REPORT
OF THE NINTH SESSION OF THE
JOINT ORGANIZING COMMITTEE

CANBERRA, 8-12 JANUARY 1974

INTERNATIONAL COUNCIL
OF SCIENTIFIC UNIONS

WORLD METEOROLOGICAL
ORGANIZATION

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(Canberra, January 1974)

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1. ORGANIZATION OF THE SESSION

1.1 Opening of the Session

The session was opened by the Chairman, Prof. R.W. Stewart, who expressed his gratitude for the invitation to meet in Australia, which is the first meeting of the JOC in the southern hemisphere and an acknowledgement of the importance of the participation of southern hemisphere scientists to GARP.

Dr. C.H.B. Priestley welcomed the JOC on behalf of the Australian Academy of Science, and expressed the best wishes of the Academy for a successful meeting. The close collaboration being engendered by GARP of scientists and various national organizations is an important element in assuring the success of the large programmes needed to realize the scientific objectives of GARP.

The WMO representative, Dr. N. Kljukin, expressed the wishes of the Secretary-General of WMO for a successful meeting and also reaffirmed the willingness of WMO to undertake its share of the actions needed to complete GARP projects.

Speaking on behalf of ICSU, Dr. W.L. Godson expressed ICSU's best wishes for the meeting and remarked on the close cooperation between ICSU and WMO for planning and implementing GARP activities that should provide a pattern for future collaboration.

The list of participants is given in Annex A.

1.2 Election of Officers of the JOC

Following the rules of procedure given in the Agreement between WMO and ICSU on the GARP, that two Officers be elected anually, the following two members were unanimously re-elected: V.A. Bugaev and J. Smagorinsky.

1.3 Approval of Agenda

The final agenda of the session is given in Annex B.

2. REPORT OF THE CHAIRMAN

The Chairman reported briefly on events since JOC-VIII; his report in full is contained in Annex C. The most important action items taken involving JOC are as follows:

The JOC Officers met in Vienna, 5-7 September 1973. The report of this meeting is given in Annex D.

Resulting from decisions taken at JOC-VIII, a GATE Panel was established and met at Bracknell with the ISMG to review the status of scientific and operational planning. The Panel report is given in Appendix F, and was discussed under the GATE agenda item.

At its XXVth session, the WMO Executive Committee decided to establish an Inter-governmental Panel for the First GARP Global Experiment and JOC has been invited to be represented. The Chairman designated himself as the JOC representative, but explained that he intended to consider requesting an appropriate person to attend any specific meeting on JOC's behalf, depending on the major item of business at that meeting. The WMO Executive Committee also decided to establish an FGGE Project Office, but this has not yet been accomplished. Consultants have been named for certain aspects of further FGGE planning, as decided at the Officers' meeting in Vienna, and have started their work (c.f. section 7.4).

Professor P. Morel has been designated to represent JOC on the WMO Panel on Meteorological Satellites.

The Working Group on Numerical Experimentation has been extensively reorganized. Prof.A. Wiin-Nielsen has been appointed chairman, Dr. A. Robert having resigned from the chairmanship. The activities of the WGNE are given in section 3 below.

Considerable progress has been made in the planning of the GARP International Study Conference on the Physical Basis of Climate and Climate Modelling, details of which are given under agenda item 7.1.

3. THE NUMERICAL EXPERIMENTATION PROGRAMME

The Chairman of the Working Group on Numerical Experimentation (WGNE), Prof. A. Wiin-Nielsen, reported on the activity of the group since the last session of JOC. The report of the ninth session of this group is given in Annex E.

3.1 The Working Group on Numerical Experimentation

3.1.1 Reorganization of the Working Group

In order to achieve a simpler and more effective organization of the Working Group on Numerical Experimentation, the JOC Officers decided at their meeting in September 1973 (c.f. Annex D) that

- The Working Group should consist of the chairman and the leaders of the component coordinating groups representing problem areas relevant to the GARP Numerical Experimentation Programme.
- The number and subject of the coordinating groups may be changed and adjusted by the JOC at any time on the basis of current requirements.
- Since each problem area covers a wide range of research activity, the composition of the various coordinating groups should be flexible.
- The leaders of the coordinating groups should be appointed for a period of two years and be asked to report on their activity to the chairman at the end of that period.

3.1.2 Present Problem Areas

At present there are five component coordinating groups representing the following problem areas:

(i) Data Problems: This covers observing systems simulation, four-dimensional assimilation, quality control and other related problems dealing with analysis and processing of data.

(ii) Physical Processes: This problem area is aimed at understanding internal dynamical and lower boundary interactions and energy conversion and transfer. It mainly concerns the development of appropriate parameterization techniques which would enable the proper incorporation of different physical processes occurring in the atmosphere into the numerical models.

(iii) Computational Considerations: This deals with the development of efficient finite-difference and spectral techniques applicable to the solution of the hydrodynamical equations used in the modelling of the atmosphere and ocean.

(iv) Prediction Simulation: This mostly deals with weather forecasting from one day to a few weeks, general circulation simulation, predictability, verification procedures, etc.

(v) Climate Modelling: This problem area deals with the design of the numerical models for studies of climatic change and parameterization of large-scale eddy fluxes in terms of the basic dynamic quantities, as needed for computing the statistical long-term response of the coupled atmosphere-ocean system.

3.1.3 Membership

The JOC approved the following membership of the Working Group on Numerical Experimentation:

Chairman:	Prof. A. Wiin-Nielsen (Denmark)
(i) Data Problems:	Dr. L. Bengtsson (Sweden)
(ii) Physical Processes:	Dr. S.S. Zilitinkevich (U.S.S.R.)
(iii) Computational Considerations:	Dr. A. Robert (Canada)
(iv) Prediction Simulation:	Dr. F. Bushby (U.K.)
(v) Climate Modelling:	Dr. L. Gates (U.S.A.)

3.2 Objectives

The general objectives of the Working Group originally stated at the Oslo meeting in 1968 are still valid. Meanwhile some refinements have been made to adjust them to the current needs; these are

(i) The Working Group will attempt to bring together research groups throughout the world in a coordinated effort to solve problems which are related to the planning of the GARP realistic atmospheric models.

(ii) The Working Group will formulate studies aimed at achieving a substantial improvement in the quality of weather predictions ranging from one day to several weeks and in atmospheric predictability, as well as better understanding of the atmospheric general circulation.

(iii) The Working Group will coordinate the efforts of research groups all over the world in the design and testing of numerical models for the study of climate and its variations.

(iv) The Working Group will respond to requests for specific studies originating from the Joint Organizing Committee in order to answer technological and observational questions in connexion with the planning of the observational experiments.

3.3 Prediction Skill of NWPs

The WGNE proposal to collect statistics on the prediction skill of short-range forecasts for the past 10-20 years (see Annex E, paragraph 6.4) was discussed. *The JOC agreed on the general desirability of publishing such statistics and decided to refer the matter to the WMO Commission on Atmospheric Sciences.*

With regard to longer-range predictions, the JOC recognized that attention should now be given to the question of assessment of the accuracy of such prediction experiments that will be carried out with the global data sets from FGGE. Notwithstanding such facts as that there are now relatively few long-range numerical weather predictions, the JOC agreed that thought has to be given as to how to establish some current milestones of prediction so that future experiments based on more complete models and global real data sets can be evaluated.

The JOC requested the WGNE to study this matter and suggest appropriate activity.

3.4 Development of Improved Numerical Techniques

The WGNE stressed the importance of further development of efficient and accurate numerical techniques applicable to the solution of hydrodynamic equations, and proposed a scheme whereby numerical model groups could test and intercompare their methods in a standardized series of experiments.

The JOC endorsed the need for such further development of numerical techniques as expressed in the report of the WGNE (Annex E, paragraph 6.3), but was not sure that at this time a "competition" would be the most fruitful way to accomplish the goal.

The JOC requested the WGNE to consider this matter further, with emphasis on arranging for suitable intercomparisons of various numerical techniques as a way to evaluate the current state of the art.

3.5 Reports on Activities in Numerical Experimentation

The JOC warmly endorsed the informal reports that have been prepared by Dr. A. Robert and distributed to interested groups. JOC expressed the strong hope that the preparation of such reports will continue in the present form, i.e. brief summaries of recent progress in the many aspects of numerical work, timeliness of preparation and distribution, and informal nature and somewhat limited scope so as to keep them brief and of a current character.

JOC requested the D/JPS to advertise the existence of the NWP reports in the GARP Newsletter so that all who may be interested may request it from the JPS. JOC also requested that, in order to facilitate the requesting of specific issues, the NWP reports be numbered serially or otherwise suitably identified in a specific manner.

3.6 Possible Role of IAMAP

The desirability was discussed that IAMAP may have a useful role to play in furthering the work in the development of numerical weather prediction methods.

JOC requested the ICSU representative to bring this possibility to the attention of the IAMAP.

3.7 Observing Systems Simulation Experiments

The report of the WGNE described proposals for Observing Systems Simulation Experiments in connexion with the distribution of stations in the polar regions (Annex E, paragraph 3.4). During the discussion on FGGE, additional Observing Systems Simulation Experiments were recommended for the tropical region and the southern hemisphere, as discussed below in section 5.5.

4. THE GARP ATLANTIC TROPICAL EXPERIMENT

4.1 The JOC Panel on GATE

The Panel met with the ISMG in Bracknell, 2-6 July 1973. The report of this meeting is given in Annex F; the findings of the Panel are summarized briefly below:

4.1.1 Scientific Plan

The Panel concluded that, if the sub-programmes as outlined in the July review are implemented, the GATE scientific objectives will be met. The Panel also concluded that scientific planning for these sub-programmes was essentially complete and that only a little effort in addition was needed to complete this phase of the work of ISMG. The Panel recommended, however, as a matter of urgency, that the scientific plans for these sub-programmes be published and distributed as quickly as possible, in particular the plan for the convection sub-programme.

The JOC endorsed these recommendations of the GATE Panel.

4.1.2 Operational Plans

The Panel recommended that the ISMG turn its main attention to the completion of the operational plan, that is, the specification of observational efforts and strategy to obtain the required time and space distribution of data. In this regard the Panel had several comments:

(i) The operational plan for the boundary-layer sub-programme should contain explicit details of how the flux data are to be obtained for the verification of numerical parameterization experiments.

(ii) More attention should be paid to the use of detailed satellite observations in the decisions on observational strategy.

(iii) The details of the aircraft plan must include specific criteria for making decisions having to do with flight tracks, e.g. what should an aircraft do when a large cloud is on the path of the flight trajectory? Under what circumstances, safety considerations aside, should an aircraft penetrate or circumnavigate? How will such choices affect the sampling statistics?

In the light of this last concern, the JOC was informed of the plan to conduct an international working meeting on GATE flight planning sponsored by ISMG and hosted by NCAR, Boulder, Colorado, 7-15 March 1974. Satellite and all available synoptic data from 1972/73 are being screened to prepare a number of simulated but realistic conditions that will be encountered during GATE. Elements of random failure will be introduced (e.g., aircraft or instruments not available). Aircraft operational experts and scientists from all the countries contributing aircraft are being invited to go through the decision-making processes for mission selection and conduct (simulated) as expected at Dakar. A group of experts will evaluate each case. By this working meeting it is expected to gain valuable experience in working out the details of the rather complex decision-making process that will be required at Dakar to achieve an optimum use of aircraft to meet the central objectives and also to meet as much as possible the objectives of the various sub-programmes.

JOC endorsed the concept of such a GATE flight planning working meeting and suggested that the JOC Panel should be represented during its conduct.

4.2 The Fifth Meeting of the Tropical Experiment Board

The fifth session of the TEB was held in Geneva, 3-7 December 1973. Professor Suomi represented JOC at this meeting (and will again be the JOC representative at TEB-VI in April). The report of TEB-V is published as No. 11 in the GARP Special Report Series. The JOC reviewed the information on the current status of GATE planning and action items directed to the JOC.

4.2.1 GATE Telecommunication Plan

As mentioned in the report of TEB-V (section 3.5) this plan is not yet complete, some problems having been identified with interference to some scientific equipment arising from the use of communication equipment. TEB-V recommended, however, that at least a minimum communication schedule must be maintained to ensure the operational safety of the experiment and to provide for at least daily collection of data. It had been planned to make appropriate revisions to the plan and publish it by the end of December. The WMO representative informed JOC that while this schedule had not been met, its plan will be available in the near future.

JOC, recognizing the great importance of adequate data communication, and noting that progress is being made to solve the technical problems and that it is expected to have the communication plan available soon, cautioned that this intention must not be allowed to slip as an adequate communication plan must be implemented if the objectives of GATE are not to be compromised.

4.2.2 Status of the WWW GTS

The JOC was informed of the study of transmission of data from the GATE A-scale area over the GTS for August 1973. The results are shown in the table given in Annex G. The low percentages of radiowind data accepted during this period by the computers at Bracknell and Washington were of great concern to JOC, as they had been to TEB-V, which recommended some specific remedial action.

To facilitate synoptic analysis and research over an area extending well beyond the GATE sector, it had earlier been hoped that it would be possible to acquire global data via the GTS during GATE which would not suffer from the deficiencies that have plagued research workers for decades - namely, missing and mangled or erroneous data. The CBS Working Group on GTS discussed the request of the JOC Officers (September 1973) to provide for a capability to systematically interrogate within 24 hours stations with bad or missing reports. The working group recommended a procedure involving NMCs and RTHs which, if fully implemented, would meet the objectives of the request. Checks are being made at present and deficiencies are being brought to the attention of countries concerned, with the request to remedy them. The JOC recognized that little remedial action could be expected with respect to global data by the time of GATE, but that such action was extremely desirable for data from the GATE area and would be essential for global data during FGGE.

Accordingly, JOC recommended that WMO request CBS to study these problems at its sixth session (Belgrade, March 1974) and, in particular, to propose, as a matter of urgency, action which would ensure that GATE stations whose data were missing, garbled or erroneous could be interrogated, and valid messages transmitted within the corresponding 24 hour period.

4.2.3 Representation of JOC at Dakar during GATE

JOC, in order to fulfil its review function and realizing that none of its members could be in Dakar during the whole period of GATE, decided to designate qualified scientists in residence at Dakar as the JOC representatives on the Experiment Review Board, as described in the report of the TEB-V (section 3.1.6; Annex A). At this time it is understood that Professor Richard J. Reed (University of Washington, Seattle, USA) may be available. The availability of additional board members should be explored.

JOC agreed that the Director of JPS request Professor Reed to undertake this assignment.

4.3 Recommended Post-GATE Activities

When the field operations of GATE have been completed in September 1974, there will be several further tasks which remain to be carried out. These can be divided as follows:

(a) Preparation of a record of the field operations;

(b) Collation, correction, processing and storage of the data;

(c) Scientific analysis of the data aimed both at specific GARP objectives and other problems.

The organization, personnel and other facilities for these tasks will be different from one another.

4.3.1 Report on Field Operations

The final record of the field operations must be prepared by scientists who took an active part in the operational phase of GATE. The ISMG should be able to complete this task by the spring of 1975 if adequate continuity is provided in its staff. The primary objectives of the record of field operations will be (i) to ensure that experience gained in this very large international cooperative observational effort is available to guide the planning of similar operations in the future and (ii) to provide the GATE scientists at an early time with a survey of the accomplished missions.

4.3.2 Data Management

Plans for handling of GATE data have already been drawn up by the ISMG but remain to be finalised. The plans envisage five sub-programme data centres in different countries where the main effort in collation, error correction and basic analysis will take place. Subsequently, the data will be transferred to the World Data Centres. The activities of Sub-programme Data Centres (SDCs) will continue over at least 30 months following the observational phase of GATE.

The JOC was informed that some of the SDCs will aim at preparing some preliminary data sets and analyses within 6 months of the GATE field operations. When these are available they plan to consult a representative group of scientists as to the further

development of the data handling plans in order to ensure that the scientific requirements are adequately met. Meetings are planned for these discussions.

The JOC commends this approach to the planning of the final data sets and proposes its adoption by all SDCs. At a later stage, similar discussions may be needed to ensure that the output of the specialised SDCs include summarised data analysed in a form suitable for the use of scientists whose main interests are in aspects of GATE, other than those of concern to the particular SDC.

During the period of work of the SDCs, it will be essential that a coordinating function for the completion of the GATE data management plan is maintained. This function should include contact with the SDCs to monitor their progress and to ensure that the final records of the data from the five SDCs are consistent as regards presentation and format. It will also be necessary to ensure that the final analysis of the data for each sub-programme is in a form which can conveniently be used to tackle the basic problems of GARP and that the output schedule of the SDCs is maintained and mutually consistent.

The JOC agrees with the ISMG proposal that the Data Coordination function will require two or three technical data experts and a secretary.

4.3.3 Research and Evaluation Phase

The GATE has been designed to improve our knowledge of the structure of tropical disturbances and their interplay with the underlying ocean surface, to aid in our attempts to parameterize sub-scale processes for the study of their dynamics and their role in the general circulation of the atmosphere.

A considerable effort is being organized by the ISMG and TEB to collect and bring the GATE data into a form that will be useful to the individual scientist, through the five SDCs created by TEB. It will obviously be necessary to maintain a close connexion between these centres and the outside scientific community and to ascertain that data analysis satisfies the GARP objectives. It is of great importance that this progress takes place on a broad front and in a consistent manner, leaving no serious gaps in time or research topics.

To achieve these aims maximum use should be made of existing organizational bodies.

4.3.3.1 The Role of the Joint Organizing Committee

In the definition of the stages in planning and implementation of GARP sub-programmes (approved by the Executive Committees of WMO and ICSU, c.f. EC-XX, Annex III, Part D) it is stated that in the Research and Evaluation Phase (E) it is expected that the research problems for which each sub-programme is supposed to provide specific answers will be undertaken by various research groups in the universities, the academies and the Meteorological Services. The evaluation of the results would be their primary responsibility. The JOC would have a coordinating role and would be responsible for submitting to the Executive Committee a consolidated report with recommendations for further action.

JOC will discharge this responsibility through its existing working groups, specifically through its Working Group on Numerical Experimentation.

(1) As discussed above, meetings will be held (in early 1975) at the various SDCs with invited scientists from other parts of the world to ascertain that the work at the centres will satisfy the needs for GARP. *JOC proposes that the WGNE representatives participate in these meetings.*

(2) A most important following task will then be the synthesis of the data from the five centres into a condensed form which will be useful in attempts by individual scientists to improve present parameterization schemes. *To stimulate work in this direction, the JOC requested the Numerical Experimentation Group to undertake arrangements for a "Study Conference on the development of numerical models for the tropics", sometime in the summer of 1975, to which a selected number of scientists, including representatives from the SDCs, will be invited.*

(3) *In order to review the progress of GATE research, there will be need for arranging a series of symposia for the GATE sub-programmes as well as for the Central Programme starting in late 1975.* Recommendations regarding the arrangements of these will be made by JOC-X (November 1974).

4.3.3.2 Role of the WMO/Commission for Atmospheric Sciences (CAS)

It is self-evident that the huge data set that will be collected during GATE should also be used for the solution of many problems of importance to the weather services in the area concerned.

It was reported to JOC by the President of the WMO Commission for Atmospheric Sciences that, in response to a suggestion made by the WMO Executive Committee (Geneva, September 1973), this Commission at its sixth session (November 1973) had set up a Working Group on Tropical Meteorology, the terms of reference of which include the following:

> "To study the extent and value of data collected during GATE in terms of their impact on current and potential tropical research activities;
>
> To make recommendations and proposals on how such data could be made available to research workers in the most profitable way, in particular to developing countries."

The JOC welcomes the initiative of the Commission for Atmospheric Sciences of WMO to create such a working group on tropical meteorology to deal with other aspects of the proper utilization of the GARP data.

Since the interests of the CAS Working Group extend to all fields of tropical meteorology in which research can be stimulated by the availability of GATE data, *it was recognized by the JOC that this Working Group would be able to give attention to the many by-products of GATE that are not closely related to the major GARP objectives. Accordingly, JOC expressed the hope that members of the WMO/CAS Working Group would take early steps to familiarize themselves with the GATE, and in particular with the GATE Data Management Plan.*

4.3.3.3 Possible Role of IAMAP

The Committee envisaged that IAMAP should be expected to supply a mechanism for the holding of international symposia on GATE results. IAMAP, with co-sponsorship by IAPSO, has already planned a symposium at the IUGG General Assembly in

Grenoble, France, in August/September 1975, to deal with "GARP First Objective - Weather Predictability". It is currently envisaged that two days of this symposium will be devoted to the preliminary results of GATE. IAMAP will probably hold its Second Special Assembly in 1977, at which time a further symposium on GARP (including definitive results from GATE) could logically be scheduled.

