7.8 Lidar observations of clouds and aerosols

(1) Personnel

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(2) Objectives

Objectives of the observations and experiments in this cruise are

- to study distribution and optical characteristics of dust and other aerosols using a two-wavelength dual polarization lidar,
- to study microphysical parameters of ice clouds and thin water clouds with the combination of the lidar and the cloud profiling radar,
- to study a new polarization bistatic lidar method for measuring cloud particle size of lower water clouds.

(3) Measured parameters

- Vertical profiles of backscattering coefficient at 532 nm and 1064 nm.
- Vertical profile of depolarization ratio at 532 nm.

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength dual polarization lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 100 mJ per pulse at 1064 nm and 50 mJ per pulse at 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 25 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a digital oscilloscope and stored on a hard disk with a computer. The lidar system was installed in a 20-ft container with the cloud profiling radar (CPR) of the Communications Research Laboratory (CRL). The container has a glass window on the roof, and the lidar was operated continuously regardless of weather.

The experiment on the bistatic lidar method was performed with an additional receiver installed at a distance of 14 m from the lidar transmitter. The bistatic receiver detects backscatter from the lower clouds at a scattering angle of about 179 deg. Clouds particle size is derived from the ratio of signal intensity of two polarization components.

(5) Results

Figure 1 shows the quick-look time-height indication of the range-corrected signal during the cruise.

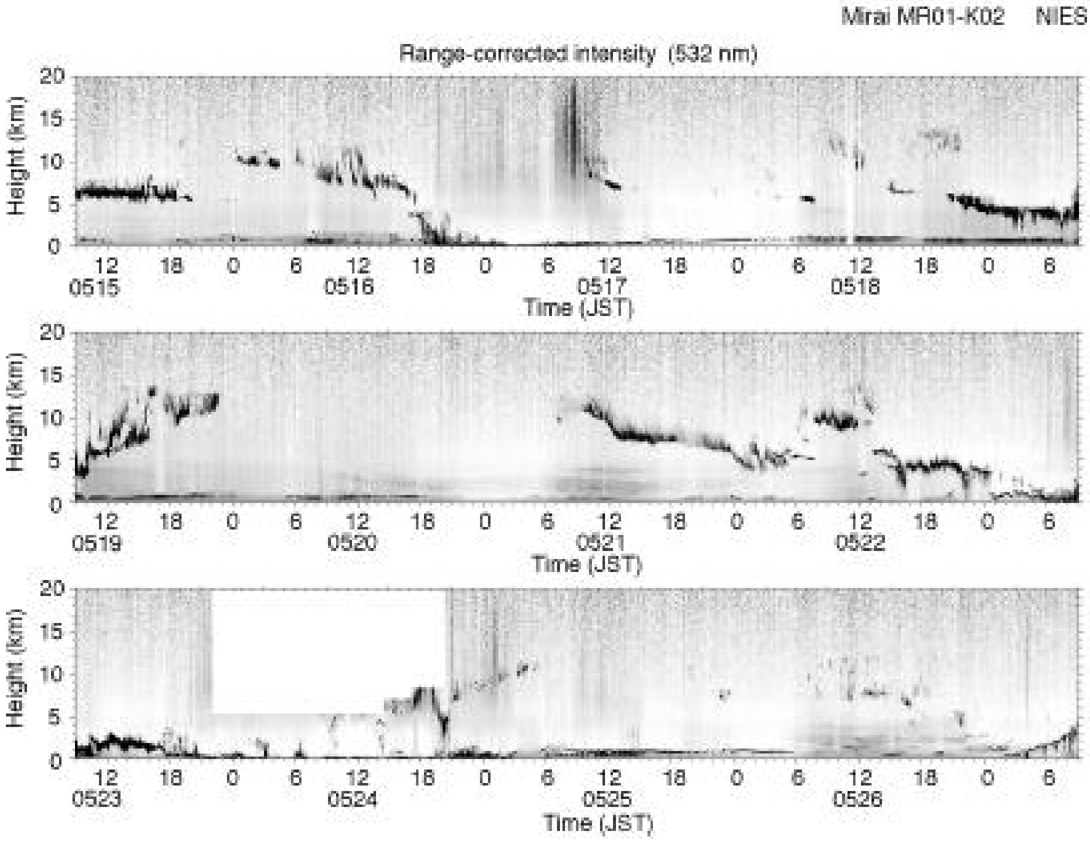

Fig. 1 Range-corrected signal at 532 nm.

Various types of clouds are observed. Structures accompanied by warm front and cold front are seen on May 22-23 and 24, respectively. Rain from the melting layer at about 4 km altitude is seen on May 22 and 24.

Notable features about aerosols are the layers observed during May 19-22, and on May 26. The depolarization and two-wavelength data show that the upper part (> 2km) of the plume observed during 8:00-15:00 of May 21 is mostly dust aerosols. The lower part is mostly sulfate or other small spherical aerosols. The aerosol layers observed on

May 26 are mostly dust. But the high-density part observed at 10:00-14:00 below 2 km is not dust.

The experiment on the bistatic lidar was performed on May 19, 20 and 25. The result of the preliminary analysis shows that there is difference between convective cumulus and stratus in spatial distribution of particle size in the cloud.

(6) Data archive

- raw data

  lidar signal at 532 nm (parallel polarization)

  lidar signal at 532 nm (perpendicular polarization)

  lidar signal at 1064 nm

  period 05140738-05272400 (UTC), continuous

  temporal resolution 10 sec.

  vertical resolution 6 m.

- processed data

  cloud base height, apparent cloud top height, cloud phase

  cloud fraction

  boundary layer height (aerosol layer upper boundary height)

  backscatter coefficient of aerosols

  depolarization ratio