

SCAR

SPECIAL COMMITTEE ON ANTARCTIC RESEARCH

BULLETIN

ARGENTINA AUSTRALIA BELGIUM
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NORWAY SOUTH AFRICA UNITED KINGDOM
UNION OF SOVIET SOCIALIST REPUBLICS
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2 September 1960***Present:** President: G. R. Laclavère

Delegates: Argentine, R. N. Panzarini; Australia, K. E. Bullen; Belgium, J. van Mieghem; Chile, D. H. Fuenzalida; France, G. Weill; Japan, T. Nagata; New Zealand, R. W. Willett; Norway, T. Gjelsvik; South Africa, J. J. Taljaard; United Kingdom, G. de Q. Robin; United States, L. M. Gould; USSR., M. M. Somov; IGU., V. Schytt; IUBS., E. B. Worthington; IUGG., G. R. Laclavère.

Observers: SCOR., G. E. R. Deacon; WMO., K. Langlo; International World Day Service (invited), A. H. Shapley.

Advisers: Australia, R. Carrick, H. A. de Dassel, W. J. Gibbs, F. Jacka, R. E. Knightley, B. P. Lambert, D. F. Martyn; Belgium, F. Bastin, Mlle P. Doyen, J. Loodts, R. Schoonlau; France, J. Alt, R. Bost, A. Cailleux, Mlle J. Laclavère, A. Lebeau, R. Merle, J. Prevost, R. Rolland; New Zealand, V. Armstrong; M. A. F. Barnett, R. H. Clark, J. W. Gadsden, R. S. Unwin; Norway, S. Helle, K. Z. Lundquist; South Africa, J. A. King, P. W. Thomas; United Kingdom, Sir Miles Clifford, S. Evans, Sir Vivian Fuchs, M. W. Holdgate, H. H. Lamb, A. F. Moore, W. R. Piggott, A. H. Sheffield, W. D. C. Wiggins; United States, A. P. Crary, R. C. Cross, J. Jones, R. C. Peavey, M. J. Rubin, M. D. Turner, D. M. Tyree, G. D. Whitmore; USSR, V. L. Lebedev.

(1) The Meeting expressed deep regret at the loss of eight scientists in the fire at "Mirnyy" station in August 1960.

(2) *Finance.* The Finance Sub-Committee reported a balance in hand on 31 December 1959 of \$3,422.66. Their recommendation that the 1961 subscription from member countries remain at \$500 was accepted. The possible need to increase this amount in 1962 was noted.

(3) *Antarctic Symposium at Buenos Aires.* The meeting expressed thanks to Argentina for this notable Symposium. Argentina is arranging the publication of all papers in seven volumes, the first of which, *General Organization and Exploration and Geography*, is almost ready. Six thousand copies are to be distributed free of charge.

(4) *Poland.* It was reported that Poland had not sent a wintering party to Antarctica, so was not yet eligible to join SCAR.

(5) *President.* Ing. Gen. G. Laclavère was re-elected President for a 3-year term by unanimous vote.

(6) *International Antarctic Analysis Centre.* The meeting thanked Australia

for operating this important centre, and Argentina, Australia, France and the United States for providing meteorologists there. The work so far accomplished had been very worth while, but much more could be done if additional staff could be recruited from other countries, and if radio communications could be further improved.

(7) *SCAR Indian Ocean Project*. The value of observations which could be made by SCAR ships in the southern part of the Indian Ocean was emphasized.

(8) *Annals of the IGY*. Although CIG is primarily responsible for the volume on the Antarctic programme, the co-operation of SCAR is needed. Two suggestions made will be forwarded to CIG for consideration. One is that the volume contain sections on Organization, Operations and Scientific programmes, while the alternative proposal is that each country active in the IGY Antarctic programme should prepare a chapter on its work covering the years 1959-60.

(9) *Symposium on Biological Research*. An approach to the International Union of Biological Sciences to ask that they act as co-sponsors of an international Symposium on Antarctic Biology to be held in about two years time was approved.

(10) *Register of scientists*. A draft letter was approved for circulation through ICSU to scientific organizations in non-SCAR countries, in addition to circulation to National Committees of SCAR, announcing that the SCAR secretariat proposed to maintain a Register of Scientists willing to work as members of Antarctic expeditions sent out by nations other than their own. Scientists were invited to submit their particulars to the Secretary on a form to be circulated with the letter.

(11) *SCAR and the Antarctic Treaty*. Several delegates reported that they had received communications from their respective Governments in general expressing the following views:

- (a) The free exchange of information and views among scientists participating in SCAR, and the recommendations concerning scientific programmes and co-operation which have been formulated by SCAR, constitute a most valuable contribution to international scientific co-operation in Antarctica.
- (b) The Governments recognize that these activities of SCAR constitute the kind of activity contemplated in Article III of the Antarctic Treaty, now pending ratification.
- (c) It is the intention of the Governments to encourage SCAR to continue this advisory work which is so effectively facilitating international co-operation in scientific investigation in Antarctica.

(12) *Nuclear reactor in Antarctica*. Dr Gould announced that it was planned to install a nuclear reactor, of 1500 kW. capacity, at "NAF McMurdo" in order to provide electrical power for the United States station there. It was hoped to have the reactor in action by March 1962. Extreme care was being taken to ensure that no radiation hazard would be caused by this, and possible later reactors at other United States Antarctic stations.

(13) *IUPAC*. It was decided to invite the International Union of Pure and Applied Chemistry to appoint a geochemist as a delegate to SCAR to assist in the standardizing of techniques of analysis and reporting systems.

(14) *Reporter on Geomagnetism*. Professor T. Nagata was appointed Reporter on Geomagnetism in order to lessen the load of work carried out by Dr Schneider, reporter for upper atmosphere physics.

(15) *Permanent Working Groups*. The meeting approved the formation of the following working groups:

- (a) Geology. Chairman, R. W. Willett.
- (b) Meteorology. Chairman, W. J. Gibbs.
- (c) Biology. Permanent Secretary, R. Carrick.
- (d) Logistics. Chairman, Rear-Admiral, D. M. Tyree, USN. Secretary, A. P. Crary.

These are in addition to:

- (e) Cartography. Chairman, Ing. Gen. Laclavère. Secretary, B. P. Lambert.
- (f) Communications. Chairman, A. H. Sheffield.

The President stressed the fact that SCAR did not have the funds to finance meetings of permanent Working Groups. The normal method of work should be by correspondence. However, if an emergency in communications should arise, the Chairman of that group could call a meeting if necessary. The Secretary of SCAR should be kept fully informed on the activities of Working Groups.

(16) *Assessment of the progress of Antarctic research during 1959-60*. See Appendix I.

(17) *Amendments to scientific investigations recommended by SCAR*. *SCAR Bulletin*, No. 3, 1959. A number of amendments were proposed by Working Groups and accepted by the Plenary Session subject to ratification by National Committees. These are being circulated and those that receive ratification will be published in *SCAR Bulletin*, No. 8.

(18) *Recommendations of working groups (including a resolution by the Plenary Session on Biology)*. See Appendix II.

(19) *Time and place of next meeting*. The invitation for the next meeting to be held in New Zealand was accepted, and a date in September or October 1961 was suggested.

(20) The President thanked the Royal Society and the Scott Polar Research Institute for the invitation to hold the meeting in Cambridge, the admirable arrangements made for the meeting and the hospitality extended to delegates and observers.

APPENDIX I

ASSESSMENT OF THE PROGRESS OF ANTARCTIC RESEARCH DURING 1959/60

Working groups were asked to review the progress of scientific research in Antarctica in various disciplines. In most cases preliminary papers had been prepared on the basis of information supplied by specialists from SCAR countries. Although the information was not always complete, and although specialists may differ on some

of the statements, it is considered that publication of these reviews in the *SCAR Bulletin* will be of general interest. The list of members of each working group is given when the group discussed the reviews. The name of the principal author of each review is given at the end of the review, but it should be emphasized that the final document is a compromise between the views of the author and those of the working group.

Meteorology

The following statements give the views of individual authors, since time did not permit a careful study of the reviews by the working group.

A. General studies

Since the IGY many meteorologists have studied data from the Antarctic and the results of their investigations have been presented in a number of scientific journals and at the Symposium on Antarctic Research in New Zealand, February 1958; the Symposium on Antarctic Meteorology, Melbourne, February 1959; and the Antarctic Symposium in Buenos Aires, November 1959. At these Symposia, a considerable amount of new material was presented on the general circulation in Antarctica and adjacent regions, the heat and moisture budgets, the interaction of Antarctic and lower latitude synoptic processes, local effects in the Antarctic and the air flow in the friction level over the Antarctic continent, particularly with reference to katabatic winds. In these fields there have been very significant advances in meteorological knowledge—where formerly there was only meagre data and tentative ideas there is now a very great volume of information and well documented studies.

