

role in climate. An understanding of these processes and the parameterization or representation of their effects is an important research problem.

Research Elements

Within the WCRP the following elements are identified:

- Climate model development
- Climate predictability
- Climate sensitivity
- Climatologically significant processes
- Climate diagnostics
- Climate data requirements

Scientific Priorities

The following specific topics should receive high priority in the WCRP. They have been identified as scientifically tractable and of fundamental importance in climate research:

- Observational synthesis of the global and regional climate system
- Development of a hierarchy of models to study the dynamics and statistics of global and regional climate
- The role of the oceans in the climate system
- Biogeochemical cycles of radiatively important tracer gases
- Cloud formation, distribution and radiative properties

- Aerosol types, optical properties and influence on clouds
- The hydrological cycle, evaporation and precipitation, etc.
- Land-surface and cryosphere properties and processes and their impacts on climate
- Paleoclimatic reconstructions relevant to global and regional climate changes.

Functions of the World Climate Research Programme

Recognizing that diagnostic, theoretical and experimental research activities relevant to climate are carried out by scientific research establishments within nations, the broad aim of WCRP should be to co-ordinate and enhance these national efforts. The principal functions of the WCRP should be to:

- Initiate as required specific regional or global experiments for the study of particular phenomena or mechanisms
- Identify research priorities for recommendation to national bodies or institutes
- Stimulate and co-ordinate relevant international research activity as required
- Arrange for the rapid dissemination of information regarding climate research.

Appendix III

AGREEMENT BETWEEN*

THE WORLD METEOROLOGICAL ORGANIZATION AND THE
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
ON THE WORLD CLIMATE RESEARCH PROGRAMME

THE WORLD METEOROLOGICAL ORGANIZATION and THE INTERNATIONAL
COUNCIL OF SCIENTIFIC UNIONS,

BEING MINDFUL of the Working Arrangements agreed upon by
the two organizations which specify that "the two organizations,
with a view to facilitating the attainment, in the most effective
and economical manner, of the objectives set forth in the respective
constitutions, will act in close co-operation...",

RECOGNIZING the intrinsic scientific importance of under-
standing the physical basis for climate, the increasing vulner-
ability of our social and economic life to fluctuations in the
annual cycle of climate and the possibility that human activity
is now reaching a scale which could influence local, regional
and global climate,

* The text given is that which received the approval of the
Eighth World Meteorological Congress. It introduces a few
minor changes acceptable to ICSU. To facilitate compari-
son with the text adopted by the General Assembly these are
marked with a *

NOTING that, in order to take full advantage of the opportunities thus presented, the two organizations are jointly undertaking a Global Atmospheric Research Programme (GARP) under the terms and conditions specified in a formal Agreement between them signed on 10 October 1967.

CONSIDERING:

(1) That the activities undertaken under GARP have proved successful* in that they have resulted in a major advance in man's knowledge of the atmospheric processes and have provided the basis for substantial future research which will advance such knowledge still further.

(2) That GARP has shown in a striking manner that despite the differing constitutions and procedures the two organizations are able to work together in an effective and harmonious manner for the common good.

RECOGNIZING that the principal components* of the World Climate Programme (WCP) will be:

- The Climate Data Programme (CDP);
- The Climate Applications Programme (CAP);
- The Climate Impact Study Programme (CIP);
- The Climate Change and Variability Research Programme (CRP)

* This component may be referred to below by a short title "The World Climate Research Programme (WCRP)"

BEING MINDFUL OF:

(1) The need for the completion of activities with regard to the First GARP Objective,

(2) The fact that the research activities related to the Second GARP Objective will be included in the Programme for Research on Climate Change and Variability of the proposed WCP.

AGREE:

(1) That there should be only one World Climate Research Programme, and it should be sponsored jointly by the two organizations,

(2) To invite and call upon all other appropriate national and international organizations and the world community of scientists to collaborate in this globally important task,

(3) That the WCRP should have as its long-range objectives a better understanding of climate change and variability and their causes, whether from natural or human influences.

(4) To establish a Joint WMO/ICSU Scientific committee

(JSC):

(a) to provide scientific guidance in those aspects of the Programme for Research on Climate Change and Variability

that need international co-operation for their successful conduct within the framework of the joint WMO/ICSU interests;

- (b) to be regarded by both organizations as the main scientific organ for the formulation of overall scientific concepts and the co-ordination of efforts at the international level within° the framework of the World Climate Research Programme, conforming to the WMO and ICSU practices and procedures;
- (c) to determine the main research objectives of the Programme for Research on Climate Change and Variability to be jointly implemented by WMO and ICSU;
- (d) to review and assess the development of all elements of this research programme and to report to the executive bodies of both organizations on progress,
- (e) to facilitate the exchange of information among scientists responsible for carrying out the research at the national and international levels;
- (f) to complete the planning and studies within the framework of the First GARP Objective.

