Ain shams university

Optical characteristic of the atmosphere over Cairo from sunphotometer measurements

A thesis

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by

Eman Gaber Hamza
(B. Sc. Physics, Faculty of Science, south valley University 1997)
(M. Sc. Meteorology, Cairo University 2004)

Supervised by

Prof. Dr. M. M. Abdel-Wahab
Astronomy and Meteorology Dept.,
Faculty of Sci. Cairo Univ.
(Egypt)

Dr. M.M. Abdel aal
Ass. Prof. Dr. of Phys.
Phys. Dpt.
Faculty of Girls, for Arts, Sci. and Edu.
Ain shams Univ.

Dr A. Zakey
ICTP Trieste.
Italy

Ain shams university

Approval sheet

Name: ***Eman Gaber Hamza Hassan***

Title: "Optical characteristic of the atmosphere over Cairo from sunphotometer measurements "

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Supervisors:

1. Dr. M. M. Abdel-Wahab	Prof. Dr. M. M. Abdel-Wahab Astronomy and Meteorology Dept. Faculty of Sci. Cairo Univ. (Egypt)
2- Dr. M. M. Abdel aal	Prof. Dr of Phys. Dpt. (Egypt) Faculty of Girls, for Arts, Sci. and Education. Ain shams Univ
3-Dr. A. Zakey	ICTP Trieste Italy

Examiners:

1-

2-

3-

Abstract

This study is based on an analysis of available meteorological data from ground stations in addition to AERONET data.

Recent studies using year (2004–2005) satellite (including Moderate Resolution Imaging Spectroradiometer (MODIS) and ground Aerosol Robotic Network (AERONET) data show strong seasonal variability of aerosol optical depth (AOD) with maximum aerosol loading ($1 > \tau_a > 0.3$) during spring season. A number of major dust storms, originating from western arid and desert regions (west Desert), affect the whole during the season (March–May). Pronounced changes in the aerosol optical parameters, derived from AERONET, have been observed over Cairo University (30^o $01^\backslash$ N, 31^o $.12^\backslash$ E) during dust storm events (2004–2005). These measurements were recorded by sunphotometer that measures direct sunlight over a narrow range of wavelengths, some sunphotometer use "interference filters" to make a sharp cut off to ensure the measurement at selected of wavelength.

Monthly average values of aerosol optical depth (AOD) showed a pronounced temporal trend, with a maximum AOD during winter and the transition season (spring) at two sites urban areas.

Abstract

Variation of Angstrom exponent (α) with the AOD was clear and the α- value depends on the spectral range used in its determination.

The number of occurrence distribution measurements are carried out at seven stations in Egypt some of these stations are urban/industrial areas, and other is an agricultural area covering the period from Jan 1968 to Dec 2005.

The dust model includes dust emission as a function of (vegetation cover- soil type and texture – soil wetness – friction velocity), dust deposition (wet and dry), horizontal and vertical advection and vertical diffusion through an improved formulation of PBL. One case with very remarkable sandstorms has been described and investigated through this study. The model output for 72 hours were validated and verified with satellite images and visibility as actual data. In addition, the aerodynamic parameters (friction velocity, wind speed and vertical motion for compression) are the main factors in the dust emission. The author concludes that:

1) The model had an excellent performance in predicting dust over Egypt during the forecast period when compared with the satellite images and actual visibility.

2) The dust storm events are extremely associated with the cold front.

3) The dust emission start to increase sharply when friction velocity u* reaches over 0.5 m/s.

4) The downward motion was needed to make excitation for the dust to liberate from the soil and then upward motion was the main factor in lifting the dust to different heights according to its intensity and the weight of the parcel.

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Eman

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Nomenclature

Symbol	Notation
σ_{ep}	Aerosol light extinction coefficient
σ_{sp}	Aerosol light scattering coefficient
σ_{ap}	Aerosol light absorption coefficient
τ	Aerosol optical depth
ω	Aerosol single scattering albedo
σ_{sg}	scattering by gases
σ_{ag}	absorption by gases
I_{λ}	The light intensities at wavelength λ
$N_m(D_P)$	The mass size distribution function
E_{ext}	mass extinction efficiency
D_p	function particle diameter
ri	refractive index
Q_{scat}	Mie scattering efficiencies
Q_{abs}	Mie absorption efficiencies
Xv	The visual length
D	the fractional day length
T_{at}	the atmospheric transmission
A_c	fractional cloud cover
B	the scatter fraction
$n(D_p)$	the cumulative particle number distribution
D_i	the mean particle radius
$log\ \sigma_i$	a measure of particle poly dispersity
Z_h	The roughness element
R_d	the roughness density
$u_t^*(D_p)$	threshold friction velocity

ρ_p	particle density
ρ_a	air density
g	is gravitational acceleration
u^*_{ts}	the threshold frication velocity
σ_i	standard deviations
e_i	binding energies
K	radius index
	surface pressure
P_S	vertical velocity
η	virtual temperature
T_V	the specific total water content
q_{DW}	
R_a	the aerodynamic resistance
R_s	the surface layer
R_t	the transfer resistance

Fig (1.1)	:	An idealized illustration showing total suspended particles (TSP), as well as fine (PM2.5) and coarse (TSP-PM2.5) particle modes , with their major chemical mass components .
Fig (1.2)	:	Mie scattering efficiency (550 nm) for a purely scattering aerosol (ri = 1.53),and the absorption and scattering efficiency for an aerosol that has both scattering and absorbing components (ri = 1.53 – 0.66i).
Fig (1.3)	:	Mass scattering efficiency (550 nm) for a purely scattering aerosol (ri = 1.53), and the mass absorption and scattering efficiency for an aerosol that has both scattering and absorbing components (ri = 1.53 – 0.66i)
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Fig (2.2)	:	Optical properties of spherical particles as a function of particle radius according to Mie

theory. The optical indices pertain to a particle made from a mixture of sea salt and water at 80% relative humidity. The optical wavelength is 3.5 m.

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Fig (2.4) : The real part of the optical index for dust as a function of optical wavelength. The solid circles are tabulated values from the literature, and the lines connecting them were generated by linear interpolation within the NAM6 code

Fig (2.5) : The imaginary part of the optical index for dust as a function of optical wavelength. The solid circles are tabulated values from the literature, and the line connecting them were generated by linear interpolation with the NAM6 code.

Fig (2.6) : The real part of the optical index for B1 aerosol.

Fig (2.7) : The imaginary part of the optical index for B1 aerosol.

Fig (2.8) : The real part of the optical index for sea salt.