Reconstruction of spatially continuous OMI tropospheric NO2 columns over China by combining GOME-2 products

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Measurements of nitrogen dioxide (NO2) are essential for understanding air pollution and evaluating its impacts, and satellite remote sensing is an essential approach for obtaining tropospheric NO2 columns over wide temporal and spatial ranges. However, Ozone Monitoring Instrument (OMI) onboard Aura is affected by a loss of spatial coverage (around one-third of 60 viewing positions) commonly referred to as row anomaly since June 25th, 2007, and especially after June 5th, 2011. Global Ozone Monitoring Experiment-2 (GOME-2) onboard MetOp-A/B provides data with a maximum swath width of 1920 km, and it needs one and a half days to cover the globe. Therefore, it is challenging to obtain diurnal spatially continuous vertical column densities (VCDs) of tropospheric NO2, which is limited by the performance of the instruments. Besides, the presence of clouds generates numerous missing and abnormal values that affect the application of VCDs data. To fill data gaps due to the above two reasons, this study proposes a framework for reconstructing OMI (afternoon overpass) tropospheric NO2 VCDs over China by combining GOME-2 (morning overpass) products. First, we investigated the ground-based hourly NO2 concentration to characterize the diurnal variations, thus deriving the underlying factors that cause the difference between morning VCDs and afternoon ones. Then, the eXtreme Gradient Boosting (XGBoost) method was applied to estimate the missing values of OMI QA4ECV tropospheric NO2 VCDs from GOME-2 GDP offline products and other ancillary variables. The spatial coverage of OMI grids (binned to 0.25°) over China from 2015 to 2018 increased from 22% to 63% averagely. Furthermore, for those grids that are null in both products, we utilized an adaptive weighted temporal fitting method to fill missing data that the previous step produced. The reconstructed data set shows spatial and temporal patterns that are coherent with the adjacent areas. Our approach has great potential for reconstructing spatially continuous tropospheric NO2 columns, which are critical for daily air quality monitoring.