



WMO



of UNESCO

CONFERENCE ON THE WORLD CLIMATE RESEARCH PROGRAMME: ACHIEVEMENTS, BENEFITS AND CHALLENGES

(Geneva, 25-28 August 1997)

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FINAL VERSION OF CONFERENCE STATEMENT

I would like to thank you sincerely for participating in and contributing to the Conference on the World Climate Research Programme: Achievements, Benefits and Challenges in Geneva at the end of August. The Conference was successful in attracting the attention of the international climate research community and of a number of policy- and decision-makers, as well as of the media. Numerous useful comments were made by participants on the future directions to be followed by the WCRP from the Conference floor, in the Working Group sessions, and in the questionnaires.

To the extent possible, comments and ideas put forward have been incorporated into the draft statement reviewed at the Conference itself and I now have pleasure in enclosing for your information and consideration the final version of this statement. I also enclose a copy of the covering message to the Conference of the Parties to the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification which highlighted the widely-voiced concerns on the status of observational systems. I would add that the full proceedings of the Conference, including the final version of the Conference statement and extended abstracts of the presentations given, are being compiled and will be available early in 1998.

Thank you again for your interest in and support to this important WCRP event.

A handwritten signature in black ink, appearing to read 'J.P. Bruce'.

(J.P. Bruce) Chairman, Organizing Committee

To: All participants in the Conference on the World Climate Research Programme: Achievements, Benefits and Challenges, Geneva, August 1997.

Proceedings of the Conference on the World Climate Research Programme: Achievements, Benefits and Challenges
Geneva, Switzerland, 26-28 August 1997
Conference Statement and Messages from the Sponsors: WMO, ICSU and IOC of UNESCO

Message to the Conferences of the Parties to the United Nations Framework Convention on Climate Change and United Nations Convention to Combat Desertification

Well over 300 members of the climate research and policy communities present at the Conference on the World Climate Research Programme (WCRP) (Geneva, Switzerland, 26-28 August 1997) agreed that comprehensive observations of the climate system are critical and noted with concern the decline in conventional observation networks in some regions. This is a serious threat to continuing progress in climate research, and to detection of climate change and attribution of its causes. Without action to reverse this decline and develop the Global Climate Observation System, the ability to characterize climate change and variations over the next 25 years will be even less than during the past quarter century. In some regions, for example, drought-prone parts of Africa, climate change detection, prediction of seasonal and long term variations and reliable assessment of climate impacts could become impossible.

Recognizing the obligations of the Parties to the United Nations Framework Convention on Climate Change under Article 4.1 (g) and (h) (Commitments) and Article 5 (Research and Systematic Observations), we strongly urge that, at the coming sessions of the Conference of the Parties, arrangements be put in place to ensure funding and support for the essential observation networks of the Global Climate Observing System (*GCOS*) and its oceanographic and terrestrial counterparts, and for research involving data interpretation and analysis, as well as for retrieval and preservation of historical data in electronic form.

Without such support, future assessment reports of the Intergovernmental Panel on Climate Change (IPCC) which draw heavily on WCRP research and on the observational data sets, will be significantly compromised.

The full text of the Conference Statement is attached.

STATEMENT OF THE INTERNATIONAL CONFERENCE ON THE WORLD CLIMATE RESEARCH PROGRAMME: ACHIEVEMENTS, BENEFITS AND CHALLENGES

Geneva, 28 August 1997

PREAMBLE

Much has been learned about the behaviour of the global climate system since the establishment of the World Climate Research Programme (WCRP) in 1979 as the research component of the international, interdisciplinary, interagency World Climate Programme. WCRP research has underpinned the Scientific Assessments of the Intergovernmental Panel on Climate Change (IPCC) and the negotiation of the United Nations Framework Convention on Climate Change (UNFCCC) and has provided the scientific basis for major advances in climate services around the world.

Notwithstanding, for nations to meet their fundamental obligations to ensure safety of their citizens and promote sustainable development, they must better understand, monitor, and manage the extremes of flood and drought and the threats of human-induced climate change. Support to and cooperative action in the framework of the WCRP offers an outstanding opportunity to improve understanding and prediction of climate. It is critically important that nations reinforce their commitment to a cooperative international research effort through the WCRP and its associated global observing, research and service programmes.

We, as representatives of the international climate research and policy communities, have taken stock of the achievements, benefits and limitations of WCRP during the past eighteen years and have considered the scientific challenges lying ahead. We commend our findings, summarized below, for the urgent consideration of the governing bodies of the World Meteorological Organization (WMO), the International Council of Scientific Unions (ICSU), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and through them, the governments of all nations, especially those who have committed themselves to the objectives of the UNFCCC, the United Nations Convention on Biological Diversity, and the United Nations Convention to Combat Desertification.

