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A research product for tropospheric NO_2 columns fromGeostationary Environment Monitoring Spectrometerbased on Peking University OMI NO_2 algorithm

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Tropospheric vertical column densities (VCDs) of nitrogen dioxide (NO_2) retrieved from sun-synchronous satellite instruments have provided abundant NO_2 data for environmental studies, but such data are limited by retrieval uncertainties and insufficient temporal sampling (e.g., once a day). The Geostationary Environment Monitoring Spectrometer (GEMS) launched in February 2020 monitors NO_2 at an unprecedented hourly resolution during the daytime. Here we present a research product for tropospheric NO_2 VCDs, referred to as POMINO-GEMS. We develop a hybrid retrieval method combining GEMS, TROPOMI and GEOS-CF data to generate hourly tropospheric NO_2 slant column densities (SCDs). We then derive tropospheric NO_2 air mass factors (AMFs) with

explicit corrections for surface reflectance anisotropy and aerosol optical effects, through parallelized pixel-by-pixel radiative transfer calculations. Prerequisite cloud parameters are retrieved with the O_2-O_2 algorithm by using ancillary parameters consistent with those used in NO_2 AMF calculations.

Initial retrieval of POMINO-GEMS tropospheric NO_2 VCDs for June–August 2021 exhibits strong hotspot signals over megacities and distinctive diurnal variations over polluted and clean areas. POMINO-GEMS NO_2 VCDs agree with the POMINO-TROPOMI v1.2.2 product (R = 0.98, and NMB = 4.9%) over East Asia, with slight differences associated with satellite viewing geometries and cloud and aerosol properties affecting the NO_2 retrieval. POMINO-GEMS also shows good agreement with OMNO2 v4 (R = 0.87, and NMB = −16.8%) and GOME-2 GDP 4.8 (R = 0.83, and NMB = −1.5%) NO_2 products. POMINO-GEMS shows small biases against ground-based MAX-DOAS NO_2 VCD data at nine sites (NMB = –11.1%) with modest or high correlation in diurnal variation at six urban and suburban sites (R from 0.60 to 0.96). The spatiotemporal variation of POMINO-GEMS correlates well with mobile-car MAX-DOAS measurements in the Three Rivers' Source region on the Tibetan Plateau (R = 0.81). Surface NO_2 concentrations estimated from POMINO-GEMS VCDs are consistent with measurements from the Ministry of Ecology and Environment of China for spatiotemporal variation (R = 0.78, and NMB = –26.3%) as well as diurnal variation at all, urban, suburban and rural sites ($R \geq 0.96$). POMINO-GEMS data will be made freely available for users to study the spatiotemporal variations, sources and impacts of NO_2.

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