回折格子分光器を用いた小型・ローコストな太陽光分光カラム濃度測定装置の開発とその観測結果

Development of a portable, low-cost instrument using a grating spectrometer for atmospheric CO_2 column density measurements from solar spectra and observation results

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The ground-based observation of CO_2 column concentration which is performed by near-infrared spectroscopy of solar light (around 1600 nm) is very important. To obtain the CO_2 column concentration, the TCCON (Total Carbon Column Observing Network) uses a large FTS (Fourier spectrometer, Bruker 125HR wavenumber resolution ~ 0.01 cm^{-1}), some groups uses a small FTS (Bruker EM 27 resolution 0.5 cm^{-1}). Both of them had highly cost. In previous research, we used OSA (Optical Spectrum Analyzer wavelength swept type spectrometer, resolution 0.2 cm^{-1}) to obtain the CO_2 column concentration with lower cost.

In this study, we use a small size fiber spectrometer of a commercially available array type infrared sensor (Ocean Optics, NIRQuest, 1557-1625 nm resolution 1.0 cm^{-1}) and an equatorial mount for amateur astronomy (Kenko Sky Memo S). The wavelength resolution was confirmed as 1.0 cm^{-1} by entering a single mode semiconductor laser of 1570 nm. According to observations by the compact FTS (EM 27), the wavelength resolution was lower than that of the large FTS, but it can be measured with the same degree of precision on measuring the column concentration of CO_2. Although the resolution of this apparatus is a little lower than that of EM 27, According to laboratory simulation results by wu et al.(2013) show that it is possible to measure CO_2 column quantity with sufficient accuracy. FTS and OSA take several seconds to several minutes to interferometer drive and wavelength sweep, and disturbance due to the passage of thin clouds there between may cause distortion of the spectrum. Since this system uses an array type sensor, there is an advantage in that the entire area can be measured instantaneously. It can be observed even in cloudy weather. The sun tracking device is simple and easy to observe even in unstable places such as ships and automobiles. It was realized with a budget of about 1.8 million yen for the whole system such as spectrometer and automatic equatorial mount. Since it is sufficient for a budget of 1/50 or less of the large FTS and about 1/10 of the small FTS, this compact apparatus can be arranged in a large number. We used this instrument to conduct continuous solar spectrum observations at Nagoya University during one-month and calculated the XCO_2 column concentration. The observation result is still under analysis.

Finally, we are expecting it is possible to analyze the dynamics of CO_2 in urban areas from multipoint observations and not only in satellite verification at various places.

キーワード：二酸化炭素コラム、アレイ型赤外線センサ、低コスト

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