4.3.3.4 GATE International Sub-programme Advisory Groups

The existing groups formed for the conduct of the scientific sub-programmes of GATE, consisting of outstanding scientists from the participating nations, should play a continuing role in achieving the defined sub-programme objectives during the research and evaluation phase.

4.3.4 Organizational Considerations

It appears that for the field operations' report the ISMG should continue in its present form until about April 1975, as recommended by the TEB-V. The new rasks, discussed in paragraphs 4.3.2 and 4.3.3, are of a different nature and it may be advisable to discontinue the formal existence of the ISMG at that time.

The coordination of the data management plan (4.3.2) and the research (4.3.3) must, however, be continued and it is essential that a small office be maintained for these post-GATE activities. The JOC estimated that the total staff required will be one full-time individual who has a broad scientific background and full familiarity with GATE, two to three technical data experts and a small secretarial staff. The location of this GATE Coordinating Office is of secondary importance, as long as close liaison with JOC/JPS and WMO is assured.

5. THE GLOBAL EXPERIMENT

5.1 The Availability of Satellites for FGGE

5.1.1 Polar Orbiters

The JOC expressed great concern over the lack of knowledge of specific plans for polar orbiting satellites carrying advanced remote-sensing sounders for retrieval of of temperature and water vapour vertical profiles and data collection and location systems.

JOC re-affirms the critical need for such capability for FGGE, to assure temperature retrievals accurate to approximately $\pm$ 1°C, even in areas of cloudiness, and to make it possible to implement the special observing systems for the southern hemisphere (e.g. buoys and constant-level balloons).

The JOC requested the D/JPS to initiate enquiries on the status of plans for such satellites and for explicit information on the instrumentation to be included and the projected launch schedule.

5.1.2 Geostationary Satellites

ESRO - It is understood that the plans for the METEOSAT are firm, with a projected launch period of late 1976.

JAPAN - It is understood that the plans for the GMS are still firm, with a projected launch period of late 1976.

USA - The USA operational satellites will be launched this year in time for GATE. Since the USA is planning these satellites as an operational series, it is assumed that two working satellites will be in orbit for FGGE.

USSR - There are no further details about the specific plan and launch period for the USSR satellite.

The JOC requested the D/JPS to obtain information about the current official planning for these satellites.

5.2 Performance Characteristics of Remote Sounders

Recent information on the retrieval of temperature profiles from remote satellite soundings indicates that the performance to date is less satisfactory than expected. JOC expressed concern over this as it is foreseen from the planning of the FGGE that the success of the experiment depends on the availability of adequate temperature profiles over a large part of the globe.

JOC requested Prof. Morel to visit appropriate institutions in the satellite launching countries to get specific information from experts on the performance of instruments and temperature retrieval methods expected to be in operation by FGGE, and make a report to the next meeting of JOC. It was also agreed that an expert on four-dimensional assimilation should be asked to join Prof. Morel in preparing an assessment of the value of remote sounding temperature profiles.

5.3 Special Observing System for the Equatorial Belt

JOC reaffirmed that vertical wind profiles in the tropics are required in excess of what may be expected from the surface based WWW network and endorsed the continuing development of the carrier-balloon system as one possible solution to this observational problem, ships releasing omega sondes being another.

Dr. N. Rider, consultant for this part of the observing system, is undertaking a study on how best to merge the special techniques for high vertical resolution wind in the tropics, considering the WWW systems (including geostationary satellites) as a basic observing network to which ship stations and carrier balloons must be added to achieve the required number of wind soundings and their adequate distribution. He is working on a plan for an optimum launch strategy for the carrier-balloons, and an assessment of the communication requirements from geostationary satellites to conduct the carrier-balloon operation. This latter material will be furnished to the Coordinating Group on Geostationary Satellites.

5.3.1 WWW Upper-Air Network in the Equatorial Tropics

The JOC recommended at its eighth session that wind observations be made up to 30 mb. Meanwhile it was stressed that the experiment itself presents a great opportunity to study the nature of dominant disturbances in the equatorial stratosphere associated with Kelvin waves. In this regard it is desirable that some specific stations carry out wind observations up to 10 mb.

On the basis of this recommendation the XXVth session of the WMO Executive Committee asked JOC to specify those stations in the equatorial belt which should be equipped to make regular observations up to 10 mb during the Global Experiment. The available information on the existing WWW upper air network performance was analysed by the WMO Secretariat and presented to the JOC.

A list of stations and the statistics in percentage of the radiowind observations which reached or exceeded the 30 and 10 mb levels during a summer and a winter month in 1971 (prepared in the WMO Secretariat) is given in Annex H.

It appeared that about 37 upper-air stations can potentially provide radiowind soundings up to 30 mb, i.e. Africa - 11 stations, Asia - 5, South America - 11, Southwest Pacific - 10. The distribution of the stations concerned is shown in Annex H. With regard to wind observation up to 10 mb, the appropriate number of stations is 22 and they are located as follows: 4 in Africa, 2 in Asia, 7 in South America and 9 in the Southwest Pacific.

JOC agreed to request Dr. M. Yanai and Dr. N. Rider, on the basis of this study, to specify a minimum network of upper-level stations adequate to describe the equatorial stratospheric circulation for FGGE.

It was further pointed out that some of the ship stations implemented for the Special Observing Periods and using omega sondes could also be requested to attain 10 mb, as the omega sonde technique lends itself readily to soundings at the higher levels.

5.4 Special Observing System for the Southern Hemisphere

Current work on data assimilation in the southern hemisphere suggests that independent reference level information is required to maintain an adequate initial state.

Such information can be obtained at present only by subjective interpretation techniques applied to satellite-derived cloud patterns. The direct measurements of reference level parameters by ocean buoys and constant level balloons is a strong requirement in order to improve the data base.

JOC, on the basis of these discussion, reaffirmed the very strong need for independent surface and upper-level information in the southern hemisphere for FGGE to close the important gaps in the WWW and the satellite systems. Constant-level balloons and drifting surface buoys will be needed as part of the composite observing system.

5.4.1 Constant-level Balloon System

JOC was informed that arrangements have been completed in France to proceed with the provision of a data collection and location system for incorporation on USA operational satellites starting in late 1977. Information was also received on the development for the system components of the USA TWERLE constant-level balloon experiment to be conducted in 1974. All components are under construction at lower costs than had been foreseen, and the outlook is positive for a feasible low-cost system for FGGE.

JOC noted with concern, however, the lack of any current national plans for such a constant-level balloon system for FGGE.

5.4.2 Buoy Systems

The D/JPS reported that considerable progress has been made toward developing suitable small buoys that will satisfy the FGGE requirements for surface pressure and temperature. An inter-governmental meeting is being organized by WMO to take place in Geneva in March 1974, in collaboration with IOC, SCAR and SCOR, and a detailed document has been prepared by several buoy experts. It seems clear that at least one and perhaps several designs for simple inexpensive buoys will be available that meet the meteorological requirements. Other, more complex buoys, would of course be welcome also. Extensive tests are planned for 1974/75 in connexion with the data collection and location system on Nimbus-F. Some 150 buoys, including several designs suitable for FGGE, will be tested in extensive experiments.

5.4.3 Use of Subjective Analyses of Cloud Patterns

The Committee was informed by Dr. Tucker that current operational numerical analyses over the southern hemisphere south of about 20°S, prepared by the Melbourne WMC, are possible only by recourse to subjective interpretation of satellite derived cloud patterns over data sparse ocean areas. It is certainly possible that a similar type of information will be required during the FGGE. *At the request of JOC, Dr. Gibbs agreed to arrange for the provision of a monograph describing the way in which these subjective data are used in the numerical analysis scheme.*

5.4.4 Additional Planning Work Needed

JOC agreed that additional planning work is needed to study the various possibilities for the composite observing system for the southern hemisphere and agreed that a consultant for this matter should be engaged.

JOC requested Dr. Tucker to ascertain if a suitable expert from Australia could be made available.

5.5 Observing Systems Simulation Experiments for the FGGE

In consideration both of the planning schedule for implementation of the FGGE and of the progress of four-dimensional data assimilation techniques, it is appropriate to examine various unresolved trade-offs in the design of the FGGE observing system.

JOC therefore recommends that such observing systems simulation experiments be conducted as a matter of urgency during 1974. The required experiments should be performed with advanced general circulation models with a resolution equivalent to a meshwidth not greater than 500 km, and at least a 5 level vertical resolution. These models should also incorporate a reasonably realistic representation of the significant atmospheric processes, particularly in the tropics.

The data base needed for conducting the experiments should be artificial data produced by another circulation model preferably with a significantly larger number of degrees of freedom, i.e. for example, 250 by 250 km horizontal resolution. This artificial data base should be established under conditions where the southern hemisphere circulation is most active and the natural variability is the highest, i.e., for the southern hemisphere winter or possibly for equinox conditions.

In order that extensive data quality control and/or optimal objective analysis should not be indispensable, the artificial data sets proposed below have been constructed in such a way as to prevent excessive repetitious shocking of the model flow. For example, relatively noisy wind data (3 m sec^{-1} RMS) available in the extra-tropics are not included in the artificial data sets, even though a proper use of this supplementary information cannot but improve the definitions of the atmospheric circulation. It is indeed recommended that such supplementary data be included also where available, on the condition that the resulting dynamic imbalance be removed by an appropriate analysis scheme.

In stating accuracy requirements, one must develop a rationale for assessing the aliasing properties of different observing systems, e.g. satellite radiances versus radiosonde temperatures vis-à-vis the aliasing properties of models. Otherwise accuracy criteria are misleading if not meaningless.

Finally, the result of the assimilation experiments should be assessed in terms of the accuracy (RMS difference) of the reconstructed meteorological fields, i.e., for example, the wind field at 500 and 200 mb and the surface pressure field (southern hemisphere) compared to the natural RMS variability of the same quantities in the particular general circulation model.

The data sets (observing systems)proposed for these simulation experiments are described below:

Experiment I: Reference Data Set

This data set (defined in the table below) will serve as a baseline for comparing the performances of other possible observing systems.

Parameter updated	Vertical and horizontal resolution	Time resolution	RMS-error
Temperature T	500 km all levels everywhere	12 h	1^{o} over land areas 2^{o} (upper levels and 3^{o}-4^{o} (lower levels) over oceans and Antarctica
Low level winds	500 km one level at 800-900 mb $40^{o}N$-$40^{o}S$	12 h	1-2 m sec^{-1}
Wind profiles	500 km all levels $10^{o}N$-$10^{o}S$	24 h	2 m sec^{-1}
Surface pressure	500 km land areas, except Antarctica	12 h	No error

Experiment 2: Trade-off between Space and Time Resolution in the Equatorial Tropics

Same as the reference data set (Exp. 1) except for the horizontal resolution and the frequency of the vertical wind profiles in the equatorial belt

$V(p)$ within $10^{o}N$ - $10^{o}S$:

Horizontal resolution : $500 \cdot \sqrt{2}$ km

Time resolution : 12 hours

Experiment 3: Reduced Tropical Wind Data Set

Same as the reference data set (Exp. 1) except for the space and time resolution of the vertical wind profiles in the equatorial belt. (This data set was proposed by the ad-hoc working group on Special Observing Systems).

$V(p)$ within $10^{o}N$ - $10^{o}S$:

Horizontal resolution: 1000 km over oceans
500 km over continents

Time resolution: 12 hours

Question: Would an increased time resolution (say 6 or 8 hours) improve the accuracy of the wind field?

Experiment 4: Southern Hemisphere Upper-level Observations

Same as the reference data set (Exp. 1) except for the addition of pressure, temperature and wind at one upper level of known geopotential altitude in the southern hemisphere.

P, T, V at approximately 200 mb within $10^{\circ}S$ - $70^{\circ}S$:

Time and space resolution: 1000 km once per day and again at alternate grid points, 1000 km apart 12 hours later

RMS errors:

Temperature	: $1^{\circ}C$
Wind	: 1 m sec^{-1}
Pressure	: 1 mb

Experiment 5: Southern Hemisphere Ocean Surface Observations

Same as the reference data set (Exp. 1) except for the addition of surface pressure and ocean surface temperature in the zone of persistent cloudiness.

P_s and T_w within $50^{\circ}S$ - $65^{\circ}S$

Horizontal resolution: 1000 km

Time resolution: 12 hours

No error.

Question: How would the extension of this surface observation network to all ocean areas in the southern hemisphere improve the determination of the windfield?

Experiment 6: Southern Hemisphere Surface and Upper Level Observations

Same as the reference data set (Exp. 1) except for the addition of both the observations at one upper level specified in Experiment 4 and the surface observations specified in Experiment 5.

NOTE: The error estimates given in Experiments 1 to 6 above must be considered tentative, pending a more thorough review of the current and expected performance of the various instruments planned to be in operation during the FGGE. A revised estimate of the expected (random) errors should be available by mid-1974.

5.6 The Data Systems Test

The JOC was informed by correspondence that the first test of the data communication system had just taken place in late December and had verified the performance specification. Plans are now essentially complete for the full-scale test starting as soon as the Synchronous Meteorological Satellite (SMS) and Nimbus-F satellites are in operation just prior to GATE. The data collection will be global and use all WWW and special observing systems (buoys, constant-level balloons, carrier-balloons, etc.) and will include the delayed near-real time analyses at the National Meteorological Center (Washington), and provision of these products to research centres (such as GFDL, GISS, NCAR).

JOC was gratified to hear of the final planning details of this comprehensive test, the results of which will be so critical to the further planning of FGGE.

JOC agreed to request from Dr. M. Tepper (NASA, USA) a detailed report for JOC-X on the first data collection phase of the Data Systems Test (DST).

5.7 Status of Development of Four-Dimensional Assimilation Techniques

Preliminary results were reported of a survey being conducted by the JOC consultant on this topic, Dr. L. Bengtsson. The current situation is that while some progress is being made at a number of centres on work in this area, some serious problems remain. Dr. Bengtsson's survey and analysis of his findings will be ready for discussion at JOC-X.

The JOC recommended that a conference on the scientific use of the FGGE data sets, including the problem of four-dimensional assimilation, should be organized in 1975.

5.8 Data Management and the Role of the World Meteorological Centres (WMCs)

The Planning Conference on the FGGE (September 1972, Geneva) had recommended that representatives of the WMCs and suitable experts on telecommunications should meet to discuss, for example, how satellite radiances may be communicated to and among the WMCs, and to begin work on development of the details of the Data Management Plan for FGGE.

JOC agreed with the need for the meeting and requested the Secretary-General of WMO to make the necessary arrangements. It is expected that the meeting will take place in late 1974.

JOC also agreed that telecommunication experts, representing current conventional communication technology as well as satellite technology, should be asked to meet in advance to prepare some input to the WMC meeting. Furthermore, it was suggested that representatives of other large analysis and computing centres, such as the Meteorological Office and the European Centre for Medium Range Weather Forecasts at Bracknell, U.K., be invited.

5.9 Possible Back-up or Supplementary Communication System during the FGGE

It appears that a significant fraction of the WWW upper-air observations is lost in transit or deteriorated to the point of being rejected in the global analysis. This situation is found to be especially serious in the tropics (c.f. paragraph 4.2.2).

This loss of data and/or transmission delay would have a devastating effect on the results of the FGGE because, on account of the very large amount of data to be handled in this global experiment, it does not appear practical to wait for delayed repetition of the information through surface mail as could be envisaged for a more limited endeavour, such as the collection of the Basic Data Set. In fact, it has been indicated by the WMCs that performing a delayed analysis of global data sets incorporating the late data would greatly inconvenience their normal operation schedule. Thus the global analysis for the FGGE must be conducted in quasi-real time, i.e. within 24 hours of data acquisition.

JOC recognized the great burden this requirement of the FGGE data management plan places on the operation of the surface telecommunication system, especially in the case

of remote permanent stations, temporary sounding facilities or ships which may be activated during the FGGE. JOC took note also of the progress of satellite data collection techniques currently being developed for application to the special observing systems such as automatic dropsondes released from carrier-balloons, constant-level balloons and drifting buoys. It is relevant to note that:

(i) the five geostationary satellites planned to be operating during the FGGE will provide a practically global coverage for relay of coded messages from automatic platforms, and

(ii) the new generation operational polar orbiting satellites planned by the USA will include a random access data collection and location system provided by France.

Both systems could conveniently serve to collect coded messages from appropriate UHF communication devices and transmit these data to the WMCs almost immediately.

JOC therefore recommended that WMO study the satellite data collection as a possible back-up or supplementary communication system to be implemented during the FGGE wherever appropriate to ensure a maximum utilization of the observations which will be obtained.

5.10 Supplementary Observations for the Second GARP Objective

While it was recognized that the GARP International Study Conference on the Physical Basis of Climate and Climate Modelling Conference to be held in mid-74 will provide considerable guidance to this question, it may be useful to alert the participants at the conference as soon as possible as to the need for FGGE plans to take into account any requirements for special data programmes to ensure that the experiment could contribute to studies relevant to the understanding of climatic change.

It was decided to request the keynote speakers to address themselves explicitly to this question.

5.11 Possible Ways to Contribute to the FGGE

JOC discussed the kinds of material contributions needed for FGGE to assure that the observational and data collection requirements are met. It was agreed that a comprehensive document is needed to submit to the countries prior to the next FGGE Planning Conference.

JOC requested D/JPS to prepare such a document for discussion at JOC-X.

5.12 Oceanographic Programmes during the FGGE

The JOC welcomes the initiative taken by Professor H. Stommel, as consultant to JOC (see Annex I), and SCOR through the proposed creation of a special working group, to promote oceanographic investigations related to the FGGE GARP objectives. It was noted that most of the oceanographic programmes listed by Professor Stommel in this preliminary report concern local interaction or response studies: most oceanographers apparently regard it as premature to embark on extensive field investigations of the long-term, large-scale coupling between the ocean and the atmosphere at this time.

In view of the significance of interactions at these scales for the second GARP objective, and the opportunities for experiments during the FGGE, the JOC decided to re-examine this operation later in the light of the results of the GARP International Climate Study Conference.

5.13 Institutional Arrangements for the Global Experiment

The JOC was informed on the current status of the institutional arrangements for the Global Experiment by Professor B. R. Döös and the WMO Observer, Dr. N. Kljukin.

(i) Recommendations by the General Committee of ICSU (September, 1973):

The ICSU General Committee concurred with the recommendations made by the Study Panel on the Institutional Arrangements for the FGGE that

- a central policy coordinating body for FGGE be established which should be an Inter-governmental Panel of the WMO Executive Committee
- the JOC would be the principal scientific advisory body for the detailed planning and implementation of the FGGE
- an FGGE project office be established as part of the WMO Secretariat and that it should be headed by a Director of FGGE (D/FGGE)

Furthermore, the General Committee approved the suggestion that the D/FGGE would be responsible to the Secretary-General of WMO and the D/JPS to the JOC and concurred with the resolution of the Executive Board of ICSU that the scientific integrity of this complex international experiment will be most effectively maintained by combining the post of D/FGGE with that of D/JPS.

(ii) Decisions made by the WMO Executive Committee (September, 1973)

The WMO Executive Committee decided:

- to establish an Inter-governmental Panel to act as the focal point for all activities related to the planning and the implementation of the Global Experiment
- an FGGE Project Office be established in the WMO Secretariat and that this office should be headed by a Director of FGGE (D/FGGE)
- the post of D/FGGE should be combined with that of D/JPS, recognizing that the person concerned will have a dual responsibility. As D/FGGE he will act as the international project leader of the FGGE and will be responsible to the Secretary-General of WMO; as D/JPS he will be responsible to the JOC.

The full text of the discussion and decisions on this matter are presented in the report of the WMO Executive Committee XXV (c.f. Appendix J).

JOC agreed that the D/FGGE-JPS should be appointed as soon as possible since he should participate in the selection of the two officers for the Project Office. It was also suggested that D/JPS explore with the Secretary-General of WMO the possibility that in the interim period up to July 1974, the authorized date for the establishment of the Project Office and the time that the posts are filled, funds allocated to the salaries of the two officers be used as required to support consultants to carry on work needed to advance the planning for FGGE, in particular to prepare for the first meeting of the Inter-governmental Panel, which will take place in late 1974.

