Principal component analysis and singular spectrum analysis of ULF geomagnetic data associated with earthquakes

Serita A., Hattori K., Yoshino C., Hayakawa M., Isezaki N.

Graduate School of Science and Technology, Chiba University, Inage, Chiba 263-8522, Japan; Japan Defense Agency, Tokyo, Japan; Marine Biosystems Research Center, Chiba University, Inage, Chiba 263-8522, Japan; The University of Electro-Communications, Chofu, Tokyo 182-8585, Japan; Department of Earth Science, Faculty of Science, Chiba University, Inage, Chiba 263-8522, Japan

Abstract: In order to extract any ULF signature associated with earthquakes, the principal component analysis (PCA) and singular spectral analysis (SSA) have been performed to investigate the possibility of discrimination of signals from different sources (geomagnetic variation, artificial noise, and the other sources (earthquake-related ULF emissions)). We adopt PCA to the time series data observed at closely separated stations, Seikoshi (SKS), Mochikoshi (MCK), and Kamo (KAM). In order to remove the most intense signal like the first principal component, we make the differential data sets of filtered 0.01 Hz SKS-KAM and MCK-KAM in NS component and 0.01 Hz band. The major findings are as follows. (1) It is important to apply principal component analysis and singular spectral analysis simultaneously. SSA gives the structure of signals and the number of sensors for PCA is estimated. This makes the results convincing. (2) There is a significant advantage using PCA with differential data sets of filtered (0.01 Hz band) SKS-KAM and MCKKAM in NS component for removing the most intense signal like global variation (solar-terrestrial interaction). This provides that the anomalous changes in the second principal component appeared more sharply. And the contribution of the second principal component is 20-40%. It is large enough to prove mathematical accuracy of the signal. Further application is required to accumulate events. These facts demonstrate the possibility of monitoring the crustal activity by using the PCA and SSA. © 2005 Author(s). This work is licensed under a Creative Commons License.

Authors with affiliations:

1. Serita, A., Graduate School of Science and Technology, Chiba University, Inage, Chiba 263-8522, Japan, Japan Defense Agency, Tokyo, Japan

2. Hattori, K., Marine Biosystems Research Center, Chiba University, Inage, Chiba 263-8522, Japan

3. Yoshino, C., Marine Biosystems Research Center, Chiba University, Inage, Chiba 263-8522, Japan

4. Hayakawa, M., The University of Electro-Communications, Chofu, Tokyo 182-8585, Japan

5. Isezaki, N., Department of Earth Science, Faculty of Science, Chiba University, Inage, Chiba 263-8522, Japan