A Relationship between Riometer Absorption Events Observed at Different Latitudes near the Auroral Oval

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Abstract

The possibility that particle precipitation in the auroral oval may in some way be connected with particle precipitation at lower latitudes inside the trapping region is investigated by making use of riometer absorption events observed at different latitudes near the auroral oval (Sanae at 59,7° invariant latitude and College at 64,6°). Events connected with particle precipitation at lower latitudes inside the trapping region (T-type events) do seem to be associated with events occurring in the auroral oval (A-type events). It is shown that the probability of finding a T-type event associated with an A-type event increases linearly with increasing magnetic activity, and that the magnitude (in decibels) of these T-type events also increases with increasing magnetic activity.

Samevatting

Die moontlikheid dat presipitasie van deeltjies in die aurora-ovaal verband hou met presipitasie van deeltjies by laer breedtegrade, is ondersoek aan die hand van riometerabsorpsie-gebeurtenisse wat waargeneem word by verskillende breedtegrade naby die aurora-ovaal (Sanae by 59,7° invariante breedte en College by 64,6°). Gebeurtenisse veroorsaak deur presipitasie van deeltjies by laer breedtegrade in die invangsgebied (T-tipe gebeurtenisse) blyk verband te hou met gebeurtenisse in die aurora-ovaal (A-tipe gebeurtenisse). Die waarskynlikheid van 'n T-tipe gebeurtenis gepaard met 'n A-tipe gebeurtenis, neem lineêr toe met toenemende magnetiese aktiwiteit en die grootte (in desibel) van die T-tipe gebeurtenisse neem ook toe met toenemende magnetiese aktiwiteit.

Introduction

Feldstein (1966) reported that the auroral oval lies at an invariant latitude of 80° in the day and 70° in the night during periods of weak magnetic activity ($K_p =$ 0–1). When K_p reaches values > 5, however, the oval shifts by 6° down to 74° on the dayside. On the nightside the oval broadens until the equatorward boundary reaches an invariant latitude of 59°. Sanae, which is at an invariant latitude of 59,7°, would therefore be inside the auroral oval at night, provided the magnetic conditions were sufficiently disturbed. During the daytime and during periods of weak magnetic activity Sanae would be equatorward of the auroral oval and therefore inside the trapping region.

It was reported by *Kühn* (1969) that two apparently different types of riometer absorption events are observed at Sanae, the South African Antarctic base (70,5°S, 2,5°W geographic). The so-called A-type events, which show much the same characteristics as fluxes of precipitated electrons of energies $>$ 10keV, seem to take place during periods of strong magnetic activity when the auroral oval broadens sufficiently to include Sanae. The so-called T-type events, on the other hand, seem to occur when the auroral oval is poleward of Sanae, that is, when Sanae lies in the trapping region during periods of weak magnetic activity. These T-type events appear to be the result of the precipitation of more energetic electrons.

The effect of the position of Sanae relative to the auroral oval on the occurrence of riometer absorption events is shown in Figure 1 where the frequency of occurrence (percentage disturbed days) of both A-type and T-type events at Sanae is given for different values of the magnetic character figures, C9. Figure 1 shows that the possibility of observing a T-type event during strong magnetic activity *decreases* with increasing magnetic activity as represented by increasing C9 values. The probability of observing an A-type event, on the other hand, *increases* with increasing magnetic activity. This is in agreement with Feldstein's results mentioned above.

The possibility of a relationship between particle precipitation in the auroral oval and particle precipitation in the trapping region has been put forward by a number of workers. *O'Brien* (1962) proposed the "splash catcher" model of the outer zone electrons, according to which the particle densities in the outer radiation zone are enhanced simultaneously with auroral-zone electron precipitation. *Roederer* (1967) found on the basis of theoretical work that the recovery of a prototype magnetic storm results in an inward diffusion and energization of particles on the dayside of the earth. These observations suggest that A-type absorption events may be followed within a very short time by T-type events at lower latitudes inside the trapping region.

If, therefore, one wants to look for a possible relationship between A-type and T-type events at Sanae, it is necessary to take the A-type events observed at a higher invariant latitude as reference and determine whether T-type events at the lower latitude of Sanae are associated with them. Only those periods should be included when Sanae lies outside the auroral oval and the higher latitude station is inside. When the magnetic activity is so violent that both Sanae and the high latitude station are included in the auroral oval and A-type events appear at both stations, then these events must be excluded from the analysis.

Experimental Results

The analysis was done on the basis of the approach outlined above, using Sanae riometer data obtained in the period March 1964 to December 1966. The high latitude station used as reference was College, Alaska (64,6° invariant latitude), the College riometer data for this period being obtained from their *High Latitude Geophysical Data* bulletins (UAG-C Series). The absorption events were classified as either A-type or T-type on the basis of characteristics given by *Kühn* (1969).

