Discussion

Shapley, A.H.: It should be noted that PCA events which are classified as large by one technique may be small as seen by another, and vice-versa. There are many examples of this when one compares your "forwardscatter" list with the one compiled by Piggott and myself from southerh hemisphere f_{min} data. Isn't this because the techniques are effectively sensitive to increased ionizations at different levels, f_{min} relatively high and forward scatter relatively low?

Bailey, D. K: The answer to your question is "yes" as I described. In my list PCA's are classified according to the magnitude of the absorption observed at VHF at oblique incidence, and at levels below the scattering stratum.

Shapley, A.H.: The list of IGY PCA events by Piggott and myself from Antarctic f_{min} data was included in a paper given last month at the Pacific Science Congress. One looks forward to the possibility of intercomparing the various lists of events.

Piggott, W.R.: Mr. Chairman. If practical, it would be very helpful to us all to include Dr. Bailey's list of PCA events in the Proceedings of this Conference. Such lists are invaluable for further work.

Bailey, D. K.: If the conference proceedings can accomodate the extra material I should be happy to supply the list.

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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part I

I-2-6. Some Auroral Zone Disturbances at Times of Magnetic Micropulsation Storms

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Studies of magnetic field fluctuations coincident with auroral luminosity pulsations (J.G.R., Jan., 1961), with riometer absorption (J.G.R., Jan., 1961) and with electron bremsstrahlung (J.G.R., Oct., 1961) have been reported. There is strong evidence, therefore, that 5 to 30 sec period pulsations of the earth's magnetic field arise in the auroral zone at times of the precipitation of electrons into the ionosphere. It is the purpose of this paper to report some further investigations with this same point of view. The measurements to be described were taken near College, Alaska, between September, 1959, and September, 1960, using a two meter diameter loop antenna of 21,586 turns (J.G.R., Nov., 1959). A more complete report on this work will appear soon in the scientific literature.

First, we will discuss some studies in which standard magnetometer (magnetograms) and ionospheric sounder data (f-plots) were utilized. From the one year's records of 5 to 30 sec period micropulsation activity it was possible to select 31 occasions on which the field amplitudes increased rapidly on the record, clearly defining a "micropulsation storm" onset. Magnetograms and ionospheric f-plots were scaled during these times (Fig. 1). Most of the storms occurred near the midnight hours. The average behavior of the micropulsations shows a maximum in the first five minutes after the commencement and a decay at a rate of apx. 2.5 gamma per hour (Fig. 2). A measure of the percentage electron density increase over the monthly average value, evidenced by the f_{min} values, was obtained for the storm times and is shown in Fig. 3. Although only 15 min. data samples were available in this case a clear indication that the maximum occurs 30 to 60 min. following the micropulsation

