Relationship Among Pc5 Micropulsations, Auroral Activity and Relativistic Electrons: Preliminary Observations

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Abstract. The *Pc5* micropulsation power at Mould Bay, the *AE* index and the relativistic (energy > 2 MeV) electron count rates from GOES6 geosynchronous satellite have been compared through correlation and coherence methods. The periods considered are the months January and August 1986. Dependencies of results on the magnetic local time at Mould Bay and on the *Kp* index are shown. The best correlation and average coherence are found between *Pc5* power and *AE*, especially around local magnetic midnight. A quite good correlation between the *Pc5* power and the electron rates is observed under the cusp location in August, when the cusp is closer than in January to Mould Bay latitude. In addition, the correlation *Pc5* power vs. electron rates sharply maximizes during the geomagnetic quietest periods ($Kp \leq 1$), both in January and August 1986. Differently, the correlation between *AE* and the relativistic electron rates is better for $3 < Kp \leq 4$.

INTRODUCTION

A significant association between the *Pc5* (150-600 s) micropulsation power and the substorm occurrence has previously been observed [1]. In particular, a significant correlation is found between low frequency micropulsation power and the *AE* index, monitoring the level of the auroral electrojet [2]. On the other hand, several studies focused on predicting the relativistic electron fluxes at geosynchronous orbit based on time series of geomagnetic indices [3; 4; and references therein] and specifically time series of *AE* [5]. The methods used for these electron fluxes forecasts are linear filters [5] or neural networks [3].

In this context, a possible relationship between *Pc5* power and the relativistic electron fluxes may be reasonably expected, because both are related to *AE*. However the relationship between the electron rates and the substorm or storm occurrence is not uniquely determined. For example, Reeves [6] has previously noted that relativistic electron enhancements were associated with magnetic storm in Dst, but magnetic storms could occur with no appreciable electron flux enhancements.

This paper presents preliminary results about the observation of possible correlation or average spectral coherence among *Pc5* power, *AE* and the relativistic electron fluxes at geosynchronous orbit.

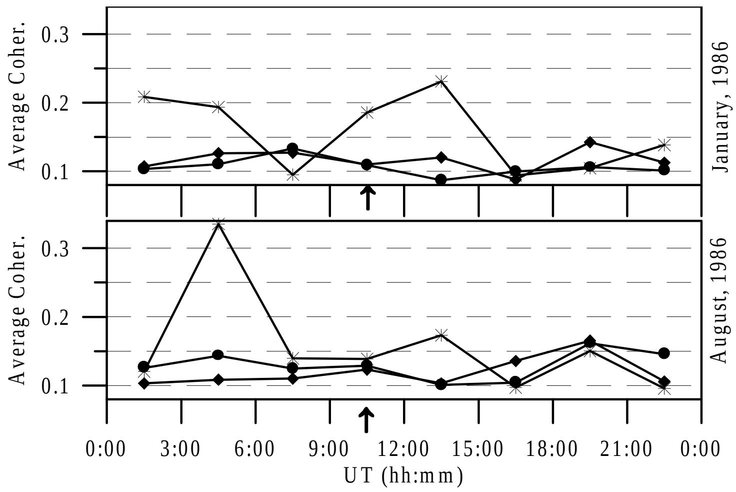

FIGURE 1. Average coherence in the *Pc5* frequency range between geomagnetic variations and *AE* (*), between geomagnetic variations and the electron count rates (•) and between *AE* and the electron count rates (♦). Data points are shown at the center of the 3 h UT range to which they refer. The arrow indicates the magnetic local midnight at Mould Bay.

DATA ANALYSIS AND OBSERVATIONS

Measurements at 1 min resolutions are considered for the total horizontal component of the geomagnetic field at Mould Bay (Corrected Geomagnetic Coordinates, CGM: 80.85° N latitude, 272.65° E longitude), for the relativistic (> 2 MeV) electron rates from GOES6, and for the *AE* index. Spectra and spectral coherence for these three sets of data are calculated over 3 h UT intervals. The *Pc5* average (i.e., averaged over the *Pc5* frequency range) spectral coherences have been further averaged in separate time ranges and results are reported in Figure 1.

