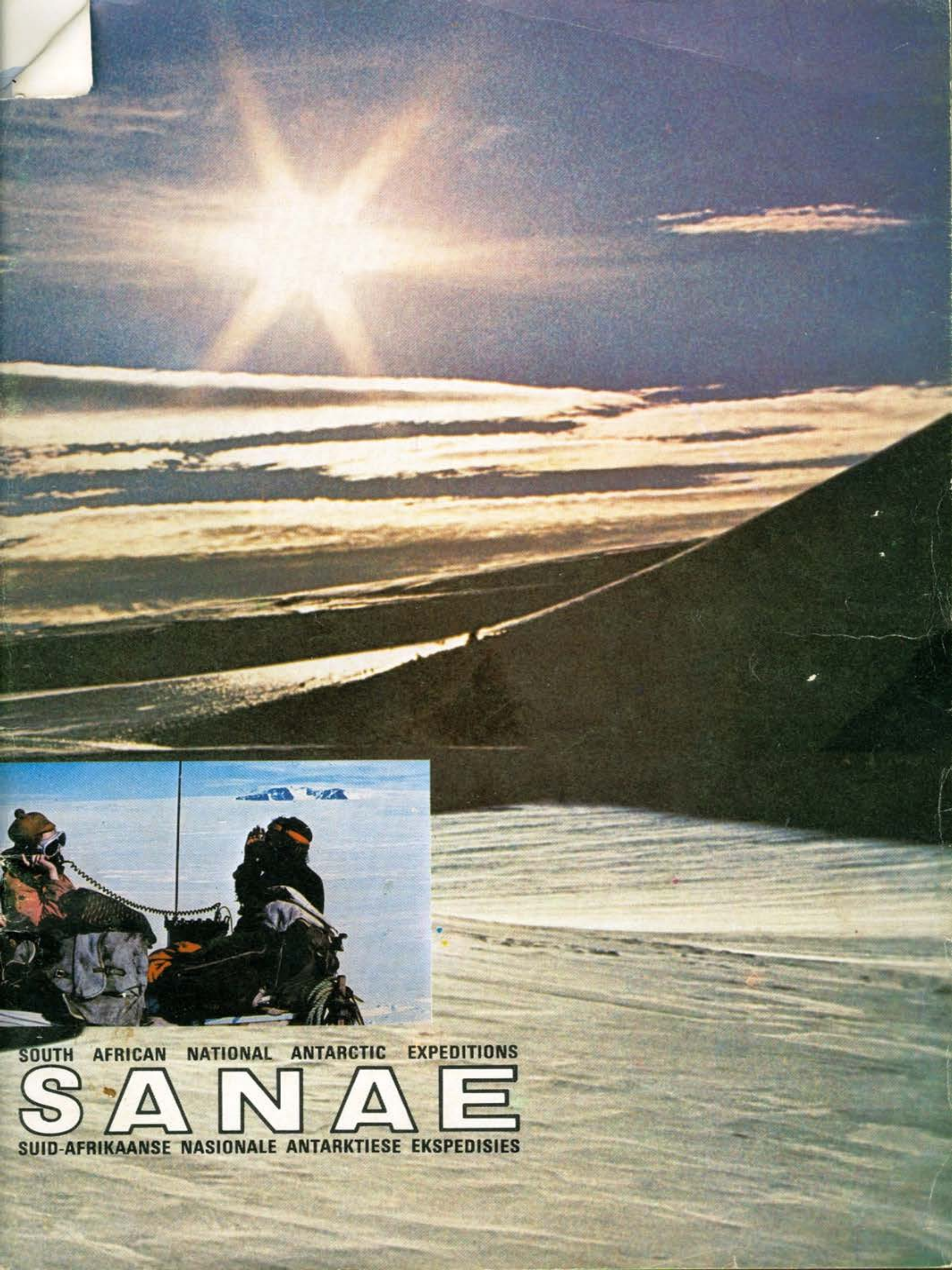
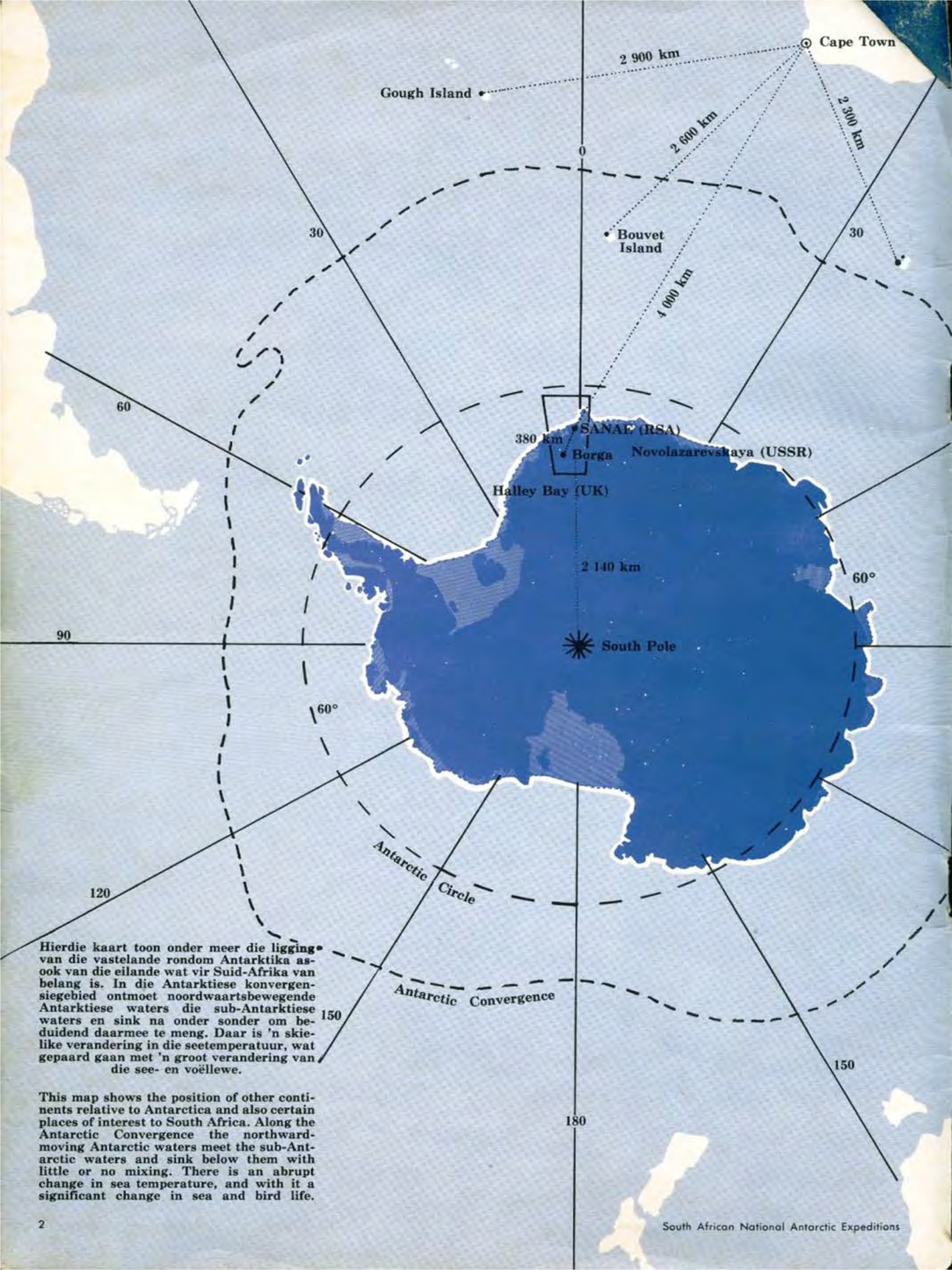


SOUTH AFRICAN NATIONAL ANTARCTIC EXPEDITIONS

SANAE

SUID-AFRIKAANSE NASIONALE ANTARKTIESE EKSPEDISIES



Hierdie kaart toon onder meer die ligging van die vastelande rondom Antarktika asook van die eilande wat vir Suid-Afrika van belang is. In die Antarktiese konvergensiegebied ontmoet noordwaartsbewegende Antarktiese waters die sub-Antarktiese waters en sink na onder sonder om beduidend daarmee te meng. Daar is 'n skielike verandering in die seetemperatuur, wat gepaard gaan met 'n groot verandering van die see- en voëllewe.

This map shows the position of other continents relative to Antarctica and also certain places of interest to South Africa. Along the Antarctic Convergence the northward-moving Antarctic waters meet the sub-Antarctic waters and sink below them with little or no mixing. There is an abrupt change in sea temperature, and with it a significant change in sea and bird life.

Inhoud Contents

Hierdie brosjure

Die Departement van Vervoer, lede van nasionale Antarktiese navorsingsprogramme en die WNNR het saamgewerk om hierdie brosjure op te stel (verwys ook na p 22). Dit is versorg en as bylaag tot die WNNR-lyfblad **Scientiae**, *uitgegee deur die Publisiteitsafdeling van die WNNR.*

In 1974 in die Republiek van Suid-Afrika gedruk deur Die Koöperasiepers Bpk, Pretoria.

This brochure

The Department of Transport, members of national Antarctic research programmes and the CSIR collaborated in compiling and producing this brochure (refer also to p 22). It is presented as a supplement to **Scientiae**, *official journal of the CSIR and was published by the CSIR's Publicity Division.*

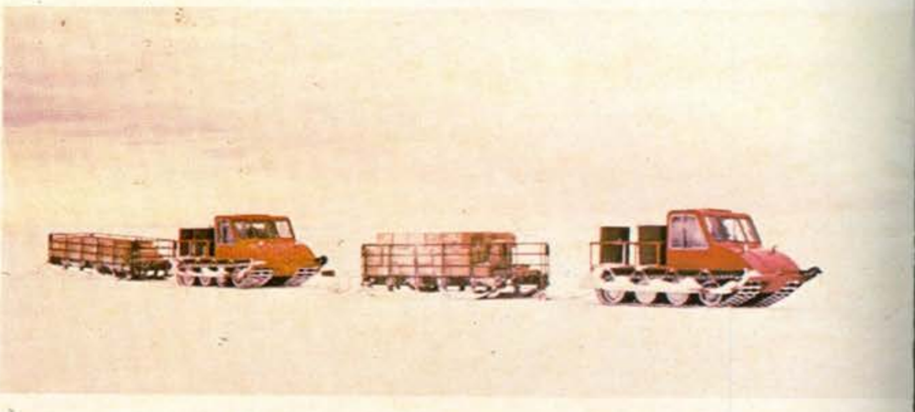
Printed in South Africa in 1974 by The Co-operative Press Ltd, Pretoria.

Top: Wind sculpture
Bo: Die wind se beeldhouwerk

Bo links: *R S A* breek deur pakys
Above left: *R S A* breaks through pack ice

Bo regs: Vasgeval!
Above right: Stuck!

Right: Mechanical Huskies – Muskeg tractors
Regs: Meganiese Huskies – Muskeg-trekkers



Top: Interior of Marion Island
Bo: Die binneland van Marion

Centre: Icescape
Middel: Yslandskap

Bottom left: Marion coastline
Links onder: Marion-kuslyn

Bottom right: Sea ice against the background of the ice shelf
Regs onder: See-ys voor die ysbank

From vision to reality

Man's romantic imagination conjured up a vast Utopian continent in the southernmost part of the earth long before Antarctica was, in fact, discovered.

The continent derives its name from the ancient Greeks who named the brightest star circling the sky, Arctos (the Bear) and the pole around which it appeared to revolve, the Arctic pole. To balance the natural order they felt there must be a similar pole opposite – an anti-Arctic. Aristotle's demonstration that the earth was a sphere and not flat as the early Greeks believed, brought with it a sequel to the balance in the heavens – a belief that a similar balance must be maintained on earth and that there must be a land mass in the south to balance those in the north.

In much later times the search for this legendary land – which fertile imaginations had over the years endowed with fabulous riches – drew many famous navigators south. They had little success, except to narrow down the area in which the southern continent was to be found. The southernmost tip of Africa had, in the meantime, been rounded and Australia discovered to be a land mass on its own and not an extension of the fabled continent of Antarctica. Islands such as Bouvet, the Kerguelen group and South Georgia were sighted, but no continent.

Drake's voyages also served to whittle down the imagined size of the unknown continent. Blown far south from Cape Horn by high winds he reported a wide expanse of ocean in which no land was to be seen to the south.

Captain Cook

Men continued to cling to all sorts of theories about the size, nature and location of the mysterious continent, however, until Captain James Cook crossed the Antarctic Circle in his circumnavigation of the globe in high southern latitudes between 1772 and 1775 and proved that there was no continental land north of latitude 60°S in the Indian and Atlantic oceans.

Cook sailed right round Antarctica although he did not actually sight the continent. He encountered vast expanses of pack ice and many icebergs and saw many seabirds, all of which led him to believe that there was land to the south. His reports of the nature of these inhospitable southern seas put paid to men's fancies of earlier years about a rich and fertile land. Situated around the southern pole, it was far from a paradise but a barren area of ice and snow with an environment cold and hostile to man.

Cook's reports of seals on the island of South Georgia, an island first sighted by a Spanish merchantman, brought the sealers flocking to the Antarctic areas and they were probably the first people to see the continent of Antarctica.

Bellingshausen

After Cook came many other explorers, among them the Russian, Fabian von Bellingshausen. His object was to circumnavigate the Antarctic area trying to keep as far south as possible in those longitudes where Cook had made northward detours. In 1821 Bellingshausen sighted the first land ever seen within the Arctic Circle, a small island which was named Peter I. A week later, another and larger island was sighted, this one being named after the emperor Alexander I.

The first known landing on Antarctica was made in 1821 by Captain John Davis of New Haven, Connecticut, who sent a boatload of men ashore to look for seals on the shore of what is now known as Hughes Bay. His logbook, found only recently, records 'I think this Southern Land to be a Continent'.

Wilkes

The proof that Antarctica was indeed a continent came from an expedition of five ships led by Lieutenant Charles Wilkes of the United States Navy in 1838/39. He sighted land at numerous points over a distance of 2 400 km and after his return the world at last accepted the existence of a southern continent vastly different from the imaginary pictures of earlier years.

The main purpose of Antarctic expeditions in the 19th century was the survey of coastal regions. Here we may mention Dumont d'Urville, Charles Wilkes and James Clark Ross, all of whose names are commemorated in areas in Antarctica. Ross sailed as far south as it is possible to go by ship before coming up against a great southern barrier, the edge of Ross Ice Shelf. He found the best way to reach the heart of the continent and the closest navigable approach to the South Pole. From this region the first land journeys were to be made in later years.

Heroic Era

The Heroic Era in Antarctica's history – the period of the first exploration of the vast unknown interior of the continent – began with the first winter-

Left: James Cook

Top right: Fabian von Bellingshausen

Right: Charles Wilkes

Far right: James Clark Ross

ing in the area in 1898 by the expedition ship *Belgica*. It was, in fact, an unintentional stay because the ship froze fast in the Bellingshausen Sea and drifted with the pack ice until the summer break-up eventually freed the vessel.

The first winter land base to be established was that of a British expedition led by C E Borchgrevink which landed at Cape Adare. Ten members stayed in Antarctica when the ship returned to New Zealand, in much the same way as wintering over and summer changeover of research teams is done in Antarctica today. Bases are set up in summer and journeys made into the interior the following spring.

This was the start of the era in which Amundsen, Scott and Shackleton achieved fame, and tragedy struck in man's search for the South Pole.

Organized scientific research in Antarctica has its roots in this period. Captain Robert Falcon Scott of the Royal Navy, who commanded the British National Antarctic Expedition from 1901 to 1904 – and who was later to achieve fame in his courageous bid to be the first to reach the South Pole – had strong scientific interests. From his McMurdo Sound base numerous parties set out to explore and observe. They went south over the Ross Ice Shelf for over 480 km, climbed the Victoria Land mountains and reached the polar plateau for the first time. By the time these scientists, together with those of German and Swedish expeditions who had also been studying the area, left Antarctica in 1904, they had collected enough information to provide a firm basis for Antarctic studies.

From then on there were expeditions to Antarctica nearly every year and these included men from many nations.

Increasing numbers of whalers also entered the area. They, too, investigated places not seen before and some made maps of harbours and other geographical features.

Shackleton

In these years Douglas Mawson and Jean Charcot carried out geomagnetic surveys and W S Bruce set up a meteorological station on Laurie Island.

Lieutenant Ernest H Shackleton, a member of Scott's first expedition, was to become one of the great leaders in Antarctic exploration. He crossed the Ross Ice Shelf, climbed the glaciers at its head and reached a point only 155 km from the South Pole. Other parties climbed the volcano Erebus – first seen and named by Ross – and scaled the Victoria Land plateau and located the South Magnetic Pole, ending a search begun 70 years earlier with the voyages of Wilkes, Ross and d'Urville.

The climax of the Heroic Era came in 1911 and 1912 when the Geographic South Pole was reached, first by the great Norwegian explorer Roald Amundsen and shortly afterwards by Captain Robert Scott. This feat, which demanded remarkable courage and endurance, was, however, to be shadowed by the tragic death of all of Scott's party in their unsuccessful battle to return to base camp.

The end of the epoch came with Shackleton's attempt to cross the Antarctic from the Weddell Sea to the Ross Sea by way of the South Pole. Two parties were to make the attempt, one to cross from the Weddell Sea and a supporting group to come from the Ross Sea and lay depots of food and fuel across the 640 km of the Ross Ice Shelf. But the ships of both parties froze fast in the ice and drifted hundreds of miles away. Shackleton's was eventually crushed and the men took to the pack ice and later to the sea in their small boats. Eventually they managed to reach Elephant Island and then South Georgia. The other party's ship survived the pack ice but the men stranded on shore had to wait many months before it finally returned to rescue them.

With Shackleton's death in 1922, the last of the great men of the Heroic Era of Antarctic exploration vanished from the scene.

The failures and successes of these explorers contributed greatly to knowledge about the techniques of Antarctic exploration and set the scene for more intensive scientific studies, such as those of the Polar Years of 1882-83 and 1932-33.

The next great concerted scientific effort in Antarctica was organized within the International Geophysical Year (IGY) in 1957-58. A feature of this was the Commonwealth Trans-Antarctic Expedition under Sir Vivian Fuchs, which has been described as 'man's last great journey'. South Africa was one of the sponsors of this expedition. The South African representative was Mr Hannes la Grange, who accompanied the expedition and was the first South African to reach the South Pole.

The global observations of the IGY ushered in the era of intensive scientific research in Antarctica.

