A new long baseline interferometer system for the observation of Jovian decametric radiation

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1. Introduction

It has been thought that the positions of Jovian decametric radiation sources cannot be determined with the accuracy of a few 10 arc seconds because of the enormous influence of the terrestrial ionospheric plasma. However, in Tohoku University, the long baseline interferometer observation has been carried out, since early 1980's, in order to identify the source positions of Jovian decametric radiation solving the ionospheric problems which disturb the stable interferometer function. Since 1995, a newly developed dual frequency interferometer system has been started in Tohoku University with 4 element stations of the long baseline interferometer observation. The results also show that the sources are located in the both polar regions. In this context, a further long baseline interferometer system with baseline length of 530 km has been developed with collaboration between Tohoku University and Fukui University of Technology (F.U.T.) where the Jovian decameter radio observation station has been built in the Awara observatory.

2. Ionospheric disturbances

In the long baseline interferometer observation with the baseline length over about 5 km, it has been well known that the observed fringe phases are fluctuated by the temporary variation of TEC (Total Electron Content) of the terrestrial ionospheric plasma. We must eliminate the TEC effects in order to detect accurate and stable source positions. The dual frequency interferometer, which has been established in the field of VLBI, is a powerful method to separate the information of source positions from the effects of TEC by solving the simultaneous equations. However, the problem caused by the dependence of the linear equations must be considered in the case of the observation of Jovian decameteric radiation. That is, it is difficult to separate the solution of source positions from TEC effect even we apply dual frequency method because of the dependence of the equations which is caused by the narrow character of frequency spectrum of Jovian decametric radiation. Based on a simulation study, we have showed that the following conditions are required in order to solve this problem; that is (i) the fringe phases are detected with accuracy under the standard deviation of 6 degree, and (ii) the temporal variation of TEC difference between two observation sites should be smaller than 5.0*10^15[1/m^2]. The observations in 2002 and 2003 were carried out based on the criteria deduced from the simulation results. As the results, the temporal variations of source positions are determined with the accuracy of +/-10 arcsec (The diameter of Jupiter is about 30 to 40 arcsec). This accuracy is sufficient to separate the temporal variation of source positions between the northern and southern polar region.

3. Significance of 500 km class baseline interferometer system

Another powerful method to overcome the problem of dependence of the equations is to increase the baseline length when the ionospheric condition is not change. Based on the basic feature of simultaneous equations used in the dual frequency interferometer observation, it is shown that the accuracy of solution of source positions increases proportionally to the baseline length. By participation of Awara observatory, the maximum baseline length becomes up to about 530 km (Awara - Yoneyama); this baseline length becomes almost 5 times as longer as the baseline length of the interferometer network of Tohoku University. It is expected that the temporal variation of source positions is measured with the accuracy of +/- 2.0 arcsec by the observations using 500 km class baseline interferometer system. This accuracy will enable us to detect the temporal variation of source positions corresponding to the east-west distribution of Jovian auroral region.