Microwave Propagation Model - Accuracy and Limitations

The model developed is based on generally accepted references analysing measured data and is appropriate to a well-mixed atmosphere, uncluttered by obstacles or ionised scattering phenomena. Data from the model can be used to reliably estimate the average loss in a standard atmosphere to an accuracy of a few dB.

The earth/sea reflecting surface is not smooth and there will always be a random scattered component in addition to a reduced amplitude specular reflection. This can affect both amplitude and phase in the Interference zone, modifying both null depths and ESM system measurement accuracy.

Weather conditions can alter the microwave horizon considerably. Still air stratification and temperature inversions can cause anomalous propagation by modifying the refractive gradient to extend the radar horizon by ducting signals to match the earth's curvature. The inverse can also occur, effectively reducing the horizon range. Stratification can also open multiple paths between transmitter and receiver; interference between these paths can be responsible complex signal variations. Rain along the propagation path attenuates signals; experimentally proven data on rain is modelled. The water vapour absorption line at 22GHz, and the oxygen line at 60GHz are not modelled although data is readily available; for example, see, PW Rosenkranz, "Absorption of Microwaves by Atmospheric Gases," *Atmospheric Remote Sensing by Microwave Radiometry*, (MA Janssen, editor, Wiley 1993.

Table 1 Accuracy and Limitations Comments

Region	Accuracy Comment
Interference zone	Positions of interference peaks and nulls in general is good. Depth of nulls is dependant upon surface roughness - not always easy to estimate. There is also a random component due to scatter from the sea surface which may be significant and dominate in nulls.
Horizon	Affected by atmosphere refractive index variation with height. Noticeable with night-time temperature inversion in calm conditions. Anomalous propagation occurs when the refractive index variation curves the direct propagation path close to matching the Earth's curvature. Horizon movement shifts Intermediate, Diffraction, and Tropospheric Scatter zones accordingly
Intermediate Zone	This is a mathematical approximation between the well-defined loss at the last interference peak before the horizon and the diffraction loss at the point beyond the horizon, where the diffraction loss rate becomes dB-linear. It is an approximation to the early part of the diffraction zone, seemingly too complicated to calculate. The difference could rise to few dB in the mid-range of the approximation; possibly larger at frequency extremities.
Diffraction Zone	Diffraction loss is fairly predictable some way beyond the horizon for sea paths. It is dependant upon the smoothness of the Earth surface in the horizon region.
Tropospheric Zone	Fairly reliable, although atmospheric variation may produce variations of some 10dB
General	The model's accuracy is generally less reliable at extremities of applet parameter ranges. Care should be taken at low receiver/transmitter heights to ensure that wave or swell values are controlled so that wave wash-over or wave peaks do not cause path obscuration. Propagation features not modelled include, the effect of man-made obstacles, anomalous propagation, molecular absorption lines, atmospheric multipath, ionised layers, random surface reflected component, wave wash-over, and wave top scatter/path obscuration.

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