I. MAJOR ACHIEVEMENTS AND BENEFITS OF WCRP

WCRP has stimulated commitments of national support for research on critical climate issues and provided the international context for enhancing the value of national research efforts. Among achievements to date, the WCRP has contributed in significant measure to:

- the capability to observe, describe and predict climate anomalies several seasons in advance related to the El Niño - Southern Oscillation phenomenon. This capability is a direct result of the WCRP Tropical Oceans - Global Atmosphere (TOGA) project. The predictions so obtained are in increasing operational use and are providing major benefits in drought preparedness, water resource management, agriculture and public health in both developing and developed countries;

- improved modelling of the coupled physical climate system (comprising atmosphere, oceans, land surface and cryosphere) through systematic model diagnosis and intercomparisons, thereby providing more accurate predictions of natural climate variations and giving increased confidence in models and projections of anthropogenic climate change. These results are central to the Scientific Assessments of the IPCC and furnish essential basic information for the discussions on the implementation of the UNFCCC;
- data analyses and model simulations that have underpinned the assessment of natural climate variability, and hence the first suggestion of a discernible anthropogenic climate change signal, as discussed in the IPCC Second Assessment Report in 1995. Evidence presented at the Conference supported further the key conclusions of the IPCC Assessment;
- studies of atmospheric, hydrological and oceanic processes upon which the above developments were based, and which have led to better understanding, description and parameterization of important processes in the climate system;
- systematic observations of the ocean's three-dimensional structure, combined with satellite altimetry providing a vastly increased knowledge of the ocean circulation and behaviour, and permitting the development and testing of ocean models. This is enabling improved assessments of water and energy transports, ocean currents, and spatial patterns of change in sea level, essential for understanding climate change and variability and in the management of ocean and coastal resources;
- assembly of critical data sets, on global and regional scales, of radiative fluxes; clouds, the oceans, water vapour and the hydrological cycle as a basis for improved understanding and modelling of climate and of water resources;
- raising the level of scientific, governmental and public appreciation of the importance of climate issues, increasing the collaboration with the International Geosphere-Biosphere Programme (IGBP) in capacity building in developing countries, and fostering much greater cooperation between hitherto distinct scientific disciplines in understanding the whole climate system.

II. FUTURE PRIORITIES AND CHALLENGES

The objectives of the WCRP are to determine to what extent climate can be predicted and the extent of human influence on climate, aiming at the general goal of a greatly improved understanding of the role of climate in the total Earth system. The Conference agreed that the overall research priorities for the next decade should be:

- assessing the nature and predictability of seasonal to interdecadal variations of the climate system at global and regional scales, and providing the scientific basis for operational predictions of these variations for use in climate services in support of sustainable development.
- detecting climate change and attributing causes, and projecting the magnitude and rate of human-induced climate change, regional variations, and related sea level rise (as needed for input to the IPCC, UNFCCC and other Conventions).

The research required to reach these two targets is closely interconnected. The Conference considered that the present WCRP project structure (the Global Energy and Water Cycle Experiment (GEWEX), Stratospheric Processes and their Role in Climate (SP ARC), the World Ocean Circulation Experiment (WOCE), the Climate Variability and Predictability study (CLIV AR), the Arctic Climate System Study (ACSYS), and the cross-cutting Climate Modelling activities) provides an efficient and flexible framework to tackle the priority scientific issues raised by the Conference and to respond to the questions identified in IPCC Scientific Assessments. The Joint Scientific Committee (JSC) for the WCRP needs to examine appropriate modifications to or extension of the scope of some of the projects (in particular ACSYS) to take into account the specific proposals made below. Particular efforts should be made to develop co-operation with the International Geosphere Biosphere Programme (IGBP) in the quest to develop the understanding and ability to predict the evolution of the fully coupled climate system (including the physical components already being studied by WCRP, as well as chemical and biospheric aspects) and to investigate the modes of behaviour of this system. Attention also needs to be given to encouraging the exploitation of WCRP results in climate impact studies.

These steps must be complemented by the systematic, sustained and reinforced observations of all key climate variables, by capacity building involving all nations in climate research activities, and by improving interactions with other climate-related programmes within the framework of the international Climate Agenda.

The Conference urged that the WCRP maintain an awareness and sensitivity to evolving user requirements. In particular the ultimate target of achieving an operational system for climate prediction with adequate regional detail on interannual and longer timescales, and the groundwork required for a future operational ocean observing and prediction system must be borne in mind. However, the Conference emphasized strongly that the main motivation of the WCRP must continue to be fundamental research into understanding the basic behaviour of the physical climate system.

