, in truth, that he had kept his "Star Wars" dream alive and kicking.

Soviet strategy seems to assume that if the Soviet Union doesn't get an agreement now, one won't be possible for three years or more. Soviet leaders may not like Mr. Reagan, but they fully appreciate that he is in a stronger position to make a deal than any of his likely successors. By his hand, a bipartisan consensus could be locked into place for the next several years.

Otherwise, whether the next President is a moderate Republican or Democrat, he would have to start all over again. Worse, in all probability, he would face opposition from the right, perhaps including Mr. Reagan and his supporters.

Why shouldn't the President follow up the Gorbachev gambit? Some Administration officials fear that Mr. Reagan is politically too weak now to bargain effectively. They fear he might give away too much to regain his standing after the Iran scandal. But the only way to know is for Mr. Reagan to get his Administration together and try.

The Russians, no matter how much they may enjoy the President's squirming, would probably prefer to see him solidly planted across the negotiating table. Americans, sensing the possibility of arms control breakthroughs, should want to see him there, too.

estat[illegible] ownership and, to use a harsh term, speculation. It can be much more profitable than the S&Ls' normal [illegible] state of the S&Ls.

Hooked on Chlorofluorocarbons

CHLOROFLUOROCARBONS, the Boy Scouts of industrial chemicals, have become as American as apple pie. Neither poisonous nor flammable, they are central elements in air conditioning, most notably of cars. Inexpensive to produce, they are widely used to make foam products, from hot-drink cups and packaging materials to padded upholstery.

They have only one flaw: when returned to the air, as almost all eventually are, they rise into the stratosphere and thin out the ozone layer that shields the Earth from ultraviolet radiation. The effects are still not fully understood, but scientists think a weaker ozone layer could mean a vast increase in skin cancers; smaller crops and weaker plants; damage to aquatic life; and an addition to the "greenhouse effect" wherein release of man-made gases alters the Earth's climate.

In 1978 the Environmental Protection Agency banned the use of these chemicals as propellants in aerosol sprays. In 1980 the Carter administration proposed freezing production for other uses. The manufacturers protested, saying partly that it made no sense to limit production here while it was not limited abroad. Scientists also began to waver in their assessment of the damaging effects, and the Reagan administration, disinclined to regulate in any case, shelved the Carter proposal.

Now, however, industry and the administration have partially reversed themselves. New scientific evidence is one reason. In 1985 an alarming hole in the ozone layer was discovered over Antarctica; such nonalarmist centers of inquiry as NASA, the space agency, have warned against the possible consequences of continuing emissions. The chemical companies—DuPont in particular—may also be close to the production of alternatives. The industry has also succeeded in making its main point that any action should be international. Why then resist?

EPA, following a lawsuit by an environmental group, has agreed to decide by next November whether it thinks further regulation is needed. Meanwhile, formal international discussions have begun. At a meeting this month, the administration is proposing a worldwide limit on emissions—the strongest proposal made by any government so far.

There remain enormous problems. Environmental groups want faster action, while industry warns against large expenditures before the risks are defined. There are also practical difficulties in enforcing any international agreement and in weaning so many industries from their dependence on these substances. But all the movement is in the right direction. Industry and environmental groups both believe the talks could produce an international agreement that would be a model of its kind. This is now a moderate, constructive debate. For a large environmental issue, that makes it a model already.

Haiti in Doubt

[illegible] build democracy in [illegible]h. There have [illegible] and tragic [illegible] turned out [illegible] with an [illegible]des until [illegible]volution- [illegible]cess. It [illegible] few [illegible] their officers. There have been some human rights violations of a sort that no government ought to tolerate. Meanwhile, the far left is beginning to organize and, while it is very unlikely [illegible] to reach for power, it [illegible] enough to [illegible] des[illegible]

Hard Choices Await Industry as Ozone-Layer Fears Rise

Nations May Curb Certain Chemicals Despite Growing Global Demand

By Barry Meier
Staff Reporter of The Wall Street Journal

In 1930, Thomas Midgley Jr., a General Motors Corp. chemist, stood before a scientific audience and inhaled a whiff of a new refrigerator coolant to prove its safety.

Mr. Midgley showed no ill effects. Since then, uses of that chemical and related substances have blossomed in products ranging from air conditioners to throw-away packaging.

But governments world-wide, and thousands of U.S. companies including GM, now face hard choices as evidence mounts that such compounds are eating away the fragile natural layer of ozone that shields the earth from ultraviolet rays. U.S. officials warned recently, for instance, that 40 million more Americans than previously expected face skin cancer over the next century if global use of ozone-destroying chemicals isn't checked. Substantial ozone loss is also likely to harm crucial plant and sea life and affect the world's climate, many researchers believe.

Evidence of widespread chemical depletion of the ozone layer—which begins eight miles above the earth's surface—is far from conclusive. Scientists are still debating the causes behind recent reports of ozone loss over the South Pole and elsewhere. Yet the risks of waiting for science to find definitive answers is too great, officials of some governments say. Of particular concern, some say, is that the huge reservoir of ozone-destroying chemicals already in the atmosphere is growing and is expected to persist for decades. "If we can't control these chemicals now we probably won't get a second chance," says Victor Buxton, a Canadian environmental official.

Nations Meet in Geneva

This week, some 45 nations, including the U.S. and Canada, are meeting in Geneva, Switzerland, in a bid to hammer out global limits on ozone-destroying chemicals. Some activists believe the process, if successful, could set the pattern for resolving other industrial-pollution dilemmas that threaten all nations.

Getting industry to curb its appetite for these compounds, however, may be a problem. U.S. chemical makers aren't racing to create safer products. Auto makers like GM may face costly plant overhauls, for example. While some U.S. manufacturers are cutting down on these chemicals, others aren't, even when alternatives exist. And American industry uses only about 30% of the world's production of such compounds.

Chlorofluorocarbons, or CFCs, the most pervasive ozone-destroying chemicals, are used as coolants in refrigerators and air conditioners, as solvents in electronics manufacturing and in making plastic foam insulation and foam cups and packages.

The largest producer is Du Pont Co., which markets CFC products under the brand name Freon. Other major producers include Allied-Signal Inc., Pennwalt Corp., Kaiser Aluminum & Chemicals Corp. and Racon Inc. There are other ozone-destroying compounds, such as halons, a chemical group used in high-tech firefighting equipment.

The ozone debate began in 1974 when two University of California chemists, F. Sherwood Roland and Mario J. Molina, argued that CFCs don't decompose in the lower atmosphere as do most other compounds. Instead, they theorized, CFCs slowly drift into the upper atmosphere, where they eventually break down, starting a complex chemical reaction that destroys ozone, a naturally occurring form of oxygen.

Reports of the chemists' work sparked a massive U.S. consumer boycott of aerosol deodorants, hair sprays and similar products that depended on CFCs. In 1978, the Environmental Protection Agency banned CFCs as propellants in most aerosols, resulting in a 40% decrease in U.S. industrial demand for the chemicals.

The action, however, proved only a stopgap. Though the propellant ban still is in effect, CFC sales in the U.S. have since zoomed back to pre-aerosol-ban levels, largely sparked by the explosive growth of such products as foam throwaway packaging, and increasing demand for CFCs as a solvent by electronics manufacturers. Researchers say it doesn't matter how CFCs are used, whether in a spray can or a hamburger package; eventually, they all are released into the atmosphere.

Global sales of the compounds are also rising because, among other things, most European nations didn't follow the U.S. aerosol ban.

No Easy Targets

Lacking easy targets such as spray cans, consumer action alone isn't likely to blunt the growing use of CFCs. The family car, for example, is filled with CFC-based products, ranging from the coolant in its air conditioner to the padding for its seat and dashboard.

Because of the compounds' pervasive use, U.S. companies that eluded regulation in the 1970s probably won't escape again in any tightening of regulations. "They know the handwriting is on the wall," says Kathleen A. Wolf, an analyst with Rand Corp., a Santa Monica, Calif.-based consulting concern. In recent months, a number of U.S. concerns such as GM, Ford Motor Co. and International Business Machines Corp. have formed in-house task forces to study ways to reduce CFC use.

The mobile air conditioner, found in the vast majority of American cars, is a major source of CFC pollution in the U.S. CFC-based coolants are frequently released into the air when the systems undergo repair. While some U.S. cities such as Tampa, Fla., are moving to have bus air-conditioner repairmen trap the compounds for recycling, the impact of recycling on the problem is limited. Engineers say about 65% of a car's air conditioner coolant leaks before it ever gets to a repair shop.

Auto makers say they are attacking the problem on several fronts. GM engineers, for example, are looking at tightening existing systems with new gaskets and other devices, says Richard Klimisch, the company's top environmental official. But rather than shoulder the huge financial burden of developing new types of air conditioners, GM is relying on chemical companies to develop alternative coolants, he says.

Who Will Pay?

As was the case during the first ozone-layer controversy, battle lines are forming over who—CFC producers or auto makers—will pay for research and development of environmentally safer compounds. GM officials say both Du Pont and the British-based ICI Industries PLC have agreed only to produce test batches of a possible ozone-safe air conditioner replacement coolant known as FC134a.

"They're interested in making (FC134a), but there are questions over who is going to pay for the toxicity testing and the types of (sales) guarantees they want from us," Mr. Klimisch says. FC134a was first developed in the late 1970s, but both chemical and auto makers dropped work on the compound when government pressure to expand the scope of CFC regulations eased in the early 1980s.

U.S. chemical producers clearly aren't rushing to develop substitutes. Morristown, N.J.-based Allied-Signal, for example, dispatched sales teams nationwide this summer in a bid to get electronics manufacturers to switch *to* CFCs from other solvents, according to chemical distributors. An Allied-Signal spokesman declined to comment on the matter.

Du Pont, after disputing the CFC-ozone link for 12 years, recently conceded that the compounds could pose a future ozone threat and called for global limits on their use. Company officials say they have restarted research into FC134a but aren't planning heavy spending on it until regulatory action or consumer demand justify it. The principal problem with FC143a production is the lack of a chemical catalyst to produce the substance in commercial quantities.

