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High-resolution (0.05°×0.05°) NO_x emissions in the Yangtze River Delta inferred from OMI

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Emission datasets of nitrogen oxides (NO_x) at high horizontal resolutions (e.g., 0.05°×0.05°) are crucial for understanding human influences at fine scales, air quality studies, and pollution control. Yet high-resolution emission data are often lacking or contain large uncertainties especially for the developing regions. Taking advantage of long-term satellite measurements of nitrogen dioxide (NO_2), here we develop a computationally efficient method to inverting NO_x emissions in major urban areas at the 0.05°×0.05° resolution. The inversion accounts for the nonlinear effects of horizontal transport, chemical loss, and deposition. We construct a 2-dimensional Peking University High-resolution Lifetime-Emission-Transport (PHLET) model, its adjoint model (PHLET-A), and a Satellite Conversion Metrix approach to relate emissions, simulated NO_2, and satellite NO_2 data. The inversion method is applied to summer months of 2012–2016 in the Yangtze River Delta area (YRD, 118°E-123°E, 29°N-34°N), a major polluted region of China, using the POMINO NO_2 vertical column density product retrieved from the Ozone Monitoring Instrument. A systematic analysis of inversion errors is performed, including using an Observing System Simulation Experiment-like test. Across the YRD area, the inverted summer average emission ranges from 0 to 12.0 kg km-2 h-1, and the lifetime (due to chemical loss and deposition) from 1.4 to 3.6 h. Our inverted emission dataset reveals fine-scale spatial information tied to nighttime light, population density, road network, and maritime shipping. Many of the inverted fine-scale emission features are not well represented or not included in the widely used Multi-scale Emissions Inventory of China. Our inversion method can be applied to other regions and other satellite sensors such as the TROPOspheric Monitoring Instrument.