(5) To ensure that the administrative and financial arrangements provide for a large measure of flexibility to the JSC and to its supporting staff,

APPROVE:

(1) The programmatic transition from GARP to the WCRP to take place gradually from the date of this Agreement° and the transition in membership of the JOC to the JSC to reflect the evolving programmatic emphasis,

(2) The details and procedures to be followed in the practical application of this Agreement which are specified in the following annexes to this Agreement:

Annex A: Procedures to be followed in implementing this Agreement

Annex B: Definition of the World Climate Research Programme

Annex C: Financial arrangements

Annex D: Functions and rules of procedure for the Joint Scientific Committee (JSC) and Joint Planning Staff (JPS)

Annex E: Initial membership of the JSC*

Annex F: Initial budget for the WCRP*

* Annexes E and F are not available at this stage

AGREES:

(1) °That this Agreement shall be reviewed every four years by both organizations,

(2) °That this Agreement may be terminated by either organization with two years' notice.

AGREE that this Agreement shall come into force on the first day of the month of January 1980 on which date the GARP Agreement shall terminate.

Signed at.....

on the..... day of.....

.....

.....

President
International Council
of
Scientific Unions

President
World Meteorological Organization

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

Paris, 11 February 1980

TO: National Members of the International Council of
Scientific Unions (ICSU)

From: Secretary-General of ICSU, Sir John Kendrew
Secretary-General of WMO, Dr. Aksel Wiin-Nielsen

Subject: Participation of the Scientific Community in the World
Climate Research Programme (WCRP)

We would like to refer to the letter of 9 July 1979 addressed by the President of ICSU, Professor C. de Jager, to National Members of ICSU regarding the World Climate Programme. As you will recall, the VIII th World Meteorological Congress (April-May 1979) established this new programme, which comprises four major components (climate data, climate applications, climate impact and climate research). The implementation of the programme will require a concerted effort by many international organizations both governmental and non-governmental.

In establishing the World Climate Programme and in continuation of the former very successful WMO/ICSU Agreement of GARP, a new agreement was drawn up between our two organizations to jointly undertake the above mentioned research component of the WCP.

known as the World Climate Research Programme (WCRP). This Agreement between WMO and ICSU has now been signed by the Presidents of both our organizations.

The WCRP will be jointly financed by WMO and ICSU through a Joint Climate Research Fund (JCRF) in similarity with the former joint support to the GARP Implementation Fund. The input from WMO has already been provided for in the WMO Budget approved by its Congress-VIII in 1979, and the input from ICSU will be met by direct contribution from ICSU and its National Members. In specifying the WMO contribution, account has been taken of the fact that the ICSU input was based on an annual level of \$ 200.000.

Specifically, we wish to thank those who have pledged financial support to the WMO/ICSU Joint Climate Research Fund and especially to those who have substantially increased their support over that provided to the ICSU GARP Fund. To those who have not yet decided on the level of contribution, we urge consultation between ICSU and WMO Members in order that the goal of doubling the ICSU subscription may be met. This target is within reach, but has not yet been met. A shortfall in the ICSU share would handicap implementation of the World Climate Research Programme.

It is our sincere hope that the partnership which proved to be so successful in planning and implementing the First GARP

Global Experiment will continue and flourish. This depends on the intellectual and financial cooperation between ICSU and WMO Members at the national level, and thus we urge that you plan your scientific and financial participation together.

The scientific significance of this programme and its practical importance to all nations suggest universal participation, whether it be large or small. We invite your attention to involvement in, and support of, the World Climate Research Programme. Should you have any questions, please write to either of us, and in any event it would be appreciated if you would advise the Secretary-General of ICSU of your plans by 15 April 1980.

Sir John Kendrew
Secretary-General of ICSU

Aksel Wiin-Nielsen
Secretary-General of WMO

International Council of Scientific Unions

Paris, June 6, 1980

To: Professor K. Husimi
President
Science Council of Japan

From: Prof. T. F. Malone
Treasurer of ICSU

Dear Professor Husimi:

The International Council of Scientific Unions is experiencing a significant shortfall in national member participation in the Joint WMO/ICSU World Climate Research Program. In fact, of the 26 National Members which supported the Global Atmospheric Research Program, only 10 thus far have recognized the vital nature of the World Climate Programme and pledged their support.

