Determination of aerosol optical depth using a Micro Total Ozone Spectrometer **II** (MICROTOPS **II**) sunphotometer

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Abstract

Aerosols affect climate and climate change by absorbing and scatting incoming solar radiation. These effects are quantified by the aerosol optical depth (AOD), which is the exponential decrease in solar radiation, due to the presence of aerosols. We performed the retrievals of AOD during an Intensive Observational Period (IOP) at Brookhaven National Laboratory (BNL) from July 15 through August 15, 2011, using a MICROTOPS **II**, which provides fully automatic measurements of aerosol optical depth (AOD), and direct solar irradiance at five wavelengths near 340, 500, 870, and 1040nm. The calibration of the instrument to measure AOD at multiple wavelengths is based on Langley analysis, in which the logarithm of the intensity of the direct solar radiation at a given wavelength is plotted against the inverse of the cosine of the angle between the sun and the vertical. The negative slope of the line is the total optical depth. The optical depth due to Rayleigh scattering, Ozone and Nitrogen dioxide absorption, are subtracted to obtain the AOD. The main goal of this experiment is to determine the aerosol optical depth over several days at multiple wavelengths. Our results show that the AOD varies considerable from day to day, ranging from 0.16 to 1.99, 0.11 to 1.69, 0.04 to 1.72, 0.05 to 2.16, with wavelengths 340, 500, 870, and 1020 nm. In addition, AOD depends on wavelength, increasing as wavelength decreases.

Introduction

Aerosol is a suspension of fine solid or liquid particles in air, ranging from a few nanometers to several tens of micrometers. Routine observation of total atmospheric aerosol optical depth is a fundamental way of determining aerosol optical characteristics and their influence on the global radiation budget and in climate change. Aerosols affect climate and climate change by absorbing and scattering incoming solar radiation. These effects are quantified by the aerosol optical depth (AOD).The primary focus of our research during this intensive observational period is to determine the AODs over several days at multiple wavelengths , using a MICROTOPS II 5 Channel Sun-photometer . It is well known that AOD is wavelength dependent and can vary considerably with different types of weather and climate conditions.

Method and Materials

MICROTOPS II 5 Channel Sun-photometer

Wavelengths: 340, 500, 870, 936 and 1020 nm

AOD for each wavelength is derived based on Beer-Lambert- law

Measured Solar Irradiance

Solar Irradiance on Top of the Atmosphere

$$\frac{I}{I_0} = e^{m\tau_{tot}}$$

Total Optical Depth

Airmass (= 1/cos (Zenith Angle))

$$\tau_{tot} = \frac{\ln(I_0) - \ln(I)}{m}$$

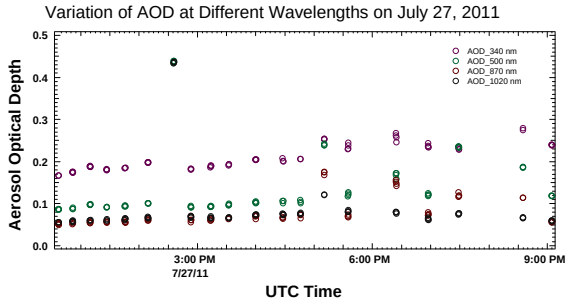
$$\tau_{tot}(\lambda) = \tau_{aer}(\lambda) + \tau_{Ray}(\lambda) + \tau_{O_3}(\lambda) + \tau_{NO_2}(\lambda)$$

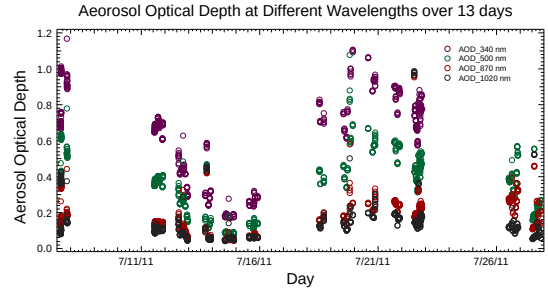
$$\tau_{aer}(\lambda) = \tau_{tot}(\lambda) - \tau_{Ray}(\lambda) - \tau_{O_3}(\lambda) - \tau_{NO_2}(\lambda)$$

TOTAL OPTICAL DEPTH

- τ_{aer} = Aerosol Optical Depth (AOD)
- τ_{Ray} = Rayleigh Optical Depth
- τ_{O_3} = Ozone Optical Depth
- τ_{NO_2} = Nitrogen dioxide Optical Depth

Results





AOD varies as function of wavelength and illustrates variability over time and day due to fluctuation in aerosol concentration and size

Conclusion

Our results show that the AOD varies considerable from day to day, ranging from 0.16 to 1.99, 0.11 to 1.69, 0.042 to 1.72, and 0.05 to 2.16, with wavelengths 340, 500, 870, and 1020 nm. In addition, AOD depends on wavelength, increasing as wavelength decreases.
The high AOD values in our data could be due to the presence of clouds or misalignment of the instrument with the sun.

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