Link Margin vs. Range
For Different ITU Rain Zones at 99.99% Availability

Link Margin & Rain Zones Explained

The ultimate measure of performance of an FSO link is its link margin. This is the simply the amount of laser power received at either end of the link over and above what is necessary to keep the link up. On a typical day, an FSO link may have hundreds or even thousands of times more power than is really necessary, but on bad-weather days this margin will be reduced as the laser light gets attenuated in the atmosphere.

If by "weather" we are talking specifically about rain, then we have a convenient way to predict FSO link performance using ITU rain zones. The International Telecommunication Union (ITU) has created a statistical model in which the Earth is divided into different "rain zones," where each zone corresponds to a certain level of rain rate. For example, in zone C (which includes some areas of Alaska and Northern Africa) the rain rates tend to be relatively light, whereas in zone P (which includes many tropical islands) the rain rates are much higher. Worldwide maps of the ITU rain zones are shown on pages 2-4 of this document.

The link margin of an FSO link will decrease with increasing rain rate, which is measured in mm/hr of rain. Note that it is the *rate* that matters, not the *amount* of rain that falls (usually measured in millimeters or inches of rain).

In those areas where rain is more severe than fog (e.g. in many tropical areas), the availability of an FSO link, which is the annual percentage of time the link is up, will be a function of the rain rate statistics of the particular rain zone. For example, if a certain link can withstand up to 42mm/hr of rain before going down, then it will have an availability of 99.99% in zone K because in that zone the rain rate is less than 42mm/hr 99.99% of the time.

In the plots below, link margins and ranges are shown for rain rates that yield 99.99% availability for the respective rain zone. These rain rates are shown in the legend next to the corresponding zone letter. Calculations were made using fSONA's proprietary Link Planning Tool. This tool predicts worst-case performance in real-world conditions, and includes such effects as scintillation, smog base and wind. The point at which any curve reaches 0dB Link Margin (the bottom of the chart) corresponds to the maximum range for that product in that weather condition.

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- **8" receiver**

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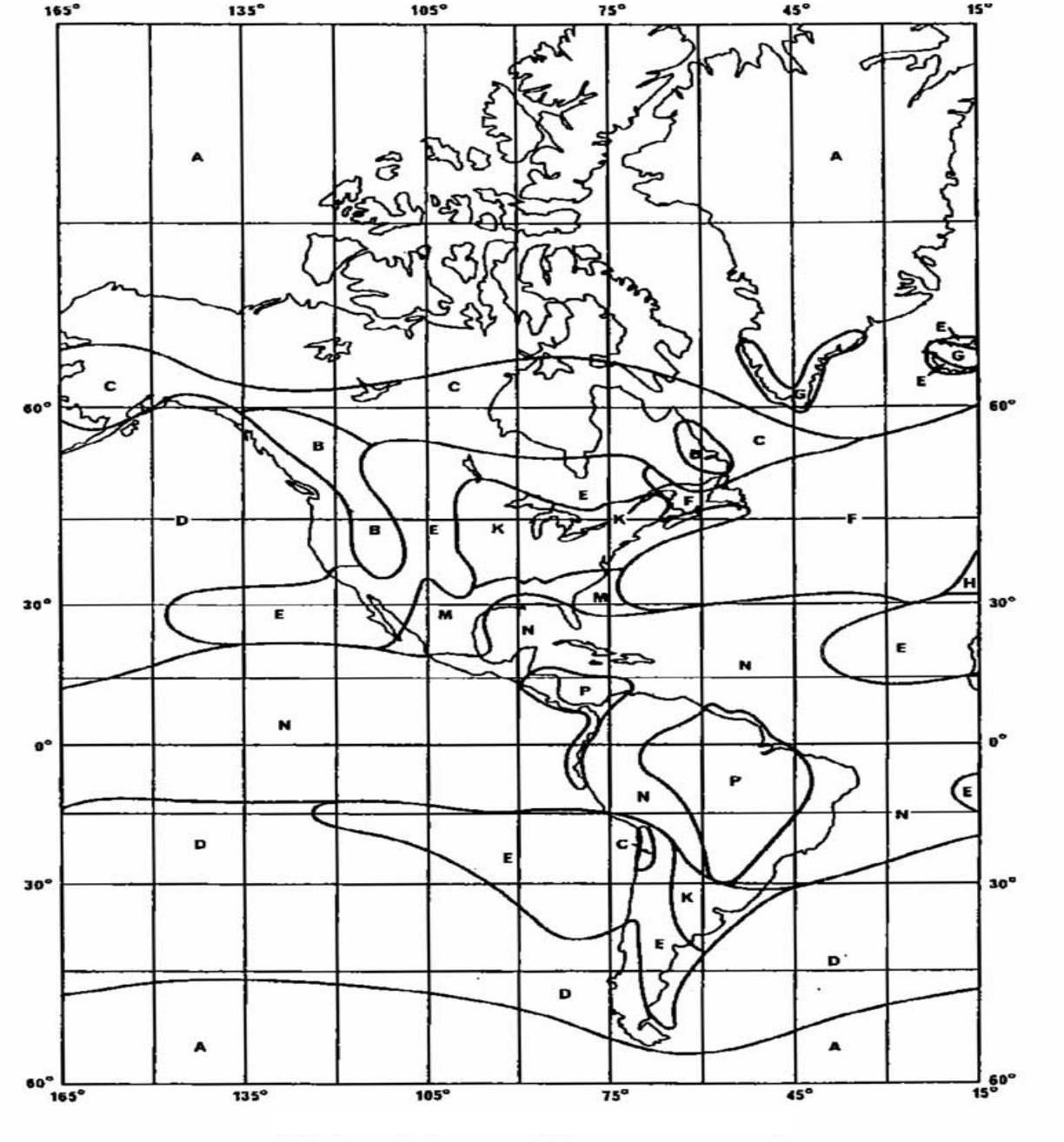
SONAbeam -E
- **100mW**
- **2 transmitters**
- **4" receiver**

