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Direct space-based observations of anthropogenic CO_2 emission areas from OCO-2

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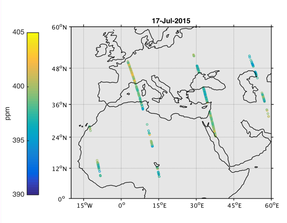
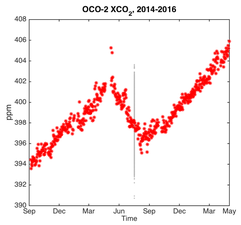
Key Points

- We present a direct methodology, solely based on satellite data, to observe anthropogenic CO_2 emission areas from OCO-2 measurements.
- The OCO-2 XCO_2 anomaly maps show agreement with the spatial features derived from the OMI NO_2 tropospheric columns and the CO_2 emission inventories.
- We apply cluster analysis to XCO_2 anomalies and NO_2 data in order to separates different polluted regions.
- We observe positive correlation between XCO_2 anomalies and emissions inventories.

Data and Methodology

We use the measurements of column-averaged dry air mole fraction of CO_2 (XCO_2) from Orbiting Carbon Observatory-2. We use the latest reprocessed lite files (Version 7r), including bias corrected XCO_2 data available from September 2014 to April 2016. The data is screened using quality flags set to zero and warning levels smaller than 15.