Competitive Pressures

U.S chemical producers, however, may soon face competitive pressures. ICI Industries has also restarted work on FC134a. A Japanese chemical maker, Diakin Kogyo Co., and a German concern, Hoechst AG, hold FC134a production patents, says Richard Lagow, a University of Texas chemistry professor and a consultant to the EPA on the CFC issue. Both Du Pont and ICI officials say FC134a development is at least five years away.

Some companies aren't waiting. At Digital Equipment Corp. plants in Andover, Mass., and Salem, N.H., water-based systems recently replaced CFCs in some electronics-cleaning processes, says James Rogers, a company environmental manager. He says the Maynard, Mass.-based producer of computers and computer parts has set the immediate goal of capping CFC use followed by a phase-out where practical. "We feel the consequences of under-reacting (to the ozone threat) are worse than the consequences of overreacting," he says.

Other companies could apparently do without the CFCs they currently use. For instance, while some McDonald's Corp. foam packages for its McDLT hamburgers contain CFCs, others don't. A spokeswoman for the Oak Brook, Ill.-based fast-food company says CFC-based packages don't keep a hamburger hotter, but simply reflect CFC use by some of McDonald's foam-package suppliers. McDonald's hasn't yet decided whether to switch suppliers, the spokeswoman says. She adds, however, that the company has met with suppliers in recent weeks to discuss the issue.

World-wide, the pressure also is building to control CFCs. A global approach is critical, say some regulators and activists, because an estimated 70% of the world's CFC use occurs outside the U.S. Intensified demand from developing nations is also projected in future years as their purchases of air conditioners, refrigerators and other items grow.

Supply and Demand

The global freeze proposals under study at the Geneva meeting this week would exploit the law of supply and demand. By capping CFC production, some regulators argue, prices of ozone-destroying chemicals would rise, forcing users to seek alternatives. That would provide chemical makers with the incentive to develop safer products, they say.

Richard Benedick, the State Department official heading the U.S. delegation at Geneva, said recently that he expects the world's nations to agree by July on the need to limit ozone-destroying chemicals. After reaching a general accord, nations can debate specific limits on the chemicals' uses, revising them downward or upward as scientific data build, he added.

Others are less sanguine. European chemical producers, for instance, still advocate substantial CFC growth. If the global talks stall, Sen. John Chafee (R., R.I.) recently said, he will push for legislation restricting imports of some CFC-based products. The EPA is also under a court-ordered May deadline to decide on added CFC regulations.

Science may not be able to provide policy makers with firm guidance. Preliminary data from Antarctica, for example, indicate that annual ozone loss there may result from both chemical and as-yet-unexplained regional and seasonal factors, says Robert Dezafra, an atmospheric physicist at the State University of New York, Stony Brook.

Yet Mr. Dezafra, a member of the recent U.S. scientific expedition to Antarctica, says he is worried. Every day, he says, the cloud of CFC in the atmosphere is building, pushing the world further along a process it won't be able to reverse. Says Mr. Dezafra, "We got a late start studying this problem and we're getting an even later start finding a solution."

CFC-11 + CFC-12 : US as fraction of world production.

1982	30.1	Avg. based on totals:
1983	32.2%	31.4%
1984	34.3%	
1985	28.7% (estimated)	

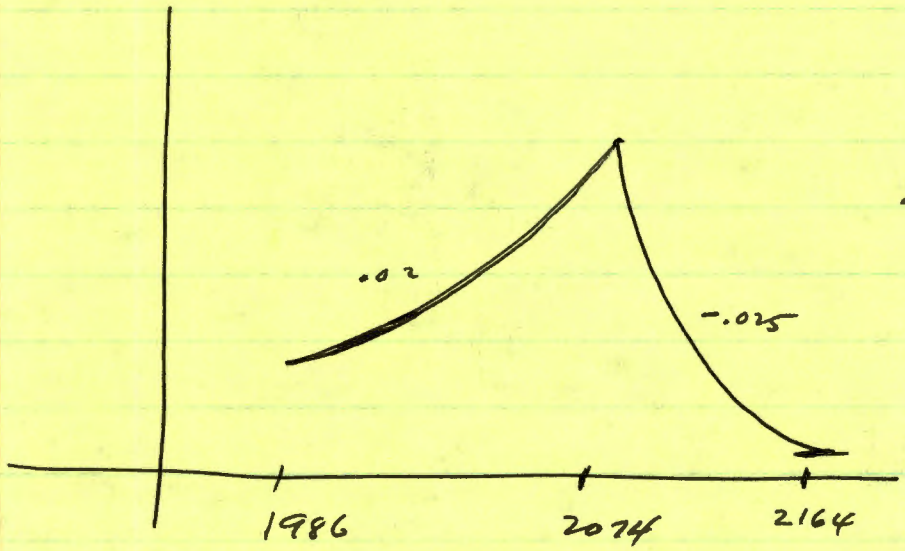
31.3% Avg. of the 4 percentage.

NAMS — National Air Monitoring System.

Darrell

[(1) Size of CFC industry? Value added on an annual basis? Gross value of output?

(2) Sources of SO_2. These should be tracked down immediately.



$500,000

$\rho = -.02$

Al Larson

Telling the story re: OZMO. Would have a more direct role.

Martin Bailey - on Alan Walk's staff. Had done a lot of research on CFR's.

Actual negotiation headed by Bureau of OES Dick Benedict. Bailey was there for State Dept.

647-7688 - Bailey.

Dick Benedict.

International Free Rider problem
AER - pres. address last year - Kindleberger had an essay on this.

Stock policy. Oil Stocks.

Wright + Williams. Has some.

Ran 3336 at US State Dept.

Wallace has always been the semi-official link with CEA on the ERP.

OES + Larson to come up to Alan's office.

Martin Bailey. — would be glad to get the people together

Had researched CFR question for several yrs.

If we limit production, producers would move abroad. Controls on emissions would simply imp

Gyration of the estimates. True level of the uncertainties.

Very explicit about uncertainties. 95% CI range very lonely states.

Doing right thing for the wrong reason. Right policy for the wrong reason. Industry decided to support EPA to use international effort to fend off the lawsuit. We had asked for almost ban + quicker cap on production.

Important thing is to have enough time for new information to come in.

Present state of atmospheric chemistry says that emissions at current level + not grow, ozone would increase. CFR production has been stable, emissions have been catching up. If other gases continue to grow (CO_2, methane), combined effect will be to have ozone increase. If CFR emissions start growing 3-5%/yr, 20-30 yr. growth of ozone, then it will start to decline. 1981-82 chemistry.

Now they say the ozone is decreasing.

[redacted]

Also, discovery of the ozone hole.
measures in Antarctica do not find CFR's in as high a concentration as it should be. Also, they don't know what is causing this.

Huge #s of cancers are now based on the assumption of growing emissions. The computer runs were based on level emission in the 80's. When they found that with level emissions, the threat was disappearing, they discovered the need for growing emissions.

This week

Costs for aerosols were quite small. Consumer welfare costs. But restricting refrig. & air conditioning, best candidate alternatives are quite poisonous. For some uses, there seems to be a happy medium. Less stable chemically. Basic scientific point - non-reactive chemical can't hurt anybody. Highly reactive chemical will hurt somehow. CFR's are so stable they get to the Stratosphere.

MC can't be a very sharp elbow.

John Rowe Scientific Ocean & Environ bureau. Bureau of Oceans & Int. Environ & Sci. Affairs.

Information Needed:

(1) Size of CFR industry, cost of phase-out (estimate of direct & indirect costs)

(2) additional articles.

(3) Calculation of expected value of more information? (Use to justify more research?)

Global Climate Change 11/5/86
Sen Gore:

(1) Vastly increase research funding
(2) Immediate ban on CFC's.
(3) Deforestation initiatives.

Recommend in a couple of weeks.

11/25/86

State of the World

Action	No O_3 problem	Serious O_3 Problem
Do Nothing	0	−$400 billion
Control CFC's	−$20 billion	−$100 billion.

p_1 = prob. of no problem = .9375

p_2 = prob. of serious problem = .0625

EVPI:

If no problem, choose A, value 0.

If problem, choose B, payoff −100.

Value of problem is $0(.9375) - 100(.0625) = -6.25$

Based on priors, if you choose either A or B, you get

$EV = -400(.0625) = -25.$

So, $EVPI = -6.25 - (-25) =$ $18.75 billion.

Calculate p_1, p_2 ∋ you are indifferent.

$$E(A) = 0 \cdot p_1 - 400 p_2$$
$$E(B) = -20 p_1 - 100 p_2$$

$$-400 p_2 = -20(1 - p_2) - 100 p_2$$

$$p_2[-400 - 20 + 100] = -20$$
$$p_2 = .0625$$
$$p_1 = .9375$$

With these prices, you are indifferent from an EV standpoint.

Now, suppose you have a way of improving your forecast. Let X = no problem, Y = serious problem. Then suppose

$p(X_p|X) = .6, \quad p(X_p|Y) = .2$

Relatively "pessimistic" experimental strategy.

$$p(X_p) = p(X_p|X)p(X) + p(X_p|Y)p(Y)$$
$$= (.6)(.9375) + (.2)(.0625)$$
$$= .575$$

$p(Y_p) = .425$, so it's a rather "gloomy" or very conservative predictor. Suppose also $p(Y_p|Y) = .9$

$$p(Y_p) = p(Y_p|X)p(X) + p(Y_p|Y)p(Y)$$
$$.425 = p(Y_p|X)(.9375) + (.9)(.0625)$$

So $p(Y_p|X) = .3933$

Now, suppose the prediction is X_p. Then

$$p(X|X_p) = \frac{p(X_p|X)p(X)}{p(X_p)} = \frac{(.6)(.9375)}{.575} = .9783$$

$$p(Y|X_p) = \frac{p(X_p|Y)p(Y)}{p(X_p)} = \frac{(.2)(.0625)}{.575} = .0217$$

So. $EV(A) = 0 + .0217(-400) = \$8.68$

$EV(B) = -21.736$

So, choose A, value -8.68

Suppose you get Y_p. Then

$$p(X|Y_p) = \frac{p(Y_p|X)\,p(X)}{p(Y_p)} = \frac{(.3933)(.9375)}{.425} = .8676$$

$$p(Y|Y_p) = \frac{p(Y_p|Y)\,p(Y)}{p(Y_p)} = \frac{(.9)(.0625)}{.425} = .1324$$

So $E(A) = 0 - 400(.1324) = \$-52.96$

$E(B) = -20(.8676) - 100(.1324) = -30.59$

So, choose B, value -30.59

So $EV = (.575)(-8.68) + (.425)(-30.59)$

$= -17.99$

Without any information, you would ~~choose~~ have $EV = -25$, so this information is worth $-17.99 - (-25) = \$7.01$ billion.

