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A MODULATION OF Pc 3 AMPLITUDE AND ASSOCIATED AURORAL PRECIPITATION (EXTENDED ABSTRACT)

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We report a close correlation between an occurrence of magnetic pulsations (Pc 3) and a concurrent enhancement of auroral precipitations by comparing data from three ground stations, one at high latitude of nightside sector and the other two stations at very-low latitude of dayside sector. Before proceeding to a comparison of the ground data, let us look at particle signatures in the magnetosphere in Fig. 1 by employing the electron and ion flux data from charged-particle-analyzer (CPA: electrons, 30–300 keV; ions, 95–600 keV) on board LANL satellites (1982-019, 1984-129, 1984-037) in geosynchronous orbit. First of all, electron injections associated with Pi 2 onset were detected at 1908 UT and at 1928 UT, prior to the Pc 3 event that will be discussed below, by CPA on board 1984-037 at midnight meridian (lower trace). The electron event was detected only in the lower energy range, 30–95 keV, and there appeared no indications of ion injections in the whole energy range of ions (not shown). The injected electrons were drifted eastward and a flux peak for 30–45 keV range was detected first by 1984-129 (1035 LT sector) at 2117 UT, and then by 1982-019 (1910 LT sector) at 2147 UT and again by 1984-037 (0259 LT sector) at 2226 UT after a travel all the way around the Earth (*e.g.*, REEVES, 1990). The estimated eastward angular drift velocity is in the range of 2.0–2.9 LT/10 min for 30–45 keV range. From this velocity estimation, it seems that the flux peak would arrive at Syowa meridian at about 2200 UT with a longitudinal distribution of the electron clouds being more than 6-hours of local time (estimated from half-width of the flux distribution and its angular drift velocity), to both east and west of the peak. During the passage of the electron clouds over the midnight sector after their travel all the way around the Earth, high latitude station (Syowa Station, Antarctica) and very-low latitude stations (Melekeok and Okinawa) moved to the midnight and morning sector, respectively, and Pc 3 pulsations (which are observed normally in the dayside sector (SAKA and ALPEROVICH, 1993)) and concurrent modulation of the precipitation were observed at these stations. All-sky image and induction magnetometer data from Syowa and fluxgate magnetometer data from Melekeok/Okinawa were utilized in this report. Melekeok is at the dip-equator of 195° E meridian, while Okinawa is at 15° N of the

