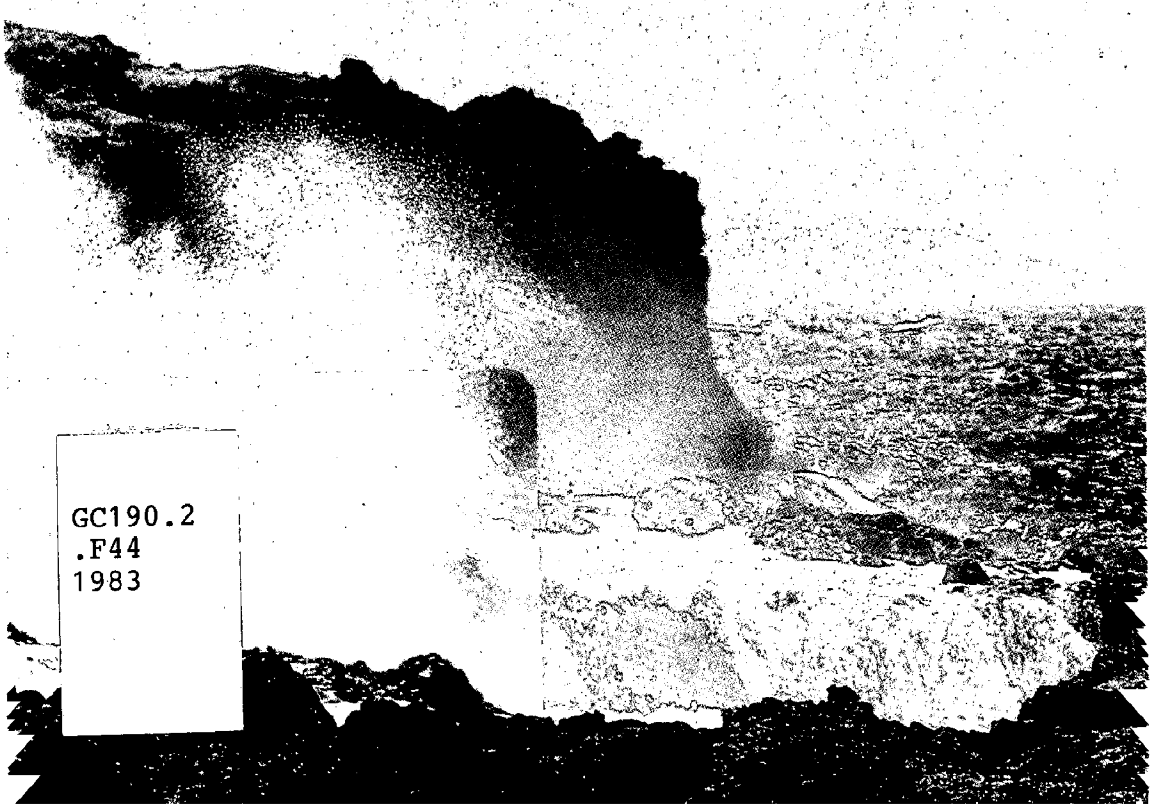
The TROPICAL OCEAN & GLOBAL ATMOSPHERE PROGRAMME

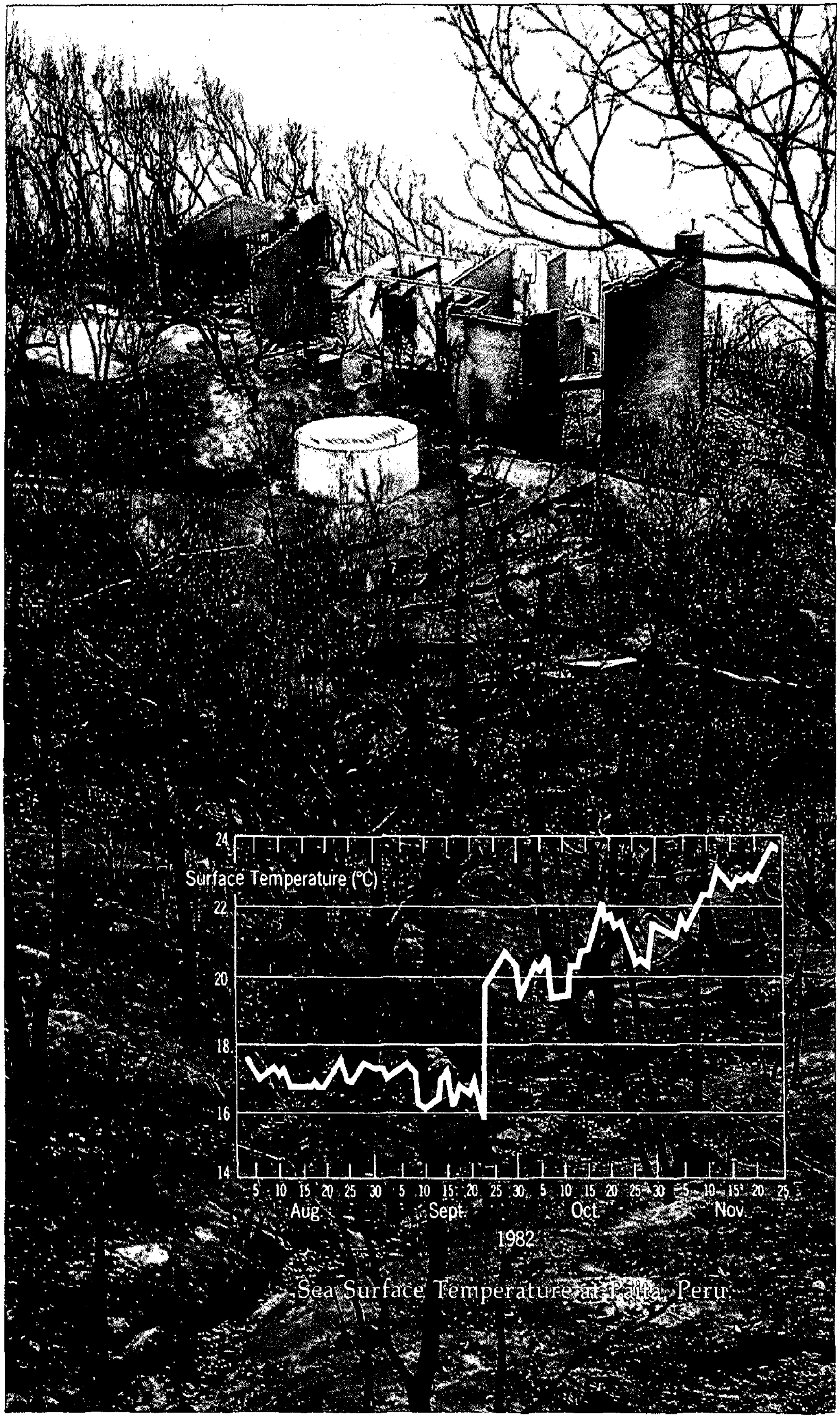


The Tropical Ocean and Global Atmosphere (TOGA) Programme is part of the World Climate Research Programme (WCRP). The WCRP has been established by the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU) with the objective to determine to what extent the climate can be predicted and the extent of man's influence on climate. In view of the role of the ocean in climate variations, the TOGA Programme is also supported by UNESCO's Intergovernmental Oceanographic Commission (IOC) and ICSU's Scientific Committee on Oceanic Research (SCOR).

The scientific planning for the WCRP is undertaken by the Joint Scientific Committee (JSC)—formed by the WMO and ICSU. The scientific planning of the oceanic component of the WCRP is accomplished by the Committee on Climatic Changes and the Ocean (CCCO)—formed by the IOC and SCOR. The detailed scientific planning for TOGA is the responsibility of the JSC/CCCO TOGA Scientific Steering Group.

Cover: High seas at the Galapagos Islands during the 1982-83 El Niño. Photo from Jerry Meehl.

Contents



Surface Temperature (°C)
24
22
20
18
16
14
5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
Aug.
Sept.
Oct.
Nov.
1982
Sea Surface Temperature at Paita, Peru

JERRY MEEHL

Introduction

Late in September of 1982 the sea surface temperature rose 4°C in 24 hours along the seacoast near the town of Paita, Peru. Officials in this peaceful village were immediately on the alert for El Niño—an ocean warming phenomenon associated with reductions in fish, birds, and marine mammals. Little did they anticipate the depth of destruction and human suffering that were to beset their town and the country of Peru. This El Niño event was to be one of the worst to affect South America.

