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Contribution of Smart Cables to Earthquake and Tsunami Early Warning in the Sumatra and Java Regions

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Aims and Scope

SMART (Science Monitoring And Reliable Telecommunications) cables as a potential next generation of marine are powerful solutions to earthquakes and tsunamis. We present results from a series of exploratory numerical experiments regarding the deployment of a linear array of SMART stations seaward of the trench in the Sumatra-Java region using a set of seismic ($8.5<M_w<9.3$) as well as landslide sources. Through numerical simulations we analyze the improvements in early detection and evaluation of tsunami and seismic hazard from addition of SMART stations to the existing local and regional networks.

Method

Tsunami Simulations:

We use the Method of Splitting Tsunamis algorithm (Titov *et al*, 2016) to simulate tsunamis from six potential rupture scenarios (Salaree & Okal, 2020) in Sumatra and Java. We then calculate estimates of tsunami arrival times at our 76 designed SMART stations (Fig. 1) in a linear array right off (seaward) the trench, assuming a detection threshold of 2 cm.

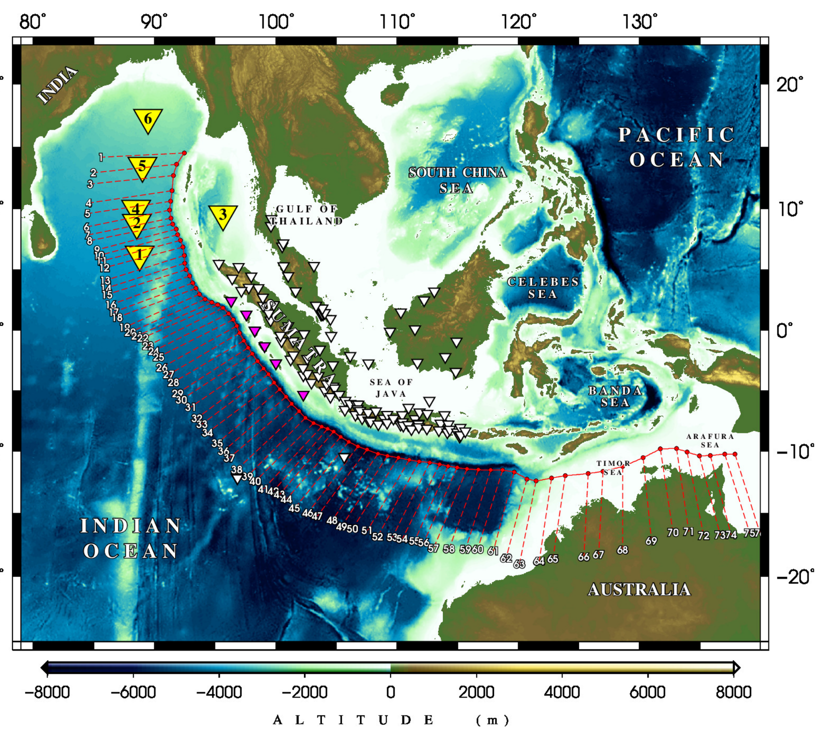

Figure 1. Proposed SMART array (red dots) off the Sumatra trench. The 76 SMART repeater stations are indexed from north to south. DART stations are shown as yellow inverted triangles and are indexed from south to north. Smaller, white triangles represent seismic stations. Pink triangles are island seismic stations which are closer to the trench.

Seismic Arrival Times:

We use the TauP toolkit (Crotwell *et al.*, 1999) to calculate seismic phase travel times from earthquake hypocenters to stations.

