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Real-time tsunami risk evaluation method by synthetic dynamics and Bayesian update

Reika Nomura *

International Research Institute of Disaster Science (IRIDeS)
Tohoku University, Sendai, Japan
* E-mail: nomura@irides.tohoku.ac.jp

Extended Abstract

Tsunami disasters have significant implications for both individuals and society. In recent years, especially in Japan, tsunami/seismologic researcher community has paid significant attention to the incoming Nankai megathrust earthquake. In Japanese history since A.D. 684, large earthquakes with a magnitude of approximately 8 or more along the Nankai Trough, have occurred regularly with a period of approximately 100 to 150 years (Ishibashi et al. 2014). In the near future, we can expect this place to invoke great earthquakes, which resulting in a huge tsunami. Since the close location of the coastal area, the faster wave arrival and shorter evacuation time could appear as the remarkable risk for Shikoku region. Therefore, real-time prediction of tsunamis is important for mitigating the tsunami disaster risk in the coastal region.

We propose a framework [1] of rapid and accurate prediction of the onshore tsunami risk at upcoming Nankai megathrust, by combined use of numerical flow simulations and POD techniques. We firstly conducted both onshore/offshore tsunami flow simulations by TUNAMI-N2 with the estimated Mw 8 class fault rupture scenarios. At the total 666 case simulations, we evaluate wave data from 147 computation points as the proxy of in-situ values provided by buoys. Pre-calculated 666 flow simulation results are learned for “spatial modes” extraction by Proper Orthogonal Decomposition (POD) method. The spatial modes extracted from POD techniques enable to describe dominant trends of gauge data with much more reduced order. At the real-time forecast phase, the unknown tsunami events are predicted by obtained in-situ gauge data and pre-calculated spatial modes. And then, the particle filter schemes minimize the uncertainties remaining on the time variational coefficients correspond with the spatial modes by successive updating based on the Bayesian method. Finally, the inundation risk map corresponding is provided as the most suitable scenarios among the pre-simulated 666 flow results.

A series of frameworks require neither immediate tsunami flow simulations nor simultaneous earthquake faults estimations at real events occurrences. Although this study focuses on Nankai megathrust and Shikoku region in Japan, the presented framework is universal and readily applied in some other regions at risk of tsunamis.

References

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