DISTRIBUTION OF AURORAS IN THE SOUTHERN HEMISPHERE*

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Several attempts to delineate the southern zone of maximum frequency of visibility of auroras have led to widely discrepant results. That of White and Geddes (1939) suffered through lack of observations ; that of Vestine and Snyder (1945) was based on observed relations between morphology of geomagnetic disturbance and auroras in the northern hemisphere, and application to the southern hemisphere using very limited geomagnetic data. It may be, too, that the distribution of auroras changes slowly with solar activity.

The data obtained in Antarctica during the International Geophysical Year 1957–58 offer the possibility of a new study of the geographic distribution of auroras around the epoch of solar activity maximum. To be entirely satisfactory this study must take into account a number of factors not yet considered even in relation to the now extensive body of northern hemisphere data. The geographic distribution is different for different auroral forms ; there is a marked diurnal variation in latitude and a strong dependence of latitude on level of world-wide magnetic disturbance (Jacka 1953). It is also desirable that the distribution of auroras be specified with a resolution in latitude much less than the width of the curve of frequency of occurrence versus latitude.

As a first step in such a study I.G.Y. data from the Australian National Antarctic Research Expeditions' (ANARE) stations Mawson and Macquarie Island have been used to make a tentative estimate of the location of the isoaurore of maximum frequency of occurrence of auroras with discernible lower borders.

From measured angles of elevation and azimuth to points on the auroral lower borders, assumed at a constant height of 105 km, the positions of all auroras were plotted on synoptic maps at 15 minute intervals. From these maps the frequency of occurrence versus geomagnetic latitude was determined on a number of geomagnetic meridians. The frequency distributions all have a mode within a few degrees of the observer's latitude. Because some faint auroras observable overhead may not be observable at lower elevations it is possible that the observed modal latitude is shifted a little towards the observer's latitude. We have therefore taken as our estimate of the latitude of the mode, the mid point of the range in which the frequency exceeds 2/3 the maximum observed frequency. These estimated positions are marked by crosses in Figure 1.

These data are very meagre, so we tentatively introduce the hypothesis that the isoaurores are symmetrical about the geomagnetic meridian through the magnetic dip pole. Guided by the Mawson and Macquarie Island data and

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this hypothesis the full line curve on Figure 1 was drawn as a tentative representation of the isoaurore of maximum frequency of occurrence of auroras with discernible lower borders.