Far left: Robert Falcon Scott

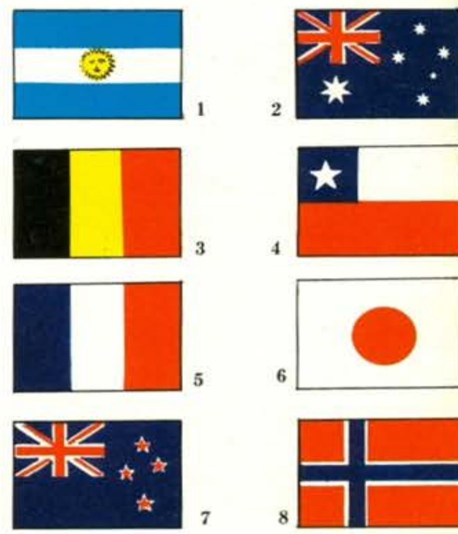
Left: Roald Amundsen

Right: Ernest Shackleton

Above: Base at Marion Island, and Borga Base in Antarctica
Bo: Basis op Marion-eiland, en Borga-basis in Antarktika

Below: Field camp on the ice
Onder: Veldkamp op die ys

Bottom: (left) Front door to SANAE Base and (right) weather balloon launched by light of midnight sun
Heel onder: (links) SANAE se voordeur en (regs) 'n weerballon word losgelaat by middernagsonlig



1. Argentina
2. Australia
3. Belgium
4. Chile
5. France
6. Japan
7. New Zealand
8. Norway
9. South Africa
10. U S S R
11. United Kingdom
12. U S A

The Antarctic Treaty

International scientific co-operation in Antarctica led to the conclusion of a political contract without precedent — the Antarctic Treaty.

The primary aim of the treaty is to ensure the continuation of international scientific research in Antarctica. The first treaty ever designed to protect a scientific programme, it is symbolic of the world of science which knows no national or other political boundaries.

SIX PROVISIONS

Its six main provisions bear witness to its unusual character. The Antarctic Treaty:

- **ensures the continuance of the international scientific co-operation which characterized the International Geophysical Year.**
- **reserves Antarctica for peaceful purposes only**
- **guarantees the non-militarization of the whole continent of Antarctica**
- **prohibits all nuclear explosions on the continent**
- **provides for an unprecedented system of unilateral inspection of any part of Antarctica by observers of any signatory nation**
- **freezes all national territorial claims and rights for 30 years from the date of entry into force of the treaty.**

The Antarctic Treaty was signed in Washington D C on 1st December, 1959, by representatives of twelve nations — Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, U S A and U S S R — and officially implemented from 23rd June, 1961. Provision was made by the nations which orginally ratified the treaty for accession by other nations, whether directly involved in Antarctic research or not. At present there are 17 signatory nations, the new signatories being Czechoslovakia, Denmark, Poland, the Netherlands and Roumania.

The treaty created no formal secretariat or organization, but the signatory nations meet every two years to discuss problems of mutual concern. Designed to protect the scientific programme in Antarctica, the treaty left to the Scientific Committee for Antarctic Research (S C A R) a non-governmental organization, the co-ordination of that programme.

CONSERVATION

Since the treaty was implemented, the signatory nations have approved numerous measures for greater co-operation in Antarctica, among the most important of which is the 'Agreed Measures for the Conservation of Antarctic Fauna and Flora'. Antarctica provides scientists with a unique opportunity for studying a content which, because of its isolation and because it has never been the home of man, has a flora and fauna which represents the only sizable assemblage of organisms on earth as yet uncontaminated by man. No new plants or animals have been introduced into the area and these conservation measures aim at preserving Antarctica as far as possible in its natural state.

The treaty aims to ensure that scientists will be given every opportunity of working together to coax the icy vastness of Antarctica to yield up its treasures for the enrichment of man's knowledge of the world in which he lives, to provide resources which every nation can use, and to work towards a world that will yield enough for every man in every country.

SANAE-EMBLEEM

Die ronde helmteken bo toon simbolies die son agter die kleure van die Suid-Afrikaanse vlag, met 'n Koningspikkewyn, verteenwoordigend van Antarktika, op die voorgrond.

Die riddershelm met wrong en dekklede het geen simboliese betekenis nie, maar is deel van die heraldiese tradisie.

Twee pikkewyne op 'n blou ysbank hou die skild waarop wit ysberge, die blou see en die wit leegheid van Antarktika voorgestel word.

Die wapenspreuk 'Unitate Fortior' beteken 'Sterker deur Eenheid'.

SANAE EMBLEM

The rounded crest shows, symbolically, the sun behind the colours of the South African flag with a King penguin superimposed to represent Antarctica.

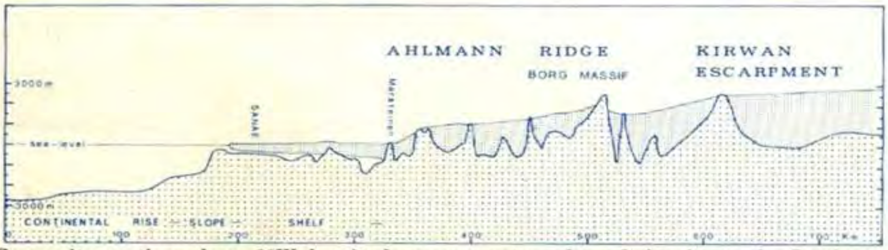
The helmet, wreath and mantling have no symbolic meaning but are part of the heraldic tradition.

The supporters, two King penguins on blue ice, flank a shield on which white icebergs, the azure ocean and the white emptiness of Antarctica are represented.

The motto, 'Unitate Fortior' means 'Strength in Unity'.

Antarctic Treaty commemorated
Antarktiese Verdrag herdenk

The ice-bound seventh continent



Composite section along 2°W longitude across outer edge of the Antarctic Continent and its continental terrace off Princess Martha Coast, Queen Maud Land (reproduced from Neethling 1970).

Deursnit by 2° Westerlengte deur die buiterand van die Antarktiese vasteland en sy kontinentale yslip langs die Prinses Martha-kus, Koningin Maud-land (oorgeneem uit Neethling 1970).

Bevrore berge
Mountains of ice

Antarctica is the earth's seventh continent. It is the highest, driest, windiest and coldest of the continents. Its area is approximately 13½ million square kilometres, roughly 11 times the area of the Republic of South Africa.

The continent is divided into two major regions – Greater and Lesser Antarctica.

Greater Antarctica lies east of the Transantarctic Mountains and is an irregular ice dome centred slightly east of the Pole of Inaccessibility – the point most distant from the sea in all directions – and has a maximum elevation of about 4 250 m and a mean elevation of 2 420 m. The plateau slopes gently down to about 1 500 m at a distance of about 30 km from the coast, after which it slopes steeply into the sea.

Lesser Antarctica lies west of the Trans-Antarctic mountains and consists of the mountainous Antarctic Peninsula, the Filchner and Ross ice shelves and the intervening areas.

Ice sheet

Approximately 95% of the continent is covered by an ice sheet having an estimated average depth of 2 000 m. The ice sheet contains about 90% of the planet's fresh water supply (34 million cubic kilometres). If this ice cap were ever to melt, it is estimated that the level of the world's oceans would increase by about 60 m.

The coastline of the continent is often 'extended' by ice shelves. An ice shelf consists of ice which has accumulated on the continent (through snow precipitation) and flowed seawards by glacier action. At the coastline proper of the continent the ice shelf hinges on the land ice and floats on the sea. The thickness of an ice shelf is typically some 400 m. SANAE, the main South African base, is built on such an ice shelf and is approximately 130 km from the true coastline of the continent.

The Ross and Filchner ice shelves are the largest in Antarctica. Icebergs are formed from the edges of these ice shelves by fragments which 'calve' or break off.

The greatest exposure of rock occurs in the Antarctic Peninsula and the Trans-Antarctic Mountains. The peaks of the mountains generally rise 200 to 2000 m above the ice of the surrounding plateau.

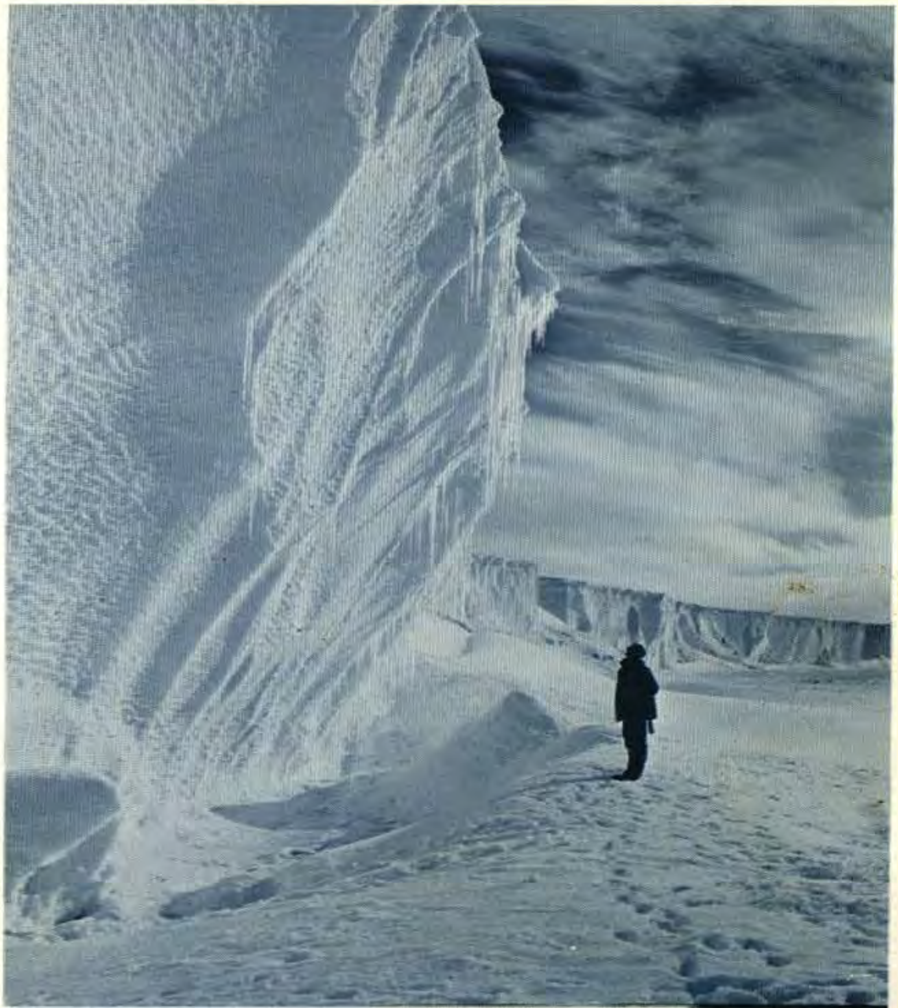
Climate

The climate of Antarctica is the coldest and harshest in the world. Temperatures decrease with increasing altitude. The mean annual temperature at SANAE (50 m above sea level) is about -17°C while the South Pole (3 400 m above sea level) has a mean annual temperature of -57°C. The lowest temperature ever recorded is -88°C, measured at the Russian base Vostok.

When cyclonic and katabatic wind influences combine then tremendous winds are experienced. Winds in excess of 240 km/h have been recorded for periods of several days. Generally, however, winds over the interior of the continent are relatively light, averaging 24 km/h.

Antarctica is a cold desert receiving the major portion of its precipitation in the form of snow. The mean annual snow accumulation over the continent is equivalent to 12 cms of water, while in the interior of Greater Antarctica this figure drops to about 5 cms. Around the coast the mean annual water equivalent of precipitation is between 20 and 50 centimetres.

During the winter months the sea surface for hundreds of kilometres around the continent freezes and the whole polar cap extends a few degrees further northwards. During summer this ice breaks up under the influence of winds and ocean currents to form the pack ice so hazardous to shipping.



Poetry in white
Wit poësie

Can the *R S A* offload here?
Kan die *R S A* hier aflaai?

Why research so far from home?

Why does the Republic of South Africa carry out research on the desolate continent of Antarctica and on the isolated sub-Antarctic islands of Marion, Prince Edward and Gough?

METEOROLOGICAL RESEARCH PROGRAMME

The practical applications of the meteorological research programmes are obvious and direct since improved weather forecasting results. The atmosphere above the sea between South Africa and Antarctica is often termed 'the weather factory of the world'. Thus intensive meteorological studies in these regions can only serve to improve man's knowledge of the earth's weather systems.

Weather research was in fact the reason for South Africa's first participation in research in Antarctica. When Norway advised in 1959 that it would be vacating its station at the end of that year, the South African Weather Bureau quickly stepped in to request that the station be taken over by South Africa. This was done in 1960. Meteorological observations were, accordingly, of most importance in the early years. With the passage of time, however, other disciplines began to play a greater role and *SANAE* developed from a weather station into a scientific research station of much wider scope.

UPPER ATMOSPHERE PHYSICS

Upper atmosphere physics research in Antarctica and the sub-Antarctic islands is of importance for a number of reasons. The South African Antarctic base, *SANAE* is, for instance, in a unique position for the study of radiation and magnetic anomalies in the atmosphere which occur in these regions. These phenomena are not only of scientific interest but of great importance for radio communication.

GEOLOGY

Geological investigations in the mountainous regions to the south of *SANAE* also have their value. The geological exploration of a continent whose mineral resources are unexploited (because of practical reasons beyond present, but possibly not future, technology) is vital when one considers a world whose known resources promise to be inadequate to supply the demands of future generations.

INTERNATIONAL VIEWPOINT

Research in the Antarctic regions is important from the point of view of international relations and co-operation. South Africa is, or has been a participant in numerous international scientific research projects – the International Geophysical Year, the International Biological Programme and the International Magnetospheric Study (IMS), to name just three of the many past and present international projects.

These are some of the practical reasons for research in Antarctica. But Antarctic research is not only a practical project. It is also carried out to increase man's knowledge of the world in which he lives. The various aspects of research outlined above, are part of his endeavours to obtain a more coherent understanding of the science of the southern polar regions and to unlock the door to some of the secrets of one of the last remaining unexplored regions of the earth.

Part of the Princess Martha coastline, photographed by the ERTS satellite. SANAE Base is just off the photograph to the left.

Surveying Antarctica by satellite

Deel van die Prinses Martha-kuslyn, afgeneem deur die ERTS-satelliet. SANAE-basis lê net links van die foto.

Over the past few years SCAR has become increasingly aware that the technique known as earth resources surveys from satellites can have important applications in Antarctic research.

The cartographic applications of satellite imagery are immediately obvious. ERTS-1 (Earth Resources Technology Satellite) imagery is being used by various nations to revise existing maps of Antarctica. South African cartographers too, have expressed an interest in using ERTS imagery to revise and update maps of the SANAE area.

The use of earth resources survey techniques extends beyond cartographic applications and ERTS imagery is being used to study snow and glacier hydrology; to monitor the mass and aerial extent of snow cover (mass-balance studies) e g changes of the ice-shelf coastline of Antarctica, and to study Antarctic marine and biological resources.

Many other problems also appear to be amenable to these techniques, especially as sensor technology develops.

South African biologists currently engaged in research on Marion Island have expressed their interest in obtaining data on the changes in animal populations (migrations) and the seasonal changes in vegetation, snow cover, etc, on Marion and Gough Islands.

In view of the interest shown in the technique of surveying earth resources from satellites SCAR is planning, during the course of 1974, to give detailed consideration to the types of problems that are indeed amenable to study by the new technique and particularly to problems unique to Antarctic research.

It is also intended to explore ways of collaborating with the various space agencies in an attempt to provide solutions to these problems.

SCAR

The Scientific Committee on Antarctic Research

For many years scientists have recognized the significant contribution that polar research can make to man's knowledge of the earth on which he lives. In 1882-83 an international scientific undertaking known as the First Polar Year was implemented and 11 nations sent expeditions to the Arctic. In 1932-33 there was a Second Polar Year, also focussing attention on the Arctic.

Proposals in 1950 for a Third Year gave birth to the idea of the International Geophysical Year (IGY) – a much wider international research programme, but one which from the beginning recognized scientific research in Antarctica as one of its main objectives.

These polar years set an example to the world in international co-operation in science – an example that has during the last decade or so been followed in many scientific disciplines. It was realized, however, that the 18 months of the IGY would only allow for superficial exploration of the vast area of Antarctica and it was therefore recommended to the International Council of Scientific Unions (ICSU) that a permanent organization be formed to continue scientific research in Antarctica. This led to the creation of the Scientific Committee for Antarctic Research (SCAR) in 1958.

SCAR is composed of a number of working groups covering various fields of scientific research. These are biology; communications; geodesy and cartography; geology; geomagnetism; glaciology; logistics; meteorology; oceanography; solid earth geophysics; upper atmosphere physics and human biology and medicine.

Twelve countries interested in Antarctic research have permanent delegates to SCAR – Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, the United States of America and the USSR.

The participating countries prepare annual reports for SCAR and delegates meet every two years to exchange information gained from research work in Antarctica and to make arrangements for future programmes. In addition, the observational or scientific data from all Antarctic stations are deposited in the established world data centres and are available to all on request.

The CSIR, through its Science Co-operation Division, adheres to SCAR on behalf of South Africa. The Deputy President of the CSIR, Dr F J Hewitt, is chairman of the S A Scientific Committee for Antarctic Research (SASCAR).

Looking into the frozen continent
Wat lê alles in dié bevrore land?

SASCAR

The South African Scientific Committee on Antarctic Research

Dr F J Hewitt
Chairman of the South African Scientific Committee on Antarctic Research.
Voorsitter van die Suid-Afrikaanse Wetenskaplike Komitee vir Antarktiese Navorsing.

South African Antarctic research programmes and expeditions are administered by the S A Department of Transport on the advice of SASCAR and financed by funds allocated by the South African Government to Antarctic research.

For convenience we regard the South African Antarctic research activities as embracing work on the sub-Antarctic islands also. The regions involved include the Western Queen Maud Land region of Antarctica and Marion, Prince Edward and Gough Islands (the latter a British possession). Bouvet Island, which is a Norwegian possession, has also had visits from South African scientists in the past.

South African Antarctic research activities can be classified broadly under these headings:

- Upper atmosphere physics
- Biological sciences
- Earth sciences
- Meteorology

At present SASCAR is responsible for co-ordination of the following projects:

UPPER ATMOSPHERE PHYSICS
Cosmic ray programme run by the Physics Department of the University of Potchefstroom;

Airglow observations, at various locations, as part of other programmes;

Geomagnetic and aurora programme run by the University of Potchefstroom in conjunction with the CSIR's Magnetic Observatory;

Whistler and micropulsations programme of the Physics Department, University of Natal;

Ionosphere programme run at *SANAE* by the Physics Department, Rhodes University and on Marion Island by the CSIR's National Institute for Telecommunications Research.

BIOLOGICAL SCIENCES
Biological energetics programme run by the Department of Environmental Sciences, University of the Orange Free State;

Seal project of the Institute of Mammalogy, University of Pretoria;

Ornithology project of the Percy FitzPatrick Institute of African Ornithology, University of Cape Town.

EARTH SCIENCES
Geology, glaciology and geophysics programme of the S A Geological Survey;

Cartographic support programme of the S A Trigonometrical Survey.

METEOROLOGY
Meteorological programme of the Weather Bureau.