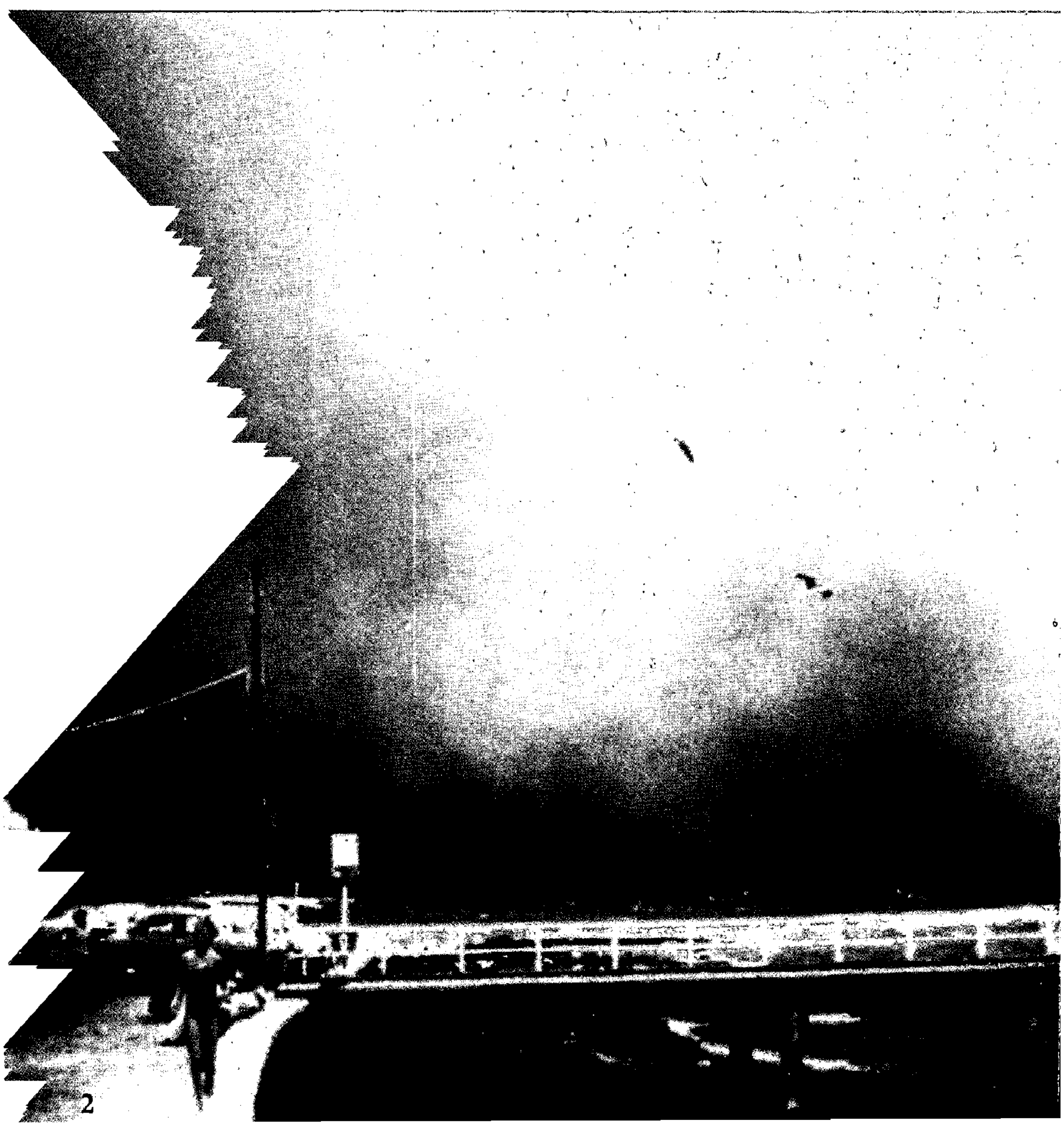
It had been realized by a few scientists who monitor the winds in the sparsely populated region of the western equatorial Pacific, that the normally steady easterly trade winds (surface winds which blow from east to west) had reversed to westerly winds from the last week of June through the entire month of July. This steady reversal of the winds over such an extended period implied a significant change in the normal mass distribution of the atmosphere (as measured by surface barometric pressure) and perhaps a shift of the Southern Oscillation—a seesaw or cycle in sea level pressure with high pressure in the South Pacific Ocean and low pressure in the Indian Ocean at one end of the cycle, and opposite conditions at the other end of the cycle. These scientists knew that if there was a significant change in the Southern Oscillation Index (the atmospheric pressure at Tahiti minus the pressure at Darwin, Australia) El Niño might ensue. Little were they to realize that these anomalous westerlies would continue for nearly a year—into the first week of June, 1983 before abruptly ending. They would reflect a record swing in the Southern Oscillation which would cause the worst El Niño in this century and which would lead to dramatic climatic changes in many other parts of the world that would significantly affect the lives of nearly half the earth's population.

Australian brush fire damage during that country's most severe drought (1982-1983) associated with the record swing in the Southern Oscillation.

Nature's Challenge

Man learns to conduct his daily affairs and economic activity according to the climatic regime in which he lives. When forces in nature abruptly change that ensemble of weather events we call climate, man is often ill-prepared for the consequences. The weather events of 1982-1983, well documented in many chronicles, provide such an example. The record change in the Southern Oscillation left a wake of hardship around the globe.

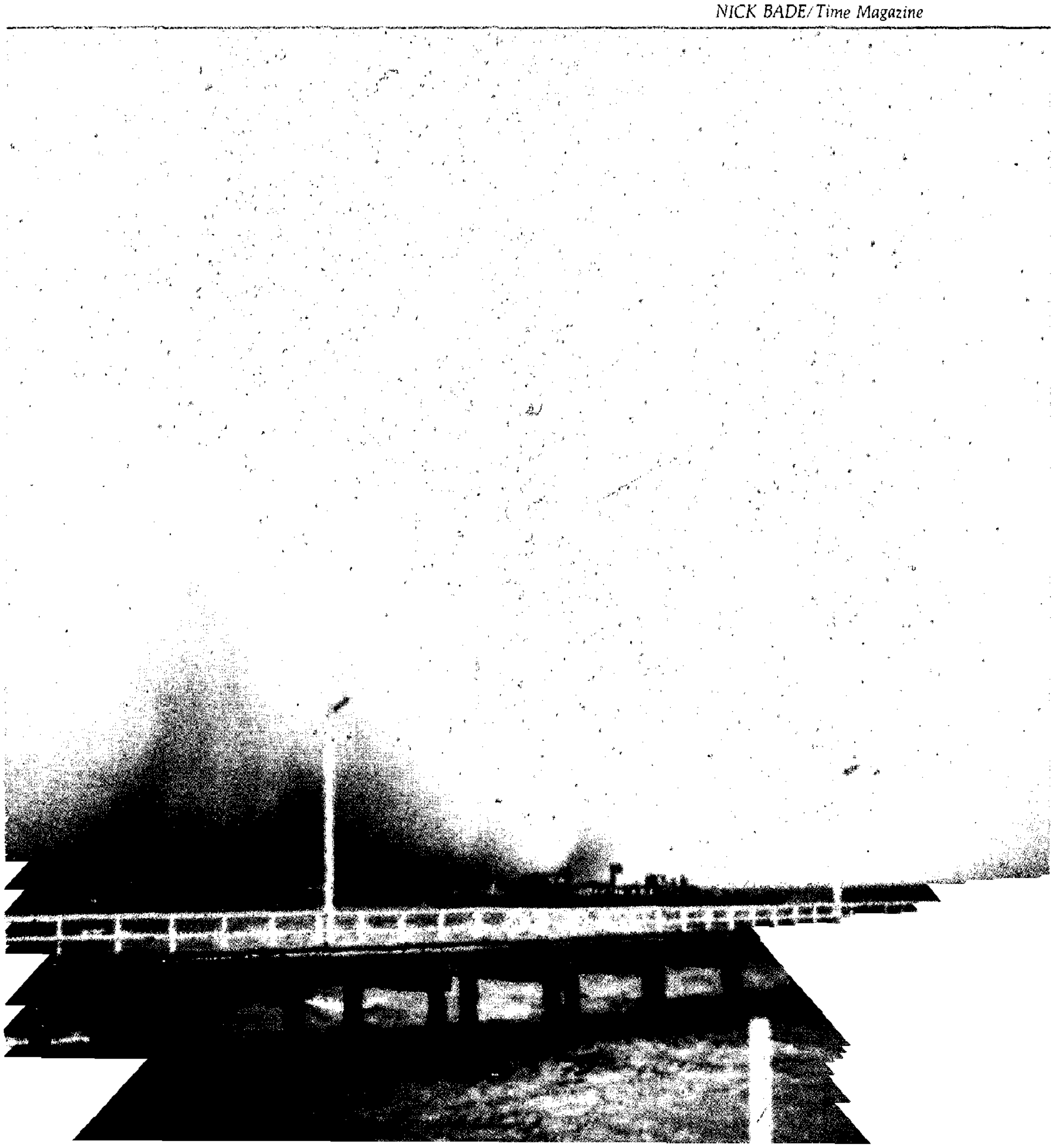
Surface pressure over the Indian Ocean began to systematically rise in the last half of 1981. Drought conditions began to spread from southern India eastward to Indonesia, Australia, and the Philippines. By mid-1982 in Darwin, Australia, the five-month



running mean surface pressure reached its highest recorded value. Australia was experiencing the worst drought in the 200 years since the settlers arrived. The immense dust storms, the tragic brush fires, and the two-billion-dollar loss in agriculture and livestock production will not soon be forgotten.

The normal region of maximum cloudiness and precipitation in the far western equatorial Pacific moved eastward with the Southern Oscillation transition. The altered atmospheric stability conditions and warmer sea surface temperatures in the central and eastern Pacific led to shifts in the tracks of typhoons.

