FOIA Number: 2012-0769-F

FOIA MARKER

This is not a textual record. This is used as an administrative marker by the William J. Clinton Presidential Library Staff.

Collection/Record Group: Clinton Presidential Records

Subgroup/Office of Origin: Council on Environmental Quality

Series/Staff Member: Kathleen (Katie) McGinty

Subseries:

OA/ID Number: 2613

FolderID:

Folder Title:
Ozone Depletion Hearing United Nations Environment Programme November 15, 1991

Stack:	Row:	Section:	Shelf:	Position:
S	61	5	6	2

Ozone/UV Radiation Hearing Roadmap

November 14, 1991

Your opening statement.

Notes: 1. In attendance in the audience are the Ozone Secretariat for UNEP (United Nations Environment Programme), Dr. K.M. Sarma from Nairobi, Kenya (he is especially pleased to have the opportunity of meeting you), and Dr. Steve Lee-Babty, Department of the Environment, London, and Co-Chair of the UN ozone technology panel with Dr. Stephen Anderson (EPA).

2. Dr. Margaret Kripke must leave the hearing at 12:00 o'clock for a flight out of Washington.

3. It might be useful to identify the Co-Chairs present of the 3 UN ozone panels (Drs. Watson [NASA] and Albritton [NOAA] - the science of ozone depletion and synthesis of the UN ozone report; Dr. van der Leun [Inst. of Dermatology, Utrecht, The Netherlands] - impacts of ozone depletion; and Dr. Stephen Anderson [EPA] - strategies for reducing emissions of ozone-depleting chemicals.

Statement of ground-rules for roundtable discussion - you are the moderator and each person should first be recognized by you before responding to another's comment's etc., in order to maintain a modicum of organization.

Opening statements - delivered in alphabetical order [refer to witness list].

Opening of roundtable discussion:

Ask Watson to begin by summarizing the science portion of UN ozone report [Watson has a tendency to talk rapidly and at length, and to take charge, so to speak. As a means of pacing Watson and therefore, maximizing the impact of his portion of the report, it might prove effective to occasionally interject and ask Dr. Watson to repeat major points, thus emphasizing these points at the same time.

Go to Albritton for summary of the climatic significance of the science section of the UN ozone report [Albritton and his message are powerful. In my opinion Albritton's testimony is one of the central strengths of this hearing. He has genuine scientific authority and is deeply, personally and professionally concerned about the integrity of the environment. Go to him often as an authority base.

<u>Note</u>: Ask Watson and Albritton to cite how many international scientists were involved in writing the UN ozone report (over 100 scientists) and how many international peer reviews the report has received (over 45 I believe). These 2 points cannot be overemphasized. These are points worth coming back to as often as seems appropriate.

Go to Dr. van der Leun for a summary of the impact portion of the UN ozone report.

Go to Dr. Teramura who also served as a contributor and member of the UN impact panel.

Go to Dr. Weiler who was also a former program director at NSF, in charge of research aimed at assessing UV radiation impact on oceanic phytoplankton, the ocean's primary producers of food in that realm (70% of the Earth by area). I anticipate that her testimony will be quite good and eminently important.

<u>Note</u>: Dr. Worrest, administrator from EPA, also served as a contributor and member of the UN ozone impact panel. His expertise is marine phytoplankton. You may want to solicit his input here, as a scientist, as opposed to his input as an EPA administrator.

Go to Dr. Kripke, Dept. of Immunology, University of Texas. She was a contributor to the impact portion of the UN report. She will address immune system responses in humans to UV radiation. I anticipate that her testimony will be dynamite. She has a couple of powerful, yet little known messages to deliver.

<u>Note</u>: 1. The impact of increased UV, especially increased UV-B radiation, associated with ozone depletion, is the most powerful and central message that this hearing offers, perhaps even exceeding Albritton's climate impact. There has been virtually no discussion of this most lethal aspect of ozone depletion which impacts directly on human health and the health of the entire biosphere, including food resources. There has been virtually no monitoring of UV radiation.

2. Dr. Kripke must leave at 12:00 o'clock in order to catch a flight to a symposium in Texas that afternoon.

Broaden discussion as you see fit - at this point you might engage the panel in a broad-based, free-wheeling discussion, including agency representatives as well.

Agency/Program Administrators

Note: There is a problem within federal research agencies insofar as there appears to have been virtually no monitoring of UV radiation, and impacts, in concert with monitoring and measuring ozone depletion. This has serious management, planning and technological implications for federal and international research programs/agencies.

Go to Dr. Tilford, Director of the Earth Sciences Division at NASA.

Go to Dr. Patrinos, Acting Director, Environmental Sciences at DOE.

Go to Dr. Worrest, Program Manager for EPA's Stratospheric Ozone Research Program. He was also a member and contributor to the UN ozone impact panel.

End of roundtable discussion.

Your closing statement.

Dr. Albritton:

Q - Would you elaborate a bit more on the conclusions of the new UN report regarding ozone depletion and climate change?

- How definite are those conclusions?

Q - Is it now true that CFC's may presently be close to "greenhouse neutral"? Would you explain this climatic implication, especially with regard to the greenhouse warming potential of other gases such as CO-2?

A - It appears that the warming or cooling effect of ozone losses (and gains?) throughout the atmosphere, and the greenhouse warming due to CFC's, presently results in net neutral warming/cooling effect, thus altering the view on the part of some that the elimination of CFC's (presumably the compounds which were most quickly and most easily eliminated from use, thus from the atmosphere), would offset the radiative forcing of CO-2 and other greenhouse gases now appears to be in error. CO-2 is the real long-term concern with regard to greenhouse climate warming.

Q - Is ozone depletion principally due to the input of man-made chlorine and bromine compounds into the atmosphere?

A - Yes, the evidence suggests a virtual certainty that anthropogenically-introduced chlorinated compounds are responsible for the ozone depletion observed. It's the closest, tightest cause-and-effect linkage that science has to offer. Rarely are scientists able to so clearly demonstrate cause-and-effect, as is the case with CFC-driven ozone depletion.

Q - We know that ozone in the upper atmosphere blocks UV radiation from reaching the Earth's surface. What many people do not realize is that that absorption leads to a warming of the ozone layer? Could you explain how that works?

A - The more ozone in the upper atmosphere the more effective the absorption and therefore, the more effective the blockage of UV radiation reaching the Earth's surface. However, the more UV radiation absorbed (a function of increased ozone in the upper atmosphere), the more heat this portion of the atmosphere stores, thus serving to warm the surrounding upper atmosphere as a radiator would warm a home. A thinner ozone layer in the upper atmosphere would mean less storage of UV heat energy, thus less warming of the upper atmosphere (cooling, in other words, in the upper atmosphere).

Q - Is it also true that tropospheric ozone is a greenhouse gas. Of course, most ozone in the lower atmosphere is from automobile emissions and the like. How does tropospheric ozone compare to stratospheric ozone in terms of greenhouse warming?

A - The climatic significance of ozone is complex, and largely a function of its position in the atmosphere. Where ozone resides, and how much is present in each reservoir, at each region of the atmosphere, largely determines it's climatic impact at the Earth's surface, which then, is clearly a function of the net effect of ozone at various levels in the atmosphere.

Q - Would you explain the role of ice crystals in the Antarctic winter atmosphere, and the role of sulfur compounds in ozone depletion?

A - Ice in winter clouds in Antarctica serve to act as reaction surfaces which accelerate the rate of ozone depletion due to chlorine and bromine compounds. Elsewhere, in mid (and high?) latitudes year-round, in both hemispheres, sulfur compounds serve the same role as ice does in the Antarctic winter, increasing the rate of ozone loss. Since sulfur aerosols reside principally in the lower stratosphere, it suggests a reason why the most recent ozone losses were largely found in the lower stratosphere, along with chlorine compounds.

Q - Would you explain the concept of residence time and apply it to CFC's and related, ozone-depleting compounds?

A - Residence time is the time that certain chemical compounds reside in the atmosphere before falling to the EArth's surface, out of the atmosphere. With respect to CFC's, the residence time is aapx. 75 to 100 years (?), meaning that it would take CFC's being presently introduced into the atmosphere, appx. 75 to 100 years to fall out of the atmosphere, and thus, no longer have an ozone-depleting and/or climate impact.

Q - Would it be fair to conclude then that with respect to ozone depletion, we have already condemned our children and our children's children to having to cope with the consequences of a thinner ozone shield?

A - Yes, it's a fair statement.

Q - Has ultraviolet radiation increased as a result of reported ozone losses? How is this data collected and where?

A - Yes. But most measurements have thus far been confined to Antarctica.

Q - How hard is it to make these measurements of UV radiation?

A - The measurements are exceedingly tricky, being influenced by air pollution, aerosols, dust, clouds, etc., in addition to ozone depletion, particularly around urban areas where most UV monitoring stations are located.

Q - Does this mean our environmental degradation itself has now made it more difficult to calibrate, and measure precisely, the environmental deterioration itself, such as changes in the levels of UV radiation reaching the Earth's surface?

A - Yes.

Dr. Kripke:

Q - Would you identify what you consider the most serious implication of your research on the impact of UV-B radiation on the human immune system, especially in light of the new UN report?

A - Yes.

Q - Would you explain the function of the human immune system?

A - Yes, it is the body's natural way of fighting off viruses, diseases, etc., and protecting itself from diseases and viruses as well, and from any outside influences which might disrupt the body's ability to keep itself healthy and repair itself when necessary.

Q - What is immuno-suppression?

A - The holding back of the immune system, to some extent, or the loss of the immune sytem's ability to fight off diseases, viruses and the like.

Q - Do increased levels of UV-B radiation, even so-called small increases in UV-B radiation, lead to suppression of the immune system?

A - Yes, new studies on the human immune sytem's response to increased levels of UV-B radiation in Florida indicate that increased UV-B, even small doses, causes suppression of the human immune system, or it's ability to thwart off diseases. These results from studies on the impact of increased UV-B radiation on humans are consistent with earlier and parallel studies on mice.

Q - In other words, radiation suppression of the human immune system translates to a decreased ability to fight off diseases, etc., thus a higher susceptibility to diseases, infections and viruses?

A - Yes.

Q - Is it true that increased levels of UV-B radiation often result in suppression of the human immune system, irrespective of skin color?

A - Yes, recent studies in Florida indicate that this is true, contrary to the more popularized notion that people with light complexions are more susceptible to skin cancer, for example, than people with darker compexions, as a result of increased UV-B radiation.

