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SCAR BULLETIN

No 18, September 1964

IQSY PROGRAMME ON METEOROLOGY—ANTARCTIC STRATWARM

BY H. R. PHILLPOT*

In general, the annual temperature cycle in the stratosphere over both polar regions is characterized by very low temperatures during the winter and relatively high values in summer. During the winter a stratospheric jet stream develops in the strongly baroclinic zone between the cold core over the Pole and the relatively warm zone found in middle latitudes, whilst in summer the stratospheric polar circulation is generally weak with anticyclonic conditions prevailing.

The spring transition period, when the polar vortex breaks down and the stratosphere warms, is extremely interesting because of its complexity. For the past few years only has it been studied closely and it is clear that there are significant differences between the behaviour over the Arctic and the Antarctic, although less is known about the Antarctic.

During the IQSY there will be an intensified observational effort, and it is desirable that forecasts of the occurrence of the sudden warming periods should be available. In the publication "Details of the IQSY plan for alerts of stratospheric warmings" issued in December 1963 by the CIG, it is stated that "In addition to meteorologists the existence of winter stratospheric warmings will be of interest to some participants in at least several other IQSY programmes, including Aeronomy, Space Research and Ionosphere."

The WMO has arranged for selected meteorological centres to issue these forecasts, and proposed to the Director of the Commonwealth Bureau of Meteorology that one in Australia should undertake this responsibility for the Antarctic.

The International Antarctic Analysis Centre in Melbourne was the obvious choice, but the position was complicated, first because the additional work would lead to a major expansion of the programme when the degree of professional support was strained to maintain that already established, and second, because of insufficient knowledge of the technical problems involved.

These difficulties were resolved (at least in part) by the Bureau undertaking to provide additional professional support to enable the Centre to accept the increased work, and by the writer making a special urgent study of the phenomenon in the Antarctic.

For those unfamiliar with it, an illustration of the problem is given in the Fig which shows the temperature change at the 50 mb level at the South Pole during

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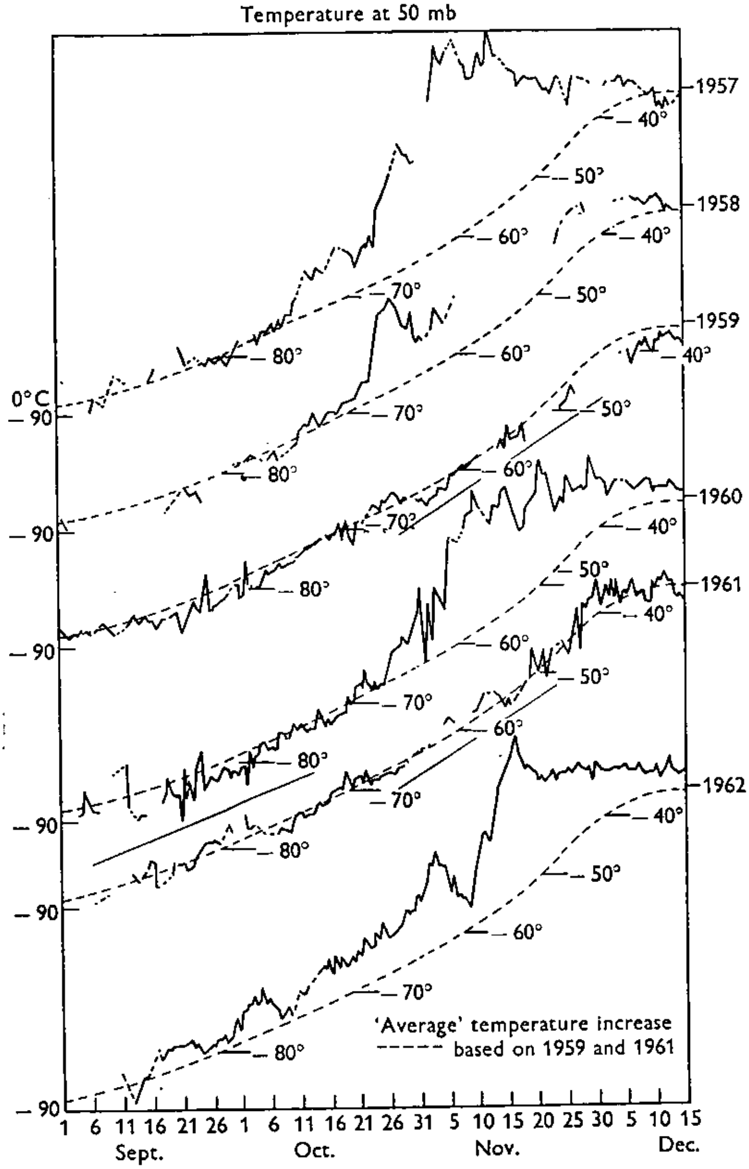