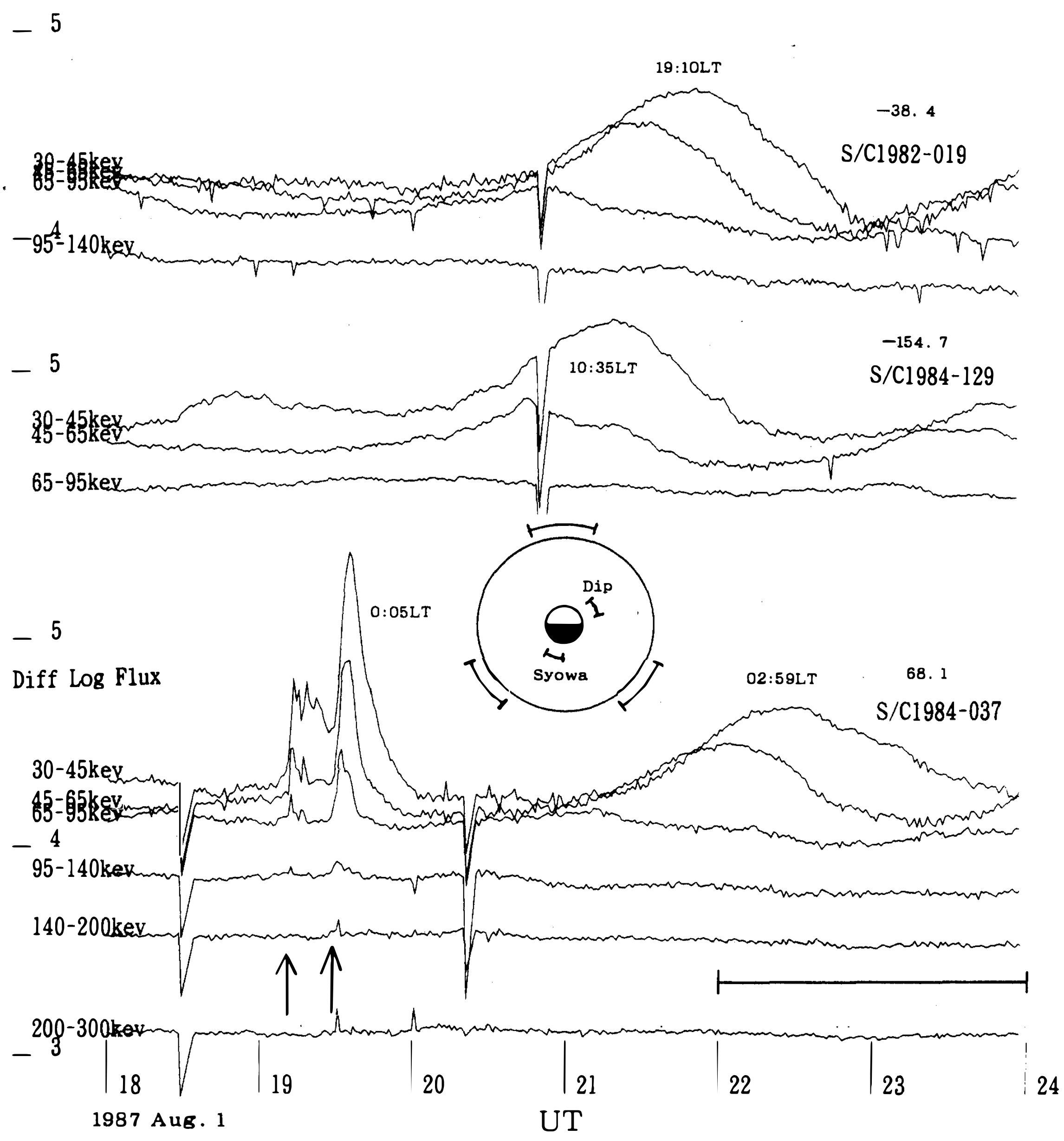

Fig. 1. Differential log flux of the low energy electrons in the energy ranges, 30–45 keV, 45–65 keV, 65–95 keV, 95–140 keV, 140–200 keV, 200–300 keV. Only lower energy channels are shown for satellites 1982-019, and 1984-129. The interval for the Pc 3 event (2200–0000 UT) is shown by horizontal bar. The electron injection events prior to the Pc 3 event are indicated by arrows. The local time of the three satellites and ground station, Syowa and Melekeok (dip), during 2200–0000 UT interval are illustrated in the figure. The LT in the figure is the local time of the satellite where the flux peak passed by the respective satellite sector (see text).

same meridian.

We demonstrated in Fig. 2 pulsation signatures at Syowa Station and at Melekeok/Okinawa along with a concurrent meridian scan of the all-sky image (position-time display). The pulsation activities were demonstrated by dynamic power spectra in Fig. 2, wherein the power spectra were calculated by FFT method

