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STATUS I

DIRECTORATE STATUS

FROM: ADAMS, Michael

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/25/91

SUBJECT: RE: HIS PROPOSAL, "THE ICARUS PROJECT, A WORKABLE
PROGRAM FOR ATMOSPHERIC RESTORATION".

DIRECTORATE

STAFF

ASSIGNED: ENVIRONMENT

ASSIGNED:

ACTION

STAFF

REQUIRED: DIRECT REPLY

ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE: 12/20/91

STAFF DUE DATE

DATE COMPLETED:

DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

PHONE:

EXT:

REMARKS: THIS LETTER WAS FORWARDED THROUGH LISA COLDWELL.

CLOSED

OSTP RECEIVED: 12/06/91

DEPT RECEIVED:

FILE: P-ENVIRONMENT-OZONE LAYER

CENTRAL FILES:

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Michael W. Adams (Ret.)
Countersurveillance and Deception Division



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Belvoir RD&E Center
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RECEIVED

91 DEC 6 AIO: 32 25 November, 1991

OSTP
MAIL ROOM

Ms. Lisa Caldwell
358 Old Executive Office Building
The White House
Washington, D.C. 20500

Dear Ms. Caldwell:

My name is Michael Adams. We spoke on the telephone this afternoon, and I've enclosed the paper I mentioned, along with a copy of the Congressional Record which really spurred the writing of my Proposal, which had been developing in my mind for some time. The Record was passed to me by Frank J. Kelly, of the office of Sen. Daniel Inouye of Hawaii. I had been working with Mr. Kelly informally, on the matter of the Kuwait well fires, and in fact sent a paper to your office on the subject, through the courtesy of Dr. Richard Greenfield of the National Science Foundation.

By way of background, I am a Vietnam Veteran, a native Texan, and was until recently a Physicist at the Camouflage Laboratory at the Belvoir Research, Development and Engineering Center, at Ft. Belvoir, Virginia, just outside Washington, D.C.

The subject of the enclosed proposal is a Project which, if I can gain support for it, could become very important. As I mentioned over the telephone, I'm not a lobbyist for any interest, public or private, and am not on a corporate payroll. I am doing this on my own hook. I hope this doesn't

25 November 1991

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seem an effort to "sell" anything, or that I come off as a pamphleteer. The bulk of my time, as I mentioned, has been spent in Physics research, and now in freelance writing. If, after review, you think the enclosed has merit, I invite you to show and discuss it with Dr. Bromley, and/or other persons whom you select.

Before I close, there are a few aspects of this effort of mine which I'd like to touch on briefly. I suspect, without claiming any particular clairvoyance on the subject, that there would be resistance to this idea in your neck of the woods, at least initially. This is a big Project, and it would involve considerable investment of time, effort and commitment on the part of the Administration. I think it would be worth it, for several reasons.

First, as you've undoubtedly noted, the country is in the throes of a recession, and a pretty severe one. This Project would create jobs, and generate economic growth, in our country and worldwide. It would create whole new industries in its wake, and whole new markets for goods and services in our country. It would be a tremendous stimulus to the national economy, both over the short term and in the long run.

Second, as you've also probably noted, President Bush

the close of the Second World War -- of global leader in a hard, costing job, with the survival of the earth literally in the balance.

This is a large program, and the task it proposes is formidable. But as with every task, large or small, it still depends, for its successful completion, upon what we do.

...to the "Hague" ... on the ...

has come under considerable fire lately for perceived
"insensitivity to the environment," from political
opponents. I'll-scale commitment of the Administration to
this project would silence all such critics forever.
Third, the plain truth is that the problem addressed
in my proposal -- ozone depletion -- is vital to our
well-being. As you'll note, the emphasis in the
paper is for a United Nations effort. This is the only
fact that the problem is global, and must be addressed by
the global community of Nations. But it is, at the same time,
also true that we here in our country have always been the
global leader: we have led in war, and we have led in peace.
A powerful commitment by us to this effort, outlined in
my proposal, would be applauded in every corner of the earth.
It would raise our real role -- the role we've played since
the close of the Second World War -- of global leader to
a new, exciting job, with the survival of the earth literally
in the balance.
This is a large program, and the task it proposes is
formidable. But as with every task, large or small, it still
depends, for its successful completion, upon what we do.

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If, after reviewing my proposal, you find yourself in a positive frame of mind about it, I suspect you'll encounter considerable in-house resistance to it -- perhaps even with Dr. Bromley and President Bush.

All I can tell you is that, yes, it will not be easy. Nothing of value ever is. And it is also important -- not just for us, but for our children: the ones who are going to have to follow us on this continent, and make a life here after we are gone.

So I invite you to examine the enclosed, and, if you think it has merit, and must be done, pitch in, and turn some folks in your shop around, in their initial position on this initiative of mine: The Icarus Project.

Whatever the outcome, I want to thank you for your time, and your consideration in examining my proposal, in the midst of what is probably a very busy work schedule.

Sincerely,



Michael Adams
7514 Republic Court #201
Alexandria, Virginia 22306
(703)- 768-6028

P.S. -- I've sent a copy of the enclosed proposal also to Dr. Robert Watson, of NASA Headquarters, in Washington, D.C.

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the midst of what is probably a very busy work schedule.

Sincerely,

Michael Adams
7511 Laurus Court, W201
Alexandria, VA 22304
(703) 768-8028

P.S. -- I've sent a copy of the enclosed proposal also to
Mr. Robert Watson, of NASA Headquarters, Washington, D.C.

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THE ICARUS PROJECT

A Workable Program for Atmospheric Restoration

by

Michael W. Adams

PART I :

THE SITUATION WE FACE

At a press conference at the United Nations on 22 October, 1991, a team of scientists convened by the United Nations Environment Program disclosed satellite data showing a Summer ozone loss of 3% over the Continental United States. This disclosure was the culmination of a long series of disclosures dating back to the mid-1980s: the first discovery of the ozone "hole" over Antarctica in 1985; the later discovery of the Antarctic hole's increase in magnitude; the discovery of the expansion of the ozone hole to the midlatitudes in the Winter months; and now finally the discovery of the 3% Summer decrease in ozone over the Continental United States -- from Florida to Canada. The new data, shocking in its implications, now shows a significant decrease of ozone both in the Northern and Southern Hemispheres, not only in Winter, but in Spring and Summer. The phenomenon of ozone layer depletion, previously thought to be restricted to the Arctic and Antarctic Poles, is, on the basis of this new data, now known to be of global extent. And the process is accelerating: from a 1% loss in the 1970s to a 3% loss in the 1980s. Current projections are for an additional 3% loss in the 1990s.

For the first time in history, the full cumulative effect of 80 years of catastrophic abuse of the atmospheric environment, particularly the ozone layer, has now come to the attention of the international community, through the United Nations. Finally, the world is becoming fully aware of the mortal danger which now confronts us from the peeling away of the ozone layer by

chlorofluorocarbons. In addition, the world public is now aware of the deadly dilemma this situation poses: the buildup of CFCs in our atmosphere thins the ozone layer, letting through deadly ultraviolet radiation to the earth, with serious damage to human health, crops, and the plankton which anchor the food chain in our oceans. And yet, at the same time, restoration of the ozone layer to its former thickness, allowing a greater absorption of UV radiation, will result in a heating-up of the ozone layer, which will in turn radiate more heat to the earth, resulting in a deadly acceleration of the Greenhouse Effect.

And so, with reference to the predicament in which the human race now finds itself, we are very much like a stag caught upon a fence, beset by savage dogs, unable to gore one way or kick the other. Our predicament is deadly, and we are running out of time in which to find solutions. In this situation, there is a very real question as to what choices we have, if any. This question will be addressed in the portion of our discussion which immediately follows this one.

PART II :

THE CHOICES WE HAVE

Our choices are stark.

We can continue with "business as usual" here in the industrial world, meanwhile seeking to speed up the elimination of CFCs by international agreement. This road, if we choose to continue upon it, is slow, and fraught with peril: there is an excellent chance that this approach will prove to be "too little, too late." And the consequences for the world, if we fail to meet Mother Nature's deadline, will be catastrophic.

The good news is that we have a real-world alternative to the above. There is another road we can choose:

Proceed with the current effort to control/eliminate CFCs by international protocols, and, at the same time, initiate a crash program, employing every international resource at our command, and rescue our atmosphere.

The effort would involve the commitment and energies of every country on the face of the earth. The unifying, directing agency for the effort would be the United Nations. That organization would provide the framework within which the effort would be undertaken, and would be the agency for the martialing of human talent and economic support for the Project. The effort itself would be the most massive, and historically significant crash program since the Manhattan District, which made the atom bomb in the final years of the Second World War.

The Project would have only one purpose, and one immediate objective: to get control of the global chemistry experiment which is currently sending the world into permanent ecological ruin.

It is this second alternative, this "second road" which is open to us, which the author wishes to explore. That will happen in the part of our discussion which immediately follows this one.

PART III :

THE ICARUS PROJECT

In the Greek Pantheon of Classical Mythology, Icarus was the son of Daedalus, the architect who built a labyrinth for King Minos of Crete. Having completed the task, Daedalus found himself suddenly out of favor with King Minos, and was imprisoned in a tower by the iron-fisted tyrant. Frustrated with his sudden confinement, and angry at the ingratitude of his patron, Daedalus decided to make good his escape. Since escape by land route was cut off, Daedalus chose the one avenue of escape which remained open to him: the air. Being a consummate engineer, he fashioned two sets of wings, one pair for himself, and one for his son Icarus. The construction of the wings was ingenious: they consisted of light frames, with feathers fastened to the frames with wax. When the work was done, and before attempting the escape flight from the tower to Sicily, Daedalus instructed his son Icarus on the method of escape. He spoke in this fashion: "When you take to flight, keep to the middle course. If you fly too low, your wings will become damp and heavy with moisture, and you will fall into the sea. If you fly too high, the heat from the sun will melt the wax which holds the feathers of your wings to their frames. The feathers will fall off, and you will fall into the sea."

