Simulation of propagation of VHF overseas TV broadcasting waves scattered by equatorial plasma bubbles

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We have made continuous observation of VHF wave s with the LPDA(Log-Periodic Dipole Array) antenna setteled in Tateyama, Chiba prefecture, and the overseas TV broadcasting waves in frequency of 50-75MHz have been observed at 20-24LT in equinox seasons. On the other hand, equatorial plasma bubbles are observed in Sata, Kagoshima prefecture, at the same time as that of the reception of TV waves. The purpose of this study is the calculation of the ray-path of these TV waves in consideration of the equatorial plasma bubbles and VHF waves for TV broadcasting observed in Tateyama.

Plasma bubble is the phenomenon in which plasma density decreases locally (2 or more figures), in the ionosphere (F layers).After appearing in a magnetic equatorial region from the evening to night of spring and autumn, it goes up to 1000km or more, and it is spread along with magnetic field line.Inside, it has an irregular density distribution of scale of several meter.If the VHF wave whose wavelength is several meter rushes in into a bubble, it will be scattered ,owing to this plasma irregularity.The scattered directions are the directions which make p(angle) between magnetic field and themselves, when the angle between the magnetic field in a rushing point and the propagation direction of the wave is set to p. Since bubble is field-aline structure, if we obtain the magnetic field line extended from the plasma bubble's position observed in Sata (an altitude is 250km), the distribution of it will be obtained easily.Then, we modeled plasma bubble by virtue of the magnetic field line obtained using the IGRF model.It has the shape of a board which is perpendicular to the surface of the earth and extended in the direction of latitude.

In this study, the Ray-tracing method is used as a method of calculating the wave propagation path. This calculates the propagation path from transmitting point to receiving point in determining the propagation direction of the wave by change of refractive index.Then, the simulation of the propagation path of the wave by the Ray-tracing method was performed in consideration of the influence of scattering by the plasma bubble.

In this research, the example November 12, 2001 was verified. The plasma bubble was observed to the position of north latitude 27-33[deg]east longitude 127[deg] about 23 o'clock of the same day, and reception power increased at some frequencies (50-75MHz) at 20-24 o'clock in Tateyama. Then,we regarded waves (59.75,65.75,71.75MHz) thought to have been transmitted from Philippines.

First of all,we simulated about the wave of 59.75MHz. The wave became resulted in coming to Tateyama at 23 o'clock when both events were observed at the same time.Secondly, when 65.75 and 70.75MHz were similarly simulated, it became a result that the wave came respectively. It agrees with the observation that doesn't depend on the frequency, and the phenomenon can be explained by simulating.

Finally, the area, where the plasma bubble expected to exist so that the wave transmitted from Philippines reachs to Tateyama, has been searched for by calculating.

As mentioned above, the VHF wave observation in Tateyama City and the correlation of the plasma bubble were confirmed by the simulation in this research. Moreover, we obtained the position of the plasma bubble so that the wave having been transmitted from Philippines is observed in Tateyama.