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Aerosols loading statistical dimensions over Serekunda-Gambia

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Aerosols loading statistical dimensions over Serekunda-Gambia

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Abstract. Aerosols loading and retention justifies the efficiency of the 'self-cleansing' mechanism of the geographical air space. The advantage of the proposed technique which is based on the coefficient of variation helps to estimate the aerosols retention over a geographical area without necessarily going through the complexities of formulating sectional equations to illustrate the physics of the atmosphere. The system of aerosol retention over Serekunda suggests that air pollution should be taken more seriously to avoid natural disasters in the nearest future. It was discovered that the 'self-cleansing' cycle over Serekunda is four years. The year with a fairly high aerosols retention and correlation was between 2006 & 2007 i.e. 36.82 and 0.61 respectively.

1. Introduction

West Africa has the highest biomass burning, dust interference from Sahara and anthropogenic pollution [1-3]. The technicality of aerosol retention over the air space of any geographical region cannot be over emphasized because of its importance in ascertaining the state of the natural 'self-cleansing' mechanism of the atmosphere. Therefore, the state of aerosols dispersion and retention is equally important for the adequate understanding of aerosols loading and transport. Within the tropospheric layer, the shape of the size distribution, number of aerosol particulates and the chemical composition of the average aerosol particles vary as a function of altitude.

Since, this scientific omission of aerosols retention extends to the radiosonde temperature biases noticed on a wide variation between the temperature of device sensor and its surrounding air [4], there is the need solve this challenge to aid sondes manufacturers. However, this is not the objective of this study. In this paper, we investigated the aerosols loading over Serekunda. Serekunda is the most populous city in Gambia and it is located on longitude 16.6667 ^{o}W and latitude 13.4333 ^{o}N in the Sahelian geographic region south of the Sahara (see Figure 1), hence, we expect a high impact of the north east winds alongside Sahara dust. Over the past forty years Serekunda as well as Gambia has experienced a decline in mean total annual rainfall [5]. The volume of automobiles and anthropogenic activities in Serekunda increases the carbon aerosols within its atmosphere. The anthropogenic activities is biomass burning from farm activities in the mangrove forest. Since there is poor ventilation in the evening, the carbon and Sahara dust aerosols would accumulate over few months.

In summary, we propose that the success of the any of the parameter for determining aerosols loading depends strictly on the aerosols retention over a geographical area. In this paper, we intend to statistical analyze the aerosol loading over Serekunda for further analysis.

2. Methodology

We shall be adopting major Microsoft excel statistical tool. We also adopted already validated aerosol models. Aerosols retention between two consecutive years has been postulated by Emetere [6] as:

$$A = \left|\frac{G_r - G_P}{G_r}\right|^2 \times 100\% \tag{1}$$

Here, the previous and current years are denoted as G_P and G_r respectively. The beauty of this formulation is the inclusion of the possibility of obtaining CV that is above unity. However, the possibility of obtaining above 100% is inevitable. Hence the proposition of the second equation:

$$A = \left|\frac{G_P}{G_P - G_r}\right|^2 \times 100\% \tag{2}$$

Equation (2) is valid only if $G_P - G_r > G_P$. Upon this salient assumption, the aerosol retention can be controlled below unity or 100%.

Fourteen years satellite observation was obtained from the Multi-angle Imaging Spectro Radiometer (MISR). The raw MISR dataset was processed using the Excel package. The aerosol optical depth (AOD) mean for each month were calculated for each year.

3. Result and Discussion

Serekunda and its environs are prone to increased frequency and severity of drought events (Figure 1). The rainy season which runs from mid-June to October has little influence on the AOD, hence, the type of aerosols in abundance would be carbon-compound aerosols. The AOD trend agrees with the Emeteres' model which shows that the model can be used to forecast future events over Serekunda. In 2010, the AOD was highest between January and July while the previous year i.e. 2009 had almost uniform. After 2010 i.e. 2011 the AOD trend was the most turbulent as shown in Figure 1. Hence, the maximum AOD for 2009, 2010 and 2011 are 0.65, 1.83 and 0.72 respectively. After 2009-2011, it was observed that the value of AOD increased in 2012 and 2013 i.e. 0.8 and 0.82 respectively.