NICK BADE/*Time Magazine*



French Polynesia had escaped the fury of Pacific typhoons for the previous 75 years but was hit six times in five months during the 1982-83 event. Hawaii was hit twice, including one which struck from the southwest—a rare event which last happened during the 1957 El Niño year.

The devastation to the people, villages, and economy of several South American countries from the 1982-83 El Niño was unprecedented. Previous El Niño events had shown that the depression of the thermocline in the eastern Pacific cuts off phytoplankton production and changes the entire marine ecosystem. The reaction of the biological species in the region varied according to their biomass, the intensity of its exploitation and the magnitude of El Niño itself. When the 1972-73 El Niño occurred, it was simultaneous with excessive anchoveta fishing levels. The two combined to stress the reproduction process and resulted in the near collapse of that fishing industry—a fleet of 1,500 units and approximately 100,000 fishermen stopped operating.

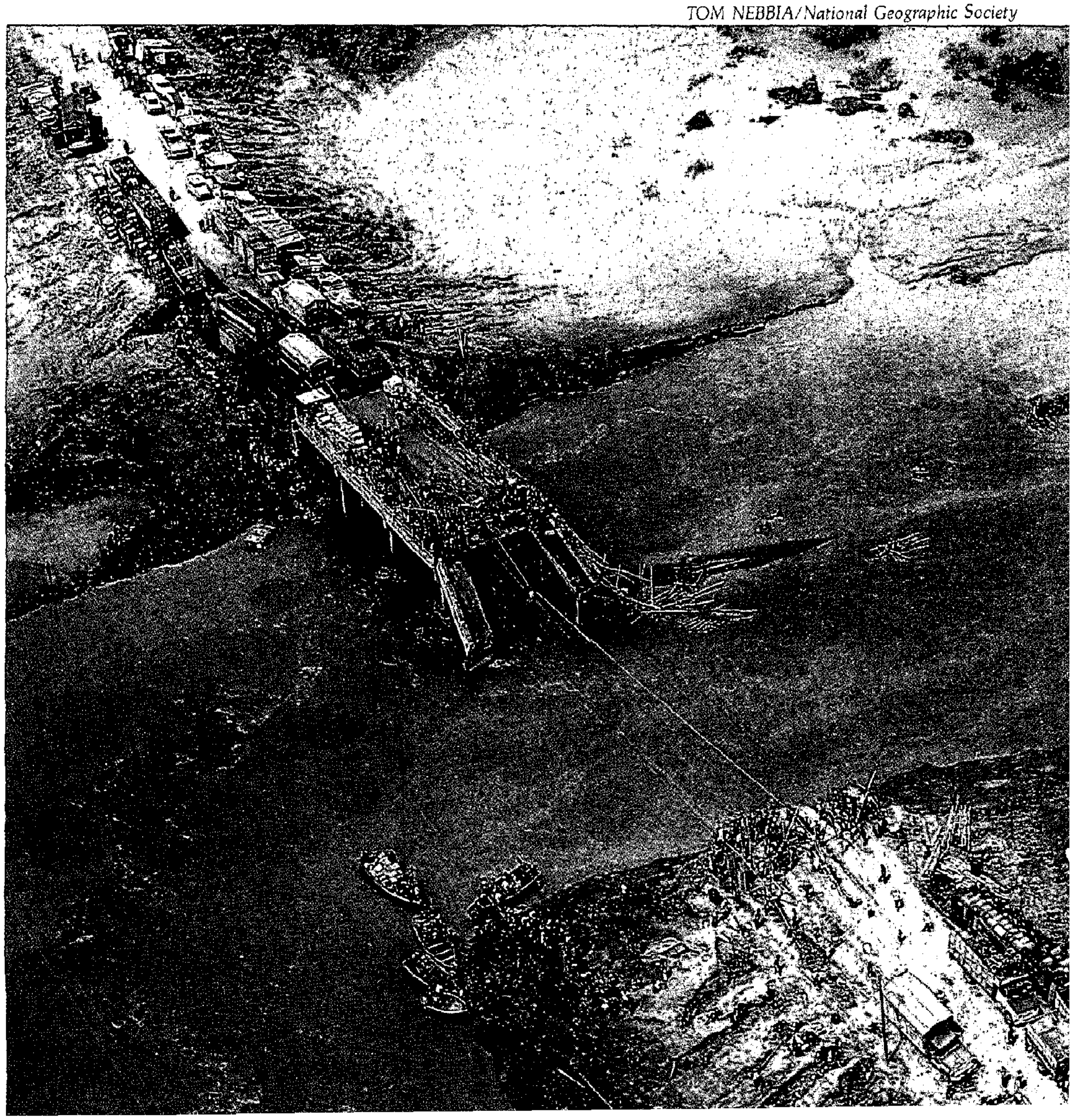
The 1982-83 El Niño occurred when the species (sardine, jack mackerel, and caballa) that replaced the anchoveta were in an expansion process. The decline in sardine fishing started first off Ecuador in September of 1982 and spread southward. The sardines disappeared off Ecuador by January 1983, then later off the northern coast of Peru. Further south along the Peruvian coast the population decrease began in January 1983 and reached its lowest level in June. Further south yet, off the coast of Chile, the sardine catch increased from January to July, 1983, but the individual fish were only 25% of their normal weight. The jack mackerel and caballa catches were severely depressed along Ecuador and Peru. The anchoveta disappeared. These fishing losses to Ecuador and Peru were severe but still less than other economic losses that were to occur to these


JERRY MEEHL

countries from this 1982-83 climatic fluctuation. The loss of the stabilizing influence of the cool air off the normally cold coastal waters and the changed general circulation pattern of the entire eastern Pacific, led to dramatic changes in the precipitation patterns of the region.

The rains started in October of 1982, along the coast of Colombia and Ecuador, and spread southward. The rainfall in Ecuador and Peru was intense and persistent until approximately July of 1983. In Colombia the rainfall was about double the normal amount. Along the coast of Ecuador it reached over 30 times the normal average (Guayaquil, June 1983). In northern Peru the rainfall reached as high as 340 times the normal (Paita, May 1983).

TOM NEBBIA/National Geographic Society



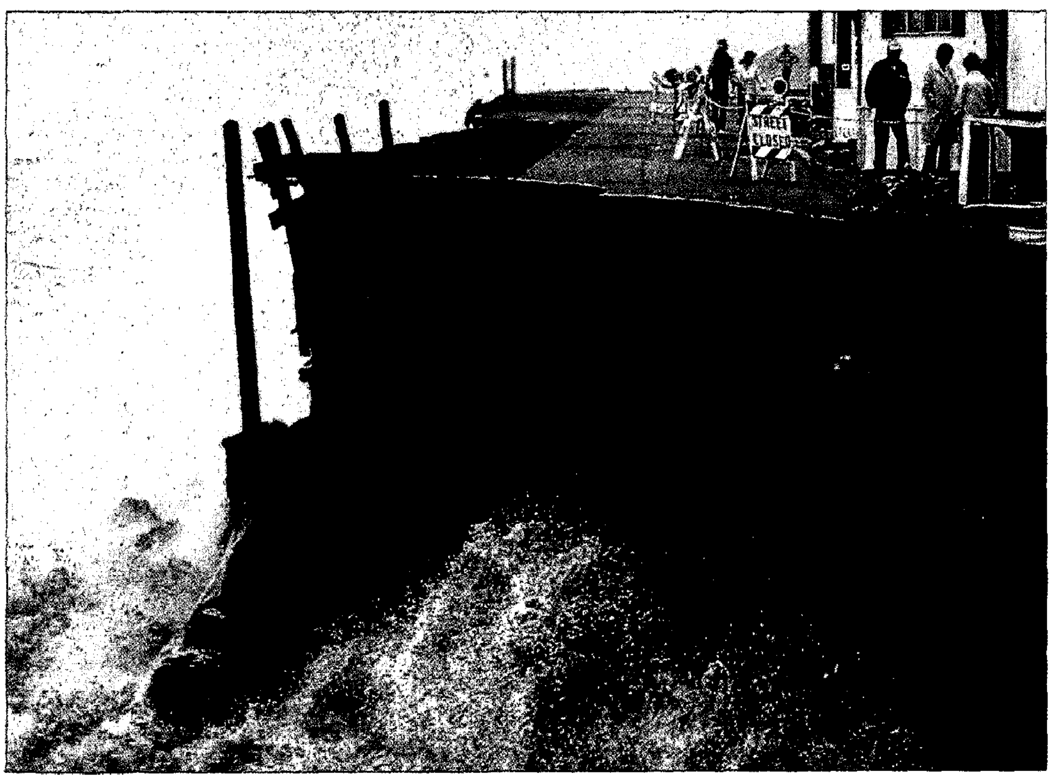
Such excessive rains transformed the landscape. Some rivers carried over 1,000 times their normal flow. The widespread flooding took its toll on crops, livestock, roads, bridges, schools, homes, and human life. Many escaped death but not the suffering from such widespread destruction. In Ecuador 40,000 families lost their homes in total or in part. In Peru the number was 50,000.

