SnT 2025
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Real Time Global Assessment of Tsunami Risks Using Acoustic Gravity Waves

Usama Kadri[1] , Ali Abdolali[2], Maxim Filimonov[3]

[1] School of Mathematics, Cardiff University, UK
[2] Earth System Science Interdisciplinary Center, University of Maryland, US
[3] School of Computer Science, Cardiff University, UK

Introduction

We developed a real-time acoustic monitoring technology that detects and classifies geophysical events, initially developed for tsunami early warning, by integrating physics-based computational models with machine-learning. The system works in real-time and require no pre-calculations. It estimates source characterisation (location, magnitude, and fault dynamics) and maps risk areas and trajectories in real time, supporting rapid, actionable response. Designed to complement existing warning frameworks, it is flexible enough to extend to underwater explosions and other seismic activities.

Results

- Validated on real-time & historical events with robust performance, demonstrating accurate, timely situational awareness.
- Global-scale analyses complete in seconds on standard multi-core machines, enabling operational use.
- Real-time outputs include source characterisation (location, magnitude, faulting) and risk/trajectory maps for decision support.
- By addressing key challenges, false alarms, non-seismic tsunami and response delays, the system enhances global monitoring and disaster preparedness for decision-makers.

Introduction: Global Real-time Early Assessment of Tsunami (GREAT)

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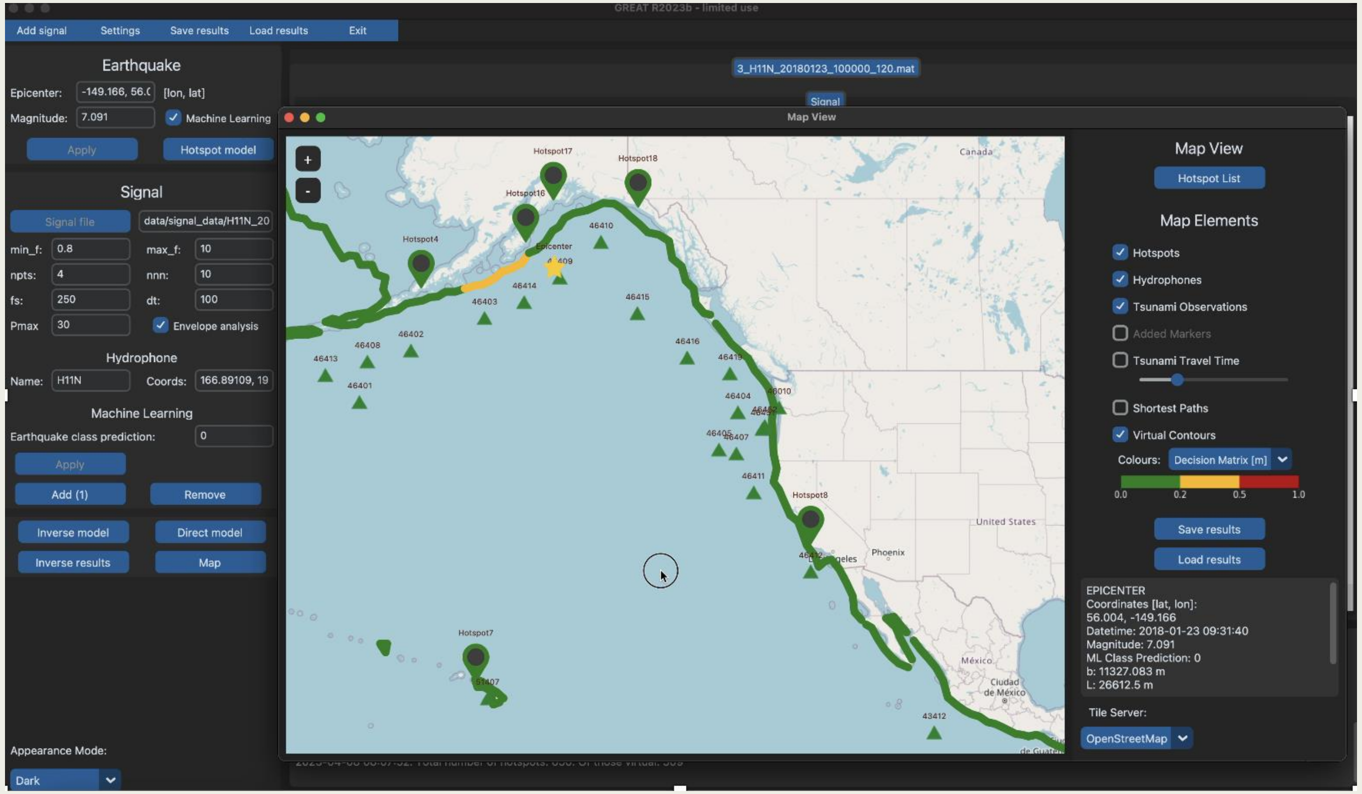
GREAT v1.0 is a real-time tsunami assessment tool that exploits co-generated **acoustic signals** to infer source parameters (location, magnitude, strike mode) and to **map risk/trajectories in real time**, as a **complement** to existing warning centres and a way to cut false alarms.

