S2-1 Lidar Network Observation of Asian Dust over Japan in 1999 Spring

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http://info.nies.go.jp:8094/kosapub/

1. Introduction

We have continued the lidar network observation of Asian dust in Japan in the spring of 1999. This is a voluntary-organized network oriented for the observation of Asian dust, which is named as LINK-J for convenience. The employed instruments are mainly, lidar, sky radiometer, and optical particle counter (OPC). Parts of the results in 1998 spring have been reported (Murayama et al, 1998). Figure 1 shows the participated sites in the campaign of 1999.

Here we present some results during the campaign in 1999. In general, we have not observed large Asian dust events like occurred in the last year; the Asian dust events in April 1998 were so huge that they reached US West Coast. However, as in usual we have often observed Asian dust layers afloat and experienced few Yellow-sand episodes. One of such events was occurred at the beginning of March 1999.

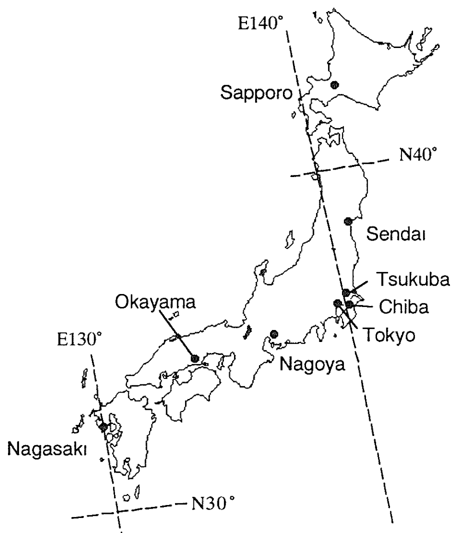

Figure 1.Observation sites of LINK-J in 1999.

2. Yellow sand event at the beginning of March, 1999

2.1 Network observation

Figure 2 shows a quick look image of the time to height indication of range-corrected lidar-backscattered signal obtained by the NIES compact Mie-lidar (λ=532 nm) at Tsukuba, which has been continuously operated. Descending process of Asian dust is clearly seen during the midnight of March 1-2. Similar process was also recorded in Tokyo. The scattering ratio of the dust layer was more than 5 and the total depolarization ratio was exceeded 20% at the peak, respectively. The hornlike development of dust layer seems to be typical. This event subsequently continued until March 4. The data obtained at Okayama and Nagoya during on March 3 are shown in Figure 3 and 4, respectively. The floated dust layer around 2 km in height in Figure 3 was also recognized in around 3 km Figure 2. High depolarization ratio of the layer was confirmed over

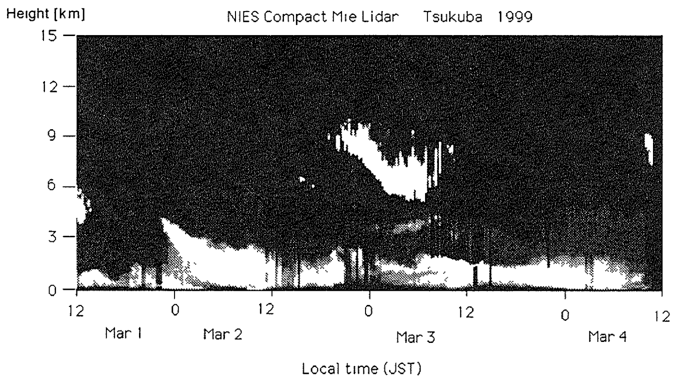

Figure 2. Quick look image of lidar backscattering profiles during March 1-4, 1999 over Tsukuba.

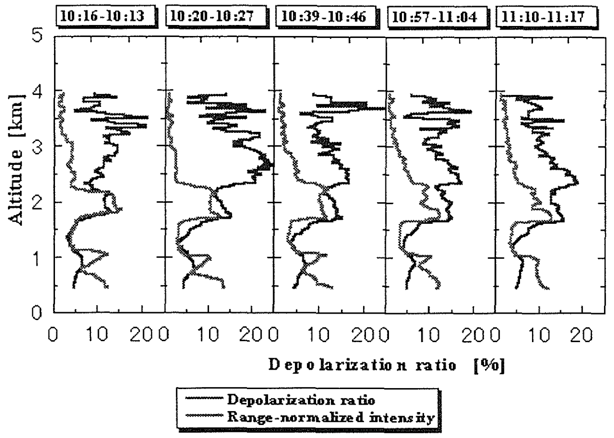

Figure 3. Polarization lidar data at Okayama on March 3, 1999.

