COMPARISON OF VERTICAL EXTINCTION PROFILES OBTAINED FROM 2 GROUND-BASED MIE-SCATTERING LIDARS AT GOSAN, KOREA DURING ABC-EAREX2005

Man-Hae Kim[(1)], Soon-Chang Yoon[(1)], Sang-Woo Kim[(1)], Nobuo Sugimoto[(2)], Atsushi Shimizu[(2)]

[(1)] *School of Earth and Environmental Sciences, Seoul National University, San 56-1, Sillim-Dong, Gwanak-Gu, Seoul 151-747, Korea, E-mail: askgo@air.snu.ac.kr; yoon@snu.ac.kr; kimsw@air.snu.ac.kr*
[(2)] *Atmospheric Environment Division, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba 305-8506, Japan, E-mail: nsugimot@nies.go.jp; shimizua@nies.go.jp*

ABSTRACT

We present intercomparison results of range-corrected lidar return signals as well as vertical aerosol extinction profiles determined from two mie-scattering lidars, Seoul National University Micro Pulse Lidar (SNU-MPL) and National Institute for Environmental Studies Lidar, at Gosan, Korea during ABC-EAREX2005 campaign. The vertical profiles of backscatter and extinction were retrieved dependently from SNU-MPL and NIES lidar systems by using a same retrieval algorithm, and by assuming a constant value of an altitude-independent extinction-to-backscatter ratio. We find good agreement between two systems that the systematic errors associated with the measured vertical profiles of tropospheric aerosols with lidar system is 12 ~ 18 % at visible wavelength, though there is no definitive proof that one of the methods is fundamentally flawed.

1. INTRODUCTION

Extensive measurements of the vertical profile of tropospheric aerosol extinction and reduction of its uncertainty have been drawn a strong attention in recent years from the climate research groups in the context of the radiation budget and atmospheric thermodynamics (i.e., heating/cooling rates) [Kim *et al*., 2004; Schmid *et al*., 2006; Won *et al*., 2004].

Within the framework of the Atmospheric Brown Cloud (ABC)-East Asian Regional Experiment 2005 (EAREX2005), an intercomparison experiment between ground-based lidars, which is one of obvious ways to measure the vertical profile of ambient aerosol extinction, was performed at Gosan, Korea from March to June, 2005. In this study, we present intercomparison results of range-corrected lidar return signals as well as vertical aerosol extinction profiles determined from co-located two mie-scattering lidars. We also discuss the source of discrepancies and suggest what factors might help to reduce them.

2. OBSERVATIONAL EXPERIMENT AND METHODOLOGY

ABC-EAREX2005 intensive observation period (IOP) yields one of the best suited measurement sets obtained from the Seoul National University (SNU)-Micro Pulse Lidar (MPL) and the NIES lidar to assess our ability to measure the vertical profile of tropospheric aerosol extinction. The SNU-MPL is a single channel (523.5 nm), and is permanently deployed at the ABC Gosan site, as part of the NASA Micro Pulse Lidar Network (MPL-NET). The NIES lidar is two-wavelength (532 and 1064 nm) Mie-scattering lidar with the depolarization ratio measurement channel at 532 nm. The SNU-MPL utilizes a high-repetition micro-pulse Nd:YLF laser and a photon counting receiver system. Contrary to the SNU-MPL, the NIES lidar employs a giant pulse Nd: YAG laser and an analog detection system. However, it should be noted that vertical profiles of backscatter and extinction were retrieved dependently from SNU-MPL and NIES lidar systems by using a same retrieval algorithm, referred to as the Fernald method [Fernald *et al*., 1974], and by assuming a constant value of an altitude-independent extinction-to-backscatter ratio (~ 50 Sr). The SNU-MPL obtained the vertical extinction profile every 1 minute with 75 m vertical resolution, but NIES lidar made every 10 minutes with 6 m vertical resolution. For intercomparison, therefore, we averaged the SNU-MPL data for 10 minutes and NIES lidar data for 30 m altitude.

3. RESULTS AND DISCUSSION

Fig. 1 represents comparisons of the vertical profiles of range-corrected lidar signals between SNU-MPL and NIES lidar system on May 25 and May 27, 2005, respectively. It is impossible to compare the absolute value of range-corrected signals due to the different lidar system. Plotting the profiles of range-corrected intensity, however, allows a visual evaluation on a profile-by-profile basis. The vertical variations of SNU-MPL signals in Fig. 1 are in good agreement with the NIES lidar measurements.