As we are both aware, the scientific communities of the world have not been exempt from current worldwide economic stresses, and it is apparent that difficult choices are being made regarding the allocation of diminishing resources. I am writing to you personally at this time because of my deep conviction there are few international cooperative undertakings with such potential for both short-term and long-term scientific and societal benefits. At last, we have in place the mechanism (as well as a financial commitment from the World Meteorological Organization) to

undertake a global study of how climate changes and variations occur and the effect of human activity on these processes. I know you don't need me to tell you the importance of this knowledge for future life on this planet.

I know you are familiar, too, with the cost-effective character of ICSU participation in international programs of this nature - for a relatively small investment, participating national institutions have access to a full range of data collected and research results obtained your national scientific community can make to this enterprise, will, I hope, encourage you to participate in the ICSU/WMO Climate Research Program and joint with your fellow ICSU National Members in making the essential financial contribution.

I hope you will pursue this matter further in Japan, and I have enclosed some background information for your convenience. Your support for this important program is urgently needed. Please do not hesitate to contact me if I can be of any assistance in securing the appropriate backing in your country.

With kind regards,

Sincerely yours

Signed: Thomas F. Malone

Treasurer

Enclosures:

1. ICSU/WMO Agreement on the World Climate Research Programme
2. Definition of the World Climate Research Programme
3. Financial Arrangements and Budget

cc: Professor K. Gambo

Dr. Shohachi Kubota

Professor I. Watanabe

Professor R. Kubo

International Council of Scientific Unions

January 12, 1981

To: President K. Husimi
Science council of Japan
From: Prof. T. F. Malone, U.S.A.

Dear Sir:

I write to express my deep concern and that of the ICSU Executive Board over inadequate financing by voluntary contributions of the World Climate Research Program (WCRP) and to request your institution reconsider its support of this important program.

Certainly, one of the highlights of international scientific cooperation during 1980 was the successful launching of the WCRP as a joint activity of ICSU and the World Meteorological Organizations. Under the guidance of the ICSU/WMO Joint Scientific committee, a carefully considered outline of the research required has been established, and a program office under the direction of Professor B.R. Doos is working in close liaison with other international governmental and nongovernmental organizations. The predecessor of the WCRP was the Global Atmospheric Research Program, for which the observation phase was completed a little more than a year ago. It was undoubtedly one of the most complex

international efforts ever undertaken, and the research results beginning to emerge promise that it will be one of the most successful as well.

At the end of 1980, voluntary contributions received to fulfill the ICSU commitment (set by the 1978 ICSU General Assembly) were approximately half of the required \$200,000. Accordingly, we invite you to consider once again your level of support. If you are already contributing, please ascertain whether your level of support can be increased. If you have not yet agreed to participate, we hope you will find it possible to do so.

I would very much appreciate receiving early word of your decision so ICSU may invoice you accordingly -- and so the scientific cooperation that was so essential to the success of GARP may continue in the World Climate Research Program.

Should you desire more information, please let me know. This matter is particularly urgent now as the ICSU Executive Board reviews financial plans for 1981.

Sincerely yours,

Signed: Thomas F. Malone

Treasurer

気候変動国際協同研究計画

World Climate Research Programme (WCRP)

目 次

| | | |
|--------|---------------------|----|
| § 1 | 緒 言 | 38 |
| § 2 | 気候変動と世界気候計画 | 38 |
| § 3 | 気候変動研究計画提唱の経過 | 42 |
| § 4 | 気候変動研究計画の目標 | 44 |
| § 5 | わが国の気候変動研究計画 | 54 |
| 附録 I | 研究項目および主要参加機関 | 59 |
| 附録 II | 研究経費の概要 | 61 |
| 附録 III | 年度別研究経費 | 62 |
| 附録 IV | WCRP 分科会委員名簿 | 63 |
| 附録 V | 世界気候小委員会委員名簿 | 63 |
| 附録 VI | 略語一覧表 | 64 |

