Lidar and sun photometer measurements of aerosol optical properties over Taipei

Wei-Nai Chen[1], Yei-Wei Chen[1,2], Shih Yu Chang[1], Charles C.-K. Chou[1], Jen-Ping Chen[1,2]

[1]Research Center for Environmental Changes, Academia Sinica

[2]Department of Atmospheric Science, National Taiwan University

Abstract

Tropospheric aerosols have been observed for the spring and winter periods from February 2004 to January 2006 with a lidar and a CIMEL sun photometer. Variations of aerosol vertical profile and column optical thickness derived from the lidar and the sun photometer measurements are presented. The simultaneous measurements of these instruments also allowed us to estimate the extinction-to-backscatter ratio (so called lidar ratio), which ranged from 20 to 80. The correlation between angstrom exponents derived from sun photometer and lidar ratio for the columnar mean aerosols were discussed. Seasonal (Oct-Jan and Feb-May) dependence is found between aerosol angstrom exponent and lidar ratio. In Feb-Apr, fraction of aerosol in the free atmosphere is higher then other months. With depolarization measurement we notice the correlations between angstrom exponent and lidar ratio are different in Asian dust dominated episodes and non-dusty episodes.

Introduction

Aerosol optical depth (AOD) indicates the column-integrated burden in the atmosphere and is a main parameter of the aerosols that significantly impacts the climate. Lidar is powerful techniques for active remote sensing of the vertical profile of troposphere with high temporal and spatial resolution. The effects of aerosols represent one of the largest uncertainties in predicted climate change (Haywood and Boucher, 2000). In this paper, we present the optical characteristics of aerosols over Taipei as they are determined by lidar and sun photometer. We briefly describe the instrumentation we used for this study. The optical characteristics determined from these measurements are discussed and compared with the ones from studies that correspond to regions with Asian dust burning episodes.

RCEC/ASNTU Lidar is a dual-wavelength Raman and Depolarization Lidar system (manufactured by Zenon SA, Greece). The lidar system employs the second

and third harmonics of Nd-YAG laser at 532 nm and 355 nm. Aerosol backscattering ratio *R* is define as:

$$R_{\lambda}(z) = 1 + \frac{\beta_a(\lambda,z)}{\beta_m(\lambda,z)}$$

The aerosol optical depth (AOD) was also retrieved from the radiances measured by the Cimel Electronique CE318-1 automatic sun-tracking sun photometer. This instrument had seven filters centered at 340, 380, 440, 500, 675, 870, and 1020 nm. The spectral dependence (Angstrom exponent) of AOD is important for modeling the radiative effects of aerosols on the Earth/atmosphere system and is related to the aerosol size distribution which is defined as:

$$\alpha = -\frac{d\ln AOD(\lambda)}{d\ln\lambda}$$

References

Haywood, J. and O. Boucher, 2000: Estimates of the direct and indirect radiative forcing due to tropospheric aerosols: A review, *Reviews of Geophysics*, **38**, 513–543.

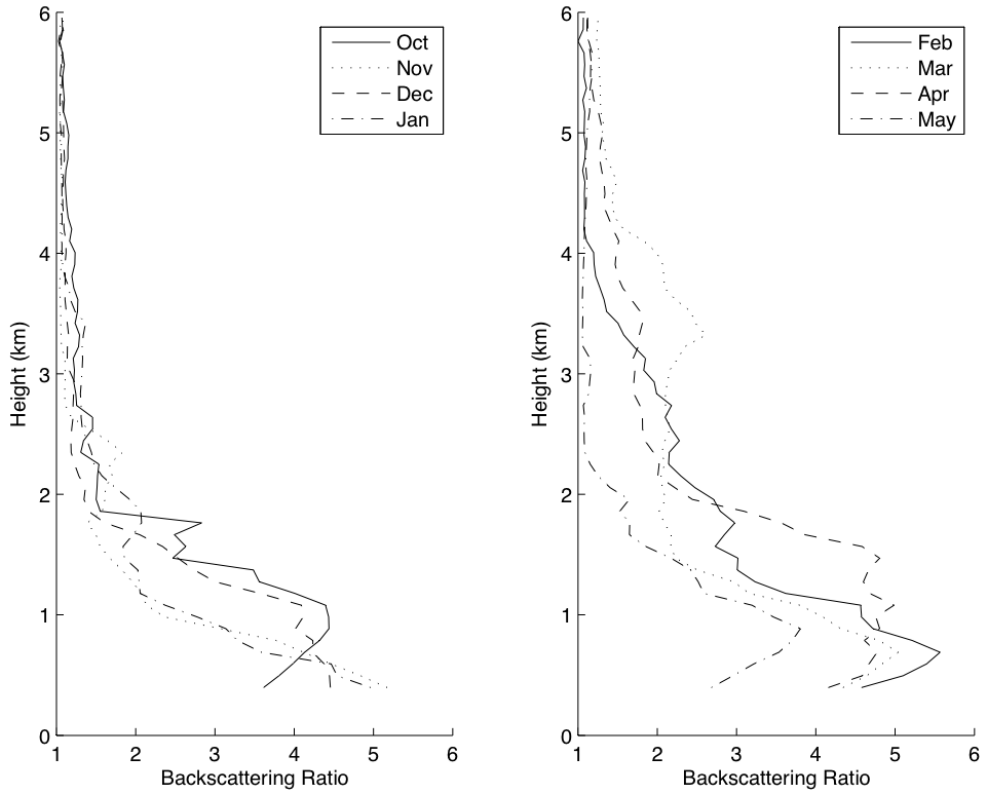

Figure 1. Monthly averaged vertical distribution of aerosol backscattering ratios measured by lidar at winter (Oct-Jan) and spring (Feb. May).