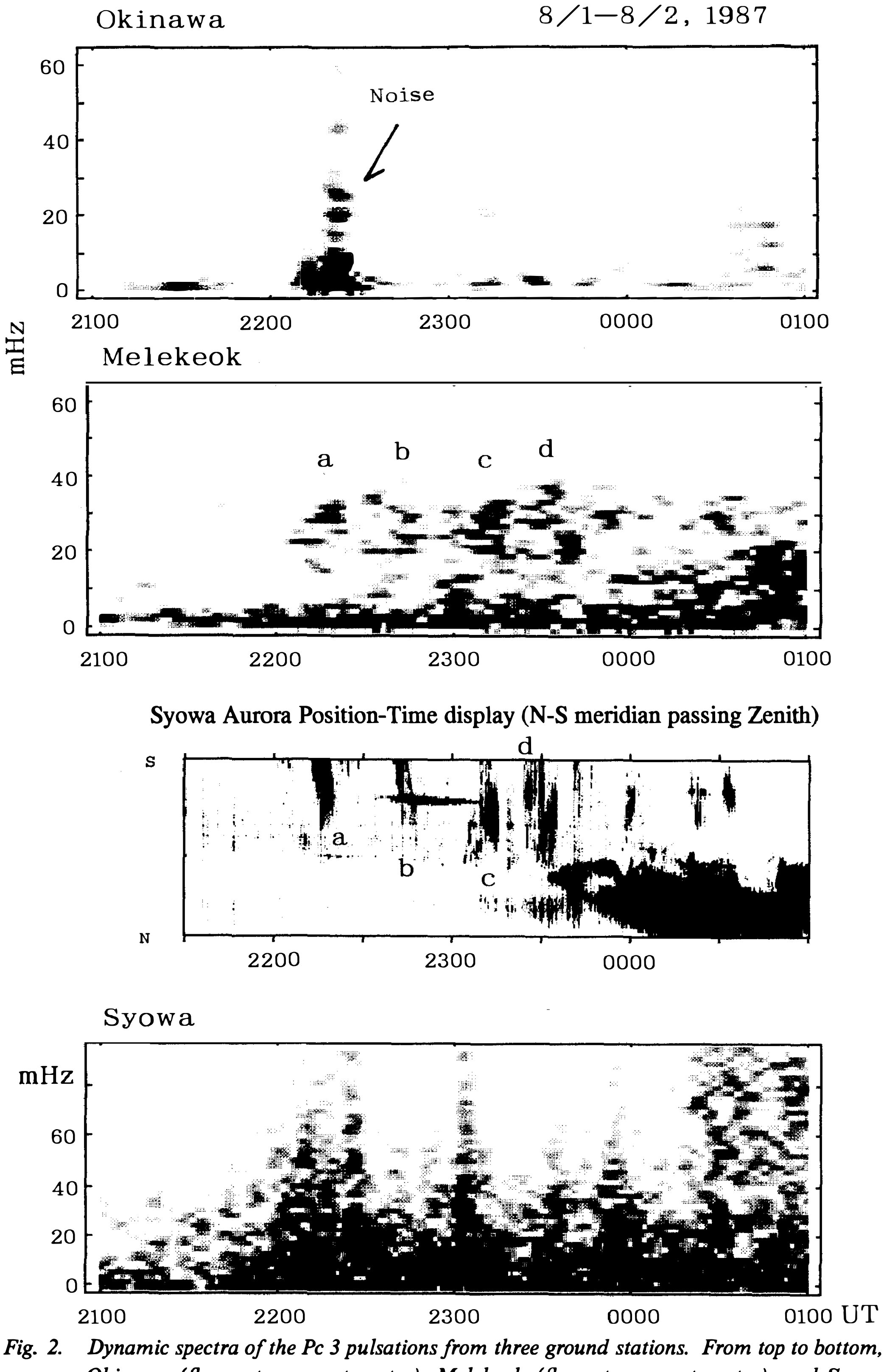

Fig. 2. Dynamic spectra of the Pc 3 pulsations from three ground stations. From top to bottom, Okinawa (flux gate magnetometer), Melekeok (fluxgate magnetometer), and Syowa (induction magnetometer). Position-time display of the Syowa all-sky image along N-S meridian passing zenith is shown in the third panel. S is for South (poleward). Enhanced power at 2220 UT for Okinawa is caused by an artificial noise.

