CSAGI - MOSCOW, AUGUST, 1958

(Extract from report of attendance of W.J.Gibbs at the Fifth Assembly of the Special Committee for the International Geophysical Year Moscow 1958)

The Fifth Assembly of the Special Committee for the International Geophysical Year was held at Moscow 30 July to 9 August 1958. It was attended by the Assistant Director (Research), Bureau of Meteorology, Mr. W.J.Gibbs.

At meetings of the CSAGI symposia, papers were presented covering different fields in meteorology, including those of Numerical Forecasting and Antarctic Meteorology.

1. SYMPOSIUM ON NUMERICAL FORECASTING

Contributors to the Symposium on Numerical Forecasting were Sutton, Wexler, Pone, Obukhov and Monin, and Schumann.

In presenting his paper Sutton stated that the U.K. Meteorological Office had conducted research in numerical prediction for 10 years. The machines used were too slow for operational use but were quite suitable for research purposes. A faster machine (Ferranti-Mercury) will soon be delivered to the Meteorological Office. Thirty synoptic situations have been treated and the prognostic accuracy has been at least equal to that of the forecaster. Objective analysis has been done by the machine with radiosonde data being fed direct from teletype to the automatic computer. Sutton stated that he believed that objective machine analysis may be as important as numerical prediction. Experiment has shown that the stratosphere has little effect on flow patterns at lower levels. Sutton stated that the use of the method of finite differences has been responsible for about one third of the error in numerical prediction. In the future, the Sawyer-Bushby two parameter model (contour height and contour thickness) will be used as in the past. Also as in the past allowance will be made for non-adiabatic heat transfers. The new machine will be able to produce a thirtysix hour forecast taking five minutes for solution of the equations.

In presenting his paper Wexler stated that since April no maps had been analysed by hand in the U.S. numerical prediction unit. The data is fed from the teletype machine to a punch card converter and then to the computer. Data can be printed out on a chart by the machine or an objective analysis may be printed out but normally these two steps are not included as routine. In speaking of numerical methods of five day forecasting Wexler referred to a paper by Namias in the April 1957 issue of the transactions of the New York Academy of Science. He stated that forecasts were made at zero day for the period D + 2 to D + 7. A five day mean 500 mb chart centred on zero day is constructed three days of which are observed and two days taken from the short period numerical weather prediction. A prediction is attempted for the period D + 2 to D + 7. It appears that in the case of five day forecasting the automatic computer is used mainly as a statistical rather than a dynamical tool.

A paper by Pone on numerical forecasting was delivered in French the main points of which appeared to be that the new French computer will commence operation in 1959 and that it is anticipated that operational numerical forecasting will be done from that date.

2. SYMPOSIUM ON ANTARCTIC METEOROLOGY

Papers in the Symposium on Antarctic Meteorology were presented by Gibbs (Australia), Wexler (U.S.A.) and Krichak (USSR). Abstracts of these papers follow:

(a) Some Problems Associated with the Synoptic Meteorology of the Southern Ocean and Antarctica

by W.J.Gibbs

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Australian meteorologists are vitally interested in the atmospheric processes over the Indian, Pacific and Southern Oceans. This interest is illustrated in papers by Ball, Clarke, Garriock, Gibbs, Gotley, Langford, Lloyd, Martin and Troup in Australian Meteorological Magazine, ANARE Reports and the Quarterly Journal of the Royal Meteorological Society.

Before 1948 when there were no meteorological stations in the South Indian or Southern Oceans the synoptic processes in these areas were imperfectly understood. There are still vast ocean areas with no observing stations, but the few that are operating have given a general idea of the nature of synoptic systems over the Southern Ocean and the way they behave.

It appears reasonably certain that the major cyclones follow preferred paths, although there is considerable uncertainty about the area to the south of Australia.

The origin of these cyclones is also somewhat obscure as is the question of frontal analyses over these areas. Because of the small amount of data available it is unwise to form inflexible views regarding frontal analysis. My personal views are that the major axis of the pressure trough associated with the vigorous southern cyclones is not necessarily co-incident with frontal zones. This view could be elaborated to include the proposition that the major cyclones are not necessarily "frontal" cyclones.

It has been suggested that there is a fundamental difference between the northern and southern hemisphere in the frequency of occurrence and pattern of distribution of cyclones and anticyclones. There is some evidence to suggest that the intense high latitude anticyclones of the northern hemisphere are rarely found in corresponding southern latitudes.

