GARP

GLOBAL ATMOSPHERIC RESEARCH PROGRAMME

GARP
SPECIAL
REPORT

No. 5

REPORT OF THE SECOND SESSION OF THE TROPICAL EXPERIMENT BOARD

GENEVA, DECEMBER 1971

INTERNATIONAL COUNCIL
OF SCIENTIFIC UNIONS

WORLD METEOROLOGICAL
ORGANIZATION

GLOBAL ATMOSPHERIC RESEARCH PROGRAMME (GARP)

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NOTE

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F O R E W O R D

This publication, the fifth in the series of GARP Special Reports, contains the report of the second session of the Tropical Experiment Board (TEB) of the GARP Atlantic Tropical Experiment (GATE), held in Geneva from 14 to 16 December 1971. Invitations to participate in the session were issued by the Secretary-General of WMO on behalf of WMO and ICSU.

The TEB was established by WMO and ICSU. Its functions are to act as the central international body for the planning and implementation of GATE. This experiment will be carried out by an international team of scientists using ships, aircraft, ocean buoys, land observing stations, satellites and many other new technological devices. Expressed in its simplest terms, the aim of the Experiment is to acquire a more detailed knowledge of how the radiant energy from the sun is transformed into heat energy which is in turn converted into kinetic energy in the form of atmospheric motions of varying scales and patterns over the vast area selected for the Experiment. It is expected that the Experiment will contribute significantly in extending our knowledge of the atmospheric fluctuations in the tropics which are undoubtedly linked with variations of the circulation in the higher latitudes; it is therefore directly relevant to the whole problem of the global atmospheric circulation. This is an enormously complex task that can only be undertaken through international collaboration of an unprecedented character.

The first session of TEB established the Interim Scientific and Management Group (ISMG) for the purpose of preparing a Preliminary Plan for GATE. This Plan was presented to the second session of the Board and a condensed version appears as Appendix C to this report. The ISMG working in the WMO Secretariat has succeeded in performing its allotted task of producing the first GATE planning design in a way which deserves the highest praise.

The findings and recommendations made by the Board will be considered in due course by competent bodies of WMO and ICSU. Pending such consideration action is however being taken on certain of the more urgent interim measures proposed.

I wish to express my appreciation of the co-operative spirit and interest shown by all the delegates to the second session of the Board, and to the ISMG for its excellent contribution to this unique scientific endeavour.

D A Davies

Secretary-General, WMO

C O N T E N T S

1. ORGANIZATION OF THE SESSION

1.1 Opening of the session

1.1.1 The second session of the GARP Tropical Experiment Board (TEB) was opened at 10 a.m. on 14 December 1971 at the WMO Secretariat by the Chairman of the TEB, Dr. B.J. Mason.

1.1.2 The Secretary-General of WMO, Dr. D.A. Davies, welcomed the participants and expressed his pleasure and satisfaction in so doing. He recalled that it was only some four years ago that the original agreement was signed between WMO and ICSU, and that already GARP had become on all sides a symbol of hope and promise for a much-needed and long-awaited major improvement in man's understanding of the atmospheric processes and in the application of this knowledge for useful practical purposes. Dr. Davies mentioned that since GATE would be the first GARP experiment, the second session of the TEB would take on added importance. He took the opportunity to pay tribute to the Interim Scientific and Management Group (ISMG) which had been breaking new grounds, facing new problems and adopting new methods. The ISMG had succeeded in performing its allotted task of producing the first GATE planning design in a way which deserved the highest praise and the substantial document which contains this plan bears witness to the collective skill, perserverance and devotion to duty of Dr. Kuettner, Dr. Rider and Dr. Sitnikov. In thanking the ISMG, Dr. Davies also mentioned his gratitude to Dr. White, Dr. Mason and Academician Fedorov for having shown their faith in the untried concept of the ISMG by placing such competent scientists at the disposal of the planning effort. In conclusion Dr. Davies wished the Board every success in its important work and re-affirmed his willingness to assist the meeting in every possible way.

1.1.3 Prof. B. Bolin, Chairman of the JOC welcomed the participants on behalf of the International Council of Scientific Unions (ICSU) and expressed his sincere hopes and best wishes for the meeting, which signified one further important step in the co-operation between ICSU and WMO. In conclusion Prof. Bolin also thanked the ISMG for their efforts.

1.1.4 The list of participants is reproduced in Appendix A.

1.2 Election of Chairman

1.2.1 Dr. B.J. Mason was unanimously re-elected Chairman of the Tropical Experiment Board for the duration of the session and up to the next session of the Board.

1.2.2 Dr. Mason thanked the Board for their confidence in him and accepted his nomination with pleasure. He mentioned the complex and difficult task that the Board had to face in a short time and expressed the hope that the meeting would produce a useful and concise document, to be presented to Member governments by January 1972.

1.3 Approval of the agenda

1.3.1 After a slight addition to item 7, by the inclusion of the word "location", the proposed agenda was adopted. The approved agenda is reproduced in Appendix B.

1.4 Working arrangements

1.4.1 The Board decided to meet mainly in plenary sessions; small working groups would be formed when necessary.

2. MEMBERSHIP OF THE BOARD

2.1 The Board learned with regret that the Government of Belgium would no longer be able to participate in GATE and that consequently Belgium would no longer take part in the work of the Board; Japan had expressed regret that it would be unable to participate in this TEB session.

2.2 The Netherlands had indicated the likelihood that the ship "Snellius" would be able to take part in GATE. Since this would represent a significant contribution to the Experiment, the Chairman of TEB, acting on behalf of the Board between sessions in respect of its membership, had asked the Secretary-General to invite the Netherlands to become a member of the TEB. The Netherlands accepted this invitation and designated a permanent member to serve on the Board.

2.3 Finland had also indicated its intention of contributing substantially to GATE (see paragraph 6.6) and the Secretary-General had extended an invitation to Finland, on behalf of the Chairman of TEB, to become a member of TEB. The Government of Finland accepted this invitation and designated a permanent member to serve on the Board.

2.4 The Board agreed to the proposal submitted by the ISMG that Dakar is a suitable location for the primary base for ships and aircraft taking part in GATE. Dakar is also recommended as the location of the GATE Operational Control Centre. The Board understood that Senegal was willing to contribute substantially to GATE by providing major operational bases and would thus qualify for membership on the TEB. The Board therefore requested the Secretary-General to explore with the Government of Senegal their potential contributions to GATE and the desirability of Senegal becoming a member of TEB.

2.5 The TEB now consists of the following members:

Canada	Portugal
Federal Republic of Germany	U.S.S.R.
Finland	United Kingdom
France	U.S.A.
Netherlands	

3. REVIEW OF THE DECISIONS AND COMMENTS OF THE SIXTH WORLD METEOROLOGICAL CONGRESS AND THE WMO EXECUTIVE COMMITTEE CONCERNING THE TEB

3.1 The Board was informed of the various matters discussed by the Sixth Congress of WMO and the twenty-third session of the Executive Committee concerning GATE and decided to take appropriate action under the relevant agenda items.

4. PRESENTATION BY THE ISMG OF THE PRELIMINARY PLAN FOR THE CONDUCT OF GATE

4.1 The members of the ISMG made a verbal presentation of their experimental design proposal for GATE as contained in Volume I of the report submitted to the session. Volume II consists of annexes containing contributions by numerous experts who have worked with the ISMG and reference material (Volume II is available on request). Dr. J.P. Kuettner, the senior scientist of the ISMG, described the general approach to the experiment design, including the scientific problem and objectives; Dr. N.E. Rider then presented the plan for the deployment and operation of observing platforms and systems for data management, and Dr. I.G. Sitnikov described arrangements related to numerical modelling, parameterization, analysis and prognosis.

4.2 The Tropical Experiment Board was unanimous in warmly commending the report of the ISMG and agreed that it set out the objectives, the plan for conduct and the requirements of the experiment with great clarity and in adequate detail. The Board suggested some minor points of amendment and updating, and in expressing its appreciation to the ISMG, recommended that, subject to these and other amendments arising from discussion of items 5 and 6, Volume I of the report be published in the GARP Publication Series. This publication should be circulated to governments of participating countries. A shorter but definitive document, which would clearly spell out the requirements in terms of equipment, ships, aircraft, satellites, etc (see paragraph 6.1 and Appendix C), prepared on the basis of the ISMG report, would be sent to all governments having membership on the Board and to governments within the GATE area.

5. DISCUSSION OF THE PRELIMINARY PLAN FOR GATE

5.1 The Board felt that given the allocation of the defined resources and the successful development of certain critical observing techniques, GATE can be carried out in 1974 and recommended the first day to be 15 June 1974. The experiment will continue for 100 days, that is, until about the end of September.

