Study on the pulse noise removal technique for Pc1 geomagnetic pulsations on the ground by signal processing

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An electromagnetic ion cyclotron (EMIC) wave, which is a type of plasma waves generated in the magnetosphere, propagates along the geomagnetic field line and we can observe it as the fluctuation in the geomagnetic field on the ground called Pc1 geomagnetic pulsation (0.2 to 5 Hz). We observe Pc1 pulsations at Kapuskasing (Canada). The ground observation is carried out using an induction magnetometer, and the Pc1 pulsations are observed with a high sensitivity and a high time resolution (64 Hz). However, when the observation instrument vibrates due to a strong wind, pulse noise is included in the observed waveforms.

We have been studying an extracting method of Pc1 pulsation by removing the pulse noise included in observed waveform using signal processing technique. Pulse noise shows in a wider frequency range (0.1 to 10 Hz) than the frequency range of Pc1 pulsation and its duration is shorter than the duration of Pc1 pulsation. Pulse noise removal consists of detecting the pulse noise candidate, classifying the pulse noise candidates into pulse noises and others by Neural Network (NN), and interpolating the waveform at the pulse noise domain. In the first step, we set an amplitude threshold for the differential waveform to detect pulse noise candidates. In the second step, as learning data for classification, we use waveform applied a High Pass Filter (HPF) to emphasize pulse noises. In the third step, we use an average energy around the pulse noise in the interpolation. We use random phase, observation phase including the pulse noises, and estimated phase by nonlinear least squares method. For each phase, we evaluated the SNR before and after the pulse noise removal. As a result, the SNR improved with 22dB using the estimated phase, but it requires a huge calculation time.

In this presentation, we will report on the pulse noise removal of Pc1 pulsation using signal processing technique in detail. Conventionally it was necessary to examine and construct the observation environment which suppresses the vibration of the observation equipment as much as possible, we think that our signal processing will be useful for reducing the ground observation costs and a more detailed analysis of Pc1 pulsation.

Keywords: Pc1 geomagnetic pulsation, Noise removal, Signal processing