Long-Term Observations of Planetary-Boundary-Layer Mean Sulfur Dioxide Concentrations by MAX-DOAS in Japan, Including the COVID-19 Pandemic Period

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Abstract

We conducted long-term observations of planetary-boundary-layer (PBL) mean sulfur dioxide (SO_2) concentrations by ground-based multi-axis differential optical absorption spectroscopy (MAX-DOAS) utilizing the ultraviolet region. The observations were made at five sites in Japan, namely Chiba, Sendai, Tsukuba, Kasuga, and Fukue. At Chiba, four MAX-DOAS instruments were operated simultaneously with four different viewing directions (i.e., north, east, west, and south). Back trajectory analysis clearly showed the dominance of SO_2 from volcanic eruptions at the Kasuga and Fukue sites located in western Japan. On the other hand, for Chiba, Tsukuba, and Sendai sites the analysis suggested the influence of power plants and factories around ports and coastal areas. At these urban and suburban sites, the highest SO_2 concentrations were less than 10 times the median value during the observation period. This suggests that volcanic eruptions have a greater impact on the daily mean SO_2 concentrations in Japan than anthropogenic sources in recent years. In addition, an interesting abrupt reduction in PBL SO_2 concentrations by 59% was detected. The decrease was probably due to the closure of a significant thermal power plant since September 2019 and decreased activity at a major steel mill because of lower iron demand during the COVID-19 pandemic since June 2020. Analysis of wind direction and speed at the Chiba site after 2022 showed that SO_2 concentration tends to be higher when winds blow from the southwest, suggesting the influence of thermal power plants located in the southwest direction of the Chiba site and ships on Tokyo Bay. In this presentation, we also assessed SO_2 changes during the COVID-19 pandemic by comparing actual observations and a business-as-usual scenario built by a machine-learning approach.

Early Career Scientist

YES, I am an early career scientist.

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