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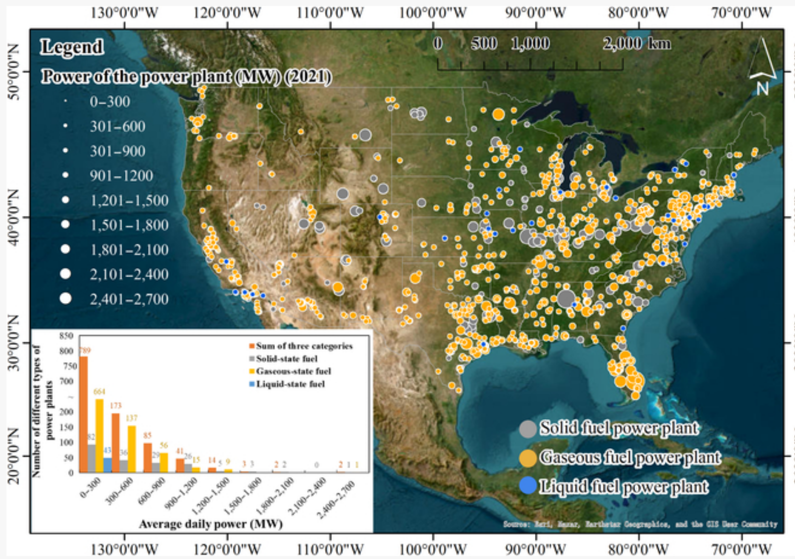
# Scientific argumentation on satellite indicators to further meet Global stocktake requirements

FAYETTEVILLE, GA, UNITED STATES, April 2, 2025 /EINPresswire.com/ -- In a new study, scientists have evaluated the effectiveness of satellite technology in tracking carbon emissions from thermal power plants, revealing critical gaps in existing monitoring systems. By identifying key limitations in spatial resolution, precision, and monitoring frequency, the research proposes significant technological advancements to improve global carbon stocktake accuracy.



Spatial distribution and power distribution histogram of the study object (the lower 48 states).

Accurate carbon emission assessment is essential to achieving the Paris Agreement's climate goals, especially for thermal power plants—one of the largest sources of fossil fuel emissions. While ground-based monitoring remains the gold standard, satellite remote sensing offers a scalable and efficient alternative. However, current satellite systems struggle with detection precision, spatial coverage, and observation frequency, leading to considerable underestimations of emissions. This underscores the urgent need for enhanced satellite capabilities to ensure a more accurate and comprehensive global carbon inventory.

Published (DOI: 10.34133/remotesensing.0469) in Journal of Remote Sensing on March 14, 2025, a study led by researchers from the Chinese Academy of Sciences tackles these challenges by analyzing the performance of Orbiting Carbon Observatory (OCO) satellites. While these satellites represent cutting-edge technology, they significantly underestimate emissions from smaller power plants. The research presents a correction framework aimed at refining satellite data accuracy, offering a potential breakthrough in precise emission monitoring on a global scale.

The study’s findings are striking: current OCO satellites underestimate U.S. power plants’ total emission by 70%, primarily due to their inability to detect emissions from smaller facilities. However, with the advancement of retrieval algorithm, while enhancing satellite precision to 0.5 ppm, the estimation error could be reduced to 52%. Further improvements, including a finer spatial resolution (0.5 km) and increased monitoring frequency, could push the error rate below 20%. The study also assesses the capabilities of upcoming satellite missions, such as CO2M and TanSat-2, projecting that these advancements could significantly improve emission detection.

Analyzing data from 1,060 U.S. power plants, the researchers leveraged OCO-2 and OCO-3 satellite observations, applying Gaussian plume models and z-test methods to determine minimum detectable emission levels. At a precision of 1 ppm, only 72 power plants could be accurately monitored, covering just 29% of total emissions. Increasing precision to 0.5 ppm expanded detection to 166 power plants, capturing 48% of emissions. Simulations of future satellite capabilities suggest that even greater gains in precision and spatial resolution could revolutionize carbon emission tracking.

"Our findings highlight the severe limitations of existing satellite technology in global carbon accounting," said Dr. Tianhai Cheng, lead researcher of the study. "However, with enhanced precision and resolution, future satellites could transform our ability to monitor and mitigate carbon emissions, offering a critical tool in the fight against climate change."

The study incorporated data from the U.S. Environmental Protection Agency's Clean Air Markets Program Data (CAMPD) alongside OCO satellite observations. Researchers employed Gaussian plume models to simulate emission dispersion and applied z-tests to determine detection thresholds. Additionally, meteorological datasets from ERA5-Land and ERA5 hourly records were used to account for wind speed and atmospheric variations, refining emission estimates. The study also proposed adjustment factors to correct for fluctuations in power plant emissions over time.

With the promise of daily monitoring, higher precision, and finer spatial resolution, next-generation satellites have the potential to dramatically improve global carbon accounting. These advancements could make it possible to track emissions from smaller power plants with unprecedented accuracy, enabling countries to better meet their climate commitments. The study provides key insights for the development of future satellite missions, paving the way for more effective global climate change mitigation strategies.

References
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