Use of Complex Refractive Index for Domain Termination in Split-Step PE Solutions

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The parabolic equation (PE) technique is widely used in the study of wave propagation over earth and inhomogeneous atmosphere. One of the unresolved challenges is the proper truncation of the domain in the split-step Fourier solution of the PE, particularly for wide angles of propagation such as encountered over irregular terrain or with ground-to-air terminals. Most of the previous studies have used shaping windows in the spatial and wavenumber domains to accomplish this (M. Levy, "Parabolic Equation Methods for Electromagnetic Wave Propagation", IEE, 2000), although the use of a complex refractive index has been mentioned in (F. B. Jensen, *et al*., "Computational Ocean Acoustics", AIP, 1994). In this work we consider a complex refractive index to gradually attenuate the fields at large altitudes and study its performance on the overall solution. The refractive index in most of the computational domain is equal to the actual refractive index, while an artificial imaginary part is added near the upper boundary. This lossy layer is uniform in the range direction (x-axis) but has a varying profile in the vertical direction (z-axis). Three different vertical profiles (linear, quadratic, and exponential model) for the modified refractivity are compared. The results show that all of them work well when the maximum magnitude of the modified refractivity is about two orders of magnitude or more. Furthermore the absorption layer needs to have a height of ¼ of the maximum atmosphere height. Instead of adding complex part to the refractive index, a Hanning window may also be used in the z-domain. The results show that in most cases use of the complex refractive index is superior to the Hanning window. A Gaussian beam antenna with variable beam-width and scan-angle and both narrow- and wide-angle PEs are considered in the study.