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Implicit and semi-implicit high-order well-balanced methods for systems of balance laws

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The goal of this work is to design 1D implicit and semi-implicit high-order well-balanced numerical methods for systems of balance laws with stiff numerical flux and source term. When the relaxation parameter ε is very small, the relaxation terms become very strong and highly stiff, and numerical schemes may produce spurious results. The strategy introduced by two of the authors in [1] is applied, based on the application of a well-balanced reconstruction operator. The well-balanced property is preserved when quadrature formulas are used to approximate the averages and integral of the source term in the cells. This technique is combined with a time discretization method for the time evolution of type RK-IMEX or RK-implicit (see [2]). The methodology will be applied to several systems of balance laws, such as the Burgers equation or the shallow water model.

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