Temperature change at 50 mb level during the spring periods of each year 1957 to 1962 at the South Pole.

the spring periods of each year 1957 to 1962. The variations in both the time at which the warming occurred, as well as its rate, are clearly revealed, ranging from the quite reasonably regular or unaccelerated change observed in 1959 and 1961 to the dramatic rise of almost 30 °C between 12 GMT 8 November and 00 GMT 16 November 1962.

The study which has been made includes a brief review of the literature, which refers mainly to observations made during or before the IGY, and then examines some of the very considerable observational data collected since 1958.

The warming phenomenon can be more clearly detected at very high levels, i.e. 50 mb (20 km approx.) and above, but unfortunately, partly because of the very low stratospheric temperatures (−80° to −90 °C) which persist during the winter and spring over the Antarctic, many radiosonde ascents do not reach 50 mb. Maximum attention has therefore been given to the 100 mb (15 km approx) level, using other levels as a supplement.

The data examined included:

(i) The available 100 and 50 mb temperatures at the South Pole during the winter months, June, July and August, for each year from 1959 to 1962 which appeared to show no excessively large daily variation.

(ii) The temperature at the 100 mb level for the period 1 September to 15 December for each year of record from 1957 to 1963 for twenty-four Antarctic stations, from which it was found that:

(*a*) in 1959 (and to a lesser extent 1961) no acceleration in the warming rate occurred,

(*b*) there were significant variations in the warming rate from year to year,

(*c*) there was essentially more regular warming at stations in the highest latitudes (e.g. "Byrd", "Vostok", South Pole), than those at lower latitudes on the continent (e.g. Mirny, Wilkes) where short warming and cooling periods were super-imposed on the general warming, and

(*d*) at Macquarie Island (lat 54° 30′ S), not only was there marked variation during the season in any one year, but also from year to year.

(iii) The circulation at the 100 mb or the 50 mb level for the spring of each year from 1957 to 1963 using either published charts, or by constructing streamline/isotherm charts for selected days, to see how the vortex broke down. These showed that:

(*a*) the winter polar vortex was cold but the centre of the cold air was usually not coincident with the vortex centre,

(*b*) the movement of the cold air was important and its persistence in the South American sector frequent,

(*c*) warm air tended to move on to the continent from the Australian, i.e. (90° to 180° E) or perhaps the Indian Ocean (i.e. 0° to 90° E) sector,

(*d*) at the 100 mb level the accelerated warming at a given station appeared to be determined by the manner in which warm air was advected across the continent, and

(*e*) when, as in 1959, no general accelerated warming was observed, the vortex was centred nearer to the geographic South Pole, there was no marked shift of cold air into the South American sector and the warming in lat 50° to 60° S was more symmetrical.

(iv) Winds at the 100 mb level in the 1963 spring period, which showed that:

(*a*) there was marked constancy in wind direction at each station,

(*b*) wind speeds were greatest in the sector from about Mawson eastwards to "Hallett", and (*c*) no direct relationship appeared to exist between wind speed and air temperature, except that (as would be expected) there was a pronounced decline in wind strength when the summer temperature level was reached.

(v) Comparison of 100 mb temperatures in the 1963 spring period at stations on the Antarctic continental coast, which certainly did not suggest that short period temperature changes were translated downstream.

(vi) Detailed temperature time-sections during October and November 1963 (to the highest limits of the radiosonde flights) for the stations, "Novolazarevskaya", Mirny, Wilkes, "Vostok", "Hallett", "McMurdo", "Little Rockford", "Byrd" and the South Pole, which showed that the temperature rise was noted first at the highest levels and was propagated downwards, and to some degree polewards, with time.

