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Comparison of GEMS and TROPOMI NO₂ observations with ground-based measurements over South Korea

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Nitrogen dioxide (NO₂) is one of the most important trace gases in the atmosphere, mainly produced from the combustion of fossil fuels, thermal power plants, transportation activities, and natural sources. Short-term exposure to high concentrations of NO₂ in the atmosphere can be problematic as it can cause adverse effects on human health, such as respiratory diseases, and exacerbate the symptoms of those already suffering from lung or heart conditions. The Tropospheric Monitoring Instrument (TROPOMI) has limitations in tracking diurnal variation. TROPOMI scans South Korea only once daily. On the other hand, the Geostationary Environment Monitoring Spectrometer (GEMS) onboard the GEO-KOMPSAT 2B satellite was designed to continuously observe air pollutants, including NO₂, SO₂, HCHO, O₃, and aerosols. The spatiotemporal pattern of total NO₂ vertical column density (VCD) from GEMS shows spatial variability and the diurnal cycle of NO₂. In this study, monthly averaged data were generated to compare GEMS, TROPOMI, and ground observation data.

The research results showed that the monthly total NO₂ VCD from GEMS and surface NO₂ mixing ratio exhibited greater temporal variations compared to the total NO₂ VCD from TROPOMI. Additionally, the monthly NO₂ values were higher in spring and winter, while lower in summer and autumn. GEMS effectively detected the characteristics of NO₂ in South Korea, including the distinct weekday-weekend effect, which is similar to ground observations. In the analysis of diurnal variations, GEMS exhibited a continuous increase in NO₂ values from 9:45 to 14:45 KST for January. In contrast, other months showed a diurnal cycle. The comparison between GEMS and ground data showed a moderate level of correlation ($R=0.77$), while TROPOMI exhibited a higher correlation ($R=0.81$). However, the slope of GEMS was closer to the 1:1 line. GEMS demonstrated a good correlation, particularly in urban observation sites where total NO₂ VCD was relatively high throughout the year. However, it showed a lower correlation in port observation sites.