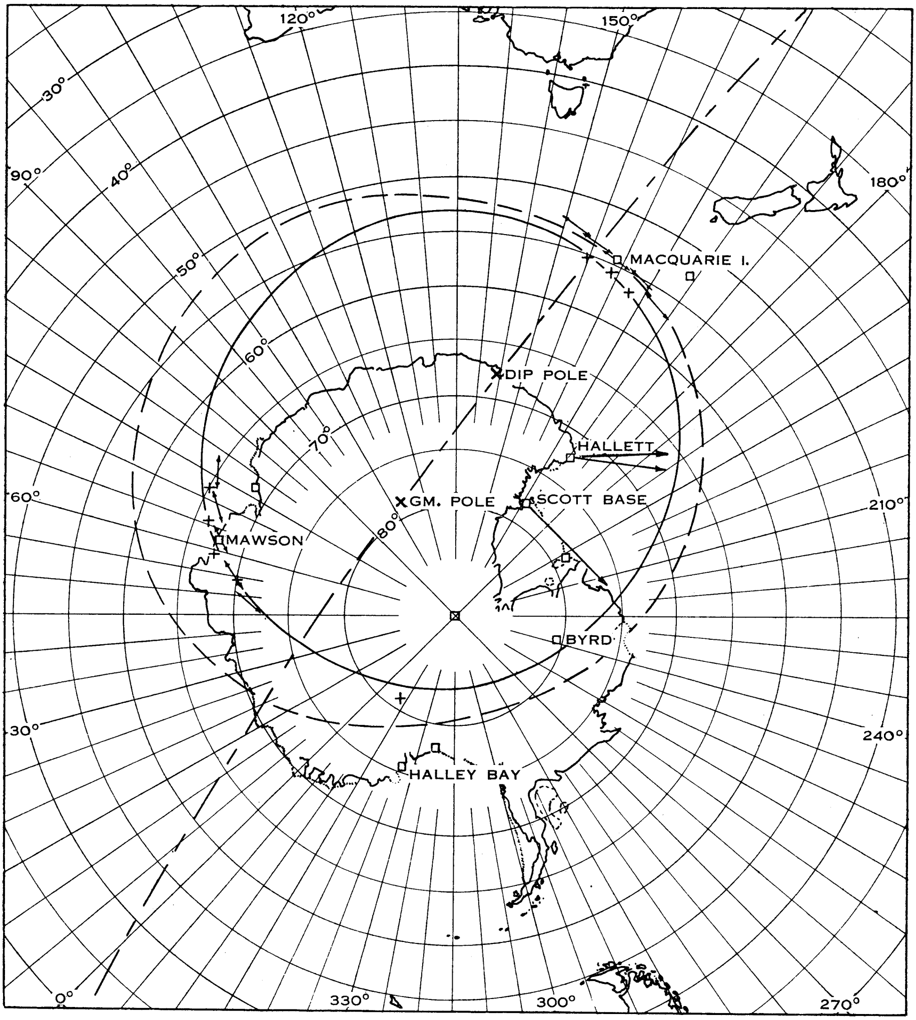

Fig. 1.—Full line curve : estimate of the isoaurore of maximum frequency of occurrence of auroras with discernible lower borders based on observed positions denoted by crosses in the regions of Macquarie Island and Mawson and assuming symmetry about the geomagnetic meridian through the dip pole. Dashed curve : Hultqvist's projection from 5·6 Earth radii in the geomagnetic equatorial plane.

The cross near geographic longitude 345° E. indicates the position of most frequent occurrence of auroral arcs estimated from the data summarized by Evans and Thomas (1959) for Halley Bay. This point is in reasonable agreement with our curve.

If Figure 1 is not grossly in error, there is one other I.G.Y. station (Byrd) from which the maximum frequency isoaurore should be observed at high elevation and several (marked by squares on Figure 1) from which it might be observed at low elevation and consequently low reliability.

The synoptic maps also permit the measurement of orientation of auroras relative to the meridians. The orientation angles show a small diurnal variation but the frequency distribution of angles is fairly narrow and roughly symmetrical. The mean orientations of arcs and simply shaped bands on a number of meridians near Mawson and Macquarie Island are indicated by short double-ended arrows on Figure 1. These are approximately parallel with the estimated isoaurore. We expect then that the mean value of azimuth (taking values 180° apart as equivalent) to the nearest (greatest elevation) point of arcs is perpendicular to the isoaurores. Two such azimuths (from data of Hatherton and Salmon (1959)) are indicated by arrows from Scott Base and Hallett in Figure 1. Agreement with our estimated isoaurore is reasonable.

In the region well inside the maximum frequency isoaurore, even the general form of the geographical distribution of auroras is uncertain. There is, however, mounting evidence for the existence of an inner zone of maximum frequency.

At this stage it is perhaps desirable to seek some correspondence with northern hemisphere data. Hultqvist (1958, 1959) has shown that projections from circles in the geomagnetic equatorial plane, along the actual magnetic field lines, onto the Earth's surface, produce oval curves which very closely parallel the auroral isochasms in the northern hemisphere. Using Hultqvist's data, we find that a circle of 5·6 Earth radii projects onto the dashed curve in Figure 1. The discrepancy between the curve and our maximum frequency isoaurore is so great as to cast doubts on the soundness of this approach to the problem of revealing a correspondence between the two hemispheres. On the other hand, Hultqvist's projections are based on geomagnetic field data of epoch 1945 which were very scanty in high latitudes, especially in the southern hemisphere.

The authors are now seeking data from other antarctic stations to enable more comprehensive study of the distribution and morphology of auroras in the southern hemisphere.

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