Proc. NIPR Symp. Upper Atmos. Phys., **11**, 134–138, 1998

ACTIVITIES AND FORMS OF PULSATING AURORAS AT THE CONJUGATE-PAIR OBSERVATORIES NEAR $L=6$ (EXTENDED ABSTRACT)

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Pulsating aurora with a period of 0.5 s to 20 s is one of the most common phenomenon that commences in the aftermath of auroral breakup, *i.e.*, during the recovery phase of auroral substorm (*e.g.*, OGUTI, 1978; YAMAMOTO, 1988). However, even today, the basic characteristics of pulsating auroras, such as their period, periodicity and shapes are still open questions. Characteristics of conjugate pulsating aurora are to be investigated in detail to clarify the generation and precipitation mechanism of pulsating aurora. For example, if pulsating auroras show a clear north-south conjugacy, the source region for the aurora should be located in the equatorial region in the magnetosphere with a symmetric precipitaion of aurora-producing particles into the both hemispheres along the lines of geomagnetic field. On the other hand, if pulsating auroras show poor conjugacy, the generation and precipitation of aurora producing particles should be asymmetric in the opposite hemispheres.

Certain qualitative studies indicate a good correlation between the north and south hemispheres as regards the shape and phase of pulsating auroras (BELON *et al.*, 1969). However, cases of poor conjugacy have also been found (STENBAEK-NIELSEN *et al.*, 1973). A more detailed analysis using TV cameras has been carried out by FUJII *et al.* (1987). Recently, MINATOYA *et al.* (1995), for the first time, carried out a quantitative analysis of various characteristics such as the spatial patterns, intensity variation, periods, and periodicity of the periodic type pulsating auroras using TV camera data obtained at 3 nearly geomagnetic conjugate stations, Syowa and Asuka Stations in Antarctica and Husafell in Iceland. Their results revealed a distinct lack of correlation between pulsating auroras at geomagnetic conjugate stations during the event in question. One of the weakness of the event they analyzed is that there is a possibility of lack of conjugacy in the field of view caused by a noticeable asymmetry in the geomagnetic field structure in the two hemispheres. The purpose of this paper is to confirm whether or not the pulsating aurora shows conjugacy or nonconjugacy after analyzing rather simple events observed at Syowa and Husafell conjugate-pair stations in the auroral zone near $L=6$ on 9–10 September, 1994. Details of the observation system at Husafell have already been reported by SATO and SAEMUNDSSON (1987).

The digitization and processing of the video data observed simultaneously at Syowa and Husafell was carried out by the ARSAD (Automatic Retrieval System for Auroral Data; ONO *et al.*, 1987). The analysis for signals of spatial and temporal correlation of pulsating auroras at the conjugate stations we used here follows the same methods used by MINATOYA *et al.* (1995). All-sky image data are projected onto rectangular geomagnetic coordinates deduced from the IGRF 1990 model, on the assumption that aurora is at a height of 100 km.

Active auroras were observed in a clear sky at the conjugate-pair stations on 9–10 September, 1994. Figure 1 shows temporal variations of the H component of magnetic field and the Cosmic Noise Absorption (CNA) observed at the two stations. Many active pulsating auroras were seen from ~2345 UT in the recovery phase of the substorms. The pulsating auroras, we are interesting in here, were selected in the time from ~0013 UT to 0021 UT on 10 September. An isolated conjugate auroral arc, which was observed simultaneously at ~0017 UT on the poleward side from the both sta-