Q - Does this mean that a higher percentage of the human population worlwide, is at risk, as a result of increased levels of UV radiation, possibly due to ozone depletion in the upper atmosphere?

A - Yes.

Q - Is there any such thing as a safe level of UV radiation? Would you explain?

A - Probable answer is not really.

Q - How effective are sunscreens in blocking out UV radiation?

A - Some are totally ineffective, providing no protection whatsoever from the effects of UV radiation.

Q - Is it fair to conclude that there seems to be an wholescale lack of observations and measurements on UV radiation, and it's biological implications, particularly by comparison with the observations and measurements which we gathered on the depletion of ozone?

A - Yes, very much so.

Q - Have you seen a recent magazine article by Leslie Crawford, in the Financial Times, outling apparent reports of blind salmon, wild rabbits with loss of vision, tree buds with deformed growth, and algae secreting a red pigment, in southern Chile?

A - Yes.

Q - Are such disorders, even if the events described in the piece are hearsay, consistent with laboratory experiments on the impact of increased UV radiation?

A - I am not certain what her response will be, except that she faxed me a copy of the article without having asked for it.

Dr. Watson:

Q - Would you elaborate on the conclusions of your portion of the UN report on the science of ozone depletion?

A - Yes.

Q - How many contributors are there to this new UN ozone report, worldwide? Would you elaborate?

A - Probable answer, more than 100 scientists including virtually everyone on this panel with the exception of Weiler and Tilford.

Q - Has this report been extensively peer reviewed internationally? Would you elaborate?

A - Probable answer, over 45 peer reviews internationally.

Q - What has been the historic cause, up until three years ago, of the odd-even year fluctuation in the Antarctic ozone hole's severity, and why has it not occurred within the last three years? What are the implications?

A - Natural variability of temperature and wind patterns and strength(?). The latter possibly indicates that CFC chemistry is becoming dominant over dynamical influences on Antarctic ozone depletion.

Q - If we have full compliance to the Montreal Protocol, what will happen to the ozone layer in the future? And what would happen if we stopped all emissions of ozone-depleting gases today?

Dr. Weiler:

Q - Having been a former National Science Foundation program director of research on the effects of UV radiation on oceanic phytoplankton (marine algae or plants), would you summarize for us what scientists presently know about the impact of UV-B radiation upon oceanic phytoplankton?

A - I am reasonably certain that she will say that the impact so far appears to have resulted in a net loss of phytoplankton, at least in the ocean surrounding Antarctica, perhaps by as much as 8%. Antarctic phytoplankton produce UV-blocking compounds however, species vary in their sensitivity to UV-B radiation. In general, current levels ofUV-B radiation affect phytoplankton cellular processes, nitrogen metabolism, DNA integrity, cell division, cell viability, pigmentation, protein content, cell orientation and primary production. UV-B radiation is harmful at pre- and post-ozone hole levels.

Note: You might also pose a similar question to Dr. Teramura and/or Dr. van der Leun and/or Dr. Worrest.

Q - Would you discuss the work of Smith and others on the effects of UV radiation on phytoplankton in marine waters off of Antarctica?

A - There is presently, increased UV-B radiation reaching the surface of the Southern ozone due to a 50% to 60% depletion in ozone above the Antarctic continent. As the ozone layer thinned, UV-B radiation was increased in the surface, photosynthetically-active layers of the Southern ocean. UV-B inhibition of photosynthesis increased as a function of ozone depletion. UV-B related losses in primary productivity were estimated to be a minimum of 6-12% in the Southern ocean. There is a reduction of photosynthesis for populations sampled inside the ozone Antarctic ozone hole.

Q - Could you provide us with some insight into the implications of UV radiation-driven losses in oceanic primary productivity on the order of 14%, for example, with regard to the impact of such losses on the rest of the oceanic food chain?

A - Although I am not certain of her response, I suspect that no one presently knows the answer to that question, but that it is a matter of great concern. It has implications for food resources worldwide, among other things, and the rates may be geometric (probably non-linear in any case) as well, as one chases the impact through higher parts of the oceanic food chain. Changes in the abundance, size distribution, or nutritional value of primary producers could affect higher levels of the food chain by reducing feeding efficiency and potentially causing nutritional deficiencies.

Q - There appears to be little information or observational measurements available on UV-B radiation and its impact upon the biosphere, and certainly vastly less than on ozone depletion itself. Would you comment on how and why there is presently so little known about these two aspects of ozone depletion?

A - She will admit that there is much basic research and measurments which are badly needed to sort out radiation fluxes and impacts to the biosphere. Beyond that I do not know what her answer will be.

<u>Note</u>: An analagous question could be posed to Drs. Teramura, van der Leun, and Worrest.

Q - Do you have or know of any estimates of how much food, or food mass is lost, as a consequence of a 14% loss in primary productivity represents?

A - She will probably say no, she does not know the answer, nor is she aware of such an answer.

<u>Note</u>: This is a good question to pass around the table to Drs. van der Leun, Teramura, Worrest, and even Kripke. This is a good issue to converge on and play with. Any discussion would be worthwhile.

Q - Would it be fair to say that the present impact of UV-B radiation on life and life-support systems is largely negative, and that any additional increases due to ozone depletion, for example, could only be construed as worse?

A - I believe that she will agree.

<u>Note</u>: This question should be passed around the loop to Drs. Kripke, Worrest, van der Leun, and Teramura. Should anyone disagree, it might be interesting to ask if anyone present would care to replace their present light bulbs at home with UV-B lights. If there are no takers-on one clearly has to weigh the implications of such reluctance.

Dr. van der Leun:

Q - Welcome to the U.S. Senate Dr. van der Leun. Would you care to elaborate a bit more on the KEY points in the UN report on ozone depletion?

A - No doubt UV-B radiation will increase as a consequence of ozone depletion. UV-B induced immunosuppression in humans has already been demonstrated, not only in those of light pigmentation, but deeply-pigmented individuals as well. World's population is at risk to potential adverse effects of increased UV-B radiation. There are a host of eye disorders associated with increased UV-B radiation. A sustained 10% decrease in ozone will be associated with a 26% increase in non-melanoma skin cancer (UV-B driven skin cancer irrespective of skin pigmentation). This translates to an increase in such cancer cases in excess of 300,000 cases per year, worldwide.

There is concern as well for potential harmful UV-B radiation effects upon the terrestrial biosphere, and natural ecosystems in general, as ozone depletion continues. Growth and photosynthesis of certain plants (rye, maize and sunflower, for example) can be inhibited even under ambient levels of UV-B radiation. Certain tropical plants may also be adversly affected by enhanced UV-B radiation.

Aquatic ecosystems are already under UV-B stress and grave concern that an increase in UV-B radiation will cause detrimental effects. The possible negative UV-B radiation impact on marine phytoplankton, representing more biomass than all terrestrial ecosystems, is of great concern. Loss of marine biomass production is propagated throughout the entire food web. This could result in loss of food resources for human consumption, particularly in a world whose population is already increasing exponentially. Any reduction in marine biomass will result in less uptake of atmospheric CO-2 and thus, increased greenhouse effect, long-range as well. Phytoplankton production of DMS (dimethylsulfide), a precursor to cloud condensation nuclei (CCN) and clouds, would be reduced, again serving as a positive feedback to global greenhouse warming. UV-B induced decreases in microorganisms fixing nitrogen would require significant fertilization by substitute artificial fertilizers (rice production, for example).

There is also concern for UV-B radiation driven increases in chemical reactivity in the troposphere. Tropospheric ozone concentrations could rise in heavily polluted areas, but should increase in unpolluted areas (with low NO-X levels). Potentially harmful substances (hydrogen peroxide, acids, and aerosols) are expected to increase in the troposphere due to enhanced chemical reactivity. These changes could exacerbate problems of human health and welfare, increase damage to the biosphere, and might make current air quality goals more dofficult and expensive to attain.

UV-B radiation also results in degradation of wood and pastic, with loss of strength as well. There will be increased costs in using higher levels of conventional light stabilizers. Very limited information/data are available for wood, plastic, plastic coatings and rubber.

Key areas of uncertainty are: quantification of primary effects on food production and quality, forestry, and natural ecosystems; clarification and quantification of influences on human health, especially the immune system, and the occurrences of melanomas and cataracts; and effects on biota of enhanced UV-B radiation during Antarctic springtime ozone depletion.

Q - Are there any good or benign effects of increased UV-B radiation, Dr. van der Leun?

A - He should say no or something very close.

Note: This is another good question to pass around to Drs. Kripke, Teramura and Worrest.

Dr. Teramura:

Q - Dr. Teramura, would you summarize for us your research on the effects of increased levels of UV-B radiation on plants and crops?

A - For over 300 species of plants investigated over the past 15 years, over one-half of these appear to be sensitive to UV radiation. The msot sensitive are peas, beans, squash, melons and cabbage. In all field studies done on crops to date, crop yield was reduced in nearly half of the studies of the impact of UV radiation. There are reductions in quality as well. There is very little known about the UV effects on forest tree species. There is evidence which suggests that exposure to UV radiation may alter plant sensitivity to diseases, making some more susceptible to attack by pathogens. Growth and photosynthesis of bean seedlings have been altered by present-day levels of solar UV. Breeding more UV-resistent varieties of natural plants and forests is not an option here. Present day levels of UV radiation can be damaging to plants even in the absence of ozone depletion.

Dr. Anderson:

Q - Would you summarize the results of the technology portion of the UN ozone report?

A - Since 1986 there has been a 40% drop worldwide drop in the production of CFC's, at rates in excess of those called for in the Montreal Protocol. Several multinational companies are phasing out ozone-depleting substances faster than even the most stringent regulation. By January, 1992 the first companies will have eliminated the use of CFC-113 solvents in all worldwide operations. Halon and CFC recycling will be accepted worldwide. The first HFC-134a auto air conditioners will be commercialized. The first HFC-134a domestic refrigerators will be commercialized in 1992.

The international fire protection community has nearly eliminated halon emissions caused by discharge testing, and training and service emissions have been drastically cut back. It is technically feasible in developed countries to phase out production of CFC's and halons by 1997 or earlier, 1,1,1-trichloroethane as early as 1995, and carbon tetrachloride in most cases, by 1995.

All of the above is contingent upon the safety tests presently being run on the CFC substitutes (e.g., HCFC-22, HCFc-123, HCFC-124, HCFC-141b, HCFC-142b, and HFC-134a) in refrigeration, air conditioning, insulating foam, for some aerosols and some sterilization and minor solvent uses. The above schedule is also contingent upon commercial availability in adequate quantities, while halon phaseout is contingent on the use of recycled halons as the prime supply of those halons.