ITU Rain Zones for North, Central and South America



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ITU Rain Zones for Africa, Europe, Scandinavia and the Middle East

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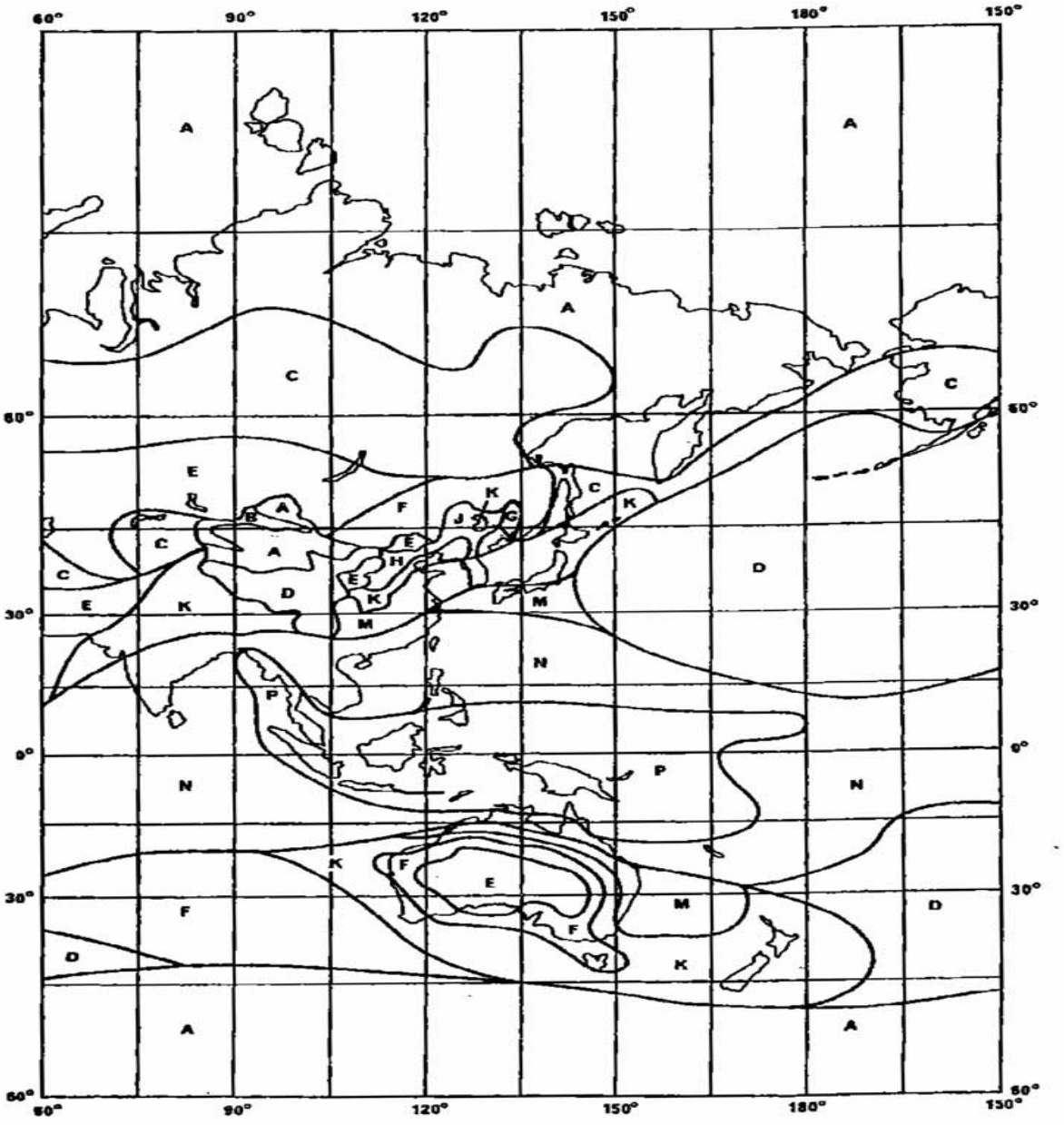
ITU Rain Zones for Asia and Australia