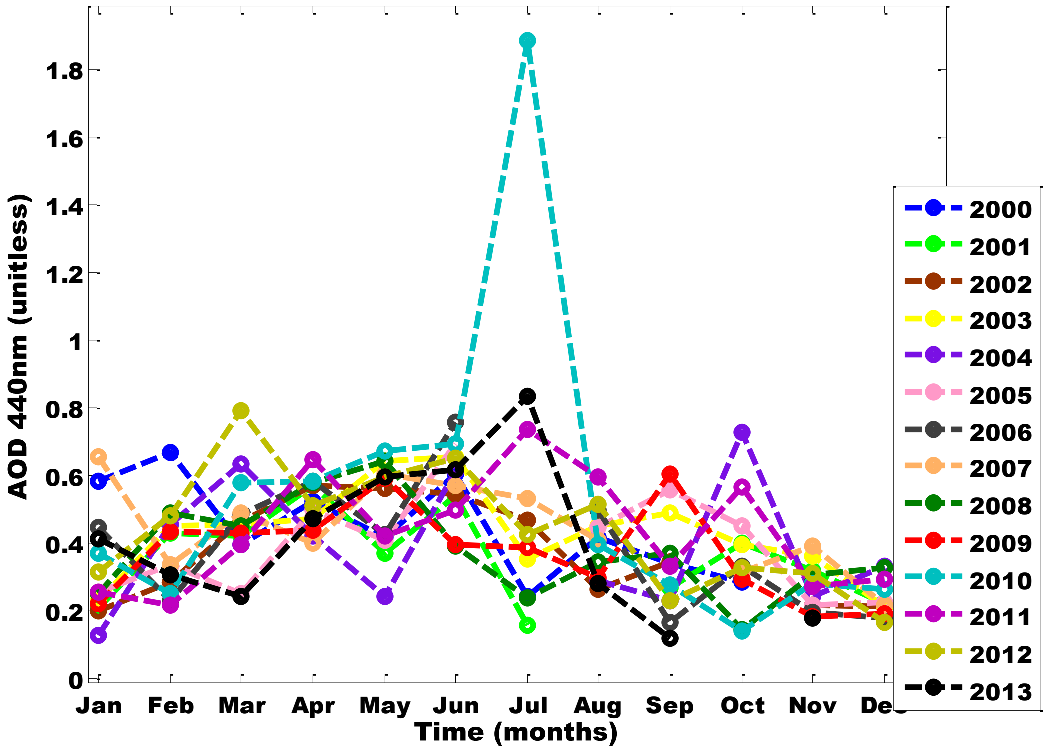

Figure 1. AOD pattern for Serekunda 2000 - 2013

The statistical analysis is shown in Tables 1 & 2. The highest AOD mean, 95% confidence interval, 99% confidence interval, variance, standard deviation and coefficient of variation was in 2010. The highest skew and kurtosis can be found in 2005 and 2003 respectively. The highest Kolmogorov-Smirnov stat can be found in 2002. This results shows that the lower atmosphere of Serekunda has high rate of turbulence. Hence we examine the atmospheric aerosol retention shown in Tables 3 & 4.

Table 1. Statistical AOD analysis 2000-2006

Statistics Tool	2000	2001	2002	2003	2004	2005	2006
Mean	0.448	0.356	0.377	0.432	0.393	0.395	0.391
Standard error	0.045	0.041	0.045	0.039	0.059	0.046	0.057
95% confidence interval	0.102	0.091	0.100	0.086	0.13	0.103	0.127
99% confidence interval	0.146	0.129	0.142	0.122	0.186	0.147	0.181
Variance	0.02	0.018	0.022	0.018	0.038	0.024	0.036
Standard deviation	0.142	0.135	0.149	0.136	0.194	0.154	0.190
Coefficient of variation	0.318	0.379	0.396	0.314	0.494	0.389	0.485
Skew	0.152	0.161	0.157	0.082	0.534	0.557	0.469
Kurtosis	-1.17	-0.926	-1.90	-0.043	-0.960	-0.375	-0.41
Kolmogorov-Smirnov stat	0.184	0.110	0.186	0.165	0.167	0.18	0.165

Table 2. Statistical AOD analysis 2007-2013

Statistical Tool	2007	2008	2009	2010	2011	2012	2013
Mean	0.448	0.379	0.374	0.533	0.436	0.44	0.407
Standard error	0.041	0.042	0.04	0.134	0.049	0.05	0.071
95% confidence interval	0.091	0.091	0.089	0.294	0.108	0.12	0.16
99% confidence interval	0.129	0.129	0.126	0.415	0.153	0.16	0.23
Variance	0.018	0.021	0.02	0.215	0.029	0.03	0.05
Standard deviation	0.135	0.144	0.14	0.463	0.171	0.18	0.224
Coefficient of variation	0.302	0.38	0.375	0.869	0.391	0.41	0.551
Skew	-0.03	0.372	0.253	2.567	0.396	0.32	0.651
Kurtosis	-0.83	-0.19	-0.744	7.571	-1.141	-0.4	-0.269
Kolmogorov-Smirnov stat	0.154	0.127	0.151	0.28	0.143	0.15	0.175

The highest correlation was found between 2001 & 2002 i.e. 0.74. The highest aerosols retention is within 2010 & 2011 i.e. 67.06. The year with a fairly high aerosols retention and correlation was between 2006 & 2007 i.e. 36.82 and 0.61 respectively. This means that 2007 was the trigger point that results in the events around 2010 and 2011.