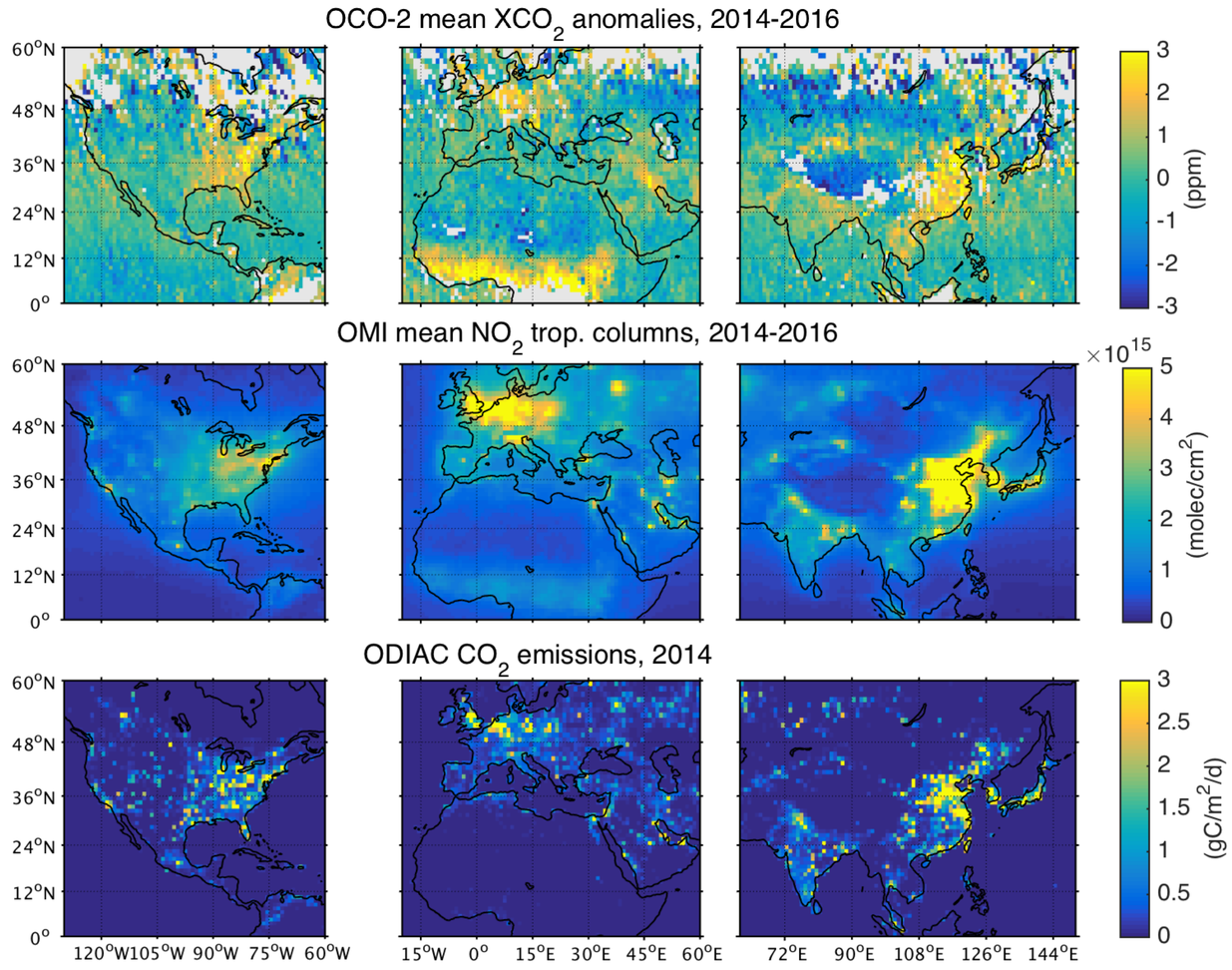


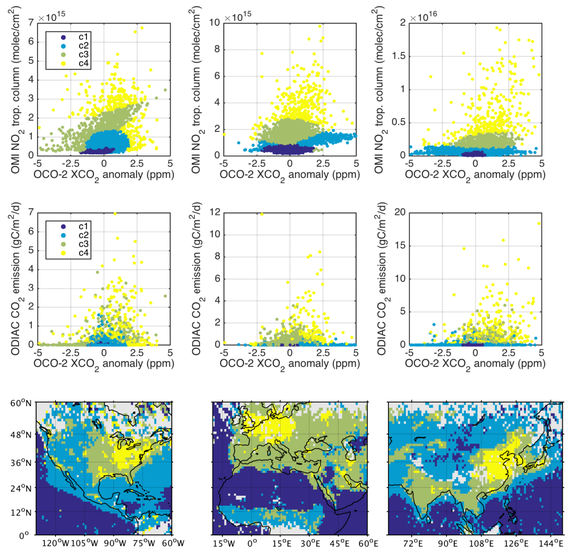


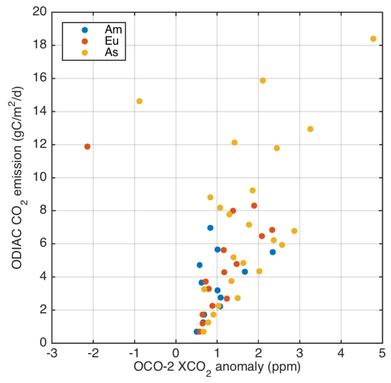
In comparison to NO_2 and other short-lived air pollutants, trends, seasonality, long lifetime and large atmospheric background, significantly complicate the analysis of the anthropogenic CO_2 emissions. Three main investigation regions with large anthropogenic CO_2 emissions (based on existing inventories) are selected. In order to isolate the pollution areas, we first subtract the daily median — calculated from the selected study region — from the individual observations. Hence, the XCO_2 anomalies are derived as

XCO_2(anomaly) = XCO_2(individual) – XCO_2(daily median).

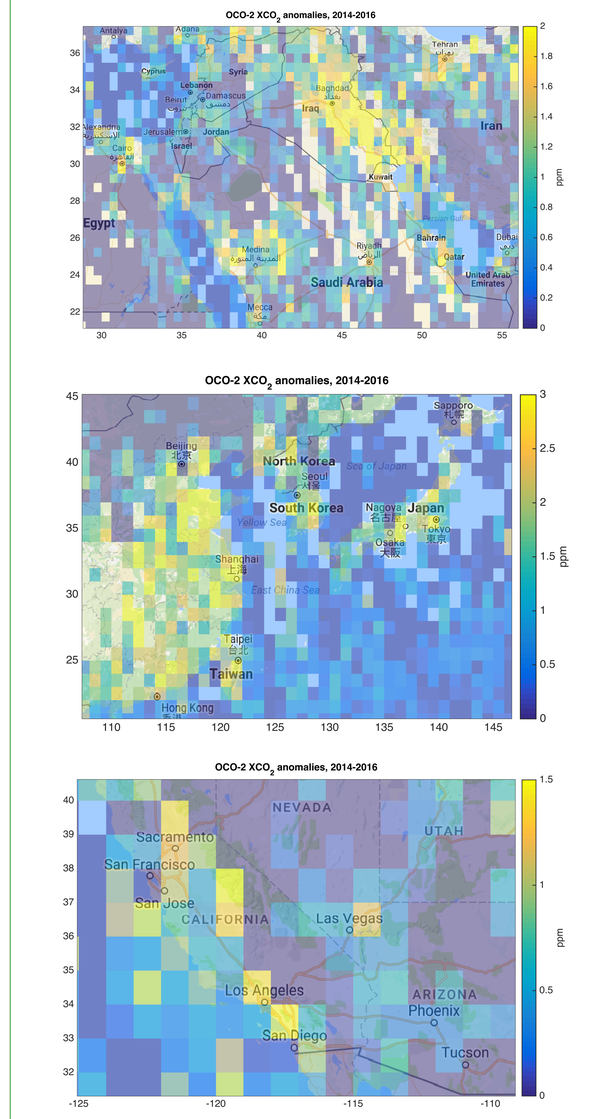
This step allows us to simultaneously deseasonalize and detrend the data. The approach also reduces the effect of the changing spatial distribution of the data points and the impact of potential regional scale biases in the OCO-2 dataset.







Left: In order to analyze the correlation between the the gridded tropospheric NO_2 and XCO_2 anomaly datasets an approach based on cluster analysis is employed. This allows us to separate different populations in the scatter plot and to identify their corresponding geographical location. The middle panel shows the direct comparison between XCO_2 anomalies and ODIAC CO_2 emissions, grouped according to the same clusters. **Up:** The data are binned according to the emission values every 0.5 gC/m^2/d.



Take Home Message

- OCO-2 shows anthropogenic CO_2 emission areas from space with unprecedented spatial coverage and detail.
- The results demonstrate the power of spaceborne data for monitoring anthropogenic CO_2 emissions.

Reference: Hakkarainen, J., I. Ialongo, and J. Tamminen (2016), Direct space-based observations of anthropogenic CO_2 emission areas from OCO-2, Geophys. Res. Lett., 43, doi: 10.1002/2016GL070885.