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Folder Title: 330 – Global Climate Change (1)
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United States Department of State

Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs

Washington, D.C. 20520

January 15, 1988

MEMORANDUM

TO: Dr. Ralph Bledsoe
Domestic Policy Council
The White House

FROM: Richard J. Smith, Acting

SUBJECT: Global Climate Change

THE ISSUE

Global climate change poses policy issues of major importance to the United States Government. The topic has become a focus of interest in the Congress, in the media, and in international organizations.

As scientific research on global climate change has advanced over the past decade, global warming has become an issue in national and international fora. Significant uncertainties remain about the magnitude, timing and regional impacts of climate change. Still, global warming at an unprecedented rate in the coming decades appears likely, as a result of human activities (e.g., emissions of CO_2, NO_x, CFC's, and deforestation). Global warming within a century could be greater than that experienced over the past 10,000 years. The resulting changes will surely have broad implications for U.S. domestic and international policies.

AN ACTIVE INTERNATIONAL AGENDA

Various individuals and agencies of the U.S. government have participated and will participate in a complex agenda of international activities addressing this issue. For example:

-- The World Climate Program (WCP), sponsored by the World Meteorological Organization (WMO), the U.N. Environment Program (UNEP), and the International Council of Scientific Unions (ICSU), recently has begun to focus more on changes in the decades-to-centuries time scale (it has traditionally focused on weather and seasonal-to-interannual variations).

-- A conference sponsored by UNEP, WMO and ICSU on the Role of Carbon Dioxide and Other Greenhouse Gases in Climate Variations and Associated Impacts was held in Villach, Austria, in 1985.

-- A non-governmental Advisory Group on Greenhouse Gases (AGGG) was established to follow up on the 1985 Villach recommendations. On the AGGG's recommendation, UNEP, WMO and ICSU sponsored workshops on the science and response strategies in Villach and in Bellagio, Italy in 1987.

-- Planning has already begun for the WCP's Second World Climate Conference, to be held in 1990. (The First World Climate Conference was in 1979.)

-- In response to the recommendations of the World Commission on Environment and Development (WCED), the Canadian Government has announced a major, policy-oriented conference on "The Changing Atmosphere: Implications for Global Security," to be held in Toronto in June 1988. Lee Thomas, Bill Nitze and other Administration officials have been invited.

-- Last summer, the UNEP and WMO governing bodies called for establishment of an intergovernmental panel to assess the state of scientific knowledge about the magnitude, timing and regional impacts of climate change, in order to lay a sound basis for consideration by governments of possible responses.

-- The UNEP Governing Council also requested its executive director to report to the next GC on "the full range of possible responses by Governments and international agencies to anticipated climate change, including possibilities for reducing the rate of climate change...."

-- The OECD will consider at its spring Environment Committee meeting a work program in this field.

-- Proposals are currently under consideration in the Conference on Security and Cooperation in Europe (CSCE) for a statement on climate.

-- The International Geosphere-Biosphere Program (IGBP), being developed under ICSU, is a major multidisciplinary research program which will extend through the 1990's. U.S. participation is coordinated by the National Academy of Sciences, with extensive executive branch participation. For example, Dr. S.I. Rasool of NASA is coordinating a multinational IGBP group on data, which will hold a conference in Moscow in August 1988.

-- At the U.S.-Soviet summit, the President and General Secretary Gorbachev approved a bilateral initiative to pursue joint studies in global climate and environmental change under our bilateral environmental and space agreements. The joint statement also said the two sides will continue to promote broad multilateral cooperation in this field.

DOMESTIC AND INTERNATIONAL POLICIES

It is imperative that we develop coherent domestic and international policies to deal with this issue. The global change issue is inherently international; domestic policies and activities must take this into account. Conversely, positions the United States takes in international fora must be fully consistent with domestic policies. U.S. credibility on this issue will be enhanced internationally if we have a coherent national policy.

The Global Climate Protection Act of 1987, incorporated in the State Department authorization, states: "The Secretary of State shall be responsible to coordinate those aspects of United States policy requiring action through the channels of multilateral diplomacy...." The Act also states: "The President, through the Environmental Protection Agency, shall be responsible for developing and proposing to Congress a coordinated national policy on global climate change."

RECOMMENDATION

To assist the Department of State in fulfilling its mandate under the Global Climate Protection Act, I recommend that the Domestic Policy Council, through its Working Group on Energy, Natural Resources and the Environment (ENRE), take up the global climate issue. The ENRE Working Group, and as appropriate the DPC itself, should participate in developing U.S. positions on this issue in international fora, by providing guidance on relevant domestic policies.

I suggest the issue be placed on an early ENRE agenda, that the appropriate scientific agencies be asked (perhaps through the Committee on Earth Sciences) to provide a briefing on the state of the science, and that I provide a briefing on the international agenda.

The National Climate Program Policy Board should, I believe, be asked to keep the DPC informed (through ENRE), to refer issues as appropriate, and to develop options for consideration by ENRE on climate policies. Agencies should be asked to see that their participation in the Climate Board is at an appropriate level. (The Climate Board will also keep the Committee on Earth Sciences informed, particularly on science and program coordination aspects. As noted by Dr. Graham at the CES meeting last month, CES will work with the DPC on the science side.) Other relevant bodies (e.g., the Panel for

International Programs and International Cooperation in Ocean Affairs, the Interagency Group on Space Activities) should coordinate with and refer issues to the DPC as appropriate.

NASA (which has a major earth observation program) and NSF (which funds numerous domestic and international environmental research programs) should be invited to participate in ENRE meetings when global climate issues are on the agenda.

AN IMMEDIATE ISSUE

We should bring to the Working Group's attention now the U.S. position on the WMO/UNEP intergovernmental panel. We want to make the panel a responsible, workable forum for governments to consider what we know, what we need to know, and how the international community can and should respond.

The Climate Program Policy Board is preparing a paper on the U.S. position on the intergovernmental panel. We plan to have the U.S. permanent representative to the WMO (Richard Hallgren of NOAA) circulate the paper at a February 8 meeting of the WMO Bureau. In this way, we expect to be able to have a significant impact on shaping the intergovernmental panel. The paper will also guide U.S. representatives in consultations with the PRC and the Soviet Union in late January and early February, in order to lay the groundwork for the WMO Bureau meeting. We expect the paper to be ready later today, reflecting the discussion in this morning's Board meeting.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE GENERAL COUNSEL

JAN 22 1988

MEMORANDUM FOR: Ralph Bledsoe
Executive Secretary
Domestic Policy Council

FROM: J. R. Spradley
Deputy General Counsel, NOAA

SUBJECT: Global Climate

I recommend that the DPC Working Group on ENRE address global climate.

Attached is a draft U.S. Position for the establishment of an Intergovernmental Panel on Climate Change. Attachment A. The proposal calls for the Panel to carry out: I. Assessment of the Science; and, II. Assessment of the Social and Economic Effect of Climate Change and Societal Responses.

U.S. scientists are meeting with representatives of China (Jan. 28, here) and the U.S.S.R. (Feb. 1, there) and at WMO (Feb. 8) to discuss, inter alia, global climate. In addition, Canada is hosting a conference on global climate on Jan. 27-30, 1988, in Toronto. Attachment B. Most importantly, the Congress has directed the President to develop a policy on global climate. Attachment C.

Given the status of these activities it is appropriate and timely for the DPC to review the subject and establish a policy.

Attachments (3)

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THE WHITE HOUSE

WASHINGTON

November 3, 1986

MEMORANDUM FOR THE WORKING GROUP ON ENERGY, NATURAL RESOURCES AND ENVIRONMENT

FROM: RALPH C. BLEDSOE Ralph Bledsoe

SUBJECT: Agenda for Next Meeting

The next meeting of the Working Group will be on Wednesday, November 5, 1986 at 10:00 A.M. in Room 208 of the Old EOB. The major topic of discussion will be global climate change, background materials for which are enclosed.

Enclosure

REPORT OF THE

AD HOC SUB-WORKING GROUP ON

GLOBAL CLIMATE CHANGE

NOVEMBER 1, 1986

CONTENTS

Discussion Material

DRAFT

DISCUSSION MATERIAL:

- o NATURAL VARIABILITY OF THE CLIMATE SYSTEM
- o THE POTENTIAL FOR MAN MADE CHANGE
- o ECONOMIC AND STRATEGIC IMPLICATIONS OF GLOBAL CLIMATE CHANGE

NOVEMBER 1, 1986

Fig. 1. Earth photo from space.

COMPONENTS OF THE ATMOSPHERE-OCEAN-ICE-LAND SURFACE-BIOMASS CLIMATIC SYSTEM

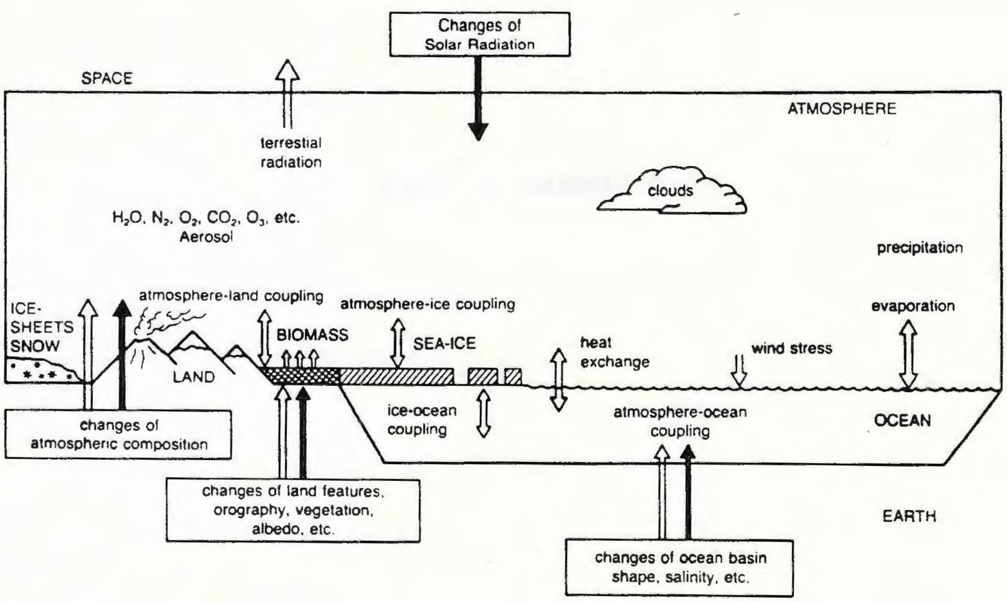

Fig. 2. Schematic of Earth's climate system.

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NATURAL VARIABILITY OF THE CLIMATE SYSTEM

To understand the present implications of global climate change, some perspectives on the natural variability of the Earth's climate system are needed.

The Earth's climate system (Figures 1 and 2) comprises the atmosphere, the hydrosphere, the geosphere, and the cryosphere. Each of these components embodies numerous processes that determine its role in the system, and each interacts strongly with the other.

Large changes in the climate system are thought to result in part from changes in external forcing factors such as solar radiation, Earth's rotational effects, or (some have argued) meteor impacts. Other changes occur because of alterations in processes internal to the climate system, greenhouse warming or sea level changes, for example.

This complex array of interacting components, each of which contains a variety of processes that strongly affect one another, constitutes what scientists call a highly interactive nonlinear system. The most relevant single feature of such a system (for this discussion) is the fact that it is inherently non-intuitive: altering one process will generally have complex effects throughout the rest of the system, many of which cannot readily be foreseen.