Figure 1 shows quite small coherence among the considered data sets, with possible exceptions for geomagnetic variations vs. *AE*. The average coherence in this case maximizes when Mould Bay is the near noon and near midnight magnetic local time (MLT) in January 1986, and in the range 16:30-19:30 MLT in August 1986. Possible recurrence of similar results during the rest of the year and for other years could indicate possible seasonal effects on the coupling of geomagnetic variations with *AE* index.

The spectra of the geomagnetic variations at Mould Bay have been integrated over the *Pc5* frequency range, so that the integrated *Pc5* powers at 3 h resolution have been derived. The *AE* and the electron count rates have been averaged over the same 3 h intervals in order to calculate the correlations among the logarithms of *Pc5* micropulsation power, of *AE* and of electron rates, as reported in Table 1. These *log-log* correlations are better than the linear correlations in these cases.

TABLE 1. Correlation coefficients, ρ; N is the number of data points considered.

Correlation's Parameters	**January, 1986**	**August, 1986**
Pc5 power vs. AE	$\rho = 0.73$, N = 248	$\rho = 0.49$, N = 247
Pc5 power vs. Electrons	$\rho = 0.38$, N = 248	$\rho = 0.50$, N = 243
AE vs. Electrons	$\rho = 0.18$, N = 248	$\rho = 0.25$, N = 244

Table 1 shows that the best correlation is between the *Pc5* power and *AE*, while the worst is between *AE* and the electron rates. We note that, during January 1986 only, correlations larger than in Table 1 can be seen by considering only electron fluxes < 400 counts/sr s cm^2, as illustrated in Figure 2.

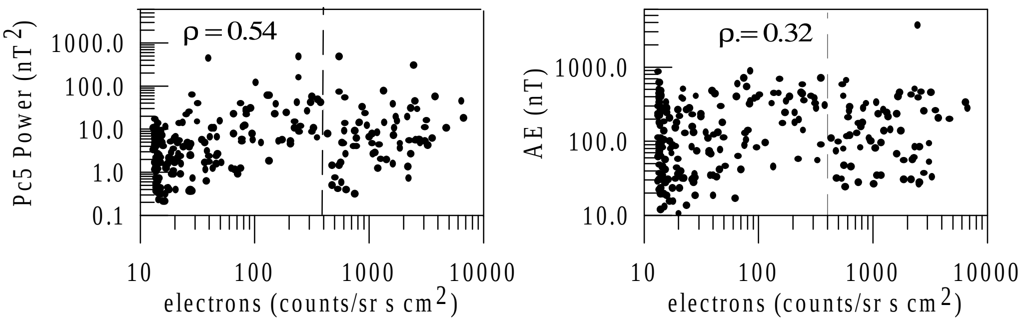

FIGURE 2. Scatter plots between average electron rates and *Pc5* power (left panel) or *AE* (right panel) during January 1986; the correlation coefficient (ρ) refers to electron fluxes < 400 count /sr s cm^2 (the number of data points is 177).

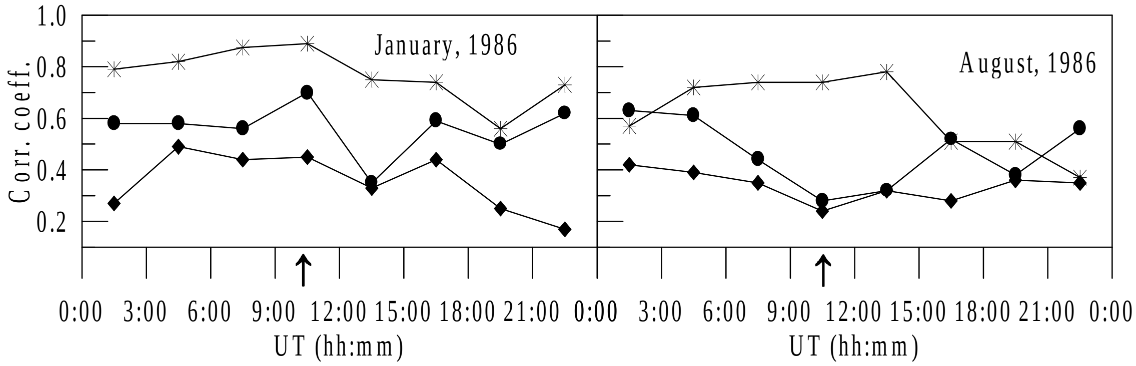

FIGURE 3. Coefficients of the correlations *Pc5* power vs. *AE* (*), *Pc5* power vs. electron rates (•) and *AE* vs. electron rates (♦). Data points are shown at the center of the 3 h UT interval to which they refer. The arrow indicates the magnetic local midnight at Mould Bay.

