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Complete flux schemes for conservation laws of advection-diffusion-reaction type

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Complete flux schemes are recently developed numerical flux approximation schemes for conservation laws of advection-diffusion-reaction type; see e.g. [1, 2]. The basic complete flux scheme is derived from a local one-dimensional boundary value problem for the entire equation, including the source term. Consequently, the integral representation of the flux contains a homogeneous and an inhomogeneous part, corresponding to the advection-diffusion operator and the source term, respectively. Suitable quadrature rules give the numerical flux.

For time-dependent problems, the time derivative is considered a source term and is included in the inhomogeneous flux, resulting in an implicit semi-discretisation. The implicit system proves to have much smaller dissipation and dispersion errors than the standard semidiscrete system, especially for dominant advection.

Just as for scalar equations, for coupled systems of conservation laws, the complete flux approximation is derived from a local system boundary value problem, this way incorporatin the coupling between the constituent equations in the discretization. Also in the system case, the numerical flux (vector) is the superpostion of a homogeneous and an inhomogeneous component, corresponding to the advection-diffusion operator and the source term vector, respectively. The scheme is applied to multi-species diffusion and satisfies the mass constraint exactly.

References

[1] J.H.M. ten Thije Boonkkamp and M.J.H. Anthonissen, The finite volume-complete flux scheme for advection-diffusion-reaction equations, J. Sci. Comput. 46, pp. 47-70 (2011).

[2] J.H.M. ten Thije Boonkkamp, J. van Dijk, L. Liu and K.S.C. Peerenboom, Extension of the complete flux scheme to systems of comservation laws, J. Sci. Comput. 53, pp. 552-568 (2012).

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