# Correlation between ULF electric field changes and sizeable earthquakes around Kakioka station, Japan

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There have been many reports of anomalous ULF (ultralow frequency) electromagnetic field changes related to earthquakes. Case and statistical studies have been performed on anomalous fluctuations in ULF magnetic field data, and they showed statistically significant correlations with earthquakes and statistical assessment for earthquake precursors. On the other hand, there are few statistical studies for electric field data. Therefore, in this study, we investigated statistical correlation between anomalous ULF electric field change observed at Kakioka station (KAK) and sizeable earthquakes near the station. The analyzed period is a 26-years period from January 1, 1993 to December 31, 2018. At KAK, the EW and NS components of the electric field are measured at baseline lengths of 180 and 190 m, respectively. In this study, one-minute data was used for analysis.

Observed electric field data contain the effects of artificial noises originated from trains and factories, as well as natural effects of rainfall and geomagnetic storms. Only night time data from 01:00 to 04:00 (LT) were used to reduce the effect of artificial noises. We confirmed that there was almost no effect of rainfall. In addition, geomagnetic storm effects are well contaminated and should be removed, so we removed the effects. The number of the observed data is 180 per a day as a total for EW and NS components, and the median, standard deviation, skewness, and kurtosis have been computed, and the obtained value was used as a representative value for one day. Anomaly was defined when the calculated standard deviation, skewness, and kurtosis data exceed the range of the median ±1.5 IQR (interquartile range).

Here we mention the day of the target earthquake for the analysis. We select the day when the Es index (Earthquake energy per day felt in the station) exceeds 10 to the 8th power at KAK, and check that there was no target day (the day when the Es index exceeds 10 to the 8 power) before and after 30 days, that is, we analyze only the isolated earthquake day the day.

As a result of the case studies, there were days when anomalies were seen before and after the earthquake and days when anomalies were seen even without earthquakes, so we decided to use statistical analysis. SEA (Superposed Epoch Analysis) method was used for the statistical analysis. As a result, it was found that the standard deviation showed statistical significance 10 to 6 days before the earthquake and the kurtosis 16 to 20 days after the earthquake. At least in the standard deviation, it was confirmed that a significant ULF electric field data anomaly preceding the earthquake appeared. The detail results will be given in the presentation.

 