LOW FREQUENCY BURSTS OBSERVED BY MULTIPLE SATELLITES

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1. Introduction

Low frequency (LF) busts, also called isotropic terrestrial kilometric radiation (ITKR), are found by Steinberg et al. [1] in 1988. Their frequencies are between 30 and 100 kHz and often associated with auroral kilometric radiation (AKR). The lowest frequency of AKR sometimes becomes 30 kHz and AKR is spin modulated. On the other hand, LF bursts are not spin modulated and isotropic. They often last more than one hour. Steinberg et al.[2] proposed that they are back scattered in the interplanetary (IP) medium far down the tail magnetosheath and lobes ducted after radiation is emitted near the Earth. The present paper compares intensities of LF bursts observed by Geotail, POLAR, and WIND satellites in order to examine their source and propagation mechanisms. The apogee and perigee of Geotail are 30 Re (Earth radii), 10 Re, respectively. It was mostly just outside of the magnetosphere. Those of POLAR are 9 Re and 1.8Re, and 86° in inclination. It sometimes observes AKR near the source region. WIND was in the solar wind between the earth and the sun mostly at more than 200 Re. Their positions are very convenient to compare intesities at various points.

When a satellite is in the solar wind outside the magnetosphere, the plasma frequency (fp) line emission, which shows the local plasma frequency, and twice of fp (2fp) emission, which is radiated from the bow shock where the plasma frequency is close to twice of that of the solar wind. LF bursts are observed between the two frequencies. AKR is generated in the polar region and its components whose frequencies are higher than 2fp can go out from the magnetosphere.

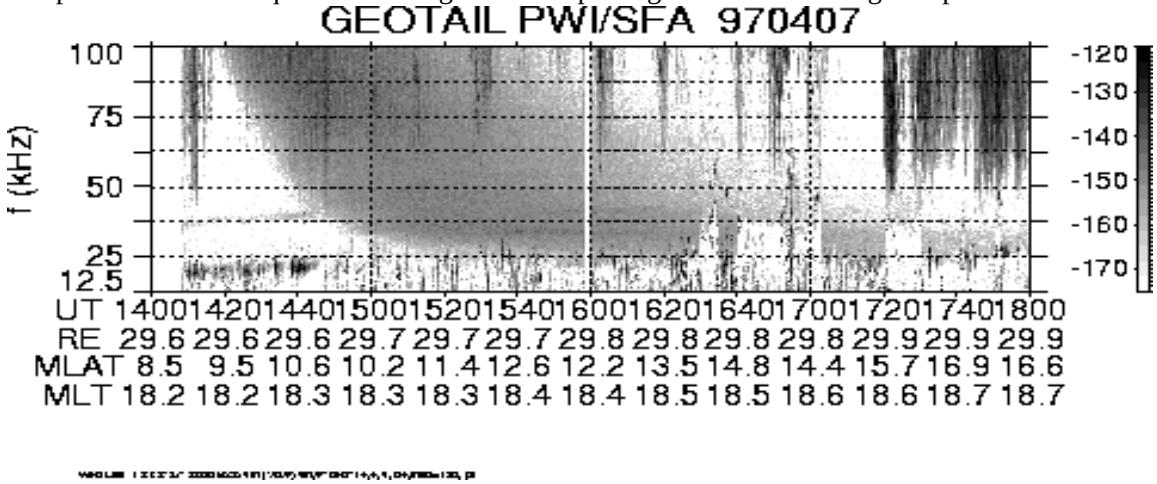

Figure 1. Solar type III bursts observed on April 7, 1997.

2. Observations

The type III solar bursts are emitted from the interplanetary medium and their intensities do not depend on observed positions outside of the magnetosphere. Solar electron beams radiate the bursts at their plasma frequency or twice of that. Their frequencies decrease as the beams expand and become less dense. An example of the bursts observed by Geotail at 30 Re on April 7, 1997 is shown in Figure 1. This is also observed by WIND at 230 Re and their intensities are compared at 40 kHz in Figure 2. The triangles are intensities observed by Geotail and shows bursty nature. The plus signs are those of WIND averaged for 1 minute. The bursts were observed between 1500 and 1620 UT at 40 kHz. Their intensities are very close each other when they were observed. The intensities observed by both satellites are confirmed to be well calibrated.