Further south of the region of excessive rainfall, severe drought plagued southern Peru and Bolivia. Estimates of the damage due to the 1982-83 climatic changes in Ecuador, Peru and Bolivia are provided in the Table (below). These figures were compiled by the Economic Commission for Latin America. The total losses were $640 million for Ecuador, $800 million for Bolivia, and $2,000 million for Peru. Some losses, like the flooding of archeological remains on the Peruvian coast, cannot be determined.

Evaluation of physical damages caused during the 1982-83 El Niño Phenomenon in Educador, Peru and Bolivia

(In millions of US Dollars)	Ecuador	Peru	Bolivia
Agribusiness	233.8	649.0	716.0
Fishing	117.2	105.9	——
Industry	54.6	479.3	——
Electric energy	——	16.1	——
Mining	——	310.4	——
Transportation and communications	209.3	303.1	98.0
Housing	6.3	70.0	17.8
Health, water and sewage systems	10.7	57.1	4.7
Education	6.6	5.9	——
Archeological remains	___ without appraisement ___		
Others	2.1	——	——
Total	**640.6**	**1,996.8**	**836.5**

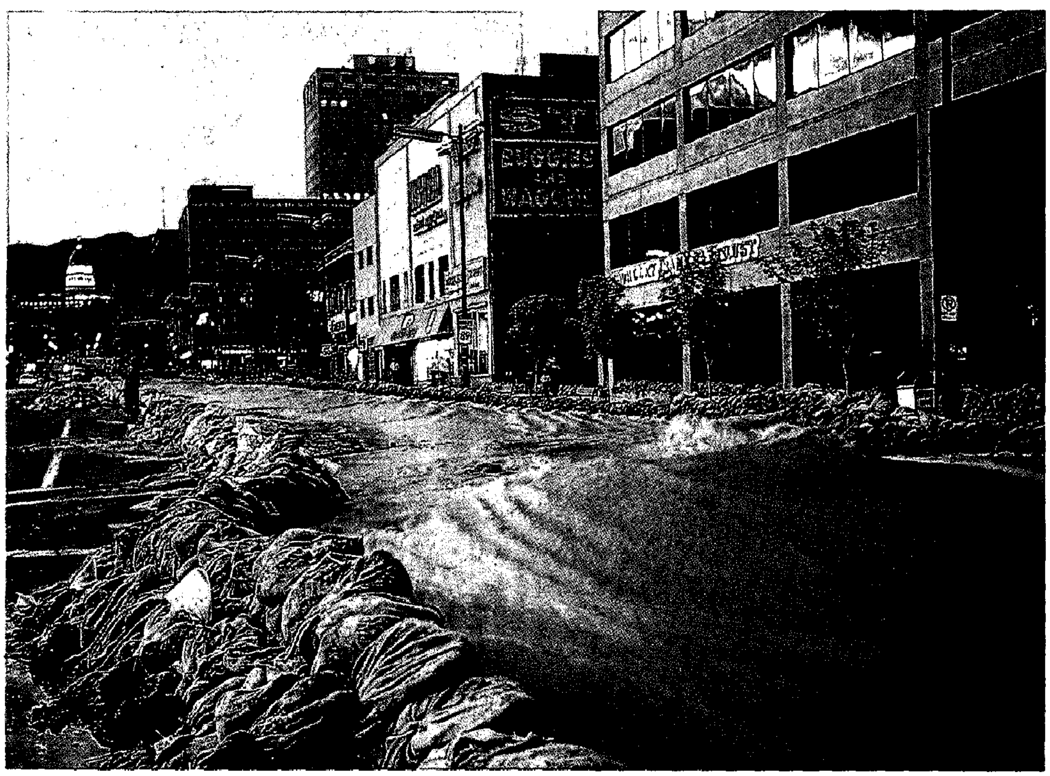
When the normally steady trade winds decrease from their usual intensity (as they do across most of the equatorial Pacific when the Southern Oscillation shifts from high to low pressure in the eastern Pacific), the sea level (which can be as much as a meter higher on the western Pacific than on the eastern side due to the steady trades) becomes lower in the west and rises in the east. As the rising sea level encounters the continental land masses on the eastern side of the equatorial Pacific, higher levels progress poleward in both hemispheres. The sea level rise, the warmer water, and changes in biological species were well documented all along the west coast of North America—as far as Alaska. Cold-water salmon abandoned the fishery off northern California. Marine creatures from the subtropics came as far north as Vancouver Island off British Columbia, Canada.



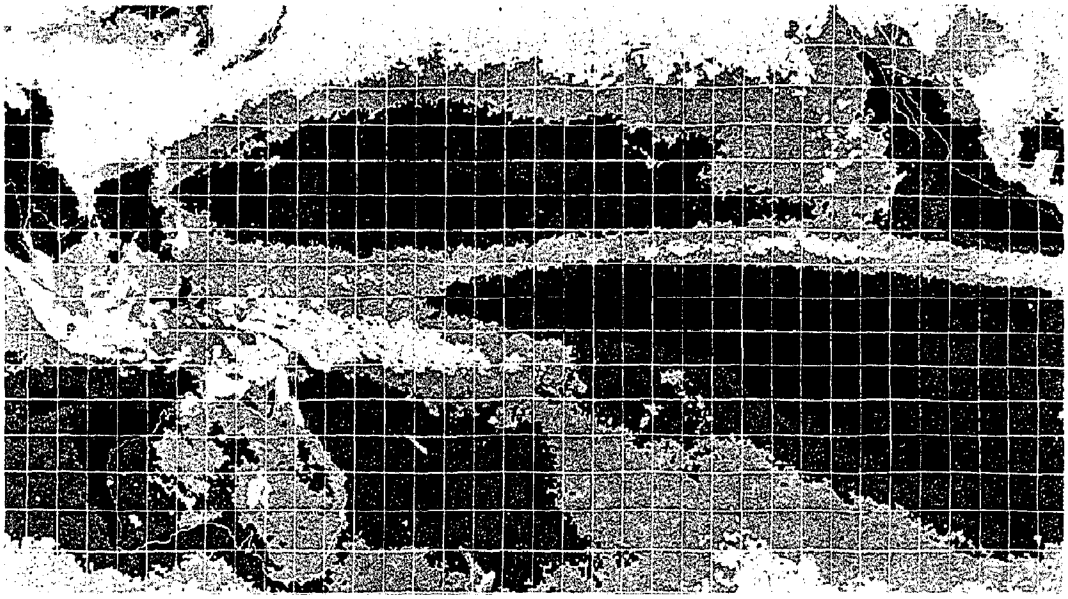
JAMES A. SUGAR/National Geographic Society

The combination of higher sea level, stronger westerly winds in the higher latitudes (a typical response during the Southern Oscillation change described here), and a progession of violent storms (associated with a deeper than normal Aleutian low pressure region) brought unprecedented wind, wave, and water damage to coastal property along the west coast of the United States. These same storm tracks led to a record snowpack on the Rocky Mountains and subsequent springtime flooding.

The fact that this record 1982-83 El Niño event brought exactly opposite conditions to southern California, as did the previous El Niño of 1976-77 (when record drought conditions occurred) testifies to the challenge that nature provides us in trying to understand what makes Southern Oscillation cycles evolve differently.



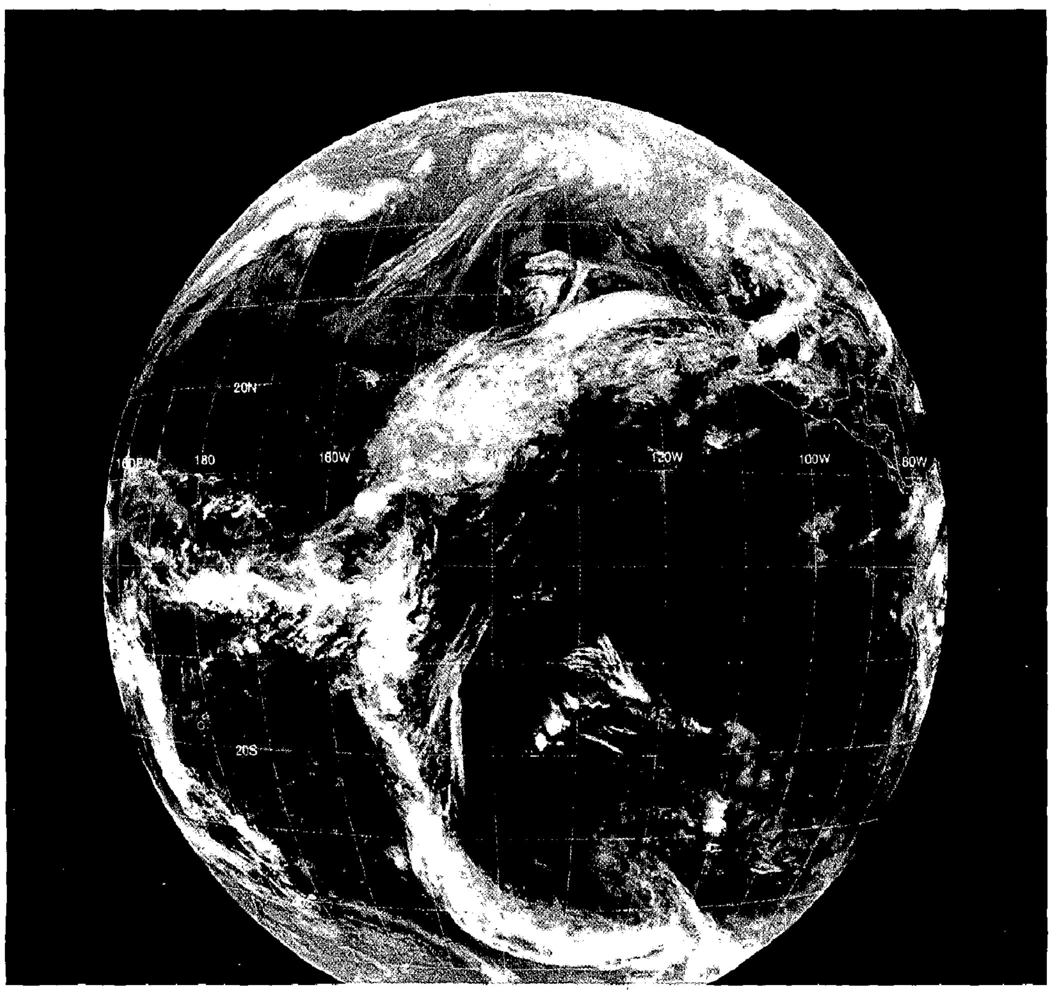
MARK KAUFFMAN/National Geographic Society



