DECREASE IN THE CLEAR AIR TRANSMISSION AT HELWAN OBSERVATORY SITE

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Abstract. Clear air atmospheric transparency of eight nights at Helwan Observatory site during autumn period of 1987 have been determined using the yellow filter GG5. The prevailing atmospheric transmission extends to 58%. A comparison with previous values obtained with the same filter and site during autumn period of 1963 shows a considerable decrease at the present years in the clear air transmission of the site of Helwan. This can be attributed to the aerosol pollution of the site caused mainly by the increase of the industrial centers at Helwan Zone. Clear air atmospheric transparency values at the beginning of winter season and at spring season are also given.

1. Introduction

A wide program is carried out at Helwan National Research Institute of Astronomy and Geophysics to measure the atmospheric transparency of many sites in Egypt. Circular measurements are done for some sites to check the atmospheric aerosol pollution of these sites. Mikhail (1979) has determined clear air monochromatic extinction of the site of the 74″ telescope of Kottamia observatory in five narrow pass-band filters of peak transmission between 4000 Å and 8000 Å. The atmospheric transparency has been deduced for 51 selected dates of observations between the years 1963 and 1969. The results have demonstrated in this period the state of the atmosphere at Kottamia.

The author has deduced for each season the absorption components due to the aerosol above the site and their variations with wavelength.

The spring season gives the most high extinction due to aerosol. For different seasons the maximum extinction of aerosol particles is detected at wavelength near 5000 Å.

Assad *et al.* (1974) have studied the atmospheric transparency at Misallat, Helwan and Daraw for the observations carried out between 1962–1964. The observations at Misallat include nine clear nights during August and September 1962 using GG5 coloured filter. The results have shown that the average value of atmospheric transparency at Misallat is almost 85% which is close to that expected theoretically for a Rayleigh scattering atmosphere.

A reduction of seven winter nights of observations taken in 1964 at Daraw, near Aswan south of Cairo, have been done. The results have shown a quick change in the transparency from night to night. Two nights are characterized to be close to that expected theoretically for a Rayleigh scattering atmosphere. Two other nights

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have shown dust and fairly clear conditions. Three nights are the worst and the conditions are beyond the limit given theoretically.

At the beginning of Autumn 1963 three nights of observations have been carried out at Helwan observatory using yellow filter. The deduced transparency values are 78%, 64% and 81%. On the average, the atmospheric condition has been described as dust and fairly clear conditions.

At present time, a large expand of the buildings at Helwan zone with an increase of the inhabitants and the industrial centers. A large pollution can easily be noticed. It is useful to find the effect of the present pollution on the clear air transmission at the site of Helwan observatory. It is worthy to note that the site is equiped with three tracking satellite stations beside the 30″ reflector telescope.

2. The Method Applied for Determining Atmospheric Transparency

The method used in the present study to deduce the atmospheric transparency at Helwan is given before by Asaad *et al.* (1974). In what follows, we give summary to the basis and the formulae applied to deter mine the atmospheric transparency.

Neglecting the curvature of the atmosphere and the effect of refraction, then the intensity of the star light at any height h above the ground is given by

$$I_1 = I_0 e^{-\tau M}. \tag{1}$$

Where I_1 and I_0 are the intensities of light of a star at certain wavelength inside and outside atmosphere respectively, the quantity τ is called the optical thickness of the atmosphere above height h and it is a measure of the total attenuation of light passing in a vertical direction from the top of the atmosphere to the height h

$$\tau = \int_h^\infty B \, \mathrm{d}h$$

B is the attenuation coefficient per unit volume at height h for the wavelength of measurements, M is the air mass of the observed star, and the method to calculate M will be explained later.

The value of τ can be determined from Equation (1) by using the intensities of the same star (I_1) measured at different values of air masses. The plot should give a straight line from which τ can be determined.

In fact, we have measured on the same night the intensities of more than one star of different magnitudes and all the data have been plotted on one diagram using the deduced formula No. (4).

From Equation (1)

$$\log I_1 = \log I_0 - \frac{\tau}{2.303} M$$

$$\log I_1 = \log I_0 - KM \tag{2}$$

where $K = \tau/2.303$.

Pogson's formula gives

$$m = -2.5 \log I_0 + A_1$$

$$\log I_0 = 0.4A_1 - 0.5\,\mathrm{m}$$

$$\log I_0 = A_2 - 0.4\,\mathrm{m} \tag{3}$$

where m is the apparent magnitude of the observed star, A_1 is a constant and $A_2 = 0.4A_1$

From (2) and (3)

$$\log I_1 = A_2 - 0.4\,\mathrm{m} - KM$$

$$\log I_1 + 0.4\,\mathrm{m} = A_2 - KM \tag{4}$$

or

$$\log I = A_2 - KM$$

where

$$\log I = \log I_1 + 0.4\,\mathrm{m}$$

Applying formula (4) it is possible to plot one diagram for all the measured intensities (log I) of the different stars observed at different air masses (M). In such case the intensities of the different stars will be on the same scale. For the yellow filter of the present investigation their will be no correction for the colour of the stars. The slope of the best straight line between log I and M gives the value of K and hence we derive the value of (τ). The transparency of the atmosphere is calculated and equals $e^{-\tau}$.

