TSUNAMI3D

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The 3D Navier-Stokes (NS) numerical model, TSUNAMI3D, is based on the computational fluid dynamic (CFD) model originally developed in Los Alamos National Laboratory (LANL) during the 1970s, and follows early work by Hirt and Nichols (1981). It solves transient fluid flow with free surface boundaries based on the concept of the fractional volume of fluid (VOF) method using an Eulerian mesh of rectangular cells of variable size. The fluid equations solved are the finite difference approximation of the full NS equation and the incompressibility condition equation which results from the continuity equation when the density is constant. The basic mode of operation is for a single fluid phase having multiple free surfaces. However, TSUNAMI3D also can be used for calculations involving two fluid phases separated by a sharp or diffusive interface, for instance, water and landslide material. In either case, both fluids are considered incompressible and treated as Newtonian. Internal obstacles, e.g., topography, wall, etc., are defined by blocking out, fully or partially, any desired combination of cells in the domain. It is well known that full 3D NS numerical models are highly computationally intensive and require substantial computer resources. Therefore, TSUNAMI3D has been simplified to overcome as much as possible the computational burden of 3D NS tsunami simulations. The simplification is derived from the large aspect ratio (horizontal and vertical scale) of the tsunami wave and the selected computational cell size required to construct an efficient 3D grid. The large aspect ratio of the tsunami wave also requires a large grid aspect ratio to reduce runtime and memory usage. However, the grid aspect ratio should be smaller than the aspect ratio of the tsunami wave to simplify the fluid surface reconstruction. The standard VOF algorithm, the donor–acceptor technique of Hirt and Nichols (1981), has been simplified to take into account this large cell aspect ratio. The pressure term is split into two components, hydrostatic and non-hydrostatic. Although TSUNAMI3D has the capability of variable grids (1D telescoping), it does not include the nesting capability (2D telescoping) needed for detailed inundation solutions on coastal regions. The interested reader is referred to Horrillo (2006) and Horrillo et al. (2013) for more detailed information about the 3D NS model.

Reference:

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