The study of the Antarctic stratosphere has also advanced greatly and the rapid spring warming and strong westerly stratospheric winds are much better understood.

Some preliminary results have been secured on ozone content in the Antarctic atmosphere and more of this type of information is needed, particularly the vertical distribution of ozone as measured by ozone sondes. This information is likely to be valuable in the study of stratospheric circulation using ozone as a tracer.

A study of the mutual influence between pack ice and atmosphere has progressed only slowly and the importance of this subject certainly warrants a greater volume of attention from meteorologists.

Although considerable advances have been made in the study of the meteorology of the Antarctic it should be emphasized that at least 10 years' observations are necessary to make the results conclusive.

W. J. GIBBS

B. Synoptic observations

The SCAR objective in maintaining the IGY network of surface and upper air observations has been achieved. However, the large oceanic areas have in general remained as serious gaps in the meteorological network.

The routine and operational use of meteorological information has been achieved by the continuation of the IGY communication system, but although this has worked reasonably well there is a definite and urgent need for improvement.

The question of accessibility of Antarctic meteorological data is one to which SCAR should give serious consideration. Data from the IGY and IGC periods have been collected at the WMO Meteorological Data Centre, but SCAR should be active in collaborating with WMO to see that this and subsequent data are readily accessible to all research workers interested in Antarctic meteorology.

W. J. GIBBS

C. Special observations

Renewed emphasis could well be given to the following studies:

surface ozone,
sastrugi,
aerial determinations of albedo,
atmospheric and precipitation chemistry,
ice crystal morphology,
total ozone,
aerosols,
blowing snow.

Extracted from letter of H. Wexler.

D. Atmospheric nuclear radiation

Measurements of atmospheric radioactivity in 1959 were made at "Roi Baudouin" (Belgium); "Little America" and "Amundsen-Scott South Pole" station (U.S.A.) and "Dumont d'Urville" (France).

There are thus three coastal and one inland stations measuring the radioactivity of the atmosphere. This represents a minimum acceptable programme on the Antarctic continent, provided that these four stations continue to function, but it would be very desirable to increase the density of stations.

The recommendations of the CSAGI Working Group on Nuclear Radiations have only been partly followed as far as these concern measurements of tritium and carbon 14 in the atmosphere and the ice.

Attention is drawn to the value of such studies in relation to numerous meteorological and glaciological problems.

E. PICCIOTTO

J. VAN MIEGHEM

E. Rockets, and F. Acoustic probing of the upper atmosphere

No progress in these fields has been reported.

International Antarctic Analysis Centre

The International Antarctic Analysis Centre had continued to operate since its formation in Melbourne early in 1959. Australia has provided accommodation and communication facilities, a staff of twelve assistants and a professional meteorologist as Leader for the Centre. The United States and France have provided professional meteorologists as has the Royal Australian Navy. A senior Argentinian meteorologist will join the centre during late 1959. With the present professional staff an analysis programme embracing routine surface, 700, 500 and 300 mb. daily analyses has been achieved, but the facilities and assistant staff available at the Centre warrant a larger number of professional meteorologists to undertake a comprehensive research programme in addition to the routine synoptic analyses. Only a small amount of research is possible at present with the existing professional staff.

The analysed charts and diagrams are microfilmed and copies provided free of cost by Australia to all SCAR nations.

W. J. GIBBS

Upper Atmosphere Physics

F. Jacka (convener), S. Evans, J. W. Gadsden, D. F. Martyn, T. Nagata, R. C. Peavey, R. S. Unwin, G. Weill.

A. Ionosphere

The actual data obtained during the IGC 1959 is not, as yet, available. Preliminary reports suggest that the situation is not very satisfactory. An appreciable part of the IGY network has either stopped work or changed to a minimum schedule which is too small for serious research to be carried out efficiently. In particular, a number of important stations have only obtained ionograms at hourly intervals. Although hourly reduction initially is sufficient for most purposes, more frequent soundings are needed for detailed research.

The ionospheric phenomena appear to be dominated by movements of ionization, both vertically and horizontally, and special experiments are needed to find out the directions of these movements. This calls for a temporary group of relatively closely spaced stations. It is important to try to use several techniques since the movements of a layer are often different from the drift of the ionization, and also since different methods are useful at different levels of magnetic activity. It is probable that a backscatter equipment, placed well outside the auroral zone in the Weddell Sea area, would give a general survey of major layer movements in that zone very economically, though in general this technique is difficult to use at high latitudes.

In view of the limited effort available, there are considerable advantages to be gained by concentrating efforts in particular areas, keeping, of course, a skeleton network in being for general morphological studies. Much useful work could also be done economically by summer expeditions planned to solve particular zonal problems disclosed by the IGY survey.

The following abstracts from the *WWSC Third Report* (Brussels 1959) apply particularly to the Antarctic group of stations:

"SECTION V. IONOSPHERIC VERTICAL SOUNDINGS AFTER 1959

The Committee considers that the present stage in the development of the subject calls for special attention to:

(a) The maintenance of an adequate network of stations to provide accurate data for geophysical and propagational studies on a world-wide basis;

(b) The concentration of stations, and the maintenance of particularly intense programmes of observation and reduction, in zones where close networks of stations provide the possibility of resolving particularly important ionospheric problems by regional study, and the re-allocation of stations to zones where active research is progressing."

The Committee stressed the importance of maintaining new stations and of making a special effort in sunspot minimum years and stated:

"It is clear that the requirements of space research will involve a considerable new effort in ionospheric soundings which was not anticipated before the IGY."

The greatest efforts to improve the operation of existing stations, and to add special additional programmes, are needed in two zones:

The Weddell Sea-South Africa area, which contains the zone where the magnetic dip is abnormally small and the phenomena correspondingly simple.

The Ross Sea-New Zealand area, which contains the opposite extreme.

IGY studies show two major gaps in the existing programme:

(a) The measurement of absorption, particularly the dense types associated with storms, is very inadequate. It is probably too late now to attempt to study Type 3 absorption with riometers in the Southern Hemisphere, but a special effort is needed to make riometer studies of storm absorption (Type 2).

(b) Measurements of ionospheric drift on both sides of Antarctica are badly needed. These are very difficult to obtain in years of large magnetic activity, and special efforts should be made in the next few years.

It is probable that gaps in the network could be partly covered by using special techniques, for example, oblique incidence soundings between suitably spaced stations, though very little practical experience has as yet been obtained. These measurements have usually been used for communication problems only.

Analyses already completed show that there are special advantages in establishing, if possible, ionospheric measurements at the following positions:

- (a) At or near "Norway" station.
- (b) A station in the Bellingshausen Sea area, possibly near lat. 70° S., long. 88° W.
- (c) A station in South Georgia or the South Sandwich Islands.
- (d) A station near lat. $85-80^{\circ}$ S., long. $20-40^{\circ}$ W. to link the South Pole with the Weddell Sea group of stations.
- (e) The re-establishment of the station at Marion Island.

Where several sites are possible, there are special advantages in putting stations near conjugate points of stations in the Northern Hemisphere. Active work is progressing at present on conjugate point studies of whistlers, blackout, and sporadic E.

W. R. PIGGOTT

B. Aurora and Airglow

The network of observing stations has been maintained, and in some cases extended, in the Antarctic, with some coverage of the sub-Antarctic regions. Observations comprised the classical visual and all-sky camera programmes, together with still photography and moving pictures. Spectrometric and photometric work was extended. Several stations have been using auroral radar as a powerful means of observation, and in this way it is expected to obtain useful information on the movement of ionization. Radio noise studies from aurora are also being carried out, as well as riometer observations of relative ionospheric opacity.

Observational methods and techniques were the subject of special studies, and attention was given to the relative merits of visual and automatic photographic observation of aurora. Progress was reported in the use of colour film in all-sky cameras, and also in detecting subvisual features by means of sequences of varying exposure times.

Much progress was made in analysing the correlation between magnetic disturbances, the occurrence and motion of specific morphological features observed visually or by radar and the appearance and intensity of spectral emissions. Indices of magnetic activity, as well as pulsations, were considered in these studies and the correlations are far from being simple.

Isoauroral maps for limited regions were prepared by several research workers. Although much progress is being achieved, the problem of definition and location of the auroral zone as a whole, and its time changes, is not yet solved in a satisfactory manner.

More rapid progress is desirable in statistical and synoptic analysis of existing data. Statistical analysis is an essential preliminary step to several of the aims stated in the SCAR programme for aurora and airglow; this part of the work should be extended, and should comprise more regional or even hemispherical studies, as are already being done successfully in some branches of upper atmosphere research. So far, synoptic studies have only been possible to a rather limited extent. Slow progress is also being made in auroral height determinations, although new preparations in this direction are under way.