The role of the Antarctic Continent in southern hemisphere atmospheric processes is a difficult question. It is complicated by the fact that over the Antarctic is a relatively thin skin of particularly cold air which appears to develop its own circulation, to some extent independently of the air above it. This problem requires a new approach from the point of view of synoptic analysis. The circulations in the upper air over Antarctica are becoming fairly well known but the extent to which they affect, or are affected by, synoptic systems at lower latitudes is not known.

A problem of considerable interest to Australian meteorologists concerns the mechanisms producing outbreaks of cold air over Australia. My view is that it is necessary for the air to be rapidly transported from the Antarctic Continent in order for the outbreaks to occur. Other meteorologists have differing views. Associated with this problem is the question of the basic factors involved in the production of cold outbreaks over Australia. Is the "trigger" mechanism in the Antarctic or over the Southern Ocean or elsewhere?

(b) Seasonal and Secular Temperature Changes in Antarctica

by H. Wexler

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The annual variation of temperature in Antarctica has interesting properties; it is largest in the stratosphere (50° to 60°C) smaller at the surface (20° to 40°C) and smallest in the troposphere (10°C). During the winter night the troposphere temperature decreases only slightly while the stratosphere temperature drops steadily at about 1/4°C per day. This differential cooling, which weakens and at times wipes out the tropopause, is caused, on the one hand, by intense horizontal advection of maritime air into the Antarctic troposphere but, on the other hand, by very little advection through the strong stratospheric jet-stream encircling Antarctica.

This ventilation of the Antarctic troposphere by warmer marine air causes large portions of Antarctica to exhibit the "Kernlose" annual temperature curve instead of the sharp winter minimum usually found in polar continental climate. However, in the Weddell Sea region the 1957 winter was of the continental type while the 1955 and 1956 winters were of the "Kernlose" type, a change probably connected with large changes in circulation.

The Antarctic and Arctic stratospheres exhibit quite different temperature behaviours following the winter solstice. The Antarctic stratosphere continues to cool until the sun returns and then warms as much as 50°C in one month. On the other hand, the Arctic stratosphere exhibits a warming of 30° to 40°C, sometimes beginning six weeks before the sun returns.

A secular trend of temperature since 1912 of 5°F at Little America (78° 12' S, 162° 15' W) compares with a 13°F trend at Spitsbergen (78° 04' N, 13° 38' E).

Finally, temperature and outgoing radiation observations made at the South Pole IGY station during the cold period of April 19-24, 1958 are presented to illustrate quantitatively the important effect of cloud radiation on surface air temperature and its vertical gradient.

(c) The Characteristic Features of the Atmospheric Circulation over Antarctic and their relationship with the Processes in the Southern Hemisphere

by O.G.Krichak

(Member of Soviet Expedition to Antarctica)

The studies of the atmosphere carried out by the Second Soviet Continental Antarctic Expedition on the data obtained during the winter of 1957, at first time were based on the observational data of such a good network of stations that many aspects of atmospheric circulation which recently were the subject of our conjectures became sufficiently distinct. The main problems which so far could not be solved were: the role of meridional processes which were previously observed but did not seem significant for explaining the influx of moisture to the Antarctic Continent which gives away a lot of ice in the form of icebergs.

The earlier aerological data for the coastal region were so sparse and incomplete that they did not give us the opportunity to determine the height of the Antarctic anticyclone. Some scientists considered till nowadays that the atmosphere over the Antarctic was isolated from the rest of the hemisphere by the west "wind barrier".

The well-known phenomenon of katabatic glacial winds of the coastal zone was already characterized by aerological data obtained at the coast but spatial characteristics of this process became clear only on the basis of the recent inland and coastal aerological observations. Our knowledge of the Antarctic tropopause and stratosphere became systematic and were essentially increased just before and during the IGY.

The work of the Second Soviet Continental Antarctic Expedition showed a great and specific role of the Antarctic geographical peculiarities in the atmospheric processes over this Continent and near it as well as the considerable part of the southern hemisphere.