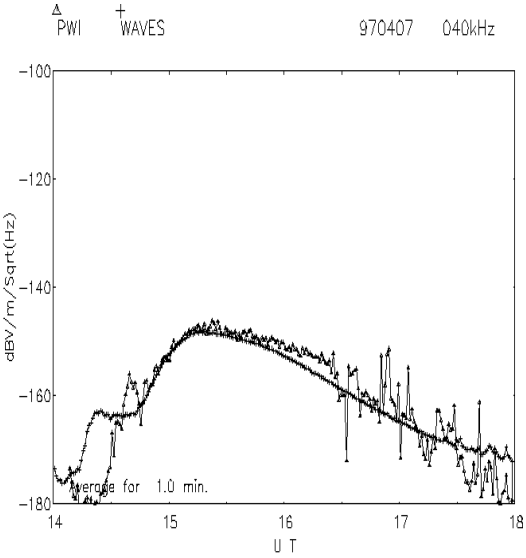

Figure 2. Intensities of type III bursts at 40

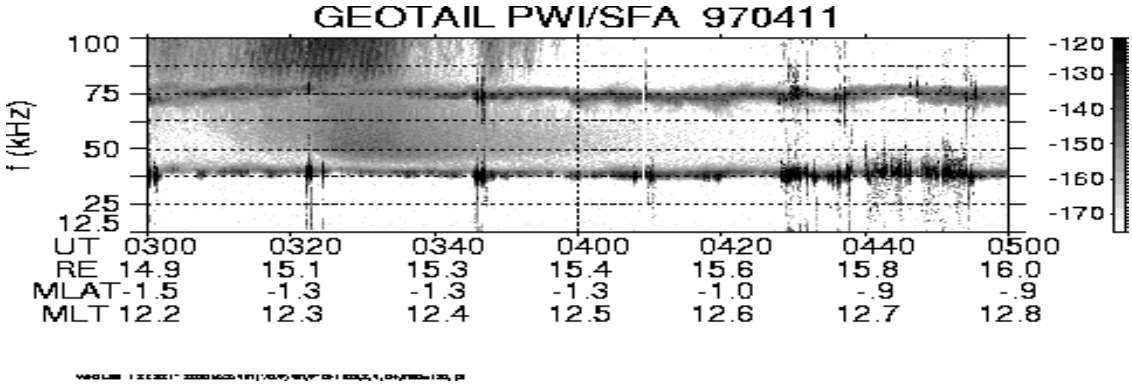

Figure 3. LF bursts observed on April 11, 1997.

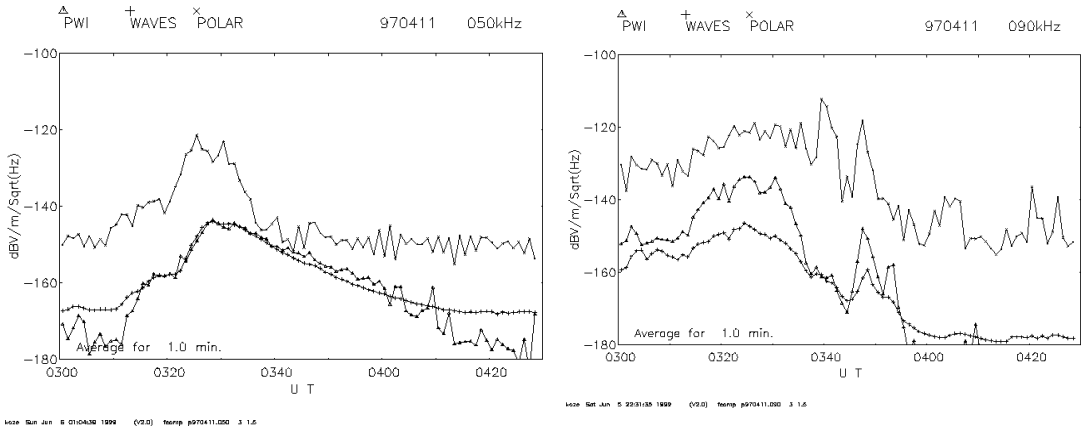

Figure 4. Wave intensities observed on April 11, 1997. (a) left: 50 kHz and (b) right: 90 kHz

Figure 3 shows an example of LF bursts observed by Geotail after 0305 UT on April 11, 1997. The local fp is about 39 kHz and 2fp line is about 75 kHz. They are observed between them with a tail-like structure. AKR is observed above 80 kHz. Wave intensities observed by the three satellites at 50 kHz and 90 kHz are shown in Figures 4 (a) and (b), respectively. The triangles, plus signs, and crosses indicate the intensities by Geotail, WIND, and Polar, respectively. Geotail was in 15 Re and WIND was 230 Re near the local noon in the solar wind outside of the magnetosphere. In Figure 4, intensities observed by Geotail and WIND are almost same although the distances from the earth are quite different. They last about one hour. This suggests that their sources are far from the earth. No spin modulation was observed. This is consistent with the scattering from the tail [2]. Those by Polar are, however, stronger by about 20 dB. They last only 15 minutes. Polar was about 7 Re near the midnight at the latitude of 68°. This is consistent with that the source is in the magnetosphere. The duration in the solar wind may extend when or after scattering from the tail. On the other hand, AKR intensities at 90 kHz observed by Geotail are 10 - 15 dB stronger than those by WIND. This is explained by the difference of the distances from the earth. Polar was close to the source and observed the strongest AKR. This case is also reported in [3] with each spectrum, geomagtetic field data, etc. although intensities are not discussed.