With those instructions from Daedalus to his son Icarus, the flight to Sicily, and freedom, began. Daedalus' son Icarus was an unusual young man. He was quite intelligent, restless and inquisitive by temperament, and was possessed of enormous, consuming

curiosity about the world around him. He had, in fact, all the basic traits which are required for the making of a fine scientist. During the flight, Icarus' curiosity overpowered him: he abandoned the middle course of flight -- the "flight plan" which his father had given him -- and began to fly upward, toward the sun. Soon, as his father had warned, the heat from the sun began to melt the wax which held the feathers fastened to his wing frames. One by one, at first slowly, then quickly, the feathers fell away. Amid Icarus' startled cries, and the angry shouts of his father, Icarus' glide path turned suddenly downward, into free-fall. He fell into the sea, and drowned. His father Daedalus, keeping to the middle course, flew on to Sicily and freedom.

Modern man, in his zeal for technological progress, and his consuming curiosity, which finds expression in scientific innovation, is very much like the young man in the ancient legend. Like Icarus, well-intentioned, and alive with curiosity for the discovery of new worlds, he has flown too near the sun. And, also like the young man in the legend, the "wax" which has held him aloft, and sustained his natural existence -- the ozone layer which shields all life on earth from deadly ultraviolet radiation -- is now being devoured by man-made chemicals, and is melting away in the heat of the sun. As with Icarus' "flight plan" from his father Daedalus, the object now is that the human race not fall into the sea and drown.

To that end, the author proposes the immediate initiation of a massive international scientific effort to reclaim our atmosphere: The Icarus Project. In spirit, scope and high purpose, it will be the historical offspring of The Manhattan District, which has since become known to the world as the Manhattan Project. It will be composed of the finest scientific minds in the world: atmospheric physicists and chemists; metallurgists; biologists; mechanical, electrical and industrial engineers; and the finest managerial and clerical staff the world community of nations can muster. It will be located in an isolated area, with a physical plant commensurate with the work to be performed. It will use the finest, most up-to-date laboratory technology available in the world. It will be funded and carried out under the auspices of the United Nations.

The blunt fact is that global ecological problems -- particularly in our atmosphere -- are occurring in combinations too powerful to be addressed by any single nation-state. The problem with the ozone layer is global in scope, and the response, out of sheer physical necessity, must be multi-national. The United Nations is the logical and obvious world organization to encompass such an undertaking.

The budget of Icarus will be drawn from the financial resources of all member nations of the United Nations. Manpower, equipment, and technological data base will also be drawn from the member nations. For the hard fact is that the sun shines

on all nations equally, and when the ozone layer finally melts away, it is literally true that all nations will fry equally. The crisis is global in scope, and the response must necessarily be a concerted, unified effort by all nations in the global community.

In closing this part of our discussion, it needs to be said that there will be "spin-offs" from a Project such as this, which will redound to the benefit of science and scientists generally. These will occur apart from the obvious benefit to the world of a solution to the deadly dilemma which now confronts us in the form of ozone depletion verses The Greenhouse Effect. As to the exact nature of these benefits, the historical precedent is there for us to read:

In the period 1944-45, at the Los Alamos Scientific Laboratory, in Los Alamos, New Mexico, one of the major participants, Enrico Fermi, kept an extra desk in his office. He put boards around the four sides of his desk, extending about one inch above the desk top. On many evenings, he could be seen "shooting" a small toy car at a group of toy cars. He would then measure the angles at which the impacted cars were ejected. He was simulating the collision of a neutron with an atomic nucleus. The reason for this scheme was that neutron interactions with atomic nuclei were not well understood at that time. It was the beginning of the

well-known Monte Carlo Computation Technique. It was also incipient to the birth of the large computers which took place at the Los Alamos Scientific Laboratory immediately following the close of the Second World War. The work of Fermi, Courant, John Von Neumann and Harold Urey marked the dawn of the computer age. And it all began in the laboratories of LASL, with the work of Enrico Fermi and his model using toy cars on a flat table, for the simulation of a neutron interaction with an atomic nucleus.

The point the author is making here is that when men and women of unusual scientific gifts and capacity are brought together, and set to an important task, there is a literal explosion of incredibly fruitful "spin-offs" which enrich science, materially and spiritually, for decades, and even centuries, to come. So the Icarus Project, in addition to its main purpose of getting the world out of its present atmospheric predicament, would also enrich science itself, in ways which cannot now be imagined.

By now the reader might be thinking something like the following: "All that is well and good. But how can a program such as you envisage here be brought into the real world, in the current political and economic climate?"

The answer to that question is the subject of the next part of our discussion.

PART IV :

THE PRESENT POLITICAL/ECONOMIC CLIMATE

It is a fact of life that science, like war, does not occur in a vacuum. In order for any important scientific effort to be initiated, the political and economic climate must be favorable. In the present case, at this moment in the history of the world, political and economic conditions are ripe for a scientific initiative such as this one. In the wake of the devastating news of 22 October, 1991, from the team of scientists convened by the United Nations Environment Program, the peoples of the world now know, through the world press, that the entire earth is at risk, from depletion of the ozone layer by chlorofluorocarbons. From this point on, the governments of the world, and their leaders, will be under intense, steadily-mounting pressure from their local populations to do something about this peril, and in a timely manner. As one of this writer's old college professors was fond of remarking: "The data is what we know, and the theory is what we make up." For the peoples of the world, the data -- the hard, incontrovertible evidence -- is now in: the world is in the throes of a genuine, potentially terminal environmental emergency. For the leaders of the world's governments, from this point forward, sensitivity to this issue will be tantamount to political survival. And that hard fact will not be lost on them.

In addition, world economic trends now favor the initiation

of Icarus. The United States is in the throes of an economic recession, which, instead of going away, is deepening with every passing day. And every reliable economic indicator now shows that the economic downturn is not restricted to the U.S. economy alone. Because of the interconnectedness of world markets, the economic downturn is extending itself, and becoming global. The initiation of Icarus would revitalize the world economy, stimulate world trade, and generate economic growth on a scale never before seen in the history of the world. It would create whole new markets for goods and services, and generate entire new industries in its wake. The economic spin-offs from this Project would reach into, and revitalize, the economies of every country on the face of the earth.

From both the political and the economic viewpoints, the time is ripe for the initiation of Icarus. The manner in which that can be carried out, from the practical standpoint, is the subject of the next part of our discussion.

PART V :

THE IMPLEMENTATION OF ICARUS

The key point to be made here is that the timing of Icarus is exactly right. With any initiative of historical importance, that is by far the most critical single factor. If that factor is in place (as it now is in the case of Icarus) the rest follows in the natural evolution of events.

What is now needed is solidarity on the part of the scientific community in putting this initiative forward with the world-political leadership. Happily, a group is already in existence which can perform exactly that function: it is the 80-member team, from 80 countries, who are currently assessing the previously-described global ozone trends. This group, supported by the world scientific community, could perform the historic act of putting Icarus forward with the world political leadership, in the forum of the United Nations.

Who would be the spokesperson for this group, on behalf of Icarus, with the world political leadership?

Once again, history provides the answer.

In the period shortly before American entry into the Second World War, Professor Albert Einstein wrote a letter to President Franklin D. Roosevelt, at the instigation of Leo Szilard. Szilard was fearful (rightly, as it turned out) that the Nazis would take note of recent experimental breakthroughs in Berlin verifying the feasibility of the fission of Uranium by "fast" neutrons, and make an atom bomb. After obtaining the

letter from Professor Einstein, Szilard arranged that the letter and supporting materials be taken to Franklin Roosevelt through an intermediary named Alexander Sachs. Dr. Alexander Sachs knew President Roosevelt well, and had been chief economist for the National Recovery Administration in the early days of the New Deal. Roosevelt met for an hour with Sachs, and reviewed the Einstein letter and supportive materials which Szilard had provided. Roosevelt then summoned his secretary, Brigadier General Edwin M. ("Pa") Watson. He handed the papers to Watson and said: "Pa, this requires action."

With that simple directive, an historic chain of events was set in motion which would ultimately result in the Los Alamos Scientific Laboratory, the Manhattan District (later known to history as the Manhattan Project) and the atom bomb.

The plain fact is that our scientific community today contains scientists of world stature -- some of them Nobel Laureates -- who held key positions of responsibility in the effort which the world has come to know as the Manhattan Project. Such a person (or persons) would be the ideal choice to put this initiative forward with the world political leadership, in the forum of the United Nations.

Such an initiative, carried forward by a scientist or scientists of world stature, with unchallengeable reputation, backed up by the entire scientific community, would have the necessary weight to overcome all resistance, put Icarus through,

and make this program a reality. As remarked, this is now possible due to the changed world climate of opinion in the wake of the news of 22 October, 1991, by the team of scientists convened by the United Nations Environment Program, that the phenomenon of ozone layer depletion is now global, and that it is accelerating.

Because of that, the historical moment for The Icarus Project has arrived.