5.2 It was a unanimous feeling of the Board that, given the observational data called for in the plan, GATE can fulfil the scientific objectives which are clearly stated in the ISMG report. The Board suggested that the priority given to the items listed in Table 5 of the preliminary plan should be re-examined.

5.3 Considering that the conduct of independent national programmes in a common geographical area will not suffice if the aims of the Central Programme are to be achieved, the Board recommended that the nations contributing major resources agree to use their resources jointly in a concerted and well co-ordinated scientific effort.

5.4 Before considering specific details of the plan, the Board discussed the extent to which oceanographic work could be incorporated in the experiment. The Board was informed that the oceanographic component of GATE was now under development with the active participation of oceanographers in several nations. It was noted that oceanographic observation in the mixed layer of the ocean are absolutely essential to the objectives of the experiment. In addition, a number of scientific projects of interest to physical, biological and geological oceanographers have been proposed, which could effectively utilize the GATE platforms and which would benefit from the concurrent meteorological observation. The Board welcomes

the participation of oceanographers, noting that while GATE must remain first and foremost a meteorological experiment, many complementary oceanographic studies should be possible which would not jeopardize the meteorological programme. The Board was informed that a meeting of SCOR would take place in Copenhagen in January 1972 and noted that Dr. R.W. Stewart would represent JOC, but felt that it would also be desirable for a member of the ISMG to attend this meeting in order to explain the plans for the conduct of GATE.

5.5 Moreover, the Board agreed that there would be great advantage in having an oceanographer among members of the SMG for GATE, and noted with satisfaction that the Chairman of IOC hopes to arrange with the Netherlands for an oceanographer to join the SMG for a period of 3 to 6 months.

5.6 The Board learned with interest that the Federal Republic of Germany was planning to carry out a national oceanographic programme in conjunction with GATE. This programme would focus on the mixed upper layer of the sea, on areas of free upwelling, on the equatorial under-currents and also on ocean wave spectra, using between ten and twenty instrumented buoys.

5.7 The Board decided that the A-scale area for GATE should be as follows: 24°N, 95°W; 24°N, 70°W; 20°N, 70°W; 20°N, 47°E; 10°S, 47°E; 10°S, 95°W. Related to the general area approved by the Executive Committees of ICSU and WMO in 1970, this represented a slight extension of the eastern and western boundaries and an additional area to permit the inclusion of a few more upper-air stations.

5.8 The Board further recommended that SMG should work out an operational plan, including a plan for communications. In this plan consideration should be given to the proposal that some five ships across the GATE area carry out continuous observations throughout the project period; and also that two additional ships should be located on the equator. The Board asked SMG to continue to study and evaluate climatological and synoptic data presently available from the GATE area.

5.9 Regarding the B-scale area, based on analysis of available data concerning the nature and frequency of occurrence of the convective phenomena of interest and also based on logistical constraints, the Board decided that the area should be in the Eastern Atlantic centered near 10°N and 27°W. The Board felt that in principle the B-scale observing network could remain in one fixed position throughout the duration of the experiment rather than being moved in latitude with the expected movement of the belt of maximum sea surface temperature as recommended by ISMG. Regarding the actual geometry of the B-scale ship network, it was agreed that this should be determined once the available number of these ships is known.

5.10 The Board agreed that, for the oceanic A and B-scale observing network a total of about 27 dedicated ships, 12 for the A-scale and 15 for the B-scale observing network, is needed. Of these:

(a) all ships should be capable of deploying radiosondes and measuring upper winds at least to the 80 mb level;

(b) a majority should be able to undertake temperature-salinity-depth soundings;

(c) about nine ships be fitted with wind-tracking and weather radar; preferably the weather radar should be of the C-band (5.7 cm).

5.11 The Board decided that in connexion with the proposed schedule of ship movements, the "zero" day should be 15 June 1974, allowing at least a week at the beginning for intercomparison purposes. This would mean that phase I of the project would occur at the beginning of July and that the experiment would last for 100 days, that is, until about the end of September 1974.

5.12 The Board decided that the SMG should continue the development of details of various GATE sub-programmes to ensure proper input from these to the central programme. Especially needed is further development of the boundary-layer, radiation and oceanography sub-programmes in the overall plan for GATE.

5.13 The Board agreed that for the C/D-scale observations a total of at least 12 dedicated aircraft is needed. Of these:

(a) all should be equipped with at least some wind-finding facility and temperature and humidity sensors;

(b) nine fully-instrumented aircraft (including three jets) with a range of 4,000 km or more and, desirably, dropsonde capability, should participate in co-ordinated group flights over the B-scale area;

(c) two more long-range aircraft should be equipped with advanced infra-red scanners for sea-surface temperature mapping;

(d) three aircraft should be fitted with advanced motion sensing and turbulent flux probes.

5.14 One member of the Board felt that penetration of cloud clusters by what would of necessity be long-range aircraft, was a somewhat hazardous undertaking and felt that measurements could be carried out in analagous cloud conditions in more convenient localities and the results applied to GATE. However the Board was not able to explore this question fully and referred the subject for further study by SMG.

5.15 There was considerable discussion as to the type of weather radar for quantitative assessment of precipitation which should be carried by ships in the B-scale network. The Board recommended C-band radar (5.7 cm wavelength) for this purpose, but appreciating that it might be impossible for all platforms to be so equipped, agreed that X-band radar (3 cm wavelength) would be better than none at all.

5.16 In view of the probable limitations of weather radar in making quantitative assessments of precipitation, the Board requested the SMG to consider the possibility of using some other means of measuring rainfall amounts aboard the ocean observing platforms, and to draw up a plan for co-ordination of all precipitation measurements.

5.17 The Board considered that reliable operation of existing and planned WWW stations with twice-daily radiosonde and wind soundings in the GATE area is a necessity for the success of GATE. Telecommunications to receive these data within two hours at the WMCs, RMCs and the GATE Operational Control Centre are equally vital for the operation of GATE. The TEB confirmed these urgent requirements and asked the TEC to collaborate in testing the operation of these systems during an "early test period" for GATE in the summer of 1973 according to a test-operational plan to be prepared by SMG.

5.18 The Board was in general agreement that the single observed parameter of greatest importance to the success of the experiment was the direct wind measurement at all levels. Since it will be too difficult and too expensive to equip all ships with stabilized radar, it was noted that GATE will depend on the availability of an OMEGA navigational-type wind-finding system since LORAN coverage would not be available in the GATE area. The Board recommended that every effort be made to develop the OMEGA wind-finding techniques and to bring it to an operational stage with the accuracy called for in the Plan by early 1973, so that OMEGA will be used during GATE as widely as possible. The Board acknowledged the information that a paper on the OMEGA dropsonde requirements and technology will be made available to interested members by the U.S.A. and requested to be kept informed of further developments of these techniques.

5.19 The most critical problem in data collection and compatability will arise from the variety of observing techniques used by the participating countries. This difficulty, it was felt, can only be overcome by an agreement of the participating nations to use identical observing tools and methods wherever possible and to conduct intensive inter-comparison and calibration tests prior to GATE. The Board stressed the importance of using a minimum of different types of sensors, particularly in respect of rawinsonde ascents. It was noted that, in fact, there would probably be only two types of sonde and three types of tracking equipment used by ocean platforms in the B-scale area. The Board recommended that observing techniques which are not fully developed or tested prior to the commencement of GATE should not be made part of the basic observing system.

5.20 The Board strongly recommended a preliminary trial during the northern hemisphere summer of 1973 (in addition to the period of approximately one week provided for in the schedule of ship movements immediately prior to phase I of the experiment) which would permit, amongst other things, inter-comparison and inter-calibration of observing equipment and techniques and test of the communications system. This preliminary trial should preferably be held in the actual area of the experiment, but if this proved impossible it would still be of value if held in the north Atlantic or elsewhere. The Board requested the SMG as a matter of urgency to draw up a plan for such a preliminary trial, assuming that three or more countries would participate, and it was hoped that a special effort would be made to obtain the maximum possible upper-air data from the adjacent continentalareas during this period of the trial.

5.21 Regarding the role of satellites in the experiment, the scientific objectives of the plan as accepted now assumed the availability of a geostationary satellite over the east Atlantic and the Board reiterated that the presence of a geostationary satellite over the GATE area was essential and noted with appreciation that the U.S.A. presently is planning to place such a satellite over the GATE area in time for the experiment. Discussing measures to take in the event that major observing components such as satellites could not be provided, the Board felt that after 1972 it would be very difficult to postpone or cancel the experiment and requested the SMG to give consideration to the need for a "contingency plan" for the conduct or postponement of the experiment in these circumstances.

5.22 Although GATE will make full use of the existing facilities, a GATE Operational Control Centre (GOCC) and a GATE Data Centre (GDC) will have to be added. SMG was requested to prepare for the next session of the Board detailed requirements for GOCC and GDC.

