

Atmospheric NO₂ Measurements in Dalian City by Employing a Continuous-wave Differential Absorption Lidar

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Differential absorption lidar (DIAL), as a powerful active remote sensing tool, has been widely utilized for remote sensing of atmospheric trace gases. However, conventional NO₂-DIAL technique based on the time-of-flight principle requires a narrow-band tunable high-energy pulsed laser source (e.g., dye laser) operating at around 450 nm for differential absorption measurements, which has been a great challenge for field applications owing to the optical complexity and frequent change of dye, etc. In this work, we propose and develop a continuous-wave differential absorption lidar system (CW-DIAL) based on the Scheimpflug principle for nitrogen dioxide (NO₂) monitoring. The DIAL technique utilizes a low-cost high-power multimode 450-nm (1.6-W) laser diode as the laser source and an image sensor as the detector, which cannot only substantially reduce the system cost but also the maintenance during field operations comparing with the conventional DIAL technique. The laser diode can fast switches the emission wavelength between the on-line and off-line wavelengths by tuning the injection current, while the atmospheric echoes are recorded by a CCD image sensor. Meanwhile, a high-precision spectrometer measures the laser spectrum during measurements for real-time calibration of the NO₂ differential absorption cross section. The CW-DIAL system has been used for long-term continuous observation of NO₂ concentration under a near-horizontal path in the urban area of Dalian City. It has been found out that the measured NO₂ concentration was in good agreement with the data recorded by a nearby national pollution monitoring station. The detection sensitivity can reach up to about 2 µg/m³ with a range resolution of 500 m. The CW-DIAL technique demonstrated in this work opens up great possibilities for remote sensing of atmospheric NO₂.

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