TEMPERATURE CHANGES THROUGH THE AGES

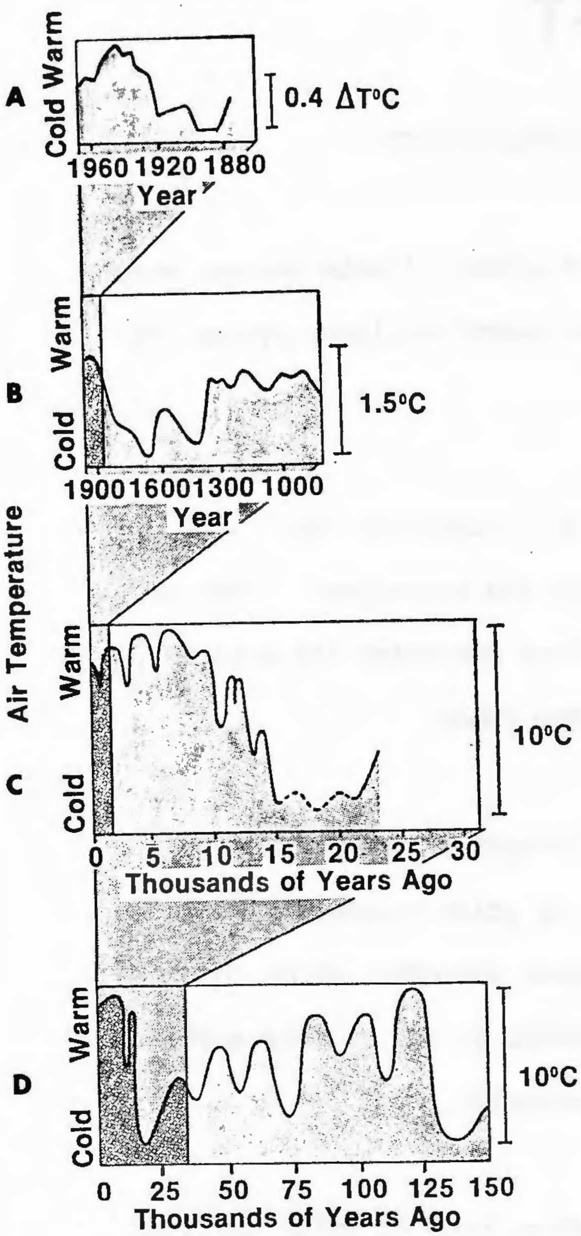
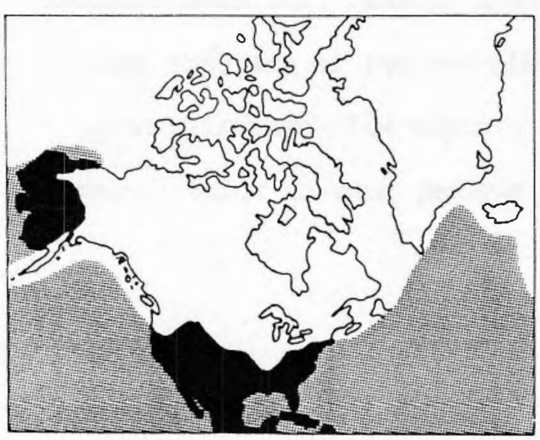
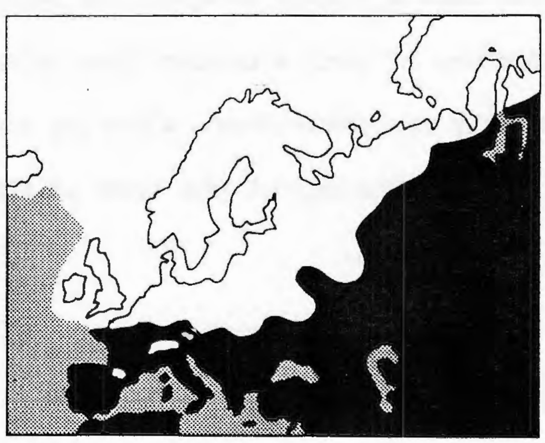


Fig. 3. Telescoping temperature records for past 150,000 years (D). (C) through (A) delineate increasingly detailed records up to the present.



The areas of North America covered by glaciers during the last Ice Age.



The areas of Europe covered by glaciers during the last Ice Age.

Fig. 4. Extent of Northern Hemisphere ice ages.

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One helpful perspective on global climate change is provided by temperature data for the past hundred thousand years (Figure 3).

Examining the longest record in Figure 3D, we see the periods of relative cold, the well-known ice ages, the last of which occurred approximately 20,000 years ago. The average temperature at the surface of the Earth is estimated to vary over a range of approximately 10°C in major ice age events.

The effects of such a change can be seen in Figure 4, which delineates the areas of North America and Europe covered by polar ice in the ice age that occurred around 20,000 years ago (see Figure 3C).

If we examine the period of the last thousand years, the average temperature of the Earth is known to have varied by approximately 1.5°C (Figure 3B). This change produced some remarkable results. The period which began around 900 or 1000 AD was known as a modest "climate optimum" and was followed by a cooling around 1300 that led to the well-known "Little Ice Age" in northern Europe.

Fig. 5. Frost fair on the Thames.

AVERAGE ANNUAL TEMPERATURE CYCLE FOR WARMEST DECADE (1943-52) AND COLDEST DECADE (1691-1700) ON RECORD IN CENTRAL ENGLAND

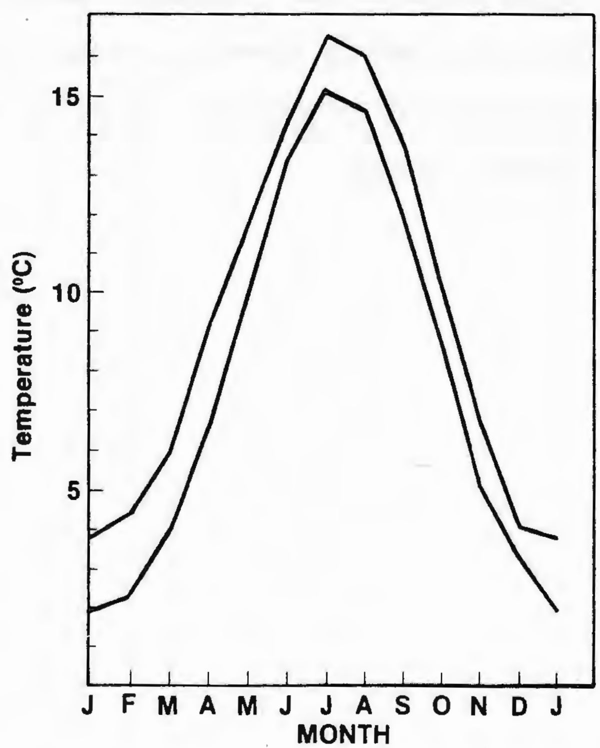

Fig. 6. Mean temperatures in central England during two contrasting periods.

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England enjoyed a relatively mild climate during the optimum period; wine vineyards, for example, were wide-spread. At the same time Greenland experienced a mild, ice free climate quite unlike that of today. Figure 5 depicts the contrasting situation that existed in England only a few centuries later during the Little Ice Age. The figure is a contemporary wood cutting of a frost fair (winter festival) on the Thames in London, where a small semi-permanent city arose on the frozen river.

Neither of these extremes is representative of the climate existing in England or northern Europe today, yet each occurred in relatively recent historical time.

The magnitude of associated temperature changes in England is shown in Figure 6, for purposes of later comparison. The curves reflect the average annual temperature cycle for the warmest and coldest decades on record in central England. They indicate that the climate of central England during the Little Ice Age and the present more temperate climate of today differed by approximately 1 1/2 - 2^{o}C in regional average temperatures.

GLOBAL MEAN TEMPERATURE CHANGE

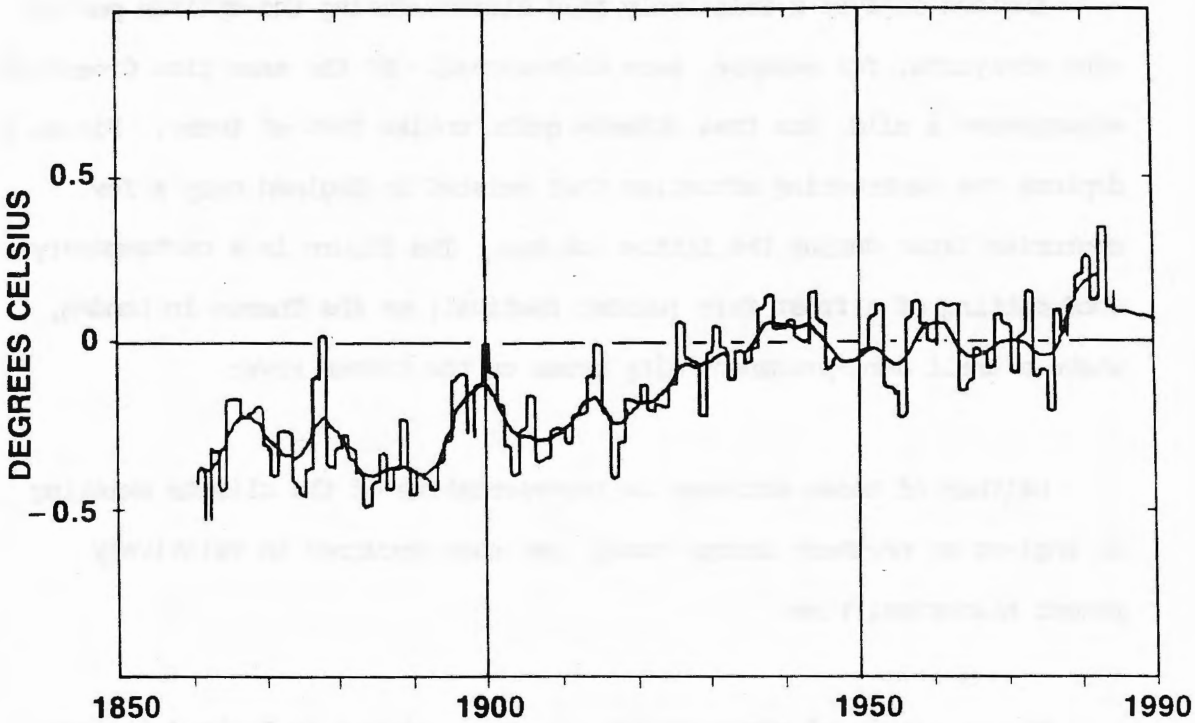

Fig. 7 Global average temperatures computed from the most complete set of historical observations.

U.S. MEAN ANNUAL TEMPERATURE

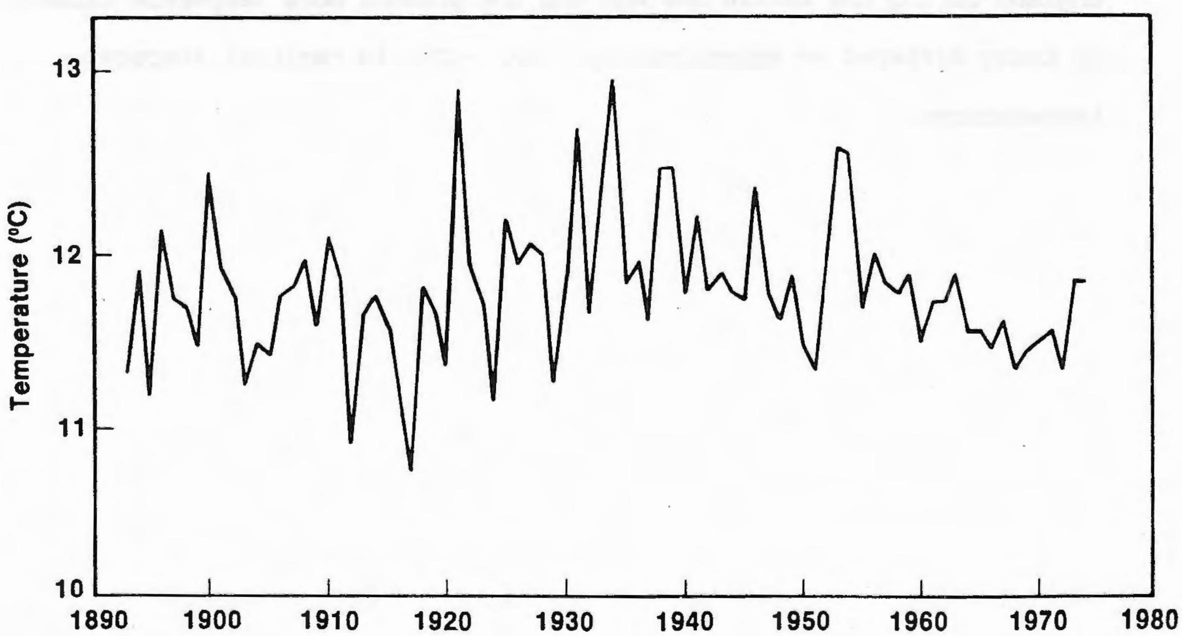

Fig. 8. Temperature variability for U.S. mainland.