DONALD MILLER and ROBERT FEDDES

Tropical convection and latent heat release are among the main driving forces for the atmospheric circulation in higher latitudes. Their effects are vividly illustrated by examining changes which can occur in the far western equatorial Pacific. In this region the world's warmest open ocean temperatures occur and surface winds from the west converge with winds from the east resulting in an extremely cloudy convective region. This is clearly seen from composites of satellite cloud pictures. (See figure above, showing the merging of the Intertropical Convergence Zone and the South Pacific Convergence Zone over the warm water region near Papua New Guinea.) When periodic bursts of surface westerlies move farther eastward (as often occurs after surges of cold air move southward from Asia during the winter monsoon over Indonesia), the area of maximum cloudiness moves eastward and atmospheric wave phenomena can carry momentum and energy poleward into both hemispheres (see satellite picture at right). As the areas of tropical forcing move eastward with the Southern Oscillation shift, the weather patterns at high latitudes would be forced differently. Thus, weather conditions in the higher latitudes of both hemispheres can be systematically altered by events in the tropics.

There are further examples of higher latitude effects that occurred during the 1982-83 event. Lower air temperatures over the northeast portion of the People's Republic of China during the summer severely affected grain production—such conditions are common during El Niño phases. Elsewhere in the northern hemisphere, the Hawaiian Islands experienced drought conditions during the 1982-83 event. In the southern hemisphere the strong westerlies matched those of the northern hemisphere. In New Zealand it was referred to as the "summer that never was." Winds from the west and southwest were much more frequent and much stronger than normal. This resulted in the summer (October 1982 to mid-February 1983) as a whole for the entire country being 1-2°C below normal. Drought conditions prevailed in parts of New Zealand's North Island. Mexico also experienced drought conditions—apparently as a result of this 1982-83 event.



The Global Problem

We have described thus far a sequence of events that primarily affected the Pacific Ocean basin and the countries which surround it. The redistribution of atmospheric mass between the eastern Indian Ocean—Indonesian region and the eastern Pacific Ocean changes the pressure gradient across the tropical Pacific, this in turn changes the intensity and sometimes even the direction of the normally steady Pacific trade winds. The change of the wind across the Pacific alters the thermocline depth, mean sea level, and oceanic currents. These oceanic variations lead to significant changes in ocean sea surface temperature. The accompanying relocation of the normal atmospheric convergence zones leads to different areas of latent heat release, which in turn modifies the weather and climate.

It is our current concept that those low frequency oscillations between the atmosphere and the oceans occur on a global basis. Indeed, surface pressure correlations that identify the Southern Oscillation have significant values in the Atlantic Ocean as well.

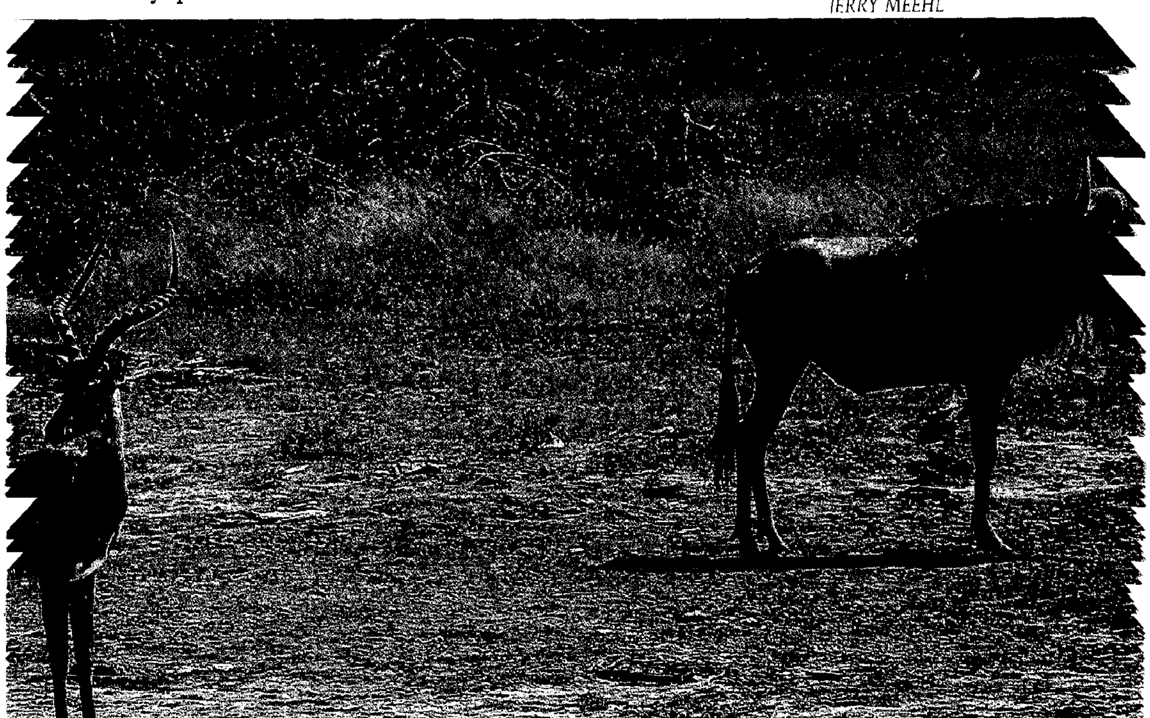
During the intense 1982-83 event, major changes occurred over the vast country of Brazil. In the northeast significant drought was experienced. In regions of the country south of the equator, there was extremely heavy flooding.

A number of studies have shown that changes in atmospheric conditions over the tropical Atlantic Ocean seem to follow (by a few months) the changes that occur in the Pacific. During 1982-83 the mid-latitude westerlies became quite strong over the Atlantic. The westerly pressure gradient along the Greenwich meridian between 50°N and 70°N had large positive values and reached a record +32 mb during January 1983. At this time the Azores Anticyclone had moved northeastward and was anomalously centered over Spain. The usual Icelandic low pressure area became more intense than normal, contributing to the strong pressure gradient. This pressure pattern led to a mild winter over continental Europe and these conditions continued over time—providing the region with a considerably warmer and drier summer than normal.

A similar change in atmospheric circulation was found in the southern Atlantic at the same time. The center of the St. Helena Anticyclone moved eastward very close to the South African coast. A consequence of this anomalous surface pressure was suppressed upwelling all along the west coast of Africa. Marine species were found far from their normal feeding areas and fish catches were considerably altered.

A far more tragic impact of the anomalous pressure over the Atlantic was the enhanced drought condition brought to the entire breadth of Africa. In Northwest Africa, the usual rain resulting from the northward progression of the Intertropical Convergence Zone (January to August) did not occur. This added to the problems of a drought-stricken region where malnutrition and starvation were already present.

JERRY MEEHL



On the other side of the continent, in northeast Africa, one looks again at the area where the anomalous high pressure had its start—over the Indian Ocean. At least for this 1982-83 event, the high pressure anomaly seemed to build from the Indian subcontinent and move slowly southward—affecting the east African and the Australian regions simultaneously. This began the severe intensification of the drought in Ethiopia. The drought spread southward along the entire east African continent. Tanzania, Uganda, and Zimbabwe were also among those countries severely affected. At the height of the drought, 150 children starved to death every day in Tanzania alone.