5.23 The Board unanimously agreed that, since Dakar was already a WWW Regional Meteorological Centre and Regional Telecommunication Hub, and in view of its suitable geographical location in respect of the B-scale area, its airport and its harbour facilities, the GOCC might be located at Dakar. The Board

appreciated that this would be a major contribution to the experiment and asked the Secretary-General of WMO to investigate with Senegal the arrangements under which these facilities could be made available. It recognized that additional facilities such as satellite data receiving stations, communications and special high-speed computer equipment, will also be required. It hoped that these special facilities could be contributed by other TEB member governments for the duration of the experiment. The Board will have to consider these matters in greater detail at its next session.

5.24 Regarding the plans for data management, the Board recognized that this matter was extremely important and required detailed co-ordination at national and international levels. In particular, detailed planning for the GOCC and GDC had now become urgent. The Board stressed the importance of arranging standardization of formats and media for use when data are submitted to the data centres participating in the experiment and recommended that all data collected in GATE should be available to all nations at the earliest possible time. To achieve an orderly and timely processing and validation of all basic data the SMG was requested to work further on the development of a data management plan once the available resources are known.

6. NATIONAL CONTRIBUTIONS REQUIRED FOR GATE

6.1 The Tropical Experiment Board, noting that the report of the ISMG on the experiment design proposal for GATE made a clear and realistic assessment of the requirements for the successful conduct of the experiment, decided that a concise document should be drawn up in non-technical terms explaining the objectives of GATE and setting out the requirements to be met by participating countries in terms of observation platforms, equipment and expertise. The Board drew up a draft of such a document which is reproduced in Appendix C.

6.2 The Board agreed that this document should be circulated as soon as possible by the Secretary-General of WMO to the appropriate governmental authority of all countries within the GATE area and to other countries which had expressed interest in participating in GATE, with a copy to the Permanent Representative of the country with WMO. Countries intending to contribute should be requested to make known their firm commitments of platforms, equipment and expertise before 31 March 1972. These should be studied and assembled by the SMG for presentation to the third session of TEB.

6.3 As well as commitments in material, the Board urged all participating countries which could do so to nominate experts to work on a long-term basis (i.e. 8-12 months or longer) with the SMG. The subjects which require to be covered by the group include instrumentation and observational techniques, satellite and radiation programmes, aircraft observing programmes, instrumentation and flight operations, boundary-layer programme, logistics and communications, data management, tropical numerical models and parameterization programme and oceanographic aspects. The field of expertise and the period of availability of experts who could be released within the next few months for work with the SMG should be conveyed to the Secretary-General of WMO by 31 March 1972.

6.4 Noting with some concern that a recent survey of upper-air observations received from the 53 WWW stations in the original GATE area showed that only between 34 and 37 per cent of the scheduled observations were received at the WMC Moscow, the Board emphasized that GATE would rely heavily upon the efficient transmission

of reliable data from existing stations, and on the establishment of all new stations in the area scheduled for implementation in the World Weather Watch Plan 1972-1975 in time for the experiment. It was pointed out that there was little value in setting up a costly network of observing platforms over the ocean if the network in adjacent continental areas remained inadequate. The Board was pleased to learn that the Secretary-General of WMO had agreed to draw the attention of donor countries under the WWW Voluntary Assistance Programme (VAP) to the importance of achieving an adequate network of upper-air stations within the GATE area in time for the experiment and asked the Secretary-General to take all further steps possible to solve the problem of data gaps in continental areas. The Board also recommended that the TEC give special attention to the problem at its next session, and support a test programme in the GATE area during the test period of 1973 recommended in paragraph 5.20 above.

6.5 The Board wished to draw the attention of all countries with observing stations within the GATE area to the need for recording observations on computer-compatible media (i.e. magnetic tape, punched cards, etc). As pointed out in paragraph 5.24, the SMG was requested as a matter of urgency to give attention to the media and formats to be used for this purpose.

6.6 The Board noted with appreciation comments made on national contributions as follows:

- The offer of Portugal to co-operate if a member of the SMG and the WMO Secretariat wished to visit the Cape Verde Islands to make an assessment of the facilities there.

- That the Netherlands planned to install a temporary radiosonde station in Surinam in addition to the possible availability of the ship "Snellius".

- That Finland had promised at least nine complete upper-air stations offered under VAP which would remain after the completion of the experiment and also to man with personnel from Finland one of these stations for the duration of the experiment.

The Board also noted that one of the three survey ships originally intended as a contribution by the Federal Republic of Germany would now appear not to be available.

6.7 For purposes of resupplying A and B-scale ships, it was agreed that the majority of the ships would probably use the port at Dakar, although some A-scale ships in the more westerly parts would use western Atlantic ports such as Barbados or ports in the north-eastern part of South America.

7. THE ORGANIZATION, LOCATION, OPERATION AND ESTABLISHMENT OF THE SMG

7.1 The need for a Scientific and Management Group (SMG) in order to ensure the scientific and technological coherence of all the national efforts in GATE planning had been discussed at TEB-I and by the WMO Executive Committee, which, at its twenty-third session, had requested the Secretary-General of WMO to recruit a director and deputy-director for the SMG as soon as nominations had been received from the Tropical Experiment Board. The Board unanimously agreed that the SMG should be established as of 1 January 1972 and that it should start work on the problems of the experiment as soon as possible. The Board asked Dr. Kuettner to act as Director of the SMG until such time as a formal appointment is made.

7.2 Accordingly, the Board decided to ask the Secretary-General of WMO to advertise the posts of director and deputy-director of the SMG as soon as possible. The Board unanimously expressed the opinion that if Dr. Kuettner, Senior Scientist of the ISMG, should be available, he should be offered the post of Director. The representative of JOC stated that this opinion was also shared by the JOC.

7.3 Although the ISMG has completed the main part of its responsibilities and its members would return to their respective national services immediately after the conclusion of TEB-II, it was considered desirable to maintain their services until the SMG long-term experts are named. The Board requested the Secretary-General of WMO to arrange for necessary continuity to be maintained by keeping the former members of the ISMG informed of developments and by convening occasional meetings with them as and when necessary.

7.4 As noted in paragraph 6.3 the effectiveness of the SMG will be dependent upon obtaining long-term experts of the right scientific background and in sufficient numbers. The Secretary-General of WMO was asked to appeal to the participating governments to assign such experts to the SMG when he transmitted the report of the session and the GATE plan. This appeal should stress the type of persons needed and indicate their general terms of service. In connexion with the terms of service of the seconded personnel, it should be made clear that the Secretary-General of WMO is authorized to meet travel costs of experts while on SMG business but that all their other costs will need to be met by the respective countries concerned.

7.5 The Board in general reaffirmed the terms of reference of SMG as agreed at its first session. As the activities of SMG would cover a very wide range of specialized fields it was felt that it would be necessary to allocate responsibility for different fields to individual members or perhaps small groups within SMG. As a corollary to this, it would be essential to ensure that the persons nominated by governments to serve on the SMG should cover all the necessary fields (see Appendix D). Small gaps in the expert knowledge of the SMG as a whole could probably be filled by ad hoc arrangements, but major gaps would create serious difficulties. The experience of the ISMG working in the WMO Secretariat would, of course, provide valuable guidance to the SMG in organizing its work.

7.6 The Board noted that in its budget for the four-year period 1972-1975 the Sixth Congress of WMO had provided for a sum of U.S. $700,000 as "direct WMO support to GARP", and that the Executive Committee had allocated for the first year of the period (1972) the sum of $150,000. Whilst it recognized that other GARP activities requiring "direct WMO support" will have to be met from this source, the Board expressed the strong hope that the Secretary-General of WMO would allocate most of this sum to costs arising from SMG activities.

7.7 Regarding the future location of the SMG, the Board recalled that the Executive Committee of WMO at its twenty-second session had referred the question to the TEB for decision and that TEB-I had accepted the United Kingdom's offer to house the SMG at Bracknell. The representative of the U.K. reaffirmed his government's offer and informed the Board that accommodation at Bracknell for about 20 persons would be available after 1 April 1972.

7.8 The delegate of the U.S.S.R. noted that: (a) the Sixth World Meteorological Congress in Resolution 5(Cg-VI) had urged Members to provide the necessary support for the Experiment by helping in its further planning, and also that both EC-XXII and EC-XXIII clearly stated that the Scientific and Management Group (SMG) should consist of a director and deputy-director both recruited as international civil servants, and also long-term consultants seconded from the participating countries to SMG; (b) the work which would have to be carried out by the leaders

of the SMG would mostly be of an organizational, international co-ordinating and administrative character; and (c) the results achieved during the last year by the ISMG working within the WMO Secretariat in Geneva had been excellent. He therefore proposed that the director and his deputy in their role as international civil servants should both start their work in the WMO Secretariat in Geneva. Some of the long-term experts seconded by their countries might, however, start their work at Bracknell. The next session of the Board should discuss further, if necessary, the location aspects of the SMG in the light of experience.