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Global temperature averages over the last century (Figure 3A) have typically varied within the range of 0.5°C, but until recently the global trends were not particularly well-known. The most recent computation of the global temperature over the last century is shown in Figure 7. An overall increase of approximately 0.5°C is indicated over the last century. But an unambiguous interpretation of the increase is made difficult by the relatively steady value from 1940 to 1980. In other words, there is more than one way to view Figure 7, and cautious interpretation is required. The implications of the data in this figure are still being debated by scientists.

Examination of the average annual temperature in the U.S. over the last century (Figure 8) reveals another important feature of the climate system. This curve is characterized by year to year (interannual) variability that is much larger than any long-term trends over the same period. The typical year-to-year difference in the average annual temperature for the U.S. is slightly greater than the difference in the mean temperatures of northern Europe between the present and the Little Ice Age of the 1600's. This strong regional signal, greatly reduced in global averages, is typical of the Earth's climate system. In general, local variations in climate can exceed global averages several times over.

Strong interannual variability in climate will later be shown to produce highly variable human conditions. This feature of the climate system is now known to be a result of year-to-year changes in the atmospheric heating patterns in the tropics.

ATMOSPHERIC VERTICAL CIRCULATION ALONG EQUATOR

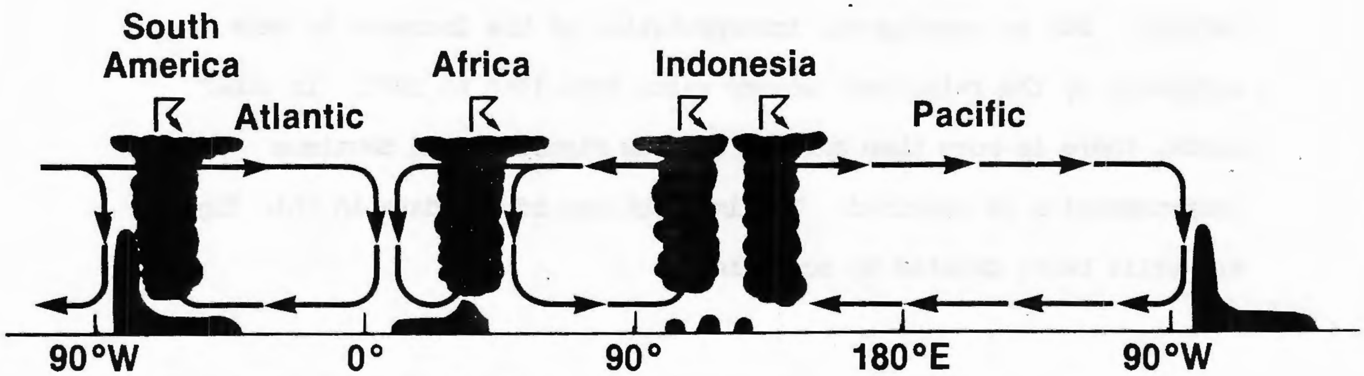

Fig. 9. Schematic of atmospheric heating patterns along the Earth's equator. The three major convective centers are shown, with the resulting vertical air motions.

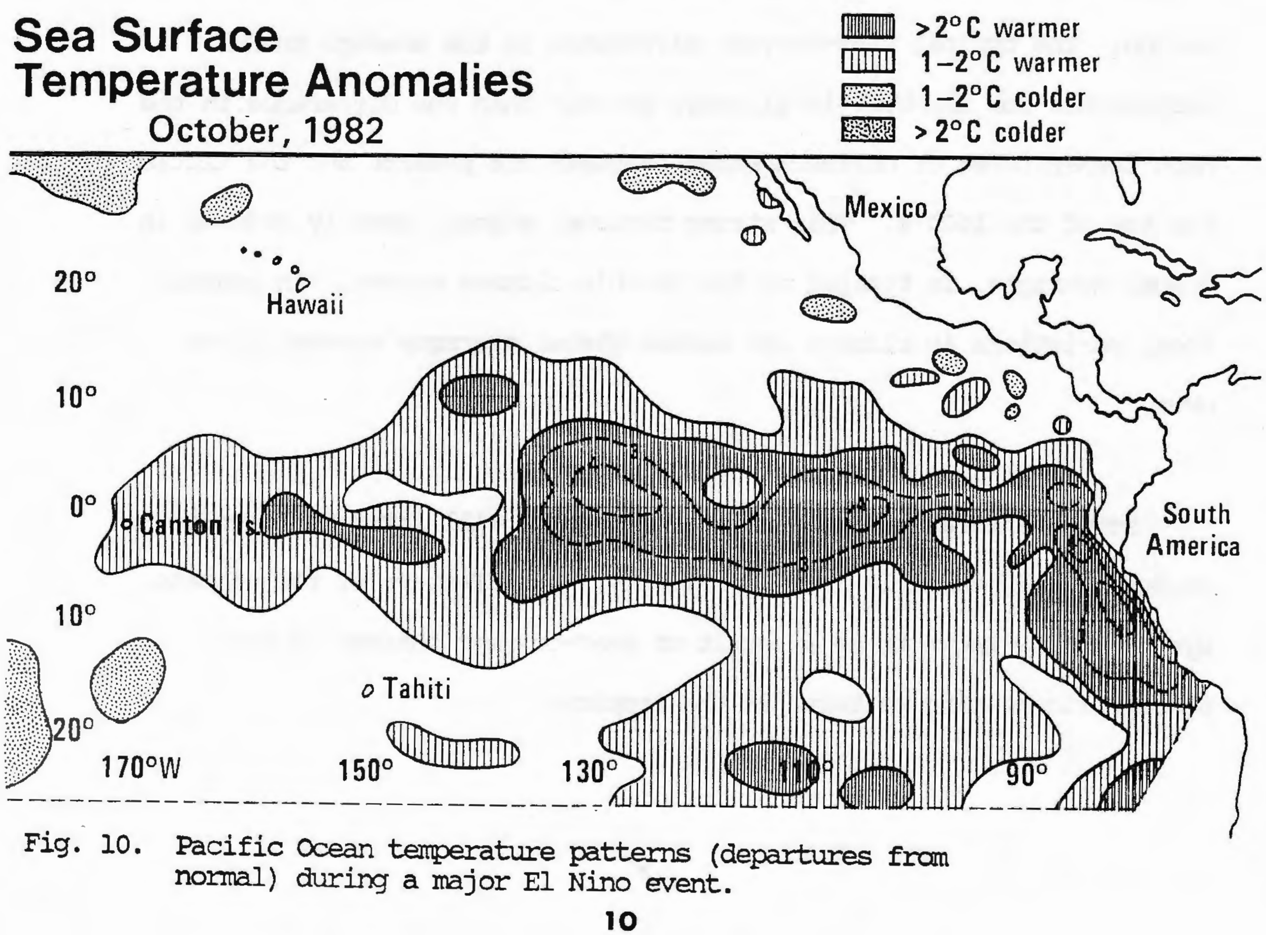

Fig. 10. Pacific Ocean temperature patterns (departures from normal) during a major El Nino event.

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Figure 9 depicts the normal pattern of atmospheric heating in the tropics. Most of the heating which fuels the global atmospheric 'heat engine' occurs over the continents of South America and Africa and at the maritime continent centered over Indonesia. The center of maritime heating dominates the other two since it provides most of the moisture to the tropical atmosphere. This center of heating is also critically important because it can move away from its normal position (unlike the other two) as a consequence of major changes in underlying oceanic conditions.

These changes in the position of the atmosphere's principal source of heat occur frequently but irregularly and are accompanied by unusually warm water in the central and eastern tropical Pacific (Figure 10). The "anomalies" indicated in this figure are departures from the temperatures normally observed in the region. This Pacific Ocean warming phenomenon is known as El Nino; the strongest such variation occurred recently, in 1982.

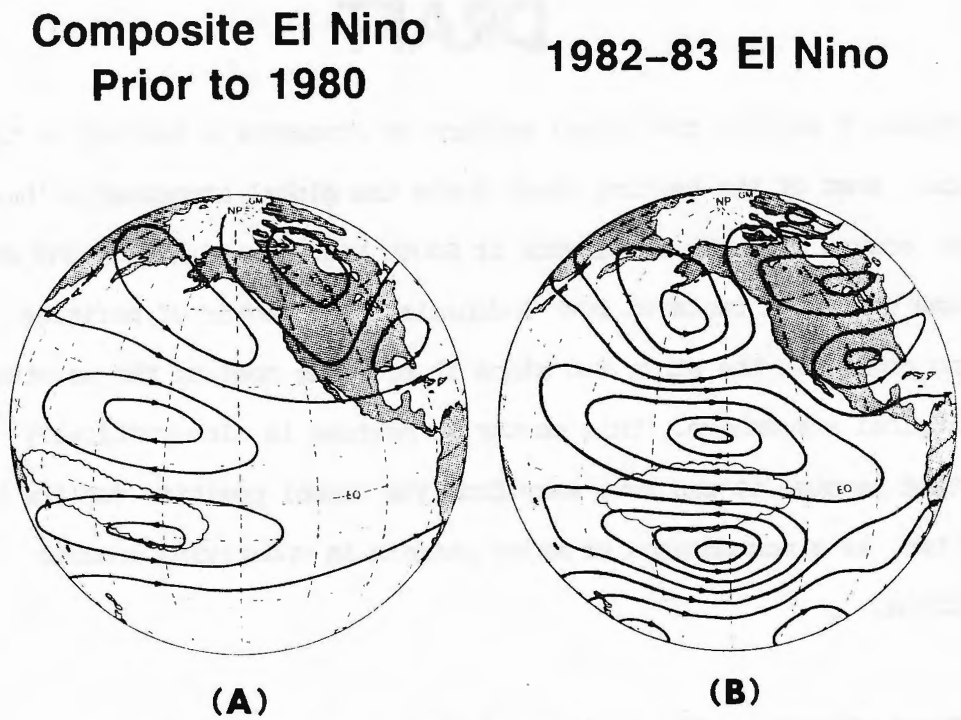

Fig. 11. Atmospheric circulation patterns resulting from tropical heating patterns.

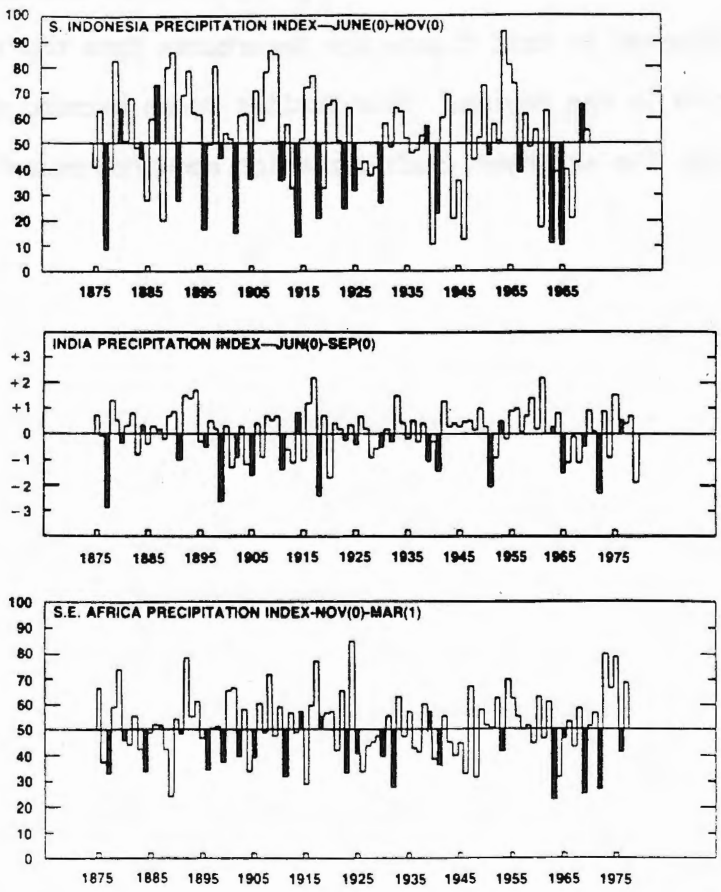

Fig. 12 Precipitation indices from three regions with strong interannual climate variations.