EPILOGUE

There will be some who will read what is written here and remark, with fashionable cynicism, that the spirit which generated The Manhattan District is dead and gone, and that we no longer have the inner wherewithal to bring a program of this magnitude into the world, as was done in the Age of Einstein, Roosevelt, and The New Deal. To them I say simply that spiritlessness is not a part of the American character, and I'm afraid I'll always be impatient with that nonsense.

A unique historical opportunity now exists to initiate a Project which will change the world forever. The Manhattan District did happen, and a project of similar magnitude can happen again. All that is required to bring that about is that men and women of science rise to the occasion, and seize the historical opportunity which is now before us. We cannot, and must not, shrink from that opportunity. History loves a bold suitor, and life always rewards the strong.

We can do anything we're big enough to do.

APPENDIX

The author wishes to state from the outset that he is not an atmospheric Physicist or Chemist. The bulk of his working life as a Physicist has been spent in Defense, with the United States Army. Some of this work has involved investigations into the properties of radar-defeating camouflage paints for military equipment, and radar-defeating coatings for camouflage nets. Much of that work has involved the Physics of dipoles: dipoles infused into paints and coatings for the purpose of defeating enemy radars, in battlefield situations. So the author's comments, in this appendix, are intended only to "get the tea kettle singing" with a few possible approaches to the problem, and perhaps provide a point of departure for further investigation in this area. It is his hope that his attempt to essay a few new directions of investigation will be helpful to those men and women who have spent their lives in the exciting field of atmospheric Physics and Chemistry. It is in that spirit that these comments and suggestions are offered.

It is apparent that the problem which confronts us in the atmosphere is actually the result of two deadly, steadily-developing processes which are indissolubly connected.

The two deadly processes are:

- (1) The depletion of the ozone layer by CFCs, allowing too much ultraviolet radiation to pass through the ozone layer to earth, with attendant damage to earth's ecosystems.
- (2) The trapping of greenhouse gases by the ozone layer, resulting in a net heating of the earth's atmosphere.

And the corresponding dilemma:

Any attempt to lessen ultraviolet penetration by regulating CFCs (i.e., increasing the ozone layer), results in an increase in the greenhouse effect. And any attempt to lessen the greenhouse effect by not regulating CFCs, results in a corresponding erosion of the ozone layer, letting in an unacceptable (i.e., lethal) amount of ultraviolet radiation.

In all honesty, this is a pretty difficult situation in which we now find ourselves. But as with many problems in Physics, this problem is separable, and solvable, if attacked one part at a time, and in functions of one variable.

The first step is to consider what is actually needed in this situation. What is needed?

First, we need a translucent substance/device in the ozone layer which will act as a filter. That is, a substance/device which will admit exactly the right amount of UV radiation, and reflect the rest back into space. This will protect the ozone layer from an excess buildup of heat, and thus eliminate the danger of the ozone layer feeding the greenhouse effect.

Second, we need a substance/device which can produce ozone, to make up for the depletion of the ozone layer due to the buildup of CFCs in our atmosphere.

Ideally, one substance with both of the above properties would do the trick. But, failing that, two substances, each with one of the above properties (UV filter or ozone producer) would be adequate for the job.

Now there are two obvious difficulties with the above-mentioned "substance/device" and that needs to be addressed here.

The first and most obvious difficulty is that when we speak of significantly altering the composition of the ozone layer we are speaking of literally millions of tons of material. That would be true for a UV filter substance and for a substance

which produces ozone. Clearly, if we did manage to find the "substance/device" we could not possibly make enough of it to make a difference, in terms of net effect, in the global atmosphere. The quantities required are simply too great. And even if we could make the material in the required amounts, the delivery systems are not adequate to transport it into space (that is too big a job even for NASA).

The above difficulty can be gotten round in the following manner: we need to develop a substance/device which is spontaneously self-regenerating when struck by sunlight.

By doing that, we can "seed" the ozone layer with the substance/device, and it will self-regenerate in sufficient quantities, over time, to make the needed amount of UV reflective material/ozone producer. Now clearly, this will require a significant amount of "seeding," especially initially. But it is within the physical capability of our earth-to-space delivery systems, as this is written.

The second difficulty with the above-mentioned "substance/device" is that the process of self-regeneration when struck by sunlight cannot be endless: we'd wind up with a total shutout of UV radiation to the earth, and far too much ozone in the layer above our heads. This difficulty can be overcome in the laboratory by developing a substance/device with a fixed lifetime in space. The fixed lifetime would

limit the amount of self-regeneration for each unit, allowing the total output of the substance/device to be pre-determined by laboratory design. In that way, we could control, with a considerable degree of precision, how much UV radiation is let through the ozone layer to earth, and how much fresh ozone is produced to fill out the depleted ozone layer we now have. We could, in that way, "get control of the global chemistry experiment," which is really the crux of the whole matter, and the real solution to this problem which is now staring us in the face.

Now what in the world is this "substance/device" to which the author constantly refers? It is a legitimate question, and the author would dearly love to get it off the shelf and show it, and collect his Nobel Prize. The fact is that exact identification and development lies ahead, after much work in the laboratory, by many men and women.

But the author can list its properties -- the "spoor" of the animal, in the language of the big game hunter:

(1) The UV filter would be a photosensitive, self-regenerating material, which partially filters out the ultraviolet band on the far edge of the visible electromagnetic spectrum. It would "grow" when exposed to sunlight in the upper atmosphere, in the way one grows certain crystals, under controlled conditions, using a slightly different technique, in the laboratory. It would

most likely be found in the realm of solid-state Physics.

(2) The ozone producer would be of two possible varieties:

(a) A photoelectric device similar to a capacitor (i.e., a condenser) capable of absorbing radiant energy from the sun and spontaneously producing a potential difference across a gap, generating an electrical discharge in air, producing ozone. The device would then recharge from the same source (the sun), and repeat the process through its lifetime.

(b) A photochemical material capable of reacting with sunlight to produce ozone, with spontaneous self-regeneration of the material after the reaction. Or, alternatively, a photochemical material reactive with the air of the upper atmosphere, producing ozone, and self-regenerating, with sunlight as the catalyst for the process of self-regeneration.

The author wishes to re-emphasize that these are suggested directions for laboratory investigation, and not pre-tested solutions.

With that said, it must be added that the author is

confident that investigations along these lines, in the laboratory, will prove extremely fruitful in terms of real-world results.

The End.



United States
of America

Congressional Record

PROCEEDINGS AND DEBATES OF THE 102^d CONGRESS, FIRST SESSION

Vol. 137

WASHINGTON, THURSDAY, OCTOBER 24, 1991

No. 154

Senate

(Legislative day of Thursday, September 19, 1991)

The Senate met at 10 a.m., on the expiration of the recess, and was called to order by the Acting President pro tempore [Mr. ROBB].

PRAYER

The ACTING PRESIDENT pro tempore. We will begin with a word of prayer from the Chaplain.

The Chaplain, the Reverend Richard C. Halverson, D.D., offered the following prayer:

Let us pray:

Preserve me, O God: for in thee do I put my trust.—Psalm 16:1.

Gracious God, this word from the

RECOGNITION OF THE MAJORITY LEADER

The ACTING PRESIDENT pro tempore. Under the standing order, the majority leader is recognized.

SCHEDULE

Mr. MITCHELL. Mr. President and Members of the Senate, the period for morning business today will extend until 11:15 a.m., during which time several Senators are to be recognized to address the Senate for specified times.

At 11:15 this morning, the Senate

consideration of S. Act. That measure until 2:30 p.m. previous consent will return to facilities Act.

ent governing S. remain for consideration on final passage matters are to be hour time limitate will conduct rollcall votes, today, thereby, the Federal fa-

STRATOSPHERIC OZONE DEPLETION

Mr. BAUCUS. Mr. President, the sky may not be falling but there is getting to be a lot less of it than there once was.

For the second time in 6 months we have received disturbing news about the Earth's ozone layer from the international experts who are studying it.

In April we were told that between 4 to 5 percent of the wintertime ozone layer over North America, Europe, and the midlatitudes in both the northern and southern hemispheres had been destroyed in the last decade.

The Environmental Protection Agency reported that as a result, some 12 million Americans would develop skin cancer, and more than 200,000 of them would die, over the next 50 years.

At a press conference at the United Nations on Tuesday, these experts released new data showing a depletion of the ozone layer over the United States during the summertime months. I have with me the executive summary as well as press clips from the New York Times and the Washington Post on their announcement, which I ask unanimous consent to include in the Record at the conclusion of my remarks.

The ACTING PRESIDENT pro tempore. Without objection, it is so ordered.

Mr. BAUCUS. What is new and significant about their finding? For the first time, scientists have found that in the summertime over all of our country, the ozone layer decreases by 2 to 3 percent. We have substantially increased the risk of skin cancer and crop damage from ultraviolet radiation at precisely the time when school children are playing outdoors and crops begin to grow.

And we have only ourselves to blame.

MORNING BUSINESS

The ACTING PRESIDENT pro tempore. There will now be a period for the transaction of morning business not to extend beyond the hour of 11:15 a.m., with Senators permitted to speak therein.

The Chair recognizes the Senator from Montana [Mr. BAUCUS].

Frank J. Kelly
Legislative Assistant

Daniel K. Inouye
United States Senator
Hawaii

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ment and labor, rich and poor, black and white. Self-alienation from God fragments society.