Each substitute has difficult trade-offs in ozone-depleting potential (ODP) of transitional substances, global warming potential, energy efficiency and toxicity. For small usese, there are no substitues as yet, but the UN Technical and Economic Assessment is optimistic.

Developing countries will require appropriate phaseout technology, supporting technical assistance and training, and adequate financial assistance. There are international cooperative technology projects to assist developing countries in phasing out CFC's on schedule.

Q - Comparatively speaking, what are the trade-offs of HCFC's versus CFC's in terms of ozone-depleting potential and global warming potentials?

A - ?

Q - Should the testing on the CFC substitutes begin to show serious problems with these substitutes are there an alternatives in the pipeline?

A - ?

Dr. Tilford, NASA Administrator:

Q - Why is there so little information, observational or otherwise, available on UV radiation changes and its impact upon life systems, particularly by comparison with the level of information we have on ozone levels?

A - I do not know what he will say. However, there is clearly a programmatic, planning or technology problem, or some combination of all three possibilities. This is a serious hole in the federal global change effort which belies little adherence to monitoring the full range of theoretical expectations, so that we can prove or disprove our knowledge base as we go along. But in addition, the impact on health, life, and food resources should have made this a first-order priority. Why was it clearly not so?

<u>Note</u>: Drs. Worrest and Patrinos might be drawn into this question, in addition to any other panel members who represent the research side of this issue.

Dr. Worrest, EPA Program Manager:

Q - What current and future programs does EPA have to monitor UV radiation changes as a result of ozone depletion, as well as the human and biological impact of UV radiation due to ozone depletion and other factors?

A - ?

Note: This question could be passed around to Dr. Patrinos of DOE and Dr. Tilford of NASA.

Dr. Patrinos, Acting Director, Environmental Sciences Division of DOE:

Q - Would you explain the goals of DOE's Atmospheric Radiation Measurement Program (ARM), and the progress to-date of this program? Are there provisions for measure ozone and radiation changes?

A - It's DOE's contribution to the Global Change Research Program coordinated by the Committee on Earth and Environmental Sciences (CEES). ARM was initiated in 1990 in response to the uncertainty of clouds. As to the latter question, it's not entirely clear except that ARM measures radiation, and losses and gains in atmospheric heat.

Q - What on-going and future programs does DOE have on monitoring ozone depletion and UV radiation changes, as well as well as monitoring the impact of radiation on life systems?

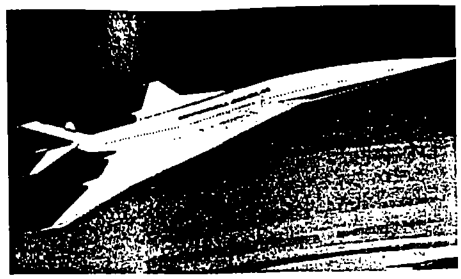
A - ?

The Supersonic Question

Boeing

Will fleets of high-speed jetliners damage the fragile ozone layer?

By RICHARD MONASTERSKY



McDonnell Douglas

U.S. and foreign aircraft manufacturers are developing plans for a new breed of supersonic planes that they hope to have on the runways by 2005. According to current design scenarios, the planes would fly subsonically over land areas to avoid annoying sonic booms, although NASA is conducting research to reduce sonic booms to a level where planes could fly supersonically over land.

While the Atlantic Ocean once held center stage in world affairs, nations of the Pacific Rim are rapidly rising in prominence. The surging interest in Asia, Australia and other regions has lured waves of business people and tourists across the vast Pacific Ocean, arriving at their destinations bleary-eyed from flights that can stretch 12 hours or longer. To these weary voyagers, the prospect of supersonic planes holds an immediate appeal. Imagine eating lunch in San Francisco's Chinatown and landing in Hong Kong before you're hungry for supper.

Recognizing the potential market for such speedy transport, the National Aeronautics and Space Administration and several aircraft companies have started exploring the possibility of developing a new breed of supersonic plane. Called high-speed civil transport (HSCT), these jets would fly faster and carry more passengers than the Concorde, the only commercial airliner that currently breaks Mach 1, the speed of sound.

"We think it's the most important thing we're doing right now in civil aviation," says Howard L. Wesoky, who heads NASA's high-speed research program at the agency's Washington, D.C., headquarters.

But before civil aviation makes this jump past the sound barrier, it must first resolve the same environmental uncertainties that 20 years ago grounded U.S. plans to build supersonic passenger planes. Among those concerns, a critical question remains: Will high-speed aircraft damage the ozone layer that screens out harmful ultraviolet radiation?

Simple computer studies in the last few years have tended to confirm the dire forecasts made in the early 1970s showing that fleets of supersonic jets could indeed significantly weaken the ozone layer. But the newest computer simulation, using a more sophisticated model of atmospheric chemistry, points in the opposite direction. High-flying jets might not diminish ozone concentrations apprecia~~bly, according to work by Debra K.~~ Weisenstein and colleagues at Atmospheric and Environmental Research, Inc., in Cambridge, ~~Mass.~~ Paradoxically, the pollution from such planes could cause an ozone increase under some conditions, the researchers find.

The ozone question revolves around a certain class of chemicals, called nitrogen oxides, that HSCT engines emit as exhaust. These compounds are nothing exotic; the same nitrogen oxides spew out of cars and conventional planes. The problem with supersonic jet exhaust is one of location. To achieve their extreme speeds, HSCT must fly at high altitudes where the air is thinner and creates less friction than does air at lower altitudes. So unlike other planes, which emit their exhaust in the lowest layer of the atmosphere, HSCT pollution affects the stratosphere, the region where protective ozone is most concentrated.

Concerns about the effect of nitrogen oxides on ozone first surfaced 20 years ago and helped kill an already floundering movement to build supersonic planes in the United States. In the time since then, the world has grown increasingly aware of the ozone layer's vulnerability. The dramatic discovery of the Antarctic ozone hole in 1985 demonstrated just how seriously chemical pollutants can affect this protective shield around the planet. Closer to home, researchers have detected sizable ozone loss over midlatitude regions such as the United States (SN: 4/13/91, p.231). Although scientists have yet to decipher the exact cause behind much of this ozone decrease, experts believe chemical pollutants are involved in the process.

Into this politically charged arena, NASA has now ventured with the HSCT project.

While NASA's public image most often revolves around ventures in space, the first "A" in its name stands for aeronautics; part of the agency's charter directs it to help the U.S. commercial aviation community develop new technology. Under contract from NASA, two aviation firms, the Boeing Co. and McDonnell Douglas Corp., analyzed the economic potential for HSCT.

They found that the expected market in the year 2015 could indeed support supersonic jets capable of flying across the Pacific, which the Concorde cannot. The contractors, however, remained unsure

	Concorde	Projected High-Speed Civil Transport
Range (km)	5,600	9,000–12,000
Payload (passengers)	100	250–300
Community noise standard	Exempt	Far 36, Stage 3
Fare levels	Premium	Standard
Speed	Mach 2	Mach 2.4

Adapted from NASA

however, as we phase out CFCs & Cl, ↓ heterog. control)

whether the aviation community could produce environmentally acceptable HSCT jets by that time. To answer that question, NASA last year launched a six-year, $284 million research program.

The scientific effort addresses three primary concerns: ozone depletion, noise from sonic booms, and noise created when planes land and take off at subsonic speeds. While all three represent potential problems, the ozone question may end up playing the crucial role in determining whether the HSCT idea flies.

Much of NASA's work with ozone involves computerized replicas of the atmosphere, with which scientists can gauge the effects of HSCT exhaust. Most simulations to date have focused on two-dimensional models that mimic the chemical reactions between various gases in the stratosphere and troposphere. These models have shown serious ozone loss from high-speed traffic; some predict that a fleet of aircraft would lower ozone values substantially.

McDonnell Douglas

But these previous model simulations do not include a number of reactions that could dramatically alter the picture. Chief among the factors left out is heterogeneous chemistry — reactions that take place on the surfaces of liquid and solid particles in the atmosphere. Scientists have grown particularly sensitive to the importance of heterogeneous reactions in recent years because they play a critical role in creating the Antarctic ozone hole. Prior to the ozone hole's discovery, atmospheric chemists considered such reactions relatively unimportant — an oversight that prevented experts from foreseeing the hole's appearance.

When Weisenstein and her colleagues ran their model without heterogeneous chemistry, they found that 500 aircraft flying at a speed of Mach 2.4 (three times the speed of modern commercial jets) could lower ozone values by a significant 3 to 6 percent in northern midlatitudes. That weakening in the ozone layer would let some 6 to 12 percent more ultraviolet light reach Earth's surface, raising the risk of skin cancer, cataracts and damage to animals and plants.

But when the researchers included a particular heterogeneous reaction in their calculations, they found that HSCT traffic would slightly *increase* ozone concentrations by a few tenths of a percent.

The turnabout develops because heterogeneous reactions alter ozone's habits in the stratosphere, where it is continually created and destroyed by various reactions. In a model without heterogeneous chemistry, ozone is particularly sensitive to levels of nitrogen oxides because such compounds are the biggest destroyers of ozone.

When the model *includes* heterogeneous reactions, however, nitrogen oxides lose their starring role and drop to supporting players while other compounds become the biggest ozone-eaters. Thus ozone levels do not react strongly to the additional nitrogen oxides from HSCT pollution. Weisenstein's group will report their findings in an upcoming issue of GEOPHYSICAL RESEARCH LETTERS.

Far from settling the question about HSCT exhaust, the new results demonstrate the importance of making models more realistic — meaning that scientists face several more years' work before they can create a reasonable facsimile of the atmosphere to address this issue. Models must incorporate other heterogeneous reactions, as well as the effects of water vapor that the airplanes will release into the normally dry stratosphere. Especially in the polar regions, water vapor pollution could enhance ozone destruction. If so, the Antarctic ozone hole might grow wider and a new ozone hole could open over the northern pole, notes Michael J. Prather, who heads the atmospheric studies for NASA's HSCT program at the Goddard Institute for Space Studies in New York City.

"This is why I don't think the simple models [currently in use] can answer the question," Prather says.

In the end, though, scientists will not decide the fate of HSCT jets. They can only offer predictions on how much ozone destruction might result from such traffic. Government leaders must then address the question: How much ozone loss — if any — is acceptable? □

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 453-8400

extra

For Release

October 9, 1991

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/453-1547)

Dolores Beasley
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-2806)

RELEASE: 91-168

1991 ANTARCTIC OZONE LEVELS REACH RECORD LOW

Ozone levels in the Antarctic have reached the lowest values ever observed, according to preliminary data obtained by officials at NASA's Goddard Space Flight Center, Greenbelt, Md.

