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OA/ID Number:	29149
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Folder Title:
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Record Group: Bush Presidential Records
Office: Chief of Staff, White House Office of
Series: Sununu, John, Files
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Date Closed:	**OA/ID Number:** 29149-005
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(b)(9) Release would disclose geological or geophysical information

BASELINE DEFICIT ESTIMATES
(in billions of dollars)

5/22/90

		FY '90	FY '91	FY '92	FY '93	FY '94	FY '95
1)	5/17/90 CBO baseline estimate (includes RTC guesstimate).....	177 – 207	196 – 246	124	132	121	110
2)	5/17/90 CBO baseline estimate (excludes RTC).....	145	149 – 159	141	148	133	119
3)	January OMB baseline estimate (excludes RTC).....	120	93	73	39	13	-13
4)	5/20/90 OMB estimate (includes RTC guesstimate).....	194	199	181	95	-52	42
5)	5/20/90 OMB estimate (excludes RTC).....	155	138	130	92	61	32
6)	5/20/90 OMB estimate (excludes RTC and Social Security cash surplus).....	202	195	191	165	144	122
7)	5/20/90 OMB estimate (excludes RTC and Social Security cash and interest).....	218	215	217	195	181	165
8)	5/20/90 OMB estimate (excludes RTC and all trust funds).....	280	276	278	260	246	228
9)	5/20/90 OMB estimate of total new public borrowing requirements.....	180	194	182	97	52	41
10)	5/20/90 OMB estimate of new public borrowing requirements less working capital.....	161	182	179	120	74	42
11)	5/20/90 OMB estimate of new public borrowing requirements less RTC...	140	134	130	94	61	32

BASELINE DEFICIT ESTIMATES (Cont'd)
(in billions of dollars)

		FY '90	FY '91	FY '92	FY '93	FY '94	FY '95
12)	Adjust for $50 billion FY '91 deficit reduction package.....	NA	-50	-65	-80	-100	-125
13)	Revised "line 10" deficit after package.....	NA	132	114	40	-26	-83
14)	Revised "line 11" deficit after package.....	NA	84	65	14	-39	-93
15)	Total new public borrowing after package (includes RTC).....	NA	144	117	17	-46	-84

YALE-3074-1003

John:
This is not very
profound but you might
find it interesting
Allan

THE GREENHOUSE EFFECT

by

D. Allan Bromley

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Yale University, New Haven, Connecticut

November 1988

I. INTRODUCTION

It is important to recognize at the outset that the **greenhouse effect** is nothing new, that it is extremely complex, and that our input to this effect in the past century, without our recognizing it, has embarked us on an enormous, unplanned, planetary experiment that poses unprecedented challenges to our wisdom, our foresight, and our scientific capacity.

The greenhouse effect is one that is familiar to almost everyone of us. Its most common and familiar application is that of the market gardener who uses it to bring the temperature of his greenhouses sufficiently above the ambient outside temperature to allow him to extend the growing season. But the greenhouse effect is much older than this. Indeed it is the greenhouse effect that is responsible for this planet developing in such a fashion that life has become possible on it.

In its simplest manifestation, the greenhouse effect results in trapping of some of the energy that reaches the earth from the sun — enough to raise its temperature to a range acceptable to carbon-based life. I shall return to this below.

Only very recently have we begun to appreciate the exquisite complexity of the chemistry and physics underway in our atmosphere as radiant energy from the sun — nuclear fusion energy — interacts with complex molecules in the upper atmosphere; molecules such as ozone, O_3, which shield out the ultraviolet radiation that would otherwise make the surface of the earth untenable to life, molecules like chlorine oxide, ClO, that are a new addition to our atmosphere and that catalyze the destruction of this ozone leading, for example, to the — recently discovered massive holes in the ozone layer that appear over the Antarctic — and now increasingly over the Arctic — and molecules like water H_2O and carbon dioxide CO_2 which are transparent to the incoming radiation from the sun but opaque to the radiation that the earth would otherwise reemit back into space. Beyond that, the situation is enormously complex because the greenhouse effect is obviously no respecter of national or political boundaries and its understanding demands information and analyses that span the entire globe. Only within the past very few years have we had the information handling capacity to even begin to approach so gargantuan a computational and information handling problem.

Those working in atmospheric sciences can well be excused from being reminded of King Alfonso X of Castile, a medieval patron of astronomy who, after much study, is reported to have said,

> **"If the Lord Almighty had consulted me before embarking on the Creation, I would have recommended something simpler."**

It is well to remember that significant scientific study of the greenhouse effect began only during the International Geophysical Year (IGY) of 1957-1958 and public interest and concern about the effect is, of course, much more recent having peaked dramatically during the summer of 1988 as a consequence of the extensive droughts in the Middle West and the unusually high temperatures experienced across the continent. Charles Keeling of the Scrips Institution of Oceanography in La Jolla, California was the person most responsible for the greenhouse component of the International Geophysical Year program and, in particular, for setting up the two primary measuring sites for atmospheric carbon dioxide. One is near the summit of Mauna Loa on the island of

Hawaii and the other is at the South Pole station of the US Antarctic program. These measuring sites have been used continuously since their establishment and provide us with the basic CO_2 data that we have today. More recently they have been augmented, of course, with a great many measuring sites worldwide but the Mauna Loa data, in particular, provide us with the most direct evidence for the fact that mankind has, since 1850, put something like 650 billion tons of carbon — in the form of carbon dioxide — into the atmosphere of this planet. By a very large margin this is the largest impact that man has had on Spaceship Earth.

The consequences of this massive global experiment are still far from certain but the combination of better data, better models, better computers, and greatly increased public interest has made it possible for us to begin to see some of the inevitable consequences, at least in broad outline. These consequences are staggering and almost beyond question will have significant effects within the lifetime of our children and massive, if not indeed, catastrophic effects within the lifetime of our great grandchildren.

II. UNDERLYING SICENCE

Let us begin then with some very elementary physics — all that is required to understand at least the outlines of the greenhouse effect. The wavelength of any radiation depends directly on the temperature of the source that emits it. The radiation coming from the Sun, for example, is 20 times shorter in wavelength than that from the earth; that from the sun has its energy peaked in the visible range of wavelengths whereas that from the earth is in the infrared. Moreover it is well known that the intensity of the radiation — that is the amount of energy carried by it — is proportional to the fourth power of the temperature (T^4) of its source and it is this sharp temperature dependence that makes the balance on which we depend for regulation of the earth's temperature such a sensitive one. Clearly at balance, all the energy reaching the Earth from the Sun must eventually be reradiated into space otherwise the temperature of the Earth rises until this balance is again established. The original equilibrium was established many millions of years ago and since the energy output of our sun is remarkably stable over time, change in the earth's temperature occurs whenever we — or Nature — change the character of our atmosphere and upset the balance between the short wavelength radiation coming in and the long wavelength radiation attempting to escape.

It was the water vapor in the early planetary atmosphere that blocked a particular range of infrared wavelengths and, in so doing, caused the temperature at the surface of the earth to rise to the present average value of 15°C or 59°F with which we are all familiar. Were it not for the greenhouse effect, in fact, the oceans would have frozen solid, would have remained solid throughout the year and the planet would have remained lifeless. On the other hand, if the greenhouse effects runs away — as it has done on Venus where the atmosphere is much more opaque to infrared radiation — the surface temperature, at balance, is 400°C or 750°F so that, for example, lead on the surface of that planet is normally molten.

There are a broad range of infrared wavelengths and, in achieving the early planetary balance, water vapor blocked out only a small subset of these wavelengths. Because there is enough water vapor in the atmosphere to remove essentially all the energy at wavelengths to which water vapor is opaque, change in the amount of the water vapor over any normal range no longer changes the earth's temperature. We have removed all the energy in this particular band of wavelengths so adding more water cannot remove more; and we would have to remove an enormous amount of water,

however, far beyond the capability of any forseeable natural process before we reached the state where energy in this band again began to escape.

The case of carbon dioxide is different in that we have not yet saturated our atmosphere despite the enormous amount of this gas that we have delivered to it.

III. THE HISTORICAL RECORD

By drilling deep holes into the Greenland and Antarctic icecaps — icecaps that are several miles in depth — we can, in a sense, go backward in time and, from the tiny bubbles trapped in this primordial ice, we can examine samples of the Earth's atmosphere dating back in time for hundreds of thousands of years. What we find from such measurements is that the amount of carbon dioxide in the primordial atmosphere remained essentially constant at 275 parts per million (ppm) over hundreds of thousands of years until about 1850. Since 1850, the amount has increased almost linearly with time and now amounts to about 346 ppm; superimposed on this steady climb is an annual oscillation. The amount of carbon dioxide in the atmosphere drops by a few percent during the summer and autumn and increases during the winter and spring. This is almost certainly a reflection of the fact that plants and forests absorb more carbon dioxide during their growing season than is emitted from other sources but return much of this to the atmosphere during the winter and spring.

IV. SOURCES OF CARBON DIOXIDE

Where does this incremental carbon dioxide, appearing since 1850, come from? More than 50% comes from the burning of fossil fuels. In this country from 1850 to about 1900 wood was the dominant fuel. From 1900 to 1950 wood was replaced by coal and from 1950 until the present, coal has been replaced by oil and natural gas. All of these release energy through the oxidation of carbon to produce carbon dioxide. The cleanest of these fossil fuels, both in an environmental sense generally and in terms of the amount of carbon dioxide liberated per unit of energy, is natural gas with coal being by far the worst in both respects.

A second major source of carbon dioxide occurs in the manufacture of Portland cement where limestone — calcium carbonate — is heated to yield lime — calcium oxide — and release carbon dioxide. A third major source of carbon dioxide occurs in the destruction of forests and, in particular, tropical forests.

Forest destruction contributes to carbon dioxide in two ways. First of all, in killing the living trees it makes them unavailable to absorb carbon dioxide and incorporate it into their biomass structure; secondly, cutting of the tropical forests exposes the formerly protected humus on the forest floor to biological decomposition, again yielding carbon dioxide. Cutting also adds to the humus layer the nonmarketable debris left after the forest harvesting.

It is a sobering and scandalous fact that at our present rate of destruction of tropical forests all significant such forests will be gone in 15 years. The largest remaining, by a large margin, are in the Amazon basin in Brazil with lesser ones in equadorial Africa; it bears emphasis that in addition to the effects just noted the destruction of these tropical forests vastly reduces the biological diversity, the gene pool, remaining on the planet. This gene pool is one of our greatest treasures — a treasure that we have only begun to appreciate from which we can, over time, discover new kinds of plants, new antibiotics, new characteristics in biological systems that can have the most profound consequences on our future as a race. Here too we have only

begun to appreciate the rate at which we are irretrievably destroying a fantastic heritage.

These are the major sources of carbon dioxide but it bears noting that, in addition to the forest takeup of this particular molecule, the earth's oceans have absorbed just about the same amount of carbon dioxide as is currently in the earth's atmosphere, something approaching 650 billion tons of carbon equivalent, and have done so almost entirely through the living creatures in the ocean. Until very recently it was assumed that the upper hundred meters or so of the ocean was involved in rapid turnover with the surface and that this layer contained most of the living creatures in the ocean so that it also contained most of the trapped carbon dioxide. Detailed studies in recent years have shown, however, that this is not entirely true and that slow turnover and exchange between the abyssal waters and those at the surface continue the absorption of carbon dioxide and thus prevent that in the atmosphere from rising as rapidly as it otherwise would.

Carbon dioxide now in the earth's atmosphere is approaching a level where it will absorb all the energy in the wavelength bands to which it is sensitive and will thus saturate so that further CO_2 will have no further effect on the earth's temperature.

V. OTHER GREENHOUSE GASES

Unfortunately, however, we can draw very little comfort from this fact because there are other greenhouse gases which are still in very low concentration in the atmosphere and which are sensitive to large wavelengths bands. With increasing concentration these other gases can have major impact on the temperature balance. First among them is methane, CH_4, a very powerful greenhouse gas whose major source is decaying vegetation and humus, rice paddies, and the breath of ruminant animals. Again with destruction of tropical forests and the increased decay rate of the waste vegetation, with massive increase in the area under rice cultivation, and with major increase in the earth's bovine population, methane in the atmosphere is increasing rapidly.

Although ozone is normally discussed only in terms of its behavior as a shield in the upper atmosphere against solar ultraviolet radiation, it too is a very powerful greenhouse gas produced at lower altitudes primarily as a result of photochemistry, induced by solar radiation, in smog clouds resulting from automotive exhaust.

It is a somewhat sobering fact that the New Haven region has the worst ozone contamination situation anywhere. Whereas prior to 1850, ozone in this part of the world was normally at about the 10 parts per billion (ppb) level, during the summer of 1988, it frequently reached 200 ppb in New Haven. Worse than that there is nothing whatsoever that could be done by Connecticut as a State, or New Haven as a city, to change this situation in any significant way. These 200 ppb of ozone that we measure typically between 11 a.m. and 1 p.m. result from solar radiation-induced photochemistry in the cloud of smog produced by the morning automobile traffic into New York City as this cloud drifts in the prevailing wind pattern up the Connecticut coast reaching New Haven about noon. It bears emphasis that in addition to ozone, this smog photochemistry also produces some extraordinarily dangerous carcinogens and other harmful chemicals. The ozone itself, in addition to its greenhouse potential, is enormously destructive of rubber products, specifically automobile tires, and of the tissues in the human lung. These are effects of ozone in the **lower** atmosphere as opposed to those more frequently discussed in the **upper** atmosphere.

VI. GREENHOUSE EFFECT TEMPERATURE CHANGES

I have mentioned above that it is the greenhouse effect that is responsible for holding the temperature of our planet at some 15°C. How big a change in this average planetary temperature is required to have significant other effects? Fortunately we have excellent information on this because studies on the polar ice caps have shown conclusively that at the depth of the most recent ice age, about 140,000 years ago, the average planetary temperature was 5°C — that is — the average had decreased by only 10°C or 18°F. From these same ice cores we can determine with high precision that in the so-called Little Ice Age in the 17th century — a time wherein both the northern United States and Europe had snow throughout the summer — corresponded to an average temperature drop of only 1.5°C — 2.7°F — from the current value. The point here is that even a very few degrees change in the average temperature can have completely dramatic consequences. The system is an extraordinarily sensitive one.

VII. WORLD CLIMATE MODELS

What is new in the past few years is our ability to understand this sensitivity in vastly greater detail than was the case previously. In large measure this has resulted from the availability of supercomputers that are able to cope with the enormous data flow required to characterize the state and behavior of the earth's atmosphere. Currently there are three major world centers having such capabilities. One is at Princeton, New Jersey, under the direction of Joseph Smagorinski operated by the National Oceanographic and Atmospheric Administration; one is at Cambridge University in England, under the direction of Professor Brian Mason, and one is in Novasibirsk, the science city in Soviet Siberia, where, until very recently, the Center was under the direction of Professor Yuri Marchuk who has just recently been appointed to the Presidency of the Soviet Academy of Sciences. Only within the past year or two has it been possible to compare the computer results obtained using quite different models developed independently in these three centers to obtain some feeling for the model reliability and the degree to which their predictions agree. Fortunately, the agreement is remarkably good suggesting that the underlying science is reasonably in hand.

Unfortunately, however, our measurements, our data base, and our predictions are all enormously crude. Currently, for example, we make predictions at 10 levels in the atmosphere on a grid that is 300 miles on the side. Under United Nations auspices, we are currently moving to a finer grid where we will be able to make predictions at 20 levels in the atmosphere and on a grid 150 miles to the side. This change to a less crude grid represents a factor of 16 in the cost of data collection and analysis. On the horizon, but still far out of reach both economically and technically, is the desire to make predictions at 20 levels in the atmosphere and on a grid 60 miles to the side. This would require an increase by a factor of 500 in the collection and analysis cost and it is quite clear that even here we would still be far beyond the region where one could hope for predictions about local weather. It is well to keep in mind the distinction between climate and weather, between macroscopic and microscopic predictions.

What have we learned in these massive atmospheric studies, beyond the fact that our models appear to be soundly based? Striking, perhaps, is the fact that the planetary warming, because of the greenhouse effect, would be highly nonuniform. For every degree temperature rise at the equator, there would be roughly six degree rises at the Poles. Since this is where the major ice caps store enormous volumes of water in the polar ice, these are the regions where a six degree temperature change could have dramatic consequences. Although we cannot predict in detail what the consequences will be, it is already generally agreed that they fall in four classes, namely, changes in

percipatation patterns, changes in the incidence and strength of severe storms, changes in agricultural productivity in different land mass areas, and finally, changes in the sea level. Most important of all it has become clear from even our present crude models that these changes need not take place uniformly either in space or in time. It is already clear that there can be quite rapid flucuations on regional and local bases.

VIII. SEA LEVEL CHANGES

Perhaps the most dramatic consequences will be those relating to mean sea level. Currently the mean sea level worldwide is rising at a rate of about one inch per decade. To provide some calibration, it is relatively easy to calculate that complete melting of the polar ice caps would raise the mean ocean level by several hundred feet. We know from fossil and geologic records that 125,000 years ago — at the warmest point in the period between the last two ice ages — the mean sea level was 20 feet higher than at present and we can also calculate that the disappearance of only the Ross ice shelf in the Antarctic would correspond to just such a rise in sea level. This ice shelf is several miles thick, is some 200 miles in length, and can be thought of as a huge slab of ice anchored only at one end on the rocks of the Antarctic continent and floating on the ocean water throughout most of its lengths. One of the truly catastrophic scenarios discussed by atmospheric scientists involves a sufficient increase in mean sea level — through gradual warming of the planet — with part of the increase coming from the melting of ice caps and part from simple thermal expansion of the water in the oceans — to the point where the Ross ice shelf breaks loose from its moorings and slips off the continent. Were this to happen, the mean sea level would rise some 20 feet almost instaneously, that is in the time that the resulting tidal wave would take to travel round the globe. What is the probability of this happening? No one knows for sure — but it is entirely possible!

IX. AGRICULTURE PRODUCTIVITY

With respect to agricultural productivity, it is quite clear that even a few degrees increase in the mean planetary temperature would shift major agricultural productivity from the US Midwest into the Canadian prairies, from India and the Southern Soviet Union into Siberia, and that the agricultural productivity of both South Africa and Argentina would be increased at the expense of more tropical areas. It is possible also that Australia could become vastly more productive with precipitation extending into the central desert on more than the current few times per century basis. One thing is abundantly clear; the United States would lose in any such agricultural shift and the Soviet Union would win. It would take remarkably little change to reestablish a central desert in the US Southwest.

X. INTENSE STORMS

Our understanding of the earth's atmosphere is not sufficiently detailed, as yet, for us to predict with any certainty the kind of changes to be expected in the frequency and intensity of hurricanes, tornados, and other more localized phenomena. It is clear, however, that warmer oceans will unquestionably drive wilder hurricanes and more violent tornados. It is also true that warming of the general oceans can have dramatic consequences through, for example, a shift of the entire Gulf Stream away from its current path where it moderates the climate of the British Isles, Scandinavia, and Northern Europe in a way that becomes all too obvious when one compares the English climate with that of Hudson Bay.

XI. MAJOR CLIMATE CHANGES

I have mentioned that precipitation patterns could revitalize the Australian desert. Even farther beyond our range of prediction, is what might happen to the Sahara. Our models are sufficiently good now, however, that we can run computer experiments asking, **what if,** in many regions of the globe. One of the interesting consequences of such experiments is the discovery that if it were possible to put enough water on the Sahara Desert to moisten the surface to a depth of only 4 inches, the climate pattern would flip and the Sahara region would become a tropical rain forest in a new stable climate configuration which, incidentally we know to have occurred in the past from our radar observations from satellites, all of which show massive fossil river beds and water courses throughout the entire Sahara. It is quite clear also that the pattern of the monsoons in India and Southeast Asia would change completely with even a small change in average world temperature. Since literally millions depend for their existence on the reproducibility of these monsoons to produce the rice crops, change here could be catastrophic. The fact that 1987s monsoon was unusually weak has led to the death of more than 10 million people in India and Bangladesh and serves as an indicator of possible futures. The 1987 massive drought in the Brazilian Northeast — because of the low population density in that region — had no such striking consequences but it, too, is indicative of the sensitivity of our atmospheric system and our world climate patterns to even small changes.

