Lecture series as part of the elite degree programme Scientific Computing

Date: 13.11.2019 | Time: 10:00 am | Location: H30, Building FAN B

Afterwards there is coffee / tea in front of the S 106 FAN C.

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Geometrically Intrinsic Modeling of Shallow Water Flows

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Abstract: Shallow water models of geophysical flows must be adapted to geometric characteristics in the presence of a general bottom topography with non-negligible slopes and curvatures, such as mountain landscape. In this paper we derive an intrinsic shallow water model from the Navier-Stokes equations defined on a local reference frame anchored on the bottom surface. The resulting equations are characterized by non-autonomous flux functions and source terms embodying only the geometric information. We show that the proposed model is rotational invariant, admits a conserved energy, is well-balanced, and it is formally a second order approximation of the Navier-Stokes equations with respect to a geometry-based order parameter. We then derive a numerical discretization by means of a first order upwind Godunov Finite Volume scheme intrinsically defined on the bottom surface. We study convergence properties of the resulting scheme both theoretically and numerically. Next, we extend the approach to derive a second order Discontinuous Galerkin method and show its properties. Simulations on several synthetic test cases are used to validate the theoretical results as well as more experimental properties of the solver. The results show the importance of taking into full consideration the bottom geometry even for relatively mild and slowly varying curvatures.

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