The preliminary data from the Total Ozone Mapping Spectrometer (TOMS) on NASA's Nimbus-7 satellite indicate that ozone values of less than 120 Dobson units have been measured. Values as low as 110 (plus or minus 6) were observed on Oct. 6, however, validation of these numbers is dependent on final calibration.

"The minimum ozone on Oct. 6, 1991, is the lowest we have ever seen with the TOMS instrument in its 13-year record of data," said Goddard scientist Arlin Krueger. "Although the data are preliminary, we expect that the final results will confirm this conclusion."

This is the fourth severe ozone hole since 1986 and the third consecutive year that severe ozone depletion has developed over the Antarctic. The implications of a single-day minimum are uncertain. The severity of each year's ozone hole also is measured by the persistence of the depletion through the southern spring and its geographical extent across Antarctica.

Though research has linked man-made chlorine compounds and other chemicals to ozone depletion, the extreme magnitude 1991 minimum cannot necessarily be attributed solely to chemical processes, said Dr. Jack A. Kaye, head of NASA Headquarters' Atmospheric Chemistry Modelling and Analysis Program. Meteorological processes can cause temporary small fluctuations inside a chemically produced ozone hole.

- more -

Ozone, a molecule made up of three atoms of oxygen, comprises a thin layer of the upper atmosphere that absorbs harmful ultraviolet radiation from the Sun. The ozone hole is a large area of intense ozone depletion over the Antarctic continent that occurs typically during late-August through early-October and breaks up in mid-November.

This is the 13th year that the ozone hole has been monitored using the TOMS on the Nimbus-7 spacecraft. Both are managed by the Goddard Space Flight Center. On Aug. 15, a refurbished engineering model of TOMS was launched aboard a Soviet Meteor-3 spacecraft. This new instrument began gathering data soon after launch and also has observed this year's ozone hole.

- end -

GEOPHYSICAL RESEARCH LETTERS, VOL. 18, NO. 10, PAGES 1869-1871, OCTOBER 1991

PROLONGED ENHANCEMENT IN SURFACE ULTRAVIOLET RADIATION DURING THE ANTARCTIC SPRING OF 1990

John E. Frederick and Amy D. Alberts

Department of the Geophysical Sciences, The University of Chicago

Abstract. Measurements of the ultraviolet solar spectral irradiance from the earth's surface at Palmer Station, Antarctica, latitude 64.8 degrees South, show behavior in the spring of 1990 which differs from that observed during the seasonal ozone depletions of the previous two years. As the Austral spring progresses, the sun rises in the sky, and the duration of daylight increases up to the summer solstice on December 21. This is naturally accompanied by increasing ultraviolet irradiances irrespective of the behavior of column ozone. If, as in 1988, the ozone depletion is confined to October and early November, the irradiances at local noon may why? remain at or below values characteristic of an unperturbed summer solstice. However, in 1990 enhanced irradiances persisted well into December. The largest values observed at a wavelength of 306.5 nm were approximately double those expected at summer solstice with an unperturbed ozone amount.

Introduction

Enhanced ultraviolet irradiances at the Antarctic surface related to the springtime ozone depletion have been observed by a scanning spectroradiometer located at Palmer Station since 1988 [Lubin and Frederick, 1990, 1991; Lubin et al., 1989]. From the vantage point of atmospheric science the reduction in ozone over Antarctica can be characterized by the minimum column amount observed during the spring season [Schoeberl et al., 1989; Stolarski et al., 1990; Newman et al., 1991]. However, when the focus is on potential ecological effects, it is appropriate to think in terms of the magnitude and duration of enhanced radiation levels. Measurements of ultraviolet irradiance include the combined effects of attenuation by ozone and transmission through clouds. Both of these processes are important in determining the radiation climatology of a region. However, the ecosystem of the Antarctic peninsula has evolved in a radiation environment which includes the influence of clouds. The transmission of ultraviolet radiation associated with scattering by clouds varies over time scales of hours to days, but over the course of a season the average transmission likely differs little between one year and the next. The true perturbation to the radiation field is the springtime depletion in ozone.

Results

The present analysis characterizes the radiation field in a manner which highlights the effects associated with the springtime ozone depletion and minimizes fluctuations related to cloud cover. To an acceptable approximation clouds provide an attenuation which is independent of wavelength over the limited spectral region of interest, being 295 to 350 nm. Given this, the ratio of irradiances measured at two wavelengths, where the numerator is dependent on absorption by ozone and the denominator is not, provides an index of the radiation field which is insensitive to cloudiness. We selected irradiances measured at 350 nm in wavelength, where no absorption by ozone occurs, for the denominator and denote these by F(350). Although the ratios F(w)/F(350) for any wavelength w are essentially independent of cloud cover, they still vary with solar zenith angle, although less markedly than do the absolute irradiances.

Figure 1 presents measured and computed irradiance ratios appropriate to local noon in December of 1988 and 1990. The calculated ratios are derived from the model of Frederick and

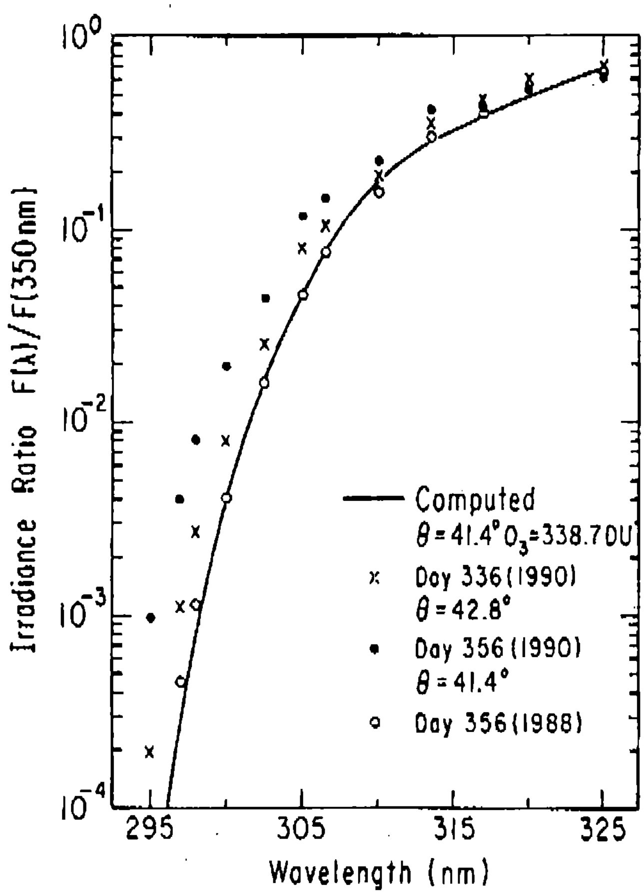


Fig. 1. Variation of the irradiance ratio with wavelength for local noon during December at Palmer Station, Antarctica (64.8 degrees South). The vertical scale is the ratio of solar irradiance at a specified wavelength to the irradiance at 350 nm. The solid line is the result of a calculation for the summer solstice and an unperturbed ozone amount. Symbols refer to measurements on various days of 1988 and 1990 where theta is the solar zenith angle.

Paper number 91GL02083
0094-8534/91/91GL-02083$03.00

Lubin [1988]. The results include absorption and all orders of scattered radiation and refer to summer solstice with an unperturbed ozone amount near 340 Dobson Units (DU). The model results are in excellent agreement with measurements made on December 21, 1988, day 356, at which time the ozone layer had recovered to normal values. The solid curve is representative of the largest irradiances which would appear over the Antarctic peninsula during a year in the absence of an ozone depletion. Although increased ultraviolet radiation levels existed over Palmer Station in the spring of 1988, the enhancement vanished prior to the time of year when the largest irradiances normally occur [Lubin et al., 1989]. A different situation prevailed in 1990, as shown by the measurements for local noon on December 2 and 22, being day numbers 336 and 356 respectively. As wavelength decreases from 315 nm, a large enhancement exists during 1990 as compared to the unperturbed radiation levels of 1988.

"climatological"

Assessment of potential biological effects of ozone depletion start from a wavelength-dependent weighting, or action spectrum, convolved with the spectral irradiance. The product of the action spectrum for erythema [McKinlay and Diffey, 1987] and the spectral irradiances observed in 1990 produces a maximum biologically weighted irradiance at 306.5 nm in wavelength and half-maxima near 300 and 315 nm. Given this, we adopt the ratio F(306.5)/F(350) as an index of biologically effective radiation.

where DNA absorbs?

Figure 2 presents daily values of F(306.5)/F(350) for local noon over the period from mid-September through December 1990. The solid curve denotes climatological values computed from unperturbed ozone amounts based on the tabulation of Nagatani et al. [1988], and the dashed curve is double the climatological irradiance ratio. In the absence of an ozone depletion the points would scatter on either side of the climatological curve. Enhanced irradiances exist throughout the entire period, with approximately 20% of the values exceeding the climatological prediction by a factor of two or more. The column ozone abundances in the first several days of December, the period of peak irradiances, were in the range 210-220 DU. Only ten days during the period have irradiance ratios less than the climatological prediction. These