As George Washington put his trust in Thee—as Thomas Jefferson had faith in a Creator God from whom all human rights derive—so we as a people need to return to our roots. You promised, Lord, "If my people, which are called by my name, shall humble themselves, and pray, and seek my face, and turn from their wicked ways; then will I hear from heaven, and will forgive their sin, and will heal their land."—II Chronicles 7:14.

In the name of Him who loved us and gave Himself for us. Amen.

• This "bullet" symbol identifies statements or insertions which are not spoken by a Member of the Senate on the floor.

S 15097

We have through our actions, changed the composition of our atmosphere. Because we have continued to vent ozone depleting chemicals into our air, despite the warnings of scientists, we have fundamentally changed our way of life for years to come. We and our children and our children's children will be forced to reevaluate our practices of going outside during the summertime months when our exposure to ultraviolet radiation is at a maximum.

The new results, in the words of EPA Administrator Reilly, are "more serious than we would have believed."

Mr. President, that has always been our response—when the Antarctic ozone "hole" was discovered, when it increased in magnitude, when ozone depletion expanded to the midlatitudes in the wintertime months and now that we are finding a summertime depletion as well—it is always more serious than we would have believed.

Now it is time for us to get serious. It is time to completely do away with these dangerous chemicals.

The Montreal protocol as amended by the London amendments of 1990 requires a complete phaseout of CFC's by the year 2000. Even though we now know that this is not fast enough, I would like to point out that the United States still has not ratified the London amendments. When I testified before the Foreign Relations Committee in July on the ratification of the London amendments, I urged my colleagues to move with haste. The need for expediency has grown stronger. As a show of good faith, the United States must quickly ratify the London amendments.

But we must go further. Ozone depleting chemicals must be phased out on an accelerated timeframe.

The mechanism to do so already exists. The Clean Air Act requires the EPA Administrator to accelerate the phaseout of ozone depleting chemicals more rapidly than the year 2000 deadline, if scientific information suggests it is necessary to protect human health and the environment.

Thus far, the Administrator has refused to act on his authority, saying that the United States would not take unilateral action.

Mr. President, that is a nonargument. Let me remind my colleagues that all of the industrialized countries, with the exception of the United States and Japan, have committed to an earlier phaseout of ozone depleting chemicals. Germany and the Nordic countries have accelerated their phaseout date to 1995; the European Community, Canada, Australia, and New Zealand are committed to 1997.

For ourselves, our children, and our children's children, the United States must take action too.

Mr. President, I yield the floor.

EXHIBIT 1

[From the Washington Post, Oct. 23, 1991]
FIRST SUMMER THINNING FOUND IN U.S. OZONE LAYER—SKIN CANCER RISK INCREASES, EXPERTS SAY

(By Michael Weisskopf)

Scientists reported yesterday the first summertime thinning of the protective ozone layer over the United States, raising the risk of skin cancer as heavier doses of ultraviolet radiation leak to the ground during the time of year when people are most exposed.

E.I. du Pont de Nemours, the world's largest producer of chlorofluorocarbons (CFCs), the most damaging of the man-made chemicals to ozone, responded to the new data by pledging to halt production of the chemicals by 1997—three years ahead of schedule—and to speed the phaseout of substitutes that are less destructive than CFCs but still capable of fraying the ozone layer.

"The data included in this recent assessment underscore the urgency for a more rapid and aggressive response," Du Pont vice president Joseph Glas said in a statement to the media.

Along with a report in April that wintertime ozone has thinned twice as fast as previously projected, yesterday's data is expected also to fuel diplomatic efforts to accelerate the timetable of an international treaty calling for the phaseout of CFCs at least by the turn of the century.

"The problem is more serious than we believed," said Environmental Protection Agency Administrator William K. Reilly. "The world community needs to reconsider the course that it's on, as to whether it's fast enough and whether substitutes can be brought on more quickly."

A vaporous veil lying 15 miles above the surface, ozone shields life on Earth from the damaging effects of ultraviolet rays. Yesterday's findings of significant depletion between May and September when people wear less clothing and spend more time outdoors deepens concerns about skin cancer, experts said.

EPA officials said they factored in possible summertime erosion of ozone in last April's projection of a near-doubling of skin cancer cases and deaths over the next 40 years. According to the American Cancer Society, there are now more than 600,000 cases of skin cancer a year in the United States and nearly 9,000 deaths.

According to Edward De Fabo, a photobiologist at George Washington University Medical Center, the increased doses of solar rays during the growing season could endanger certain crops and jeopardize planktonic organisms at the base of the oceanic food chain.

Yesterday's report was based on what is considered the most comprehensive data gathered since monitoring of the ozone layer began in 1985.

Readings were taken by National Aeronautics and Space Administration satellites and ground-based spectrometers, and the data were analyzed by a panel of international scientists that was convened by the United Nations Environment Program and the World Meteorological Organization.

The data confirmed earlier findings of winter ozone depletion as high as 5.6 percent in the Northern Hemisphere, including the United States and Western Europe.

But for the first time, the instruments recorded summertime depletion of 2.9 percent to 3.3 percent at latitudes reaching roughly from Florida in the south to central Canada in the north.

According to Jack Kaye, manager of NASA's atmospheric chemistry modeling and analysis program, scientists are uncer-

tain whether the summertime finding result from refinement in analytical tools or from increased atmospheric levels of chlorine, which comes from the breakdown of CFCs and destroys ozone molecules.

He said some scientists believe the destructive chemical reactions may be catalyzed not only by polar ice clouds interacting with the chemicals in the winter but also by sulfate particles all year long. Sulfates, put into the air by volcanoes and burning fossil fuels, may remove some of the nitrogen compounds that suppress the activity of chlorine, he said.

In another important finding, scientists discovered that ozone loss in the lower stratosphere has a cooling effect on global temperatures, apparently countering the warming effect created by CFCs.

[From the New York Times, Oct. 23, 1991]
SUMMERTIME HARM TO SHIELD OF OZONE DETECTED OVER UNITED STATES—NEW PERIL, SCIENTISTS SAY

(By William K. Stevens)

UNITED NATIONS, Oct. 22.—For the first time, scientists have found the earth's protective ozone shield to be weakened over the United States and other temperate-zone countries in summer, when the sun's harmful ultraviolet rays are the strongest and pose the greatest danger to people and crops.

Since this summertime depletion of the ozone shield was not known until now, predicted increases in skin cancers and crop damage are too low, an international panel of scientists convened by the United Nations said here today.

Furthermore, they said, the rate of ozone depletion has accelerated and will continue at the higher rate in the 1990's, requiring a more rapid phasing out of chlorofluorocarbons, halons and other manmade chemicals that destroy ozone high in the atmosphere.

STRICTER CONTROLS TO BE SOUGHT

United Nations officials said they would seek to reopen international discussions next year in an effort to speed up abandonment of the ozone-eating chemicals for the second time since controls on them were first adopted in 1987. As of now, developed countries have agreed to phase them out by the year 2000 and developing countries by 2010.

Until recently, scientists believed on the basis of measurements from satellites that ozone depletion was taking place only over the poles, and in the middle latitudes in winter. The depletion is worse nearer the poles, and worst of all over the Antarctic, with its ozone "hole."

"We now see a significant decrease of ozone both in the Northern and Southern Hemispheres not only in winter, but in spring and summer, the time when people sunbathe, putting them at risk for skin cancer, and the time we grow crops," said Dr. Robert Watson, a National Aeronautics and Space Administration scientist who is co-chairman of an 80-member group of scientists from 80 countries who have been assessing ozone trends. He said the situation was "extremely serious."

Chlorofluorocarbons and other ozone-destroying chemicals are used in a wide variety of industrial and consumer applications, including refrigeration and air conditioning, and halons are used in fire extinguishers.

The chemicals take years to waft up to the upper atmosphere. There, they touch off chemical reactions that lead to the destruction of the ozone, which screens out harmful frequencies of ultraviolet radiation. Unscreened, the rays can cause cancer and cataracts, harm some crops and other plants

and, scientists fear, disrupt the feeding patterns of marine life.

Dr. Mostafa K. Tolba, executive director of the United Nations Environment Program, called the findings "very disturbing" and said there was "definitely a need for a quick response" and for a reopening of international talks on the subject. They spoke at a news conference here today.

Besides destroying ozone, chlorofluorocarbons, or CFC's, are among several gases that trap heat in the atmosphere. In another new finding, the scientists reported that the ozone depletion may have a cooling effect, offsetting part of the global warming trend that some scientists fear may already have begun. If this finding is confirmed, restoring atmospheric ozone levels could increase global warming.

The finding could undercut the Bush Administration's position on global warming. The Administration has sought to avoid making possibly costly cuts in carbon dioxide emissions by insisting that actions it is taking to reduce CFC's are sufficient for the next decade or more. Dr. Tolba, under whose leadership the ozone and the climate talks are taking place, said that these findings showed clearly that "the main emphasis should be on carbon dioxide."

ADMINISTRATION DEFENDS POLICY

But William K. Reilly, the administrator of the Environmental Protection Agency, said today that unexpected findings vindicated the Administration's policy of emphasizing research rather than immediate action on global warming. "What had been thought was a major greenhouse gas turns out in fact to be having a cooling effect," he said.

The United States, along with other industrialized countries, has agreed to phase out CFC's by the end of this decade, and Mr. Reilly said the country was ahead of schedule. And today, the Du Pont Company, the world's largest manufacturer of CFC's and halons, announced that in response to the new scientific report it was accelerating its phaseout of the chemicals by three to five years. In 1988 the company pledged to eliminate them by 2000.