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These shifts in atmospheric heating patterns periodically alter the circulation of much of the Earth's atmosphere. In an El Nino event, the Earth's normal pattern of high and low pressure systems is altered as shown in Figure 11. In this figure the cloud depicted at the equator represents an area of abnormal atmospheric heating that, in turn, produces a pattern of altered atmospheric motions.

The change in atmospheric circulation can produce a variety of effects globally. In an El Nino like the one in 1976-77 (Figure 11A), a relatively mild winter was experienced in the southwestern United States. The atmospheric circulation shifted the winter jet stream over the western U.S. northward, deflecting cold arctic air away from that region. The northeast U.S., on the other hand, experienced unusually cold winter conditions.

For the contrasting case of the 1982-83 El Nino, the changes in atmospheric circulation produced a highly intensified pattern of severe storms hitting the southwest coast of the United States (Figure 11B).

This changing pattern of atmospheric heating in the tropics constitutes one of the most important features of climate variability. Excepting locally intense features such as regional drought, it is the strongest global climate signal to which man is presently subjected.

Another of the worldwide features associated with interannual changes is represented in Figure 12. Throughout much of the world, there is a strong year-to-year variation in precipitation that results from changing tropical heating patterns. This strongly varying precipitation will later be shown to affect human society in fundamental ways.

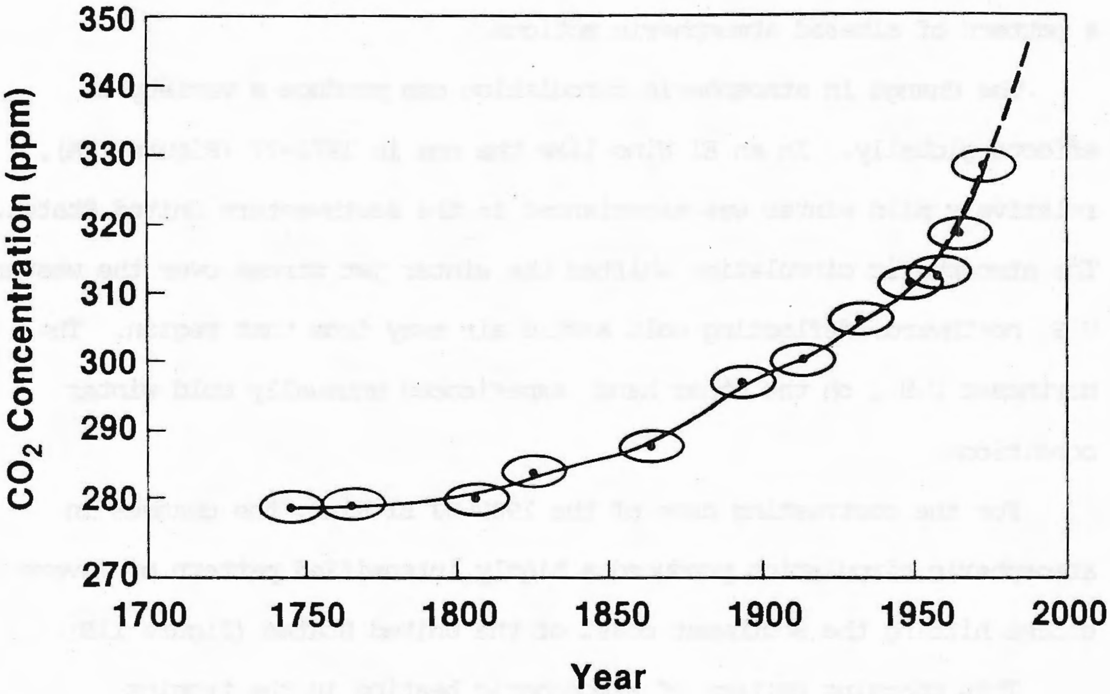

Fig. 13. Atmospheric carbon dioxide concentrations.

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THE POTENTIAL FOR MAN-MADE CHANGE

We are now faced with the fact that human activity is unquestionably a factor in the global climate system. Several recent trends have left little doubt that man can influence climate in important ways.

Man has little known effect on the year to year variability discussed above, but appears to be increasingly able to produce inadvertent change on the decadal time scales shown in Figure 3A.

One sign of man's effects on the climate system is seen in the steady upward trend of atmospheric carbon dioxide concentration shown in Figure 13. Since the upward trend began in the 1800's and has accelerated into the present, these concentrations are thought to be due in large part to the burning of fossil fuels, continually increasing since the Industrial Revolution.

The effect of increasing carbon dioxide in the atmosphere is to increase the ability of the Earth's climate system to retain solar radiation. This change in the Earth's radiation balance is the well-known atmospheric greenhouse effect.

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Many scientists fear that the upward trend in carbon dioxide will continue and that it will be accompanied by a global warming. Recent research has indicated that other atmospheric trace gases, such as methane or nitrous oxides, may produce greenhouse effects comparable to those of carbon dioxide. Estimates of the projected magnitude and timing of greenhouse warming vary widely, but a 2°C global warming is possible in the next few decades. As with most climate variations, the resulting regional changes would be even larger if this were to occur. Unfortunately, we cannot state with high confidence that such a warming will or will not occur.

Another of man's potential influences on climate is related to the ozone layer found in the Earth's stratosphere. One of the principal roles of the Earth's ozone layer is to absorb ultraviolet solar radiation that would otherwise be extremely harmful to life on Earth. Man made chlorofluorocarbons (CFC's) escaping to the atmosphere are believed to alter the amount of ozone in the Earth's stratosphere (upper atmosphere) through a complex series of chemical reactions.

CFC's are used in a variety of human activities, principally as refrigerants, synthetic foams, and aerosol spray propellants. Concern over their possible role in depletion of the Earth's stratospheric ozone layer led the U.S. to ban their use in spray cans several years ago.

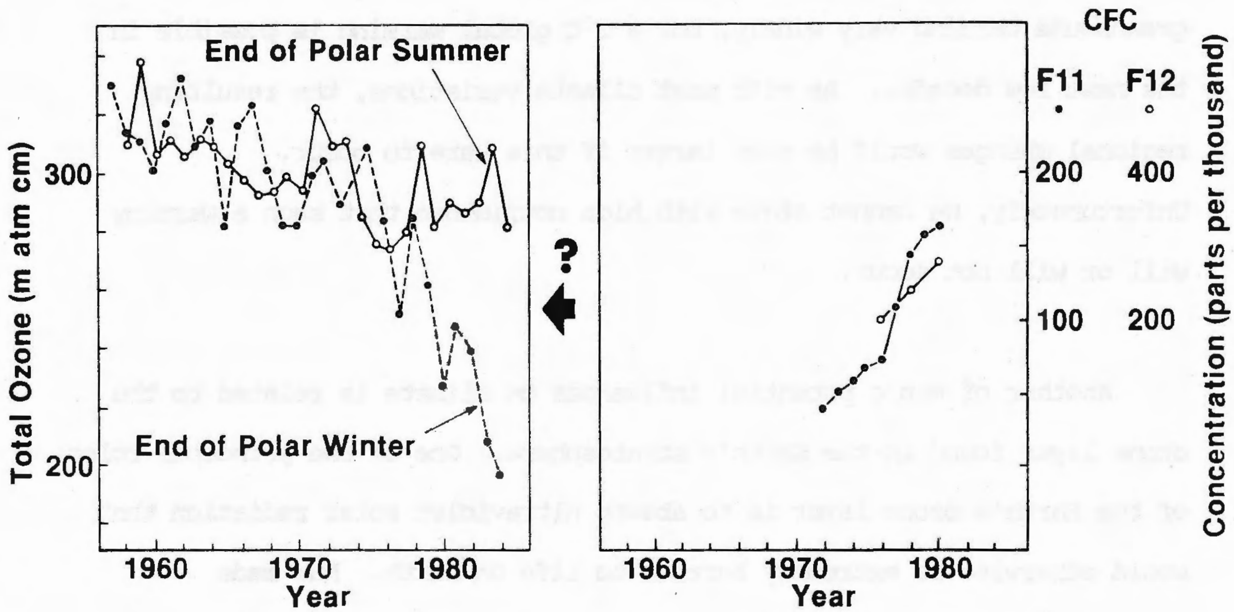

Fig. 14. Data from the Antarctic "ozone hole" with CFC curves for the same period.

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One recent and potentially alarming ozone trend is shown in Figure 14. Each year, after the long solar winter in the southern hemisphere, a large area of low stratospheric ozone concentration is found in the Earth's atmosphere over the Antarctic. After a period of several weeks, the ozone layer generally recovers to concentrations near its normal (annual average) value.

For the past several years, the ozone concentration during this annual period of low values has decreased. This ever-deepening "ozone hole" has many Earth scientists concerned, because it corresponds to the period over which CFC concentrations in the stratosphere have markedly increased. (CFC's are very stable compounds, released at the Earth's surface, that take many years to find their way to the stratosphere).

There is not yet an unambiguous interpretation to the data in Figure 14. The ozone hole may be a natural phenomenon, or the CFC hypothesis may be proven correct. Research is underway to determine the answer.

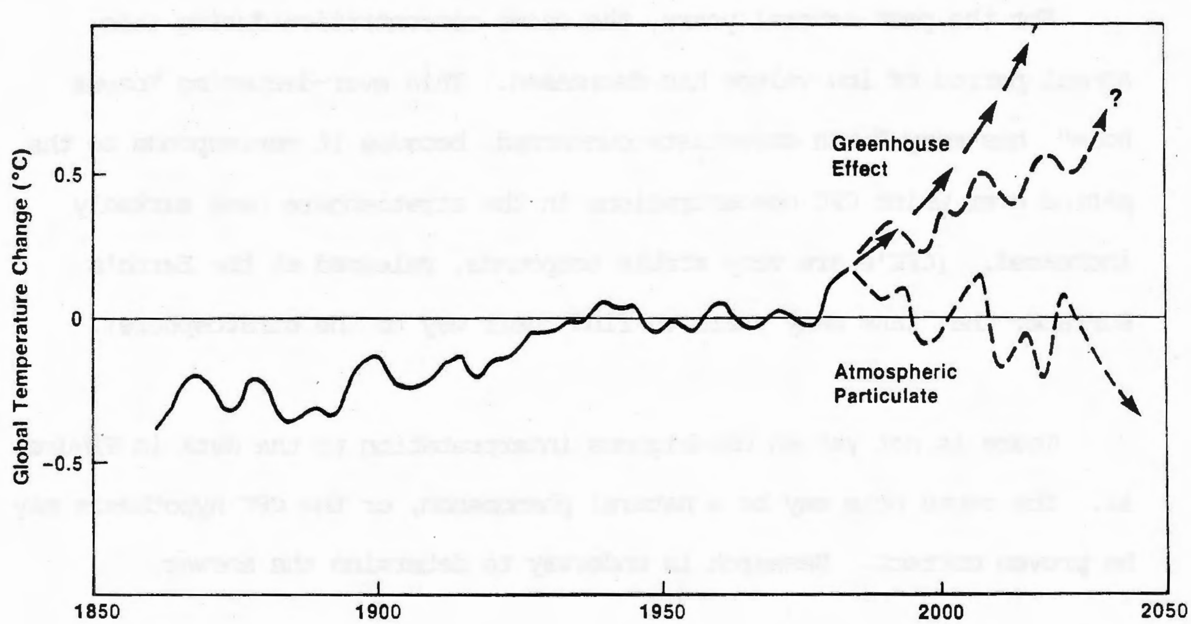

Fig. 15 Schematic of potential changes in climate due to human activities.

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Trends in concentrations of greenhouse gases such as carbon dioxide, accompanied by unexplained changes in the Earth's ultraviolet radiation shield, have placed modern societies in an increasingly uncertain position with respect to global climate change.