7.9 Some members expressed strong doubts about the practicability and efficacy of splitting the SMG between two localities. However, other speakers expressed the view that locating the SMG in two places, whilst it might appear inexpedient at this time, could prove to be a possible way of performing the duties with which it was being charged.

7.10 After a long discussion, the majority of the members of the Board recognized that the SMG would have to carry out substantial activities both at Bracknell and at Geneva and that it would therefore be necessary to have adequate direction of the work in both places. It was therefore decided that at the outset one of the two international civil servants (i.e. the director or deputy-director of the SMG) should be located in Geneva and the other in Bracknell. It was further decided that the situation would be reviewed by the TEB as the programme of work develops.

7.11 The representative of the U.S.S.R. declared that in view of the above decision regarding the location of the SMG, the U.S.S.R. reserves its position on the question of seconding long-term experts for work with the SMG.

7.12 The Board considered it essential for the implementation of GATE and its many international aspects that the established close co-operation between the ISMG and the Secretariat of the WMO and the JPS be maintained by the SMG.

8. DATE, PLACE AND SUBJECTS OF THE NEXT TEB SESSION

The Tropical Experiment Board decided that its third session should be held as soon as the contributions to GATE of participating countries were known in order to give any necessary guidance to the SMG on the line of action to be taken in view of the available facilities. The Board therefore agreed that the tentative date for the opening of the session should be 27 April 1972 at the WMO Secretariat in Geneva.

9. REPORT OF THE SESSION

Noting its decision regarding the publication of Volume I of the ISMG's report (see paragraph 4.2) and the document for circulation to participating governments (see paragraph 6.2), the Board decided that the report of the second session should be drawn up and distributed in a similar manner to the report of the first session, that is, as a GARP Special Report.

A P P E N D I X A

LIST OF PARTICIPANTS

1. Representatives of Members of WMO

S.P. Huovila	principal delegate	Finland
U. Toivola	delegate	
L. Facy	principal delegate	France
J. Alt	delegate	
K. Brocks	principal delegate	Germany, Federal Republic of
H. Hinzpeter	delegate	
C.J.E. Schuurmans	principal delegate	Netherlands
A. Silva de Sousa	principal delegate	Portugal
M. Petrossiants	principal delegate	Union of Soviet Socialist Republics
B.J. Mason	principal delegate	United Kingdom
R.F. Jones	delegate	
R.E. Hallgren	principal delegate	United States of America
V.E. Suomi	alternate delegate	
E.W. Bierly	delegate	
G.D. Cartwright	delegate	
N.L. Durocher	delegate	
N.E. La Seur	delegate	
D.H. Sargeant	delegate	
B. Taft	delegate	
R.F. Long	observer	

2. Representatives of Regional Associations

M. Seck	RA I
R.F. Caracciolo	RA III
L. Reyes Rivera	RA IV

3. Representatives of International Organizations

T.F. Malone	ICSU
F.W.G. Baker	
L. Capurro	IOC
B. Bolin	JOC

B.R. Döös		JPS
M. Pittavino	observer	ASECNA
B. Taft	observer	SCOR

4. Members of the ISMG

J.P. Kuettner
N.E. Rider
I.G. Sitnikov

5. WMO Secretariat

O.M. Ashford	Representative of SG

R.D. Bojkov
E.M. Dobryshman
A.H. Glaser
T.C. Leyerweerd
R.M. Perry

(Other members of the staff of the Secretariat were also present for part of the meeting).

A P P E N D I X B

AGENDA

1. ORGANIZATION OF THE SESSION
   - 1.1 Opening of the session
   - 1.2 Election of the Chairman
   - 1.3 Approval of the agenda
   - 1.4 Working arrangements
2. MEMBERSHIP OF THE BOARD
3. REVIEW OF THE DECISIONS AND COMMENTS OF Cg-VI AND EC-XXIII CONCERNING THE TEB
4. PRESENTATION BY THE ISMG OF THE PRELIMINARY PLAN FOR THE CONDUCT OF GATE
5. DISCUSSION OF PRELIMINARY PLAN FOR GATE
6. NATIONAL CONTRIBUTIONS REQUIRED FOR GATE
7. THE ORGANIZATION, LOCATION, OPERATION AND ESTABLISHMENT OF THE SMG
8. DATE, PLACE AND SUBJECTS OF THE NEXT TEB SESSION
9. REPORT OF THE SESSION

A P P E N D I X C

SUMMARY OF THE GATE PLAN

This document was drawn up by the Tropical Experiment Board during the course of its second session (see paragraphs 4.2 and 6.1 of the text of the report of the session)

APPENDIX C

1. INTRODUCTION

1.1 The Atlantic Tropical Experiment (GATE), scheduled for the summer of 1974, will be the first major observational experiment of the Global Atmospheric Research Programme (GARP) sponsored jointly by the World Meteorological Organization and the International Council of Scientific Unions. The objectives of GATE are to study the structure and evolution of weather systems in the tropical eastern Atlantic and to assess the extent to which these tropical disturbances affect the behaviour of the whole atmosphere. It is believed that tropical convective storms, besides being a dominant feature of the weather in the tropics, provide a strong driving force for the whole atmosphere and that they transport vast quantities of heat and moisture from the tropical oceans into the atmosphere at higher latitudes and therefore affect the weather everywhere.

1.2 Great progress has been made in recent years in devising new methods of observing the weather from satellites, and in formulating very complex mathematical models of the global atmosphere which, with the help of giant computers, are used to make good mathematical predictions of the broad scale features of the weather for two or three days ahead. Such techniques are gradually replacing the traditional subjective methods in many countries.

1.3 Experience with these models and current research indicate that reliable forecasts for a week ahead and perhaps longer are capable of being achieved within the next few years, provided that adequate observations of the global atmosphere are forthcoming. One of the objectives of GARP will be to determine the minimum requirements for the global weather observing system and to determine to what extent the range and accuracy of weather forecasts are set by the atmosphere itself.

1.4 First priority has been given to the tropical experiment because we know so little about the behaviour of tropical weather systems and how to incorporate them into global models.

1.5 The proposed tropical experiment, whose objectives and plans are briefly summarized in the following pages, calls for a combined task force of satellites, some 30 ships and 10 large aircraft, and will be by far the largest and most complex international scientific experiment so far undertaken. In calling for an unusual degree of joint international planning and management, it provides a major challenge and opportunity for the participating nations to work closely together as a combined team on a problem whose solution will be of ultimate benefit to the whole world.

2. THE OBJECTIVES

2.1 The Global Atmospheric Research Programme (GARP) has been established by the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU) as a long range programme to understand the transient behaviour of the atmosphere which controls changes in weather over the whole world. As our improved understanding of both the high latitude weather systems and tropical weather systems is included in more realistic models of the atmosphere, man stands to benefit significantly through improved forecasts by being better able to plan for the changing weather in both the tropics and at higher latitudes. Furthermore, this increased understanding is fundamental to a better understanding of the physical basis of climate and its possible change, through natural or man-made influences.

2.2 The GARP Atlantic Tropical Experiment (GATE) has been developed as a major contribution to the Global Atmospheric Research Programme. The primary aims of GATE are to extend the knowledge of those aspects of the meteorology of the equatorial belt which are essential for a proper understanding of the circulation of the earth's atmosphere as a whole. The knowledge and experience derived will also provide a basis for a major advance in the understanding of tropical meteorology and for development of weather forecasting in the equatorial belt.

2.3 The atmosphere and oceans of the tropical belt contain the main heat sources which drive the general circulation of the atmosphere as a whole. Fluctuations in this belt are undoubtedly linked with variations of the circulation in the higher latitudes, although the nature of these connexions is as yet obscure.

2.4 The GARP Atlantic Tropical Experiment aims to provide a basis upon which to develop methods for estimating the effects of the smaller tropical weather systems on the larger scale circulations. This is possible because the tropical atmosphere is noteworthy for convective storms and there is little doubt that this convection is a major factor in the vertical transport of heat, water vapour and probably of momentum. Satellite photographs show that a major part of this convection occurs in organized "cloud clusters".

2.5 The GATE, therefore, has been designed to provide a description of the internal structure of a number of these cloud clusters, to estimate the vertical and horizontal transport of heat, moisture and momentum associated with the systems and to relate them to movements of the tropical atmosphere on a larger scale. This requires observing systems on a broad scale to define the large-scale disturbances of the wind field and on a finer scale to resolve the internal structure of the cloud clusters and their effects on the circulation in their immediate environment.