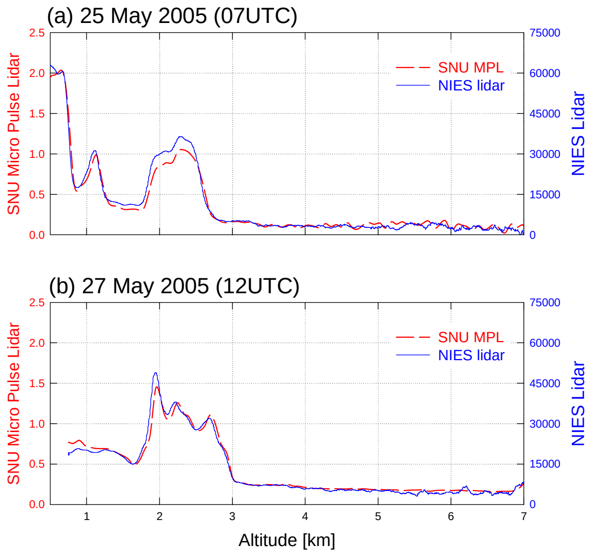

Fig. 1. Vertical profiles of range-corrected lidar return signals measured by SNU-MPL and NIES lidar systems on (a) 25 May 2005 and (b) 27 May 2005 at Gosan, Korea. We note that the vertical axis is arbitrary unit.

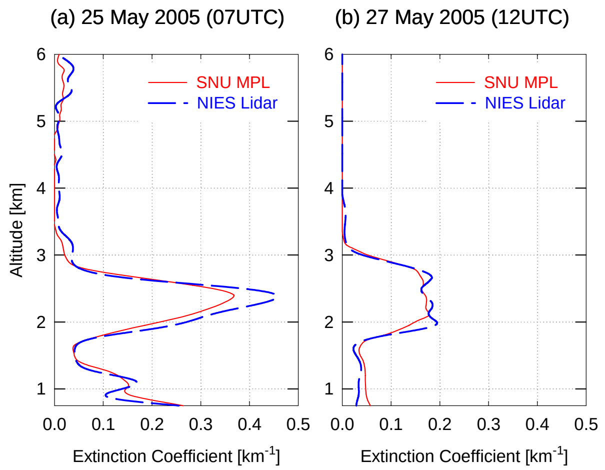

Fig. 2. Vertical profiles of aerosol extinction coefficient retrieved by the same Fernald inversion algorithm with 50Sr for SNU-MPL (523.5 nm) and NIES lidar (532 nm) systems on (a) 25 May 2005 and (b) 27 May 2005 at Gosan, Korea.

Both in Fig. 1(a) and 1(b), SNU-MPL indicates lower aerosol signal in elevated aerosol layers above 2 km, but slightly higher values below 2 km. This may be an effect of inadequate corrections for SNU-MPL afterpulse, and/or due to overlap of MPL (field of view: 1 mrad) and/or NIES lidar (field of view: 100 rad) system. The propagation of this discrepancy into aerosol extinction coefficient is assessed in Fig. 2.

Fig. 2 shows the vertical profiles of aerosol extinction coefficient, derived from the range-corrected lidar signals depicted in Fig. 1 by using a same Fernald lidar inversion algorithm. The two data sets show good agreement for the vertical distribution of aerosol layer including fairly thin layers. The absolute magnitudes of aerosol extinction coefficient for the aerosol layer generally agreed within 0.010 ~ 0.015 km^{-1}, except for the peak of the aerosol layer (0.021 km^{-1}) in Fig. 2(a). As discussed above, the differences in range-corrected signals between SNU-MPL and NIES lidar systems translated into the discrepancy in aerosol extinction coefficient, especially for the centre of the aerosol layer and below 2 km altitude.

In this study, we conclude that the systematic errors associated with the measured vertical profiles of tropospheric aerosols with lidar system is 12 ~ 18 % at visible wavelength, though there is no definitive proof that one of the methods is fundamentally flawed. This result is well consistent with the results of current state-of-the-art instrumentations, 15 ~ 20% discrepancy, reported by Schmid *et al.* [2006].

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