Detection → Analysis → Dissemination

- Provides **initial assessment** based on EQ epicentre, sensors' locations, and required evacuation time.
- Detects signals; **categorises** earthquakes / events; **analyses** hydroacoustic data; calculates **tsunami size**
- Operates **automatically**, and **manually** (after training)
- Hydrophones & Tide-gauges data are already integrated; other data sources can be integrated, e.g., seismic/GNSS, SMART cables, …

M 7.9 - 2018 261 km SE of Chiniak, Alaska Earthquake 2018-01-23 09:31:40 (UTC)



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Access to IMS/CTBTO Real-Time Hydroacoustic Data

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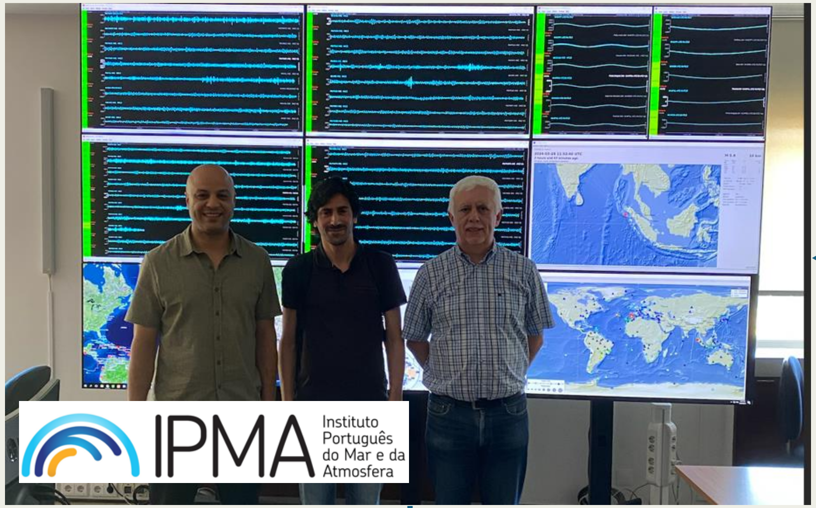
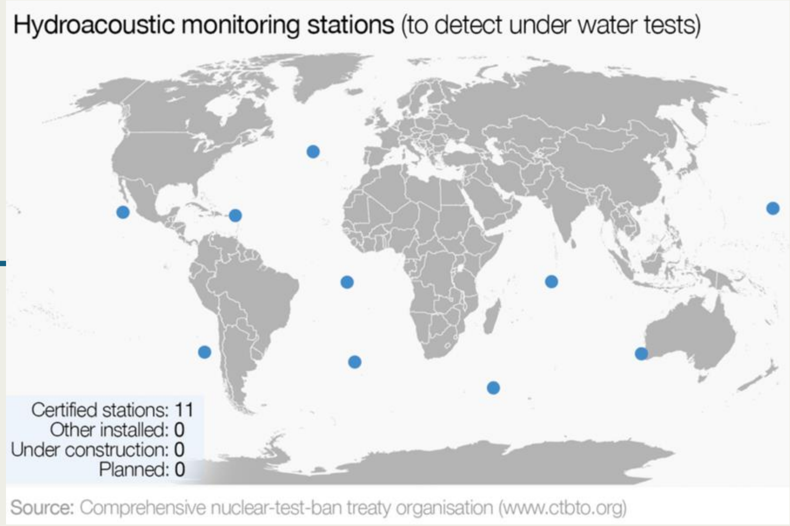
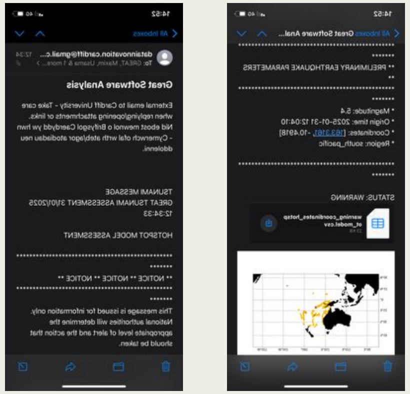
Software deployed at IPMA June 2024

