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HARDWARE-OPTIMIZED NUMERICS FOR A DISCONTINUOUS GALERKIN SHALLOW WATER MODEL

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Current trends in high performance computing require model codes which can be efficiently run on various hardware architectures. In this talk we focus on the discontinuous Galerkin (DG) discretization of the shallow water equations (SWE) based on the UTBEST model [1] and present a hybrid CPU-GPU algorithm which exploits the benefits of each hardware component.

Based on our quadrature-free formulation for the nonlinear SWE [2], which allows to elegantly separate discrete equations for different polynomial orders, we introduce a novel p-adaptive discretization method. The goal of this work is to achieve improved performance by separating the fixed (i.e. the constant or the linear) degrees of freedom of a DG solution from the adaptive (higher-order) ones. The respective computations can then be done in parallel either on the same architecture or on a heterogeneous one, e.g. the lower degrees of freedom on GPU and the higher-order correction terms on CPU. We present various configurations to investigate which model components and which algorithmic parts are best suited for which part of a heterogeneous CPU-GPU setup.

The method is implemented within the ExaStencils code generation framework which is based on the domain-specific language (DSL) ExaSlang and outputs an optimized C++ or CUDA code. Our work extends the framework using a Python frontend – called GHODDESS – which is responsible for the mapping of the DG scheme to ExaSlang.

REFERENCES

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