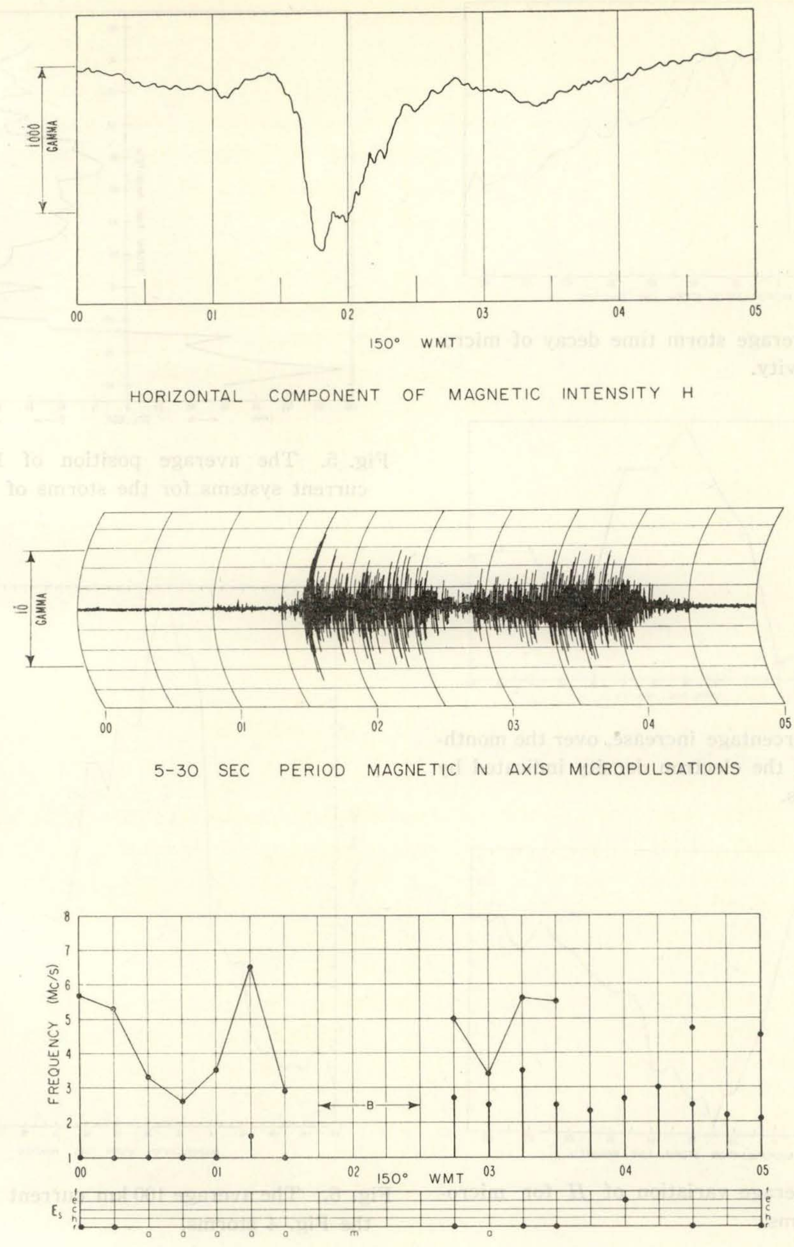

Fig. 1. An example of the data used for the first study.

storm onset is seen. For every micropulsation storm selected a negative bay-like disturbance was observed on the magnetograms; about half of these were later found to be magnetic storms. (In the auroral zone, where most of the disturbance field changes are of ionospheric origin, the difficulty of identification is understandable). In Fig. 4 the average variation of the horizontal field, as measured with the magnetometer, shows a maximum departure some 20 to 40 minutes following the storm onset. Assuming a 100 km height for an E-W auroral current system the magnetometer records were used to determine the average position (Fig. 5) and current intensity (assuming a line source).

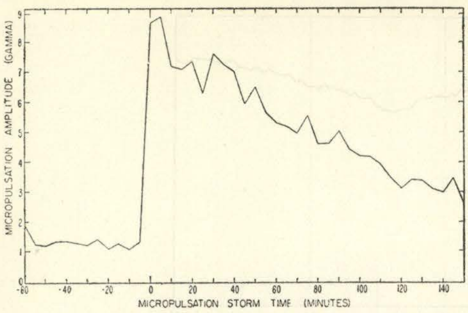

Fig. 2. The average storm time decay of micropulsation activity.

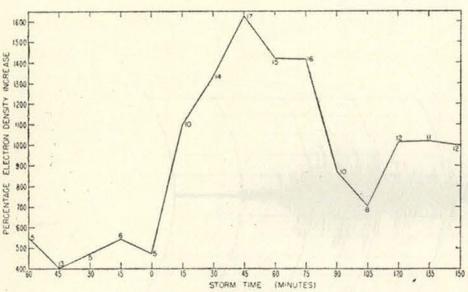

Fig. 3. The percentage increase, over the monthly average, of the electron density indicated by by f_{min} values.

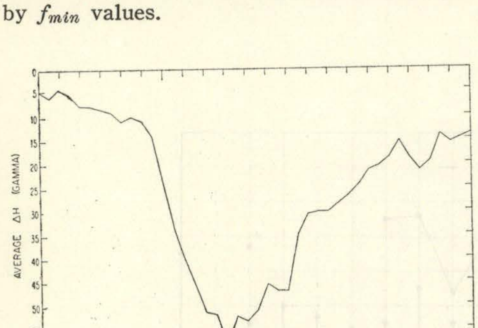

Fig. 4. The average variation of H for micropulsation storms.