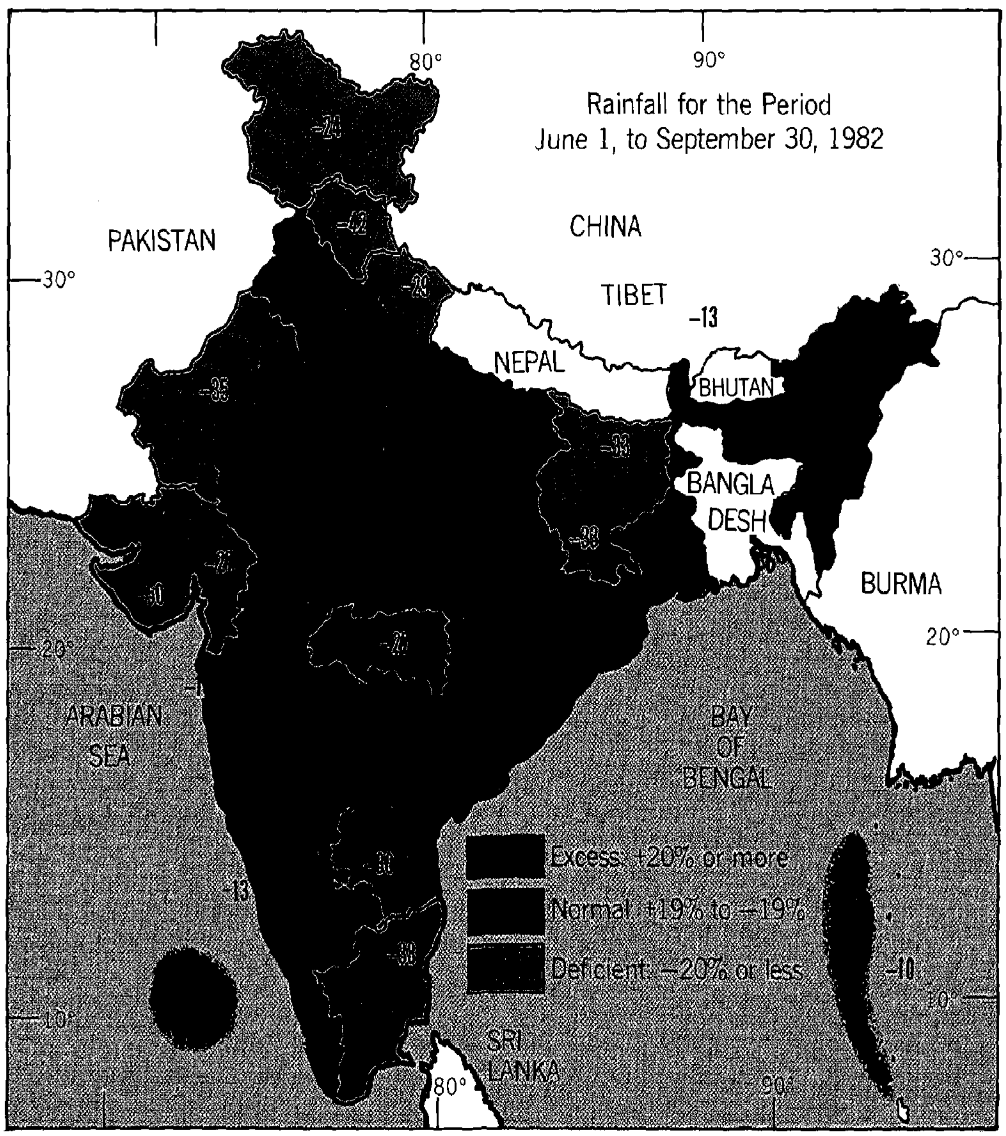
Drought spread into southern Africa. Many farmers lost up to 90% of their cattle. Food was imported for the first time in several countries of this region.

The summer monsoon rains, which are so vital to India, are also connected to the interannual climate changes described here. The monsoon of the summer of 1982 was considered very poor (15% less rainfall than normal) for India. The summer monsoon of 1983 was near normal, but by this time the anomalous high pressure had retreated from the Indian Ocean region.

These climatic changes are the result of global interactions of the atmosphere and oceans. Understanding the cause of these aperiodic cycles to the point of predicting their occurrence would be of immense economic value. Just knowing that an event is already underway, and then being able to predict the intensity and/or the degree of shifting of precipitation patterns, would allow man some time to adjust—to prepare for the impact of such changes.

Particularly important problems that must be addressed concern understanding the variability of monsoons and the occurrences of droughts. We know that these are related to the oscillations referred to previously. We must pinpoint the various factors that cause the monsoons and droughts, distinguish the various time scales over which these forces operate to produce variability, and ultimately apply this knowledge to improve advisories and predictions.

Another problem to solve is why some regions are affected differently by different Southern Oscillation events. This can be due to variability internal to the event and other factors which force climate change beyond those described here—particularly at higher latitudes. Understanding these differences, and improving the confidence level of predictions in such cases, would be a significant advance.



Another important concern is to determine why and how the El Niño event ends so abruptly. Solving this last puzzle has great practical value, especially for those countries which have to decide whether to replace a washed out bridge (and risk seeing it washed away again) or delay its replacement (and suffer the economic loss and personal inconveniences).

Today, scientists have only partial answers to the above questions. Most scientists feel that the cycle of climate change, as described above, can eventually be explained and predicted. However, nature has provided a challenge that is global in scope. No one nation can provide all the observations and research that is required.

What Science Can Do

Investigation of large-scale oscillations of the tropical atmosphere has been conducted over 80 years. Through the years, various scientists have correlated these low-frequency atmospheric oscillations to changes occurring in the tropical oceans. Later, it was realized that these interactions between the tropical oceans and atmosphere were linked with changes of weather and climate in the higher latitudes of both hemispheres. However, it is only recently that the latest results from the analyses of available data, field experiments, and theoretical work have come together to create a sense of priority in the scientific community concerning this subject.

In the last few years, there has been a large increase in individual research investigations. However, it is now extremely clear that significant progress in understanding and predicting these climate events will require a cooperative effort to obtain global fields of information about the relevant atmospheric and oceanic variables. An international activity that will provide this information has been formed and is called the Tropical Ocean and Global Atmosphere (TOGA) programme.

What is TOGA?

TOGA is part of the World Climate Research Programme (WCRP), which has been planned with support of intergovernmental and non-intergovernmental scientific organizations. TOGA is a study of the interannual variability of the tropical oceans and global atmosphere.

As an international programme, all countries may participate in, contribute to, and draw benefits from the activities which have been planned. TOGA has three major components.

"Ten-year Measurements" will be conducted which consist of monitoring atmospheric, ocean-atmosphere interface, and oceanographic variables relevant to the scientific objectives.

"Real-time Assessment" of large-scale climatic variations in the tropical oceans and global atmosphere (e.g., El Niño, monsoon variability in Asia and Africa, droughts in Africa and South America, and other special events).

"Modelling Studies" of various levels of complexity will be performed. These will range from simple models used in real time to detect potential climatic changes to very complex research models where the dynamics of the atmosphere and ocean are coupled.

Timing:

TOGA formally began in January of 1985. It is a ten-year programme which will see a buildup of resources and commitments of individuals, agencies, and countries. In the latter half of the ten-year programme, new ocean satellites will augment the observational components of the programme.

Scientific Objectives:

The TOGA programme has three scientific objectives:

(1) To gain a description of the tropical oceans and the global atmosphere as a time-dependent system in order to determine the extent to which this system is predictable on time scales of months to years, and to understand the mechanisms and processes underlying its predictability.

(2) To study the feasibility of modelling the coupled ocean-atmosphere system for the purpose of predicting its variations on time scales of months to years.

(3) To provide the scientific background for designing an observing and data transmission system for operational prediction if this capability is demonstrated by a coupled ocean — atmosphere models.

Observations Needed:

The observational domains for the TOGA programme are the tropical oceans from about 20°N to 20°S and the global atmosphere. One of the unique aspects of TOGA is the assembling of complete fields of information about the global atmosphere, the tropical oceans, and the fluxes between the two. It will not be necessary to determine these fields in great detail for every day of the TOGA period. In view of the time scales of interest, monthly to interannual, many fields can be averaged over time. Nevertheless, efforts will be required to fill major observational gaps in atmospheric and oceanic fields of interest.

The wind field and the atmospheric mass field (temperature and humidity structure) must be determined globally. Critical areas of the tropical region lack the necessary wind observations to account for the rotational and divergent wind components which are important in this portion of the earth's atmosphere.