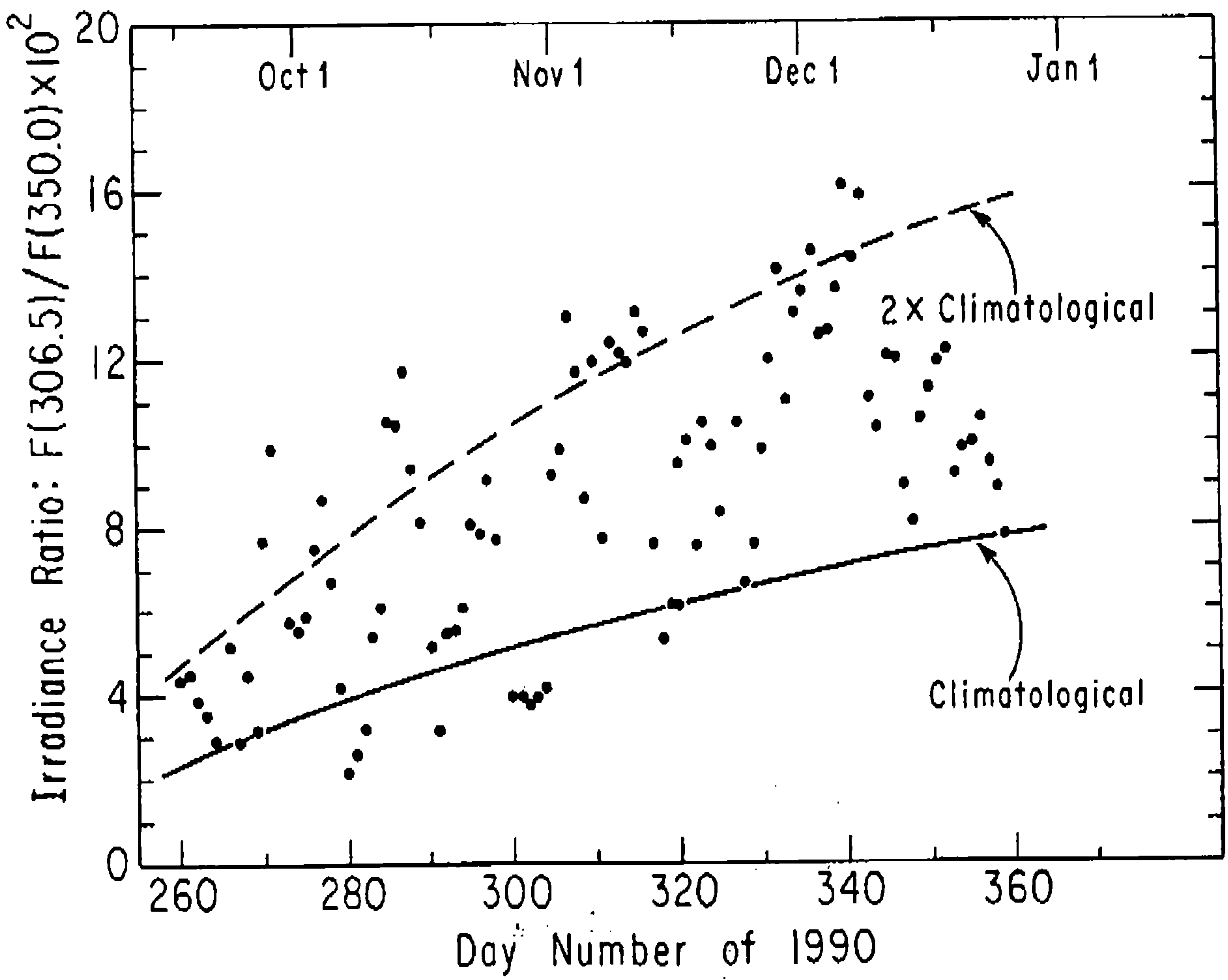


Fig. 2. Ratios of noontime solar irradiance measured at 306.5 nm to that at 350 nm (points) for the Austral spring of 1990 at Palmer Station. The curve labelled "climatological" is a calculation based on ozone amounts which are typical of those present over Palmer Station in years prior to the existence of a major ozone depletion. The dashed line is double the climatological irradiance ratio.

correspond to periods when the region of depleted ozone moved off of Palmer Station, and unperturbed air flowed over the area.

Conclusion

Both the magnitude and duration of the depletion in column ozone are important in determining the peak ultraviolet irradiances incident on the Antarctic peninsula. If the decline in ozone persists into December, as was the case in 1990, then the relatively high elevation of the sun can lead to noontime ultraviolet irradiances a factor of two or more above the climatological values. The long duration of daylight in December further enhances the 24-hour integrated surface irradiance. The radiation levels observed over Palmer Station in December 1990 may be the largest experienced in this region of the world since the development of an ozone layer on earth.

Acknowledgements. The Antarctic spectroradiometers were assembled and the data processed by Biospherical Instruments, Inc. We are grateful to C. R. Booth, T. Lucas, and D. Neuschuler for providing the data sets analyzed here. This research was supported by the Division of Polar Programs of the National Science Foundation under grant DPP-9006560.

References

Frederick, J. E., and D. Lubin, The budget of biologically active ultraviolet radiation in the earth-atmosphere system, *J. Geophys. Res.*, 93, 3825-3832, 1988.

Lubin, D., and J. E. Frederick, Column ozone measurements from Palmer Station, Antarctica: Variations during the Austral Springs of 1988 and 1989, *J. Geophys. Res.*, 95, 13, 883-13, 889, 1990.

Lubin, D., and J. E. Frederick, The ultraviolet radiation environment of the Antarctic peninsula: The roles of ozone and clouds, *J. Appl. Meteor.*, 30, 478-493, 1991.

Lubin, D., J. E. Frederick, C. R. Booth, T. Lucas, and D. Neuschuler, Measurements of enhanced springtime ultraviolet radiation from Palmer Station, Antarctica, *Geophys. Res. Lett.*, 16, 783-785,1989.

McKinlay, A. F., and B. L. Diffey, A reference action spectrum for ultraviolet induced erythema in human skin, in *Human Exposure to Ultraviolet Radiation: Risks and Regulations*, edited by W. F. Passchier and B. F. M. Bosnajakovic, pp. 83-87, Elsevier Science, Amsterdam, 1987.

Nagatani, R. M., A. J. Miller, K. W. Johnson, and M. E. Gelman, *An Eight-Year Climatology of Meteorological and SBUV Ozone Data*, NOAA Technical Report NWS 40, pp. 16-21, 1988.

Newman, P., R. Stolarski, M. Schoeberl, R. McPeters, and A. Krueger, The 1990 Antarctic ozone hole as observed by TOMS, *Geophys. Res. Lett.*, 18, 661-664, 1991.

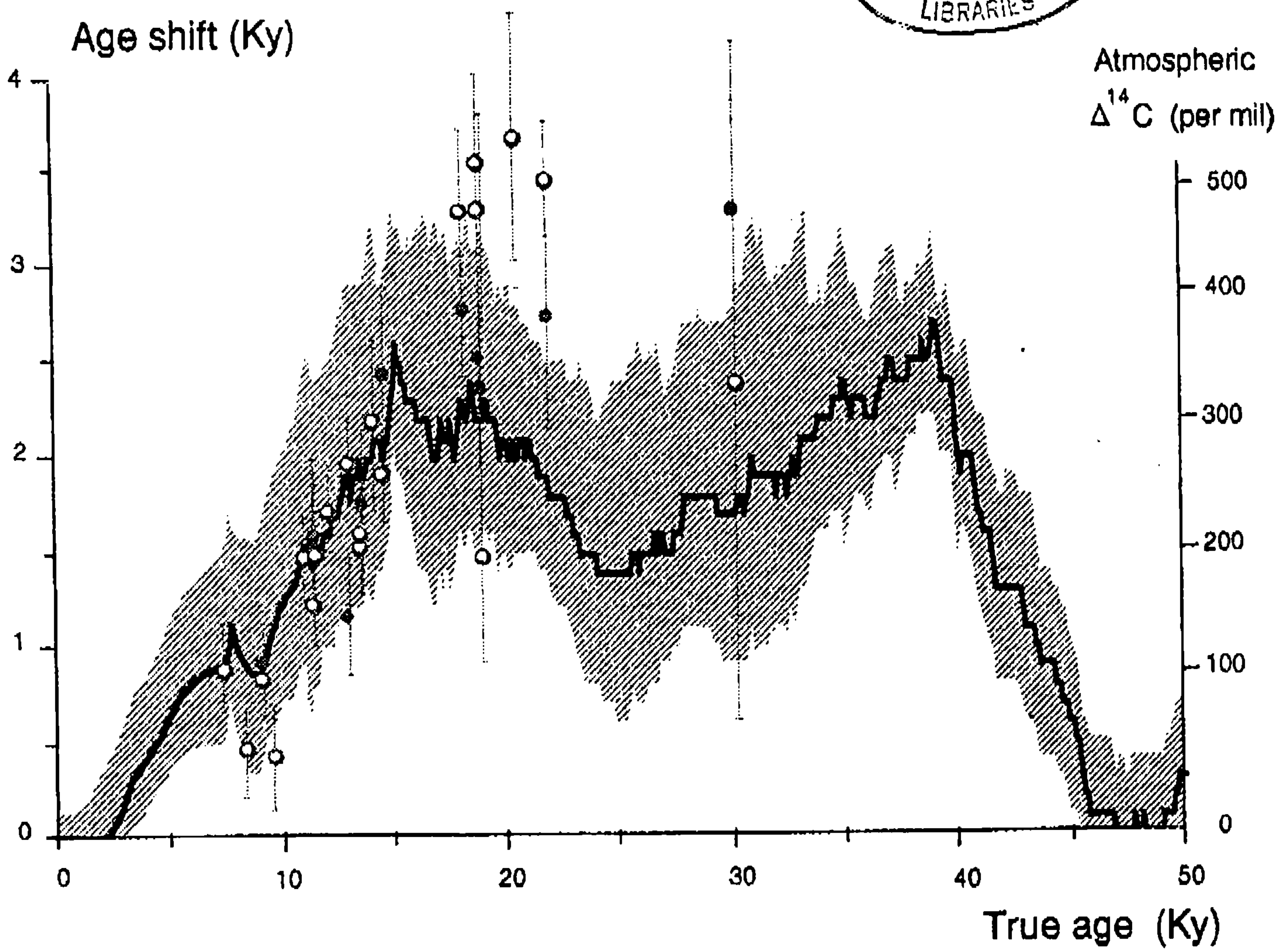
Schoeberl, M. R., R. S. Stolarski, and A. J. Krueger, The 1988 Antarctic ozone depletion: Comparison with previous year depletions, *Geophys. Res. Lett.*, 16, 377-380, 1989.

Stolarski, R. S., M. R. Schoeberl, P. A. Newman, R. D. McPeters, and A. J. Krueger, The 1989 Antarctic ozone hole as observed by TOMS, *Geophys. Res. Lett.*, 17, 1267-1270, 1990.

J. E. Frederick and A. D. Alberts, Department of the Geophysical Sciences, The University of Chicago, 5734 South Ellis Avenue, Chicago, IL 60637

(Received July 22, 1991;
accepted August 5, 1991.)

Geophysical Research Letters



OCTOBER 1991
Volume 18 Number 10
AMERICAN GEOPHYSICAL UNION

Oct 29, 1991

AOS

EOS

TRANSACTIONS
AM[...]N GEOPHYSICAL UNION
The Weekly Newspaper of Geophysics

[E]os, Transactions, American Geophysical Union [(I]SSN 0096–3941) is published weekly by the [A]merican Geophysical Union, 2000 Florida [A]venue N.W., Washington, DC 20009. Sec[o]nd-class postage paid at Washington, DC, [a]nd at additional mailing offices. POSTMAS[T]ER: Send address changes to Eos, 2000 Flor[i]da Avenue N.W., Washington, DC 20009.

