Research Paper Aerosol Science

To Study the Effect of Different Aspects on the Vertical Profiles of Aerosols

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ABSTRACT

Aerosol measurements have been carried out during the period 1 January 2009 to 30 December 2011 to study the vertical distribution of aerosols at Kolhapur (16°42'N, 74°14'E) by using Semiautomatic Twilight Photometer. The basic principle of this technique is if more number of aerosols exists in the atmosphere then more scattering takes place. The twilight scattering method yields the reasonable, qualitative picture of the vertical distribution of aerosols from about 6km to a maximum of 350km. In this study an attempt has been made to conduct experiments during different activities such as cloudy days, meteor activities etc. Many such graphs were studied and results were obtained. The results acquired revel that; many natural parameters affects on the general trend of typical vertical profiles of aerosols obtained at very clear sky days. Each of these activities demonstrates their effect with varying intensity and at different altitudes with own characteristics.

KEYWORDS Aerosol vertical profiles, clouds, TSM

1. INTRODUCTION

Aerosol measurements have been carried out at Kolhapur (16°42'N, 74°14'E) during the period 1 January 2009 to 15 May 2013. The site is located at an elevation of about 560 m above the mean sea level (AMSL). The instrument used for this study is newly designed Semiautomatic Twilight Photometer. The more details regarding the instrument are given elsewhere, (Mane et al., July-2012). The instrument is based on passive remote sensing method called as Twilight Sounding Method (TSM). The details about the basic principle of the twilight sounding method are given elsewhere, (Mane et al., June-2012). The TSM yields a reasonable qualitative picture of the vertical distribution of aerosols from about 6 km to a maximum of 350 km. Using this data Aerosol Number Density per cm^3 (AND/ cm^3) was calculated and the typical aerosol vertical profiles with AND plotted against shadow height (h). The details regarding the typical aerosol vertical profiles in different atmospheric layers are enclosed by Mane (2013).

There are different activities such as clouds, twilight airglow; natural and manmade activities etc, affects the general trend of typical aerosol vertical profiles obtained at very clear sky days. During this study attempts were made to study the effect of different aspects on the vertical profiles of aerosols.

2. RESULTS AND DISCUSSION

2.1. Very clear sky days:

Figure 1(a and b) shows the typical vertical profiles of aerosols obtained at very clear sky days. It is observed that, the AND over Kolhapur in volcanically quiescent period declines from 185 particles per cm^3 (~6 km) to about 1 particle per cm^3 (~44 km). The aerosol layer peak occurs at ~20 km (5 particles per cm^3). Mesospheric AND decreases from ~700 particles per dm^3 (~50 km) to ~ 225 particles per dm^3 (~85 km). Thermospheric AND vary from 225 particles per dm^3 (~85 km) to ~105 particles per dm^3 (~250 km). After ~ 250 km, many deviations noticed up to 350 km in between 100-120 particles per dm^3.

2.2. Windblown dust:

The transfer of particles to the atmosphere from the Earth's surface is caused by winds and atmospheric turbulence. As shown in the Figure 1(c) one dust layer overlapped with Junge layer was observed in between 12 and 25 km, peaking at ~17 km with ~165% increase in aerosol loading.

2.3. Man made activity:

In 2009 the road construction work was in process at Kolhapur (16°42'N, 74°14'E). At that time one additional aerosol layer was observed in troposphere in between 11 to 14 km peaking at 12 km with ~400% increased aerosols (Figure 1(d)).

2.4. Twilight airglow:

The airglow is the light of electronically and/or vibration-rotationally excited atoms and molecules existing at 80 km or higher. Sunlight shining upon the high atmosphere during twilight gives energy to the atoms and molecules of the air, causing them to directly reemit some of this energy in the form of light. The resulting twilight airglow emissions can be quite bright. In semiautomatic twilight photometer a red glass filter peaking at 670nm with half bandwidth of about 50 nm is used. Therefore the twilight airglow lines having wavelengths in between 620 nm and 720nm were detected by this photometer.

The twilight airglow lines were observed ~80 km and above. The intensity of these lines is ~600% to 1000% higher than that natural twilight glow due to aerosols. Figure 1(e and f) shows effect of twilight airglow on the vertical profiles of aerosols.

2.5. Clouds:

TSM being passive remote sensing technique, clear sky conditions are preferable for obtaining the vertical profiles of aerosols. However, in this study an attempt has also made to conduct an experiment during cloudy sky conditions. Suppose if there exist an isolated cloud in the field of view of the twilight photometer, the color of the cloud changes from yellow to orange (or deep red in humid or polluted atmosphere) as the sun sinks. It then fades to gray as the earth's shadow falls on it. The rate of change of red light due to clouds exist in the field of view of the twilight photometer would show a large maximum on the vertical profiles of aerosols. There exist many types of clouds affecting differently. The three of main types among them are as follows:

I. Low and Middle level clouds:

In the presence of low and middle level clouds only distortions were observed and no signal obtained (Figure 2(a)).

II. High level clouds:

Due to high level clouds intense peaks were observed above 6 km in the troposphere. The intensity of these peaks is ~400% to 600% higher than that due to aerosols (Figure 2(b)).

