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Tsunami focusing and leading wave height

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Field observations from tsunami events show that sometimes the maximum tsunami amplitude might not occur for the first wave, such as the maximum wave from the 2011 Japan tsunami reaching to Papeete, Tahiti as a fourth wave 72 min later after the first wave. This might mislead local authorities and give a wrong sense of security to the public. Recently, Okal and Synolakis (2016, Geophys. J. Int. 204, 719–735) discussed "the factors contributing to the sequencing of tsunami waves in the far field." They consider two different generation mechanisms through an axial symmetric source –circular plug; one, Le Mehaute and Wang's (1995, World Scientific, 367 pp.) formalism where irritational wave propagation is formulated in the framework of investigating tsunamis generated by underwater explosions and two, Hammack's formulation (1972, Ph.D. Dissertation, Calif. Inst. Tech., 261 pp., Pasadena) which introduces deformation at the ocean bottom and does not represent an immediate deformation of the ocean surface, i.e. time dependent ocean surface deformation. They identify the critical distance for transition from the first wave being largest to the second wave being largest. To verify sequencing for a finite length source, Okal and Synolakis (2016) is then used NOAA's validated and verified real time forecasting numerical model MOST (Titov and Synolakis, 1998, J. Waterw. Port Coast. Ocean Eng., 124, 157-171) through Synolakis et al. (2008, Pure Appl. Geophys. 165, 2197-2228). As a reference, they used the parameters of the 1 April 2014 Iquique, Chile earthquake over real bathymetry, variants of this source (small, big, wide, thin, and long) over a flat bathymetry, and 2010 Chile and 211 Japan tsunamis over both real and flat bathymetries to explore the influence of the fault parameters on sequencing. They identified that sequencing more influenced by the source width rather than the length.

We extend Okal and Synolakis (2016)'s analysis to an initial N-wave form (Tadepalli and Synolakis, 1994, Proc. R. Soc. A: Math. Phys. Eng. Sci., 445, 99-112) with a finite crest length, which is most common tsunami initial waveform. We fit earthquake initial waveform calculated through Okada (1985, Bull. Seismol. Soc. Am. 75, 1135-1040) to the N-wave form presented by Tadepalli and Synolakis (1994). First, we investigate focusing phenomena as presented by Kanoglu et al. (2013, Proc. R. Soc. A: Math. Phys. Eng. Sci., 469, 20130015) and compare our results with their non-dispersive and dispersive linear analytical solutions. We confirm focusing phenomena, which amplify the wave height in the leading depression side. We then study sequencing of an N-wave profile with a finite crest length. Our preliminary results show that sequencing is more pronounced on the leading depression side. We perform parametric study to understand sequencing in terms of N-wave, hence earthquake, parameters. We then discuss the results both in terms of tsunami focusing and leading wave amplitude.

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