



Satellite Data: A Game Changer in GHG Monitoring

Leveraging satellite data to bridge the gap in global GHG monitoring

Highlights:

- The Bank set an ambitious goal at COP28 to allocate 45 percent of its annual financing to climate-related projects by 2025. For effective mitigation, new metrics are essential for monitoring greenhouse gas (GHG) emissions. Satellite readings offer a global solution to the lack of accurate and consistent emissions data, providing independent, objective, and international data collection.
- Satellite-based emissions measurements have inspired the creation of comprehensive global databases showing long-term trends, short-term variations, and specifically - urban emissions.
- To support existing country-level efforts, the Bank announced plans to launch 15 national programs within 18 months, aiming to reduce up to 10 million tons of methane emissions. World Bank research with satellite readings will aid in monitoring emission-reductions from top emitters.

In their efforts to tackle climate change, countries have committed to curbing their carbon emissions through Nationally Determined Contributions (NDCs). Also, the Global Methane Pledge, backed by over 120 nations, aims to substantially reduce methane emissions levels by 2030.

The Challenge

The lack of accurate and consistent carbon dioxide (CO₂) and methane (CH₄) emissions data has hindered these and other efforts to rapidly reduce emissions. Recognizing the urgent need for a

comprehensive and reliable GHG monitoring scheme, a multi-disciplinary team at the World Bank launched an initiative to leverage advancements in satellite based GHG measurements to fill the global information gap.

“In recent years, the satellite-based GHG emission measurements have emerged as potentially a game-changing solution, offering independent, objective, and international data collection,” says **Dr. Susmita Dasgupta**, a Lead Environmental Economist in the Development Research Group who coordinates the project.

Dasgupta and her team analyzed and processed data from NASA’s (National Aeronautics and Space Administration) Orbiting Carbon Observatory-2 (OCO-2) and ESA’s (European Space Agency) TROPOMI.

To make the complex satellite data useful for policymaking, the team developed a robust and transparent data framework with baselines and tools to monitor changes worldwide. This enormous undertaking resulted in the creation of **two global CO₂** and **three global CH₄ databases** containing data that are comparable across space and time.

Measuring Carbon Dioxide Levels

The first database focuses on global CO₂ anomalies and mean values. The database provides a comprehensive understanding of CO₂ emissions worldwide over the past decade that is mapped across a 25-kilometer global grid. The data allows World Bank teams as well as researchers and policymakers around the world to assess long-term trends and short-term variations in CO₂ emissions.

The screenshot shows the 'Global XCO2' dataset page on the Development Data Hub. The page includes a navigation bar with 'Development Data Hub', 'SEARCH', 'HOME', 'DATA', 'ADD DATA', 'MY DATASETS', and 'COLLECTIONS'. The breadcrumb trail is 'Home / Search Results / Details'. The dataset title is 'Global XCO2' with a subtitle 'Global XCO2 Anomalies And Means'. A metadata update notice states 'Metadata last updated on - Jun 6, 2023'. A 'Compare' button and a version dropdown menu showing '2 (Latest)' are present. A description states: 'The database includes monthly mean values for CO2 concentrations and concentration anomalies for the global 25 km grid along with the grid cell id, centroid coordinates, year and month.' An 'Overview' section is active, listing three dataset versions: 1) 'Global XCO2 Anomalies and Means. Labels' (CSV, 266 Bytes, Last Updated: Jun 5, 2023, 4 downloads); 2) 'Global XCO2 Anomalies and Means. Version 1' (STATA, 63.8 MB, Last Updated: Aug 10, 2022, 32 downloads); 3) 'Global XCO2 Anomalies and Means. Version 1' (CSV, 116.2 MB, Last Updated: Jun 5, 2023). A 'Data Access and Licensing' box on the right indicates the dataset is 'Public' and licensed under 'Creative Commons Attribution 4.0'. A 'Contact' section lists Susmita Dasgupta and Brian Blankespoor with the email 'data@worldbank.org'.

The 'X' refers to the observation taking place from a satellite.

Urban areas account for over 70% of global CO₂ emissions, yet very few, primarily in developed countries, have access to consistent CO₂ emission data. To address this gap, the team utilized multi-year CO₂ estimates from NASA's OCO-2 to monitor 1,799 urban areas with populations exceeding 500,000.

To present this data, [the second database](#) was set up, summarizing changes in CO₂ specifically within functional urban areas (densely inhabited cities plus less densely populated zones with populations that are highly integrated with the cities). The goal here is to offer valuable insights into CO₂ emission sources and patterns in the biggest urban areas around the world.