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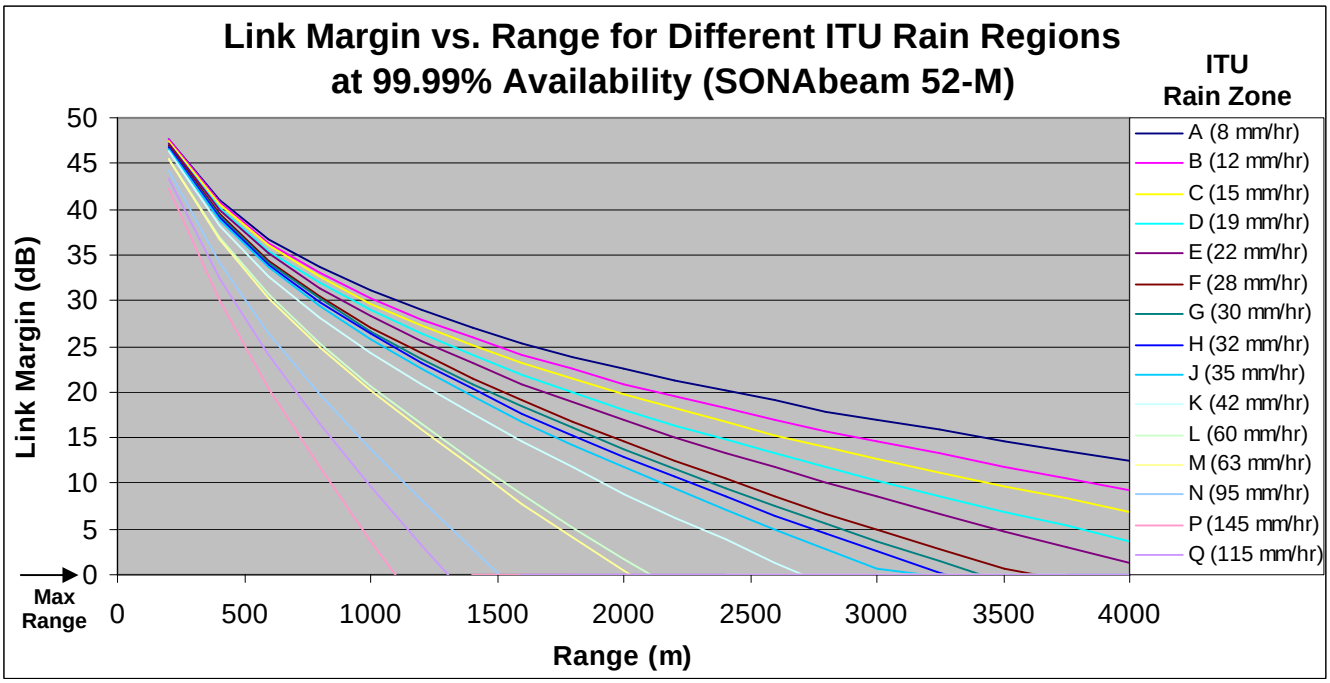

