AUSTRALIAN ANTARCTIC RESEARCH - NOW AND IN THE FUTURE

James E. BLEASEL

Australian Antarctic Division
Channel Highway
Kingston - Tasmania
Australia 7050

Proceedings of the Belgian National Colloquium on Antarctic Research
Brussels, October 20, 1987
Prime Minister's Services - Science Policy Office

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ABSTRACT

The Australian Antarctic Division has the prime responsibility for maintaining Australia's activities in Antarctica. It is supported in its scientific role by a number of other government and non-government organisations which together comprise the Australian National Antarctic Research Expeditions (ANARE). The Antarctic Division undertakes research in glaciology, terrestrial and marine biology, upper atmosphere physics, cosmic ray physics, medicine, and psychology. These programs are conducted from our wintering stations of Davis, Casey, Mawson and Macquarie Island and a series of summer stations. Field programs are maintained through long range tractor traverses and by helicopter. We operate over 4000 km of the Antarctic coast using two ships and six helicopters. This year 131 scientists will travel to Antarctica while many others will remain in Australia working on the results of last years Antarctic program.

Geology and geophysics are undertaken in the vicinity of year-round stations and our summer bases. Programs aim at producing modern geological maps and conducting detailed research into the origin of the development of the Antarctic shield.

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Meteorological data gathering is conducted at all year-round stations to provide input for Australian contributions to the World Meteorological Organisation, to aid Australian weather prediction and to assist operations in Antarctica.

Meteorological data is also gathered at all summer bases and from our ships.

Our Cosmic Ray Physics is concerned with variations of cosmic ray particle intensity.

The combined surface-and-underground installation at Mawson operates within an international network of cosmic ray observatories.

The Mawson facility plays a key role in bi-hemisphere investigations. It includes the only high energy installation at polar latitudes, and the main telescope, 11 metres underground is now the largest of its kind in the Southern hemisphere. The 11 metres of rock covering the telescope shield its counters from the low energy particles, which are recorded separately at the surface.

This high energy telescope enabled us to discover an important new phenomenon in cosmic ray modulation. It was the first major discovery in this field in the past 15 years.

The Upper Atmosphere Physics research program contributes to an understanding of the interaction between the solar wind and the earth's magnetic field and magnetosphere; the mechanisms that control the composition, the structure and dynamics of the upper atmosphere; the response of the upper atmosphere to natural and man-made disturbances; the coupling between lower and upper atmosphere and the role of the upper atmosphere in relation to climate and weather.

Optical measurements of certain phenomena have been made at Davis station during 1987 to determine seasonal and daily variations in the temperature between 80 and 90km altitude and to determine the extent of auroral influences on the region.

The advent of satellites transmitting in the VHF and SHF ranges has not, as had been expected, solved the problems of signal transmissions without ionospheric imposed disturbances and research continues into the problems.

In Glaciology, the common theme addressed by the Division's broad range of projects is the interaction of the Antarctic ice sheet and surrounding sea ice with the global environment, including the physical processes involved in that interaction.

Significant advances have been made during 1986/87 in several aspects of the program. A 234m deep ice core was recovered from a high accumulation area of Law Dome, a self-contained ice cap adjoining the main ice sheet, providing samples for detailed measurements of past atmospheric levels of the so-called "greenhouse" gases, and a test of some of the equipment and procedures to be used in the forthcoming deep drilling program.

The oversnow traverses made out of Casey have been a major field program and provide a substantial Australian contribution to the International Antarctic Glaciological Project. The major traverse routes established out of Casey span an area of over one million square kilometres of the interior of the ice sheet.

Shallow snow cores, up to 40m depth, are used to investigate the processes related to transformation of snow to ice and the development of the crystal structure found within the ice sheet, to establish the starting conditions for characteristics observed in the deep ice cores, and to provide basic "ground truth" information used in the interpretation of remote sensing data obtained from satellites.

Analyses of the physical properties of these cores are currently being used to provide a means of dating the deeper ice cores.

The laboratory study of ice mechanics aims at gaining an improved knowledge of small scale factors which influence the flow of ice masses.

Data on surface climatology, the processes of ice sheet-atmosphere energy exchange and katabatic wind flow over the Antarctic interior are obtained via satellite from automatic weather stations. Five automatic weather stations operated during the last year.

A Deep Ice Drilling program is now well underway after the first year of its approximate five year plan. Its aims are to drill and extract a 1200m ice core to bedrock near the summit of Law Dome and to analyse the core for its historical record of environmental and geophysical information. The Law Dome drilling will test the mechanical coring system's capability of drilling 4500m through the ice sheet further inland; a program we hope to commence within 4 years.

A recent research program has revealed a 500 year record of the atmospheric "greenhouse" gases carbon dioxide, methane and nitrous dioxide. Concentrations of chlorofluorocarbons will soon be measured. New core is now being similarly analysed. Its overlap with modern, direct air measurements should confirm the accuracy of the analysis.

Oxygen isotope ratios reveal climatic records and annual cycles of accumulation in ice cores. Measurements on shallow cores taken during inland traverses are being used to investigate variations in snow accumulation. The climatic record of the last few hundred years is being refined.

Data on the size and distribution of icebergs in the Southern Ocean continues to be collected on all resupply and research voyages. Observations made during the 1986/87 season allowed the seasonal change in iceberg numbers to be determined and suggested that once icebergs are in open sea, free of the seasonal pack ice, they break up in only a few months. This has implications for the conjectured schemes for using icebergs as a freshwater resource.