A decade ago it was argued that the Earth was cooling and that this trend would be accelerated by man's increased release of particulates into the atmosphere (smog).

Now we are faced with some evidence that the increasing concentration of greenhouse gases, again enhanced by human activity, may be producing a global warming beyond that which our society could reasonably tolerate. We must, therefore, recognize that we face a heightened "envelope of uncertainty" in projecting natural or man made changes in the global climate system over the next century (Figure 15). And we must consider carefully the associated effects to which man's institutions must increasingly be prepared to respond.

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ECONOMIC AND STRATEGIC

IMPLICATIONS OF GLOBAL CLIMATE CHANGE

The effects of climate variability on human activities, on the stability of societal institutions, and even on the Earth's ability to sustain life, have always been exceedingly difficult to quantify. Climate patterns are deeply ingrained in virtually all human activities, and we are often unaware of the extent to which societies are built around known climate variability and of their continuing vulnerability to climate change that cannot be projected.

The effects of climate change on human activities can be viewed in two ways: (1) year-to-year (interannual) variability in climate has profound economic and strategic implications as we adjust (or fail to adjust) to real or projected change, and (2) long-term (interdecadal or longer) changes have imposed limits on human activities throughout history, affecting even the basic stability of social structures. The second of these effects goes beyond anything that can be readily quantified. The climate of Greenland during the climate optimum of the last millenium was unusually mild by today's standards. A viable agrarian society was sustainable (hence the name Greenland), and the land was extensively colonized by northern European societies. The demise of that culture in Greenland, due to climate change, is clearly beyond any quantifiable significance to the people who live there.

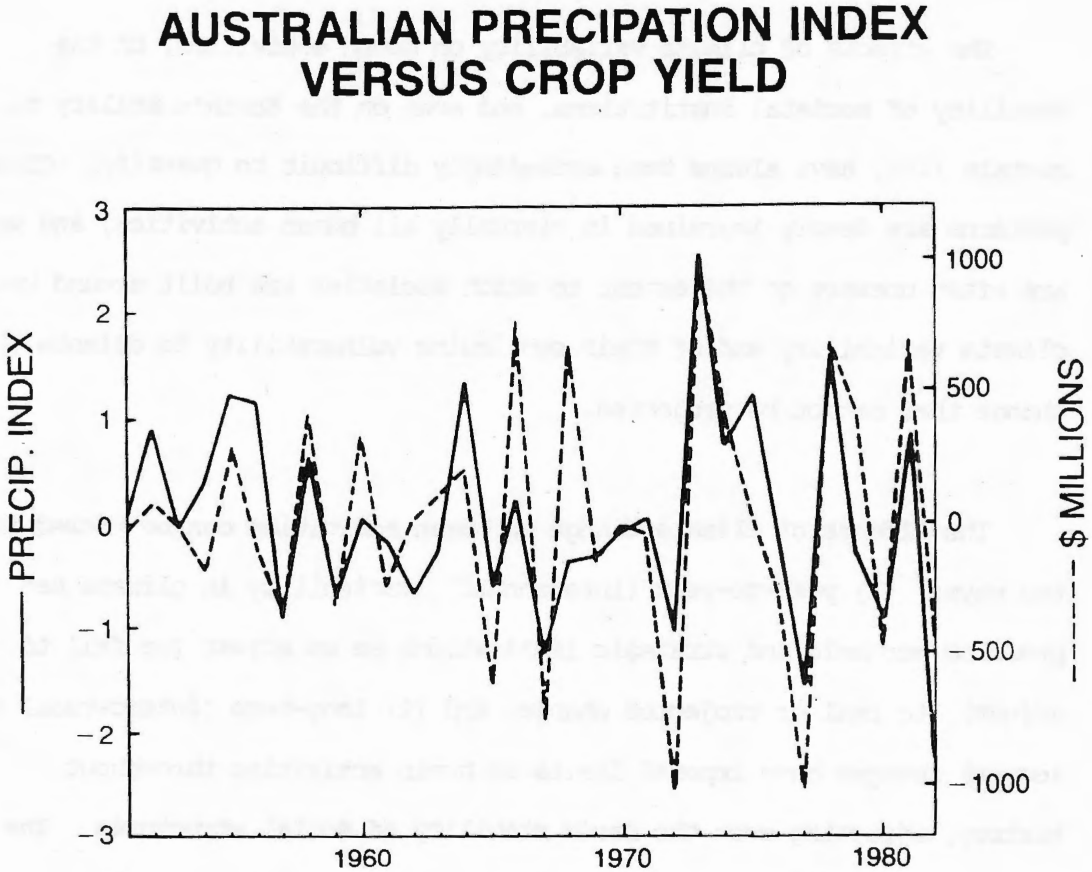

Fig. 16. Simplified representation of Australian crop values and a potentially predictable component of rainfall.

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The shorter term effects of climate change can be more readily studied, and some attempts have made to estimate their importance. It must be emphasized that climate assessments are presently limited in scope; much of the available evidence is anecdotal. A review of some of the quantifiable evidence available is helpful in estimating the probable magnitudes of climate effects.

Consider first a climate system in which much of the variability in agriculture can be related to a single variable. Australia, for example, has a climate system in which much of the agricultural productivity depends strongly on annual rainfall in different regions of the country. Such a view is an over simplification, but it is nevertheless illuminating for those tropical regions of the world that are subjected to monsoon changes.

One of Australia's leading climate scientists has identified a component of Australian precipitation patterns that he believes can be related to nearby sea surface temperature, and is thus predictable. His work is focused on this single, potentially predictable component of rainfall in order to examine how well it correlates with Australian crop yields. A greatly simplified representation of the work is shown in Figure 16. Two features of this diagram are relevant: (1) the extreme year-to-year variability of crop yield, and (2) the extent to which crop variations can be tied to a precipitation index that is believed to be predictable.

Note that the magnitude of the crop variations is on the order of $2 billion annually. The motive for pursuing such work is to predict parameters affecting crop yield and, through agricultural adjustments, to reduce the magnitude of the variation in yield. The extent to which this can be achieved is not presently known.

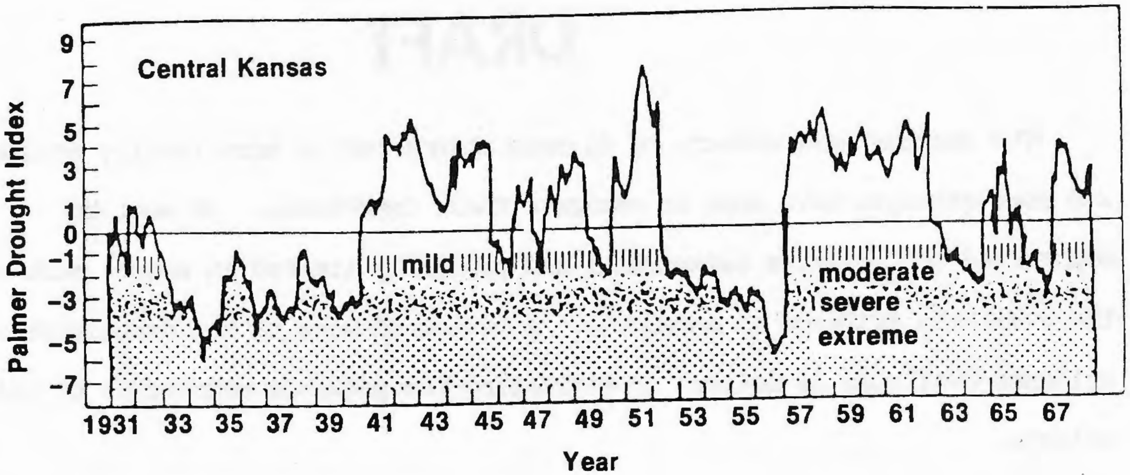

Fig. 17. The Palmer Index of U.S. drought, incorporating precipitation, temperature, and soil moisture into a single variable.

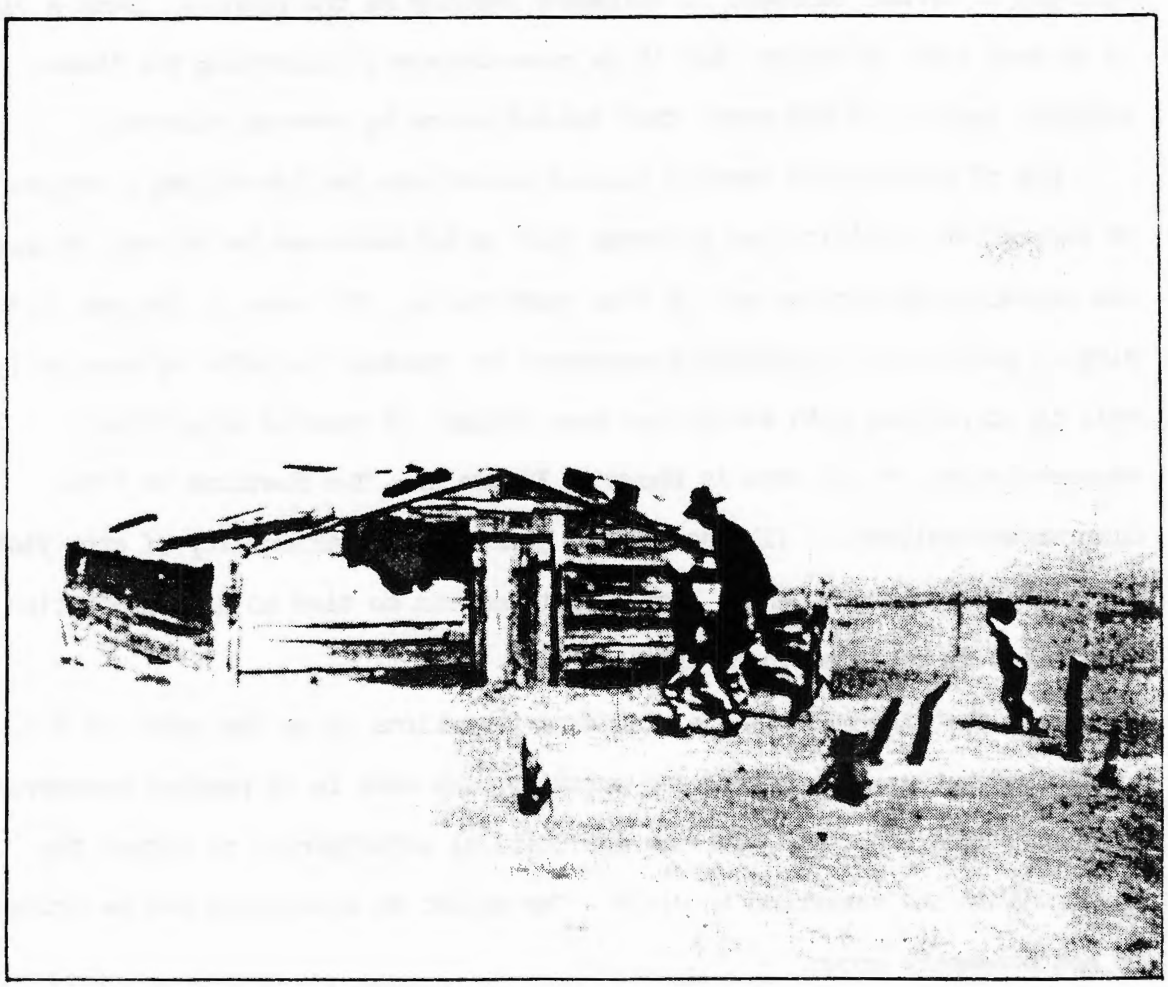

Fig. 18. The Dust Bowl.

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Turning to the climate system in the United States, the picture is more complex and single parameter descriptions are much less useful. This makes the system more difficult to predict and makes climate impacts harder to quantify.

The variability of U.S. climate as it affects agriculture in the central United States is shown in Figure 17. An index of drought (Palmer) must be used that incorporates rainfall, temperature, and soil moisture into a single variable. The year-to-year variability that characterizes the temperature record alone (Figure 9) is transformed so that the mid-western U.S. is subject to moderately strong year-to-year variability with cycles of major drought that can last several years. These drought cycles result in part from a soil moisture feed-back mechanism that further decreases precipitation after periods of heat or lowered rainfall. The most notable cases of multi-year drought are the dust bowl years of the 1930's (Figure 18) and the severe drought of the mid-1950's.

