Development of photovoltaic-driven MAX-DOAS system (Eco-MAXDOAS)

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It is recognized that the Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) technique is suitable for routine observations of atmospheric constituents as its setup is simple, power consumption is low, and fully automated long-term operation without absolute radiometric calibration is possible. In addition, it is also a powerful technique with abilities enabling simultaneous measurements of aerosols and their gaseous precursors, such as nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). To exploit its further applications, we are developing the photovoltaic-driven MAX-DOAS system, called Eco-MAXDOAS. By utilizing the Eco-MAXDOAS, we expect to make multi-component air quality observations possible in areas with problems on stable power supply. For this development, we removed a temperature controller to reduce the power consumption. Instead, a shutter was introduced just before the entrance slit of the spectrometer. With this modification, it was made possible to take dark count measurements more often than for the normal MAX-DOAS instrument by closing the shutter between observations at different elevation angles. We tested the Eco-MAXDOAS and found that the spectrometer temperature varied by less than ±0.3 degrees for 3 minutes interval of changing elevation angles. Using dark count data taken before and after scattered sun light observations, the SNR was estimated to be about 10,000. This supports that analysis for a differential absorption as small as 10^{-4} (0.01%) is possible. In addition, we compared the aerosol and NO2 data retrieved from Eco-MAXDOAS and MAX-DOAS observations, and we confirmed that the two retrieved values were usually almost the same but occasionally showed significant differences. To investigate the cause, we devised the 4AZ-MAXDOAS system, a set of 4 MAX-DOAS instruments directed toward different azimuth angels of north, south, east, and west. The observation with the 4AZ-MAXDOAS confirmed that the data can show significant differences depending on the azimuth angle. We concluded that the differences were caused by the spatial inhomogeneity of atmospheric components, supporting the consistency between Eco-MAXDOAS and MAX-DOAS data.

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