In April, the Environmental Protection Agency reported that over the previous decade, ozone declined by 4.5 to 5 percent over the United States and other Northern Hemisphere countries in the winter and early spring. Agency analysts calculated that as a result, some 12 million Americans would develop skin cancer, and more than 200,000 of them would die, over the next 50 years.

The United Nations analysis, which includes more recent data and independent information from satellites and ground-based instruments, shows that from May through August, high-atmosphere ozone in the Northern Hemisphere temperate zones decreased by about 3 percent in the 1980's. This is about triple the rate of the 1970's. Similarly, the analysis showed a decrease of about 5 percent in the Southern Hemisphere summer, from December through March.

Because CFC's are still rising slowly to the ozone layer and will be for some years, Dr. Watson said, "we believe there will be an additional 3 percent ozone loss between now and the end of the century" in the northern latitudes, which include Europe and North America, and in the Southern Hemisphere's temperate zones. Only in the tropics was no significant increase detected.

The scientists did not calculate how many additional cancer deaths might result from the summer ozone depletion. But Dr. Watson said that with the form of skin cancer called melanoma, which is often

fatal, there would be about a 1 percent increase in cases for every 1 percent of ozone depletion. For other skin cancers, which are less often fatal, each 1 percent of ozone depletion brings a 3 percent increase in cases, he said.

EXECUTIVE SUMMARY ON THE SCIENTIFIC ASSESSMENT OF STRATOSPHERIC OZONE OCTOBER 22, 1991

RECENT MAJOR SCIENTIFIC FINDINGS

Over the past few years, there have been highly significant advances in the understanding of the impact of human activities on the Earth's stratospheric ozone layer and the influence of changes in chemical composition on the radiative balance of the climate system. Specifically, since the last international scientific review (1989), there have been five major advances:

Global Ozone Decreases: Ground-based and satellite observations continue to show decreases of total column ozone in winter in the northern hemisphere. For the first time, there is evidence of significant decreases in spring and summer in both the northern and southern hemispheres at middle and high latitudes, as well as in the southern winter. No trends in ozone have been observed in the tropics. These downward trends were larger during the 1980s than in the 1970s. The observed ozone decreases have occurred predominantly in the lower stratosphere.

Polar Ozone: Strong Antarctic ozone holes have continued to occur and, in four of the past five years, have been deep and extensive in area. This contrasts to the situation in the mid-1980s, where the depth and area of the ozone hole exhibited a quasi-biennial modulation. Large increases in surface ultraviolet radiation have been observed in Antarctica during periods of low ozone. While no extensive ozone losses have occurred in the Arctic comparable to those observed in the Antarctic, localized Arctic ozone losses have been observed in winter concurrent with observations of elevated levels or reactive chlorine.

Ozone and Industrial Halocarbons: Recent laboratory research and re-interpretation of field measurements have strengthened the evidence that the Antarctic ozone hole is primarily due to chlorine- and bromine-containing chemicals. In addition, the weight of evidence suggests that the observed middle- and high-latitude ozone losses are largely due to chlorine and bromine. Therefore, as the atmospheric abundances of chlorine and bromine increase in the future, significant additional losses of ozone are expected at middle latitudes and in the Arctic.

Ozone and Climate Relations: For the first time, the observed global lower-stratospheric ozone depletions have been used to calculate the changes in the radiative balance of the atmosphere. The results indicate that, over the last decade, the observed ozone depletions would have tended to cool the lower stratosphere at middle and high latitudes. Temperature data suggest that some cooling indeed has taken place there. The observed lower-stratospheric ozone changes and calculated temperature changes would have caused a decrease in the radiative forcing of the surface-troposphere system in the middle- to high-latitudes that is larger in magnitude than that predicted for the CFC increases over the last decade. In addition, the ozone depletion may indeed have offset a significant fraction of the radiative forcing due to increases of all greenhouse gases over the past decade.

Ozone Depletion and Global Warming Potentials (ODPs and GWPs): A new semi-empirical, observation-based method of calculating ODPs has better quantified the role

of polar processes in this index. In addition, the direct GWPs for tropospheric, well-mixed, radiatively active species have been recalculated. However, because of the incomplete understanding of tropospheric chemical processes, the indirect GWP of methane has not, at present, been quantified reliably. Furthermore, the concept of a GWP may prove inapplicable for the very short-lived, inhomogeneously mixed gases, such as the nitrogen oxides. Hence, many of the indirect GWPs reported in 1990 by the Intergovernmental Panel on Climate Change (IPCC) are likely to be incorrect.

SUPPORTING EVIDENCE AND RELATED ISSUES

Global ozone

Independent observations from the ground-based Dobson and M-83/124 instruments and the TOMS satellite instrument all show, for the first time, that there are significant decreases in total-column ozone, after accounting for known natural variability, in winter and now in spring and summer in both the northern and southern hemispheres at middle and high latitudes, but not in the tropics. The following table illustrates some of these points.

TOTAL OZONE TRENDS

(Percent per decade with 95 percent confidence limits)

Season	TOMS: 1979-91		
	45°S	Equator	45°N
December to March	-5.2 ± 1.5	+0.3 ± 4.5	-5.6 ± 3.5
May to August	-6.2 ± 3.0	+0.1 ± 5.2	-2.9 ± 2.1
September to November	-4.4 ± 3.2	+0.3 ± 5.0	-1.7 ± 1.9

Season	Ground-based: 26°N-64°N	
	1979-91	1970-91
December to March	-4.7 ± 0.9	-2.7 ± 0.7
May to August	-3.3 ± 1.2	-1.3 ± 0.4
September to November	-1.2 ± 1.6	-1.2 ± 0.6

There is strong combined observational evidence from balloonsondes, ground-based Umkehr, and the SAGE satellite instruments that, over the past decade, annual-average ozone has decreased in the middle- and high-latitude stratosphere below 25 km (about 10% near 20 km).

Ozone losses in the upper stratosphere have been observed by ground-based Umkehr and SAGE satellite instruments. Changes in the shape of the vertical distribution of ozone near 40 km are qualitatively consistent with theoretical predictions, but are smaller in magnitude.

Measurements indicate that ozone levels in the troposphere up to 10 km above the few existing balloonsonde stations at northern middle latitudes have increased by about 10% per decade over the past two decades. However, the data base for ozone trends in the upper troposphere, where it is an effective greenhouse gas, are sparse and inadequate for quantifying its contribution to the global radiative balance. It should be noted that the response of ozone in the upper troposphere is particularly sensitive to oxides of nitrogen injected by aircraft.

The temperature record indicates that a small cooling (about 0.3°C per decade, globally averaged) has occurred in the lower stratosphere over the last two decades, which is in the sense of that expected from the observed ozone change.

Increases continue in the atmospheric abundances of source gases that affect ozone and the radiative balance. Although methane has continued to increase in the atmosphere, the rate of increase has slowed, for reasons that are not understood. Methyl

bromide is the major contributor to stratospheric bromide (15 pptv). The sources of methyl bromide are not well characterized; however, significant anthropogenic emissions have been suggested.

Recent laboratory studies have identified key heterogeneous reactions and have allowed a more quantitative assessment of the role of global stratospheric sulfate aerosols in leading to enhanced abundances of reactive chlorine species.

Limited observations suggest that the abundance of chlorine monoxide (ClO) in the lower stratosphere at northern middle latitudes is greater than that predicted by models containing only currently known gas-phase chemistry, and the observed seasonal and latitudinal dependences are inconsistent with those predicted. Some new studies that incorporate currently known heterogeneous processes provide an improved simulation for some observed gases, such as ClO and nitric acid.

Present models containing only gas-phase processes cannot simulate the observed seasonal ozone depletions at middle and high latitudes. However, models incorporating currently known heterogeneous processes on sulfate aerosols predict substantially greater ozone depletion (e.g., a factor of 2-3 at middle latitudes) from chlorine and bromine compounds compared to models containing only gas-phase processes. Indeed, the heterogeneous models simulate most of the observed trend of column ozone in middle latitudes in summer, but only about half of that in winter.

There is not a full accounting of the observed downward trends in global ozone. Plausible mechanisms include (i) local heterogeneous chemistry on stratospheric sulfate aerosols (as evidenced by, for example, elevated levels of ClO and the presence of sulfate aerosols at the altitudes of the observed ozone depletion) and (ii) the transport of both ozone-depleted and chemically perturbed polar air to middle latitudes (as evidenced by high levels of reactive chlorine and low levels of reactive nitrogen, which is a characteristic of chemically perturbed polar air). Although other possible mechanisms cannot be ruled out, those involving chlorine and bromine appear to be largely responsible for the ozone loss and are the only ones for which direct evidence exists.

Since the middle latitude ozone losses are apparently due in large part to chlorine and bromine, greater ozone losses are expected as long as the atmospheric levels of these compounds continue to increase. With the increases in the levels of chlorine and bromine that are estimated for the year 2000, the additional ozone losses during the 1990s are expected to be comparable to those already observed for the 1980s.

There are numerous ways in which further increases in stratospheric halogen abundances can be reduced. The table below illustrates the effects of reducing the emissions of several types of halocarbons. Four aspects are shown: (i) the change in peak chlorine loading, (ii) the times at which chlorine abundances have decreased back to 2 ppbv (the abundance in the late 1970s, which is when the Antarctic ozone hole started and when the accelerated trends in total-column ozone losses in the northern hemisphere began); (iii) the times at which chlorine abundances have decreased back to 3 ppbv (the abundance in the mid-late 1980s); and (iv) a measure of the cumulative ozone loss for the time period that the chlorine levels are above 3 ppbv. All of the values in the table are relative to the reference scenario (AA).

