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A versatile algorithm for the treatment of open boundary conditions in Smoothed particle hydrodynamics GPU models

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Abstract

An open boundary algorithm for weakly compressible Smoothed particle hydrodynamics (WCSPH) numerical models is presented. Open boundary conditions are implemented by means of buffer regions whereby physical quantities are either imposed or extrapolated from the fluid region using a first-order accurate SPH interpolation. A unique formulation has been developed which can be used for inflow, outflow, and mixed open boundary conditions. The extrapolation process from the fluid domain encompasses quantities such as velocity, density, pressure and also free-surface elevation. The algorithm has been parallelized for both CPU and general-purpose on graphics processing units (GPGPU) and it has been tested against the 2-D reference solutions of flow past a cylinder and open channel flow. Finally, its capability to simulate 2-D and 3-D complex flows such as water waves and flow past a surface-piercing extraterrestrial submarine is demonstrated.

Keywords: SPH, inlet, outlet, open boundary, free surface, CFD
2010 MSC: 76M28, 65Y05, 65Z05

1. Introduction

Smoothed particle hydrodynamics (SPH) is a numerical method originally developed for astrophysical modeling [1, 2] and later adapted for free-surface

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