

QUADRATURE-FREE DISCONTINUOUS GALERKIN METHOD FOR SHALLOW WATER EQUATIONS ON BLOCK-STRUCTURED GRIDS

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Computational domains relevant for real-life ocean applications often have complex geometry and are thus best suited for unstructured-mesh discretizations. However, structured grids offer better computational efficiency on cache-based CPUs and GPUs due to their predictable memory access patterns. To combine the geometrical flexibility of unstructured meshes with performance of structured grids we develop a block-structured grid methodology that includes a first of its kind block-structured grid generator for realistic ocean domains [1], a new quadrature-free discontinuous Galerkin discretization scheme for the shallow water equations [2] derived from the UTBEST model [3], and the capability to run on CPUs and GPUs based on the code generation framework ExaStencils [4].

REFERENCES

- [1] D. Zint, R. Gross, V. Aizinger, H. Köstler, Generation of Block Structured Grids on Complex Domains for High Performance Simulation. *Comput. Math. and Math. Phys.* 59 (2019), pp. 2108–2123.
- [2] S. Faghih-Naini, S. Kuckuk, V. Aizinger, D. Zint, R. Gross, and H. Köstler, Quadrature-free discontinuous Galerkin method with code generation features for shallow water equations on automatically generated block-structured meshes. *Adv. Water Resour.* 138 (2020), 103552.
- [3] V. Aizinger and C. Dawson, A discontinuous Galerkin method for two-dimensional flow and transport in shallow water. *Adv. Water Resour.* 25 (2002), pp. 67–84.
- [4] Ch. Lengauer et al., ExaStencils – Advanced Multigrid Solver Generation. In *Software for Exascale Computing – SPPEXA 2016-2019*, Lecture Notes in Computer Science and Engineering, Vol. 136, pp. 405-452, Springer, 2020.