O. SCHNEIDER

C. Geomagnetism

General. Since the IGY, quite a good network for geomagnetic observation over the Antarctic continent has been set up. The density of magnetic observatories in the Antarctic is now nearly sufficient to follow the distribution of geomagnetic daily variation as well as geomagnetic disturbances in this region, especially in comparison with those in the Arctic. Some of these data, though not all, are currently flowing in to the IGY World Data Centres for geomagnetism, and are used for morphological studies on geomagnetic variations over the whole earth. Several remarkable results of such studies were reported in the Buenos Aires Symposium on Antarctic Science.

So far as research on daily and disturbance variations in the geomagnetic field in the Antarctic continent is concerned, it does not seem necessary at present to increase the number of magnetic observatories, but it seems desirable to maintain the present network during the coming sunspot minimum period. However, it must be remarked that there is a great gap between the Antarctic network and the existing network of magnetic observatories in southern countries, Australia, New Zealand, Chile, Argentina and South Africa, except for Macquarie Island and the South Orkney Islands. This situation causes some difficulty in obtaining complete pictures of distribution of geomagnetic variations in the southern hemisphere. In order to fill the gap, it seems desirable to encourage the setting up of magnetic observatories on as many islands as possible in sub-Antarctic areas, such as South Georgia, Crozet, etc.

In this connexion, pen-recording magnetographs may be satisfactory at any station which has insufficient scientific personnel to operate a magnetic observatory of the usual type. Four years' operational experience at "Dumont d'Urville" has shown that this type of instrument is capable of adequate stability and sensitivity while being simple to establish and maintain.

Difficulty has been found in research on geomagnetic secular variation, which is exceptionally large and complicated in Antarctica compared with any other part of the earth's surface. In order to overcome this difficulty, it is recommended that repeat magnetic stations for three components be set up at sub-Antarctic islands, such as South Georgia, Crozet, Bouvet, New Amsterdam, St Paul, Heard, Gough, etc.

Research on geomagnetic disturbances. In the light of recent progress in upper atmosphere and space research, studies on geomagnetic disturbances and related phenomena (auroral displays, ionospheric disturbances, etc.) in the Antarctic have become extremely important. Preliminary studies have already been made, the results showing several promising ways to attack space electromagnetic problems by well-planned co-ordination between mutually conjugate stations in the Antarctic and Arctic.

Magnetic surveys. Results of magnetic surveys made by many traverse parties in the Antarctic in the past few years are very useful for correcting adequately the existing magnetic charts which were compiled from rather poor data. It seems now desirable to take action to compile new magnetic charts based upon the data already available.

T. NAGATA

Cosmic Rays

In the period since January 1959, cosmic ray stations in the Antarctic region have provided valuable records of ground-level intensity and continue to occupy important positions in the world network of observing stations. The long-term objectives of the programme remain unchanged.

In relation to these objectives, maintenance of the programme during the period has been particularly rewarding, as several outstanding solar-related disturbances in cosmic ray intensity have occurred. The most interesting of these events have been the Forbush-type intensity decrease in May 1959, the unusual series of super-

posed intensity decreases of the Forbush-type in July 1959, and the well-defined example of a sudden large intensity increase associated with a solar flare on 4 May 1960.

The value of the ground-level observations at points well distributed in latitude and longitude is enhanced by the increasing availability of supplementary information from measurements of high altitude balloon-borne equipment, earth satellites, and space probes, and substantial progress is expected towards an understanding of the mechanisms controlling such disturbances when analyses of all records are further advanced.

Balloon-borne experiments have so far been carried out mainly in the northern hemisphere. Advantages in extending such work to high southern geomagnetic latitudes are evident and participating groups should examine the possibility of such work at Antarctic stations.

Coverage of the Antarctic region with standard ground-level intensity recorders is now rather better than in previous years and every effort should be made to maintain the existing observatories in the Antarctic, and indeed throughout the world, to accumulate records at all phases of the solar activity cycle. The value of concurrent auroral, magnetic, ionospheric and radio noise observations in elucidating the mechanisms of solar-initiated geophysical disturbances is stressed and it is hoped that wherever possible these programmes can be maintained at a high level.

F. JACKA

Geology

R. W. Willett (Chairman), A. Cailleux, V. E. Fuchs, T. Gjelsvik, L. M. Gould, M. M. Somov.

The progress of geological regional mapping in the Antarctic has been reasonably steady over the last summer season with an increase in geological activity devoted to special problems and special collections for related sciences.

The Argentine geologists have continued regional work in the Ardley Peninsula, King George Island. Previous work on the geology and petrology of Potters Cove in the same island is in the press and an annotated bibliography of Antarctic Geology has been published.

Australia has carried out geological work leading to 1:250,000 mapping of Edward VIII Gulf, Vestfold Hills, Rauer Group, Larsemann Hills and Fyfe Hills, all areas of high-grade metamorphic rocks. In the Vestfold Hills lake studies have been pursued and rock samples collected for age and palaeomagnetic measurements. In Vincennes Bay, Davis Bay, Henry and Chick Islands, geological reconnaissance has been completed.

Belgian parties worked in east and west regions of the Sor Rondane Mountains mapping the metamorphic rocks of this massif. Isolated nunataks were visited, those of Nord, Romnoes and Seal were found to be massive intrusives. Within the crystalline rocks calcareous lenses were observed. The work was concentrated in the Gunnestadbreen and Hargreavesbreen regions.

Chile is each summer continuing petrographic field study and sampling, mainly to study the relations between igneous bodies in Antarctica and those of Tierra del Fuego-Patagonia. This material is being studied at Santiago during the winter and reports will be published in the near future.

Within the area under action by the Falkland Islands Dependencies Survey, detailed 1:25,000 and 1:5,000 geological mapping has been carried out in the James Ross Island group and west coast of Crown Prince Gustav Channel, Argentine Islands, south-west part of King George Island, Neny Fjord area of Marguerite Bay and parts of north coast of South Georgia. Reconnaissance mapping greater than 1:250,000 was carried out over the north-east part of Livingston Island.

French expeditions based on "Dumont d'Urville" have made petrographic studies on the island of Archipel, together with petrographic studies of moraines at Pointe Géologie and glacial morphology studies.

Both expedition and base activities of the Japanese Antarctic work have resulted in certain geological and geomorphological studies in the vicinity of "Syowa" base, and this work is being continued by the present winter party.

New Zealand continued regional geological work following a pattern started in 1956. During the year under review an area between Barne Inlet and Shackleton Inlet was mapped at a scale of 1:250,000. Between Shackleton Inlet and the Beardmore Glacier the work was of reconnaissance nature only as a result of the loss of a Sno-cat with tragic consequences and the loss of an aircraft. A further area to the south-east of the Beardmore Glacier was mapped in detail by the New Zealand Alpine Club survey party, while the Victoria University expedition continued work in the dry valleys of the Wright and Victoria Glaciers area. Mapping of the entire dry valley area was completed.

Geological work under the sponsorship of the United States National Science Foundation mapped in the Taylor Glacier Dry Valley areas and the Windmill Islands. Geomorphological studies, ice movement, wind drift, etc., were made in the Wilson Piedmont and Taylor Glacier Dry Valley areas and in the McMurdo Sound region. Rock collections for age determination and rock weathering studies were made in the Royal Society Range, Taylor Dry Valley, Marble Point and Gneiss Point.

The Soviet Union continued geological work during the summer of 1959/60 in the mountains south of "Lazarev" station. The work has followed the same programme as that of the previous 1958/59 summer.

R. W. WILLETT

Crustal Geophysics

K. E. Bullen (Chairman), R. H. Clark, A. P. Crary, G. E. R. Deacon, T. Nagata, G. de Q. Robin, V. Schytt.

A. Seismology

Report on progress. These notes deal with the station seismology as ice-thickness measurements by seismic methods are dealt with under Glaciology.

Station activity. Station activity has continued at approximately the same level as during the IGY. It is clear that there are not sufficient stations as yet to enable more than a few shocks in Antarctica proper to be located each year.

Antarctic seismicity. All investigations show that the seismicity of Antarctica is abnormally low. Local minor shocks have been recorded at "Scott" base and at Halley Bay. On the other hand Antarctic stations have located many epicentres not detected by other stations which were a limited distance to the north of the continent. These epicentres have been found in the Ross and Weddell Sea areas, in the vicinity of the Balleny Islands, and also in the region between Antarctica and the southern continents.

Crustal structure. Refraction shooting has yielded some *P*-wave velocities in rocks beneath the ice sheet. Measurements of dispersion of surface seismic waves over various Antarctic paths has been made with a view to estimating the depth to the Mohorovicic discontinuity. Some of these results indicate a crustal thickness of order 35 km. for part of "East" Antarctica while some other interpretations are still tentative.

Distant earthquakes. Most stations have recorded numerous distant earthquakes, and so contributed to global seismology.

