SOME UNUSUAL VLF EMISSIONS OBSERVED AT HIGH LATITUDES

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ABSTRACT

More than 250 whistler-triggered chorus events were recorded in frequency range 5-10 kHz on Jan 15-16, 1993. Simultaneously Pc1 waves were observed. Next day after an SSC (Jan 19, 1993) there were observed low frequency VLF chorus, which were related to burst-like ULF waves. On Jan 25, 1993 Dst was highly positive. In total 17 narrow band hiss bursts in the frequency range of 6-9 kHz were observed. Pc1 bursts appeared together with narrow band hiss bursts. Mysterious short lasting VLF bursts were observed in spring 1992. They had sharp start and/or end. They consist of 50 Hz periodic signals.

INTRODUCTION

VLF emissions can be divided into four main groups: hiss, discrete emissions, chorus, and combination of the above-mentioned types. The energy of VLF emissions has its source in the energetic particles. Characteristic time scales of the VLF phenomena vary from fractions of seconds to minutes or tens of minutes. Often the phenomena show regular periodicity. This kind of event can last for several minutes and in some cases even several hours.

One mechanism, which can modulate VLF waves, is based on ULF waves, i.e. Pc3, SI, SSC, and maybe Pc1. VLF emissions can be triggered by different kind of signals, e.g. natural whistlers and emissions, VLF transmitter signals, and power line harmonic radiation (PLHR).

WHISTLER-TRIGGERED CHORUSES

More than 250 whistler-triggered chorus events were recorded in frequency range from 5 kHz to 10 kHz on Jan 15-16, 1993. It is important that simultaneously Pc1 waves were observed in all cases. Locally the process could be similar to the processes, which take place when periodic ULF waves modulate the VLF activity.

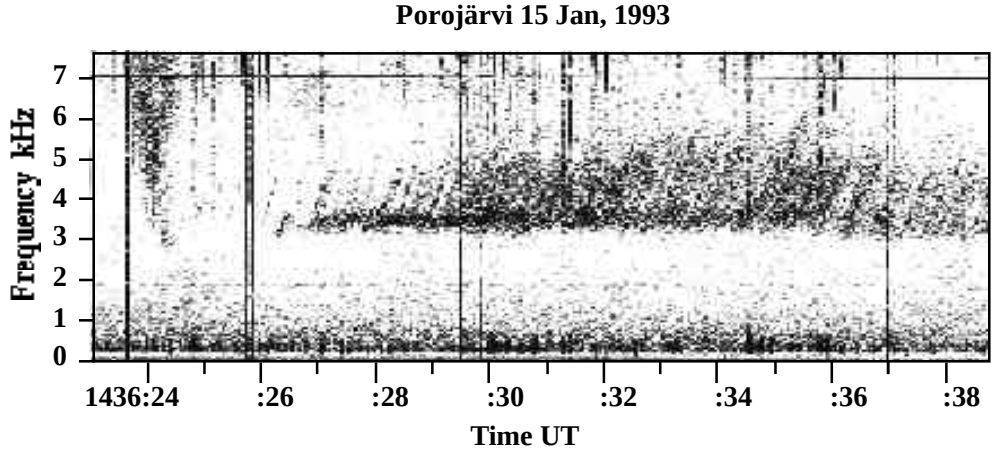

Figure 1. An example of whistler-triggered chorus.

VLF CHORUS RELATED TO ULF BURSTS

An SSC occurred on January 19, 1993, which increased the magnetic activity for a couple of days. Next day there were observed some other kind of VLF chorus at the frequencies of < 3 kHz and > 5 kHz which are related to burst-like ULF waves in the band of 0.2 - 1.5 Hz. The upper cut-off frequencies are following each other's in ULF and VLF frequencies in the way that VLF frequency (< 3 kHz) is all the time about 1840 (= fhe/fhp) times higher than the frequency of ULF waves. The intensity of upper VLF frequencies (> 5 kHz) and the intensity of ULF waves are following each other's.