Agter die SANAE-ekspedisies
– administrasie en logistiek

Die Departement van Vervoer is verantwoordelik vir die administratiewe beheer van en logistiese ondersteuning aan ekspedisies na Antarktika en die eilande Marion en Gough. Sy funksie behels die werwing van ekspedisielede, die voorsiening van behuising en noodsaaklike lewensmiddele en die vervoer hiervan na die basisse. Daarby kom nog o a die beheer van die fondse en skakeling met ander Antarktiese Verdragslande deur die Departement van Buitelandse Sake.

Die Wetenskaplike Komitee vir Antarktiese Navorsing (WKAN) van die WNNR tree op as die Departement se raadgewer m b t alle wetenskaplike aangeleenthede. Met uitsondering van die weerkundige program wat deur die Afdeling Weerburo van die Departement onderneem word, doen die Departement van Vervoer self geen natuurwetenskaplike navorsing nie.

Keuring en opleiding van ekspedisielede

Ekspedisies na die basisse op Antarktika en op Marion- en Gough-eiland duur gewoonlik 'n jaar. Voornemende ekspedisielede word dan ook aan streng mediese en sielkundige keuring onderwerp om vas te stel of hulle opgewasse sal wees teen die veeleisende lewe in afsondering.

Afgesien van wetenskaplikes, is ondersteunende personeel ook nodig.

Voornemende ekspedisielede moet reeds in die rigting waarin hulle belang stel, gekwalifiseerd wees. Hulle kry egter gespesialiseerde opleiding vir die take wat op hulle wag. Wetenskaplikes bly vir 'n tyd na hul terugkeer in diens om die ingesamelde gegewens te verwerk.

Voor vertrek na 'n basis word die hele span in Pretoria saamgetrek. Besondere aandag word dan geskenk aan voorbereiding vir die ekspedisielewe en aan opleiding in byvoorbeeld brandbestryding, kookkuns en reddings- en oorlewingstegnieke.

Die voorradeskip *RSA*

Aflosreise na die Suid-Afrikaanse basisse geskied normaalweg een maal per jaar met die voorradeskip *RSA*. Antarktika kan slegs gedurende Januarie en Februarie per skip bereik word. Andersins word dit deur 'n ondeurdringbare ysgordel omring. Selfs gedurende Januarie en Februarie moet daar soms dae lank gespook word om deur die pakys te kom.

In April word Marion-eiland besoek en in Oktober Gough.

Die *RSA* is nie 'n ysbreker nie maar is spesiaal versterk vir ystoestande. Hy het plek vir 31 passasiers, 'n bruto tonnemaat van 1 550 ton en kan 'n spoed van 11 tot 12 knope behaal.

Hoewel sekere oseanografiese en ander inligting gedurende aflosreise ingewin word, is die *RSA* basies 'n voorradeskip en nie 'n navorsingskip nie.

Basisse en die bevoorrading daarvan

In 1960 het die Eerste Suid-Afrikaanse Nasionale Antarktiese Ekspedisie (SANAE 1) intrek geneem in 'n basis wat van Noorweë oorgeneem is. In 1962 het die Departement van Openbare Werke die eerste Suid-Afrikaanse basis, genoem SANAE, opgerig. SANAE (70°18'S, 02°21'W) is op 'n drywende ysbank geleë ongeveer 20 km van die yswal en 130 km van die vasteland. Aangesien die basis nie op vaste land gebou is nie, raak dit elke jaar dieper onder die sneeu begrawe. Toegangskagte moet dus aanhoudend verleng word. Toe die 1962-basis aan die begin van 1971 vervang is, was dit deur 15 m sneeu bedek – ál teken van lewe op die oppervlak was skoorstene, radiomaste en los wetenskapshutte wat periodiek bo die sneeu-oppervlak uitgelig word.

In Brief

ADMINISTRATION AND LOGISTICS

The Antarctic Section of the South African Department of Transport is responsible for the administrative control of and logistic support for South African expeditions to *SANAE* as well as to Marion and Gough Islands. This includes support for eleven main programmes, the majority of which have subdivisions.

Appointment of expedition members is preceded by medical and psychological tests. Teams assemble in Pretoria for orientation purposes before departure to the bases.

Relief voyages are undertaken by means of the M V *RSA* which is not an ice breaker but a ship strengthened to withstand pressure from ice.

Buildings at the research stations are erected and maintained by the Department of Public Works. *SANAE* base is on a floating ice shelf which makes it necessary to rebuild it every five or six years. The terrain on the islands also necessitates special construction methods for the base buildings.

The relief ship visits the bases only once a year so that supplies must ordered with the utmost care.

Because of the isolation of the bases special emphasis is laid on recreational facilities.

Special protective clothing to withstand the extreme weather conditions has to be provided for the research teams. With the exception of footwear, virtually all clothing is made in South Africa. Extensive use is made of sheepskin.

Transportation facilities include D4 Caterpillars, modified Muskeg snow tractors and toboggans. South African designs are used and some of the equipment is of local construction e g steel sledges.

All the bases are equipped with modern communication facilities. The main link is by radio teleprinter.

Die *R S A* teen die ys vasgemeer
The *R S A* moored against the ice

SANAE-basis bestaan uit afsonderlike houtgeboue. Hulle is met ysgange verbind. Die skeiding voorkom dat brand dalk van een gebou na 'n ander versprei. Brand is die grootste enkele gevaar by 'n basis.

'n Geologiese oorwinteringsbasis, BORGA, (72°58'S,03°48'W) is gedurende 1969 op die vasteland ongeveer 380 km suid van SANAE opgerig. 'n Soortgelyke basis is begin Mei 1971 te Grunehogna (72°02'S,02°48'W) opgerig, 215 km suid van SANAE.

Op die eilande Marion en Gough sneeu die geboue wel nie toe nie, maar ook hier moet spesiale boumetodes gebruik word.

Aangesien die basisse slegs een maal per jaar besoek word, moet voorrade goed beplan word. Wat vergete gebly het, moet vir 'n jaar ontbeer word. Terwyl die eilande in 'n noodgeval wel nog weer gedurende die jaar besoek kan word, is 'n besoek aan SANAE buite Januarie/Februarie onmoontlik. SANAE word derhalwe van genoeg voedsel en brandstof vir twee jaar voorsien vir geval die basis een jaar weens pakys nie bereik kan word nie.

Vanweë die afgesonderdheid waaronder ekspedisielede moet lewe, word die eensaamheid so draaglik moontlik gemaak. Opvoedkundige en vermaaklikheidsrolprente word voorsien, daar is 'n ten volle toegeruste donkerkamer, hoëtrou-klankstelle, 'n goeie biblioteek, snoeker- en tafeltennistafels, en so meer.

Klerasie, vervoer en kommunikasie

Antarktika stel besondere eise ten opsigte van klerasie. Voorheen is feitlik alle beskermende klerasie ingevoer. Tans word, met die uitsondering van skoeisel, feitlik alles plaaslik vervaardig – heelwat van skaapvel.

Op die eilande maak die hoë reënval waterdigte oorklere noodsaaklik en die moerasagtigheid vereis die gebruik van waterstewels.

Meganiese vervoer kan nie op die eilande gebruik word nie; op Antarktika is dit onontbeerlik. In die gebied waar Suid-Afrika op Antarktika werksaam is, kan slegs voertuie met rusperbande gebruik word. Dié voertuie word gebruik om voorrade van die skip na die basis te vervoer. Alle vervoer weg van die basis is per sneeutrekker; ook dié van die span na Borgabasis. Die ongeveer 380 km kan in gunstige omstandighede in 'n week afgelê word, maar dit kan ook 'n maand of langer duur.

Vir swaar vervoer, veral vir die aanvulling van velddepots, word D4 Caterpillars gebruik. As ligter voertuie word die Kanadese Muskeg-sneeutrekker gebruik. Hierdie voertuie word in Suid-Afrika gemodifiseer om by ons behoeftes aan te pas. Petrolenjins word byvoorbeeld met dieselenjins vervang en 'n outomatiese ratkas word ingebou. Vir die ligste vervoer is die sleë wat voorheen deur Huskiehonde getrek is, nou feitlik totaal deur motorsleë (toboggans) vervang.

Die Departement lê hom daarop toe om soveel moontlik meganiese werk aan Antarktiese toerusting in Suid-Afrika te doen. Afgesien van die aanpassing van voertuie is 'n handige staalslee hier ontwerp en gemaak. Sneeutrekkers is ook al hier gebou.

Al drie die stasies is met moderne kommunikasieapparaat toegerus. Die normale daaglikse verbinding met Suid-Afrika is per teledrukker; ook word van die radiotelefoon gebruik gemaak. Vir kommunikasie tussen basisse en veldpartye word kragtige draagbare radio's gebruik.

Once at SANAE, man has to solve his own problems
Op SANAE moet 'n boer 'n plan maak

The capital of Marion Island
Hoofstad van Marion-eiland

Die ekologie van Marion en Prins Edward

Waar die wêreld se groot oseane mekaar in die yskoue suide ontmoet, lê 'n paar flentertjies verlate land – die Suidelike eilande. Van hierdie eilande is Marion en Prins Edward vir die wetenskaplike van die interessantste.

Die twee klein eilandjies is in 1948 deur Suid-Afrika geannekseer en tot natuurreservate verklaar. Tans is hulle van die laaste oorblywende natuurparadyse wat nie deur die mens versteur is nie. Vir die bioloog is hulle ekologies van groot waarde en is hulle 'n skatkamer van studiemateriaal; ook die geologie van die twee eilande vorm 'n interessante studiegebied. Biologiese en geologiese navorsing word van 1963 af op Marion en later ook op Prins Edward gedoen.

Hoe oud is die eilande?

Een van die eerste take was die bestudering van die oorsprong en die ouderdom van die eilande. Hierdie geologiese navorsing is gedoen onder leiding van dr W J Verwoerd.

Deur die bepaling van die verhouding van die isotope Kalium 40 en Argon 40 in die rotse is die ouderdom van die ou grys lawa en die jonger swart lawa, wat op die eilande voorkom, vasgestel. Aan die hand van hierdie en ander inligting kon bepaal word dat Marion en Prins Edward ruim 'n kwart miljoen jaar gelede as gevolg van groot vulkaniese uitbarstings uit die seebodem opgerys het. Hierdie vulkanisme staan in noue verband met die verskynsel van kontinentale drywing.

Die grys lawa toon verder 'n gladde gepoleerde oppervlak waarop gletserskrape voorkom. Hierdie verskynsels bewys dat die eiland Marion tussen ongeveer 100 000 en 15 000 jaar gelede 'n ystyd gehad het en waarskynlik vir 'n lang tyd deur 'n dik yslaag bedek was.

Die geskiedenis van die plantelewe is deur professor E M van Zinderen Bakker en sy medewerkers ondersoek.

Die stuifmeel, wat deur die eeue in die grondlae bewaar gebly het, lewer 'n sleutel tot die plantegroei van die verlede. In die talle moerasse wat op die eilande voorkom is borings gedoen en die stuifmeelkorrels wat daarin gevind word, bestudeer. Die ouderdom van die grondmonsters – en gevolglik ook van die stuifmeel – word met die radiokoolstofmetode (C14) bepaal. Die resultate toon hoe die plantegroei ná die ystyd geleidelik ontstaan en ontwikkel het tot die teenswoordige toendravegetasie. Plantesade en -spore is – en word waarskynlik nog – na hierdie eilande aangebring deur storms en veral deur die duisende seevoëls wat op die eilande leef. Die voëls kan selfs ook kleiner dierelewe met hulle saam bring.

Ander biologiese onderwerpe wat in 'n breë kwalitatiewe loodsstudie bestudeer is, sluit in gedragstudies en verspreiding van voëls, die verspreiding van die plante en plantgemeenskappe, die sistematiek van mosse, insekte en al die organismes wat op die eilande en in die eb- en vloedgebied voorkom. Hierdie eerste studies is saamgevat in die omvangryke werk, *Marion and Prince Edward Islands*, wat in 1971 verskyn het onder redaksie van E M van Zinderen Bakker, J M Winterbottom en R A Dyer. (A A Balkema, Kaapstad, 427 bls.)

In die huidige navorsingsprogram wat in 1973 onder leiding van proff J D Skinner, W R Siegfried en E M van Zinderen Bakker geloods is, geniet bioenergetika aandag, d w s die opname en vaslegging van son-energie deur die lewende organismes en die vloei van dié energie deur die lewensgemeenskappe.

Die eenvoudige struktuur van die lewensgemeenskappe op hierdie klein eilandjies bied 'n uitstekende geleentheid vir bioenergetiese studies. Hierdie studies begin by metings van die inkomende sonenergie en die persentasie daarvan wat deur die groen plante as gevolg van fotosintese in die vorm van koolhidrate vasgelê word. Die kaloriewaarde van hierdie primêre voedselproduksie deur die plante word noukeurig bepaal. Studies oor die sekondêre voedselproduksie, waarby die koolhidraatryke plante deur die diere en voëls op land en in die water opgeneem word, is onlangs geloods.

Die eilande is ook ideaal geleë vir studies oor die invloed van die voedselryke oseaan op die voedselarme klein landmassas. Die fauna – waaronder duisende robbe en miljoene pikkewyne – kry hulle voedsel, en dus energie, van die oseaan; dié energiebron word na die land vervoer, waar dierlike reste die plantgemeenskappe op die eiland verryk. 'n Uitvoerige studie word veral gemaak van die kringloop van die minerale op die eilande. Die prosesse wat in die bodem plaasvind, soos gaswisseling, verwering van lawagesteentes en stikstoffiksasie, word ondersoek in samehang met die bodemflora en -fauna.

Besondere onderwerpe wat in verband met die energiesiklus bestudeer word, is die spesifieke rol van die plante- en dierelewe van die eb- en vloedsone. Die invloed van die oseaan is ook vasgestel by die bestudering van die samestelling van die reënwater wat die eilande se mere, stroompies en vegetasie voed.

Veldlaboratorium

Hierdie navorsing verg geweldig baie veld- en laboratoriumwerk en 'n goed toegeruste veldlaboratorium is op Marion gebou. Gedurende die baie dae van slegte weer word die chemiese en ander binnenshuise navorsing daar afgehandel.

Navorsing op die eilande word gefinansier deur die Departement van Vervoer en staan onder leiding van die Wetenskaplike Komitee vir Antarktiese Navorsing van die WNNR.

Die uiteindelike doelstelling van die program is om 'n beter insig te kry in die werking van 'n natuurlike ekosisteem. Hierdie kennis behoort te lei tot 'n insig in die prosesse wat in die natuur plaasvind wanneer dit deur menslike aktiwiteite versteur word. Hopelik kan op hierdie manier metodes gevind word om die nadelige uitwerking van hierdie versteuring teen te werk.

In Brief

MARION AND PRINCE EDWARD

The islands Marion and Prince Edward are situated at 46°50'S 37°50'E. They have a cold, oceanic, wet and stormy climate and are covered by tundra vegetation. These small islands, which were probably discovered in 1663, were annexed by the South African Government in 1948 and have since been proclaimed nature reserves.

Geological research has shown that these volcanic islands are approximately a quarter of a million years old and that they were covered by extensive glaciers between approximately 100 000 and 15 000 years ago. The origin of the vegetation has been studied using fossil pollen preserved in the many peat deposits. A comprehensive first study of the climate, geology, flora and fauna has been published under the title *Marion and Prince Edward Islands,* **(Eds E M van Zinderen Bakker, J M Winterbottom and R A Dyer) by A A Balkema, Cape Town (1971, 427 p).**

The present five-year research programme is concerned with bioenergetics, the study of the flow of energy through the islands' ecosystems. The small islands, poor in food resources, which are surrounded by the very rich Southern Ocean, offer excellent opportunities for these studies. Research on the primary production of fresh and ocean water and terrestrial vegetation is coupled with studies on the energy uptake by the millions of birds which live on the islands. In connection with this programme much research is being done on soil and plant chemistry, Co_2-flux, plant associations, intertidal flora and fauna and nitrogen-fixation, avian biology and an intensive study of seals.

Prince Edward from Marion
Prins Edward vanaf Marion

Bouvet Island

– the most isolated place in the world?

Icing
Yskombers

Bouvet Island, or Bouvetøya, to give it its Norwegian name, is situated at 54°25'S and 3°24'E. It is perhaps the most isolated island or piece of land in the world. If a circle having a 1 600 km radius were drawn around this island, then no other island or land mass would be contained within that circle.

The island was discovered in 1739 by the Frenchman, Pierre Bouvet, but was not visited again until 1808 when a certain Captain Lindsay, finding its position to differ from that given by Pierre Bouvet, thought he had discovered a new island, which he consequently named Lindsay Island.

Eventually three islands were reported to exist in the area, the third being named Thompson Island.

It is now generally accepted that Lindsay and Bouvet islands are one and the same, misplaced through navigational errors, although a controversy still rages over Thompson Island. It is thought that Thompson Island could have been raised above the sea surface and then disappeared again (possibly to just below the surface) through volcanic doming action. Investigations are still in progress today to attempt to resolve this enigma.

Since 1927 Bouvet Island has been a Norwegian possession.

Bouvet is a particularly inhospitable island. It is roughly 10 km by 6 km and its highest peak is some 800 m above sea level. Ninety-eight per cent of the island's surface is covered by ice and snow and the remaining two per cent consists of exposed volcanic rock. The island usually has a cloud cover and rain and snow often blur its outline.

Because of Bouvet's isolated position, from as far back as 1918 there has been talk by meteorologists of various nations of establishing a weather station on the island. As yet no station has been

Slegs twee persent van Bouvet steek onder die sneeu uit
Only two per cent of Bouvet shows above the ice

established. South Africans have, however, been able to conduct a number of expeditions to the island.

In 1939, a South African meteorologist accompanied a British team to investigate the possible establishment of a weather station on Bouvet.

The First South African Meteorological Expedition to Bouvet Island took place in 1955. Unfortunately, this expedition did not have air support and could not reach the highlands of the central plateau to inspect suitable sites for a manned station.

The Second South African Expedition took place in March-April 1964. This expedition was provided with a helicopter. A British scientific party aboard the HMS *Protector*, which visited the island at the same time, had the support of two helicopters. Inclement weather, however, permitted only one brief landing during a four day period, on the so-called 'West Wind Beach'. Thus, with the elements against them, the first two South African expeditions were unable to achieve all that they had hoped.

In February-March 1966, the Third South African Expedition was favoured with good weather. This expedition – of 10 scientists from various disciplines – had the support of two helicopters and 15 naval and Air Force personnel. During a six-and-a-half-day period of good weather, more than a hundred landings were made at numerous points on the island. Meteorological, glaciological, cartographic and geological observations were made.

Since 1966 there have been no South African expeditions to Bouvet, although, whenever possible, the *RSA* sails via the island on the return leg of the annual SANAE relief voyage. Those who have seen the island are fascinated by the remote landscape and South African scientists still cherish the idea of manning a station on Bouvet in collaboration with the Norwegian authorities.