The United States Coast and Geodetic Survey reports that data from Antarctic seismological stations have enabled improved determinations to be made of distant epicentres, and have in particular proved valuable in studies of the Earth's core.

Microseisms. There is some evidence that Antarctic 3 to 10 sec. microseisms are less in winter than in summer. This is in contrast to what happens in temperate countries where winter storms produce greater activity. There are probably two main sources, associated with depressions passing to the northwards and with coastal waves. The lower activity in the Antarctic winter may be due to the pack ice keeping waves away from the coast. Further study might allow changes in mean activity to be used as some indication of the extent of the pack-ice fringe.

K. E. BULLEN

B. Glaciology

The extensive operations of inland expeditions to determine the general features of the Antarctic ice were continued during the 1959 season. A notable contribution was made by the USSR with a line of stations from "Komsomolskaya" to "Vostok" to the United States South Pole station, linking the USSR network of "east Antarctica" traverses to the British Commonwealth Trans-Antarctic Expedition profile made in 1957-58. The average thickness of the ice along this USSR profile was about 3290 m., and the average elevation of the ice sheet 3240 m. indicating that the level of the subice rock is about sea level. The United States sent two traverse teams into the field in 1959, one to the Victoria Land plateau where a line north-west from the Skelton Glacier connected to the southernmost point of the French traverse of 1957-58, then ran due east to the mountainous area south of Rennick Bay. In the area covered by this traverse most of the bedrock was found to be below sea level. In Marie Byrd Land a traverse operated between the "Byrd" station and the Amundsen Sea with most of the area having relatively thin ice. Exposed ranges and nunataks were mapped and some coastline ice shelf delineated. Extensive ice thickness studies were also made by the Belgians in 1959 from the "Roi Baudouin Base" to the Sør-Rondane Mountains and the polar plateau.

The need is stressed for determination of the variation of *P*-wave velocity at depths below the surface layers. Full presentation of such data is necessary. In addition travel times of reflexions and source data should be included in reports.

At all stations on the Antarctic continent not located on a rock surface, measurements of the accumulation and/or ablation at the surface continue. An important contribution was made by the re-measurements of accumulation and surface elevation by Norwegian scientists at the "Maudheim" station which was last visited in 1952. At many Antarctic stations pit studies of stratigraphy, temperature at depth and crystal character are under routine investigation.

Absolute and relative movement studies of the ice, floating in some cases and grounded in others, are being carried out near the stations of "Scott", "Roi Baudouin", "Norway", Halley Bay, "Ellsworth", "Byrd" and others. Movement stakes were located, and in some instances re-surveyed, in five glaciers of the Sør Rondane Mountains. Measurements were made of the volume of ice flow from the Skelton Glacier on the western side of the Ross Ice Shelf in 1959. The initial survey was completed along the northern front of the Ross Ice Shelf for re-surveying in 1962 or 1963. At many stations special observations are contributing to glaciological knowledge such as geochemical studies, snowdrift problems, sea ice investigations, etc.

Attention of the SCAR delegates is invited to new fields of glaciological research that have been suggested. These include thermal conductivity measurements in the snow and firn layers, electrical properties of drifting snow, measurements of melting at the bottom of shelf ice and location of the transition zone from temperate

to cold ice along the Antarctic peninsula. Other observations for which increased activities have been suggested are measurements on glacier discharges, long-term budget studies and increased seismic velocity determinations for the subice rock material.

A. P. CRARY

C. Gravity

Many new gravity stations were occupied in Antarctica during 1959. On the traverses of the USSR between "Komsomolskaya", "Vostok" and the South Pole the gravity observations showed 100 to 200 milligal negative anomalies after Bouguer reduction to sea-level. The USSR observations have tied their Eastern Antarctic network to the South Pole station where previous British and United States observations were made. On the United States oversnow traverse in Victoria Land, gravity observations included a tie to the furthest south gravity station of the French traverse of 1957, and in Marie Byrd Land gravity observations were made between the "Byrd" station and the Amundsen Sea. From the "Roi Baudouin" Base the Belgians have made gravity measurements into the Sør Rondane Mountains where many stations were located on rock surfaces.

Despite these increased gravity meter ties, the need for increased pendulum gravity ties between Antarctica and first order stations in Australia, New Zealand, South Africa and South America, as well as between coastal stations of Antarctica, should be again emphasized.

Gravity measurements were made in Ross Island and McMurdo Sound areas by New Zealand and United States scientists. Extensive gravity work was carried out along the peninsula by British, Argentinean and Chilean workers, with the British making gravity ties from the peninsula to Port Stanley, Falkland Islands. United States gravity observations made during the cruise of the *Glacier* include values on the Thurston Peninsula, Bulls Island, Deception Island, Falkland Islands and Buenos Aires. A further tie was made between McMurdo Sound and the ice sheet satellite of "Wilkes" station during a flight in early December 1959.

The gravity programme appears to be progressing well with respect to investigations recommended by SCAR, with the possible exception of sea-borne gravity meter observations. With the continual improvement of meters and stabilized platforms, it is anticipated that this phase of the programme will be more active in the near future.

A. P. CRARY

Cartography

G. R. Laclavère (Chairman), B. P. Lambert (Secretary), T. Gjelsvik, S. Helle, A. Lebeau, J. Loodts, K. Z. Lundquist, R. N. M. Panzarini, V. Schytt, M. M. Somov, P. W. Thomas, M. D. Turner, G. D. Whitmore, W. D. C. Wiggins, R. W. Willett.

No general review of the progress of field surveys or map production has been attempted. The secretary of SCAR has prepared the following notes from the report of the Working Group on Cartography at the 4th meeting of SCAR. Further information of the activity of this group is shown in Appendix II under Cartography:

The free interchange between member countries of certain mapping material, the continued production of 1:10,000,000, 1:6,000,000 and 1:3,000,000 topographic maps of Antarctica, and the giving of advance notice of field-mapping activities among member nations, are now in operation.

A recommended set of conventional signs for use on topographic maps of Antarctica was prepared at the 4th meeting of SCAR. Certain technical specifications for maps of Antarctica prepared by the 3rd meeting of SCAR have been very largely adopted.

Oceanography

M. M. Somov (Reporter), A. Cailleux, A. P. Crary, G. E. R. Deacon.

British expeditions have studied sea ice distribution, thermophysical properties of sea ice at Halley Bay, tides at South Georgia and the Argentine Islands, and ocean wave penetration of the pack ice. Some towed magnetometer work has been started.

Argentina made an oceanographic cross-section of the northern part of the Weddell Sea studying physical, chemical, geological and biological phenomena. The whole water column was studied. All ships crossing Drake Passage made surface oceanographic observations in order to establish the exact location of the Antarctic Convergence Zone.

The Belgian expedition twice carried out oceanographic cross-sections from 0 to 100 m. depth between Cape Town and "Roi Baudouin". Depths measurements, dredge and grab stations and tidal observations were carried out in Breidvika. Visual observations on the currents, ice drift and on the colour of the sea were accomplished.

The work of the New Zealand expedition was concentrated in the Ross Sea area. Eight temperature salinity stations were completed, and ^{14}C samples were taken at two localities. Observations have also been taken en route to and from the Antarctic by means of bathythermographs with the emphasis on Convergence studies.

The Soviet oceanographic expedition completed the standard cross-section along 20°E . meridian consisting of nine complex oceanographic stations covering the whole water thickness. Ice reconnaissance flights were carried out regularly throughout the year over the Davis Sea and adjacent parts of the ocean. At "Mirnyy" observatory coastal oceanographic observations were made. A cruise around the Antarctic was accomplished from 20°E . to Drake Strait in an easterly direction, on which eleven complete oceanographic stations were occupied and current observations by an electromagnetic method were carried out as well as radar observations on ice and icebergs, temperature and salinity observations and continuous echo sounding. By means of radar, surveying, photography and sketching a more exact determination of the position, size and configuration of Peter I Øy was established. Depth soundings were made around the island.

United States oceanographic observations were carried out on four ships in the Bellingshausen Sea and Drake Strait area. Standard oceanographic stations were accomplished as frequently as possible. Studies conducted while ships were underway included bathythermograph observations and continuous echo soundings. A notable paucity of bottom-dwelling marine life was found along the Bellingshausen Sea coast. At McMurdo Sound coastal observations included measurements of water temperatures, salinities, currents and ice conditions.

The French oceanographic expedition occupied sixty bathythermograph stations in the Antarctic Convergence zone en route from Tasmania to Terre Adélie. Arrangements were made to provide for sea level observations at Ile Kerguelen and at Terre Adélie and for a hydrographical survey of the Ile de Pérel area in 1961.

