Evaluation of Atmospheric Pressure on the Temperature Measurement Method by Three-Wavelength CO_2 DIAL

Yasukuni Shibata [(1)], Chikao Nagasawa [(1)], Makoto Abo[(1)]

[(1)] *Tokyo Metropolitan University, 6-6, Asahigaoka, Hino, Tokyo, Japan, sibata@tmu.ac.jp*

Measurements of the lower troposphere temperature profiles are useful for monitoring the temperature inversion layer, the planetary boundary layer, the mixing ratio of gas molecules, etc. We have developed a differential absorption lidar (DIAL) system with three laser wavelengths selected on a single CO_2 absorption spectrum in the 1.57 μm wavelength region for atmospheric temperature measurement. The CO_2 absorption spectrum has dependences on temperature and pressure. When we conduct the temperature profile measurements by this three-wavelength DIAL, we must assume the pressure profile over the Tokyo Metropolitan University (TMU) lidar site. Since the CO_2 density profile is unknown, the CO_2 density is measured from the lidar signals of the λ_{on} and λ_{off} pair. The online wavelength λ_{on} is tuned at the peak of the absorption spectrum, and the off-line wavelength λ_{off} is tuned on the weak absorption area around the λ_{on}. Similarly, the CO_2 density is also measured from the lidar signals of λ_{on} and the third wavelength λ_T, which is located additionally at an intermediate position between the λ_{on} and λ_{off} of the single CO_2 absorption spectrum. The atmospheric temperature is given by the temperature where the solutions of both CO_2 densities match.

The discrepancy between the assumed atmospheric pressure and the actual atmospheric pressure is one of the error sources for the atmospheric temperature measurement. The atmosphere pressure profiles can be obtained actually from (a) radiosonde observations, (b) barometric formula, and (c) objective analysis closest to the TMU lidar site (35.66 N, 139.37 E). The closest Tateno radiosonde station to the TMU lidar site is about 90 km away. Moreover, the frequency of the radiosonde observation is insufficient for our lidar observation duration. Therefore, it is considered that the atmospheric pressure profiles obtained from the barometric formula or the objective analysis are more reliable than those obtained from the Tateno radiosonde to estimate the atmospheric pressure profiles over the TMU lidar site.

We evaluate the measurement accuracy for these atmospheric temperature profiles by using simulation. The results suggest that NCEP GDAS/FNL analysis data are useful for measuring temperature by the three-wavelength DIAL at the TMU lidar site. The temperature error is less than 0.4 °C up to an altitude of 5000 m.