Spatiotemporal variations of NO_2 over Fukuoka Japan, observed by multiple MAX-DOAS and 3-D coherent Doppler lidar

*Hironobu Ueki¹, Hisahiro Takashima², Martina Michaela Friedrich³

1. Fukuoka university graduate school, 2. Fukuoka university, 3. Belgian Institute for Space Aeronomy

To clarify spatiotemporal variations and transport processes in nitrogen dioxide (NO₂) over Fukuoka, an urban area in Japan, continuous NO₂ profile observations using Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) with high temporal resolution of four minutes have been conducted since October 2018 at three observatories: Yakuin (33.580°N, 130.396°E), Sohara (33.580°N, 130.356°E) and Fukuoka University (33.550°N, 130.364°E).

We first performed case studies at particular days and observed enhanced NO₂ contents above the city center on some days. In the case of 29 November 2018, high NO₂ concentrations were observed near the ground in the morning (around 7:00–10:30 am). Higher contents of NO₂ appeared gradually at higher altitudes over the urban area, and disappeared at around 13:00–14:00 pm. We investigated a three-dimensional (3-D) wind field observed using a 3-D coherent Doppler lidar installed at Fukuoka University. The NO₂ variations were consistent with the wind variation: the airmass with high NO₂ concentration was transported upward from near the ground over an urban area; it advected southward (landward) because of a sea breeze in the afternoon.

We also validated the tropospheric NO_2 vertical column density (VCD) using the Sentinal-5P/TROPospheric Ozone Monitoring Instrument (TROPOMI) satellite with MAX-DOAS observations. Results showed that the satellite data are underestimates, as shown in earlier studies (e.g., Kanaya et al., 2014), but large variations exist from 34% to 154%. These results suggest that underestimation can be attributable not only to the shield effect by aerosols near the ground but also to inhomogeneity and transport processes of the NO_2 airmass over urban areas.

Keywords: NO2, MAX-DOAS, TROPOMI, doppler lidar