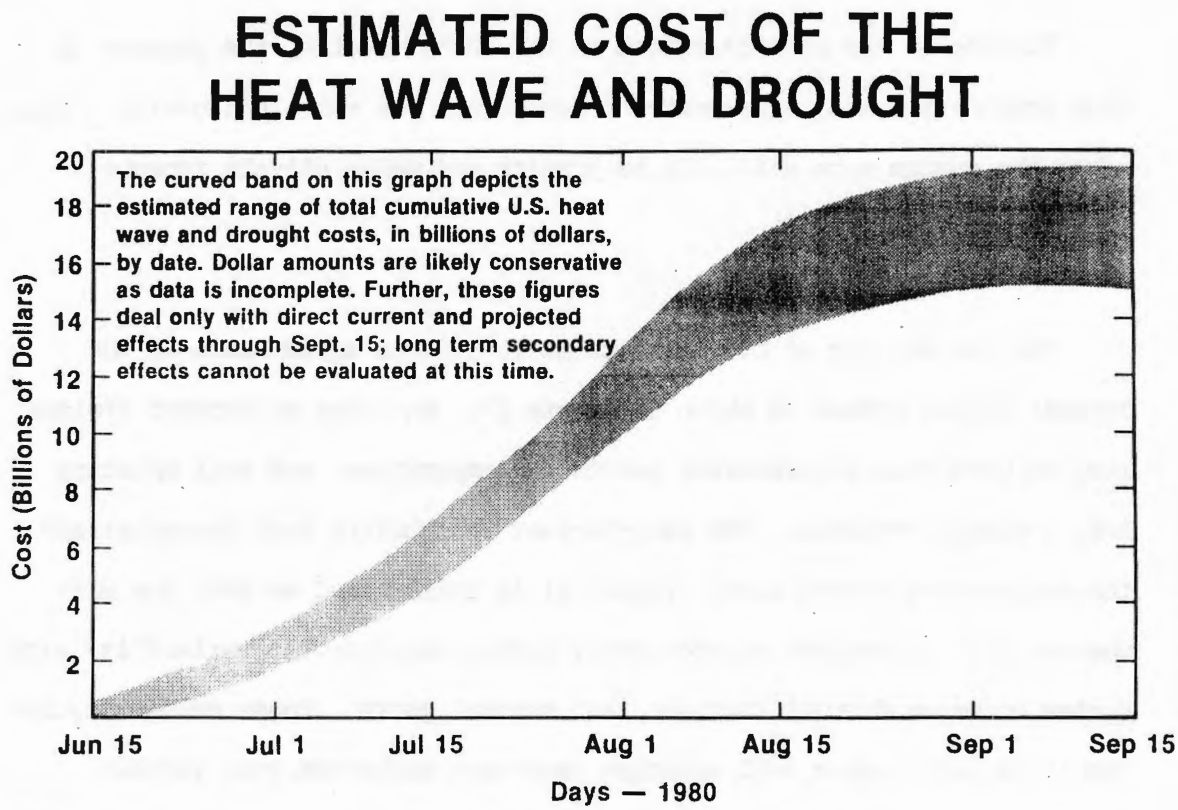

Fig. 19. Compilation of data from U.S. drought of 1980.

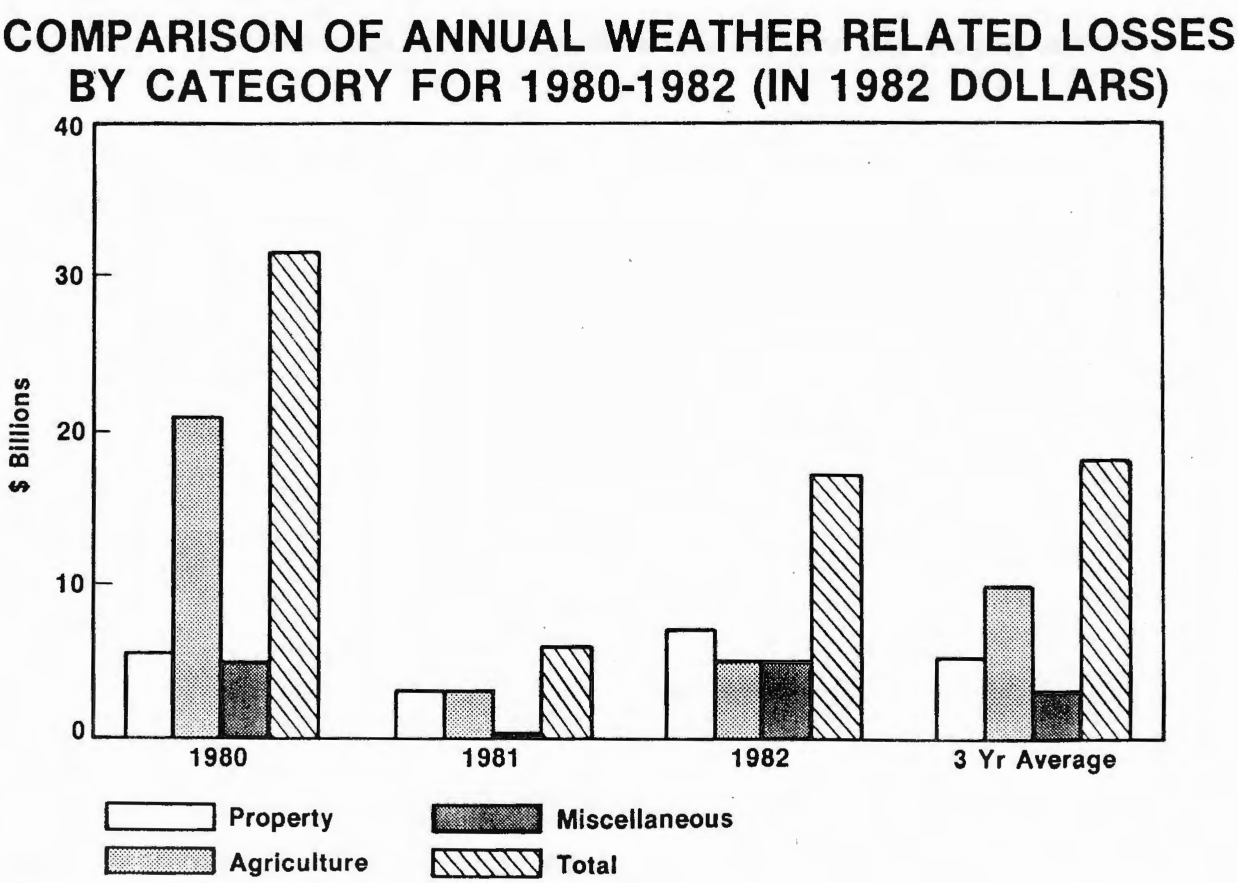

Fig. 20. Data for U.S. mainland

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It is also possible for the U.S. to experience relatively severe drought of only one or two years duration. One such case, for which attempts have been made to quantify impacts, occurred in 1980.

Data in Figure 19 were compiled during the 1980 drought, and indicate that the combined effects of drought and heat wave had grown to the range of $15 - 20 billion before the end of the year. When the costs of the 1980 drought were quantified in retrospect, the total loss figure had grown to over $30 billion.

The extreme variability in U.S. agricultural and other losses is shown in Figure 20, which spans a period of three years and includes the effects of the 1980 drought. Much like the climate system itself, estimates of U.S. losses due to climate variation show strong year-to-year variability, with a "signal" on the order of tens of billions of dollars.

The variable U.S. costs for such things as agricultural adjustments, fuel distribution and consumption, or property replacement are in large measure tied to climate. More specifically, they are a reflection of the fact that our yearly cycle of climate change is not regular, but has a strongly varying character that we cannot yet predict.

ENERGY VARIABILITY

- **Average U.S. Heating Bill, October-April**

  $46 Billion

- **Weather Variability ±10%**

  $9 Billion Range

Fig. 21. Estimates of variable U.S. heating energy costs.

"I referenced the fuel bill impacts of last winter (76-77) as in the range of $4 to $8 billion. That is purely on the fuel bill alone. We have done some very rough estimating of the overall impact on the economy, and it is something in the range of $20 billion. Probably, had we known in advance, as little as 6 months in advance, there would have been the possibility of reducing that cost by half by simply positioning fuel stocks at a time when we could, for example, move them to the river system before the river system was frozen."

John F. O'Leary, Administrator,
Federal Energy Administration

Fig. 22. Quotation from congressional testimony.

DRAFT

It is particularly important to consider what portion of costs can be avoided through successful prediction of climate change. Little comprehensive information is available, but some outstanding examples exist. One estimate of the approximate level of spending for winter heating bills in the United States is shown in Figure 21. Year-to-year variations in fuel costs (largely due to aggregate effects of weather) have a range of approximately $9 billion.

In 1976-77 one of the strong interannual events associated with El Nino produced an unusually cold winter in the northeast U.S. The value of reducing losses associated with this event through prediction and strategic location of fuels is suggested to have been in the range of $10 billion (Figure 22). An opportunity of this magnitude does not happen every year, but events of this type have occurred every three years (on average) for the last two decades.

Scientists now believe that strong interannual events like this are potentially predictable, although successful predictions have not yet been achieved.

U.S. AFRICAN DROUGHT ASSISTANCE
FY 73-84

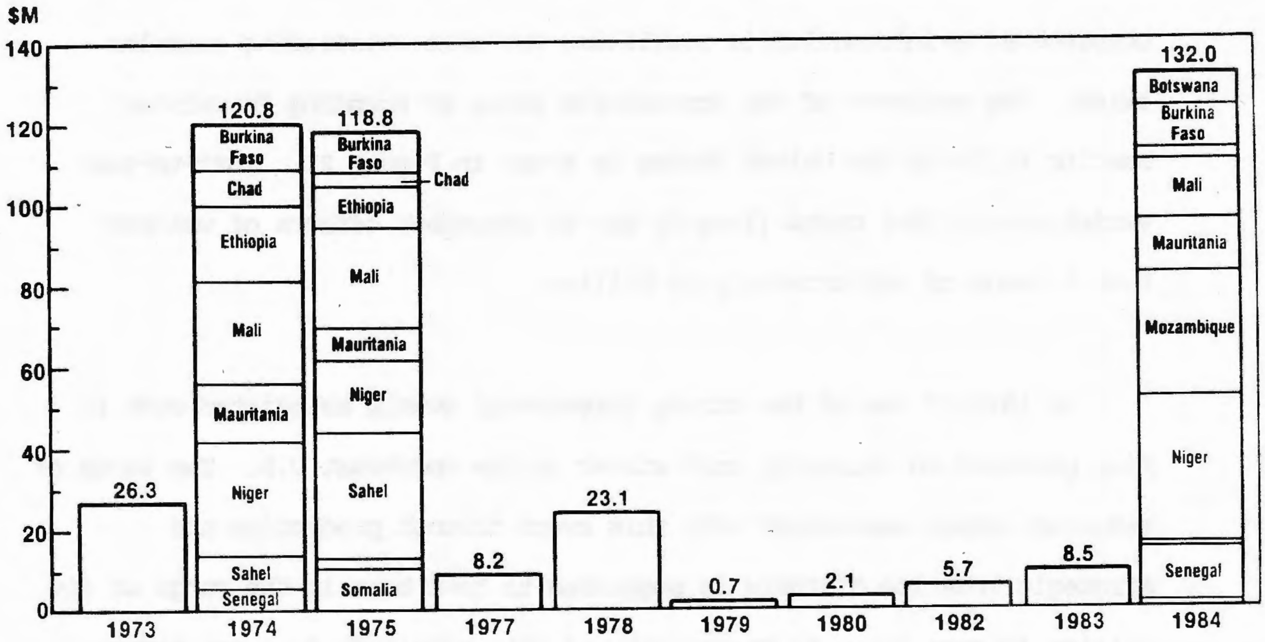

Fig. 23. Figures compiled by National Climate Program Office.