(vii) Temperatures at "Byrd" and Wilkes stations which, during the winter and spring periods of 1962, were observed to be very high levels, and also at Campbell Island (lat 52° 33′ S). These showed that warming:

(*a*) may have occurred in the vicinity of Campbell Island in mid-winter at levels above 50 mb,

(*b*) may have occurred over the coastal regions of Antarctica between about 90° E and 180° in mid-winter near the 10 mb level, but

(*c*) did not appear to extend further south towards the South Pole earlier than the latter part of September near the 10 mb level.

(viii) A series of temperature cross-sections drawn over the continent for a number of days in the spring of 1961 and 1962, which supported earlier conclusions on the differences between years when accelerated warming was observed and when it was not.

(ix) Limited consideration of the ozone problem by examining some of the ozone soundings made at Halley Bay in 1958.

The results of this investigation were given at a Discussion Group attended by members of the Meteorological Physics Division of CSIRO, the Meteorology Department of Melbourne University, and the Bureau of Meteorology. Constructive suggestions were offered and these will be considered when the IAAC analysts jointly investigate this problem in detail in the spring months of 1964.

SCIENTIFIC INVESTIGATIONS RECOMMENDED BY SCAR

This list amends and supersedes, for the disciplines of Glaciology, Solid earth geophysics, Geology, Geomagnetism, and Upper atmosphere physics, the list published in *SCAR Bulletin*, No 3, 1959, p 34–41, and includes amendments approved by SCAR up to July 1964. In view of possible revision of the programmes in Biology, Geodesy and Cartography, Meteorology and Oceanography which may be recommended by forthcoming meetings of the Working Groups, programmes in these subjects are not being reprinted at present.

Geology

Systematic regional mapping on sheets based on the recommendations of the Working Group on Cartography.

Although the nature of the geology and the area of exposures will control scale of sheets, it is recommended that each participating country retain one scale throughout for the regional geological maps in the sectors in which it has agreed to work. In addition to regional mapping and its ancillary studies (petrological, palaeontological), the Antarctic calls for attention within the basic framework of regional geology:

(*a*) Geomorphology and Quaternary geology including work of ice, frost and wind

(*b*) Palaeoclimatic studies

(*c*) Palaeomagnetic studies

(*d*) Geochemical studies of rocks and minerals

(*e*) Terrain beneath the ice in association with geophysical studies

(*f*) Volcanology, study of past and present volcanisms and its products

(*g*) Structural geology

(*h*) Sediments and sedimentation

Geomagnetism

(*a*) The existing geomagnetic observatory programme with base level control should be maintained at the 1960 level, which comprises the minimum necessary geomagnetic network in this area

(*b*) Geomagnetic variation recordings, including quick-run and induction magnetographs for rapid variations, should be encouraged at all stations involved in high atmosphere studies and the recording and analysis should be designed to meet these requirements. The importance of low sensitivity recording is emphasized. Attention is drawn to the possible connexion between geomagnetic disturbances at Antarctic stations and those at their geomagnetically conjugate stations in the Arctic area

(*c*) Geomagnetic surveys in the Antarctic area (continent and southern sea) should be carried out and co-ordinated with the World Magnetic Survey programme. Encouragement should be given to airborne and shipborne magnetic surveys as well as surveys by sledge parties. As far as possible three components should be recorded

(*d*) In connection with the research programmes of crustal and upper mantle geophysics in Antarctica, the following geomagnetic work should be encouraged:

(i) magnetic sounding on land and over the sea as a part of glaciological and geological research

(ii) palaeomagnetism through the study of Antarctic rocks

(iii) observation and analysis of regional geomagnetic secular variation, relevant to regional characteristics of the earth's crust and upper mantle

(iv) research on regional characteristics of electromagnetic induction in the interior of the earth in this area

(v) observation and analysis of earth-currents.

Glaciology

Scientific aims.

Scientific interest in the Antarctic ice sheet arises because:

(*a*) The vast ice mass determines natural conditions in Antarctica and influences conditions and processes over the entire earth

(*b*) Study of the Antarctic ice sheet provides a means of understanding processes which took place on other continents during former ice ages

(*c*) The Antarctic ice sheet provides a unique area of deposition and preservation of atmospheric precipitation which is almost free from local sources of contamination.