What if the test is biased the other way, in the "optimistic" direction? (or at least less pessimistic)

$p(Y_p|Y) = .6, \quad p(Y_p|X) = .2$

Then $p(Y_p) = p(Y_p|Y)p(Y) + p(Y_p|X)p(X)$

$= (.6)(.0625) + (.2)(.9375)$

$= .225$

So $p(X_p) = .775$

and $p(X_p|X) = .8$

Then

$p(X_p) = p(X_p|X)p(X) + p(X_p|Y)p(Y)$

$.775 = (.8)(.9375) + p(X_p|Y)(.0625)$

$p(X_p|Y) = .4$

So, suppose prediction is X_p.

$$p(X|X_p) = \frac{p(X_p|X)\,p(X)}{p(X_p)} = \frac{(.8)(.9375)}{.775} = .9677$$

$$p(Y|X_p) = \frac{p(X_p|Y)p(Y)}{p(X_p)} = \frac{(.4)(.0625)}{.775} = .0323$$

$EV(A) = 0 - 400(.0323) = -12.92$

$EV(B) = -20(.9677) - 100(.0323) = -22.58$

So, choose A.

but what if the test is biased the other way?

Now, suppose prediction is Y_p. Then

$$p(X|Y_p) = \frac{p(Y_p|X)p(X)}{p(Y_p)} = \frac{(.2)(.9375)}{.225} = .8333$$

$$p(Y|Y_p) = \frac{p(Y_p|Y)p(Y)}{p(Y_p)} = \frac{(.6)(.0625)}{.225} = .1667$$

$EV(A) = -400(.1667) = -66.67$
$EV(B) = -20(.8333) - 100(.1667) = -33.34$
So choose B.

$EV = -22.58(.775) - 33.34(.225) = -25$
So this information would appear to be of very little value. The discrimination of the test is not great enough. The problem is that $p(X_p|X) = .8 < p(X)$ unconditional. Test has no power to discriminate.

Try another example.

$p(X_p|X) = .99$, $p(X_p|Y) = .5$

Then $p(X_p) = p(X_p|X)\,p(X) + p(X_p|Y)\,p(Y)$
$= (.99)(.9375) + (.5)(.0625)$
$= .9594$

$p(Y_p) = .0406$

and $p(Y_p|Y) = .6$, so that
$.0406 = p(Y_p|X)\,p(X) + p(Y_p|Y)\,p(Y)$
$p(Y_p|X) = .0033$
So this is a very "optimistic" test.
Rarely gives "false positives."
So: Suppose X_p

$$P(X|X_p) = \frac{p(X_p|X)\,p(X)}{p(X_p)} = \frac{(.99)(.9375)}{.9594} = .9674$$

$p(Y|X_p) = .0326$

$EV(A) = -400(.0326) = -13.04$
$EV(B) = -20(.9674) - 100(.0326) = -22.61$

Choose A, value -13.04

Suppose Y_p

$$p(X|Y_p) = \frac{p(Y_p|X)\,p(X)}{p(Y_p)} = \frac{(.0033)(.9375)}{.0406} = .0762$$

$$p(Y|Y_p) = \frac{p(Y_p|Y)\,p(Y)}{p(Y_p)} = \frac{(.6)(.0625)}{.0406} = .9236$$

So $EV(A) = 0 - 400(.9236)$

$EV(B) = -20(.0762) - 100(.9236) = -93.88$

Choose B.

Ok. So value of ~~info is~~ problem is

$$EV = -13.04(.9594) - 93.88(.0406) = -16.32$$

So value of this info is $-16.32 - (-25) = \$8.68$ billion.

State Rm. 7256 11/18/86
Martin Bailey

1. Facts + where we stand.
2. US position
3. What to avoid (if anything)
4. State's analysis of the actual problem.
5. Any papers we could have that would help in drafting the section.

Current issue of Science by Mark Crawford.

Suzanne Butcher of environmental office.
John Rowe
Jack Fitzgerald

Ozone – premature to make any definitive statement. Major volume at start of the year. EPA needs guidance from Scient Adv. Board. won't have that in time.

Does appear that there is growing consensus that we are in a danger zone. Avoid irreparable loss to the ozone. Cl– acts as a catalyst, doesn't get used up for 50+ yrs.

Conclusions are theoretical, but production grows at rate

1978 – US cut aerosols. Significant cut.

Current growth ~ 4–5% world-wide.

This year we matched peak yr. level of overall production.

USE of CFC's closely linked with GNP.

Before mid-70's, growth rate had been 10%/yr. High income elas. of demand for CFC's.

Modeling tends to show that continuing levels of growth above 3% will have adverse effects.

Int. process: 1985 Convention for Protection of Ozone. Unable to get agreement on Protocols.

Begins in Geneva 12/1.

Concern has grown to point where NGO's as well as major producers + users need to have a sensible policy on growth.

Tentative US position:

(1) Near term freeze of production at or about current levels

(2) Project long-term phase-out of the most harmful chemicals (give industry a clear signal that these products not viable over the long term.) (Some more benign chemicals could be expanded.)

(3) Process + commitment to concerted scientific review + modification of the protocol if the science warrants it.

90% producers EEC, Japan, + US. EEC didn't join aerosol ban, said they had already reduced production by 30%. But they can + continue to grow into 21st Century.

EEC not fully persuaded that the science calls for major control policy.

Germans: small workshop industry of filling the aerosol cans. They can deal only with CFC's. The ban would destroy all these small firms.

EPA has domestic timetable National Resources Defense Council lawsuit settlement imposes a timetable. Rules issued by May; final rule by November. We may combine the domestic with a ban on imports to give incentive to EEC.

Japan: Phased approach. Japan finds CFC113 very important in electronics. Even USSR acknowledges a problem.

Convention not in force yet. Needs 20 to ratify. USSR (counts 3), Canada, US, Finland, Norway. (Ukraine + Byelorussia)

Some 45-50 countries participating.

Several 3rd World countries participating; they are neither producers nor consumers.

Trade controls + agreement not to transfer own production would control.

Compliance: National reporting + publication of statistics. No on-site verification mechanism.

Plan would be to put on a ceiling + require reporting. Country would get to decide which ones to produce.

Policy must be one of risk mgt.
Short-term conservative regime. Chances of ~~modeling being worse~~ reality being worse.

Acid Rain

— Multilateral + bilateral.
Protocol ECE - reduction of SO_2 by 30%.
We did not sign because we didn't get credit for existing reduction.

— Bilateral 5 billion program ~~to~~ to show feasibility of reduction progs.
Canada: Single most important agenda item.
We have not spent the $5 billion;
we have $400 previously appropriated for demo of cleaner coal technologies.
Industry contribution $560 million.
Does this count towards the envoys 5 billion?
DOE - yes. EPA - no.

The 5 billion was within 5 yrs, half industry;

before G-R

Canada has no uncertainty about the damages. They have made decisions based on conclusive scientific evidence.

Canada has fewer sources - large smelters. They have hydro + nuclear plants. No scrubbers in Canada.

They think 50% of damage in Canada due to US emissions. They want us to reduce emissions 4 million tons across the border.

Do not reveal

EPA work will indicate marked improvement in Canada because of improvements from Sudbury. (One big smelter.) Canada for some time shut down Sudbury when Ni was low; they have also retrofitted the place.

Not known what we will say at next Shamrock Summit.

Aquatic damage - measurable + there. 5% of Canadian lakes at risk. (This may be low.) They have officially proclaimed that only 5% of lakes at risk. What cannot be minimized is Canadian perception.

Natural Gas Deregulation — would help a lot. Fuel use act exemptions for boilers, but not power plants.

Wild Card - Congress + its actions.

Emotional issue - us has no right to pollute them. Actually a moral problem

Envoys report focus on research + development. Envoys report useful to us, but we have to show we care.

Material cost is probably the most credible.

Say something complimentary about the Envoys report.

Ozone: Time frame. 12/1 - 12/5 → late Feb.

Diplomatic Conf. in late April to adopt the protocol. Won't know until Feb. if we will be able to sign.

Clean Air Act require Adm. to act if something is threatening the ozone. No national security escape clause. ##

Industry viewpoints. Very different. Does proposed protocol control emissions or production?

Protocol will have to decide. Now, ~~ozone depleting coefficient~~ weights take account of ~~emissions~~ emissions.

Calculations: Non-melanoma cancers well agreed upon. 1% depletion ⇒ 2% ~~skin~~ Ultraviolet ⇒ x% squamous etc. cancers. non-melanoma skin.

Melanoma cancers less solid. Less certain. High correlation of skin cancers with ultraviolet exposures. Skin cancer rates + UV correlation good. Much weaker correlations for melanoma.

1/2 of % death rates for non-melanoma cancers.

Let's try the decision problem.

State of World

Action	X	Y
A	10	40
B	60	5

$p(X) = .3$, $p(Y) = .7$

$E(A) = 10(.3) + 40(.7) = 3 + 28 = 31$

$E(B) = 60(.3) + 5(.7) = 18 + 3.5 = 21.5$

So, absent any info., you will choose A.

Now, what if you had perfect info?
If X, you choose B. If Y, choose A.

~~[illegible]~~

Expected value $= 60(.3) + 40(.7) = 18 + 28 = 46.$

So, you would pay $46 - 31 = \$15$ to have perfect information.

Now, what about imperfect info?

