ML Surrogate for Tsunami Forecasting and Hazard Assessment in Eastern Sicily

PRESENTER:

Naveen Ragu Ramalingam

naveen.raguramalingam@iusspavia.it

www.linkedin.com/in/naveen-ragu/

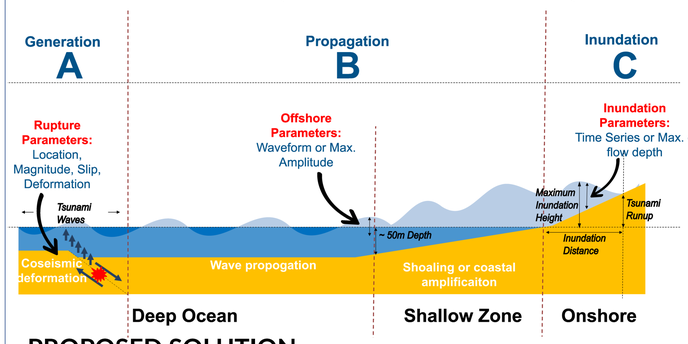
www.naveenragur.github.io

BACKGROUND

In the aftermath of a tsunami event, accurate and timely information on inundation and its impacts is crucial for effective emergency response and recovery efforts.

CURRENT METHODS AND CHALLENGES

- Full tsunami forward modelling based on earthquake source information is typically conducted, but the computational power and data needed is not always available in real-time for high-resolution simulation.
- Long term hazard assessment (PTHA) requires the simulation of large numbers of inundation scenarios to capture the aleatory and epistemic uncertainty.



PROPOSED SOLUTION

- Alleviate this ***computational burden*** by leveraging machine learning surrogates - an ***encoder-decoder neural network*** trained on synthetic tsunami data.
- Offshore tsunami waveforms are used as basis for predicting high-resolution inundation at ***10m grid cells***.
- Input can be derived from offshore ***tsunami sensors*** in real time or ***low-fidelity*** tsunami propagation models.
- When nearfield events are considered, we also use ***local deformation*** fields as an additional input.

SUMMARY: Evaluation of Tsunami ML surrogate with a large simulation database, incorporating local deformation effects, relevant to PTHA and PTF.