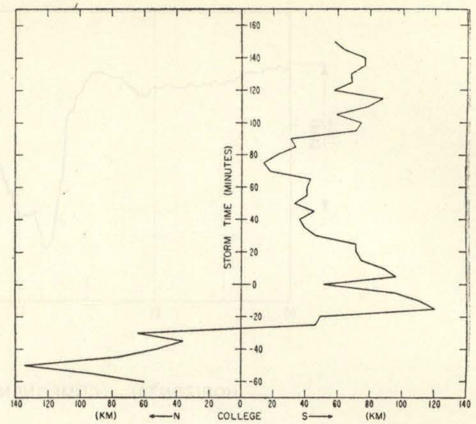

Fig. 5. The average position of 100 km gross current systems for the storms of Fig. 4.

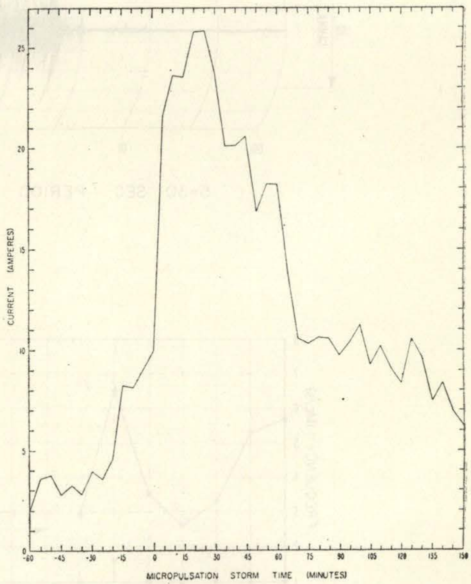

Fig. 6. The average 100 km current intensity for the Fig. 4 storms.

Our picture of the average event is now this one: the current system measured by the magnetometer is small and to the north of College preceding the storm and moves slowly southward. At the commencement of the storm the current amplitude as measurd at College increases rapidly and extends northward. With this rapid increase the maximum intensity of micropulsation activity is obtained. When the current intensity has become quite large and has extended overhead then the maximum electron density increases are indicated.

Following a data search request by R. R. Brown it had been found that there was an increase of micropulsation activity during an enhancement of electron bremsstrahlung indicated by X-ray detectors flown in balloons above College (Campbell, AGU meeting, Washington D.C. April, 1961). A unique storm starting at about 0150 on June 28, 1960, was investigated. The micropulsation and magnetometer records showed a commencement about one minute before the riometer absorp-