Let ~~X and Y~~ X_p and Y_p be predictions of X and Y.

$P(X_p) = .4$, $p(Y_p) = .6$ (historical consistency)

Also, $p(X_p|X) = .8$; $p(X_p|Y) = .4$ (forecast performance)

So, calculate $p(X/X_p)$

$$p(X/X_p) = p(X \cap X_p) \cdot p(X_p)$$
$$= p(X_p|X) \cdot p(X_p)$$

~~So $p(X_p|X) = p(X|X$~~

$$p(X \cap X_p) = p(X_p|X) \cdot p(X) = p(X/X_p) \cdot p(X_p)$$

So $p(X/X_p) = \dfrac{p(X_p|X)\, p(X)}{p(X_p)}$

Now, $p(X_p) = p(X_p|X)p(X) + p(X_p|Y)p(Y)$

$p(X_p) = .8(.3) + (.4)(.7) = .24 + .28 = .52$

$p(Y_p) = .48$

So, this prediction method is biased in favor of predicting disaster (X)

Now, can I calculate $p(Y_p|X)$ and $p(Y_p|Y)$

well, suppose $p(Y_p|X) = .2$

Then $p(Y_p) = p(Y_p|X)\,p(X) + p(Y_p|Y)\,p(Y)$

$$.48 = (.2)(.3) + p(Y_p|Y)\cdot(.7)$$

$$p(Y_p|Y) = \frac{.48 - .06}{.7} = .6$$

So we have the full slate.

$$p(X|X_p) = \frac{p(X_p|X)\,p(X)}{p(X_p)} = \frac{(.8)(.3)}{.52}$$

$$= .4615$$

$$p(Y|X_p) = \frac{p(X_p|Y)\,p(Y)}{p(X_p)} = \frac{(.4)(.7)}{.52} = .5385$$

So, suppose the prediction is X_p. Then what is the value of the set-up?

$$E(A) = 10(.4615) + 40(.5385) = 26.155$$
$$E(B) = 60(.4615) + 5(.5385) = 30.3825$$

So choose B, value of 30.3825

What if prediction is Y_p? Then

$$p(X|Y_p) = \frac{p(Y_p|X)p(X)}{p(Y_p)} = \frac{(.2)(.3)}{.48} = .125$$

$$p(Y|Y_p) = \frac{p(Y_p|Y)p(Y)}{p(Y_p)} = \frac{(.6)(.7)}{.48} = .875$$

So $E(A) = 10(.125) + 40(.875) = 36.25$
$E(B) = 60(.125) + 5(.875) = 11.875$

So choose A, value 36.25.

So Expected gain has to be weighted by the frequency of the predictions:

E value of prediction $= 30.3825(.52) + 36.25(.48)$
$= 33.1989$

So, without prediction, EV is \$31. So you will pay $33.1989 - 31 = \$2.20$ for this prediction.

04. Look at the actual matrix.

	No O_3 problem X	O_3 Problem Y
A Do Nothing	0	−400
B Control CFC's	−10	−100

Suppose $p(X) = .9$, $p(Y) = .1$

$E(A) = 0 - 400(.1) = -40$

$E(B) = -10(.9) - 100(.1) = -9 - 10 = -19$

So, absent any additional information, you will control CFC's, value of −19.

What would perfect information be worth?

If X, you will do nothing, value of 0.

If Y, control CFC's, value of −100.

$EVPI = 0(.9) + (-100)(.1) = -10$

So, you will pay $9 billion for perfect information. [Note the assumption built in here of no risk aversion.]

What if you have a test procedure ∋

$$p(X_p|X) = .95, \quad p(X_p|Y) = .6$$

Then $p(X_p) = p(X_p|X)p(X) + p(X_p|Y)p(Y)$

$$= (.95)(.9) + (.6)(.1)$$
$$= .915, \text{ close to historical}$$

Also, $p(Y_p) = .085$, so the test procedure is "optimistic"

$$p(Y_p|X) = .05$$

So $$.085 = p(Y_p|X)p(X) + p(Y_p|Y)p(Y)$$
$$= (.05)(.9) + p(Y_p|Y)(.1)$$

$$p(Y_p|Y) = .4$$

So, $$p(X|X_p) = \frac{p(X_p|X)\,p(X)}{p(X_p)} = \frac{(.95)(.9)}{.915} = .9344$$

$$p(Y|X_p) = \frac{p(X_p|Y)p(Y)}{p(X_p)} = \frac{(.6)(.1)}{(.915)} = .0656$$

Then,

$E(A) = 0 - 400(.0656) = -26.24$

$E(B) = -10(.9344) - 100(.0656) = -15.904$

So choose B, value -15.904

If Y_p, then

$$p(X|Y_p) = \frac{p(Y_p|X)\,p(X)}{p(Y_p)} = \frac{(.05)(.9)}{.085} = .5294$$

$$p(Y|Y_p) = \frac{p(Y_p|Y)\,p(Y)}{p(Y_p)} = \frac{(.4)(.1)}{.085} = .4706$$

So $E(A) = 0 - 400(.4706) = -188.24$

$E(B) = -10(.5294) - 100(.4706) = -52.354$

So, choose B, value -52.354

Then, expected value $= -15.904(.915) - 52.354(.085)$

$= -19.002$

What is the value of the information? Looks like zero, since you will make the same decision in any case. That makes sense. You don't get any gain unless the info. is strong enough to get you to change.

Let me do one the other way around.

$p(X_p|X) = .6, \quad p(X_p|Y) = .2$

Relatively "pessimistic" prediction. We then have

$$p(X_p) = p(X_p|X)\,p(X) + p(X_p|Y)\,p(Y)$$
$$= (.6)(.9) + (.2)(.1) = .54 + .02 = .56$$

$p(Y_p) = .44$, so it is a pessimistic predictor.

$p(Y_p|Y) = .9, \quad p(Y_p|X) = ?$

$$.44 = p(Y_p|X)(.9) + (.9)(.1)$$
$$p(Y_p|X) = .3889$$

OK. Suppose you get X_p. Then

$$p(X|X_p) = \frac{p(X_p|X)\,p(X)}{p(X_p)} = .9643$$

$$p(Y|X_p) = \frac{(.2)(.1)}{.56} = .0357$$

$E(A) = 0 - 400(.0357) = -14.28$

$E(B) = -10(.9643) - 100(.0357) = -13.213$, so choose B.

So the information is not going to be worth anything again. It has to be a very pessimistic test that still yields X_p to make it worth anything

This illustrates that with the payoff matrix so unbalanced, you will <u>choose B no matter what.</u>

	P_X	P_Y
	0	-400
	-10	-100

$$-400 p_Y = -10 p_X - 100 p_Y$$

$$p_X = 1 - p_Y$$

$$-400 p_Y = -10(1-p_Y) - 100 p_Y$$

$$p_Y(-400 - 10 + 100) = -10$$

$p_Y = .0323$ — this is the knife-edge. To be indifferent between the courses of action, you have to assign very low probability to the disaster. If you assign a higher prior probability to it, more information is not worth it, since it will not alter the decision. So this explains why environmentalists want to act now, while skeptics want more information.

Valuation of additional deaths from ozone depletion.

Population growth

$P_t = P_0 e^{\delta t}$ through 2074

$P_t = P_1$ in 2074

$P_t = P_1 e^{\theta(t-88)}$ 2074 – 2164

and $P_{178} = .1\, P_1$

Calculate θ

$.1 P_1 = P_1 e^{90.\theta}$

$\theta = -.025$ approx. (approx. is all I need.

$\delta = .02$

So if $P_0 = 220,000,000$

$P_1 = 1,278,000,000$ approx.

Now, assume deaths simply proportional to those alive in the particular year. Ok. Calibrate total deaths.

$$D = \int_0^{88} k P_0 e^{\delta t} dt + \int_{88}^{178} k P_1 e^{\theta(t-88)} dt$$

$$= \frac{k P_0}{\delta} e^{\delta t} \Big|_0^{88} + \frac{k P_1}{\theta} e^{\theta(t-88)} \Big|_{88}^{178}$$

$$= k\left[\frac{220}{.02}(5.812 - 1) + \frac{1278}{-.025}(.105 - 1)\right]$$

.812 $= k\,[52937 + 45732]$

$k = 8.2 \times 10^{-6}$

Next, compute PDV. Assume $\rho = .02$, v = value of life

$$PDV = \int_0^{88} v k P_0 e^{\delta t} e^{-\rho t} dt + \int_{88}^{178} v k P_1 e^{\theta(t-88)} e^{-\rho t} dt$$

$$= v k P_0 t \Big|_0^{88} + \int_{88}^{178} v k P_1 e^{(\theta-\rho)t + 88\theta} dt$$

$$= v k P_0 t \Big|_0^{88} + \frac{v k P_1}{(\theta-\rho)} e^{(\theta-\rho)t - 88\theta} \Big|_{88}^{178}$$

$$= V\left[159323 + {}^{-}233719\left(2.997\times10^{-3} - .172\right)\right]$$

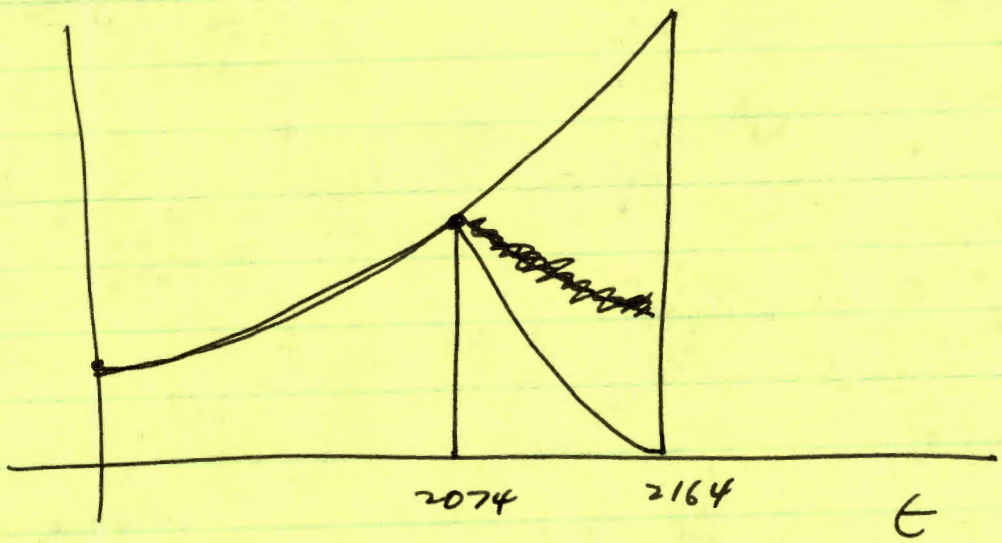
$$= V\left[159{,}323 + 39{,}510\right]$$

$$= 3.98 \times 10^{11} \text{ if } V = \$2{,}000{,}000$$

$$\approx \$400 \text{ billion.}$$

Backup (actually done first)

$P = P_0 e^{\delta t}$ $\quad \delta$ = population growth rate. Suppose it is 2%.



