

Terrain Model Resolution Impacts on Propagation Modeling

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Semi-empirical propagation models, such as the Irregular Terrain Model or Hata model, were first developed in the 1960s to predict radio frequency (RF) electromagnetic (EM) wave propagation. These models blend physics with empirical observations. Over the past 60 years, a wide variety have been developed and used to model RF propagation for numerous applications. Although some of these semi-empirical models can be used over water, they are more commonly used for land-based applications.

Parabolic equation (PE) models, developed in the 1990's, were developed specifically for over water applications. These deterministic RF propagation models, derived directly from Maxwell's equations, became feasible with advances in computational power. Their deterministic formulation allows for accurate modeling of anomalous propagation caused by atmospheric effects, which is a common occurrence in maritime environments. Although developed for maritime applications, PE models can be used over land, although this is less common.

Because semi-empirical and PE models use different approaches to modeling RF propagation, the choice of terrain profile and terrain resolution can have a significant impact on model prediction accuracy. Because PE models use a marching algorithm where propagation factor is calculated at each step, PE models are highly sensitive to variations in terrain. Semi-empirical models generally use terrain profiles that are uniformly sampled over distance and are less sensitive to variations in terrain. Intuitively, terrain profiles generated from higher resolution Digital Elevation Maps (DEMs) should yield higher fidelity propagation model predictions for both PE and semi-empirical models. However, that is not always the case.

The Irregular Terrain Model (ITM), a semi-empirical model, is widely used for applications such as predicting communications link reliability or determining coverage of transmitted signals. The Tropospheric Electromagnetic Parabolic Equation Model (TEMPER) is a PE model commonly used to predict electromagnetic system performance in real-time. In this work we expand upon our previous efforts to examine the effects of terrain resolution on the predictions generated by ITM and TEMPER. Understanding these impacts will better inform users how to get the best performance from the models.