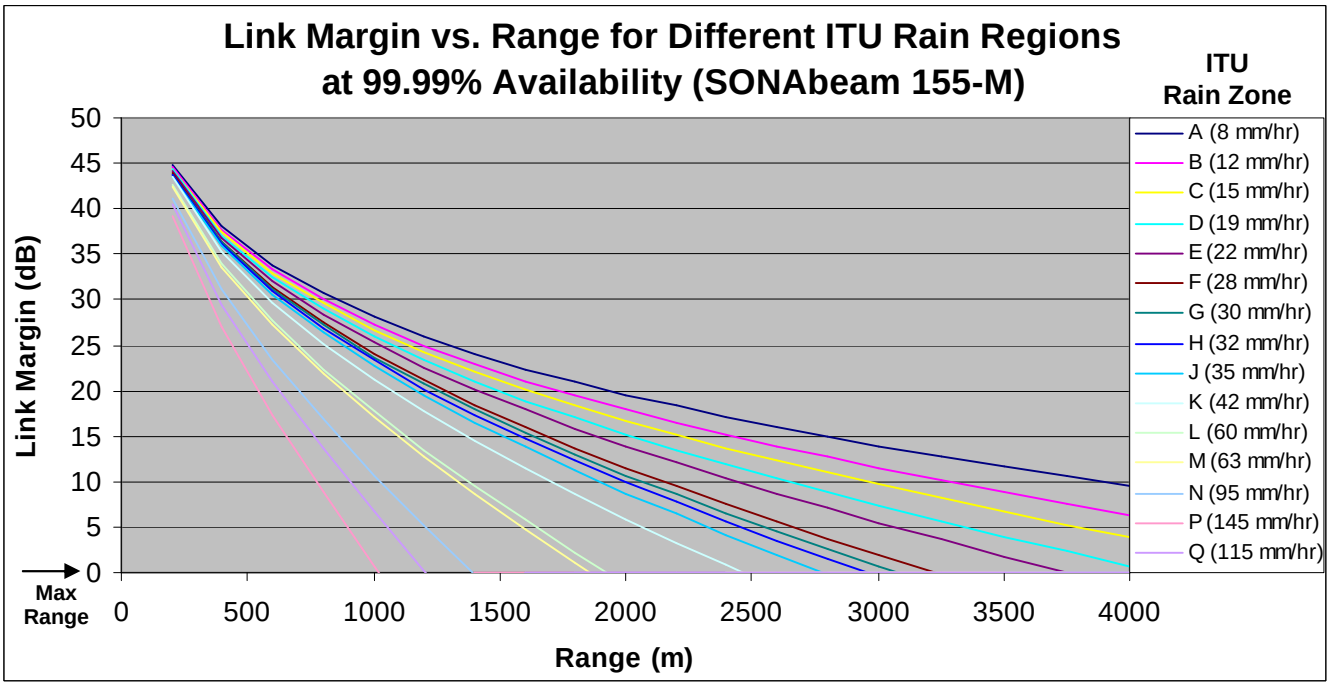