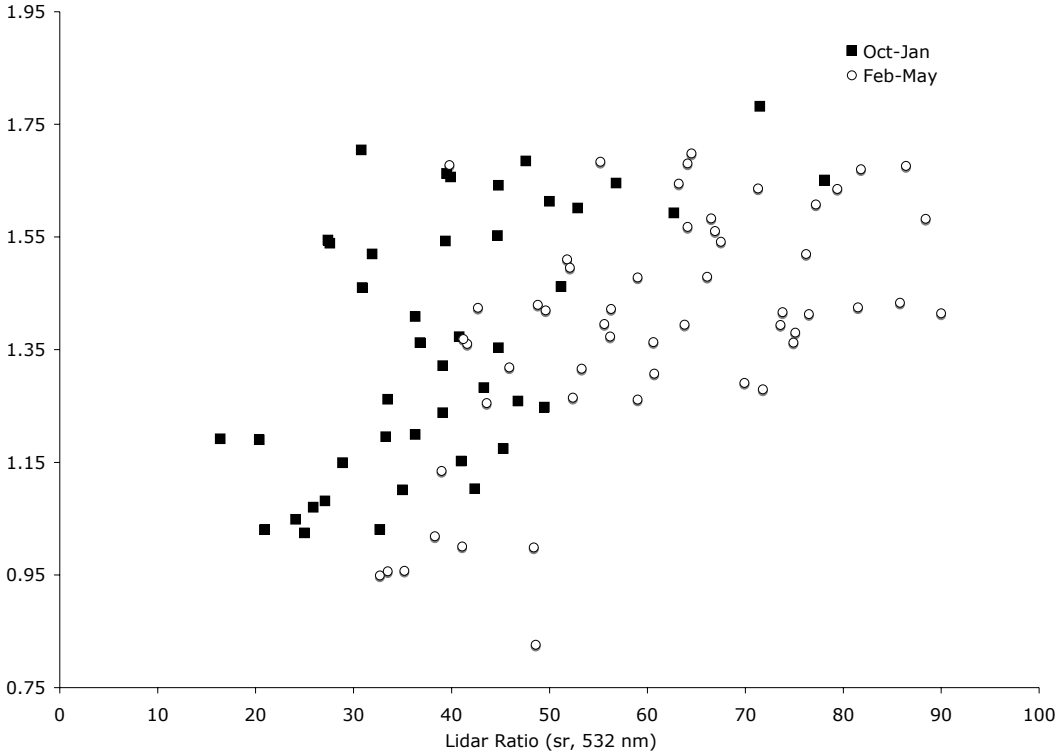

Figure 2. Scatter diagram of CIMEL angstrom exponent versus lidar ratio for the winter and the spring periods.

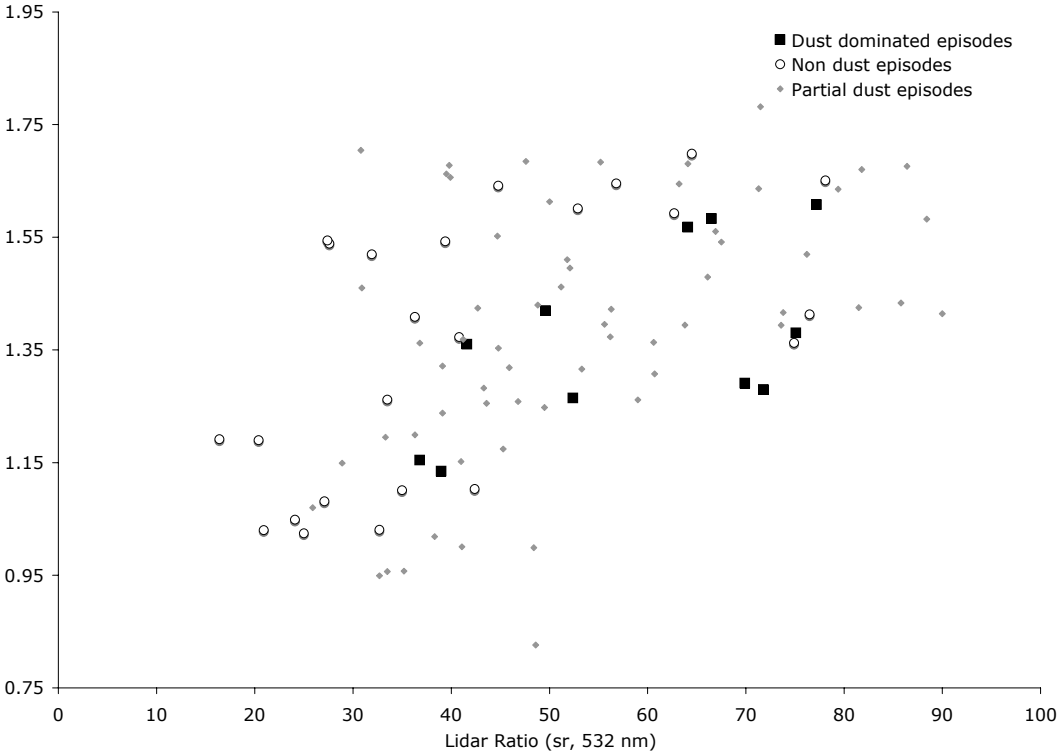

Figure 3. Same as Figure 2 but categorized by AOD fraction of Asian dust.