An Accurate Interpolation Method for Propagation Models

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Conventional interpolation techniques are known to introduce errors when applied to complex-valued electromagnetic fields, such as those simulated by the JHU/APL Tropospheric Electromagnetic Parabolic Equation Routine (TEMPER). A Fourier interpolation scheme, specifically formulated for interpolating TEMPER fields, has been developed. This formulation provides better efficiency and accuracy for TEMPER applications than standard Fourier interpolations, and far more accuracy than non-Fourier interpolation techniques. The new interpolation method leverages the fact that, while periodic repetitions within a discrete cosine transform (DCT) inherently generate slope discontinuities, the discrete sine transform (DST) can, with proper modifications, be made continuous across periodic-interval repetitions.

There are many potential applications for such an interpolator. While conventional-interpolator errors are often tolerable in TEMPER post-processing applications, certain high-fidelity applications will benefit from a more accurate interpolator. Furthermore, several potential upgrades to TEMPER's representation of propagation over terrain are predicated on having a more accurate, efficient interpolator within TEMPER's equation-solver loop. For these applications, a high level of accuracy is required because slight interpolation errors can accumulate into larger output errors, and efficiency is required because an in-loop interpolation will be performed many times over the course of a single TEMPER run.

When calculating propagation over terrain, the TEMPER shift map algorithm is used. This method computes the field on a grid which is attached to the terrain. Thus the solution is given on a set of points which shift up and down with the undulations of the surface. It is desirable to have the solution given on a regular, rectangular grid of points. This requires interpolating the solution onto the regular grid. Since the phase as well as the amplitude of the solution is needed, the interpolation must be as accurate as possible.

When the terrain is too steep to use the shift map, the terrain is simulated as a series of knife edges. Here interpolation is again needed, as the knife edge will not in general fall on a regular grid point.