5.14 Further Planning of the Global Experiment

The JOC agreed to the following schedule for the further planning of the Global Experiment and experiments planned to be conducted concurrently with the Global Experiment:

1974

March 5-8	Planning Meeting on Drifting Buoys for the FGGE (c.f. paragraph 5.4.2)
September	Second Informal POLEX Study Conference (c.f. paragraph 6.4)
October	Working Group Meeting for the preparation of the data management plan for the FGGE
October	Second Study Conference on MONEX
November	JOC-X. This session will mainly be devoted to the Global Experiment, e.g. the formulation of detailed specifications of possibilities for nations to contribute to the Global Experiment.
November	Meeting of the FGGE Inter-governmental Panel.

1975

April	Sixth World Meteorological Congress. Presentation of the FGGE plan, the need for additional national contributions from smaller countries, and how such efforts may be useful to the countries themselves.
Later in 1975	An Inter-governmental Planning Meeting to which all members of WMO will be invited. At this meeting the countries should be invited to present their commitments for the Global Experiment and related regional experiments.

5.15 Timing of the FGGE

In view of the satellite schedule mentioned in section 5.1, JOC affirmed its proposal that the FGGE start in 1977. However, it is realized that the availability of suitably instrumented polar orbiting satellites may be delayed by approximately half a year. On this account, it seems most likely that the First Special Observing Period will start in December 1977 and that the Special Observing Period associated with the onset of the Southwest Monsoon over India will take place in May-June 1978. The FGGE may consequently continue throughout much of 1978. These possibilities had been foreseen in the time schedule for FGGE as discussed in GPS No. 11.

6. OTHER GARP EXPERIMENTS AND RELATED PROGRAMMES

6.1 The Air-Mass Transformation Experiment (AMTEX)

A report was presented on the current status of AMTEX. The first observational programme will be conducted in the period 14-28 February 1974. At this time it appears that the plan will be carried out essentially as conceived, with the possible exception that the position of the JMA ships will be shifted owing to the lack of availability of omega signals for upper-air soundings from the ships.

Following the field phase of AMTEX-I, the third AMTEX Study Conference is tentatively being planned to be arranged in May 1974, to asses the AMTEX-I operation and to begin planning for AMTEX-II in January-February 1975.

The JOC noted with appreciation the work carried out in this contribution to GARP and commended the Japanese Management Committee for AMTEX for the detailed and clear manner in which they have set forth the scientific objectives of AMTEX and the operational plan to attain them.

6.2 The Joint Air-Sea Interaction Experiment (JASIN)

The JOC noted with appreciation the report (Annex K) on the experiment carried out by the U.K. in September 1972.

6.3 The Monsoon Experiment (MONEX)

The JOC heard detailed reports from Prof. Murakami and Dr. Pisharoty on recent work on analyses of the large scale features of the monsoon. These analyses clearly demonstrate the planetary nature of this circulation anomaly which indicates the strong desirability of the participation of all countries in the area of the monsoon circulation, from the African countries to the east, the USSR, People's Republic of China, and Japan to the north, Australia to the south, and the countries in the West Pacific, perhaps to about 180^{o}-170^{o}W.

The Committee noted the importance of the summer monsoon in the Asiatic region as a major feature of the general circulation of the atmosphere during the northern summer. It was also noted that many of the features of the monsoon circulation are of a large scale and will be adequately described by the observing system designed for the FGGE, if fully implemented. Several of these phenomena (e.g. monsoon depression, monsoon fluctuation, etc.) are of considerable practical importance and deserve specific study in this regard as well as in regard to their role in the global circulation.

With the preceding considerations in mind, the JOC reiterated the need for a Second Informal Study Conference to be held.

It was agreed that this meeting should be organized prior to JOC-X and that the main objectives for this conference should be:

(a) to delineate in detail the specific scientific questions to be addressed and to develop a scientific rationale for the experiment.

(b) to consider how to ensure that the FGGE data and facilities can be fully utilized for the study of monsoon phenomena.

(c) to define the special observation programmes which are needed in limited areas in addition to the FGGE observations in order to study particular small-scale processes in the atmosphere or the ocean which are critical for the understanding of the monsoon phenomena.

(d) to propose relevant national or multi-national programmes to meet foreseen observational requirements.

6.4 The Polar Experiment (POLEX)

6.4.1 Report of the Informal Planning Meeting on the Polar Experiment

A meeting of experts on polar meteorological and oceanographic and ice dynamics problems was held in Leningrad, 11-14 December 1973. The JOC consultant for POLEX, Prof. C. Rooth, prepared a report which was available in preliminary form for JOC-IX. The discussions were largely centered on the arctic regions as little background information was available relating to specific proposals for analogous work in the Antarctic.

A rather complete programme for polar research is outlined in the above mentioned report and many important research tasks are proposed.

6.4.2 The Scientific Objectives of POLEX

On the basis of the proposals in the report of the informal planning meeting on POLEX, the JOC agreed to the following formulation of the scientific objectives:

I. With regard to the first GARP objective:

To resolve by a combination of field experiments and special modelling studies those problems in small scale process parameterization, which are significant in the polar regions. Priority should be given to problems of:

- *air-ice-sea heat transfer and relevant ice dynamics*
- *low level inversion formations and summer stratus*

II. With regard to the second GARP objective:

(i) To develop a better physical understanding of the oceanic exchange processes acting between sub-polar and temperate regions, and parameterization schemes or prediction models adequate for long time-scale estimation of the associated transfer rates.

(ii) To develop sub-systems for global numerical models for dealing with specific polar problems, and to generate special polar data sets for model testing, with emphasis on sensitive indicators of climatic fluctuations.

III. With regard to the implementation of the FGGE:

(i) To identify supplementary observations in the polar regions that are required to provide adequate coverage for global models;

(ii) To ascertain that the satellite techniques envisaged for the global observing system yield best possible information.

6.4.3 Second Informal Planning Meeting on POLEX

The overall goal for the further development of POLEX is to have a final plan ready before the end of 1974. To meet this goal the JOC agreed that a Second Informal Planning Meeting should be convened before JOC-X.

This Second Planning Meeting should be directed to prepare a plan consistent with the objectives presented above and should include detailed assessments of the scientific background in the various problem areas.

In addition, it was agreed that the JOC consultant, Professor C. Rooth, should coordinate the national planning activities by personal contacts with the different major experiment groups.

6.4.4 POLEX Problems related to Antarctica

With respect to a possible POLEX South, JOC took the view that as regards the observational coverage during FGGE required for the First GARP Objective, it appears that the current level of national meteorological programmes of the nations operating stations in Antarctica is commensurate with the meteorological coverage in other land areas of the southern hemisphere, and is far in excess of that for the southern hemisphere generally. JOC noted with appreciation the action by SCAR in recommending the continuation of such meteorological upper-air programmes for the FGGE.

JOC noted the fact that very important scientific questions of the Antarctic region remain unsolved, such as the continental katabatic wind system, the possible variability of heat budget of the ice-ocean regime, the formation of the Antarctic cold deep water layer and its circulation to other oceans, but also noted that if any work on such problems is to be recommended for GARP, in particular for the FGGE, relevance must be shown to the GARP First and Second Objectives. It must also be ascertained that such work would not divert critical resources needed elsewhere to assure that the observational requirements of FGGE are met.

The JOC requests the relevant bodies, such as the Scientific Committee on Antarctic Research (SCAR), the International Commission on Polar Meteorology (ICPM) and the Scientific Committee on Oceanic Research (SCOR) to consider these matters further and to suggest at the Second Informal Planning Meeting on POLEX any specific need for a POLEX South programme.

7. ORGANIZATION OF FUTURE WORK

7.1 The GARP International Study Conference on the Physical Basis of Climate and Climate Modelling, 29 July - 10 August 1974

The Chairman of the Study Conference, Prof. B. Bolin, reported that firm arrangements have been agreed as regards the time, place and conduct of the Conference (c.f. Annex L). The Committee was also informed that financial support ($ 70,000) for the Conference will be obtained from the United Nations Environment Programme.

The JOC considered it desirable that the Organizing Committee for the Conference should include the President of the WMO Commission for Atmospheric Sciences.

It was agreed that information on current national efforts on climate modelling would be of great use at the Conference. It was agreed to request appropriate participants to collect this information and provide it to the Conference.

Furthermore, it was decided to request the key speakers to define data requirements relevant to the understanding of climate change (c.f. section 5.10).

The COSPAR WG 6 Report on Application of Space Techniques to Climate Investigations will be an important document to the Conference. Any additional information on new work or possibilities should be made available.

JOC requests COSPAR WG 6 to update in so far as possible at this time the information contained in their above mentioned report.

It was also noted that the proceedings of the IAMAP Melbourne Symposium on pollution problems will be available, and USA colleagues were requested to arrange to have the appropriate USA Climatic Impact Assessment Program documents made available.

7.2 Calendar of Future Meetings related to GARP

1974

4 - 8 February	Washington, USA	Informal Planning Meeting on GATE Data Management Plan
26 - 28 February	London, England	Informal Planning Meeting on GATE Oceanographic Sub-programme
4 - 8 March	Fort Collins, USA	Informal Planning Meeting on GATE Radiation Sub-programme
5 - 8 March	Geneva, Switzerland	Planning Meeting on Drifting Buoys for the FGGE
7 - 15 March	Boulder, USA	Workshop on GATE Flight Planning
April	Leningrad, USSR	Informal Planning Meeting on GATE Oceanographic Sub-programme
5 - 6 April	Geneva, Switzerland	Informal Planning Meeting on GATE Telecommunication Sub-programme

8 - 11 April	Geneva, Switzerland	VIth Session of the Tropical Experiment Board
8 - 10 May	Tokyo, Japan	Third AMTEX Study Conference
13 -18 May	Geneva, Switzerland	IVth Coordination Meeting on Geostationary Meteorological Satellites
13 - 22 May	Geneva, Switzerland	WMO Panel on Meteorological Satellites
23 May - 13 June	Geneva, Switzerland	XXVIth Session of the WMO Executive Committee
24 June - 1 July	Sao Paulo, Brazil	XVIIth Plenary Meeting of the Committee on Space Research
29 July - 10 August	Stockholm, Sweden	The GARP International Study Conference on the Physical Basis of Climate and Climate Modelling
12 - 14 August	Stockholm, Sweden	Meeting of the JOC Officers
12 - 16 August	Copenhagen, Denmark	International Symposium on Spectral Methods in Numerical Weather Prediction
19 - 22 August	Copenhagen, Denmark	Xth Session of the JOC Working Group on Numerical Experimentation
18 - 27 September	Ankara and Istanbul, Turkey	ICSU 15th General Assembly and Associated Meetings
30 September - 4 October	Oslo, Norway	2nd Informal POLEX Study Conference
September - October	Place to be decided later	Ad-hoc Working Group on Data Management for the FGGE
28 October - 1 November	Singapore	2nd MONEX Study Conference
6 - 12 November	Budapest, Hungary	Xth Session of the Joint Organizing Committee
October - November	Geneva, Switzerland	First Session of the FGGE Inter-governmental Panel

7.3 GARP Publications

7.3.1 The Committee noted with appreciation that the following GARP reports had been published since JOC-VIII.

GPS No. 11:	The First GARP Global Experiment - Objectives and Plans, March 1973
GPS No. 12:	The Complete Atmospheric Energetics Experiment, June 1973
GPS No. 13:	The Air-Mass Transformation Experiment, July 1973
GSR No. 9:	Report of the Fourth Session of the Tropical Experiment Board, March 1973
GSR No. 10:	Report on Special Observing Systems for the First GARP Global Experiment, February 1973
GATE Report No. 3	The Central Programme, January 1974
GATE Report No. 4	The Radiation Sub-programme for GATE, October 1973
GATE Report No. 5	The Boundary Layer Sub-programme, December 1973

7.3.2 The following reports will be published in the near future

The GARP Publications Series (decisions by JOC-VIII and -IX):

- Modelling for the First GARP Global Experiment. Edited by A. Robert and JPS (March, 1974)

- Climate Modelling. Report on the GARP Conference on the Physical Basis of Climate and Climate Modelling (late 1974).

- Four-dimensional Assimilation of Meteorological Observations by L. Bengtsson (late 1974)

- The Monsoon Experiment (MONEX) (early 1975)

- The Polar Experiment (POLEX) (early 1975)

- Numerical Methods Used in Atmospheric and Ocean Models (1975)

The GATE Series:

- Pre-GATE Tests and Studies (in preparation)

- The Convective Sub-programme for GATE (in preparation)

- The Oceanographic Sub-programme for GATE (in preparation)

7.4 The Joint Planning Staff

7.4.1 On 31 December 1973 Dr. V. Meleshko (USSR) left the Joint Planning Staff after having spent more than four years with them in Geneva. The Committee expressed its appreciation for the valuable work he had carried out during this time and wished him every success in his new post at the Main Geophysical Observatory in Leningrad.

7.4.2 Dr. V. Boldirev, from the Hydrometeorological Centre, Moscow, arrived at the beginning of the year to replace Dr. Meleshko. Having spent some time with the JPS in 1972 as a JOC consultant, Dr. Boldirev is already familiar with the work involved and will certainly prove to be a most able and welcome staff member.

7.4.3 USA is responding to the request that nations second suitable scientists to support the work of the JPS, by sending Prof. J. Kutzbach, of the University of Wisconsin, to spend six months early in 1974 with the JPS to concentrate on the preparation of documentation and arrangements for the GARP International Conference on the Physical Basis of Climate and Climate Modelling to be held in Stockholm in the summer.

Australia has plans for seconding a scientist, and the USA also has other possibilities in this respect.

7.4.4 Four experts in specific fields have, since the last JOC session, signed Special Service Agreements to carry out assignments in connexion with the planning of the FGGE. These are as follows:

Dr. L. Bengtsson, Swedish Meteorological and Hydrological Institute: to stimulate the research and development within the field of 4-dimensional assimilation of meteorological data and prepare a report on this subject in the GARP Publications Series;

Dr. N. Rider of the UK Meteorological Office: to institute an operational analysis programme to consider the mixed special observing systems for the equatorial tropics during the Global Experiment and to assess the compatability of data provided by the elements of the mixed systems;

Prof. C. Rooth of the University of Miami: to coordinate internationally the GARP Polar Experiment and prepare a report on the subject in the GARP Publications Series;

Prof. H. Stommel of the Massachusetts Institute of Technology: to develop an oceanographic programme within the First GARP Global Experiment.

Furthermore, Prof. T. Murakami, of the University of Hawaii, has undertaken to prepare the background material for the Second Study Conference on the Monsoon Experiment, to be held in late 1974. A Special Service Agreement will shortly be prepared for Prof. Murakami to cover this assignment.

7.5 GARP Implementation Fund

The JOC took note of the document submitted by the Secretary-General of WMO, containing an updated proposal for the GARP Implementation Fund Budget for 1974 (c.f. Annex M), in light of the decisions made by the XXVth session of the WMO Executive Committee in September 1973.

Regarding the proposed expenditure for 1974, in respect of the Joint Planning Staff (JPS) it is estimated that an additional amount of approximately $ 44 000 would be required. In order to supplement the GARP Implementation budget in this respect, WMO and ICSU would agree, if necessary, to provide additional funds, each contributing an equal amount.

The Committee approved the proposed budget and welcomed the additional support in respect of the JPS.

LIST OF PARTICIPANTS

I. The following members were present:

B. Bolin
V.A. Bugaev (Officer)
K. Gambo
K. Hasselmann
P. Morel (Vice-Chairman)
P.R. Pisharoty
J.S. Sawyer
R.W. Stewart (Chairman)
V.E. Suomi
G.B. Tucker

Prof. J. Smagorinsky (Officer) and Acad. A.M. Oboukhov were unable to attend.

II. The following observers attended the session:

From WMO:	N. Kljukin
From ICSU:	W.L. Godson
Invited experts:	W. Gibbs
	T. Murakami
	C.H.B. Priestley
	A. Wiin-Nielsen

III. Prof. B.R. Döös, Director of the Joint Planning Staff (JPS), acted as secretary for the session; Mr. S. Ruttenberg served as joint secretary.

AGENDA

1. ORGANIZATION OF THE SESSION
   - 1.1 Opening of the session
   - 1.2 Election of Officers
   - 1.3 Approval of the agenda
2. REPORTS ON JOC ACTIVITIES
   - 2.1 Report of the Chairman
   - 2.2 Report of the JOC Officers' meeting
3. THE NUMERICAL EXPERIMENTATION PROGRAMME
   - 3.1 Report of the Working Group on Numerical Experimentation
   - 3.2 Organization and membership of the Working Group on Numerical Experimentation
   - 3.3 Plans for future activities of the Working Group on Numerical Experimentation
4. THE GARP ATLANTIC TROPICAL EXPERIMENT(GATE)
   - 4.1 Report of the International Scientific and Management Group (ISMG) for GATE
   - 4.2 Report of the JOC Panel on the GARP Atlantic Tropical Experiment
   - 4.3 Collection of Global Data during GATE for Numerical Experimentation
   - 4.4 Comments related to the status of the planning of GATE as presented in the report of the fifth session of the Tropical Experiment Board
   - 4.5 Required Post-GATE activities
5. THE GLOBAL EXPERIMENT
   - 5.1 The special observing systems in the equatorial belt
   - 5.2 The special observing systems in the southern hemisphere
   - 5.3 Present status of four-dimensional data assimilation
   - 5.4 The Data Systems Test
   - 5.5 Data management and the role of WMO6 in the data processing for the Experiment
   - 5.6 Institutional arrangements for the Global Experiment
   - 5.7 Performance capability of the WWW upper-air network in the tropical belt $10^{o}S$ - $10^{o}N$
   - 5.8 Supplementary observations related to the second GARP objective
   - 5.9 Possible ways to contribute to the FGGE
6. OTHER GARP EXPERIMENTS AND RELATED PROJECTS
   - 6.1 The Air-Mass Transformation Experiment (AMTEX)
   - 6.2 The Joint Air-Sea Interaction Trial (JASIN)
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REPORT OF THE CHAIRMAN

A considerable amount of activity has taken place since JOC-VIII in London. At that meeting it was decided that the frequency of JOC meetings was now insufficient for JOC as a body to effectively respond to any needs which may arise with respect to GATE. Therefore a panel consisting of V.E. Suomi, J.S. Sawyer, K. Miyakoda, I. Sitnikov and M. Yanai was appointed by JOC-VIII to serve as a body to help fulfil JOC's responsibilities towards GATE. As requested, this panel (except for Sitnikov) visited Bracknell and discussed the status of scientific and operational planning for GATE. It has been indicated to us that this panel served a very useful purpose.

Still with GATE, one of the most presseing things now facing JOC is the question of the nature of the post-operational phase of GATE. JOC-IX will have to deal with this question.

With respect to the FGGE, there have been a number of developments. The General Committee of ICSU and the Executive Committee of WMO have agreed to the establishment of an FGGE Inter-governmental Panel. JOC has been invited to be represented, and I took it upon myself to name myself as the official JOC representative. However, in doing so I pointed out that at any particular meeting it might very well be some other member of JOC who would serve that function, depending upon the subject matters to be discussed.

The WMO XXVth Executive Committee also agreed to establish a Panel on Meteorological Satellites. The Chairman of JOC was named as a member of the Panel, but I chose instead to nominate Professor Morel since he is one of our particular experts on this topic.

It was further decided that an FGGE Project Office will be established, to be sited at WMO Headquarters in Geneva. However, due to budgetary constraints within WMO, it is not expected that any action will be taken on this until the middle of 1974.

A further decision taken is that the post of Director of the FGGE Project Office and Director of JPS/GARP will be a joint one with a single incumbent. He will report to JOC for JPS matters and to the Secretary-General of WMO for matters with respect to the FGGE Project Office .

At the JOC Officers' meeting in Vienna in September, it was agreed that consultants would be named immediately for certain aspects of FGGE planning. Dr. Lennart Bengtsson is now well underway with his task to stimulate the research and development within the field of four-dimensional assimilation of meteorological data, and he will prepare a report on this subject in the GARP Publications Series. Dr. Norman Rider has accepted the responsibility of serving as a consultant to examine the vexed problem of the equatorial wind system. Professor Henry Stommel has similarly accepted to examine some oceanographic aspects. There are good prospects that we may obtain the services of an Australian to examine the problems of the southern hemispheric systems.

