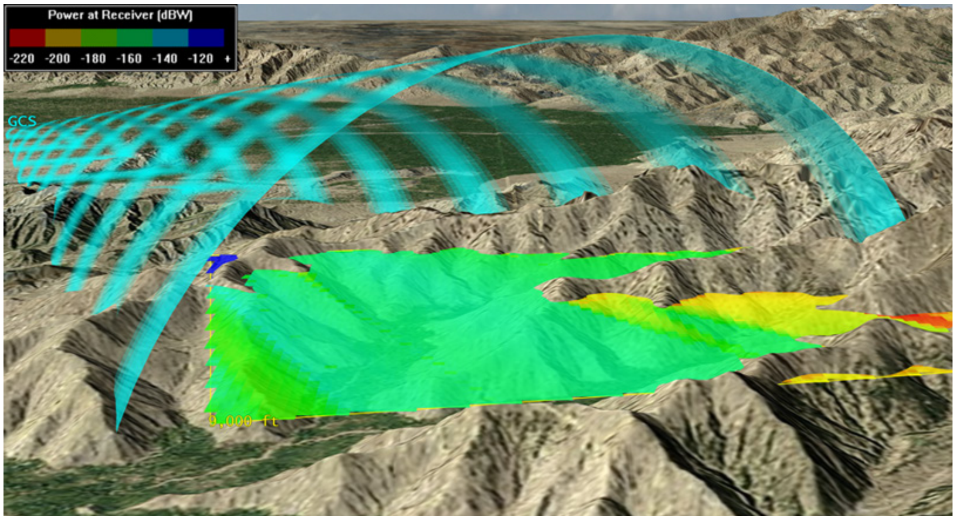
STK TIREM
STK COMMUNICATIONS AND STK RADAR EXTENSION

AGI

Terrain Integrated Rough Earth Model (TIREM) provides the functionality needed to calculate RF propagation loss over irregular terrain, from 1MHz to 20 GHz.

Communication and Radar analysts can calculate and dynamically model point-to-point line-of-sight effects for link performance in STK. However, in some cases there is the need to consider the effect of irregular terrain, seawater, and non-line-of-sight effects. The TIREM extension for Communications and Radar lets you perform such analysis and modeling by adding fidelity to radio frequency (RF) calculations.

In addition to propagation loss over irregular terrain, TIREM models near-field considerations, power density and field strength equation. TIREM examines the elevation profiles, and, based on the geometry, selects the optimum model for the calculations. It can also select appropriate modes of propagation for paths based on the geometry of the profile—such as multiple knife-edge diffraction and troposcatter, two physical phenomena that extend the signals propagation into the BLOS (beyond line-of-sight).



TIREM has been fully integrated into STK, enabling propagation loss calculations from within Communications and Radar. It incorporates the government-standard terrestrial propagation algorithm directly into the STK RF environment—allowing users to perform analyses among dynamic nodes as part of an overall system simulation. This capability can be enhanced through visualization in 2D or 3D by performing access or coverage analyses over areas of terrain.

TIREM path loss guidelines

<table>
<tr><th rowspan="2">Frequency</th><th colspan="3">Line of sight</th><th colspan="3">Beyond line of sight</th></tr>
<tr><th>Sea</th><th>Sea/land</th><th>Land</th><th>Sea</th><th>Sea/land</th><th>Land</th></tr>
<tr><td>1 to 16 MHz</td><td rowspan="3">Smooth-earth loss</td><td rowspan="3">Weighting by sea/land distance</td><td>Smooth-earth or reflection loss</td><td rowspan="3">Smooth-earth diffraction or troposcatter loss</td><td rowspan="3">Weighting by sea/land distance</td><td>Smooth-earth or troposcatter loss</td></tr>
<tr><td>16 to 20 MHz</td><td>Interpolation from 16 to 20 MHz</td><td>Interpolation from 16 to 20 MHz</td></tr>
<tr><td>20 MHz to 10 GHz</td><td>Reflection loss</td><td>Smooth-earth diffraction, rough-earth diffraction, or troposcatter loss</td></tr>
<tr><td>10 to 20 GHz</td><td colspan="6">Loss as calulated above plus atmospheric absorption</td></tr>
</table>

Median propagation loss

Median propagation loss is calculated using free-space spreading, reflection, diffraction, surface-wave, tropospheric-scatter, and atmospheric absorption. These various techniques help predict median propagation loss from 1 MHz to 20 GHz to solve many communications analysis problems.

Propagation loss along a path of irregular terrain

TIREM calculates the propagation loss along a path over irregular terrain, providing additional fidelity for current RF calculations over terrain. This enables space and terrestrial-based users of STK to leverage the full functionality of Communications and Radar with the best analytical tools possible.

Automated selection of modes of propagation

Based on the geometry of the profile, TIREM selects all appropriate modes of propagation for paths with endpoints that are either within line-of-sight (LOS) or beyond line-of-sight (BLOS).

Enhanced modeling

TIREM models the phenomena that have the largest impact on terrestrial communications:

- **Multiple knife-edge diffraction**. Physical phenomena that extends the signal's propagation into the BLOS zone.
- **Troposcatter**. Another of the physical phenomena that extend the propagated signal into the BLOS zone. In this case, the electromagnetic signal is reflected off of the Earth's troposphere. TIREM models troposcatter as a function of frequency and other environmental and equipment factors.

Calculation considerations

TIREM offers more precise calculations via:

- Atmospheric absorption for frequencies above 10 GHz.
- Long-term power fading can be considered for climatic conditions representing most parts of the world.
- Modeling variability as a result of the standard deviation of the model from measured data can also be considered.