Cape Circoncision with West Wind Beach on the far right
Kaap Circoncision met die Westewindstrand regs agter

Ysgang
Ice passage

Kok vir die dag
Chef of the day

Borga-basis van binne
Inside Borga Base

SANAE

INSIDE – BINNE

Die ledige ure
Time

Aandete
Supper

Marion-kamp
Camp on Marion

On the islands
Op die eilande

Going out
Na buite

Biological work
Biologiese studie

Weerwaarneming
Weather observation

Geologie
Geology

Out into the cold
Uit in die koue

Beskerming teen die elemente
Protection against the elements

Windverwaaide ys (sastrugi) by SANAE
Wind-blown ice (sastrugi) at SANAE

Weather balloon
Weerballon

Veldwerk
Field work

Huskie

Keiser pikkewyn
Emperor penguin

Yskasteel
Ice castle

Swart ysberg
Black iceberg

The earth sciences programmes

Geology, geophysics and glaciology

South Africa has had an active earth sciences research programme in Antarctica since the first South African expedition to that continent in 1960. A total of twenty geologists and three technicians working in the field of radio echo-sounding have participated in the fourteen expeditions that have so far been made.

The research programme is directed by the South African Geological Survey in Pretoria. Pre-expedition training is carried out at the Geological Survey during a period of three to four months prior to the departure of the expedition. The training consists of familiarization with Antarctic geology and, in particular, the specific area in which the men will be working, together with guidance on understanding conditions and methods of work in Antarctica.

After a year in Antarctica the men return to the Geological Survey for three to nine months to process the data obtained and write up reports and prepare articles for publication.

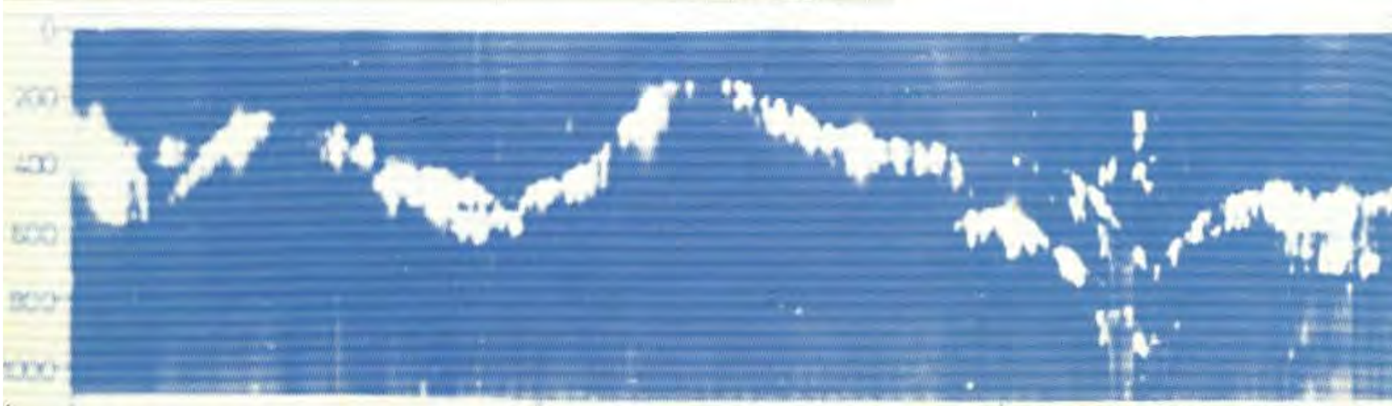
During the fourteen years that South Africa has had an active earth sciences programme in Antarctica, most of the Ahlmann Ridge and Borgmassivet, as well as the extreme southwestern part of the Kirwanveggen (all of which are mountain ranges of the continent) has been mapped on scales as large as 1:25 000. For the first few expeditions, activities consisted mostly of a reconnaissance survey of the area and the defining of problem or key areas. The specific areas were mapped in greater detail by members of subsequent expeditions.

The area in which the earth sciences programme is being carried out at present is approximately bounded by latitudes 70°S and 74°S and longitudes 0° and 6°W. The geology of this area can be summarized as consisting of an ancient crystalline basement overlain by the oldest undeformed platform sediments yet found in Antarctica. These sediments are extensively intruded by 1 700 million years old mafic rocks and overlain by 850 million years old andesitic lavas. The sediments have been correlated with those of the Waterberg System in South Africa. In the south-western part of the area, younger sediments and lavas correlating with the Cape and Karroo Systems in South Africa, are also found.

The geology of the area is of particular interest to South African geologists as that part of Antarctica is thought to have been adjacent to the coast of Natal prior to the start of continental drift and the break-up of Gondwanaland.

Links: Landmeting met die 'Tellurometer'
Onder: Eggo's van 'n verborge kontinent

Left: 'Tellurometer' surveying
Below: Echoes from a submerged continent



The theory of continental drift, accepted by most modern geologists, postulates the existence of a supercontinent in early geological times. This continent started breaking up about 200 million years ago into the present southern continents of Antarctica, South America, Africa and Australia, together with India. A knowledge of Antarctic geology is essential for any attempt to reconstruct the fit of the Gondwana continents, as Antarctica formed the centre or core of Gondwanaland.

The Antarctic earth sciences programme is, however, not concerned only with geology but also with geophysics and glaciology. Geophysical and glaciological observations are carried out on a routine basis along all traverse lines. During the last three years, particularly, oversnow traverses have played a greater role than before in the programme.

The geophysical observations consist of measuring the earth's gravity and magnetic fields. Until 1970 the gravity measurements were used to calculate ice thicknesses. This method, although not so accurate, was easier, faster and less expensive than the seismic method of ice thickness determination.

Since 1971, determinations of ice thickness have been made by radio echo sounding. This technique entails the transmitting of radio pulses through the ice to the ice-rock or ice-water interface and timing the travel times of the reflected signals. These data are then recorded on a moving photographic film. The technique has the advantage of being more accurate than that previously used and of giving a continuous record of ice thicknesses along a line traversed, unlike the gravity or seismic methods which only give depths at specific points.

Over the past three years ice thicknesses have been measured, by radio echo sounding, for a distance of more than 1 500 km of traverse lines. The ice thickness profiles so obtained are used to create a picture of the subglacial topography, which is of great importance in determining structural trends, mass transport of ice streams and other phenomena.

Wat gaan hier onder aan?
What's down below?

Other glaciological work carried out includes the routine measuring of snow accumulation against stake networks at the bases and the determination of snow accumulation by the measuring and interpretation of snow stratigraphy in cores obtained with an ice-coring auger. These measurements are used to determine the mass-balance of the Antarctic ice-cap, i e whether the amount of ice is increasing or decreasing. Temperatures measured in boreholes at depths of 10-15 m give a good idea of the mean annual temperature at that spot and, for this reason, such measurements are taken at as many locations as possible.

At present all the field work of the earth sciences programme is carried out from either of two 4-6 man wintering-over bases in the mountains. These are Grunehogna base, 215 km from SANAE and Borga base, 380 km from SANAE. The two bases make it possible for programme personnel to spend the winter near where they will be working immediately after winter, and so obviate the necessity for their travelling long distances before work can be started.

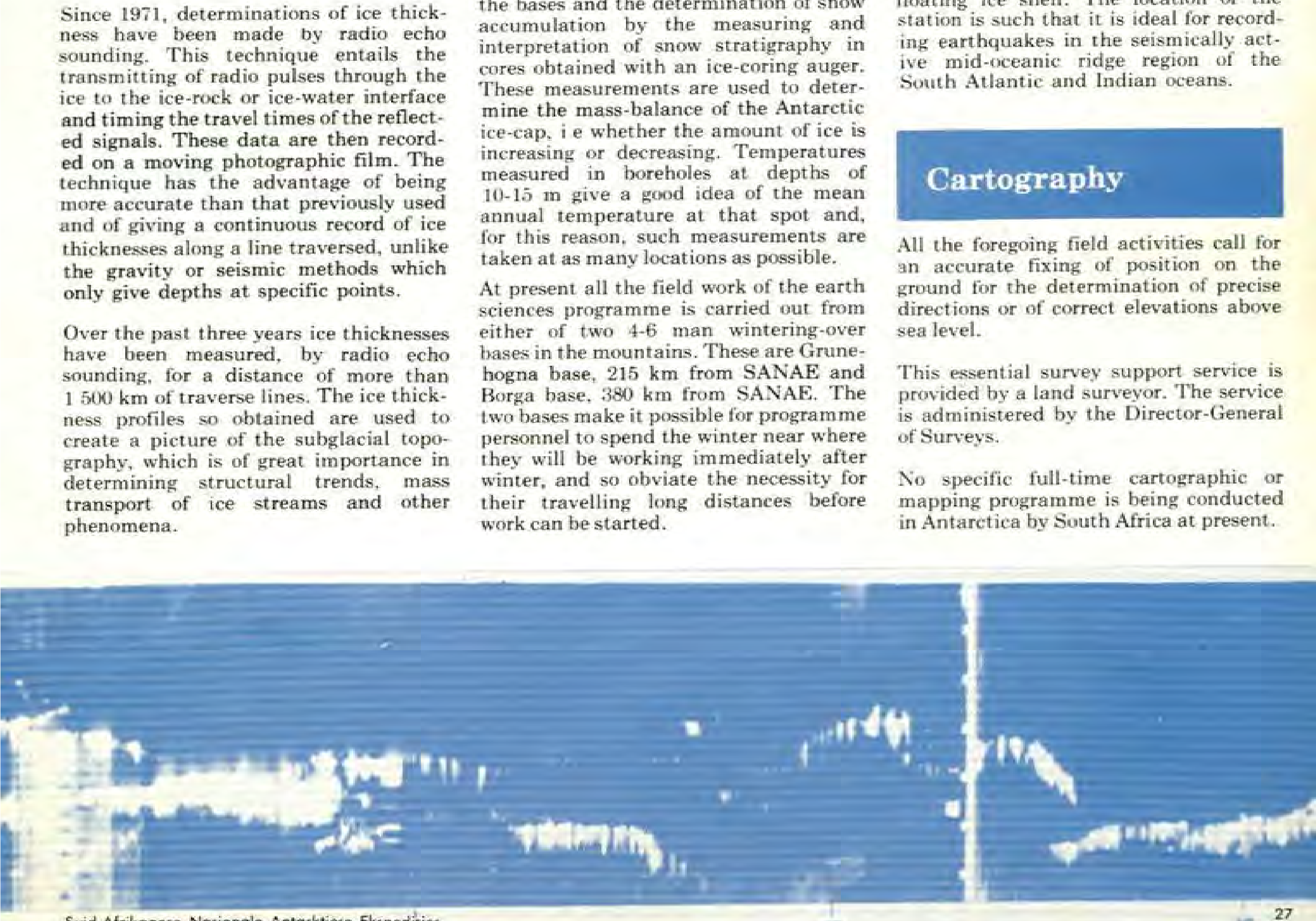
The earth sciences team also has a seismological observatory at SANAE, which is unique in the sense that it is built on a floating ice shelf. The location of the station is such that it is ideal for recording earthquakes in the seismically active mid-oceanic ridge region of the South Atlantic and Indian oceans.

Cartography

All the foregoing field activities call for an accurate fixing of position on the ground for the determination of precise directions or of correct elevations above sea level.

This essential survey support service is provided by a land surveyor. The service is administered by the Director-General of Surveys.

No specific full-time cartographic or mapping programme is being conducted in Antarctica by South Africa at present.



Antarktika en die weer

Suid-Afrika se weerkundiges roem daarop dat hulle steeds aan die voorpunt gestaan het met die stigting van stasies op die sub-Antarktiese eilande Tristan da Cunha, Gough en Marion, asook by SANAE op Antarktika.

Reeds in 1939 het 'n weerkundige vir die eerste keer voet aan wal gesit op die smal strandjie onder die hoë yswalle aan die ooskus van Bouvet-eiland, om te sien of daar 'n weerstasie opgerig kan word. By drie latere geleenthede het Suid-Afrikaanse ekspedisies weer die eiland besoek maar dit was eers in Maart 1966 dat 'n suksesvolle verkenning uitgevoer is. By hierdie geleentheid het die aflosskip, *RSA*, en die S A Vloot se opmetingskip, die SAS *Natal*, met die hulp van helikopters van die S A Lugmag, daarin geslaag om weerkundiges, geoloë, 'n landmeter en deskundiges op die gebied van die oprigting van stasies, op die eiland te plaas. Daar is gevind dat 'n stasie wel opgerig sou kon word op die oostelike yshelling van die eiland, maar hierdie ideaal van die Weerburo ontwyk nog steeds verwesenliking.

In April 1942, tydens die Tweede Wêreldoorlog, het die Suid-Afrikaanse Lugmag se Weerkundige Seksie 'n stasie by die nedersetting aan die noordwestekant van die bykans 2 000 m hoë vulkaniese piek op Tristan da Cunha gestig. Tristan is omtrent 3 200 km wes van Kaapstad geleë en aangesien stormstelsels in die westewindgordel oorwegend van wes na oos beweeg, is verwag dat hierdie stelsels omtrent twee dae sou neem om vanaf die eiland tot by die Kaap te beweeg. In die algemeen is dié verwagting bewaarheid, maar soms het die stelsels uitgesterf en op ander geleenthede het nuwe storms in die groot gebied verskyn, sodat meer waarnemings nader aan die Kaap nodig geblyk het.

In 1961 het die vulkaniese uitbarsting op Tristan die einde van Suid-Afrika se weerstasie daar beteken. Van dat die eilandbewoners in 1963 teruggekeer het, is slegs kort beriggies periodiek vanaf die Britse amptenare daar ontvang. Die leemte wat só ontstaan het, is egter gevul deur die volledige weerstasie wat intussen op Gough-eiland opgerig is. Gough-eiland, wat 400 km suidoos van Tristan da Cunha geleë is, is in 1955/56 verken deur 'n ekspedisie van Britse universiteite en in Mei 1956 is die Suid-Afrikaanse weerstasie daar gestig. Dié stasie is later na meer geskikte terrein verskuif en gemoderniseer.

Afgesien van wisselvallige waarnemings vanaf skepe op die roete na Suid-Amerika, het die groot gaping in weerkundige waarneming ten weste van Suid-Afrika egter bly voortbestaan totdat in September 1969 'n klein weerskip by 40°S en 10°O gestasioneer is. Hierdie weerskip kan nie in dieselfde asem genoem word as die luukse weerskepe van die Noordelike Halfrond nie en daar word heelwat minder as die volledige program van waarnemings uitgevoer, maar weervoorspellers voel deesdae verlore wanneer die skip gedurende een week per maand nie op sy pos is nie.

Toe Suid-Afrika in Januarie 1948 'n ekspedisie na Marion en Prins Edward gestuur het om hierdie eilande van Brittanje oor te neem, is die geleentheid te baat geneem om ook hier 'n volledige weerstasie te stig. Marion-eiland is ongelukkig bietjie ver na die ooste geleë 2 300 km SO van Kaapstad) sodat die koue fronte van laagdrukstelsels wat ooswaarts beweeg omtrent gelyktydig sowel Suid-Afrika as die eiland se weer affekteer, maar die waarnemings verskaf tog 'n grootskaalse geheelbeeld wat onontbeerlik is vir weervoorspelling in Suid-Afrika.

Toe Noorweë in 1959 bekend gemaak het dat 'Norway Station' aan die einde van die jaar ontruim word, het die Weerburo voorbrand gemaak dat dié pos deur Suid-Afrika oorgeneem word. Dit het dan ook in Januarie 1960 gebeur. Aanvanklik het weerkundige waarnemings en navorsing die vernaamste program hier gevorm maar mettertyd het ander dissiplines toegeneem en 'n oorwegender rol begin speel, sodat SANAE naderhand 'n wetenskaplike navorsingstasie geword het in stede van 'n 'weerstasie' soos dit aanvanklik populêr bekend was.

Van eerste orde

By SANAE en die twee eilandstasies word redelik volledige weerkundige waarnemingsprogramme uitgevoer. Die Weerburo (wat onder die Departement Vervoer ressorteer) is verantwoordelik vir hierdie programme. Die drie stasies word beskou as weerstasies van die eerste orde, waar bykomstige gevorderde waarnemings gedoen word. Vanweë die feit dat al die werk deur tegnici gedoen word omdat vakkundiges nie beskikbaar is nie, word daar geen spesifieke weerkundige navorsing gedoen nie. Aanvanklik is spesiale waarnemings by 'Norway Station' en SANAE gedoen om die vertikale verdeling van wind en temperatuur langs 'n hoë mas te registreer, sodat profiele van hierdie elemente en die vertikale oordrag van hitte oor alle toestande verkry kan word, maar dit is later gestaak, omdat die sensitiewe waarnemings baie moeilik is en besondere aandag verg. Daar is ook gedurende hierdie eerste jare sneeutemperature op verskillende dieptes geregistreer en jagsneeu tot 'n paar

In Brief

ANTARCTICA AND THE WEATHER

The history of the establishment of the South African weather stations on Tristan da Cunha, Gough and Marion Islands and at *SANAE* in Antarctica is briefly described. Observations on Tristan da Cunha were discontinued in 1961 but at the other stations the programmes of routine surface and upper-air observations have been gradually expanded. While Gough has remained essentially a weather station, *SANAE* has developed into a scientific research base where active research in several disciplines receives more attention than the weather. On Marion Island, biological and geophysical research have become important. Whereas purely routine weather observations are presently being made at these stations, the data are used for weather map analysis and forecasting on a daily basis in Southern Hemisphere countries and they are also transmitted to the World Weather Centres in Washington and Moscow. The meteorological data obtained at these isolated South African stations, as well as at other stations in Antarctica and the sub-Antarctic, are used for research on atmospheric circulation and considerable work has been done and is continuing in this field.

meters bo die oppervlak gemeet. Vir meer as die laaste vyf jaar word slegs die standaard voorgeskrewe waarnemings aan die oppervlak en in die bolug gedoen. Planne om weer spesiale navorsingstake te onderneem is nie verwesenlik nie.

Aan die oppervlak word lugdruk, temperatuur, voggehalte, wind, wolke, weer, neerslag, sig, sonskyn, son- en aardstraling en optiese verskynsels waargeneem. Sommige van hierdie elemente word voortdurend deur middel van outografiese instrumente geregistreer en andere word elke drie uur visueel waargeneem of met spesiale instrumente noukeurig gelees. Bolugtemperatuur, -voggehalte en -wind word een of twee keer per dag tot hoogtes van 15 of 20 km bepaal met radiosondes en radioteodoliete. By Marion- en Gough-eiland word hierdie waarnemings daagliks om 01 h 00 en 13 h 00 SAST gedoen en by SANAE slegs om 01 h 00.

Alle waarnemings word op spesiale datavorms aangestip en verwerk vir latere publikasie, maar die drie-uurlikse waarnemings word onmiddellik in kode, dws in groepe van vyf syfers elk volgens internasionale voorskrif, geskryf en oorgesein na Suid-Afrika en die Australiese stasie Mawson vir verdere aansending oor die hele wêreld. So sal iemand in die weerinstitute in Washington en Moskou vind dat die berigte vanaf die stasies op Marion- en Gough-eiland en SANAE reeds binne twee uur na waarnemingstyd op hulle weerkaarte aangestip is.