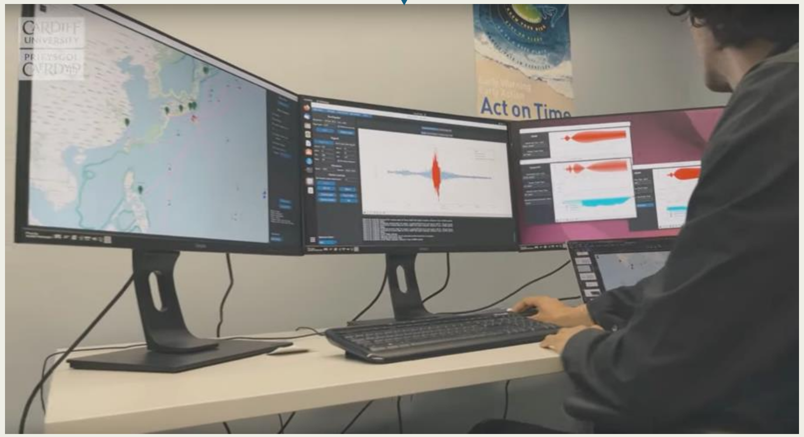


Real-time access

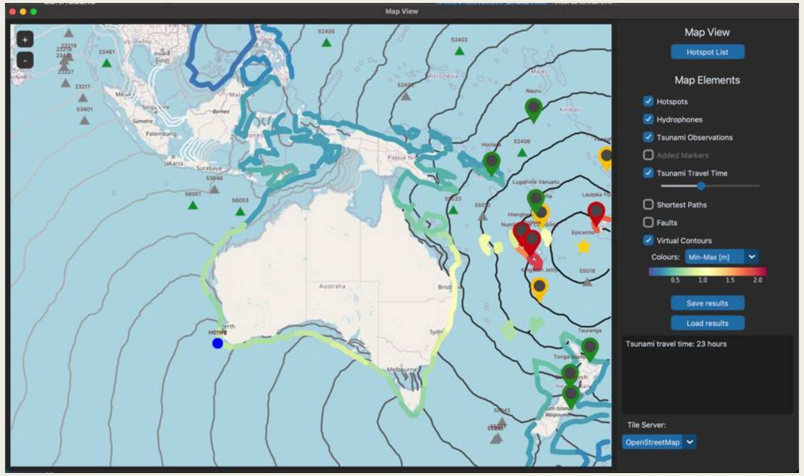


e-mail Alerts



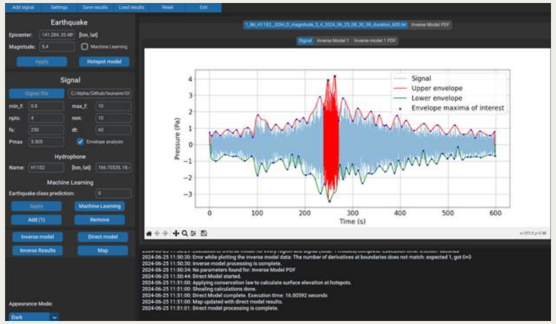


Cardiff University Tsunami Centre, UK



Assess Tsunami globally & benefits coastal communities, especially SIDS and LDCs

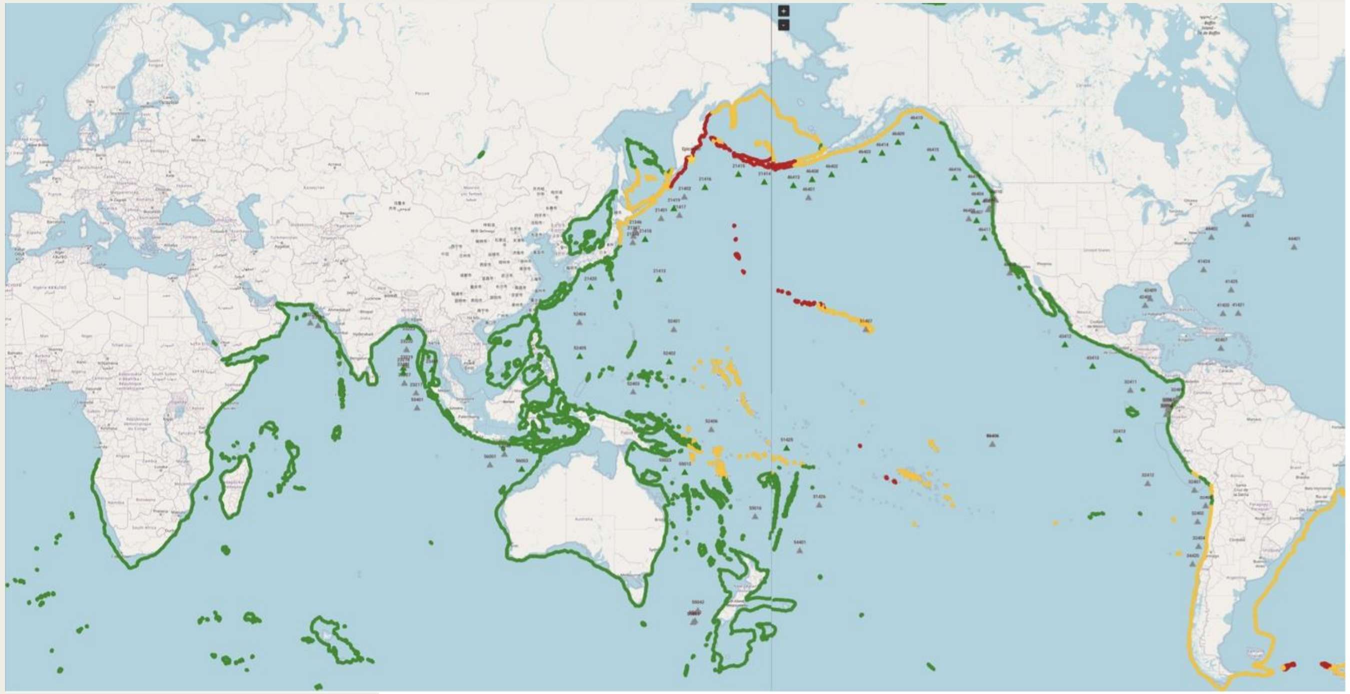
Live streaming

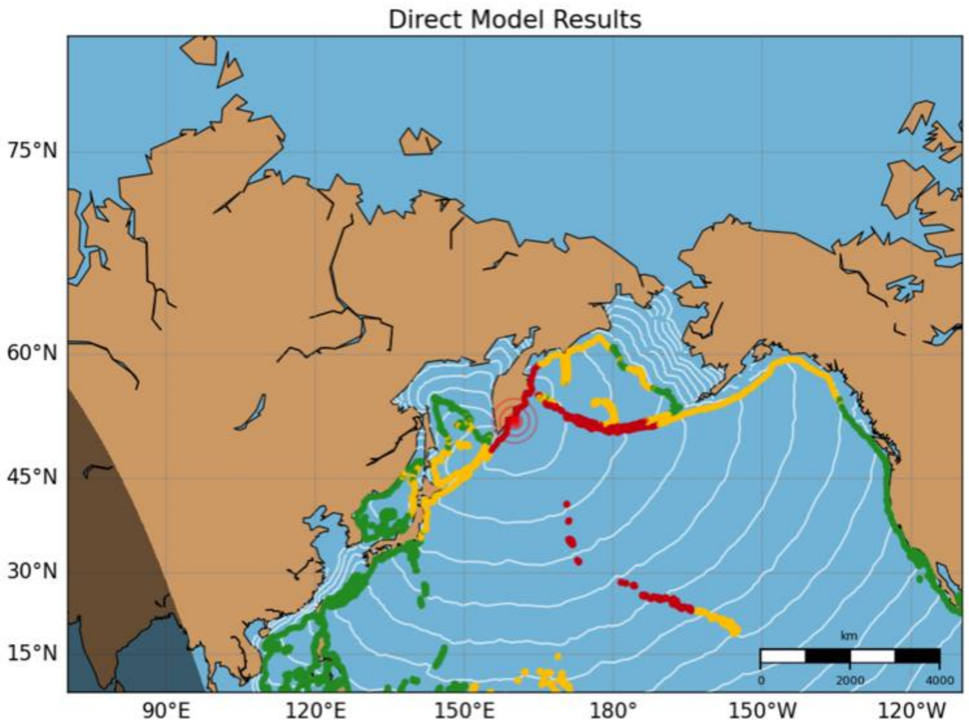


Results: recent real-time analysis

M 8.8 - 2025 Kamchatka Peninsula, Russia Earthquake

2025-07-29 23:24:52 (UTC) | 52.498°N 160.264°E | 35.0 km depth





DART Station	Lat	Lon	Time of measure (UTC, min)	Period (min)	Observed height (m)	GREAT height (m)
21415	50.2N	171.9E	117	8	0.20	0.590
21414	49.0N	178.2E	103	32	0.28	0.260
46413	48.0N	174.2W	144	40	0.19	0.180
52402	11.9N	153.9E	507	44	0.06	0.076
52403	1.1N	154.2E	551	52	0.05	0.075

Methods/Data

