

Quantitative Analysis of THz Imaging Systems In Brownout Conditions

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Brownout refers to dust cloud created by the rotor downwash of a helicopter. When it occurs, the visibility becomes limited, or even null. The pilot can be disorientated and accident may happen. No existing imaging systems can see through dust clouds, in real-time and with sufficient resolution. Using waves between 100 GHz and 1 THz seems to be a good solution to make a compact and suitable imaging system.

First, we define a brownout model based on spherical particles with refractive index of silica with radius following the Marshall-Palmer distribution [1, 2]. The atmosphere attenuation is taken into account. We then establish theoretically the power balance of the involved sources of signal (ballistic signal from the source) and noise (backscattered source power, thermal radiations of ground and sky). This analysis is made for a photometric detection system and with one compounded of antennas.

The backscattered power noise is evaluated with a Monte Carlo simulation, combined with Mie theory, to solve the Radiative Transfer Equation [3]. Thermal radiations are estimated from the Planck function [3]. One result of the simulation is shown in figure 1.

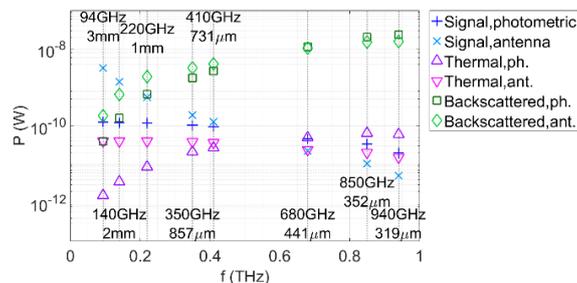


Fig.1. Comparison of signal and noise powers detected by one photometric or one antenna-based pixel at the central frequencies of the atmosphere transmission windows (frequencies and matching wavelengths written in the figure)

Finally, this work indicates that the thermal radiations is negligible compared to signal and backscattered noise. The best configuration is a bistatic imaging system. Hence, a compact THz imaging system seems very promising to image over tens of meters. The challenge remains in the development of appropriate technology (powerful THz source, small and sensitive detectors...). This system can play an important role as for military or civilian missions in desertic areas.

References

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