2.6 A full understanding of the behaviour of cloud clusters and the transport of heat, water vapour and momentum arising from them will not be achieved without a concentrated international observational programme in an appropriate geographical area. Some of the significant aspects of the proposed experiment in the Tropical Atlantic are discussed in the following sections.

3. THE MANAGEMENT

3.1 It was recognized early in the planning (July 1970) that full-time staff would be required to prepare the detailed plans for the experiment and to take part in the processing and scientific analysis of the vast amount of data which would accrue. A Scientific and Management Group (SMG) was therefore proposed to be headed by a director and his deputy who would carry out the functions of scientific leader and project manager between them. These two would have the status of international civil servants and the remainder of the Group would be seconded by participating countries who would pay their salaries and allowances. This proposal was considered and approved by the Executive Committees of WMO and ICSU who, recognizing the urgency, set up an Interim Scientific and Management Group (ISMG) in Autumn 1970. A novel international management arrangement has been created under the auspices of WMO and ICSU. The Tropical Experiment Board, comprised primarily of representatives of the governments of those countries planning substantial contributions to the conduct of the experiment, serves as the central body for planning and execution. Present members include Canada, Finland, France, Federal Republic of Germany, Netherlands, Portugal, Union of Soviet Socialist Republics, United Kingdom and United States of America. The broader Tropical Experiment Council is comprised of representatives of countries within the proposed area of the experiment and other interested countries.

3.2 The Sixth World Meteorological Congress approved funds for two international civil servants (the Director of the SMG and his deputy) to be appointed, and for organizing a number of necessary planning meetings. However, in the meantime, the ISMG functioning in Geneva produced a First Experiment Design Proposal (to be published by WMO and ICSU) which were considered at the second session of the Tropical Experiment Board in December 1971. The Board agreed with the general strategy outlined and decided to appoint the SMG with effect from 1 January 1972. Recognizing that there was much organizational work to be done in Geneva, the Board decided that at least for the present the SMG should be arranged so that one international civil servant be accommodated at Geneva and one at Bracknell. In view of the great number of scientific and logistic studies that have to be made within the next 2-3 years, there is an urgent need for participating countries to second experts to the SMG to work for extended periods in the following areas:

tropical models and parameterization programmes;

satellite and radiation programmes;

boundary-layer programme;

instrumentation and observational techniques and networks;

data management;

logistics and communications;

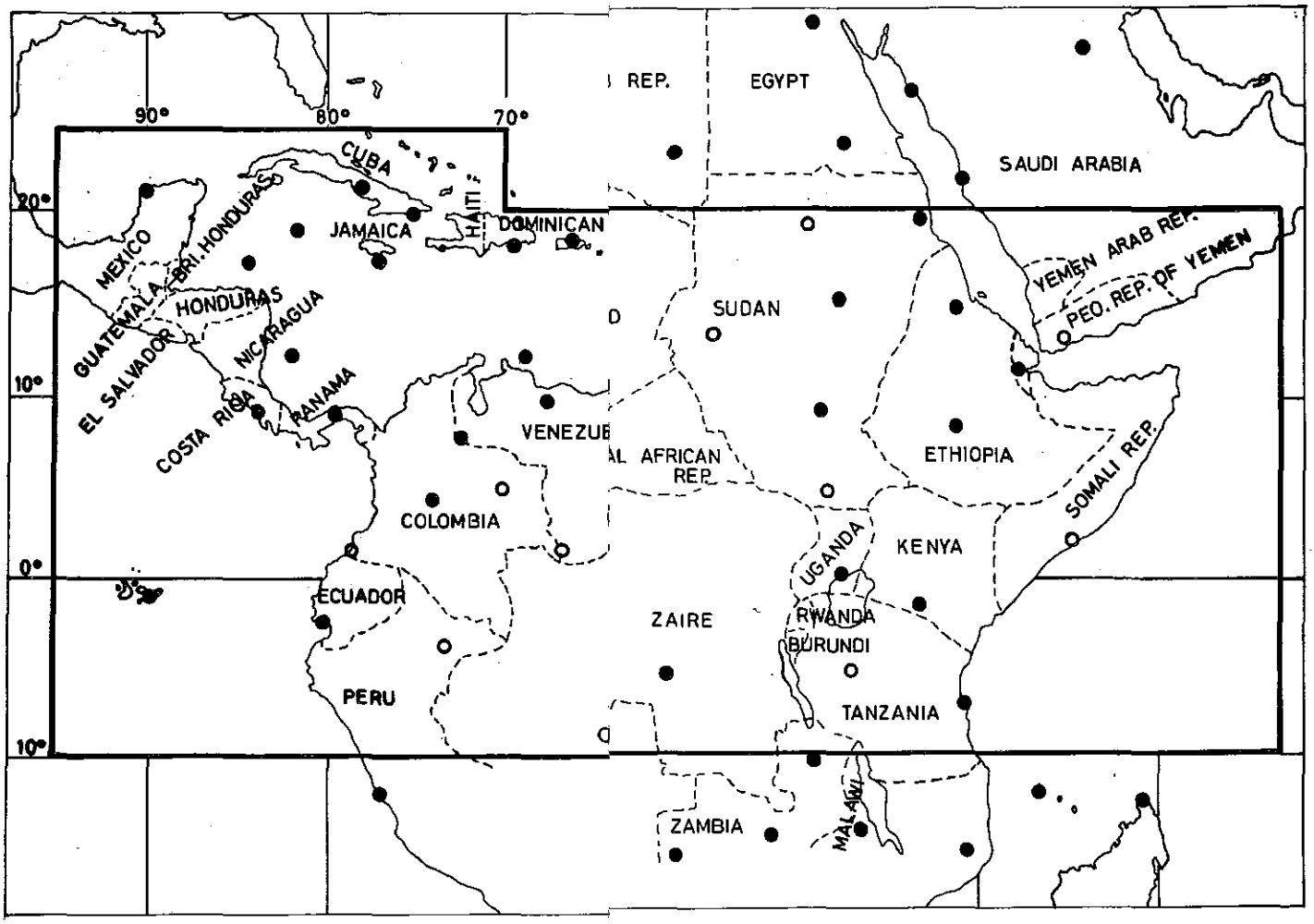
aircraft observing programme, instrumentation and flight operations;

oceanographic programme.

BASIC PROJECT INFORMATION

WHAT:	GATE: GARP ATLANTIC TROPICAL EXPERIMENT
WHERE:	Tropical Atlantic Ocean and adjacent land and island areas Special concentration: Eastern Atlantic, west of Dakar
WHEN:	Main Observational Phase: June 15 to September 30, 1974 Preliminary Tests: Summer 1973 Firm National Commitments: March 31, 1972
WHO:	Organized by World Meteorological Organization and the International Council of Scientific Unions Participants: Interested nations Managed by: the GATE Tropical Experiment Board (through its Scientific and Management Group - SMG) and the Tropical Experiment Council
HOW:	Co-ordinated international programme composed of national contributions of special observing platforms, facilities and personnel supplementing the existing World Weather Watch systems
WHY:	To understand and model the processes of organized, deep tropical convection and the interaction with the larger scales of motion which are essential determinants not only of the weather and climate of the tropics but of the global circulation of the entire atmospheric system.

TABLE 1



The designations employed and the presentation of the material on the map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

4. THE OBSERVATIONAL STRATEGY

4.1 A summary of basic project information is presented in Table 1 and a map showing the area of the experiment is given in Figure 1.

4.2 As noted in section 1, observations are required to characterize an extremely great range of spatial scales, both to define the significant features of the large-scale atmospheric circulation (the so-called A-scale) and to characterize the important convective processes (C and D-scales) which are organized into cloud clusters (B-scale). To provide the required observations, a composite observing system has been designed which includes geostationary and polar-orbiting satellites, the augmented WWW network of land stations, a special network of ship stations, instrumented aircraft, and possibly special balloon and buoy systems. Thus the final, complete data set must be obtained from the integration of complementary observations from a number of independent systems, none of which would suffice by itself.

4.3 The A-scale will be observed primarily by a network of fixed stations, ideally having an average lateral separation of about 500 kilometres, the same as that envisaged as a permanent requirement for the World Weather Watch (WWW). Over the land areas this requirement can largely be met by early implementation of already existing WWW plans, although some temporary or mobile stations may be needed. To provide adequate coverage over the oceans, however, requires the establishment of ship stations in the tropical Atlantic which are capable of making adequate surface and upper-air observations. It may be possible to improve the A-scale coverage if high-flying aircraft with wind-finding dropsondes also can be provided. More detailed specifications for the observational capabilities needed are given below and in section 5. A proposed network design, based on a number of scientific and practical considerations, is shown in Figure 1.

