

**ESTIMATION OF ATMOSPHERIC
TURBIDITY PARAMETERS USING
SKYLIGHT POLARIZATION AND
SOLAR INTENSITY
MEASUREMENTS**

by

A. V. U. A. Wickramarathna

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Thesis submitted to the University of Sri Jayewardenepura for the
award of the Degree of Master of Philosophy in Physics on

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DECLARATION

The work described in this thesis was carried out by me under the supervision of Prof. C. P. Abayaratne and Dr. M. K. Jayananda and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/ Diploma.

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Table of Contents

Table of Contents	i
List of Figures	iii
List of Tables	vi
Acknowledgements	vii
Abstract	viii
List of Abbreviations	x
1 Introduction	1
1.1 Polarization	2
1.2 Skylight Polarization	3
1.3 Principal Plane	5
1.4 Degree of Polarization	6
1.5 Neutral Points	6
1.6 Total Optical Thickness/Optical Depth	8
1.7 Linke Turbidity Factor	9
1.8 Angstrom Coefficient	11
1.9 Influence of Clouds on Solar Radiation	12
1.10 Organization of the thesis	12
2 Literature Survey	13
2.1 Skylight Polarization	13
2.2 Atmospheric Parameters	14

2.3	Cloud Interference for Solar radiation	15
2.4	Polarimeters	16
3	Materials and Method	18
3.1	Characteristics of the Sites of Measurements	18
3.2	Instrumentation	19
3.2.1	Sun Tracking Unit	22
3.2.2	Stepper Motor Controlling Unit	23
3.2.3	Light Sensor	24
3.2.4	Humidity and Temperature Sensor	27
3.2.5	Processing Unit	28
4	Results and Discussion	29
4.1	Degree of polarization	30
4.2	Total optical depth	44
4.3	Aerosol optical depth	55
4.4	Linke turbidity factor	57
4.5	Angstrom's coefficient	59
4.6	Sources of errors	63
4.7	Further Development	64
4.7.1	Light Sensor	64
4.7.2	Optical Filters	64
5	Conclusion	66
	References	67
	Appendices	

List of Figures

1.1	Contrast of scene viewed by un-polarized and polarized light	2
1.2	Polarization states	3
1.3	Polarization by scattering	4
1.4	principal plane [1]	5
1.5	Positions of the neutral points in the principal plane of the sun	7
3.1	Bird's eye view of the sites	19
3.2	The flow chart of Fully Automated Polarimeter	20
3.3	Fully Automated Polarimeter	21
3.4	The block diagram of Fully Automated Polarimeter	22
3.5	The window comparator unit	22
3.6	The photograph of the window comparator unit	23
3.7	Sensor Unit	24
3.8	Experimental setup for unit conversion of light intensity	25
3.9	The graph of Lux values obtained by BH1750FVI sensor vs Anlog values corresponding to the voltage across the LDR	26
3.10	The graph of intensity variation of BH1750FVI sensor with cosine of angle between the transmission direction of polarizer and analyser according to Malu's law. Error bars are smaller than the marker size	27
4.1	DOP at various angular distances from the sun measured on 05.02.2016 at University of Sri Jayewardenepura	30

4.2	DOP at various angular distances from the sun measured on 13.02.2018 at University of Kelaniya	31
4.3	Some images of sky observed at Kelaniya	32
4.4	Some images of sky observed at Kandy	32
4.5	DOP at various angular distances from the sun measured on 03.05.2018 at Kandy	33
4.6	Some images of sky observed at Mahiyanganaya	33
4.7	DOP at various angular distances from the sun measured on 22.07.2018 at Mahiyanganaya	34
4.8	DOP at various angular distances from the sun measured on 04.04.2017 at University of Sri Jaywardenepura	35
4.9	DOP at various angular distances from the sun measured on 02.05.2018 at Kandy	36
4.10	DOP at various angular distances from the sun measured on 23.07.2018 at Mahiyangana Ground	37
4.11	DOP at various angular distances from the sun measured on 16.01.2013 and 18.01.2013 at University of Sri Jayawardenepura	38
4.12	DOP at various angular distances from the sun measured at the four sites (Sri Jayewardenepura, Kelaniy, Kandy, Mahiyangana) for white light . . .	40
4.13	Total intensities at various angular distances from the sun measured at the four sites for white light	41
4.14	Variation of DOPmax with solar elevation angle	42
4.15	Extraterrestrial solar intensity [2]	43
4.16	The relationship between the logarithm of the solar flux and the atmospheric air mass, corresponding to average atmospheric depth for white light. Error bars are smaller than the marker size.	45