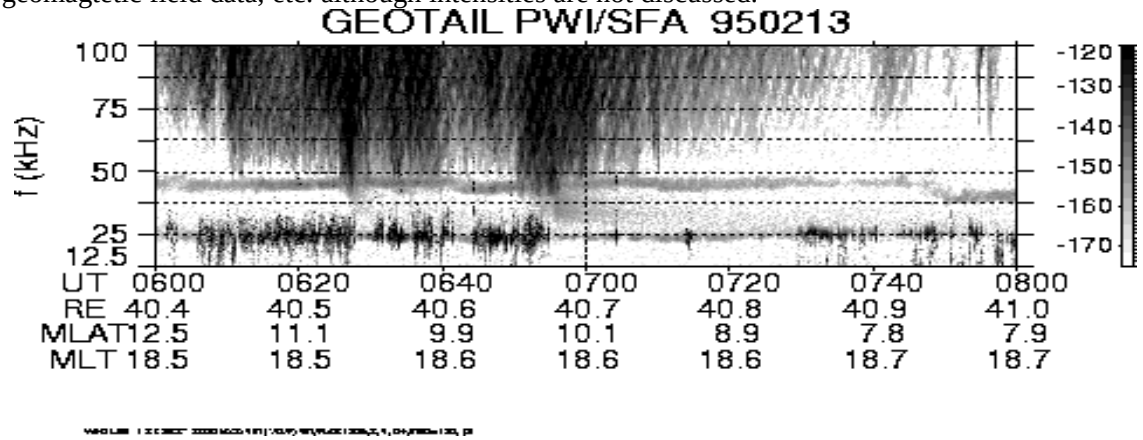

Figure 5. LF bursts observed on February 13, 1995.

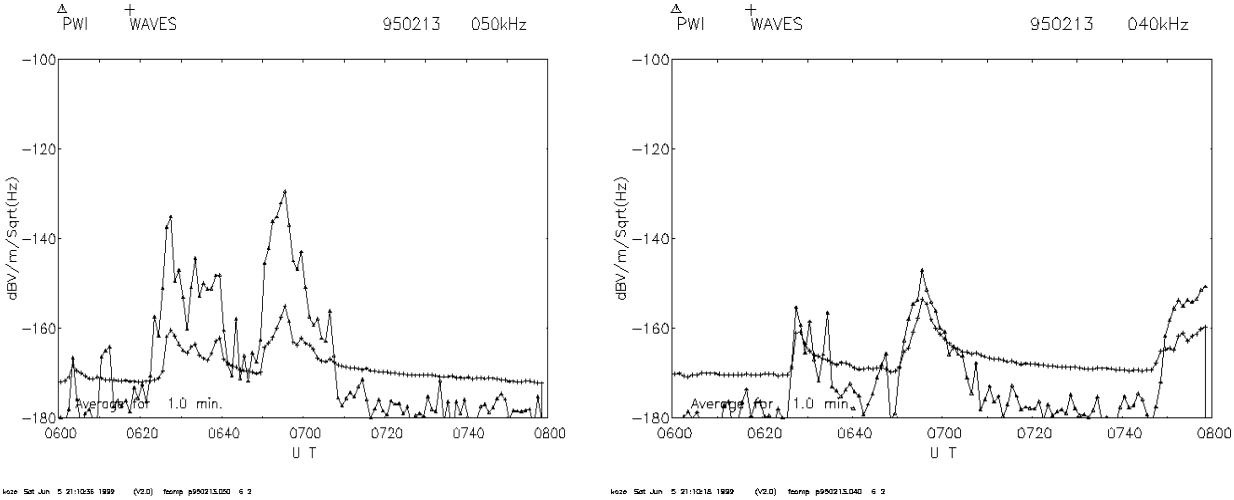

Figure 6. Wave intensities observed on February 13, 1995. (a) left: 50 kHz and (b) right: 40 kHz

Figure 5 shows other examples of LF bursts observed after 0625 and 0650 UT on February 13, 1995. Figure 6 compares the intensities observed at (a) 50 kHz and (b) 40 kHz by Geotail and WIND. The frequency of 2fp was about 45 kHz in this case. Geotail was at 40 Re and 18.5 LT, in the evening side outside the magnetosphere. WIND was at 200 Re and 11 LT. AKR observed at 50 kHz by Geotail is about 30 dB stronger than that by WIND as shown in Figure 6 (a). LF bursts at 40 kHz are only 4 dB stronger in Geotail as shown in Figure 6 (b). This might be caused by the fact that Geotail in the evening side although further study is necessary.

3. Discussion

The first intensity comparisons of LF bursts among multiple satellites indicate that their intensities are quite similar in the solar wind (outside the magnetosphere). This fact has been confirmed by many other observations. They are stronger inside the magnetosphere. These characteristics are quite different from AKR, which can pass through the magnetosphere and whose intensities depend on the distance from the earth. The present observations are consistent with the hyposesis that LF bursts is generated in the magnetosphere and scattered far down the tail magnetosphere. Further analyses are necessary to obtain intensity distributions in the magnetosphere and identify the source.

References

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