Rain Fade

Even the most reliable satellite communications technology can sometimes be out-matched by the forces of nature. It's a phenomenon known as "rain fade" or "rain attenuation" – a weakening of the satellite signal as it passes through raindrops.

Rain fade is one of the most common, and often most misunderstood, phenomena to affect satellite signals. But the more you learn about the causes of rain fade, the better your chances are to lessen its impact on your satellite system.

The Causes

Any satellite communications system network operator using a Ku-Band system (12/14 GHz or higher frequencies) will face the effects of rain fade at some time. But to understand why this weakening occurs with Ku-Band transmissions, you must first understand the causes of rain fade. Two of the most common causes are listed below.

1. Absorption – Part or all of the energy generated when a radio wave strikes a rain droplet. The droplet is converted to heat energy and absorbed by the droplet.
2. Scattering – A non-uniform transmission medium (the raindrops in the atmosphere) causes energy to be dispersed from its initial travel direction.

Scattering can be caused by either refraction or diffraction:

- Refraction – The refractive index of the water droplets encountered by the radio wave.
- Diffraction – the travel direction of the radio wave also changes as it propagates around the obstacle in its path (a water droplet).

These different reactions ultimately have the same effect – they cause any satellite system to lose some of its normal signal level. Don't expect to lose your satellite signal every time it rains, though. Rain outage will only occur during the heaviest rains (convective and stratiform are the most predominant types) with only a small portion of the transmission path experiencing attenuation. In fact, of a typical satellite transmission path measuring 22,300 miles, less than .02% will be affected by rain fade.

The Impact of Rain Rate

Rain rate is the most common factor used to determine rain fade. Rain fade seems to correlate very closely with the volume of raindrops (expressed in cubic wavelengths) along the path of propagation. This is opposed to the common misconception that the degree of attenuation is proportional to the quantity or individual size of the raindrops falling near the receive site.

Pinpointing the specific factor that lead to attenuation is essential to accurately predicting the problem. Models can be developed from this data to chart the effects of rain fade on a regional or individual site basis. From this information, you can determine the correct antenna size you'll need to counteract the effects of rain fade.

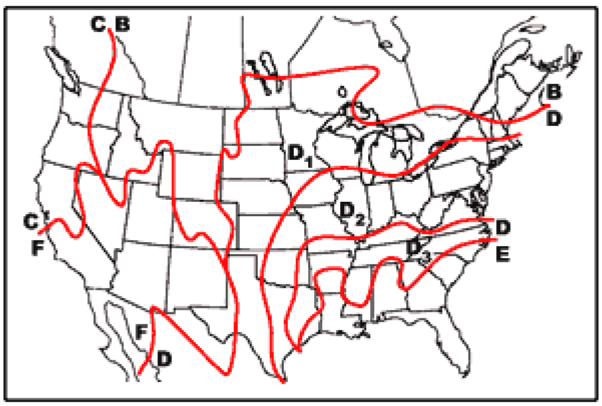
This doesn't mean, however, that buying the largest antenna possible will solve all rain-related problems. There is a point (usually under extremely heavy rain conditions and only for very brief periods) where virtually 100% of the satellite signal is absorbed by rain and no increase in antenna size will raise availability.

Service at Your Fingertips

SpaceCom provides unmatched technology and services for minimizing any rain fade problems.

An example of a rain climate Region map used with the Crane mathematical model.

B Moderate
C Maritime
D Continental
E Wet
F Arid



Point Rain Rate Distribution Values (mm/hr) versus Percentage of Year Rain Rate is Exceeded

Percentage of Yr. Rain Rate is Achieved	Rain Climate Region (see map)							Minutes per Yr. Rain Rate Occurs	Hours per Yr. Rain Rate Occurs
	B	C	D1	D2	D3	E	F		
0.001	54	80	90	102	127	164	66	5.3	0.09
0.002	40	62	72	86	107	144	51	10.5	0.18
0.005	26	41	50	64	81	117	34	26	0.44
0.01	19	28	37	49	63	98	23	53	0.88
0.02	14	18	27	35	48	77	14	105	1.75
0.05	9.5	11	16	22	31	52	8	263	4.38
0.1	6.8	72	11	15	22	35	5.5	526	8.77

0.2	4.8	4.8	7.5	9.5	14	21	3.8	1052	17.5
0.5	2.7	2.8	4	5.2	7	8.5	2.4	2630	43.8
1	1.8	1.9	2.2	3	4	4	1.7	5260	87.66
2	1.2	1.2	1.3	1.8	2.5	2	1.1	10520	175.3