4.4 To examine the internal structure of oceanic cloud clusters which have a typical scale between 100 and 1,000 kilometres requires a finer network which can be established reasonably only in a limited area called the B-scale area. Based on analysis of available data concerning the nature and frequency of occurrence of the convective phenomena of interest, and also on logistical constraints, an area in the Eastern Atlantic centered near 10°N and 27°W has been selected. In this B-scale area would be concentrated some 15 of the total number of 25 to 30 ship stations envisaged, as shown in Figure 1. These B-scale ships, spaced about 200 km apart, will make more frequent observations during disturbed conditions, and a number will require radar for precipitation observations, as well as special instrumentation to make radiation, boundary-layer and oceanographic observations.

4.5 The most critical problem in data collection and compatibility will arise from the variety of observing techniques used by the participating countries. To achieve maximum consistency in the observing system it is recommended that the number of types of radiosondes should be reduced as far as possible, and that intensive intercomparison and calibration tests be performed between main observing systems prior to the beginning of GATE.

4.6 To investigate the convective cloud groups and cloud elements smaller than about 100 km across, instrumented aircraft will be used in conjunction with the ship radars and data obtained using the geostationary satellite. Since these aircraft need to operate within the B-scale ship network, which is some 1,000 km or more from the proposed base at Dakar, long-range aircraft are essential. Based on

analysis of several proposed flight configurations and tracks, it is estimated that up to 12 aircraft will be needed. In addition to flight-level wind and thermodynamic measurements, a few of the aircraft should be equipped to measure turbulent fluxes, sea surface temperature, radiation, liquid water content and to take cloud photographs. Weather radar and a dropsonde capability to measure vertical profiles in the atmosphere would also be very desirable.

4.7 Data to be obtained from satellites have great potential for GATE as new systems and techniques are being developed. Frequent day and night images from a geostationary satellite will provide an overall and detailed view of the observational area and will be invaluable for operations planning and control as discussed below. In addition, successive images allow determination of cloud-tracer displacements from which the wind field can be inferred. Also, data from ships, buoys and balloons can be collected, and graphical data can be relayed.

4.8 Polar-orbiting satellites will, by remote-sensing techniques, provide large numbers of atmospheric temperature soundings, sea-surface and cloud-top temperatures as well as day and night images. Experimental satellites may also provide advanced infrared and microwave sounders and various radiation measurements. Of special interest is a proposed constant-level balloon tracking experiment which could provide useful data if held concurrently with GATE. Constant-level stratospheric balloons carrying wind-finding dropsondes which can report through a satellite could also provide valuable measurements of vertical wind profiles over the broad oceanic area.

4.9 Although the oceanographic component of GATE is not yet as well developed as the meteorological part, interest is rapidly increasing and competent oceanographers are beginning to formulate a programme. The need is apparent for measurements defining the heat budget of the upper oceanic layers and the interactions with the atmospheric boundary layer. In this connexion, suitably instrumented moored or drifting buoys capable of making surface and subsurface measurements including currents are considered promising contributors to the observing system.

4.10 As noted in section 2, the scientific objectives of GATE are complex and the specific hypotheses and models to be tested do not admit unique or simple statements. Nonetheless, it has been possible to formulate a number of specific analytical approaches to the fundamental problems so that scientists can state with some confidence the type of data and general accuracy requirements. It is clear, for example, that wind measurements are critical and that the accuracy required is rather stringent. Fortunately, a new observational technique, using so-called "omega sondes", is becoming available which does not require that all ships be equipped with expensive stabilized radars. Even relatively simply equipped ships should be able to accept the required systems, and at a cost measured in tens rather than hundreds of thousands of dollars. Other critical measurements, such as precipitation using radar, boundary-layer and turbulence measurements are more demanding, but not all platforms require these. Thus it does not appear unreasonable to assemble the required capability. A partial summary of the accuracies required in some of the more common measurements, as formulated by the group of experts, is given in Table 2. A summary of the platforms needed is presented in the concluding section 7.

4.11 The number of observations made on board the ships should be as numerous as possible so as to reduce the statistical observational error. Surface observations should be made every three hours, in accordance with WMO recommendations. The number

MEASUREMENT ACCURACIES

Quantity	Minimum	Desirable	Remarks
Wind (m/sec)	± 2 m/sec absolute ± 1 m/sec relative	± 1.0 m/sec absolute ± 0.5 m/sec relative	Aircraft: 0.5 m/sec (relative) on D-scale
			Vertical Resolution: 2 km for A&B scale 300 m in boundary layer
Temp (°C)	± 1°C	± 0.5°C	Aircraft: 0.2°C (relative) on D-scale
Pressure (mb)	± 1 mb	± 0.5 mb	
R.H: (%)	± 10% at T > -10°C ± 15% at -10°C > T > -40°C	± 5% at T > -10°C ± 10% at -10°C > T > -40°C	Aircraft: ± 7% at T > 0° ± 15% at 0° > T > -40°
Sea Surface Temp (°C)	± 0.5°C	± 0.25°C	0.25°C desirable for D-scale

TABLE 2

of radiosonde ascents depends on the capacity of the ships for hydrogen or helium. A minimum of four ascents a day is needed, with a frequency of eight ascents a day during certain periods of GATE. Each ascent should measure upper winds at least to the 80-mb level. Over the continental network, two rawinsonde ascents per day are required. Each of these ascents should make wind measurements to at least the 80-mb level.

5. DATA MANAGEMENT

5.1 In order to ensure that high quality data are made available to the intended users in a suitable form and at the appropriate time, a data management plan is essential. It will not be sufficient merely to provide and deploy observational platforms in a co-ordinated system, no matter how sophisticated the instrumentation and no matter how accurate the sensors. As a general principle, all of the primary GATE data will be made available to all participating countries and to all interested users.

5.2 To the degree possible, existing facilities and capabilities should be used to achieve the collection, processing, transmission and archiving of the data. Each participating nation will assume responsibility for the initial processing and checking of the data collected by its systems and will provide these data in scientific units, in an agreed general format, and on standardized technical media to an appropriate international centre. The existing Global Telecommunication System, Regional Meteorological Centres (RMC's), World Meteorological Centres (WMC's) and World Data Centres will play a significant role. In addition a special operations control centre will have to be created to function during the operational phase of the experiment, as described in the next section, and a special GATE Data Centre is needed to receive and integrate the national data sets for eventual archiving in the World Data Centres.

5.3 Two primary classes of data can be distinguished according to the time lapse before use; (i) those needed in near-real-time, primarily for operational analysis and forecasting and for monitoring the performance of the observing system, and (ii) the research data directed to the scientific objectives. The former class will be provided primarily to Regional and World Meteorological Centres and the GATE Operations Control Centre by means of the Global Telecommunication System, although some special systems using satellites and radiotelecommunications will be needed to collect data from the ships.

5.4 The remaining bulk of the data will pass through national processing centres, and then to the GATE Data Centre. Most of these data will be transported physically, for example, on magnetic tapes, to the appropriate national facilities. It is planned that the observations taken during selected periods of a few days will be assigned high priority and processed within one month. These data will provide the basis for early scientific analyses and case studies, and should allow some possible adjustment of later observing phases. The data should be processed in national centres as promptly as possible, especially the "routine" data pertaining to the central programme. All data collected in GATE should be provided to the GATE Data Centre within nine to eighteen months.

5.5 The GATE Data Centre will catalogue, integrate, validate and reformat the data received from participating nations. It will make preliminary disseminations as required, and will provide the final data set to the World Data Centres within about two years, after which its existence can be terminated. The scientific analysis phase of GATE will, of course, continue beyond that time, but will be carried out largely in the institutions of the interested scientists.

5.6 As described below, it is absolutely essential that a carefully planned programme of common calibration and intercomparison of observing systems be carried out if a sufficiently homogeneous data set is to be derived from the composite data from various national systems. The data resulting from these comparisons will be equally as important as the observations of the phenomena of interest, and such data will be provided both to national centres and to the GATE Data Centre.