Op SANAE is daar voorsiening vir drie weerkundiges maar by Gough- en Marion-eiland is daar vier poste elk, afgesien van radio-tegnici en persone met mediese kennis. Die weer slaap of sluimer nooit, en daarom word waarnemings dag en nag uitgevoer.

Alhoewel daar tans, wat weerkunde betref, slegs waarnemings by SANAE en die eilandstasies gedoen word, word dié waarnemings nie alleen vir daaglikse weervoorspelling in lande van die Suidelike Halfrond gebruik nie, maar die data dien ook om die klimaat en eienskappe van weerstelsels en die sirkulasie van die aarde se atmosfeer te bestudeer. Data afkomstig van Suid-Afrika se weerkundige waarnemingstasies is reeds in tientalle navorsingspublikasies opgeneem.

Weerfabriek
Weather factory

The ionosphere studied from SANAE

It took nearly a quarter of a century after Marconi first sent radio signals across the Atlantic, to prove that they were reflected back towards the earth by a 'layer' in the upper atmosphere. Since Appleton and Barnett proved in 1925 that this reflecting region actually existed, our understanding of it has improved gradually. It is, of course, very important to know as much as possible about it, for it makes possible radio communications over the horizon. If the radio waves were not reflected back, they would go off into space like light waves, or VHF waves, and could not be received much beyond the line of sight.

We now know that there are three so-called layers in the upper atmosphere which are responsible for its reflecting properties: the E region between about 90 and 130 km overhead, the F1 region from about 130 to 200 km and the F2 region from 200 to 500 or so km. During the night the F1 and F2 regions coalesce to form one region, the F region. There is also a D region below the E, but it partially absorbs radio waves rather than reflecting them, unless they are of very low frequency.

The ability of these regions – collectively known as the ionosphere – to reflect radio waves, depends on the presence of free electrons. These electrons are produced by the splitting up of the molecules and atoms of nitrogen and oxygen in the upper atmosphere by the ultraviolet rays of the sun.

In sunlight

When the sun rises in the morning, molecules are split up (ionized) in this way to form free electrons and positively charged ions. Although these immediately start recombining to form molecules again, more are continually being produced by the sunlight, so that there are always quite a lot of free electrons during the day – something like a million per cubic centimetre in the F2 region at noon. As the sun goes down, the rate of ionization decreases, and more of the electrons recombine with ions; after sunset ionization ceases and recombination goes on slowly during the night until sunrise next day.

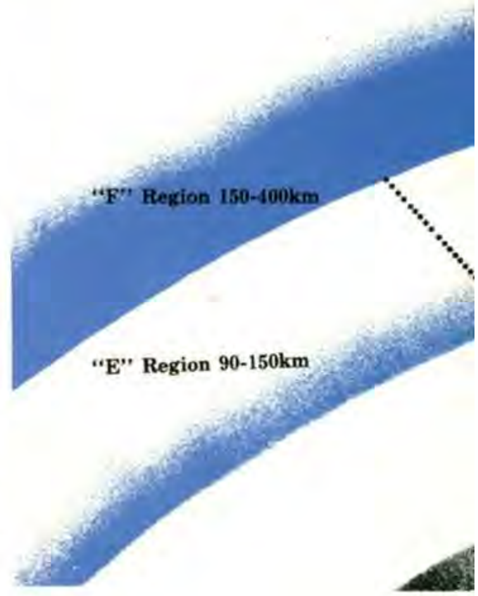
The highest frequency of radio waves that a region can reflect back vertically depends, to express it simply, on the number of electrons per cubic centimetre. Thus a million electrons per cm^3 will reflect waves up to 9 MHz, but will let higher frequencies pass through; whereas a hundred thousand electrons per cm^3 will only reflect waves up to 3 MHz. By sending out radio waves of gradually increasing frequency, and measuring how long they take to come back so that we can calculate how far up they have been, we can work out how many electrons there are per cm^3 at different heights and so get a good picture of what is happening in the ionosphere.

Interesting possibilities

Antarctica offers some interesting possibilities for ionosphere research. Do the ions and electrons recombine completely during the long dark winter night, leaving no ionosphere at all? We find that they do not. Even in midwinter there are typically 300 000 electrons per cm^3 in the F region. Where do they come from? Surprisingly, they seem to 'know', in some way, what is happening in the sun, even though it remains far below the horizon. For the ionosphere at the South Pole responds to sunspots even in winter. One of our interests is to find the explanation for this curious behaviour.

SANAE is situated in the South Atlantic sector of Antarctica, and it happens that the Van Allen radiation belts penetrate right down into the F region there, but not at other places round the globe.

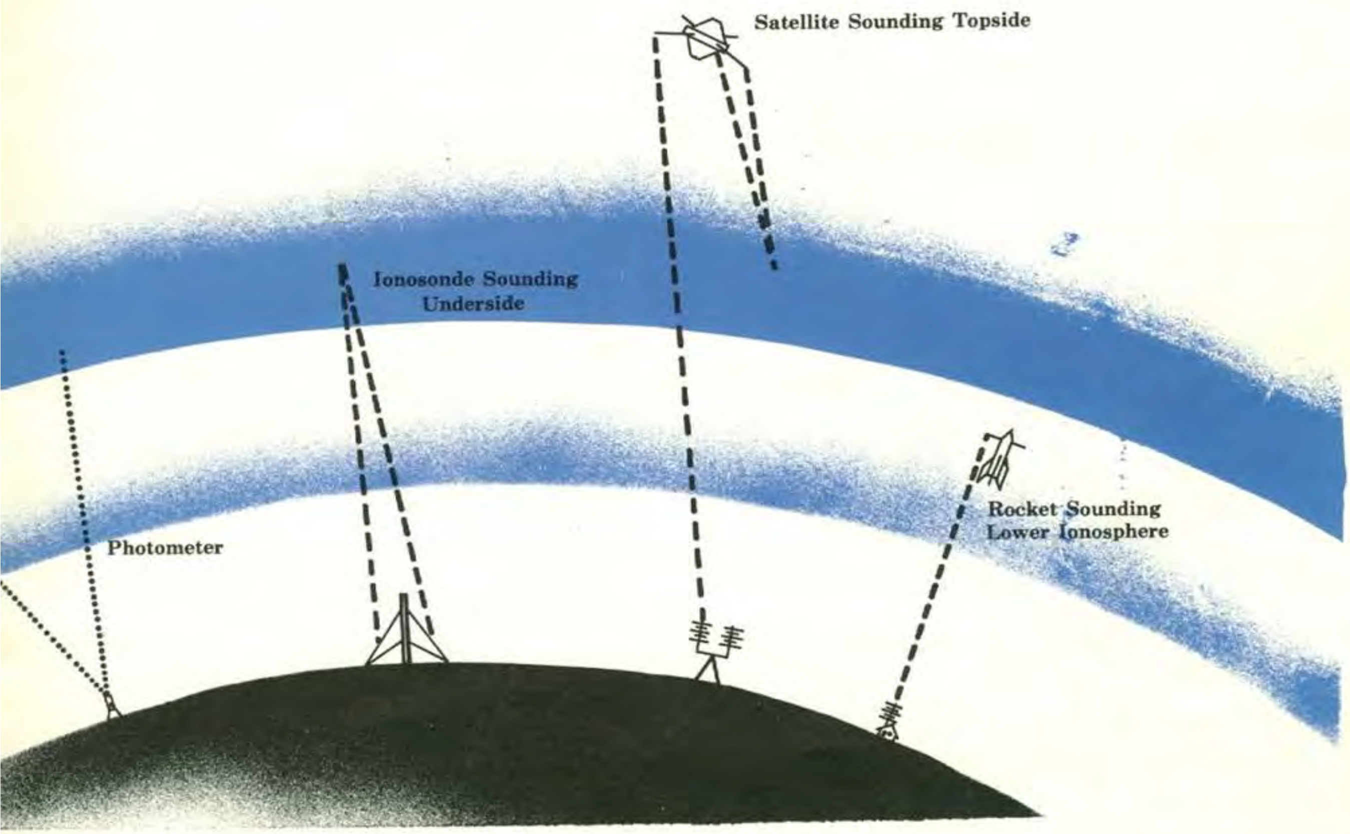
The Van Allen radiation belts consist of fast-moving electrons and protons, many of which have come from the sun. These energy charged particles can knock out many electrons from atoms and molecules of nitrogen and oxygen with which they collide in the upper atmosphere. Thus they should add to the production of free electrons by solar ultraviolet radiation. They are believed to come into the atmosphere irregularly, often at night, when there would be no sunlight. We might therefore expect the ionosphere at SANAE to be more variable than it is at other places, and to have more electrons per cm^3 on the average, because of this extra source of electrons.



Sophisticated

Research in the past has shown that this is probably true. Now a sophisticated device is being used in research work at SANAE to study the distribution of electrons in the ionosphere. This is coupled to a similar device in Grahamstown which receives radio waves transmitted via the ionosphere from SANAE. This equipment makes it possible not only to study the ionosphere over Antarctica but also over the bleak ocean between SANAE and Southern Africa.

We hope by this means to learn what is



Metodes om die ionosfeer te bestudeer
Methods of probing the ionosphere

happening in those inaccessible parts of the ionosphere and to look for the effects of the Van Allen belt particles. By comparing our ionospheric measurements with counts of Van Allen electrons and protons made with instruments in satellites circling the earth, we hope to be able to prove conclusively that these particles do play an important part in releasing electrons from their parent molecules, and to measure their efficiency in doing so in comparison with sunlight. It is suspected that they may in fact also be partly responsible for unexpected and irregular variations in the F region in other parts of the world, thus adversely affecting man's ability to communicate between countries and continents.

The ionosphere from Marion Island

An ionospheric observing station, operated by the CSIR's National Institute for Telecommunications Research (NITR), was established on the sub-Antarctic Marion Island in 1972.

This station is helping to fill a serious gap in the network of stations around the world which gather information on the ionosphere for the prediction of radio propagation conditions.

To be able to plan radio communications in a satisfactory manner, it is essential to be able to forecast at least the systematic variations in the ionosphere.

The ionosphere, in common with other atmospheric phenomena, is highly variable. It varies over the earth's surface, with the time of day, the seasons and with the eleven-year sunspot cycle. In addition, there are random fluctuations. Information about these variations is necessary to be able to establish the optimum frequency of short-wave radio transmission paths, because these frequencies vary with the state of the ionosphere.

Ionosondes are used at the observing stations to probe the ionosphere. These instruments send up radio pulses sweeping through the entire high frequency wave band and receive back the echoes from the various reflecting layers of the ionosphere. From these data the heights and ionization densities of the layers can be calculated and this information is then used to predict radio propagation conditions.

Data obtained from ionospheric observing stations all over the world are used for the construction of world charts of ionospheric characteristics. These charts, in turn, form the basis for monthly forecasts of short-wave radio propagation conditions which are made by the NITR.

Radio propagation

The more complete the network of ionospheric observing stations around the world, the more accurately will researchers be able to predict radio propagation conditions. The network should, ideally, consist of observation points placed at uniform distances apart. Unfortunately this is not always feasible. Coverage over the southern hemisphere, with its large oceanic regions, is particularly sparse.

Observation post on Marion
Waarnemingspos op Marion

Southern Africa, which has four stations, is well served. The NITR has carried out a programme of ionospheric observations from observing posts near Johannesburg and Cape Town since the inception of the Institute in 1946 – research aimed not only at discovering more about the influence of the ionosphere on radio communication but also at a better understanding of the physical environment generally.

But there is virtually no coverage of the ionosphere above the vast region between South Africa, South America and Antarctica.

This gap is all the more serious because it extends over a pronounced anomaly in the earth's magnetic field, which exerts a significant controlling influence on the ionosphere. Because of this, ionospheric charts could be seriously in error, and in fact, prediction of radio communication conditions in this area are known to be most unreliable.

Though only on the fringe of the region where the effects of the geomagnetic anomaly can be expected to be most pronounced, the ionospheric observing station at Marion Island can nevertheless provide information which is of great importance for radio communication.

Co-ordinated observations

There has recently been much interest in co-ordinated ionospheric observations at geomagnetically conjugate points – that is, pairs of points on the earth's surface linked by a magnetic field line. Here, too, Marion Island's geographical position is of importance because its conjugate point is near Lindau in Germany, where there is a well-known ionospheric research institute.

In north-south meridian observations of the ionosphere – from which valuable information is also obtained – Marion Island is once again ideally situated. Here it helps to close up the break in the chain of observing stations from Northern Europe through Africa to Antarctica.

Airglow observations

Certain physical processes in the ionosphere give rise to the emission of light, known as airglow. Observations of airglow are consequently of importance in ionospheric research and are also to form part of the NITR's research programme on Marion Island.

IMS

The International Magnetospheric Study

The International Magnetospheric Study (IMS), which is being planned for 1976-78, is the latest in a series of relating international research programmes aimed at studying the Sun-Earth environment. It has as its chief objective a comprehensive quantitative understanding of the dynamical processes operating in the plasma and field environment of the earth.

The whole basis of the enterprise is a plan to co-ordinate with each other the programmes of observations made from appropriate space craft and from the ground, aircraft, balloons and rockets.

A number of satellites will be launched specifically for the IMS by the satellite launching countries and it is hoped they will be operational by the end of 1976. South African scientists active in upper atmospheric physics research will join scientists from a large number of other countries in so-called GBR (Ground-based, rocket and balloon) experiments. As is clear from other articles in this brochure, South African scientists have access to a wide network of research stations – *SANAE*, those on the sub-Antarctic islands and stations on the subcontinent of Africa – where sophisticated equipment is used to study a wide range of related phenomena.

On the one hand, South African scientists can expect to gain considerably from participation in IMS through access to data collected on a global scale by spacecraft and other means, while on the other hand their contributions will be necessary to ensure adequate global ground-based studies of the phenomena.

'n Studie van kosmiese strale

Die navorsingsprogram oor kosmiese strale behels 'n studie van die son, van die magnetosfeer en van galaktiese kosmiese strale. Waarnemings word gemaak op Potchefstroom, SANAE in Antarktika en by die Magnetiese Observatorium op Hermanus.

Die son

Daar is nog baie geheime in die son opgesluit. Mens kan sê dat die studie van die son – wat ons naaste ster is – maar so pas begin het. Waarnemings in die ruimte deur 'n bemande satellietlaboratorium, of op grondvlak, van verskillende effekte van sonuitbarstings maak dit moontlik om die prosesse op die son se oppervlak en in sy korona (die son se atmosfeer) te bestudeer. Die energie wat die son uitstraal, maak lewe op aarde moontlik. Deur die son en sy prosesse beter te verstaan, kan ons dalk die probleem van ons beperkte energiebronne op aarde oplos. Sonaktiwiteit het onder meer ook 'n invloed op radiokommunikasie op die aarde.

Kosmiese strale is gelaaide atoomkerne wat vanuit die buitenste ruimtes afkomstig is. Hierdie strale word beïnvloed deur die magneetveld van die son wat tot ver anderkant die aarde se baan om die son uitstrek. Die aktiwiteit van die son en sy uitbarstings beheer die sogenaamde interplanetêre magneetveld en daardeur ook die intensiteit van kosmiese strale. Omgekeerd, uit die intensiteit van kosmiese strale, soos dit op die aarde gemeet word, kan ons die aard van die interplanetêre magneetveld van oomblik tot oomblik aflei of 'monitor'.

'n Monitor vir kosmiese strale is op SANAE ideaal geleë ten opsigte van die magnetiese suidpool van die aarde. Die monitor op SANAE 'kyk' in rigtings in die interplanetêre magneetveld wat deur geen ander monitor gedek word nie; dit is ook een van die weiniges in die Suidpoolgebied.

Tydens die gereelde vaarte van die voorradeskip *RSA* na Antarktika en die suidelike eilande, word die breedtegraadspreiding van kosmiese strale waargeneem. Hierdie breedtegraadspreiding is 'n effek van die aarde se magneetveld op kosmiese strale. Hieruit kan die energiespektrum van die primêre strale afgelei word asook die energie-afhanklikheid van die effek van die interplanetêre magneetveld op die galaktiese spektrum van kosmiese strale.

Wanneer daar op die son 'n uitbarsting plaasvind wat 'n steuring langs die interplanetêre magneetveld die ruimte instuur, ontstaan 'n afname in kosmiese strale wat die aarde bereik – die sogenaamde Forbush-afname. Uit die intensiteite van kosmiese strale soos geregistreer deur die wêreldwye netwerk van monitors, waarvan ons monitor op SANAE deel is, kan ons dan die ruimtelike struktuur van hierdie steuring aflei. Hieruit volg weer afleidings oor die meganisme van die betrokke uitbarsting op die son se oppervlak.

Energieke protone wat uit 'n protonfakkel op die son ontstaan, word ook deur die monitor by SANAE waargeneem. 'n Toename in energieke protone word daaraan toegeskryf dat die protone tydens 'n sonfakkel versnel word in 'n magneetveld tussen twee sonvlekke met teengestelde polariteite.

Die studie van die magnetosfeer

Die korona van die son strek tot ver verby die baan van die aarde om die son. Die korona word verteenwoordig deur 'n geïoniseerde gas met 'n baie lae digtheid wat met 'n gemiddelde snelheid van sowat 500 kilometer per sekonde verby die baan van die aarde beweeg. Omdat hierdie sogenaamde sonwind geïoniseerd is, kruis dit nie die magneetveld van die aarde nie, maar beweeg daaromheen. Die aarde se magneetveld veroorsaak dus 'n holte in die sonwind en dié word die magnetosfeer genoem. Die magnetosfeer bestaan uit 'n gedeelte van geslote veldlyne en 'n ander deel – by die poolgebiede – waar die veldlyne oop is en deur die sonwind soos 'n 'stert' van die magnetosfeer meegevoer word.

Wanneer 'n uitbarsting op die son voorkom, en die sterker stroom van deeltjies wat die son die ruimte instuur die baan van die aarde tref, word die magnetosfeer vervorm en kom magnetiese storms voor. 'n Vraag wat nog nie na behore beantwoord is nie, is watter uitwerking dié verskynsel het op die intensiteit van kosmiese strale wat die aarde deur die magnetosfeer bereik.

