POSSIBLE USE OF IODINE ABSORPTION/FLUORESCENCE CELL IN HIGH-SPECTRAL-RESOLUTION LIDAR

Nobuo Sugimoto, **Yoshitaka Jin, Tomoaki Nishizawa**

National Institute for Environmental Studies, Tsukuba, Japan, E-mail: nsugimot@nies.go.jp

Iodine absorption cell is often used as a blocking filter in the Rayleigh scattering receiver of high-spectral-resolution lidar at 532 nm to remove Mie-scattering component of the lidar backscattered signal. The light absorbed by the iodine cell is usually not used, but a part of the absorbed light is emitted as fluorescence. We experimentally studied the possibility of using the fluorescence to detect the Mie-scattering signals (Sugimoto et al., Appl. Opt. 60, 3617-3622, 2021). Although the sensitivity was limited by the low collection efficiency of the fluorescence from the iodine cell, we succeeded in obtaining the lidar Mie-backscattering profiles using the fluorescence. In this presentation, we describe our progress in improving the performance of the iodine fluorescence detector and discuss possible applications where this approach may have advantages.

The efficiency of the iodine fluorescence detector is determined by the fluorescence quantum efficiency and the optical efficiency of collecting fluorescence. The quantum efficiency was estimated to be ~0.1 from the measured fluorescence lifetime of 0.18 μs and the radiative lifetime of 2.3 μs estimated from the literature. The efficiency of collecting fluorescence in the experimental system was very low (~0.008). The fluorescence collecting efficiency, however, can be improved by using an integrating sphere or using an array of detectors surrounding the iodine cell. It was also shown in the experiment that about ~1/2 of the Rayleigh (Cabannes) scattering component was absorbed by the cell due to the spectral width of the iodine absorption line.

In the method using an array of detectors surrounding the iodine cell, we may use the dependence of the excitation spectrum on the light penetration depth in the cell. The Mie scattering and the central part of the Cabannes line are absorbed quickly in the cell, and the fluorescence intensity decreases rapidly with the penetration depth. However, the wing part penetrates longer. Using this difference we can detect, in principle, the Mie and Rayleigh components with the fluorescence detector only.

The method using the fluorescence from iodine cell may be useful, for example, for detecting very low density aerosols having very low Mie to Rayleigh scattering ratio. The advantage of this method compared with the interferometric methods is that a narrow spectral bandwidth is obtained without large angular dependence.