1. **RESEARCH ACTIVITIES**

The main future priorities and challenges are:

(i) *Variability*

- identifying modes of variability of the coupled ocean-atmosphere system, understanding their underlying mechanisms and investigation of their predictability;
- studying effects of anthropogenic forcing on the frequency or intensity of natural modes.

(ii) *Understanding the hydrological cycle:*

- reducing uncertainties associated with the hydrological cycle, its main components and its interaction with changes in radiative forcing;
- improved understanding of land surface processes and linkages with the atmosphere;
- refining techniques for prediction of regional precipitation and run-off anomalies on time scales from seasons to decades.

(iii) *The role of the oceans.*

- formulating a dynamically consistent view of the ocean circulation with the goal of producing improved models of the global ocean circulation and its variability, essential to longer-term climate prediction and estimation of sea-level rise;
- focused exploration of modes of natural variability in the oceans on all time scales and their effects on ocean resources and climate.
- designing, in the light of new scientific results and technology developments, a global observational system for the oceans and supporting its implementation.

(iv) *Extremes:*

- assessment of past fluctuations and trends in extreme events such as severe storms, heavy rains and droughts, and estimation of future evolution;
- improving the capability of providing longer term warnings of floods and other extreme events.

(v) *External forcing:*

- assessing the impact of natural and human-produced aerosols on the climate system as needed to understand present and past climates and to make projections of the future climate, supported by improved knowledge of the global distribution of aerosols of different types and their optical properties;
- refining evaluation of climate forcing due to trace (greenhouse) gases, including improved determination of oceanic and terrestrial sources and sinks, and measurements of global distribution;
- examination of effects of natural external forcing (in particular solar variability) on decadal to centennial timescales.

(vi) *Detection and attribution of climate change.*

- exploitation of all available data (including ocean and palaeo-climatic data sets) and model results in discerning climate change, and its attribution to specific causes.

(vii) *Feedbacks and response to climate change.*

- reducing uncertainties associated with water vapour, cloud/radiation and atmosphere/ocean interactions, and snow/ice albedo feedback mechanisms;
- investigating (as a joint initiative with IGBP) the responses of terrestrial and marine ecosystems to climate variability and change, including positive and negative feedbacks.

(viii) *Regional climate simulation and predictions:*

- intensive efforts to develop regional and smaller-scale coupled models able to draw on the results from coarser-scale global climate models to give more realistic simulations of regional climate, local climate variations and change.

(ix) *Sensitive regions*

- special attention to be given to sensitive key regions such as arid or desert areas, mountainous zones, polar regions, and small island countries;
- improved understanding of climate processes having an important role in such sensitive regions, in particular those involved in droughts and desertification in order to broaden the scientific basis for implementation of "the United Nations Convention to Combat Desertification;
- Promotion of appropriate regional projects, involving local concerned nations and drawing on local expertise.

(x) *The role of the cryosphere:*

- investigation of the role in climate of the global cryosphere (sea ice, snow cover, ice sheets and shelves, glaciers, lake and river ice, frozen ground and permafrost), requiring expanded WCRP activity in the field of cryospheric research;
- examination of factors determining the extent and variability of the cryosphere, feedbacks to the global climate system, and role in global climate variability and change and in sea-level rise.

(xi) *Stratospheric interactions:*

- improving the understanding of the physical and chemical characteristics of upper tropospheric/lower stratospheric interactions (as a joint initiative of WCRP/SP ARC and the IGBP International Global Atmospheric Chemistry Project), including particularly stratosphere/troposphere exchanges of energy, water vapour and chemicals;
- quantifying and clarifying the impact of the major depletions of ozone in the lower stratosphere resulting from human activities, and of the observed increase of stratospheric water vapour on global climate;
- investigation of the potential effects of the rapidly increasing emissions from the growing fleet of civilian aircraft.

(xii) *Palaeo-climate;*

- extending palaeo-climatic data sets, improving temporal and spatial resolution, and identifying spatial patterns of past climate variations, especially over the past few thousand years;

- improving knowledge of transfer functions for the optimum translation of proxy data into climate information.

(xiii) *Research data sets:*

- continued generation of specialised high quality global atmospheric, oceanographic, land-surface and cryospheric climatological data sets as needed to improve understanding of the physical climate system and transports of heat, momentum and water and other constituents in the different components of the climate system. These are required to validate climate models and for detection and attribution of climate change.

(xiv) *Model development:*

- constructing a hierarchy of comprehensive models of the coupled climate system able to simulate realistically past and present climate and predict climate variations, through use of results of research on climate system processes, analyses of model errors, and model intercomparisons;
- maintaining the close connection between models as developed for climate studies and operational numerical weather and ocean prediction, particularly as a means of verifying and refining models.