SANAE is geleë in 'n skeidingsgebied tussen oop en geslote veldlyne van die aarde se magneetveld. Protone en elek-

In Brief

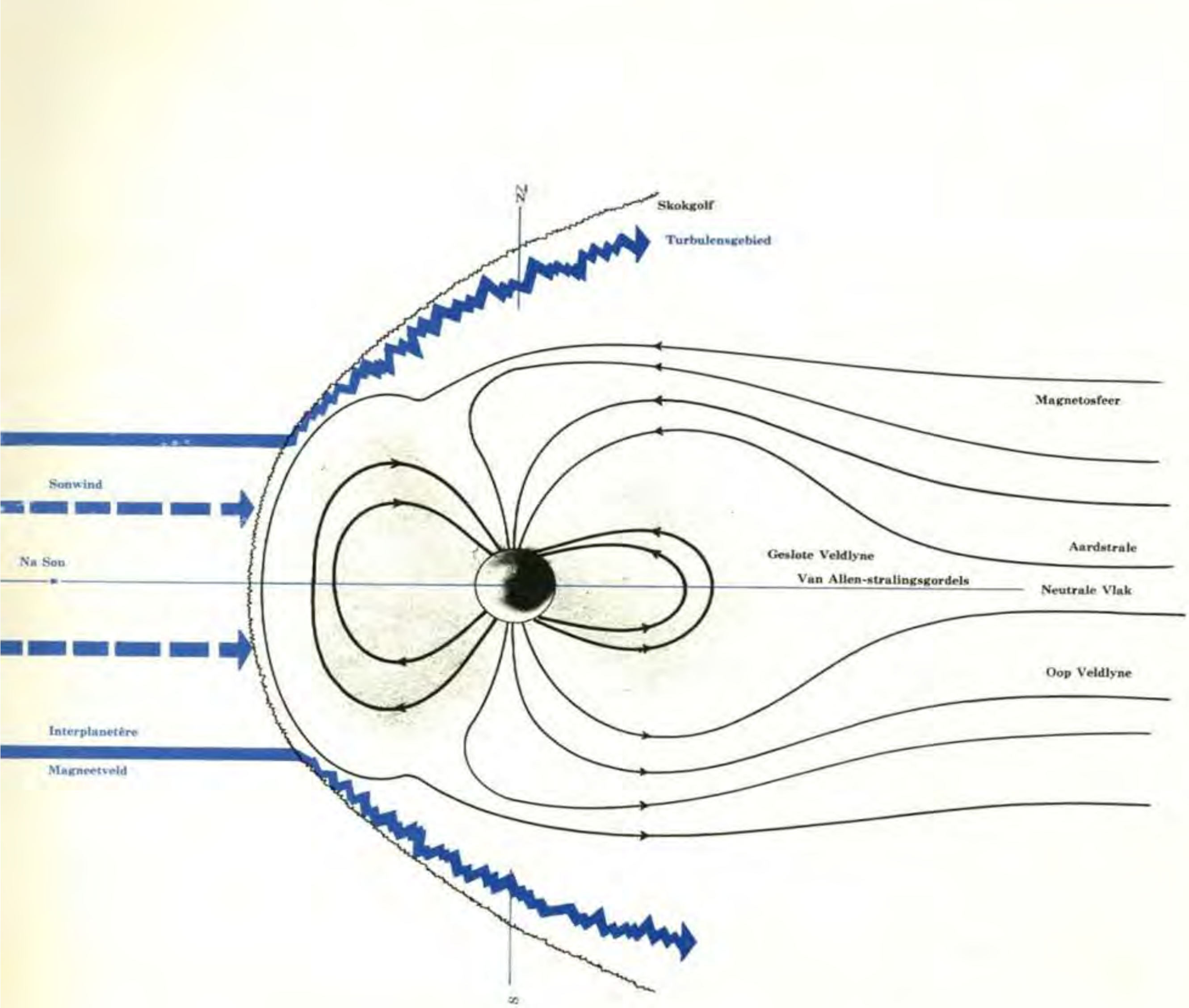
RESEARCH INTO COSMIC RAYS

The intensity variations of cosmic rays recorded at different locations are in general not the same at the various places because at each location on the globe a cosmic ray monitor 'looks' in a different direction into space. A three-dimensional picture of the mechanism (e g the interplanetary magnetic field, or the solar proton flare) causing the anisotrophy – the differing properties in different directions – in intensities can be constructed in principle. These intensity variations can be traced back to the sun. By studying cosmic ray variations, researchers are in effect studying the solar mechanisms causing these long and short term variations.

The cosmic ray monitor at *SANAE* is one of the few on the Antarctic continent. It is the only monitor in the southern polar region along the European/African longitudinal line. At this high latitude it is sensitive to lower rigidity (or energy) cosmic rays than are monitors in South Africa.

The precipitation of electrons from the magnetosphere is also studied at *SANAE*. Riometers are used for recording 20 and 30 MHz cosmic radio noise. Different absorption events are observed for electrons precipitating from closed and open field lines at *SANAE*.

Upper atmospheric charged radiations and X-radiations are recorded by a detector carried into the stratosphere by balloon. The energy spectrum of precipitating electrons may be deduced from the X-radiation, while intensity variations of cosmic rays in the upper atmosphere are monitored from charged particle recordings.



Sonwind, interplanetêre magneetveld, magnetosfeer en Van Allen se stralingsgordels
Solar wind, inter-planetary magnetic field, magnetosphere and Van Allen radiation belts

trone wat vasgevang is in die gebied van geslote veldlyne, vorm die sogenaamde stralingsgordels van Van Allen. Dit blyk dat hierdie vasgevange deeltjies maklik in die SANAE-omgewing uit die stralingsgordels na die aarde se atmosfeer presipiteer; dit is 'n effek van die Kaapse en Brasiliaanse geomagnetiese anomalieë.

Gedurende magnetiese storms verskuif die geslote veldlyngebied in die rigting van die ewenaar sodat die oop veldlyngebied bo SANAE kom. Dit bring 'n verandering in die patroon van presipitasie van deeltjies mee. Die presipiterende deeltjies ioniseer die boonste luglae en veroorsaak sodoende gedeeltelike absorpsie van kosmiese radioruis. Hierdie verskynsels word by SANAE bestudeer met behulp van waarnemings deur 'n riometer wat die ionosferiese absorpsie van kosmiese radioruis van 30 MHz en 20 MHz registreer.

Die botsing van presipiterende elektrone met lugmolekule gee aanleiding tot 'n kontinue X-straalspektrum. Uit die verloop van hierdie kontinue X-straalspektrum kan die energiespektrum van die presipiterende elektrone afgelei word. Hierdie X-straalspektrum kan in die boonste luglae noukeurig bepaal word met behulp van 'n NaI(Tl)-sintillator. So 'n detektor word met 'n plastiekballon die lug ingestuur tot op die 10 tot 5 mb drukvlak (31 tot 36 kilometer).

Ook word die intensiteit van kosmiese strale in die boonste atmosfeer tydens gereelde vlugte gemonitor met 'n detektor bestaande uit 'n geigerteleskoop.

Galaktiese kosmiese strale

Die son nader tans 'n onaktiewe tydperk in 1975/6 en dus keer die intensiteit van kosmiese strale terug na 'n maksimale intensiteitswaarde. Die vraag is nou hoe naby aan die galaktiese intensiteit die intensiteit van kosmiese strale by die aarde sal kom – soos gemeet by verskillende afsnystyfhede. Die intensiteit van kosmiese strale word by SANAE, Potchefstroom en by die Magnetiese Observatorium op Hermanus gemeet. Die intensiteit kan by Hermanus en Potchefstroom nader aan die galaktiese intensiteit kom as by SANAE waar kosmiese strale van veel laer styfhede (energieë) gemeet word as in Suid-Afrika. Die galaktiese intensiteitspektrum is nog onbekend maar die volgende paar jare sal moontlik 'n antwoord op die vraag bring.

Interessante afwykings om die aarde

Die Brasiliaanse magnetiese anomalie

Die Brasiliaanse magnetiese anomalie word gekenmerk deur baie lae waardes van die totale magnetiese veldsterkte (of -intensiteit) in 'n groot gebied om Rio de Janeiro (figuur 1) in vergelyking met ander gebiede op die aardbol. Hierdie veld by Brasilië met sy lae intensiteit kan verklaar word as die aarde se veld afkomstig is vanaf 'n magnetiese dipool, wat met 'n afstand van 342 km vanaf die middelpunt van die aardbol verplaas is in die teenoorgestelde rigting as Rio de Janeiro.

Die Kaapse (of Kaapstadse) magnetiese anomalie

Die magneetveld op die aarde se oppervlak kan tot 'n redelike benadering deur die bogenoemde eksentriese dipool beskryf word met 'n opvallende uitsondering in die gebied ôm en suid van die suidpunt van Afrika. In hierdie gebied het die aarde se magneetveld 'n baie groter inklinasie as wat verwag sou word van die veld van 'n eksentriese dipool. As gevolg van hierdie groot inklinasie (ongeveer 64° by Kaapstad – die inklinasie by SANAE in Antarktika is ook 64°) het die horisontale komponent van die aarde se magneetveld baie lae waardes om die suidpunt van Afrika. Hierdie afwyking vanaf 'n dipoolveld in die gebied om en suid van die Kaap, word die Kaapse (of ook die Kaapstadse) magnetiese anomalie genoem. Die afwyking van 'n dipoolveld word in figuur 2 geïllustreer, waar lyne van konstante horisontale intensiteit vir 'n dipoolveld en die werklike veld geteken is. Om die Kaapse magnetiese anomalie wiskundig te beskryf is 'n multipoolveld tot sowat sesde orde nodig.

Die Suid-Atlantiese geomagnetiese anomalie

Dis 'n term wat gebruik word (Gledhill, 1971) om die gekombineerde effek van 'n eksentriese dipool en hoër multipoolterme vir die beskrywing van die aarde se magneetveld aan te dui. Hierdie benaming omsluit dus beide die Brasiliaanse en Kaapse magnetiese anomalieë.

Die Suid-Atlantiese en suidelike stralingsanomalieë

As gevolg van die Suid-Atlantiese geomagnetiese anomalie sal elektrone en protone wat in die aarde se magneetveld (of magnetosfeer) vasgevang is en bo die Noord-Atlantiese Oseaan by 'n magnetiese veldsterkte bo die atmosfeer spieël, bo die Suid-Atlantiese Oseaan binne die atmosfeer beland voordat hulle by dieselfde magnetiese veldsterkte kan kom om weer terug weerkaats te word. Die spieëlpunte van gelaaide deeltjies wat in 'n magnetiese skil om die aarde vasgevang is, is heelwat laer in die anomaliegebied as daarbuite.

Figuur 3 gee die resultate van metings deur Ginzburg et al (1962) op 'n isotrope vloed van elektrone met energieë groter as 8 MeV op 'n hoogte van 330-340 km bo die Suid-Atlantiese Oseaan weer. Intensiteite van elektrone tot sowat 100 keer groter as elders bo die aardoppervlak op dieselfde hoogte is hier waargeneem, versprei oor twee duidelik te onderskeie gebiede. Die Russiese navorsers het die stralingsgebied bo die atmosfeer, gesentreer by ongeveer 30°W, 30°S, die Suid-Atlantiese Anomalie genoem, en die stralingsgebied gesentreer by ongeveer 0°O, 63°S, die Suidelike Anomalie. Die gebied van laasgenoemde stralingsanomalie strek oor en verby SANAE (Gledhill, 1971).

VERWYSINGS

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GLEDHILL, J A, Scientific results of the South African Antarctic ionosphere programme 1962-1970, *Suid-Afrikaanse Tydskrif vir Antarktiese Navorsing* No **1,** 3-10 (1971).

STOKER, P H, Kosmiese strale en Antarktiese navorsing, *Tegnikon Jrg* **15,** 133-142, 1966.

Fig. 1: Lyne van gelyke totale veldsterkte (F) vir 1922 – oorgeneem uit Gledhill (1971)

Fig. 1: Lines of equal total field strength (F) for 1922 – taken from Gledhill (1971)

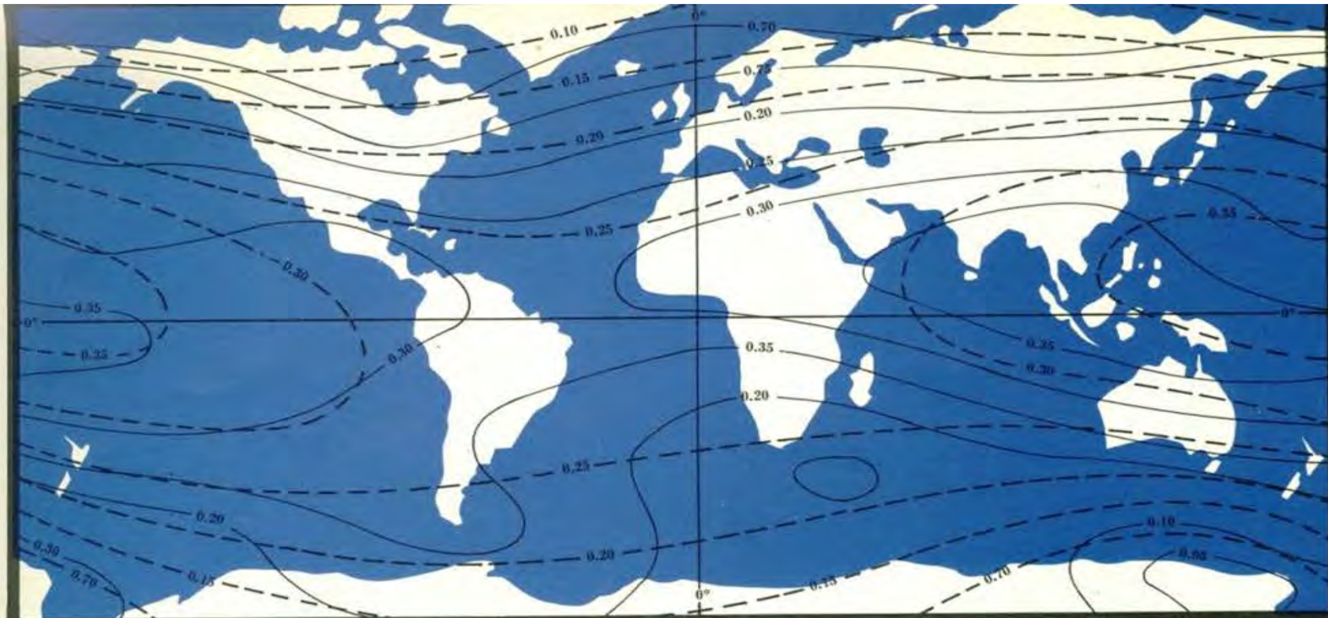


Fig. 2: Die stippellyne stel lyne van konstante horisontale veldsterkte (H) vir die veld van 'n eksentriese magnetiese dipool voor. Die vol lyne is die werklike lyne van konstante horisontale veldsterkte vir 1922 – oorgeneem uit Stoker (1966)

Fig. 2: The broken lines are lines of constant horizontal field strength (H) for the field of an eccentric magnetic dipole. The full lines are actual lines of constant horizontal field strength for 1922 – taken from Stoker (1966)

ERRATUM

SANAE Brochure — supplement to **Scientiae**, official journal of the CSIR:

"Fig. 3 on p. 37 should be interchanged with Fig. 3 on p. 43."

ERRATUM

SANAE-Brosjure — bylaag tot die WNNR-lyfblad **Scientiae:**

"Fig. 3 op bladsy 37 en Fig. 3 op bladsy 43 moet omgeruil word."

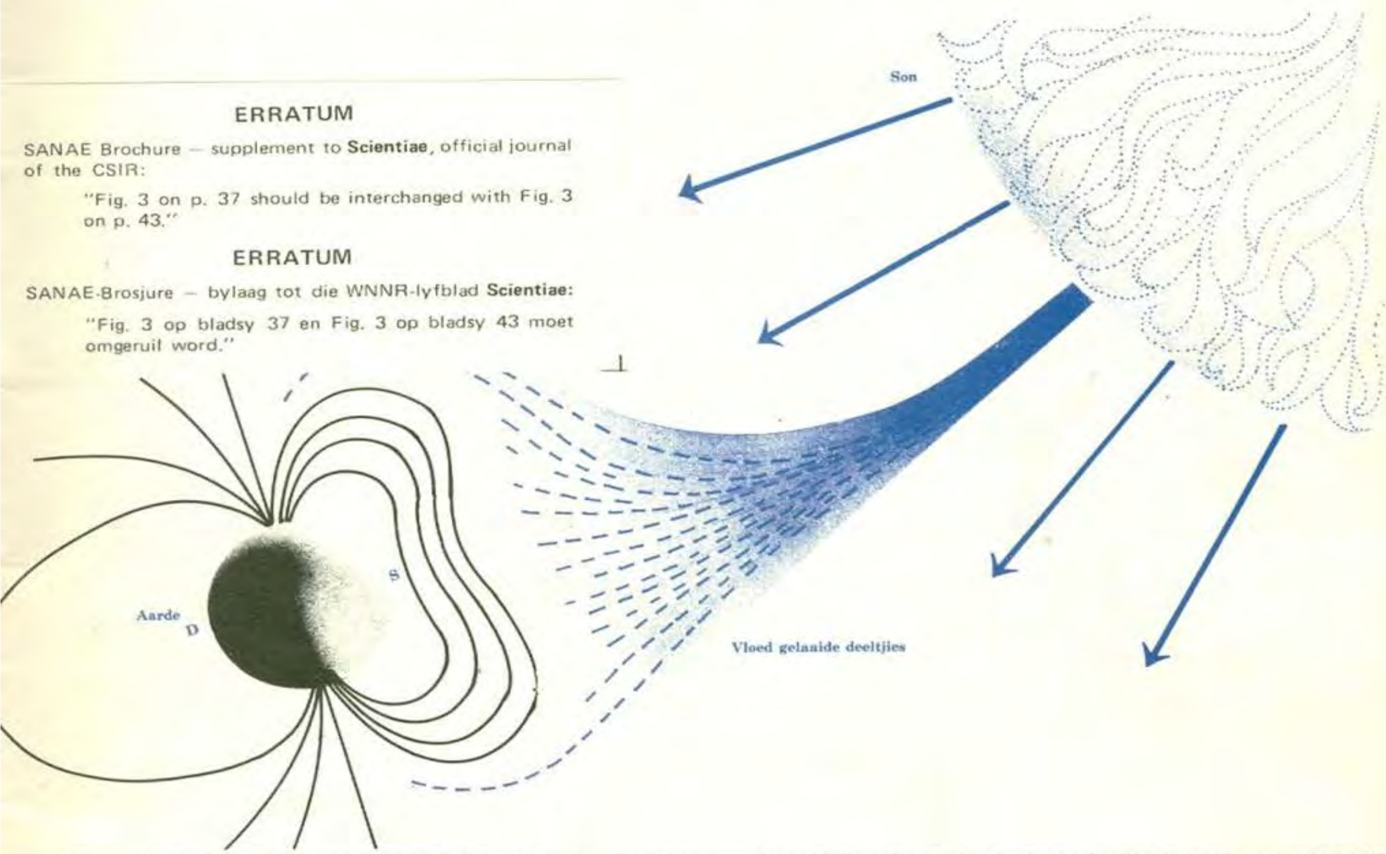


Fig. 3: Teltempo's van hoogenergieke elektrone soos beskryf deur Ginsburg et al (1962) – oorgeneem uit Gledhill (1971)

Fig. 3: Counting rates of high energy electrons as described by Ginzburg et al (1962) – taken from Gledhill (1971)

In Brief

INTERESTING ANOMALIES

Measurements of the magnetic field of the earth have revealed the existence of anomalies in the field strengths in the regions to the south and west of the Cape. These are introduced and attention is focussed on their influence on charged particle radiation in the atmosphere.

