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GEOPHYSICS

1967

SovietRxiv

Abstract

Full Text

UDC 550.371.3

GEOPHYSICS

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SIMULTANEOUS OCCURRENCE AT CONJUGATE POINTS OF BURSTS OF CLASS Pc-1 MICROPULSATIONS

(Presented by Academician M. A. Sadovskii on 13 VII 1966)

Records of rapid variations of the magnetic field made at the magnetically conjugate points Kerguelen (France) and Sogra (USSR) made it possible to carry out a detailed study of the highest-frequency part of the spectrum of these variations (oscillations of the pearl type, *Pc-1*, and irregular oscillations, *Pi-1*). The first results of these studies, devoted mainly to the properties of regular *Pc-1* series, were published in ([1]). The present article gives new data on the properties of characteristic intervals of oscillations decreasing in period (k.u.p. intervals), which represent a combination of both types of oscillations, *Pc-1* and *Pi-1* ([2]). These characteristic disturbances are also known in the literature under the names pulsation storms ([3]), solar whistlers ([4]), and gartlers ([5]). Combinations of these oscillations constitute the basic element of the microstructure of magnetic storms and are an indicator of the occurrence of disturbances in the ionosphere, the development of active forms of aurora, and abrupt changes of intensity in the radiation belts ([2]). This phenomenon was first simultaneously recorded at conjugate points of the subauroral zone with the aid of installations described by Stefan ([6]) and Baranskii ([7]).

Over the course of a year (February 1964–February 1965), the most typical cases of this kind for the conjugate regions Sogra–Kerguelen in 1964 were the cases of 12 and 20 II, 1 and 18 IV, 10 VI, 15 and 28 IX, 19 X, and 16 XII. In 1965 the cases of 23 II and 3 III were selected. Analysis of these disturbances was carried out from sonograms (frequency–time dependence) and from ordinary field records (amplitude–time) with a sweep speed from 60 to 600 mm per minute and a sensitivity of $\sim 10^{-8}$ oersted.

Morphology of the phenomenon. The k.u.p. interval has a duration varying on average from 30 to 90 min. It is characterized by a tendency to repeat 2–3 times one after another. The sonograms obtained made it possible for the first time to trace the identical character of the development of the phenomenon at conjugate points in the frequency–time representation, and also to reveal a

number of new properties of this phenomenon. As the k.u.p. interval develops, the width of the noise band corresponding to the irregular oscillations expands and at the same time increases in frequency. Toward the end of the phenomenon a characteristic raised "tail" of noise is usually observed. The beginning and end of the intense noise band develop simultaneously at both conjugate points. In this noise band individual structured elements are distinguished, as a rule increasing in frequency (Fig. 1, see insert to p. 823), which correspond to individual bursts of *Pc-1* oscillations observed on ordinary records (amplitude-time).

Results. For the structured elements, the phase shift between the time of their occurrence at the conjugate points and the polarization of the oscillations composing them were studied.

An unexpected result of the comparison of the sonograms was the coincidence in time of a number of structured elements of the type indicated above at the conjugate points. The simultaneity of excitation of bursts of oscillations

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Fig. 1. Sonogram of the recording of 3 March 1965 at Kerguelen. The sonogram shows the main characteristics of the k.u.p. interval. The noise broadens in frequency with time and ends with a "tail"that increases in frequency. Individual structured elements are superimposed irregularly on the general noise.

Fig. 2. Example of the simultaneous excitation, during the k.u.p. interval, of a *Pc*-1 burst (a structured element) at both conjugate stations (at 14 h 48 min 23 s GMT).

Pc-1 corresponding to the structured elements on the sonogram was also traced from the direct amplitude-time records (Fig. 2, see insert to p. 823).

The polarization analysis was carried out for oscillations comprising the interval of simultaneous intensification events (SIE) on 23 February 1965, since records of the two field components at high chart speed (600 mm/min), necessary for investigations of this kind, were available for both stations only from 1 February 1965.

The polarization analysis of the oscillations also yielded a new result not previously known: namely, for an observer looking along the field line toward the Earth, the direction of rotation of the polarization ellipse proved to be the same at both conjugate points.* Thus, individual bursts of *Pc*-1 oscillations (individual pearls on ordinary amplitude-time records) arising during an SIE interval possess a polarization different from that of analogous bursts within *Pc*-1 series, and do not exhibit the phase shift at magnetically conjugate points that is typical of such series. It should be noted that *Pc*-1 series arise mainly during periods of low magnetic activity, whereas SIE intervals are characteristic of magnetic storms and chiefly of the main phase of a storm.

The results obtained make it possible to suggest that the nature of excitation of

bursts of Pc-1 oscillations in the magnetosphere is different for SIE cases and for Pc-1 series. In the case of an SIE, apparently, two hydromagnetic waves of different modes are excited simultaneously and propagate in opposite directions. In the case of structured Pc-1 series, hydromagnetic waves of one definite mode arise and then propagate from one hemisphere to the other along the field line.

It is interesting to note that only with the simultaneous excitation of two waves of different modes is an undoubted connection observed between the recorded oscillations and a series of phenomena in the upper atmosphere, namely: changes of intensity in the radiation belts ([9]), the occurrence of sporadic layers of the E_s type, lowering of the critical frequencies in the ionospheric F-2 layer, bursts of X-ray radiation in the stratosphere, and the appearance of active forms of aurorae ([10]).

The results of detailed investigations of these connections will be published in a separate paper.

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Received
13 July 1966

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* In contrast to the opposite direction of rotation usually observed for Pc-1 series ([8]).

Note: Figure translations are in progress. See original paper for figures.