III. Invisible cirrus clouds:

In the earth's atmosphere optically thin cirrus layers frequently

observed just below the tropopause. These thin cirrus layers extend several hundred to more than a thousand kilometers horizontally and persist for period of several hours to several days before dissipating. Though they play a less significant role in the earth's radiation budget than thick cirrus, their impact on the upper tropospheric thermal structure and vertical velocity, on the lower stratospheric water vapor mixing ratio, and on remote sensing applications are not negligible. These clouds are invisible for normal eyes; but one can observe a typical intense peak (~700% to 1000% intense thin peak lines) at the height of their existence on the vertical profiles of aerosols obtained by Semiautomatic Twilight Photometer as shown in the Figure2(c).

2.6. Meteor showers:

The dust particles during meteor showers intrude in the Earth's atmosphere above 50 Km i.e. in the mesosphere and thermosphere. These dust particles would show a large maximum on the vertical profiles of aerosols. There are three different types of meteor showers and there effects are also special.

I. Strong meteor showers:

The dust particles during strong meteor showers intrude in the Earth's atmosphere below 100 km. These dust particles shows intense peak with ~250% increase in intensity (Figure2 (d)).

II. Medium meteor showers:

The dust particles during weak meteor showers intrude in the Earth's atmosphere in-between 120km and 250 km. One narrow intense flux was observed having ~160% enhance in intensity (Figure2 (e)).

III. Weak meteor showers:

The dust particles during weak meteor showers intrude in the Earth's atmosphere above 275 km. The broad intense peak with ~140% raise in intensity was observed as shown in the Figure 2(f).

3. SUMMARY AND CONCLUSIONS

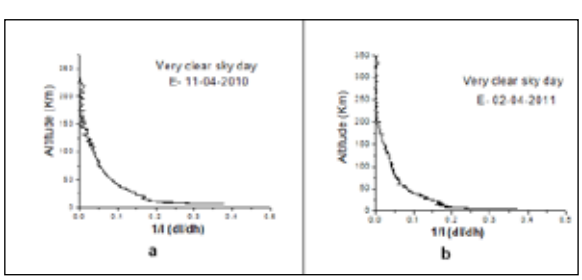
The measurements using the twilight sounding method presented in this paper suggest the following,

I. The newly designed Semiautomatic twilight photometer yields a reasonable qualitative picture of the vertical distribution of aerosol number density (AND) from about 6 km to a maximum of 350 km.

II. Many natural parameters affects on the general trend of typical vertical profiles of aerosols obtained at very clear sky days. Each of these activities demonstrates their effect with varying intensity and at different altitudes with own characteristics.

III. Acknowledgements:

Author is grateful to the Shivaji University authorities, Kolhapur, for the encouragement during the course of this work and also the SERB, DST, India, for providing funds for the development of twilight photometer.



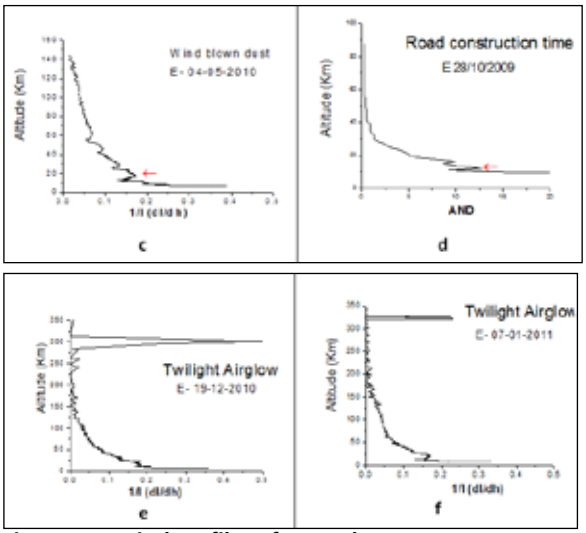


Figure 1: Vertical profiles of aerosols

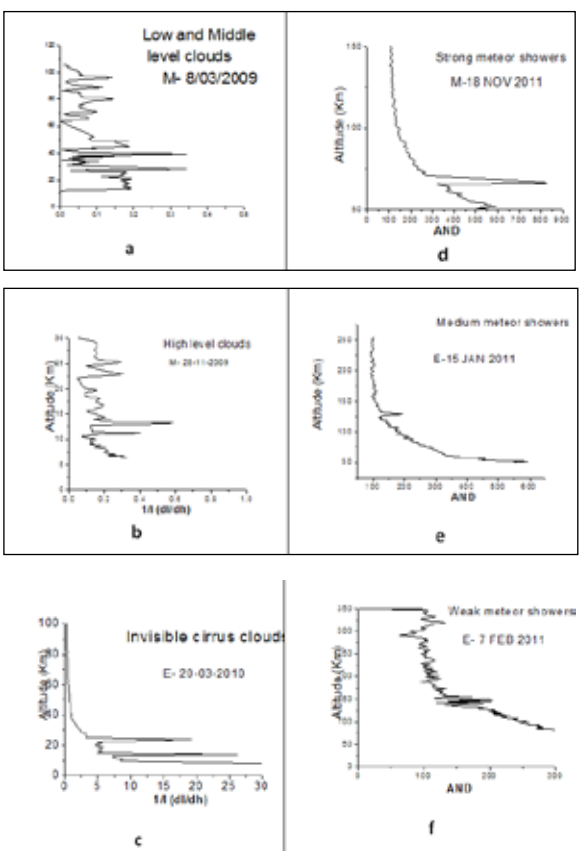


Figure 2: Vertical profiles of aerosols

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