With respect to satellite systems, the information we have is that the FGGE requirements will be met. We confidently expect to have five geostationary satellites. The countries and organizations involved: United States, Japan, USSR and ESRO, have been cooperating closely with respect to design considerations. Concerning the question of a satellite capable of transmitting information and of locating drifting balloons and buoys, it now appears that a US satellite with capability equivalent to that proposed for TIROS N - although perhaps not TIROS N - will be in orbit.

One of the most important working groups of the JOC, the Working Group on Numerical Experimentation, has been extensively reorganized. Its former Chairman, Dr. André Robert, has found it necessary to resign. The JOC owes him a debt of gratitude for the energy and dedication he displayed while chairing this group. The new Chairman is Professor Aksel Wiin-Nielsen, and we consider ourselves fortunate that we can continue to attract the support of such outstanding people for the difficult but very important tasks of this Working Group.

Concerning other GARP experiments and activities, there has continued to be much activity:

The first phase of AMTEX will begin this February unless fuel problems prove insurmountable. (This is not expected.) An approach was made to obtain Chinese participation in AMTEX, but the Chinese feel that they are unable to participate in a joint WMO/ICSU venture such as GARP while they are not members of ICSU. Nevertheless, it is hoped that important data from the mainland of China will be made available to those analysing AMTEX results.

With respect to POLEX, a major meeting was held in Leningrad in December. Professor Claes Rooth, who is working as a JOC consultant on the Polar Experiment, participated at the meeting and has prepared a most comprehensive document for submission to JOC-IX.

At JOC-VIII, it was agreed that a second informal study group meeting of experts for MONEX should be held in the spring of 1974. However, at the September Officers' meeting it was agreed that the study group meeting should be postponed until the fall of 1974. It is hoped that Professor T. Murakami will accept - as a JOC consultant - to help in the development of a detailed rationale for the Monsoon Experiment and prepare the background documentation for this meeting. It is anticipated that some discussions with respect to MONEX will take place during the IAMAP/IAPSO joint meetings in Melbourne this month.

Planning is proceeding for the Climate Conference. Professor Bolin reported on the progress of the planning to the September Officers' meeting. A nearly-final list of invitees has been prepared and many of those who will be asked to present position papers have been identified. The Conference will take place this coming summer in Stockholm.

It can be seen that GARP activity is proceeding on many fronts, and that we are getting fine cooperation from our parent bodies, from the scientific community and from governments.

SUMMARY OF THE MEETING OF THE JOC OFFICERS

(Vienna, 5-7 September 1973)

A meeting of the JOC Officers was held in Vienna, 5-7 September 1973 with the following participation:

R.W. Stewart	JOC Officer	(Chairman)
V.A. Bugaev	JOC Officer	
P. Morel	JOC Officer	
J. Smagorinsky	JOC Officer	
B. Bolin	JOC Member	(Item 7)
J. Sawyer	JOC Member	(Item 7)
B.R. Döös	Director JPS	
J. Kuettner	Director ISMG	(Item 3)
A. Glaser	WMO Observer	
N.K. Kluykin	WMO Observer	

1. THE NUMERICAL EXPERIMENTATION PROGRAMME

1.1 Reorganization of the Working Group on Numerical Experimentation

A present the Working Group on Numerical Experimentation consists of four members, including the chairman. In addition there are five component coordinating groups responsible for five different problem areas.

In order to achieve a simpler and more effective organization the JOC Officers decided that

- *The membership should consist of a chairman and the leaders of the component coordinating groups.*
- *The leaders of the coordinating groups should be appointed for a period of two years and be asked to report on their activities to the chairman at the end of that time period.*

- *The choice and number of problem areas should be adjusted to the current needs.*

At present there are five component groups representing the following problem areas:

1. Data Problems
2. Physical Processes
3. Computational Considerations
4. Prediction and Simulation
5. Modelling Aspects of Climate

The Officers considered the membership of the reorganized Working Group on Numerical Experimentation and it was decided that the final decision should be made by the Chairman of JOC after advice had been received from the Working Group on Numerical Experimentation. In particular the Officers requested that the Working Group on Numerical Experimentation should propose candidates for the leaders of the coordinating groups 2 and 3, at their meeting in Novosibirsk in September 1973.

After the final decision has been taken regarding the new membership, the Director of JPS was requested to notify the persons concerned.

2. THE GLOBAL EXPERIMENT

2.1 The Observing System

The Officers agreed to the desirability that two JOC consultants be engaged to assist the JPS in the following problem areas:

(i) Special observations in the equatorial belt: The development of an operational analysis programme for the observing system in the equatorial belt. This analysis should include consideration of logistical, balloon launching, dropsonde release scheduling and other operational problems involved in the optimal utilization of the mixed observing system (WWW basic network, ships and carrier balloons).

(ii) Special observations in the southern hemisphere: The development of a detailed plan for the observing system in the southern hemisphere mid-latitudes. Considerable planning work is still required for the planning of the southern hemisphere observing system which, in addition to the Basic Observing System, includes constant-level balloons and drifting buoys.

(iii) Ocean weather stations: The Officers noted that the increasing effectiveness of remote measurements of atmospheric parameters from space, particularly in respect of temperature profiles, together with the ongoing development of methods for assimilation of non-synchronous data, hold the promise of allowing a reduction of the number of ocean weather stations in the future. However, it was pointed out by the JOC Officers that upper air and surface observations from ocean weather stations are presently, and for the immediate future, essential elements of the global data set. *Since the design of an optimum composite global observing system for the WWW is one of the major objectives of the Global Experiment, a definitive and scientifically founded discussion of the continuation of the operation of the ocean weather stations should be deferred until after the completion of the Global Experiment.*

2.2 The Data Management Plan

The Planning Conference on the FGGE recommended that the Secretary-General of WMO be requested to:

- Take action now aimed at requesting nations involved to provide capacity on the GTS for the transmission of sounding radiances from up to four polar orbiters.

- Establish a working group for the preparation of a detailed implementation plan for the activities of the WMCs composed of the programme managers of the three WMCs, representatives of JOC and other experts as required; in this connexion, particular reference was made to the need for telecommunication experts.

The Officers agreed to the following plan of action:

- *An informal preparatory meeting be arranged with representatives from the three WMCs, the JPS and the Coordinating Group on Data Problems (The GARP Numerical Experimentation Programme).*

- *It was suggested that this informal preparatory meeting be held in early 1974 and that the "formal" meeting of the Working Group be held in late 1974 or early 1975.*

- *In particular it is important that more precise resolution requirements for the sounding radiances are formulated (both for operational work and research).*

- *In order to assist the JPS in the further planning of the data processing and telecommmunication plan for the Global Experiment it is proposed that a JOC consultant be engaged as soon as possible.*

In conjunction with the discussion on this subject the Officers were informed that Dr. L. Bengtsson had been engaged as a JOC consultant in order to stimulate the research and development within the field of four-dimensional assimilation of meteorological data and to prepare a report on this subject in the GARP Publications Series.

3. THE GATE

The Third Session of the GARP Tropical Experiment Board (Geneva, April 1972) took note of the JOC statement on the global context of GATE and asked the Secretary-General of WMO to arrange for consideration of JOC proposals in this regard and to submit as assessment of the implications to TEB and JOC. The assessment of the various points raised is as follows:

(i) Keep fully active all WWW stations: This is of course a basic requirement of the WWW plan. However, to assure the maximum function of the GOS, it is proposed to distribute to Members information on GATE and its global context, requesting their full cooperation in the Experiment.

(ii) Intensify observations from commercial aircraft and merchant vessels: Steps are being taken to increase the number of these observations appearing in international meteorological exchanges. The matter

has been considered by RA-I, RA-III, CAeM and CMM.

(iii) Expedite reporting and transmission of observations: Steps are being taken under national, Voluntary Assistance Programme (VAP) and bilateral programmes to improve national data collections.

(iv) Systematically interrogate within 24 hours stations with bad or missing reports:

(a) Bad reports. No internationally standardized procedures exist as yet for the detailed quality control of meteorological reports, but it must be apparent that a serious error or mutilation can readily be identified by a user of the report. This makes possible the establishement of an ad hoc system of interrogation based on assigned responsibilities of data users for initiation of queries. With respect to mutilations, all RTHs and WMCs are now supposed to request repetition of all bulletins received mutilated.

(a) Missing reports. Present procedures call for each station to be accounted for within the bulletin in which it is to be contained. At present an indication is given as to whether the report may be expected in a RETARD bulletin or is known to be absent. However, since this procedure is not applied uniformly, the forthcoming CBS Working Group on the GTS is expected to recommend modification. The requirement for the ultimate collection of late reports should be considered there.

(v) Organize Collection Centres: It is our understanding of the GATE plan that a synoptic data centre will be established, possibly at Bracknell. It would appear that global data sets incorporating the GATE area data might be accumulated there.

4. THE AMTEX

The Officers emphasized again (c.f. JOC-VIII, 6.1.2) the desirability of the participation of the People's Republic of China in the Japanese Air-Mass Transformation Experiment (AMTEX) scheduled for the period 14-28 February 1974 and again for two weeks in January-February 1975.

A particularly useful area of participation would be the extension of the existing rawinsonde observations at the stations near the coast of the East China Sea at more frequent intervals during the periods of AMTEX.

5. THE MONEX

5.1 The Second JOC Study Group Conference

At the eighth session of the JOC (March 1973) it was agreed that a Second JOC Study Group Conference on MONEX should be arranged in the spring of 1974, and it was recommended that WMO be requested to assist in securing participation in the second informal study group meeting by appropriate experts from the countries in the general monsoon area (e.g. countries in East Africa, the Arabian Peninsula, all of Southern Asia, Australia and countries in the East Central Pacific).

After consultation with Dr. Koteswaram it has now been decided that this JOC Study Group Conference should be held in Bombay, 11-16 March 1974.

5.2 The Establishment of a Plan of Action

In view of the considerable amount of planning and international coordination work which needs to be carried out before the study conference, the Officers emphasized the need for a plan of action to be established and recommended that a small preparatory meeting should be organized. It was furthermore recommended that the following individuals should be invited to participate in this meeting:

Dr. R. Burlutzky, Dr. P.K. Das, Professor T. Murakami and Dr. P.R. Pisharoty.

(This meeting is now being planned to be organized in conjunction with the IAMAP/IAPSO Assemblies in Melbourne, in January 1974.)

5.3 Preliminary Considerations regarding the Management of MONEX

In designing the management structure for MONEX, the following facts and viewpoints need to be taken into account:

- The MONEX will be carried out during one of the Special Observing Periods of the Global Experiment

- The design of the observing system for MONEX and the Global Experiment must be closely coordinated

- It is expected that USSR will make a significant contribution (ships) to the MONEX

- It is also expected that several other countries will contribute to MONEX and thereby also to the Global Experiment.

In view of the above, together with the general principle that the organizational arrangements should be as simple as possible, it appears both sufficient and desirable that only one body be created for the management of the MONEX. This body may be called the MONEX Management Group. This group should be responsible for:

- the detailed scientific design of the experiment
- the development of the observing, telecommunication and data processing for the experiment
- proposing and organizing the numerical experimentation programme related to the experiment.

Composition: It is essential that the management committee includes representatives from the countries which contribute substantially to the experiment. The establishment of special working groups for the various problem areas appears to be desirable.

In order to simplify and accelerate the decision-making process, it *is recommended that a small executive panel be established within the management group*. To ensure that the planning of the MONEX is closely coordinated with the Global Experiment, it is suggested that the Director of the FGGE be represented in this panel.

6. THE POLEX

The Officers agreed to the proposal that an informal meeting, co-sponsored by JOC and the International Commission on Polar Meteorology, should be organized with representatives from the interested countries in order to reach an agreement on the main scientific objectives of POLEX and to develop an operational plan for the conduct of this experiment during the Global Experiment.

This meeting will be held in Leningrad, 10-14 December 1973.

7. THE GARP STUDY CONFERENCE ON THE PHYSICAL BASIS OF CLIMATE AND CLIMATE MODELLING

Two of the three JOC Members (Prof. B. Bolin and Mr. J. Sawyer) belonging to the committee for the organization of this conference, participated in the discussion on this agenda item.

The Director of JPS informed the meeting that a request for economic support of this conference had been included in a project document submitted by WMO to the United Nations Environment Programme (UNEP).

The meeting was also informed that Dr. John Kutzbach of the University of Wisconsin, USA, has been engaged to assist the JPS in the planning of this conference.

Specific recommendations were made regarding the agenda, documentation and participation in this conference, and these will be included in the final plan for the organizatation of the conference which will be presented by the Chairman of the organizing committee, Prof. B. Bolin, before the end of October.

The conference is tentatively planned to be held 25 June - 6 July 1974 at the conference centre Wijk near Stockholm.

8. REPRESENTATION OF JOC AT MEETINGS PRIOR TO JOC-IX

The Officers recommended that:

(i) Professor P. Morel (21 September) and Professor B.R. Döös (20,24-28 September) should represent JOC at the twenty-fifth session of the WMO Executive Committee.

(ii) Professor V. Suomi should represent the JOC at the fifth session of the TEB in Geneva, 3-7 December 1973.

9. GARP PUBLICATIONS SERIES

The Officers agreed on the desirability that the report containing detailed descriptions of general circulation models should be published in the GARP Publications Series as soon as possible. Professor Smagorinsky agreed to write an introductory chapter to this publication.

JOC-IX Report, ANNEX E
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
WORLD METEOROLOGICAL ORGANIZATION

JOINT GARP ORGANIZING COMMITTEE

REPORT OF THE NINTH SESSION OF THE WORKING GROUP ON NUMERICAL EXPERIMENTATION

(Novosibirsk, 22-25 September 1973)

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I. INTRODUCTION

I.1 The Working Group on Numerical Experimentation held its ninth session in Akademgorok, Novosibirsk, USSR, at the House of Scientists, 22-25 September 1973. All members of the group were present:

Dr. A. Robert (Chairman)
Prof. L.S. Gandin
Prof. K. Miyakoda
Prof. A. Wiin-Nielsen

I.2 The following experts were invited:

Dr. L. Bengtsson (4-dimensional assimilation)
Prof. E.P. Borisenkov (POLEX)
Dr. S.S. Zilitinkevich (Boundary layer)

Furthermore, the following also took part in various discussions:

Acad. G.I. Marchuk
Dr. A.S. Chaplygina
Dr. G.N. Kurbatkin
Dr. V. Penenko

Dr. V.P. Meleshko, Scientific Officer of the Joint Planning Staff, acted as Secretary for the session.

The agenda of the meeting is attached as Appendix A.

I.3 In his introductory remarks, Acad. G.I. Marchuk welcomed the participants to the meeting on behalf of the Siberian Branch of the USSR Academy of Sciences.

Acad. Marchuk then made a short review of the problems that GARP faced at the present time. In particular he stressed the urgent need of real global data for the testing of sophisticated atmospheric models, and for the development of efficient four-dimensional assimilation techniques for assimilation of non-synchrounous data randomly distributed in space. In the light of the growing interest in the study of climate, efforts should also be concentrated on the proper parameterization of physical processes in joint ocean-atmosphere

models and the development of ways related to the verification of ocean simulated states with real observations.

2. THE BASIC DATA SET PROJECT

2.1 Dr. A. Robert reviewed the history of the Basic Data Set Project and highlighted its current status. He mentioned that a complete set of data for the November 1969 and June 1970 periods are stored on 39 magnetic tapes and are available at a cost of $ 60 per tape from the National Climatic Centre (USA). A complete data set was also sent to the World Meteorological Centre in Moscow and it is expected that it will soon be available at the World Meteorological Centre in Melbourne.

At present two research groups, i.e. Geophysical Fluid Dynamics Laboratory (GFDL) and Dynamic Prediction Research Division (DPRD), are preparing a global analysis with the November data set, which is considered as being the more complete. Besides the observations from the surface and upper-air WWW network, commercial aircraft, merchant ships and SIRS data (temperature and geopotential) from the polar orbiting satellite Nimbus 3, the set also includes tracer cloud winds from geostationary satellites, ATS-I (Pacific) and ATS-III (Atlantic).

The GFDL group is preparing a global analysis with a 12-hour interval for the period 2-12 November 1969. The grid-point values ($4^{o} \times 4^{o}$) of geopotential, temperature, wind and humidity are calculated at 13 vertical levels. The objective three-dimensional analysis is applied for this purpose. Before the objective analysis, hydrostatic checking is performed.

The DPRD group has analysed temperature fields at 10 levels and surface pressure for six consecutive days (4-9 November 1969) using three-dimensional analysis which is close to the optimum interpolation. Analysis of the wind fields is underway with the same interpolation technique, except for the sparse data areas where the wind is calculated from the linear balance equation. The analysed fields are presented in terms of the spherical harmonics truncated at rhomboidal wave number 25. This form of presentation is thought to be convenient for data storage and exchange. There is an intention to produce a complete analysis for the whole November period.

It was further noted that there are about 10 research groups at present expressing their willingness to use the Basic Data set for medium range forecasting (1-5 days), and at least two groups are interested in making use of the data for 4-dimensional assimilation study.

2.2 The Working Group pointed out that the Basic Data Set is the most complete set of observations that has ever been available and thereby is unique at the present time. In particular, it concerns the tropics and the southern hemisphere. However, experience gained from the November data set clearly shows that despite the additional data available they are still inadequate to specify confidently the state of the atmosphere in the whole southern hemisphere because ocean areas continue to pose an enormous problem in providing observations. For instance, a substantial portion of the ocean bounded by $40^{o}S$-$60^{o}S$, where the persistent cloudiness is generally observed, has no observations whatsoever. Furthermore, it was revealed that wind data from one of the two geostationary satellites were completely missing and all data for 12 November were also missing. It was understood that only special efforts, for instance the deployment of buoys assisted by satellite temperature profiles down to the cloud tops, may remedy the situation. The Working Group stressed the importance of this point in connexion with the planning of the observing system for the Global Experiment.

In response to the JOC-VIII recommendation that an article on the present status of the BDSP data be prepared and published in the WMO Bulletin, the Working Group requested Dr. A. Robert and Prof. K. Miyakoda, when the work is over, to summarize their experience gained from running the BDSP analysis and write such an article. Special emphasis should be given in the paper to the level of the data quality and data space distribution.

3. THE POLAR EXPERIMENT

3.1 Prof. E.P. Borisenkov reported to the Working Group on the aims and status of the POLEX. The experiment is proposed for the region that is believed to control the large-scale oceanic-atmospheric processes. It is aimed at a proper understanding of heat and moisture exchange between the ocean-land surfaces and the atmosphere and the role of ice-snow cover in handling the atmospheric circulation in the middle latitudes and the polar region. It is also important to study the sensivity of climate to ice dynamics.

The field programme started as from 1972 and consists of several expeditions.

3.2 It was recalled that JOC-VI (October 1971) strongly supported the concept of the Polar Experiment and suggested that it be fitted in with the Global Experiment in order to gain mutual benefit from combined observational efforts over the sparse data areas of the Arctic. Furthermore, JOC-VIII (March 1973) recommended that the Working Group on Numerical Experimentation consider the problems related to the planning of POLEX and formulate a specific proposal on the kind of numerical experiments required.

3.3 The Working Group identified three problem areas which are of mutual interest to both the Global and Polar Experiments:

(i) Parameterization of physical processes over a specific underlying surface. The thermal conditions over the whole polar region are mostly determined by the property of the underlying surface, which may be either ice, snow or water. Its change results in a great difference in heat balance components near the surface. Thus, in the case of open sea water in autumn and winter the sensible heat flux and evaporation rate are increasing by as much as about one order of magnitude in comparison with an ice covered case. A general review of the lower boundary interaction problem in connexion with the construction of parameterization schemes relevant to GARP is discussed in GPS No. 8. The Working Group noted that the recommendations on theoretical and observational studies set forth in the publication and needed to improve the parameterization schemes have stood well and therefore could be used successfully as a background for planning an international polar programme.

