Occurrence characteristics of Jovian hectometric radio emissions.

Fumimaru Nakagawa[1], Akira Morioka[2], Hiroaki Misawa[1]

[1] Planet. Plasma and Atmos. Res. Cent., Tohoku Univ., [2] Planet. Plasma and Atmos. Res. Cent.,Tohoku Univ.

In the Jovian magnetosphere and also from the polar ionosphere, nonthermal radio emissions from below 10 kHz to above 3 GHz are radiated, being resulted from the free energy supply from the hot plasma and energetic particles. These planetary radio waves, therefore, provide the important information on the magnetospheric plasma environment and dynamics. In these radio emissions, Jovian hectometric (HOM) radiations are strongly emitted in the frequency range from 100 kHz to about 3 MHz. Observations of HOM emissions have been made only by spacecraft and satellites. By such reason, the detailed characteristics and sources of HOM emissions have never been well known.

In this study, we performed detailed analyses of the occurrence characteristics using the Ulysses, Galileo and WIND database, and the 3D ray-tracing analyses to confirm the statistical nature of HOM emissions, and to have some arguments on the source characteristics and the propagation of HOM emissions.

In the data analysis of Ulysses, the data were normalized with respect to a distance from Ulysses to Jupiter using the least square method, eliminating the constant noise component completely. Consequently, we could treat the exact intensity data of HOM emissions. The results of the analysis for the Ulysses data are summarized as follows:

(i)Occurrence characteristics of Jovian HOM emissions with respect to System III longitude were confirmed. It was found that HOM emissions have constant component which are observed in all System III longitude.

(ii)From cross correlation analysis, it was confirmed that HOM emissions have correlation with dynamic pressure of the solar wind. Furthermore, it was found that the correlation between HOM emissions and dynamic pressure has dependence of System III longitude. From this result, HOM emissions have been divided into two types, 'non solar wind related HOM' (nsw-HOM) and 'solar wind related HOM' (sw-HOM).

From the data analysis of Galileo, occurrence characteristics of Jovian HOM emissions were investigated.The results of the analysis of the Galileo data are summarized as follows:

(i)From the data, we discovered asymmetry between northern and southern HOM emissions.

(ii)It was found that particularly intense HOM emission at higher frequency is observed in the local time range from 21 LT to 4 LT around System III longitude of 0 (deg). The source of this emission is considered to be fixed on 0 (deg) in System III longitude and in the night side.

From the data analysis of WIND, for a 6-year period, long term occurrence characteristics of Jovian HOM emissions were investigated. The results of the analysis of the WIND data are summarized as follows:

(i)The long term variation of occurrence characteristics in System III longitude together with changes of Jovicentric latitude of an observer was confirmed.

(ii)It was pointed out that nsw-HOM emission should have dependence on the sunspot number.

Using the 3D ray-tracing, the occurrence characteristics of Jovian HOM emissions could be reproduced. The results for 3D ray-tracing simulation are summarized as follows:

(i)The occurrence characteristics of HOM emissions observed by Ulysses were well reproduced by the 3D ray-tracing estimation. From this result, it was found that the ratio of intensity of southern HOM emission to that of northern HOM emission is about 3.0, which is consistent with the Galileo observation, and the ratio of nsw-HOM intensity to sw-HOM intensity is about 2:1.

(ii)Assuming that both nsw-HOM and sw-HOM emissions are emitted through the same mechanism in the same electro-magnetic environment, the L-value of sw-HOM emission source is considered to be larger than that of nsw-HOM.