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Remote sensing of atmospheric trace gases by diode laser spectroscopy

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Gaseous ammonia is the most abundant alkaline trace gas in the atmosphere. In order to study its role in acid deposition and aerosol formation, as well as its influence on the regional air quality and atmospheric visibility, several instruments has been developed based on TDLAS (Tunable Diode Laser Absorption Spectroscopy) techniques. In this paper, a long open path TDLAS system and a continuous-wave CRDS (Cavity-Ring down Spectroscopy) system are presented.

The long open path system has been developed for NH3 in-situ monitoring by combining wavelength modulation with harmonic detection techniques to obtain the necessary detection sensitivity. The prototype instrument has been used to monitor atmospheric NH3 concentration at an urban site near Beijing National Stadium during Beijing Olympics in 2008, and recently used to measure the fluxes of NH3 from farm fields by flux-gradient method. The detection limit for ammonia is proved approximately 3ppb for a total path length of 456m.

The continuous-wave, rapidly swept CRDS system has been developed for localized atmospheric sensing of trace gases at remote sites. Passive open-path optical sensor units could be coupled by optical fiber over distances of >1 km to a single transmitter/receiver console incorporating a photodetector and a swept-frequency diode laser tuned to molecule-specific near-infrared wavelengths. A noise-limited minimum detectable mixing ratio of $\sim$11 ppbv is attained for ammonia at atmospheric pressure.

The developed instruments are deployable in agricultural, industrial, and natural atmospheric environments.