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Machine Learning for Detecting Time-Transient Phenomena in the Ionosphere and Correlation with Seismo-Induced Events

The ionosphere serves as a dynamic interface between Earth's atmosphere and space, characterized by intricate temporal fluctuations influenced by diverse terrestrial and extraterrestrial factors. This research investigates the significance of scrutinizing ionospheric anomalies for the detection of seismic event precursors. A key focus is on leveraging Machine Learning algorithms for the processing and analysis of extensive ionospheric electromagnetic spectrum data obtained from observations by the Demeter satellite for the duration of 6 years from 2005 to 2010. Our earthquake data involves around 8000 events with magnitude greater than or equal to 5.0, recorded in the duration of these 6 years. The study employs a grid-based approach, dividing the Earth into equal-degree grids (20x20), and defining eleven low-energy frequency bands of spectrum data. Notably, percentile values Q1, Q2, and Q3 are the primary features of interest. Analysis entails examining variations in percentile features across each grid location on Earth for the day and night orbit spectrum data. Utilizing diverse machine learning and deep learning algorithms enables the identification of anomalies in the data for each grid location. This yields a time series of anomaly indexes, facilitating the exploration of the relationship between anomaly occurrence and earthquake data, with potential implications for interpreting unknown data. In contrast to many current methods, our approach aims to objectively analyze data without biases, ensuring fair and impartial analysis, leading to more reliable findings. This study holds the potential for enhancing early warning systems and advancing earthquake understanding.

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