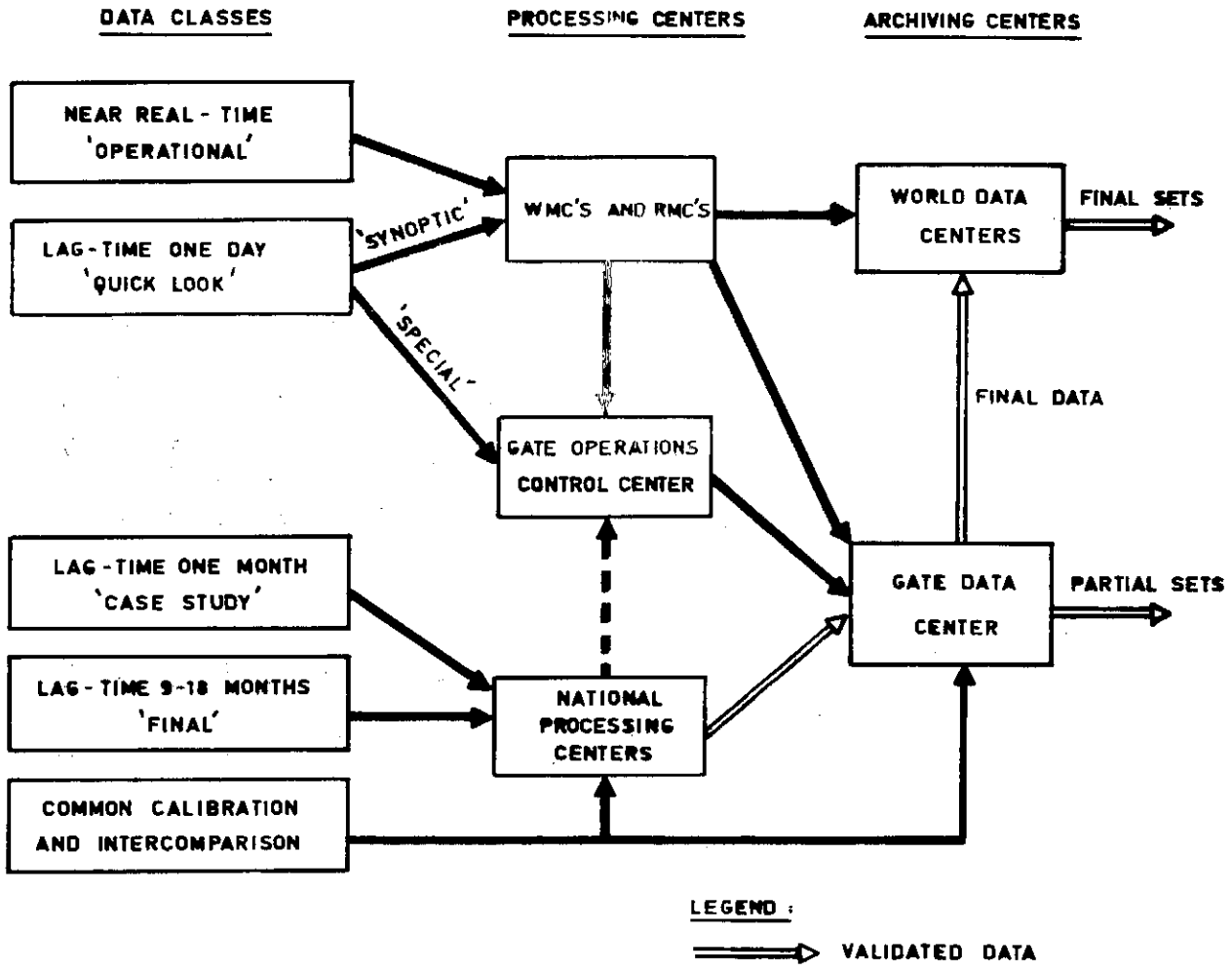
5.7 Figure 2 shows the basic classes of data and the logical flow between the various centres, and Figure 3 illustrates the geographical relationships of the centres and the layout of the Global Telecommunication System.

6. OPERATIONS AND SCHEDULES

6.1 A unique international project of this scope and magnitude must have complete international understanding, co-operation and support. Those problems normally encountered in a national programme become multiplied when dealing on an international scale with different platforms, equipment, sensors, techniques, etc.

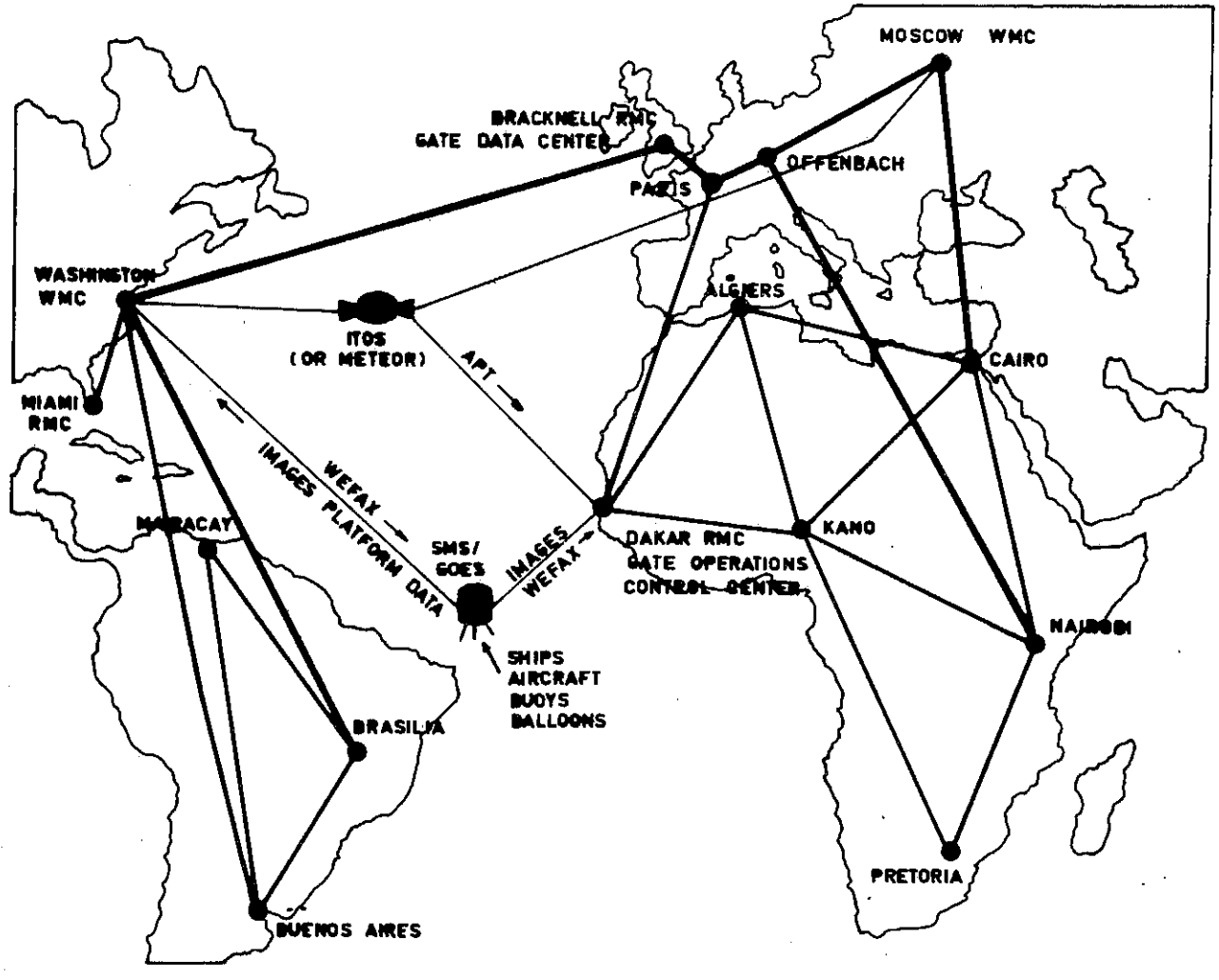
6.2 This international understanding and co-operation will result in a sizeable gathering of ships, aircraft and other sensing platforms in the Tropical East Atlantic in the summer of 1974. All platforms, equipped as described in sections 4 and 7, will operate in accordance with a schedule similar to the following:

Movement or Activity No.	Day	Activity
1	1 - 5	Trial runs and inter-comparison of the systems
2	6 - 8	In port
3	9 - 11	On passage
4	12 - 32	Project phase I
5	33 - 35	On passage
6	36 - 40	In port
7	41 - 43	On passage
8	44 - 64	Project phase II
9	65 - 67	On passage
10	68 - 72	In port
11	73 - 75	On passage
12	76 - 96	Project phase III
13	96 - 98	On passage



GATE DATA SYSTEM ELEMENTS AND FLOW

Figure 2



GATE DATA FLOW

GLOBAL TELECOMMUNICATION SYSTEM

Figure 3

6.3 Although it is anticipated that a secondary support facility for those platforms operating in the western portion of the A-scale area will probably need to be established, it is proposed that the main body of ships and aircraft would operate from Dakar, Senegal. Under this proposed plan, Dakar would serve as the major port and extensive use would be made of both aircraft and ship support facilities as well as the housing of crews while in port, although some A-scale ships in the most westerly parts of the area would use western Atlantic ports such as Barbados or ports in the north-eastern part of South America.

6.4 The GATE Operations Control Centre (GOCC) is also proposed for establishment at Dakar and would function as the nerve centre for the day-to-day operational control of the experiment. Although the basic operational plan will have been predetermined, a team of experts based at the GOCC will amend that plan as necessary on a daily basis.