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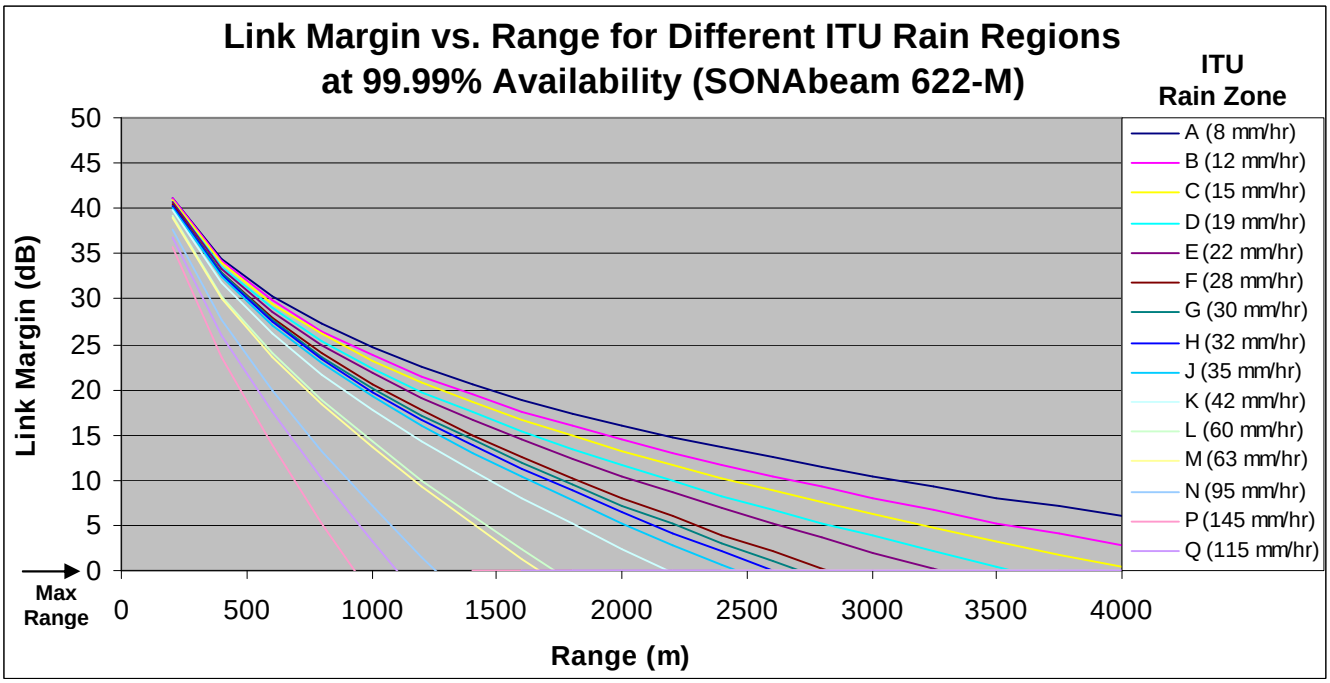

