

Public release of whole-atmosphere monthly mean carbon dioxide concentration based on observations by Greenhouse gases Observing SATellite "IBUKI" (GOSAT)

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National Institute for Environmental Studies
Japan Aerospace Exploration Agency

The project of the Greenhouse gases Observing SATellite "IBUKI" (GOSAT), the world's first satellite designed specifically for monitoring greenhouse gases from space, is jointly promoted by the Ministry of the Environment, Japan, the National Institute for Environmental Studies, and Japan Aerospace Exploration Agency. The satellite has been in operation since its launch on January 23, 2009.

The whole-atmosphere monthly mean concentration of carbon dioxide (CO₂), calculated by using GOSAT data that reflect CO₂ levels in all layers of the atmosphere, was found to have reached 398.8 ppm in May 2015, while showing seasonal oscillation and yearly rise over the analyzed period. It was also confirmed that the trend line of the whole-atmosphere CO₂ mean, derived by removing averaged seasonal fluctuations from the monthly CO₂ time series, had reached 398.2 ppm in July 2015. The trend line is expected to exceed 400 ppm within the year 2016, given that the rising trend continues. The GOSAT observation elucidates for the first time that CO₂ concentration averaged over all layers of the atmosphere will soon reach the level of 400 ppm, and demonstrates the importance of global greenhouse gas monitoring from space.

• About Greenhouse gases Observing SATellite "IBUKI"

The Greenhouse gases Observing SATellite "IBUKI" (GOSAT) is the world's first satellite designed specifically for the monitoring of greenhouse gases from space. Its primary purpose is to measure the atmospheric concentration of carbon dioxide (CO₂) and methane from space so as to improve the estimation of the surface fluxes of these two gases and, further, to contribute to refining the prediction of future carbon cycle. The satellite has been in operation since its launch on January 23, 2009. The GOSAT Project is jointly promoted by the Ministry of the Environment, Japan, the National Institute for Environmental Studies (NIES), and Japan Aerospace Exploration Agency (JAXA) (hereafter the three parties).

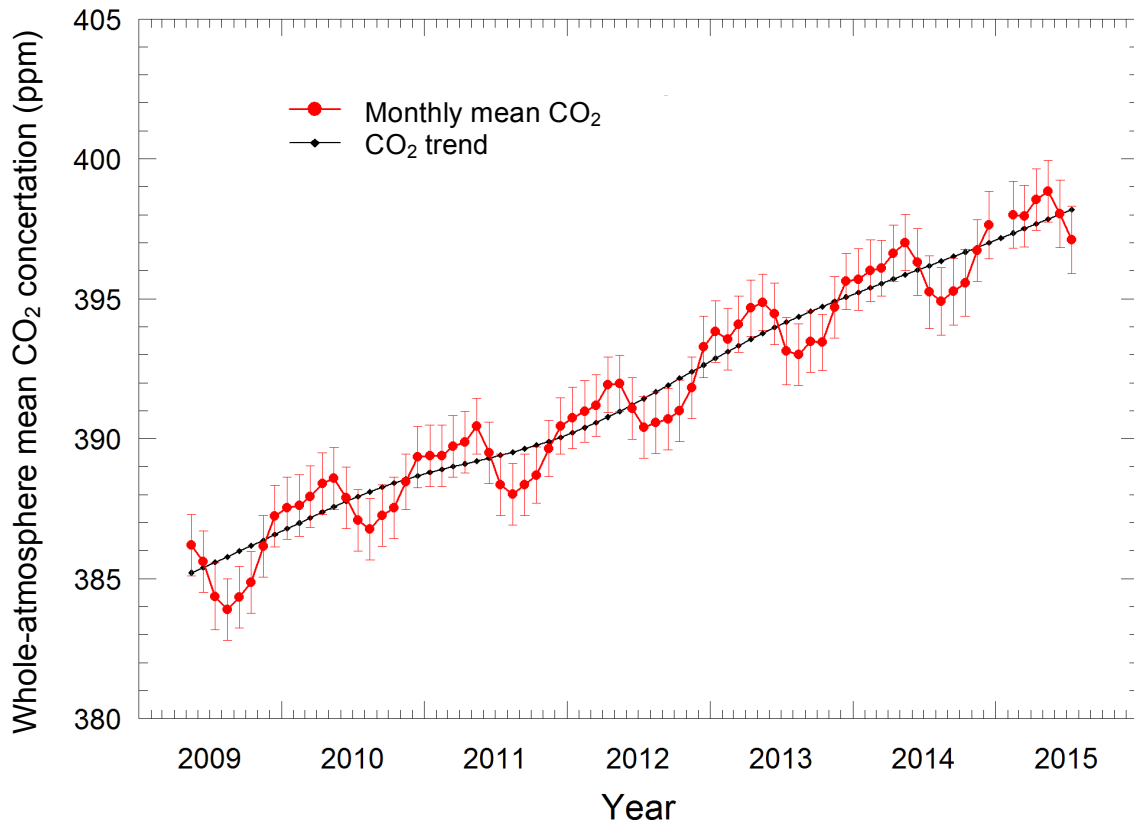
• Characteristics and significance of greenhouse gas observation by GOSAT

