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Detailed analysis of the effects of stencil spatial variations with arbitrary high-order finite-difference Maxwell solver

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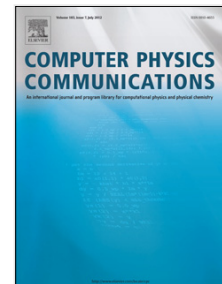
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3 finite-difference Maxwell solver.
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15 **Abstract**

16 Very high order or pseudo-spectral Maxwell solvers are the method of choice to reduce discretization
17 effects (e.g numerical dispersion) that are inherent to low order Finite-Difference Time-Domain (FDTD)
18 schemes. However, due to their large stencils, these solvers are often subject to truncation errors in many
19 electromagnetic simulations. These truncation errors come from non-physical modifications of Maxwell's
20 equations in space that may generate spurious signals affecting the overall accuracy of the simulation results.
21 Such modifications for instance occur when Perfectly Matched Layers (PMLs) are used at simulation domain
22 boundaries to simulate open media. Another example is the use of arbitrary order Maxwell solver with
23 domain decomposition technique that may under some condition involve stencil truncations at subdomain
24 boundaries, resulting in small spurious errors that do eventually build up. In each case, a careful evaluation
25 of the characteristics and magnitude of the errors resulting from these approximations, and their impact at
26 any frequency and angle, requires detailed analytical and numerical studies. To this end, we present a general
27 analytical approach that enables the evaluation of numerical errors of fully three-dimensional arbitrary order
28 finite-difference Maxwell solver, with arbitrary modification of the local stencil in the simulation domain.
29 The analytical model is validated against simulations of domain decomposition technique and PMLs, when
30 these are used with very high-order Maxwell solver, as well as in the infinite order limit of pseudo-spectral
31 solvers. Results confirm that the new analytical approach enables exact predictions in each case. It also
32 confirms that the domain decomposition technique can be used with very high-order Maxwell solvers and a
33 reasonably low number of guard cells with negligible effects on the whole accuracy of the simulation.
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38 *Keywords:* 3D electromagnetic simulations, very high-order Maxwell solver, pseudo-spectral Maxwell
39 solver, Domain decomposition technique, Perfectly Matched Layers, Effects of stencil truncation errors
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