Table 3. Atmospheric aerosols retention over Serekunda 2001-2006

	2001	2002	2003	2004	2005	2006
Aerosol retention	2.6	0.18	6.76	13.3	7.37	3.95
Correlation	0.59	0.74	0.29	0.29	0.53	0.59

Table 4. Atmospheric aerosols retention over Serekunda 2007-2013

	2007	2008	2009	2010	2011	2012	2013
Aerosol retention	36.82	4.18	0.014	32.31	67.06	0.26	6.32
Correlation	0.61	0.37	0.2	0.63	0.29	0.26	0.61

The year of highest atmospheric aerosols retention was found between 2010 and 2011. This explains the sudden increase in the AOD data for July, 2010 (Figure 2). Therefore, knowing the aerosols retention in the atmosphere is as important as knowing the aerosols dispersed into the atmosphere. The significance of the aerosols retention over Serekunda portrays that its high value in 2004, 2007, 2010 and 2011 are not mere coincidence but shows that the 'self-cleansing' cycle is four years. However, climate change influence is gradually altering the 'self-cleansing' cycle as shown in 2011. The significance of the atmospheric aerosols retention in a geographical region has great influence on aviation schedules [7], human health [8], measuring instruments, energy budget and meteorology [6]. It is therefore suggested that the recovery of the regional atmosphere can be done via accurate instrumentation configuration. Hence, the flow chart in Figure 2 below.

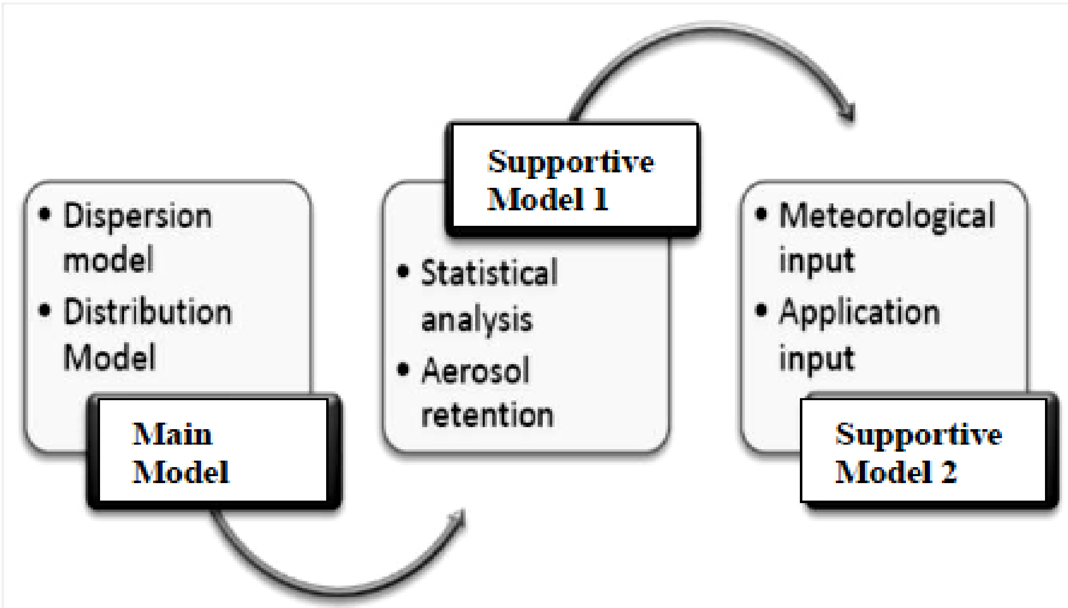

Figure 2. Architecture of aerosol retrieval Technique

4. Conclusion

The influences of aerosols retention over all aerosols dispersion or loading parameters have been proven. It was shown that there is a correspondence between aerosols loading and retention. The year with a fairly high aerosols retention and correlation was between 2006 & 2007 i.e. 36.82 and 0.61 respectively. Therefore, aerosols retention in the atmosphere is as important as knowing the aerosols dispersed into the atmosphere. Also it was discovered that the 'self-cleansing' mechanism in the atmosphere has a unique cycle. For Serekunda, the 'self-cleansing' cycle is four years i.e. 2007 to 2010.

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References

[1]. Emetere M E, Akinyemi M L and Oladimeji TE 2016 Statistical examination of the aerosols loading over Kano-Nigeria: The Satellite Observation Analysis *Scientific Review Engineering and Environmental Sciences* **72** 167

[2]. Emetere M E, Akinyemi M L and Akinwumi S A 2016 Aerosols loading trends and its environmental threats over Cotonou-Benin *Nature Environment and Pollution Technology* **15**(3) 1111

[3]. Emetere M E, Akinyemi M L and Oladimeji T E 2016 A conceptual mathematical examination of the aerosols loading over Abuja-Nigeria *Communications in Mathematics and Applications* 7(1) 47

[4]. Sun B, Reale A, Schroeder S, Seidel D J and Ballish B 2013 Toward improved corrections for radiation induced biases in radiosonde temperature observations *J. Geophys. Res. Atmos*. **118** 4231
[5]. Njie M 2007 The gambia national adaptation programme of action (NAPA) on climate change. Banjul, The Government of The Gambia
[6]. Emetere M E 2016 statistical examination of the aerosols loading over mubi-nigeria: the satellite observation analysis *Geographica Panonica* **20**(1) 42
[7]. Gettelman A and Chen C 2013 The climate impact of aviation aerosols *Geophys. Res. Lett.* **40** 1
[8]. Wyzga R E and Folinsbee L J 1995 Health effects of acid aerosols *Water, Air, and Soil Pollution* **85** (1) 177