Singular Spectral Analysis and Principal Component Analysis of ULF Geomagnetic Data Associated with the 2000 Izu Island Earthquake Swarm

***Katsumi Hattori*[1] *and Daishi Kaida*[2]**

[1]Graduate School of Science, Chiba University, Chiba, Japan
E-mail: hattori@earth.s.chiba-u.ac.jp

[2]Graduate School of Science and Technology, Chiba University, Chiba, Japan

Abstract

ULF geomagnetic data (frequency range 0.001 ~ 1 Hz) are consider a superposition of signals of different origins. The first one is originated from the external source field associated with the solar-terrestrial interactions such as the geomagnetic pulsations or geomagnetic storms, and their induced field, which appear in the global (hundreds of km) scale. The second one is the regional (a few tens of km) signals such as artificial noises associated with the leakage current from DC-driven trains, and signals propagating under the ground, which are considered earthquake-related signals and to be detected. The third one is local signal associated with motion of magnetized objects such as cars. In order to detect the weak earthquake-related signals, the effective signal discrimination will be required. In this paper, the singular spectrum analysis (SSA) has been adopted to develop the signal discrimination method for removing the most intense global noises. We perform SSA to the site data and the reference data and the both data are decomposed to a lot of principal components. The correlation among the principal components is investigated. When we remove the high correlated principal components from the original time series, the common global variation have disappeared.

The effectiveness of the global noise reduction using SSA has been examined using the principal component analysis. We adopt PCA to the time series data after noise reduced observed at closely spaced stations, Seikoshi (SKS), Mochikoshi (MCK), and Kamo (KAM) stations. Then, PCA have been adapted to the time series data sets filtered at 0.01 Hz of NS component at three stations. The major findings are summarized as follows. (1) It is important to apply simultaneously SSA and PCA. SSA removes the global noises and 0.01 Hz filter remove the shaking effects of the sensors. (2) There is a significant advantage using PCA with the SSA filter. This yields that the anomalous changes in the second principal component were detected more clearly, and the contribution of the second principal component is found to be about 20%. It is enough to prove mathematical accuracy of the signal. Further application is required to accumulate events. These facts demonstrate a possibility of monitoring the crustal activity with using the PCA after SSA filtering.