2. **DATA REQUIRED FOR RESEARCH AND SERVICES**

Progress in climate science, applications and services depends upon the timely availability of global and special observations of the whole climate system. Issues requiring particular attention by governments, national and international agencies include the following:

- Operational weather observation systems, integrated in the WMO World Weather Watch (WWW), are under serious threat in several regions of the world. The maintenance of these networks, enhancement where necessary to meet the requirements for observing climate, and data archival in electronic form for climate analysis and modelling purposes, are of critical importance;
- Other operational and quasi-operational climate-related observational systems, including subsets of the WWW (e.g. the Global Climate Observing system (GCOS) upper air and surface networks) and specialized hydrological, oceanographic and terrestrial networks, particularly as needed to support seasonal and longer-range predictions, are, or may become, threatened by lack of appropriate funding. This is a concern that should be recognized and addressed by governments;
- GCOS, the climate-related aspects of the WMO Global Atmosphere Watch (GA W), and the climate components of the Global Ocean Observing System (GOOS) and Global Terrestrial Observing System (GTOS) integrate the observational requirements for monitoring climate, and provide essential advice on and predictions of climate variability and impacts. Greater financial support and continuing sustained commitment to these are needed from all countries, as required under Articles 4.1 g, h and 5 of the UNFCCC;

- An operational ocean observing system must be developed for seasonal and longer-term predictions, for the estimation of climate variability and for detection of climate change and its attribution. Existing research-specific observational networks should be continued, expanded and transformed into components of routine global climate observations;
- Global satellite observations are crucial for climate prediction and research but require continuous calibration and validation. Satellite-operating countries are urged to give high priority to climate-related missions and to support the calibration and validation activities necessary to ensure the utility of satellite data for climate applications;
- Long-term, stable support for data management, information systems, analysis and reanalysis, quality control, archiving and distribution is essential for advancing climate science and services on a global basis. At present, support for these data activities is inadequate. Governments should provide the necessary long-term support for the full range of data services required for climate research and applications;
- Free and unrestricted access to all climate-related data for research purposes is vital to meet agreed international obligations of the UNFCCC (Article 4.1h) and to protect safety of life and property. Appropriate mechanisms, based on the example of Resolution 40 of WMO (Cg-XII), must be adopted to ensure such access;
- Monitoring changes and variations in climate requires increased support for seamless transitions between new and established observing and data management systems;
- Long-term historical data sets, which presently exist in non-electronic form should be rescued before they are permanently lost;
- The continuation of existing monitoring stations for which long-term data records have been collected is of extreme importance. These stations should be identified and treasured;
- Particular attention needs to be paid to filling the gaps in data-sparse areas of the globe, for example equatorial regions and much of the southern hemisphere. The lack of capacity in many countries is a major continuing concern and an obstacle to progress.

3. INSTITUTIONAL FRAMEWORK AND CAPACITY BUILDING

To meet the challenges outlined in previous sections and to deliver research results relevant to the entire global community, the WCRP must interact with many partners and must promote the involvement of scientists from developing countries.

The main WCRP partners and relationships are identified in Figure 1. On the "Research Axis", WCRP is a key component together with the IGBP and the International Human Dimensions Programme on Global Environmental Change (IHDP) in what has been termed Earth System Science or, in some cases, Global Change Research.

The WCRP is also a key component of the Climate Agenda, which provides an overall integrated framework for climate-related programmes, and which is supported by many agencies and organizations. The WCRP is a major foundation of the research thrust "New Frontiers in Climate Science and Prediction" and also contributes to the other (closely-related) thrusts "Dedicated Observations of the Climate System", "Climate Services for Sustainable Development", and "Assessment of Impacts of Climate Variability and Change and Response Strategies to Reduce Vulnerability". Furthermore, the WCRP provides the essential scientific research which forms the basis of the assessments of anthropogenic climate change by the IPCC.

In order to involve scientists from developing countries more intensively in the planning and conduct of WCRP activities, scientific capacity in developing countries must be built up in a sustained and expanding manner. WCRP cooperates with IGBP and IHDP in the Global Change System for analysis, Research and Training (START), the Inter-American Institute for Global Change Research (IAI) and other related inter-governmental groupings in capacity building efforts. Through START, WCRP contributes to a multi-disciplinary capacity building programme on agriculture and climate variability, aimed at improving agricultural output at local and national levels. The Conference regarded the following specific actions as particularly important:

- building up a critical mass of research activities and a critical number of research scientists;
- building to the extent possible upon existing institutions;
- strengthening cooperation between developing countries in a particular region;
- seeking the funding required for sustained capacity building activities;
- encouraging developing countries to indicate their own priorities within the international research framework.