XII. GREENHOUSE TIME SCALES

What has perhaps surprised atmospheric scientists more than anything else in recent years, is the discovery that massive changes can occur in periods of only a few years. That is instantaneously on a geological time scale. The most striking example of such a rapid change is the development of the so-called ozone hole over Antarctica. It has been found that 90% of all the ozone between 15 and 20 km above the Antarctic ice cap has disappeared in the past 9 years for a 50% decrease overall in the Southern polar region. Because this is such a striking phenomenon, it has attracted the world's atmospheric scientists and amazingly rapid progress has been made in understanding the phenomena involved. It is now known, for example, that this depletion of the polar ozone is caused by a single molecular catalyst, chlorine oxide (ClO). It is also known that the chlorine in this molecule comes almost entirely from man-made chlorofluorocarbons (CFC's). The reason that these catalytic molecules operate so effectively over Antarctica and not elsewhere on the planet, at least at their present concentrations, reflects the fact that Antarctica is an isolated continent surrounded by the frigid Antarctic Ocean and the South Polar Current. During the Antarctic winter, the temperature drops low enough to form clouds of icy microcrystals on whose surfaces the catalytic destruction of the ozone proceeds very rapidly and the presence of the frigid polar current keeps the atmospheric temperature low enough to maintain these aerosols long enough to destroy a substantial fraction of the ozone. The same effect has not been at northern latitudes because there is no similar free-flowing water surface around the polar ice cap to keep the atmospheric temperature down; ominously, however, only in the past few months scientists have begun to report local ozone depletion in the Arctic.

It is clear, that if we continue to produce chlorofluorocarbons this effect will continue to spread as the concentration of chlorine oxide in the atmosphere increases.

XIII. ATMOSPHERIC CHLORINE

This question of the release of chlorine into the earth's atmosphere has been recognized internationally as an emergency situation and, in September 1987, 24

countries signed the so-called Montreal protocol which calls for cutting CFC use in half by 1998. Only six months later, the findings of NASA's Ozone Trends Panel suggest that the protocol's limitations probably will not be sufficient to save the ozone layer and that even more stringent reductions in CFC's will be required.

The CFC's were introduced in 1930 and have four basic uses — refrigerants, blowing agents for making foam, cleaning fluids, and propellants. As refrigerants, they are used in most freezers and refrigerators as well as in air conditioning units in automobiles and buildings. As blowing agents, they are used in making both rigid foam, which appears in such items as foam ice chests and fast food hamburger boxes and flexible foam appearing in furniture cushions and foam pillows. As cleaning agents, they wash hundreds of products from computer chips to artificial hip joints. As propellants, they are used in aerosol sprays in much of the world, although their use has been banned in the United States. They also appear in fire extinguishers, in urethane shoe soles, and in applications too numerous to list. Currently, the world chlorofluorocarbon industry is a $2.5 billion one and we in the US produce roughly 500,000 tons of these products each year. DuPont alone produces over $600 million worth of CFC's per year but DuPont has taken the leadership in announcing that it will phase out CFC production entirely — replacing the CFC's with new molecules that have been developed with additional hydrogens in their structure so that they are susceptible to break-up in the lower atmosphere. Much of the problem with CFC's simply reflects the same property that makes them so desirable in the above listed applications; they are extraordinarily stable and because of that make their way unscathed into the upper atmosphere where they are finally broken up by energetic ultraviolet from the sun and their chlorine atoms are left free to do their catalytic work.

XIV. FEEDBACK MECHANISMS

Obviously there are very complicated interactions here. If there is less ozone, then less infrared will be stopped by the ozone layer and the greenhouse effect resulting from of the ozone will be decreased while ultraviolet transmission to the earth's surface will increase. There are other feedback mechanisms. If the mean temperature increases, then the Arctic permafrost melts and releases large amounts of both carbon dioxide and methane which in turn increase the temperature rise so that we have a positive feedback loop. Again, if the earth's temperature increases, the polar sea temperatures increase and complex molecules in the Arctic and Antarctic Ocean called **calthrates** that are stable only at very low temperature decompose liberating huge amounts of methane further increasing the temperature rise.

A feedback loop that is not at all well understood is associated with the fact that automotive transport produces not only carbon dioxide but also oxides of nitrogen. The higher the combustion temperature the more abundant the nitrogen oxides compared to carbon dioxide. On the one hand, these nitrogen oxides can act as fertilizers and promote much more rapid growth of the planet's forests so that carbon dioxide is taken out of the atmosphere and bound into biomass. On the other hand they can increase the low atmosphere ozone levels — the photochemistry in smog problem discussed above — which results in the destruction of forests and the release of carbon dioxide so that we have the potential of both negative and positive feedback driven by the nitrogen oxides. This is only a crude example of the kind of complexity that atmospheric chemists and physicists are attempting to resolve in order to improve their models, recognizing that each time one of these improvements is added to a climate model, the amount of computation required goes up by orders of magnitude and new generations of supercomputers become essential.

XV. COURSES OF ACTION

What then can we, as a civilization, do about the greenhouse effect. First of all it must be emphasized that **nothing** that we do will have an immediate effect. We have already loaded an enormous mass of greenhouse gas into the earth's atmosphere and we have no way of removing it. At best, we can stop making the situation worse.

Perhaps most direct and immediate, we can ban production of chlorofluorocarbons and attempt to convince other nations to follow suit. We can take steps to reduce the amount of carbon dioxide that we are adding to the atmosphere through the burning of fossil fuels. It bears emphasis that the Chinese have long considered that the burning of such fuels verges on the criminal because these exquisite organic molecules that we burn for their thermal energy are the feedstuff for pharmaceutical, plastic, and a great many other industries and our descendants will find it necessary to recreate such molecules at vast expenditure of resources and energy because we will have depleted most of those that nature has produced over the roughly 5 billion year life of our planet. It is a sobering thought that although we in the United States have less than 6% of the world's population, we are responsible for more than 33% of the total world's energy consumption. It is also sobering to realize, that the developed world, in something a little over 60 years, has used well over 50% of the readily available oil and natural gas.

But how do we stop burning fossil fuels? Obviously we are not prepared for a massive reduction in our standard of living nor are we prepared to switch from electricity to much less convenient sources of energy. It appears to me that we have little choice but to move forward with the exploitation of nuclear energy, an energy source that provides no atmospheric load whatsoever.

We have had nuclear fission energy available to us with uranium and thorium fuels for some 40 years but, particularly in this country, we have not used it wisely. In France and in Japan, the announced national goals are to have more than 90% of electrical energy — and a significant fraction of space heating as well — produced from nuclear sources by the mid 1990s whereas in the US the fraction of our energy coming from nuclear fussion sources has remained essential constant at about 12% since the early 1960s. This, in part, reflects the fact that in Japan, for example, it is possible to go from the decision to build a nuclear reactor to the point where it is producing economic electricity in 4.5 years. Whereas in the United States, 14.5 years is more typical. The ten year difference, coupled with the cost of financing these nuclear power plants, clearly makes us economically noncompetitive with the Japanese.

More important, however, we have not, in this country, succeeded in convincing our public that nuclear energy is indeed safe. In part, this has reflected a somewhat cavalier view that nuclear reactors were not all that different from coal or oil fired burners in that they produce steam which drives turbines which generated electricity in the usual way and, therefore, the standards of training and of operation in the civilian power industry are not, for example, anywhere near those which Admiral Rickover insisted upon in the nuclear Navy. The architectual and engineering firms who designed the nation's civilian reactors also made the very profitable — for them — mistake of reinventing the wheel at each reactor site. Obviously this was done with the intent of deriving additional profit but also it happened because both they and their utility customers wished to include each engineering improvement as it appeared. This unfortunately resulted in reactors that were all different; each one had to be put through an extraordinarily long and detailed safety certification program, stretching out the construction time and increasing the cost.

I am convinced that in order for the United States to return to nuclear energy in a substantial way it will be necessary for the industry and the utilities to develop new reactors that are intrinsically safe — that is, that if their electrical power or their cooling water, or anything else, is interupted they simply close themselves down — without damage — and remain until someone chooses to correct the situation. Such reactors have been clearly demonstrated to be feasible. What is required is some several hundred million dollars of up-front engineering costs to make them commercially feasible. Secretary Herrington of the Department of Energy has just announced that in developing a new weapons material (tritium and plutonium) production reactor system for the nation he plans to develop just such a reactor — a 350 megawatt, modular high-temperature, gas-cooled unit which can be made in multiple copies, certified as safe once and for all so that a utility simply adds more of these units as it needs more capacity, gaining at the same time the flexibility of being able to turn off one of more of these modular units for refueling, repair, modification, or what have you. Unfortunately, such a development is perhaps five years and more probably ten years away in this country.

There has been much discussion of the possibility of eliminating fission energy — because of perceived waste disposal problems — and going directly to fussion, reproducing here on the earth's surface the energy source of our Sun. Unfortunately, although we have now demonstrated that the release of fussion energy is feasible on a laboratory scale, the engineering problems, which include compressing the heavy hydrogen fuel to some 20 million pounds per square inch and simultaneously heating it to close to 100 million degrees are so demanding that it is most unlikely that we will have economic fussion energy before 2025.

It is essential, however, that we make the decision to move in this direction of increased dependence on nuclear energy as soon as possible. It is essential that we recognize that the current trend to switch from oil and natural gas to coal in our electrical generating stations is in the wrong direction in terms of the greenhouse effect and it is essential for us to realize that we who use a disproportionate share of the planet's energy must take the lead in reducing the utilization of fossil fuels.

We must recognize, for example, that it is unreasonable for the United States to turn to the Third World and demand that it eschew the use of convenient fossil fuels in its development after we have used such a prodigal share in ours. We have the ability to go directly to a nuclear technology whereas the Third World simply does not and it is essential that the United States join with France and Japan and the other developed countries in moving away from the era of fossil fuels.

It is important also for us to work together with countries like Brazil to develop alternatives to the destruction of tropical forests not only because of greenhouse considerations but also as noted above because they are irreplacable gene pools.

And it is also essential that we continue to develop better automotive engines with cleaner exhaust, because in their absence, major urban centers are well on their way to becoming unlivable. Mexico City is an excellent example at the present time; Los Angeles and New York are rapidly becoming ones. One of the new technologies in this area that demands careful study is that evolved in Brazil where all new automobiles are required to burn alcohol rather than petroleum-based fuels with considerable reduction in the exhaust problem. The transition between these fuels is much less simple than is generally anticipated in that it requires major changes in most engine components to avoid the very rapid destruction that occurs when alcohol is burned in an engine designed for gasoline.

XVI. CONCLUSIONS

Like a great many other problems in a democracy, the greenhouse effect and its potential consequences will not be addressed unless informed citizens make it clear to their representatives in Washington and in state capitals that they are concerned about the issue and that they expect action. It is the responsibility of citizens to inform themselves about such problems and then to communicate their concerns directly to their representatives. Even a few thoughtful, individual letters on a particular topic appears as a ground swell of public concern to a hard-pressed legislator and just as we have the responsibility for taking leadership in this country we also have at hand the mechanisms for doing so.

As I have indicated above, the greenhouse effect is nothing new and indeed life on earth depends upon it but our modifications of our atmosphere, and the consequence change in the greenhouse effect that these modifications produce, does represent the largest unplanned experiment that our race has yet undertaken. Unless we devote our best efforts to understanding what the greenhouse effect can do to world climate and through it to the areas that I have discussed in this paper, the consequences for our descendants may well be catastrophic. We have no time to waste!

FIGURE CAPTIONS

Figure 1: Carbon dioxide concentrations measured, in parts per million, at the Mauna Lao Observatory established in 1957 by the Scripps Institution of Oceanography. The annual oscillations are thought to reflect the take-up of carbon dioxide from the atmosphere by forest growth during spring and summer and its subsequent release during autumn and winter as deciduous trees lose their leaves. The advantage of the Mauna Loa Observatory is that the 3000 and more miles of the Pacific Ocean surrounding it in all directions effectively isolates it from local perturbations and provide a true measure of the average planetary atmospheric concentration.

Figure 2: An artist's conception of the planet some 20,000 years ago when it was entering the coldest part of the last ice age. As indicated, huge ice sheets — several miles in thickness in some places — covered much of North America, Europe, Asia, and Antarctica. With so much of the planet's water locked up in this ice, sea levels were very much lower — perhaps as much as 100 meters lower — than is the case today. The enormous weight of the ice in these sheets was such that the continental land mass was depressed by many tens of meters in, for example, the Central Plains in both the US and Canada and these areas are still rebounding. Long Island is the terminal moraine resulting from this last great glaciation period and marks the southern extremity of the ice sheet.

Figure 3: Carbon dioxide concentrations and atmospheric temperature changes as functions of time — measured backwards from the present. Both of these measurements are obtained from the small samples of atmosphere trapped in bubbles in the remaining ice sheets in Greenland and in Antarctica. Since these ice sheets, in some regions, preserve the annual contributions to the sheet in much the same way that tree rings record the annual growth, and something of the growth environment, it is possible — by selecting an appropriate set of annual slices from the ice cores — to isolate atmospheric samples from a particular time period in the past. Having made such a selection, when the ice has melted the atmospheric sample trapped at the time in small bubbles the snow fall involved became part of the ice sheet is released and can be subjected to detailed analyses. The carbon dioxide content can be measured directly by infrared spectroscopy, for example, while the atmospheric temperature at the time of deposition can be measured from precision examination of the ratio between the concentrations of ordinary and heavy hydrogen i.e. hydrogen and deuterium. The carbon dioxide concentrations here are given in parts per million and from the deuterium concentrations the changes in temperature, measured relative to the present value, are shown in degrees Centigrade. It bears noting that at the depth of the last ice age, some 20 million years ago the average atmospheric temperature was only slightly less than 10 degrees lower than at present and that some 130,000 years ago the temperature was roughly a degree higher than at present. The remarkable thing about these data is the extent to which the carbon dioxide and temperature records are correlated; it is this kind of experimental data that provides the evidence for the greenhouse effect and for the dominance of carbon dioxide as the greenhouse gas in the historical past.

Figure 4: Average seasonal variation of ozone showing a typical peaking in the spring and summer months and a decrease in winter in representative locations in the Northern Hemisphere in the United States and in Europe. For comparison, data for Paris from the year 1880 is also shown in this figure. The changes both in terms of absolute magnitude and of its seasonally variation, are striking. Ozone

Figure 5: Atmospheric methane concentrations, shown here in parts per billion, can also be extracted from the Greenland ice cores. As is evident from this figure, the concentration remained roughly constant at about 750 ppb until about 100 years ago and has more than doubled since that time; currently the concentration is rising exponentially.

Figure 6: In order to establish the reality of methane as an effective greenhouse gas, it is possible to compare the time dependence of the atmospheric methane with the average world temperature profile — both determined from the ice core studies as was done for the case of carbon dioxide in Figure 3. As illustrated here, the methane concentration, in parts per million, tracks the temperature variation, as determined from hydrogenic isotope data, over the period from 130,000 to 160,000 years before the present — a period in which a major glaciation came to an end.

Figure 7: Global mean temperature variations based on land and marine measurements shown relative to those from a 1950-1979 reference period. The solid line drawn through the histogram is a running average of the annual averages and shows a clear rise over the period shown. As indicated in this figure, over the past 100 years the mean global temperature has increased by roughly 0.5^{o} Centigrade. It is of interest to note that 6 of the warmest years since such global mean temperature data have been accumulated on a systematic basis, i.e. the last 150 years, have occurred since 1980. It is too early yet to identify these anomalously warm years with the greenhouse effect as opposed to a local fluctuation such as that evident in the period around 1900 but the trend has captured public attention both in the United States and abroad and has made available for the first time the resources that can lead to much fuller understanding of the complex greenhouse phenomena.

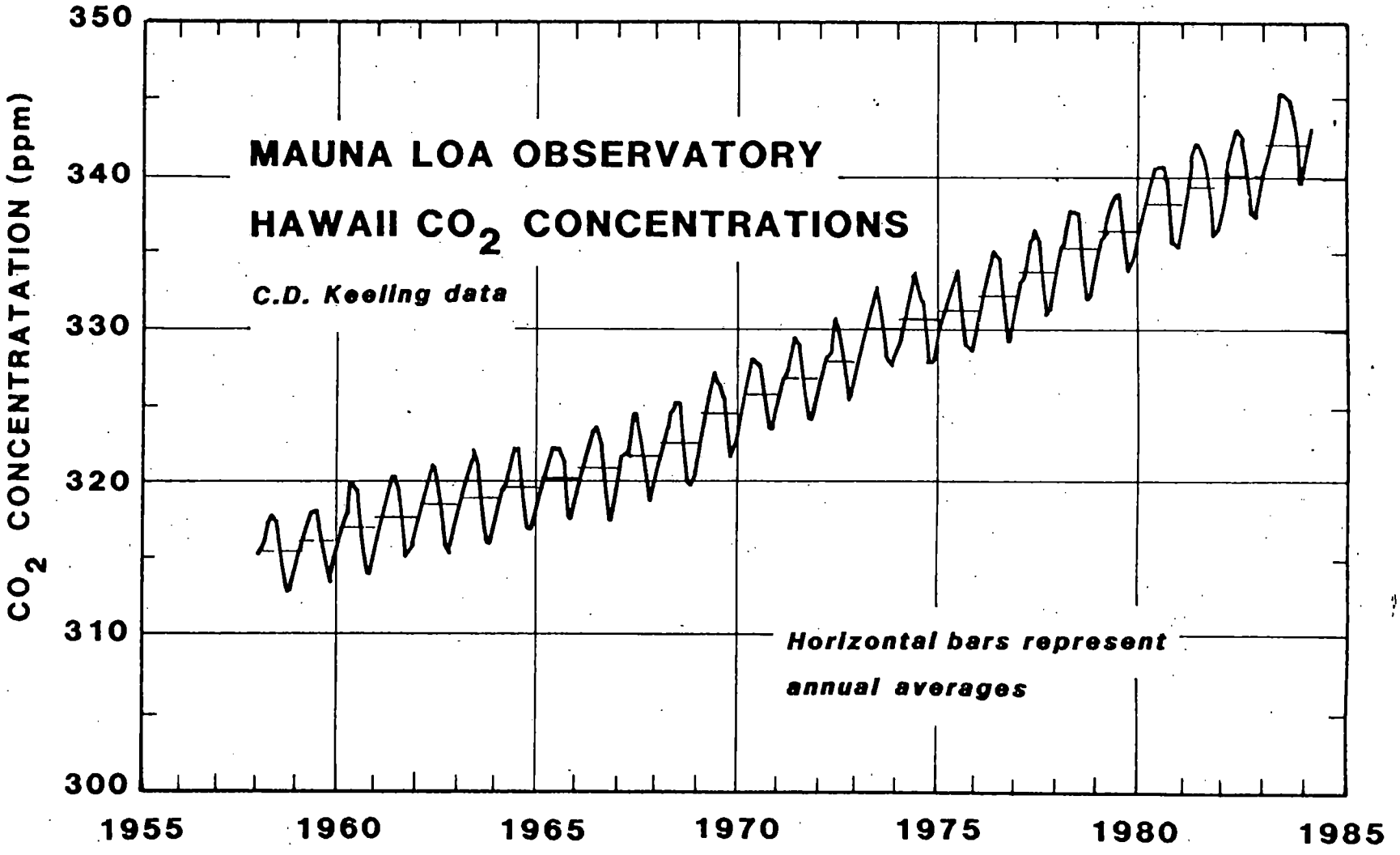
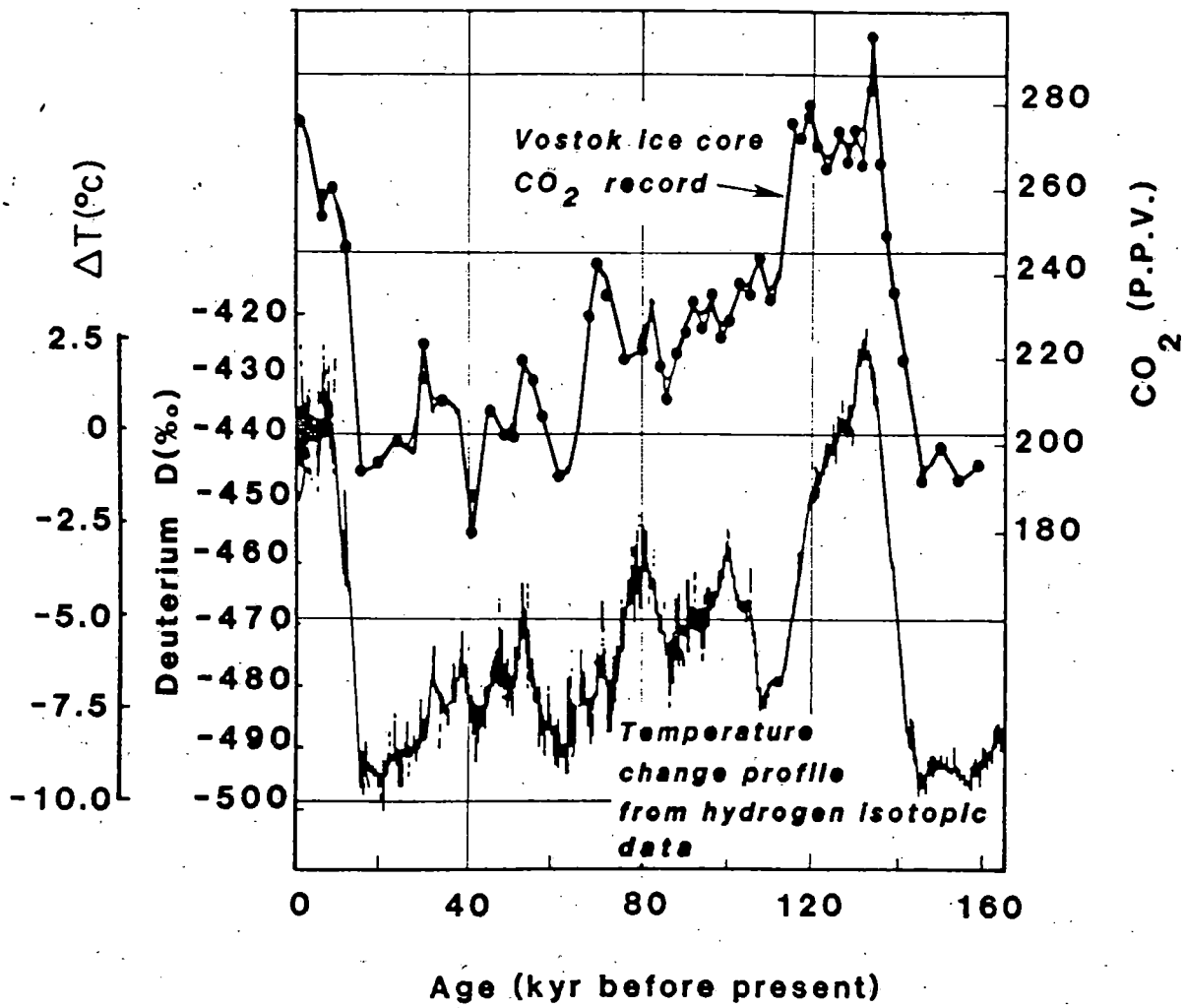