[S]ubscription price to regular members is in[c]luded in annual dues ($20 per year). Infor[m]ation on institutional subscriptions is avail[a]ble on request.

[F]or speediest treatment of articles, meeting [r]eports, and news items, send three copies [o]f the double-spaced manuscript to Eos Man[a]ging Editor, AGU, 2000 Florida Avenue [N].W., Washington, DC 20009.

[A]GU Meetings Calendar

October 27–31, 1991 **Chapman Conference on Rocky Mountain-Plate Tectonics Puzzle,** Santa Fe, N. Mex.

December 9–13, 1991 **1991 Fall Meeting,** San Francisco, Calif. Abstract deadline: September 12, 1991. Preregistration deadline: November 8, 1991.

January 27–31, 1992 **1992 Ocean Sciences Meeting,** New Orleans, La. Abstract deadline: October 16, 1991. Preregistration deadline: December 31, 1991.

February 17–21, 1992 **Chapman Conference on Micro and Meso Scale Phenomena in Space [...]s,** Kauai, Hawaii. Abstract deadline: November 15, 1991. Preregistration deadline: February 3, 1992.

March 23–27, 1992 **Chapman Conference on Climate, Volcanism, and Global**

Ethics (cont. from page 473)

also complained that they had not been able to discuss the regulations before they were announced, and only learned of their existence through the *Federal Register*.

Earlier in the fall, when the Office of Government Ethics solicited comments on the regulations, AGU Executive Director Fred Spilhaus responded on AGU's behalf. "About 5,000 (20%) of our members are Ph.D.-level government researchers and administrators;" he wrote. "Clearly it is important that this major fraction of our nation's capability to address problems such as changing climate, earthquake prediction, and travel in space be as productive as possible. Implementing the proposed policies can only result in just the opposite."

After the recent House hearing, AGU Group Director Les Meredith said, "I believe very substantial progress has been made on resolving the association issue in the draft ethics policy."—*Lynn Teo Simarski*

Brown Assails Congressional Earmarking

Since President Bush first submitted his budget to Congress it was clear that it would be difficult, if not impossible, to fully support all of the NASA activities contained in the budget. Now the appropriations bill containing NASA funding for fiscal year 1992 is sitting on the president's desk. Many space science programs were cut, ranging from the Earth Observing System (–$65 million) to the CRAF/Cassini program (–$117 million).

Nevertheless, powerful members of Congress sitting on the appropriations committees managed to find money for many projects in their home districts and states via special earmarking of funds. During House consideration of the final version of H.R. 2519 on October 2, George E. Brown, Jr. (D-Calif.), chairman of the House Science, Space, and Technology Committee, spoke out against earmarking.

"I want to take this opportunity to comment on the matters under the jurisdiction of the Committee on Science, Space, and Technology that are funded in H.R. 2519. . . . There is one disturbing aspect of the process. . . . I must call to the attention of my colleagues since it threatens to undermine any good work that we manage to do. That relates to the practice of adding unauthorized, unrequested earmarks for personal interest items.

"This, of course, is in many ways a time-honored tradition of this body and could be overlooked if it were not for the severe budgetary environment that we have had to operate within this year and in the foreseeable future. This year, the budget reductions that Congress has had to make have made it entirely inappropriate to indulge in the earmarking that we are being asked to approve.

" . . . I want to take a few moments to cite a few examples and explain why I believe this practice has simply gone too far. In the NASA area, I am certain that my colleagues recall the debate earlier this year over the space station. That debate was, in many ways, a historic one. We were asked to make a major decision on whether we could afford to continue the space station when so many other pro[...] were in dire need of funding. These included space science programs, housing programs, environme[...] programs, and veterans programs. We voted to continue the station and there can be no doubt that many of these other

lege. I do not believe anyone in Congress or in NASA knows what this will be used for.

"It includes continued funding for a consortium of universities and consultants in the Saginaw, Mich., area which somehow has emerged as the center for environmental research over the past 3 years. Total funding for this project, called CIESIN, is now over $41 million all awarded without adequate competition and virtually no congressional oversight. NASA itself has little idea where this funding is going.

"It includes $20 million for the Christopher Columbus Center for Marine Research in Baltimore. I stress Marine research, not Space research. . . .

"The conference report terminates a vast variety of NASA scientific projects such as the space infrared telescope, our next great observatory, the orbiting solar observatory that will provide valuable data on the Sun, and the flight telerobotic servicer. These are all projects that scientists have spent decades planning and developing. These are all projects that could have been funded with a little more restraint on the part of the conferees. . . .

"My comments today are not made out of anger but sorrow. I will vote for this conference report because it is important to the future of our space program, the National Science Foundation, and environmental research. Yet, I sincerely hope that we can find a way to curb this unwarranted appetite for personal projects that has become such a burden."—*Richard Jones, American Institute of Physics*

Antarctic Radiation Exposure Doubles

New data reveal that the Antarctic Peninsula received twice its normal maximum dose of hazardous solar ultraviolet radiation in December 1990. The prolonged persistence of the ozone hole over Antarctica caused an increased exposure of radiation, according to a paper published in the October issue of *Geophysical Research Letters*.

John Frederick and Amy D. Alberts of the University of Chicago calculated the amount of ultraviolet solar spectral radiation from data collected at Palmer Station, Antarctica. During the spring of 1990 the largest observed values for ultraviolet radiation were approximately double the values expected, based on previous years. "The measurements from Palmer Station are consistent with similar data from McMurdo Sound, where a factor of three ultraviolet radiation enhancement was recorded, according to work by Knut Stamnes and colleagues at the University of Alaska," Frederick said.

"The radiation levels observed over Palmer Station in December 1990 may be the largest experienced in this region of the world since the development of the Earth's ozone layer," he added.

Each year the protective ozone layer over Antarctica weakens for a few weeks, forming what is known as an "ozone hole." In the past, the ozone layer would return to normal during November as the air warmed above Antarctica. However, in 1990 the decline in ozone persisted longer than in previous years and extended well into December. This is significant because during December, in the presence of reduced ozone, the relatively high elevation of the Sun can lead to noontime ultraviolet irradiance levels two or more times larger than normal climatological values. Also, the long duration of daylight in December further enhances the 24-hour total solar ultraviolet irradiance.

The raw ultraviolet measurements were corrected to reduce fluctuations caused by cloud cover. The ultraviolet radiation is measured at the Antarctic surface by scanning spectroradiometers located at Palmer Station and McMurdo since 1988. The Division of Polar Programs of the National Science Foundation supports the research.—*Charles Blue*

Global Volcanism Report: August 1991

Excerpts from the *Bulletin of the Global Volcanism Network* 16 (8), published monthly by the Smithsonian Institution's National Museum of Natural History. Subscriptions are available through AGU Orders, 2000 Florida Avenue N.W., Washington, DC 20009; toll-free 800-966-2481. The *GVN Bulletin* is also available on Kosmos/Pinet.

Volcano Reports

Unzen (Kyushu): Continued lava dome extrusion and pyroclastic flows
Sakura-jima (Kyushu): Explosions continue
Pinatubo (Luzon): Secondary pyroclastic flows feed large ash columns; frequent mudflows; fewer explosions
Malindang (Mindanao): False report of eruption
Arjuno-Welirang (Java): White plume from Welirang summit
Raung (Java): Dense plumes
Lokon-Empung (Sulawesi): Incandescent tephra cause fires that burn plantations
Api Siau (Sangihe Is.): Explosive activity and glow
Gamalama (Ternate Is.): Explosions eject white clouds
Dukono (Halmahera): Explosions and glow; ashfall to coast; small lahars
Langila (New Britain): Ash clouds; incandescent tephra; lava flows in crater
Manam (Bismarck Sea): Occasional ash emission; lava dome
White Island (New Zealand): Tephra emission; shock waves in crater
Ruapehu (New Zealand): Lake temperature rises; possible minor eruptions
Barren Island (Andaman Is.): Basaltic andesite lava from flank vent reaches sea
Karthala (Comoros Is.): Details of seismicity and deformation associated with the July 11 eruption
Ol Doinyo Lengai (Tanzania): Carbonatite lava production continues on crater floor
Stromboli (Italy): Continued moderate explosive activity; gas data
Hudson (southern Chile): Basaltic fissure eruption preceded andesitic paroxysmal phase; strong winds rework major ash deposits
Villarrica (central Chile): Weak explosions
Marchena (Galápagos): First historic eruption
Galeras (Colombia): Explosions eject incandescent tephra; increased seismicity and deformation
Ruiz (Colombia): Seismicity, deformation, and gas emission remains unchanged
Irazú (Costa Rica): New fumaroles but seismicity declines
Poás (Costa Rica): Crater lake rises, covering fumaroles; low-frequency seismicity
Arenal (Costa Rica): Explosions and seismicity decline; lava flows
Rincón de la Vieja (Costa Rica): Explosions eject ash and blocks
Santiaguito (Guatemala): Continued explosions and block lava production
Colima (Mexico): Fumarole temperatures increase
Kilauea (Hawaii): Continued lava flow into sea; lava pond overflows; magma intrusion
Atmospheric effects: Some dispersal of Pinatubo aerosols to higher latitudes, strong sunsets to 52°N

DRAFT

Katie

Ozone/UV Radiation Hearing Roadmap

November 14, 1991

Your opening statement.

Notes: 1. In attendance in the audience are the Ozone Secretariat for UNEP (United Nations Environment Programme), Dr. K.M. Sarma from Nairobi, Kenya (he is especially pleased to have the opportunity of meeting you), and Dr. Steve Lee-Babty, Department of the Environment, London, and Co-Chair of the UN ozone technology panel with Dr. Stephen Anderson (EPA).

2. Dr. Margaret Kripke must leave the hearing at 12:00 o'clock for a flight out of Washington.

3. It might be useful to identify the Co-Chairs present of the 3 UN ozone panels (Drs. Watson [NASA] and Albritton [NOAA] - the science of ozone depletion and synthesis of the UN ozone report; Dr. van der Leun [Inst. of Dermatology, Utrecht, The Netherlands] - impacts of ozone depletion; and Dr. Stephen Anderson [EPA] - strategies for reducing emissions of ozone-depleting chemicals.

Statement of ground-rules for roundtable discussion - you are the moderator and each person should first be recognized by you before responding to another's comment's etc., in order to maintain a modicum of organization.

No -- Chrmn then extras

Opening statements - delivered in alphabetical order [refer to witness list].

