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Advances in Space Research 72 (2023) 4420–4434

ADVANCES IN SPACE RESEARCH (a COSPAR publication)

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Applying support vector machine (SVM) using GPS-TEC and Space Weather parameters to distinguish ionospheric disturbances possibly related to earthquakes

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Received 5 September 2022; received in revised form 12 August 2023; accepted 16 August 2023
Available online 22 August 2023

Abstract

The effort to identify and comprehend potential earthquake-related phenomena shares a common goal: successful earthquake forecasting. Advancements in science and technology have made this goal multidisciplinary. Currently, possibly earthquake-related anomalies in the Vertical Total Electron Content (VTEC) of the Earth's ionosphere are being investigated. Global Navigation Satellite Systems (GNSS) can be used to calculate this ionospheric parameter. In this research work, GPS VTEC was calculated for periods between the years 2015 and 2019. The selection of this periods considered both seismically active and non-seismically areas in Mexico. The $M_w \geq 5$ earthquakes under study were registered by the National Seismological Service. Moreover, different geomagnetic storm and solar activity parameters, such as the geomagnetic equatorial Dst index and the F10.7 index, were analyzed. Additionally, the daily average and monthly mean number of sunspots (R, SSN, respectively) were included as a direct, long-term record of the development of the solar cycle. To the periods under study different statistical methods were applied, such as Mean-Square Error (MSE) and cross-correlation. The above aims to apply a machine learning technique capable of classifying between periods with seismic and non-seismic activity. The features were constructed using statistical data and results from the implemented analysis. Furthermore, Principal Component Analysis (PCA) was applied to reduce the feature vector dimensions, and accuracy scores were compute using k-fold cross-validation. The results from the Support Vector Machine (SVM) model indicated an accuracy of 88.9% for the training set, and an accuracy of 80% was obtained for the test set. One of the limitations of the current study was the sample size. However, the present initial approach for classifying seismic events from non-seismic periods using SVM demonstrated promising results when considering the indicated parameters and the days under study.

Keywords: Earthquakes; GPS-TEC; Geomagnetic and solar indices; Support Vector Machine; Statistics

1. Introduction

Controversy over the extent to which seismic precursors are considered a suitable factor in earthquake forecasting is

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https://doi.org/10.1016/j.asr.2023.08.028
0273-1177/