(ii) Construction of the consistent global data set. The Polar and Global Experiments supplement each other from the standpoint of building up a consistent data set. A great problem exists in getting the complete set of data in accordance with data requirements from the polar region. Estimates show that nearly 22 supplementary observational stations are needed to close the data gaps over the area bounded by the 70°N latitude circle. The observational problem results from the fact that satellite temperature and humidity profile determination is substantially complicated for the lower troposphere of the polar region because of the existence of strong inversions which are dominant in the whole region in winter time. In summer time the temperature derivation is becoming even more difficult resulting from the contamination of persistent cloudiness. Deployment of automatic surface stations in accordance with requirements for the Global Experiment would be of particular need for obtaining reference temperature and pressure observations. Temperature measurements make it possible to restore temperature profiles from cloud tops down to the surface. The pressure measurements provide mass field determination. The recommendation of the Working Group on the subject concerned is set forth in section 3.4.

(iii) Study of climate sensitivity to distribution of the polar ice. An interest is growing in the problem of physico-mathematical modelling of climate and its variations. It was noted that theoretical and observational studies of that kind have not been formulated so far within the GARP programme. Reference was

made to the International Study Conference on the Physical Basis of Climate and Climate Modelling which is planned for June-July 1974, where a rational approach to climate study is expected to be developed and the observational requirements be established. The Working Group endorsed the numerical modelling experiments proposed by the USA Joint POLEX Panel aimed at the study of the sensitivity of climate against ice dynamics and encouraged the interested research groups to carry out additional experiments directed to the development of long-range prediction models which would properly treat the fluctuation of the physical properties of the underlying surface in the polar region.

3.4 In order to assess the efficiency of the observing system in the polar region and particularly the role of the automatic surface stations as discussed in section 3.3 (ii), the Working Group proposed observing systems simulation experiments with the following observational components and specification of variables:

(i) World Weather Watch network. The geographical distribution of the existing surface and upper-air stations is given in GPS No. 11

- surface pressure (error $\pm$ 0.5 mb)
- temperature $\pm$ 1^{o}C
- Wind (vector error $\pm$ 3 m/sec)
- two observations per day.

(ii) Polar orbiting satellites rotating in perpendicular planes with 2 hours orbit. The temperature profiles are contaminated by the clouds inside the circle 70^{o}N (summer time)

- sea surface temperature with error $\pm$ 1^{o}C
- temperature profiles $\pm$ 1^{o}C

(iii) Automatic land stations measuring air temperature and pressure

- air temperature $\pm$ 1^{o}C
- surface pressure $\pm$ 0.5 mb
- two observations per day

Two alternative observing systems could be tested:

(a) WWW network and polar orbiting satellites available with the above specification

(b) The same as (a), plus automatic stations evenly distributed with a spacing of 500 km apart.

In both cases it is necessary to determine how each of the two observing systems defined the state of the atmosphere in the polar region.

The Working Group requested interested research groups to carry out the above specified observing systems simulation experiment. It was pointed out that besides the global models advanced hemispheric models may also be successfully used for this kind of simulation experiment.

4. EXPERIMENTATION PROGRAMME WITH GATE DATA

The Working Group made some general comments on the use of GATE data and the extent to which the group could be involved in this activity. It was agreed that the GATE itself would represent another source of data that would be considerably more numerous than the Basic Data Set. Some estimates revealed that about 800 magnetic tapes would be needed to record the complete GATE data set. In this regard the Working Group on Numerical Experimentation expressed deep concern about the immediate availability of the data set for research soon after the observational experiment. *It was particularly stressed that every effort should be made in order to avoid the repeat of a delay such as had occurred in obtaining the Basic Data Set.*

The GATE is designed to provide a description of the internal structure of the cumulus ensembles and to develop appropriate schemes for their parameterization in terms of the large-scale parameters. It was also agreed that GATE data are needed:

(i) to improve day to day forecasting models for which prediction skill is very low at present, particularly for the summer period.

(ii) to study the dynamics of the tropical atmosphere in connexion with the preparations for FGGE.

Since the wind is essential for the determination of the tropical atmosphere it was indicated that it is extremely important to have adequate wind coverage in the whole A-scale area for numerical simulation experiments.

5. BOUNDARY LAYER STUDY RELEVANT TO GARP

5.1 Dr. S.S. Zilitinkevich reported to the Working Group on the Symposium on Boundary Layer Turbulence held in Moscow, 27-30 August 1973. A meeting of an ad-hoc group on "physical processes" was organized at the time of the Symposium as an arrangement under the auspices of the Working Group on Numerical Experimentation. The group reviewed

the problems related to the boundary layer and identified specific studies (observational and theoretical) that are needed for the improvement of existing parameterization schemes.

5.2 It was noted that most boundary layer models proposed so far have been developed under stationary conditions and for the homogeneous underlying surface. Recently, however, a number of studies have been undertaken in which more general approaches are considered. In this regard attention was drawn to the need for a reference observational data set in order to verify different assumptions in the theoretical boundary layer models and to test parameterization techniques. It was pointed out that studies directed at the appraisal of the sensitivity of general circulation models to different ways of the boundary layer parameterization were also required in order to identify critical parameters in parameterization schemes and to better understand their significance in circulation models of varying complexity.

The Working Group confirmed the importance of the above mentioned studies in connexion with developments of advanced general circulation models of the atmosphere and encouraged scientific groups working in the field to undertake such studies.

5.3 In the light of the importance of the boundary layer interaction processes for GARP in general, the Working Group supported the idea of the preparation of an appropriate status report. It was suggested that the report should include a review of the boundary layer models and parameterization techniques recently developed. Emphasis should be placed on the latest findings that were not discussed in GPS No. 8.

The Working Group was informed that a group of prominent scientists working in the problem concerned might contribute to the writing of such a report. In this regard Dr. Zilitinkevich was invited to take on the responsibility of the final preparation of the report and to present it to the next meeting of the Working Group.

6. REVIEW OF THE ACTIVITY OF THE COORDINATING GROUPS

The Working Group on Numerical Experimentation reviewed the activity of the coordinating groups responsible for the relevant problem areas within the numerical experimentation programme. The following are the comments and proposals made during the discussion:

6.1 Activity within the Data Problem area has been very efficient so far and has mainly concentrated on observing systems simulation studies. The coordinating group

actively responded to the JOC requests to carry out simulation experiments aimed at appraisal of the capability of the observing systems in the tropics and the southern hemisphere. Status reports on the subject had been submitted to the JOC sessions and the Working Group on Numerical Experimentation meetings. The results of the numerical experiments were very helpful in formulating the concept of the composite observing system for the Global Experiment.

Further activity is expected in the near future in connexion with the recommendation of JOC-VIII "to carry out the additional experiments for the southern hemisphere with realistically simulated observing conditions in order to provide further information about the special efforts needed to meet the requirements" (JOC-VIII, para. 3.2.4), as well as in connexion with the recommendation of the Working Group to perform simulation experiments related to the planning of the POLEX programme (c.f. section 3.4 of this report).

The Chairman of the Working Group on Numerical Experimentation was requested to contact the appropriate research groups and inform them about the simulation experiments required.

It was also noted that some difficulty arose in connexion with the development of a four-dimensional analysis technique for the tropics, and in particular the southern hemisphere, because of lack of data. For instance, knowledge of statistical properties of meteorological fields such as variances, auto-correlation functions, etc., is required since they might be quite different in the southern hemisphere. *The Chairman of the Working Group was requested to assist in the data exchange required for those research groups that ask for it.*

6.2 Activity within the Physical Processes problem area has been limited so far. Recently some action was undertaken in connexion with the Symposium on Boundary Layer Turbulence held in Moscow. It is expected that a status report on the parameterization of the boundary layer will be prepared soon (c.f. section 5.3).

6.3 Activity on a limited scale on the Computational Considerations problem area has been undertaken on the initiative of the Chairman of the Working Group on Numerical Experimentation in connexion with a request for numerical experiments with different space resolution.

A proposal was made that some kind of prize competition be arranged amongst scientific groups to encourage them to develop efficient numerical techniques applicable to the solution of hydrodynamic equations. An accuracy and time integration efficiency of

techniques (finite difference or spectral) was suggested to be tested for a barotropic, frictionless, primitive equation model.

Three types of solutions were considered:

(i) Vortex of solid rotation around the globe with axis of rotation at 67°N, S and within a period of 10 days

(ii) Neamtam solution for wave number four. The axis of the vortex rotation is inclined at 67°N, S around the globe. The solution is quasi-exact for a non-divergent case and exact for a divergent case.

(iii) A prescribed 500 mb stream function field given in a certain number of harmonics.

For the first two cases the solution can be verified against exact or quasi-exact solutions; in the third case it can be compared against the models themselves.

The comparison should be made for 2, 10 and 30 days of integration. The efficiency of the method may be estimated in the form of the product from rms error and number of operations required to produce the calculations.

The Working Group supported the proposal and recommended that it should be further elaborated by the coordinating group. Furthermore, the JOC was requested to discuss the idea of the prize competition and, if approved, make appropriate organizational arrangements.

6.4 The Prediction and Simulation Problem area dealing mostly with application aspects of the model has not been active so far.

With regard to short-range forecasting, the members of the Working Group expressed great interest in the statistics on the prediction skill for the last 10-20 years available in weather services of different countries. *The Working Group proposed that such statistics be collected and published in an issue of the GARP Working Group on Numerical Experimentation progress report.*

6.5 Activity for the Climate Modelling problem area is discussed in section 8.3.

7. GARP PUBLICATIONS

7.1 Description of Numerical Models

JOC-VI (October 1971) proposed that the Working Group on Numerical Experimentation prepare a GARP publication on atmospheric general circulation models at present in use.

20 model descriptions had been received from research groups by September this year. They include global and hemispheric models of a different degree of complexity.

The Working Group examined the composition of the publication and gave some advice to the JPS on how its structure could conveniently be arranged. The Working Group was informed that after some editing work the publication should come out at the beginning of next year.

7.2 Four-dimensional Data Assimilation

Dr. L. Bengtsson, a JOC consultant, was invited to report to the Working Group on the work he is going to undertake in the field of four-dimensional data assimilation. The plan is that Dr. L. Bengtsson will visit a number of institutions all over the world to get information on the research that is underway and summarize it in a report which will eventually be published in the GARP Publications Series.

The Group discussed the general content of the report and agreed that it should include:

- a discussion on data problems (relative importance of different variables, accuracy, checking, etc.)
- a review on the present status of existing four-dimensional data assimilation approaches (dynamical, statistical and mixed)
- the initialization problem
- suggestions for future studies

The Working Group pointed out that the problem of four-dimensional data assimilation is the key subject of the whole of GARP and of the Global Experiment in particular, and progress in this field would undoubtedly have an impact on how successfully the global data set would be used in the numerical experimentation programme. In the light of this the Working Group strongly supported the work being undertaken by Dr. L. Bengtsson.

It was suggested that the first version of the report be submitted to the JOC for general comments and the final version be presented to the next session of the Working Group on Numerical Experimentation.

7.3 Monograph on the Application of Numerical Techniques

The Working Group noted that the monograph "Methods for the Approximate Solution of Time Dependent Problems" published in the GPS No. 10 was a valuable background in many respects. It basically provides a competent review of the fundamentals with regard to the construction of finite-difference schemes for time dependent differential equations.

Meanwhile it was considered that some continuation of the publication relevant to the application of numerical methods in existing ocean-atmosphere models should be made. A new survey should include a critical analysis of the techniques involved and this may best be carried out by a scientist or group of scientists who are working in the field.

The Working Group strongly supported the proposal and requested the Chairman of the JOC to take the necessary action.

7.4 Progress Report on Numerical Experimentation

Dr A. Robert informed the Group that the last issue of the progress report on the GARP programme on numerical experimentation had come out in April this year and the next one was planned to be published at the end of October. He also agreed in future to bring out the publication twice a year.

The members of the Working Group expressed their gratitude to Dr. Robert for his willingness to continue with the preparation and publication of the report.

7.5 Other Publications

The view was expressed on the desirability to prepare a textbook which would include a comprehensive review of the numerical methods and parameterization techniques in use. The Working Group considered such a monograph as valuable but because of the tremendous work required for its preparation it was suggested that the Director of JPS should study the question. In particular, it concerns the finding of a suitable person who would be willing to carry out such a task.

8. ORGANIZATIONAL MATTERS OF THE WORKING GROUP

8.1 The members of the Working Group were informed about the new organization of the Group in the near future, as recommended by the JOC Officers' meeting held in Vienna (September 1973). It was recalled that at present the Working Group consists of four members. In addition there are five leaders of coordinating groups responsible for five problem areas, i.e.:

(i) Data Problems

(ii) Physical Processes

(iii) Computational Considerations

(iv) Prediction and Simulation

(v) Modelling Aspects of Climate

In order to achieve a simpler organization and the same level of efficiency for an expanded degree of responsibility, the JOC Officers decided that:

- the membership should consist of a chairman and the leaders of the coordinating groups who are prominent scientists actively working in the appropriate fields
- the leaders of the coordinating groups should be appointed for a period of two years and be asked to report on their activity to the chairman at the end of that time period
- the choice and number of problem areas should be adjusted to the current needs.

The JOC Officers requested the Working Group to discuss and come up with proposals for suitable candidates as leaders of the coordinating groups. It was also noted that the final decision regarding the new membership would be made by the Chairman of the JOC in the light of advice from the Working Group on Numerical Experimentation.

8.2 The Working Group discussed and suggested alternative candidates for the specified problem areas. In the course of the discussion the view was expressed that besides the five leaders and the chairman it would be desirable to have two more members in the Working Group with a wide scope of interest, i.e. so-called generalists who would provide some sort of closer scientific interaction between the members responsible for particular problem-areas, and who would also carry the largest part of the burden in the organizational activity directed by the Working Group.

8.3 The Working Group discussed the action to be taken in the light of the JOC recommendation to expand the responsibility of the Working Group on Numerical Experimentation with regard to climate modelling. It was recalled that in view of the increased interest in the study of climate and its variations, JOC-VIII had suggested that a fifth coordinating group within the Working Group be set up with the following responsibility:

- to review the physico-mathematical methods used for climatic studies

- to consider the problem of parameterization of large-scale eddy fluxes in terms of basic dynamic quantities as needed for computing the statistical long-term response of the coupled atmosphere-ocean system

- to study the problem of computing the time dependent distribution of clouds as an additional degree of freedom in the climatic models.

The Working Group on Numerical Experimentation discussed the composition of the coordinating group and assigned an immediate task for its near future activity. With regard to the review of studies relating to numerical simulation of climate it was pointed out that particular emphasis should be placed on the problem as to what extent the presently used models could reliably simulate climate. The group should also concentrate on the question of the kind of equations and numerical methods to be used to minimize time-consuming calculations in the long-term model integration.

The Working Group suggested that a meeting of the group be arranged next spring and ideas on the above mentioned problems be summarized in the report that should eventually be presented at the forthcoming International Study Conference on the Physical Basis of Climate and Climate Modelling which is planned for June-July 1974.

The Director of JPS was requested to make the necessary arrangments relating to the organization of such a meeting of the coordinating group.

8.4 The Working Group on Numerical Experimentation expressed the view that it would be desirable if one of its present members be invited to the next JOC session (Canberra, 8-12 January 1974) to present the group's thoughts on matters related to its activity. *Prof. W. Wiin-Nielsen was requested to accept this responsibility on behalf of the Working Group.*

9. OTHER RECOMMENDATIONS

It was understood that the next meeting of the Working Group would be held with the new membership. However, it was felt that it would be desirable to arrange this meeting sometime during the summer, preferably after the JOC Study Conference on the Physical Basis of Climate and Climate Modelling, in order to be able to review the whole numerical experimentation programme, particularly in the light of the recommendation on the second GARP objective. Reference was made to the International Symposium on Spectral Methods in Numerical Weather Prediction which is planned for August 1974 by the Institute for Theoretical Meteorology of the University of Copenhagen. In this regard the Working Group meeting could be conveniently arranged at the same time, say three days prior to or after the Symposium.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

WORLD METEOROLOGICAL ORGANIZATION

JOINT GARP ORGANIZING COMMITTEE

WORKING GROUP ON NUMERICAL EXPERIMENTATION
NINTH SESSION
NOVOSIBIRSK, 1973

AGENDA

1. BASIC DATA SET PROJECT

2. RESEARCH RELATED TO GARP SUB-PROGRAMMES

   2.1 Numerical Experimentation related to POLEX

   2.2 Modelling Aspects of GATE

   2.3 Other Sub-programmes

3. ORGANIZATIONAL ARRANGEMENTS

4. GARP PUBLICATIONS

REPORT OF THE MEETING OF JOC PANEL ON GARP ATLANTIC TROPICAL EXPERIMENT

(Bracknell, 2-6 July 1973).

1. INTRODUCTION

1.1 The JOC Panel on GATE held its meeting from 2 to 6 July in the ISMG offices in Bracknell. The following participants were present at the meeting:

V.E. Suomi	Chairman
J.S. Sawyer	Member
K. Miyakoda	Member
M. Yanai	Member
V.P.Meleshko	JPS

Dr. I.Sitnikov was unable to attend.

1.2 The Chairman of the Panel outlined the terms of reference of the group in the light of the JOC recommendation (JOC-VIII Report, section 5.6.1). Afterwards, the Panel made a review of the draft documents prepared by the ISMG on:

Central Programme
Convection Sub-programme
Synoptic Sub-programme
Boundary-layer Sub-programme
Radiation Sub-programme

The oceanographic sub-programme was not available in written form and was presented orally.

The members of the ISMG also took an active part in the discussion on particular subjects and provided valuable help responding to specific questions raised by the members of the Panel during the discussion.

2. REVIEW OF THE CENTRAL PROGRAMME AND ITS SUB-PROGRAMMES

2.1 The Panel undertook a review of the documents prepared by the ISMG to describe the Central Programme and sub-programmes of GATE. One of the main purposes of this review was to assess whether these programmes would meet the objectives of GATE as formulated by the JOC. The Panel welcomed the division by the ISMG of the various elements of the programme into a Central Programme, supporting programmes and other experiments. In this connexion it was noted that the scientific objectives of GATE were formulated (JOC-V, section 4.2.1)

as a determination of the effects of smaller-scale weather systems of the Tropics on the larger-scale circulation and the testing of numerical weather simulation methods in the Tropics. It was regarded as important that the Central Programme should not be extended to embrace other objectives to an extent that may prejudice the primary tasks.

In many respects the Central Programme document is the key document of the entire set. It sets forth GATE's scientific objectives, describes in general terms the approach to be used in conducting the experiment, lists key observations and indicates what the candidate parameterization schemes must do if they are to be considered satisfactory. Because it is such an important document it is also a very sensitive one. It will be used to set priorities, determine which are the key observations, etc. Thus when the limited amount of our resources must be faced, the document will be used as a basis for some of the inevitable reductions that must be made. Thus the document must reflect a clear sense of priorities and above all, indicate which data outputs either as direct observations or quantities to be derived from these observations must be produced by the GATE experiment. It will be necessary to make some revisions to the Central Programme document in order to make it fully consistent with the available sub-programme documents which give the full details but which only became available after the Central Programme document was drafted. After this is done the scientific definition phase of the GATE programme must be regarded as essentially complete, that is, the major scientific objectives should be regarded as finalized.

The Panel indicated that the ISMG must complete the scientific planning phase as promptly as possible but in no case have it continue beyond the end of August. The time available to complete the detailed operational plan phase is very short. In this regard, the tasks of the operational planners can be aided significantly if the documents which specify the scientific requirements they are expected to meet convey a clear sense of programme priorities. The Panel is convinced that the present documents do not do this sharply enough. Our sense of these priorities is indicated sub-programme by sub-programme in the sections which follow.

2.2 The Convection Sub-programme as presented to the Panel provided a review of the scientific objectives which was fully in accord with the objectives of GATE and allocated broad priorities on an appropriate basis. The observational requirements were set out in a realistic manner, but it was recognized that some compromises would be called for in the future on account of the limitations of resources. There is a need for a more compact document since it is likely that the shorter document would provide the operational planners with clearer indications of priorities. Scientific objectives should be addressed to the understanding interaction of cumulus convection with the large-scale environment, which leads to better parameterization schemes. Major tasks of the experiment are:

1. To test the existing theories by comparing the observed and predicted mass flux and the budgets of heat and moisture. These studies will be based on B-scale measurements plus satellite information and will emphasize mass flux, detrainment and cloud liquid water content.

2. To improve the parameterization scheme further. For this we need to know roles of meso-scale organization (C-scale), moist downdrafts and momentum transports by convection.