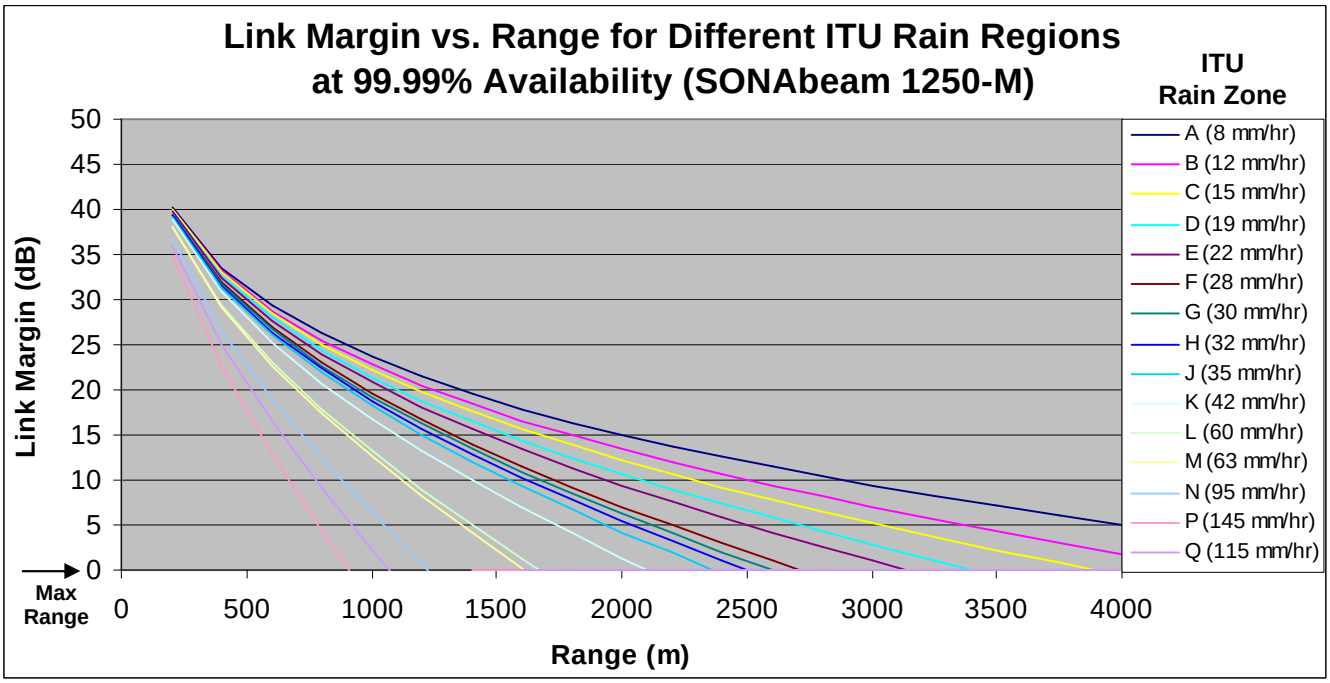

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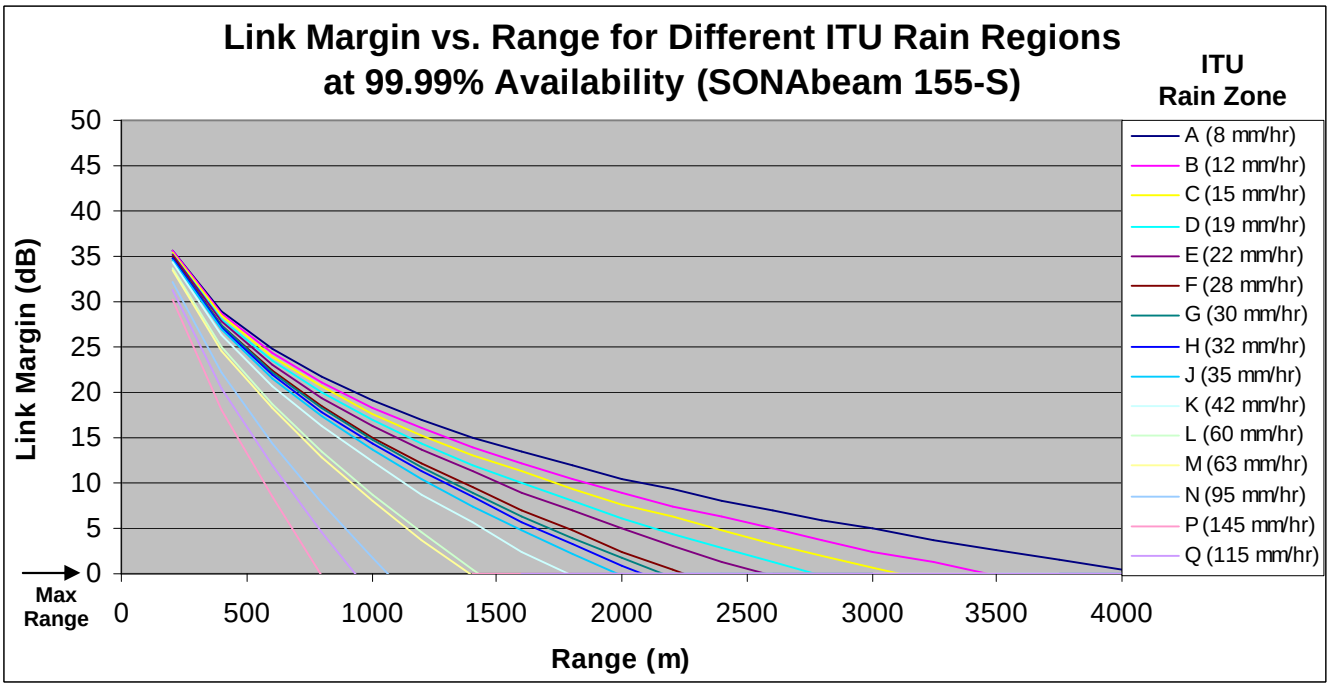