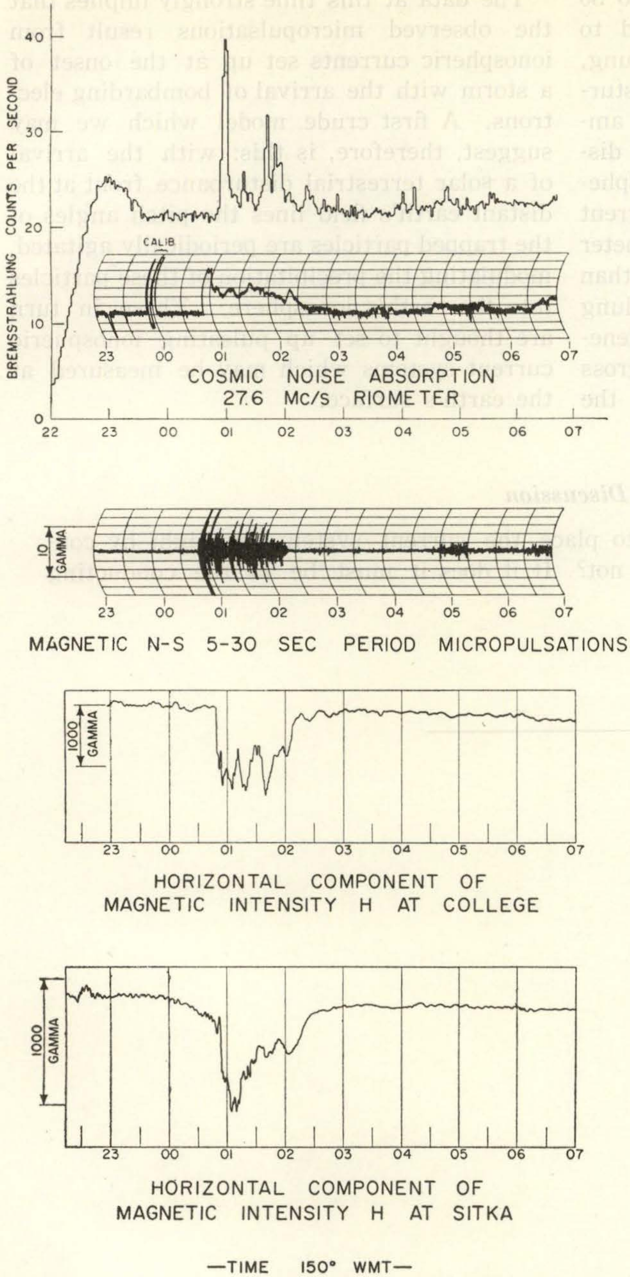

Fig. 7. Sharp commencing storm of June 28, 1960.

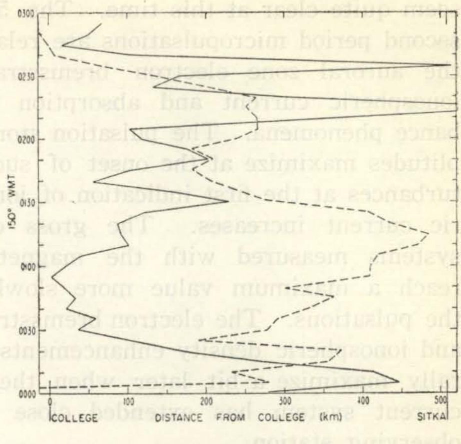

Fig. 8. Apparent position of gross current element at 100 km as seen from College (—) and Sitka (---) during June 28, 1960 storm.

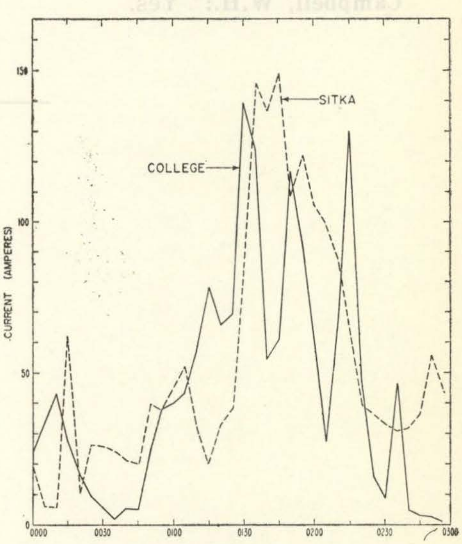

Fig. 9. Apparent current intensity for Fig. 8.

tion or bremsstrahlung count first indications (Fig. 7). Assuming a 100 km current height and a magnetic E-W direction the apparent position of the current element as seen from College and Sitka (projected on a magnetic N-S plane) was determined (Fig. 8). The current element intensity was evaluated (Fig. 9). In this specific example it appears that the storm "started" between College and Sitka spreading both north- and southward rapidly as the current intensity increased and the micropulsations reached their maximum amplitude. The bremsstrahlung and ionospheric absorption appeared moments later when the current intensity was quite high and had extended close to the observing station.

We may enumerate these things which

seem quite clear at this time. The 5 to 30 second period micropulsations are related to the auroral zone electron bremsstrahlung, ionospheric current and absorption disturbance phenomena. The pulsation storm amplitudes maximize at the onset of such disturbances at the first indication of ionospheric current increases. The gross current systems measured with the magnetometer reach a maximum value more slowly than the pulsations. The electron bremsstrahlung and ionospheric density enhancements generally maximize a bit later when the gross current system has extended close to the observing station.

The data at this time strongly implies that the observed micropulsations result from ionospheric currents set up at the onset of a storm with the arrival of bombarding electrons. A first crude model which we may suggest, therefore, is this: with the arrival of a solar terrestrial disturbance front at the distant earth's field lines the pitch angles of the trapped particles are periodically agitated, modulating the precipitation of these particles into the earth's ionosphere. These in turn are thought to set up pulsating ionospheric current systems which may be measured at the earth's surface.

Discussion

Martyn, D. F.: Is it not possible to place the current system in height by considering whether it shows a "jet" or not? If it does it must be in the conducting foot of the ionosphere.

Campbell, W.H.: Yes.