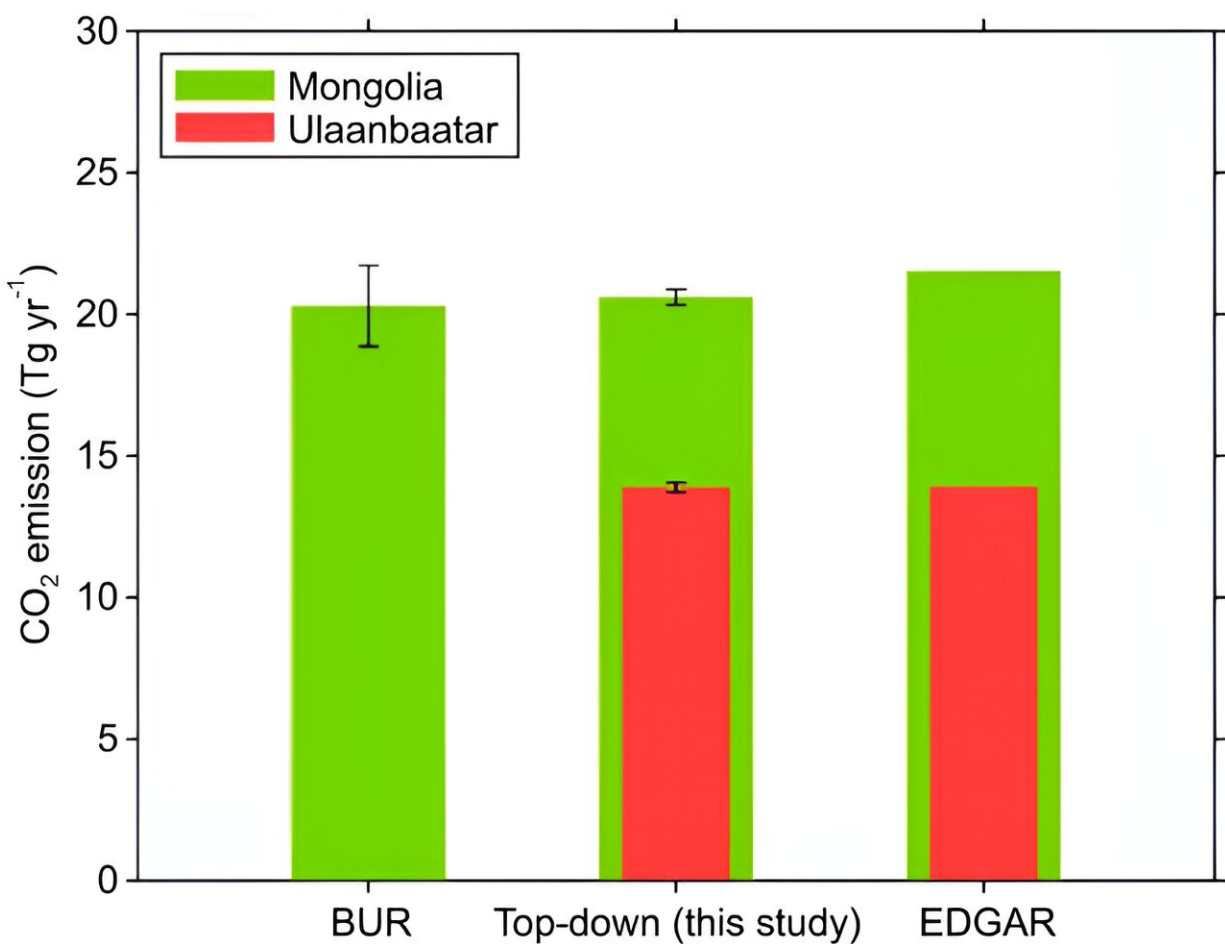


A cost-efficient and transparent method to measure carbon dioxide emission estimates using GOSAT

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The 2018 data shows how much CO₂ the energy sector in Mongolia emitted, comparing two calculation methods. One is Mongolia's BUR2 using the bottom-up approach (left) and EDGAR (right). The other is the calculation result from this study using the hybrid approach (center) based on the top-down approach.

The green represents CO₂ emissions for all of Mongolia, while the red indicates emissions from Ulaanbaatar city. Note that for BUR and top-down data, the vertical lines represent the reliability of the results, suggesting that the actual value is likely to be within this range with 95% probability. Credit: *Scientific Reports* (2023). DOI: 10.1038/s41598-023-42664-3

Researchers in Japan and Mongolia have carried out the world's first instance of incorporating satellite-based CO₂ emission estimates into a GHG emission report as the verification on the Second Biennial Update Report (BUR2) of Mongolia submitted to the UNFCCC on 15 November 2023, resulting in high accuracy match with actual reported values, reports a new study published online in *Scientific Reports* in 2023.

Countries have reported their CO₂ emissions to the UNFCCC, primarily from human activities and a significant contributor to climate change. The method adopted for this reporting is based on detailed statistical data. However, some nations have faced challenges reporting due to a lack of data and experts.

A research team from Chuo University, Japan, the Information and Research Institute of Meteorology, Hydrology and Environment, Mongolia, and the Ministry of Environment and Tourism, Mongolia, led by Chuo University Institute Professor Masataka Watanabe, developed an approach that utilizes satellite observations of greenhouse gases (GHGs) in the atmosphere.

Their hybrid system, integrates the atmospheric transport models, inverse analysis, and socio-economic methods which estimated national CO₂ emissions by inputting GOSAT satellite data.

"We sought to measure the CO₂ emissions of Mongolia's energy sector

accurately by developing a novel hybrid system distinct from previous methodologies. This hybrid system capitalizes on the advantages of the conventional bottom-up approach, which uses statistical data, and the top-down approach, which employs satellite data."

"This research aimed to verify how closely the CO₂ emissions from Mongolia, as determined by the hybrid system, align with values obtained using existing methods, thereby demonstrating the effectiveness of this new system," said lead author and Institute Professor Masataka Watanabe.

"This method provides a complete picture of GHG dynamics regarding its spatial and temporal distribution, with indication of sources and removal, as well. It is essential for countries like Mongolia, where the [landscape features](#) by complex topography as a precondition to occur more localized factors for GHG dispersion, such as a temperature inversion."

"Remote sensing information like GOSAT data for interpretation of, which uses a more sophisticated methodology, as presented here, is an essential, cost-effective, and transparent tool for climate change study and for establishing a stable GHG monitoring system in Mongolia, which is a more sparsely populated and limited human resources country," said Dr. Batjargal Zamba, the former special envoy for [climate change](#) in Mongolia.

The research team conducted targeting observations of Ulaanbaatar city in Mongolia using GOSAT. When applying the hybrid system to calculate the CO₂ emissions of Mongolia's energy sector, the team's results showed a few percentages of differences from the traditional values reported by the Mongolian government, and the global GHG emission database "The Emissions Database for Global Atmospheric Research (EDGAR)".

These findings demonstrate the effectiveness of the [hybrid system](#) in estimating CO₂ emissions and indicate that Mongolia's calculation of CO₂ emissions in the [energy sector](#) aligns closely with accurate estimates. This result suggests a scientifically transparent and high-quality report.

More information: Masataka Watanabe et al, Enhancing scientific transparency in national CO₂ emissions reports via satellite-based a posteriori estimates, *Scientific Reports* (2023). [DOI: 10.1038/s41598-023-42664-3](#)

Provided by Chuo University

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