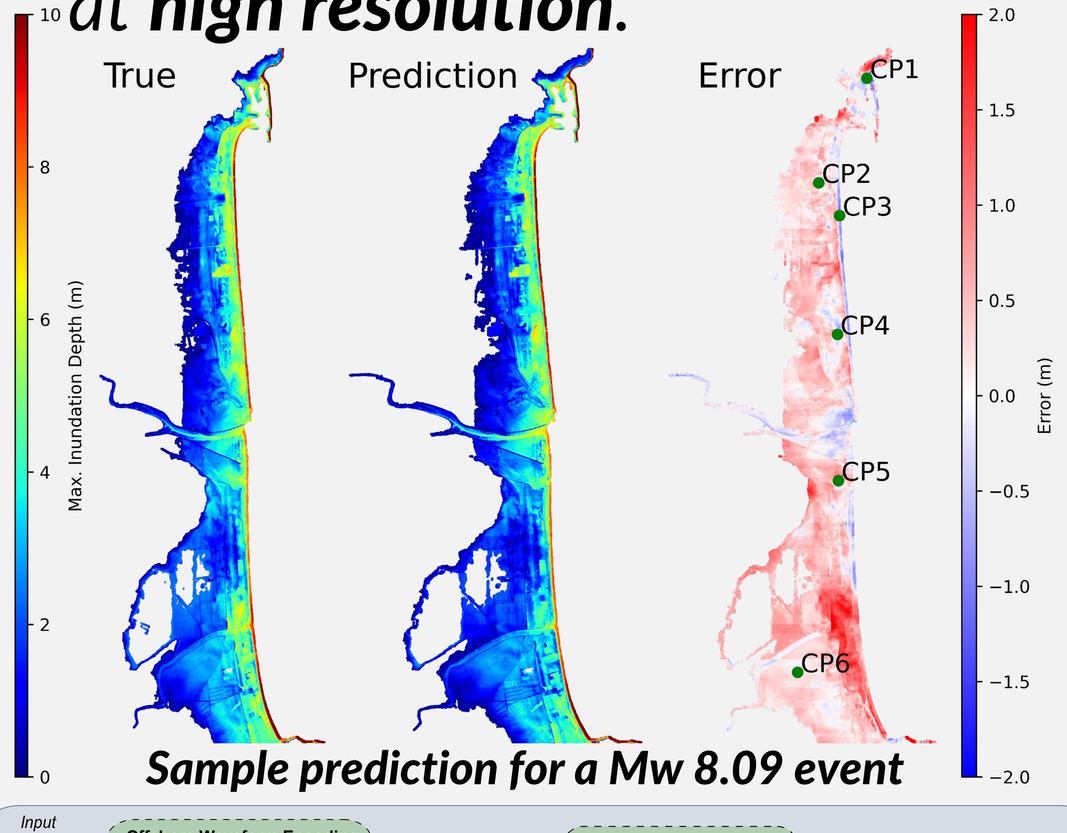
This presentation participates in OSPP

EGU

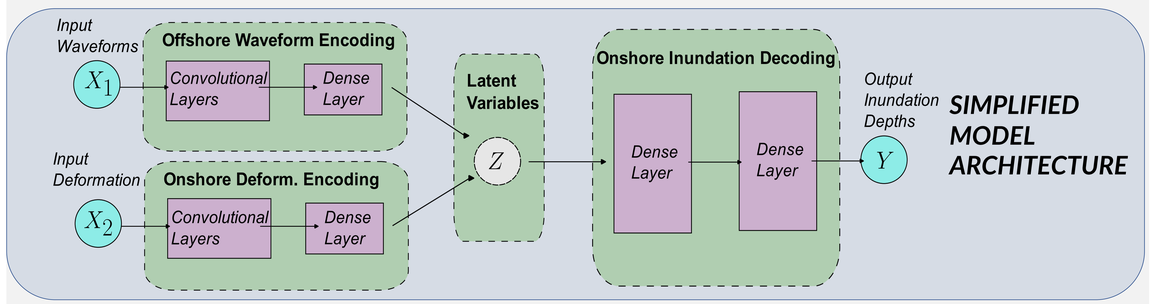
Outstanding Student & PhD candidate Presentation contest

Sharing is encouraged

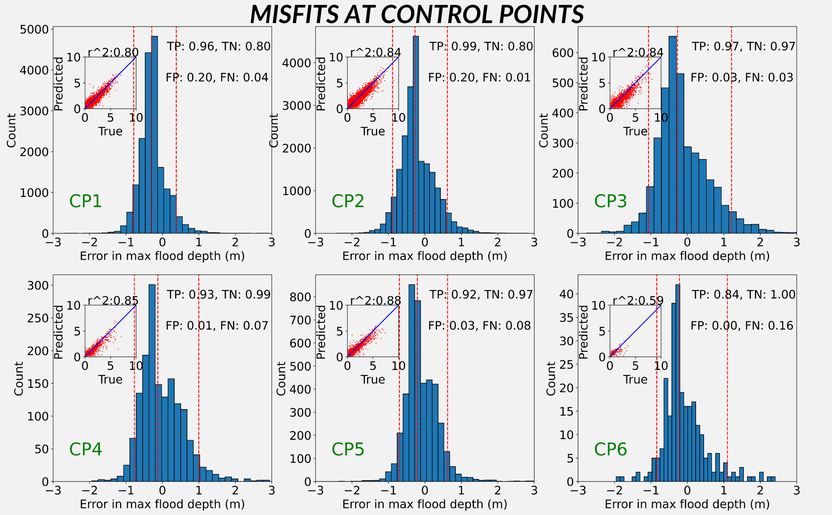
Accelerating tsunami predictions at high resolution.



