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A machine learning approach to investigate possible signals in the ionosphere related to earthquake activity

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A statistical analysis based on Machine Learning was performed to investigate the relationship between ionospheric magnetic field perturbations and earthquakes worldwide. Results show that supervised machine learning techniques are able to loosely identify seismic active regions on Earth from magnetic field measurements in the ionosphere.

These results are based on analysis of magnetic field data measured by the three Swarm satellites during the first two years of the mission and the full earthquake catalogue from USGS. We applied some filtering to these data to exclude from the analysis the intervals characterized by stronger perturbations induced by the Sun, such as the ionosphere at high geomagnetic latitudes, and the periods with more intense geomagnetic activity.

The Swarm and earthquakes data were both gridded geographically to enable temporal and spatial analysis to be performed separately. A number of supervised and unsupervised machine learning algorithms, including K-Means and Random Forest were applied to the Swarm magnetic field measurements to detect possible correlations between seismic events worldwide and magnetic perturbations in the ionosphere. The supervised techniques were trained with simple statistical features extracted from the magnetic field signals. To assess the results a 10-fold cross-validation approach was applied. This cross-validation found that seismically active regions could be identified from ionospheric measurements alone to a high accuracy.