AEROSOL SIZE DISTRIBUTION DERIVED FROM 355-nm AND 532-nm MIE LIDAR SIGNALS

Edgar Vallar, Mannelyn DelaCruz, Gerry Bagtasa, Ernest Macalalad, Eric Bangsal, and Ma.Cecilia Galvez

LIDAR Group, Physics Department, De La Salle University (DLSU), 2401 Taft Avenue, Manila, Philippines 1004
vallare@dlsu.edu.ph

ABSTRACT

A Lookup Table (LUT) was generated using eleven aerosol size distributions (ASD) (from urban to maritime with 9 logarithmic increments in between them). In the computations, aerosol size ranged from 0.001-10µm with 1.40 to 1.60 real and 0.000-0.030 imaginary refractive indices for the 355-nm and 532-nm LIDAR wavelengths. The extinction coefficients $(\sigma)_{EXPT}$ were calculated for the LIDAR data using Fernald's inversion method. The ASD in the De La Salle University area was determined by comparing $(\sigma_{532}/\sigma_{355})_{EXPT}$ to $(\sigma_{532}/\sigma_{355})_{THEO}$ values found in the LUT. Results show that the ASD is affected by local meteorological conditions and by man's activities (e.g., fireworks during New Year's eve).

1. INTRODUCTION

Aerosols play a major role in maintaining the delicate balance of the Earth's environment. LIDARs have proven to be a most effective technique in studying the properties of aerosols. In particular, the ASD can be derived from multiwavelength LIDAR signals by utilizing Mie theory. Using LIDAR and radiometer data, the complex refractive index and size distribution of atmospheric particulates was determined in [1]. The potential of a multiwavelength LIDAR for discriminating between several aerosol types was shown in [2]. Two iterative methods to determine the aerosol size distribution from a multiwavelength LIDAR were presented in [3]. A Lookup table (LUT) was proposed in [4] to derive vertical distributions of aerosol optical parameters from multiwavelength Mie LIDAR observations. This study presents the determination of the size distribution of aerosols in the DLSU area using a Lookup table (LUT) generated from Mie theory.

2. METHODOLOGY

The DLSU Mie LIDAR system is at 14°33.978' N; 120°59.523' E. The system utilizes a 20-Hz Nd:YAG laser and a 200-mm diameter telescope to collect the backscattered signals. Software developed by our group automatically acquires and processes LIDAR data. More information about the system can be found in http://www.dlsu-lidar.tk.

This study utilizes the data gathered from the 355-nm and 532-nm channels of the LIDAR. Fernald's inversion method [5] is employed to deduce the aerosol extinction coefficients $(\sigma)_{EXPT}$ for the data. S1 is assumed to be 50. The Lookup Table is generated using the urban aerosol size distribution (USD), maritime size distribution (MSD), and 9 logarithmic increments in between USD and MSD. The radii of the size distribution range from 0.001µm to 10µm in increments of 0.001. The real part of the refractive index is varied from 1.4 - 1.6 at steps of 0.01 and while the imaginary part is changed from 0.0 - 0.03 at increments of 0.0001. Also, only spherically shaped aerosols are used.

The ratio of extinction coefficients $(\sigma_{532}/\sigma_{355})$ will be the basis of the size distribution retrieval of this study and is outlined in [6]. The ASD for the LIDAR data gathered is obtained by taking the nearest value (i.e., least difference) of $(\sigma_{532}/\sigma_{355})_{EXPT}$ to the theoretically computed ratio using Mie theory $(\sigma_{532}/\sigma_{355})_{THEO}$ and generated by the LUT.

3. RESULTS AND DISCUSSION

The aerosol size distributions (ASD) considered in this study are the urban ASD [ASD(0)] and maritime ASD [ASD(10)] and 9 logarithmic increments between them. These 2 ASD were chosen since they are the closest match for the De La Salle University area, being located at the center of Manila and about 1km from Manila bay. The color bar in the ASD THI graphs shown below represents the 11 ASD models. The closer the ASD values to (0) means it resembles the urban ASD more and closer to (10) for a maritime-like ASD. When $(\sigma_{532}/\sigma_{355})_{EXPT}$ is outside the range of $(\sigma_{532}/\sigma_{355})_{THEO}$, its value is set to 12 (black) to distinguish the null point from the others. The plots shown below indicate a dependence of the ASD at the LIDAR site on the meteorological conditions at the time of the experiment.