Results

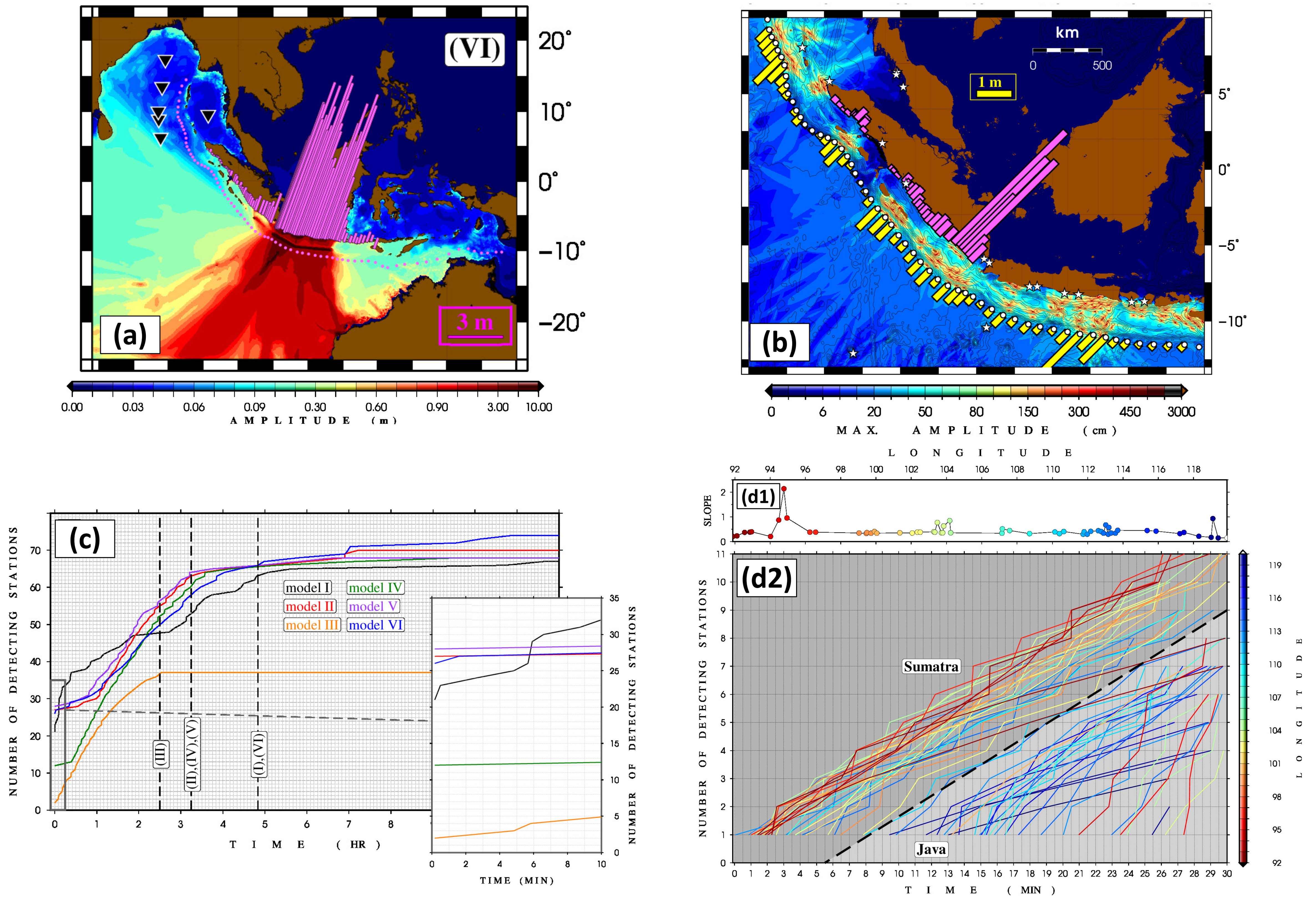

Figure 2. (a) Maximum tsunami amplitudes from our worst-case source model in Java. Pink bars are maximum coastal tsunami amplitudes. (b) Cumulative map of maximum tsunami amplitudes across all landslide scenarios; pink and yellow bars are maximum tsunami amplitudes at SMART stations and along the coast, respectively. (c) Cumulative number of stations detecting the tsunami over simulation time for each source scenario. Vertical dashed lines show approximate times after which no meaningful increase in recording stations occurs for each labeled model [the smaller panel is the zoomed view of the area inside the gray box, shown to highlight early detection. (d) Similar to (a), for landslide scenarios. Each scenario is shown by a different color according to source longitude. Diagonal dashed line shows an approximate transition form western to eastern dipole locations. (b) Slopes of the curves in (a) as a function of source longitude.

