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Central-Upwind Schemes for Shallow Water Models

In the first part of the talk, I will describe a general framework for designing finite-volume methods (both upwind and central) for hyperbolic systems of conservation laws. I will focus on Riemann-problem-solver-free non-oscillatory central schemes and, in particular, on central-upwind schemes that belong to the class of central schemes, but has some upwind features that help to reduce the amount of numerical diffusion typically present in staggered central schemes such as, for example, the first-order Lax-Friedrichs and second-order Nessyahu-Tadmor scheme.

In the second part of the talk, I will discuss how central-upwind schemes can be extended to hyperbolic systems of balance laws, such as the Saint-Venant system and related shallow water models. One of the main difficulties in this extension is preserving a delicate balance between the flux and source terms. This is especially important in many practical situations, in which the solutions to be captured are (relatively) small perturbations of steady-state solutions. Other crucial points are preserving positivity of the computed water depth (and/or other quantities, which are supposed to remain nonnegative) and treatment of nonconservative products appearing in, for example, the classical Saint-Venant system in the case of discontinuous bottom topography or generically nonconservative multilayer shallow water equations. I will present a general approach of designing highly accurate and robust central-upwind schemes and illustrate their performance on a number of shallow water models.