Opening of roundtable discussion:

Ask Watson to begin by summarizing the science portion of UN ozone report [Watson has a tendency to talk rapidly and at length, and to take charge, so to speak. As a means of pacing Watson and therefore, maximizing the impact of his portion of the report, it might prove effective to occasionally interject and ask Dr. Watson to repeat major points, thus emphasizing these points at the same time.

Go to Albritton for summary of the climatic significance of the science section of the UN ozone report [Albritton and his message are powerful. In my opinion Albritton's testimony is one of the central strengths of this hearing. He has genuine scientific authority and is deeply, personally and professionally concerned about the integrity of the environment. Go to him often as an authority base.

Note: Ask Watson and Albritton to cite how many international scientists were involved in writing the UN ozone report (over 100 scientists) and how many international peer reviews the report has received (over 45 I believe). These 2 points cannot be overemphasized. These are points worth coming back to as often as seems appropriate.

Go to Dr. van der Leun for a summary of the impact portion of the UN ozone report.

Go to Dr. Teramura who also served as a contributor and member of the UN impact panel.

Go to Dr. Weiler who was also a former program director at NSF, in charge of research aimed at assessing UV radiation impact on oceanic phytoplankton, the ocean's primary producers of food in that realm (70% of the Earth by area). I anticipate that her testimony will be quite good and eminently important.

Note: Dr. Worrest, administrator from EPA, also served as a contributor and member of the UN ozone impact panel. His expertise is marine phytoplankton. You may want to solicit his input here, as a scientist, as opposed to his input as an EPA administrator.

Go to Dr. Kripke, Dept. of Immunology, University of Texas. She was a contributor to the impact portion of the UN report. She will address immune system responses in humans to UV radiation. I anticipate that her testimony will be dynamite. She has a couple of powerful, yet little known messages to deliver.

Note: 1. The impact of increased UV, especially increased UV-B radiation, associated with ozone depletion, is the most powerful and central message that this hearing offers, perhaps even exceeding Albritton's climate impact. There has been virtually no discussion of this most lethal aspect of ozone depletion which impacts directly on human health and the health of the entire biosphere, including food resources. There has been virtually no monitoring of UV radiation.

2. Dr. Kripke must leave at 12:00 o'clock in order to catch a flight to a symposium in Texas that afternoon.

Broaden discussion as you see fit - at this point you might engage the panel in a broad-based, free-wheeling discussion, including agency representatives as well.

Agency/Program Administrators

Note: There is a problem within federal research agencies insofar as there appears to have been virtually no monitoring of UV radiation, and impacts, in concert with monitoring and measuring ozone depletion. This has serious management, planning and technological implications for federal and international research programs/agencies.

Go to Dr. Tilford, Director of the Earth Sciences Division at NASA.

Go to Dr. Patrinos, Acting Director, Environmental Sciences at DOE.

Go to Dr. Worrest, Program Manager for EPA's Stratospheric Ozone Research Program. He was also a member and contributor to the UN ozone impact panel.

End of roundtable discussion.

Your closing statement.

Dr. Albritton:

Q - Would you provide us with a summary of the climatic implications of the new Un ozone report? Would you at the same time, provide us with an historic perspective on ozone, ozone depletion, atmospheric loading of anthropogenically-introduced, ozone-depleting CFC gases and climate, contrasting the state of the atmosphere, and climate, prior to the production and introduction of CFC's, to the present state of the atmosphere, and climate, as a function of the introduction of CFC's?

Q - Is ozone depletion principally due to the input of human-made, chlorine and bromine compounds into the atmosphere?

A - Yes, the evidence suggests a virtual certainty that anthropogenically-introduced chlorinated compounds are responsible for the ozone depletion observed. It's the closest, tightest cause-and-effect linkage that science has to offer. Rarely are scientists able to so clearly demonstrate cause-and-effect, as is the case with CFC-driven ozone depletion.

Q - Is it true that ozone in the upper atmosphere serves to block UV radiation from reaching the Earth's surface, by absorbing UV radiation and thus acting as a radiator of sorts? Would you explain?

A - Yes, the more ozone in the upper atmosphere the more effective the absorption and therefore, the more effective the blockage of UV radiation reaching the Earth's surface. However, the more UV radiation absorbed (a function of increased ozone in the upper atmosphere), the more heat this portion of the atmosphere stores, thus serving to warm the surrounding upper atmosphere as a radiator would warm a home. A thinner ozone layer in the upper atmosphere would mean less storage of UV heat energy, thus less warming of the upper atmosphere (cooling, in other words, in the upper atmosphere).

Q - Is it also true that ozone in the middle atmosphere serves to trap heat (long-wave radiation) from escaping into the upper atmosphere, thus leading to greenhouse warming of the Earth below the zone of ozone confined to the middle atmosphere? Would you explain?

A - Yes, this is a secondary role which ozone plays, based upon its position in the atmosphere.

Q - And yet, is it also true that ozone in the lowest portion of the atmosphere closest to the surface of the Earth is primarily due to automobile emissions and the like, and that the problem in this region of the atmosphere is one of too much loading of ozone into that portion of the atmosphere?

A - Yes, the climatic significance of ozone is complex, and largely a function of its position in the atmosphere. Where ozone resides, and how much is present in each reservoir, at each region of the atmosphere, largely determines it's climatic impact at the Earth's surface, which then, is clearly a function of the net effect of ozone at various levels in the atmosphere.

Q - Would you explain the role of ice in the Antarctic winter atmosphere, and the role of sulfur compounds in the lower stratosphere in mid-(and high?) latitudes year-round, with respect to CFC's and the rate and volume of ozone depletion?

A - Ice in winter clouds in Antarctica serve to act as reaction surfaces which accelerate the rate of ozone depletion due to chlorine and bromine compounds. Elsewhere, in mid (and high?) latitudes year-round, in both hemispheres, sulfur compounds serve the same role as ice does in the Antarctic winter, increasing the rate of ozone loss. Since sulfur aerosols reside principally in the lower stratosphere, it suggests a reason why the most recent ozone losses were largely found in the lower stratosphere, along with chlorine compounds.

Q - Is it now true that CFC's may presently be close to "greenhouse neutral"? Would you explain this climatic implication, especially with regard to the greenhouse warming potential of other gases such as CO-2?

A - It appears that the warming or cooling effect of ozone losses (and gains?) throughout the atmosphere, and the greenhouse warming due to CFC's, presently results in net neutral warming/cooling effect, thus altering the view on the part of some that the elimination of CFC's (presumably the compounds which were most quickly and most easily eliminated from use, thus from the atmosphere), would offset the radiative forcing of CO-2 and other greenhouse gases now appears to be in error. CO-2 is the real long-term concern with regard to greenhouse climate warming.

Q - Would you explain the concept of residence time and apply it to CFC's and related, ozone-depleting compounds?

A - Residence time is the time that certain chemical compounds reside in the atmosphere before falling to the EArth's surface, out of the atmosphere. With respect to CFC's, the residence time is aapx. 75 to 100 years (?), meaning that it would take CFC's being presently introduced into the atmosphere, appx. 75 to 100 years to fall out of the atmosphere, and thus, no longer have an ozone-depleting and/or climate impact.

Q - Would it be fair to conclude then that with respect to the environmental and climatic implications of CFC's and ozone depletion, we have already burdened our children and our children's children, literally two generations of offspring hence, with the impacts of this state of affairs?

A - Yes, it's a fair statement.

Q - Has ultraviolet radiation increased as a result of reported ozone losses?

A - Yes, but most measurements have thus far been confined to Antarctica.

Q - Why are there no measurements of changes in UV radiation elsewhere, outside of the Antarctic?

A - The measurements are exceedingly tricky, being influenced by air pollution, aerosols, dust, clouds, etc., in addition to ozone depletion, particularly around urban areas where most UV monitoring stations are located.

Q - Does this mean our environmental degradation itself has now made it more difficult to calibrate, and measure precisely, the environmental deterioration itself, such as changes in the levels of UV radiation reaching the Earth's surface?

A - Yes.

Dr. Kripke:

Q - Would you provide us with an overview of your research with respect to the impact of UV-B radiation on the human immune system, especially in light of the observed increased levels of ozone depletion?

A - Yes.

Q - Would you explain the difference between UV-B and UV-A and the implications for humans, as well as other animals, with regard to increased levels of either, related, for example, to ozone depletion?

A - Yes.

Q - Would you explain the function of the human immune system?

A - Yes, it is the body's natural way of fighting off viruses, diseases, etc., and protecting itself from diseases and viruses as well, and from any outside influences which might disrupt the body's ability to keep itself healthy and repair itself when necessary.

Q - What is immuno-suppression?

A - The holding back of the immune system, to some extent, or the loss of the immune sytem's ability to fight off diseases, viruses and the like.

Q - Do increased levels of UV-B radiation, even so-called small increases in UV-B radiation, lead to suppression of the immune system?

A - Yes, new studies on the human immune sytem's response to increased levels of UV-B radiation in Florida indicate that increased UV-B, even small doses, causes suppression of the human immune system, or it's ability to thwart off diseases. These results from studies on the impact of increased UV-B radiation on humans are consistent with earlier and parallel studies on mice.

Q - In other words, radiation suppression of the human immune system translates to a decreased ability to fight off diseases, etc., thus a higher susceptibility to diseases, infections and viruses?

A - Yes.

Q - Is it true that increased levels of UV-B radiation often result in suppression of the human immune system, irrespective of skin color?

A - Yes, recent studies in Florida indicate that this is true, contrary to the more popularized notion that people with light complexions are more susceptible to skin cancer, for example, than people with darker compexions, as a result of increased UV-B radiation.

Q - Does this mean that a higher percentage of the human population worlwide, is at risk, as a result of increased levels of UV radiation, possibly due to ozone depletion in the upper atmosphere?

A - Yes.

Q - Is there any such thing as a safe level of UV radiation? Would you explain?

A - Probable answer is not really.

Q - How effective are sunscreens in blocking out UV radiation?

A - Some are totally ineffective, providing no protection whatsoever from the effects of UV radiation.

Q - Is it fair to conclude that there seems to be an wholescale lack of observations and measurements on UV radiation, and it's biological implications, particularly by comparison with the observations and measurements which we gathered on the depletion of ozone?

A - Yes, very much so.

Q - Have you seen a recent magazine article by Leslie Crawford, in the Financial Times, outling apparent reports of blind salmon, wild rabbits with loss of vision, tree buds with deformed growth, and algae secreting a red pigment, in southern Chile?

A - Yes.

