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

by

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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.

Signature:..... Date:.....

CERTIFICATION OF APPROVAL

We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the university for the purpose of evaluation.

Principle Supervisor:.....

Signature:.....

Date:.....

Co-Supervisor:.....

Signature:.....

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We certify that all corrections, additions and amendments have been done in accordance with the comments and suggestions made by the members of the viva-voice examination.

Principle Supervisor:.....

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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 30^0 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 Plarization
- 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