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RECONNECTINGTHEWORLD

Handbook on Radio Frequency Spectrum Requirements for Civil Aviation

Volume II - Frequency assignment planning criteria for aeronautical radio communication and navigation systems (ICAO Doc 9718, Volume II)

Sidetrack: Radio Propagation,- coverage areas vs. separation distances

Workshop/Training on
“Frequency Finder 2023” application

Bangkok, Thailand | 9 – 13 October 2023

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Desirable:

- Good signal quality
- Reliable communications between ATC and aircraft pilot

Undesirable

- Harmful interference
- Potential of miscommunication between ATC and aircraft pilot

Frequency Assignment Planning is all about preventing the undesirable.

But,- what if we want to plan reliable coverage?

ITU has developed several recommendations on propagation

- The simplest one of those is Recommendation ITU-R P.525, on free space propagation:

  Free space path loss $= 37.8 + 20 \log f + 20 \log d$

  (distance in NM and frequency in MHz)

  tends to underestimate the actual realized path loss due atmospheric factors

- For aviation we normally use Recommendation ITU-R P.528-5

  Link: P.528 : A propagation prediction method for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands (itu.int)

✓ Software available, including a graphical user interface, can be used to estimate path loss:

  Link: Releases · NTIA/p528-gui (github.com)

Some examples using Recommendation ITU-R P.528-5

Hypothetical scenario for analysis: 120 MHz, 25W transmitter, signal strength at receiver 1µV / 50Ω
Transmitter at 5m elevation, Receiver at 10000m elevation
No significant ground obstructions (flat surface)

Transmitter power: 25W EIRP = 14 dBW, or 44 dBm

Signal strength at receiver: 1µV / 50Ω = -137 dBW, or -107 dBm

Calculate link budget:

14 dBW – (-137 dBW) = 151 dB – maximum path loss
for 1µV signal at Receiver, or stronger

The Graphical User Interface for Recommendation ITU-R P.528-5:

