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Development of photovoltaic-driven atmospheric observation instrument Eco-MAXDOAS

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Atmospheric aerosols are an important factor controlling the Earth's climate. However, their complicated formation mechanisms and effects on climate are poorly understood. Under these circumstances, the MAX-DOAS technique that enables simultaneous measurements of aerosols and their gaseous precursors, such as nitrogen dioxide (NO_2), has been developed by Chiba University. The MAX-DOAS technique can derive the vertical distribution and column amount for aerosols and gases by utilizing the inversion analysis of scattered sunlight spectra measured at multiple viewing elevation angles. When MAX-DOAS observations are made, the line of sight must be clear at all elevation angles selected for the observations. In addition, there is the need for sufficient electric power, limiting the observation site. To solve these limitations, we developed the new instrument, called Eco-MAXDOAS, using the photovoltaics as a power source. 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 changed by less than ± 0.3 degrees for 3 min. interval of changing elevation angles. Using dark count data obtained before and after a scattered sunlight observation was made, the SNR was estimated to be about 10000. This supports that analysis for a differential absorption as small as 10^{-4}(0.01%) is possible. In addition, we conducted continuous observations using 30-W and 60-W solar panels. When the 30-W solar panel was used, the Eco-MAXDOAS terminated in few days. On the other hand, using the 60-W solar panel prolonged the operation time period and the Eco-MAXDOAS worked continuously for over full test observation period of two weeks under usual weather conditions in winter. In this presentation, we also assess the performance for the Eco-MAXDOAS observation by comparing aerosol an NO_2 data retrieved from Eco-MAXDOAS and MAX-DOAS observations.

Keywords: MAX-DOAS, solar power, aerosol, nitrogen dioxide