"Ray Daniel of Chase Econometrics notes that if planners had known that drought would reduce corn farmers' production by a billion bushels in 1983, they could have saved $20 billion on the payment-in-kind program . . ."

Technology Review

Fig. 24. Quotation from MIT publication.

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Another kind of climate information of strategic value to the United States is suggested in Figure 23. The long-term nature of African drought is a well-known phenomenon. The situation has been getting progressively worse for three decades, yet U.S. aid still exhibits strong year-to-year variability. The striking feature of Figure 23 is the extreme interannual variation that, again, reflects strong interannual changes in precipitation (recall Figure 12).

Information such as this raises the possibility of anticipating at least some critical needs before they arise and, through preparation, to relieve human suffering and reduce associated costs.

A more striking indicator of how we unthinkingly incorporate climate information (or fail to) in societal planning is indicated by the quote in Figure 24. In 1982-83 another of the major interannual climate events discussed earlier took place. A new program (Payment-in-Kind, or PIK) for holding U.S. agricultural land out of production was introduced at the same time the global climate system was preparing the United States for a significant drought. The quotation suggests that advanced climate information, and the willingness to use it strategically, was worth billions of dollars that year. Note that the magnitude of the potential reduction is comparable to that suggested in Figure 22. Each of these multi-billion dollar examples treats only a single national decision within a complex varying climate regime.

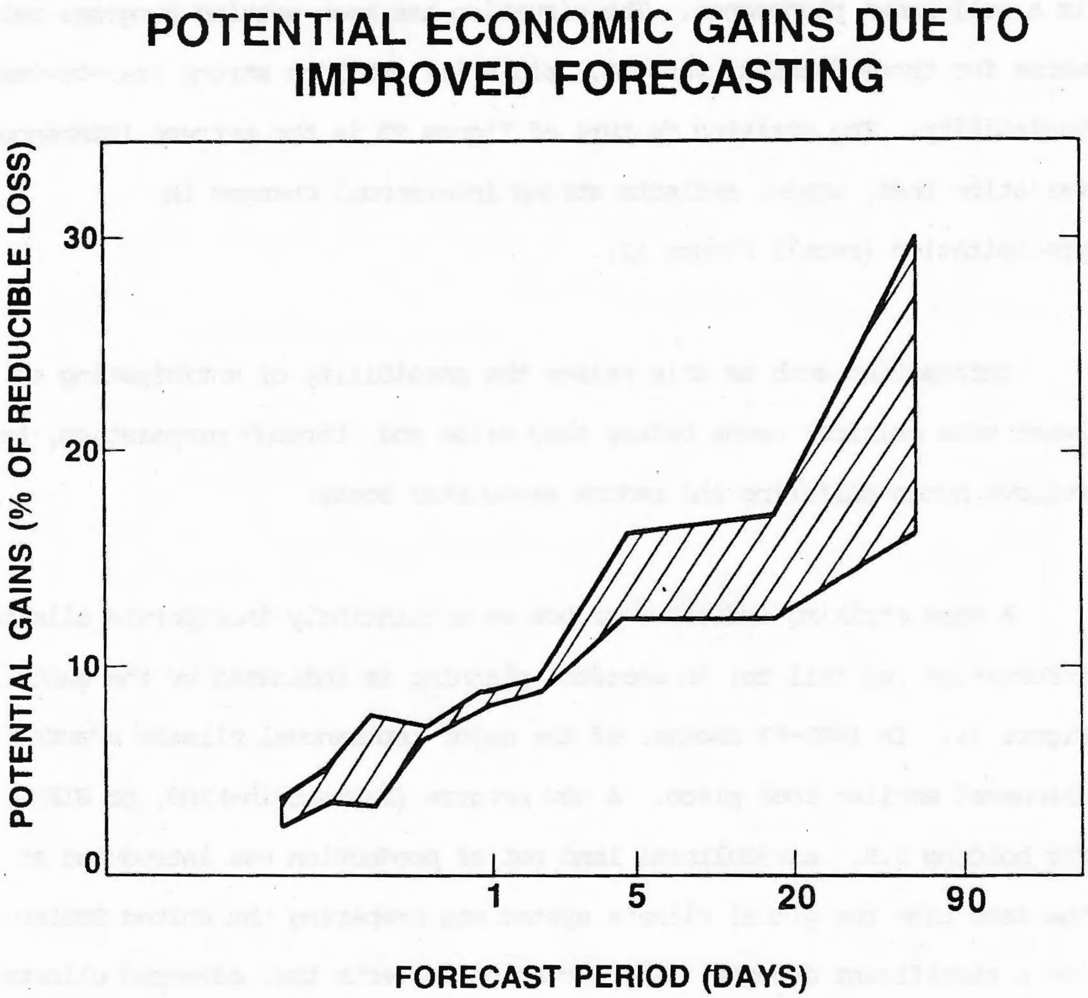

Fig. 25. Estimated potential reduction of weather related losses as a function of forecast period (greatly simplified).

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It can be argued that our society regularly gambles on climate prediction: we assume that the normal (average) annual cycle of climate change will perpetuate itself indefinitely. Each year we gear myriad economic and social decisions to that single assumption and, in most years, the assumption proves to be incorrect (to varying degrees).

Comprehensive cost figures for climate change cannot presently be known, for lack of sufficient study, but these and other examples suffice to underscore the extent of our gamble. Losses from failure to anticipate year-to-year variability alone amount to tens of billions of dollars annually, much of which could be saved through successful prediction.

One study of how weather related losses could be reduced through successful prediction examined forecast periods out to 90 days, within the range of short term climate variation (Figure 25). The author's complex methodology, using hypothetical decision-making models, has been simplified for clarity. The points to note here are that the estimated value of 90 day forecasts was a 15 to 30 percent reduction in loss, and that the estimates increases sharply with forecast period.

One of the difficulties we face as a society is the fundamental shortage of reliable information on the extent of our risk and the potential to reduce it through successful prediction. The problem is not purely scientific. There is a parallel problem of understanding what we pay for lack of better information and how we might use response planning to mitigate the costs.

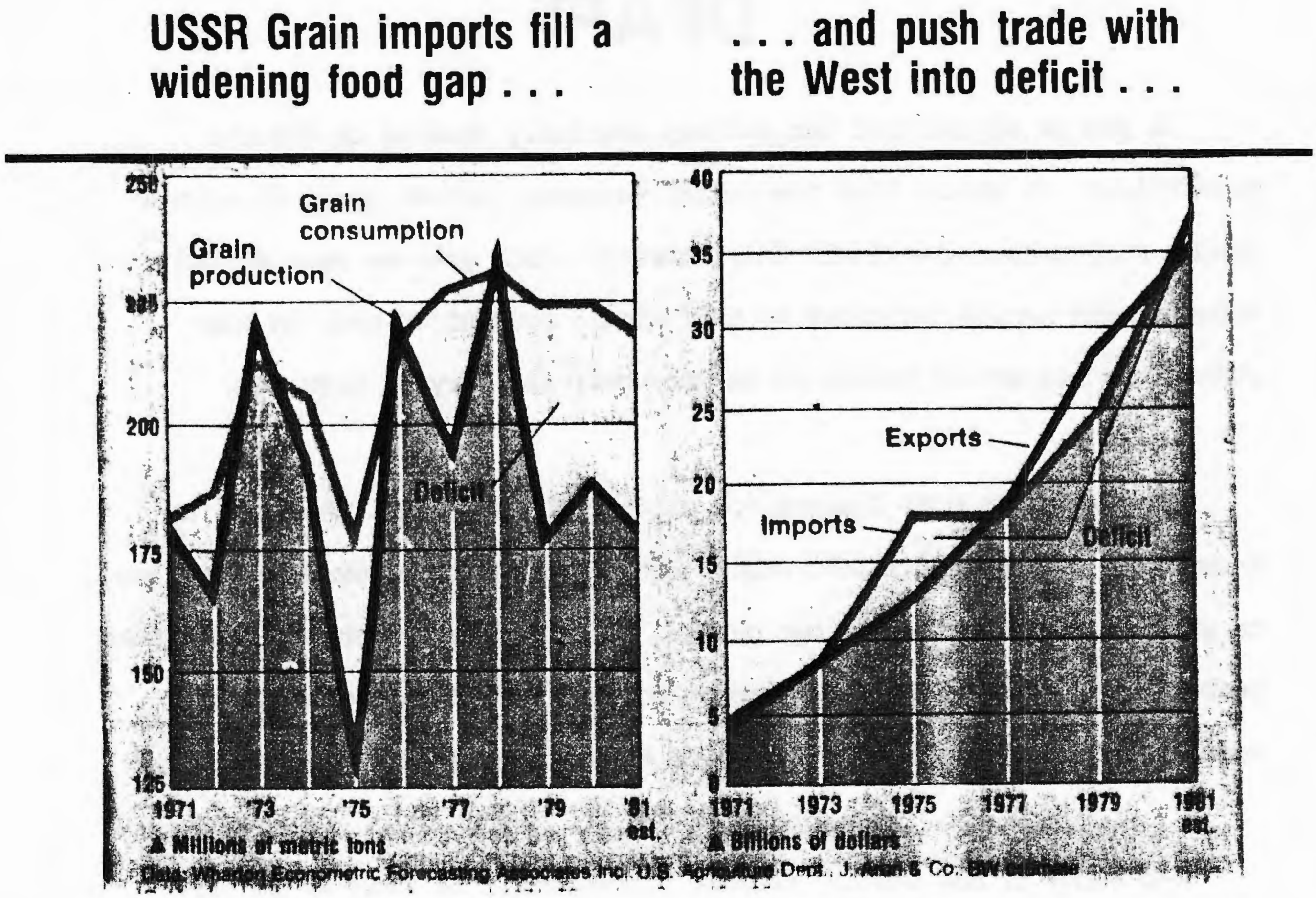

Fig. 26. Figure excerpted from Business Week article.

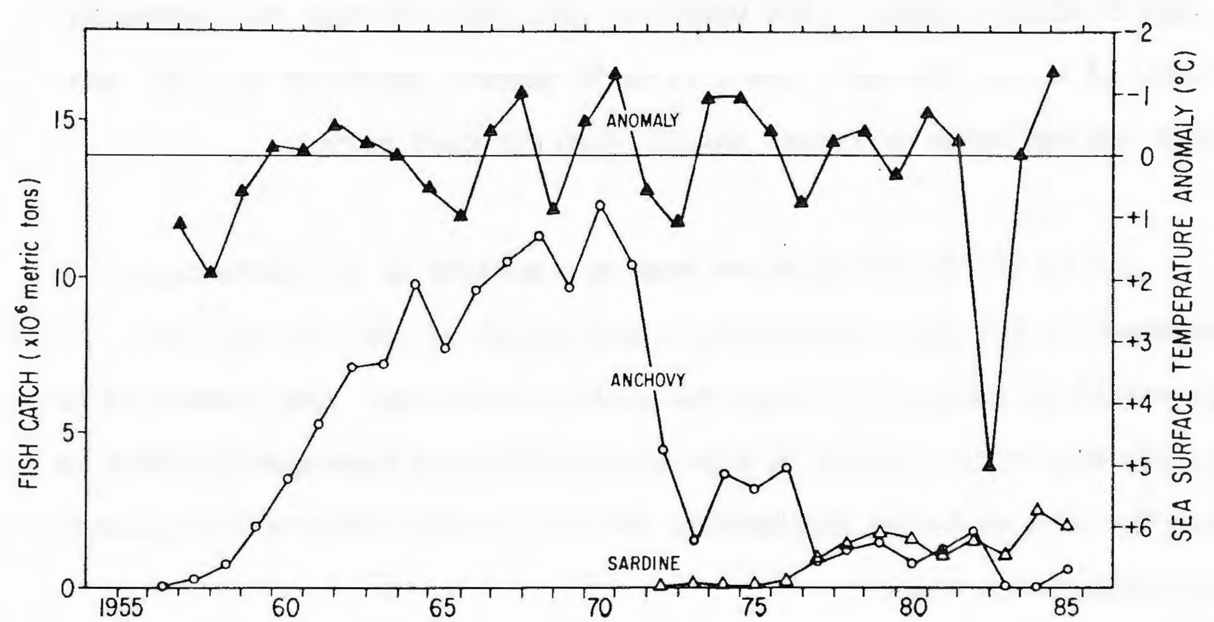

Fig. 27 South American anchovy fishery shown in conjunction with eastern tropical Pacific Ocean temperatures.

