MODELING ATMOSPHERIC CIRCULATIONS WITH HIGH-RESOLUTION METHODS

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ABSTRACT

Because of the enormous range of scales and physical phenomena, direct numerical simulation of the Earth's weather and climate is far beyond the reach of current computational technology. This necessitates careful selection of numerical tools suitable for simulations of atmospheric circulations. The recently documented in the literature implicit large eddy simulation (ILES) approach based on non-oscillatory finite-volume (NFV) schemes [1] appears particularly useful, as it enables the representation of high Reynolds number flows without need for explicit subgrid scale models. This talk will highlight an anelastic multiscale NFV model [2] built on the second-order-accurate high-resolution multidimensional positive definite advection transport algorithm (MPDATA) [3]. Among the chief properties of MPDATA are the preservation of sign of scalar quantities such as density or water content, the nonlinear stability of the simulation, and the suppression of unphysical oscillations. To illustrate the strengths of the ILES approach, the results will be shown of several diverse calculations of turbulent flows ranging from a canonical decaying turbulence in a triply-periodic box to idealized terrestrial (and solar) climates. These results will be contrasted with pseudospectral calculations and theoretical estimations to demonstrate that fluid models built on high-resolution methods can compare favorably with (formally) high-order codes.

References

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[3] P.K. Smolarkiewicz, Multidimensional positive definite advection transport algorithm: an overview, *Int. J. Numer. Meth. Fluids*, **50**, 1123-1144, (2006).