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A study of the noise integration kernel in the wave distribution function method considering different signal to noise ratio among sensors

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The analysis of plasma waves obtained from in-situ observations by scientific satellites is an effective method to investigate the space plasma environment. Direction finding of plasma waves provides important information for understanding not only local plasma environment but also the global features about space plasma, because of propagation characteristics of plasma waves.

One of the methods about direction finding is the wave distribution function (WDF) method[1, 2], which derives directional distribution of wave energy density using a priori information such as the propagation mode, plasma density and geomagnetic field intensity. The WDF method is attracting attention as a method to realize detailed propagation analysis of plasma waves, as this method can be applied when multiple waves are superimposed or the wave source is widely distributed.

Among the solutions of the WDF methods, the Markov random field model (MRF)[3] is known as a robust model that provides accurate estimation results even in noisy environments. The MRF takes into account an integration kernel corresponding to white noise (noise integration kernel) used for the estimation, which improves the robustness. The noise integration kernel is conventionally designed under the assumption that the noise levels of all electromagnetic field sensors are equal. However, the noise levels of the electromagnetic field sensors on board a scientific satellite often change due to the degradation of the sensors during long-term operation period of the instruments.

In this study, we propose some methods to design the noise integration kernel to obtain robustness even in the different noise levels among sensors. We evaluate the effectiveness of these methods by simulation.

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References

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