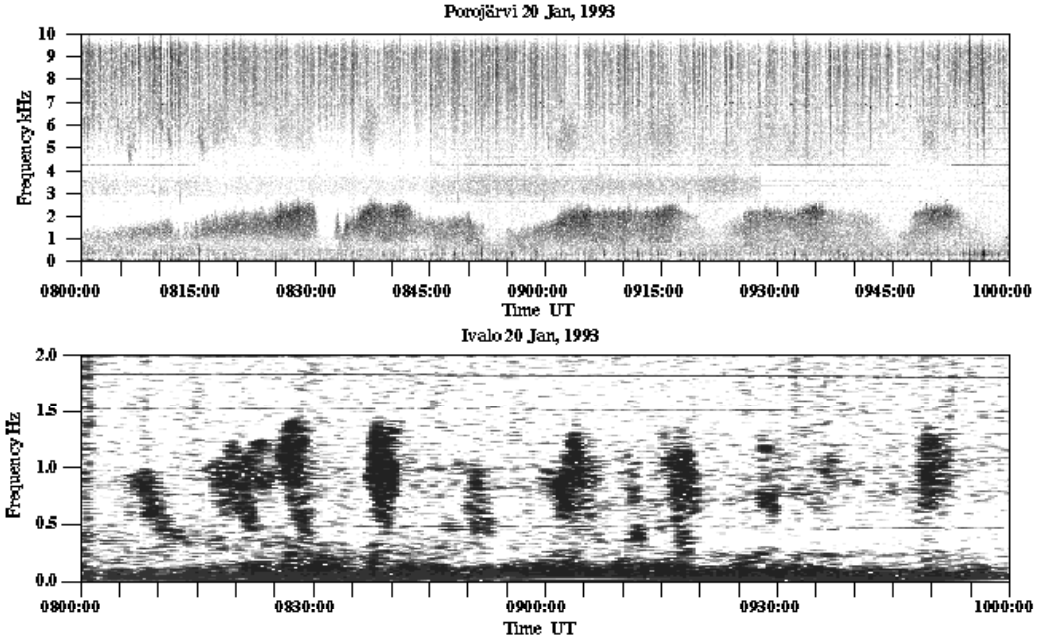

Figure 2. VLF chorus related to ULF bursts.

NARROW-BAND VLF HISS ABOVE 5 kHz

The morning of January 25, 1993 was magnetically quiet. Dst index had unusual high positive values. The Dst was increasing until a sharp decrease occurred at 14 UT. In total 17 narrow band hiss bursts in the frequency range of 6-9 kHz were observed. There are some characteristic features related to all these hiss bursts. Also low frequency chorus in the frequency band of 0.6-1.8 kHz existed simultaneously with narrow band hiss bursts. It showed upward frequency drift and both activations and weakenings occurred rather similar to hiss bursts. Magnetic Pc1 bursts in the frequency range of 0.3-1.2 Hz appeared together with narrow band hiss bursts. They had also a tendency to extend towards higher frequencies.