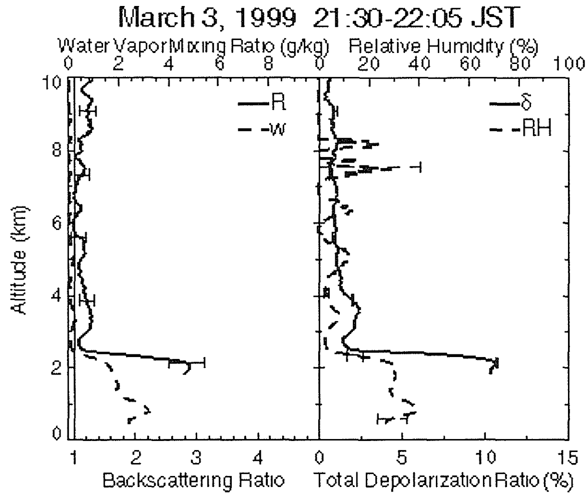

Figure 4. Mie-Raman Lidar data at Nagoya on March 3, 1999.

Tokyo at the similar time. Raman lidar is a powerful method to derive quantitative optical parameters of aerosols and water vapor concentration (Sakai et al., 1997). A result of Mie-Raman Lidar observation at Nagoya was shown in Figure 4. The main dust layer occupied below 2.5 km in altitude and mixed with boundary-layer aerosols.

2.2 Descending process to boundary layer

During the event described above, we have found that the penetrating process of the dust layer to the boundary layer was not uniform and strongly related with the development of the mixed layer. For example, the real-time simultaneous observation of

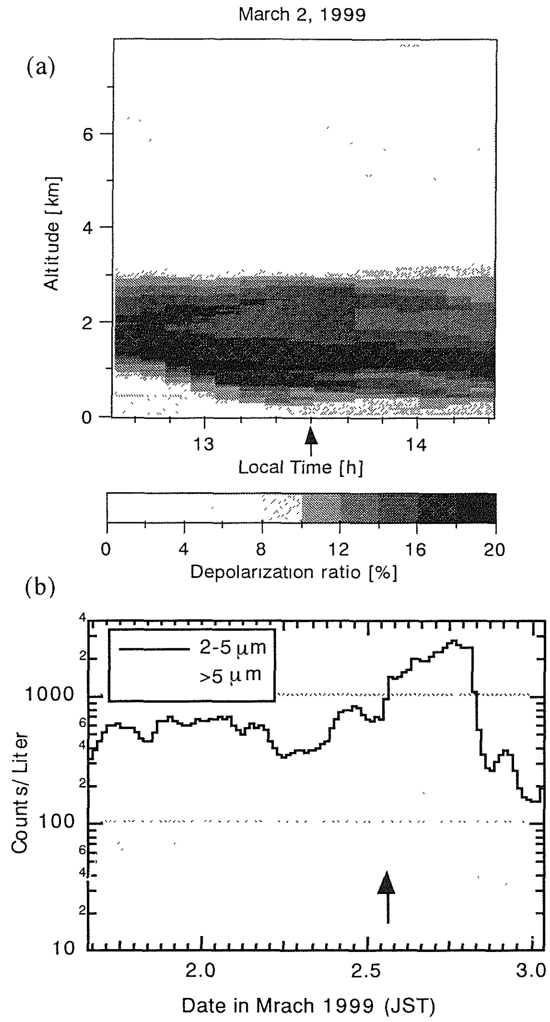

Figure 5. Descent of dust layer in the boundary layer on March 2, 1999 at Tokyo. Time series of (a) Lidar depolarization ratio vertical profile and (b) number of large particles counted by optical particle counter. The arrow indicates the time when the dust reached the ground level.

Asian-dust descending process by lidar and OPC at Tokyo on March 2nd is shown in Figure 5. Around 1330 LT the dust layer was finally merged with the boundary layer, although the major dust layer was already fell at several hundred m level at 0700 LT. However, it took more several hours to reach the ground level. This effect is considered as due to the inversion effect formed over the boundary layer. When the mixed layer has well developed and the lid was broke up, the dust layer over the mixed layer finally could fall into the boundary layer. The process is clearly seen the depolarization ratio and the optical particle counter observation at ground level as shown in Figure 5. Same phenomenon was also observed on March 4, but the occurrence was much earlier, i.e., at 0900 LT. The timing of merging process should depend on the strength of the inversion and mixed-layer developing process.

