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Research on the single-host parallel computing with the local time step scheme for modeling of hydro-sediment-morphodynamic processes

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In recent decades, computational hydraulics and sediment modelling have a great development due to compute technology. Applying a finite-volume Godunov-type hydrodynamic shallow water model with hydro-sediment-morphodynamic processes, this work demonstrates and analysis the ability of single-host parallel computing technology with algorithmic acceleration technology. This model is implemented for high-performance computing using the NVIDIA's Compute Unified Device Architecture (CUDA) programming framework, using a domain decomposition technique and across multiple cores through an efficient implementation of the Open Multi-Processing (Open MP) architecture, and using an algorithmic acceleration technology named local time stepping scheme (LTS), which is capable of obtain much efficiency improvement via different time step sizes for different grid sizes. The model is applied for three cases, through which we compare the effectiveness of CPU, Open MP, Open MP+LTS, CUDA, and CUDA+LTS, demonstrating high computational performance across CUDA+LTS which can lead to speedups of 40 times with respect to CPU and high-precision results across CUDA +LTS.

KEY WORDS: Hydro-sediment-morphological modeling; local time step; Open MP; CUDA.