Development of tsunami simulator TNS and release of version 1.0

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A tsunami is a natural phenomenon in which disturbance generated in the sea by abrupt submarine deformation, propagates to the surrounding sea area with the gravity as restoring force, and often runs up to the land area. The National Research Institute for Earth Science and Disaster Resilience (NIED) has developed a software that can calculate a tsunami phenomenon including inundation on a computer by numerical simulation using finite-difference method (Miyoshi et al., 2018 JpGU). The software was named Tsunami Simulator (TNS: TsuNami Simulator).

Numerical codes of the TNS was developed to operate on the Central Processing Unit (CPU) and the Graphics Processing Unit (GPU), the main code of the CPU written in Fortran 90 and the GPU written in CUDA C in accordance with CUDA 7.5. The concept of the codes is basically equivalent to TUNAMI-N2 (Imamura et al., 2006), and tsunami propagation and inundation based on two-dimensional nonlinear long wave theory can be implemented using a nesting grid with a space grid ratio of 1: 3 in the Cartesian coordinate system. The initial wave height is calculated by the crustal movement in the semi-infinite medium with respect to a fault plane using the program DC3D (Okada, 1992 BSSA). Horizontal crustal movement (Tanioka and Satake, 1996 GRL) and hydraulic filters by Kajiura (1963, BERI) are also applicable. In the offshore boundary, the transmission boundary (Imamura et al., 2006) and the absorb area (e.g. Clayton et al., 1977 BSSA) are applied, and inundation boundary is used in the land side (Kotani et al., 1998 Coastal Engineering Journal). For distant tsunamis, a spherical coordinate system is introduced and connects to the region in the Cartesian coordinate where inundation simulation is carried out. In the spherical coordinate, Coriolis force and dispersion effect can be considered as the previous study, and loading effect (Inazu and Saito, 2013 EPS) can also be applied.

Real-time tsunami inundation forecast system using numerical database requires a large amount of tsunami scenario. From the TNS development version, we packaged the essential parts for constructing a tsunami scenario bank and released as TNS Version 1.0 (Miyoshi et al., 2019 Technical Note of the NIED). The users are assumed to be researchers, engineers, officers of local governments who is responsible for disaster prevention, and make it possible to calculate on the general Linux environment. The package included an operation guide, executable files precompiled on Linux, and some examples. The solver can conduct sequential computation by single CPU, and can conduct parallel computation using OpenMP, and the general-purpose computing on graphics processing units (GPGPU) in order to achieve reduction of calculation time.

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