AEROSOL CHARACTERTICS OVER ULAANBAATAR USING SATELLITE REMOTE SENSING

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ABSTRACT

The aim of the study is to investigate air pollution over Ulaanbaatar. Ulaanbaatar is the capital city of Mongolia where air pollution is one of the most severe problems. Hence, it is very important to study aerosol properties over the area of interest, and its impact on human life. For this propose we retrieve aerosol optical thickness (AOT) and Angstrom exponent (AE) from Moderate-resolution Imaging Spectroradiometer (MODIS) imagery dating from 2002 to 2008. Daily mean AOT reveals clear seasonal variations over the study area. We are also studying the monthly mean and the seasonal mean of both AOT and AE. Finally, to understand the long-term changes, annual mean values in different seasons will be studied.

1. INTRODUCTION

Mongolia is traditionally regarded for its purity of air due to the minimum industrial pollution it has compared to many other countries. The vast area and lower population which is spread across the nation, involving mainly in animal husbandry, helped to maintain the air quality. However, over the last several years, severe weather has adversely affected the livestock and caused much human causality, leaving the families in charge of the herds to search for other ways of living.

This has resulted in an increasing migration of a large number of families from the countryside to the capital city, Ulaanbaatar. Also, young people are more likely to settle down in Ulaanbaatar where the probability of finding a job is higher, and the modern way of living can be enjoyed. All these activities have an

impact on the city's air quality. In this work, we plan to study the change in the aerosol characteristics over Ulaanbaatar over last 7-8 years.

2. STUDY AREA

Ulaanbaatar is located in central region in the sea level of 1.351m high. It is the capital city covering 135.100 hectares square kilometers and has a high density of industry, transport relation, infrastructure and population. Central location of Ulaanbaatar city, that is involved in the survey. (Figure 1) /47.52-48.00N, 106.40-107.10E/

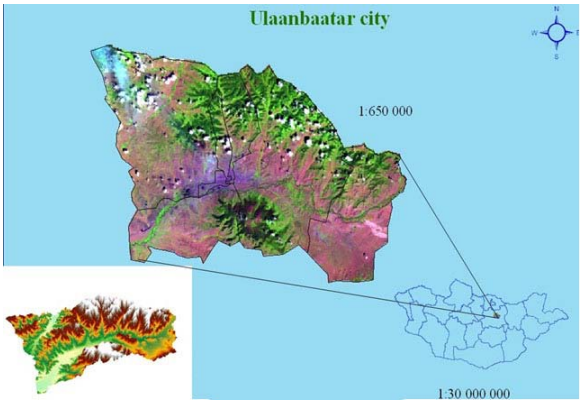


Figure 1. Study area (Ulaanbaatar city)

In 2011, there were 1,166,800 people living in Ulaanbaatar which has a total area of 4,704.4 km^2. Ulaanbaatar stands on a windswept plateau at an elevation of 1,350m and Density 235/km^2

3. DATA AND OBSERVATION

In this study we have used the aerosol products available from MODIS instrument on Terra satellite from 2002 to 2008. The level 2.0 data are available in 10 km x 10 km spatial resolution on daily basis. The AOT and AE products over Ulaanbaatar, Mongolia are selected for the study. For this we selected latitude of 47.9° N and longitude of 106.9° E, and took the average value of AOT and AE within a grid of ±0.25°.

In addition to using satellite data, we also conducted ground based measurements of PM10 over Ulaanbaatar in the year 2009. The observations were taken on a mobile platform from different locations in the Ulaanbaatar city.

Monthly PM10 values at different locations over Ulaanbaatar. The colors denote different locations where measurements are conducted. (Figure 2) Horizontal red line donate air quality standard value which standardized by Air quality control office of Mongolia. Horizontal blue line donate air quality standard from European countries.

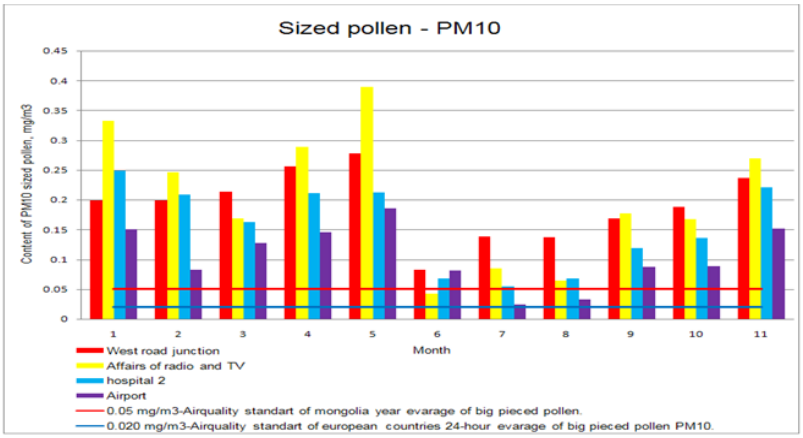


Figure 2. Monthly PM10 values at different locations over Ulaanbaatar. The colors denote different locations where measurements are conducted. Horizontal red line donate air quality standard value which standardized by Air quality control office of Mongolia. Horizontal blue line donate air quality standard from European countries.

