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Influence of Dust Storm Cell Size on the Microwave Attenuation Prediction Method

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[Eltahir E.I.](#) ^{a,b} ; [Islam, Md Rafiqul](#) ^a ; [Elsheikh, Elfatih A. A.](#) ^c

[Habaebi, Mohamed Hadi](#) ^a ; [Hashim, Aisha Hassan A.](#) ^a ; [+2 authors](#)

^aInternational Islamic University Malaysia (IIUM), Department of Electrical and Computer Engineering, Kuala Lumpur, Malaysia

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Abstract

This paper investigates how variations in dust cell size affect dust storm attenuation predictions based on two severe dust storm events measured on terrestrial microwave links in Khartoum, Sudan. All prediction models were used to estimate the specific attenuation in dB/km, and to obtain total attenuation, the specific attenuation is multiplied by the path length. This paper proposes a mathematically derived reduction factor, formulated from a two-dimensional exponential visibility model, to calculate the effective path length and correct for overestimated attenuation-especially for non-uniform and spatially limited dust cores. The June 6th and July 3rd, 2014 storms, differing in intensity and distribution pattern, were analyzed using the Goldhirsh exponential visibility decay model to extract minimum visibility (V_0) and characteristic radial distance (L_0). Key storm parameters are: June 6 ($V_0=0.01362$ km, $L_0=6.4$ km) and July 3 ($V_0=0.02016$ km, $L_0=7.3$ km), which

highlight different attenuation reduction factor behaviors. The reduction factor decreased with path length, reflecting the finite spatial extent of the dust cores, with the compact storm yielding lower values over longer paths compared to the broader storm. Two microwave links-operating at 21.2 GHz over 6.2 km and 14.5 GHz over 7.6 km -were analyzed. Results showed full core (100%) exposure for both links during the June 6 storm, while during the July 3 event, only the 6.2 km link experienced full exposure, with the 7.6 km link exposed to 88.4% of the dust core. The study highlights the critical roles of storm cell size and link length in determining the attenuation reduction factor, ultimately contributing to more accurate prediction models for designing reliable wireless communication systems in arid regions. © 2025 IEEE.

Author keywords

Cell Size; Dust storm attenuation; Microwave propagation; Reduction factor; Visibility; Wind speed

Indexed keywords

Engineering controlled terms

Dust; Forecasting; Microwave links; Numerical models; Prediction models; Storms; Wind

Engineering uncontrolled terms

Cell-size; Dust storm; Dust storm attenuation; Microwave propagation; Pathlengths; Prediction modelling; Reduction factor; Specific attenuation; Storm attenuation; Wind speed

Engineering main heading

Visibility

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Abstract

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