The analysis showed that T-type events at Sanae occur more often on days when A-type events are observed at College than on other days. This is evident from Figure 2, in which the ratio of the number of days containing both A-type events at College and T-type events at Sanae to the total number of days containing A-type events at College, is given in the zero interval. The other intervals give the frequency of T-type events at Sanae on the preceding and succeeding days.

A more detailed examination of the data used in Figure 2 leads to another interesting observation. If the above analysis is repeated for different values of the C9 character figures, and the ratio used in Figure 2 is plotted in terms of the C9 values, then the results given in Figure 3 are obtained. From this figure it appears that the probability of finding a T-type event at Sanae associated with an A-type event at College increases linearly with increasing magnetic activity. This relationship between the frequency of occurrence of the T-type events and the degree of magnetic activity must not be confused with the relationship found when all the T-type events are considered (see Figure 1). If we assume that the relationship exhibited in Figure 3 is real, then it seems to be characteristic only of those T-type events observed at Sanae which are associated with A-type events at a higher latitude.

A linear relationship is also found when the absorption magnitudes (in decibels) of the Sanae T-type events are plotted in terms of the C9 character figures (see Figure 4). The average maximum magnitude of those T-type events associated with A-type events at College increases with increasing magnetic activity.

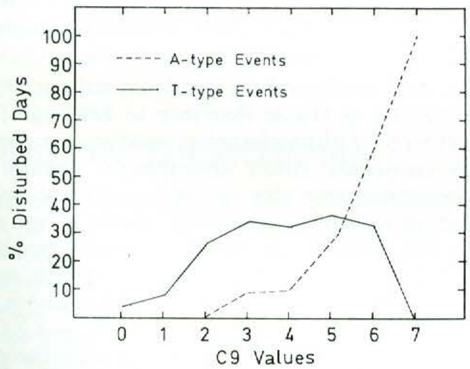

Fig. 1. The percentage of days of a given C9 value containing either A-type (dotted line) or T-type (solid line) absorption events is given in terms of the C9 values.

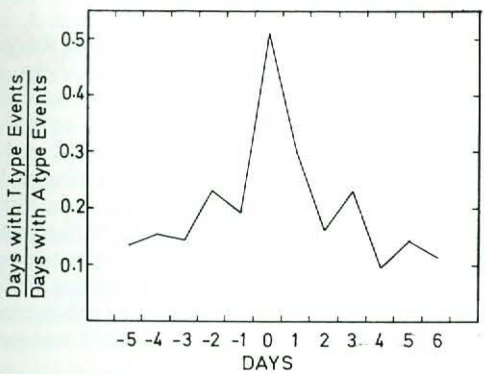

Fig. 2. The possibility of finding a T-type event at Sanae associated with an A-type event at College is given in the zero interval. The other intervals give the probability of finding a T-type event at Sanae on the days preceding or succeeding the "zero day".

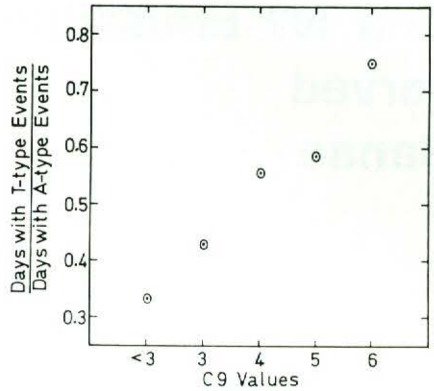

Fig. 3. The probability of finding a T-type event at Sanae associated with an A-type event at College in terms of the values of the C9 magnetic character figures.

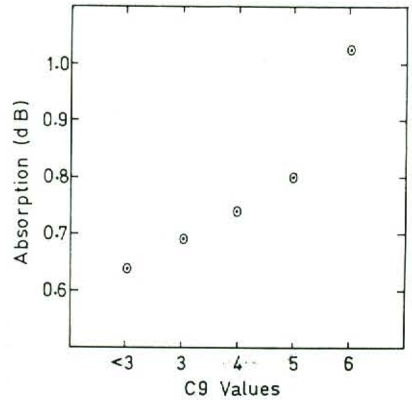

Fig. 4. The mean maximum absorption per event in terms of the C9 values for those T-type events used in Figure 3.

Conclusions

This analysis appears to support the "splash catcher" model proposed by O'Brien, and Roederer's theoretical results, in the sense that particle precipitation in the trapping region appears to be closely associated with particle precipitation in the auroral oval. It had in fact been reported earlier (*Kühn*, 1969) that at Sanae T-type events seem to follow A-type events within a day or two.

Acknowledgements

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References

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