

A Study of Positive Definite Schemes

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ABSTRACT

In this paper we give a detail comparative studies of two recent positive definite methods of Smolarkiewicz (1983, 1984) and Hsu and Arakawa (1990). We have tested the schemes with one dimensional linear advection. The Gaussian, Gaussian pus constant, sine and square waves are used as initial conditions. The convergent rate, stability, accuracy, maintenance of peak value, efficiency and the implementation of the methods are discussed. A new mixed order of Smolarkiewicz method is proposed. The mixed order scheme yields the same result as the high order of Smolarkiewicz scheme.

Our computations indicate that no more than three corrective steps should be used in the mixed order and the high order of Smolarkiewicz schemes. Maximum of two corrective steps should be used in the low order scheme of Smolarkiewicz. The high order scheme in the third corrective steps have the best peak value (almost 100% after 320 time steps). The high order scheme in the second corrective steps have 93% of the original peak value. The low order Smolarkiewicz in second corrective schemes have 80% and the Hsu-Arakawa scheme both have 86.5% of the original peak value. The low order scheme have upstream phase shift. The high, mixed order of Smolarkiewicz schemes and Hsu-Arakawa scheme do not have phase shift. The central fourth, second order finite differencing and upstream scheme are included for the comparison.

Key Words: advection equation, positive definite scheme, anti-diffusion