Summary of specific recommended actions

To the Joint Scientific Committee (JSC), Joint Planning Staff (JPS) and the Project Offices of the WCRP:

- Develop further collaboration with IGBP (particularly on aerosols, trace gases, hydrological cycle and modelling of the physical-chemical-biological climate system) and with IHDP;
- Maintain and strengthen further links with IPCC, and in particular consider the needs of the Third Assessment Report in determining shorter-term research priorities;
- Determine research needs and provide results as required to the United Nations Conventions to Combat Desertification and on Biological Diversity, and to the UNFCCC, the latter primarily through the IPCC;
- Foster capacity building in the framework of START, and intergovernmental groupings such as IAI in implementing the WCRP research agenda, making full use of existing regional centres, such as the African Centre for Meteorological Applications for Development and Regional Meteorological Training Centres;

- Develop an effective communication strategy directed towards national governments, funding agencies, non-governmental organizations and the general public, to promote WCRP achievements and benefits and to highlight the challenges being faced;
- Play an active role in coordination of activities in the Climate Agenda, particularly in support of Climate Information and Prediction Services (CLIPS) and ensuring appropriate involvement of national meteorological, hydrological and oceanographic agencies.

To National Governments and Funding Agencies:

- Support national programmes of research and observations aligned with and underpinning the WCRP and take advantage of WCRP achievements in applications of climate prediction and information to social and economic activities;
- Establish or strengthen national committees or focal points for climate research, or for earth system science (including IGBP and IHDP);
- (Developed countries) Support capacity building in research and applications of climate information through national, regional and international funding channels (e.g., the Global Environmental Facility (GEF));
- (Developing countries) Ensure that climate research and observations are placed on the agenda for discussion with potential donors;
- Support action through the UNFCCC to make operational the commitments under Articles 4.1 (g) and 5, by making use of WCRP, GCOS and linked programmes, particularly START;

To Organizations sponsoring WCRP (WMO, ICSU, IOC (of UNESCO):

- Promote and expand coordination in the Climate Agenda between WCRP, other components of the World Climate Programme, GCOS, IGBP and IHDP, and relevant regional bodies with the aim of advancing climate research and related observations, data management and use of information on climate variability and change;
- Encourage respective counterpart national agencies to adopt coordinated approaches in their countries in the planning and implementation of WCRP and related monitoring and services;
- Improve the capability of providing longer-term warnings of floods, droughts and other extreme climatic events and the wide dissemination and use of warnings in all nations;
- Keep under review the need for further international and regional conferences on climate issues;
- Seek greater support from the private sector for WCRP activities.

MESSAGE FROM THE SECRETARY-GENERAL OF THE WORLD METEOROLOGICAL ORGANIZATION

It is a pleasure for me to be with you today at the opening of this important Conference on the World Climate Research Programme and to welcome you to Geneva on behalf of the World Meteorological Organization. I wish to express my appreciation to Madame Dreifuss, Federal Councillor and Representative of the Government of Switzerland, the honourable Ministers and the high level government officials for their presence. This reassures us of the continued interest of the governments of Member countries in the global climate and its implication for the preservation of the environment. Many of you present here today are representing Organizations or institutions that have made important contributions to the WCRP over many years, and I wish to take this occasion to place on record WMO's gratitude for these efforts. I also wish to acknowledge the tremendous efforts of the Joint Scientific Committee on the WCRP in developing and guiding the activities undertaken under the Programme over the years.

In view of the concerns about climate variability and anthropogenic climate change and their broad implications for humanity, a Conference to review the achievements and benefits of the WCRP during its first 17 years, and to map out its future direction, is certainly very timely. Indeed, as we carry out this review, we recall the background which led to the WCRP. The early knowledge about climate variability and possible climate change came from the data collected under the aegis of WMO and its predecessor, the International Meteorological Organization (IMO), going back into the last century. Indeed, by 1929, IMO had already set up a Commission for Climatology to address the issues related to climate. The Commission continues to function today and based on its work, WMO was able to issue the first authoritative statement on climate change in 1976. In 1979, WMO organized the First World Climate Conference and in the same year, the World Meteorological Congress established the World Climate Programme (WCP) having the WCRP as its research component. In 1980, ICSU joined WMO in the implementation of the WCRP and in 1993, the Intergovernmental Oceanographic Commission (IOC) of UNESCO also became a co-sponsor.