The Japanese Antarctic Research Expedition accomplished eleven serial oceanographical stations in the Lützw-Holmbukta area. Plankton samples were obtained. Surface observations were carried out en route from Japan to the Antarctic. During the cruise across the Antarctic Convergence Zone these observations were accompanied by bathythermograph measurements. Ice observations were made in Antarctic waters. Several ice reconnaissance helicopter flights were undertaken.

Australia and Norway reported that no oceanographic observations were made

in the 1959-60 season by their ships, while no reports from Chile and South Africa are available.

It is clear that oceanographic research in the Antarctic is at a lower level than that in land-based disciplines. This is largely due to the fact that observations are frequently only incidental to the transport work of an expedition ship, and their time and place are dictated by other than purely scientific considerations. In addition few expedition ships attempt observations covering the whole water column. Oceanographically Antarctic waters remain the least known in the world though they play an important role in the water circulation of the southern hemisphere and of the whole World Ocean. Therefore SCAR recommends that lively effort should be made to widen oceanographic investigations in the Antarctic, even at the expense of land-based research.

M. M. SOMOV

Biology

The following notes were prepared by the SCAR reporter, who draws attention to the fact that the SCAR programme in Terrestrial Biology was not drafted until March 1959, and could not therefore be put into operation until 1960:

Prior to 1957, several nations had undertaken research in terrestrial biology, and some of these continue to pursue it more or less independently. The United Kingdom publications on ecology and reproduction of seals and penguins are outstanding; Australia has published on a wide range of subjects, and other nations also. Bird-banding, and to a lesser extent, seal-branding have been done by most nations, and the results justify much expansion.

Organized international co-operation has been limited to the United States scheme for banding McCormick's Skua (*Catharacta skua maccormicki*). There has been exchange of collected material.

Although a few nations are actively engaged in fairly comprehensive programmes, the general progress since SCAR took over from CSAGI in 1959 has been slight. The biogeographical gaps are considerable. Much systematic collecting, both of specimens and of standard life-cycle data, remains to be done. Much better knowledge of the food-chain relationships of terrestrial forms which feed at sea is required. Much ecological, physiological and behavioural study of mammals and birds remains to be attempted. It cannot yet be said that any part of the current SCAR programme could be dropped.

Antarctic terrestrial biology is still at a relatively early stage of development. National participation requires to be widened, and international co-ordination developed so that biogeographical surveys will be more complete and standard, and so that cognate specific projects in each field will obtain mutual stimulation.

R. CARRICK

The Working Group on Terrestrial Biology, which included the following biologists: R. Carrick, M. Holdgate, J. Prevost and A. W. Worthington, considered that the present research effort in the life sciences in the Antarctic falls considerably short of that in the physical sciences.

Medical Research

Physiology. Many medical officers have made studies in this field, and some expeditions have continuous programmes of physiological research under way. Studies are known to have been made by expeditions from Argentina, Australia, Belgium, France, Japan, New Zealand, the United Kingdom, USSR and the United States. Extreme climatic conditions in which studies of human physiology have been made exist at the USSR "Vostok" station and the United States "Amundsen-Scott South Pole" station.

The following review refers mainly to studies by United Kingdom and United States expeditions.

Human physiology. Subjects studied include:

Food intake during the year, both at base and during sledging. Weight changes and the thickness of the subcutaneous fat have also been followed. Food intake in terms of calories is high, especially during sledging, but in general weight changes are small. There is evidence of a seasonal weight change with a rise during the winter and a fall in the summer; there are corresponding changes in subcutaneous fat thickness. Some estimates of energy expenditure have been made; these are in general high. It appears that the high food intake is due to the increased level of energy expenditure, rather than a direct effect of low temperature on metabolism.

Sleep rhythms have been followed in a large number of subjects for periods of up to one year. Although there may be some disruption of sleep patterns during time of 24-hour light or 24-hour darkness, such disruption varies very considerably from base to base, and is markedly affected by the social organization. Average duration of sleep does not differ during different seasons of the year.

Work continues in an attempt to obtain evidence of physiological adaptation to cold in man. Clothing records suggest that less clothing is worn by the adapted individual, but this requires confirmation. Cold diuresis studies have begun, in the expectation that adaptation to cold decreases the diuretic response to a cold stimulus.

The micro-climate of man is now being studied in some detail. New techniques have been developed for recording the ambient temperature to which a subject is exposed during the 24 hours. Studies of the heat gained from solar and reflected radiation have indicated that in the conditions of the polar summer with up to 24 hours sunlight at a low altitude heat gain can be very considerable.

These studies should now be extended to cover the radiant heat loss to the sky during winter.

Animal physiology. Studies of the nutrition of the husky dog have continued at United Kingdom bases. These show that the energy expenditure of the dog approaches that of man, and, in relation to body weight is very high.

Studies of the physiology of penguins cover skin, body and incubating egg temperatures. A study of water metabolism of the penguin with emphasis on the role of sea water and salt in the food is being continued at "Hallett" station. It was found that newly hatched chicks have a well-developed salt gland that can function immediately after hatching, and that the capacity for excretion of salt increases during development. In a series of tests, birds subjected to water loads were noted not to respond by heavy diuresis.

A programme of erythrocyte counts and haemoglobin estimates in seals and fishes, by means of haemoglobin and erythrocyte count and microscopic examination, was carried out in the Weddell Sea area during December 1958 to January 1959.

Fish metabolism studies by means of oxygen consumption rates relative to weight and temperature were made at McMurdo Sound from November 1958 to January 1959.

A programme of ecological and physiological studies of marine animals commenced in 1959 will be continued during the 1960-61 season. This programme includes studies of fish metabolism as related to variations in temperature, body weight and activity during October to March. Comparisons of metabolism and growth rates will be made between sedentary bottom species and more active pelagic forms found under the ice cover at McMurdo Sound.

Comments. It would be valuable if there could be more parallel studies on the food intake and energy expenditure of man in the cold. There is still considerable controversy regarding food requirements in the cold, and whether there is a specific effect of cold.

Systematic studies of human thermal balance during different activities in the Antarctic should be encouraged.

The psychology of isolated groups is also in need of more study.

Research of the physiological type of Antarctic animals is unique and should be supported.

Whenever practical standardization of techniques and collaboration in human studies should be encouraged. This may be particularly profitable in the case of nutritional surveys and field thermal balance studies. This would mean that more data from different locations could be obtained in a shorter space of time.

Since no specialists in medical research were present at the 4th meeting of SCAR, the above summary was based on a review prepared by Dr O. G. Edholm (United Kingdom) supplemented by comments from the United States Polar Committee and notes on the United States programme prepared by Dr Rodahl.

APPENDIX II

RECOMMENDATIONS OF WORKING GROUPS

The recommendations contained in the reports of working groups (a-k below) were accepted. Resolutions by the Plenary Session on the report of the Working Groups on Biology, Geology and Meteorology appear at the end of the recommendations of those groups.

Working Group on Meteorology (Chairman, W. J. Gibbs)

(a) That, in view of the summary of meteorological requirements attached hereto, and the importance of these requirements, SCAR strongly requests its members to give urgent assistance in arranging the communication facilities necessary to meet the requirements, and requests WMO to take cognizance of the needs expressed when considering telecommunication arrangements for the southern hemisphere. Members are asked to examine the attachment and inform the Secretary of SCAR of any necessary amendments or addition thereto.

Summary of meteorological requirement for synoptic data

Note: for the purposes of this summary "Antarctica" is taken to include sub-Antarctic islands.

Station or country	From within Antarctica		From outside Antarctica	
	Information required	Frequency of collection	Information required	Frequency of collection
"NAF McMurdo"	All available surface and upper air data	Four times daily in summer, two in winter	Selection of data from Australia, New Zealand, S. Africa, S. America. Analyses from IAAC, etc.	Twice daily?
"Mirnyy" IAAC	No details but thought to be similar to "NAF McMurdo" All available surface and upper air data	A minimum of twice daily	Selected surface and upper air reports from S. Africa, S. America, New Zealand and Australia	Once or twice daily

Station or country	From within Antarctica		From outside Antarctica	
	Information required	Frequency of collection	Information required	Frequency of collection
"Amundsen-Scott"	Generally limited requirement for information from adjacent bases, forecasts required at times	Generally not more than once or twice daily	Requirement usually restricted to analysis statements	Once or perhaps twice daily
"Byrd"				
"Hallett"				
"Scott-Base"				
"Roi Baudoin"				
Halley Bay				
S. African base				
"Wilkes"				
"Davis"				
"Syowa"				
Mawson	Requirement likely to be similar to Halley Bay, etc.			
"Dumont d'Urville"				
Stanley				
"Vostok"	Surface and upper air data from coastline between 90° W. eastward to 90° E.	Twice daily	—	—
"Lazarev"				
"Komsomolskaya"				
South Africa				
New Zealand	Surface and upper air data from Antarctic sector between 90° E. eastward to 90° W.	Summer season four times daily. Winter season twice daily	—	—
France (Kerguelen)				
Australia (apart from IAAC)	Surface and upper air data from coast of east Antarctica	Once daily	—	—
U.S. requirement in New Zealand	In summer season requirement as for "NAF McMurdo". Nil in winter	Four times daily	—	—
Argentina and Chile	For S. America section of Antarctica	Once daily?	—	—
USSR	As for "Mirny"??	Once daily?	—	—

(b) that SCAR commends the members of the IAAC* and Australian authorities for the achievements of the IAAC in producing useful analyses and providing microfilm copies thereof, and looks forward to an increase in the effectiveness of analysis statements at present broadcast by radio when the delay in their issue can be reduced, following the expected improvement in communications. SCAR also commends the attachment of meteorologists to the Centre by Argentina, Australia, France and United States, and requests all members of SCAR to indicate to the Secretary by 1 November 1960 their intentions regarding attachment of meteorologists to the Centre in the future. SCAR also requests the WMO to invite its members similarly to indicate their future intentions in this regard.