Q - Are such disorders, even if the events described in the piece are hearsay, consistent with laboratory experiments on the impact of increased UV radiation?

A - I am not certain what her response will be, except that she faxed me a copy of the article without having asked for it.

Dr. Watson:

Q - Would you summarize your portion of the UN report that deals with the science aspects of ozone and ozone depletion?

A - Yes.

Q - How many contributors are there to this new UN ozone report, worldwide? Would you elaborate?

A - Probable answer, more than 100 scientists including virtually everyone on this panel with the exception of Weiler and Tilford.

Q - Has this report been extensively peer reviewed internationally? Would you elaborate?

A - Probable answer, over 45 peer reviews internationally.

Q - What has been the historic cause, up until three years ago, of the odd-even year fluctuation in the Antarctic ozone hole's severity, and why has it not occurred within the last three years, and what are the implications?

QBO being overwhelmed

A - Natural variability of temperature and wind patterns and strength(?). The latter possibly indicates that CFC chemistry is becoming dominant over dynamical influences on Antarctic ozone depletion.

Q - At the present rates of ozone depletion how long would it take (how much additional CFC's would it require) to deplete the upper atmosphere of ozone, and at that point, by what factor would UV radiation have increased over the present worldwide average of UV radiation?

A - I don't know what his answer will be but it would be an interesting answer under any circumstances.

Dr. Weiler:

Q - Having been a former National Science Foundation program director of research on the effects of UV radiation on oceanic phytoplankton (marine algae or plants), would you summarize for us what scientists presently know about the impact of UV-B radiation upon oceanic phytoplankton?

A - I am reasonably certain that she will say that the impact so far appears to have resulted in a net loss of phytoplankton, at least in the ocean surrounding Antarctica, perhaps by as much as 8%. Antarctic phytoplankton produce UV-blocking compounds however, species vary in their sensitivity to UV-B radiation. In general, current levels ofUV-B radiation affect phytoplankton cellular processes, nitrogen metabolism, DNA integrity, cell division, cell viability, pigmentation, protein content, cell orientation and primary production. UV-B radiation is harmful at pre- and post-ozone hole levels.

<u>Note</u>: You might also pose a similar question to Dr. Teramura and/or Dr. van der Leun and/or Dr. Worrest.

Q - Would you discuss the work of Smith and others on the effects of UV radiation on phytoplankton in marine waters off of Antarctica?

A - There is presently, increased UV-B radiation reaching the surface of the Southern ozone due to a 50% to 60% depletion in ozone above the Antarctic continent. As the ozone layer thinned, UV-B radiation was increased in the surface, photosynthetically-active layers of the Southern ocean. UV-B inhibition of photosynthesis increased as a function of ozone depletion. UV-B related losses in primary productivity were estimated to be a minimum of 6-12% in the Southern ocean. There is a reduction of photosynthesis for populations sampled inside the ozone Antarctic ozone hole.

Q - Could you provide us with some insight into the implications of UV radiation-driven losses in oceanic primary productivity on the order of 14%, for example, with regard to the impact of such losses on the rest of the oceanic food chain?

A - Although I am not certain of her response, I suspect that no one presently knows the answer to that question, but that it is a matter of great concern. It has implications for food resources worldwide, among other things, and the rates may be geometric (probably non-linear in any case) as well, as one chases the impact through higher parts of the oceanic food chain. Changes in the abundance, size distribution, or nutritional value of primary producers could affect higher levels of the food chain by reducing feeding efficiency and potentially causing nutritional deficiencies.

Q - There appears to be little information or observational measurements available on UV-B radiation and its impact upon the biosphere, and certainly vastly less than on ozone depletion itself. Would you comment on how and why there is presently so little known about these two aspects of ozone depletion?

A - She will admit that there is much basic research and measurments which are badly needed to sort out radiation fluxes and impacts to the biosphere. Beyond that I do not know what her answer will be.

Note: An analagous question could be posed to Drs. Teramura, van der Leun, and Worrest.

Q - Do you have or know of any estimates of how much food, or food mass is lost, as a consequence of a 14% loss in primary productivity represents?

A - She will probably say no, she does not know the answer, nor is she aware of such an answer.

Note: This is a good question to pass around the table to Drs. van der Leun, Teramura, Worrest, and even Kripke. This is a good issue to converge on and play with. Any discussion would be worthwhile.

Q - Would it be fair to say that the present impact of UV-B radiation on life and life-support systems is largely negative, and that any additional increases due to ozone depletion, for example, could only be construed as worse?

A - I believe that she will agree.

Note: This question should be passed around the loop to Drs. Kripke, Worrest, van der Leun, and Teramura. Should anyone disagree, it might be interesting to ask if anyone present would care to replace their present light bulbs at home with UV-B lights. If there are no takers-on one clearly has to weigh the implications of such reluctance.

Dr. van der Leun:

Q - Welcome to the U.S. Senate Dr. van der Leun. Would you care to summarize for us the impact portion of the Un report on ozone depletion?

A - No doubt UV-B radiation will increase as a consequence of ozone depletion. UV-B induced immunosuppression in humans has already been demonstrated, not only in those of light pigmentation, but deeply-pigmented individuals as well. World's population is at risk to potential adverse effects of increased UV-B radiation. There are a host of eye disorders associated with increased UV-B radiation. A sustained 10% decrease in ozone will be associated with a 26% increase in non-melanoma skin cancer (UV-B driven skin cancer irrespective of skin pigmentation). This translates to an increase in such cancer cases in excess of 300,000 cases per year, worldwide.

There is concern as well for potential harmful UV-B radiation effects upon the terrestrial biosphere, and natural ecosystems in general, as ozone depletion continues. Growth and photosynthesis of certain plants (rye, maize and sunflower, for example) can be inhibited even under ambient levels of UV-B radiation. Certain tropical plants may also be adversly affected by enhanced UV-B radiation.

Aquatic ecosystems are already under UV-B stress and grave concern that an increase in UV-B radiation will cause detrimental effects. The possible negative UV-B radiation impact on marine phytoplankton, representing more biomass than all terrestrial ecosystems, is of great concern. Loss of marine biomass production is propagated throughout the entire food web. This could result in loss of food resources for human consumption, particularly in a world whose population is already increasing exponentially. Any reduction in marine biomass will result in less uptake of atmospheric CO-2 and thus, increased greenhouse effect, long-range as well. Phytoplankton production of DMS (dimethylsulfide), a precursor to cloud condensation nuclei (CCN) and clouds, would be reduced, again serving as a positive feedback to global greenhouse warming. UV-B induced decreases in microorganisms fixing nitrogen would require significant fertilization by substitute artificial fertilizers (rice production, for example).

There is also concern for UV-B radiation driven increases in chemical reactivity in the troposphere. Tropospheric ozone concentrations could rise in heavily polluted areas, but should increase in unpolluted areas (with low NO-X levels). Potentially harmful substances (hydrogen peroxide, acids, and aerosols) are expected to increase in the troposphere due to enhanced chemical reactivity. These changes could exacerbate problems of human health and welfare, increase damage to the biosphere, and might make current air quality goals more dofficult and expensive to attain.

UV-B radiation also results in degradation of wood and pastic, with loss of strength as well. There will be increased costs in using higher levels of conventional light stabilizers. Very limited information/data are available for wood, plastic, plastic coatings and rubber.

Key areas of uncertainty are: quantification of primary effects on food production and quality, forestry, and natural ecosystems; clarification and quantification of influences on human health, especially the immune system, and the occurrences of melanomas and cataracts; and effects on biota of enhanced UV-B radiation during Antarctic springtime ozone depletion.

Q - Are there any good or benign effects of increased UV-B radiation, Dr. van der Leun?

A - He should say no or something very close.

Note: This is another good question to pass around to Drs. Kripke, Teramura and Worrest.

Dr. Teramura:

Q - Dr. Teramura, would you summarize for us your research on the effects of increased levels of UV-B radiation on plants and crops?

A - For over 300 species of plants investigated over the past 15 years, over one-half of these appear to be sensitive to UV radiation. The msot sensitive are peas, beans, squash, melons and cabbage. In all field studies done on crops to date, crop yield was reduced in nearly half of the studies of the impact of UV radiation. There are reductions in quality as well. There is very little known about the UV effects on forest tree species. There is evidence which suggests that exposure to UV radiation may alter plant sensitivity to diseases, making some more susceptible to attack by pathogens. Growth and photosynthesis of bean seedlings have been altered by present-day levels of solar UV. Breeding more UV-resistent varieties of natural plants and forests is not an option here. Present day levels of UV radiation can be damaging to plants even in the absence of ozone depletion.

Dr. Anderson:

Q - Would you summarize the results of the technology portion of the UN ozone report?

A - Since 1986 there has been a 40% drop worldwide drop in the production of CFC's, at rates in excess of those called for in the Montreal Protocol. Several multinational companies are phasing out ozone-depleting substances faster than even the most stringent regulation. By January, 1992 the first companies will have eliminated the use of CFC-113 solvents in all worldwide operations. Halon and CFC recycling will be accepted worldwide. The first HFC-134a auto air conditioners will be commercialized. The first HFC-134a domestic refrigerators will be commercialized in 1992.

The international fire protection community has nearly eliminated halon emissions caused by discharge testing, and training and service emissions have been drastically cut back. It is technically feasible in developed countries to phase out production of CFC's and halons by 1997 or earlier, 1,1,1-trichloroethane as early as 1995, and carbon tetrachloride in most cases, by 1995.

All of the above is contingent upon the safety tests presently being run on the CFC substitutes (e.g., HCFC-22, HCFc-123, HCFC-124, HCFC-141b, HCFC-142b, and HFC-134a) in refrigeration, air conditioning, insulating foam, for some aerosols and some sterilization and minor solvent uses. The above schedule is also contingent upon commercial availability in adequate quantities, while halon phaseout is contingent on the use of recycled halons as the prime supply of those halons.

Each substitute has difficult trade-offs in ozone-depleting potential (ODP) of transitional substances, global warming potential, energy efficiency and toxicity. For small usese, there are no substitues as yet, but the UN Technical and Economic Assessment is optimistic.

Developing countries will require appropriate phaseout technology, supporting technical assistance and training, and adequate financial assistance. There are international cooperative technology projects to assist developing countries in phasing out CFC's on schedule.

Q - Comparatively speaking, what are the trade-offs of HCFC's for CFC's in terms of global warming potentials, residence times and environmental toxicity or pollution?

A - ?

Q - Should the testing on the CFC substitutes begin to show serious problems with these substitutes is there an alternative in the pipeline?

A - ?