APPENDIX

REPORT ON ANTARCTIC BUSINESS MEETING

The Committee on Antarctic Research had two business meetings on September 13, 1973, in Kyoto. Six working groups were organized with 20 members, and worked out the geomagnetic, auroral VLF's, ionospheric, rocket-borne and balloon-borne programs for IMS, in compliance with a request of SCAR asking the Committee to initiate the planning of Antarctic research during the period of IMS.

The membership and recommendations of each working group are as follows:

Membership

Chairman NAGATA, T.
Secretary OGUTI, T.
WG-1 Geomagnetic Variations and ULF
CAMPBELL, W. H.
LANZEROTTI, L. J.
PERRAUT, S.
RASPOPOV, O. M.
TROITSKAYA, V. A.
WG-2 Radar and Optical Aurora
DAVIS, T. N.
EATHER, R. H.
UNWIN, R. S.
WG-3 VLF and Whistler
CARPENTER, D. L.
HELLIWELL, R. A.
KAISER, T. R.
MORGAN, M. G.
WG-4 Ionosphere and CNA
GLEDHILL, J.
KING, J. W.
MATUURA, N.
PIGGOTT, W. R.
WG-5 Rockets and Satellites
OGUTI, T.
PERRAUT, S.
WG-6 Balloons
KEYS, J. G.
OGUTI, T.
ROSENBERG, T. J.

RECOMMENDATIONS FOR IMS

WG-1 Geomagnetic Variations and ULF

Reporter: L. J. LANZEROTTI

Two items of current, important interest concerning the use of magnetic pulsations requested in the Antarctic are the following:

1) Data from Antarctic stations separated in longitude (but at approximately the same magnetic latitudes) should be examined for the same individual pulsation events. In particular, data should be obtained from stations spaced in longitude about local noon. The orientation of Pc-3 and Pc-4 ellipses should be studied to confirm, on an individual event basis, the statistical result of pulsation orientation about local noon; *i. e.*, statistically it has been observed that the ellipses for conjugate events have their major axis in the northwest direction before local noon and in the northeast direction after local noon.

2) Data should be obtained from a dual pair of conjugate stations spaced in latitude about the nominal plasmapause location in order to investigate, simultaneously, the character of Pc-3 and Pc-4 pulsations, particulary if one of the frequencies typically appear outside the plasmapause and the other inside. Studies should be made of amplitude, spectral characteristics, and sense of polarisation of both frequency bands. It is highly likely that one frequency may predominantly appear outside the plasmapause.

WG-2 Radar and Optical Aurora

Reporter: T. N. DAVIS

1. All-Sky Cameras—as many stations as is feasible should be operated during all dark hours with image rate at least 1/min and preferably 2/min. Essentially each manned station on the continent should operate a camera.

2. All-Sky (OR Large Field) TV—should be operated at Syowa during rocket launches, balloon flights and satellite passes.

3. Specific Investigations—among specific studies to be emphasized utilizing various instruments (*i. e.*, radar, photometeric, etc.) are

a) Statistical conjugacy—especially between Syowa and Iceland.
b) Coordinated conjugate aircraft flights.
c) Observation and location of cusp phenomena.
d) Participation in active experiments.

WG-3 VLF and Whistler

Reporter: R. A. HELLIWELL

1. VLF network in Antarctica for IMS

The U. S. can make a unique contribution to the IMS by monitoring the

density and drift of magnetospheric plasma using whistlers detected in the Antarctic. These measurements will play a major role in inferring the large scale convection patterns in the magnetosphere. A network of 6 stations, clustered around Siple Station, is recommended, in order to take advantage of the high rate of occurrence of nose whistlers in that area. The basic VLF data needed for such studies are the dispersion of whistlers and the angle-of-arrival of the whistlers.

The VLF stations should be spaced no more than 1000 km apart. For proper longitude coverage a chain of 5 stations along $L=4$ is recommended. Possible locations for the instruments are Sanae (SA), Hally Bay (UK), General Belgrano (Argent.), Siple (U.S.A.) and a new automatic station (U.S.A.) to the west of Siple. For latitude coverage, one additional station at Palmer is needed.

Each of the 6 stations would include a VLF goniometer and VLF spectrum recorder. Stations other than Siple or Palmer would be either manned or unmanned, depending on relative costs.

Supporting instruments at the stations would include photometers, a riometer, a magnetic pulsation system and a magnetometer. Manned ionosondes are required at Siple and Palmer in order to monitor wave-induced precipitation and effects and changes in the F-region associated with $\bar{E}$ and $\bar{B}$ drift. An important experiment related to these measurements is the wave-particle work centered around the Siple VLF wave-injection transmitter and the associated balloon and (planned) rocket-borne particle detectors.