MAUNA LOA OBSERVATORY
HAWAII CO_2 CONCENTRATIONS
C.D. Keeling data
Horizontal bars represent
annual averages
CO_2 CONCENTRATATION (ppm)
350
340
330
320
310
300
1955
1960
1965
1970
1975
1980
1985

Figure 1

Drawing by Anastasia Sotiropoulos from *Ice Ages: Solving the Mystery*, Imbrie and Imbrie, 1979, Harvard Univ. Press

Figure 2

CARBON DIOXIDE CONCENTRATIONS
and
ATMOSPHERIC TEMPERATURE CHANGES



A-2-89-02340

Figure 3

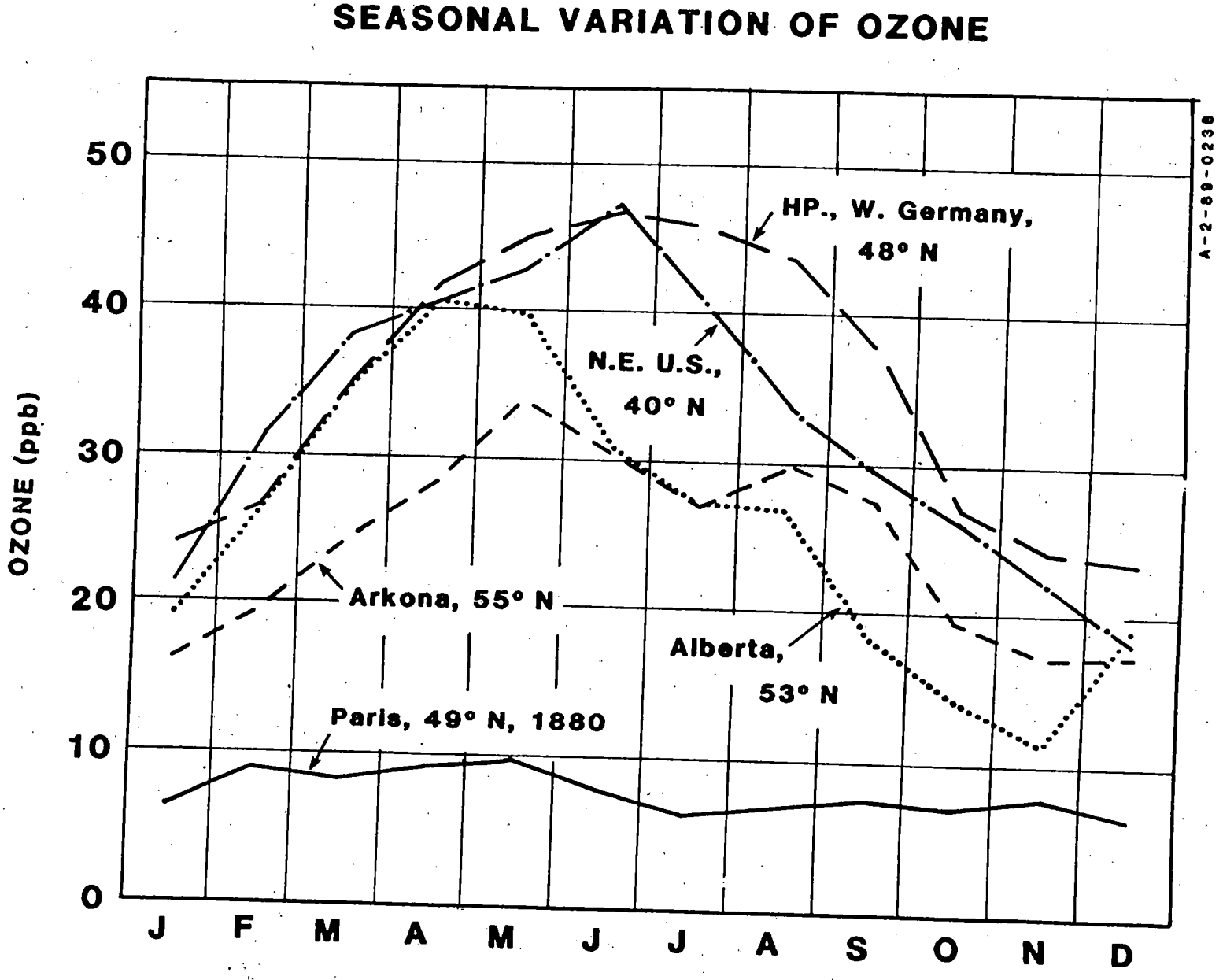

SEASONAL VARIATION OF OZONE
OZONE (ppb)
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
HP., W. Germany,
48° N
N.E. U.S.,
40° N
Arkona, 55° N
Alberta,
53° N
Paris, 49° N, 1880
A-2-89-0238

Figure 4

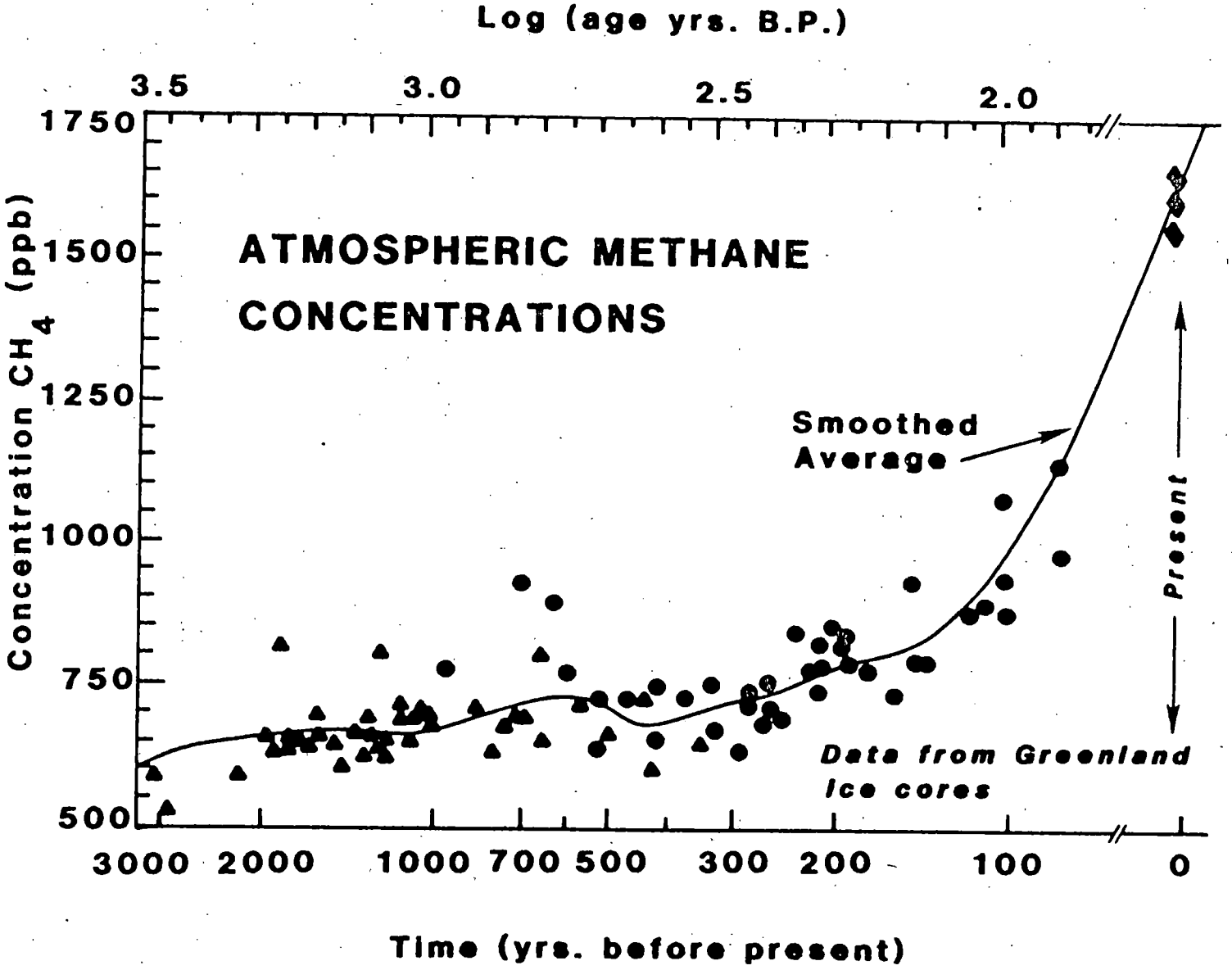

Log (age yrs. B.P.)
3.5
3.0
2.5
2.0
1750
1500
1250
1000
750
500
Concentration CH_4 (ppb)
ATMOSPHERIC METHANE
CONCENTRATIONS
Smoothed
Average
Present
Data from Greenland
Ice cores
3000
2000
1000
700
500
300
200
100
0
Time (yrs. before present)

Figure 5

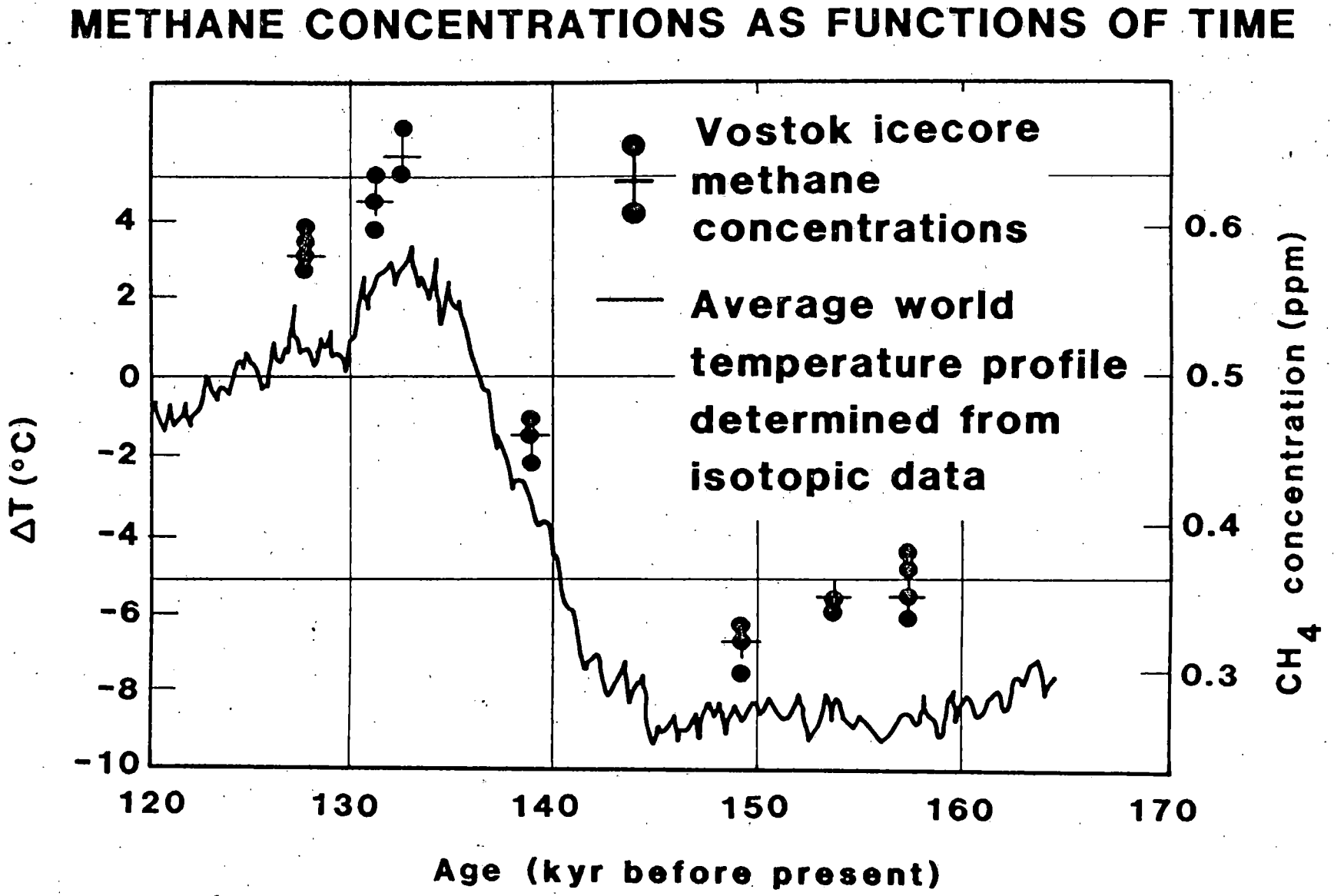

METHANE CONCENTRATIONS AS FUNCTIONS OF TIME
Vostok icecore methane concentrations
Average world temperature profile determined from isotopic data
ΔT (°C)
4
2
0
-2
-4
-6
-8
-10
0.6
0.5
0.4
0.3
CH4 concentration (ppm)
120
130
140
150
160
170
Age (kyr before present)

Figure 6

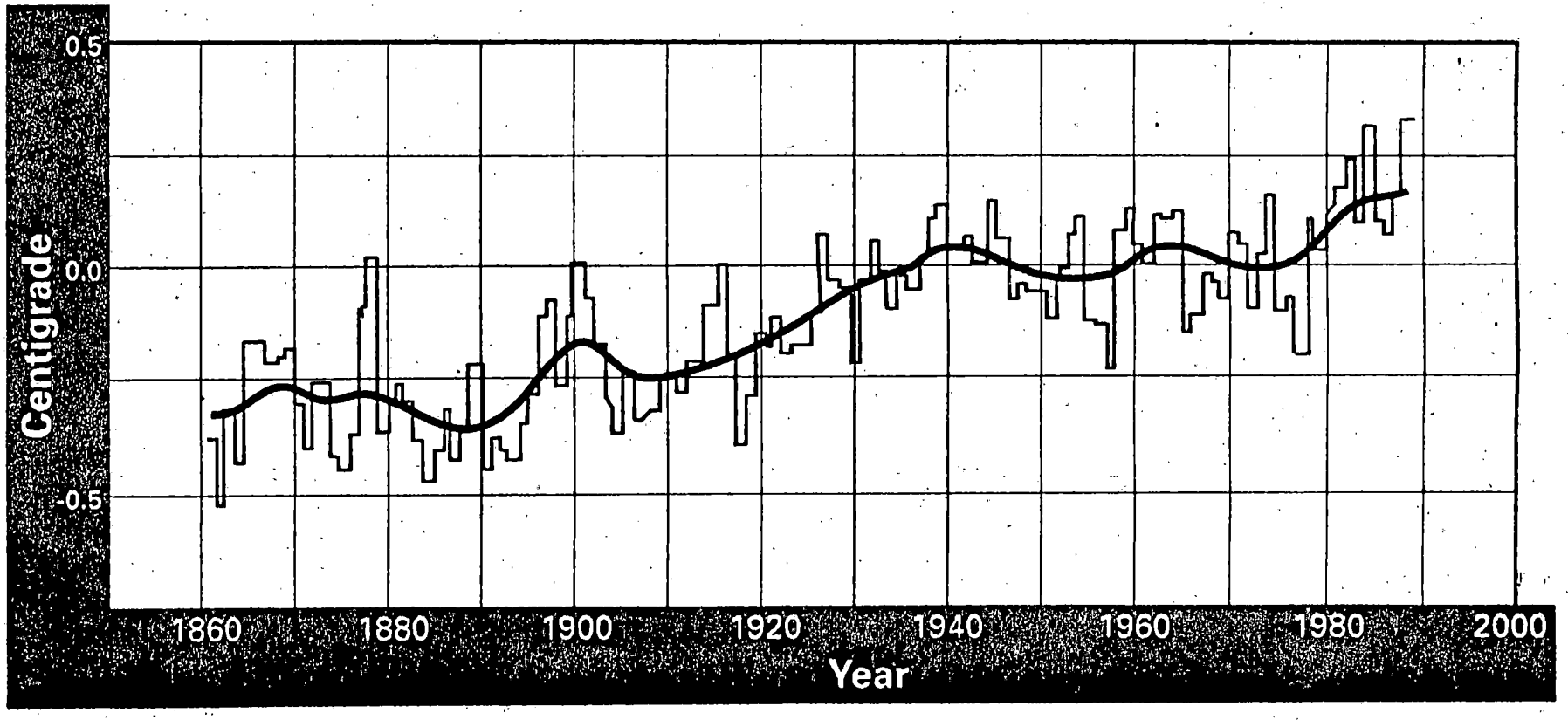

0.5
0.0
-0.5
Centigrade
1860
1880
1900
1920
1940
1960
1980
2000
Year

Figure 7

AC HAS SEEN

United States Department of State

Bureau of Oceans and International Environmental and Scientific Affairs

Washington, D.C. 20520

April 23, 1990

UNCLASSIFIED

TO: Members of the Working Group on Climate Change

FROM: OES/EGC - Daniel A. Reifsnyder DAR

SUBJECT: Revised RSWG Legal Measures Paper on Elements of a Framework Climate Convention

On behalf of RSWG Chairman Dr. Frederick M. Bernthal, attached is the revised RSWG Legal Measures paper, the product of the April 10-11 Topic Coordinators' meeting in Geneva. Note that, in both format and content, the revised version resembles the draft circulated by the international topic coordinators a few weeks ago. The paper will be up for adoption at the June RSWG meeting, along with the rest of the RSWG report. If adopted at the June RSWG meeting, the attached paper would take the place of the Legal Measures paper developed at the RSWG Workshop in October 1989.