Considering the theme of this Conference, one might ask the following question: ***What have been the major achievements and benefits of the WCRP?***

Firstly, it should be recognized that WCRP's scientific activities, conducted mainly through large scale projects, have been aimed at improving the understanding and prediction of the behaviour of the complex global climate system, and at the assessment of the extent of human influence on climate. The projects concerned address the major science uncertainties with respect to, for example, the role of the oceans and the hydrological cycle in climate variability. One such major successful research effort was the now completed *Tropical Ocean and Global Atmosphere (TOGA)* project. TOGA brought a tremendous breakthrough to climate forecasting through an improved understanding of the El Niño/Southern Oscillation (ENSO) phenomenon, with a very high potential of producing direct socio-economic benefits to many nations around the world, especially in tropical and subtropical regions. Seasonal climate predictions arising from this research are being increasingly relied upon for early warning systems against, for example, droughts, floods and tropical cyclone activity, and as an aid in improving agricultural production and water management.

Secondly, the WCRP has influenced several major global developments. One of these was the convening by WMO, ICSU and UNEP of the 1985 Villach Conference on the effects of increasing greenhouse gases in the atmosphere on the Earth's climate. As a result, WMO and UNEP established in 1988 the Intergovernmental Panel on Climate Change (IPCC), which was charged with the responsibility of assessing the science, the environmental and socio-economic impacts of climate change, and appropriate response strategies. Drawing heavily on the research results of the WCRP, the IPCC has since issued two major assessment reports, in 1990 and in 1995. The first report gave further urgency to the intergovernmental negotiations, initiated by WMO and UNEP, which subsequently led to the *United Nations Framework Convention on Climate Change* (UNFCCC), which itself had been adopted at UNCED in 1992.

Furthermore, it is partly the result of WCRP's work on climate modelling that enabled the IPCC, in its Second Assessment Report, to conclude that "*...the balance of evidence suggests that there is a discernible human influence on climate*". This conclusion, which has far-reaching implications, heightened global concern about climate change, resulting in renewed calls for stronger commitments to reduce greenhouse gas emissions, including calls by the recent Special Session of the UN General Assembly which reviewed and appraised the implementation of UNCED's Agenda 21.

Thirdly, we can point to WCRP's achievements made through the ongoing *World Ocean Circulation Experiment* (WOCE), the *Global Energy and Water Cycle Experiment* (GEWEX) and the *Arctic Climate System Study* (ACSYS). The massive amounts of precision ocean data and the increasing climatological data sets compiled are already making significant contributions to climate research. It is anticipated that the *Climate Variability and Predictability* (CLN AR) study project which is building on the findings of TOGA and WOCE, and the project on *Stratospheric Processes and their Role in Climate* (SP ARC), will also make similar major contributions in our understanding and prediction of the global climate.

In the process of implementing these major projects, the WCRP has contributed to substantial developments in global atmospheric models which allow for the improved climate predictions. The opportunities offered by these advances have encouraged several WMO Member countries to establish national climate centres and/or national climate services.

Fourthly, by promoting research encompassing the global atmosphere, oceans, both sea and land ice, and the land surface, the WCRP has continued to be the main international mechanism to foster and coordinate the essential basic research in the climate system. It has progressed through the remarkable and unique cross-disciplinary collaborative efforts between many scientific disciplines, and cooperation between governmental and non-governmental organizations and the academic community.

A second question is: ***What the major challenges and strategy considerations for the WCRP are as we move into the early part of the 21st century?***

Firstly, for the WCRP to benefit from the improved symbiosis among the various climate-related programmes, and to optimize on available resources in the implementation of Agenda 21 and the related conventions, the sponsors of the WCRP and other partner Organizations have prepared a "***Climate Agenda***", which is an integrating framework for the international climate-related programmes. This Conference will need to consider the requirements for one of the Agenda's main thrusts, namely, "*new frontiers in climate science and prediction*" to which the WCRP is one of the

to the other thrusts of the Agenda, the climate-related conventions, such as the UN Convention to Combat Desertification (CCD) , and to WMO's *Climate Information and Prediction Services* (CLIPS) project. CLIPS will, among other things, promote the use of climate information and prediction services, capacity building, research and the development of new applications.

Secondly, the Conference will need to address issues related to the adequacy and the quality of the available data for advancing climate research. This must take into account the major data collection programmes of WMO, namely the World Weather Watch (WWW), the Global Atmosphere Watch (GA W) and the hydrological networks, as well as activities of the *Global Climate Observing System* (GCOS), the *Global Ocean Observing System* (GOOS) and the *Global Terrestrial Observing System* (GTOS) which are meant to provide a wide spectrum of climate- related data.