Detection of Earthquakes

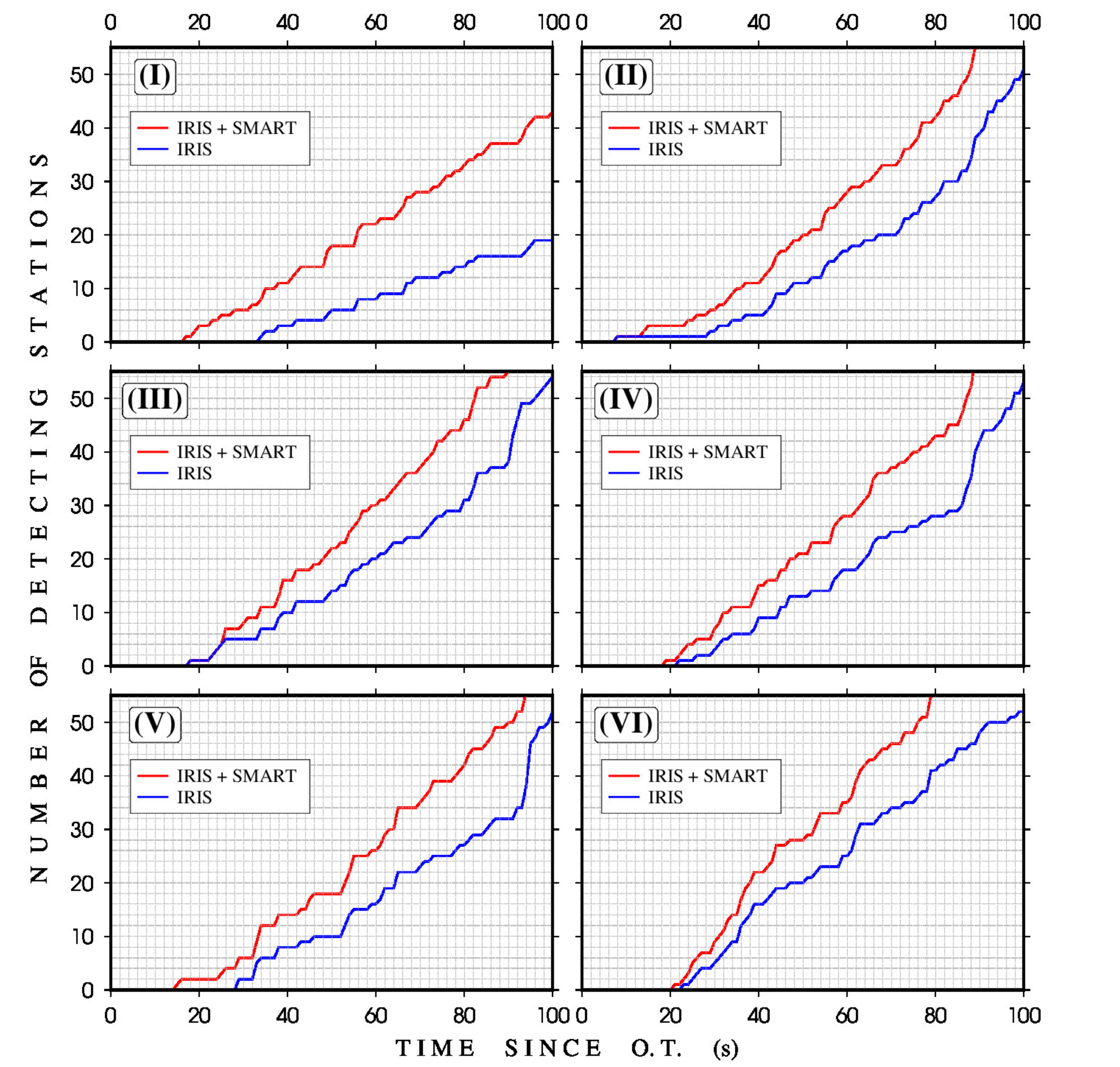

Figure 3. (a) Cumulative number of stations in the existing seismic network (IRIS, shown in blue) and IRIS+SMART (red) detecting P-waves, over time since O.T. I-VI panels represent sources from our designed rupture models.

Conclusions

Our results show that inclusion of the proposed SMART array will improve the detection of earthquake tsunamis up to several hours compared to the existing DART system in the Indian Ocean.

Similarly, the seismic network coverage is noticeably improved (other than obviously closing the otherwise large azimuthal gap to the west) via increasing the number of recording stations.