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Signal Discrimination of ULF Electromagnetic Data with Using Singular Spectrum Analysis and Principal Component Analysis

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Various electromagnetic phenomena associated with the crustal activity have been reported in a wide frequency range (DC-HF). In particular, ULF electromagnetic phenomena are the most promising among them because of the deeper skin depth. But sometimes ULF electromagnetic data contain spontaneous or impulsive variations caused by interactions between the geomagnetic field and the solar wind, leak current originated from a DC-driven train (train noise), and precipitation. In generally, intensity of electromagnetic signals associated with the crustal activity is smaller than above variations. Therefore, it is important that how to identify the other intense and spontaneous changes. In this paper, we have developed algorithms to detect or remove the above changes using Singular Spectrum Analysis and Principal Component Analysis. As a result, we can detect geomagnetic storms generally, and mostly remove such variations. In terms of variation from train noise and precipitation, we can not remove such changes. But it is found that we can detect such changes mostly. The train noise detection enables to analyze the daytime data although we did not use them for investigation on earthquake-related ULF electromagnetic phenomena so far.

Keywords: ULF, electromagnetic field, Singular Spectrum Analysis, Principal Component Analysis, train noise, detection