(c) that SCAR, recognizing the significant advances made in Antarctic meteorology following the IGY and post-IGY programme of meteorological observations,

* International Antarctic Analysis Centre, Melbourne, Australia.

and desiring to maintain this progress, urges members to give special attention to the following:

- (i) the need to maintain, and where possible add to, existing stations and carry out comprehensive meteorological observations;
- (ii) the need to renew efforts to place observing teams on uninhabited sub-Antarctic islands, or failing this, to establish automatic weather stations thereon;
- (iii) the spectacular success of the United States satellite Tiros I, which promises a very significant increase in the knowledge of the distribution of cloud and pack ice in Antarctic and sub-Antarctic regions. Arrangements should be made to distribute the results of the analysis of such data for operational and research purposes;
- (iv) pack ice reconnaissance by sea and air should be intensified in anticipation of pack-ice observations by artificial satellites. It is desirable that a member or members of SCAR should undertake the collection and analysis of the information;
- (v) noting the successes achieved by the United States in the use of drop-sondes and the USSR with observations from meteorological reconnaissance aircraft, commends these methods to the attention of other nations;
- (vi) noting that there are still expedition and other ships in higher latitudes of the southern hemisphere whose meteorological observations are not available in routine meteorological synoptic messages, members should ensure that all ships operating in these waters (including tankers) are recruited to make observations, and when operating south of 50° S. transmit them both to an Antarctic station and to the appropriate radio station recommended by WMO. The South African Weather Bureau is to be commended for its action in organizing reports from whaling ships, and should be requested to take care of any additional arrangements necessary in providing ciphers for whalers and tankers. Efforts should be made to ensure that oceanographical and similar expeditions in Antarctic and sub-Antarctic waters are equipped to make comprehensive meteorological observations;
- (vii) noting that automatic weather stations housed in anchored buoys are likely to provide valuable meteorological information in sub-Antarctic waters, members should strive to develop and station these at advantageous locations, bearing in mind the relevant recommendations of WMO (Resolution T21 of EC-XII), Rec A, 7 (CMM-11), Res. A.3 (CMM-11);
- (viii) the measure of success in the use of land-based automatic weather stations in Antarctica suggests that it would be profitable to continue and extend the operation of these stations;
- (ix) the technique for measuring snow drift and the results of these measurements described by Mellor, and by Mellor and Radok, in papers to be published in the report of the Proceedings of the Symposium on Antarctic Meteorology held in Melbourne in 1959, indicate that the application of this technique in a network at Antarctic stations would yield essential information for the study of the mass budget of moisture;
- (x) noting the valuable measurements of ozone made at a number of stations in Antarctica, it is desirable that the observations should be intensified and extended to form a synoptic network particularly including sub-Antarctic islands;
- (xi) the number of stations at which atmospheric nuclear radiation measurements are made should be increased and the importance of measuring isotopes, such as Tritium and ^{14}C , in the atmosphere and the ice is stressed;

- (xii) noting the work done in Canada and Sweden on the electrification of blowing snow and its effects on radio communications, members may consider the establishment of a programme of observations of this phenomenon.

(d) that SCAR, noting that certain IGY meteorological data for the Antarctic is still not available at the WMO Data Centre, urges members concerned to supply the missing data as soon as possible. In view of the very great importance of post IGY Antarctic and sub-Antarctic data for meteorological research, SCAR further suggests that members who are not planning to place this data on punched cards should inquire through the WMO whether another member would be prepared to arrange punching of this data.

(e) that SCAR notes with satisfaction the progress made by South Africa in its project for synoptic analysis of the IGY southern hemisphere surface and 500 mb. data, and records its appreciation of the effort involved and the great value of these analyses to research workers in the future.

(f) that SCAR, noting the remarks of the representative of SCOR attending this meeting, regarding the desirability of close co-operation between meteorologists and oceanographers in studying related problems, urges National Committees to insure, that as far as possible planning and carrying out of meteorological and oceanographical observations and investigations should be adequately co-ordinated.

(g) that in view of the importance of CLIMAT and CLIMAT TEMP data from Antarctic and sub-Antarctic regions, members should prepare and despatch such information promptly and regularly.

SCAR also urges WMO to arrange for the provision of a code for CLIMAT WIND and suggests that the following might be approved for interim use:

CLIMAT TEMP WIND HHHHT TTT₄T₄T₄ Xddff, where dddff is the vector mean wind.

SCAR also suggests that WMO might consider the reporting of monthly vector mean surface wind from Antarctic and sub-Antarctic stations, using a group Xddff appended to the existing CLIMAT code.

(h) that SCAR requests WMO to take speedy action to amend the code for reporting wind direction at the South Pole station so that wind from longitude

0°	is reported as 36
90° E.	is reported as 09
180°	is reported as 18
90° W.	is reported as 27, etc.

(i) that SCAR, saddened at its fourth meeting by the notice of the tragic fire at "Mirnyy" in which eight meteorologists perished, expresses deep regret to the USSR member, and asks that its heartfelt sympathy be extended to the families of the men who gave their lives in the cause of science in Antarctica.

(j) that SCAR, noting that the WMO Executive Committee in its twelfth session (Resolution T.3, EC-12) decided that the use of the tropopause group in the TEMP code [FM35B] is optional, and that if it is used it shall be in complete form, and noting that a recent investigation in the United States suggests that tropopause data have forecasting significance in Antarctica, urges its members to instruct their Antarctic stations to include §11 of FM35-B in its complete form in all TEMP messages as soon as possible.

The final Plenary Session approved the formation of a Permanent Working Group on Meteorology under the chairmanship of W. J. Gibbs.

Working Group on Upper Atmosphere Physics. (Convener, F. Jacka)

Ionosphere

- (a) That the need to regard ionospheric observation in the Antarctic as a research rather than a routine be stressed to all concerned;
- (b) that Ionograms, taken not less frequently than at quarter hourly intervals, should be obtained at all ionospheric stations;
- (c) that special effort be made to operate ionospheric stations in the Weddell Sea and Ross Sea chains as full stations;
- (d) that special effort be made to deploy riometers in the Antarctic;
- (e) that special effort be made to deploy ionospheric drift measuring equipment at several stations in the Antarctic;
- (f) that the recommendations of IPS on the desirable minimum network of ionospheric sounding stations for prediction purposes be sought and adopted.

Auroral and airglow physics

- (a) Atlas of auroral forms and auroral nomenclature. That SCAR should welcome the decision of the IAGA committee on aurora and airglow to revise the *Atlas of Auroral Forms* and auroral nomenclature, and urges SCAR nations to offer their full support to this project.
- (b) World data centres for auroral data. That SCAR should call the attention of the CIG and its reporter for aurora to the urgent need to revise and simplify the IGY recommendations for the type and quantity of auroral data to be sent to World Data Centres, and recommends that the national auroral reporters for the countries involved in Antarctic work be specifically consulted by CIG in arriving at this revision, recognizing the possibility that the northern and southern auroral data flow may have to be different on account of the special requirements associated with the operation of Antarctic expeditions. The latter may have to be restricted to those data required to permit a catalogue of sources and types of data held at individual central laboratories to be maintained.

Geomagnetism

- (a) That co-ordination between Antarctic and Arctic magnetic stations, and special co-operative observational programmes on geomagnetic disturbances (together with auroral and ionospheric observations) be continued and developed;
- (b) the setting up of repeat magnetic stations on as many islands as possible in the Antarctic and in the sub-Antarctic ocean areas, in order to measure the unusual geomagnetic secular variation observed in these areas;
- (c) the setting up of magnetic observatories so far as possible on islands in the sub-Antarctic area;
- (d) that SCAR recognizes that there is need for immediate action
 - (i) to compile Antarctic magnetic charts using all results of magnetic surveys carried out hitherto,
 - (ii) to establish the morphology of geomagnetic daily variations and disturbances in the Antarctic area using data obtained during the IGY and IGC 1959.

