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Relative Components of Dust Particle Size Distribution on Microwave and Millimeter-wave Band (Sudan- case study)

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ABSTRACT —This paper is reporting investigate the influence of Particle Size Distribution (PSD) in dust particle in Microwave (MW) and Millimeter Wave (MMW) Bands. Dust ounces on particle number and surface area for a given particle mass in the environment of dust media - Sand and Dust Storm (SDS) in the microwave and millimeter wave links and significant of use in predictive models. Particle size distribution directly affects the dynamism requirements of the processing steps and the characteristics of the final models. The paper also explains brief1y the samples of dust grains from Sudan in Central regions. In fact, the present lack of information on particle size distribution is one of the main causes of over grinding and how to measure PSD in quartz, clays, calcite, and other materials. The size of dust grains related to wavelength low efficiency within smaller particles. The high efficiency of distributing of the larger particles in dust media in millimeter links it does not reach spans. These results of the experimental are in line with theoretical findings of PSD that have recently been published.

Keywords—Particle Size Distribution, Dust Storm, Microwave, Millimeter-wave

I. Introduction

Dust storms throughout Saharan Africa, the Middle East and Asia are estimated to place more than 200 to 5000 million tons of mineral dust into the earth’s atmosphere each year. Dust is an important constituent of atmospheric aerosols and plays an essential role in cloud condensation and composition in the arid and semiarid area. Moreover.the impact of Sand and Dust Storm (SDS) in millimeter wave bands (MMW) in telecommunication has been investigated by many researchers in the last decades [1-7].

The dimensions of the links for transmission and reception become comparable to or even larger than the wavelength, thus allowing the narrow beam transmission. However, as the wavelength of millimeter wave becomes comparable with atmospheric in homogeneities, a relatively large atmospheric effect on propagation might be expected particle mass particle number concentration and particle size with high time resolution and high accuracy. The major obstacle faced in using the frequencies 30-300 GHz millimeter wave band for terrestrial radio relay applications is the influence of the atmospheric conditions on the propagation of the electromagnetic waves. In particular, attenuation far in excess of that at long wavelengths is experienced at these frequencies. The main causes for this excessive attenuation are the absorption due to particles, water vapor, atmospheric precipitation and under certain circumstances, refractive index variations the atmospheric precipitation in particular PSD in dust media.

The propagation of the electromagnetic wave (EMW) with the Erath's atmosphere depends on the wavelength of signal radiation and the nature of the medium being traversed. This medium consists of different molecular species and aerosol particles. Dust media are one competent of atmospheric and other are ubiquitous in nature and frequently are determining factor in a number of signals transmit and received in the design stage of prediction models.

In this regard, propagation of millimeter wave through the lower atmosphere arises both from the possible application of these frequencies in many communications, despite their severe limitations. However, many reported are concerned mainly with particles absorption and scintillations either along a path at or near vertical incidence (between ground and outer space) or on a link with terminals located in the rural environment. Little work has been done in a town environment [7-8]. It is clear that there is a strong need for quantitative millimeter wave observations of interest are:

- Attenuation due to precipitation as a function of frequency and rate of precipitation;
- the amplitude of scintillations on line-of-sight links in a town environment,
- absorption due to fog,long term statistics,
- any other clear-air effects.

Dust particles can also serve as cloud condensation provide sites for heterogeneous chemical reactions involving important trace gas species, which, in turn, indirectly affect the earth's radiation balance. Unfortunately, many of these processes arepoorly understood due to our incomplete knowledge of the physical and chemical characteristics of the particles, including dust concentration and global distribution, as well as aerosol composition, mixing state, and size and shape distributions. Field measurements of aerosol properties are often carried out by remote sensing using satellite or ground based instruments.Previous, researcher [2] [5] the attenuation due to precipitation is increased at these high frequencies, the millimeter wave systems are still very useful and efficient for interconnecting links of networks and short links between centers within towns. "Accurate" measurement of size is important because quality and performance of most particulate products are closely related to size distribution of dust particles. The past decade has seen rapid evolution and growth of applications for measuring size and shape. The aims of paper the look of the radio signal are lost as it propagates through dust media and influence of PSD. Dust storms directly affect visibility and impact daily commercial and military operations in dust prone regions. Attenuation of millimeter waves induced by dust media are analyzed, and its expressions applied to earth-space paths is presented [5]. Interestingly, the specific attenuation and attenuation versus height and visibility arc gotten for two kinds of particle size distribution, namely normal, and lognormal. Results obtained are briefly discussed. This study consisted four sections: Section one of this paper is the introduction, objective, and literature review, section two presented methodology. Section three tacked the analysis of empirical data. Finally, section four devoted to the empirical results, conclusions.