Magnetic barrier protects the earth

If the earth had no magnetic field, charged particles from the sun would bombard us and conditions at the surface of the earth would be very different from those that now exist.

The magnetic field acts as a protective barrier around the earth and serves to enclose it in what could be described as a giant bottle, the region within this bottle and surrounding the earth being known as the magnetosphere.

Within the magnetosphere there is matter in the plasma state which can be considered an extension of the earth's ionosphere; it co-rotates with the earth and its behaviour is controlled by the earth.

The region outside the magnetospheric boundary can be regarded as interplanetary space.

The magnetic barrier encircling the earth is not a uniform distance from the surface of the earth. Modification of the field lines is caused by the charged particles emanating from the sun.

Solar wind

Some of these particles are emitted in a continuous stream and are known as the solar wind because they are rather like a wind blowing outward from the sun. Other particles originate in giant flares at the sun's surface and are much more energetic.

When the solar wind reaches the neighbourhood of the earth it interacts with the earth's magnetic field and is deflected by it. In this process the shape of the magnetic bottle is modified (see fig 3 on page 43). On the sunward side this bottle extends perhaps 65 000 km above the surface of the earth, and on the other side it stretches hundreds of thousands of kilometres into space.

The polar regions are eminently suited for studying the properties of the magnetosphere because in this neighbourhood magnetic field lines may connect with field lines in interplanetary space, and various boundary surfaces intersect with the surface of the earth.

Whistlers

At the Physics Department of the University of Natal in Durban there has been an interest in this branch of physics since the International Geophysical Year in 1957/58. Under Professor N D Clarence, a group has since then been studying the magnetosphere by means of the atmospherics known as whistlers.

Whistlers originate in the radio waves given off by a lightning flash. They travel through the magnetosphere along the earth's magnetic field lines and are heard as a descending whistle on appropriate receiving equipment. Analysis of whistlers reveals much about the magnetosphere.

The University's early whistler experiments were carried out in Durban and on Marion Island where a member of the department spent a year on research in 1960. Later, in 1964 and 1965, the equipment was transferred to SANAE with the co-operation of a Rhodes University ionosphericist.

In 1969 it was decided that the department should participate fully in the Antarctic programme and new whistler equipment was taken to SANAE in 1970. The University has had a member on the Antarctic team every year since.

Aurora on television

The interest has meanwhile broadened. Equipment to measure very small changes in the earth's magnetic field (geomagnetic micropulsations) has been installed at SANAE and a new and exciting development is the construction of a television system with which it will be possible to study the aurora even when it is much too faint to be visible. From these studies knowledge about the energetic charged particles from the sun, as well as of the magnetospheric structure, can be gained.

The system is to be installed in 1975. The theoretical side of the programme is now being studied by Professor A D M Walker who came to the University from Rhodes University in 1972.

THE GEOGRAPHIC POLES, often referred to as simply the South Pole and the North Pole, are determined by the daily rotation of our planet. They are the two points where the axis of rotation passes through the surface of the Earth. This axis is a line through the centre of our planet, around which it spins like a perpetual top. Because the Earth continues to rotate around the same axis, the geographic poles do not move. (Actually, scientists believe that the geographic poles have moved very slowly throughout geological time, but the movement is too little to measure in the relatively short history of man.) Their constant position allows us to use these points as the basis of our system of direction and location. An imaginary circle halfway between these poles, the Equator, divides the world into Northern and Southern Hemispheres. Circles parallel to the Equator are the lines of latitude, and lines connecting the geographic poles – longitude – complete the system.

FOUR POLES

THE GEOMAGNETIC POLES are used by scientists to describe the Earth's basic magnetic field. Most of the characteristics of this field could be created if a powerful bar magnet were buried in the centre of the Earth with its axis tilted at about 11,5° to the axis of rotation. The geomagnetic poles are the two points where a continuation of the axis of this theoretical magnet would cut the Earth's surface: approximately 78°30'N, 69°W and 78°30'S, 111°E – about 1 300 km from the corresponding geographic poles. Because these points are part of an explanatory theory, they are imaginary and do not move.

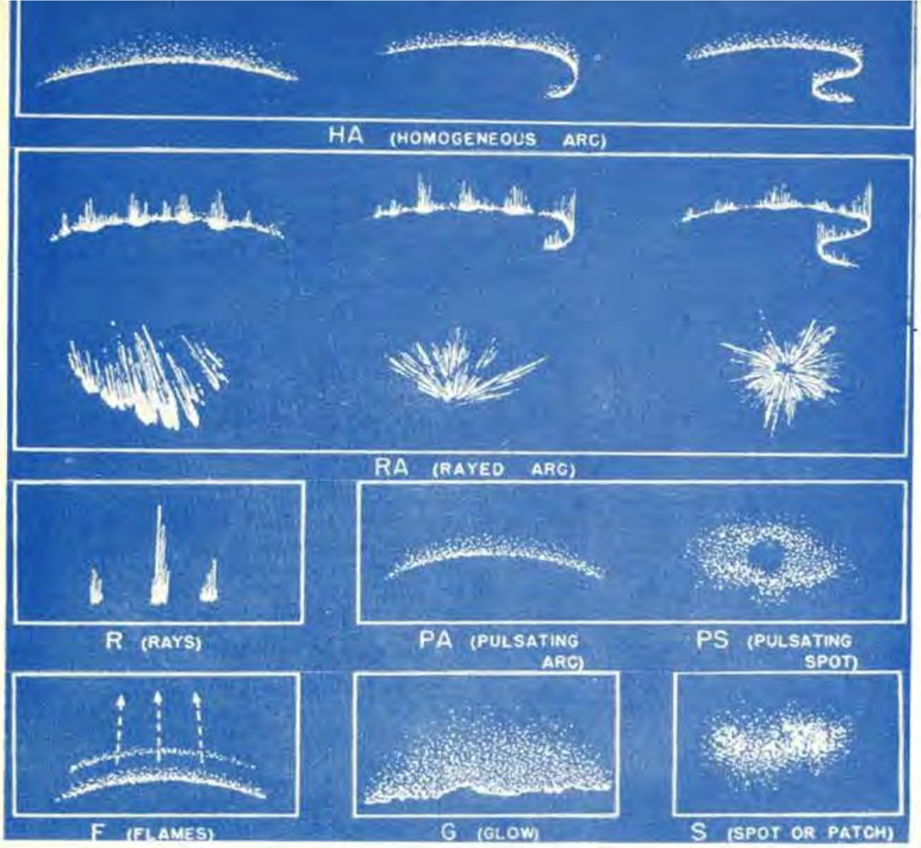
Scientists interested in geomagnetism use them as the basis of a system of *geomagnetic* latitude and longitude: the geomagnetic equator is inclined 11,5° to the geographic equator, and the zero meridian in geomagnetic longitude is the one passing through both of the geomagnetic poles and the *geographic* South Pole.

THE MAGNETIC POLES (sometimes called the magnetic dip poles) are real, not theoretical points. They are the places you would arrive at if you followed, north and south, the path indicated by a compass needle. At these points, one end of your compass needle would dip straight down, showing the convergence there of the magnetic lines of force.

If the Earth's actual magnetic field were exactly the same as that which the scientists' hypothetical magnet would produce, your compass needle would be horizontal at the Geomagnetic Equator and would lead you to the North and South Geomagnetic Poles, where it would be vertical. This is not so. Other, local magnetic fields in the Earth make the real magnetic field near the surface different from the theoretical field. So your compass leads you to the magnetic dip poles at about 75°N, 101°W, in the islands of northern Canada, and 70°S, 148°E, on the coast of Antarctica – roughly 1 100 km from the corresponding geomagnetic poles. (The search for the exact location of the magnetic poles was an important factor in early polar exploration.)

A straight line between the magnetic poles does *not* pass through the centre of the Earth. They also differ in another way from the geographic and geomagnetic poles: they move quite a bit. Recently they have been drifting north-westward at about eight kilometres a year.

THE POLE OF INACCESSIBILITY. This is the point on the Antarctic continent furthest from the sea in all directions. The coldest temperature ever recorded on earth was measured here viz -88°C. The Russian base, Sovetskaya, is located in the vicinity of this pole, but is not at present occupied. This base is at an altitude of 4 250 m above sea level. The geographical position of the Pole of Inaccessibility is 78°24'S, 87°35'E.



Aurora in verskillende gedaantes
The many faces of Aurora

Geomagnetism and the Aurora

The study of geomagnetism dates far back in history. This does not mean, however, that nothing new can be learnt in this field. In fact, the discipline is as full of interesting problems today as in the past.

The polar regions, as has already been mentioned, are of special interest in the study of magnetospheric phenomena. Charged atomic particles, such as electrons and protons, trapped in the magnetic field, can penetrate lower into the atmosphere over the polar caps than elsewhere on the earth.

Under normal conditions, these particles spiral around magnetic field lines and bounce back and forth between the northern and southern hemispheres. However, during magnetic storms, when the earth's magnetic field changes significantly, these particles may penetrate so low into the atmosphere that they interact with the neutral constituents (molecules) of the lower atmosphere, causing phenomena such as aurorae, and ionospheric disturbances at altitudes from about 80 to 250 km.

These so-called particle precipitation events occur in two oval bands – the auroral ovals – encircling the two polar caps at a latitude of approximately 70°. The South African Antarctic base, SANAE, is situated on the northern side of the southern auroral oval, which makes it an excellent location for the study of particle precipitation phenomena.

The motion of the charged particles, both when they are trapped and when they are precipitated into the atmosphere, is closely determined by the earth's magnetic field, which means that information on magnetic field conditions is of prime importance in the study of particle phenomena. To provide this information, three components of the magnetic field are recorded at SANAE. These are the horizontal intensity, vertical intensity and declination (direction of the field), from which the total intensity of the magnetic field may be calculated.

Satellite observations in the past two decades have greatly advanced the study of geomagnetism but ground-based observations, such as those made at SANAE, have not lost their significance because of this. The reason is that the satellite can only 'look' at the conditions at a particular point in space for a brief moment in time and then return to that point only after a long period, if at all. The information the satellite provides on the development of magnetic phenomena in space and time is therefore wholly inadequate unless it can be supplemented by ground-based observations.

Another drawback of magnetic observations by satellite is that the space vehicle is some distance away from the geomagnetic phenomena. It cannot come closer because the higher density of the atmosphere at the altitude where these phenomena occur would cause excessive friction which would slow down the satellite so that it would be lost within a short time.

Apart from its importance in providing supporting data for the study of other phenomena, geomagnetism is a most interesting field of study in its own right. In this respect the so-called quiet day variation of the magnetic field may be mentioned. This smooth variation which occurs on each day on the dayside of the earth is still not fully understood. To arrive at a more complete understanding, observations are needed from as many magnetic recording stations as possible over the entire earth. The South African magnetic stations at SANAE and also on Marion Island are very useful because they are situated in a region which is sparsely covered by magnetic recording stations.

Aurora

The most spectacular manifestation of particle precipitation in the polar regions – the aurora or polar lights – is also being studied at SANAE. When charged particles enter the atmosphere in the auroral oval, they collide with the neutral molecules in the atmosphere, thus exciting or ionising them. These excited atoms then return to their ground state by radiating photons, resulting in a display of light in the sky. The aurora may be quiet, forming an arc or a band, or it may have a more complex shape, appearing like a drapery in the sky. Sometimes such violent changes and motions are exhibited that they defy all attempts at description.

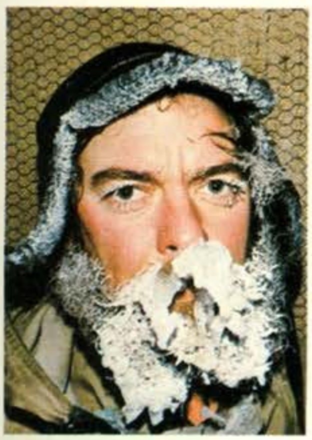
It is well known that the aurora shifts towards the equator when there is increased magnetic activity. During the International Geophysical Year (1957/58) the aurora was in fact observed as far north as Cape Town. This is a rare occurrence, however, so it is best studied in the polar regions.

A large variety of methods are used for observation of the aurora because it is such a complicated phenomenon. These include visual observations, photographing of the whole sky using a camera with a 'fish-eye' lens, recording of a limited part of the sky with television systems, and measurement of the variations in light intensity with photometers.

Cameras on satellites are also used to record the aurora (DAP and ISIS satellites), but ground-based observations are essential for the comparison of observations made during consecutive passes of the satellite over the auroral oval.

Bo links: Ontspanning.
Bo regs: 'Maak groot oop!'
Regs: Aurora oor SANAE
Onder: Ys-asem

Top left: Recreation.
Top right: 'Open wide!'
Right: Aurora over SANAE
Below: Frozen breath



Bo: Aflaai by Marion
Middel: Antenne van ionosonde by SANAE
Regs: Rand van Antarktiese ysbank

Above: Off-loading at Marion
Centre: Ionosonde antenna at SANAE
Right: Edge of Antarctic ice shelf

'n Gloed in die naghemel

Luggloed is die naam wat aan 'n baie swak liguitstraling van die naghemel gegee word en wat eers teen die einde van die vorige eeu ontdek is. Die spektrale aard daarvan is byna dieselfde as dié van die skouspelagtige auroras wat reeds vir eeue aan die mens bekend is. Suiwer luggloedlig is egter honderde male swakker en min of meer ewe intens oor die hele aarde, met min fluktuasie in ruimte en tyd.

Luggloed is een van die vensters waardeur die geheimenisse van die hemelgewelf bestudeer kan word. Dit is sterk aanvullend veral vir ionosferiese waarnemings omdat beide verskynsels hoofsaaklik die gevolg is van gelaaide deeltjies wat deur die ultravioletlig vanaf die son op groot hoogtes bokant die aarde vrygestel word. Luggloed het egter die voordeel dat gelokaliseerde gebiede van die ionosfeer gepeil kan word met behulp van die nou hoek van die teleskopiese sisteem van 'n luggloedmeter.

Waarom ook na SANAE?

Die veelkleurige auroras in die noordpoolgebied het die verbeelding van wetenskaplikes reeds lankal beetgepak. Manne soos Störmer het aan die begin van hierdie eeu die verskynsel toegeskryf aan die beweging van gelaaide deeltjies in die atmosfeer. Mettertyd het 'n duideliker beeld ontstaan van die sogenaamde magnetosfeer; die gebied rondom die aarde waarin gelaaide deeltjies die invloed van die magneetveld van die aarde ondervind.

Wanneer gelaaide deeltjies in 'n magneetveld beland, word kragte loodreg op hul bewegingsrigting uitgeoefen. Gewoonlik begin hulle dan in spirale rondom die veldlyne van so 'n magneetveld beweeg. Hoe sterker die veld word (fig. 1), hoe nouer word die spirale en ook al meer loodreg op die veldlyne totdat die deeltjies by 'n sekere punt omdraai en terugwaarts beweeg. Deeltjies in die aardveld beweeg soms op hierdie manier van poolgebied na poolgebied – in slegs 'n paar sekondes! Die beweging is uiters ingewikkeld en word ook nog deur die rotasie van die aarde beïnvloed. In fig. 2 dui A die pad van 'n inkomende deeltjie aan en B sy pad terug.

Omdat die deeltjies hoofsaaklik deur die buitenste veldlyne wat by die pole eindig, vasgevang word, word hulle meestal na dié gebiede afgedwing (fig. 2). Verder geskied dit op so 'n manier dat weinig van hulle hoër as 75 en laer as 65 breedtegraad afkom. Die deeltjies kom dus meestal in gordels rondom die magnetiese noord- en suidpoolgebiede voor – die sogenaamde aurora-ovaal.

Sommige van hulle dring die atmosfeer te diep binne en verloor dan hul energie as gevolg van botsings met lugmolekule. Hulle sak dus heeltemal uit die vloed van deeltjies – soos die baan C in fig. 2 aandui – maar het in dié proses waarskynlik een of meer atome of molekule in die atmosfeer opgewek. Die gevolg hiervan is dat lig uitgestraal word, te sien as luggloed of auroras, afhangende van bykomstige omstandighede.

Die gelaaide deeltjies in die atmosfeer is afkomstig van die son in die sogenaamde sonwind. Dit oefen 'n sterk invloed op die vorm van die aardveld uit (fig. 3). Die uitwerking van gebeurtenisse in die hemelruim kan dus waarskynliker in die poolstreke waargeneem word as nader aan die ewenaar.

Program by SANAE

Uit die bostaande volg dat SANAE, wat op die rand van die aurora-ovaal lê, 'n

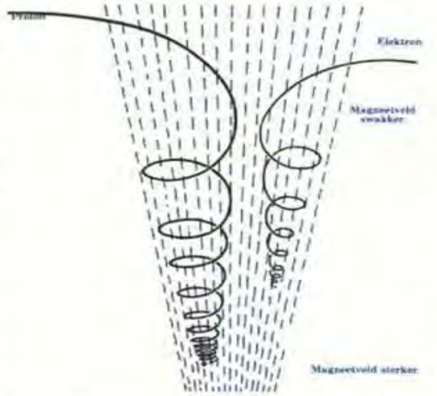
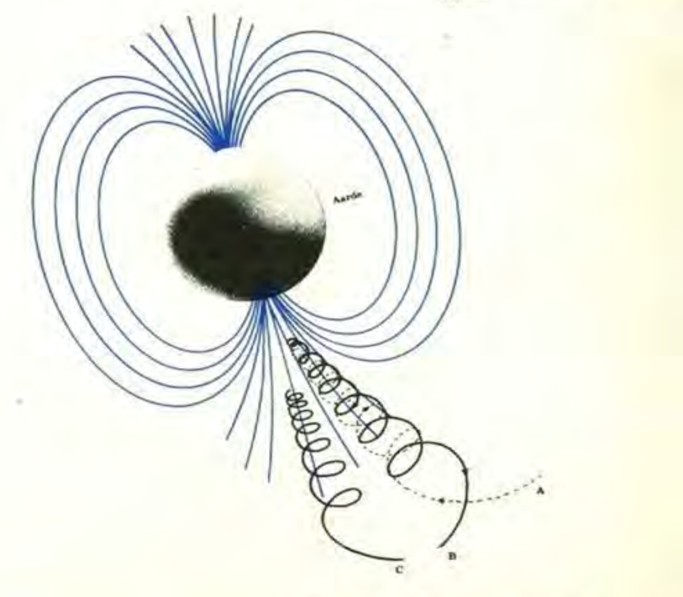


Fig. 1: Spiraalbane van 'n elektron en proton om die magnetiese kraglyne van die aarde. Omdat die proton swaarder as die elektron is, is sy spirale wyer. Omdat dit positief gelaai is, is sy bewegingsrigting andersom as dié van 'n elektron.

Fig. 1: Spiral curves of an electron and proton around the lines of force of the earth. As the proton is heavier than the electron, its spiral tracks are wider. Because it has a positive charge, its direction of motion is the opposite to that of the electron.