§ 1 結 言

気候変動研究計画 (World Climate Research Programme, WCRP) は、国際学術連合会議 (International Council of Scientific Unions, ICSU) と世界気象機関 (World Meteorological Organization, WMO) とが1979年に合意し協同提案した国際協同研究計画であって、WMOが他の国連専門機関などと協議して提案した世界気候計画 (World Climate Programme, WCP) の中核となる研究計画である。WCRPの目的は、数週間ないし数十年の時間スケールの気候変動の物理機構に関する理解を深め、それによって1~2ヶ月先までの気候の長期予報および数ヶ月~数年の気候変動 (年々変動) の予測を可能ならしめると共に、二酸化炭素の増加などの人間活動がより長期の気候変化におよぼす影響を明らかにすることである。

本文は、WCRP分科会 (日本学術会議国際協力事業特別委員会) および世界気候小委員会 (日本学術会議地球物理学研究連絡委員会附置) の討議に基づき、日本学術会議の地球物理学、海洋学および南極各研究連絡委員会の検討を経て立案されたわが国のWCRPの概要を述べたものである。

§ 2 気候変動と世界気候計画 (WCP)

人類は、過去において気候の変化に伴う生活環境の著しい変化を経験してきた。気候変化にはさまざまな時間スケールのあることが知られているが、測器による気温の観測が得られるようになった最近の約100年間について見ると、北半球の平均気温には、図1に示すように19世紀末から20世紀初頭の低温、20世紀中葉の高温、その後の低温化傾向が見られ、さらにより短い時間スケールの変動が重なっている様子が認められる。このような全球的または半球規模の気温の変化に比べて、局地的な変化は一般により短い時間スケールで現われ、その値ははるかに大きく10倍以上に達する場合もしばしば起こっている。その一つの例は1976年末から77年始めにかけての冬で、北日本と北米大陸東岸は厳しい寒さに見舞われ、北海道は平年より4℃近い低温、アメリカ中東部は10℃も低温となって各地で寒さによる被害が出たばかりでなく、石油の需給にも影響が現われた。同じ時に北米大陸西岸は異常高温と早ばつに見舞われ、アラスカでは平年より12℃も高温であった。この異常寒波をもたらした大気の流れは「ブロッキング」と呼ばれる独特の形態をしており、それがひと冬 (3ヶ月) を通じて持続したのであ

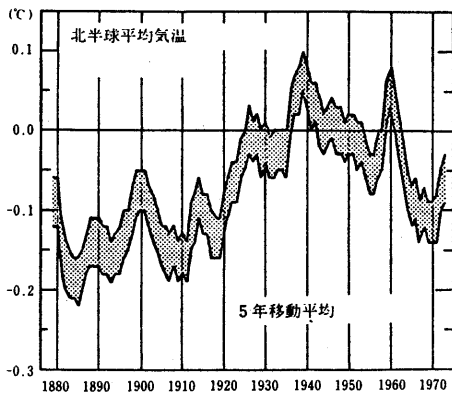


図1 過去約100年間の北半球の地上平均気温の変動。前世紀末から1940年頃までの昇温傾向とそれ以降の降温傾向に、より時間スケールの短い変動が重なっている様子が見られる。
(Yamamoto, R., and M. Hoshiai: 1980, J. Meteor. Soc. Japan, vol. 58, 187-193)

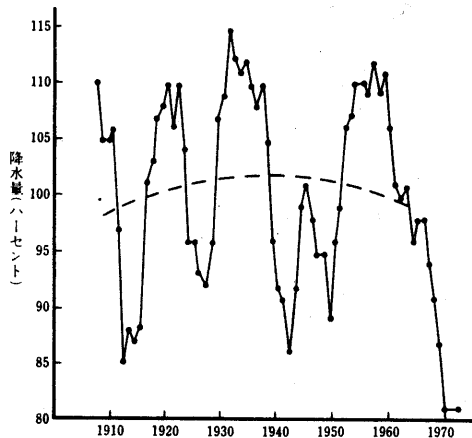


図2 西アフリカサヘル地方の年降水量の5年平均の推移。1951-1970の65年間の平均値に対する比をパーセントで表わしている。破線は長期傾向を示す。1960年代末からのかんばつが、過去4回のかんばつに比べて特に著しいものであったかがわかる。