3. To attempt quantitative budget-type studies of C-scale cloud organizations by aircraft and to determine their significance in vertical transports of heat, moisture, etc. This requires both in-cloud and around-cloud flights.

A further step which is urgently required is to prepare a plan for the coordination of the data arising from the Convection Sub-programme and for its final presentation in a form which will be of maximum utility to research groups concerned with tropical meteorology - not only those concerned primarily with convection but those with major interests in dynamical modelling. For this purpose major aspects requiring attention are (a) uniformity of format; (b) compatibility of data from different sources,and (c) elimination of extraneous material and presentation of data in limited sets for specific types of study of specific periods. The Panel was informed that appropriate steps are being taken.

2.3 The draft document on the Synoptic-Scale Sub-programme provides a valuable and far-sighted review of the development of the dynamical meteorology of A-scale features of the tropical atmosphere and of the requirements of the research scientists for data. The document brings out the widespread scientific interest in wave-motions on a very large scale and it was noted that JOC-VIII had encouraged the use of the GATE period for A-scale studies even extending outside the GATE area. The Synoptic-scale Sub-programme recognizes these interests and the Panel welcomes the steps taken to provide for such studies in the plan for data collection and processing. However, it was considered that it would be inappropriate to expect the ISMG to undertake the stimulation of additional observations outside the GATE area as envisaged in section 5.3.3 of the report of JOC-VII. A request for requisite action should be put to WMO which should also be invited to encourage its members to ensure that all data relevant to the large-scale global circulation during GATE is adequately archived.

The Panel understands that a Data Systems Test is under active discussion in the United States. If this test is implemented it will provide an exceedingly valuable data source for many aspects of GATE, but in particular the Synoptic Sub-programme. The ISMG should seek to become familiar with the DST's details since if implemented it will have a major impact on the data management for GATE.

The Panel recognized that some conflicts may arise in planning the network of A-scale observations and agreed that where compromise is necessary priority should be given to the requirements of studies of A, B-scale interaction within and immediately around the B-scale network. Otherwise there is a risk that the full value will not be obtained from the efforts devoted to B-scale observations. Observations intended primarily for long period time series analysis were regarded as having a lower priority than those needed for A-B scale interaction studies. These remarks should not be construed to indicate that there is no need for some continuous observations for the whole 100 day period. Indeed the Panel recognizes the need to maintain some surveillance of the A- and B-scale weather systems even when most ships are back in port.

Moreover, it was recognized that observations from positions on the equator have a considerable importance in defining the A-scale disturbances. This has been suggested both by theoretical consideration and the observed variability of equatorial winds. In consequence it would be unwise to risk an inadequate definition of the extension southward of the A-scale disturbances which affect the B-scale area, and the Panel recommends that every endeavour should be made to maintain not only two equatorial observations but also hopefully to increase the platforms to more than two. In view of the possible significance of these observations and the high wind variability in the upper troposphere of the area the somewhat lower accuracy of the Omega sonde may have to be tolerated provided that wind errors do not exceed 5 m/sec.

It was emphasized that the efforts be concentrated on providing internally consistent and complete data sets for numerical models representing synoptic-scale motions and certain aspects of sub-synoptic phenomena and the wishes of certain research centres to operate their numerical models for experimental purposes in near-real-time should be borne in mind and met as far as communication resources permit. The communication load for these purposes must not be allowed to conflict with the needs of the operational forecasting programme to be carried out at Dakar.

2.4 The draft of the Boundary-layer Sub-programme provides a thorough review of the scientific background and available techniques and methods. During the course of discussion on the revised plan of the Boundary-layer Sub-programme it became evident that there are three major objectives of the sub-programme. These are:

1. To provide budgets of heat, water vapour and momentum in the sub-cloud layer in the B-scale area under a variety of different convection regimes.

2. To test and improve the parameterization schemes of the transfer processes in the boundary-layer, and

3. To furnish the boundary-layer flux data at several levels for the verification of numerical experiments.

The above stated objectives are closely related to the Convection Sub-programme because of a possible strong interaction between the cloud and sub-cloud layers. There is a need to know when the observations are in clouds or just near the cloud base as pointed out in the report of JOC-VIII, section 5.5.3.

Although not essential to the GATE Central Programme there is a unique problem of the behaviour of the planetary boundary layer near the equator. The Panel noted that study of this problem should also be considered. For example, advantage might be taken of the oceanigraphic ships which will occupy and traverse the equator. If one of the ships which traverses the equator could carry a simplified tethered balloon or kite system very valuable boundary-layer profile observations could be obtained.

2.5 In reviewing the Radiation Sub-programme it was noted that radiation observations will give information about the radiative fluxes only at certain locations and for certain times over areas smaller than the B-scale array. The sub-programme recognizes the need for estimates of these quantities for a substantial area and at least for the B-scale array. The analysis methods which will provide such estimates are still to be developed but it was learned that the ISMG are giving prime consideration to a technique in which radiation measurements are first used to define the radiative transfers characteristic of various representative degrees of convective activity and cloudiness and subsequently the radiative transfers are assessed over a wide area and extended time period by determining the occurrence and extent of the various convective regimes. The Panel endorsed this approach and recommends a further development as a matter of priority. The Panel further considered that priority should be given to deciding the manner (e.g. resolution in time and space - area and format) in which these estimates should be presented to the scientific community for use in dynamical modelling and parameterization studies.

2.6 The draft of the GATE Oceanographic Sub-programme has not yet been completed, because the experts on the oceanography have only recently joined ISMG. However, the Panel discussed the proposed programme with these experts and assumed that the final draft may not be vastly different from the draft of SCOR Working Group 43.

The structure of the sub-programme differs somewhat from other sub-programmes, since there are two aspects of the sub-programme: one is directly related to the GATE meteorological experiment, and the others are designed for oceanographic study which are not immediately related to the central programme of the GATE but which are justified as important oceanographic problems.

There are three categories of experiments, i.e. C-scale, B-scale and equatorial experiment. The Panel recognized that priorities have not been given to each of these problems by the Working Group. From the standpoint of the central programme of the GATE, the detailed budget study in the area of the B-scale array should receive special attention. The study includes the accurate determination of sea temperature and the budgets of mass, salt and heat in the mixed layer for three periods during the GATE; in particular the salinity distribution in the B-scale network is a useful information in determining the amount of rainfall, though the Panel realizes that spatial aliasing is a serious problem. In addition, it is well known that the sea surface temperature has an important influence on the activity of cumulus convection and accordingly the behaviour of the ITCZ. The Panel recommends a considerable effort be made to produce sea surface temperature maps for the entire GATE area. This is a unique opportunity to compare sea surface temperature maps from different sources. The Panel also welcomes the study of other important problems within the sub-programme such as the equatorial air-sea coupling, internal waves and the mixed layer development.

3. CONCLUDING REMARKS

This report is presented as another JOC action needed to fulfil its agreed responsibility (to the TEB) for keeping under review the planning of GATE to ensure that the scientific objectives of GATE will be met (GPS No. 4, section 7.5).

Our principle finding is that the scientific definition phase is essentially complete. We are pleased to report that the scientific plan is sound and if successfully carried out will meet fully the original objectives intended for GATE. The Panel feels strongly that the next urgent task is to complete the

detailed operational plan. Not to do so could compromise the main objectives of GATE. The JOC's scientific review role must now shift from a definition phase to a monitoring one. We urge the TEB to continue its support of the ISMG with the best qualified scientific talent. In this next phase hard choices will be inevitable and in order to ensure that the scientific objectives of highest priority are preserved individuals with mature judgement ability are needed.

An active dialogue must be maintained with the potential users of GATE data in the universities and research institutions to ensure that the GATE data is ultimately presented in a manner which meets the requirements resulting from the continually evolving ideas of the scientific community.

The Panel hopes that the ISMG will also keep in mind the desirability of arranging early scientific discussion of the output from GATE including discussion of interim results and results from individual experiments. Such discussions are desirable in order to maintain the interest of the scientific community during the period until the final GATE data sets become available and to encourage the participation of new research groups in GATE studies.

The Panel wishes to commend most highly those individuals who truly represent the real creators of the plan. They have often received conflicting advice, have had to reduce dreams to reality and to do all this in a manner which allows them to face their colleagues at home. Some have gone home and others are about to. We are sure that when the history of GATE is written a large share of the credit for its success should go to them. We have carefully examined their documents, engaged in debate with them on details and so on. When we indicate that they should be warmly thanked we know of what we speak.

PERCENTAGES OF CURRENTLY SCHEDULED UPPER WIND DATA FROM THE GATE AREA FOR AUGUST 1973 IN THE UK METEOROLOGICAL OFFICE DATA BANK IN OCTOBER 1973*

		1 - 15 August 1973				16 - 31 August 1973			
		00 GMT		12 GMT		00 GMT		12 GMT	
		No of stat	%	No of stat	%	No of stat	%	No of stat	%
Region I:	100 mb	10	13	35	30	10	18	35	33
	200 mb	10	23	35	36	10	24	35	39
	700 mb	10	27	35	42	10	28	35	43
Region II:	100 mb	1	0	2	0	1	0	2	0
	200 mb	1	0	2	3	1	0	2	3
	700 mb	1	0	2	3	1	0	2	3
Region III:	100 mb	5	0	17	15	5	0	17	9
	200 mb	5	0	17	20	5	0	17	10
	700 mb	5	0	17	24	5	0	17	16
Region IV:	100 mb	14	53	20	45	14	50	20	41
	200 mb	14	61	20	52	14	59	20	45
	700 mb	14	76	20	66	14	71	20	59

* Statistics presented by the International Scientific and Management Group at the fifth session of the Tropical Experiment Board.

WWW UPPER AIR STATIONS IN THE EQUATORIAL BELT 10^{o}N - 10^{o}S THAT ARE MAKING RADIOWIND OBSERVATIONS REACHING THE 30 MB AND 10 MB LEVELS

DISCUSSION

1.1 At its eighth session in London in March 1973, the JOC discussed the observational capability and data requirements for different observing sub-systems in the tropics during the Global Experiment, and recommended that:

> " ..... wind observations in the belt 10^{o}N-10^{o}S be made up to 30 mb. Meanwhile, it was stressed that the Experiment itself presents a great opportunity to study the nature of dominant disturbances in the equatorial stratosphere associated with Kelvin waves. In this regard it is desirable that some specific stations carry out wind observations up to 10 mb. WMO and JPS were requested to provide JOC with information on the existing capability of upper-air stations for wind soundings up to that height."
>
> (JOC Report, section 4.2.4.2)

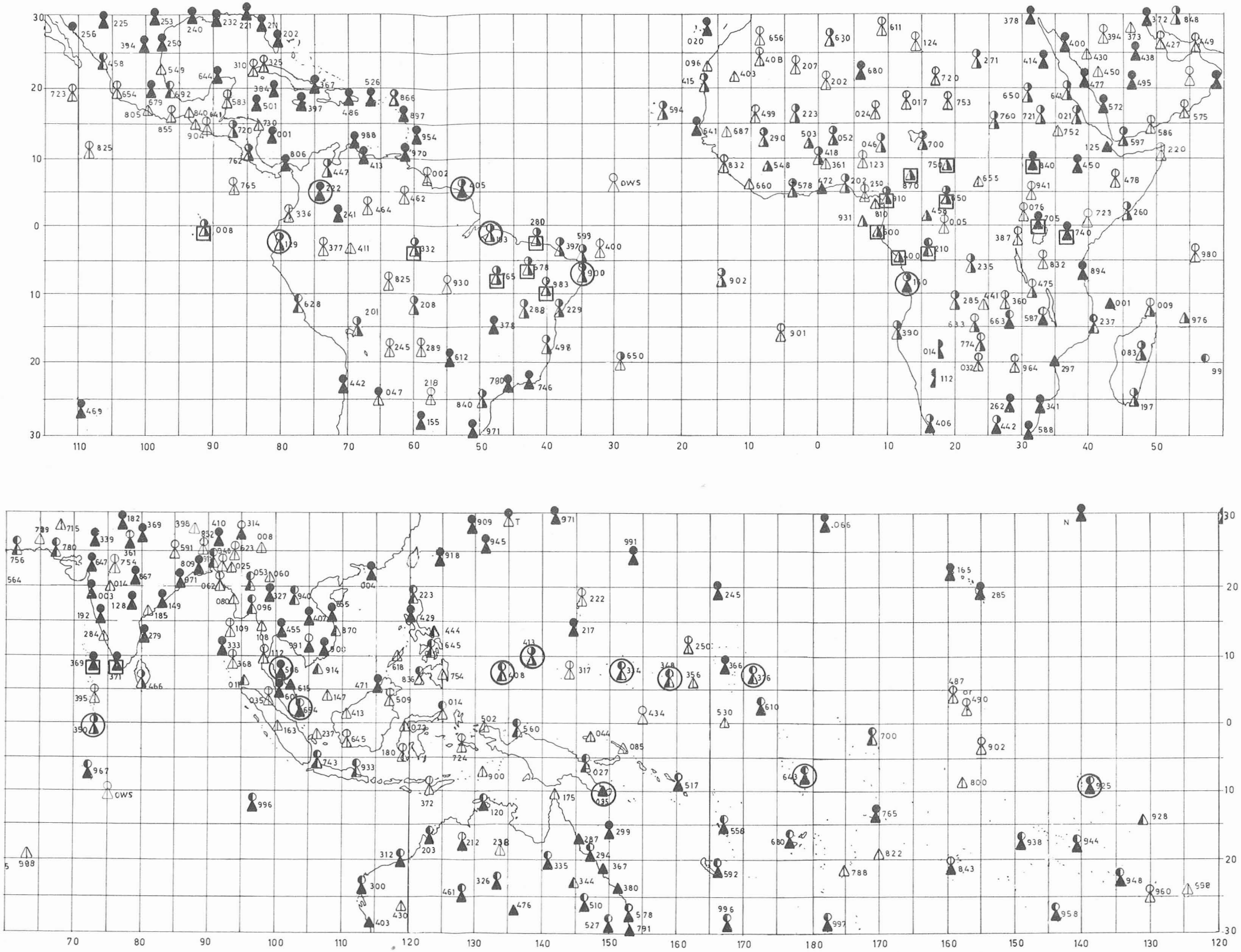
1.2 The available information on the existing WWW upper-air network performance in the tropical belt 10^{o}N-10^{o}S was analysed in the WMO Secretariat and some statistics were prepared.

It turned out that about 37 upper-air stations can potentially provide radiowind soundings up to 30 mb, i.e. Africa - 11 stations, Asia - 5, South America - 11, Southwest Pacific - 10. The distribution of the stations concerned is shown in Fig. 1. With regard to wind observations up to 10 mb, the appropriate number of stations is 22 and they are located as follows: 4 in Africa, 2 in Asia, 7 in South America and 9 in the Southwest Pacific.

A list of stations and the statistics in percentage of the radiowind observations which reached or exceeded the 30 and 10 mb levels during a summer and a winter month in 1971 is given in Appendix A.

1.3 The JOC may wish to discuss the observational performance of the WWW upper-air stations in the tropical belt and make the necessary comments on the matter.

FIGURE 1 · THE WWW UPPER-AIR STATIONS THAT COULD PROVIDE RADIOWIND SOUNDINGS UP TO 30 MB and 10 MB LEVELS



Symbols: □ radiowind soundings reaching 30 mb level ○ radiowind soundings reaching 10 mb level

WWW/GOS UPPER-AIR STATIONS IN THE TROPICAL BELT (10°N, 10°S LATITUDE) THAT ARE MAKING RADIOWIND OBSERVATIONS REACHING THE 30 MB and 10 MB LEVELS

Stations			Indicated highest level intended to be reached regularly by the present observations	Statistical information Percentage of radiowind observations which reached or exceeded the 30 and the 10 mb levels during a summer and a winter month in 1971			
				February		August	
Block/ index number	Name	Location Latitude, Longitude		30 mb	10 mb	30 mb	10 mb
	Region I (Africa)						
62840	Malakal	09°33'N, 31°39'E	20 mb	7	0	13	0
63705	Entebbe	00°03'N, 32°27'E	(highest poss.)	5	0	7	0
63741	Nairobi	01°18'S, 36°45'E	(highest poss.)	13	0	10	0
64210	Kinshasa	04°23'S, 15°26'E	10 mb	15	8	31	0
64400	Pointe-Noire	04°49'S, 11°54'E	150 mb	4	0	42	3
64500	Libreville	00°27'N, 09°25'E	150 mb	10	0	81	0
64650	Bangui	04°24'N, 18°31'E	150 mb	13	0	16	0
64750	Sarh	09°09'N, 18°23'E	150 mb	36	7	0	0
64870	Ngaoundere	07°21'N, 13°34'E	150 mb	46	0	42	3
64910	Douala	04°00'N, 09°42'E	150 mb	11	0	26	0
66160	Luanda	08°51'S, 13°14'E	10 mb	88	18	77	21
	Region II (Asia)						
41350	Gan	00°41'S, 73°09'E	10 mb	54	32	58	32
41369	Minicoy	08°18'N, 73°00'E	25 mb	4	0	10	0
41371	Trivandrum	08°29'N, 76°57'E	25 mb	7	0	10	0
48568	Songkhla	07°12'N, 100°36'E	100 mb	25	7	68	29

Stations			Indicated highest level intended to be reached regularly by the present observations	Statistical information Percentage of radiowind observations which reached or exceeded the 30 and the 10 mb levels during a summer and a winter month in 1971			
				February		August	
Block/ index number	Name	Location Latitude, Longitude		30 mb	10 mb	30 mb	10 mb
	Region III (South America)						
80222	Bogota	04°42'N, 74°08'W	20 mb	11	4	26	19
81405	Cayenne	04°50'N, 52°22'W	No indication	90	36	30	3
82193	Belem	01°23'S, 48°29'W	10 mb	26	16	91	14
82280	Sao Luiz	01°32'S, 44°17'W	20 mb	37	7	20	0
82332	Manaus	03°09'S, 59°59'W	10 mb	58	34	86	14
82678	Floriano	06°46'S, 43°01'W	20 mb	37	0	80	0
82765	Carolina	07°20'S, 47°28'W	20 mb	18	0	44	0
82900	Recife	08°08'S, 34°55'W	20 mb	40	8	58	5
82983	Petrolina	09°23'S, 40°30'W	20 mb	7	0	50	0
84008	San Cristobal	00°54'S, 89°37'W	3 mb	50	4	73	0
84129	Guayaquil	02°12'S, 79°53'W	10 mb	64	32	57	4
	Region V (South-west Pacific)						
48694	Singapore	01°22'N, 103°55'W	10 mb	56	3	96	15
91334	Truk	07°28'N, 151°51'E	20 mb	93	64	97	36
91348	Ponape	06°58'N, 158°13'E	10 mb	86	75	90	48
91376	Majuro	07°05'N, 171°23'E	20 mb	57	57	94	42
91408	Koror	07°20'N, 134°29'E	20 mb	89	57	77	55
91413	Yap	09°29'N, 138°05'E	20 mb	85	59	90	70
91643	Funafuti	08°31'S, 179°13'E	10 mb (Radiosonde)	93	36	100	29
91925	Autona	09°48'S, 139°02'W	10 mb	78	4	26	6
94035	Port Moresby	09°26'S, 147°13'E	100 mb	71	61	91	71

STATEMENT OF ACTIVITIES TO DATE BY THE GARP/JPS CONSULTANT ON THE DEVELOPMENT OF AN OCEANOGRAPHIC PROGRAMME, WITHIN THE FIRST GARP GLOBAL EXPERIMENT, RELEVANT TO THE GARP OBJECTIVES

H. Stommel

I have been attempting to stimulate interest and activity among the U.S. physical oceanographers toward developing plans for FGGE and the wider objectives of GARP, and accordingly organized two workshops on "The Role of the Ocean in Predicting Climate" under the auspices of the Ocean Science Committee with essential ingredients supplied by IDOE and ONR. The first, "Dynamical Experiments in the Deep Ocean" took place in Brookline, Mass., September 4-7, 1973; the second, "Phenomenology and Statistics of Monitored Variables", in Victoria, B.C., October 17-20, 1973.