Thirdly, as the WCRP provides the major scientific input into the work of the IPCC, it must take into account the needs of the IPCC for more precise climate change projections at regional and subregional levels. In this regard, the future work of the WCRP should continue to give priority to reducing the uncertainties arising from:

- (i) representation of climate processes in numerical models, especially radiation balance and parameterizations of feedbacks associated with clouds, oceans, sea ice, land surface and vegetation; and.
- (ii) possible "surprises" involved in climate change, due to the non-linearity of the climate system and its response to rapid forcing.

Advances in these areas are necessary in order to adequately quantify the magnitude of human-induced climate variability; to improve particularly regional and subregional projections of climate change, the magnitude of sea level rise and the impacts on ecosystems; and, to improve the assessment of the impact of climate change on the distribution, frequency and intensity of extreme weather events, such as tropical cyclones and mid-latitude storms. The extent to which the increased global losses due to climate-related disasters could be related to anthropogenic ally-driven climate change, or as a result of natural or other socio-economic factors, remains an important subject for study. Information in this area is of particular importance to governments and the insurance industry. I would urge climate researchers to coordinate their efforts in this regard with those working on tropical cyclones and other severe storms.

Fourthly, bearing in mind the social and economic dimensions of climate change, it is of great importance that there be considerable emphasis on the "discernibility" of climate change. In this regard, the collaboration between the *Working Group on Climate Change Detection* of WMO's Commission for Climatology and those implementing the CLIVAR Project will be particularly important. The Conference should therefore review the climate policy requirements which would assist the IPCC in demonstrating the possible cost of long-term damages or benefits due to climate change and the cost-effectiveness of investments in future climate-related activities.

Fifthly, since the climate issue is a universal one, the Conference would need to consider an appropriate mechanism for associating a greater number of developing countries with the activities of the WCRP. The present mechanism has not proved adequate. In addition to the benefits of wider research experiences, the new mechanism would lead to a more global contribution to the WCRP.

Despite the tremendous advances made in climate research over several years, the goal of fully understanding and predicting future climate will still remain a challenge for some years to come. I want to assure you that WMO will continue to strengthen its support to the Programme to meet the challenges of the early years of the 21st century. In the process, WMO will continue to strive for strengthened cooperation among its partners in the WCRP and will also continue to encourage governments and other funding mechanisms to maintain their support at both the international and national levels.

In conclusion, I look forward to the outcome of this Conference which, I am convinced, will demonstrate to governments the benefits of the WCRP and, at the same time, set realistic future research directions that are aligned with the immediate requirements of nations and the long-term aspirations of humanity.

I wish you a productive session and an enjoyable stay in Geneva.

MESSAGE FROM THE PRESIDENT OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

Over the past 20 years, the understanding of the earth system has turned from an intellectual and scientific challenge into a necessary ingredient for policy-making on national and global scales, as exemplified by the UN Conference on Environment and Development. Understanding the Earth system is a prerequisite for forecasting global changes, assessing their impacts, and developing preventive and adaptive policies. Such understanding can only be achieved by intensive scientific research that obviously needs to be both international and interdisciplinary.

In such a spirit, in 1980 ICSU and WMO jointly set up the World Climate Research Programme (WCRP). The WCRP is a direct successor to the Global Atmospheric Research Programme, of which ICSU and WMO were also co-sponsors. In this historic event, an agreement to sponsor a research programme was signed for the first time between a governmental (WMO) and non-governmental (ICSU) organisation. The programme led to significant improvements in weather forecasts, and the concept of the WCRP was built on this success. In 1993, the Intergovernmental Oceanographic Commission of UNESCO also became a formal co-sponsor of the programme, demonstrating the importance of the ocean in understanding the climate system.

In 1994, ICSU appointed a panel to review the performance of WCRP. Periodic reviewing is a part of the normal procedures for all our scientific undertakings. It was the ICSU evaluation which called for the important conference which I am honoured to attend today. The appointed evaluation panel proposed that a scientific conference be held to review and highlight WCRP results and research needs. The recommendation was that this conference should carry out a first major review of the WCRP achievements, and serve to foster climate research and help to set priorities for the future. We are eager to hear during the presentations in the next three days, just how WCRP has contributed to global climate predictions and science, and how it sees itself progressing in the future.

The people engaged in the WCRP seek to determine to what extent climate can be predicted and how human activities are affecting climate. Indeed, human actions, by changing the face of our planet and the composition of the atmosphere, have initiated a departure from natural conditions - with far reaching implications. This is an additional reason why our understanding of how the global climate system functions should be improved. In the past seventeen years, the projects designed by WCRP to address two key problems: the way cloud affects radiation, and the way oceans influence climate, have evolved and helped increase the confidence of seasonal and annual climate predictions.

