Performance deterioration of communication systems due to cloud noise in microwave and millimeterwave frequency bands

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ABSTRACT

The two most important aspects in present days radio communication scenario are directivity of radio energy of transmitted and received signals and regulation of the power from transmitter. The less power is to be transmitted from transmitter in the region which is radio environment friendly while more power is to be transmitted in the region where rain and cloud occurs for more time. An accurate media characterization in relation to cloudy condition is therefore needed for optimize use of transmitted power.

It is seen that noise temperature of the cloud degrades the performance of satellite communication for frequency above 10 GHz. A detailed study on total atmospheric noise temperature including the noise contribution from cloud for different months during different time for different cloud thickness at 10 GHz, 18 GHz, 32 GHz, 44 GHz and 70 GHz over two Indian tropical stations, Delhi (28.35°N, 77.12°E) and Kolkata (22.32° N, 88.27° E) has been made. Such results on cloud noise temperature have been deduced by using the estimated results on attenuation of radio wave due to cloud in radiative transfer calculations. It has been found that the total atmospheric noise temperature over Delhi varies from 10.64° K to 19.43°K at 10 GHz for cloud having thickness between 1 km and 2 km while it varies from 83.24°K to 131.83°K for cloud thickness varies between 1 km and 2 km at 32 GHz. The total atmospheric noise temperature over Kolkata varies between 12.51°K and 19.85°K at 10 GHz for cloud thickness from 1 km to 2 km while it varies from 102.36°K to 150°K at 32 GHz having cloud thickness from 1 km to 2 km. The total noise temperature including noise contribution from cloud having thickness 1.5 km at 44 GHz over Delhi and Kolkata have been found to be 189°K and 222.02 °K respectively.

The change in signal to noise ratio (S/N) of a communication system operating at 32 GHz estimation shows that cloud which attenuates radio wave equal to 1.8 dB causes around 5 dB degradation in signal to noise ratio. This effect is more severe at 32 GHz for low noise receivers. Such results on degradation of 5 dB at 32 GHz has been estimated by considering clear air noise temperature of 38.01°K with clear air attenuation of 0.56 dB and then assuming that the cloud with noise temperature of 128.36°K and attenuation 2.38 dB moves into the antenna beam. The noise temperature of the receiver was considered to be 50°K in this case. The degradation in signal to noise ratio for communication receivers at various other frequencies due to cloud noise having different thickness over Delhi and Kolkata has also been deduced and discussed in this paper.