った。アメリカではこの後も1979年まで厳しい冬が繰り返し現われて経済活動にも大きな影響を与えた。もう一つの異常天候の例として西アフリカのサハラ砂漠の南縁(サヘル地方)の大旱ばつがあげられる。図2は、サヘル地方の年降水量の経年変化を示したものであるが、この地方では今世紀に入ってから数回の旱ばつが発生し、特に1960年代末から1970年代始めにかけて大旱ばつに見舞われている。サヘル地方にある諸国——モーリタニア、セネガル、マリ、アッパーボルタ、ニジェール、チャド——では、この大旱ばつによる食糧不足のため、各国からの食糧補給や世界的救援活動にも拘らず、数十万人の餓死者を出している。1972年には、ソ連邦やインドも大旱ばつに見舞われたため、世界の食糧備蓄は2%以上も減少して、第二次世界大戦後の最低値を記録している。このような異常天候の発生頻度は、図3に見られるように、近年ますます増加する傾向を示している。

一方、人間活動の急速な発展は、全地球的規模の大気汚染を増加させており、その影響として、人間活動による「予期せざる気候変化」がひき起こされる危険性の高いことも懸念されるようになった。その一つとして、大気中の二酸化炭素の増加があげられる。

大気中の二酸化炭素は、図4に示すように、年々顕著な増加傾向を示している。19世紀末に約290ppmVであったものが最近では約345ppmVになっており、増加率も年を追う毎に大きくなっている。このような二酸化炭素の増加は、化石燃料の消費によるほか、森林破壊も大きく

図3 世界の65地点で出現した異常低温と異常高温の、各10年毎の頻度。60年間の統計から求めた出現確率90パーセントの範囲からはみ出たものを異常高温又は異常低温としている。1920年以後、異常低温の発生が増加している傾向がみられる。

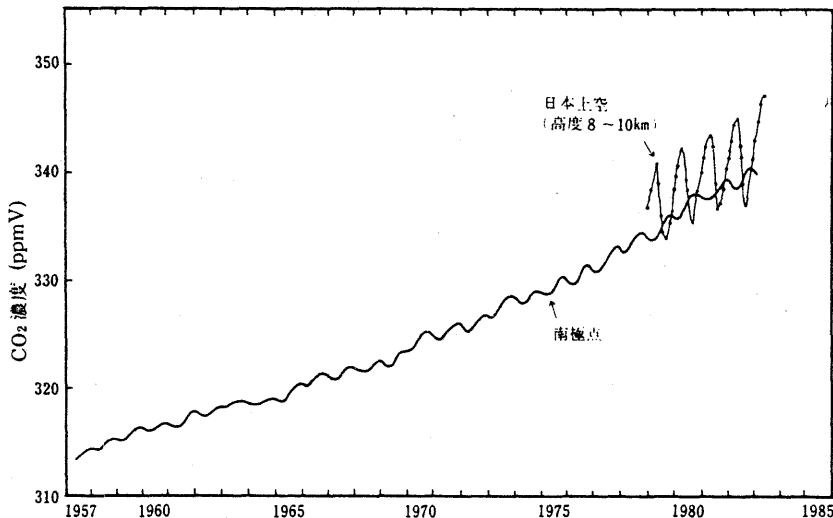
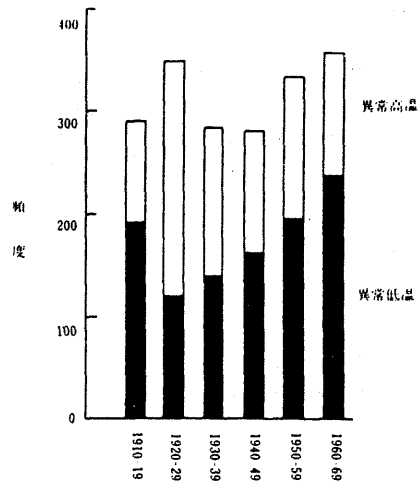


図4 南極点および日本上空でのCO₂濃度の増加傾向。南極点での長期観測の結果をみると年々の増加量が年を追う毎に大きくなっている様子がわかる。(C.D. Keeling 及び東北大学理学部超高層物理学研究施設提供)

関与していると考えられているが、その詳細はまだ明らかではない。

二酸化炭素は、太陽放射に対してはほぼ透明であるので、地球・大気系の太陽放射の吸収にはあまり影響を与えない。しかし、赤外放射を強く吸収する性質があるため、地球表面や大気下層が宇宙空間へ向けて放出している赤外放射量は、大気中の二酸化炭素によって抑制される。これが温室効果である。二酸化炭素が増加すると、温室効果が強まり、地上の気温は上昇する。大気中の二酸化炭素は21世紀中葉にはほぼ2倍まで増加するものと予想されているが、それによる全地球平均の地表気温の上昇は2～3℃と見積られている。このような昇温は地球上いた