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A HIGH-ORDER SCHEME BY MULTI-MOMENT CONSTRAINED FLUX RECONSTRUCTION AND ITS APPLICATION ON GLOBAL MODELLING

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A high-order numerical scheme based on local spatial reconstruction was proposed in this study. The local degrees of freedom (DOFs) for the predicted variables are point-wisely defined at the solution points within each control volume. These DOFs are updated through the differential-form governing equations. As a result, the evaluation of the derivatives of flux is the key problem in discretization. The reconstruction polynomial for flux is obtained by using multi-moment constrained concept [1]. The moments adopted for flux spatial reconstruction include the point values at the constraint points and the first-order derivatives at two endpoints of each control volume. The solution points and constraint points are arranged at Guass-Lobatto points in this study considering the results of the spectral analysis. The accuracy of the proposed scheme is verified by the convergence tests for both advection and Euler equations.

The proposed scheme is applied to develop the numerical model for global atmospheric dynamics. The cubed-sphere grid is adopted to represent the spherical geometry. Thus, a high-order global model can be implemented by straightforwardly extending the proposed scheme to the general curvilinear coordinates. Compared with the high-order finite-volume or finite-difference schemes, the multi-moment scheme with a compact stencil has advantages in treating the patch boundaries on cubed-sphere grid, where the discontinuous connections between the coordinate systems on adjacent patches usually generate large errors. A numerical model for global shallow-water flows has been accomplished and most of the widely used benchmark tests were checked. The numerical results are competitive to most existing advanced models and the multi-moment numerical framework is promising for developing the general circulation model.

REFERENCES

[1] F. Xiao, S. Ii, C. G. Chen, X. L. Li. A note on the general multi-moment constrained flux reconstruction formulation for high order schemes. *Applied Mathematical Modelling*, Vol. **37**, 5092–5108, 2013.