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Abstract of Doctoral Dissertation

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Title of Doctoral Dissertation

A Mechanism-Independent Tsunami Source Modeling for Advanced Rapid Tsunami Estimation
(津波即時予測の高度化に向けた発生メカニズムに依存しない津波波源モデリング)

This study aims to evaluate the validity of constructing initial sea surface displacement for various tsunami generation mechanisms, including both seismic and non-seismic sources. Accurate representation of the initial sea surface condition is crucial for tsunami modeling, hazard assessment, and the development of effective early warning systems. Specifically, this research investigates whether simplified static representations of initial sea surface displacement can adequately reproduce tsunami waveforms under different source scenarios.

The analysis employs tsunami waveform data to assess the applicability and limitations of static displacement models based on Gaussian functions, which are commonly used due to their simplicity and computational efficiency. Two case studies are utilized to represent diverse tsunami source characteristics: the 2018 Anak Krakatau tsunami as a non-seismic example, and the 2024 Noto tsunami as an event potentially involving a combination of seismic and non-seismic sources. This approach is applied to observed waveforms from the 2018 Anak Krakatau tsunami and synthetic waveforms representing the 2024 Noto tsunami scenario, using the tsunami waveform inversion method to evaluate how well the static initial sea surface displacement models represent the tsunami generation processes across different source types.

The results indicate that while static initial sea surface displacement models can effectively approximate tsunami sources in many cases, their performance is strongly influenced by the complexity and dynamics of the actual source. This study highlights several important considerations and limitations in the construction of initial sea surface displacement and extends existing approaches for the development of rapid tsunami estimation methods that may support future early warning systems. The findings are expected to enhance the physical realism of tsunami source modeling and open up new opportunities for more accurate and adaptive warning systems.

Keywords: Initial sea surface displacement; Tsunami waveform inversion; Rapid tsunami estimation; Early warning system.