World magnetic survey (Convener, T. Nagata)

- (a) That three component surveys be carried out during 1960 to 1965 over Antarctica and the surrounding ocean area by SCAR member nations, as far as possible according to the technical instructions proposed by the IUGG World Magnetic

Survey Committee (Resolution No. 16 XIth Assembly, Toronto, 1957). Where it is not possible to measure three components, one-component surveys (F or Z) carried out from ships or by sledging parties are still valuable;

(b) that existing magnetic observatories should preserve the accuracy of their base line values, as well as scale values, as recommended in the *IGY Instruction Manual* at least until 1965.0 in order to maintain a basic reference network for the surveys;

(c) that repeat stations should be established to extend knowledge of the secular variation in the gaps between magnetic observatories. The secular information is necessary for the reduction of the survey data to a particular epoch (1965.0) and for the intrinsic interest in the origin of the main field. Repeat stations should be established at a fixed mark to be visited as often as possible, and at least annually during 1961 to 1965.

Interdiscipline co-operation

(a) That SCAR draws attention to the very great benefits to be derived from close co-operation between those working on different aspects of upper atmosphere physics at the one station.

Sunspot minimum programme

(a) That SCAR supports specific upper atmosphere research projects which call for a measure of international co-operation in the Antarctic. Some such projects are of particular importance around the time of solar activity minimum since they will complement IGY projects. In this connexion, the importance of associated Arctic studies should not be overlooked.

In view of the time needed to construct equipment, train operators and deploy the equipment in the Antarctic, it is desirable that plans for any special projects during sunspot minimum—the sunspot minimum programme—should be discussed as soon as possible;

(b) that among other projects for the sunspot minimum programme should be a standardized all-sky camera auroral programme timed as follows:

- (i) the initial discussion, planning and design to be completed by the end of the fifth SCAR meeting;
- (ii) construction of equipment to be completed during 1962;
- (iii) rigorous field testing to be carried out during 1963;
- (iv) the equipment to be operated throughout 1964 and 1965.

Analysis of existing data from the Antarctic reveals that standardization of observational technique is essential. The proposed network should cover the region centred on lat. 75° S., long. 135° E., and of radius approximately 35° .

The project should be co-ordinated by the convenor of the Working Group on Upper Atmosphere Physics;

(c) that during 1964 and 1965 other equipment available for auroral observation (e.g. photometers, radars, etc.) be used to supplement this main project. However, no standardization (apart from appropriate calibration) of these equipments is envisaged;

(d) that, during the period 1961 to 1963 inclusive, auroral observatories in the Antarctic concentrate their efforts on particular research projects of interest to individual workers.

Working Group on Geology (Chairman, R. W. Willett)

(a) That member nations when preparing regional geological maps do so sheet by sheet, each sheet carrying a brief, approximately 5,000 word, summary of the geology thereon. This is in no way considered to replace geological reports and bulletins, but is designed to enable the maps to be available for other specialist workers without the inevitable delay arising from the preparation of bulletin texts;

(b) that where possible geological map series be published on the same scale as the corresponding topographic map series. For large-scale maps it is recommended that SCAR member nations consider, for discussion at next SCAR meeting, the possible uniform use of certain large scales for detailed geological maps;

(c) that the member nations of SCAR continue geological mapping in the Antarctic. That colour schemes, symbols, and abbreviations be circulated to all SCAR member nations for comments, and that a correlation of these comments be presented to the next SCAR meeting;

(d) that, prior to the next meeting of SCAR, the member nations give consideration to the following points for discussions:

- (i) production of geological maps,
- (ii) geological symbols and colours,
- (iii) stratigraphic and formation names, correlation, proposals to be prepared for next meeting,
- (iv) co-ordination of isotope dating of Antarctic rocks,
- (v) any other relevant matter.

(e) that the Soviet proposals for geological mapping in the Antarctic be circulated with a view to discussion at the next SCAR meeting;

(f) that the Oceanographic Group be urged to continue work on submarine geological studies. It is further recommended that deep samples by the piston coring method be obtained. The Working Group draws attention to the desirability of more rapid publication of bathymetric and echo sounding data.

The Working Group notes the existence of overlap in the proposed work programmes of several participating nations and suggests that these differences be resolved bi-laterally in order to prevent any unnecessary waste of man-power and logistics.

The Plenary Session approved the formation of a permanent Working Group on Geology under the chairmanship of Dr R. W. Willett.

Working Group on Cartography (Chairman, G. R. Laclavère)

(a) That all member nations use in their topographic maps the conventional signs recommended by the Working Group on Cartography; and requests the Secretary of that Working Group to distribute these conventional signs in published form to members of SCAR and to other interested agencies.

(b) that

- (i) those member nations which have not already done so, immediately exchange their gazetteers of place names, as recommended by SCAR at its Third Meeting;
- (ii) in future, members of SCAR distribute, on a similar basis, amendments to their gazetteers giving early details of any new place names decided upon;
- (iii) that any member nations finding that they are in conflict with respect to place names endeavour to resolve their differences bi-laterally.

(c) that SCAR, having considered the statement submitted jointly by the United

States Advisory Committee on Antarctic Names and the United Kingdom Antarctic Place Names committee on the subject of under-ice features, recommends that features lying under an ice cover should be named according to the already adopted geographical terminology prefixed with the term "subglacial"; the abbreviations of this prefix on maps being "Sg";

(d) that member nations prepare and maintain air photography flight index diagrams, preferably on 1:1,000,000 scale base maps, showing appropriate information with respect to:

- (i) location, date and identification of air photography,
- (ii) scale of photography and camera characteristics,
- (iii) whether photography consists of verticals and/or obliques,
- (iv) evaluation of quality;
- (v) that the originating countries forward each year to every other member nation, and the Secretaries General of IUGG and IGU, one up-to-date copy of their photo indexes;

(e) that nations intending to concentrate their future mapping efforts at scales not less than 1:3,000,000 in any particular area, as shown in the index prepared by the USSR, should inform SCAR accordingly at its regular meetings, and that wherever possible nations should co-operate to cover whole sheets;

(f) that SCAR, wishing to encourage the production of scientific atlases of Antarctica, recommends that member nations assist wherever practicable, and that where such assistance is given, it be duly acknowledged in the publication.

The Working Group draws attention to the fact that the proposed photogrammetric mapping programmes of the following countries appear to overlap:

- (i) USSR and Australia—in respect of the coastal area between long. 78° and 110° E.
- (ii) Belgium and Norway and USSR—in the vicinity of "Lazarev" station.
- (iii) Belgium and Japan—in respect of the coastal area between long. 30° and 40° E.

Working Group on Crustal Geophysics (Chairman, Professor K. E. Bullen)

Seismology

(a) That additional centres should be encouraged to undertake wave studies, and that increased attention be given to refraction shooting which will yield knowledge of seismic velocities and layer thicknesses down to, and possibly below, the Mohorovicic discontinuity. (It is to be noted that for *P* waves the highest efficiency is obtained by having explosions in the sea or lakes.)

(b) that more short-period seismographs should be installed at existing stations to assist in studying local earthquakes;

c) that, between now and the next SCAR meeting, National Committees give consideration to the setting up of a regional Antarctic seismological centre. The function of this centre would be to compile, publish and distribute in monthly (or quarterly) bulletins, details of seismic readings taken at Antarctic stations in respect of earthquakes inside or possibly within ten degrees of the Antarctic Convergence. It is envisaged that the bulletins would be similar in form to bulletins issued by regional seismological organizations in other parts of the world, possibly modified as a result of recommendations from the ISS Committee. It is hoped that, as a consequence of such considerations, it may be possible to place a more specific proposal before the next meeting of SCAR.

Upper mantle project

That attention be drawn to a resolution of the XIIth General Assembly of the IUGG that, during the next three years at least, substantially increased attention be paid to problems of the Earth's upper mantle, i.e. the outermost 100 km. or so of the Earth. This resolution bears significantly on research in Antarctica as in other regions of the Earth. It is consequently desirable for National Committees on Antarctic Research to give special consideration to geological, volcanological and seismological research, including explosion seismology, to boring projects, to the study of thermal and chemical problems of the solid Earth, and to problems of geomagnetism including palaeomagnetism. In due course, more specific projects may be proposed, in line with programmes as they develop in other regions, so that Antarctic research can play its appropriate part in the global coverage.

Gravity

(a) that reference pendulum stations be established along the coasts of Antarctica for calibration and control of gravity meters.