Two particular areas of improvement in the text should be noted. First, the language on monitoring has been moved from the issues section to the generally agreed section. Second, in addition to previous references to the comprehensive greenhouse gas approach, this option is now reflected in more places. For example, on page 2 of the topic coordinators' report (ticks 2 and 3) and on page 8 (tick 4), reference is now made to "protocol(s)". On page 15, the list of individual greenhouse gases as posssible subjects of protocols has now been deleted and replaced with the sentence: "While it is recognized that the Convention is to be all-encompassing, the negotiating parties will have to decide whether greenhouse gases, their sources and sinks, are to be dealt with: individually, in groups or comprehensively; in annexes or protocols to the Convention."

Attachment:
As stated.

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EB/ODF - Larry Butcher

cc: NSF - Dr. Bernthal

IPCC: RESPONSE STRATEGIES WORKING GROUP

LEGAL MEASURES: REPORT OF TOPIC CO-ORDINATORS

(Canada, Malta and the UK)

Executive Summary

1. The co-ordinators' report has as its primary objective the compilation of elements that might be included in a future framework Convention on Climate Change, and a discussion of the issues that are likely to arise in the context of developing those elements.

2. There is a general view that while existing legal instruments and institutions with a bearing on climate should be fully utilized and further strengthened, they are insufficient alone to meet the challenge. A very broad international consensus has therefore emerged in the IPCC, confirmed notably at the 44th United Nations General Assembly, on the need for a framework Convention on Climate Change. Such a Convention should generally follow the format of the Vienna Convention for the Protection of the Ozone Layer, in laying down, as a minimum, general principles and obligations. It should further be framed in such a way as to gain the adherence of the largest possible number and most suitably balanced spread of countries while permitting timely action to be taken; it should contain provision for separate Annexes/protocols to deal with specific obligations.

(a) Financial needs of developing countries: The need for additional resources for developing countries and the manner in which this should be addressed, particularly in terms of the nature, size and conditions of the funding, even if detailed arrangements form the subject of a separate protocol, will have to be considered by the negotiating parties.

(b) Development and transfer of technology: The basis on which the promotion of the development and transfer of technology and provision of technical assistance to developing countries should take place will need to be elaborated, taking into account considerations such as terms of transfer, assured access, intellectual property rights and the environmental soundness of such technology.

(c) Institutions: Views differ substantially on the role and powers of the institutions to be created by the Convention, particularly in exercising supervision and control over the obligations undertaken.

5. The inclusion of any particular element in the paper does not imply consensus with respect to that element, or the agreement of any particular government to include that element in a Convention.

6. The co-ordinators have not sought to make a value judgement in listing and summarising in the attached paper the elements proposed for inclusion in a framework Convention: their text seeks merely to assist the future negotiators in their task. They note however that a readiness to address the foregoing fundamental problems in a realistic manner will be a prerequisite for ensuring the success of the negotiations and the support of a sufficiently wide and representative spread of nations.

As part of the commitment of the parties to action on greenhouse gas emissions and the adverse effects of global warming, the Convention would also address the particular financial needs of the developing countries, the question of the access to and transfer of technology, and institutional requirements.

3. The paper points out a number of issues to be decided in the negotiation of a Convention. In general these are:

- the political imperative of striking the correct balances: on the one hand, between the arguments for a far-reaching, action-oriented Convention and the need for urgent adoption of such a Convention so as to begin tackling the problem of climate change; and, on the other hand, between the cost of inaction and the lack of scientific certainty;

- the extent to which specific obligations, particularly on the control of emissions of carbon dioxide and other greenhouse gases, should be included in the Convention itself or be the subject of separate protocol(s);

- the timing of negotiation of such protocol(s) in relation to the negotiations on the Convention.

4. In particular, within the Convention the following specific issues will need to be addressed:

11 APRIL 1990, 6 p.m.

POSSIBLE ELEMENTS FOR INCLUSION IN A FRAMEWORK CONVENTION ON CLIMATE CHANGE

PREAMBLE

In keeping with common treaty practice including the format of the Vienna Convention, the Climate Change Convention would contain a preamble which might seek to address some or all of the following items:

- a description of problem and reasons for action (need for timely and effective response without awaiting absolute scientific certainty);

- a reference to relevant international legal instruments (such as the Vienna Convention and Montreal Protocol) and declarations (such as UNGA Resolution 43/53 and Principle 21 of the Stockholm Declaration);

- recognition that climate change is a common concern of mankind, affects humanity as a whole and should be approached within a global framework, without prejudice to the sovereignty of states over the airspace superadjacent to their territory as recognised under international law;

- recognition of the need for an environment of a quality that permits a life of dignity and well-being for present and future generations;

- reference to balance between sovereign right of states to exploit natural resources and concomitant duty to protect and conserve climate for benefit of mankind, in a manner not to diminish either;

- endorsement and elaboration of concept of sustainable development;

- recognition of the need to improve scientific knowledge (eg through systematic observation) and to study the social and economic impacts of climate change, respecting national sovereignty;

- recognition of the importance of development and transfer of technology and of the circumstances and needs, particularly financial, of developing countries; need for regulatory, supportive and adjustment measures to take into account different levels of development and thus differing needs of countries;

- recognition of responsibility of all countries to make efforts at the national, regional and global levels to limit or reduce greenhouse gas emissions and prevent activities which could adversely affect climate, while bearing in mind that:

  - most emissions affecting the atmosphere at present originate in industrialised countries where the scope for change is greatest;

  - implementation may take place in different time frames for different categories of countries and may be qualified by the means at the disposal of individual countries and their scientific and technical capabilities;

- emissions from developing countries are growing and may need to grow in order to meet their development requirements and thus, over time, are likely to represent an increasingly significant percentage of global emissions;

- recognition of need for development of strategies to absorb greenhouse gases, ie protect and increase greenhouse gas sinks; to limit or reduce anthropogenic greenhouse gas emissions; and to adapt human activities to the impacts of climate change.

Other key issues which will have to be addressed during the development of the preambular language include:

- should the preamble address the particular problems of countries with an agricultural system vulnerable to climate change and with limited access to capital and technologies, recognising the link with sustainable development?

- should mankind's interest in a viable environment be characterised as a fundamental right?

- is there an entitlement not to be subjected, directly or indirectly, to the adverse effects of climate change?

- should there be a reference to the precautionary principle?

- in view of the inter-relationship among all greenhouse gases, their sources and sinks, should they be treated collectively?

- should countries be permitted to meet their aggregate global climate objectives through joint arrangements?

- should reference be made to weather modification agreements such as the ENMOD treaty as relevant legal instruments?

- is there a common interest of mankind in the development and application of technologies to protect and preserve climate?

- does the concept of sustainable development exclude or include the imposition of new conditionality in the provision of financial assistance to developing countries, and does it imply a link between the protection and preservation of the environment, including climate change, and economic development so that both are to be secured in a coherent and consistent manner?

- is there a minimum standard of living which is a prerequisite to adopting response strategies to address climate change?

DEFINITIONS

As is the practice, definitions will need to be elaborated in a specific article on definitions. The terms which will need to be defined will depend on the purpose of the Convention and thus the language used by the negotiating parties.

GENERAL OBLIGATIONS

Following the format of such treaties as the Vienna Convention, an article would set out the general obligations agreed to by the parties to the Convention. Such obligations may relate to, for example:

- the adoption of appropriate measures to protect against the adverse effects of climate change, to limit, reduce, adapt to, and as far as possible prevent, climate change in accordance with the means at parties' disposal and their capabilities; and to avoid creating other environmental problems in taking such measures;

- the protection, stabilisation and improvement of the composition of the atmosphere in order to conserve climate for the benefit of present and future generations;

- taking steps having the effect of limiting climate change but which are already justified on other grounds;

- use of climate for peaceful purposes only, in a spirit of good neighbourliness;

- co-operation by means of research, systematic observation and information exchange in order to understand better and assess the effects of human activities on the climate and the potential adverse environmental and socio-economic impacts that could result from climate change, respecting national sovereignty;

- encouragement of the development and transfer of relevant technologies, as well as the provision of technical and financial assistance, taking into account the particular needs of developing countries to enable them to fulfil their obligations;

- co-operation in the formulation and harmonization of policies and strategies directed at limiting, reducing, adapting to and, as far as possible preventing, climate change;

- co-operation in adoption of appropriate legal or administrative measures to address climate change;

- provision for bilateral, multilateral and regional agreements or arrangements not incompatible with the Convention and its annexes/protocols, including opportunities for groups of countries to fulfil the requirements on a regional or sub-regional basis;

- co-operation with competent international organisations to implement effectively the objectives of the Convention;

- encouragement of and co-operation in the promotion of public education and awareness of the environmental and socio-economic impacts of greenhouse gas emissions and of climate change;

- strengthening or modification if necessary of existing legal and institutional instruments and arrangements relating to climate change;

- provision on funding mechanisms.

Other key issues which will have to be addressed in the process of elaborating this article include the following:

- should there be a provision setting any specific goals with respect to levels of emissions (global or national) or atmospheric concentrations of greenhouse gases while ensuring stable development of the world economy, particularly stabilisation by industrialised countries, as a first step, and later reduction of CO_2 emissions and emissions of other greenhouse gases not controlled by the Montreal Protocol; such provision would not exclude the application of more stringent national or regional emission goals than those which may be provided for in the Convention and/or its annexes/protocols?

- in light of the preambular language, should there be a provision recognising that implementation of obligations may take place in different time frames for different categories of country and/or may be qualified by the means at parties' disposal and their capabilities?

- should there be a commitment to formulate appropriate measures such as annexes, protocols or other legal instruments and, if so, should such formulation be on a sound scientific basis or on the basis of the best available scientific knowledge?

- in addressing the transfer of technology particularly to developing countries, what should be the terms of such transfers (ie commercial vs. non-commercial, preferential vs. non-preferential, the relationship between transfers and the protection of intellectual property rights)?

- should funding mechanisms be limited to making full use of existing mechanisms or also entail new and additional resources and mechanisms?

- should provision be made for environmental impact assessments of planned activities that are likely to cause significant climate change as well as for prior notice of such activities?

- what should be the basis of emission goals in the protocol(s)?

- should the particular problem of sea-level rise be specifically addressed?

- is there a link between nuclear stockpiles and climate change?

INSTITUTIONS

It has been the general practice under international environmental agreements to establish various institutional mechanisms. The parties to a Climate Change Convention might, therefore, wish to make provision for a Conference of the Parties, an Executive Organ and a Secretariat. The

Conference of the Parties may, among other things: keep under continuous review the implementation of the Convention and take appropriate decisions to this end; review current scientific information; and promote harmonization of policies and strategies directed at limiting, reducing, adapting to and, as far as possible, preventing climate change.

Questions that will arise in developing provisions for appropriate institutional mechanisms include:

- should any of the Convention's institutions (eg the Conference of the Parties and/or the Executive Organ) have the ability to take decisions inter alia on response strategies or functions in respect of surveillance, verification and compliance that would be binding on all the parties and, if so, should such an institution represent all of the parties or be composed of a limited number of parties eg based on equitable geographic representation?

- what should be the role of the Secretariat?

- what should be the decision-making procedures, including voting requirements (eg consensus, majority)?

- if a trust fund or other financial mechanism were established under the Convention, how should it be administered?

- should scientific and/or other bodies be established on a permanent or ad hoc basis, to provide advice and make recommendations to the Conference of the Parties concerning research activities and measures to deal with climate change?

- should the composition of the above bodies reflect equitable climatic or geographic representation?

- should there be a provision for working groups, eg on scientific matters as well as on socio-economic impacts and response strategies?

- what should be the role of non-governmental organisations?

RESEARCH, SYSTEMATIC OBSERVATIONS AND ANALYSIS

It would appear to follow general practice to include provision for co-operation in research and systematic monitoring. In terms of research, each party might be called upon to undertake, initiate, and/or co-operate in, directly or through international bodies, the conduct of research on and analysis of:

- physical and chemical processes that may affect climate;
- substances, practices, processes and activities that could modify the climate;

- techniques for monitoring and measuring greenhouse gas emission rates and their uptake by sinks;
- improved climate models, particularly for regional climates;
- environmental, social and economic effects that could result from modifications of climate;
- alternative substances, technologies and practices;
- environmental, social and economic effects of response strategies;
- human activities affecting climate;
- coastal areas with particular reference to sea-level rise;
- water resources; and
- energy efficiency.

The parties might also be called upon to co-operate in establishing and improving, directly and/or through competent international bodies, and taking fully into account national legislation and relevant on-going activities at the national, regional and international levels, joint or complementary programmes for systematic monitoring and analysis of climate, including a possible worldwide system; and co-operate in ensuring the collection, validation and transmission of research, observational data and analysis through appropriate data centres.

Other issues that will arise in developing this provision include:

- should consideration be given to the establishment of panels of experts or of an independent scientific board responsible for the co-ordination of data collection from the above areas of research and analysis?

- should provision be made for on-site inspection?

- should there be provision for open and non-discriminatory access to meteorological data developed by all countries?

- should a specific research fund be established?

INFORMATION EXCHANGE AND REPORTING

Precedents would suggest the inclusion of a provision for the transmission of information through the Secretariat to the Conference of the Parties on measures adopted by them in implementation of the Convention and of protocols to which they are party. In an annex to the Vienna Convention, the types of information exchanged are specified and include scientific, technical, socio-economic, commercial and legal information.

For the purposes of elaborating this provision, issues having to be addressed by the negotiating parties include the following:

- is there a need for the elaboration of a comprehensive international research programme in order to facilitate co-operation in exchange of scientific, technological and other information on climate change?

- should parties be obliged to report on measures they have adopted for the implementation of the Convention, with the possible inclusion of regular reporting on a comparable basis of their emissions of greenhouse gases?

- should each party additionally be called upon to develop a national inventory of emissions, strategies and available technologies for addressing climate change; if so, the Convention might also call for the exchange of information on such inventories, strategies and technologies?

DEVELOPMENT AND TRANSFER OF TECHNOLOGY

While the issue of technology has been addressed in the section on General Obligations, it might be considered desirable to include separate provisions on technology transfer and technical cooperation. Such provisions could call upon the parties to promote the development and transfer of technology and technical cooperation, taking into account particularly the needs of developing countries, to enable them to take measures to protect against the adverse effects of climate change, to limit, reduce and as far as possible prevent climate change, or to adapt to it.

Another issue which will arise is: should special terms be attached to climate-related transfers of technology (such as a preferential and/or non-commercial basis and assured access to, and transfer of, environmentally sound technologies on favourable terms to developing countries), taking into consideration the protection of intellectual property rights?

SETTLEMENT OF DISPUTES

It would be usual international practice to include a provision on the settlement of disputes that may arise concerning the interpretation or

application of the Convention and/or its annexes/protocols. Provisions similar to those in the Vienna Convention for the Protection of the Ozone Layer might be employed, ie voluntary resort to arbitration or the International Court of Justice (with a binding award) or, if neither of those options is elected, mandatory resort to conciliation (with a recommendatory award).

OTHER PROVISIONS

It would be the usual international practice to include clauses on the following topics:

- amendment of the Convention;
- status, adoption and amendment of annexes;
- adoption and entry into force of, and amendments to, protocols;
- signature;
- ratification;
- accession;
- right to vote;
- relationship between the Convention and its protocols;
- entry into force;
- reservations;
- withdrawal;
- depositary;
- authentic texts.

ANNEXES AND PROTOCOLS

The negotiating parties may wish the Convention to provide for the possibility of annexes and/or protocols. Annexes might be concluded as integral parts of the Convention, while protocols might be concluded subsequently (as in the case of the Montreal Protocol to the Vienna Convention on Protection of the Ozone Layer). While it is recognized that the Convention is to be all-encompassing, the negotiating parties will have to decide whether greenhouse gases, their sources and sinks, are to be dealt with: individually, in groups or comprehensively; in annexes or protocols to the Convention. The following, among others, might also be considered as possible subjects for annexes or protocols to the Convention:

- agricultural practices;
- forest management;
- funding mechanisms;
- research and systematic observations;
- energy conservation and alternative sources of energy;
- liability and compensation;
- international emissions trading;
- international taxation system;
- development and transfer of climate change-related technologies.

Issues that will arise in connection with the development of annexes and protocols include:

- timing, ie negotiating parties advocating a more action-oriented Convention may seek to include specific obligations in annexes as opposed to subsequent protocols and/or negotiate one or more protocols in parallel with the Convention negotiations;

- sequence, ie if there is to be a series of protocols, in what order should they be taken up?

United States Department of State

Bureau of Oceans and International Environmental and Scientific Affairs

Washington, D.C. 20520

April 23, 1990

UNCLASSIFIED

TO: U.S. Participants in RSWG Activities

FROM: OES/EGC - Daniel A. Reifsnyder DAR

SUBJECT: Draft Executive Summary for RSWG Report

On behalf of RSWG Chairman Dr. Frederick M. Bernthal, attached for your review is a draft of the Executive Summary for the IPCC Response Strategies Working Group (RSWG) report. The summary is based on inputs received from the RSWG international Subgroup Chairmen and Topic Coordinators. The report thus attempts to reflect the wide range of views which were discussed in the various RSWG meetings. Also attached for review is a draft introduction for the overall (200-page) RSWG report describing the formation and activities of the RSWG.

We would appreciate your comments on whether the attached draft papers accurately summarize the RSWG Subgroup Reports and Topic Papers. RSWG Chairman Bernthal has not yet reviewed the drafts; we will prepare revised versions for him based on comments received. Final drafts are due in the IPCC Secretariat in Geneva by May 1.

There are two aspects of the RSWG's work which were not included in this draft. The first is the description of the five emissions scenarios prepared under Steering Committee Task A. For the sake of simplicity and clarity we felt it would be preferable in the Executive Summary to concentrate on the 2030 "business-as-usual" scenario and omit altogether the hypothetical 2060, 2090, and less than doubling scenarios. However, if there is some clear and concise way to describe all of the scenarios, this could be added to the Executive Summary.

The second issue relates to the recommendations in the Coastal Zone and Agriculture and Forestry Subgroups that international protocols be developed related to coastal zone management and tropical forests (in conjunction with an energy protocol). These have not been included in this initial draft Executive Summary because they were not discussed in the Legal Measures group, which is responsible in the RSWG for dealing with international legal issues.

Please fax any comments you may have to me by COB, Thursday, April 26. The fax number is: 647-5947. Again, however, please note that the purpose of this review is to ensure that the draft accurately summarizes the RSWG Subgroup Reports and Topic Papers. Also, because the Executive Summary will be read widely, it needs to be as simple and concise as possible - proposed modifications should thus be written with an audience of non-specialists in mind.

Attachments:
As stated.

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DRAFT

REPORT OF THE

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
RESPONSE STRATEGIES WORKING GROUP

EXECUTIVE SUMMARY

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4/23/90

EXECUTIVE SUMMARY - RESPONSE STRATEGIES WORKING GROUP

1.0 INTRODUCTION

Climate change is an issue which concerns the entire international community. The IPCC's Response Strategies Working Group (RSWG) explored possible options for responding to climate change at the national, regional, and international levels. In carrying out this work the RSWG evaluated current and future sources and levels of greenhouse gas emissions, available measures for limiting the increase in the atmospheric concentration of such gases, and options for adapting to possible climate change.