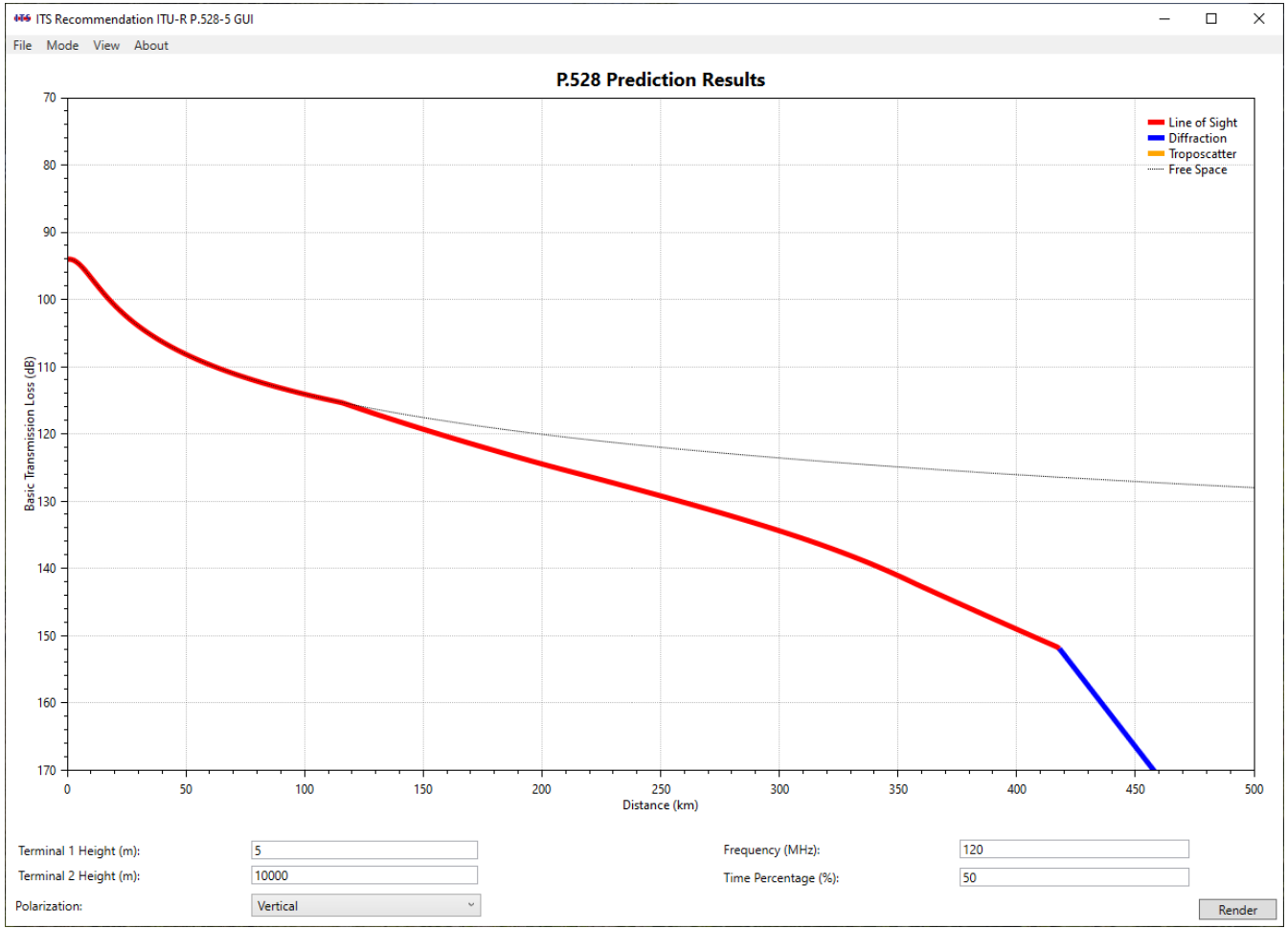
Elevation of the transmitting and receiving terminals, Polarization, Frequency and Time Percentage selected below graph.

Under View, you can select:

- Limits for the x and y plot axes
- Units in metric or NM/feet

This slide shows metric

The next slides will use NM and feet



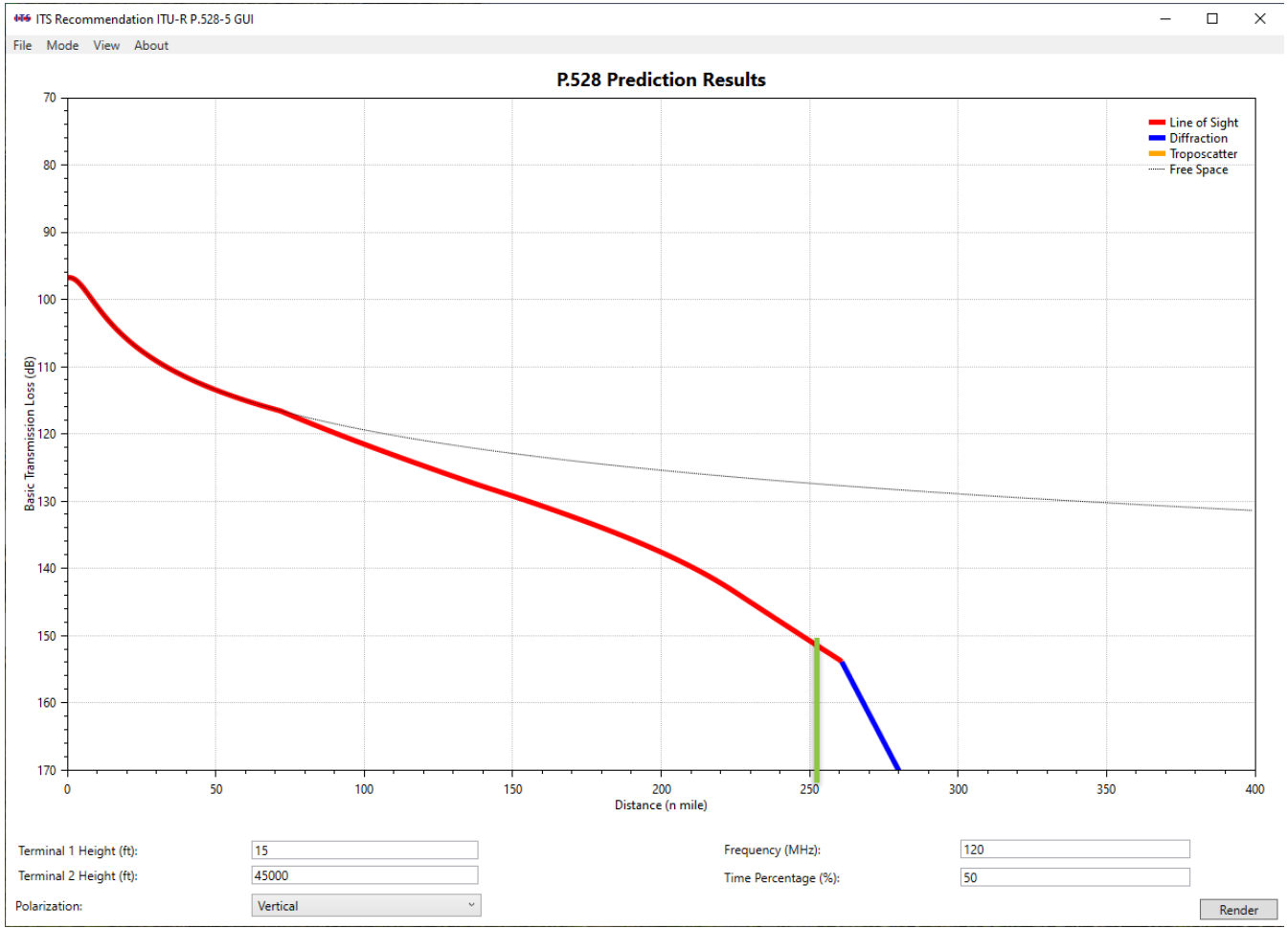
The Graphical User Interface for Recommendation ITU-R P.528-5:

Average (50% of time) propagation:

This is the same plot as before, now in NM and feet

For a link budget of 151 dB when ground terminal is at 15 feet, aircraft at 45000 feet and zero dB gain antennas are used, we find that the average achievable propagation distance is:

251 NM

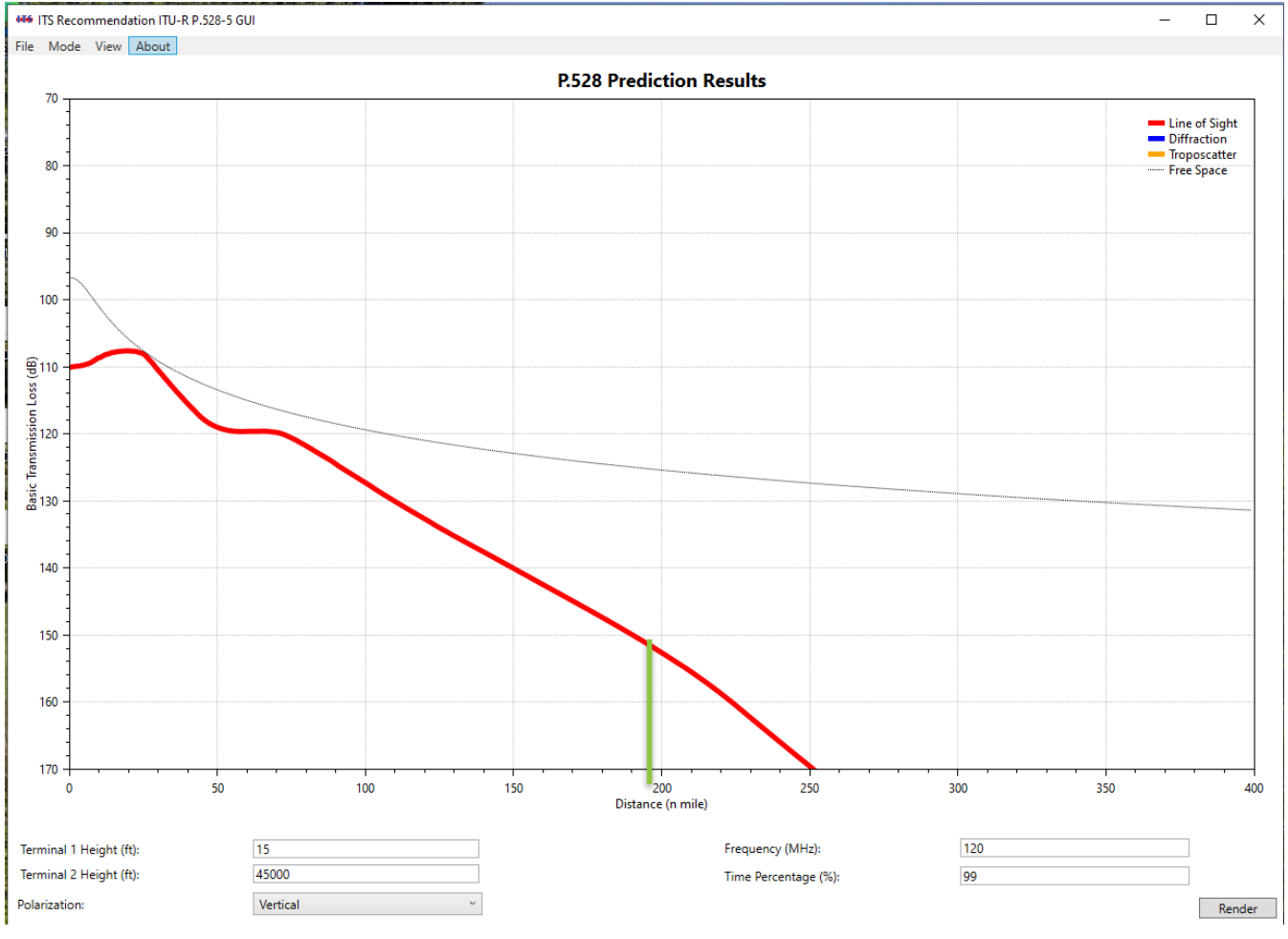


The Graphical User Interface for Recommendation ITU-R P.528-5:

Reliable (99% of time) propagation:

For a link budget of 151 dB, when ground terminal is at 15 feet, aircraft at 45000 feet and zero dB gain antennas are used, we find that the reliable (99% of time) propagation distance is:

195 NM

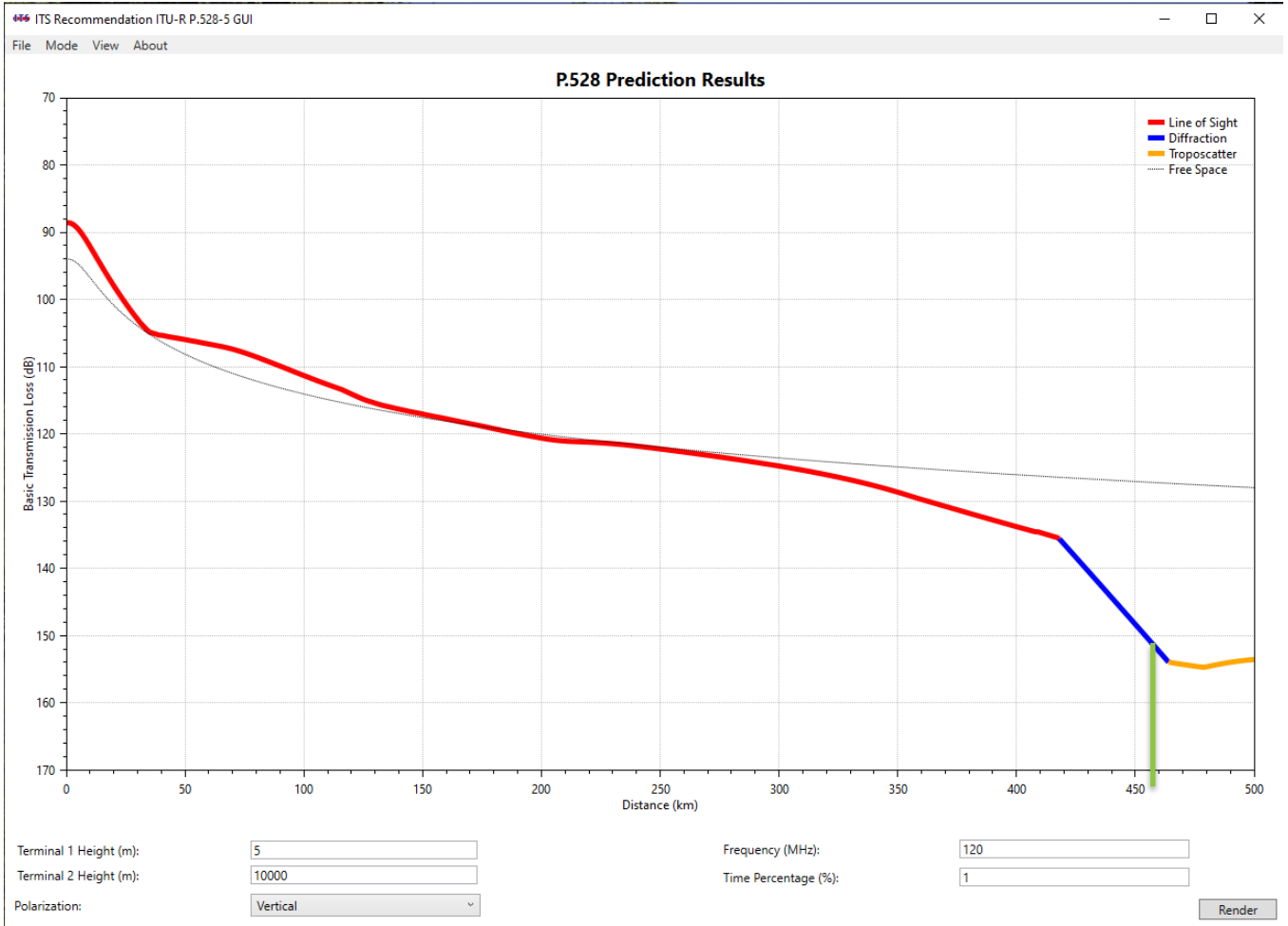


The Graphical User Interface for Recommendation ITU-R P.528-5:

Sporadic (1% of time) propagation:

For a link budget of 151 dB, when ground terminal is at 15 feet, aircraft at 45000 feet and zero dB gain antennas are used, we find that sporadically (1% of time) the propagation distance can go as far as:

459 NM



QUESTIONS?

Thank You!

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There may be free software available which could be used to calculate coverage, taking into account terrain:

- **Radio Mobile:** Radio Mobile WEB Site (ve2dbe.com)
- **SPLAT:** SPLAT! A Terrestrial RF Path Analysis Application For Linux/Unix (qsl.net)

Radio Mobile coverage example (Kathmandu airport)

Note - this example has several inconsistencies:

The Web-version of Radio Mobile is limited to Amateur Radio use only, hence 144 MHz is used in the example (Amateur Radio frequency)

Receiver is always positioned at a fixed level above ground, rather than above sea level.