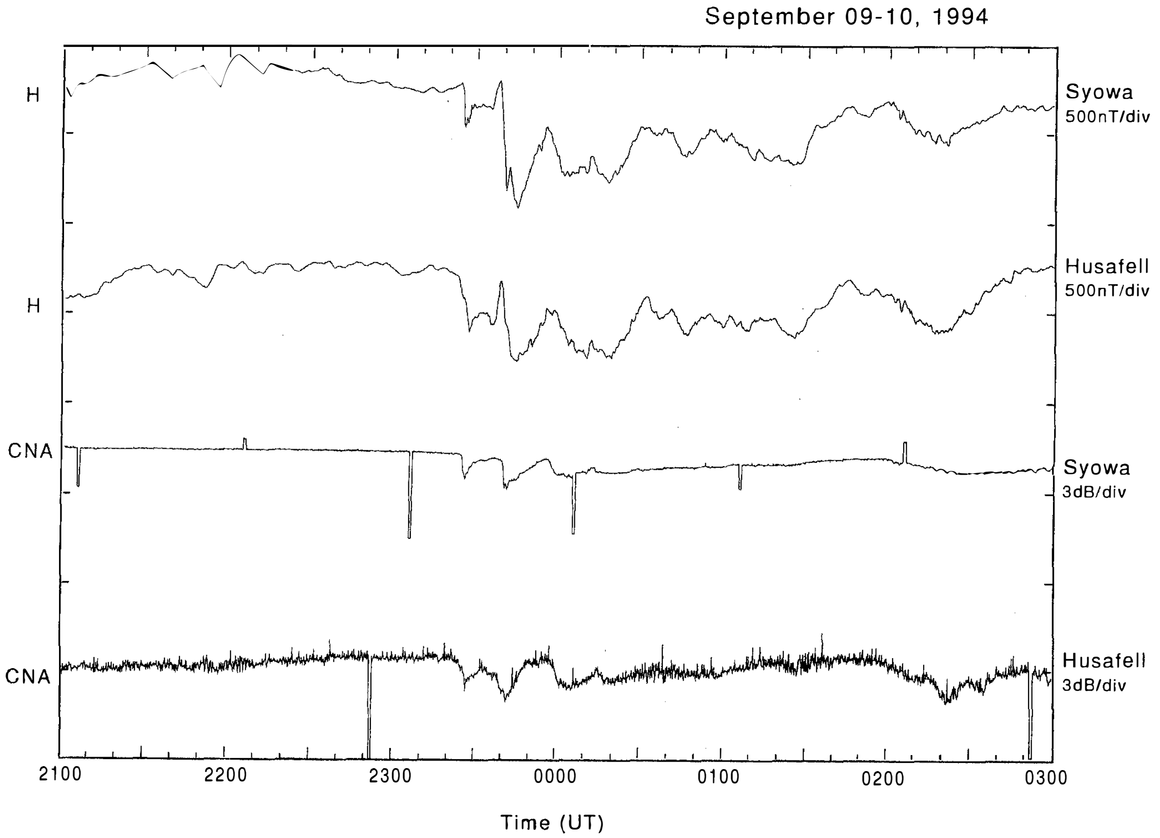

Fig. 1. The H component of magnetic variations and the CNA (Cosmic Noise Absorption) observed simultaneously at Syowa Station in Antarctica and Husafell in Iceland. We are interested in here particularly in the time interval of 0013–0021UT.

tions together with diffuse auroras comprising pulsating auroras, enabled us to confirm the magnetic linkage between the hemispheres observationally in this time period. That is, the both stations observed the same field of view connecting through geomagnetic field lines.

In order to pick up the pulsating auroral images more clearly from the background auroral activity, where most of pulsating auroras change their intensity with the period of less than ~15 s, autocorrelation analysis was applied to the intensity of each image pixel from Syowa and Husafell. Figure 2 shows the regions where the relative standard deviation exceeds 8% from the mean measured intensity. That is, this figure shows the spatial distribution of pulsating auroras and degree of on-off intensity of

