DISCRETE EMISSIONS AND WHISTLER PRECURSORS
RECORDED AT LOW LATITUDE GROUND
STATION GULMARG

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Abstract. Discrete chorus-type emission and whistler precursors recorded in March 1972 during day time hours at our ground based station Gulmarg are presented. It is shown that discrete chorus type emissions are generated in the equatorial region (L ~ 1.2) during cyclotron resonance interaction between the propagating whistler wave and the gyrating electrons. The whistler precursors are explained in terms of the mechanism suggested by Dowden (1972).

1. Introduction

Over the last decade, whistlers and VLF emissions have become very important tool for probing the plasmasphere and beyond. Originally whistlers and VLF emissions were looked upon essentially as a high latitude phenomena but the pioneering works of Japanese and Indian scientists during the last two decades have not only detected whistler traces at much lower latitudes but have also established many new morphological features (Iwai and Outsu, 1958; Somayajulu et al., 1965; Singh et al., 1977; Lalmani, 1984). The first successful recording of whistlers and VLF waves in India was carried out at Gulmarg (Geomag. lat., 24°10' N) and later on extended to Nainital (geomag. lat. 19°1' N), Varanasi (geomag. lat. 14°55' N) and Agra (geomag. lat. 17.20' N). With the decrease in geomagnetic latitude of recording stations, the whistlers with comparatively lower dispersion and reduced rate of occurrence were observed (Lalmani, 1974; Singh et al., 1977). Apart from whistlers, very low frequency emissions of various type have frequently been observed at the Japanese low latitude ground stations (Kimura, 1967). Few cases of very low frequency emissions of discrete chorus type have been reported by Singh et al. (1978) and Khosa et al. (1983). All these data of VLF emissions correspond to night time observations. No data for day time observations are reported for low latitude ground stations.

A detailed study of VLF wave spectra recorded at Gulmarg reveals the fine structure in many cases. During the course of analysis of huge amount of VLF data collected in 1972 at Gulmarg, we have found some excellent records of discrete chorus type emissions and whistler precursors during day time. The whistler precursors is one of the most intriguing naturally occurring phenomena, which is the rising tone preceding the originating whistler (Helliwell, 1965). When a VLF emission begins suddenly it is called a sudden-commencement emissions.

However, hiss and chorus may also begin and end suddenly. Many sudden commencement emissions appear to start simultaneously, but others may be initiated or triggered by whistler or other emissions. These are called triggered emissions or interactions. The most common triggered emissions are risers and hooks. These emissions usually are separate from the whistler trace at the middle or lower part. Sonogram of precursors were published by Dinger (1957) and later on precursor have been discussed in detail by various authors (Lasspere and Wang, 1968; Dowden, 1972; or Reeve and Rycroft, 1976).

As a result of increasing importance and versatility of the whistler techniques in probing the upper atmosphere it has become essential to improve upon the understanding of various aspects of whistlers and VLF propagations at low latitudes. This paper deals with discrete chorus type emissions and whistler precursors observed at low latitude ground station Gulmarg during day time. We have also briefly discussed their most probable generation mechanism. The precursors and discrete chorus type emissions were received, during whistler recording using a vertical antenna 25 m high, pre-amplifier, main-amplifier and a tape recorder. The possibility of these precursors being caused by some fault in the equipment has been ruled out. Further, it has been observed that the precursors were followed and preceded, within few hours, by discrete chorus emissions. It is quite probable that precursors and discrete emissions may have been generated by some magnetospheric process and hence an understanding of generation mechanism of low latitude whistlers, precursors and discrete chorus emissions may lead to a better insight into the magnetospheric process which causes VLF emissions in general.

2. Data Selection and Analysis

The whistlers and VLF emissions recorded at Gulmarg were always of very high quality, and numbers of data recorded were good enough to be of statistical significance. The discrete chorus emissions and whistler precursors reported in this paper were recorded on 19th March and 29th March 1972 between 1100 h and 1400 h IST. About eighty discrete rising and combinations of discrete chorus emissions were observed. Some of these emissions are shown in Figure 1. Usually these events occurred in the frequency range 1–7 KHz. For example, Figure 1(a, b, c) show a single trace rising emissions in the frequency range 1.3–7.0 KHz, two rising emissions occurring at the same time in the frequency range 1.4–4.3 KHz, and many rising emissions occurring at the same time in the frequency range 1.2–5.7 KHz, respectively. Figure 1(d) shows combinations of discrete chorus emissions in the frequency range 1.4–5.8 KHz. Figure 1(e–g) show examples of risers followed by falling tone, sometimes called inverted hooks. In Figure 1(g) the inverted hooks is preceded by two risers having lower and upper cut of frequencies 1.6 and 6.5 KHz respectively. Figure 1(h) shows an example of discrete chorus emissions in which riser is followed by hook. Figure 1(i) depicts a whistler having the dispersion of 15 sec $^{1/2}$ and a discrete chorus emission of in-