3. Mie-Raman lidar observation of Dust layer

High spectral resolution lidar and Mie-Raman lidar are advanced lidars which enable us to obtain quantitative optical properties with less ambiguity (Ferrare et al., 1998, Liu et al., 1998). We have tried to derive the extinction to backscatting ratio, so-called lidar ratio (S1) of the Asian dust since 1998 spring. S1 is an important parameter for the retrieval of the extinction from Mie-Rayleigh signal. And it is also considered as an effective optical property to characterize the tropspheric aerosols. Especially, the lidar ratio of dust layer is expected to be different from calculated value from Mie theory with information of the size distribution due to the non-sphericity (Nakajima et al., 1989). A preliminary result on May 1st, 1999 obtained at TUMM Mie-Raman lidar was indicated in Figure 6. The Raman signal (λ=607.3 nm) from nitrogen molecules exited by the emitted laser (λ=532 nm, E_p=100 mJ) was detected by the single photon counting. The narrow and dense dust layer was observed between 4 and 5km and two more thin layers existed in upper altitudes. The derived particle depolarization shows that the non-sphericity of the upper thin dust layer is similar as the lower dense dust layer, i.e., 30-35% in particle depolarization ratio. We can not find a significant difference in the lidar ratio between the dust layer and the usual tropospheric aerosols (low depolarization aerosols) in this example: the average value of S1 of the dust layer is 42.7±6.3 and the one of the lower tropspheric aerosols is 41.5±13.1. We need more systematic study on S1 measurement for Asian dust layer.

4. Discussion and Summary

We have established a voluntary network for Asian dust events since 1997. Various aspects and patterns of passage and descending process of Asian dust over Japan have been become apparent. Vertical profiles of dust obtained by lidar are now used to validate model calculations (Uno, 1999, Westphal and Liu, 1999).

Lidar and OPC combination was useful to detect the instant of the dust layer to penetrate into the boundary layer. It is an interesting to study what happen when the dust merged with urban aerosols. Dr. Chun et al. (1999) have found that the number of fine particles decreased during yellow-sand events in Korea, which is considered as a result of coagulation. Similar tendency was previously reported in the Asian dust event at Nagasaki (Tanaka et al., 1989)

It is likely that optical properties of dust aerosols obtained by advanced lidars like lidar ratio and wavelength dependence of backscattering signatures not only depolarization fairly differ from the other tropospheric aerosols. Thus these measurements should be continued in the following campaigns.

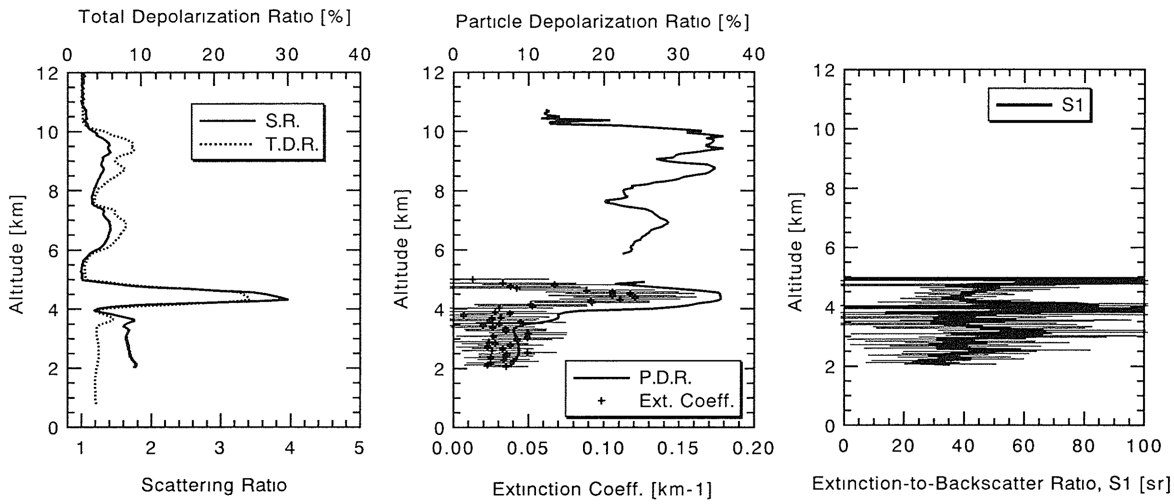

Figure 6. Mie-Raman lidar observation at TUMM/Tokyo on May 1st, 1999.
The integration time is between 19:34-21:59 LT.

5. Acknowledgements

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