Tsunami simulations for probabilistic tsunami hazard assessment in the Nankai Trough

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We have already reported the results of tsunami propagation simulations performed in each sea region along the Kuril Trench, the Japan Trench, the Sagami Trough, the Nankai Trough and the Ryukyu Trench (Takayama et al., 2016, JpGU; Saito et al., 2017, 2018, JpGU; Saito et al., 2016-2018, SSJ), along with a study on stochastic evaluation of tsunami hazards that would occur on coasts throughout Japan (Fujiwara et al., 2013, JpGU; Hirata et al., 2014-2018, JpGU; Hirata et al., 2018, SSJ). This time, we followed the method and concept of a probabilistic tsunami hazard assessment (PTHA) of earthquakes accompanying the interplate earthquakes excluding the largest class earthquake exceeding M9 announced by the government's Earthquake Research Committee (ERC) in January 2020. In addition, we calculated the tsunami propagation that would be caused by the Nankai Trough earthquake, taking into account the largest class of earthquakes excluded by ERC (see also Hirata et al., this meeting). Regarding whether to include the largest class earthquakes and others, in this presentation, we report the characteristics of tsunami heights simulated by the propagation calculation from the Kyushu to Kanto regions, that is, the Pacific coast, the Seto Inland Sea coast, and the Izu-Ogasawara Islands coast.

We describe the method of a tsunami propagation simulation. A tsunami propagation simulation used in this study estimated tsunami wave height along the coasts, solved by the non-linear shallow-water equation using a leap-frog scheme. These simulations were configured by a nested grid system consisting of four sub-regions from outer 1,350 meters to inner 50 m in a horizontal, landward inundation keeping, and transparent at the seaward edges. Initial wave height followed vertical displacement driven by seafloor deformation via Okada’s equation (Okada, 1992). The sea surface deformation consisted of vertical and horizontal displacement of seabed deformation (Tanioka and Satake, 1996), and was filtered to remove high frequency components (Kajiura, 1963). The water level standard corresponded to mean sea level of Tokyo Bay (Tokyo Peil, T.P.). A seafloor and land topography model used was created using the topographic mesh data released by the “Nankai Trough Massive Earthquake Model Study Group” of the government's Cabinet Office. We converted the topographic mesh data with a minimum grid spacing of 10 m to 50 m, as in the nearshore tsunami calculation. In order to simulate the tsunami height from the epicenter to the coast, the calculation resolution was subdivided from offshore to shore at 1,350 m, 450 m, 150 m, and 50 m, and connected. PTHA in this study was conducted at approximately 420,000 points on a 50 m grid in the water area near the shoreline on the coast line.

The following is a brief description of a seismic source used in this study (for details, see Kito et al., this meeting). The seismic source used was a total of 2,720 characterized earthquake fault models (CEFMs) from Mw7.6 to Mw9.0 built based on 79 types of source regions diversified by combining 18 source regions shown in the long-term evaluation reports. In addition to these source regions and CEFMs, we adopted a total of 83 source regions, including the largest class of earthquakes excluded by ERC, and 3,480 types of CEFMs from Mw7.6 to Mw9.1. Therefore, the tsunami simulations were performed using 2,720 kinds of CEFMs that do not consider the largest class earthquake and 3,480 kinds of CEFMs that consider the largest class earthquake.

As a result of the tsunami simulation, the tsunami height was about 2 m at the maximum on the western coast of Kyushu and the Seto Inland Sea coast, which was lower than the other coasts. Conversely, along the Pacific coast, simulated tsunamis were relatively high around capes such as Ashizuri Cape, Muroto Cape, Shiono Cape, Daio-zaki, Irago Cape, and Iro-zaki. The tsunami height was less than 30 m for 2,720 CEFMs without considering the largest class earthquake, while the height was less than 50 m for 3,480 CEFMs considering them. The impact of including the largest earthquakes was remarkable around Ashizuri Cape, Muroto Cape, and Iro-zaki, and the tsunami rose about twice as much as without them.

The outputs form this study contributes to PTHA (Abe et al., this meeting) and stochastic research such as evaluation of coastal tsunami height including uncertainty. The use of the outputs is widely promoted by making them open access services (Dohi et al., this meeting).
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Keywords: Nankai Trough, Tsunami simulation, Probabilistic tsunami hazard assessment