4.17	The relationship between the logarithm of the solar flux and the atmospheric air mass, corresponding to average atmospheric depth for 450nm wavelength. Error bars are smaller than the marker size	46
4.18	The relationship between the logarithm of the solar flux and the atmospheric air mass, corresponding to average atmospheric depth for 550nm wavelength. Error bars are smaller than the marker size	47
4.19	The relationship between the logarithm of the solar flux and the atmospheric air mass, corresponding to average atmospheric depth for 650nm wavelength. Error bars are smaller than the marker size	48
4.20	TOD variations with sun's elevation angle. Error bars are smaller than the marker size	53
4.21	Seasonal patterns of AOD for Sri Lanka and the Maldives. Value is the ratio of monthly AOD to the chosen annual AOD value [3]	54
4.22	TOD variations with sun's elevation angle for different wavelengths. Error bars are smaller than the marker size	54
4.23	Aerosol optical depth variations with sun's elevation angle for 450nm, 550nm, 650nm filters at Kandy and Mahiyangana. Error bars are smaller than the marker size	56
4.24	Aerosol optical depth variations with sun's elevation angle for different wavelengths. Error bars are smaller than the marker size	57
4.25	Linke turbidity factor at various solar elevation angle. Error bars are smaller than the marker size	58
4.26	Angstrom coefficient β at various solar elevation angle. Error bars are smaller than the marker size	59
4.27	The linear of $\ln \tau_a$ versus $\ln \lambda$ to the sun's elevation angle 25.	61
4.28	The linear of $\ln \tau_a$ versus $\ln \lambda$ to the sun's elevation angle 30.	61

List of Tables

2.1	Stations where cloud interference experiment were conducted	15
4.1	TOD calculated by Beer's law formula and Pseudo TOD obtained by Langley plots for white light	49
4.2	TOD calculated by Beer's law formula and Pseudo TOD obtained by Langley plots for Blue light	50
4.3	TOD calculated by Beer's law formula and Pseudo TOD obtained by Langley plots for Green light	51
4.4	TOD calculated by Beer's law formula and Pseudo TOD obtained by Langley plots for Red light	52

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Abstract

A fully automated polarimeter was constructed to investigate the pattern of skylight polarization in the principal plane of the sun and its dependence on the location based on measurements taken during the period 2016 – 2018 at four different locations in Sri Lanka; Sri Jayewardenepura, Kelaniya, Kandy, and Mahiyanganaya. In addition to data taken with white light, three color filters of center wavelengths 450 nm, 550 nm, and 650 nm were also employed in Kandy and Mahiyanganaya. Data collected using the polarimeter was also used to estimate three other parameters of atmospheric turbidity; Total optical depth (TOD), Linke turbidity factor (LTF), Angstrom coefficient (AC) under cloudy skies. In spite of this more or less random variation, Aerosol optical depth (AOD) was estimated from the TOD by subtracting the Rayleigh optical depth (ROD).

Cloudy skies give irregular polarization patterns and position of Babinet and Arago polarization neutral points that are believed to depend on atmospheric turbidity were visible in the region. According to previous studies for a clean molecular atmosphere, only two neutral points are simultaneously visible, but three of the neutral points could be observed simultaneously on certain days possibly due to high levels of turbidity. No significant dependence of the polarization patterns on the wavelength could be observed.

The maximum degree of polarization (MDOP) was found to decrease with the solar elevation angle. A statistical analysis of the data revealed that there was a location dependence of MDOP, TOD, LTF, and AC for white light. TOD of the white light shows a range of 0.68-1.54 for Kelaniya, 1.00-2.71 for Kandy, and 0.61-1.47 for Mahiyanganaya. A weak dependence on location was seen indicating Kandy as the location with the highest turbidity level followed by Kelaniya and Mahiyanganaya.

An analysis of spectral data for a solar elevation angle of 30° resulted in estimated Angstrom exponent (α) values of 1.48 in Kandy and 0.68 in Mahiyanganaya with standard errors of 1.35 and 0.32 respectively indicating a higher ratio of small to larger particle concentrations in Kandy compared to Mahiyanganaya. The Angstrom coefficient (β) values were

estimated as 0.41 in Kandy and 0.54 in Mahiyangana with standard errors of 0.78 and 0.26 respectively indicating a higher concentration of aerosols in Mahiyangana compared to Kandy which is interpreted as the result of aerosols due to burning of the cultivation land in Mahiyangana.

List of Abbreviations

- DOP - Degree of Polarization
- MDOP- Maximum Degree of Polarization
- TOD - Total Optical Depth
- AOD - Aerosol Optical Depth
- ROD - Rayleigh Optical Depth
- LTF - Linke Turbidity Factor
- AC - Angstrom's Coefficient
- SZA - Solar Zenith Angle
- SEA - Solar Elevation Angle
- SIP - Spectral Irradiance Polarimeter
- LDR - Light Dependent Resistor
- IDE- Integrated Development Environment