

Atmospheric CO₂ Observations from Space by the GOSAT Mission Atmospheric CO₂ Observations from Space by the GOSAT Mission

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Fossil fuel combustion, deforestation, and other human activities are now adding more than 30 billion tons of carbon dioxide (CO₂) to the atmosphere each year. These CO₂ emissions are superimposed on an active carbon cycle, driven by natural processes in the land biosphere and oceans. These processes emit more than 25 times as much CO₂ into the air each year as human activities and then reabsorb at least that much, along with about half of the human contributions. Precise measurements of atmospheric CO₂ concentrations over the past 50 years indicate that these natural carbon sinks have somehow been keeping up with the 5-fold increase in the fossil fuel CO₂ emission rates over that period, reducing the rate of buildup of CO₂ by a factor of two. The nature and location of these increasingly efficient CO₂ sinks is still largely unknown. Because of this, it is impossible to predict how much longer they will continue to control the atmospheric CO₂ buildup rates.

While the ground-based greenhouse gas monitoring network now provides a strong global constraint on both human and natural CO₂ fluxes into the atmosphere, it still does not have the resolution and coverage needed to identify and quantify sources and sinks on regional scales. One way to improve the spatial and temporal coverage and resolution is to retrieve precise, spatially-resolved, global measurements of CO₂ from space. High resolution spectroscopic observations of reflected sunlight by CO₂ and O₂ bands are well suited for monitoring surface CO₂ fluxes. These measurements can be analyzed to yield estimates of the column-averaged CO₂ dry air mole fraction, XCO₂, which are most sensitive to CO₂ variations near the surface. The Japanese Greenhouse gases Observing SATellite (GOSAT, nicknamed Ibuki) was the first satellite specifically designed to exploit this approach. The NASA Atmospheric CO₂ Observations from Space (ACOS) team has been collaborating closely with the GOSAT Project team to perform annual vicarious calibration campaigns, retrieve XCO₂ from GOSAT TANSO-FTS spectra, and validate these results against a variety of standards, including surface-based XCO₂ retrievals from the Total Carbon Column Observing Network (TCCON). Recent XCO₂ products from this collaboration show little or no bias and have random errors that are typically less than 0.5% on regional scales over much of the Earth. These XCO₂ estimates are now being used in flux inversion models to assess their impact on our understanding CO₂ sources and sinks. This experience is expected to accelerate the delivery of high quality XCO₂ products from the NASA Orbiting Carbon Observatory-2 (OCO-2), once it has been successfully launched.

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