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Tsunami simulation with linear Boussinesq equations including elastic loading and seawater density stratification

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The tsunamis caused by the 2011 Tohoku and 2010 Maule earthquakes were clearly recorded at ocean-bottom pressure gauges distributed in the Pacific Ocean such as DART system. However there were significant discrepancies between the observed waveforms and those computed using standard shallow water theory. The observed waveform mainly took the form of a delay in the time of arrival and a small drawdown prior to the first-arriving positive peak in comparison with the computed waveforms. The discrepancies have been investigated by several papers (Tasai et al., 2013, Watada 2013, Inazu and Saito 2013, Alleger and Cummins 2014). To solve the discrepancies, they reached a conclusion to include effects of elastic deformation of the Earth loaded by tsunami and seawater density vertical stratification into the shallow water theory. On the other hand, frequency dispersion is often apparent in the far-field tsunami records, which can be simulated with the Boussinesq theory. Therefore, we included the effects of elastic loading and seawater density stratification into the Boussinesq equations to aim a comprehensive tsunami simulation. We embedded the module developed Alleger and Cummins (2014) into our Boussinesq tsunami code (Baba et al., 2015), and used it for the simulation of the 2011 Tohoku tsunami. The new model including dispersion effect provided a good agreement with the observations better than the without model at the far-field stations such as DART32401.

Keywords: Tsunami, Boussinesq, seawater density stratification, elastic loading