$PM_{2.5}$ vertical concentration observations using a drone based on comparison of $PM_{2.5}$ concentration data with small sensor and atmospheric environment measurement station data

*Takashi Chiba[1], Masatsugu Kodate[1], Osamu Kiguchi[1], Makoto Inoue[1], Hirokazu Madokoro[2], Takeshi Nagayosi[1]

1. Faculty of Bioresource Sciences, Akita Prefectural University, 2. Faculty of Systems Science and Technology, Akita Prefectural University

Atmospheric particulate matter of size of 2.5 μm or less are denoted as $PM_{2.5}$. The generation of $PM_{2.5}$ encompasses primary processes on the ground surface and complicated secondary processes in the atmosphere. In the year 2009, an environmental standard value was set for $PM_{2.5}$ because of its health effects. Since then, their negative impacts on health have been reduced through continuous observations and warnings issued by measuring stations around Japan. Although component analysis is effective in identifying $PM_{2.5}$ sources, setup and operating costs for observation facilities are high, and high-frequency observation results cannot be obtained. In addition, there are automatic measuring machines (measuring at hourly intervals), which follow official methods, but the number of installations are low due to cost issues and difficulty in identification of $PM_{2.5}$ sources. On the other hand, in recent years, small particle sensors that are capable of measuring with high temporal resolution have become widespread. These sensors are based on light scattering methods; they can obtain observations at 1-second intervals and can be mounted on drones. Therefore, these sensors are expected to contribute to the diffusion process of $PM_{2.5}$ and identification of the source. However, since the mass concentration value obtained by the light scattering method is indirectly calculated from the particle number concentration, the accuracy of the obtained hourly values is not known. In this study, we compared the two data types by performing simultaneous observations with a sensor based on the laser light scattering method and an atmospheric environment measurement station that uses the official measurement method. We also compared these results with the $PM_{2.5}$ concentration obtained by the small sensor to estimate the accuracy of the obtained data Furthermore, based on the results, we attempted to correct the obtained observation values onboard the drone.The $PM_{2.5}$ concentration was measured using a Pocket $PM_{2.5}$ Sensor manufactured by Yaguchi Denshi Kogyo. To conduct simultaneous observations with the measurement station data, an observation station was constructed independently at the Shogunno General Atmospheric Environment Measurement Station in the East Third Block of Tsuchizaki Station on November 13, 2019, with the permission of Akita City. The height of the observation pole was 3.1 m, and $PM_{2.5}$ concentration data was acquired at 1-second intervals. For comparison with the measurement station, the 1-hour average values and standard deviation of the data were obtained from the small sensors. The 1-hour values, published as preliminary values by the Ministry of the Environment Air Pollutant Wide Area Monitoring System Soramame-kun (http://soramame.taiki.go.jp/Index.php), were used for the data from the measurement station. During the observation period from November 2019 to January 2020, 502 1-hour average values were obtained from sensor observations. The difference between the $PM_{2.5}$ concentrations measured by the sensor and the measurement station data, as well as the correlation coefficient between them are -1.7 ±4.7 μg/m³ and r = 0.48, respectively. A negative observation error of approximately 2 μg/m³ was observed. Based on these observations, corrections were made for the observed data up to an altitude of 500 m while using a drone from June 2018 to February 2019. The results of this study suggest that the $PM_{2.5}$ observations using a drone can be used to determine high and low concentrations, as defined by environmental standards, despite the observed errors. In this

presentation, we report the results obtained by extending the observation period.

Keywords: PM2.5, Laser light scattering, drone