2. *Resolution prepared by W. G. 3 of Committee on Antarctic Research*

IAGA notes that the coming IMS requires a network of whistler ground stations in Antarctica near $L=4$ for the purpose of monitoring the density and drift of magnetospheric plasma. Therefor IAGA recommends to SCAR that its member nations undertake to establish new stations and upgrade existing stations so as to provide the required coverage. For proper longitude coverage a chain of 5 stations along $L=4$ is suggested. The present stations at Sanae, Halley Bay, General Belgrano and Siple are suitable for this purpose. To complete this chain along $L=4$, a new station to the west of Siple on the Antarctic Coast should be established. For latitude coverage the present stations at Siple and Argentine Is. are sufficient.

WG-4 Ionospheres and CNA

Reporter: J. W. KING

1. *The effects of directly injected or precipitated energetic particles on the atmosphere and the ionosphere*

It is already known that energetic particles penetrating through the magnetospheric cleft region produce large effects in the ionosphere at times around local magnetic noon and that particles precipitated from the radiation belts are associated with various ionospheric phenomena. The details of the ionosphere-magnetosphere interaction processes are not yet known, however. Also, the manner in

which, or the extent to which, energetic particles affect the lower (meteorological) atmosphere is at present unknown; evidence is now becoming available, however, which suggests strong coupling between the solar wind and the weather. It is known that geomagnetic activity is associated with changes in the troposphere, the stratosphere, the mesosphere and the thermosphere, and it has been suggested that the composition of the upper atmosphere, and hence the amount of ionization present, is dependent on the flux of energetic particles.

Since the phenomena of particle penetration involve the geomagnetic field (which guides the particles to the near-earth environment) it can be studied with particular effort in Antarctica where the geographic and geomagnetic poles are widely separated.

In order to study the problems referred to above, measurements of particle fluxes and atmospheric composition must be made at the same time as a range of ground-based ionospheric, optical and meteorological experiments are carried out.

2. *The heat input to the auroral zones*

Although it is known that the energy input to the upper atmosphere at high latitudes is enhanced during magnetically disturbed conditions, the cause of these enhancements is not known. The relative importance of atmospheric waves, electric currents, energetic particles and other forms of heating is not clear.

The heat input to the upper atmosphere at high latitudes is an important problem (partly because the effects of auroral zone heating spread to the atmosphere and the ionosphere at lower latitudes and lower altitudes) which requires investigation. The Arctic and Antarctic regions are the only ones where the relevant measurements can be made but, because of the separation of the geographic and magnetic poles, those from Antarctica will be particularly interesting.

The following types of experiment need to be carried out simultaneously:

(a) Satellite measurements of particle fluxes and also (to study Joule heating) of electric fields.

(b) Temperature changes measured from the ground by, for example, Doppler broadening of the 6300 Å line or by laser techniques.

(c) The ionospheric structure prevailing during heating events; data from the Antarctic ionosonde network and from topside sounder satellites operating over Antarctica will be particularly valuable.

3. *Dynamic phenomena*

The morphology of the thermospheric winds which blow over Antarctica, and which lead to the well-known ionospheric "Universal Time effect", has not yet been established. The relative importance of the different possible causes (*e. g.*, thermospheric pressure gradients or electrodynamical effects) of these winds is not known. Atmospheric winds from, and waves generated in, high latitude regions affect the global energy and momentum balance. Winds are accompanied by (a) vertical motions (required for continuity) and (b) return flows at lower heights. These result in major effects on, respectively, the thermal balance of the atmosphere and the atmospheric composition. It is important, therefore, to gain

some understanding of the dynamical processes prevailing at high latitudes.

The experiments which need to be carried out include observations of winds and waves by all possible techniques. Winds can be measured by observing the Doppler shift of the 5577 Å or the 6300 Å emissions and waves can be studied using the H. F. Doppler, total electron content, ionosonde or meteor drift techniques.

4. Co-ordination with the Atmospheric Explorer (AE) satellites

The United States AE-D satellite will be launched into a 98°-inclination orbit during 1975 and, since it will carry a comprehensive payload designed to investigate a very wide range of aeronomical problems (including the composition, structure and dynamics of the region above 120 km), attempts should be made urgently by Antarctic ground-based experimenters to coordinate their observations with those made by the satellite. The Atmospheric Explorer Project Scientist (Mr. N. W. SPENCER, Code 620, Goddard Space Flight Center, NASA, Greenbelt, Maryland 20771, U. S. A.) would welcome enquiries from interested ground-based experimenters.

5. Other magnetosphere-ionosphere interactions

During the International Magnetosphere Sutdy (1976–1978), major investigations of all aspects of magnetosphere-ionosphere coupling will be made on a coordinated global scale; some of the problems referred to above will naturally constitute part of the IMS. In addition, however, other investigations (see STP Notes) will be carried out and certatin ionospheric experiments (such as riometers) operating in Antarctica will provide data which constitute a particularly valuable part of the IMS effort.