II. METHODS AND MATERIALS

This knowledge can be used to ensure the use of MMW for many of telecommunication purpose is mainly due to the high attenuation due to precipitation, sand and dust storm in the arid area. Thus to design and plan such as links, interconnection, and networks. Moreover, in MW bands desirable to have comprehensive information about the relationship between attenuation and climate environment characteristics. Additionally, used to establish relationships between attenuation experienced over a link quite a few kilometers in length and the prediction measured at one point.

1. Study Area

The study area is located a Republic of the Sudan is a republic in the Nile Valley of North Africa, bordered by Egypt to the north, the Red Sea, Eritrea and Ethiopia to the east, South Sudan to the south, the Central African Republic to the southwest, and Chad to the west and Libya to the northwest. It is the third largest country in Africa. The Nile River divides the country into eastern and western halves.

2. Definition & Formulation

Dust is a suspension of solid particles produced by mechanical disintegration of material such as crushing, grinding and blasting. Solid aerosols generated by the handling, grinding, abrasion, or cutting of a bulk material or solid and/or liquid, in gas floating particles within a particle size range between 0,001 µm to 100 µm. Dust particle size is related to the amount of energy involved in creation; the higher the energy the smaller the particle created; the lower the energy the larger the particle created [5].

Conceptually, particles pass through a laser beam uses a low power and the light scattered by them is collected over laser beam a range of angles in the forward direction. Fast it is typically less than 3minutes to take a measurement and analyze. Simple to use. The angles of diffraction are, in the simplest case inversely related to the particle size[8]. The particles pass through an expanded and collimated laser beam in front of a lens in whose focal plane is positioned a photosensitive detector consisting of a series of concentric rings. Distribution of scattered intensity is analyzed by a computer to yield the particle size distribution beside highly versatile.

3. The normal distribution

The normal distribution is applied to a continuous variable of any sign. The probability density is of the type

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-m}{\sigma}\right)^2\right] \qquad (1)$$

Where use particle radius the mean, m, and the standard deviation, a. A random variable X is said to be normally distributed or to have a normal distribution if its probability density function PDF [6].The terms describing the key points of a distribution graph are as following:

- Mode - Peak of the distribution most common value of size
- Median - the signal or size at which precisely half of the responses are below on a cumulative distribution.
- Mean - the weighted average value.

White Gaussian noise have been selected in this study because it has been a common technique that experimented in many researches, several experiments have been carried out with different noise level.

The normal distribution is not just a single distribution, but rather a family of distributions; each member of the family is characterized by a particular pair of values of (i and a. Moreover, X ~ Normal(u, o) to mean that the continuous random variable X has a normal distribution with mean a and standard deviation o. In propagation, most of the physical quantities involved (power, voltage, fading time, and others factors) are essentially positive quantities and therefore, be represented directly by a Gaussian distribution. On a related front, this distribution is used in two important cases: to represent the fluctuations of a quantity around its mean value (scintillation); To represent the logarithm of a quantity.

4. The lognormal distribution

The lognormal distribution, used by rural, urban, maritime, tropospheric, desert, and the many dusty media models is given by the equation (2)

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \frac{1}{x} \exp\left[-\frac{1}{2}\left(\frac{\ln x-m}{\sigma}\right)^2\right] \qquad (2)$$

Where m is the distribution geometric mean radius (or mode radius) in n m, and a are the standard deviation the width of the distribution measured in log10 space but of the logarithm of this variable *x*. The characteristic quantities of the variable *x* can be derived without difficulty[6].