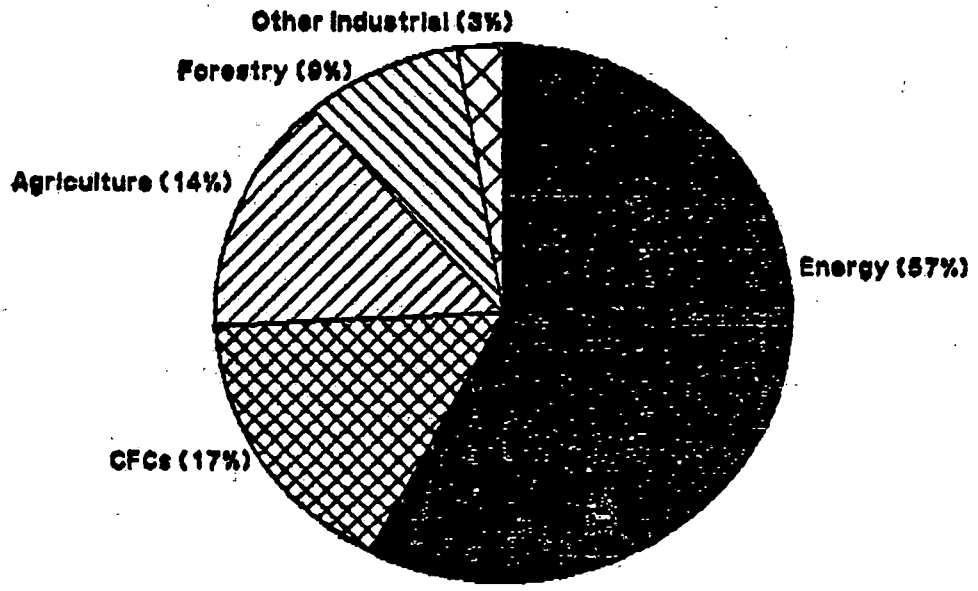
The RSWG has identified a large number of short and long term options for consideration by the international community in addressing climate change. There are, for example, many options available for limiting greenhouse gas emissions from the energy, industry, agriculture, and forestry sectors through the adoption of a variety of technologies and resource use strategies. Measures are also available for enhancing the ability of coastal regions and natural resources to adapt to a changing climate.

The implementation of specific response strategies will depend on national and regional circumstances and on the development of an international consensus on how to address climate change. This report is designed to provide a preliminary analysis of the many complex issues related to the development of such response strategies. While further work is required on the major topics which have been identified, in particular research related to the economic costs of implementing specific response options, this report, as an international consensus document, provides an important interim guide for policy makers around the world.

2.0 ANTHROPOGENIC SOURCES OF GREENHOUSE GAS EMISSIONS

A wide range of human activities result in the release of these greenhouse gases into the atmosphere. Anthropogenic emissions can be categorized as arising from energy production and use, industrial activity (primarily the production and use of CFCs), agricultural practices, and changes in land-use patterns (including deforestation and biomass burning). The relative contribution of these activities to climate forcing change are shown below in Figure X.

CURRENT CONTRIBUTIONS TO GLOBAL WARMING BY SECTOR



Source: U.S. EPA, 1989.

The most important source of greenhouse gas emissions is energy production and use. The consumption of energy from carbon-based fuels (coal, petroleum, and natural gas) for industrial, commercial, residential, transportation, and other purposes results in large emissions of CO2 and other gases and accounts for about 57 percent of the climate forcing change resulting from human activities. Industrial activities not related to energy use comprise another 20 percent of anthropogenic contributions. The vast majority of these contributions result from the production and use of CFCs and other halocarbons, powerful greenhouse gases which also deplete the stratospheric ozone layer, in various industrial processes.

Agricultural practices account for about 14 percent of climate forcing change from human activities. Significant amounts of methane are released in the process of rice cultivation and cattle raising, while nitrous oxide is released during the use of nitrogenous fertilizers. Another 9 percent of anthropogenic contributions are the result of deforestation, biomass burning, and other land-use patterns which release CO2, methane, and nitrous oxide.

Estimates of current greenhouse gas emissions, however, are imprecise because of uncertainties regarding both total emissions and emissions from each source. Emissions from certain sources are particularly difficult to measure. For

example, estimates of CO2 emissions from deforestation and of methane emissions from rice cultivation, cattle raising, and biomass burning vary by factors of two or more.

3.0 FUTURE GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions from most sources are likely to increase rapidly in the future in the absence of any specific policy measures designed to limit their growth. As economic and population growth continues, in particular in the developing countries, there is expected to be a sharp increase in energy use, agricultural activity, and land use modification patterns, which will result in rising future emissions of CO2, methane, nitrous oxide, and other greenhouse gases. CFCs provide the only exception to this trend as their use is being restricted under the terms of the Montreal Protocol on Substances that Deplete the Ozone Layer.

The RSWG developed estimates of future emissions of greenhouse gases to the year 2100 based on: World Bank estimates of world economic and population growth; estimates by experts' groups of future rates of energy use, deforestation, and agricultural production; and the assumption that the current Montreal Protocol would be implemented worldwide, albeit with less than 100 percent global compliance. Using these assumptions, it is estimated that CO2 emissions will more than triple by the year 2100 from 1985 levels, methane emissions nearly double, and nitrous oxide emissions increase nearly 50 percent. SEE FIGURE X:

FIGURE X

INCREASE IN GREENHOUSE GAS EMISSIONS OVER 1985 LEVELS

Gas	1985	2000	2025	2050	2075	2100
CO2 (petragrams C)	6	8	12	15	19	22
N2O (teragrams N)	12	14	16	17	17	18
CH4 (teragrams)	540	614	761	899	992	1062

Source: Task A report

The emissions projections also show that the regional sources of greenhouse gases are likely to change dramatically in the future. At the present time, the OECD countries account for about __ percent of all emissions, the USSR and Eastern Europe about __ percent, and the developing countries the remaining __ percent. However, as a result of the relatively greater economic and population growth rates expected to take place in developing countries, their relative share of future

greenhouse gas emissions will rise sharply, to an estimated __ percent of global emissions by the year 2050. See TABLE X

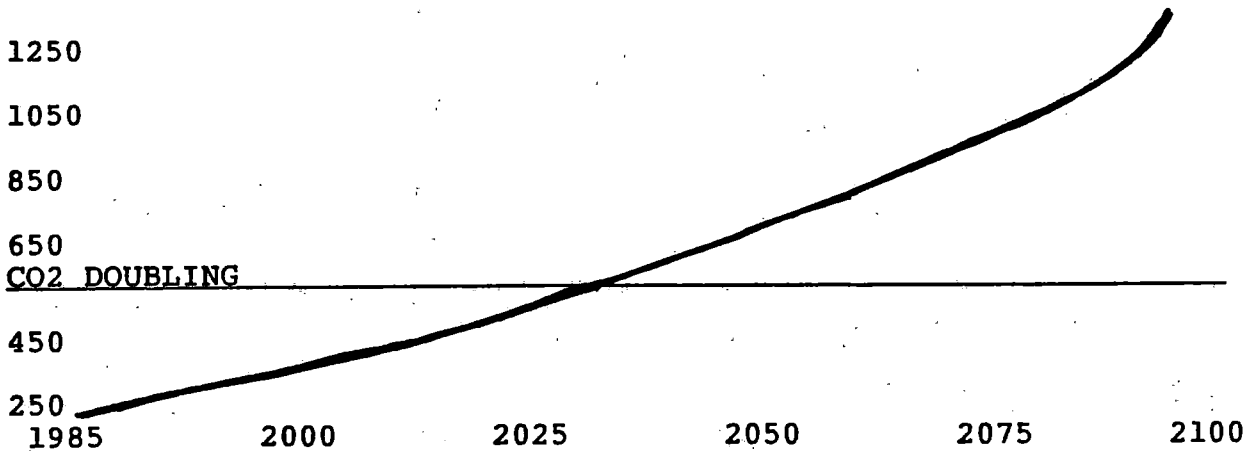
TABLE X

	1985	2050
OECD		
USSR/EE	Figures to be drawn from Task A report	
LDCs		

The cumulative effect of these projected emissions on the atmosphere was calculated using the concept of equivalent CO2 concentration, in which the contributions of all greenhouse gases to climate forcing change are converted into their equivalent in terms of CO2 concentrations. The RSWG found that, under the assumptions used in estimating future emissions, by the year 2030 the concentration of greenhouse gases in the atmosphere will contribute the same amount to climate forcing change as would a doubling of CO2 concentrations from pre-industrial levels. In the absence of any policy changes, it is estimated that these greenhouse gas concentrations will continue to increase through the rest of the century. SEE FIGURE X

FIGURE X

EQUIVALENT CO2 CONCENTRATIONS



It must be emphasized, however, that there are significant inherent difficulties in making long term projections of this

kind. Because these estimates make assumptions about future rates of population growth, economic growth, deforestation, agricultural production, technological innovation, and other factors, their accuracy is highly uncertain. While they represent an educated best guess of what the future may look like under "business-as-usual" conditions, they should be used with caution.

Nonetheless, the latest data being developed by the RSWG suggests that the 2030 date is a conservative estimate for a CO2 equivalent doubling and that emissions may actually rise faster than is projected under this scenario. For example, data supplied recently by some 20 countries on likely future energy and industry emissions indicates that energy-related emissions in the year 2025 could be roughly 20 percent higher than in the "business-as-usual" scenario discussed above.

4.0 RESPONSE STRATEGIES FOR ADDRESSING CLIMATE CHANGE

Because climate change could result in significant impacts on the global environment, it is important to begin considering now what measures might be taken in response to this prospect. The RSWG explored a wide range of measures which the international community may wish to take into account in this process. Measures both to limit net greenhouse gas emissions and to increase the ability of society and ecosystems to adapt to a changing climate were reviewed.

The consideration of climate change response strategies, however, presents formidable difficulties for policy makers. On the one hand, there is inadequate information available to make sound policy analyses because of: (1) remaining uncertainties regarding the magnitude, timing, and regional impacts of climate change; and (2) the lack of data on the economic costs of implementing specific response options. On the other hand, the potentially serious impacts of climate change on the global environment may require some response strategies to be implemented even in the face of such significant uncertainties.

Recognizing these factors, a large number of options were evaluated. Some of these options appear to be economically and socially feasible for implementation in the near-term while others, because they are not yet economically viable or require further research, may be more appropriate for implementation in the longer-term. In general, the RSWG found that the most effective response strategies are those which are:

- Beneficial for reasons other than climate change and justifiable in their own right, for example energy efficiency, better management of forests and other natural resources, and reductions in CFC production and use;

- o Cost effective and economically efficient;
- o Able to serve multiple social, economic, and environmental purposes;
- o Flexible and subject to modification, so that they can balance increased understanding of climate change with further actions;
- o Compatible with the concept of sustainable economic development;
- o Administratively practical and effective in terms of application, monitoring, and enforcement;
- o Equitable in terms of distribution of costs and obligations across nations, intergenerational and income class categories;
- o Take into account the obligations of both developed and developing countries in addressing this issue, while recognizing the special needs of developing countries

5.0 OPTIONS FOR LIMITING GREENHOUSE GAS EMISSIONS

The RSWG reviewed available measures for mitigating climate change by limiting net emissions of greenhouse gases from the energy, industry, transportation, forestry, agriculture, and other sectors. These measures include those which limit emissions from greenhouse gas sources (such as energy production) as well as those which enhance natural sinks for greenhouse gases (such as forests and other biomass). An analysis of both short and long term options for each major emissions sector is provided below.

5.1 LIMITATION OF NET EMISSIONS FROM THE ENERGY SECTOR

The energy sector plays a vitally important role in economic development for all nations. At the same time, because energy production and use accounts for about 57 percent of all current greenhouse gas emissions, energy policies need to ensure that sustained economic growth occurs in a manner that also preserves the global environment for future generations. Climate change clearly represents an unprecedented challenge to energy policy development.

The RSWG's consideration of response strategies in the energy and industry sector suggests that economic growth and reductions in greenhouse gases can co-exist and that policies and technologies can make a meaningful contribution to limiting emissions. However, there is no single quick-fix technological

option for limiting greenhouse gas emissions. A comprehensive strategy is necessary which deals with improving efficiency on both the demand and supply sides as a priority and emphasizes technological research and development.

There are a number of options available for reducing greenhouse gas emissions from energy systems. The most relevant categories of technologies and systems are:

- o efficiency improvements and conservation in energy supply, conversion and end-use;
- o fuel substitution by energy sources which are lower in greenhouse gas emissions (e.g. natural gas, nuclear, and renewable sources);
- o reduction of greenhouse gas emissions by removal, recirculation or fixation.

From an analysis of available technologies in these categories it is clear that some technologies are available now and are generally economically feasible whereas others need further technological development to lower costs or to improve environmental benefits. TABLES X and Y provide various examples of technologies within each of the broad categories defined above, and their possible application in the shorter and longer time frames. An analysis of these options by sector is provided below.

Transportation Sector: The technical potential for vehicle efficiency improvements is very high despite the substantial improvements which have already been made. Potential reduction of greenhouse gases using current technology is in the range of 50 percent. However, market potential is constrained by replacement rates of vehicles, consumer demand, and the preference for large, more powerful and better equipped cars. Substantial technical potential also exists for fuel substitution through: (1) the use of fuels derived from natural gas, ethanol, or other fuels derived from biomass; or (2) development of non-fossil electricity for electric or hydrogen-fuelled vehicles. Presently, however, the market potential of most of these options is very low for a variety of reasons.

Buildings Sector: The technical potential for energy efficiency gains in the residential and commercial sectors is substantial. New homes can be built which use only about half of the energy needed for heating and cooling existing homes, while retrofits of existing homes could result in 25 percent energy use savings. Reductions of energy use in existing commercial buildings of at least 50 percent may be feasible, and new commercial buildings could be up to 75 percent more

Table ES2
Examples of Short-Term Options

I. IMPROVE EFFICIENCY IN THE PRODUCTION, CONVERSION AND USE OF ENERGY

Electricity Generation

- Improved efficiency in electricity generation
  - Repowering of existing facilities with high efficiency systems;
  - Introduction of integrated gasification combined cycle systems;
  - Introduction of atmospheric fluidised bed combustion;
  - Introduction of pressurised fluidised bed combustion with combined cycle power systems;
  - Improvement of boiler efficiency.
- Improved system for co-generation of electricity and steam.
- Improved operation and maintenance.

Industry Sector

- Promotion of further efficiency improvements in production process;
- Materials recycling (particularly energy-intensive materials);
- Substitution with lower energy intensity materials;
- Improved electromechanical drives and motors;
- Thermal process optimisation, including energy cascading and co-generation.
- Improved operation and maintenance.

Transport Sector

- Improved fuel efficiency of road vehicles;
  - Improved efficiency in transportation facilities;
  - Higher capacity trucking vehicles.
- Technology development in public transportation;
  - Intra-city and inter modal shift (e.g. car to bus or metro);
  - Better switching equipment to increase traffic density on urban rail lines;
  - High-speed inter-city trains;
  - Better intermodal integration.
- Technologies for producing and utilising alternative fuels;
  - Improved storage and combustion systems for natural gas;
  - Introduction of flexible-fuel vehicles.
- Driver behavior, traffic management, and vehicle maintenance.

Building Sector

- Improved heating and cooling equipment and systems;
  - Improvement of energy efficiency of air conditioning;
  - Promotion of introduction of area heating and cooling;
  - Improved burner efficiency;
  - Use of heat pumps in buildings;
  - Use of advanced electronic energy management control systems.
- Improved space conditioning efficiency in house/building;
  - Improved heat efficiency through highly efficient insulating materials;
  - Better building design (orientation, window, building, envelope, etc.);
  - Improved air-to-air heat exchangers.
- Improved lighting efficiency.
- Improved appliance efficiency.
- Improved operation and maintenance.
- Improved efficiency of cook stoves (in developing countries).

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II. NON FOSSIL AND LOW EMISSION ENERGY SOURCES

Electricity Generation

- Construction of small-scale and large-scale hydro projects;
- Expansion of conventional nuclear power plants;
- Construction of gas-fired power plants;
- Standarised design of nuclear power plants to improve economics and safety;
- Development of geothermal energy projects;
- Introduction of wind turbines;
- Expansion of sustainable biomass combustion.

Other Sectors

- Substitution of natural gas and biomass for heating oil and coal;
- Solar heating.

III. REMOVAL, RECIRCULATION OR FIXATION

Energy/Industry

- Recovery and use of leaked or released CH_4 from fossil fuel storage, coal mining;
- Improved maintenance of natural gas production and distribution systems to reduce CH_4 leakage;
- Improved emission control of CH_4, CO, SO_x, NO_x and VOCs to protect of sinks of greenhouse gases.

Landfills

- Recycle of waste materials to reduce CH_4 emissions;
- Use or flaring of CH_4 emissions;
- Improved maintenance of landfill to decrease CH_4 emissions

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Table ES3
Examples of Medium-/Long-Term Options

I. IMPROVE EFFICIENCY IN THE PRODUCTION, CONVERSION AND THE USE OF ENERGY

Electricity Generation	Industry Sector	Transport Sector	Building Sector
. Advanced batteries for storage of intermittent energy.	. Increased use of less energy-intensive materials; . Advanced process technologies; . Use of biological phenomena in processes; . Localised process energy conversion; . Use of fuel cells for co-generation.	. Improved fuel efficiency of road vehicles; - Advanced engines; - More efficient power transmission (electric control transmission systems); - Advanced vehicle design (reduced size and weight, with use of lightweight composite materials and structural ceramics; improved aerodynamics, combustion chamber components, better lubricants and tyre design, etc.). . Improvements in aircraft and ship design: - Advanced propulsion concepts; - Ultra high-bypass aircraft engines; - Tandem-propeller ship propulsion.	. Improved energy storage systems; - Use of information technology to anticipate and satisfy energy needs; - Use of hydrogen to store energy for use in buildings. . Improved building systems; - New Building materials for better insulation at reduced cost; - Windows which adjust opacity to maximise solar gain. . New food storage systems which eliminate refrigeration requirements.

Table ES3 (Continued)

III. NON FOSSIL AND LOW EMISSION ENERGY SOURCES

Electricity Generation	Other Sectors
. Nuclear power plants: - Passive safety features to improve reliability and acceptability. . Solar power technologies: - Solar thermal; - Solar photovoltaic (especially for local electricity generation). . Advanced fuel cell technologies.	. Other technologies for producing and utilising alternative fuels; - Improved storage and combustion systems for hydrogen; - Control of gases boiled off from cryogenic fuels; - Improvements in performance of metal hydrides; - High-yield processes to convert ligno-cellulosic biomass into alcohol fuels; - Introduction of electric and hybrid vehicles; - Reduced re-charging time for advanced batteries.

III. REMOVAL, RECIRCULATION OR FIXATION

. Improved combustion conditions to reduce N_2O emissions.

. Treatment of exhaust gas to reduce N_2O emissions.

efficient than existing buildings. However, realization of a significant percentage of these potential gains requires major implementation efforts involving governments, the private sector, and individual consumers.

Electricity Sector: Under current price conditions, both efficiency and fuel substitution are largely dependent on the rate of retirement of existing power plants, the growth in demand for electricity, and the cost of the replacement plant. The technical potential for greater efficiency in electricity generation is in the range of 15 to 20 percent. Fuel substitution (e.g. from coal to natural gas) could achieve in the range of 50 percent improvement in CO2 emissions. The economic potential for greater fuel efficiency and for fuel switching is considerably lower and is very sensitive to assumptions about future fuel prices.

Industrial Energy: The documented technical potential for efficiency improvements in the industry sector ranges from 13 percent in some sub-sectors to over 50 percent in others. There may also be significant potential for reducing greenhouse gas emissions through industrial fuel switching. However, this potential must be viewed from the perspective of the very dramatic efficiency improvements which have been already achieved in the energy-intensive industries over the last 15 years.