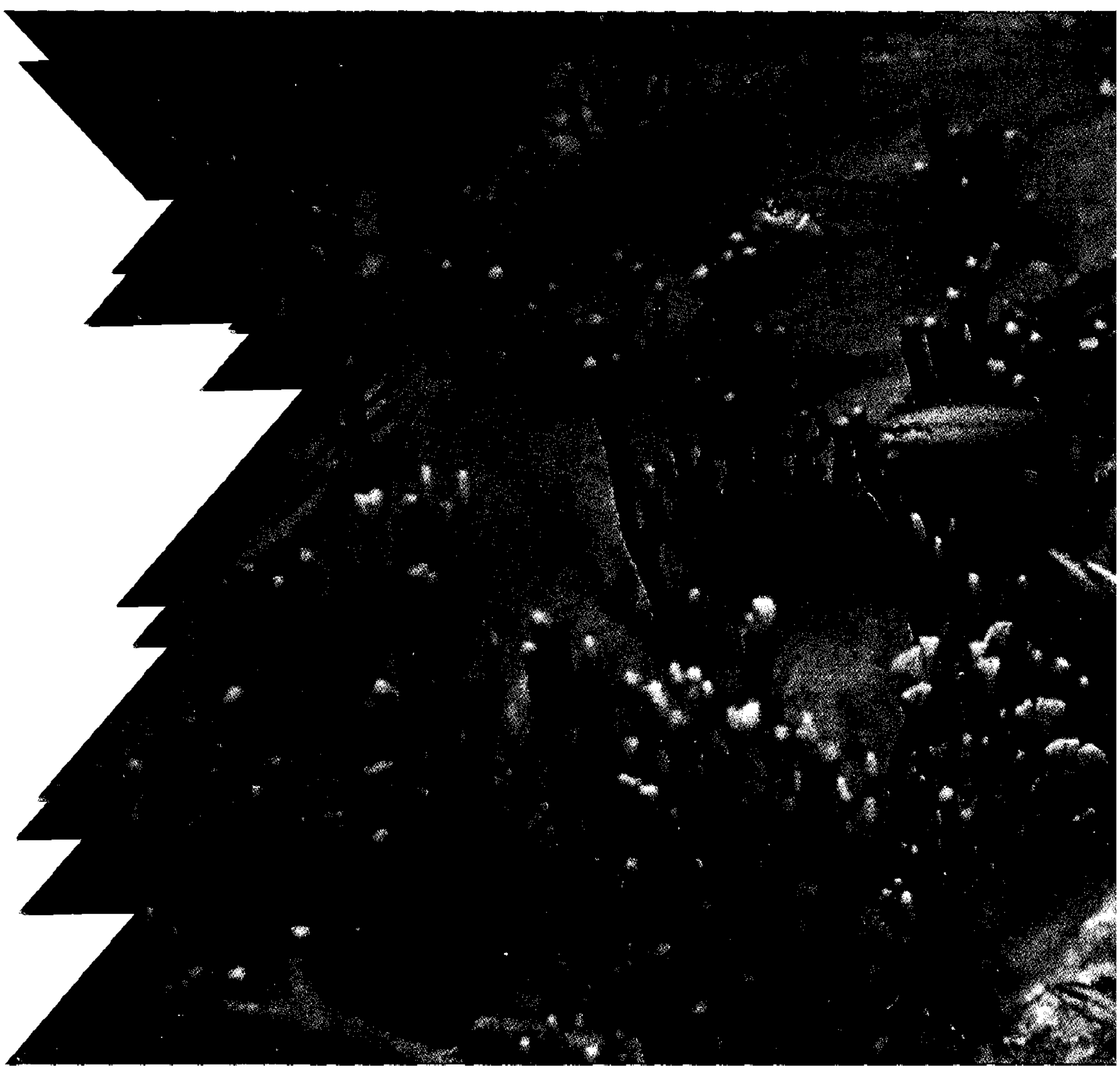
The thermal field of the upper layers (∿500 meters) of the tropical oceans must be determined. This will require considerable expansion of ships-of-opportunity Expendable Bathythermograph (XBT) lines in three tropical ocean basins. With a concerted international effort, this important field can be obtained. Surface salinity, dynamic heights of sea level, and current data (the latter at widely spaced intervals) can provide important diagnostic information for understanding and modelling. Oceanic nutrient and marine biological data are important for fisheries applications and as diagnostic tools.

Who Will Benefit From TOGA?

Countries will benefit from TOGA through improved warnings of climate change. This international cooperative programme will increase our understanding of the physical causes of these changes and, thus, accelerate the implementation of better services in climate application areas in the near-term. The programme will also provide a proper scientific foundation for continuing progress in the future. The application areas include, but are not limited to, agricultural planning, drought management, water reserve management and energy use.

The new atmospheric observing systems will also help improve the weather monitoring and forecasting services of countries. The island and coastal atmospheric systems and the new real-time oceanic observing systems will help improve the marine weather services and specialized marine services of various countries. The broad basin-wide perspective of atmospheric and oceanic conditions will be of particular benefit to those countries which depend so heavily on commercial fishing. It has been demonstrated that fisheries in one part of an ocean basin can be dramatically affected by prior conditions in a distant part of the basin.

The global nature of the problems discussed here require help from many areas of the world to achieve solutions. Global cooperation can assure a whole effort which is greater than the sum of the individual national contributions. However, individual countries

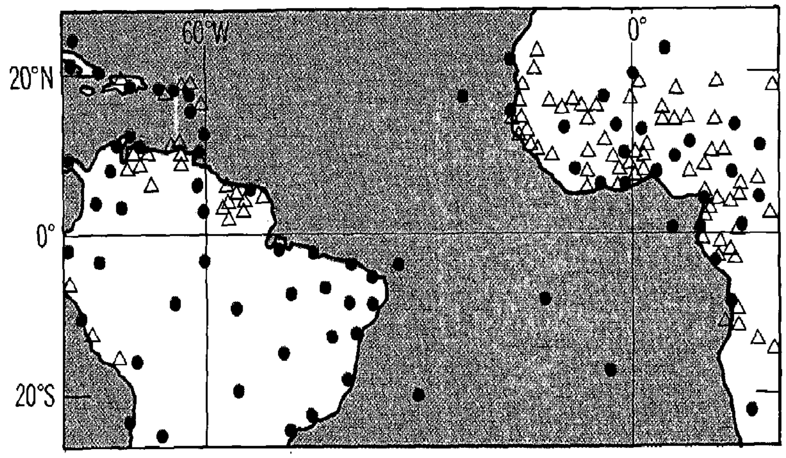


can gain immediate returns in ways other than those listed above.

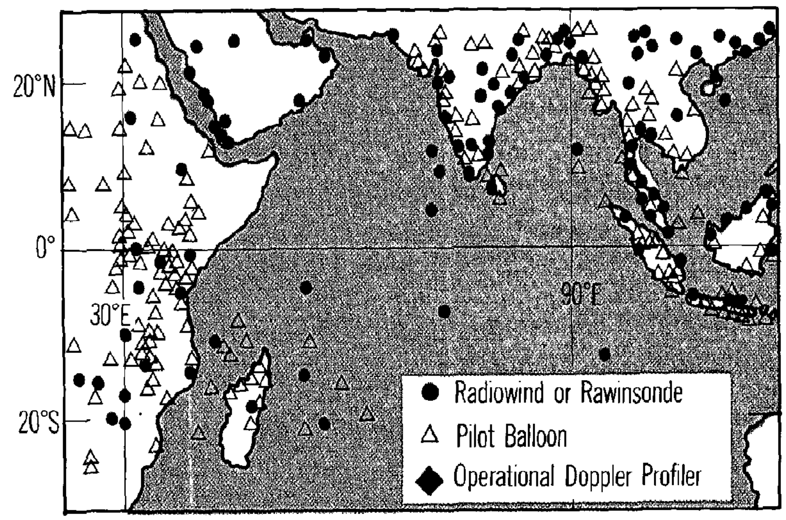
First, the real-time warning component of TOGA will advise countries when such climatic changes are about to happen or are in progress. Second, scientists will benefit from the knowledge gained in the programme and communicate it through their universities, national agencies and institutions. Third, the new technology gained by institutions and operators will be incorporated into their national programmes.

All of the above improvements can lead to more efficient management of man's activities. The TOGA programme may well be one of the most cost-effective activities undertaken in the earth sciences.

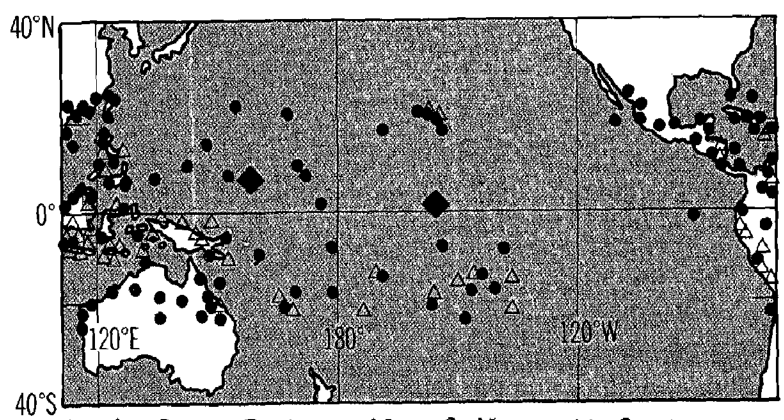

BATES LITTLEHALES/National Geographic Society



Atlantic Ocean Basin, 25°N-25°S, Upper Air Stations, per WMO-Volume A, taking a minimum of one observation (winds) per 24 hour period.



Indian Ocean Basin, 25°N-25°S, Upper Air Stations, per WMO-Volume A, taking a minimum of one observation (winds) per 24 hour period.



Pacific Ocean Basin, 25°N-25°S, Upper Air Stations, per WMO-Volume A, taking a minimum of one observation (winds) per 24 hour period.

What Countries Can Do For TOGA

Countries can contribute to the TOGA programme in a number of ways: new or improved observing systems can be implemented; funds can be provided to individual scientists or laboratory groups to participate in the on-going research phase of the programme; they can participate in the real-time watch for early indications of the occurrence of El Niño, late monsoons, drought conditions, and other anomalous events; and resources can be offered (funds, equipment, expendables, secondment of personnel) to help in the implementation of the TOGA programme. These opportunities are briefly outlined below.