CO₂ changes at surface-level monitoring sites and the global CO₂ mean based on those observations have long been reported by the World Meteorological Organization and several other meteorological agencies

around the world. To further facilitate an understanding of overall trends for CO₂ in the atmosphere, knowledge of “whole-atmosphere” CO₂ mean is necessary, and for this, more CO₂ information in the vertical direction is needed. In fact, from past measurements taken by aircraft, CO₂ levels are known to vary with altitude. Model predictions of whole-atmosphere CO₂ mean have appeared in the fifth assessment report by the Intergovernmental Panel on Climate Change, as they are important for predicting the risk of global warming due to rising greenhouse gas levels. This is where CO₂ observation by GOSAT comes in useful, as the satellite measurement encompasses levels from the surface to the top of the atmosphere and provides CO₂ concentration averaged over an entire atmospheric column (this is referred to as column-averaged CO₂ concentration).

• **Whole-atmosphere monthly mean CO₂ concentration as seen by GOSAT**

The whole-atmosphere mean CO₂ concentration was calculated based on GOSAT measurement. Observational data collected by the satellite over a period exceeding six years, between May 2009 and July 2015, were used for this calculation. Over the analyzed period, the monthly mean CO₂ concentration continually rose, with seasonal fluctuations due to photosynthetic activity by plants that intensifies and subsides over a single year in the Northern Hemisphere. The monthly mean reached 398.8 ppm in May 2015. The trend line of the global CO₂ mean, obtained by subtracting averaged seasonal fluctuations from the monthly CO₂ time series, reached 398.2 ppm in July 2015¹⁾. It was also found that the trend line will exceed 400 ppm within the year 2016, if the rising trend continues. It is expected that the monthly mean concentration will reach 400 ppm earlier than the trend line does. We note here that areas that GOSAT measurement can cover are limited to parts of the globe without cloud cover and where the local solar altitude is above a specific threshold. Therefore, the global distribution of column-averaged CO₂ concentration, needed for the calculation of the whole-atmosphere mean CO₂ concentration, was estimated from GOSAT data²⁾. Shown below are the time series of the monthly mean CO₂ concentration and the trend line calculated from the monthly time series³⁾. The values shown here are found to be smaller by 1-2 ppm than those based on CO₂ measurements at the surface level⁴⁾.



Note: The error bar on the red circle indicates uncertainty (one standard deviation) associated with the whole-atmosphere monthly mean.

● **Public release of GOSAT observation results**

The three parties will publicly release the above-mentioned whole-atmosphere monthly mean CO₂ concentration, estimated from GOSAT observations collected over clear-sky areas of the globe. The data will be released on November 16, 2015 from the website of the NIES GOSAT Project. The released data will be updated regularly over the remaining lifetime of the satellite. This public release is intended to highlight the reality of rising CO₂ levels and to contribute to efforts for reducing greenhouse gas emissions.

The released data can be obtained from the webpage “Whole-atmosphere monthly mean CO₂ concentration” (<http://www.gosat.nies.go.jp/en/recent-global-co2.html>) found on the NIES GOSAT Project website.

The three parties will continue the public dissemination of new findings from GOSAT observation. Also, the parties plan to continue the ongoing space-based greenhouse gas observation with the GOSAT successor (GOSAT-2), which is planned to be launched in 2018. Results of the continued observation will be utilized for the elaboration and refinement of global warming predictions.

Notes:

- 1) Some of the GOSAT data used in this analysis, dated after February 2015, are still preliminary, pending final validation.
- 2) See Appendix for more details on the estimation approach used.
- 3) Result for January 2015 is missing due to lacking data for instrument adjustment
- 4) US National Oceanic and Atmospheric Administration reported that global mean CO₂ concentration based on surface level measurements reached 400 ppm in March 2015. Source: <http://research.noaa.gov/News/NewsArchive/LatestNews/TabId/684/ArtMID/1768/ArticleID/11153/Greenhouse-gas-benchmark-reached-.aspx>

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