Geophysical Research Abstracts
Vol. 16, EGU2014-2937, 2014
EGU General Assembly 2014

Atmospheric CO_2 measurement using dispersive infrared spectroscopy with a scanning Fabry-Pérot interferometer sensor

Ka Lok Chan (1), Zhi Ning (1), Dane Westerdahl (2), Ka Chun Wong (1), You Wen Sun (3), Andreas Hartl (1), and Mark Wenig (4)

(1) City University of Hong Kong, School of Energy and Environment, Hong Kong (kalokchan7-c@my.cityu.edu.hk), (2) Ability R&D Energy Research Centre, City University of Hong Kong, Hong Kong, (3) Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Hefei, China, (4) Meteorological Institute, Ludwig-Maximilians-Universität München, Munich, Germany

A novel infrared absorption spectroscopic based measurement technique was developed for atmospheric CO_2 measurement by using a new scanning Febry-Pérot interferometer sensor. The sensor measures the optical spectra in the mid infrared (3900nm to 5220nm) wavelength range with full width half maximum (FWHM) spectral resolution of 78.8 nm at the CO_2 absorption band (~4280 nm) and sampling resolution of 20 nm. The CO_2 concentration is determined from the measured optical absorption spectra by fitting it to the CO_2 reference spectrum. Interference from other major absorbers in the same wavelength range, e.g., carbon monoxide (CO) and water vapor (H_2O), was taken out by including their reference spectra in the fit as well. An iterative algorithm to account for the non-linear response of the fit function to the absorption cross sections due to the broad instrument function was developed and tested. The detailed descriptions of the instrumental setup, the retrieval procedure, a modeling study for error analysis as well as laboratory validation using standard gas concentrations are presented.

A modeling study of the retrieval algorithm showed that errors due to instrument noise can be considerably reduced by using the dispersive spectral information in the retrieval. The mean measurement error of the prototype DIRS CO_2 measurement for 1 minute averaged data is about $\pm$ 2.5 ppmv, and down to $\pm$ 0.8 ppmv for 10 minute averaged data. A field test of atmospheric CO_2 measurements were carried out in an urban site in Hong Kong for a month and compared to a commercial non-dispersive infrared (NDIR) CO_2 analyzer. 10 minute averaged data shows good agreement between the DIRS and NDIR measurements with Pearson correlation coefficient (R) of 0.99. A CO_2 episode observed during the measurement period was analysis by the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model. Result shows the air mass was recirculated in the region which indicates that the CO_2 episode may result from the accumulation of local emissions. A pronounced bimodal CO_2 diurnal profile was observed indicating the CO_2 concentration is mainly related to the increase in traffic load during the rush hours.