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あらせ衛星で観測された NWC 送信局信号の伝搬特性解析

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Propagation characteristics analysis of NWC transmitter signals observed by the Arase satellite

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Propagation direction of plasma waves is crucial to understand the environment of the terrestrial inner magnetosphere. Several methods have been proposed to determine the propagation direction of plasma waves using electromagnetic field data obtained by scientific satellites. However, evaluating the accuracy of determined direction of natural plasma waves is difficult because there are several uncertainties to compare with the theoretical wave propagation direction. In this study, we analyze the propagation direction of artificial signals transmitted from the North West Cape (NWC) transmitter in Australia using the electromagnetic waveform data observed by the Arase satellite. We statistically evaluate the propagation characteristics to validate the accuracy of the estimation results.

First, considering the characteristic that a VLF signal propagate roughly along a magnetic field line, we extract the time periods when the magnetic footprint of Arase was in ± 10 degrees geographic latitude and longitude from the position of NWC station. Second, we collect the NWC signal events from the waveform data observed by the Waveform Capture (WFC) of the Plasma Wave Experiment aboard the Arase satellite. We analyze the electromagnetic power spectrum, WNA (wave normal angle), polarization, planarity, and the angle of pointing vector against the magnetic field line of the signals to investigate their characteristics. We found that the amplitudes of the signals were modulated in many of the cases, and the WNAs of these events showed rapid changes within a short period. We also conduct a hodograph analysis of the events, and confirmed that most of events is plausibly a single wave. As a next step, we investigate the relationship between amplitudes and WNAs, revealing a positive correlation between the signal amplitude and the stability of the WNA. We determine a typical WNA by taking a moving average of the sum of squares of the amplitudes with a 5-degree interval and normalized it by the observation time length. Finally, we investigate the relationship between the determined WNA and the magnetic latitude of the observation point. The results showed that the WNA tended to increase as the distance from the NWC station increased.