WG-5 Rocket and Satellite

Reporters: S. PERRAUT and T. OGUTI

1. At first, we must establish the coordination between ground measurements in Antarctica and observations on board satellites during the IMS, especially in order to make good simultaneous measurements of waves and particles on ground and in space.

As a first step we shall give the duties of this working group.

1) We must prepare a list of the observations which were made at different stations in Antarctica and which will be continued during the IMS period. We have to prepare also a list of the scientists who are responsible for these experiments.

2) A more important task of this working group is to send to the scientists defined above a brief description of the equipments and the experiments on board the main geophysical satellites. After that, the scientists who are responsible from the ground experiments and are interested in some spatial experiment must keep in contact with the W. G. The W. G. should also take the initiative in coordinating the specific campaign which will be proposed by the scientists.

3) Calculations predicting the satellite crossings above ground stations are expected to be available during the IMS through the Satellite Situation Center,

led by Dr. SUGIURA. We think, in agreement with Dr. SUGIURA, that it will be better that all the requests for satellite predictions be collected by this W. G. and then be distributed to the interested observers.

4) For coordination of the ground experiments and the ground-satellite experiments an improvement of the present telecommunication system in Antarctica is required. In particular, some experiments will need rapid exchange of information between the observatories and launching bases in Antarctica and the Telecommand Centers of the satellites. In order to accelerate the improvement, this W. G. will have to know the necessities of the experimenters, and discuss them with the telecommunication section of SCAR.

5) Within the Antarctic Research Committee some cooperative arrangements can be made between satellite observers and balloons or rockets experimenters as well.

6) A specific-cooperative program has been already started between some experimenters of the European Geostationary satellite GEOS and the Japanese scientists working at Syowa Station.

2. Considering the importance of the research on the auroral particles, in conjunction with their origin and/or the mechanism of their production, the importance of the research on the chemical problems in connection with the energy flow in aurora, and the consequent importance of the well-organized rocket experiments for the direct measurement of physical quantities in aurora, it is highly desirable that Committee on Antarctic Research, IAGA, recommends to each participating government that a strong support is given to the well-organized rocket experiments in the Antarctic region during the IMS.

WG-5, considering that the rocket experiment should be carried out in close cooperation with the ground-based observation network and balloon and satellite experiments, laying a special emphasis on the conjugate experiments during the IMS, proposes that a geostationary satellite, GEOS of ESRO, will be in operation during the IMS, just on and near the conjugate magnetic field line of Syowa-Reykjavik pair stations.

WG-6 Balloons

Reporter: T. J. ROSENBERG

Two programs should be considered for the IMS period.

1) Recognizing the favorable situation of stations near the plasmapause in the southern hemisphere (*e. g.*, Siple, Campbell, Sanae, Kerguelen, Halley Bay and others that may be operated during IMS) it is suggested that balloon programs be coordinated from several sites to study electron precipitation as measured by bremsstrahlung X-rays. Simultaneous measurements from several locations can examine the extent in longitude of wave-particle interactions associated with the plasmapause. Electric field and VLF measurements from balloons should also be considered. It will be vital to the interpretation of data to have simultaneous

VLF emission and micropulsation recordings available at the balloon launch sites and where possible, at the conjugate points. If feasible, balloon launches from conjugate $L=4$ stations should be attempted.

It is recommended that initiatives be undertaken immediately to contact the appropriate individuals or organizations concerned with antarctic research at the above-named sites in order to a) determine interest, b) difine a workable program (probably limited to austral summer), and c) outline potential logistical difficulties.

2) The use of superpressure balloons to obtain extremely long-duration flights at 10 mb and above from South Pole Station should be considered to study transient hard electron precipitation events possibly associated with the dayside polar cusp. The occurrence of such events has been suggested by riometer data, but energy spectra and the presence of rapid time structure can be obtained form balloon X-ray measurements. A single flight, powered by solar panels, should last for several weeks and remain essentially over South Pole in the austral summer.

A third program that also deserves serious attention in connection with the IMS, is a conjugate program of X-ray measurements from the Japanese auroral-zone base at Syowa and several balloons operating simultaneously in the vicinity of the projected conjugate point near Reykjavik. H. TREFALL has outlined some possible plans for multiple balloon launchings from Scandinavia coordinated with the GEOS satellite. If efforts are successful in having the satellite placed for some time in the vicinity of the Syowa-Raykjavik field line, conjugate X-ray measurements could provide detailed coverage at the ionospheric projections of the satellite field line, to facilitate comparison of fast time variations in electron precipitation with particle flux variations and plasma phenomena at the geomagnetic equator.