WCRP is an integral part of the whole range of ICSU's activities of relevance to understanding the earth system. The ICSU International Geosphere-Biosphere Programme (IGBP), launched in 1986, was planned to build on WCRP results by describing and understanding the interactive physical, chemical and biological processes that regulate the earth system, the changes occurring in the system and the manner in which they are influenced by human activities. The mission statement of both the IGBP and the WCRP clearly stress the importance of the human element. In order to provide a companion programme from the human sciences, ICSU and the International Social Science Council became co-sponsors of the International Human Dimensions Programme on Global Environmental Change in 1996. The principal objective of this programme is to describe and understand how human activity is affecting the global environment and the consequences of environmental changes for society. A research programme on biodiversity, DIVERSITAS, was launched in 1990.

As all of these ambitious research programmes are gathering momentum, it has become increasingly clear that existing observation systems would not suffice for providing the data required and for monitoring the earth system as a whole. Thus through three observing systems for climate, ocean and land, scientists and governments are making plans to keep the earth system under continuous observation. ICSU is pleased to co-sponsor these observing systems with several UN bodies.

All of these activities involve thousands of scientists throughout the globe driven by the common language of science, a common curiosity to understand our planet, and the common knowledge that science is a truly international endeavour.

An ever increasing number of scientists have been involved in recent years in establishing and maintaining global interdisciplinary programmes concerned with the environment. We consider that the role of ICSU in co-ordinating and fostering international research of this kind is very important. To this day, ICSU is the oldest, and the only, non-governmental major player in scientific co-operation. It is such that ICSU has worked closely, right from the start, with intergovernmental organisations. While ICSU has been in existence longer than the United Nations, once that organisation and many of its specialised bodies were created over 50 years ago, close links were immediately forged between the independent scientists in ICSU and the intergovernmental bodies of the UN concerned with science. The system proved to have been well designed to take full advantage of the complementary strengths and resources of the two types of organisation on the basis of a common purpose and a mutual understanding. It is such a partnership between ICSU, WMO, IOC which has provided the framework in which WCRP has been able to develop and produce - towards a greater understanding of climate on our planet.

MESSAGE FROM THE CHAIRMAN OF THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION OF UNESCO

Mr. Chairman, Madame Councillor, Secretary General, President of ICSU, distinguished guests and delegates. I am pleased to be here to represent the Intergovernmental Oceanographic Commission (IOC) of UNESCO on the occasion of this important conference. The oceans are an integral part of the planetary climate system and the national, intergovernmental and international organizations dealing with the oceans have to cooperate and assist in the resolution of climate issues. Climate variability touches all and everyone of us and the better our understanding, the better the world can deal with the needed preventative and mitigative measures and their substantial social and economic implications. The IOC had its Assembly a few months ago and climate was a feature not only in the agenda items covering research and data but also in terms of its impact on the oceans, its ecosystem, the coastal zone, sea level rise and other ocean activities.

Most of the ocean programs relating to climate are conducted through the WCRP of which the IOC is a co-sponsor. The progress has been slow but substantial. The TOGA initiative has evolved into the operational TAO array which is now providing the predictive capability for the El Niño. The World Ocean Circulation Experiment is nearing the end of its massive data collection phase but needs continuing support for the subsequent data analysis phase. WOCE and its successor CUVAR will provide the data needed for the initialization of regional and global climate models. For the input necessary for the next generation of coupled ocean-atmosphere models, operational data are required and it is hoped that the GLOBAL Ocean Observing System (*GOOS*) will provide much data by the beginning of the next century.

From the ocean standpoint the scientific problems are solvable in time but additional resources are needed to bring the time horizons to realistic boundaries.

Major powers in ocean science are, in general, moving their emphasis away from deep water research in favour of the more pressing problems in the coastal waters. I would agree that many of the pressing marine issues are to be found in the vulnerable coastal zone but even the problems close to the shore are affected by the longer time changes and the latter cannot be forsaken with impunity.

Governments are also tending to encourage a greater degree of private involvement with hitherto public good service such as weather prediction and marine operational services. This diminution of governmental capabilities will, in the long term, be counterproductive to the public interest. Good quality forecasts need internationally agreed data coverage, exchange agreements, formats and standards and peer assessments of the related research, all of which requires national oversight. Governments must retain their overall responsibilities in terms of public good science and services. I cannot see the world tackling its global issues on climate research without a system allowing the needed data to be freely accessible and available.

The IOC takes its responsibilities in climate research very seriously and will be following the results of this Conference with interest. The decisions to be taken by governments with regard to climate change have very serious economic and social consequences and cannot be taken wisely without the knowledge that the WCRP can provide. I am looking forward to the debate over the next few days on what the WCRP has achieved and its future expectations. Thank you.