



Low and Medium Frequency Ground-Wave and Sky-Wave Propagation Model for 150 kHz to 1705 kHz

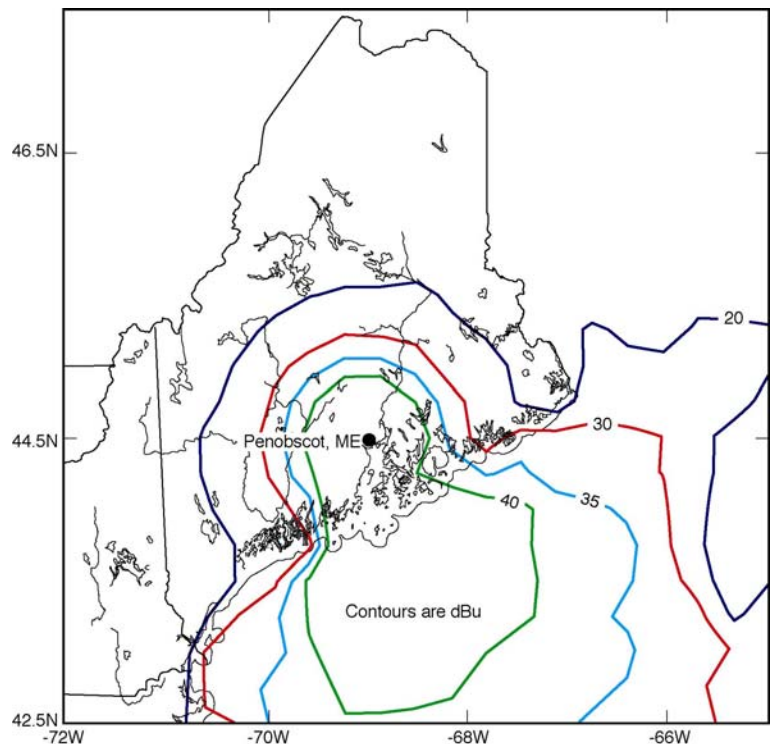
Institute for Telecommunication Sciences (ITS)



- **Windows 95/98/NT/2000/ME/XP version of the Low and Medium Frequency Ground-Wave and Sky-Wave Propagation Model for communications and interference analysis.**
- **Antenna models specific to LF/MF frequencies have been incorporated into analyses.**

The Institute for Telecommunication Sciences has developed a low and medium frequency propagation model to be used for analysis of coverage and interference in the medium frequency (MF) band and the low frequency (LF) band. This is a Windows™ - based communication/broadcasting system performance model designed for a PC. This model performs radio-wave propagation and antenna analysis in the frequency band of 150 to 1705 kHz. The sky-wave propagation models are valid from 150 to 1705 kHz, and the ground-wave models are valid from 10 kHz to 30 MHz. The radio-wave propagation prediction models can determine basic transmission loss between a communications transmitter and receiver. Examples of this include, the AM Broadcast band of 535 to 1605 kHz, and the band of frequencies from 285 to 325 kHz that is presently being used for a differential correction signal for the Differential Global Positioning System (DGPS). There are three ground-wave and three sky-wave propagation loss prediction methods contained in this model.

For the frequency band of 150 to 1705 kHz, the propagation of radio waves at night includes both a ground wave and a sky wave. The expected sky-wave signal combined with the ground-wave signal may be compared with the expected radio noise environment (consisting of atmospheric, galactic, and man-made noise components) to predict the likelihood that the communication link will operate satisfactorily. The presence of the sky wave at night could create potential interference problems between distant stations on the same frequency or frequencies that are near each other. The sky-wave models provide some means of estimating the expected field strengths of signals to assist in frequency allocation and to avoid potential interference problems. At night the undesirable interference from the sky wave can manifest itself as adjacent and co-channel interference to stations that it would not normally reach in the daytime. The absence of the sky wave during the day precludes the use of systems in this band for reliable long distance communication, since the sky wave at frequencies from 150 to 1705 kHz is strongly attenuated by the electron density in the daytime D region. Long distance radio-wave propagation during the daytime is limited by how far the surface-wave component of the ground wave can diffract around the Earth and its terrain features.



Radio coverage for an AM broadcast station generated by the low and medium frequency propagation model developed by the Institute.

Antenna modeling in this band is also quite unlike that in other bands, since the performance of an antenna on or near the surface of the Earth is very dependent on the interaction with the lossy Earth, so specific antenna models have been included that correctly launch the ground wave at the horizon angle and sky wave at the appropriate elevation angle.

This model consists of three distinct analyses called System 1, System 2, and System 3. While the models are related in function, each model is independent of the others. System 1 treats the broadcast circuit from a proposed transmitter to a particular receiver site as a point-to-point problem. The user selects transmitter characteristics, receiver characteristics, site characteristics, and a propagation model. System 2 continues to treat the desired transmitter and the desired receiver site as a point-to-point problem but interference effects are included. All adjacent and co-channel transmitters (referred to as the interfering transmitters) within a user-defined search radius are used to compute signal-to-interference ratios at the receiver location. For each adjacent and co-channel transmitter, the model lists the computed signal-to-interference ratio as well as the amount that the ratio exceeds or fails to exceed the required signal-to-interference ratio for the adjacent or co-channel case. System 3 evolves from the System 2 analysis by treating the broadcast situation as an area problem. The System 3 output is a map of the user-selected area showing contours of signal coverage or signal-to-interference ratios.

The Figure is an actual output of the low and medium frequency propagation model developed by the Institute. It shows the coverage for an AM radio station in the state of Maine.

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