Suppose the deaths are distributed as the number of people alive. 0% 2% growth to 2074, get down to zero by 2164.

$P = P_1 e^{\theta t}$ and when $\theta = 90$, $P \approx 0$.

$P_{90} = .1\, P_1$

$.1 P_1 = P_1 e^{\theta 90}$

$.1 = e^{\theta 90}$

So $\theta = -.025$

So $\quad P_t = P_0 e^{.02t} \qquad 0 \le t \le 88$

$P_t = P_1 e^{-.025(t-88)} \qquad 88 < t \le 178$

04. How do we calculate pdv.

$$PDV = \int_0^{178} V \cdot k P_t e^{-\rho t} dt$$ where ρ = discount rate.

Solve for k:

$$D = \int_0^{178} k P_t \, dt = 812{,}000$$

$$= \int_0^{88} (k P_0) e^{.02t} + \int_{88}^{178} k P_1 e^{-.025(t-88)} dt$$

$P_0 = 220{,}000{,}000$

$P_1 = 1{,}278{,}736{,}227$

$$= \frac{k P_0}{.02} e^{.02t} \Big|_0^{88} + \frac{k P_1}{-.025} e^{-.025(t-88)} \Big|_{88}^{178}$$

$$= k \cdot \frac{220}{.02}\left[(5.812) - 1\right] + \frac{k(1279)}{-.025}\left[.105 - 1\right]$$

$$= k(52932 + 45768)$$

$$= 98700k = .812$$

So $k = 8.2 \times 10^{-6}$

$-.025(t-88) - \rho t$

$= (-.025 - \rho)t + .025(88)$

So $P_0 = 1805$

$P_1 = 10520$

So $PDV = v\int_0^{88} 1805\, e^{(.02-\rho)t}\, dt + v\int_{88}^{178} 10520\, e^{(-.025-\rho)t+2.2}\, dt$

So, use a real interest rate of 2%

$$PDV = v \cdot 1805\, t\Big|_0^{88} + v\frac{(10520)}{-.045}\, e^{-.045t+2.2}\Big|_{88}^{178}$$

$$= v \cdot 1805 \cdot 88 + \frac{v(10520)}{-.045}\left(.003 - .172\right)$$

$$= 158{,}840v + 39{,}519v$$

So, if $v = \$2{,}000{,}000$

$PDV = 3.1768 \times 10^{11} + 7.9038 \times 10^{10}$

$= \$318 + 79$ billion

$= \$397$ billion or $\approx \$400$ billion

PRINCIPLES FOR AN INTERNATIONAL PROTOCOL ON STRATOSPHERIC OZONE PROTECTION

Based on current scientific understanding, considerable risks may exist to human health and the environment from continued or expanded global emissions of fully halogenated alkanes. Considerable evidence exists, both in theory and from models, linking these chemicals to depletion of ozone. However, remaining scientific uncertainties prevent any conclusive statement concerning safe levels of emissions. As a result, we believe that these chemicals should be considered suspect, and, given the substantial human health and environmental risks, we believe that a prudent protocol should provide for the following:

I. As a first step, a near-term freeze on the emissions of all fully halogenated alkanes (i.e., CFC 11, 12, 113, and Halon 1211 and 1301) at or near current levels;

II. A long-term scheduled phaseout of emissions of these chemicals; this phaseout would be implemented, subject to any modification resulting from periodic review as defined in III;

III. A periodic review of the protocol provisions based upon a regular assessment of scientific understanding of changes to the ozone layer and its effects on health and the environment. The review could remove or add chemicals from the phaseout, change the schedule, or set an emission reduction target short of phaseout.

A protocol based on the above elements should have the following characteristics:

(a) provide a simple approach to facilitate agreement on an acceptable protocol within the current UNEP timetable;

(b) be capable of gaining general acceptance among the major producer nations who are now and will remain the primary source of emissions of these chemicals;

(c) provide certainty for industrial planning in order to minimize the costs of reducing reliance on these chemicals;

(d) provide adequate time for shifting away from ozone-depleting chemicals to avoid social and economic disruption, while at the same time give a strong incentive for the rapid development and employment of emission controls, recycling, and benign substitute chemicals (i.e., a technology-forcing approach);

(e) take into full consideration scientific uncertainties and promote future improvements in understanding by instituting a requirement for reassessing the goal and timing of emission limits if changes in science suggest such action is warranted;

(f) address all fully halogenated alkanes so that the principal anthropogenic sources of atmospheric chlorine and bromine are included;

(g) allow flexibility for industrial planning by allowing trade-offs among these chemicals based on their relative ozone-depleting effects;

(h) allow flexibility for limited continued use of those chemicals which are of highest social value and for which no substitutes presently exist; and

(i) create incentives to participate in the protocol by regulating relevant trade between parties and non-parties.

11/3/86 0485T

VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

Preamble

The Parties to this Convention,

Aware of the potentially harmful impact on human health and the environment through modification of the ozone layer,

Recalling the pertinent provisions of the Declaration of the United Nations Conference on the Human Environment, and in particular principle 21, which provides that "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction",

Taking into account the circumstances and particular requirements of developing countries,

Mindful of the work and studies proceeding within both international and national organizations and, in particular, of the World Plan of Action on the Ozone Layer of the United Nations Environment Programme,

Mindful also of the precautionary measures for the protection of the ozone layer which have already been taken at the national and international levels,

Aware that measures to protect the ozone layer from modifications due to human activities require international co-operation and action, and should be based on relevant scientific and technical considerations,

Aware also of the need for further research and systematic observations to further develop scientific knowledge of the ozone layer and possible adverse effects resulting from its modification,

Determined to protect human health and the environment against adverse effects resulting from modifications of the ozone layer,

HAVE AGREED AS FOLLOWS:

Article 1

DEFINITIONS

For the purposes of this Convention:

1. "The ozone layer" means the layer of atmospheric ozone above the planetary boundary layer.

2. "Adverse effects" means changes in the physical environment or biota, including changes in climate, which have significant deleterious effects on human health or on the composition, resilience and productivity of natural and managed ecosystems, or on materials useful to mankind.

3. "Alternative technologies or equipment" means technologies or equipment the use of which makes it possible to reduce or effectively eliminate emissions of substances which have or are likely to have adverse effects on the ozone layer.

4. "Alternative substances" means substances which reduce, eliminate or avoid adverse effects on the ozone layer.

5. "Parties" means, unless the text otherwise indicates, Parties to this Convention.

6. "Regional economic integration organization" means an organization constituted by sovereign States of a given region which has competence in respect of matters governed by this Convention or its protocols and has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to the instruments concerned.

7. "Protocols" means protocols to this Convention.

Article 2

GENERAL OBLIGATIONS

1. The Parties shall take appropriate measures in accordance with the provisions of this Convention and of those protocols in force to which they are party to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer.

2. To this end the Parties shall, in accordance with the means at their disposal and their capabilities:

(a) Co-operate by means of systematic observations, research and information exchange in order to better understand and assess the effects of human activities on the ozone layer and the effects on human health and the environment from modification of the ozone layer;

(b) Adopt appropriate legislative or administrative measures and co-operate in harmonizing appropriate policies to control, limit, reduce or prevent human activities under their jurisdiction or control should it be found that these activities have or are likely to have adverse effects resulting from modification or likely modification of the ozone layer;

(c) Co-operate in the formulation of agreed measures, procedures and standards for the implementation of this Convention, with a view to the adoption of protocols and annexes;

(d) Co-operate with competent international bodies to implement effectively this Convention and protocols to which they are party.

3. The provisions of this Convention shall in no way affect the right of Parties to adopt, in accordance with international law, domestic measures additional to those referred to in paragraphs 1 and 2 above, nor shall they affect additional domestic measures already taken by a Party, provided that these measures are not incompatible with their obligations under this Convention.

4. The application of this article shall be based on relevant scientific and technical considerations.

Article 3

RESEARCH AND SYSTEMATIC OBSERVATIONS

1. The Parties undertake, as appropriate, to initiate and co-operate in, directly or through competent international bodies, the conduct of research and scientific assessments on:

(a) The physical and chemical processes that may affect the ozone layer;

(b) The human health and other biological effects deriving from any modifications of the ozone layer, particularly those resulting from changes in ultra-violet solar radiation having biological effects (UV-B);

(c) Climatic effects deriving from any modifications of the ozone layer;

(d) Effects deriving from any modifications of the ozone layer and any consequent change in UV-B radiation on natural and synthetic materials useful to mankind;

(e) Substances, practices, processes and activities that may affect the ozone layer, and their cumulative effects;

(f) Alternative substances and technologies;

(g) Related socio-economic matters;

and as further elaborated in annexes I and II.

2. The Parties undertake to promote or establish, as appropriate, directly or through competent international bodies and taking fully into account national legislation and relevant ongoing activities at both the national and international levels, joint or complementary programmes for systematic observation of the state of the ozone layer and other relevant parameters, as elaborated in annex I.

3. The Parties undertake to co-operate, directly or through competent international bodies, in ensuring the collection, validation and transmission of research and observational data through appropriate world data centres in a regular and timely fashion.

