USE OF MACHINE LEARNING FOR ANALYZING IONOSPHERIC SIGNAL PERTURBATIONS PRIOR TO EARTHQUAKES

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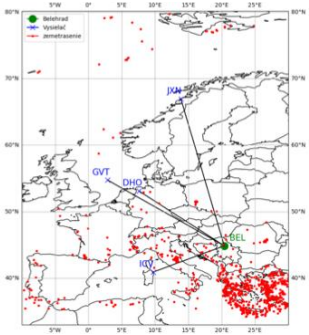
Introduction

This work focuses on analyzing the relationship between changes in the ionosphere and earthquakes using machine learning methods. Recently, changes in the ionosphere have garnered increasing attention as potential indicators of approaching seismic events, with shifts in signal amplitude andfrequency potentially offering valuable insights

Data

Data on ionospheric amplitude from several transmitters in Europe and earthquake data (mostly from Italy, Central Europe, and the Balkans) were used, focusing on earthquakes within a 250 km radius of the transmitter-receiver path. Data preprocessing included transforming time domain data into the frequency domain using the Fast Fourier Transform.



Location oftransmiters, receiver and detected eartquakes.

Modelling relations

The primary goal was to confirm the existence of a relationship between changes in the ionosphere and earthquakes through experiments conducted in both time and frequency domains using 6-hour data windows (3 hours before and 3 hours after the detected earthquake).

	Time domain			Frequency domain		
	Accuracy	F1	AUC	Accuracy	F1	AUC
Logistic regresion	**64**	**64**	**0.71**	64	64	0.67
Random forest	63	64	0.68	70	69	0.74
k-NN	60	60	0,66	62	61	0.72
SVM	**74**	**74**	**0.79**	**74**	**74**	**0.79**
FNN				68	69	**0.75**
CNN				**71**	**70**	0.74

Earthquake prediction

In the second experiment, the goal was 15-minute earthquake prediction using a 3-hour window in frequency domain. Multiple feed forward and convolutional neural networks were developed.

	Frequency domain		
	Accuracy	F1	AUC
FNN	**67**	**67**	**0.75**
CNN	65	65	0.70

Conclusion

The achieved results demonstrate that a relationship exists between changes in the ionosphere and earthquakes, as the models could identify earthquake features within the amplitude data. While the current accuracy is not sufficient for reliable prediction of seismic events, the work establishes a valuable foundation for further research.

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