Parabolic Equation Toolbox for Radio Wave Propagation

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A parabolic equation toolbox (called PETOOL) has been developed in MATLAB with a user-friendly Graphical User Interface (GUI) for modeling radio-wave propagation over variable terrain and through homogeneous and inhomogeneous atmosphere (O. Ozgun, G. Apaydin, M. Kuzuoglu, L. Sevgi, Computer Physics Communications, 182, 2638–2654, 2011). The unique feature of the toolbox is that it implements both one-way and two-way Fourier split-step method to take account of both forward and backward propagating waves over variable terrain.

The standard Fourier split-step method is a one-way algorithm that starts from a reference range where an antenna is located, and marches out in range by obtaining the field along the vertical direction at each range step through Fourier transformations. It is quite efficient for modeling both horizontally and vertically varying atmospheric refraction (especially ducting) effects. However, it is capable of handling only forward-propagating waves. The forward waves are indeed sufficient in accurate modeling for typical long-range propagation problems. But, if there are objects that redirect incoming waves by reflections and diffractions, multipath effects should accurately be modeled and included as well. To overcome this limitation, the two-way algorithm utilizes an iterative forward-backward scheme for modeling multipath effects over a staircase-approximated terrain.

PETOOL is indeed the first software package that implements the two-way algorithm for radio wave propagation and can be used as a research or educational tool for propagation engineers. It displays graphics and maps of propagation factor/loss versus range/altitude. A user can easily define arbitrary terrain and refractivity profiles, and save all input/output parameters. The tool is demonstrated and validated through analytical comparisons and representative canonical tests that are performed by Geometric Optic (GO) and Uniform Theory of Diffraction (UTD).