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Optimizing Maximum Height Inferences through Neural Networks for the Spanish Tsunami Early Warning System

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Tsunami Early Warning Systems (TEWS) play a crucial role in minimizing the impact of tsunamis on coastal communities globally. In the NEAM region (North-East Atlantic, the Mediterranean, and connected Seas), historical approaches involve using Decision Matrices and precomputed databases due to the short time between tsunami generation and coastal impact. Overcoming real-time simulation challenges, the EDANYA group at the University of Málaga developed Tsunami-HySEA, a GPU code enabling Faster Than Real Time (FTRT) tsunami simulations. This code is successfully implemented and tested in TEWS of countries like Spain, Italy, and Chile, this code has undergone rigorous verification and validation processes.

In collaboration with the National Geographic Institute of Spain, we have extended the work previously done where we take advantage of the machine learning techniques and proposed a first approach to the use of neural networks (NN) to predict the maximum wave height and arrival time of tsunamis in the context of TEWS with very good results. This approach offers the advantage of minimal inference time and can be executed on any computer. It accommodates uncertain input data, delivering results within seconds.

As tsunamis are rare events, numerical simulations using the Tsunami-HySEA are used to train the NN model. This phase demands numerous simulations, necessitating substantial High-Performance Computing (HPC) resources. Approximately 300,000 simulations have been done to cover different faults in the Atlantic Ocean.

The goal is to develop neural network models for predicting the maximum wave height of such tsunamis at multiple coastal locations simultaneously. To cover Huelva and Cádiz coast, 78 points in the coastline have been selected for their predictions. The main importance of this work is that the models developed will be implemented in the Spanish TEWS which will produce an estimation of the tsunami impact in seconds.

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