Article 4

CO-OPERATION IN THE LEGAL, SCIENTIFIC AND TECHNICAL FIELDS

1. The Parties shall facilitate and encourage the exchange of scientific, technical, socio-economic, commercial and legal information relevant to this Convention as further elaborated in annex II. Such information shall be supplied to bodies agreed upon by the Parties. Any such body receiving information regarded as confidential by the supplying Party shall ensure that such information is not disclosed and shall aggregate it to protect its confidentiality before it is made available to all Parties.

2. The Parties shall co-operate, consistent with their national laws, regulations and practices and taking into account in particular the needs of the developing countries, in promoting, directly or through competent international bodies, the development and transfer of technology and knowledge. Such co-operation shall be carried out particularly through:

(a) Facilitation of the acquisition of alternative technologies by other Parties;

(b) Provision of information on alternative technologies and equipment, and supply of special manuals or guides to them;

(c) .The supply of necessary equipment and facilities for research and systematic observations;

(d) Appropriate training of scientific and technical personnel.

Article 5

TRANSMISSION OF INFORMATION

The Parties shall transmit, through the secretariat, to the Conference of the Parties established under article 6 information on the measures adopted by them in implementation of this Convention and of protocols to which they are party in such form and at such intervals as the meetings of the parties to the relevant instruments may determine.

Article 6

CONFERENCE OF THE PARTIES

1. A Conference of the Parties is hereby established. The first meeting of the Conference of the Parties shall be convened by the secretariat designated on an interim basis under article 7 not later than one year after entry into force of this Convention. Thereafter, ordinary meetings of the Conference of the Parties shall be held at regular intervals to be determined by the Conference at its first meeting.

2. Extraordinary meetings of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any party, provided that, within six months of the request being communicated to them by the secretariat, it is supported by at least one third of the Parties.

3. The Conference of the Parties shall by consensus agree upon and adopt rules of procedure and financial rules for itself and for any subsidiary bodies it may establish, as well as financial provisions governing the functioning of the secretariat.

4. The Conference of the Parties shall keep under continuous review the implementation of this Convention, and, in addition, shall:

(a) Establish the form and the intervals for transmitting the information to be submitted in accordance with article 5 and consider such information as well as reports submitted by any subsidiary body;

(b) Review the scientific information on the ozone layer, on its possible modification and on possible effects of any such modification;

(c) Promote, in accordance with article 2, the harmonization of appropriate policies, strategies and measures for minimizing the release of substances causing or likely to cause modification of the ozone layer, and make recommendations on any other measures relating to this Convention;

(d) Adopt, in accordance with articles 3 and 4, programmes for research, systematic observations, scientific and technological co-operation, the exchange of information and the transfer of technology and knowledge;

(e) Consider and adopt, as required, in accordance with articles 9 and 10, amendments to this Convention and its annexes;

(f) Consider amendments to any protocol, as well as to any annexes thereto, and, if so decided, recommend their adoption to the parties to the protocol concerned;

(g) Consider and adopt, as required, in accordance with article 10, additional annexes to this Convention;

(h) Consider and adopt, as required, protocols in accordance with article 8;

(i) Establish such subsidiary bodies as are deemed necessary for the implementation of this Convention;

(j) Seek, where appropriate, the services of competent international bodies and scientific committees, in particular the World Meteorological Organization and the World Health Organization, as well as the Co-ordinating Committee on the Ozone Layer, in scientific research, systematic observations and other activities pertinent to the objectives of this Convention, and make use as appropriate of information from these bodies and committees;

(k) Consider and undertake any additional action that may be required for the achievement of the purposes of this Convention.

5. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State not party to this Convention, may be represented at meetings of the Conference of the Parties by observers. Any body or agency, whether national or international, governmental or non-governmental, qualified in fields relating to the protection of the ozone layer which has informed the secretariat of its wish to be represented at a meeting of the Conference of the Parties as an observer may be admitted unless at least one-third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

Article 7

SECRETARIAT

1. The functions of the secretariat shall be:

(a) To arrange for and service meetings provided for in articles 6, 8, 9 and 10;

(b) To prepare and transmit reports based upon information received in accordance with articles 4 and 5, as well as upon information derived from meetings of subsidiary bodies established under article 6;

(c) To perform the functions assigned to it by any protocols;

(d) To prepare reports on its activities carried out in implementation of its functions under this Convention and present them to the Conference of the Parties;

(e) To ensure the necessary co-ordination with other relevant international bodies, and in particular to enter into such administrative and contractual arrangements as may be required for the effective discharge of its functions;

(f) To perform such other functions as may be determined by the Conference of the Parties.

2. The secretariat functions will be carried out on an interim basis by the United Nations Environment Programme until the completion of the first ordinary meeting of the Conference of the Parties held pursuant to article 6. At its first ordinary meeting, the Conference of the Parties shall designate the secretariat from amongst those existing competent international organizations which have signified their willingness to carry out the secretariat functions under this Convention.

Article 8

ADOPTION OF PROTOCOLS

1. The Conference of the Parties may at a meeting adopt protocols pursuant to article 2.

2. The text of any proposed protocol shall be communicated to the Parties by the secretariat at least six months before such a meeting.

Article 9

AMENDMENT OF THE CONVENTION OR PROTOCOLS

1. Any Party may propose amendments to this Convention or to any protocol. Such amendments shall take due account, inter alia, of relevant scientific and technical considerations.

2. Amendments to this Convention shall be adopted at a meeting of the Conference of the Parties. Amendments to any protocol shall be adopted at a meeting of the Parties to the protocol in question. The text of any proposed amendment to this Convention or to any protocol, except as may otherwise be provided in such protocol, shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate proposed amendments to the signatories to this Convention for information.

3. The Parties shall make every effort to reach agreement on any proposed amendment to this Convention by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourth majority vote of the Parties present and voting at the meeting, and shall be submitted by the Depositary to all Parties for ratification, approval or acceptance.

4. The procedure mentioned in paragraph 3 above shall apply to amendments to any protocol, except that a two-thirds majority of the parties to that protocol present and voting at the meeting shall suffice for their adoption.

5. Ratification, approval or acceptance of amendments shall be notified to the Depositary in writing. Amendments adopted in accordance with paragraphs 3 or 4 above shall enter into force between parties having accepted them on the ninetieth day after the receipt by the Depositary of notification of their ratification, approval or acceptance by at least three-fourths of the Parties to this Convention or by at least two-thirds of the parties to the protocol concerned, except as may otherwise be provided in such protocol. Thereafter the amendments shall enter into force for any other Party on the ninetieth day after that Party deposits its instrument of ratification, approval or acceptance of the amendments.

6. For the purposes of this article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

Article 10

ADOPTION AND AMENDMENT OF ANNEXES

1. The annexes to this Convention or to any protocol shall form an integral part of this Convention or of such protocol, as the case may be, and, unless expressly provided otherwise, a reference to this Convention or its protocols constitutes at the same time a reference to any annexes thereto. Such annexes shall be restricted to scientific, technical and administrative matters.

2. Except as may be otherwise provided in any protocol with respect to its annexes, the following procedure shall apply to the proposal, adoption and entry into force of additional annexes to this Convention or of annexes to a protocol:

(a) Annexes to this Convention shall be proposed and adopted according to the procedure laid down in article 9, paragraphs 2 and 3, while annexes to any protocol shall be proposed and adopted according to the procedure laid down in article 9, paragraphs 2 and 4;

(b) Any party that is unable to approve an additional annex to this Convention or an annex to any protocol to which it is party shall so notify the Depositary, in writing, within six months from the date of the communication of the adoption by the Depositary. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time substitute an acceptance for a previous declaration of objection and the annexes shall thereupon enter into force for that Party;

(c) On the expiry of six months from the date of the circulation of the communication by the Depositary, the annex shall become effective for all Parties to this Convention or to any protocol concerned which have not submitted a notification in accordance with the provision of subparagraph (b) above.

3. The proposal, adoption and entry into force of amendments to annexes to this Convention or to any protocol shall be subject to the same procedure as for the proposal, adoption and entry into force of annexes to the Convention or annexes to a protocol. Annexes and amendments thereto shall take due account, inter alia, of relevant scientific and technical considerations.

4. If an additional annex or an amendment to an annex involves an amendment to this Convention or to any protocol, the additional annex or amended annex shall not enter into force until such time as the amendment to this Convention or to the protocol concerned enters into force.

Article 11

SETTLEMENT OF DISPUTES

1. In the event of a dispute between Parties concerning the interpretation or application of this Convention, the parties concerned shall seek solution by negotiation.

2. If the parties concerned cannot reach agreement by negotiation, they may jointly seek the good offices of, or request mediation by, a third party.

3. When ratifying, accepting, approving or acceding to this Convention, or at any time thereafter, a State or regional economic integration organization may declare in writing to the Depositary that for a dispute not resolved in accordance with paragraph 1 or paragraph 2 above, it accepts one or both of the following means of dispute settlement as compulsory:

(a) Arbitration in accordance with procedures to be adopted by the Conference of the Parties at its first ordinary meeting;

(b) Submission of the dispute to the International Court of Justice.

4. If the parties have not, in accordance with paragraph 3 above, accepted the same or any procedure, the dispute shall be submitted to conciliation in accordance with paragraph 5 below unless the parties otherwise agree.

5. A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall be composed of an equal number of members appointed by each party concerned and a chairman chosen jointly by the members appointed by each party. The commission shall render a final and recommendatory award, which the parties shall consider in good faith.

6. The provisions of this article shall apply with respect to any protocol except as otherwise provided in the protocol concerned.

Article 12
SIGNATURE

This Convention shall be open for signature at the Federal Ministry for Foreign Affairs of the Republic of Austria in Vienna from 22 March 1985 to 21 September 1985, and at United Nations Headquarters in New York from 22 September 1985 to 21 March 1986.

Article 13
RATIFICATION, ACCEPTANCE OR APPROVAL

1. This Convention and any protocol shall be subject to ratification, acceptance or approval by States and by regional economic integration organizations. Instruments of ratification, acceptance or approval shall be deposited with the Depositary.