using 256 data points (*i.e.*, 12.8 min interval), each of data was sampled at 3 s. This time interval was shifted consecutively by 1 min to obtain dynamic power profiles. Let us look at the dynamic spectra at the dip-equator, Melekeok in the second panel of Fig. 2. Pc 3 pulsations are clearly demonstrated in 20–40 mHz with intensified amplitudes during the interval labeled as a, b, c, and d. Meanwhile, no significant Pc3 power was recorded in Okinawa as is shown in the top panel. This contrast of the power level may indicate an existence of the equatorial enhancement for the Pc 3 event. As will be discussed below, the equatorial enhancement will be attributable to an electric potential as a possible driving source for the ground signal. Furthermore, we examined the Pc 3 band activities at Syowa Station during the same interval and the results are demonstrated in the bottom panel of the figure. Indeed, pulsation activities including Pc 3 band increased at Syowa Station, though one-to-one correspondence of the Pc 3 power enhancement to that at Melekeok (*i.e.*, a, b, c, and d) is rather weak, probably by local ionospheric noises responsible for particle precipitations at high latitudes.

Let us look at the position-time display (p-t display) at Syowa Station in the third panel of Fig. 2. The horizontal line extending from 2240 UT to 2310 UT in the poleward portion of the p-t display is caused by a star in the sky crossing the N-S meridian. In this report, we do not discuss the auroral band that commenced at 2330 UT in the lower latitude area of the p-t display. We note that weak activities of the precipitation repeated in the poleward portion of the Syowa field-of-view during the Pc 3 interval (2200–0000 UT). We labeled these activities as "a" through "d" in the figure. A good correlation can be seen between "a" through "d" of Pc 3 in Melekeok and "a" through "d" of the aurora.

We found a close correlation between intensification of the auroral activities and of the amplitude of Pc 3 pulsations. We argue that a probable change of the solar wind parameters (direction and intensity of the IMF) would modulate both the Pc 3 amplitudes (*e.g.*, ENGEBRETSON *et al.*, 1986) and precipitations along the field lines that intersect the poleward boundary of the aurora oval in a manner described below. The Pc 3 signals could be interpreted as being composed of an electric potential with less magnetic field component. For this reason, an intense ionospheric current might be driven by the electric field component within a narrow region along the dip-equator where the conductivity is locally enhanced (*i.e.*, equatorial enhancement) (*e.g.*, KELLEY, 1989). This model leads to a supposition that the Pc 3 pulsations at the very-low latitude stations, Melekeok and Okinawa, might not be transmitted directly across the dayside magnetosphere as a compressional wave. We argue that the ground Pc 3 signals might be generated primarily as standing oscillations with higher harmonic structures in the nightside sector of high latitudes, though the higher harmonic events are suggested to be observed mostly in a dayside sector at Syowa Station (TONEGAWA and FUKUNISHI, 1984). It is known that plasma pressures imposed on the field line generate a field-aligned current (SOUTHWOOD and KIVELSON, 1991). We recall here that peak of the injected electrons returned to the Syowa meridian at 2200 UT, slightly prior to the Pc 3 events. If these particles increased the plasma pressures in lower latitudes of the nightside magnetosphere, and a solar wind increased the plasma pressure in the tail-lobe (in the both hemispheres), a distribution of the field-aligned current along the flux tubes in the outer boundary of the nightside magnetosphere will be such that the current polarity in the lower latitudes is opposite to that in the higher latitudes. This current distribution is favorable for exciting a transient oscillation of third harmonics (SAKA *et al.*, 1996). When the plasma pressure imposed by the solar wind diminished in the higher latitude portion of the flux tube, then a transient oscillation of third harmonics ceases. Accordingly, an electric potential associated with standing harmonic waves will be set up at high latitudes, and it may cover even the very-low latitude part of the Earth (*e.g.*, KIKUCHI and ARAKI, 1979). Furthermore, we may infer that the change of solar wind pressure modulated the particle precipitations in the poleward portion of the auroral oval. This inference is consistent with the present observation that the electron precipitations were observed to the poleward portion of the Syowa field-of-view.

Acknowledgments

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