4. METHODOLOGY

Validate MODIS AOT using AERONET. (AERONET is ground based observation all around the globe). In this study we use the AERONET and MODIS AOT over Ulaanbaatar, which is the main study area. Angstrom's turbidity formula

τ: AOT;
α: Angstrom Exponent (AE)
β: Angstrom's turbidity coefficient
λ: Wavelength in micron

$$\tau = \beta \cdot \lambda^{-\alpha}$$

- α and β are independent of wavelength, and describes the size distribution of aerosol particles and the haziness of the atmosphere.
- α or AE can be calculated if AOT at multiple wavelengths are available. Typical range for AE is 0.5-2.5
- If AE is small then larger particles dominate the distribution and vice versa

5. RESULT AND CONCLUTION

In order to have an overall idea of the aerosol variation over Ulaanbaatar, we first plotted the daily AOT values during 2002 to 2008. The results are given in the left panel of (Figure 3). It can be seen that there is a significant variation in different times of the year in the AOT over Ulaanbaatar, and the pattern seems to repeat in every year, more-or-less consistently.

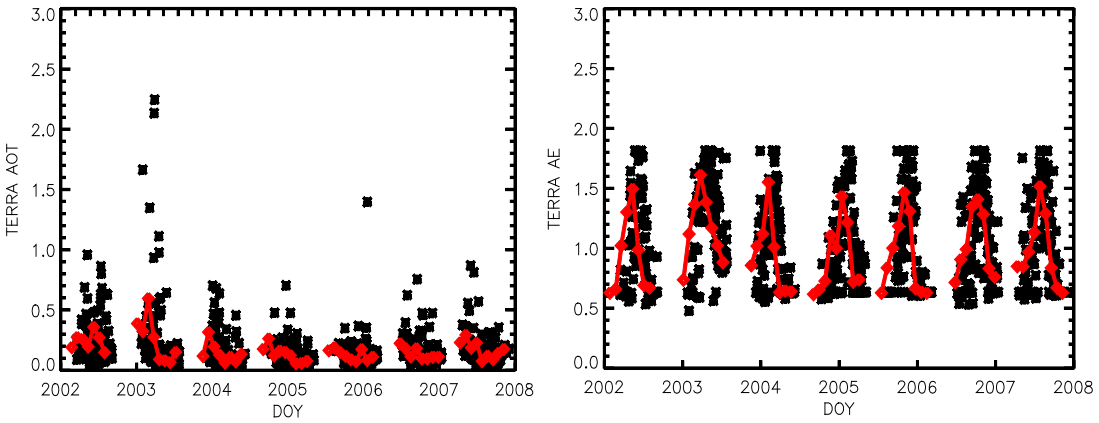
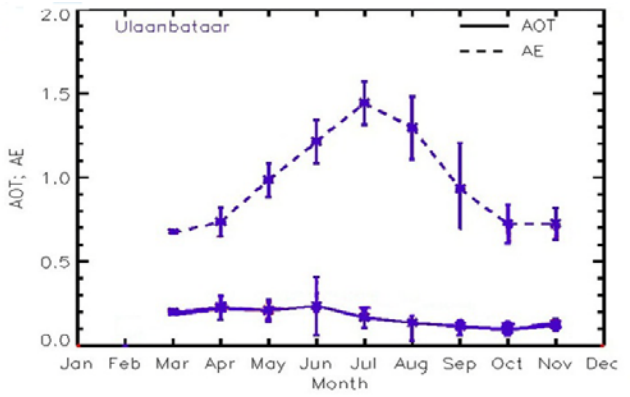


Figure 3**.** The daily AOT and AE over Ulaanbaatar during 2002-2008. The left panel gives the AOT values and the right panel give the AE values. The red line joining the symbols in each plot is the corresponding monthly mean values.

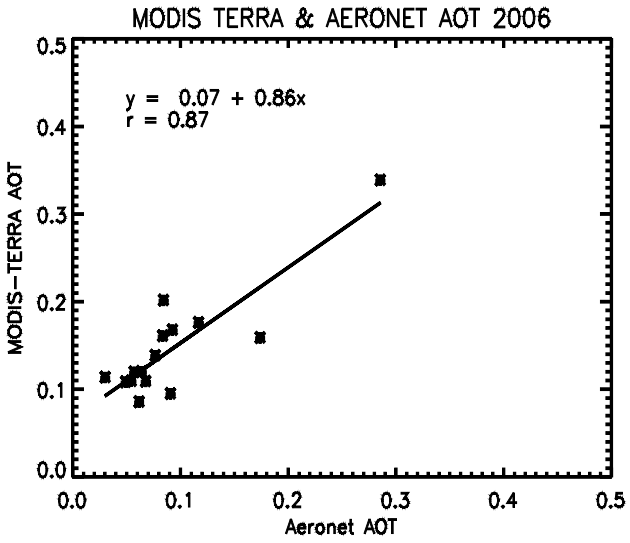
The maximum AOT in 2002 is 1.0, and it suddenly increases to about 2.5 in 2003. However, there is a decrease in AOT till 2006 (note that there is a single point, showing a value of about 1.5 in 2006), and it is increasing in 2007 and 2008. Interestingly, the maximum AOT in 2008 is also about 1.0. Thus it is important to understand in which seasons the AOT is more and what kind of particles contribute to the aerosol loading. In order to have an idea of the size of the aerosol particles over Ulaanbaatar, the AE values during 2002-2008 are shown in the right panel of a very clear and consistent seasonal variation of the

AE values can be seen in the figure. The AE values range between 0.5 to about 1.9 over a year. The smaller AE values correspond to bigger particles while larger AE values show the presence of larger particles.



(Figure 4) Monthly PM10 values

The daily AOT and AE over Ulaanbaatar during 2002-2008. The left panel gives the AOT values and the right panel gives the AE values. The red line joining the symbols in each plot is the corresponding monthly mean values. Figure 4



Not enough data points in 2002. Just finished for the year 2003. Next plan to do the validation for other years. Ichoku et al., 2002 used a three dimensional fit to calculate the MODIS AOT at the location of AERONET. Then they calculated the mean AERONET AOT within 1 hour of MODIS overpass.

6. REFERENCES

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