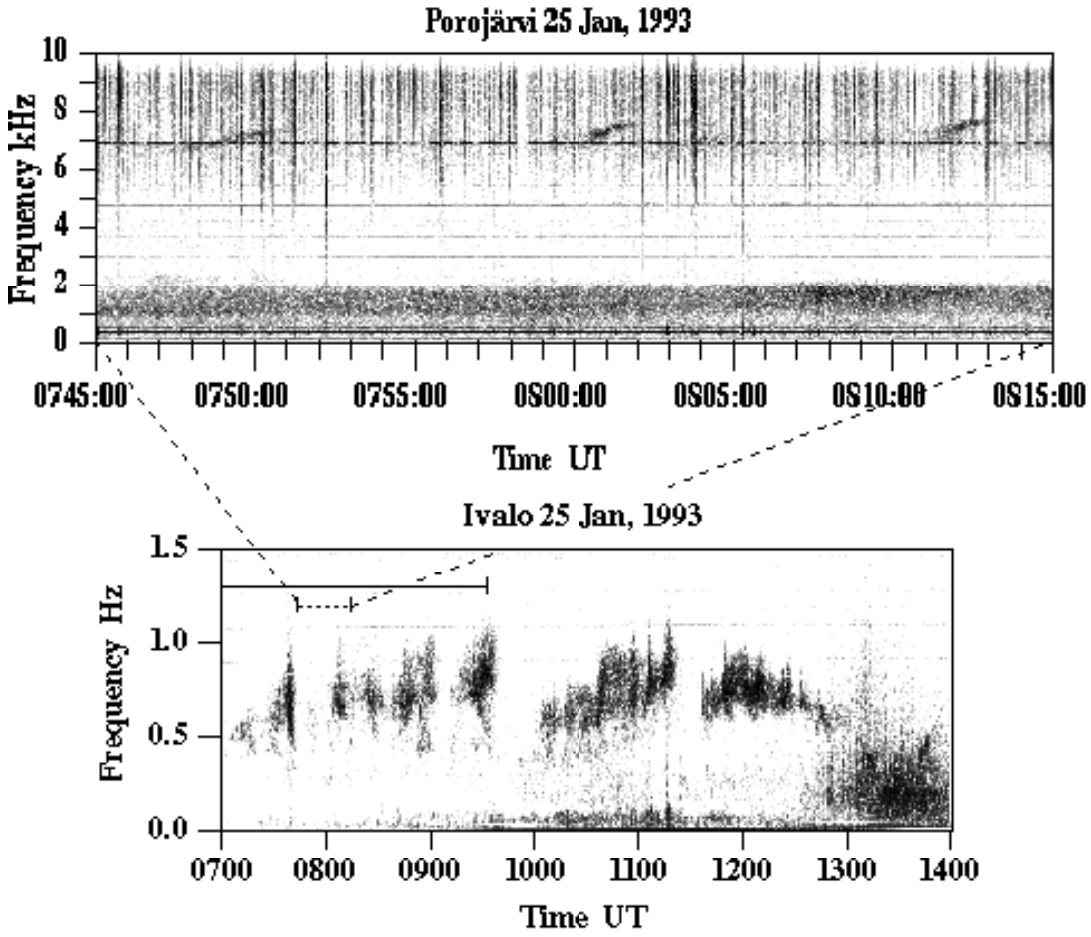

Figure 3. Narrow-band hiss events occurred at 0700-0930 UT. Simultaneously ULF bursts were observed. Dashed line shows time interval of upper panel.

MYSTERIOUS VLF BURSTS

Some mysterious VLF bursts were observed in spring 1992. They were usually short lasting bursts with sharp start and/or end. They consist of 50 Hz periodic signals. In two orthogonal receivers they appear in different frequency bands. Bursts were observed only when Russian APEX satellite signals tried to receive in ground-based VLF receiver.