The log-normal distribution is very often found in connection with propagation, mainly for quantities associated either with a power or field strength level or time. Power or field-strength levels are generally only expressed in decibels so that it is more usual to refer to a normal distribution of levels. In the case of time (for example fading durations), the log-normal distribution is used explicitly because the natural variable is the second or the minute and not their logarithm [3].

III. RESULTS AND DISCUSSION

It is important to note that the dust media anddust aerosol are solid or liquid particulate matter suspended in a gaseous medium. In many treatments of the subject the term aerosol is interchangeably used to refer specifically to the particle itself. The particles in a typical atmospheric aerosol generally comprise only a small fraction of the overall mass and volume of the aerosol, on the order of 10-6. The size of the dust particles is an imperative parameter as there is an optimal size for each application [6]. In essence, depending on the size of the particles, the numbers, concentration where they accumulate are different. Thus, particles between 10 to 150 mm are retained. Size distribution is also an important parameter that allows understanding the heterogeneity of particle sizes in a mixture.

- Particle size distribution.
- Particle concentration.
- Chemical composition of the dust particles.
- Surface-bound or adsorbed.

In study scenario, the investigation of all parameters is very interesting from the point of view of the applications of PSD, and the synthesis of the particles, as it serves to understand what happens during the optimization process when a few synthesis parameters are adjusted. The prolate ellipsoids of dust particle we study in suspension have a major axis *le* = 16 mm in length and two minor axes each 8 mm in length. These lengths closely match the length scale of measure in the laboratory are often made to support unit operations taking place in a process environment. Many other size reduction operations and technologies also require lab measurements to track changes in particle size including conduct experiments on four different particle suspensions. Even with very little buoyancy, gravity effects are important.