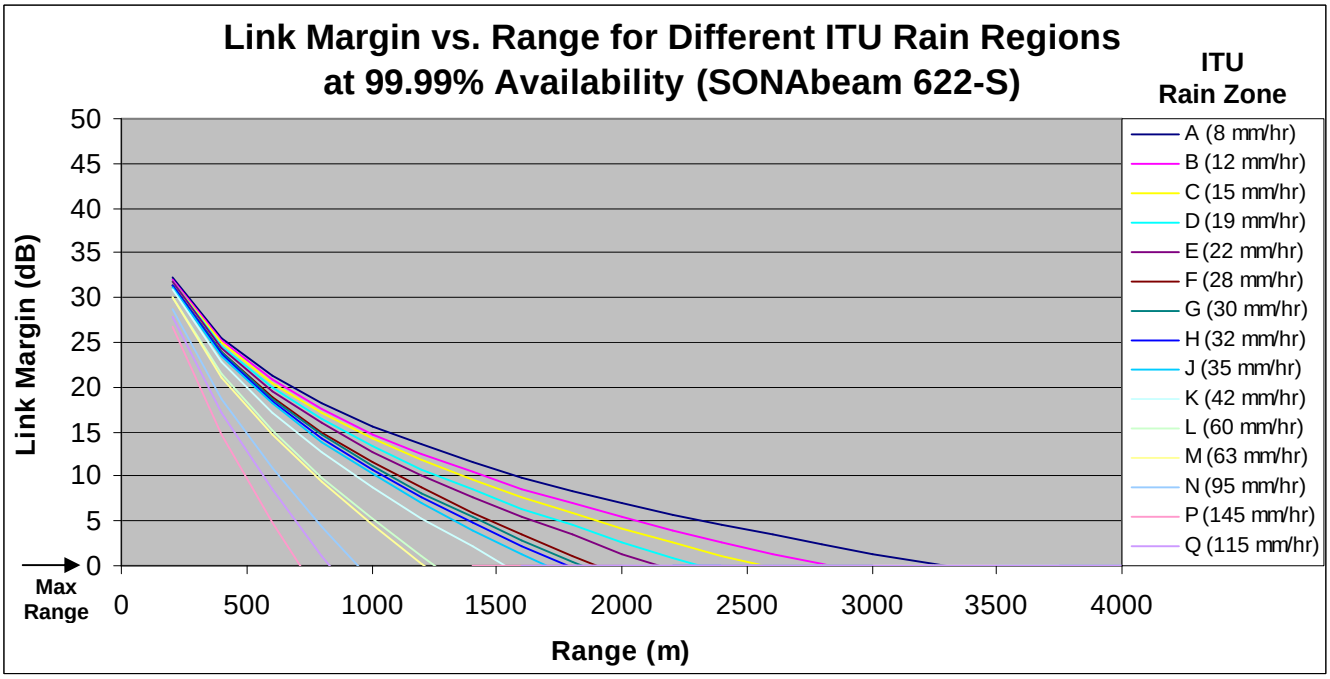

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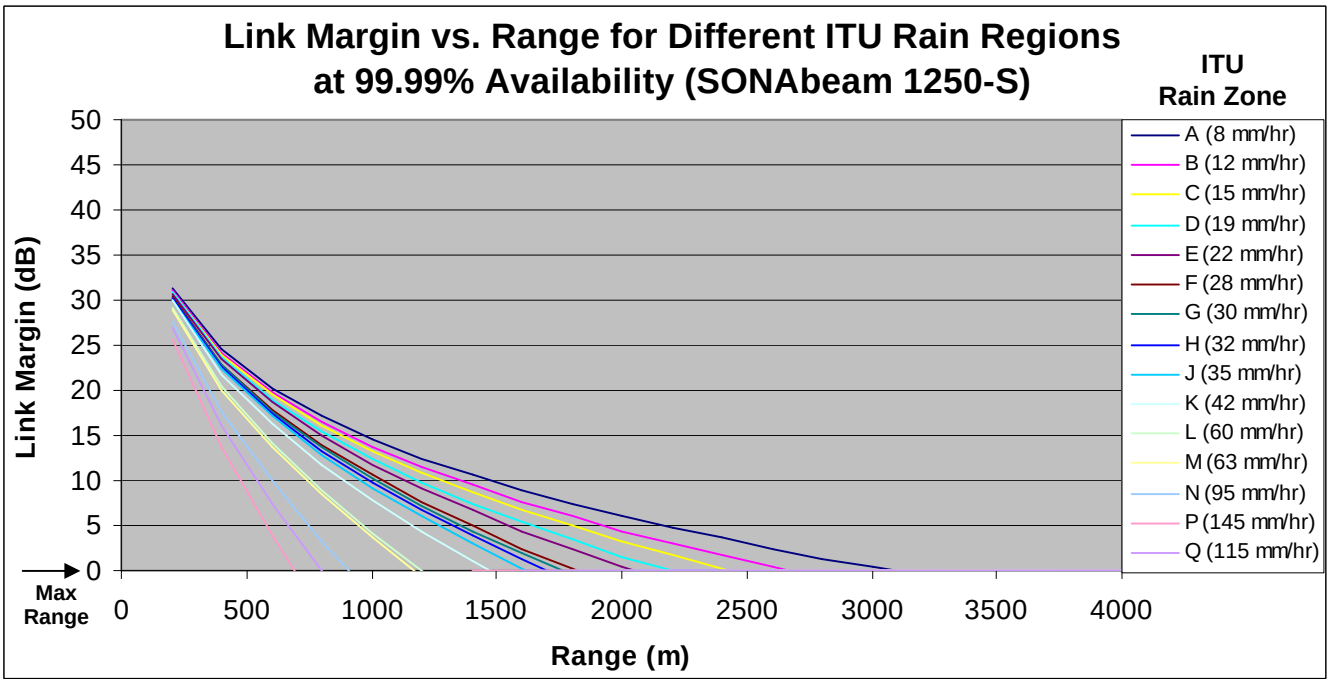

