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Review

Development of a tsunami early warning system for the South China Sea

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ABSTRACT

The Manila subduction zone is identified as one of the most hazardous tsunami source regions, and the countries around the South China Sea are under threat from tsunami hazard. However, the number of early-warning tsunami buoys being deployed in this area is far fewer than that in the Pacific Ocean. This study investigates a feasible approach for establishing a tsunami early warning system in the South China Sea without deploying buoys. The idea is to integrate existing earthquake early warning systems with a fast computing system for estimating tsunami threats. This study presents an efficient and low-cost tsunami fast computing system for early warning. The widely validated tsunami model, COMCOT is chosen as the kernel. The COMCOT source code has been optimized and parallelized in order to meet the requirements of real-time simulation. The optimized model, iCOMCOT performs at least 10 times faster than the original COMCOT. In addition, a flexible and user-friendly grid/cloud-based portal service has been built, which is also made available for mobile devices. As for the automatic generation of the tsunami sources, a new Source-Scaling relationship, which has been validated by recent mega-earthquakes, is implemented. The 2011 Tohoku tsunami is adopted as a case for validation and demonstration. The modelling results of Manila trench, chosen to demonstrate the application of iCOMCOT, show that the western coast of the Philippines is prone to get tsunami attacks. Furthermore, tsunami from the north segment of Manila trench tend to strike southern Taiwan, Hong Kong and Macau area; tsunami from the middle segment, Vietnam.

Contents

1. Introduction . . . 2
2. Fast determination of fault parameters . . . 3
3. Equations . . . 3
4. Optimization and parallelization . . . 4
   4.1. Optimization . . . 4
   4.2. Parallelization . . . 6
5. Validation . . . 8
6. Performance test . . . 9
7. Grid/Cloud-based COMCOT portal: iCOMCOT . . . 13
8. The seismicity and tsunami history of the South China Sea . . . 15
9. An application: South China Sea early warning . . . 15
10. Conclusion . . . 16
Appendix . . . 17
References . . . 17

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1. Introduction

The 2011 Tohoku earthquake, an M_w 9.0 undersea mega-thrust event, struck the sea off Fukushima Prefecture, Japan, on 11 March 2011. It triggered a large tsunami with wave heights up to 40 m and caused more than 20,000 casualties with many people still missing. This event also led to the Fukushima Daiichi nuclear power plant disaster. Highly similar to Japan in terms of geography, submarine trenches, historical tsunamis, and the development of nuclear power plants, Taiwan has always been closely monitoring the potential tsunami source in the region. One of the potential tsunami sources, the Manila Trench, is longer than 1200 km, stretching between southern Taiwan and the southwestern coast of Luzon Island (Fig. 1). With a convergence rate across the northern Manila Trench of 8 cm/year (Seno, 1977; Seno et al., 1993; Yu et al., 1999), this tsunami source region could generate large tsunami waves that could devastate communities bounding the South China Sea (Megawati et al., 2008).

The conventional tsunami monitoring system relies on tsunami sensors such as the NOAA DART buoys. However, the early-warning tsunami buoys being deployed in the South China Sea are far fewer than those in the Pacific Ocean. Compared to the Pacific Ocean, the South China Sea is a relatively enclosed system, which leads to a shorter tsunami warning time. In particular, some big cities with dense population, such as Manila City and Kaohsiung City, are located very close to the Manila Trench. Typically, the tsunami warning time for these two cities is shorter than 30 min. To cope with short warning time, a high-speed tsunami simulation model is crucial. Through the efforts of Taiwan and Japan over the past 30 years, a dense seismic monitoring network has been deployed in neighboring countries, including Taiwan, the Philippines, Vietnam, and Indonesia. That the location,

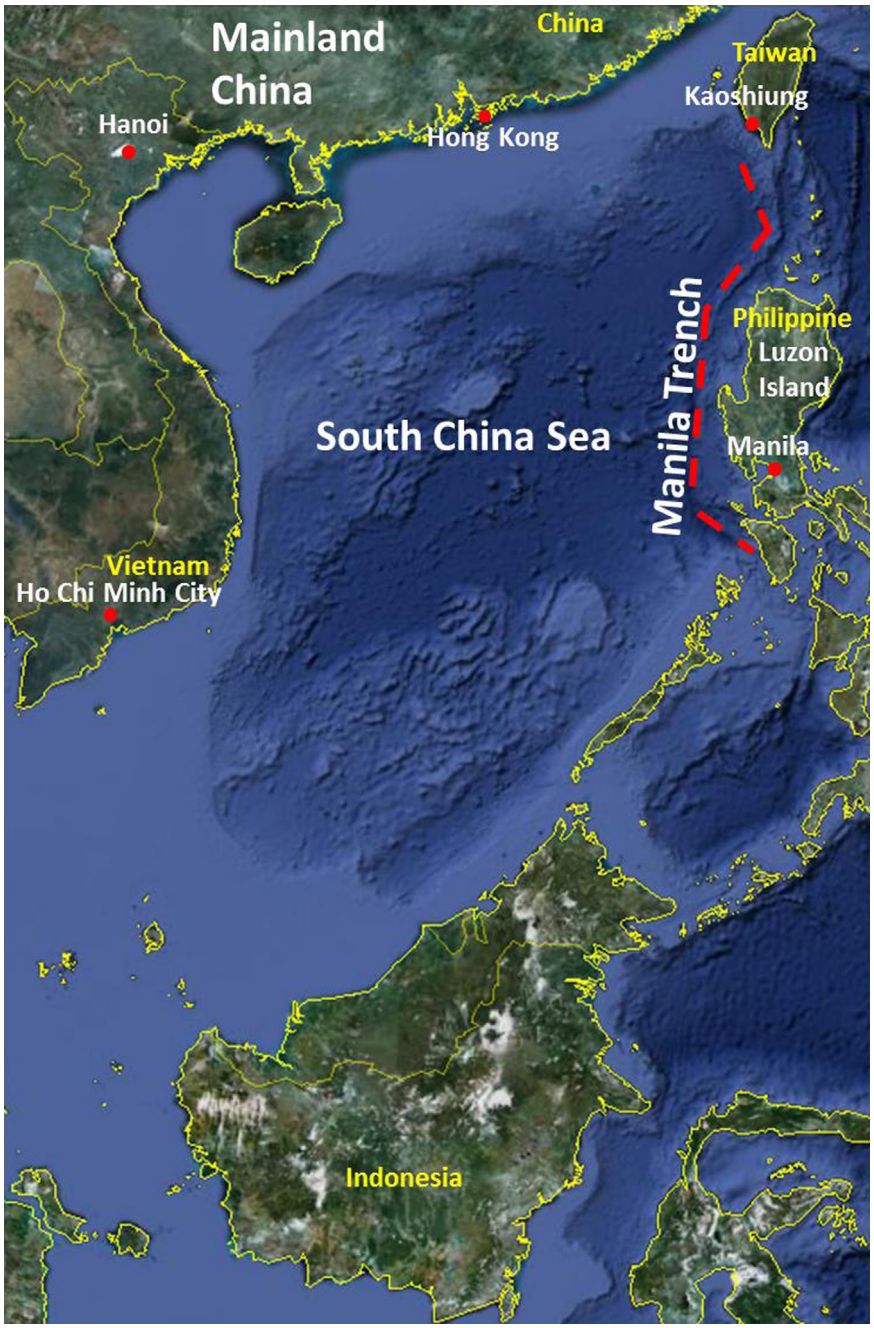

Fig. 1. The South China Sea, Manila Trench, and neighboring countries.