Development of portable Raman lidars and application to field observations

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Atmospheric lidar (laser radar) is a technique of measuring atmospheric parameters by transmitting a laser beam and receiving scatter from the atmospheric molecules or aerosol/could particles. It is an active remote sensing technique which can observe temperature, aerosol characteristics, atmospheric constituents, wind velocities, etc., as a function of range. We started lidar observation at Shigaraki MU observatory, Shiga, Japan, in 2000, and have been observing atmospheric temperature in the troposphere, stratosphere and mesosphere, and water vapor mixing ratio (humidity) in the troposphere. The Raman scatter from the atmosphere, with a Raman shift of wavelength according to the species of molecules, is useful in measuring density of different atmospheric constituents. However, the scattering signal intensity is weaker by a factor of 10^3 to 10^6 or even more, and therefore the system needs high power laser and large aperture telescope. In order to study distribution and variation of water vapor mixing ratio at a various observation field, we have developed a couple of portable Raman lidars by limiting the observational range. The first portable Raman lidar system with a Q-switch pulsed Nd;YAG laser (532 nm, 0.6W) and a 35.5 cm Cassegrain telescope was developed in order to monitor water vapor mixing ratio at 200 m altitude for 24 hours a day in day and night. This lidar was also applied to profile water vapor mixing ratio up to 4-5 km at night. Not only vertical profiles, but horizontal humidity distribution over the natural forest around Shigaraki as well as water vapor in volcanic plumes at Mt. Aso has been successfully measured and its capability for field experiment has been proved. This system can be transported by a one-box type vehicle and can be operated with a power generator. Currently, this lidar is located at NiCT Ohgimi observatory in Okinawa and has been profiling water vapor in the sub-tropical region for more than one year. The second system has been developed in order to be carried only with man power without a vehicle. High sensitive GaAsP photomultiplier tubes could reduce the telescope size down to be 20.3 cm diameter without degrading the sensitivity. The system is mounted on the tripod and beam direction could be steered easily in azimuth and elevation. Small batteries and inverters can be used as a power source. The system has now finished a test observation in Mt. Aso, and will be used at other volcanoes where a vehicle is not accessible, as well as at the fields of the forest region where monitoring of atmospheric dynamics and substantial transport has been carried out. Such a portable lidar system would be applied to observation in the various fields where no past observations have been made.

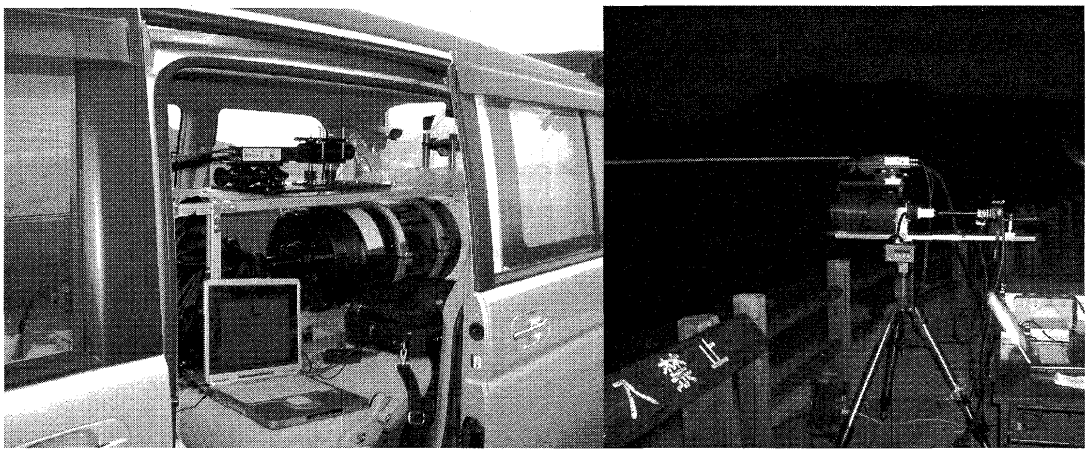

Fig. 1 (Left):The first portable Raman lidar on board a vehicle. (Right):The second portable lidar.