

The Spatial Cross Derivative Terms in the Smolarkiewicz Positive Definite Scheme

Tzay-Ming Leou¹ Hung-Chi Kuo²

¹Computer Center Central Weather Bureau

²Department of Atmospheric Sciences
National Taiwan University

ABSTRACT

Smolarkiewicz pointed out that the multi-dimensional numerical advection scheme without the spatial cross derivative terms is an unstable scheme. We explore the impact of the spatial cross derivative terms in the Smolarkiewicz method. Both the analytical Taylor expansion and numerical calculations in two dimension are used in the study. Our results indicate that the Smolarkiewicz method without the cross terms can be a stable scheme if not too large Δt is used or the position of the advected cone is not too near the computational boundary. Splitting process allow the usage of a larger Δt than the multi-dimensional calculations with the cross terms. In addition, the splitting process involves the cross spatial derivative terms automatically in the calculation. The main results of our work are summarized in fig.13 ,14 and 15, which complement the Smolarkiewicz results of 1983 and 1985. We also give the correct multi-dimensional cross spatial derivative terms for the Smolarkiewicz method.

Key Words : cross derivative terms, positive definite scheme