In reviewing the large-scale experiments that are being projected for the next five years within the physical oceanographic community, the following emerge as particularly pertinent toward the second GARP objective:

CUEA (Coastal Upwelling Ecosystems Analysis)

MODE (Mid-Ocean Dynamics Experiment)

JASIN (Joint Air Sea Interaction Experiment)

NORPAX (North Pacific Experiment)

GATE (Oceanography)

ISOS (International Southern Ocean Studies)

INDEX (Indian Ocean Experiment)

In his report on the first of these workshops to the US GARP Committee, Professor Francis Bretherton has summarised the nature of each of these large projects as follows:

"CUE-I (1971) and CUE-II (1973) have been concerned with the structure and dynamics of the summer upwelling region off the Oregon coast and substantial progress has been made at least in describing the phenomenon. The next field programme (in collaboration with the biologists) will be off the W. African coast. MODE is studying the mesoscale eddies in an area southwest of Bermuda, with a major experiment completed in March-July this year. The results include the first synoptic maps of motions on this scale in the deep ocean. Further plans are currently being evolved. Of more direct interest to the first GARP objective are JASIN, GATE and NORPAX all of which are concerned with the structure and dynamics of the well mixed layer and the seasonal thermocline. The first JASIN experiment organised by the United Kingdom with U.S. participation in September 1972 was primarily directed towards instrument evaluation, though preliminary results provide valuable reminders of the complexity of this situation (e.g., how the "well mixed layer" is rarely well mixed or horizontally homogeneous). Its lineal successors are the B & C

scale programme in GATE, and the POLE experiment of NORPAX (due January 1974). The primary goal of the latter is to establish the relevant horizontal and time scales, so that future experiments may be designed to provide adequate sampling to test existing models and theories of these upper layers of the ocean. In the meantime it is perhaps worth remembering that even an apparently straightforward measurement like sea surface temperature may be fraught with ambiguities of definition and representativeness when the precision required is closer than about 1°C, particularly in calm weather during summer when the well mixed layer is shallow or non-existent.

"The medium term objective of NORPAX is (besides continuing statistical evaluation of correlations in the surface layers of the ocean and the atmosphere) to obtain a synoptic description and understanding of the variability on a seasonal timescale of the surface and sub-surface temperatures including heat flux through the surface in the North Central Pacific. A major attack on this will coincide with FGGE. Details depend on progress in the earlier developmental experiments.

"ISOS and INDEX are both in the early planning stages, though together with NORPAX, INDEX may well become the principal focus of U.S. oceanographic activity during FGGE. ISOS embraces a number of loosely coupled projects in the Southern Ocean, including the drifters being developed by NCAR for observations of surface pressure and water temperature at various depths in the Antarctic circumpolar current. INDEX is being designed to take advantage of the (hopefully) improved knowledge of the surface wind field during FGGE. It will probably concentrate on the time dependence of the equatorial undercurrent, though possibly on the Somali current as well. There are no current plans by oceanographers to make widespread measurements of surface fluxes in the interior of the Indian Ocean [except a possible CUEA Arabian Sea upwelling study]. This emphasis is deliberate, based upon judgements of relative accessibility to observation and elucidation."

An effort was made to discuss with the physical oceanographers involved in these programmes the advantages of FGGE as a time for increased activity; as a kind of specially favourable time to conduct oceanographic investigations because of the increase of meteorological coverage.

The most obvious oceanographic beneficiaries of FGGE are the projects in the Southern Ocean and the Monsoon Areas of the Arabian Sea where FGGE actually offers a substantial increase in meteorological information. Thus FGGE is very important to the planners of ISOS, INDEX, and those within CUEA who want to study the upwelling phenomenon in the Arabian Sea. GATE of course will be finished before FGGE, but some of the oceanographers interested in the equator there may transfer interest to the Indian Ocean. From the point of view of MODE and POLYMODE (a projected USA/USSR Atlantic buoy experiment on mesoscale eddies in 1976) FGGE is not helpful, indeed competes for shiptime, and is a

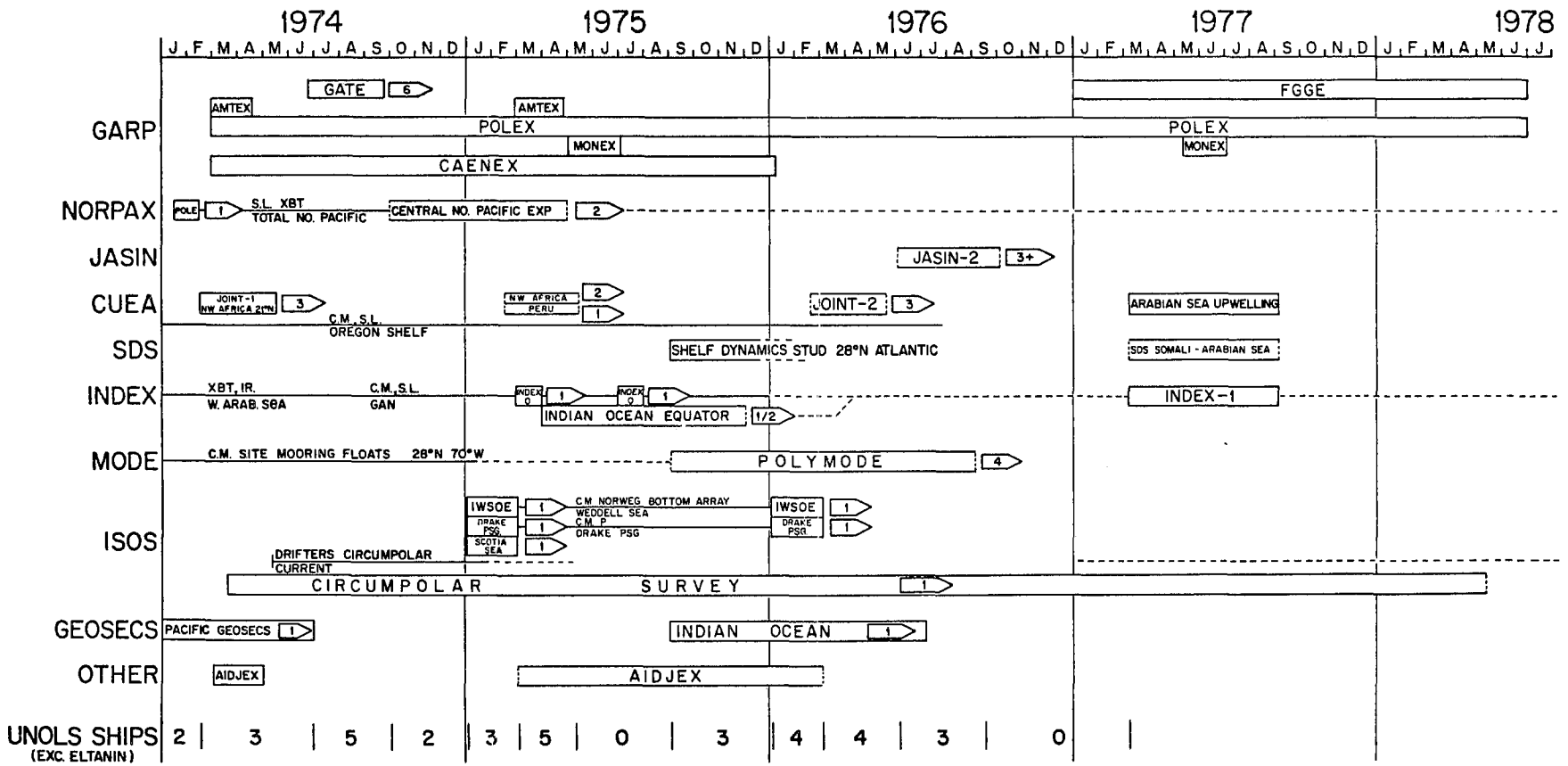
period to be avoided. NORPAX, being a North Pacific experiment where FGGE does not increase the density of observation much, will find FGGE indirectly beneficial through the development of atmospheric modelling. NORPAX scientists are somewhat ambivalent about their role and responsibility for monitoring the ocean; they are holding back from full-scale commitment to a monitoring programme because they believe more has to be known about the physics of the upper layers of the ocean before they can specify what variables should be monitored, and because they believe that even when the variables are known, certain other problems of the technology of monitoring and the statistics of measurement must be settled before large-scale monitoring can begin. It is possible that experiments with modelling conducted by meteorologists during FGGE will also shed light on the validity of trying to do the climate-problem within the context of the North Pacific Ocean all by itself. Nevertheless there is a dissenting group within NORPAX that is pressing for increased monitoring, and they are being permitted to extend monitoring efforts in certain limited ways: e.g., tide gauges and XBT traverses by commercial ships of opportunity.

It appears that there may be some spin-off from some of these projects that could be useful to meteorologists planning FGGE. Firstly, both NORPAX and INDEX involved evaluation and intercomparisons of satellite measurements of sea-surface temperature and direct surface measurements. NORPAX is also providing an opportunity to test the possible usefulness of Over-the horizon radar as a remote wind, wave, and current sensing and monitoring device.

As members of JOC know, there are two current mechanisms being advanced as the manner in which the ocean is coupled by feedback with the atmosphere in the climate problem: (i) Namias' mid-latitude surface mixed-layer thermal anomaly, and (ii) Bjerknes' equatorial upwelling, Walker cell process. NORPAX is presently concentrating upon the mid-latitude phenomena. INDEX has the opportunity of studying highly variable equatorial phenomena. It might be worth considering whether the Walker process can work in the Indian Ocean too, but this is a meteorological question outside my realm of competence.

A calendar of large-scale ocean experiments produced at the September meeting is attached as Appendix A.

During the October workshop, Dr. Robert Dickson advanced the idea of "phantom weather ships": namely that there are certain positions in the ocean which are frequently visited by ships. In some cases there are positions which are visited weekly by the ships of a single shipping company. In these cases it would be fairly simple to obtain weekly XBT soundings near fixed places in the ocean, at fairly small expense, and with little inconvenience to the crew (a ship might drop XBT's only once or twice a cruise, while underway). An oil company could undertake to maintain a couple of ocean stations on a weekly basis - and this would be quite sufficient to monitor changes of mixed layer depth from year to year, etc.


1974
1975
1976
1977
1978
J F M A M J J A S O N D
GARP
GATE
6
AMTEX
POLEX
MONEX
CAENEX
FGGE
NORPAX
POLE
1
S.L. XBT
TOTAL NO. PACIFIC
CENTRAL NO. PACIFIC EXP
2
JASIN
JASIN-2
3+
CUEA
JOINT-1
NW AFRICA 21°N
3
C.M., S.L.
OREGON SHELF
NW AFRICA
PERU
JOINT-2
ARABIAN SEA UPWELLING
SDS
SHELF DYNAMICS STUD 28°N ATLANTIC
SDS SOMALI - ARABIAN SEA
INDEX
XBT, IR.
W. ARAB. SEA
C.M., S.L.
GAN
INDEX
INDIAN OCEAN EQUATOR
1/2
INDEX-1
MODE
C.M. SITE MOORING FLOATS 28°N 70°W
POLYMODE
4
ISOS
IWSOE
DRAKE PSG
SCOTIA SEA
C.M. NORWEG. BOTTOM ARRAY
WEDDELL SEA
C.M. P
DRAKE PSG
DRIFTERS CIRCUMPOLAR CURRENT
CIRCUMPOLAR SURVEY
GEOSECS
PACIFIC GEOSECS
INDIAN OCEAN
OTHER
AIDJEX
UNOLS SHIPS (EXC. ELTANIN)
2 3 5 2 3 5 0 3 4 4 3 0

INSTITUTIONAL ARRANGEMENTS FOR THE GLOBAL EXPERIMENT

1. INTRODUCTION

The Planning Conference on the FGGE (Geneva, September 1972) recommended that the Secretary-General of WMO, in conjunction with the Secretary-General of ICSU, be requested to appoint a small panel of individuals to study the institutional arrangements needed for the conduct of the FGGE. This recommendation was accepted by both organizations and the study panel was established soon afterwards.

The study panel conducted its work by correspondence and submitted a report for consideration by WMO and ICSU.

2. RECOMMENDATIONS OF THE 2ND MEETING OF THE GENERAL COMMITTEE OF ICSU (19-21 September 1973)

The ICSU General Committee concurred with the recommendations made by the study panel that

- a central policy coordinating body for FGGE be established which should be an Intergovernmental Panel of the WMO Executive Committee
- the JOC would be the principal scientific advisory body for the detailed planning and implementation of the FGGE
- an FGGE project office be established as part of the WMO Secretariat and that it should be headed by a Director of FGGE (D/FGGE)

Furthermore, the General Committee approved the suggestion that the D/FGGE would be responsible to the Secretary-General of WMO and the D/JPS to the JOC and concurred with the resolution of the Executive Board of ICSU that the scientific integrity of this complex international experiment will be most effectively maintained by combining the post of D/FGGE with that of D/JPS.

3. DECISIONS MADE BY THE XXVTH SESSION OF THE WMO EXECUTIVE COMMITTEE (20-28 SEPTEMBER 1973)

The WMO Executive Committee decided:

- to establish an Intergovernmental Panel to act as the focal point for all activities related to the planning and the implementation of the Global Experiment
- an FGGE Project Office be established in the WMO Secretariat and that this office should be headed by a Director of FGGE (D/FGGE).

- the post of D/FGGE should be combined with that of D/JPS, recognizing that the person concerned would have dual responsibility. As D/FGGE he would be responsible as a normal WMO staff member to the Secretary-General; as D/JPS he would be responsible to the JOC.

- the Director of FGGE will act as the international project leader of the FGGE and will be responsible to the Secretary-General of WMO in the discharge of his duties.

The full text of the discussion and decisions on this matter, as presented in the report of the WMO Executive Committee, is reproduced in Appendix A.

Following the recommendations by the WMO Executive Committee, action has been taken by the Secretary-General of WMO so that the Panel can be constituted and commence its work at an early date. It is expected that the first meeting of the Panel can already be held in the beginning of 1974.

Regarding the establishment of the FGGE project office,this matter is still under consideration by the Secretary-General.

4. ACTION PROPOSED

The JOC is invited to review the institutional arrangements made for the planning and implementation of the Global Experiment and make suggestions related to the work to be performed by the Panel and the Project Office for the Global Experiment.

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

Extracts from the report of the twenty-fifth session of the Executive Committee

Institutional arrangements for the FGGE

4.2.18 The Executive Committee considered the report of the Study Panel on Institutional Arrangements for the First GARP Global Experiment (FGGE) and adopted Resolution 6 establishing an FGGE Inter-governmental Panel. In this connexion the Committee agreed that the Secretary-General, when inviting the governments concerned to nominate their representatives, should stress that these representatives should be able to speak authoritatively for their governments in support of the FGGE.

4.2.19 The Executive Committe agreed that, in view of the inter-governmental character of the panel, the participation will have to be at the expense of each government.

4.2.20 The Executive Committee also decided that an FGGE Project Office be established in the WMO Secretariat and that this office should be headed by a Director of FGGE (D/FGGE). Other staff would be available in accordance with the approved budgetary provision. The Executive Committee further decided, with the agreeement of the Executive Committee of ICSU, that the post of D/FGGE should be combined with that of D/JPS, recognizing that the person concerned would have dual responsibility. As D/FGGE, he would be responsible as a normal WMO staff member to the Secretary-General; as D/JPS he would be responsible to the JOC.

4.2.21 The Executive Committee did not consider it necessary to specify the responsibilities of D/JPS vis-à-vis JOC with regard to the planning and implementation of the FGGE since these responsibilities are laid down in the necessary detail in Annex III to the report of the twentieth session of the Executive Committee, which have been approved by both WMO and ICSU.

4.2.22 The Executive Committee decided that the Director of FGGE will act as the international project leader of the FGGE and will be responsible to the Secretary-General of WMO in the discharge of his duties. These duties will inter-alia include the following:

(1) Perform the necessary work relating to the planning and implementation of the Global Experiment in accordance with the directives of the FGGE Inter-governmental Panel, including the preparation of and participation in the:

- operational and logistic planning
- observational programmes
- data transmission and processing programmes.

(2) Maintain liaison at the working level with experts designated for this purpose by participating countries and by interested organizations (national and international).

(3) Provide support to the FGGE Inter-governmental Panel.

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

Resolution 6 (EC-XXV)

FIRST GARP GLOBAL EXPERIMENT (FGGE) INTER-GOVERNMENTAL PANEL

The EXECUTIVE COMMITTEE,

NOTING the report of the Study Panel on Institutional Arrangements for the FGGE,

EXPRESSES its appreciation for the excellent work carried out by the study panel;

CONSIDERING the need for a central body to deal with the overall policy and co-ordinating aspects of the FGGE,

DECIDES:

(1) To establish an FGGE Inter-governmental Panel to act as the focal point for all activities relating to the detailed planning and implementation of the Global Experiment, including the following functions:

(a) to review the progress made in planning and implementing the Global Experiment;

(b) to consider all questions associated with the Global Experiment;

(c) to ensure that individual contributions to the Global Experiment are combined into a co-ordinated programme;

(2) That in performing its tasks the Panel should take fully into account the scientific objectives of the FGGE as established by the JOC which will act as the principal scientific advisory body to the Panel;

(3) That the composition of the Panel shall be as shown in the annex;

(4) To request the Panel, at its first session, to make proposals for an inter-governmental planning meeting, to which all Members of WMO will be invited, in order that Governments making a contribution to the Experiment will be able to participate in its planning;

(5) That the Panel should report on its activities to each session of the Executive Committee;

AUTHORIZES the Panel to organize Informal Planning Meetings, as necessary, making maximum use of existing bodies of WMO and ICSU;

REQUESTS the Secretary-General

(1) To invite Governments and the bodies concerned to nominate their representatives to serve on the Panel;

(2) To arrange for a session of the Panel in 1974;

(3) To assist and support the activities of the Panel in all appropriate ways within the approved budgetary provisions.

Annex: 1

Annex to Resolution 6 (EC-XXV)

COMPOSITION OF THE FGGGE INTER-GOVERNMENTAL PANEL

Members:

The Governments of each of the following countries should be invited to designate a representative to serve on the Panel:

Australia
Brazil
Canada
France
Germany, Federal Republic of
Japan
Nigeria
United Kingdom
Union of Soviet Socialist Republics
United States of America

Invited participants:

A representative of ICSU
A representative of JOC
A representative of ESRO
A representative of IOC
The President of CBS
The President of CAS

THE JOINT AIR-SEA INTERACTION TRIAL - JASIN 1972

R. T. POLLARD

Scientific Co-ordinator for the Project

PURPOSE OF JASIN

The idea of an air-sea interaction experiment was originally conceived in the 1960s and suggested by the Royal Meteorological Society to the Royal Society as an appropriate United Kingdom contribution to the Global Atmospheric Research Programme. The main purpose of such an experiment would be to make detailed measurements of the temperature, density and velocity structure of the atmospheric and oceanic boundary layers on scales up to about a hundred kilometers and one month. The measurements would be used to examine the small-scale physics of mixing and exchange processes in the boundary layers, to determine the fluxes of heat and momentum through the boundary layers and across the air-sea interface, and to examine the role of the boundary layers in buffering heat and momentum transfers between the free atmosphere and the deep ocean. Ultimately, one would hope to learn how to parameterize such small-scale processes into large-grid numerical models of the atmospheric and oceanic circulations.

The first JASIN experiment took place in 1970, and is described in the June 1970 Trial Report of the Air-Sea Interaction Project, published by the Royal Society. In 1971 it was decided that at least one more field trial was desirable before mounting a full-scale experiment, as many of the components of such an experiment were relatively new and untested. Accordingly, the JASIN 1972 Trial was organized, to be followed by the GATE C-scale experiment in 1974, and a full-scale JASIN experiment in 1976.

The main technical aims of JASIN 1972 were as follows:

(T1) To gain experience with vector-averaging current meters (VACMs);

(T2) To gain experience with a new high resolution conductivity - temperature - depth profiler (CTD) (0.001 mmho, 0.001°C, 0.25 decibar);

(T3) To test spars as platforms for near-surface current measurements;

(T4) To test techniques for measuring surface pressure to 0.1 mb accuracy;

(T5) To gain experience of the LO-CATE radiosonde technique for measuring winds;

(T6) To test temperature sampling schemes for heat budget studies.