Vertical aerial photography of most of Heard Island was obtained with a helicopter mounted 70mm camera in the 1986/87 summer. The photography will be used to map the glaciers of Heard Island and as a base for monitoring changes in their extent.

Biology

Our biological projects focus on both the marine and terrestrial ecosystems.

During 1986/87, the emphasis in Marine Science continued to be directed towards gaining an understanding of the Antarctic marine ecosystem. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has designated our main study area, Prydz Bay, as one of the study sites for its ecosystem monitoring program. Much of our past and future work, in conjunction with elements of the total Biology Program, has been, and will continue to be, relevant to this program.

The main component of the program continues to be studies of the Antarctic krill, Euphausia superba, a key component in the food web. Field work consists of regular surveys with nets and acoustic equipment to assess its distribution, abundance and life history in the study area, and these are complemented by laboratory studies on age and growth, physiology and feeding behaviour. The Antarctic Division was the first laboratory in

the world to raise krill in the laboratory from eggs to spawning adults, and in the process discovered much about this animal which is so difficult to study in the wild for most of the year. Some of our laboratory krill have been living in our lab for 6 years after coming in as mature adults.

A study of the distribution and abundance of krill will continue to be undertaken to contribute to the 'rational' management of the resource.

Phytoplankton are studied as food for krill and non-krill zooplankton. The physical and chemical properties of the seawater are also studied in order to try to explain and or predict the behaviour of the organisms.

The major activity this year has been a marine science cruise to the Prydz Bay area in February to April 1987. The main aims were to conduct a study of the bottom-living fishes of the Bay and the larval ecology of krill. Additionally, an intensive study of phytoplankton and bacterioplankton was accomplished, and oceanographic data taken. This program included two Belgian scientists.

Offshore marine research was undertaken around Macquarie Island for the first time. A short program to study the fish fauna was completed during a station resupply trip. Several species were recorded at the island for the first time, and a much clearer understanding of the fauna and its relationships has been achieved.

Activity has also increased in the waters around Heard Island, where Australia claims an Exclusive Economic Zone. The Soviet Union and Australia agreed to a joint fisheries research cruise in that Zone last season and the Antarctic Division placed an observer aboard the Soviet research vessel.

During 1987/88, field work will focus on physical and chemical oceanography in the Prydz Bay and Commonwealth Bay areas, and on a survey of Crabeater seals.

Approximately 30 strains of Antarctic phytoplankton were isolated into culture by University of Tasmania participants following the 86/87 voyage. These will be used in ecophysiological experiments, to determine the response of growth rate to temperature, and to light and nutrient concentration.

Collaboration with the University of Brussels will continue in 1987/88 on the planned Antarctic Division transect from Hobart to Commonwealth Bay. The abundance of phytoplankton, bacteria and protozoa will be measured and correlated with the various oceanographic conditions encountered in order to determine the patterns of production, and utilization of organic matter, at the base of the food chain.

The oceanographic program has focused on providing a description of the broad characteristics of the water circulation within and to the north of Prydz Bay.

The principal areas of terrestrial biology research include a continuing investigation of the aquatic habitats of the Vestfold Hills region. They also include seals, penguins and other birds, as predator species, particularly in the Prydz Bay region. Botanical investigations of the environs of Casey station are another major program.

Intensive laboratory culture studies of mosses, carried out in 1986, concentrated on the effect of environment on growth form. The mosses show different responses to variations in composition of growth media, particularly to nitrogen.

HUMAN BIOLOGY AND MEDICINE

The objectives of Australia's Antarctic Human Biology and Medicine program are:

- to gain an understanding of the effects of the Antarctic environment on man;
- to take advantage of the special opportunitites provided by Antarctica for medical research.

With recent research suggesting expedition personnel in Antarctica are subject to greater psychological disturbance than has previously been supposed, the following areas of research are being carried out:

- investigation of the depression of the immune system of winterers, including photobiological studies;
- endocrine activity and its interaction with the environment;
- stress and behavioural adaptation;
- inter-related studies on nutrition, stress and cardio-vascular status of personnel;
- microbiology;
- epidemiology; and
- occupational health.

Psychological research is concentrating on determining the personal characteristics required to give the greatest probability of people being good community members, an important criterion in overwintering, and on methods of overcoming interpersonal problems in isolated communities.

INTERNATIONAL COLLABORATION

Australia has played host for several years to year round presence of scientists from the People's Republic of China, in the disciplines of glaciology, physics and terrestrial biology.

The summer programs have been more diverse than winter and the numbers of international visitors much greater. Visitors last summer were from Belgium (marine biology), West Germany (geology), Austria (geology), Sweden (geomorphology), Spain (ornithology), Japan (geophysics) and the Netherlands (ornithology).

International coordination through the Scientific Committee on Antarctic Research (SCAR) is a critical element of such programs as the International Antarctic Glaciological Program (IAGP), Biological Investigation of Marine Antarctic Systems and Stocks (BIOMASS), Evolution of Cenozoic Palaeoenvironments of the Southern High Latitudes and so on. Much marine biology is now organised under the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), a convention developed under the umbrella of the Antarctic Treaty and which has its headquarters in Hobart, the city in which the Australian Antarctic Division is based.

THE FUTURE

In Australia's future Antarctic research programs we will see an emerging emphasis on environmental research and on research directed towards the conservation of the Antarctic marine ecosystem. We expect to have a new marine research vessel in operation in two years. This vessel will have a greatly increased research capacity over our current vessel. More time will be scheduled for marine science and commercial scale trawling will be undertaken with the objective of monitoring variations in the stocks of fish and krill.

I look forward to continuing international co-operation in Antarctic research.