Surface and upper air composite synoptic charts for all centres and axes of pressure systems and trajectories prepared for each month of 1957 convincingly show that (1) the lower layer anticyclonic centres are regularly located over the eastern Antarctic, mainly in the region of the pole of the relative inaccessibility, (2) the wedges protruding from this anticyclone are found and situated as a rule in the quite definite regions- i.e. in the longitudes where the prominent parts of this Continent are situated (3) the cyclones observed over the Antarctic seas are mainly quasi-stationary and situated between the abovementioned wedges usually over the southern extensions of the Antarctic seas.

Our hypothesis is that the great orographical branches of the Antarctic glacier exert a double effect on the atmosphere. These branches block the way to the air currents and as cooling producing factors. This stimulates the formation of the pressure wedges which intensify as the Antarctic anticyclone approaches this region.

Such strictly localized pressure wedges are formed above the glacier branches, the height of which is 2 or more kilometres and that is why they act as upper pressure systems and block the cyclone movement over the seas. When the cyclone movement is retarded the warm air appears over the Continent and intensifies the upper ridge. As a result the zonal circulation is disturbed and meridional processes develop. Thus, geographical features of the Antarctic Continent produce six climatic ridge zones and six cyclonic zones.

The central parts of ridge zones lie at the longitudes 0°, 50°, 95°, 135° and 160°E and 90°W. The cyclone zones are situated over the Antarctic seas, namely over the Weddell sea, eastern part of Queen Maud Land, Mackenzie Sea, Knox Coast, George V Land and Ross Sea.

In some cases Antarctic ridges join the subtropical anticyclone wedges so that the development of meridional processes reaches its maximum.

Antarctica is a high cold Continent and Antarctic anticyclones are also high and reach the level of 300 mb or more. The availability of strong cyclones around the Continent also favours this situation. At high levels this anticyclone is also situated over the eastern Antarctic - the greatest and the highest part of the Continent. That is why the circum-Antarctic upper air cyclones are replaced to the north in the Atlantic-Indian sector where they are drawn nearer to the upper air subtropical anticyclones. The steepest pressure gradients form in this sector and therefore the jet streams develop corresponding to the position of the upper frontal zone and strong cyclonic activity. The jet streams make the cyclone move at high velocity. It appears that such is the nature of "roaring" forties-fifties latitudes.

During meridional processes the jet streams become curved and appear over the Antarctic Continent sometimes extending to the pole. In this case the strong warm air currents turn to the high latitudes. There is no doubt that the cyclones together with such currents enter the Antarctic Continent.

Thus, meridional processes constitute a very important feature of the atmospheric circulation near the Antarctic as well as over the considerable part of the southern hemisphere; at high latitudes the quasi-stationary cyclones in abovementioned areas are observed more often than zonally moving ones. It means that the inter-latitudinal air exchange over the southern hemisphere as well as at high latitudes is very extensive and the Antarctic atmosphere is by no means isolated from the rest of the hemisphere. The influx of moisture compensating the losses of Antarctic ice in the form of icebergs is mainly due to the meridional processes.

Aerological coastal observations show that there are stratospheric jet streams in winter apparently produced by the great temperature contrast formed "at the boundary of polar night" between the very cold stratosphere over the Continent and comparatively warm stratosphere lighted up by the sun over the Antarctic seas.

The soundings data and more than 40 special aircraft flights over the land and sea performed during 1957 has given us a good picture of spatial temperature field explaining the nature of katabatic glacial winds always followed by a pronounced temperature inversion in the lower layer.

It is of interest to note the relationship between the atmospheric circulation and ice conditions in the Antarctic seas. Thus, the presence of climatic cyclone and ridge zones must result in a stable wind system in the lower layers. This wind system determines the location of floating ice and the width of the ice belt around Continent. Naturally in the eastern parts of cyclonic zones the ice must be at the shortest distance from the Continent and at the largest distance in the western part of this cyclonic zone. If at the shortest distance from the Continent the ice may be very packed. The aircraft observations of ice conditions over Davis Sea for two years confirm this assertion.

Our data are in contradiction with the statement which is well known in literature about the correspondence of cyclone trajectory position to the external ice edge. On the contrary winter cyclones occur nearer to the Continent while comparing with the summer ones. That is more connected with the Antarctic anticyclone regime.

A great number of well organized actinometric observations including the aircraft observations permit to obtain new data about the radiation balance components near the ground as well as in the layer from 4 to 5 km. On the basis of this analysis V.Shlakhov obtained the values for possible minimum air temperature at the ground. Meanwhile these calculations are being confirmed by the inland stations observations.