5.2 LIMITATION OF NET EMISSIONS FROM THE INDUSTRY SECTOR

The most significant source of greenhouse gases associated with industrial activity is the production and use of CFCs and other halocarbons. However, while CFCs represent a very important source of greenhouse gas emissions (about 17 percent of global contributions), the RSWG did not consider control strategies for this gas since this issue is already addressed under the Montreal Protocol on Substances that Deplete the Ozone Layer. International negotiations are now underway on possible modifications to the Montreal Protocol. The outcome of these discussions will have an important impact on climate change response strategies.

5.3 LIMITATION OF NET EMISSIONS FROM THE AGRICULTURE SECTOR

About 14 percent of global greenhouse gas emissions can be attributed to the agricultural sector, in particular livestock systems, rice cultivation, and the use of nitrogenous fertilizers. Limitation of emissions from this sector presents a challenge because the processes by which greenhouse gases, in particular methane and nitrous oxide, are released in agricultural activities are not well understood. There appear, however, to be a number of short-term response options, economically viable in their own right, which could contribute

to a limitation of net emissions from agricultural sources. In addition, there are a number of promising technologies and practices which, in the longer-term, could significantly reduce greenhouse gas emissions.

Short-Term Options:

Livestock systems: Methane emissions can be reduced through: management of livestock wastes under low oxygen conditions; expansion of supplemental feeding practices; and increased use of production and growth enhancing agents.

Fertilizer use: Nitrous oxide emissions may be reduced by using improved fertilizer formulations and application technology.

Marginal lands: Areas marginally suitable for annual cropping systems could be shifted to perennial cover crops for fodder or pastoral land uses, or forests if soils are suitable. Such actions would increase carbon uptake, both in the vegetation and soil, and would yield other benefits.

Sustainable agricultural practices: Where appropriate, minimum or no-till systems could be introduced for those countries currently using traction tillage as part of the annual cropping sequence.

Longer-Term Options:

Rice cultivation: A comprehensive approach, including management of water regimes, development of cultivars, efficient use of fertilizers, and other management practices, could lead to a 10 to 30 percent reduction in methane emissions from flooded rice cultivation, although substantial research is necessary to develop and demonstrate these practices.

Livestock: Through a number of technologies it appears that methane emissions may be reduced from livestock systems by 25 to 75 percent per unit of product in dairy and meat production, although many uncertainties exist.

Fertilizers: Fertilizer-derived emissions of nitrous oxide potentially can be reduced (although to what extent is uncertain) through changes in practices such as using fertilizers with controlled nitrogen conversion rates, improving fertilizer-use efficiency, and adopting alternative agricultural systems.

5.4 LIMITATION OF NET EMISSIONS FROM FORESTRY AND OTHER ACTIVITIES

Forestry practices and other human activities associated with land-use, such as biomass burning and landfills, account for over 9 percent of global greenhouse gas emissions. A number of short and long term response options for limiting net emissions from these sectors have been identified.

Short-Term Options:

Forestry: The development and implementation of policies to reduce deforestation and forest degradation and to ensure the health of existing forests can lead to substantial net CO2 reductions.

-- Long term CO2 storage may be enhanced through substitution of wood for high energy input materials and further recycling of forest products.

-- Existing international institutions and programs, such as the Tropical Forestry Action Plan process and the International Tropical Timber Organization, could be strengthened, supported, and extended to deal with tropical deforestation issues.

-- Surplus or marginal agricultural land could be converted to forests to enhance CO2 sequestering.

-- Fossil energy sources may be replaced with wood through the use of managed sources of biomass, such as fuel-wood plantations, in particular in temperate and boreal regions.

Biomass Burning: Biomass burning can be reduced through fire management programs and widespread use of alternative agricultural practices.

Waste Management: Landfill methane recovery systems and flaring may be practical for many developed countries, while biogas systems to treat wastewater in developing countries also could reduce methane emissions.

Longer-Term Options:

Forestry: Wood production could be increased through the development of new silvicultural measures and genetically improved trees.

-- Forest protection could be enhanced through the incorporation of strategies for fire, insects, and diseases into future management plans and through the development of silvicultural adjustment and stress management strategies.

-- Because temperate forests are intensively managed, there could be specific opportunities to limit net CO2 emissions by expanding temperate forest biomass.

-- The demands on tropical forests for the expansion of agriculture could be reconciled with the concurrent need for forest conservation through integration of agriculture and forestry plans.

Biomass burning: Trace gas emission from biomass burning and other land use practices may be reduced through widespread adoption of sustainable agricultural practices.

Waste Management: Methane emissions from landfills could be reduced 30 to 90 percent through gas collection and flaring, while methane emissions from wastewater treatment can be reduced completely by biogas plants. Demonstration, training, and technology transfer are necessary to realize these potentials.

6.0 TARGETS AND TIMETABLES FOR GREENHOUSE GAS EMISSIONS

There has been considerable international discussion of targets for specific greenhouse gas emissions, in particular CO2, which is the most abundant of the gases. At the November 1989 Noordwijk Conference on Atmospheric Pollution and Climate Change, the final declaration called on the IPCC to examine possible quantitative targets for greenhouse gas emissions, including a stabilization of CO2 emissions by the year 2000 and a 20 percent reduction in CO2 emissions by 2005. The Conference also called for consideration of the feasibility of increasing net forest growth by 12 million hectares per year.

The RSWG has made consideration of the feasibility of quantitative targets a priority task, although it was not possible to complete such an analysis by the time of this report's publication. The primary constraint on conducting this analysis is the serious lack of data on the economic costs of the various response options for limiting net greenhouse gas emissions. While the technological feasibility of a number of options has been demonstrated, there is very little information available on the actual economic costs associated with implementation of such options. This issue has been identified as one of the most important areas for future research by the RSWG and concerned international organizations.

The RSWG was able to conduct some preliminary analyses related to the stabilization of emissions, primarily CO2, from the energy sector. It was found that, when compared to the expected rate and level of global emissions by the year 2005,

stabilizing emissions from the energy sector would require reductions of about one-third by 2010. The analysis also indicated that the capacity of different regions of the world to reduce emissions levels varies greatly. Some preliminary results on prospects for stabilizing CO2 emission from the energy sector are that:

- Some West European countries may be able to stabilize or reduce CO2 emissions by early in the next decade through a variety of measures including taxes, energy efficiency programs, nuclear power, natural gas, and renewables.

- East European countries and the USSR may be able to reduce CO2 emissions over the next two decades if policies to restructure their economies, increase efficiency, and promote economic development are successfully implemented.

- Developing countries may be able to reduce their annual growth in CO2 emission from over 3 percent to around 2 percent, while maintaining economic growth. The largest opportunities in developing countries appear to be increased efficiency in both energy supply and demand.

- Some North American and OECD Pacific countries may slow the growth in CO2 emissions by increased efficiency in energy supply and demand, fuel switching, and other measures.

7.0 MEASURES FOR ADAPTING TO CLIMATE CHANGE

In addition to the limitation options discussed above, the RSWG reviewed available options for adapting to climate change. The consideration of adaptation options is critical for two reasons. First, because there is predicted to be a lag time between emissions and subsequent climate change, the climate may already be committed to a certain degree of change. Implementation of adaptation measures may thus be necessary regardless of any limitation actions which may be taken.

Second, should significant climate change occur, it will likely be necessary to consider limitation and adaptation strategies as part of an integrated package in which policies adopted in the two areas complement each other. It is particularly important to address those cases where limitation and adaptation policies may work at cross purposes. For example, the use of plantation forests to provide substitutes for fossil fuels may be contrary to strategies for enhancing the ability of ecosystems to adapt to a changing climate.

The RSWG explored two broad categories of adaptation options:

- o Coastal zone management, or options which maximize the ability of coastal regions to adapt to possible sea level rise and increased frequency and severity of storms; and

- o Resource use and management, or options which address the potential impacts of climate change on food production, water availability, other natural resources, and biodiversity.

7.1 COASTAL ZONE MANAGEMENT

Global climate change is projected to raise sea level by as much as one meter over the next century and, in some areas, to increase the frequency and severity of storms. Although there remain uncertainties regarding the possible rate and magnitude of sea level rise, hundreds of thousands of square kilometers of coastal wetlands and other lowlands could be inundated, while ocean beaches could erode perhaps as much as one hundred meters. Flooding could threaten lives, agriculture, livestock, and structures, while saltwater could advance inland into aquifers, estuaries, and soils, thus threatening water supplies, ecosystems, and agriculture in some areas.

Some nations are particularly vulnerable. Eight to ten million people live within one meter of high tide in each of the unprotected river deltas of Bangladesh, Egypt, and Vietnam. Half a million people live in various coral atoll nations that lie almost entirely within three meters of sea level, such as the Maldives, the Marshall Islands, Tuvalu, Kiribati, and Tokelau. Even in nations that are not, on the whole, particularly vulnerable to sea level rise, some low-lying areas or regions dependent on fisheries resources could be threatened.

Available responses to sea level rise fall broadly into three categories:

- o Retreat: Under this option no actions would be taken to protect the land from the sea - the focus would instead be on providing for people and ecosystems to shift landward in an optimal fashion. This choice could be motivated by either excessive costs of protection or by a desire to maintain ecosystems.

- o Accommodation: Under this strategy, while no attempt would be to protect the land at risk, measures would be taken to allow for continued habitation of the area. Specific responses under this options would include erecting flood shelters, elevating buildings on pilings, converting agriculture to fish ponds, or utilizing flood or salt tolerant species.

- Protection: A protection strategy uses site-specific features such as sea walls, dikes, dunes, and vegetation to protect the land from the sea so that existing land uses can be retained.

There are varying socio-economic implications for each of these options. Retreat would lead to a loss of property, potentially costly resettlement of populations, and, in some notable cases, refugee problems. Accommodation would result in declining property values, increased damage from storms, and costs for modifying infrastructure. The protection option would involve the considerable economic costs of building sea walls and other structures (even ignoring the impacts of flooding, a one meter rise would require 360,000 km of coastal defenses at an estimated cost of about $500 billion) and could also result in negative impacts on fisheries and recreational uses.

Actions to Prepare for Possible Sea Level Rise:

In general, the RSWG concluded that: (1) in a few noteworthy cases, the impacts of sea level rise could be disastrous; (2) in a few cases impacts would be trivial; but (3) for most coastal nations, the impacts would be serious but manageable. While the uncertainties regarding the potential for sea level rise are being addressed by scientists, a number of short term options exist which would enhance the ability of coastal zones to adapt to sea level rise and which are also beneficial in their own right. These include:

- Improving scientific and public understanding of the problem and increasing research on which options are warranted given current information. Better information on land elevation and other coastal zone features is also necessary as most nations do not have detailed maps from which to determine the coastal areas and resources vulnerable to sea level rise.

- Ensuring that coastal development does not increase the vulnerability of coastal regions to sea level rise. Actions in particular need of review include river levees and dams, conversion of mangroves and other wetlands for agriculture and habitation, and increased settlement in low-lying areas.

- Strengthening emergency preparedness and coastal management programs. There is a need for evacuation plans, emergency shelters, and improved forecasts of tropical storms, particularly in developing countries.

- Enhancing national, regional, and international planning efforts to: identify coastal areas at risk; assess the implications of adaptive response measures; and provide assistance to developing countries in addressing the problems associated with sea level rise. The role of international organizations like the WMO and OIC in monitoring and predicting changes in see level and UNEP in collecting and disseminating information will be important.

- Considering the possibility of sea level rise in the design and location of current coastal infrastructure and coastal defenses. While structural measures to prepare for sea level rise are not yet warranted, it is sometimes less expensive to design a structure today incorporating these factors than rebuild it later.

- Developing, by the year 2000, national coastal zone management plans which ensure that risks to populations are minimized while recognizing the need to protect and maintain important coastal ecosystems.

- Supporting national efforts directed at limiting population growth in coastal areas. In the final analysis, rapid population growth in coastal areas and, in particular, areas vulnerable to sea level rise, is the main underlying problem affecting both the efficacy of coastal zone management and the success of adaptive response options.

7.2 RESOURCE USE AND MANAGEMENT

Resource use and management refers to a broad range of human activities and natural ecosystems which could be affected by climate change. These include agriculture, animal husbandry, fisheries, water resources, land use, forests, and biological diversity. Some of the major concerns which need to be addressed when considering adaptation options for resource use and management include:

- Food and fiber security: A changing climate could result in shifting patterns of food production from agricultural, fisheries, and other sources.

- Water resource availability: Because climate change could results in modifications in the hydrologic cycle, water availability patterns may be altered.

- Managed Ecosystems: A changing climate could result in shifts in the natural range of managed ecosystems, such as plantation forests, with potentially negative results.

- Unmanaged Ecosystems: Unmanaged ecosystems, which include most of the world's forests and which contain most of the

world's biological diversity, could likewise be adversely affected by shifts in climatic zones.

[The potential impacts of climate change on the use and management of resources are very poorly understood (see Impacts Working Group report). Furthermore, credible regional estimates of changes in critical climatic factors, such as temperature, soil moisture, interannual and interseasonal variability, and frequencies of droughts, floods and storms, are simply not available. While it is clear that some of the impacts of climate change on resources could be negative and others positive, a more specific quantification of those impacts is not possible at this time. In general, however, it can be said that: (1) those resources which are managed by humans are more suited to successful adaptation than unmanaged ecosystems; and (2) the faster the rate of change, the more likely it is that impacts will be negative].

In recognition of the uncertainties regarding resource use and management, the following analysis provides general, rather than specific, options. The appropriateness of these options for individual countries may vary depending on the specific social, environmental and economic context.

Possible Short-Term Adaptation Measures:

Despite the considerable uncertainties regarding climate change impacts on resource use and management, certain anticipatory actions can be taken to improve resiliency to climate change. There are a number of responses that are probably economically justified under present-day conditions and which could be undertaken for sound resource management reasons, even in the absence of climate change, to meet increasing demands on these resources. These actions, which could generally be implemented in the short-term, include:

-- Measures which would augment our knowledge base to make more reasoned judgments for resource use response strategies or which promote research on resource issues. Examples of such measures include:

  - o stimulating the development of practices for more efficient resource use;
  - o disseminating information on the resource use and management practices that already exist globally under widely divergent climatic conditions;
  - o developing new resources (e.g. drought or salinity resistant cultivars and genetically engineered species) which could cope with the potentially worst consequences of climate change;

- developing new food products that can be more easily stored and improving storage facilities where yields tend to be unstable;

- identifying vulnerable areas and developing inventories of the current and future state of resources;

- protecting biodiversity (including increased research on the preservation of biological resources in situ and ex situ) and germ plasm resources.

-- Measures which lead to an increase in the productivity or efficiency of crops, forests, livestock, fisheries, and other resources consistent with principles of sustainable economic development. Examples of such measures include:

- increased meat or milk productivity per animal

- increased productivity of fuelwood, timber, and other forest products

- increased agricultural productivity

- reviewing and eliminating, where appropriate, direct and indirect subsidies and incentives for inefficient resource use.

-- Measures to expand carrying capacities (for those areas where carrying capacities are strained or extended). These could include implementing pollution control measures, improving access to potable water or transportation infrastructure, or increasing irrigation water use efficiency and drainage to allow water supplies to serve greater areas.

-- Measures to promote and strengthen resource conservation and sustainability of resource use -- especially in highly vulnerable areas and in developing countries. This could include developing methods whereby local populations and resource users gain an economic stake in conservation and sustainable resource use (e.g. by investing resource users with clear property rights and long-term tenure)

-- Other measures which could assist adaptation, such as: encouraging water conservation; allowing voluntary water transfers or markets; improving food distribution and storage; promoting sustainable management practices and continuing and improving agricultural and natural resource research/extension institutions.

Possible Longer-Term Adaptation Options:

There are also a number of other possible responses which are costly or otherwise appear to be more appropriate for consideration in the longer-term, once uncertainties regarding climate change impacts are reduced. Options in this category include:

- Building large capital structures such as dams to provide for enhanced availability of water and other resources.
- Strengthening and enlarging protected natural areas and establishing conservation corridors to enhance the adaptation prospects for unmanaged ecosystems.
- Developing alternatives for current resource-based livelihoods.

8.0 MECHANISMS FOR IMPLEMENTING RESPONSE STRATEGIES

The RSWG also considered in detail several priority areas which must be addressed in order to adequately implement limitation or adaptation responses. These "implementation mechanisms" represent the primary vehicles through which national and international responses to climate can be brought into force. The specific implementation mechanisms considered were:

- Public information and education;
- Economic (market) measures;
- Technology development and transfer;
- Financial measures;
- Legal and institutional measures, including possible elements of a framework convention on climate change.

The results of the RSWG's deliberations on these issues are provided below.

8.1 PUBLIC INFORMATION AND EDUCATION

An environmentally informed global population is essential for addressing and coping with an issue as complex as climate change. Because climate change has the potential to affect, either directly or indirectly, almost every sector of society, broad global understanding of the issue will facilitate the adoption and implementation of response options. The dissemination of information also represents a powerful

economic instrument for ensuring that markets accurately take into account potential consequences and/or opportunities of climate change.

The core aims of public education and information programs are to:

- o Promote awareness and knowledge of climate change issues
- o Encourage positive practices to limit and/or adapt to climate change
- o Encourage wide participation by all countries, both developed and developing, in addressing climate change and developing appropriate responses.

Given the importance of a well-informed population, the RSWG developed suggestions and approaches for improving international awareness of the causes and potential impacts of climate change. In this process it was recognized that, while broad-based understanding is essential, no single mechanism can work for every group or in every culture or country. The social, economic, and cultural diversity of nations will likely require educational approaches and information tailored to the specific requirements and resources of particular locales, countries, or regions.

A number of national and international actions can be taken to disseminate broadly information on climate change. These include the:

- o Establishment of national committees or clearing houses to collect, develop and disseminate materials on climate change. This could help provide focal points for information on issues such as energy efficiency, energy savings, forestry, agriculture, etc.
- o Use by international organizations (UNESCO, UNEP, WMO, etc.) of IPCC reports in developing and providing to all countries understandable guidelines for future actions.
- o Use of an existing international institution, or development of a new institution, to serve as a clearinghouse for informational and educational materials.

8.2 ECONOMIC (MARKET) MEASURES

It is important that any potential measures to limit or adapt to climate change be as economically efficient and cost-effective as possible. In general, environmental objectives can be achieved either through: (1) regulations requiring the use of a specific technology or attainment of

specified goals; or (2) economic instruments such as emissions fees, subsidies, tradeable permits, or sanctions.

Economic instruments, through their encouragement of flexible selection of abatement measures, frequently offer the possibility of achieving environmental improvements at lower cost than regulatory measures. Unlike many regulations, they also tend to encourage innovation and the development of improved technologies for reducing emissions. It is unlikely, however, that economic instruments will be applicable to all circumstances. For example, where market distortions or failures exist, regulations may be more appropriate. In the final analysis, some combination of economic and regulatory measures will likely be the most appropriate.

Three important considerations were identified as potential barriers to the achievement of environmental objectives through these market-based mechanisms: (1) market mechanisms require the adequate dissemination of information to achieve their maximum benefits; (2) existing measures and institutions, such as subsidies, sanctions, regulations, and technical standards, may encourage counterproductive behavior; and (3) other competing social, environmental, and economic objectives may be relevant, and thus need to be considered together with climate change-related measures as part of an integrated policy package. These barriers should be addressed when developing plans for the use of economic measures.

A number of specific economic instruments were identified that might be used as alternatives or supplements to regulatory actions in meeting environmental goals:

- o A system of tradeable emissions permits: An emission permit system is based on the concept that the economic costs of attaining a given environmental goal can be minimized by allowing for the trading of emissions rights. Once an overall national or international limit on emissions has been set, emissions entitlements could be provided to emitting sources and free trading of such entitlements could be allowed. This would reduce the costs of meeting a given emission target because: (1) as in international trade, comparative advantages between trading entities would be maximized; and (2) economic incentives would be created for the development of improved greenhouse gas limitation technologies.

- o A system of emission charges: Emission charges are levied on specified emissions depending on their level of contribution to climate change. Such charges may provide a means of encouraging emitters to limit or reduce emissions to a level that is socially desirable and provide an incentive for diverse parties to implement efficient means

of limiting or reducing emissions. Another advantage of charges is that they generate revenue which could provide a funding base for further pollution abatement, research, and administration, or allow other taxes to be lowered.