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A particularly pointed example of the strategic value of climate information is provided in Figure 26 from Business Week. This figure shows a decade of estimated grain production and consumption in the Soviet Union, once again characterized by strong year-to-year variability. A reasonable estimate of the difference between production and consumption (imported grain) in 1975 is approximately $5 billion at present market prices. The right hand portion of the figure indicates probable effects on Soviet balance of payments.

There is an even more striking story behind Figure 26. In 1972 the world experienced another major climate perturbation associated with El Nino. At that time, the Soviet grain harvest was failing, but that fact was known and acted upon only by Soviet officials. The USSR purchased large stores of grain on international markets, anticipating a serious shortfall.

While the Soviets were buying grain, the strong 1972 El Nino event in the Pacific tropics caused a major failure of the South American anchovy fishery that provides a large portion of the world's total protein (Figure 27). As fish meal consumers worldwide were driven to grain substitutes by the El Nino-induced fishery collapse, the international price of grain quadrupled, but only after the Soviet Union had purchased sufficient reserves. Each of these interacting economic factors resulted in large part from a single global climate perturbation of a type we are now beginning to understand.

National Climate Program Budget Totals
FY 80 - FY 88
($ Million)

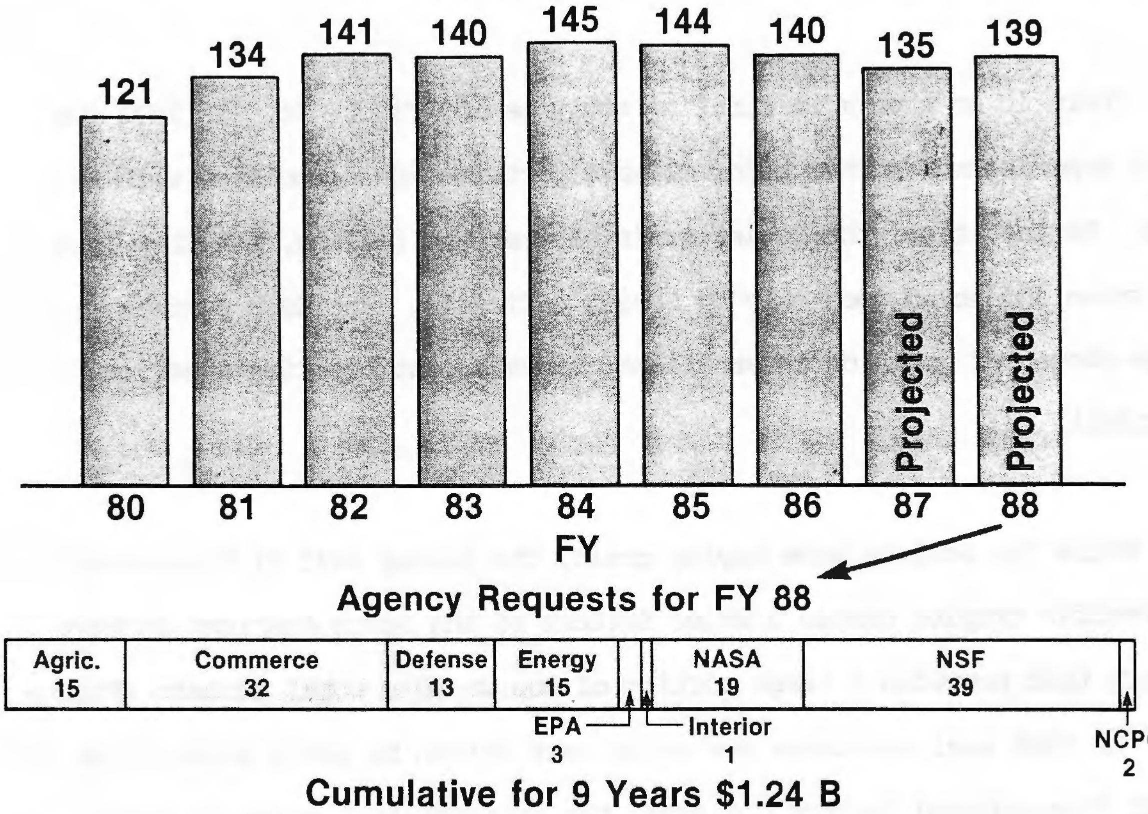

Fig. 28. From data compiled by the National Climate Program Office.

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Shortly after the strategic difficulties associated with the grain and anchovy problems of 1972, George Shultz, then Secretary of the Treasury and Chairman of the Domestic Council, addressed a question to the U.S. climate community and to those agencies concerned with climate sciences. The Government wanted to know if U.S. scientists couldn't produce information on climate variability that would allow the U.S. to take better advantage of such a situation. Within a few years the National Climate Program had been formulated, funded and implemented on an interagency basis.

Since the inception of the program, agency expenditures for climate research have exceeded one hundred million dollars annually. This strong effort is still being sustained (Figure 28).

More than a decade later man has acquired a wealth of information about climate. As a result of this decade of intensive effort, the U.S. and other nations are poised on a technological threshold where climate information of profound economic and strategic value is within our reach.

As we take note of economic and social impacts of year to year climate change and anticipate the even more profound implications of natural or man induced changes on longer time scales, the value of climate information to a complex society such as ours becomes increasingly clear. Climate research and associated response planning need not be viewed as consumers of capital: with thoughtful planning and adequate foresight they can be producers of capital and contributors to basic economic strength.

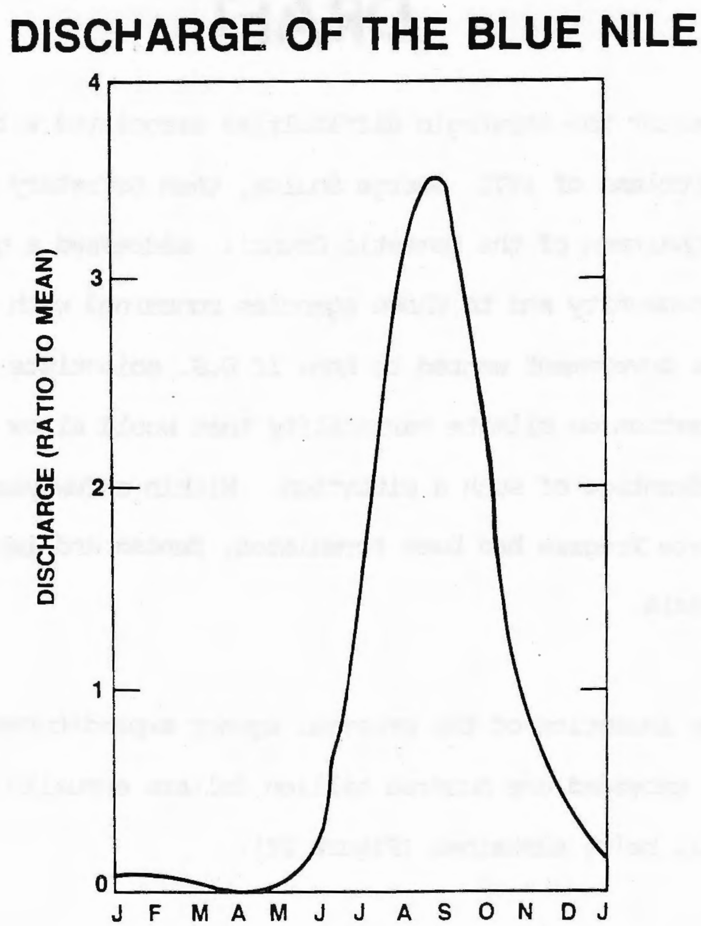

Fig. 29. Typical tropical river runoff.

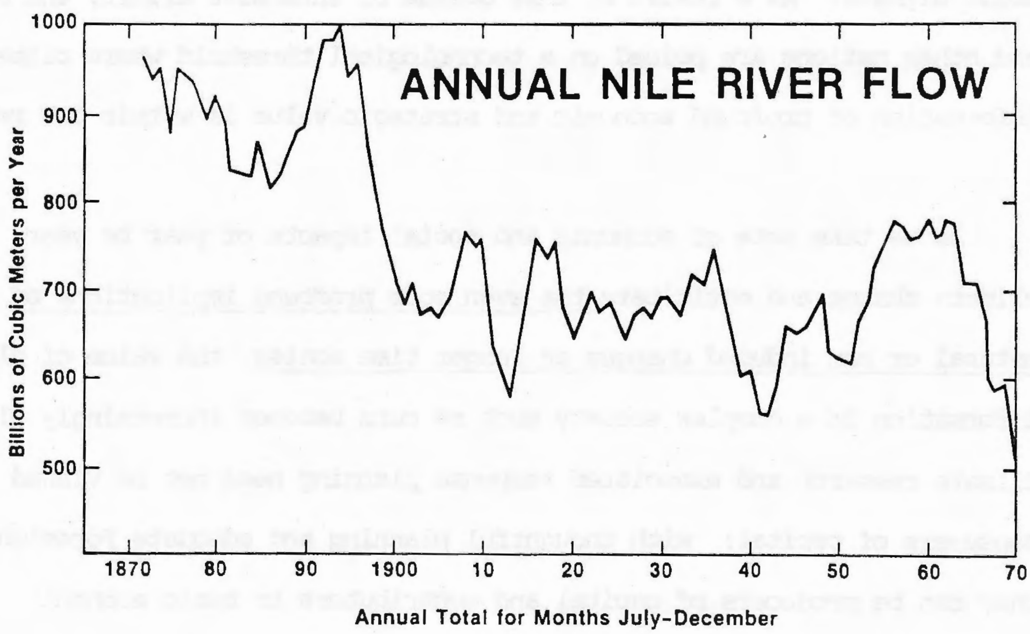

Fig. 30. Typical variability in Nile River runoff.

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Over 4,000 years ago man formed one of his oldest civilizations along the banks of the Nile, where the climate system is dominated by a single factor - the river.

The Nile is a classical example of a tropical river regime (Figure 29). The Egyptians of that period were able to study the stars and the excursions of the sun and to formulate an understanding of how their climate system changed throughout the year. They could predict the coming peak river flow and take advantage of its flooding for agricultural purposes. The Egyptians built an enduring civilization around the annual cycle of the Nile.

This civilization was predicated on a climate prediction, the assumption that the annual cycle would perpetuate itself indefinitely. Basically, it was a good gamble; their civilization endures to this day.

On the other hand, the Egyptians found themselves vulnerable to year-to-year variations in the discharge of the Nile, variations that denied them the annual replenishment of their agricultural base. Furthermore, they had no ability to foresee long term changes in Nile River discharge and to protect themselves from associated climate effects.

Figure 30 shows a typical record for a century of Nile River flow. It is most striking in the enormous year to year variability and in the fact that the annual discharge decreased by over 40 percent in one century. There is historical evidence that such changes occurred periodically during the height of Egyptian civilization and that Egyptian society suffered serious consequences.

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Not a lot has changed in the state-of-the-art since Egyptian climate prediction 4,000 years ago. Today we have a sophisticated and complex society that is very finely tuned to the annual cycle and regional patterns of climate and yet, perplexingly, we remain largely passive victims of climate change on most other time scales. Some notable exceptions to this condition do exist, but they are few. (Modern agriculture, for example, is adaptive to some range of changes that might occur on decadal time scales.)

There are several circumstances which we do not have in common with the ancient Egyptians: (1) our present grasp of the basic way in which the climate system works, (2) a technological capability which, for the first time, makes it possible to examine the climate system globally in sufficient detail, and (3) the availability of computers and numerical models that will ultimately enable us to project climate change on scales of a few months to many decades into the future.

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    b. Rasmusson, Eugene M. and Wallace, John M., 1983, Meteorological Aspects of the El Nino/Southern Oscillation, Science, 222, 1195.

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21. Joan Hock, Director, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Assessment and Information Services Center, personal communication. Based on NOAA/National Weather Service 30-90 day outlooks and a numerical model which relates energy consumption to weather variables.

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