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Spatial patterns of CO_2 concentrations across urban-rural gradient of 27 core cities in China

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Anthropogenic carbon emission is the most important reason for continuous increasing carbon dioxide (CO_2) concentrations in the atmosphere, as well as a primary driver of climate change. These emissions are largely concentrated in urban areas, thus it is reasonable to assume that CO_2 concentration peaks where human activity is most intense and declines in areas with fewer people within urban areas. Many studies have been conducted to explore the urban/rural difference in CO_2 levels based on direct ground-based measurement. The launch of NASA's Orbiting Carbon Observatory-2 (OCO-2) provides an opportunity to detect higher resolution carbon emission data than common ground-based monitoring method and made it possible to study the CO_2 distribution in a city scale.

This work analyses the spatial distribution of CO_2 concentration in 27 Chinese cities. We use several adjacent $\sim$9 km^2 grid boxes along the urban-rural transects to collect OCO-2 point data and analyses the variation of the column averaged CO_2 dry air mole fraction (XCO_2) derived from OCO-2 along the transects with urbanization gradient. We found that, in 22 cities, the statistically significant enhancements of CO_2 concentration were observed in urban-rural transition zone or rural area but not in the central urban area, which is inconsistent with former assumptions and observations. Only one city was observed an urban CO_2 domes and the CO_2 levels in other 4 cities don't have any clear spatial patterns. The same distribution recurs in different seasons with few variances in value. These phenomena can be explained by recent urban development policies in China, which encouraged industry to move out of the urban area, and the rapid urban sprawl in Chinese cities.

In conclusion, this study demonstrates that the atmosphere CO_2 concentration does not peak in the central urban area and decline in rural area as the assumption and the space-borne observation can efficiently monitor anthropogenic CO_2 emissions especially emissions from industry.