Working Group on Oceanography (Chairman, Dr M. M. Somov)

(a) That countries interested in the Antarctic should provide special time and facilities in their ships for oceanographic work, or send special oceanographic research ships to the Antarctic Ocean;

(b) that the need for studying the whole water column from surface to bottom should be emphasized;

(c) that repeated observations along 20° E., 165° E., and across the Drake Strait, or along meridians as near as possible to these should be made;

(d) that the importance of making direct current measurements at all depths in the Antarctic Ocean should be stressed;

(e) that the need for more information about the water conditions near the Antarctic continent in winter should be emphasized;

(f) that it would be valuable to have regular information about sea ice, shelf ice and outflowing glaciers from aerial photographs, and that aircraft or helicopters be kept for this purpose. It recommends authorities using weather satellites to try to get high-altitude pictures of ice distribution;

(g) that a search be made for evidence of the effect of seismic sea waves on the breaking off of coastal ice;

(h) that the need for more detailed study of the natural movements of ice shelves in relation to tides and long waves should be emphasized;

(i) that the programme should be planned to give full opportunity for biological, geological and meteorological research;

(j) that a small working group be formed to co-operate with SCOR, and exchange of representatives between national SCAR and SCOR committees be encouraged, to promote as much co-operation as possible. It asks National Committees to publish their plans as early as possible;

(k) that the co-operation of SCAR member nations with SCOR during the coming Indian Ocean Programme should be recommended, also that increased Antarctic Oceanographic research should be conducted in the appropriate areas during the period of this programme, particularly during 1962-64.

Working Group on Biology

(a) That the special problems of the conservation of nature on sub-Antarctic islands should receive further consideration before recommendations are made to the responsible governments;

(b) that an International Symposium on Antarctic Biology be held in about two years time;

(c) that member nations be urged to implement the SCAR programmes in marine and terrestrial biology;

(d) that a Permanent Working Group on Biology be formed, that a permanent Secretary of the group be appointed, and that Dr R. Carrick occupy that office. It instructs the Secretary of the working group:

(i) to collect further information on nature conservation in the sub-Antarctic islands, and to prepare documents for the next meeting of SCAR;

(ii) to draft and circulate a leaflet on preservation of wild life to all persons landing in Antarctica;

(iii) to collect the necessary information for designation of sanctuaries.

The final Plenary Session, after discussing a comprehensive report from the working group, recommended that the report on the Conservation of Nature should be accepted subject to approval by National Committees, and that the Secretary should circulate the report with the request that comments should be submitted by the end of 1960. The need to inform governments of the proposals for the conservation of nature in Antarctica as soon as possible was stressed, in view of the forthcoming meeting of a working group of the Antarctic treaty powers. Reluctance to do this officially before National Committees had been able to express their views on the proposals was also voiced, since it was very desirable that any recommendations made to governments should be in their final form. However, it was strongly recommended that National Committees should see that the appropriate government representatives were aware of the steps being taken by SCAR on the Conservation of Nature in Antarctica. Such contact with government representatives should be on an informal basis until the SCAR proposals on the conservation of nature are confirmed by the Executive Committee, after consulting National Committees and the SCAR Working Group on Biology.

SCAR proposals on the conservation of nature, when confirmed by National Committees, will be published in the *SCAR Bulletin*.

Working Group on Communications (Chairman, A. H. Sheffield)

(a) That the Radio Communications Working Group be known as the Communications Working Group;

(b) that the function of the Communications Working Group be defined as:

To advise on the practical aspects of communication within the Antarctic, and between the Antarctic and the rest of the World, because of the importance of this problem to Antarctic research;

(c) that the attention of all Antarctic radio operators be drawn to the necessity for following the internationally agreed procedures incorporated in the International Regulations, especially with regard to the inclusion in telegrams of an appropriate preamble to all messages;

(d) that the Australian Ionospheric Prediction Service and the Argentine Ionospheric Laboratory be invited to distribute to members of the Communications Working Group copies of their propagation forecasts;

(e) that radio communication tests should be carried out from 12 September 1960.

"Base Roi Baudouin" will attempt to receive the FICOL broadcasts from Port Stanley, and will relay them to Mawson; Mawson will relay the broadcasts to "NAF McMurdo". "Lazarev" will attempt to receive the FICOL broadcasts, and will relay them to "Mirny". "Mirny" will intercept the transmissions from "Base Roi Baudouin" and Mawson if reception of the FICOL broadcast at "Lazarev" fails;

(f) that the list of stations in § V of the *IGY Antarctic Radio Manual* may be brought up-to-date, members of the Communications Working Group should prepare and send to the Chairman of the group, to reach him before 15 October 1960, complete revised lists in the form of those in the *Manual*. Any subsequent amendments to the lists should be included in the Annual Reports on logistics submitted by members of SCAR. If there are no changes, this should be stated;

(g) that, in order to ensure that all delays in transmission of messages are investigated immediately, and all failures of the Antarctic communication network are rectified in the shortest possible time, a member of the staff of the International Antarctic Analysis Centre shall be nominated to supervise the operation of the network. It shall be his duty to investigate all failures and to send telegrams to the Antarctic station concerned. If a remedy cannot be found within a reasonable period a report should be sent to the Chairman of the Communications Working Group, with a copy to the representative on the Group of the member of SCAR responsible for that station. Base leaders are reminded of the necessity to exercise constant supervision over the recording and reporting of scientific observations, and the telegraphic transmission of data according to the appropriate priorities;

(h) that SCAR notes with satisfaction that arrangements are being made by the United States and Australia to establish a radio teletype link between "NAF McMurdo" and Sydney, and that the circuit is expected to be operational within a month. SCAR also notes that Australia contemplates the establishment of a main trunk radio teletype link between "Wilkes" and Australia and that it is possible that with the establishment of a regular radio teletype link between "NAF McMurdo" and "Wilkes", "Wilkes"-Australia could become the main or alternate route for exchange of meteorological traffic between Antarctica and Australia.

Working Group on National Reports (Chairman, Professor J. van Mieghem)

(a) That the National Reports be available each year not later than 30 June in order to allow each Reporter to compile an accurate discipline report, in time for the SCAR meeting, and in order that each participating country in Antarctic research should be informed in due time of the future plans and the completed programmes of the others;

(b) that *SCAR Circular*, No. 30, issued on 2 July 1959, be used as a rough guide in drafting the National Reports.

In principle these reports should mention the following items for each discipline;

- (i) station location,
- (ii) type of observation,
- (iii) type of instrument,
- (iv) comments.

They should also contain a one page summary in tabular form showing which disciplines have been, or will be, studied, at each base.

(c) that the report on completed programmes should contain a full bibliography of scientific publications on Antarctic research carried out by the country during the period covered by the report. Moreover, this report should indicate for each station

and each discipline, type and form of data available from scientific programmes conducted during the previous year, and give name and address of responsible authorities;

(d) that concise reports be presented:

- (i) in tabular form,
- (ii) discipline by discipline.

The following suggestion is made with regard to discipline listing:

- 1. Upper atmosphere physics (ionosphere, aurora and airglow, cosmic rays, geomagnetism);
- 2. Meteorology;
- 3. Earth Sciences (geomagnetism, seismology, gravity, geology);
- 4. Geodesy, topography, cartography.
- 5. Glaciology;
- 6. Oceanography;
- 7. Terrestrial biology and medical research;

(e) that inside the disciplines, stations be listed as far as possible by geographical latitudes northwards;

(f) that reports be published as far as possible in approximately a standard format (printed horizontally), e.g. 27 cm. wide by 21 cm. high.

(g) that a report on logistic aspects of activities of the coming year be published as a separate document along lines to be drawn by the Working Group on Logistics.

Working Group on Logistics (Chairman, Rear-Admiral D. M. Tyree)

(a) That pertinent logistic factors of each Antarctic permanent or semi-permanent installation, as outlined in a specimen form, be circulated to the SCAR nations for consideration, and that results be circulated by the SCAR secretary, or such party as designated by the SCAR secretary;

(b) that considering also the general value of an annual outline from each SCAR nation summarizing their proposed ship movements, air operations and itineraries of inland travelling parties prior to each Antarctic summer programme, such information should be documented and circulated to all SCAR nations as an appendix to the collection of information on logistic support capabilities. The working group realizes that many plans will of necessity be altered during operations, and urges the transmittal by radio circulars as soon as possible of major changes in plans;

(c) that the above information be compiled as soon as possible in order that it may be available for the coming Antarctic summer programme, and that the information be revised annually as necessary;

(d) having reviewed a letter by P. G. Law suggesting a symposium to discuss all aspects of logistic support, heartily endorses this suggestion and invites consideration by SCAR nations of the manner in which such a symposium might be brought about during 1961.

Medical science

The Working Group on Biology recommended the circulation of the paper submitted by Dr O. G. Edholm and the invitation of comments thereon.

Belgium

Notice has been received from the Belgian delegate that no Belgian party will winter in the Antarctic during 1961. Belgium will, however, continue to observe her obligations as a member of SCAR.

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