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Diurnal characteristics of the NO_2 columns observed over Asia from Geostationary Environment Monitoring Spectrometer (GEMS)

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Nitrogen oxides are key gas components of emissions from fossil-fuel combustion, are known to degrade air quality and have adverse health effects. Diurnal NO_2 observations are crucial for enhancing our understanding of NOx emissions, lifetime, and chemistry. Geostationary Environment Monitoring Spectrometer (GEMS) has been providing hourly observations NO_2 columns over Asia since November 2020. The latest NO_2 version 3 products have significantly improved with updated air mass factors (AMFs) and the separation of stratospheric and tropospheric columns. To identify the dependency of the distribution on the time of the day, we investigated hourly tropospheric NO_2 cycles of cities over Asia using GEMS measurements for the first time. The cities show similar diurnal concentration patterns with peaks in the morning and troughs in the afternoon, although the amplitude and specific times vary by city. The reduction rate of NO_2 was influenced by the temporal dependence of the spatial distribution within and around cities. We also observed distinct NO_2 diurnal patterns in certain industrial areas and cities where NOx emissions are thought to be controlled. To explain the location-dependent variations of the tropospheric NO_2 columns, we compared the diurnal NO_2 cycles obtained from the GEMS measurement with WRF-Chem models for some cities. In addition, estimated top-down NOx emissions from GEMS measurements are presented in comparison with bottom-up emission inventory, showing a smaller difference compared to the top-down emission from TROPOMI

measurements. It is expected that hourly top-down NOx emissions using GEMS measurements can provide a useful information in improving the future performance of air quality modeling.