The GOCC probably will receive some data directly from the ships and aircraft involved in the experiment. Such data would include sounding and radar data from ships, routine observations from aircraft, and also would involve image data from satellites.

6.5 These data, coupled with advice and forecasts received from the co-located Regional Meteorological Centre (RMC) and also via the World Meteorological Centres (WMC's) and other RMC's will be used by the GOCC in the direction of the experiment itself and for verifying the performance of observing systems. In this connexion and in the attempt to make use of existing facilities, it has been suggested that the RMC Nairobi and RMC Brasilia would serve as focal points for GATE in questions of observations, analyses and forecasts for Eastern Africa and South America respectively. The importance to the overall success of the experiment of such special analyses and forecasts for these areas cannot be over-emphasized.

6.6 Equally as important as the operational phase of the experiment and, in fact, prior to that operational phase, one must face the difficult problem of testing all aspects in an operational environment. To this end, it is planned to conduct a preliminary test of as many aspects of the observational system as possible in the summer of 1973, a year before the main period itself. Such an early test programme will serve to inter-compare and calibrate representative equipment and techniques to ensure reliability and compatibility of sensors and to ensure that meaningful data can be sensed, formatted, transmitted, analyzed, reduced and used in the manner intended. The importance of such an early test period cannot be over-emphasized.

6.7 No project can hope for success without setting forth a timetable leading up to the actual operational phase. Such a tentative timetable follows, and every possible effort must be made to adhere to it if the scientific and operational objectives are to be fulfilled.

1)	Commitment of major resources	31 March 1972
2)	Next TEB meeting	End April 1972
3)	Equipment on each platform	
a)	Definition of commitment	June 1972
b)	Installation for "early test"	July 1973
c)	Early test and comparability	Aug. 1973
d)	All installed and operational	April 1974
4)	Communications	
a)	Install on platforms and at GOCC	June 1973
b)	Test period	Aug. 1973
c)	Installed and operational	May 1974

5)	Support facilities and logistics	
a)	Listing of requirements	Sept. 1972
b)	International agreement	Dec. 1972
c)	Supply of test period needs	June 1973
d)	Final supply	April 1974
6)	Data management plan	
a)	Agreement on details	Oct. 1972
b)	Test period	Aug. 1973
c)	Final components operational	April 1974

7. NATIONAL CONTRIBUTIONS

7.1 In the preceding sections the basic plan of the experiment has been described, and the major national contributions required have been identified. For convenience, the major elements are tabulated here. Table 3 summarizes the various platforms needed to assemble the composite observing system, and Table 4 summarizes the special facilities and support needed.

7.2 Although the required commitments are substantial, they appear to be reasonably within the collective capability of the interested nations. The TEB, having considered the plan in some detail, concludes that the effort to mount such an experiment is certainly justified.

NATIONAL CONTRIBUTIONS

Proposed and Requested Platforms and Capabilities

Platform	No. Proposed	Basic Capabilities	Special Capabilities	Remarks
Land stations	Augmented WWW Plan	Wind profiles essential; other upper-air desired; surface obs.		2 soundings/day to 80 mb
Ships	27	Wind, temp. humidity profiles; surface meteorological observations; sea surface temp; ship position location	A-scale:at least some ships with STD in mixed layer (approx. 1000 m). B-scale: 8 soundings/day during intensive periods; STD 4/day; Radar (calibrated for precip. if possible); at least some with planetary boundary layer equip; surface radiation and radiometer sondes.	4 soundings/day to 80 mb (To 10 mb for equatorial stations); about 5 stations should be occupied continuously; fixed stations but possible mobility up to 100 km; In situ precip-obs.if possible.
Aircraft	A-scale * C-D scale 12	Winds, temp, humidity, pressure at flight level; position	A-scale: wind finding dropsondes; photo reconnaissance. C & D scales: At least some (3) with direct flux (gust probe) measurements; sea surface temp; radiation; liquid water content; cloud photography; dropsondes (wind) desirable.	Long range essential (4000 km total flight); at least 3 high level (30,000 ft) aircraft needed; 15-18 aircrews.
Geostationary satellite	1	Day & night images including B-scale area at short time intervals	Image enhancement; winds from cloud displacements; cloud-top temps; platforms data collection and relay; broadcast of graphical data (WEFAX)	Based on US GOES satellite plans
Polar-orbiting satellites	2	Day & night images; sea surface temps; vertical temp soundings; cloud-top temps.	Humidity estimates	Based on USSR meteor and US ITOS satellites
Research satellites	*	Tracking and data collection (e.g. balloons and buoys); advanced IR and microwave sounders; radiation fluxes and budget.		Based on US NIMBUS E & F satellites
Constant-level balloons	*	Drifting balloons at 150 mb (tracked by satellite) measuring temp, pressure, altitude; stratospheric balloons carrying windfinding dropsondes		Based on US NIMBUS F TWERLE and satellite carrier balloon system
Buoys	*	Surface and subsurface obs.	Ocean currents by tracking drifting buoys	Requirements not yet well developed; could provide improved surface wind and precip observations

* number to be determined

TABLE 3

APPENDIX D

LIST OF SOME SPECIFIC TASKS ASSIGNED TO SMG BY TEB-II

(chronologically, as they appear in the report)

Paragraph	
4.2	To prepare the experiment design proposal (Volume I of the ISMG report) for publication in the GARP Publications Series.
5.8	To develop the GATE operational plan including a plan for communications.
5.8	To continue study and evaluation of climatological and synoptic data presently available from the GATE area.
5.12	To continue the development of details of various GATE sub-programmes to ensure proper input from these to the central programme; especially needed is further development of the boundary-layer, radiation and oceanographic sub-programmes in the overall plan for GATE.
5.14	To study the possibility of carrying out cloud condition measurements by aircraft in more convenient localities, and their applicability to GATE.
5.16	To consider the possibilities of using means other than weather radar to measure rainfall amounts aboard the ocean observing platforms, and to draw up a plan for co-ordination of all precipitation measurements.
5.17 and 5.20	To prepare a test-operational plan of the observational and telecommunicational systems for GATE for the "early test period" in the summer of 1973 and to seek the collaboration of TEC for these purposes as appropriate.
5.18	To follow closely the development of OMEGA wind-finding techniques and to advise participating countries on its use during GATE as widely as possible.
5.19	To work toward specific agreements of the participating nations to use identical observing tools and methods wherever possible and to prepare plans for inter-comparison and calibration test prior to GATE.
5.21	To give consideration of the need for a "contingency plan" for the conduct or postponement of the experiment in the event that major observing components such as satellites could not be provided.
5.22	To prepare detailed requirements for the GATE Operational Control Centre (GOCC) and GATE Data Centre (GDC).
5.24	To work further on the development of the data management plan once the available resources are known.
6.2	To study the impact on the Preliminary Plan for GATE of the firm commitments made by the countries and present specific suggestions to TEB-III.
6.5	To give attention to the media and formats to be used for recording the observations during GATE.

Facilities Proposed and Requested

TYPE	REMARKS
National Processing Centres (NPCs)	Capable of accepting data from all national sources for prompt processing, validation and submission to the GDC.
World and Regional Meteorological Centres (WMCs, RMCs) and World Data Centres (WDCs)	Capability for special analyses and forecasts for operations; special processing and archiving of satellite data.
Global Telecommunication System (GTS)	Installation of high-speed Paris to Dakar link; transmit data from Tropical Africa and South America stations; arrange for special GATE analyses to be passed from WMCs and RMCs to GOCC: overall scheduling problems must be resolved.
GATE Operations Control Centre (GOCC)	Co-location with RMC at Dakar; communicate with ships and aircraft; control mission schedules; plan aircraft operations; monitor platform status; participate in special forecasts; collect and relay data from ships and aircraft; interpret operationally satellite image, radar and special aircraft data; responsible for quality control; preliminary scientific analysis; access to data-processing equipment.
GATE Data Centre (GDC)	Upon receipt of data from NPCs, undertake final validation; arrange and reformat standard synoptic data and analyses for storage and retrieval; produce preliminary and final composite data sets; publish data catalogues and disseminate to participating nations on request; provide final data sets to world data centres upon completion; access to sophisticated data-processing equipment and associated technical personnel.
Communications	Ship-to-aircraft; routine communications between GOCC and ships and aircraft; air traffic control; collection of data from ships and aircraft; capability to receive critical satellite data at the GOCC.
Support	Search and rescue services; air traffic control; air landing rights; refueling both aircraft and ships; central calibration facilities; pier support; harbour pilots; packing and crating service; ships' supplies; airlift for supply and equipment; re-supply ships and tenders; medical facilities; warehousing; space for GOCC and field HQ; mail service; cable service; interpreter services; aircraft maintenance, etc.
SMG	Long-term experts

TABLE 4