The first two points require a theoretical understanding of the growth and maintenance of continental ice sheets, based on adequate measurements of the many processes taking place on and associated with the Antarctic ice sheet. The third point indicates that studies should be made to determine the quantity and composition of cosmic and terrestrial deposits falling on the surface of the earth during recent geological time. In addition to their intrinsic value, such studies will help in understanding many glaciological processes.

Scientific problems

In order to achieve the scientific aims we must determine and understand:

(*a*) The size and distribution of parameters of the present Antarctic ice sheet. These include the mass distributions of ice, gases, salts, morainic material, cosmic and terrestrial materials; the velocity of movement, density and temperature conditions throughout the ice sheet

(*b*) External mass and heat exchanges at the boundaries of the ice sheet, including total magnitude, variations in space and time and reasons for such variations

(*c*) Internal mass and heat exchanges, including their relationships to the distribution of velocity and temperature within the ice sheet, changes taking place in these fields and the reasons for such changes

(*d*) Past history and factors governing changes of the ice sheet, including past changes of climate.

Methods

Continued exploration:
- Inland oversnow traverses
- Coastline delineation, aerial photography; changes with time.

Inland deep drilling and associated flow-line studies:
- Strain rates, variation with depth
- Ice velocity, variation with depth
- Accumulation and/or melting at ice-atmosphere and ice-rock boundaries
- Temperatures, variation with depth
- Physical and chemical properties of ice, variation with depth
- Surface elevations, changes with time
- Ice sheet thickness, changes with time.

Coastal and localized studies:
Ice shelves: volume of flow, bottom melting
Ice streams: volume of flow, velocity, profiles, surface waves
Ice sheets: volume of flow
Ice domes, regime
Snow surface morphology
Snow drift studies
Snow evaporation and sublimation
Radiation and albedo studies
Snow physics, crystallography.

Inter-disciplinary studies:
Snow surface mass and heat exchanges: meteorology, micrometeorology
Ice-free areas: geology, pedology, glacial geology, botany
Ocean bottom sediments: submarine geology, geophysics, palaeontology, sedimentology
Sea ice: physics, budget, satellite studies of extent of pack ice
Physical, chemical and geochemical studies of gases, solids and particulates from ice cores
Melt water from shelves or land ice; effect on Antarctic ocean water masses, isotope chemistry.

Solid earth geophysics

Seismology

There are two principal problems of Antarctic seismological research:

(*a*) to use local earthquakes and explosions to infer Antarctic crustal structure, and

(*b*) to use distant earthquakes both to obtain evidence on Antarctic structure and also on the earth's deeper structure. The establishment of first-class seismological observatories in the Antarctic can fill in an important global gap

(*c*) to study microseisms to find why 3 to 10 second microseisms are in general less in winter than summer, in contrast to the seasonal variation in temperate latitudes.

The setting up of new seismological observatories in the Antarctic is largely experimental. Relevant factors include the suitability of particular sites (difficulties with microseisms, etc.), the human difficulties, and the, as yet, not fully known local seismicity. The present number of seismological observatories in the world is about 700. There should ultimately be not less than a corresponding number, determined on the basis of geographical area, in the Antarctic. Stations should normally be uniformly distributed, but special problems and features of local seismic activity may make this undesirable in some areas. Each station, in addition to having an adequate set of good seismographs, should have assured absolute time marks recorded on the seismogram so that absolute time can be read to less than a second. Suitably located stations should in due course become permanent.

Gravity

(*a*) The determination of gravity for the purpose of utilizing the data for geodesy as well as for the study of the earth's crust, and for solving some problems of glaciology

(*b*) Extension of the world networks of basic gravity points to the Antarctic

(*c*) Measurements of gravity by ship-borne gravity meters be made by ships operating in the area of interest of SCAR

(*d*) Measurement with pendulum instruments as well as gravimeters with small or constant drift .

Volcanology

To begin with, volcanological studies are likely to emerge from broader geological studies, and then become more specialized as development continues. The Antarctic borders on the Pacific Ocean, from round the rim of which comes 85 per cent of the total energy released in earthquakes. It is therefore important that great attention be paid to the seismic and volcanological problems of the area.

Upper atmosphere physics

Ionosphere

(*a*) Vertical incidence sounding. The programme should follow the principles suggested in the 1958 Edinburgh report of the URSI–AGI Committee. At least two stations on the Antarctic continent should be Class F (full) and the remainder should be Class P (patrol) stations and as many as possible should be continued for at least another half solar cycle.