SCENARIOS FOR REDUCING CHLORINE EMISSIONS

Scenario	Peak Cl (ppbv)	Year at 3 ppbv	Year at 2 ppbv	Integral (Cl > 3 ppbv)
AA	4.1	2027	2060	22.7
AA3	-18	-10	-7	-7.6
D	-63	0	0	-1.3
D3	-10	0	0	-2.9
E	-90	-7	-3	-2.0
E3	-3	-10	-3	-4.4
F20	+01	0	0	+8
F40	+02	+1	0	+1.5
G20	+01	+5	+2	+4.2
AA3 + D3	-21	-11	-7	-10.4

¹ Ppbv = yr.
² These values should be reduced by a factor of about 2-3 when evaluating ozone loss rather than chlorine loading.

Definitions of scenarios: AA: Montreal Protocol (10 yr lag of 10% of CFC, plus CCL; no lag for CH₂Cl₂ and Halons). HCFC-22 increases at 3% per year from 1991 to 2020, ramps to 0 by 2040. No substitution of CFC₁ with HCFCs.

Non-substitution scenarios: AA3: 3 year acceleration of CFC₁ and CCL schedules. D: 3 year acceleration of CH₂Cl₂ schedule. D3: CH₂Cl₂ on the accelerated CFC phase-out schedule. E: HCFC-22 ramp to zero between 2000 and 2020. E3: HCFC-22 on the accelerated CFC phase-out schedule.

Substitution scenarios: HCFC substitutions begin in 1995, no growth to 2000, 3% per year to 2020, ramp to zero by 2030. HCFC-A has a 2 year lifetime, one chlorine, and an ODP of 0.013. HCFC-B has a 20 year lifetime, one chlorine, and an ODP of 0.13. F20: 20% initial substitution, HCFC-A. F40: 40% initial substitution, HCFC-A. G20: 20% initial substitution, HCFC-B.

Stratospheric bromine is 30-120 times more efficient than stratospheric chlorine in destroying ozone on a per atom basis. Therefore, 1 pptv of stratospheric bromine is equivalent to 0.03-0.12 ppbv of stratospheric chlorine.

Polar ozone

The Antarctic ozone hole in 1991 was as deep and as extensive in area as those of 1987, 1989, and 1990. The low value of total-column ozone measured by TOMS in early October in 1991 was 110 Dobson units, which is a decrease of about 60% compared to the ozone levels prior to the late 1970s. The previously noted quasi-biennial modulation of the severity of the ozone hole did not occur during the past three years. This apparent lack of variability in recent years may imply that halogen chemistry is becoming dominant over dynamically induced fluctuations on Antarctic ozone depletion.

Recent laboratory studies of heterogeneous processes, reevaluated field measurements, and modeling studies have strengthened the confidence that the cause of the Antarctic ozone hole is primarily chlorine and bromine emissions.

High concentrations of ClO have been observed in winter in the Arctic stratosphere between 16-20 km. These observations have been incorporated into diagnostic models that have calculated localized ozone depletions of about 10% at these altitudes over a period of about a month, which are consistent with concurrent ozone measurements.

Ozone/climate relations

The ozone losses observed in the lower stratosphere over the last decade are predicted to have increased the visible and ultraviolet incoming solar radiation reaching the surface/troposphere system and decreased the downward infrared radiation reaching the surface/troposphere system. For models that allow for the temperature of the stratosphere to adjust to the loss of ozone, the net effect is a decrease in radiative forcing. For middle and high latitudes

throughout the year, the magnitude of this decrease may be larger than the predicted increases in the radiative forcing due to the increased abundances of CFCs over the last decade. Indeed, this ozone-induced decrease in radiative forcing could be offsetting a significant fraction of the increased forcing attributed to the increases in the abundances of all greenhouse gases over the same period. Changes in the global annual-average radiative forcing due to the observed ozone depletion are predicted to be comparable in magnitude, but opposite in sign, to those attributed to the CFCs over the last decade.

Current tropospheric models exhibit large differences in their predictions of changes in ozone, the hydroxyl radical, and other chemically active gases due to emissions of methane, nonmethane hydrocarbons, carbon monoxide, and nitrogen oxides. This arises from uncertainties in the knowledge of background chemical composition and an inadequate understanding of chemical reactions and dynamical processes. Hence, these deficiencies limit the accuracy of predicted changes in the abundance and distribution of tropospheric ozone, which is a greenhouse gas, and in the lifetimes of a number of other greenhouse gases, including the HCFCs and HFCs, which depend upon the abundance of the hydroxyl radical.

Ozone depletion and global warming potentials (ODPs and GWPs)

Steady-state and time-dependent ODPs have been recalculated with improved models that have incorporated more accurate reaction rate coefficients and absorption cross sections and known heterogeneous processes on sulfate aerosols. The numerical values are generally similar to those in previous assessments.

A new semi-empirical, observation-based method of calculating ODPs has been developed. The resulting values are generally larger (up to a factor of two as compared to some model-based estimates) for species with long stratospheric lifetimes (e.g., HCFC-22 and HCFC-142b) and slightly smaller for species with short stratospheric lifetimes (e.g., carbon tetrachloride and methyl chloroform). Since this approach utilizes more atmospheric observations and less model calculations in characterizing polar ozone losses, it is considered to be better than standard model ODPs, at least in the polar regions.

The direct GWPs (with five different time horizons: 20, 50, 100, 200, and 500 years) for tropospheric, well-mixed, radiatively active species have been recalculated using updated lifetimes for methane, nitrous oxide, and the halocarbons and following the same methodology of IPCC (1990). With the exception of methane, new GWP results indicate only modest changes from the IPCC values, but uncertainties still exist in these calculations due to limitations in knowledge of the carbon cycle.

Because of incomplete understanding of tropospheric chemical processes, the indirect GWP of methane has not been quantified reliably at the time of this report, although improvements and quantifications of uncertainties in the near future are highly likely. The signs of the net changes in radiative forcing from known indirect effects have been established for some of the trace gases: methane, carbon monoxide, and nonmethane hydrocarbons, which are all positive. The sign of the changes in radiative forcing due to the nitrogen oxides cannot currently be established. Furthermore, the basic concept of a GWP may indeed prove to be inappropriate for the very short-lived, inhomogeneously mixed

gases, such as the nitrogen oxides and the nonmethane hydrocarbons. Hence, the IPCC (1990) indirect GWPs are not only uncertain, but many are also likely to be incorrect (e.g., for the nitrogen oxides).

Related issues

Ultraviolet radiation: Significant increases in ultraviolet radiation have been observed over Antarctica in conjunction with periods of intense ozone depletion. Under clear-sky conditions, these increases are consistent with theoretical predications. Furthermore, a Erythmal Radiative Amplification Factor of 1.25 ± 0.20 has been deduced from simultaneous measurements of column ozone and surface ultraviolet radiation at a clean air site, which is in agreement with a model-calculated value of 1.1. Therefore, for the first time, the response of ground-level ultraviolet radiation to changes in column ozone has been observed and quantified.

Supersonic aircraft: A previous, independent assessment of the impact of a projected fleet of supersonic aircraft on stratospheric ozone has reported the prediction that the ozone loss increases with the amount of nitrogen oxides emitted. These models used gas-phase chemistry and assessed ozone loss for the case of 500 aircraft flying at Mach 2.4 between 17-20 km with an annual fuel use of 7×10^{10} kg/yr. The annual-average loss of column ozone at middle latitudes in the northern hemisphere is predicted to be 2-6%. For a comparable fleet operated at Mach 3.2 between 21-24 km, the comparable column ozone losses are 7-12%. However, recent evidence has shown that reactions on sulfate aerosols can change the partitioning of nitrogen oxides. Two model studies incorporating this heterogeneous chemistry have recently reexamined the Mach 2.4 case and found substantially less ozone change (-0.5% to +0.5%). These implications are being examined as part of a separate assessment.

Shuttles and rockets: The increase in the abundance of stratospheric chlorine from one projection of U.S. annual launches of nine Space Shuttles and six Titan rockets is calculated to be less than 0.25% of the annual stratospheric chlorine source from halocarbons in the present day atmosphere (with maximum increases of 0.01 ppbv in the middle and upper stratosphere in the northern middle and high latitudes). The TOMS ozone record shows no detectable changes in column ozone immediately following each of several launches of the Space Shuttle.

Volcanoes, ozone loss, and climate perturbations: Major volcanic eruptions, such as Mt. Pinatubo, substantially increase the stratospheric abundance of sulfate aerosols for a few years. Since laboratory and field data show that heterogeneous processes can lead to increased levels of reactive chlorine in the stratosphere, such injections have the potential to increase ozone losses temporarily. Furthermore, the increased levels of stratospheric sulfate aerosols are predicted to warm the lower stratosphere by about 4°C (which has been observed) and cool the Earth's surface by a much smaller amount.

Tropospheric sulfate aerosols and climate: Fossil fuel emissions over the past century have increased the tropospheric sulfate aerosol concentration. Their contribution to the direct radiative forcing of the clear-sky northern hemisphere is opposite to that due to the greenhouse gases and is estimated to be a substantial fraction of the trace gas forcing.

