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On the accuracy of the Complex-Step-Finite-Difference method

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Abstract

The Complex-Step-Finite-Difference method (CSFDM) is a very simple methodology that can be implemented in well known numerical techniques helping to improve, for instance in the wave propagation problem, time and/or space derivative based wavefields. We clarify differences between the CSFDM and previous implementations of the Complex-Step (CS) derivative approximation in well known numerical techniques. We study dispersion properties for the one-way and two-way wave equations using the Finite-Difference method (FDM), the Pseudospectral method (PSM), the Finite-Element method (FEM) and the CSFDM, under the influence of a plane wave and Ricker source time functions. We show the gain in numerical accuracy offered by the methodology of the CSFDM over the FDM, PSM and FEM. We finally discuss consequences of the CSFDM in future scenarios and propose directions of study in this area.

Key words: numerical solution, wave propagation, Finite-Difference method, Pseudospectral method, Finite-Element method, Complex-Step method, Complex-Step-Finite-Difference method.

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