Contribution of observations:

- implement new or re-establish upper air stations especially in the tropics and other data-sparse regions, in particular, Africa and South America (see figures at left).

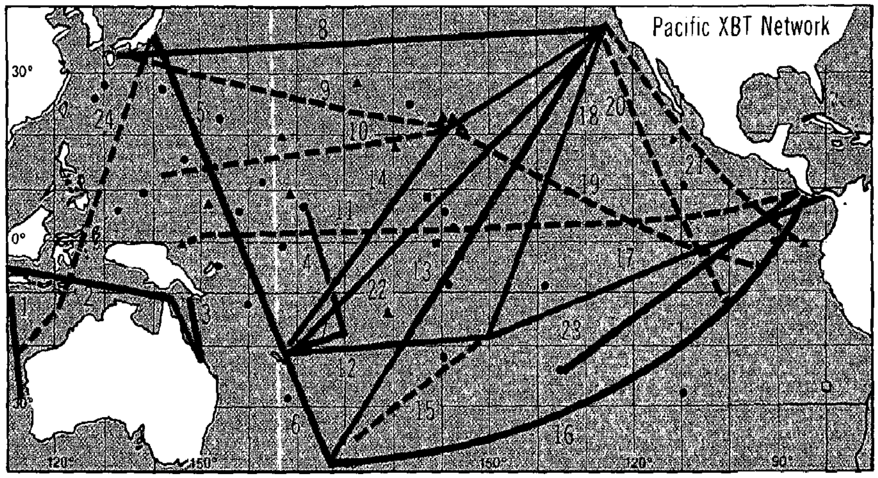
- implement automated surface meteorological stations at key islands in the tropics and southern hemisphere.

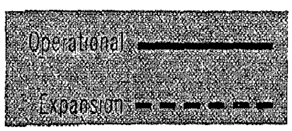
- enlist more vessels in the Voluntary Observing Ship (VOS) programme for obtaining better surface wind information in the tropical regions.

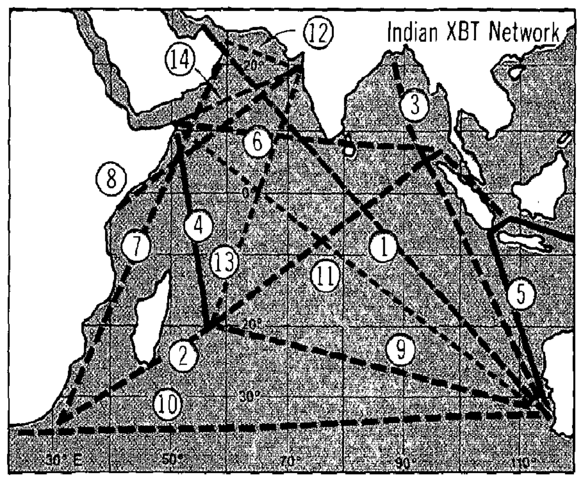
- provide real-time data transmission of winds from existing and new VOS vessels.

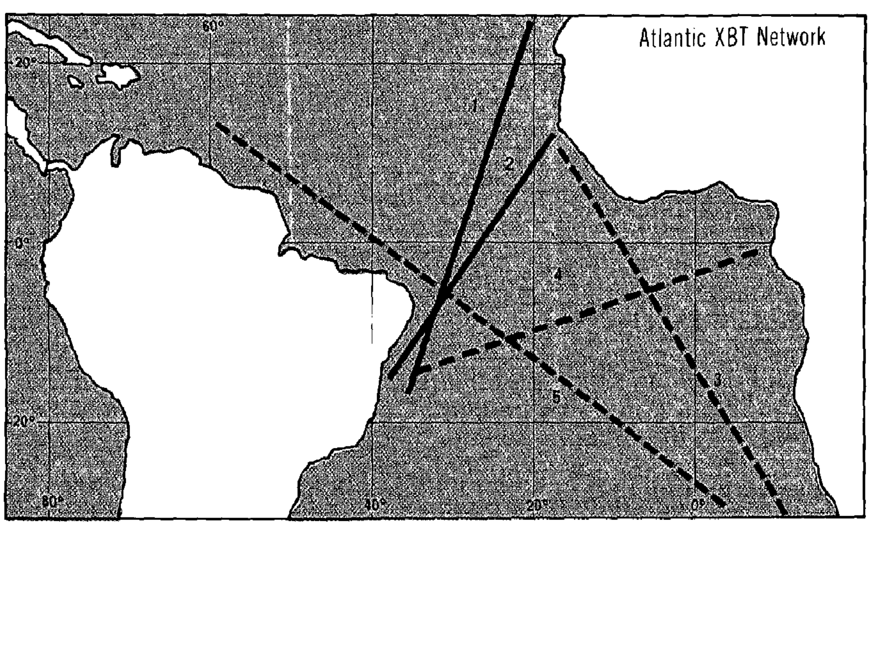
- implement more rain gauge stations and send a higher density of such information on the Global Telecommunications System.

- launch new satellite systems (at least for the last half of the TOGA) to measure global precipitation and ocean surface parameters.


Pacific XBT Network
30°
0°
120°
150°
180°
120°
90°


Operational
Expansion


Indian XBT Network
30° E
50°
70°
90°
110°


Atlantic XBT Network
60°
20°
0°
20°
60°
30°
20°
0°

- implement expendable bathythermograph (XBT) lines on existing well traveled transport routes that traverse the tropical oceans (see figures at left)

- provide XBT's to national ships-of-opportunity or to ships of other countries traversing important routes.

- implement tide gauge stations in areas of the tropical oceans that are currently not well covered.

- provide research vessels to make important atmospheric, oceanic, and biological measurements in the tropical oceans.

- deploy drifting buoy systems in the tropics for measuring surface winds, sea surface temperature, and temperature as a function of depth.

- deploy drifting buoy systems in the southern oceans for measuring surface pressure, air temperature, and sea surface temperature.

Contribution of supporting efforts:

- provide access within Exclusive Economic Zones to those research vessels which are performing TOGA scientific investigations.

- contribute special vessels or make arrangements for ships-of-opportunity to contribute to the launching of buoy systems from other countries.

- satellite operating agencies can make special efforts to get a greater density of cloud-tracked winds in the tropical regions.

- satellite operating agencies can make special efforts to compute quantitative rainfall estimates from agreed-upon algorithms.

Contribution to the research programme:

- support individual scientists who wish to do research that will contribute to the scientific objectives of the TOGA programme.

- support modelling groups with resources necessary to implement diagnostic and predictive models that will contribute toward improved understanding and prediction of tropical ocean and global atmosphere climate variability.

- support various special data centres that will contribute to TOGA data management activities.

Contribution of resources:

- provide personnel to the International TOGA Project Office to aid in the programme's implementation and administration.

- provide financial resources for the purchase of key expendables such as rawinsondes, XBT's, and drifting buoys.

The Mechanism for Participation:

Countries can contribute resources to the TOGA programme in several ways:

(1) They can make their national contributions known to the WMO or to the IOC through their permanent representatives to those organizations.

(2) Countries can make financial contributions through their national scientific institutions.

The above contributions can be initiated by letter or through statements made at international commitments meetings of the WMO and/or IOC. In all cases, countries are urged to let the International TOGA Project Office know of such intentions. If there are any questions about the TOGA programme, please contact:

Director,
International TOGA Project Office
NOAA/ERL R/E3
325 Broadway
Boulder, CO 80303 U.S.A.

Further information on the World Climate Research Programme can be obtained by writing:

Director, World Climate Research Programme
World Meteorological Organization
Case Postale No. 5
CH-1211 Geneva 20, SWITZERLAND

Further information on programmes and activities which contribute to the ocean's role in climate can be obtained by writing:

Secretary, CCCO
IOC/UNESCO
7, Place de Fontenoy
75700 Paris, FRANCE

Summary

The TOGA programme is a unique endeavour scheduled to last for ten years. It is a sustained effort to increase our understanding of the forces of nature which affect our lives.

The TOGA programme does not require an enormous new investment to meet its goals. It builds on existing meteorological and oceanographic systems and mechanisms that already serve the international community. However, the incremental resources needed are extremely important for the programme to be a success. We call upon individuals and nations to provide this base and incremental support.

Individuals take observations, send messages, make decisions and perform research. Individuals must work to provide greater quality to the existing international meteorological and oceanographic observing systems. Every observation, whether taken near a modern city or far out to sea, must be of the highest quality attainable. Where the existing systems have problems, we must find solutions. Where the existing systems work well, we must strive to make them better.

Nations must create a stable source of funds for the duration of the programme. They must follow through on commitments of observing and data management systems for the entire programme, even though individuals working on these systems may move on to other areas of interest during the course of the programme. Nations must foster creativity within the institutions that can contribute to the scientific goals of this international climate programme.

Nature has indeed provided us a challenge that is global in scope. All nations working as one can meet this challenge. Together, we can help unveil the mysteries of climate variability and make life more pleasant for us all.

ACKNOWLEDGEMENTS: This brochure was prepared by Dr. Rex J. Fleming, Director of the International TOGA Project Office. Many individuals and organizations contributed to its preparation.

Graphics support was provided by the National Oceanic and Atmospheric Administration of the United States.