- o Subsidies: Subsidies are aimed at encouraging environmentally sound actions by lowering their costs. Subsidies could be used, inter alia, to encourage the use of energy-efficient equipment and non-fossil energy sources, and the development of greater use of environmentally sound technologies.

- o Sanctions: A final type of economic instrument is the use of economic sanctions for the enforcement of international agreements. This would require an international convention to establish a system of agreed trade or financial sanctions to be imposed on countries not adhering to agreed regimes.

It has also been suggested that the economic costs of meeting possible greenhouse gas limitation targets, should such be considered necessary in the future, could be minimized by considering all greenhouse gas sources and sinks comprehensively. Under this approach individual countries would be assigned an allowable emissions level, in CO2 equivalent terms, for all their greenhouse gas emissions. Countries would then be free to determine what specific measures to implement domestically to meet that target by limiting emissions or enhancing sinks of any combination of greenhouse gases. This would enable countries to implement the domestic program which allows them to meet a given target at the least cost for their specific economic and social position.

Each of the approaches outlined above, however, has potentially significant drawbacks in terms of implementation and acceptability. Their use at the national, regional, and international levels requires careful consideration and will vary depending on the specific circumstances involved.

8.3 TECHNOLOGY DEVELOPMENT AND TRANSFER

The development and transfer of technologies is vital for any global effort to address climate change. The development of new technologies may provide the means by which societies can meet their energy, food, and other needs in the face of a changing climate while at the same time minimizing emissions of greenhouse gases. Prompt transfer of technologies, especially to developing countries, is likewise an important aspect of a global effort to limit or adapt to climate change.

Technology Research and Development Issues:

Technological development is urgently needed to: limit or reduce anthropogenic greenhouse gas emissions; absorb such gases by protecting and increasing sinks; adapt human activities to the impacts of climate change; and detect and predict climate change and its impacts. Technology development will have to be pursued in a wide range of activities such as energy, industry, agriculture, transport, water supply, coastal protection, and management of natural resources. Some of the primary areas where further technology research and development is needed are:

- Energy, in particular those technologies which provide for using energy more efficiently and which promote the use of non-fossil energy sources (e.g. affordable renewable energy sources and safe nuclear power).

- Natural Resources, including technologies for increasing yields of forests and other greenhouse gas sinks, reducing emissions from agricultural sources, and introducing new varieties which are adaptable to a changing climate, and genetic engineering to develop new species.

- Monitoring, in particular those technologies which enhance our ability to make accurate predictions about the magnitude, timing, and regional impacts of climate change.

Technology Transfer:

The fastest rate of increase of greenhouse gases emission is occurring in developing countries. As a result, the most urgent need for the transfer of technologies for limiting or adapting to climate change is to the developing countries. Such advanced technologies may provide an alternative which would allow developing countries to avoid economic growth patterns which also result in high greenhouse gas emissions. A number of efforts are currently underway through bilateral and multilateral arrangements which could be further expanded.

A number of impediments, however, hinder the effective transfer of technologies to developing countries. These include lack of financial resources, necessary institutions, and trained human resources. Existing institutions should be strengthened to finance technology transfers, train human resources, and evaluate, introduce, and operate new technologies.

Existing legal provisions and restrictive trade practices are also possible constraints. In this context, the issue of intellectual property rights presents a case where international opinion is mixed. Some hold that the universal

international protection of such rights will promote the effective development and transfer of technologies, while others hold that provisions for the protection of intellectual property rights should be determined by the recipient countries, in accordance with their particular legal regimes.

8.4 FINANCIAL MEASURES

Industrialized and developing countries alike have a common responsibility to address the potential threat of climate change. Responses to climate change can not be effective unless there is broad participation from all countries, regardless of their level of development or economic structure. However, the special circumstances of the developing countries, including their vulnerability to problems posed by climate change and their lack of financial resources, must be recognized. Financial assistance to developing countries represents an important mechanism for enabling them to undertake adequate measures to limit or adapt to climate change.

Financial resources channelled to developing countries should focus on those activities which contribute both to limiting greenhouse gas emissions and promoting economic development. Among the highest priority areas for assistance are those that promote the:

- Efficient use of energy and the increased use of low-fossil or non-fossil fuels;
- Rational forest management practices and reforestation;
- Agricultural techniques which minimize greenhouse gas emissions;
- Introduction of alternatives for ozone-depleting substances;
- Ability of developing countries to develop programs to address climate change, including research and development activities and public awareness and education;
- Participation by developing countries in international fora on climate change, such as the IPCC.

A number of possible sources for generating and channeling financial resources were considered. International opinion, however, is mixed with regard to the nature of such sources. Some have stressed the need for new resources and institutions in addition to those which already exist for providing financial assistance to developing countries. Others have emphasized, before additional resources or funding mechanisms are considered, the effectiveness of existing development

assistance programs for addressing possible climate-change related needs of developing countries must be fully evaluated.

Nonetheless, it was agreed that any assistance which may become necessary should flow in a timely, coordinated, and cost effective manner. In this context the international community should build on work underway or planned in existing institutions such as the World Bank, regional development banks, and other multilateral organizations. Individual developing countries should also initiate studies, with donor assistance, on their current and projected emissions levels and assistance needs for limiting such emissions. In addition, further consideration is needed of the important contributions which the private sector might make, through technology transfer, foreign direct investment, and other means, to assist developing countries to respond to climate change.

8.5 LEGAL AND INSTITUTIONAL MEASURES

A number of institutions and international legal mechanisms exist which have a bearing on the climate change issue, in particular those dealing with the environment, science and technology, energy, natural resources, and financial assistance. One of these existing international legal mechanisms, the Vienna Convention on the Protection of the Ozone Layer and its associated Montreal Protocol on Substances that Deplete the Ozone Layer, deals specifically with reducing emissions of important greenhouse gases which also deplete the ozone layer. However, there is a general view that, while existing legal instruments and institutions related to climate change should be fully utilized and further strengthened, they are insufficient alone to meet the challenge.

A very broad international consensus has therefore emerged in the RSWG, confirmed notably at the 44th United Nations General Assembly, on the need for a framework convention on climate change. Such a convention should generally follow the format of the Vienna Convention for the Protection of the Ozone Layer in laying down, at a minimum, general principles and obligations. It should further be framed in such a way as to gain the adherence of the largest possible number and most suitably balanced range of countries, while permitting timely action to be taken. In addition, it should contain provisions for the adoption of separate annexes/protocol(s) to deal with specific obligations. As part of the commitment of the parties to action on greenhouse gas emissions and the adverse effects of climate change, the convention should also address the particular needs of the developing countries, the question of the development and transfer of technology, and institutional requirements.

A number of overarching issues will have to be decided in the negotiation of a convention. These include:

- the political imperative of striking the correct balance: on the one hand, between the arguments for a far-reaching, action-oriented convention and the need for urgent adoption of such a convention so as to begin tackling the problem of climate change; and, on the other hand, between the costs of inaction and the lack of scientific certainty;

- the extent to which specific obligations, particularly on the control of emissions of greenhouse gases, should be included in the convention itself or be the subject of a separate protocol(s);

- the timing of negotiation of such a protocol(s) in relation to the negotiations on the convention.

In addition, specific issues will need to be addressed, such as:

- Financial needs of developing countries: The need for additional resources for developing countries and the manner in which this should be addressed, particularly in terms of the nature, size and conditions of the funding, will have to be considered by the negotiating parties even if detailed arrangements form the subject of a separate protocol.

- Development and transfer of technology: The basis on which the promotion of the development and transfer of technology and provision of technical assistance to developing countries should take place will need to be elaborated, taking into account considerations such as terms of transfer, intellectual property rights, and the environmental soundness of such technology.

- Institutions: Views differ substantially on the role and powers of the institutions to be created by the convention, particularly in exercising supervision and control over the obligations undertaken.

Many countries and international organizations have called for the initiation of international negotiations on a framework convention after completion of the IPCC's first assessment report. The RSWG's analysis of possible elements of a framework convention is intended to provide guidance on the major issues which will likely need to be considered in preparing for such negotiations.

9.0 CONCLUSION

Climate change is an issue which concerns the entire international community. All countries contribute to the atmospheric concentration of greenhouse gases and it is likely that emissions of these gases from almost all regions of the world will rise rapidly through the next century. The potential impacts of climate change would likewise be felt in all corners of the globe.

A large number of response measures are available at the national, regional, and international levels to address climate change. Actions can be taken both to limit the quantity of greenhouse gases which are being released into the atmosphere and to adapt to a changing climate. While a great many possible response options have been identified in this report, some warrant special attention as being particularly important and feasible for introduction in the short term. These include:

- Implementation of measures which are already economically and socially justifiable in their own right and which also provide benefits from a climate change standpoint. Examples include increased energy efficiency, improved use of forests and other natural resources, and reductions in the production and use of CFCs.

- Increased research to reduce the scientific uncertainties regarding the magnitude, timing, and regional impacts of climate change.

- Increased research to understand the economic costs of specific response options so as to provide an adequate information base for making sound policies.

- Development by individual countries of national inventories of greenhouse gas emissions and national plans evaluating those measures which could be undertaken to limit greenhouse gas emissions or adapt to the potential impacts of climate change.

- Strengthening of existing national, regional, and international institutions which have a bearing on climate change, in particular those which improve our scientific understanding of climate change, promote the development of technologies for limiting or adapting to such change, or assist developing countries in addressing this issue.

- Development of a framework convention on climate change which can gain the adherence of the vast majority of the international community and which, at a minimum, lays down general principles and obligations for addressing climate change.

The RSWG will continue its work to further define and evaluate the available response options. Because climate change is a truly global concern, participation of all countries in this effort is vital. Climate change represents a major challenge to the international community, but it is clear that this issue can be addressed through close cooperation in efforts such as the IPCC.

1.0 INTRODUCTION TO OVERALL (200-page) RSWG REPORT

1.1 ESTABLISHMENT OF THE RESPONSE STRATEGIES WORKING GROUP

The Intergovernmental Panel on Climate Change (IPCC) was established under the auspices of the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) to address the need for an international organization which could deal with the issue of climate change. As summarized in WMO Executive Council resolution 4 (EC-XL) of 1987, the organization's objectives are to address climate change by:

> "(i) Assessing the scientific information that is related to the various components of the climate change issue, such as emissions of major greenhouse gases and modification of the Earth's radiation balance resulting therefrom, and that are needed to enable the environmental and socio-economic consequences of climate change to be evaluated; and
>
> (ii) Formulating realistic response strategies for the management of the climate change issue."

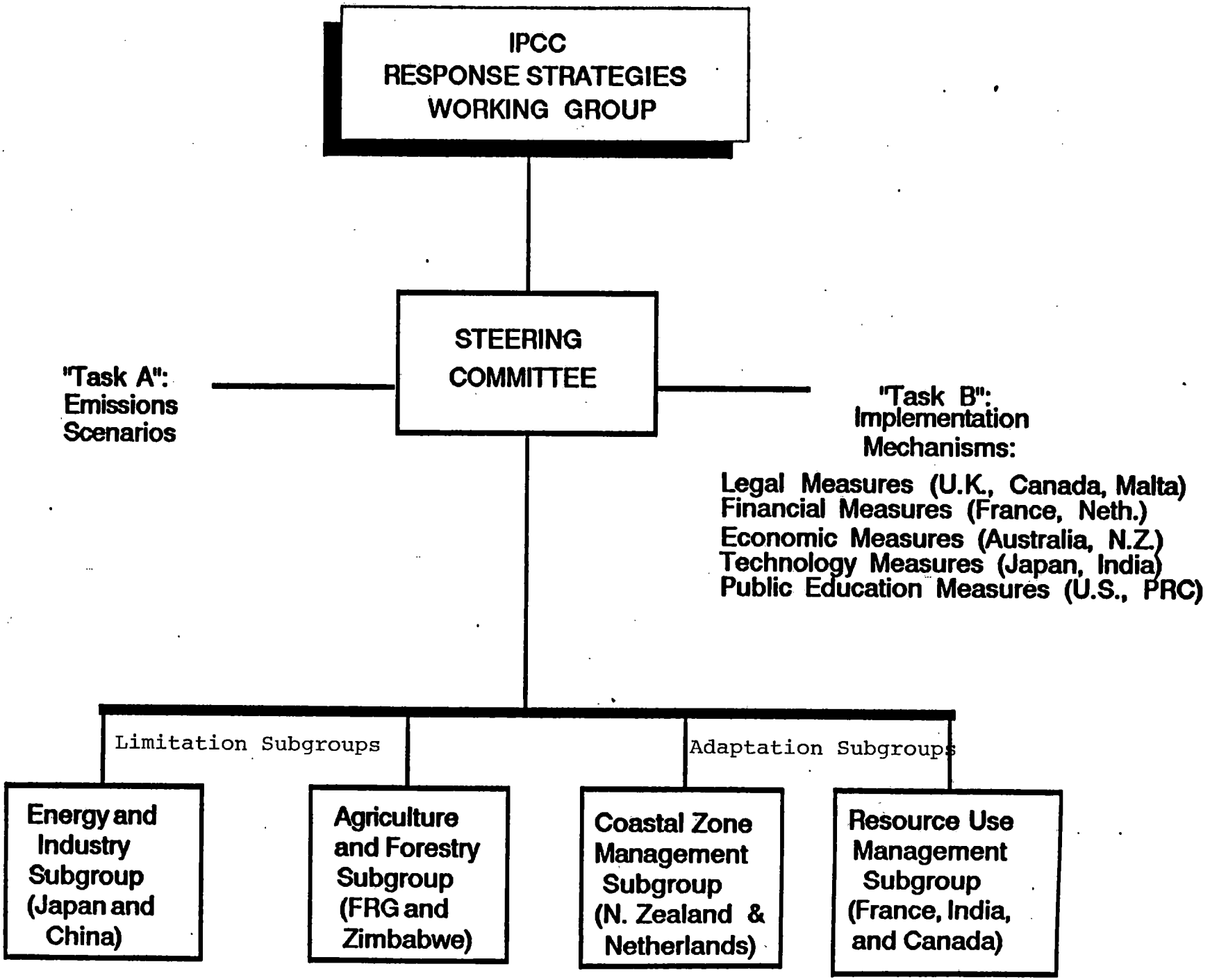
At the IPCC's first meeting in Geneva in November 1988, the Panel agreed that its work included three main tasks:

> (i) Assessment of available scientific information on climate change;
>
> (ii) Assessment of environmental and socio-economic impacts of climate change; and
>
> (iii) Formulation of response strategies.

To accomplish these tasks in the most efficient and expeditious manner possible, the IPCC decided to establish three Working Groups to deal with each of the tasks identified above. The IPCC agreed that the three working groups, on science, impacts, and response strategies, would be chaired, respectively, by the United Kingdom, Soviet Union, and United States.

The latter of these Working Groups, the Response Strategies Working Group (RSWG), held its first meeting in Washington in January 1989 under the chairmanship of Dr. Frederick M. Bernthal of the United States. RSWG Vice-Chairs were also named from Canada, China, Malta, the Netherlands, and Zimbabwe.

At that first meeting, the RSWG established a Steering Committee and four Subgroups to carry out a work plan for formulating response strategies (see figure X). The RSWG


IPCC
RESPONSE STRATEGIES
WORKING GROUP
STEERING
COMMITTEE
"Task A":
Emissions
Scenarios
"Task B":
Implementation
Mechanisms:
Legal Measures (U.K., Canada, Malta)
Financial Measures (France, Neth.)
Economic Measures (Australia, N.Z.)
Technology Measures (Japan, India)
Public Education Measures (U.S., PRC)
Limitation Subgroups
Adaptation Subgroups
Energy and
Industry
Subgroup
(Japan and
China)
Agriculture
and Forestry
Subgroup
(FRG and
Zimbabwe)
Coastal Zone
Management
Subgroup
(N. Zealand &
Netherlands)
Resource Use
Management
Subgroup
(France, India,
and Canada)

Steering Committee was given responsibility for coordinating the Working Group's activities in general and for specifically addressing two cross-cutting tasks: (1) the development of greenhouse gas emissions scenarios; and (2) the development of a strategy for considering implementation mechanisms. The four RSWG Subgroups were tasked with developing a range of climate change response strategies in the areas of: (1) Energy and Industry; (2) Agriculture and Forestry; (3) Coastal Zone Management; and (4) Resource Use and Management. It was agreed that the first two subgroups would consider measures for limiting net greenhouse gas emissions from the energy, industry, agriculture, and forestry sectors, and that the latter two subgroups would deal with measures for adapting to the impacts of climate change on coastal regions and natural resources.

1.2 RSWG STEERING COMMITTEE

The RSWG Steering Committee was established to provide for overall coordination and direction of the RSWG's work. It was also agreed that the Steering Committee would undertake cross-cutting tasks relevant to the work of all the RSWG Subgroups or to the activities of the other two IPCC Working Groups.

1.2.1 Emissions Scenarios: At its first meeting the RSWG requested that, as its first task or "Task A", the Steering Committee conduct an analysis of possible future scenarios of global emissions of greenhouse gases. The purpose of these scenarios was to provide the four RSWG subgroups and the IPCC Science and Impacts Working Groups with a preliminary basis for conducting long range analyses. By April 1989 a U.S.-Netherlands team of experts developed three possible scenarios of future emissions corresponding to: (1) the equivalent of a CO2 doubling from pre-industrial levels by about the year 2030; (2) a CO2 equivalent doubling by approximately 2060; and (3) a doubling by about 2090 with stabilization thereafter. The group subsequently developed two additional emissions scenarios corresponding to emissions projections in which atmospheric concentrations of greenhouse gases are stabilized at a level less than a CO2 equivalent doubling. In addition, the Steering Committee's emissions projections have been complemented by more recent work developed by the Energy and Industry and Agriculture and Forestry Subgroups based on individual country studies of likely long-term greenhouse gas emissions trends.

While the scenarios are hypothetical and based on a number of assumptions which are highly variable when projected over such long time periods, they provide the IPCC Working Groups with a view of what the future may look like and what actions might be necessary to modify that future. The RSWG intends to

continue modifying and refining these estimates to provide the best assessment possible of future emissions patterns.

1.2.2 Implementation Mechanisms: The Steering Committee's second task or "Task B" was to develop a plan for identifying "implementation mechanisms", or, in other words, the specific means through which response strategies can be brought into force in an effective manner. The Steering Committee agreed that it would consider five categories of implementation mechanism and named two or three countries to act as co-coordinators for each topic area:

- Public education and information, which comprises those mechanisms designed to stimulate global awareness of the climate change issue and possible response strategies (co-coordinators: United States and China);

- Economic (market) measures, or those mechanisms which ensure that response strategies are designed in the most cost-effective and economically viable manner possible (co-coordinators: Australia and New Zealand);

- Technology development and transfer, which relates both to mechanisms for promoting the development of new technologies to limit or adapt to climate change and to those which encourage the transfer of climate change related technologies internationally (co-coordinators: Japan and India);

- Financial measures, or those mechanisms which assist in the ability of countries, in particular developing countries, to address climate change (co-coordinators: Netherlands and France); and

- Legal and institutional measures, which deals with assessing legal and institutional mechanisms for addressing climate change, including the possible development of a framework convention on climate change (Co-coordinators: United Kingdom, Canada, and Malta).

The RSWG held a special workshop on these implementation mechanisms in October 1989 in Geneva. The workshop was attended by 43 countries and 8 international organizations and provided an opportunity for a broad exchange of views on these important mechanisms for addressing climate change.

1.3 RSWG SUBGROUPS

The RSWG agreed that consideration of specific response strategies would be conducted by four subgroups in the areas of: (1) Energy and Industry; (2) Agriculture, Forestry, and Other Human Activities; (3) Coastal Zone Management; and (4)

Resource Use and Management. The first two subgroups were designed to address "limitation" issues, e.g. measures to limit net greenhouse gas emissions from the energy, industry, agriculture, and forestry sectors. The latter two subgroups were set up to consider measures for adapting to the impacts of climate change, for example the impacts of sea level rise on coastal regions or of changing temperature and precipitation patterns on natural resources.