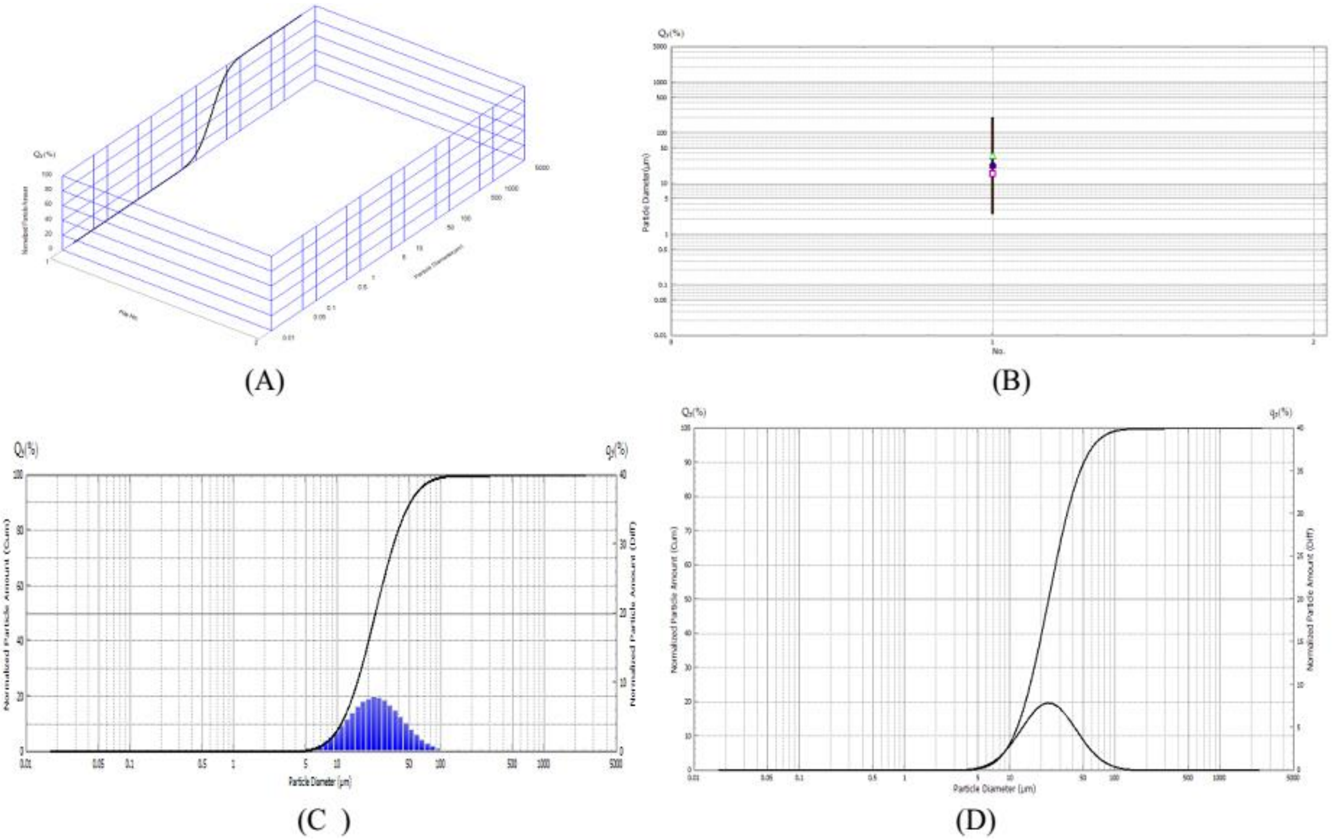

Figure 1 Fragments and dust size distributions at a limited time grinding. A) 3 D normalized particle amount. B) The diameter of Cumulative % mode and mean. C) Normal PSD graph of the sample. D) Particle diameter grinding.

To address this pressing problem, fewer methods namely ensemble analyzers these techniques look at a measured property via a cloud or assemblage of particles and several other forms of particle sizing techniques do not count or assign a size to individual particles. In other words, to solve that used Laser diffraction within sedimentation. The particles pass through an expanded and collimated laser beam in front of a lens in whose focal plane is positioned a photosensitive detector consisting of a series of concentric rings [3]. Distribution of scattered intensity is analyzed by a computer to yield the particle size distribution. Comparison of a "snap-shot" of each speckle pattern with another taken at a very short time later (microseconds).The time-dependent change in position of the speckles relates to the change of position of the particles and hence particle size. The dynamic light signal is sampled and correlated with itself at different time intervals using a digital correlation and associated computer software[5,11]. The relationship of the auto-correlation function obtained to time meteorological parameter range. Performing a particle size analysis; how PSD is those particles After the analysis is completed the have a variety of approaches for settings and finding the result.

In the fast paced many findings they prefer intervals is processed to provide estimates of the particle size distribution. In fact, all of the dust particles have many types and the range of meteorological parameters and percentage of moisture content table 1 show as an area of PSD for dust grains. Direct number answer about is the average size. However, experienced particle scientists cringe, knowing that a single number cannot describe the distribution of the sample. For new better approach is to result are the both a central point of the distribution along other values to describe the measurement of the distribution [10].

.Table1PSD in different Location and Relative Humidity

N	Sites	Relative Humidity %	Remarks
1	Rural	20	
2	Urban	16	
3	Maritime	25	fog
4	Desert	9	dry
5	Dust aerosol	14	
6	Sandstorm	15	SDS

Obviously, the results from an output oriented analysis these size distribution of dust particle is paramount for the evaluation of MW and MMW propagation attenuation due to SDS. Visibility prediction is of great importance for telecommunication system designers since MW and MMW attenuation caused by dust limits significantly the performance of the microwave links, especially in arid and desert regions. Therefore, a detailed knowledge of PSD is required for the calculation of attenuation due to dust in both terrestrial and satellite links design.

IV. CONCLUSION

As already noted, the main key the telecommunication engineering is propagation model since it influences the performance of wireless communication. The particle size distribution analysis tools provide the ability to measure and report the PSD of the sample. There are very few applications where a single and several values are appropriate and representative. Correspondingly, fitting of the grain-size distribution has historically been a manual process or has involved the use of normal, log-normal, power low, distributions of one, two, or three parameters. PDF equations are presented in this paper to fit essentially in general grain-size distribution dataset. The particle analysis was found to provide a good fit for a variety of soils. Due to the increasing number of satellite and terrestrial links in the states that meet SDS like many radars, and remote sense applications at high frequencies. Accordingly, the extremes of the grain-size distribution were also well adapted to the experimental results. Importantly, our future interest is to investigate more models the impact of PSD and dusty media to radio wave propagation.

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