3. The Determination of Air Mass

The recorded time of the stars measurements are used to obtain the different values of air masses (M) of the observed stars. The relative air mass (M) in units of the thickness at the zenith is given to a high degree of accuracy by the secant of the zenith distance Z (i.e.) sec Z. The error introduced by the inaccuracy of sec Z is only 0.005 air mass at $Z = 60°$. For, extreme values of zenith distances, M is controlled by the following formula

$$M = \sec Z - 0.0018176\,(\sec Z - 1) - 0.002875\,(\sec Z - 1)^2 - 0.0008083\,(\sec Z - 1)^3$$

According to Hardie (1962), the previous formula is accurate to 0.1% up to $M = 6.8$ where the present observations are rarely made.

4. The Observations and Data Reduction

The observations of the present study are carried out using the receiving system of the satellite tracking station at Helwan. The star light is received and collected by a cassegrain telescope of 32 cm diameter and a focal length at 1 meter. The secondary mirror of the cassegrain telescope focusses the collected light to 1 mm diaphragm. Light is passed through GG5 yellow filter and goes to a photomultiplier tube RCA 8852 and then to the counter. The detail description is given by Jelinkova and Hamal (1978).

A program is prepared at the computer sinclair *zx* spectrum to correct the measured intensity data for the background and for the magnitude of the observed stars. The program calculates the air masses from the measured time of the stars and draws a diagram between the stars intensities and the air masses.

5. Atmospheric Transparency Values for the Autumn Season

The atmospheric transparency values are calculated using Equation (4) for each night of observations from the variation of the stars intensities measurements inside the atmosphere and that of the air masses. Table I lists the dates of observations, optical thickness of the atmosphere and the atmospheric transparency values.

The observations are carried out on nine nights in the period of the autumn season. One night of observations is rejected as the observations have been interrupted by clouds. The stars selected for observations are not variable.

All charcteristics describing the atmosphere (governed by temperture, pressure, density, chemical composition, state of ionization or extinction) are functions of the elevation h which are related to optical thickness of the atmosphere.

The probable error of the extinction value of each night of observation deduced by least square method is almost ±2%.

It can be seen in Table I, that the mean clear air atmospheric transmission value detected at the present investigation of autumn season of 1987 for the site of Helwan Observatory is 58%.

Asaad *et al.* (1974) have found 74% for the mean deduced value of clear air transmission for an observation carried out at the same site using the same

TABLE I

Date of observation	τ	Transparency (visible range)
23/9/87	0.654	52%
28/9/87	0.357	70%
30/9/87	0.478	62%
14/10/87	0.635	53%
19/10/87	0.867	42%
21/10/87	Observations are interrupted by clouds	
26/10/87	0.357	70%
2/11/87	0.654	52%
10/11/87	0.511	60%
	Mean value	58%

TABLE II

Date	Transparency (visible range)
18/11/87	61%
23/1/87	72%
25/11/87	65%

filter during autumn period of 1963. Thus a considerable decrease in the clear air transmission of the present time in comparison with that obtained since 24 years.

6. Atmospheric Transparency Values of Helwan Obtained at the Beginning of the Winter Season

The clear air atmospheric transparency values have been deduced for three nights at the beginning of the winter of 1987. Table II gives the dates of observations and the atmospheric transparency values.

The optical thickness of the atmosphere (τ) is calculated for each night of observation, using the same equation and method mentioned before, and it gives almost the same probable error. The mean atmospheric transparency deduced for the three nights at the beginning of winter season is 66%.

TABLE III

Date	Transparency (visible range)
22/3/88	63%
29/3/88	57%
4/4/88	26%
12/4/88	43%
9/5/88	54%
10/5/88	59%

The mean value of the three nights obtained at the beginning of winter season may not represent the mean value of the winter season. There is no possible comparison with privious measurements carried out at the end of winter season.

It is worthy to note that Mikhail (1979a,b) has found mean value of 80% for monchromatic atmospheric transparency value obtained for winter season at Kottamia observatory for the years between 1963 and 1969.

Asaad *et al.* (1974) deduced a mean value of 71% for the seven observed nights at Daraw south of Cairo when stars measurements have been carried out at December 1964 using GG5 wide band yellow filter.

7. Atmospheric Transparency Values of Helwan for Spring Season

The atmospheric transparency values are deduced for six nights of observations at spring of 1988 at Helwan Observatory site and listed in Table III with a mean value of 50%. This mean value is very low if compared with the value deduced for Kottamia observatory site for the years between 1963–1969 which equals 77%.

8. Conclusion

The new measured values of the atmospheric transparency of the years 1987 and 1988 (Tables I–III) show very clearly decrease in the transparency values for the site of Helwan observatory when compared with previous measurements at Helwan observatory site at 1963, Daraw at 1964 or Kottamia observatory site for the years between 1963–1969. Actually any person when looking to the atmosphere of the site of Helwan observatory, it can be seen clearly an increase in the inhomogenities due to aerosol pollution of Helwan zone. Different sources of disturbances are noticed. The smoke, dust and the floating particles comming from the steel and iron factory are different from that caused by cement factory. This program will last for more investigation.

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