

Improving the time-splitting errors of one-dimensional advection schemes in multidimensional applications

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A method is presented to reduce the time-splitting errors of one-dimensional flux form advection schemes.

In multidimensional applications deformational correction terms are included in each one-dimensional advection step whereby all correction terms add up to zero.

With the correction terms a consistent form of a given one-dimensional advection scheme is achieved when time-splitting is performed.

Positive definiteness and shape preservation of the scheme are obtained by nonlinear limitation of the advective fluxes and the deformational correction terms.

Large Courant numbers are treated by applying local timestep reduction. The resulting scheme is strictly one-dimensional, mass conservative and positive definite. Shape preservation of the method is nearly achieved.

Two- and three-dimensional test runs are presented demonstrating that the method yields satisfactory results.

The horizontal flow in a terrain with a steep mountain ridge is investigated by utilizing a terrain following vertical coordinate. It is shown that even in steep orographical terrain the method works quite well, however, small errors occur in the shape preservation of the scheme. These errors increase with increasing spatial variation of the vertical grid mesh.