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Deep learning models exploration for rapid forecasting of coastal tsunami impact in near field context – application to the French Mediterranean coastline.

Pierre Andraud[1], Audrey Gailler[1], Tom Sprunck[1], and Nicolas Vayatis[2]
[1]CEA, DAM, DIF, F-91297, Arpajon, France (andraudpierre@gmail.com)
[2]Université Paris-Saclay, ENS Paris-Saclay, CNRS, INSERM, Centre Borelli, F-91190 8 Gif-sur-Yvette, France

Tsunami warning systems currently focus on the first parameters of the earthquake, based on a 24-hour monitoring of earthquakes, seismic data processing (Magnitude, location), and tsunami risk modelling at basin scale.

The French Tsunami Warning Center (CENALT) runs actually two tsunami modelling tools where the water height at the coast is not calculated (i.e., Cassiopee based on a pre-computed database, and Calypso based on real time simulations at basin scale). A complete calculation up to the coastal impact all along the French Mediterranean or Atlantic coastline is incompatible with real time near field or regional forecast, as nonlinear models require fine topo-bathymetric data nearshore and indeed a considerable computation time (> 45 min). Predicting coastal flooding in real time is then a major challenge in near field context, the aim being a rapid determination of shoreline amplitude and real time estimation of run-up and currents. A rapid prediction of water heights at the coast by amplification laws or derived transfer function can be used to linearly approximate the amplitude at the coastline, with error bars on calculated values within a factor 2 at best. However, such approach suffers from a limited consideration of local effects and no run-up estimation.

The goal is there to add complexity to the predicted models through deep learning techniques, which are newly explored approaches for rapid tsunami forecasting. Several architectures, treatments and settings are being explored to quickly transform a deep ocean simulation result into a coastal flooding model. The models provide predictions of maximum height and run-up, maximum retreat, and currents in 1 second. However, such approach is dependent of a large scenario base for learning. This work presents preliminary comparisons of the coastal impact captured from nonlinear time consuming tsunami simulations (ground truth) with predicted localised tsunami responses provided by rapid forecasting deep learning approaches at 10 m resolution along the French Mediterranean, for several earthquake scenarios.