2. Any organization referred to in paragraph 1 above which becomes a Party to this Convention or any protocol without any of its member States being a Party shall be bound by all the obligations under the Convention or the protocol as the case may be. In the case of such organizations, one or more of whose member States is a Party to the Convention or relevant protocol, the organization and its member States shall decide on their respective responsibilities for the performance of their obligation under the Convention or protocol, as the case may be. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention or relevant protocol concurrently.

3. In their instruments of ratification, acceptance or approval, the organizations referred to in paragraph 1 above shall declare the extent of their competence with respect to the matters governed by the Convention or the relevant protocol. These organizations shall also inform the Depositary of any substantial modification in the extent of their competence.

Article 14
ACCESSION

1. This Convention and any protocol shall be open for accession by States and by regional economic integration organizations from the date on which the Convention or the protocol concerned is closed for signature. The instruments of accession shall be deposited with the Depositary.

2. In their instruments of accession, the organizations referred to in paragraph 1 above shall declare the extent of their competence with respect to the matters governed by the Convention or the relevant protocol. These organizations shall also inform the Depositary of any substantial modification in the extent of their competence.

3. The provisions of article 13, paragraph 2, shall apply to regional economic integration organizations which accede to this Convention or any protocol.

Article 15
RIGHT TO VOTE

1. Each Party to this Convention or to any protocol shall have one vote.

2. Except as provided for in paragraph 1 above, regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States which are Parties to the Convention or the relevant protocol. Such organizations shall not exercise their right to vote if their member States exercise theirs, and vice versa.

Article 16

RELATIONSHIP BETWEEN THE CONVENTION AND ITS PROTOCOLS

1. A State or a regional economic integration organization may not become a party to a protocol unless it is, or becomes at the same time, a Party to the Convention.

2. Decisions concerning any protocol shall be taken only by the parties to the protocol concerned.

Article 17

ENTRY INTO FORCE

1. This Convention shall enter into force on the ninetieth day after the date of deposit of the twentieth instrument of ratification, acceptance, approval or accession.

2. Any protocol, except as otherwise provided in such protocol, shall enter into force on the ninetieth day after the date of deposit of the eleventh instrument of ratification, acceptance or approval of such protocol or accession thereto.

3. For each Party which ratifies, accepts or approves this Convention or accedes thereto after the deposit of the twentieth instrument of ratification, acceptance, approval or accession, it shall enter into force on the ninetieth day after the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

4. Any protocol, except as otherwise provided in such protocol, shall enter into force for a party that ratifies, accepts or approves that protocol or accedes thereto after its entry into force pursuant to paragraph 2 above, on the ninetieth day after the date on which that party deposits its instrument of ratification, acceptance, approval or accession, or on the date on which the Convention enters into force for that Party, whichever shall be the later.

5. For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by member States of such organization.

Article 18
RESERVATIONS

No reservations may be made to this Convention.

Article 19
WITHDRAWAL

1. At any time after four years from the date on which this Convention has entered into force for a Party, that Party may withdraw from the Convention by giving written notification to the Depositary.

2. Except as may be provided in any protocol, at any time after four years from the date on which such protocol has entered into force for a party, that party may withdraw from the protocol by giving written notification to the Depositary.

3. Any such withdrawal shall take effect upon expiry of one year after the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

4. Any Party which withdraws from this Convention shall be considered as also having withdrawn from any protocol to which it is party.

Article 20
DEPOSITARY

1. The Secretary-General of the United Nations shall assume the functions of depositary of this Convention and any protocols.

2. The Depositary shall inform the Parties, in particular, of:

(a) The signature of this Convention and of any protocol, and the deposit of instruments of ratification, acceptance, approval or accession in accordance with articles 13 and 14;

(b) The date on which the Convention and any protocol will come into force in accordance with article 17;

(c) Notifications of withdrawal made in accordance with article 19;

(d) Amendments adopted with respect to the Convention and any protocol, their acceptance by the parties and their date of entry into force in accordance with article 9;

(e) All communications relating to the adoption and approval of annexes and to the amendment of annexes in accordance with article 10;

(f) Notifications by regional economic integration organizations of the extent of their competence with respect to matters governed by this Convention and any protocols, and of any modifications thereof.

(g) Declarations made in accordance with article 11, paragraph 3.

Article 21
AUTHENTIC TEXTS

The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have signed this Convention.

Done at Vienna on the 22nd day of March 1985

Annex I

RESEARCH AND SYSTEMATIC OBSERVATIONS

1. The Parties to the Convention recognize that the major scientific issues are:

(a) Modification of the ozone layer which would result in a change in the amount of solar ultra-violet radiation having biological effects (UV-B) that reaches the Earth's surface and the potential consequences for human health, for organisms, ecosystems and materials useful to mankind;

(b) Modification of the vertical distribution of ozone, which could change the temperature structure of the atmosphere and the potential consequences for weather and climate.

2. The Parties to the Convention, in accordance with article 3, shall co-operate in conducting research and systematic observations and in formulating recommendations for future research and observation in such areas as:

(a) Research into the physics and chemistry of the atmosphere

(i) Comprehensive theoretical models: further development of models which consider the interaction between radiative, dynamic and chemical processes; studies of the simultaneous effects of various man-made and naturally occurring species upon atmospheric ozone; interpretation of satellite and non-satellite measurement data sets; evaluation of trends in atmospheric and geophysical parameters, and the development of methods for attributing changes in these parameters to specific causes;

(ii) Laboratory studies of: rate coefficients, absorption cross-sections and mechanisms of tropospheric and stratospheric chemical and photochemical processes; spectroscopic data to support field measurements in all relevant spectral regions;

(iii) Field measurements: the concentration and fluxes of key source gases of both natural and anthropogenic origin; atmospheric dynamics studies; simultaneous measurements of photochemically-related species down to the

planetary boundary layer, using in situ and remote sensing instruments; intercomparison of different sensors, including co-ordinated correlative measurements for satellite instrumentation; three-dimensional fields of key atmospheric trace constituents, solar spectral flux and meteorological parameters;

(iv) Instrument development, including satellite and non-satellite sensors for atmospheric trace constituents, solar flux and meteorological parameters;

(b) Research into health, biological and photodegradation effects

(i) The relationship between human exposure to visible and ultra-violet solar radiation and (a) the development of both non-melanoma and melanoma skin cancer and (b) the effects on the immunological system;

(ii) Effects of UV-B radiation, including the wavelength dependence, upon (a) agricultural crops, forests and other terrestial ecosystems and (b) the aquatic food web and fisheries, as well as possible inhibition of oxygen production by marine phytoplankton;

(iii) The mechanisms by which UV-B radiation acts on biological materials, species and ecosystems, including: the relationship between dose, dose rate, and response; photorepair, adaptation, and protection;

(iv) Studies of biological action spectra and the spectral response using polychromatic radiation in order to include possible interactions of the various wavelength regions;

(v) The influence of UV-B radiation on: the sensitivities and activities of biological species important to the biospheric balance; primary processes such as photosynthesis and biosynthesis;

(vi) The influence of UV-B radiation on the photodegradation of pollutants, agricultural chemicals and other materials;

(c) Research on effects on climate

(i) Theoretical and observational studies of the radiative effects of ozone and other trace species and the impact on climate parameters, such as land and ocean surface temperatures, precipitation patterns, the exchange between the troposphere and stratosphere;

(ii) The investigation of the effects of such climate impacts on various aspects of human activity;

(d) Systematic observations on:

(i) The status of the ozone layer (i.e. the spatial and temporal variability of the total column content and vertical distribution) by making the Global Ozone Observing System, based on the integration of satellite and ground-based systems, fully operational;

(ii) The tropospheric and stratospheric concentrations of source gases for the HO_x, NO_x, ClO_x and carbon families;

(iii) The temperature from the ground to the mesosphere, utilizing both ground-based and satellite systems;

(iv) Wavelength-resolved solar flux reaching, and thermal radiation leaving, the Earth's atmosphere, utilizing satellite measurements;

(v) Wavelength-resolved solar flux reaching the Earth's surface in the ultra-violet range having biological effects (UV-B);

(vi) Aerosol properties and distribution from the ground to the mesosphere, utilizing ground-based, airborne and satellite systems;

(vii) Climatically important variables by the maintenance of programmes of high-quality meteorological surface measurements;

(viii) Trace species, temperatures, solar flux and aerosols utilizing improved methods for analysing global data.

3. The Parties to the Convention shall co-operate, taking into account the particular needs of the developing countries, in promoting the appropriate scientific and technical training required to participate in the research and systematic observations outlined in this annex. Particular emphasis should be given to the intercalibration of observational instrumentation and methods with a view to generating comparable or standardized scientific data sets.

4. The following chemical substances of natural and anthropogenic origin, not listed in order of priority, are thought to have the potential to modify the chemical and physical properties of the ozone layer.

(a) Carbon substances

(i) Carbon monoxide (CO)

Carbon monoxide has significant natural and anthropogenic sources, and is thought to play a major direct role in tropospheric photochemistry, and an indirect role in stratospheric photochemistry.

(ii) Carbon dioxide (CO_2)

Carbon dioxide has significant natural and anthropogenic sources, and affects stratospheric ozone by influencing the thermal structure of the atmosphere.

(iii) Methane (CH_4)

Methane has both natural and anthropogenic sources, and affects both tropospheric and stratospheric ozone.

(iv) Non-methane hydrocarbon species

Non-methane hydrocarbon species, which consist of a large number of chemical substances, have both natural and anthropogenic sources, and play a direct role in tropospheric photochemistry and an indirect role in stratospheric photochemistry.

(b) Nitrogen substances

(i) Nitrous oxide (N_2O)

The dominant sources of N_2O are natural, but anthropogenic contributions are becoming increasingly important. Nitrous oxide is the primary source of stratospheric NO_x, which play a vital role in controlling the abundance of stratospheric ozone.

