

3.106 Measurements of atmospheric CO₂ column concentration using compact solar spectrometers.

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Abstract:

Carbon dioxide (CO₂) is the most important anthropogenic greenhouse gas and has been proved having a great influence on the changing of global temperature. The satellite observation of CO₂ has become an important approach to obtain CO₂ concentrations. As the main ground-based data source for validating satellite retrievals, the Total Carbon Column Observing Network (TCCON) sites are sparsely distributed globally with fixed positions. To increase the density of observations, low-cost and compact remote-sensing instruments are used as a promising complement to the current techniques.

In this research, we used two types of ground-based compact solar spectrometers to measure the column-averaged dry-air molar mixing ratios of atmospheric CO₂ (XCO₂), one consists of a portable scanning grating optical spectrum analyzer (Yokogawa Electric, OSA AQ6370, resolution 0.2 cm⁻¹), and the other consists of a low-cost array detector type grating spectrometer (Ocean Optics, NIRQuest, resolution 1.0 cm⁻¹).

We measured the XCO₂ using the OSA in the central area of Tokyo during Sep. 2014–Aug. 2016. The results show that the high XCO₂ values were attributed to the large local emission sources and the OSA can well capture the seasonal and daily changes of XCO₂ in Tokyo area.

Because the OSA takes several seconds to several minutes to scan the wavelength range around 1.6 μm, the passage of thin clouds can distort the spectrum. We have developed a low-cost, smaller observation system using NIRQuest. Since this system uses an array type sensor, there is an advantage that the entire spectral range can be measured instantaneously. We used this instrument to conduct continuous solar spectrum

observations at Nagoya University during daytime of one-month and calculated the XCO_2 concentration. The observational results will be presented. Finally, we are expecting that it is possible to analyze the dynamics of CO_2 from multipoint observations using the compact solar spectrometer.