Fig. 2: 'n Voorstelling van die aardveld indien dit beskou word as afkomstig van 'n magnetiese dipool wat naastenby by die senter van die aarde geleë is. In werklikheid word die aardveld deur die sonwind vervorm. Let op dat die buitenste veldlyne by die noord- en suidpool konsentreer. Inkomende deeltjies begin by voorkeur rondom hierdie veldlyne tol en dring aldus ons atmosfeer hoofsaaklik in die poolstreke binne.

Fig. 2: A diagram representing the earth's magnetic field as if coming from a magnetic dipole situated near the centre of the earth. Actually the earth's magnetic field is distorted by solar wind. Note that the outer field curves concentrate at the north and south poles. Incoming particles start spinning around these field lines by preference and thus enter our atmosphere mainly at the polar regions.



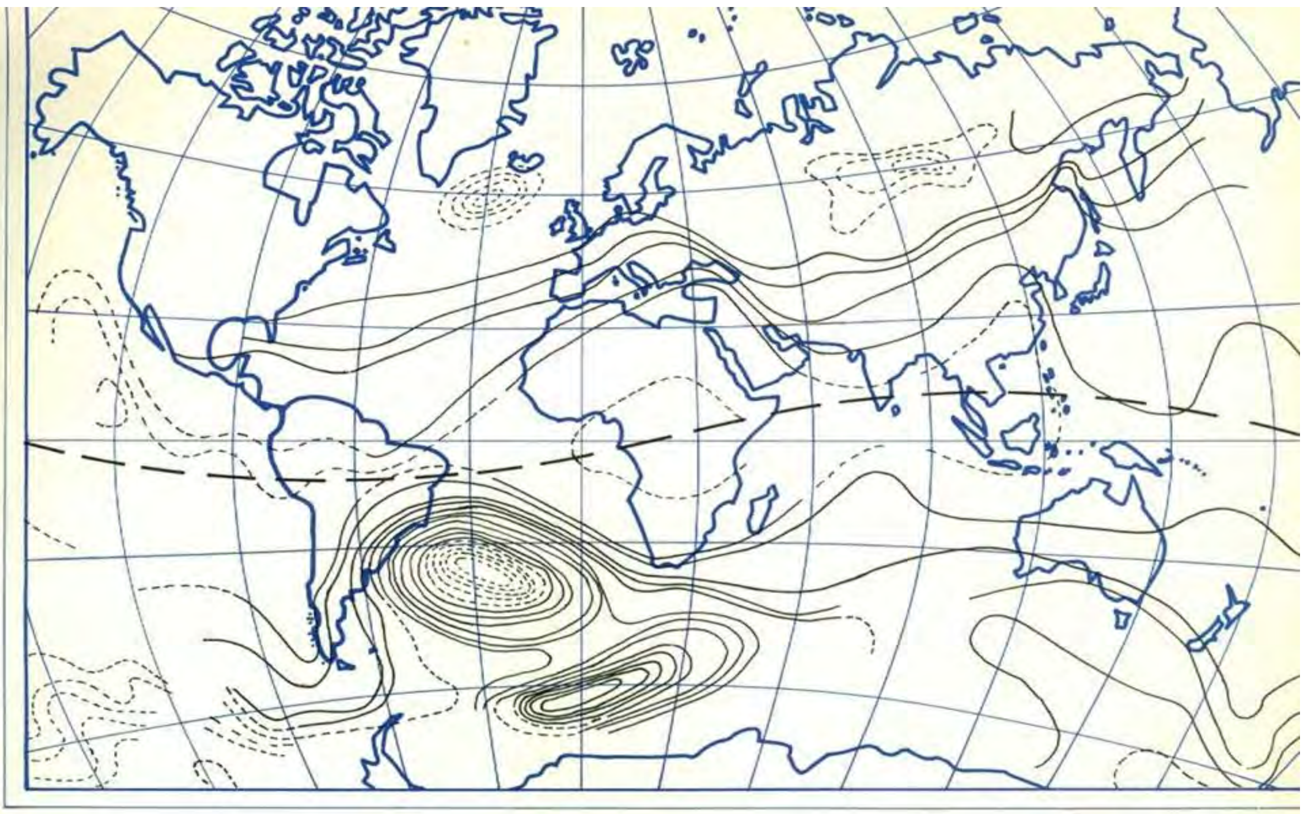


Fig. 3: Vast numbers of charged particles constantly leave the surface of the sun to form the so-called sun wind, resulting in the distortion of the earth's magnetic field. The lines of force are pressed together at the day side of the earth, S, and are stretched at the night side, D. The flood of charged particles, however, is still mainly conveyed along the field lines at the polar regions. At times eruptions occur on the sun when thousands of times more particles (dotted lines) are shot out to be precipitated at the polar regions later. It is under these conditions that southern and northern lights occur.

Fig. 3: Ontsaglike hoeveelhede gelaaide deeltjies verlaat gedurig die oppervlakte van die son en vorm die sogenaamde sonwind. Die gevolg hiervan is dat die magneetveld van die aarde vervorm word en wel so dat die kraglyne aan die sonkant van die aarde, S, saamgedruk en aan die donker kant, D, uitgerek word. Die vloed gelaaide deeltjies word egter nog steeds hoofsaaklik by die poolstreke langs die veldlyne afgevoer. By tye kom daar uitbarstings op die son waardeur duisende male meer deeltjies (stippellyne) as gewoonlik uitgeskiet word en 'n tydjie later in die poolstreke gepresipiteer word. Onder sulke omstandighede kom die suider- en noorderligte voor.

baie geskikte waarnemingspos is. In verband met luggloed moet ons nog sê dat dit gedurende die dag deur sonlig oorskadu word en dan slegs met behulp van baie spesiale metodes gemeet kan word. Selfs snags staan luggloedlyne op 'n onvermydelike agtergrond van diffuse hemellig. Om dus die intensiteite van luggloedlyne alleen te verkry, moet dié agtergrond afgetrek word. Verder, ten einde 'n rekord van die verloop van gebeurtenisse te verkry en veral as dit geld vir snelveranderende verskynsels soos auroras, moet lesings kort na mekaar geneem word. Die waarnemings word gedigitaliseer en met behulp van 'n drukker op ponsband vasgelê.

Die meetprogram op SANAE is daarop gemik om so dikwels moontlik die intensiteite van die rooi suurstoflyn by 6 300 Å, die groen suurstoflyn by 5 577 Å en die bandekop van die geïoniseerde stikstofmolekuul by 3 914 Å te meet. Agtergrondwaarnemings word by 5 300 en 6 333 Å gedoen. Aangesien onder andere ondersoek ingestel word na die beweging van die aurora-ovaal moet die fotometer in staat wees om na verskillende posisies van die hemelgewelf te kyk terwyl metings stelselmatig geneem word. Visuele waarnemings van omgewingstoestande is net so belangrik soos die metings self. Besonderhede hieromtrent word sorgvuldig aangeteken en is van baie groot waarde wanneer die resultate later verwerk en geïnterpreteer word.

In Brief

FAINT LIGHT IN THE NIGHT

Airglow is a faint light emission observed in the night sky. Its spectral nature is very similar to that of the spectacular aurorae, but many times weaker.

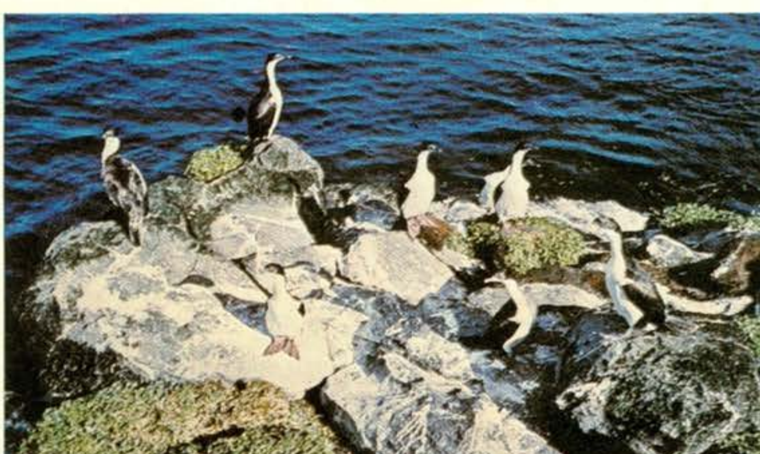
True airglow is mostly caused by electrons set free by the ultraviolet light from the sun. Aurorae, on the other hand, originate largely from charged particles coming from the sun in the so-called solar wind. Such particles experience a force from the magnetic field of the earth and begin to spiral around its lines of force (see fig. 1). They are thus carried towards the polar regions. Some of these particles are reflected back to the opposite hemisphere, as shown in A and B in fig. 2, while others are dumped in the atmosphere, like C in fig. 2. During sunbursts, large numbers of particles are thus deposited in the polar regions and cause aurorae.

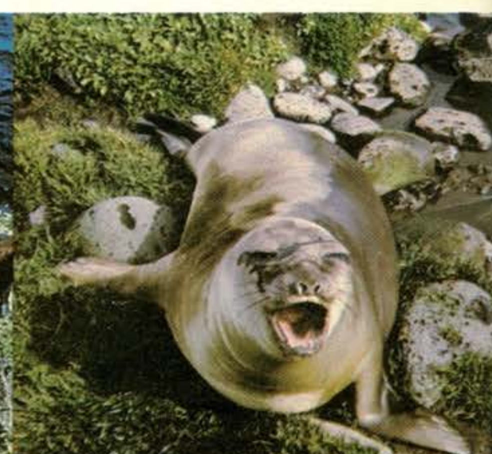
***SANAE* is well situated for the frequent measurement of interesting solar events.**

The airglow photometer scans along the geomagnetic meridian and automatically measures airglow and aurora intensities at 15 angular positions. At each position the spectral intensities of the 01 lines at 5 577 and 6 300 Å and the N_2^+ band at 3 914 Å are measured as well as background intensities at 5 300 and 6 333 Å. The results are punched on paper tape in digital form. Visual observations of environmental conditions are also recorded to aid in the interpretation of results.

Right: King penguins
Below: Emperor penguins
Bottom left: Shags on Marion Island
Bottom right: A seal surprised

Regs: Koningspikkewyne
Onder: Keiserpikkewyne
Heel onder links: Kormorante op Marion
Heel onder regs: Wie't geskrik?

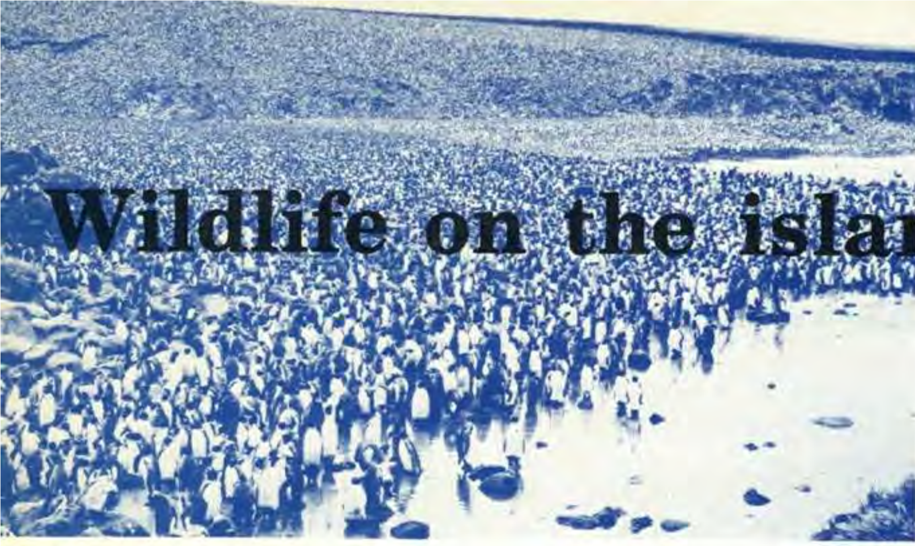




Left: Sooty albatross
Below left: Wandering albatross
Below: Vegetation on Marion
Bottom: Citizens of Marion Island

Links: Bruin malmok
Links onder: 'n Groot albatros
Onder: Plantegroei op Marion
Heel onder: Burgers van Marion-eiland

Wildlife on the islands



The birdlife

Voyaging southwards from Cape Town, the traveller will encounter an astonishing number and diversity of birds. These include penguins, petrels, albatrosses, skuas, gulls and terns.

The majority of these birds breed on islands in the sub-Antarctic ocean. Of the hundred or so species of petrels and albatrosses, for instance, roughly two-thirds breed only on sub-Antarctic islands. Sheathbills and cormorants also breed there.

Apart from occasional strays from lower latitudes and a small number of real land birds, the avian community inhabiting the islands is exclusively marine. The species are either ocean-feeders or dependent, as scavengers and predators, on other birds.

Typically, on a sub-Antarctic island penguins occupy the coastal slopes, cormorants and the smaller albatrosses the cliffs, the larger albatrosses the higher, flatter ground and petrels honeycomb the inland surface soil with their burrows. Every available nesting site seems to be filled.

Some of the largest bird colonies in the world are to be found on sub-Antarctic islands. Marion Island, for instance, harbours about 2 000 000 Macaroni Penguins.

Despite the abundance of birds on the islands, only a few of these insular bird colonies have been studied intensively, and virtually nothing is known about their impact on the ecology of the islands. Indeed, the role of birds in mineral, nutrient and energy cycles of ecosystems generally has not received much attention, although certain information on the Arctic points to the importance of birds in the ecosystems there.

Birds are, for instance, of primary importance in relation to the incidence of plants in areas of the Arctic and sub-Arctic. Vegetation is restricted along the north-east coast of Greenland mainly because of the absence of significant colonies of seabirds.

Wat maak jy?
What are you up to?

Preliminary information regarding Marion Island indicates that the avian community plays a major role in the island's relatively simple ecosystem. Because of the geological youthfulness of the island, the high rainfall causes excessive leaching and there is a continuous loss of inorganic salts and organic substances.

Consequently much of the vegetation is dependent on the birds for continued productivity. While the total weight of nutrient matter contributed to an ecosystem by a population of birds may be small compared with other components of the system, the rate of turnover can be rapid. In addition, the birds assist in dispersing the seeds of plants over the vast ranges of the Southern Ocean. The physical effects on the vegetation of millions upon millions of birds trampling, digging and so on can be very significant on a small island.

The thrust of SASCAR's ornithological programme for Marion Island is towards elucidating the role played by birds as a link in the flow of energy through the food chain, and of their part in transporting minerals and organic nutrients to the island from the surrounding richly productive ocean — with the resulting effect of these introductions on the island's terrestrial ecosystem.

The initial three-year phase of the research programme will be devoted to an investigation of the main surface-breeding birds. The Wandering Albatross, Macaroni Penguin, Antarctic Skua and Lesser Sheathbill are some of the species that have been selected for special study.

The petrels will not be included in this phase because their burrowing habits, and the fact that they are primarily nocturnal birds, make any study of them particularly difficult.

Regular photographic censuses will reveal the distribution, total number and the population structure of each species of bird for every phase of the annual cycle. This information, coupled with assessments of the diets of the various birds, their guano production and their nutrient, mineral and energy values will make it possible for analyses to be made of the contribution these birds make to the ecosystem of the island.

And the seals

'Bly weg!' brul die see-olifantbul
'Watch it!' warns this sea elephant bull

Seals of two types are found on the sub-Antarctic Marion Island – the southern fur seal *(Arctocephalus gazella)* and the southern elephant seal *(Mirounga leonina)*. Both species were hunted in the past – especially during the nineteenth century – but overexploitation and indiscriminate slaughter caused their numbers to decline so drastically that sealing operations eventually became uneconomical. The last sealing expedition took place in 1933.

Since the annexation of Marion and Prince Edward islands by South Africa in 1948, all seals on the islands have been rigorously protected.

Seals on Marion Island were first studied in 1951-1952 by R W Rand, presently Assistant Director of Sea Fisheries in South Africa, during the course of general biological work on the island. Since that time, members of South Africa's weather team and, later, biologists have kept notes on the occurrence and numbers of seals, but no scientific studies were carried out until a programme of research was initiated by the Mammal Research Institute of the University of Pretoria in 1972.

Following protection of the seals on Marion Island their numbers began to increase, especially those of the fur seal which had become rather scarce. Because it was not known how many seals the island could carry, and knowledge of the biology of the fur seal as well as of the southern elephant seal was scanty, there was a strong incentive for a study of the seals inhabiting Marion Island. Further impetus for the study was provided by an awakened general interest in seals of the Antarctic and the sub-Antarctic islands.

A number of countries participating in biological work in the Antarctic and sub-Antarctic have made significant contributions to the knowledge of seals inhabiting this part of the globe, but until now the South African contribution in this sphere has been insignificant. Detailed knowledge of Antarctic and sub-Antarctic seals is vital for a workable programme of conservation, and possible scientifically regulated exploitation of these animals in the future.

For these reasons the Mammal Research Institute initiated a programme for the study of seals in the Antarctic and on Marion Island. A scientist was appointed to study the behaviour, population dynamics, and physiology of the southern fur seal and the southern elephant seal on Marion Island. He has been on the island since June 1973 and will spend at least two years doing field work there. He is studying the general behaviour of the two seal species as well as specific aspects such as vocalizations, territorialism, breeding behaviour, behaviour of cows to their pups and vice versa, and the development of behaviour in the pups.

The various beaches are visited as regularly as possible to get an idea of how many seals overwinter on the islands; which are the preferred beaches, and how topography and situation of the beaches affect the number of seals found on them. In this way a picture can be built up of the ecology of the seals, that is, the areas where they are commonly found and the conditions of living that they prefer.

The sizes and composition of populations on various beaches are being studied and aspects such as breeding success, mortality, growth rate of pups, and reproductive physiology are also being investigated. The amount and species of fish consumed is another subject of research.

A number of different techniques are employed in this research work. Stainless steel tags are used to identify seals, and branding is employed in some cases. A number of seals will also have to be immobilized to get certain information about them; such immobilization does not harm the animals in any way. A few seals will be killed to get physiological and anatomical samples. These samples will be processed to obtain information on possible pollution in the southern hemisphere oceans, as well as knowledge about interrelationships between seals occurring in Antarctica and the sub-Antarctic islands.

The bulk of the information about the seal population will be gathered on Marion Island during the summer months, as most of the seals leave the island between May and September. Adverse weather also usually curtails field work during this period.

Pelsrob-snob
A snob in fur

Left to right: Midnight sun over pack ice; Typical field camp; Rockhopper penguin; A black iceberg – an unusual and as yet unexplained phenomenon; Radio link with home base. The main photograph, taken by C L J Minnaar, shows an icy valley in Antarctica.

Links na regs: Middernagson oor pakys; Tipiese veldkamp; Rockhopper-pikkewyn; 'n Swart ysberg – 'n ongewone en tot dusver onverklaarde verskynsel; Radioverbinding met die tuisbasis. Die hooffoto, geneem deur C L J Minnaar, toon 'n ysige kloof in Antarktika.