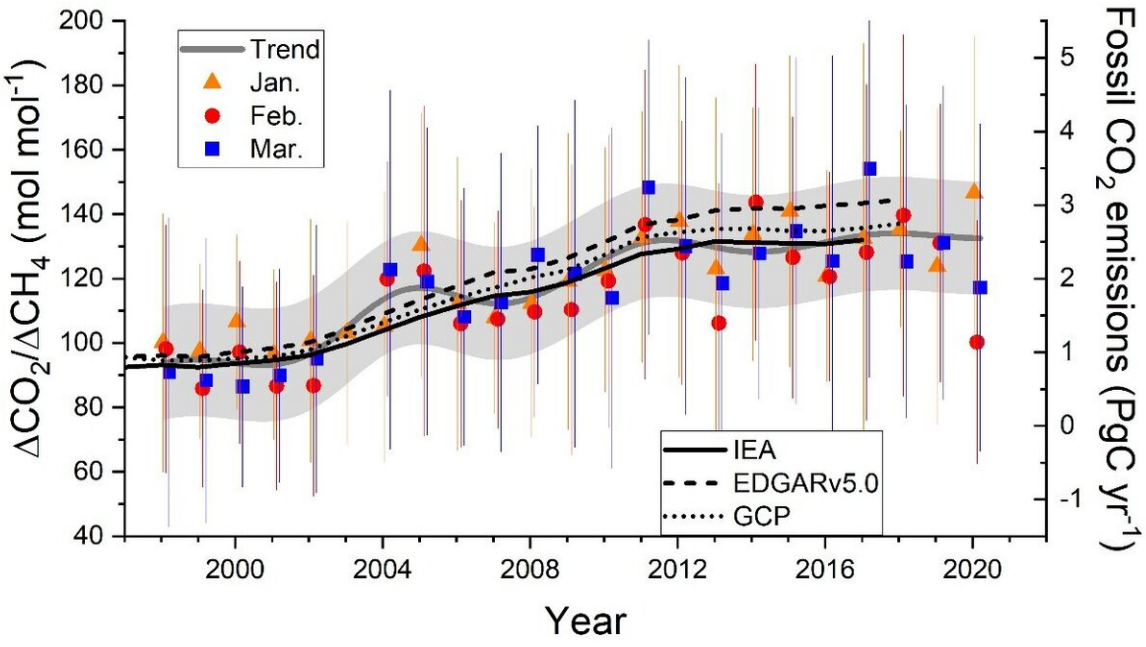
Decrease in fossil-fuel carbon dioxide emissions due to COVID-19 detected by atmospheric observations

November 6 2020



Temporal change in monthly averages of the variation ratio of the atmospheric CO2 to CH4 in January, February, and March observed at Hateruma Island since 1998. The grey thick line represents the smoothed trend curve, and the grey-shaded area represents the 95% range of the variations from the trend curve. The black solid, broken, and dotted lines are the estimated fossil-fuel-related CO2 emissions from China. Credit: NIES

Atmospheric observations at Hateruma Island, Japan, successfully detected the decrease in fossil-fuel CO_2 emissions in China associated with the COVID-19 outbreak. The weather in Hateruma island is frequently influenced by the northwest monsoon traveling over China, which carries the emission signals of air pollutants. The observed ratios of CO_2 and CH_4 variabilities showed a significant decrease during February-March 2020, corresponding to about a 30% decrease in China's fossil-fuel CO_2 emissions, according to a chemistry-transport model simulation.

Tracking emissions of anthropogenic greenhouse gasses by atmospheric observations is a major challenge for policymaking, such as the Paris Agreement. Huge atmospheric observation networks comprised of a variety of platforms including satellites have been developed to monitor regional/country-scale changes in the anthropogenic greenhouse gas emissions. The outbreak of the new coronavirus (COVID-19) has been affecting the global socio-economic activity, leading to a significant reduction in fossil-fuel-derived CO_2 ($FFCO_2$) emissions and other anthropogenic air pollutants in the world. This situation gave us a unique opportunity to assess our ability to quantify the changes in the regional FFCO2 emissions using atmospheric observations. However, there are few reports of observational evidence for CO_2 emission reduction due to the COVID-19 lockdown, although a large number of publications have reported reductions in short-lived air pollutants from various parts of the world.

In *Scientific Reports* by Nature Publishing, researchers from the National Institute for Environmental Studies (NIES), Japan, and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) analyzed atmospheric CO_2 and CH_4 concentrations observed at Hateruma Island, Japan, which is located in the continental margin of East Asia, and

detected signals related to the $FFCO_2$ reduction in China caused by the restrictions associated with the COVID-19 outbreak in January-March 2020.

We estimated that the FFCO2 emissions decreased by about 20% during January-February 2020 as a result of the measures to prevent the spread of COVID-19 within China and to the outside world. While a significant reduction of the atmospheric pollutants has been reported, papers on the atmospheric signals of the $FFCO_2$ reduction are yet to be found in the published literature. "The size of the atmospheric reservoir of CO_2 is quite large and the atmospheric CO_2 has a relatively long lifetime. These characteristics make the change in the atmospheric CO_2 concentrations caused by the COVID-19 influence quite small," stated Prabir K. Patra, co-author of the study and researcher at JAMSTEC.

To detect such faint signals in the CO_2 variations, the research team of NIES and JAMSTEC focused on the relative variation of the atmospheric CO_2 and CH_4 observed at Hateruma Island for the past 20 years at daily time intervals. "The atmospheric observation at Hateruma Island is often influenced by the continental emissions during winter due to the airflow pattern caused by the East Asian monsoon. We know that the temporal variations in the atmospheric CO_2 and CH_4 concentrations show considerable similarity, and the temporal change in the ratio of CO_2 to CH_4 variations trace very well the temporal change in fossil-fuel emissions in China for the years before 2020," said Yasunori Tohjima, lead author of the study and researcher at NIES. "Thus the variation ratio of CO_2 to CH_4 was expected to detect the signal reflecting the change in the continental CO_2 emissions related to COVID-19 restrictions."

The research team found that the monthly average ratio of the atmospheric CO_2 to CH_4 variations in January, February, and March tracked the yearly increase in FFCO2 emissions from China during 1997-2019. However, the ratios showed significant decreases in

February and March 2020, which coincided with the lockdown period in China. "The relationship between the variation ratio and the $FFCO_2$ emissions from China should be evaluated by using an atmospheric transport model and a set of CO_2 and CH_4 flux maps," said Yosuke Niwa, co-author of the study and researcher at NIES. "We used multiple simulations of atmospheric CO_2 and CH_4 at Hateruma Island for various emission reduction scenarios of fossil-fuel CO_2 by using NICAM-TM." The study thus concluded that China's $FFCO_2$ emissions decreased by about 30% in February and about 20% in March 2020. "Our approach presented in this study has the potential to detect signals from the emission reduction from any specific region in near-real-time using continuous and high-precision measurements of CO_2 and CH_4," mentioned Prabir K. Patra.

More information: Yasunori Tohjima et al, Detection of fossil-fuel CO2 plummet in China due to COVID-19 by observation at Hateruma, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-75763-6

Provided by National Institute for Environmental Studies