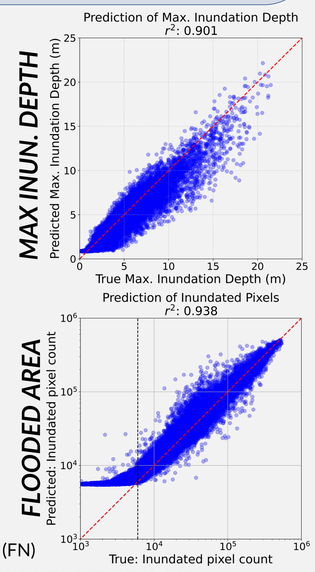
Sample prediction for a Mw 8.09 event



MISFITS AT CONTROL POINTS

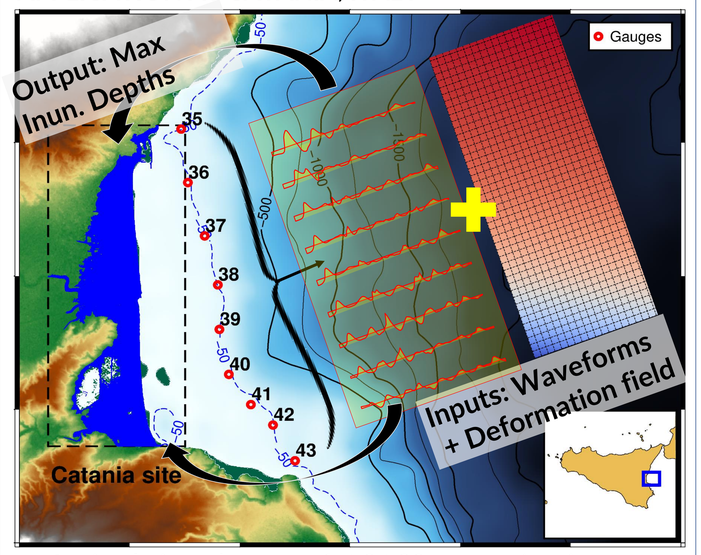


From a confusion matrix: True Positive (TP),True Negative (TN), False Positive (FP) and False Negative (FN)

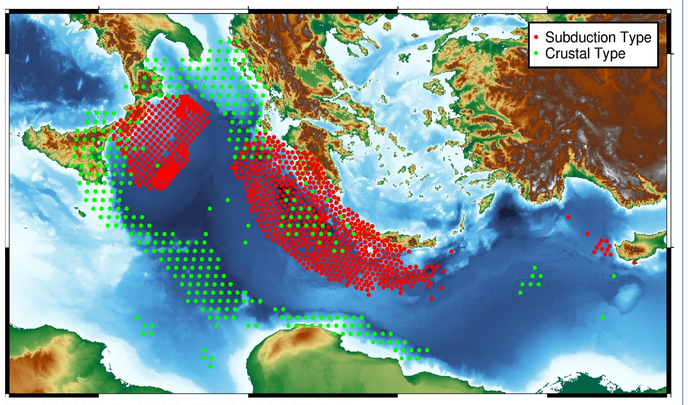


PERFORMANCE CHECK ACROSS 53,500 EVENTS SIMULATION DATABASE

APPLICATION AT CATANIA, ITALY



- A simulation dataset of ***53,500*** tsunamigenic events, each with waveforms simulated at gauge locations (35-43), deformation field and max. inundation depth across ***593,642*** **grid cells.**
- Earthquakes with magnitude M_w ***6.5-9.02*** from the ***Subduction and Crustal Events*** in the Mediterranean Sea.



TRAINING AND EVALUATION

- Training data of ***1,650 events*** for split in ***75:25 for training and validation*** and evaluated on ***full simulation set*** for testing.
- A ***pretraining - finetuning*** approach is used to efficiently build the ML surrogate.

Naveen Ragu Ramalingam[1], Erlend Briseid Storrøsten[2], Steven Gibbons[2], Kendra Johnson[3], Gareth Davies[4], Alice Abbate[5,6], Stefano Lorito[5], Manuela Volpe[5], Fabrizio Romano[5], Finn Løvholt[2], Marco Pagani[3,7], and Mario Martina[1]

[1]*The University School for Advanced Studies - IUSS Pavia, Pavia, Italy*

[2]*Norwegian Geotechnical Institute, Oslo, Norway*

[3]*Global Earthquake Model(GEM) Foundation, Pavia, Italy*

[4]*Geoscience Australia, Canberra, Australia*

[5]*Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy*

[6]*University of Trieste, Dept of Mathematics and Geosciences, Trieste, Italy*

[7]*Institute of Catastrophe Risk Management, NTU, Singapore*