IMPLICATIONS FOR POLICY FORMULATIONS

The findings and conclusions of the research of the past few years have several major implications as input to policy decisions regarding human-influenced sub-

stances that lead to stratospheric ozone depletions and to changes in the radiative forcing of the climate system:

Continued global ozone losses: Even if the control measures of the amended Montreal Protocol (London, 1990) were to be implemented by all nations, the current abundance of stratospheric chlorine (3.3-3.5 ppbv) is estimated to increase during the next several years, reaching a peak of about 4.1 ppbv around the turn of the century. With these increases, the additional middle-latitude ozone losses during the 1990s are expected to be comparable to those observed during the 1980s, and there is the possibility of incurring wide-spread losses in the Arctic. Reducing these expected and possible ozone losses requires further limitations on the emissions of chlorine- and bromine-containing compounds.

Approaches to lowering global risks: Lowering the peak and hastening the subsequent decline of chlorine and bromine levels can be accomplished in a variety of ways, including an accelerated phase-out of controlled substances and limitations on currently uncontrolled halocarbons. **Chlorine.** A significant reduction in peak chlorine loading (a few tenths of a ppbv) can be achieved with accelerated phase-out schedules of CFCs, carbon tetrachloride, and methyl chloroform. Even stringent controls on HCFC-22 would not significantly reduce peak chlorine loading (at most 0.03 ppbv, especially when ODP weighted), but do hasten the decline of chlorine. **Bromine.** A 3-year acceleration of the phase-out schedule for the Halons would reduce peak bromine loading by about 1 pptv. If the anthropogenic sources of methyl bromide are significant and their emissions can be reduced, then each 10% reduction in methyl bromide would rapidly result in a decrease in stratospheric bromine of 1.5 pptv, which is equivalent to a reduction in stratospheric chlorine of 0.045 to 0.18 ppbv. This gain is comparable to that of a three-year acceleration of the scheduled phase-out of the CFCs.

Elimination of the Antarctic ozone hole: The phase-out schedule of the amended Montreal Protocol, if fully complied by all nations and if there are no continued uses of HCFCs, affords the opportunity to return to stratospheric chlorine abundances of 2 ppbv sometime between the middle and the end of the next century. This is the level at which the Antarctic ozone hole appeared in the late 1970s and hence is about the level that is thought to be necessary (other conditions assumed constant, including bromine loading) to eliminate the ozone hole. Such levels could never have been reached under the provisions of the original Protocol (Montreal, 1987).

Uncertain greenhouse role of CFCs: The weight of evidence suggests that a large part of the observed lower stratospheric decrease in ozone is the result of CFC emissions. Furthermore, the radiative impact of this ozone decrease may have largely offset the predicted direct radiative perturbations, at middle to high latitudes, due to the CFCs increases over the last decade. Hence, even the sign of the overall radiative effect of CFC increases on the climate system over the last decade is uncertain.

Utility of GWPs: The direct GWPs are a useful indicator of the relative radiative effects of long-lived, well-mixed, radiatively active trace species. However, GWPs may be inapplicable for comparing the direct radiative effects of a long-lived, well-mixed gas to the indirect effects of a short-lived gas (for example, carbon dioxide to the nitrogen oxides). For the latter need, the application of new tools, such as three-dimensional, fully coupled chemistry-climate models may be required.

Mr. BAUCUS. Mr. President, I suggest the absence of a quorum.

The ACTING PRESIDENT pro tempore. The absence of a quorum has been suggested. The clerk will call the roll.

The bill clerk proceeded to call the roll.

Mr. REID. Mr. President, I ask unanimous consent that the order for the quorum call be rescinded.

The ACTING PRESIDENT pro tempore. Without objection, it is so ordered.

COST UNDERWRITING FOR RESEARCH EXPANSION NIH

Mr. REID. Mr. President, it is the "in thing" today, it is vogue to run down Government, to talk about what is bad in Government. This morning, I want to spend a few minutes talking about something regarding which the American public should be proud, the Congress should be proud, and the executive branch of Government should be happy: the National Institutes of Health.

I invite everyone's attention to these great centers of learning, these great centers of healing that we have here in the Washington, DC area.

Last spring, I visited the National Institutes of Health, and had a tour through these facilities. These institutes carry out research, medically directed. They do different types of work. The medical discoveries made at NIH are seemingly miraculous. The work that they have done in diabetes research, juvenile diabetes research, the work they have done with all different forms of cancer, the work they have started now in diseases directed toward women, the work that they have done dealing with paralysis, is really miraculous. In many of these areas about which I have spoken, they are on the verge of accomplishing things even more miraculous.

But the one thing that all the institutes have in common is that they are short of researchers. They do not have enough people to do the work that needs to be done. There are a lot of reasons for this, but one is that they cannot pay the private sector salaries. The institutes frequently have difficulty filling these positions, because they cannot match pay in the private sector.

Mr. President, I have here a letter that was directed to me. It is from the Director of the Office of Education of the National Institutes of Health, Michael Fordis, M.D.

After I left the National Institutes of Health and completed my tour, I met with the staff there, and I said that the problem we have to address at these great centers of learning is how to get the best and the brightest from our medical schools, from our research institutes, our institutes that teach people medical research. We

have to get them to the National Institutes of Health.

The National Institutes of Health is, without any question, the leading institution in medical research in the world. No one would debate that. It would not matter what country you are in, or what part of our country you are in. It is the leader of medical research in the world, the National Institutes of Health. And because that is the case, we want to get the best people there to continue the great work that has been done there.

Well, we discussed what could be done. Here is a letter that I recently received from Dr. Fordis. I am not going to read the whole letter, but I will read parts of it, Mr. President.

Indeed, your impression that the NIH has faced serious shortages is quite correct. Just last year, nearly one out of four entry-level positions for young physicians was vacant.

Because of the lack of physicians seeking research training—

For example—

the endocrinology and metabolism training program, which has been responsible for significant discoveries has produced many of the preeminent academic endocrinologists in this country, is facing serious difficulties in maintaining its high quality clinical research program. The number of clinical research training positions has been reduced nearly in half. Other productive clinical research programs similarly affected include medical oncology, pediatric oncology, and pulmonary medicine, among others.

They have had to cut the number of people doing research in half, because they do not have the scientists to do that work.

The doctor continued:

Young physicians, interested in academic medicine, often must undergo significant hardships to pursue careers in biomedical research. Moreover, we are closely approaching the time when a desire and determination may not be enough to enable talented young people to enter academic careers. For example, I recently met two married medical students interested in careers in biomedical research. Each of these students has a Ph.D. from Harvard. They left Boston to attend medical school in Ohio in order to minimize their educational debt.

Here are two brilliant young people who have Ph.D.'s, and they also wanted medical degrees. They could not live in the Northeast; it was too expensive. And they went someplace else to get the medical degrees.

They left Boston to attend medical school in Ohio in order to minimize their educational debt. That notwithstanding, their current debt is \$90,000 to \$100,000 apiece.

Such debt is not uncommon today when the average debt is over \$40,000 and approaching \$50,000.

Thus, the couple I mentioned above may not find it economically possible to pursue the extended research training required for a career in biomedical research, particularly when academic salaries may not be comparable to those of physicians in private practice. Repayment schedules may require young physicians to pay literally thousands of dollars per month during their preparation at the NIH for careers in biomedical research. Trainees facing arduous repayment schedules can no longer make decisions re-

garding their careers solely on the basis of wanting to serve humanity in areas of scientific promise. Many young physicians feel compelled to complete clinical training as expeditiously as possible and must look to meeting their financial obligations.

He goes on to state some of the other problems that exist.

What we did, as a body, Mr. President, is recognize that in the field of AIDS research, we were having a tremendous problem. We could not get scientists to come and study at NIH even though there was money for them to do the research, because they simply could not afford to stay there and pay off the huge debts they had acquired while going to medical school and receiving their training.

So Congress and the President developed a program. To allow scientists who would come and study and do AIDS research, a program was developed to attract research to the areas of AIDS. It is called the AIDS Loan Repayment Program and it speaks for itself. If people are willing to devote the best years of their life to medical research, we would develop for them a program to help repay their debt.

Mr. President, we have to broaden this program. To attract the critically needed researchers that we need, NIH needs to develop a program that is comparable to what we are doing with AIDS research and we would repay a predetermined amount of scientists' education loans.

So I want to extend this excellent program that we have in AIDS research to other areas that are in need of researchers.

It is hard to believe an institution as prestigious as the National Institutes of Health would have difficulty recruiting researchers but, as indicated in this letter that I have read, last year 25 percent of the positions at the entry level simply went unfilled. That is wrong.

Medical research is the one area, I repeat, in which there is no question but the United States leads the world. We have to continue to do whatever is necessary to make sure that we maintain our preeminent field in the area of medical research.

The shortages of researchers at NIH extend across so many areas that expanding the AIDS Loan Repayment Program is not going to be enough. We need to recruit more men and women to do work on AIDS. We are accomplishing that by the AIDS Loan Repayment Program, but we need to broaden this.

As the National Institutes of Health is reauthorized this Congress, I urge my colleagues to support the legislation about which I have spoken and in particular by ensuring that the Institutes remain capable of attracting the best research personnel available.

Mr. President, I yield the floor.

The ACTING PRESIDENT pro tempore. The Chair recognizes the Senator from Delaware [Mr. ROTH].

Under the previous order the Senator is recognized to speak up to 30 minutes.

Mr. ROTH. I thank the Chair.

(The remarks of Mr. ROTH pertaining to the introduction of S. 1865 are located in today's RECORD under "Statements on Introduced Bills and Joint Resolutions.")

The ACTING PRESIDENT pro tempore. The Chair recognizes the Senator from Rhode Island [Mr. CHAFEE].