(ii) Nitrogen oxides (NO_x)

Ground-level sources of NO_x play a major direct role only in tropospheric photochemical processes and an indirect role in stratosphere photochemistry, whereas injection of NO_x close to the tropopause may lead directly to a change in upper tropospheric and stratospheric ozone.

(c) Chlorine substances

(i) Fully halogenated alkanes, e.g. CCl_4, $CFCl_3$ (CFC-11), CF_2Cl_2 (CFC-12), $C_2F_3Cl_3$ (CFC-113), $C_2F_4Cl_2$ (CFC-114)

Fully halogenated alkanes are anthropogenic and act as a source of ClO_x, which plays a vital role in ozone photochemistry, especially in the 30-50 km altitude region.

(ii) Partially halogenated alkanes, e.g. CH_3Cl, CHF_2Cl (CFC-22), CH_3CCl_3, $CHFCl_2$ (CFC-21)

The sources of CH_3Cl are natural, whereas the other partially halogenated alkanes mentioned above are anthropogenic in origin. These gases also act as a source of stratospheric ClO_x.

(d) Bromine substances

Fully halogenated alkanes, e.g. CF_3Br

These gases are anthropogenic and act as a source of BrO_x, which behaves in a manner similar to ClO_x.

(e) Hydrogen substances

(i) Hydrogen (H_2)

Hydrogen, the source of which is natural and anthropogenic, plays a minor role in stratospheric photochemistry.

(ii) Water (H_2O)

Water, the source of which is natural, plays a vital role in both tropospheric and stratospheric photochemistry. Local sources of water vapour in the stratosphere include the oxidation of methane and, to a lesser extent, of hydrogen.

Annex II

INFORMATION EXCHANGE

1. The Parties to the Convention recognize that the collection and sharing of information is an important means of implementing the objectives of this Convention and of assuring that any actions that may be taken are appropriate and equitable. Therefore, Parties shall exchange scientific, technical, socio-economic, business, commercial and legal information.

2. The Parties to the Convention, in deciding what information is to be collected and exchanged, should take into account the usefulness of the information and the costs of obtaining it. The Parties further recognize that co-operation under this annex has to be consistent with national laws, regulations and practices regarding patents, trade secrets, and protection of confidential and proprietary information.

3. Scientific information

This includes information on:

(a) Planned and ongoing research, both governmental and private, to facilitate the co-ordination of research programmes so as to make the most effective use of available national and international resources;

(b) The emission data needed for research;

(c) Scientific results published in peer-reviewed literature on the understanding of the physics and chemistry of the Earth's atmosphere and of its susceptibility to change, in particular on the state of the ozone layer and effects on human health, environment and climate which would result from changes on all time-scales in either the total column content or the vertical distribution of ozone;

(d) The assessment of research results and the recommendations for future research.

4. Technical information

This includes information on:

(a) The availability and cost of chemical substitutes and of alternative technologies to reduce the emissions of ozone-modifying substances and related planned and ongoing research;

(b) The limitations and any risks involved in using chemical or other substitutes and alternative technologies.

5. Socio-economic and commercial information on the substances referred to in annex I

This includes information on:

(a) Production and production capacity;

(b) Use and use patterns;

(c) Imports/exports;

(d) The costs, risks and benefits of human activities which may indirectly modify the ozone layer and of the impacts of regulatory actions taken or being considered to control these activities.

6. Legal information

This includes information on:

(a) National laws, administrative measures and legal research relevant to the protection of the ozone layer;

(b) International agreements, including bilateral agreements, relevant to the protection of the ozone layer;

(c) Methods and terms of licensing and availability of patents relevant to the protection of the ozone layer.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 30 1986

OFFICE OF
AIR AND RADIATION

Dear Colleague:

The purpose of this letter is to inform you of the "International Conference on the Health and Environmental Effects of Ozone Modification and Climate Change" which EPA is cosponsoring with the United Nations Environment Programme (UNEP). This is one of several domestic and international conferences which we are supporting to assess the impact of potential changes on the stratospheric ozone layer and climate. This particular conference will focus on health and ecological effects and will be held at the Hyatt Regency Hotel in Arlington, Virginia on June 16-20.

I urge you to give serious consideration to attending this meeting. We have arranged for an outstanding group of scientists from the United Kingdom, Canada, Norway, The Netherlands, and other nations to present their latest research findings. Senators John Chafee and Albert Gore, Assistant Executive Director of UNEP, Genady Golubev of the Soviet Union, and EPA Administrator Lee Thomas will be among the key speakers. It will be an excellent opportunity to obtain an overview of recent information on ozone depletion and climate effects and to meet with top scientists from around the world.

Enclosed are several conference brochures and a tenative list of speakers. Steve Seidel of my staff is coordinating arrangements for the conference. Steve may be reached at (202) 382-2787.

Sincerely,

J. Craig Potter
Assistant Administrator
for Air and Radiation

Enclosures

Ed.

References

[1] Projecting the Climatic Effects of Increasing Carbon Dioxide, 1985, U.S. Dept. of Energy, DOE/ER-0237, M.C. MacCracken and F.M. Luther, eds.

[2] Watson, R.T., Geller, M.A., Stolarski, R.S., and Hampson, R.F., 1986, "Present State of Knowledge of the Upper Atmosphere: An Assessment Report". NASA Reference Publication 1162.

[3] Farman, J.C., Gardiner, B.G., Shanklin, J.O., 1985, Large Losses of Ozone in Antarctica Reveal Seasonal $CClO_x/NO_x$ Interaction. Nature, 315, 207.

[4] Solomon, S., Garcia, R.R., Rowland F.S., and Webbles, D.J., 1986, On the Depletion of Antarctic Ozone. Nature, 321, 755.

[5] Vallis, L.B., and Naturajan, M., The Stratosphere 1979-1964: Large Infusions of Odd Nitrogen during Solar Cycle 21, The Atmospheric Ozone Hole and Mid-Latitude Stratospheric Ozone Losses. (Submitted to Nature).

[6] McElroy, B., Salawitch, R.J., Wofsy, S.C., and Logan, J.A., 1986, Reductions of Antarctic Ozone due to Synergistic Interactions of Chlorine and Bromine. Nature, 321, 759.

[7] Kyle, H.L., Ardanuy, P.E., and Hurley, E.J., 1985, The Status of the Nimbus-7 Earth-Radiation-Budget Data Set. Bulletin of the American Meteorological Society, 66, 1378.

[8] National Research Council, 1986, U.S. Participation in the TOGA Plan, Climate Research Committee.

[9] World Climate Research Program (WCRP), 1982, The International Satellite Cloud Climatology Project (ISCCP): Preliminary Implementation Plan (Revision 1), WCP-35.

[10] See chapter on Forecasting Climate, Present to 2100, in Proc. of Conference on Climate Variations and Symposium on Contemporary Climate. 1850-2100. Los Angeles January 8-11, 1985, American Meteorological Society. A thorough discussion of the problems involved is given in Chapter 5 of ref. 1 (Model projections of the time-dependent response to increasing carbon dioxide, by M.J. Hoffert and B.P. Flannery).

[11] Lamb, H.H., 1982, Climate History and the Modern World, Methuen.

[12] Jones, P.D., Wigley, T.M.L., and Wright, P.P., 1986, Global Temperature Variations Between 1861 and 1984. Nature, 322, 430.

[13] Atmospheric Carbon Dioxide and the Global Carbon Cycle, 1985, U.S. Dept. of Energy, DOE/ER-0239, J.R. Trabalka, ed.

[14] Projecting the Climatic Effects of Increasing Carbon Dioxide, 1985, U.S. Department of Energy, DOE/ER-0237, M. C. MacCracken and F.M. Luther, eds.

[15] Statement of NOAA Administrator Anthony J. Calio at public announcement of NASA, NOAA, NSF Earth System Science report, June 26, 1986, Washington, D.C.

General References

Ausubel, J., and Biswas, A.K., eds., 1980, Climatic Constraints and Human Activities, International Institute for Applied Systems Analysis Proceedings Series, vol. 10, Pergamon Press.

Bach, W., Pankrath, J., and Schneider, S.H., eds., 1981, Food-Climate Interactions, Proceedings of an International Workshop held in Berlin (West), December 9-12, 1980, D. Reidel, Boston.

Global Atmopsheric Research Program (GARP) Joint Organizing Committee, 1975, The Physical Basis of Climate and Climate Modelling, GARP Publ. 16, ICSU/WMO.

Gribbin, J., ed., 1978, Climatic Change, Cambridge University Press.

Hays, J.D., 1977, Our Changing Climate,Atheneum, New York.

Hess, W.N., ed., 1974, Weather and Climate Modification, John Wiley & Sons, New York.

Kellogg, W.W., and Schware, R., 1980, Climate Change and Society: Consequences of Increasing Atmospheric Carbon Dioxide, Westview Press, Boulder, Colorado.

Maunder, W.J., 1970, The Value of the Weather, Methuen & Co., London.

The MITRE Corporation, 1977, Proceedings of the Symposium on Living with Climatic Change - Phase II, McLean, VA.

National Research Council, 1976, Climate & Food, Report of the Committee on Climate and Weather Fluctuations and Agricultural Production, National Academy of Sciences.

National Research Council, 1982, Climate in Earth History, Geophysics Study Committee, National Academy Press.

National Research Council, 1982, Solar Variability, Weather, and Climate, Geophysics Study Committee, National Academy Press.

National Research Council, 1983, Changing Climate, Report of the Carbon Dioxide Assessment Committee, National Academy Press.

National Research Council, 1984, The Polar Regions and Climatic Change, Report of the Polar Research Board, National Academy Press.

World Meteorlological Organization/International Council of Scientific Unions (WMO/ICSU), 1982, Physical Basis for Climate Prediction, WCP Publ. 47.

WMO/ICSU, 1984, Scientific Plan for the World Climate Research Program, WCRP Publ. 2.

WMO, 1984, Report of Meeting of Experts on Sea Ice and Climate Modelling, WMO #259 TP145.

WMO, 1985, Atmospheric Ozone 1985: Assessment of Our Understanding of the Processes Controlling Its Present Distribution and Change, Global Ozone Research and Monitoring Project, Report No. 16.