The screenshot shows the Development Data Hub interface. At the top, there is a navigation bar with 'Development Data Hub' on the left and 'SEARCH', 'HOME', 'DATA', 'ADD DATA', 'MY DATASETS', and 'COLLECTIONS' on the right. Below the navigation bar, the breadcrumb 'Home / Search Results / Details' is visible. The main heading is 'Change Estimates Of Carbon Emissions For Functional Urban Areas' with a share icon. A metadata note states 'Metadata last updated on - May 10, 2023'. The description reads: 'Annual change estimates for Functional Urban Areas (FUAs) from Schiavina et al. (2019) by statistical significance class, providing information that links grid cells in the World Bank's global XCO2 database to IDs for FUAs and national administrative units. Beginning in September 2014, the XCO2 database uses satellite data from NASA's OCO (Orbiting Carbon Observatory)-2 satellite, which provides...'. There is a 'View More' link and an 'Overview' tab. Two data entries are listed: 'Functional Urban Area One Year Change 2021 CO2 emissions (data)' (150.3 KB, 7 downloads) and 'Functional Urban Area One Year Change 2021 CO2 emissions (labels)' (875 Bytes, 4 downloads). On the right side, there is a 'Data Access and Licensing' section with 'Classification: Public', a description of public access, a 'Copy public dataset link' button, and 'License: Creative Commons Attribution-Non Commercial 4.0'. Below that is a 'Contact' section with profiles for Brian Blankespoor and Susmita Dasgupta, and an email address 'data@worldbank.org'.

Analyzing Methane Data

The team also looked at ways to analyze methane emissions. ESA's TROPOMI satellite data has been instrumental in identifying methane “hot spots” by location and sector. This data can aid in establishing baselines and in tracking the progress of over 100 nations that have pledged to reduce methane emissions. To present this data, three databases were developed.

The [first database](#) involves satellite-derived data on anomalies and mean values in methane emissions worldwide at a 5 km global grid for the past five years. The [second database](#) summarizes CH₄ changes within large urban areas. The [third database](#) identifies the location of the top 50% methane emitters and their sectors (agricultural soils, livestock, gas, oil, coal, landfills, and wastewater) along with changes in their emissions over time.

The screenshot shows two dataset pages on the Development Data Hub. The left page is for 'Global XCH4 Anomalies And Means (5x5 Km)', which includes metadata, an overview, and a list of related datasets like 'Global Slim Bias-Corrected XCH4 Anomalies (2019)'. The right page is for 'Methane Emissions For Functional Urban Areas', which includes metadata, an overview, and related datasets like 'Global Slim Bias-Corrected XCH4 Anomalies in FUA (2019)'. Both pages feature a 'Data Access and Licensing' section and a 'Contact' section with team members' names and email addresses.

The screenshot shows the 'Methane Emissions Changes By EDGAR Decile' dataset page. It includes metadata, an overview, and a table of data. The table has columns for Country, Province, District, Sector, and Model_1. The data shows methane emission changes across various regions in Canada and China.

Country	Province	District	Sector	Model_1
Canada	Saskatchewan	Division No. 1	Oil	Decreasing
China	Beijing	Beijing	Livestock	Increasing
China	Chongqing	Chongqing	Soils	Increasing
China	Henan	Zhengzhou	Coal	Increasing
China	Shandong	Jining	Coal	Increasing
China	Shandong	Tai'an	Coal	Increasing
China	Shanxi	Yangquan	Coal	Increasing
China	Shanxi	Changzhi	Coal	Increasing
China	Shanxi	Shuozhou	Coal	Increasing
China	Shanxi	Linfen	Coal	Increasing

Why Does It Matter?

The value of these databases lies in their versatility and accessibility—with their structure allowing for seamless integration of other geospatial data. They enable increasingly precise measurements—monthly changes in mean levels of emissions at nearly any point on the globe, for example, and provide useful estimates of how emissions are changing in large urban areas.

“By processing satellite readings, we were able to generate emission estimates that are comparable across space and time and make them open to anyone interested,” says **Brian Blankespoor**, a member of the team. *“The data can be used to understand CO₂ and CH₄ emission trends in urban areas across the world.”*

The World Bank’s pioneering efforts, in collaboration with NASA and ESA, can be transformative in the fight against climate change by providing a valuable input to designing effective strategies to curb GHG emissions paving the way for a more climate-friendly approach to urban planning and infrastructure development.

Related Links:

[Global XCO2 Anomalies and Means](#)

[Change Estimates of Carbon Emissions for Functional Urban Areas](#)

[Global XCH4 Anomalies and Means \(5x5 Km\)](#)

[Methane Emissions for Functional Urban Areas](#)

[Methane Emissions Changes by EDGAR Decile](#)

Reports:

[Identifying and Monitoring Priority Areas for Methane Emissions Reduction](#)
[Scalable Tracking of CO2 Emissions: A Global Analysis with Satellite Data](#)