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Geo-Spatial Distribution of Radio Refractivity and the Influence of Fade Depth on Microwave Propagation Signals over Nigeria

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Abstract : Designing microwave terrestrial propagation networks requires a thorough evaluation of the severity of multipath fading, especially at frequencies below 10 GHz. In nations like Nigeria, without a large enough databases to support the existing empirical models, the mistakes in the prediction technique intended for the evaluation may be severe. The need for higher bandwidth for various satellite applications makes the investigation of the effects of radio refractivity, fading due to multipath, and Geoclimatic factors on satellite propagation links more important. One of the key elements to take into account for the best functioning of microwave frequencies is the clear air effects. This work has taken into account the geographical distribution of radio refractivity and fades depth over a number of stations in Nigeria. Data from five locations in Nigeria—Akure, Enugu, Jos, Minna, and Sokoto—based on five-year (2017–2021) measurement methods of atmospheric pressure, relative, and humidity temperature—at two levels (ground surface and 100 m heights)—are studied to deduced their effects on signals propagated through a μwave communication links. The assessments included considerations for μwave communication systems as well as the impacts of the dry and wet components of radio refractivity, the effects of the fade depth at various frequencies, and a 20 km link distance. The results demonstrate that the percentage occurrence of the dry terms dominated the radio refractivity constituent at the surface level, contributing a minimum of about 78% and a maximum of about 92%, while at heights of 100 meters, the percentage occurrence of the dry terms dominated the radio refractivity constituent, contributing a minimum of about 79% and a maximum of about 92%. The spatial distribution reveals that, regardless of height, the country's tropical rainforest (TRF) and freshwater swampy mangrove (FWSM) regions reported the greatest values of radio refractivity. The statistical estimate shows that fading values can differ by as much as 1.5 dB, especially near the TRF and FWSM coastlines, even during clear air conditions. The current findings will be helpful for budgeting Earth-space microwave links, particularly for the rollout of Nigeria's 5G and 6G projected microcellular networks.

Keywords : fade depth, geoclimatic factor, refractivity, refractivity gradient
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