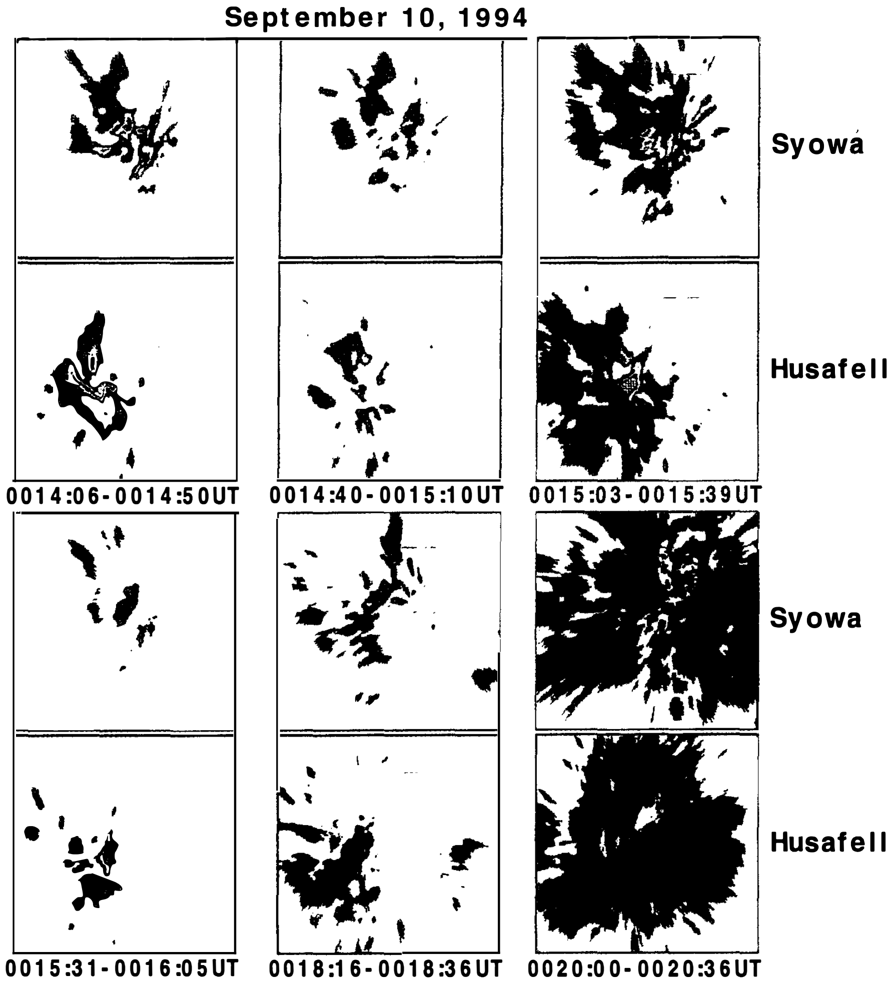

Fig. 2. Results of the relative standard deviation exceeded more than 8% from the measured mean intensity using an autocorrelation analysis method in each image pixel for the pulsating auroras observed at Syowa and Husafell during the interval of ~0014–0021 UT. The color shows the degree of relative deviation, from blue (8%), green, yellow, red to pink (more than 30%). The results were projected onto rectangular geomagnetic coordinates. Projections are 64–68° in geomagnetic latitude (~520 km at 100 km altitudes) for the vertical axis and 64–76° in geomagnetic longitude (~600 km at 100 km altitudes) for the horizontal axis in the both hemispheres.

pulsating auroras. In these figures, the images are so oriented that the vertical axis indicates geomagnetic latitude, while the horizontal axis indicates geomagnetic longitude. The ranges in longitude and latitude are 64–76 degrees and 64–68 degrees, respectively. It is seen from Fig. 2 that lots of pulsating patches are observed at the conjugate-pair stations. It is interesting to examine the conjugacy of the spatial and temporal variations of these pulsating patches. Temporal variations of the pulsating patch intensity (relative deviation) became maximum (more than 30%) in the time interval of 0014:06–0014:50 UT at the both stations. The spatial expansion of pulsating auroral regions over the field of view from the stations became maximum in the interval of 0020:00–0020:36 UT and it became minimum in the period of 0015:31–0016:05 UT at the both stations. That is, the dynamic variations of the spatial distributions and activities of the pulsating patches are very similar in the field of view at the both stations. Therefore, we can state that the activity of pulsating aurora shows a good north-south conjugacy. On the other hand, when we look carefully the characteristics of the conjugacy of each patch, it is difficult to point out whether or not each patch has counter part to that in the opposite hemisphere. For example, spatial distributions and shapes of each patch are not exactly the same between Syowa and Husafell in the time interval of 0014:06–0014:50 UT when the most active pulsating aurora was observed. In the time interval of 0015:31–0016:05 UT when pulsating auroral activity become minimum, each pulsating patch at Syowa does not have counterpart to that at Husafell. Such tendencies we mentioned above are seen in other time intervals. Therefore, we can state that each pulsating patch does not show conjugacy in shape and position.

We can summarize in the followings the characteristics of the conjugacy of pulsating auroras on 10 September, 1994 event; (1) The dynamic variations of the spatial distributions and activities of the pulsating patches are very similar to each other at the conjugate stations. (2) On the other hand, each pulsating patch does not have clear counterparts in the opposite hemisphere. That is, each pulsating patch is nonconjugate in most cases.

Our results of (2) supports the conclusion of Minatoya et al., that periodic pulsating auroras does not show clear similarities in the aurora within a wide field of view of 3 conjugate stations: Husafell, Syowa and Asuka on September 9–10, 1991 event. This conclusion is very important in theoretical interpretations for physical models, because almost all theoretical work has based on the assumption that the source region for the pulsating patch is located in the equatorial region in the magnetosphere and aurora-producing particles precipitate symmetrically into the both hemispheres along the lines of the geomagnetic field; that is, theoretical workers have been supposing explicitly that each patch of pulsating aurora will show a north-south conjugacy (*e.g.*, Coroniti and Kennel, 1970; Trakhtengerts *et al.*, 1986; Demekhov and Trakhtengerts, 1994). We want to point out here that each pulsating patch is nonconjugate in general behavior, and theoretical work must be done after taking this important characteristic in to account.

Acknowledgments

This work was carried out using the facilities of the Information Science Center and the Auroral Data Center of NIPR. Valuable data were provided through the efforts of members of the conjugate campaign in Iceland and the 35th Japanese Antarctic Research Expedition. The project in Iceland was supported by Grants in Aid for Overseas Science Survey (01044143, 04044165, 07044104) from the Ministry of Education, Science and Culture of Japan.

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(Received July 3, 1997; Revised manuscript accepted July 15, 1997)