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Tracking the Upper Hybrid Resonance Emission in the Inner Magnetosphere using a Convolutional Neural Network

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Electron number density is a key parameter for plasma wave generation, propagation and wave-particle interaction in the inner magnetosphere. Typical regions in the inner magnetosphere are characterized by the distinctive electron density profile (e.g., plasmasphere, plasma trough and plasma plume.) The most popular way to determine the quantitative electron density is observing the upper hybrid resonance (UHR) emission. The High Frequency Analyzer (HFA), which is a subsystem of Plasma Wave Experiment (PWE) aboard Arase, measures electric field power spectra in a wide frequency range (0.1-10 MHz) with a time resolution of 8 or 60 s [1, 2]. This covers a typical frequency range of the UHR emissions in the inner magnetosphere. In this paper, we propose a technique for automatically determining UHR frequencies using a Convolutional Neural Network (CNN) to derive the electron density along the orbit of Arase [3, 4]. We investigate the practical capability of this technique in terms of actual scientific use case. We find that the average error rate is below 7.8% of the wave frequency when the wave frequency is above 30 kHz and the wave spectral intensity is less than 10^{-5} $mV^2/m^2/Hz$. Approximately 91% of the data obtained by the HFA satisfies these conditions. Moreover, we find that the UHR frequency can be determined with good accuracy both during geomagnetically quiet and disturbed conditions.

References

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