Detection of anomalous VHF radio wave propagation associated with earthquake by Artificial Intelligence

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There exist probably some relations between earthquakes and electromagnetic phenomena in a global scale. Short-term earthquake prediction is one of the most important research tasks for disaster prevention in a country with frequent earthquakes like Japan. There are many reports about geophysical electromagnetic phenomena associated with earthquakes. Geophysical electromagnetic phenomena can be observable by using electromagnetic wave propagation. Almost reports on the geophysical electromagnetic phenomena are classified into two groups, direct observations or indirect observations. In indirect observations, radio wave propagation is monitored for investigating precursor of earthquakes. The target radio waves are in VHF bands. There are many papers which report anomalous propagation in the VHF band waves from over-horizon broadcasting station. We have been observed broadcasting radio waves from line-of-sight region for several years. In this report, we investigated a new relationship between anomalous fluctuations in the radio waves, which propagated from line-of-sight region, and occurrences of earthquake. In our large deviation in received signal strength is considered, because observed data is distributed under the normal distribution. When received signal strength beyond 3 times standard deviation, they were regarded as anomalous data, which means the detection threshold level of anomaly. This analysis revealed anomalous fluctuations sometimes occurred associated with earthquake, but sometimes associated without earthquake. In order to clarify the detection of the anomalous fluctuations associated with earthquake, we employed the artificial intelligence. We employed recurrent neural network (RNN) as deep learning algorithm for input continuous data. We use anomalous fluctuations in received signal strength as learning data. They are two types for training data, one is anomalous fluctuations associated with earthquake labeled as “1” data, and the other is anomalous fluctuations associated without earthquake labeled as “0”. Artificial intelligence distinguishes labels of anomalous fluctuations associated with earthquake from anomalous fluctuations. The number of data labeled as “0” is much more than the number of data labeled as “1”. In deep learning, we must equalize number of data labeled as “1” and number of data labeled as “0”. In order to equalize both number of data, we picked up continuous data including the period of the anomalous fluctuation. After deep learning, we can detect the anomalous fluctuations, which appear one day prior to earthquake near the wave propagation path. The detection of anomalous fluctuations by artificial intelligence is equal to or higher accuracy than conventional method. Our future works are to detect the anomalous fluctuations associated with earthquake more accurate than the result of this report by optimizing the deep learning.

Keywords: earthquake, anomalous propagation, artificial intelligence