THE MASS SHOOTING IN TEXAS

Mr. CHAFEE. Mr. President, I was sickened, as were all Americans, by the ghastly killings that took place on Wednesday of last week in Killeen, TX. It was lunchtime. A man drove a pickup truck into the glass window of a popular, crowded cafeteria. He got out of the cab of the truck and immediately began shooting the patrons at random as they moved or ran to get out of the restaurant. Twenty-two people were killed before the police arrived and the murderer was killed, apparently by his own hand.

What do we say about this latest act of carnage? Luby's Cafeteria, a popular eating and gathering place, was particularly full on that Wednesday, since many employees were taking their employers out for lunch to celebrate Boss' Day. A pleasant, ordinary weekday lunchtime scene in an ordinary workweek, grotesquely and horribly interrupted by a man with tons of ammo shooting as fast as he could pull the trigger, according to witnesses. In the aftermath: dazed and shocked blood-soaked survivors, and a room covered in shattered glass, blood, and slumped bodies.

This scene is so unutterably horrifying, so grotesque, that it has an almost surreal quality to it.

Mr. President, there is something wrong in our country when a local cafeteria becomes a battleground. I am not sure the word "battleground" is correct. A battle indicates there is combat, one side resisting another. This was a slaughterhouse.

There was something wrong in 1989 when a California schoolyard became a firing target. An Oklahoma post office, a Kentucky printing plant, a California fast food restaurant, a Texas university campus—all have been the sites for grisley mass shootings. It is not acceptable to have someone shot anywhere. But there is something terribly, terribly wrong when people are slaughtered in broad daylight in nonviolent, nonconfrontational, peacetime situations while they are quietly going about their daily lives.

I would just like to read, if I might, Mr. President, a list of some of the worst shootings that have taken place over the past decades.

July 18, 1984: 21 people are murdered in San Ysidro, CA, shot by an out-of-work security guard. August 1,

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9124631
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS C

FROM: ARCHIBALD, Frank S.

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/29/91

SUBJECT: RE: HIS IDEA TO REPLENISH THE OZONE LAYER.

DIRECTORATE STAFF
ASSIGNED: ENVIRONMENT ASSIGNED: Nancy Maynard

ACTION STAFF
REQUIRED: DIRECT REPLY ACTION: As Necessary

SENDER'S DUE DATE:
OSTP DUE DATE: 11/18/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 12/05/91

COPIES TO:

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: No Response Necessary

OSTP RECEIVED: 11/04/91 DEPT RECEIVED:
FILE: P-ENVIRONMENT-OZONE LAYER

CENTRAL FILES:





RECEIVED

91 NOV 4 A10:56

OFFICE OF THE
DIRECTOR650 Severn Drive
State College, PA
16803
October 29, 1991

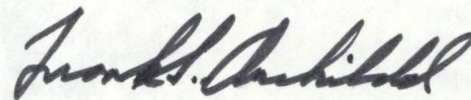
Dr. Allen Bromley
Office of Science and Technology Advisor to The President
1600 Pennsylvania Avenue
Washington, D.C. 20500

Dear Dr. Bromley,

Enclosed is an abbreviated write-up of an idea to "repair" the ozone "hole." I'm not sure that it is a practical undertaking to attempt, however it would be a timely replacement for the Cold War and a unifying peaceful international activity.

I would be interested in your opinion and I would like to be involved if this suggestion comes to fruition.

Sincerely yours,



Dr. Frank S. Archibald

OZONE GENERATION BY NUCLEAR POWER PLANTS IN ARCTIC/ANTARCTICA

- . PROPOSITION: REPLENISH/STABILIZE DEPLETION OF ATMOSPHERIC OZONE BY USING NUCLEAR POWER PLANTS TO GENERATE OZONE BY ELECTRIC DISCHARGE
- . ADVANTAGES IN ADDITION TO STABILIZED/REPLENISHED OZONE LAYER:
 - (1) USE FOR NUCLEAR WEAPON MATERIAL
 - (2) GLOBAL COOPERATIVE EFFORT BY NATIONS TO SAVE SPACESHIP EARTH (COMPARABLE LEVEL OF EFFORT TO MAN-ON-THE-MOON)
 - (3) REVIVES U.S. NUCLEAR INDUSTRY AND OPPORTUNITY TO DEMONSTRATE/DEVELOP/TEST FAIL-SAFE REACTOR TECHNOLOGY
 - (4) POLAR LOCATION ADVANTAGES:
 - (A) FAILURE/MELTDOWN WOULD LIKELY HAVE DISPERSED RADIOACTIVE DEBRIS BEFORE REACHING POPULATION CENTERS AND FLORA/FAUNA
 - (B) HIGH THERMODYNAMIC EFFICIENCY DUE TO LOW HEAT REJECTION TEMPERATURE
 - (C) LOW TEMPERATURE IMPROVES EFFICIENCY OF OXYGEN PRODUCTION BY LIQUEFACTION OF DRY ARCTIC AIR
 - (D) HEATED OZONE DISCHARGE CARRIED ALOFT FROM TALL CHIMNEYS BY THERMAL DENSITY DIFFERENCE OR SUNLIGHT HEATED REUSABLE OZONE FILLED BALLOONS
- . FEASIBILITY/ORDER OF MAGNITUDE ARGUMENT: MANKIND IN LAST 50 YEARS(SAY) HAS PRODUCED THE DEPLETION- THUS NOT ON A GEOLOGICAL SCALE/ PROBABLY ONLY A SMALL PERCENT OF OZONE DEPLETING MATERIALS REACHES HEIGHTS SUFFICIENT TO CAUSE DEPLETION. EVEN IF THIS SMALL AMOUNT IS VERY EFFICIENT IN CAUSING THE DEPLETION, THE ACTUAL QUANTITIES OF OZONE INVOLVED ARE FINITE AND IT SHOULD BE POSSIBLE TO REPLACE THEM.

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121120

FROM: KNAUSS, J.: NOAA

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/12/91

SUBJECT: E-MAIL FROM DAN ALBRITTON CONCERNING THE RECENT
PUBLIC STATEMENT REGARDING THE OZONE LAYER.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Nancy Maynard
Thomas Ratchford

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/15/91

FILE: ENVIRONMENT-OZONE LAYER



9121120

The Under Secretary of Commerce
for Oceans and Atmosphere
U.S. Department of Commerce
Washington, D.C. 20230

RECEIVED
51 APR 15 P 3:18
APR 12 1991

OFFICE OF THE
DIRECTOR

The Honorable D. Allan Bromley
Assistant to the President for
Science and Technology
Old Executive Office Building
Washington, DC 20506

Dear Allan,

The enclosed E-Mail from Dan Albritton raises an interesting issue. Most of us believe that the quick and wide acceptance of the CFC-Ozone treaty was because of the confidence in reasons given for the stratospheric ozone depletion. These new observations suggest that we may not have as many answers as we thought.

Sincerely,

A handwritten signature in blue ink, appearing to be "JL" or similar initials.

Enclosure

Posted: Fri, Apr 5, 1991 3:21 PM EST
1829

Msg: EGJB-4663-

From: D.ALBRITTON
To: J.Knauss

Subj: Recent ozone-layer EPA statements

SUBJECT: Recent public statement regarding the ozone layer

I learned that, this week, the EPA has made public statements about recent NASA findings regarding depletion of the ozone layer. These statements apparently got substantial public attention, so I wanted to summarize briefly the content and implications of the new results for you.

Scientists at NASA Goddard have completed an updated analysis of the stratospheric ozone trends in the data from the Total Ozone Mapping Spectrometer (TOMS) satellite instrument. As had been found in analyses a few years ago, this new investigation continues to find downward trends that cannot be attributed to known natural variation.

The rate of that decline is about twice that found earlier, which is the point that was stressed by the EPA. These are global trends, different and in addition to the losses that are already known to occur over Antarctica.

The NASA investigators had reported their findings at the American Geophysical Union meeting last December. Although the manuscript of the Goddard scientists has yet to be published, the findings have not been controversial scientifically.

A point that apparently was not made in the recent public statements, but one that is, in my opinion, the most significant point is that the observed downward trend is 3 - 5 times larger than what current models predict for the amount of man-made chlorine in the stratosphere.

The reason for this discrepancy is not clear. Two important hypotheses are on the table:

(1) It has been suggested (by Adrian Tuck of our Lab) that the ice-enhanced Antarctic and Arctic chemistry, which has been

thought to be relatively contained, may indeed be having an influence equatorward, causing enhanced ozone losses at midlatitudes.

(2) It has also been suggested that such surface-enhanced chemistry could be occurring on the background stratospheric aerosol layer, thereby introducing global ozone losses in addition to the purely gaseous chemistry that has been known for years.

Since neither processes are included in current models (we don't know how to), it is speculated that either or both additional ozone loss mechanisms may be the reason why the observed losses are larger than what current models predict.

The current inability to reconcile observations and predictions is why most scientists are cautious about attributing unequivocally the observed downward global trends to the chlorine-induced ozone destruction.

However, the potential seriousness of this and the need to come up with a better understanding is the rationale for the planned NASA/NOAA "Return to the Poles" in 1991/92 (Arctic) and 1993 (Antarctica).

The unexplained downward trends will also be a central issue in the upcoming international scientific assessment of stratospheric ozone that Bob Watson (NASA) and I are chairing for the United Nations Environmental Programme, which is to serve as input to the 1992 revisions of the Montreal Protocol.