1.3.1 Energy and Industry Subgroup: The Energy and Industry Subgroup (EIS), co-chaired by Japan and China, was tasked with defining policy options for climate change response strategies related to greenhouse gas emissions produced by energy production, conversion and use, as well as emissions from industrial sources not related to energy use. The EIS considered energy uses in the industrial, transportation, and residential sectors that produce CO2, methane, nitrous oxide and other gases, and defined technological and policy options to reduce emissions of these gases. The EIS also developed estimates of future greenhouse gas emissions from the energy and industry sector.

1.3.2 Agriculture, Forestry and Other Human Activities Subgroup: The Agriculture, Forestry, and Other Human Activities Subgroup (AFOS), co-chaired by the Federal Republic of Germany and Zimbabwe, was given the mandate of dealing with issues related to the limitation of greenhouse gas emissions from the agriculture, forestry and other sectors not related to the production or use of energy or industrial activities. The AFOS reviewed in particular methane emissions from livestock, rice, biomass, and waste sources, CO2 emissions from deforestation or CO2 uptake from reforestation, and nitrous oxide emissions from the use of fertilizers. The AFOS also developed estimates of future greenhouse gas emissions from the agriculture, forestry, and other sectors.

1.3.3 Coastal Zone Management Subgroup: The Coastal Zone Management Subgroup (CZMS), co-chaired by New Zealand and the Netherlands, was tasked with considering response strategies for dealing with the impacts of sea level rise and the increased incidence of storms and other extreme events on coastal regions. The CZMS reviewed information from governments, institutions, and nongovernmental organizations on technologies, practices, and other relevant activities for the coastal zone and held workshops on technologies and practices in both the Southern and Northern Hemispheres. Based on this work, the CZMS developed a series of options for dealing with potential climate change impacts on coastal regions.

1.3.4 Resource Use and Management Subgroup: The Resource Use and Management Subgroup (RUMS), co-chaired by Canada, France, and India, was tasked with considering measures for adapting to the impacts of climate change on agriculture, fisheries, animal

husbandry, water resources, forests, wildlife and biological diversity, and other natural resources. The RUMS considered possible strategies for either reducing the potential negative impacts or taking advantage of possible positive impacts of climate change on food security, water availability, and natural ecosystems in general.

1.4 OTHER FACTORS

In conducting its activities, the RSWG recognized that the task of developing response strategies was both complex and difficult, particularly because its work would depend on analyses being developed simultaneously in the IPCC Science and Impacts Working Groups. The RSWG was also faced with the need to complete an interim assessment report by the summer of 1990 to form part of the IPCC's first assessment report. Given these constraints, the RSWG agreed that it should concentrate on a short-term (18 month) work plan which would focus on the following elements:

- development and distribution of preliminary emissions scenarios;
- refinement of a strategy for considering implementation mechanisms;
- carrying out of short term work plans of the four RSWG subgroups for integration into an overall RSWG report; and
- development of longer term workplans.

This RSWG report represents the analysis which it was considered feasible to complete in the time available from the first RSWG meeting in January 1989 to the adoption of this report by the RSWG in June 1990. This report identifies a wide range of possible response strategies for limiting or adapting to climate change and reviews available mechanisms for implementing these strategies. It is recognized, however, that there is considerable work to be done in further defining and assessing the response strategies. The RSWG has thus developed a work plan for the next 18-month period and thereafter, with an emphasis on areas where further information is needed to develop response strategies, so that future efforts can be directed in the most effective manner possible.

It must also be emphasized that the RSWG's task is to identify and evaluate response strategies, not to determine which actions should be undertaken by the international community to deal with climate change. The response strategies which have been identified therefore represent options rather than recommendations. While the RSWG has sought to provide useful guidance for policy makers, the determination of what

actions should be undertaken is a subject for formal international negotiations.

Finally, the RSWG, and the IPCC as a whole, has had to deal with the difficulties presented by the relatively limited participation by the international community in some aspects of the Working Group's activities. The participation of centrally planned and developing countries, in particular, has not been as extensive in some of the RSWG's technical work as would be ideal for an exercise of this nature. The RSWG has made great efforts to increase the participation of all countries, in particular developing countries, in its work program. This remains an issue which needs the careful attention of the IPCC as a whole.

United States Department of State

Bureau of Oceans and International Environmental and Scientific Affairs

Washington, D.C. 20520

March 23, 1990

UNCLASSIFIED

MEMORANDUM

To: Distribution

From: OES - Richard J. Smith

Subject: RSWG Legal Mechanisms Paper

Attached is the revised legal mechanisms paper prepared by the international topic coordiators. We have worked with the British and Canadians informally to ensure, as was agreed in February, that the structure of the paper is that of an "issues" paper. The paper is a distinct improvement over the previous two versions and would appear to be a valuable contribution to future negotiators.

We are seeking to clarify the status of the two U.S. contributions on existing legal agreements and institutional arrangements; as you may recall, they were to be attached as appendices to this report.

Roger Beetham has invited one representative each from a limited number of RSWG members (20) to attend a meeting in mid-April to further refine the paper. In preparation for that meeting, we request that you submit any comments to Sue Biniaz (phone: 647-1370; fax: 647-1037) by March 30.

IPCC: RESPONSE STRATEGIES WORKING GROUP

Legal Measures: Report of Topic Co-ordinators (Canada, Malta and the UK)

1. The following report has as its primary objective the discussion of elements that might be included in a future framework Convention on Climate Change, and a discussion of the issues that are likely to arise in the context of developing those elements.

2. There is a general view that while existing legal instruments and institutions with a bearing on climate should be fully utilized and further strengthened, they are insufficient alone to meet the challenge. A very broad international consensus has therefore emerged in the IPCC, confirmed notably at the 44th United Nations General Assembly, on the need for a framework Convention on Climate Change. Such a Convention should generally follow the format of the Vienna Convention for the Protection of the Ozone Layer, in laying down, as a minimum, general principles and obligations. It should further be framed in such a way as to gain the adherence of the largest possible number and most suitably balanced spread of countries; contain provision for separate annexes/protocols to deal with specific obligations, eg research and systematic observation, obligations concerning greenhouse gases. As part of the commitment of the parties to action on greenhouse gas emissions and the adverse effects of global warming, the Convention would also address the particular financial needs of the developing countries and the question of the access to and transfer of technology.

3. The paper points out a number of issues to be decided in the negotiation of a Convention. In general these are:

- the political imperative of striking the correct balance between the arguments for a far-reaching, action-oriented Convention and the need for urgent adoption of such a Convention so as to begin tackling

- whether, in view of the inter-relationship among all greenhouse gases, their sources and sinks, they should be treated collectively;

- whether a number of countries should be permitted to meet their aggregate global climate objectives through joint arrangements.

2. DEFINITIONS

As is the practice, definitions will need to be elaborated in a specific article on definitions. The actual terms to be defined will depend on the purpose of the Convention and thus the language used by the negotiating parties, and may need to include:

- climate;
- climate change;
- adverse effects;
- greenhouse gases;
- their sinks and sources;
- CO_2 equivalence.

3. GENERAL OBLIGATIONS

Following the format of such treaties as the Vienna Convention, an article would set out the general obligations agreed to by the Parties to the Convention. Such obligations may relate to, for example:

- the responsibility to adopt appropriate measures to protect against the adverse effects of climate change, to limit, adapt to, and as far as possible prevent, climate change and to avoid creating other environmental problems in taking such measures;

- the responsibility to protect and improve the composition of the atmosphere in order to conserve climate for the benefit of present and future generations;

- encouragement of steps having the effect of limiting climate change (eg reforestation, energy efficiency) but which are already justified on other grounds;

- exploitation of climate for peaceful purposes only and in accordance with the principles of good neighbourliness;

- co-operation by means of research, systematic observation and information exchange in order better to understand and assess the effects of human activities on the climate and the potential adverse environmental and socio-economic impacts that could result from climate change;

- encouragement of the development and transfer of relevant technologies, as well as the provision of technical and financial assistance, taking into account the particular needs of developing countries to enable them to fulfil their obligations;

- co-operation in the formulation and harmonization of policies and strategies directed at limiting, reducing, adapting to and, as far as possible preventing, climate change;

- co-operation in adoption of appropriate legal, administrative or regulatory measures to address climate change;

- provision for bilateral, multilateral and regional agreements or arrangements not incompatible with the Convention and its annexes/protocols, including opportunities for groups of countries to fulfil the requirements on a regional or sub-regional basis;

- permissibility of more stringent national or regional emission targets than provided for in the Convention and/or its annexes/protocols;

- co-operation with competent international organisations to implement effectively the objectives of the Convention;

- encouragement of and co-operation in the promotion of public education and awareness of the environmental and socio-economic impacts of greenhouse gas emissions and of climate change;

- commitment to formulate appropriate annexes/protocols on a sound scientific basis;

- strengthening of existing legal and institutional instruments and arrangements relating to climate change, and making full use of existing funding mechanisms.

Other issues which may be expected to arise in the process of elaborating this article might include the following:

- whether a provision should set any specific goal with respect to levels of emissions (global or national) or atmospheric concentrations of greenhouse gases while ensuring stable development of the world economy, particularly stabilisation by industrialised countries, as a first step, of CO_2 emissions and emissions of other greenhouse gases not controlled by the Montreal Protocol;

- whether a provision should recognise that implementation of obligations may take place in different time frames for different categories of country and/or may be qualified by the means at a parties' disposal;

- whether, in addressing the transfer of technology, the provision should address the terms of such transfers (ie commercial vs. non-commercial, preferential vs. non-preferential, the relationship between transfers and the protection of intellectual property rights);

- whether the question of additionality, with respect to financial assistance, or the development of new funding mechanisms and additional financial resources (eg a Climate Trust Fund), should specifically be mentioned in regard to aiding (compensating) developing countries in meeting their obligations under the Convention, particularly those which may have to bear an abnormal or special burden;

- whether to provide for prior notice and provision of relevant environmental impact assessment information of large-scale planned activities that are likely to cause signficant climate change;

- what should be the basis of emission targets in the protocols (eg per capita, GDP);

- the particular problem of sea level rise;

- how much detail the Convention should go into, eg over obligations in respect of co-operation in research and information.

4. INSTITUTIONS

It has been the general practice under international environmental agreements to establish various institutional mechanisms. The Parties to a Climate Change Convention might, therefore, wish to make provision for a Secretariat, a Conference of the Parties and a Bureau/Executive Committee. The Secretariat would perform certain administrative functions assigned to it under the Convention. The Conference of the Parties may, among other things: keep under continuous review the implementation of the Convention; review current scientific information; and promote harmonization of appropriate policies, strategies and measures for minimising the release of substances causing or likely to cause climate change. The Bureau/Executive Committee might be entrusted with functions in respect of surveillance, verification and compliance.

Issues that may arise in developing provisions for appropriate institutional mechanisms include:

- whether any of the Convention's institutions (eg the Conference of the Parties or the Bureau/Executive Committee) should have the ability to take decisions on response strategies or functions in respect of surveillance, verification and compliance that would be binding on all the parties and, if so, whether such an institution would represent all of the parties or be composed of a limited number of parties based on equitable geographic representation;

- if a trust fund or other financial mechanism were established under the Convention, whether there should be an institution for the administration of such a mechanism;

- whether or not to establish a Scientific Council to provide advice and make recommendations to the Conference of the Parties concerning research activities and measures to deal with climate change;

- whether to provide for the establishment of working groups, eg on scientific matters as well as on socio-economic impacts and response strategies.

5. RESEARCH AND SYSTEMATIC OBSERVATIONS

It would appear to follow general practice to include provision for co-operation in research and, particularly with respect to air pollution agreements, systematic monitoring. In terms of research, if one were to follow the Vienna Convention model, the parties might be called upon to undertake, initiate, and/or co-operate in, directly or through international bodies, the conduct of research on:

- physical and chemical processes that may affect climate;
- substances, practices, processes and activities that could modify the climate;

implementation of the Convention and of protocols to which they are party. In an annex to the Vienna Convention the types of information exchanged are specified and include scientific, technical, socio-economic, commercial and legal information.

For the purposes of elaborating this provision, issues having to be addressed by the negotiating parties might include the following:

- whether there is the need for the elaboration of a comprehensive international research programme in order to facilitate co-operation in exchange of scientific, technological and other information on climate change;

- whether parties should be obliged to report on measures they have adopted for the implementation of the framework Convention, with the possible inclusion of regular reporting on their emissions of greenhouse gases;

- whether each party should additionally be called upon to develop a national inventory of emissions, strategies and available technologies for addressing climate change; if so, the Convention might also call for the exchange of information on such inventories, strategies and technologies.

7. TECHNOLOGY TRANSFER

While the issue of technology has been addressed in the section on General Obligations, it might be considered desirable to include a separate provision on technology transfer. Such a provision could call upon the parties to promote the development and transfer of technology and provision of technical assistance, taking into account particularly the needs of developing countries, to enable them to take steps to limit, reduce and as far as possible prevent climate change, or to adapt to it.

An issue that is likely to arise is whether special terms (eg preferential and/or non-commercial) would attach to climate-related transfers of technology. This provision will require further

- whether a single annex or protocol might cover more than one of the above subjects (eg all greenhouse gases might be the subject of a single protocol);

- timing, ie, negotiating parties advocating a more action-oriented Convention may seek to include specific obligations in annexes as opposed to subsequent protocols;

- sequence, ie, if there are to be a series of protocols, in what order are they to be taken up (for example, whether priority should be given to those areas concerning which the state of scientific understanding is most develped or whether greenhouse gases should be treated in accordance with their significance in terms of contributing to climate change.

- relationship between the Convention and its protocols;
- entry into force;
- reservations;
- withdrawal;
- depositary;
- authentic texts.

11. ANNEXES AND PROTOCOLS

The negotiating parties may wish the Convention to provide for the possibility of annexes and/or protocols. Annexes might be concluded as integral parts of the Convention, while protocols might be concluded subsequently (as in the case of the Montreal Protocol to the Vienna Convention on Protection of the Ozone Layer). The following among others, might be considered as possible subjects for annexes or protocols to the Convention:

- fossil fuels;
- carbon dioxide;
- agricultural practices;
- methane;
- nitroue oxide;
- tropospheric ozone;
- forestation;
- funding mechanisms;
- research and systematic observations;
- energy conservation and alternative sources of energy;
- protection of greenhouse gas sinks;
- liability and compensation;
- international emissions trading;
- emission control technologies;
- adaption technologies and practices;
- development and transfer of technology;

Issues that may arise in connection with the development of annexes and protocols include:

- techniques for monitoring and measuring greenhouse gas emission rates;
- improved climate models, particularly for regional climates;
- environmental, social and economic effects that could result from modifications of climate;
- alternative substances, technologies and practices;
- environmental, social and economic effects of response strategies;
- human activities affecting climate;
- coastal areas with particlar reference to sea-level rise;
- water resources; and
- energy efficiency.

Other issues that might arise in developing this provision might include:

- whether consideration should be given to the establishment of panels of experts or of an independent scientific board responsible for the co-ordination of data collection from the above areas of research;

- whether the parties should co-operate in promoting or establishing, directly and/or through competent international bodies, joint or complementary programmes for systematic monitoring of the climate, including a possible worldwide system;

- whether to co-operate in ensuring the collection, validation and transmission of research and observational data through appropriate data centres.

- the possibility of on-site inspection.

6. INFORMATION EXCHANGE AND REPORTING

Precedents would suggest the inclusion of provision for the transmission of information through the Secretariat to the Conference of the Parties on measures adopted by them in

- recognition of responsibility of all countries to make efforts to limit or reduce greenhouse gas emissions and prevent activities which would adversely affect climate;

- recognition of need for development of strategies to absorb greenhouse gases, ie protect and increase greenhouse gas sinks; to limit or reduce anthropogenic greenhouse gas emissions and to adapt human activities to the impacts of climate change.

"

Other issues which may rise during the development of the preambular language could include:

- whether it is sufficient for the preamble to recognise the responsibility of all countries to address climate change, noting that most emissions currently and historically originate in industrialized countries where the scope for change is greatest; that emissions from developing countries may need to grow in order to meet development requirements and thus are likely to represent, over time, an increasingly significant percentage of global emissions; that implementation of the Convention may take place in different time frames for different categories of countries and may be qualified by the means at the disposal of individual countries and their scientific and technical capabilities;

- whether already in the preamble the particular problems of countries with an agricultural system vulnerable to climate change and with limited access to capital and technologies should be addressed, recognising the link with sustainable development;

- whether mankind's interest in a viable environment should be characterised as a fundamental right;

- whether there is an entitlement not to be subjected, directly or indirectly, to the adverse effects of climate change;

ELEMENTS FOR INCLUSION IN A CONVENTION ON CLIMATE CHANGE

1. PREAMBLE

In keeping with common treaty practice including the format of the Vienna Convention, the Climate Change Convention would contain a preamble which might seek to address the following items:

- a description of problem and reasons for action (need for timely and effective response while awaiting absolute scientific certainty);

- a reference to relevant legal instruments (such as the Vienna Convention and Montreal Protocol) and declarations (such as UNGA Resolution 43/53, Principle 21 of the Stockholm Declaration and the ENMOD Treaty);

- recognition that climate change is a common concern of mankind, affects humanity as a whole and should be approached within a global framework;

- recognition of the need for an environment of a quality that permits a life of dignity and well-being for present and future generations;

- reference to balance between sovereign right of states to exploit natural resources and concomitant duty to protect and conserve climate for benefit of mankind;

- endorsement of concept of sustainable development;

- recognition of the need to improve scientific knowledge (eg through systematic observation) and to study the social and economic impacts of climate change;

- recognition of the importance of development and transfer of technology and of the circumstances and needs, particularly financial, of developing countries; need for regulatory, supportive and adjustment measures to take into account different levels of development of countries;

- the extent to which specific obligations, particularly on the control of emissions of carbon dioxide and other greenhouse gases, should be included in the Convention itself or be the subject of separate protocols;

- the timing of negotiation of such protocols in relation to the negotiations on the Convention.

4. In particular, within the Convention the following specific issues will need to be addressed:

(a) Financial needs of developing countries. The need for additional resources for developing countries, and the manner in which this should be addressed, particularly in terms of the nature, size and conditions of the funding, even if detailed arrangements form the subject of a separate protocol.

(b) Transfer of technology. The basis on which the promotion of the development and transfer of technology and provision of technical assistance to developing countries should take place will need to be elaborated, taking into account considerations such as terms of transfer, assured access, intellectual property rights and the environmental soundness of such technology.

(c) Institutions. Views differ substantially on the role and powers of the institutions to be created by the Convention particularly in exercising supervision and control over the obligations undertaken.

5. The co-ordinators do not seek to make a value judgement in listing and summarising in the attached paper the elements proposed for inclusion in a framework Convention: their text seeks merely to assist the future negotiators in their task. They note however that a readiness to address the foregoing fundamental problems in a realistic manner will be a prerequisite for ensuring the success of the negotiations and the support of a sufficiently wide and

consideration of issues related to assured access to, and transfer of, environmentally sound technologies on favourable terms to developing countries, and the protection of intellectual property rights.

8. CONSULTATION

The parties negotiating the Convention may wish to consider a provision on consultation between, on the one hand, parties whose planned activities are likely to cause climate change and, on the other hand, the Secretariat, relevant international organisations and other parties concerned.

9. SETTLEMENT OF DISPUTES

It would be usual international practice to include a provision on the settlement of disputes that may arise concerning the interpretation or application of the Convention and/or its annexes/protocols. Provisions similar to those in the Vienna Convention for the Protection of the Ozone Layer might be employed, ie voluntary resort to arbitration or the International Court of Justice (with a binding award) or, if neither of those options is elected, mandatory resort to conciliation (with a recommendatory award).

10. OTHER PROVISIONS

It would be the usual international practice to include clauses on the following topics:

- amendment of the Convention;
- status, adoption and amendment of annexes;
- adoption and entry into force of, and amendments to, protocols;
- signature;
- ratification;
- accession;
- right to vote;