Geo-spatial distribution of cloud cover and influence of cloud induced attenuation and noise temperature on satellite signal propagation over Nigeria

Joseph Sunday Ojo

PII: S0273-1177(17)30179-5
DOI: http://dx.doi.org/10.1016/j.asr.2017.03.006
Reference: JASR 13140

To appear in: *Advances in Space Research*

Received Date: 13 September 2016
Revised Date: 27 February 2017
Accepted Date: 8 March 2017

GEO-SPATIAL DISTRIBUTION OF CLOUD COVER AND INFLUENCE OF CLOUD INDUCED ATTENUATION AND NOISE TEMPERATURE ON SATELLITE SIGNAL PROPAGATION OVER NIGERIA

Joseph Sunday OJO
Department of Physics, Federal University of Technology, Akure, P.M. B 704, Akure, Nigeria.

Email: josnno@yahoo.com or ojojs_74@futa.edu.ng

Abstract

The study of the influence of cloud cover on satellite propagation links is becoming more demanding due to the requirement of larger bandwidth for different satellite applications. Cloud attenuation is one of the major factors to consider for optimum performance of Ka/V and other higher frequency bands. In this paper, the geo-spatial distribution of cloud coverage over some chosen stations in Nigeria has been considered. The substantial scale spatial dispersion of cloud cover based on synoptic meteorological data and the possible impact on satellite communication links at higher frequency bands was also investigated. The investigation was based on 5 years (2008 – 2012) achieved cloud cover data collected by the Nigerian Meteorological Agency (NIMET) Federal Ministry of Aviation, Oshodi Lagos over four synoptic hours of the day covering day and night. The performances of satellite signals as they traverse through the cloud and cloud noise temperature at different seasons and over different hours of days at Ku/W-bands frequency are also examined. The overall result shows that the additional total atmospheric noise temperature due to the clear air effect and the noise temperature from the cloud reduces the signal-to-noise ratio of the satellite receiver systems, leading to more signal loss and if not adequately taken care of may lead to significant outage. The present results will be useful for Earth-space link budgeting, especially for the proposed multi-sensors communication satellite systems in Nigeria.

Keywords: Geo-spatial; Cloud cover; Cloud Attenuation; Cloud noise temperature; Satellite applications; Ku/W-bands; Nigeria

1. Introduction

The technological world is indeed yearning for more transformation on a daily basis and therefore calling for more bandwidth for services that employ radio and satellite telecommunication systems. Most of the new technological devices operating at higher frequency bands enjoy the benefit of higher data transmission rate, smaller antenna size, higher throughput and larger band spectrum to mention but few (Hall, 1980. Ippolito, 2008). However, since the migration from C to higher frequency bands, satellite and terrestrial signal impairment have been the major issues to be solved by the system designers. Studies revealed that satellite communication systems operating at frequency $\geq$ 10 GHz are more susceptible to rain fade while cloud attenuation has been identified to be one of the major factors that can reduce the usage of Ku/V or higher frequency bands (Allnut and Rogers, 1989, Dissanayake *et al.,* 2001, Sarkah *et al.,* 2005, Das *et al*., 2013, Ali *et al.,* 2014). Although, rain-induced attenuation plays a major role as far as signal degradation is concerned at these frequency ranges, the effect of cloud attenuation is relatively smaller at Ku and Ka frequency bands. However, at these frequency bands, Earth to satellite links are bound to experience some level of losses due to cloud at any period of the day; depending on the season and the climate of the region (Bouchard, 2008*,* Ali *et al., 2013*). Cloud attenuation is even more pronounced at other higher frequency bands, especially those operating at low availability satellite links. This is as a