The scientific aims of the Trial depended to a large extent on how well the technical aims could be achieved. In order of decreasing optimism, we hoped

(S1) to determine the Richardson number in the seasonal thermocline and at the bottom of the mixed layer, for comparison with theoretical models of mixed layer deepening;

(S2) to examine the variability of wind, temperature and humidity in the atmospheric boundary layer on the time and space scales of the Trial;

(S3) to examine how mixing develops in the oceanic surface layer at the onset of wind after a period of calm;

(S4) to break down changes in the heat content of the mixed layer into those caused by advection, vertical mixing, and heat input at the surface;

(S5) to measure the difference between the observed wind and the calculated frictionless wind to within 1 m/sec.

SUMMARY OF THE 1972 TRIAL

The JASIN 1972 Trial took place during September 1972 in the vicinity of Ocean Weather Station Juliet (52° 30'N, 20°W). Three ships, R.R.S. Discovery, R.V. Researcher, and O.W.S. Weather Adviser, participated, and seven moorings were laid round a hundred kilometre sided triangle. Ship time was divided between intensive radiosonde work and intensive CTD/STD dips. Sea surface temperature maps were obtained by the aircraft on twelve days.

The VACMs (T1) worked well, with the exception of two instruments mounted in a surface spar buoy. Frequencies up to at least 2 cycles/hour are above the noise level, and the records contain considerable energy at internal waves frequencies between 0.5 and 2 cycles/hour.

Over 160 hours of CTD data (T2) were collected, at 30 samples/second. Frequent sampling (e.g. twelve profiles per hour) was found to be necessary (T6) to resolve internal wave periodicities. One clear event was recorded, when the wind strengthened to 15 m/sec for over a day after a week of rather calm weather. The surface layer of the ocean mixed and deepened from 25 m to about 35 m (S3). A current shear developed across the base of the mixed layer (S1), and wavelike structures at the mixed layer base became highly variable on a timescale of a few minutes (S3).

All the CTD and current data are being processed by the Department of Oceanography at Southampton University. Other data are being added to the computer data bank maintained by the Department as they become available. Present effort is being concentrated on verification and correction of the CTD data (T2), current meter intercomparisons (T1 and T3), and on scientific aims S1 and S3.

Airborne radiation thermometer (ART) measurements showed strong sea surface temperature variability in the JASIN Trial area, with horizontal gradients of up to 1°C/10 km. Such gradients were linked with strong (25 cm/sec) northgoing currents. CTD sections showed horizontal density gradients down to 1000 m which would account for geostrophic currents of 30-40 cm/sec at the surface. Dr. Saunders (Woods Hole Oceanographic Institution) is working on the ART data, and their relation to surface currents and surface heat fluxes (T6 and S4).

Surface meteorological data relevant to aims S2 and S4 are being evaluated by Dr. Payne (Woods Hole Oceanographic Institution) and Professor Burt (Oregon State University).

Several one to three day series of one or two-hourly radiosonde ascents simultaneously from two or three ships were carried out (T5) although wind fields were generally rather light. These data are being processed at IOS (Wormley) (Dr. P.K. Taylor) and aspects of T5, S2 and S5 are being worked on by Dr. Taylor and Mr. T. Guymer (Meteorology Department, Imperial College).

Surface pressure (T4) was measured on buoys (Professor E.B. Kraus, Miami University) and ships (Dr. N. Thompson, U.K. Meteorological Office, Porton Down). Technical problems and mishaps ruined much of the buoy data, though the records are smooth to better than 0.1 mb and the telemetry system worked acceptably. Dr. Thompson is analysing all pressure data in detail, but a preliminary assessment suggests that about 0.2 mb is the smallest error that can be hoped for in the pressure differences between ships. In addition, the Bernoulli effect can cause differences of up to 1 mb between static heads mounted on the bridge and on the mast, due to channelling of the airflow over the bridge.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

WORLD METEOROLOGICAL ORGANIZATION

GLOBAL ATMOSPHERIC RESEARCH PROGRAMME

INTERNATIONAL STUDY CONFERENCE ON THE PHYSICAL BASIS OF CLIMATE AND CLIMATE MODELLING

(Stockholm, 29 July - 10 August 1974)

1. General Background

At an early stage in the planning of the Global Atmospheric Research Programme (GARP) it was agreed that there were two main objectives, the first relating to increasing the accuracy of forecasting over periods from one day to several weeks and the second relating to obtaining a better understanding of the physical basis of climate.

The last few years have meant an increasing awareness of the importance of understanding better the processes that determine the climate of the earth. The Study Conference on the subject, proposed by the Joint Organizing Committee (JOC) on GARP, is one step towards increased efforts in this direction and an international co-ordination of these efforts.

2. Objectives of the Conference

The problems of climate and climate variations embrace processes with characteristic time scales from a season to hundreds of a million years. The present conference will be limited to those processes that may may play a role in inter-annual fluctuations of the general circulation of the atmosphere and the variations of the climate over periods up to about 100,00 years, thus including problems of glaciation but not, for example, influences possibly caused by geological changes.

With this in mind it has been decided that the main objectives to be achieved by the Conference should be:

(i) To outline a feasible and rational approach to climate modelling;

(ii) To propose further studies of the sensitivity of the climate to different kinds of external stimuli (man-made or natural);

(iii) To establish the observational requirements in the light of the modelling programme to be developed;

(iv) To establish a plan for the implementation of the second GARP objective.

3. Guiding Principles

In preparing for the Conference the JOC has tried to establish some guiding principles, formulated in the light of the experience gained so far in the work of GARP. It should first of all be noted that:

- The second GARP objective is closely related to the first GARP objective. A successful attack on both the prediction problem and the climate problem requires a thorough understanding of the various physical processes that have a significant influence on the structure and motion of the atmosphere.

- The difference between the two objectives lies primarily in the way the characteristic time scales of the different processes should be accounted for (explicitly or parameterized).

Climatic models will necessarily have some different characteristics as compared with models for short-term changes. The following particular aspects of the problem are important in the work to be conducted during the conference:

- The first step towards accomplishing the second GARP objective will be attempts to understand the mechanisms that are responsible for the change in climate by a given external or internal stimuli (man-made or natural) to the atmosphere-ocean-earth system. Such work will serve as a basis for the later development of models for determining the sensitivity of such stimuli and the eventual prediction of climatic changes.

- Already with the aid of existing general circulation models it is possible to undertake numerical experiments which can provide valuable information in designing the long-term monitoring programmes which are needed for the understanding of climatic change and for providing a standard of comparison against which less detailed climate models of the atmosphere may be tested. There is an urgent need for additional information regarding the kind of quantities (accuracy, resolution and frequency) which should be monitored.

- It may be possible to investigate (both observationally and theoretically) certain processes that influence longer-term variations using data collected during merely one or a few years. Once these processes are understood and parameterized, their influence can be studied by numerical models. A sub-set of these processes can be tested by available information of past climate change.

In the planning of the GARP observational experiments, particularly the Global Experiment, special emphasis should be devoted to defining supplementary sets of observations that would be useful for the accomplishment of the second GARP objective. In particular, it should be mentioned that many opportunities exist to expand the ocean observation programme and observation of the extent of ice and snow cover during the Global Experiment.

4. Basic Topics of the Conference

Considering that the study of the climate as indicated within the context of the second GARP objective refers to those aspects which lend themselves to quantitative computation and mathematical (numerical) modelling, the JOC recommended that the main aim of the conference should be to develop an approach toward comprehensive models capable of representing the coupled interactions between the atmosphere and the oceans and the land surface. For this purpose the following topics would be explored and discussed.

(I) Numerical models for computing the long-term dynamical response of the coupled system of the atmosphere, the ocean and the land surfaces including ice and snow (the cryosphere) using appropriate closure hypotheses or paramterization of the large-scale eddy fluxes.

(2) Computation of the time-dependent large-scale distribution of clouds in terms of the basic dynamical quantities for the purpose of cloud prediction as an important climatic variable and for treating radiative processes in the atmosphere properly.

(3) Oceanic transient processes which control the transport of heat by the oceans and the momentum, latent and sensible heat fluxes at the air-sea boundary, with the aim of expressing these (average) fluxes in terms of the basic dynamical quantities of the atmosphere-ocean general circulation.

(4) Dynamics and thermodynamics of sea and land ice, with emphasis on the computation of the time-dependent ice-cover of the planet from the basic dynamical quantities.

(5) Physical and chemical processes which control the production and destruction of ozone and other chemically active minor constituents, for the purpose of computing the time-dependent distribution of these constituents and their effect on radiative transfer.

(6) Physical, chemical and biochemical processes which control the balance of CO_2 in the atmosphere.

(7) Aerodynamical, physical and chemical processes which control the time-dependent aerosol system, with regard to those constituents which affect the radiative transfer.

(8) Processes which affect the properties of land surface and the vegetal cover, with respect to albedo, temporary storage of water and evaporation and the production of aerosol.

(9) Paleoclimatological observations and their significance particularly with regard to ascertaining if climatic changes in the past have been truly global or only regional.

(10) Space or ground based observation techniques for measuring the quantities relevant to the determination of the physical processes which significantly affect the long-term climatic fluctuations (with special attention to the processes listed above). Attention should also be given to those kinds of observations that might be of particular relevance in later attempts to assess whether or not the global climate is changing.

The ten topics listed above are basically of three different kinds:

(i) The basic problems of designing overall models to deal with the climate problem and predictability (1);

(ii) Studies for the most important physical, chemical and biological processes for their proper inclusion in the overall model (2-8);

(iii) Definition of the observational requirements to verify the capability of the models to describe the overall behaviour of the atmosphere but also account properly for the detailed processes that have been included (9-10).

Even though a large number of questions need to be discussed regarding the parameterization of the processes listed under (2) - (8), the most difficult problem relates to the question of defining basic characteristics of the overall models to be tried (1).

It is evident that detailed mathematical simulation of the atmosphere's three-dimensional behaviour cannot be the sole avenue to the study of long period variations of climate (e.g., period of the order of a decade or longer), and that the structure of the current general circulation models is unsuitable for that purpose on three accounts:

- The general circulation models have been deliberately designed to treat the dynamics of the atmosphere with great fidelity, whereas its interactions with the sun and underlying land or ocean surfaces have been treated relatively crudely. This strategy is appropriate, of course, if the main concern is to predict the behaviour of the atmosphere over short periods of time.

- There is an enormous disparity between the time scale of atmospheric variations and that of changes in the characteristics of the underlying land or sea surfaces. The role of the oceans becomes a much more prominent one when concerned with climatic models and requires particular attention.

- If climate simulation is to be extended to periods of several years or more over which the interactions between the atmosphere and the ocean circulation and cryosphere become significant the computing requirements for detailed simulation with current general circulation models are prohibitive in the foreseeable future. Even one of the next generation of computers would take about a year to calculate a century of climate, for a single combination of initial conditions or externally prescribed parameters. Moreover, to be of real value for climate studies, it is necessary to calculate statistics from an ensemble of numerical integration.

For these reasons, and since "climate" is a reflection of general or average conditions, it is probable that the most promising approach to a theory of climate change lies in the methods of statistical hydrodynamics. Two routes appear to be open.

One approach is to "parameterize" the statistical effects of large-scale processes averaged with respect to time, longitude, latitude or height, or combinations of such averages. In this case, the objective is to derive (from the equations that describe the detailed behaviour of the atmosphere) a closed set of approximate equations in which the variables are statistics of the detailed motion - e.g., average velocity, eddy kinetic energy, eddy momentum transport, eddy momentum transport, eddy heat transport, variance of temperature, average sea surface temperature, etc. Existing or future general circulation models will be of great value in attempts to establish the relevant statistical characteristics of the atmosphere to be used in such models.

Another approach is directed along the lines of recent developments in the statistical theory of turbulence and, more generally, in the statistical treatment of non-linear hydrodynamical systems, in which the calculation of probability distributions is the primary objective. Although the complexity of the simplest model of climate far exceeds that of any quasi-random system dealt with heretofore, a new and promising methodology is now being developed which should be easy to adapt and apply.

Although it is clear that the existing general circulation models are not the sole (or perhaps even the primary) weapons for attacking the problem of simulating long-term climatic variaitons, they play an indispensable role in testing and calibrating statistical dynamical models of climate and, indeed, in guiding the design of such models. For example, lacking a sufficiently detailed and complete description to document climatic changes over periods of several centuries, we must test the detailed behaviour of statistical-dynamical models against the statistical behaviours of the GCMs.

The other essential step in the verification of each kind of model is to check both the detailed behaviour of the GCMs and their statistical characteristics against the observed behaviour of the atmosphere during an extended period of high density and frequency of observation, i.e., the First GARP Global Experiment (FGGE). This is, in fact, the principal value of FGGE in the present context.

5. The Organization of the Conference

An Organizing Committee for the conference has been set up, consisting of the JOC members Professor B. Bolin, Professor K. Hasselmann and Mr. J.S. Sawyer; the President of the WMO Commission for Atmospheric Sciences (Dr. W.L. Godson); and the Director of the Joint Planning Staff for GARP (Professor B.R. Döös). Professor Bolin will also act as the Chairman of the Conference; Professor J. Kutzbach, JOC consultant, will act as Secretary.

6. The Conduct of the Conference

The Conference will be conducted in English.

In view of what has been said earlier, a major part of the discussion must centre around topic (1). Accordingly, 15 experts in the field of numerical modelling have been invited to the Conference as key speakers and presentations by four amongst these experts will open the discussions. Reports containing these presentations will be made available before the Conference. The names of the experts and their fields are mentioned below:

E. Lorenz, U.S.A.: The predictability of climate.

S. Manabe, U.S.A.: The use of comprehensive general circulation models for studies of the climate and climatic variations.

C. Leith, U.S.A.: The statistical-hydrodynamical approach to climate modelling and statistical constraints on the prediction of climate.

J. Adem, Mexico: A critical appraisal of simple climatic models.

It is expected that the first day will be devoted to these presentations and a general discussion of these topics.

Other experts representing each of the topics (2) - (10) have been invited to define the most relevant problems in respective fields and outline appropriate approaches in the light of present knowledge. A critical review paper will introduce each of these topics to the conference as a whole. The second and part of the third day will be devoted to these presentations and the discussions thereon. The tentative programme is as follows, the numbers within parentheses indicating the topic:

A. Arakawa, U.S.A. (2): Modelling clouds and cloud formation for use in climatic models.

A.S. Monin, U.S.S.R.: (3): The role of the oceans in climatic models.

J.F. Nye, U.K. (4): Dynamics of sea-ice and glaciers and their role in climatic variations.

P. Crutzen, Sweden (5): The basic photochemistry of ozone and other minor constituents in the atmosphere and how to incorporate such processes in climatic models.

B. Bolin, Sweden (6): A critical appraisal of present views on the carbon cycle.

Chr. Junge, Federal Republic of Germany (7): Aerosols in the atmosphere, their sources, sinks and residence times.

K. Ya. Kondratyev, U.S.S.R. (the radiation aspects of 2,5,6 and 7): Modelling the radiative characteristics of the atmosphere for climatic studies.

E. Eriksson, Sweden (8): Modelling ground hydrology, particularly soil moisture and evapotranspiration for use in climatic models.

H. Flohn (9): Climatic changes. A critical review of the evidence for their being of global or semi-global character.

A.H. Oort, U.S.A. (9): Variability of the general circulation of the atmosphere as deduced with the aid of aerological data.

The latter part of the first week and the first day of the second week will be devoted to group discussion with the aim of having an outline of a report ready for each one of the groups during the early part of the second week.

At the beginning of the second week the following topic will be introduced:

E. Raschke, Federal Republic of Germany (10): Satellite capability in monitoring climatic parameters.

Experts on satellite observations and the use of other advanced observational systems will meet with representatives of other groups to attempt the definition of priorities in the design of an observational programme. The COSPAR report on space-based observational capabilities in the environmental field appropriately updated should serve as a useful basis for the discussions.

Plenary session will be resumed during the second week to assess particularly the problems of accommodating the proposals from groups (2) - (8) into the overall climatic models. During the latter part of the second week the Conference should consider the main objectives to be achieved by the conference.

GARP IMPLEMENTATION FUND, BUDGET FOR 1974

(Submitted by the Secretary-General, WMO)

INTRODUCTION

1. The Procedures agreed between WMO and ICSU require that the Secretary-General of WMO, in consultation with the JOC, shall produce annual estimates of expenditure and revenue which shall be approved by the Executive Committees of both organizations.

PURPOSE OF DOCUMENT

2. The purpose of this document is to update the proposals for 1974 made in the GARP Implementation Fund document prepared by the Secretary-General of WMO for JOC-VIII in light of the subsequent twenty-fifth session of the WMO Executive Committee held in September 1973.

DISCUSSION

3. The Sixth WMO Congress (April 1971) approved a total expenditure of US$ 300 000 as the WMO contribution to the GARP Implementation Fund for the four-year period 1972-1975.

4. The WMO Executive Committee authorized an appropriation of $ 75 000 as WMO's annual contribution to the GARP Implementation Fund, on the understanding that the International Council of Scientific Unions provide the same amount. The Executive Committee approved the revised GARP Implementation Fund budget (as shown in Appendix B) for 1973 and in addition authorized the unused balance of the GARP Implementation Fund as at 31 December 1972 for the Global Atmospheric Research Programme. The proposed budget for 1974 was also approved and the Secretary-General was authorized to utilize in 1974 any unused balance of the GARP Implementation Fund as at 31 December 1973 for the Global Atmospheric Research Programme. Notwithstanding the fact that the revised budget for 1973 shows a reduction of $ 20 000 in respect of JPS, the Executive Committee maintained its decision (general summary, paragraph 7.4.4, EC-XXIV) to use $ 20 000 in 1973, provided in the WMO budget under GARP (direct WMO support) to supplement, if necessary, the GARP Implementation Fund in respect of the Joint Planning Staff. The Executive Committee of WMO also approved in 1974 additional direct support of $ 22 000, if this should be necessary, in respect of the JPS.

5. The Budget (revenue and expenditure) for 1974 is shown in Appendix A, while the breakdown of the expenditure into different parts of the budget is shown in Appendix B.

6. Regarding the proposed expenditure for 1974 in respect of the Joint Planning Staff (Appendix B), it is estimated that an additional amount of approximately $ 44 000 would be required. In order to supplement the GARP Implementation Fund budget in this respect, WMO and ICSU would agree, if necessary, to provide additional funds, each contributing an equal amount.

ACTION PROPOSED

7. The JOC is invited to comment on the 1974 budget contained in Appendices A and B.

GARP IMPLEMENTATION FUND

BUDGET FOR 1974

(in US dollars)

REVENUE	1974	EXPENDITURE		1974	ANTICIPATED TOTAL EXPENDITURE 1973
Contribution from WMO	75 000	I	Joint GARP Organizing Committee	146 000	146 000
Contribution from ICSU	75 000	II	Administrative And Common Services	3 000	3 000
		III	Other budgetary provisions	1 000	1 000
	$ 150 000			$ 150 000	$ 150 000

The expenditure for JPS (Personnel) in 1974 is estimated to be $ 109 000 instead of $ 65 000 proposed. Therefore, an additional amount of approximately $ 44 000 would be required. This additional requirement arises from salary increases since the approval of the WMO budget by Sixth Congress in April 1971 ($ 38 100) and of additional programme costs ($ 5 900).

It appears that ICSU will be able to make an additional contribution which, if matched by an equal amount by WMO, will enable this additional requirement of $ 44 000 to be met. As last year, the Executive Committee approved a stand-by arrangement for 1974 by providing $ 22 000 for this purpose under budget section III.B.4.

DETAILED BREAKDOWN OF THE ESTIMATED EXPENDITURE FOR THE YEAR 1974

			1974
I.	Joint GARP Organizing Committee		
	A	Meetings	
	A.1	Session of JOC	20 000
	A.2	Sessions of the JOC Officers	2 000
	A.3	Reports	500
	B	Personnel	
	B.1	Joint Planning Staff	65 000
	B.2	Travel	12 000
	C	Consultants and Study Groups	27 000
	D	Working Groups	10 000
	E	Publications	8 000
	F	Temporary Staff	1 500
			$ 146 000
II.	Administrative and Common Services		
	A	Reproduction of documents	-
	B	Stationery, office supplies	-
	C	Office equipment and machines	-
	D	Communications	3 000
	E	Premises	-
	F	Hospitality	-
			$ 3 000
III.	Other budgetary provisions		
	A	Contingencies and unforeseen expenditures	-
	B	External Audit	100
	C	Insurance and Staff Compensation Fund	900
			1 000
			$ 150 000