Development of a water vapor Raman LIDAR for boundary layer observation

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We have developed a portable Raman lidar system for profiling water vapor which is one of the most important atmospheric properties in the tropospheric weather system. Water vapor Raman lidars usually use a large power laser and the mobility is limited. However, our new lidar system is a compact and transportable system by using small Nd:YAG laser (SHG:532 nm, 30 mJ, 20 Hz) by focusing on boundary layer measurements up to 3 km. The received lights collected with a 35.5 cm telescope are measured by photon counting system for elastic (532 nm), N_2 Raman (607 nm) and H20 Raman (660 nm) signals, respectively. The weight of the major component of the system is about 75 kg with a dimension of 50 cm x 50 cm x 150 cm, and the system is transportable with a two person by means of a vehicle.

In the night time profiling observation, we estimated the error in humidity is smaller than 20 % up to 2 km height by 45 minutes and 200 m integration. This precision is enough for unattended humidity profiling planned for the humidity observations in the Asia monsoon region.

Horizontal distribution of waver vapor was observed for the night time, at Shigaraki MU observatory over the national forest. Between the distance of 400 m and 3500 m, humidity variations of an amplitude of 10 % with a horizontal scale of about 200 m were detected, correlated with variations of aerosol backscatter ratio. This suggests possibility of studying horizontal distribution of minor constituents over the forest.

We observed the volcanic gas at Mt. Aso by installing the lidar in a vehicle. Water vapor mixing ratio in the gas was 0.4 g/kg larger than that of background atmosphere (4.5 g/kg). This observation showed both the possibility of application to the volcanic study and the mobility of the developed lidar system.

To summarize, we have successfully developed a portable waver vapor Raman lidar system useful for various research regions such as meteorological, forest, and volcanic studies.

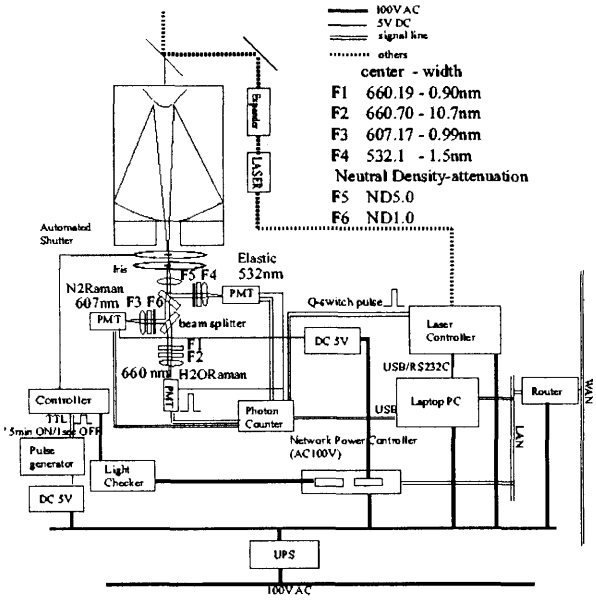

Figure 1. The block diagram of the Raman lidar system.

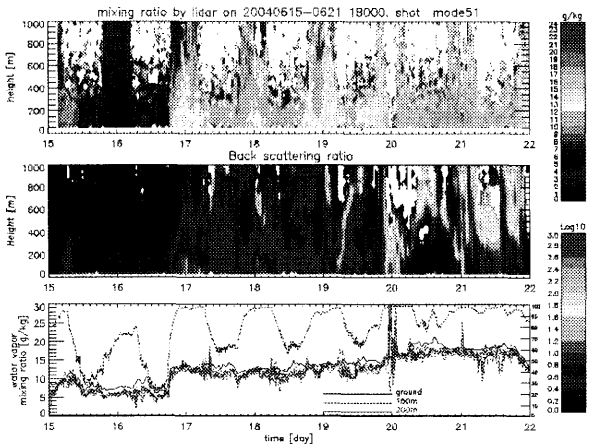

Figure 2. Time-height variations of (top) water vapor, (middle) backscatter ratio (aerosol) and water vapor mixing ratio at 200 m, 150 m, ground level with relative humidity (bottom).