- **Hotspot model** on a global unstructured mesh & Dijkstra shortest paths → travel times for P, S, acoustic, & surface-gravity (tsunami) waves from the epicentre to points of interest.
- **Machine learning** on hydroacoustic records (wavelet-features & SVM/RF) to classify strike mode and estimate magnitude in sub-second runtime, triggering downstream physics.
- **Inverse model (probabilistic)** retrieves probability distributions of **fault geometry & dynamics** from pressure spectrograms; **direct model** then yields **pressure & surface elevation** at hotspots.
- End-to-end runs in **seconds to a few minutes** on standard multi-core hardware, without pre-computes; parallelised implementation with export to NetCDF/NumPy and an interactive GUI.

Conclusions

- **Operational & complementary.** GREAT has been running **in real time since June 2024**, delivering physics-informed hydroacoustic assessments that augment warning centres and help reduce false alarms.
- **Validated at scale & live.** Benchmarked on **>40,000 historical CTBTO records** (incl. Sumatra 2004, Tohoku-oki 2011, Gulf of Alaska 2018 [false alarm], Tateyama 2009) and validated **live** since June 2024; recent sequences (e.g., **Kamchatka**) show good agreement with observations.
- **Fast operational workflow.** When a hydroacoustic station lies **within 1,000 km**, we run a **single-pass analysis** (no magnitude needed); **end-to-end latency < 8 min**, suitable for time-critical decision support.
- **Broad applicability.** The acoustic approach applies to **seismic and non-seismic sources** (e.g., underwater explosions), offering a flexible, complementary signal path.
- **Critical data access.** Reliable, timely access to **CTBTO hydroacoustic data,** especially the **Indian Ocean stations H01, H04, H08,** is **crucial** for sustained real-time performance.