The *log-log* correlations shown in Table 1 have been recalculated considering separately each 3 h interval, as shown in Figure 3. In January, the electron rates considered are < 400 counts/sr s cm^2, so that the number of data points for correlations of electrons rates vs. *AE* or vs. *Pc5* power are smaller than 31 (between 20 and 24). The rest of the correlations in Figure 3 are based on about 30 data points (exactly between 29 and 31). In agreement with substorm occurrence's expectation, when Mould Bay is around its midnight MLT, a slightly better *Pc5* vs. *AE* correlation is observed both in January and August 1986. Apart from this, it is not possible to establish a certain daily modulation for the other two correlations, most probably because of too few data points. A larger statistics is in course of development.

Regarding Figure 3, it is of interest that at 21:00-0:00 UT and 0:00-3:00 UT the *Pc5* vs. electron rate correlation coefficient is even larger than that for *Pc5* vs. *AE*. This happens when Mould Bay is in its cusp region, during August, when the cusp is closer to the 80° CGM latitude than in January [1]. Therefore it can indicate a good *Pc5* – relativistic electron rate association in the magnetospheric cusp. This could be an additional finding about the relativistic electron fluxes, which are above all investigated in the context of storms and ring current development [4; 6].

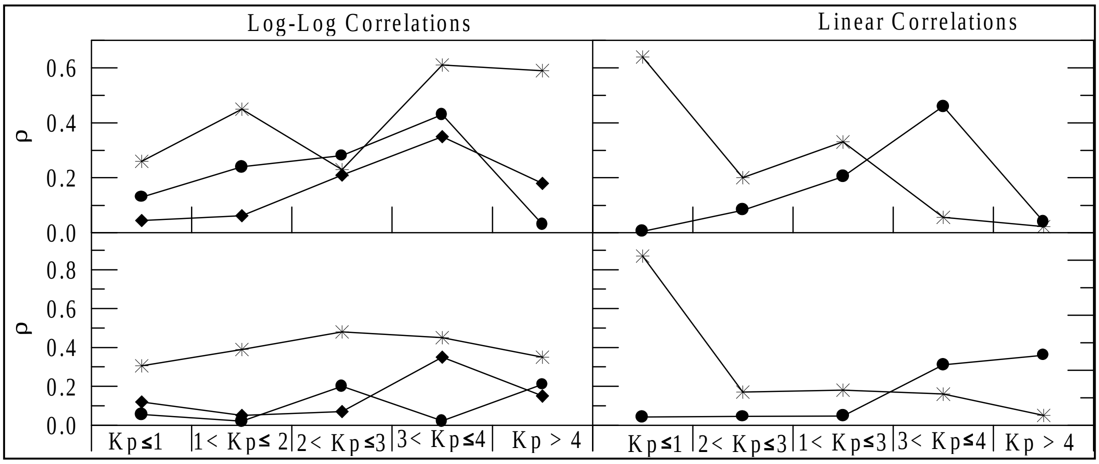

FIGURE 4. Coefficients (ρ) of the correlations between *Pc5* power and *AE* (*), *Pc5* power and the electron rates (•), *AE* and the electron rates (♦), for separate *Kp* intervals.

The correlations among the three considered data sets have been recalculated separately for data corresponding to separate *Kp* intervals. For the correlations involving the electron rates, data with fluxes ≥ 400 counts/sr s cm^2 are excluded. The coefficients reported in the left panels of Figure 4 are related to *log-log* correlations, while those in the right panels refer to linear correlations (linear correlations for *AE* vs.

the electron rates are not reported because generally smaller than the *log-log* case). Figure 4 shows that the correlation between *AE* and the electron rates maximizes for 3< $K_p \leq 4$, both in January and August. Finally, the most evident result is a very important linear correlation between *Pc5* power and the relativistic electron rates, emerging during the geomagnetic quietest periods, for $Kp \leq 1$.

ACKNOWLEDGMENTS

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