Fig. 1 shows the aerosol size distribution time height intensity map or ASD THI map for 1 January 2004 observation. Most parts of the THI map show an ASD(0) and ASD(1). The January 1 data taken at 0000h to 0213h shows an "urban-like" ASD condition.

Fig. 2 is taken on 8 January 2004 from 1108h to 1459h. Unlike the previous plot, this one shows more red (ASD(9)) and brown (ASD(10)) colors suggesting that the atmospheric ASD has a maritime ASD model feature. The difference maybe due to the fact that, during the New Year celebrations, Metro Manila is submerged in a cloud of fireworks residue which indicates an “urban-like” ASD.

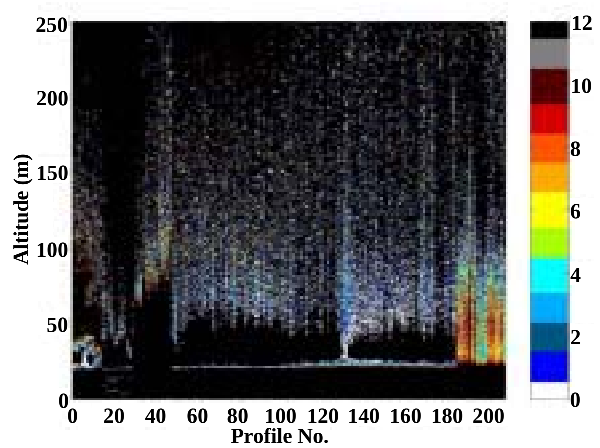

Fig. 1. 1 January 2004 ASD THI map

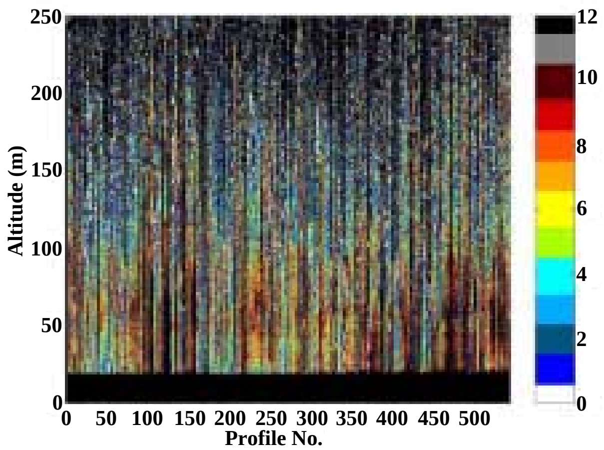

Fig. 2. 8 January 2004 ASD THI map

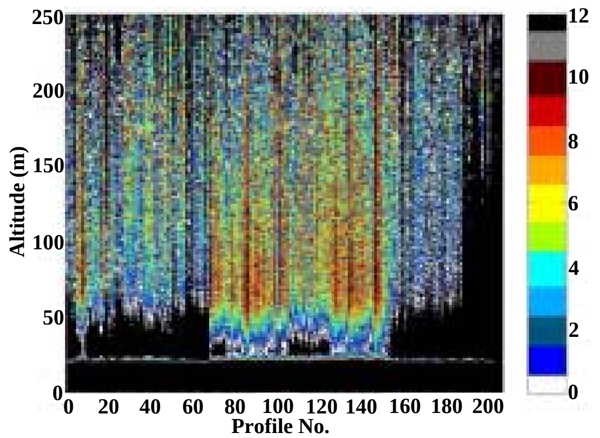

Fig. 3. 30 December 2003 ASD THI map

Fig. 3 shows the ASD THI map for 30 December 2004 taken from 1449h to 1700h. This data set shows that the ASD changes from urban to maritime and back to urban. Unfortunately, wind velocity measurements were not yet available at that time since this may clarify these changes. Winds coming from the west (Manila Bay side) will probably result to an MSD while other directions, especially from the east, will result in a USD.

4. CONCLUSION

A Lookup Table (LUT) was generated for 11 ASD models. Using the DLSU LIDAR, this study has described the features of the local ASD. The results show that the ASD varies both spatially and temporally. Further, events (e.g., New Year’s eve) may also cause the ASD to change. A mixed ASD is observed on other days suggesting that the ASD may depend on meteorological conditions.

5. REFERENCES

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