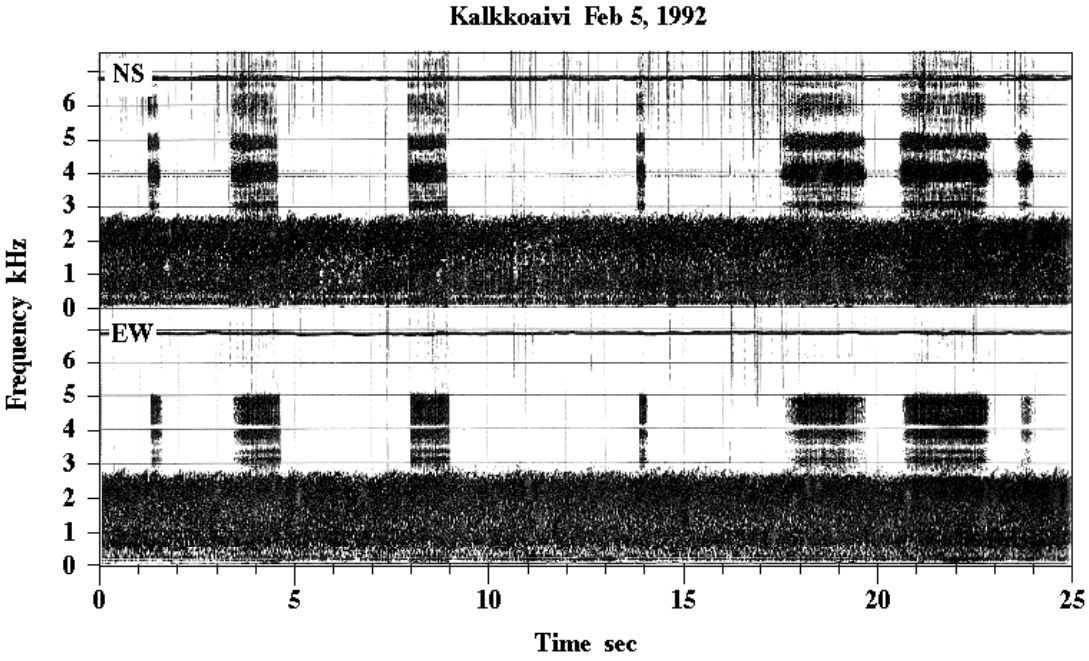

Figure 4. Example of mysterious VLF signal observed in Northern Finland. See difference between orthogonal components. Natural chorus emissions occur below 3 kHz.

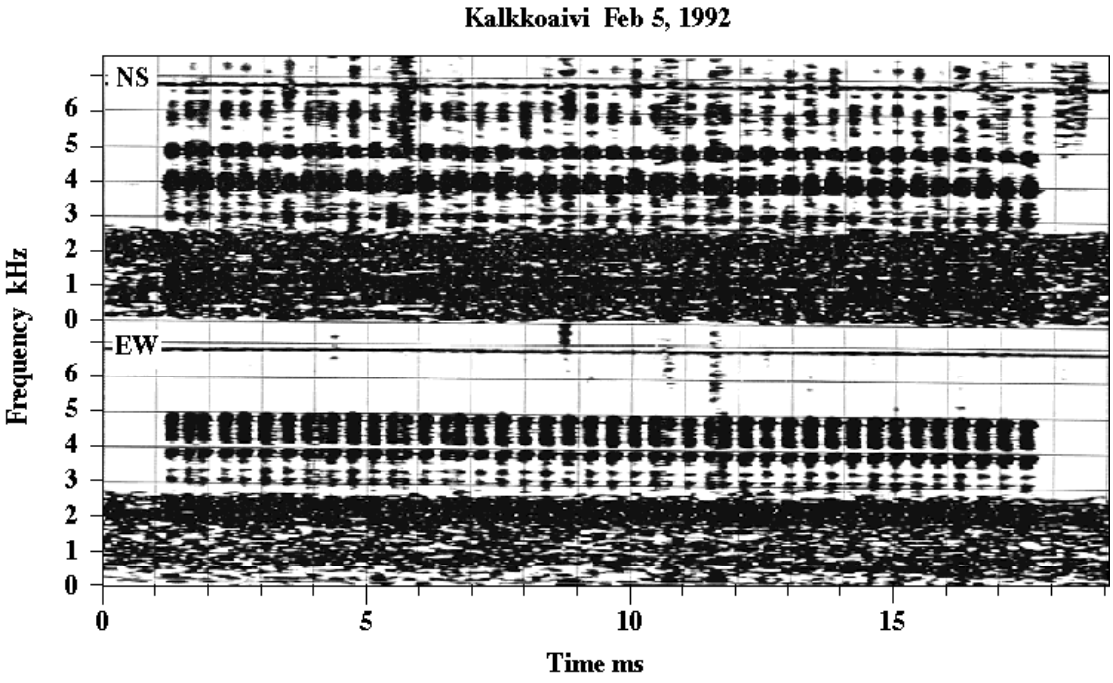

Figure 5. One event enlarged. 50 Hz modulation can be seen. Time now in ms.