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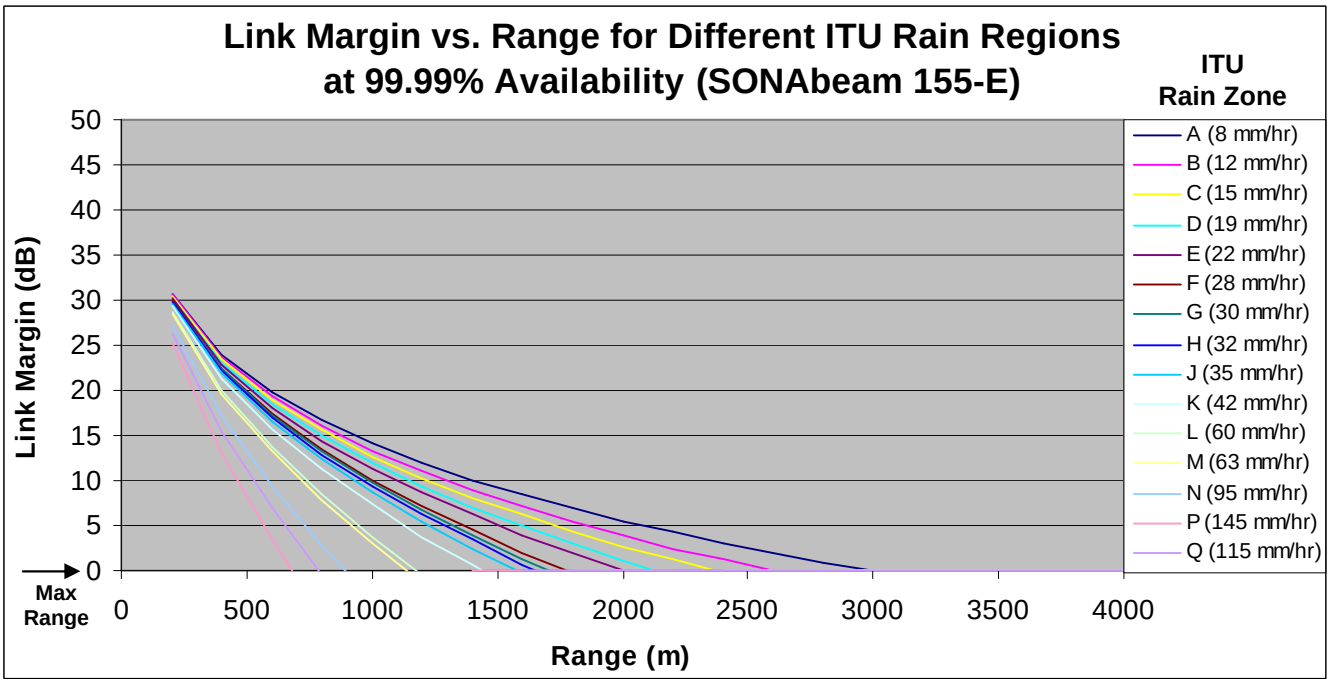

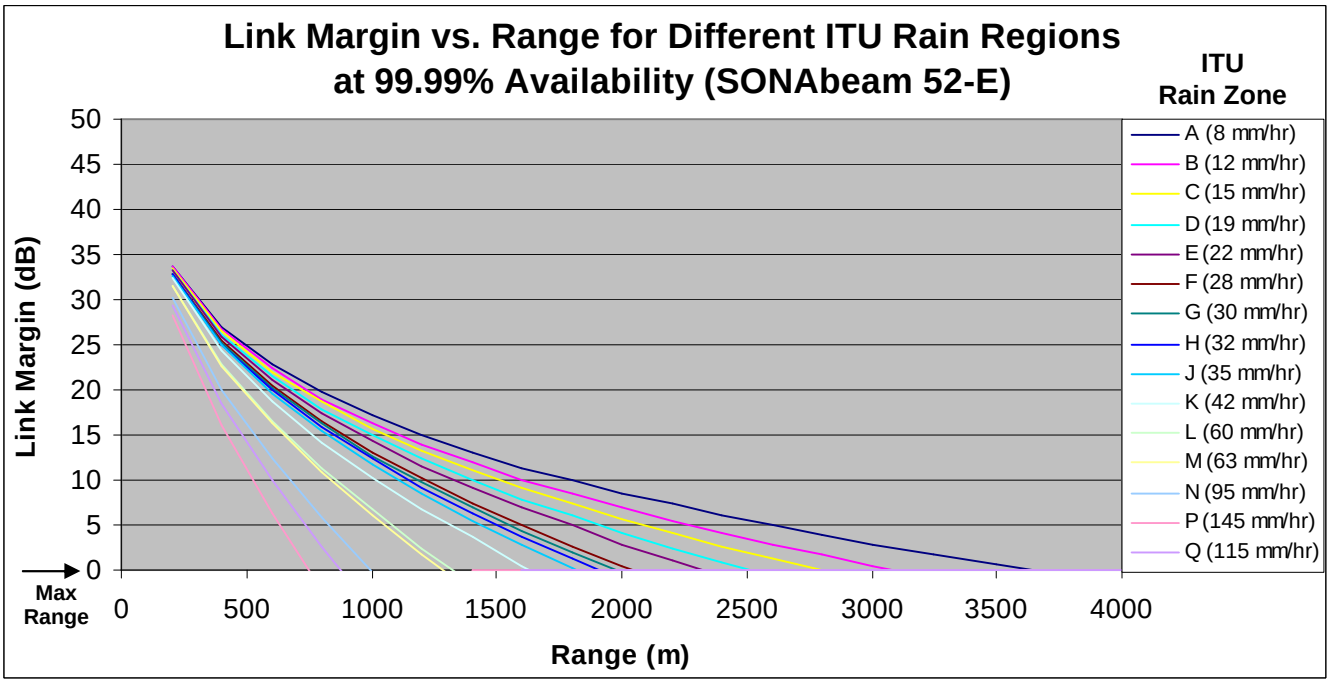

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