(*b*) Special observations. (1) Measurements of atmospheric radio noise should be continued for a full solar cycle at a minimum of two stations. (2) Special studies should be made on whistlers and very low frequency emissions, absorption and scatter and low-level echoes which may be peculiar to the southern auroral zone or polar cap. These studies should be co-ordinated with special studies in other disciplines concerning the high atmosphere.

Aurora and airglow

(*a*) The morphology of visual and sub-visual auroras, specific auroral and airglow emissions, and HF radio scattering regions. Location, shape and structural details of the southern auroral zone

(*b*) The sources of energy producing geomagnetic and ionospheric disturbances, auroras and airglow in the Antarctic regions

(*c*) The nature of the agencies causing excitation of auroral and airglow emission

(*d*) The composition and physical state of the upper atmosphere

(*e*) Search for, and explanation of, peculiarities in the space and time distribution of auroral and airglow features characteristic of the southern hemisphere.

Observational programmes should continue at stations well distributed in

Antarctic regions using the several techniques available, such as visual observation, all-sky and parallactic photography, and photometric, spectrographic and radar techniques.

Cosmic rays

(*a*) Sources and mechanism of generation of cosmic rays

(*b*) Cause of changes of cosmic ray intensity which appear to be associated with changes in the distribution of matter and/or magnetic fields in interplanetary space

(*c*) Form of the geomagnetic field at great distances from the earth

These should be the subject of long-term observations from well-distributed stations.

General comments

Attention is drawn to the possibility of gaining new information on the geomagnetic field in regions far from the earth by comparing Arctic and Antarctic observations on VLF radio emissions, auroras and cosmic ray variations. Such comparisons may also contribute to understanding the mechanism of production of auroras. This possibility should be considered before fixing the positions of any new Antarctic stations.

INTERNATIONAL COMMISSION ON POLAR METEOROLOGY

It was pointed out at the 13th General Assembly of the IUGG at Berkeley (1964) that there is a growing need to bring to bear the scientific competence of the International Association of Meteorology and Atmospheric Physics (IAMAP) to study significant problems of meteorological processes as they relate to polar regions, and to interactions between polar regions and other parts of the planet. There is also a need to co-ordinate research programmes in the Arctic and Antarctic, to sponsor symposia, and in other ways to stimulate research and exchange ideas and results. IAMAP decided that these requirements justified the establishment of an International Commission on Polar Meteorology. The Commission has thirteen members and its President is M. J. Rubin, Chief, Office of Special Programs, US Weather Bureau, Washington 25, D.C., USA and United States member of the SCAR Working Party on Meteorology. The Secretary is Prof. Svenn Orvig, Dept. of Meteorology, McGill University, Montreal, P.Q., Canada.

The immediate objectives will be: (*a*) the preparation of a report on the present status of and deficiencies in our knowledge of polar meteorology and recommendations for future research, (*b*) the organization of an international symposium on polar meteorology, (*c*) considerations of ways to stimulate interdisciplinary programmes of polar research.

SCAR NATIONAL COMMITTEES, ADDRESSES

France: Comité National Français des Recherches Antarctiques, 39ter rue Gay-Lussac, Paris 5e. (Amendment to *SCAR Bulletin*, No 16, 1964.)

USSR: Soviet Committee on Antarctic Research, Academy of Sciences of the USSR, Ul. Vavilova 30a, Moscow, B-333. (Amendment to *SCAR Bulletin*, No 16, 1964.)

SCAR WORKING GROUPS, CHANGES IN MEMBERSHIP

Biology

United Kingdom: Dr M. J. Holdgate, British Antarctic Survey Biological Unit, Department of Zoology, Queen Mary College, Mile End Road, London, E.1. (Amendment to *SCAR Bulletin*, No 14, 1963.)

Geodesy and Cartography

United Kingdom: Mr W. D. C. Wiggins, Directorate of Overseas Surveys, Kingston Road, Tolworth, Surbiton, Surrey. (Amendment to *SCAR Bulletin*, No 14, 1963.)

Solid Earth Geophysics

South Africa: Professor L. O. Nicolaysen, Director, Bernard Price Institute for Geophysical Research, University of Witwatersrand, Milner Park, Johannesburg. (Amendment to *SCAR Bulletin*, No 14, 1963.)

