SHALLOW WATER SIMULATIONS ON SPARSE GRIDS

Martin Lilleeng Sætra, CMA, University of Oslo, +4797675444, martinsa@cma.uio.no

1. Martin Lilleeng Sætra, CMA, University of Oslo

Introduction. In this talk we present a novel simulation strategy for explicit PDE solvers on GPUs which uses sparse grids. Over the last decade, GPUs have been shown to be well suited for explicit schemes for solving hydraulic problems, but efficient simulation on domains which are only partially wet is still a challenge. In our approach we use a sparse representation of the domain which reduces both compute time and memory use. We have implemented this approach in our existing shallow water simulator [1], which is based on a high-resolution explicit numerical scheme [2]. Our results have been verified against an analytical solution and validated against experimental data. Detailed performance figures and profiling results will be given, demonstrating the effectiveness of simulations on sparse grids using different datasets; both synthetic and real-world cases. Sparse Simulations. Efficient stencil operations are essential in explicit schemes like the one employed in our simulator. In particular, for conservation and balance laws, e.g. the shallow water equations, the solution will in many cases have non-constant values only in a portion of the grid. Through simple observation of the stencil and the distribution of conserved quantities we implement a method reducing both the memory footprint and the computational burden by only computing in cells where the solution changes. To this end, we use a sparse grid, in which no simulation data is represented in GPU global memory before it actually contributes to the solution. Our method is primarily motivated by the need to perform simulation of very large domains to model real-life dam-breaks and various flooding scenarios. A second benefit is that we can simulate much faster than than a classical dense simulator, thus providing simulation results at an earlier point in time, which is crucial in for instance flood emergency situations. Our method is general, and thus also applies to other stencil-based explicit solvers.