SCAR ANTARCTIC LOGISTICS SYMPOSIUM, BOULDER, 1962. CORRECTIONS TO LIST OF PAPERS PRESENTED, AS PUBLISHED IN *SCAR Bulletin, No. 13, Polar Record,* Vol. 11, No. 73, 1963, p 506–09

The publication of *Symposium on Antarctic Logistics* by the National Academy of Sciences—National Research Council, 1963, the official account of the symposium, has disclosed the following errors in the *SCAR Bulletin* list which was based on information then available.

Section 2. Air operations

Add: L. A. Arsenault. Air navigation in the Antarctic.
E. J. Dionisi. The temporary airstrip for the flight to the South Pole.

J. A. Pittaluga. Performance of the C-47 aircraft in the flight to the South Pole, 1961–62.

Section 3. Buildings

Add: Transportation of prefabricated units for buildings for Soviet Antarctic stations.

Water supply of Soviet Antarctic stations.

Both presented by the Soviet Committee on Antarctic Research.

Delete: A. P. Giovannini. Living in a station in very low temperatures.

Section 4. Vehicles

Add: Arctic and Antarctic Research Institute, Leningrad. Ground transport of the Soviet Antarctic Expedition.

P. O. Baeza. Antarctic land vehicles used by Argentina.

C. R. Bentley and J. B. Long. Oversnow traverse vehicles and sledges, US Antarctic Research Program.

V. E. Fuchs. Some aspects of tractor performance.

A. J. Heine. Base transport problems.

G. W. Homann. Logistics of ice cap surface transportation.

J. J. la Grange. The requirements and nature of the logistics support for a small national Antarctic expedition (C. Land vehicles).

N. R. Smedhurst and R. F. M. Dalton. The design of field caravans.

P. E. Victor. For those who still use dogs and sleds.

Delete: L. Hedges and F. Jacka. A simple design for a portable catamaran.*

E. J. Hird and P. A. Yates. The 557 HF polar sledge radio set.*

F. Mason. Communications problems in Antarctica.*

M. Murayama. Report on field operation JARE.*

N. R. Smedhurst. The economics of a D-4 tractor train traverse.*

F. A. Smith. The design of field caravans.

The papers marked with * were presented under Section 6.

Section 5. Antarctic provisioning

Add: Arctic and Antarctic Research Institute, Leningrad. Cold weather clothing for Soviet Antarctic explorers.

J. J. la Grange. The requirements and nature of the logistics support for a small national expedition (D. Antarctic provisioning).

J. Rivolier. Two problems of medical logistics.

For: D. P. Balza. Antarctica provisioning: *read* P. O. Baeza. Notes on Antarctic rations.

Section 6. Field operations

Add: the papers marked with * listed under Section 4.

H. P. Black. A method of navigating over featureless snow surfaces.

J. J. la Grange. The requirements and nature of the logistics support for a small national Antarctic expedition (E. Field operations).

E. A. MacDonald. Search and rescue in the Antarctic–United States.

G. W. Markham. A suggestion for operations research. in field operations.

P. M. Smith. Toward the increased efficiency of logistic support.

Delete: V. E. Fuchs. Some aspects of tractor performance (presented under Section 4).

G. W. Hawman. Logistics of ice cap surface transportation.

A. J. Heine. Base transport problems (presented under Section 4).

Soviet paper. Ground transport of Soviet Antarctic Expeditions.

PUBLICATION OF *BIOLOGIE ANTARCTIQUE*

Biologie Antarctique, comptes-rendus, Paris 2–8 *Septembre* 1962, the proceedings of the SCAR Symposium on Antarctic Biology, has been published by Hermann, Paris, at 54 fr. The editors are: Robert Carrick, Canberra, Martin Holdgate, Cambridge, and Jean Prévost, Paris, and there is a preface by Professor P.-P. Grassé.

NOTICE

The SCAR Bulletin is published in England in January, May and September each year as part of the *Polar Record*, the journal of the Scott Polar Research Institute.

Contributions are invited, and should consist of factual notes on the membership, equipment and activities of Antarctic parties; articles on matters of particular interest in connection with these activities are also welcome. Contributions should be sent to the Editor, Scott Polar Research Institute, Lensfield Road, Cambridge, England.

THE POLAR RECORD

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