The last El Niño in 2015-16 impacted the amount of carbon dioxide that Earth's tropical regions released into the atmosphere, , leading to Earth's recent record spike in atmospheric carbon dioxide. The effects of the El Nino were different in each region. Credit: NASA-JPL/Caltech

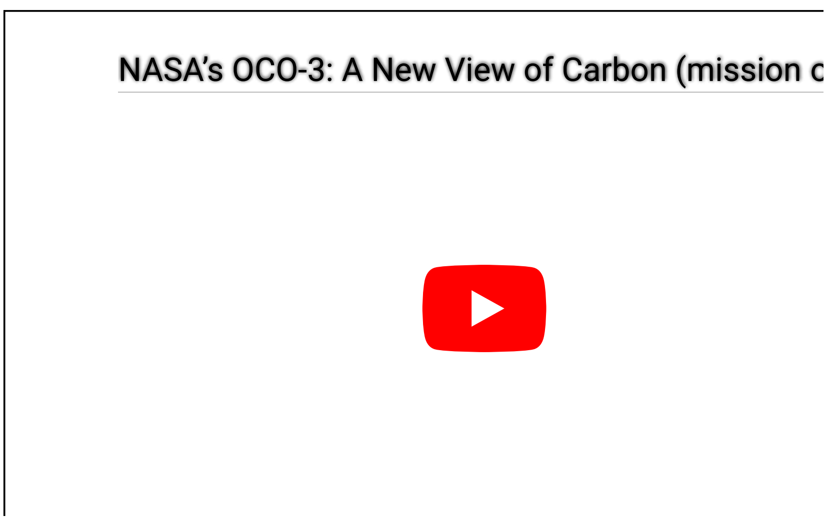
“The other half is also quite interesting,” he added. “We’re seeing northern mid- and high-latitude rainforests becoming better and better absorbers for carbon dioxide over time. One possible explanation for this is that the growing season is getting longer. Things that didn’t used to grow well at high latitudes are growing better and things that were growing well there before are growing longer. We’re seeing that in our data set. We see that South America’s high southern latitudes — the so-called cone of South America — are also strong absorbers for carbon. We don’t know if it was always this way and our previous understandings were incomplete or wrong, or if climate change has increased the intensity of the growing season. So we’ve established a new baseline, and it appears to be somewhat of a paradigm shift. Our space-based measurements are beginning to change our understanding of how the carbon cycle works and are providing new tools to allow us to monitor changes in the future in response to climate change.”

Crisp says OCO-2, OCO-3 and other new satellites are giving us new tools to understand how, where and how much carbon dioxide human activities are emitting into the atmosphere and how those emissions are interacting with Earth’s natural cycles. “We’re getting a sharper picture of those processes,” he said.

Impacts from agricultural activities also seem to be changing, he says. During summer in the U.S. upper Midwest, scientists are seeing an intense absorption of carbon dioxide associated with agricultural activities. The same thing is being observed in Eastern and Southern Asia. The strong absorption of carbon dioxide across China is erasing all but a thin strip of fossil fuel emissions along the coast, with Central China now functioning as a net absorber of carbon dioxide during the growing season. Thanks to the development of big, sophisticated computer models combined with wind and other measurements, we’re able to quantify these changes for the first time.

In response to the rapid changes observed in carbon dioxide concentrations and their potential impact on our climate, 33 of the world's space agencies, including participants from the United States, Europe, Japan and China, are now working together to develop a global greenhouse gas monitoring system that could be implemented as soon as the late 2020s, Crisp added. The system would include a series of spacecraft making coordinated measurements to monitor these changes. Key components of the system would include the OCO-2 and OCO-3 missions, Japan's GOSAT and GOSAT-2, and Europe's Copernicus missions. The system would be complemented by ground-based and aerial research.

Crisp said he and his fellow team members are eagerly poring over the first science data from OCO-3. The new instrument, installed on the exterior of the space station, will extend and enhance the OCO-2 data set by collecting the first dawn-to-dusk observations of variations in carbon dioxide from space over tropical and mid-latitude regions, giving scientists a better view of emission and absorption processes. This is made possible by the space station's unique orbit, which carries OCO-3 over locations on the ground at slightly different times each orbit.



NASA's OCO-3 mission launched to the International Space Station on May 4, 2019. This follow-on to OCO-2 brings new techniques and new technologies to carbon dioxide observations of Earth from space. Credit: NASA-JPL/Caltech

The Copernicus CO2 Mission, scheduled for launch around 2025, will be the first operational carbon dioxide monitoring satellite constellation. Crisp, who's a member of its Mission

Advisory Group, said the constellation will include multiple satellites with wide viewing swaths that will be able to map Earth’s entire surface at weekly intervals. While its basic measurement technique evolved from the GOSAT and OCO-2 missions, there’s a key difference: the earlier satellites are sampling systems focused on improving understanding of Earth’s natural carbon cycle, while Copernicus will be an imaging system focused on monitoring human-produced emissions. In fact, it will have the ability to estimate the emissions of every large power plant in every city around the world.

Crisp says as time goes on the objective is to build an operational system that will monitor all aspects of Earth’s environment. Pioneering satellites like OCO-2, OCO-3, GOSAT and GOSAT-2 are adding greenhouse gas measurements to the data on temperature, water vapor, cloud cover, air quality and other atmospheric properties that have been collected for decades.

“We know our atmosphere is changing and that these changes may affect our civilization,” he said. “We now have the tools to monitor our atmosphere very carefully so that we can give policymakers the best information available. If you’ve invested in a carbon reduction strategy, such as converting from coal to natural gas or transitioning from fossil fuels to renewables, wouldn’t you like to know that it worked? You can only manage what you can measure.”

For more on OCO-2, visit https://ocov2.jpl.nasa.gov/.

For more on OCO-3, visit https://ocov3.jpl.nasa.gov/.

Part One of this series: '*The Atmosphere: Earth's Security Blanket'*

Next up: 'The Atmosphere: Tracking the Ongoing Recovery of Earth’s Ozone Hole'

This website is produced by the Earth Science Communications Team at

NASA's Jet Propulsion Laboratory | California Institute of Technology

Site Editor: **Holly Shaftel**
Managing Editor: **Susan Callery**
Senior Producer: **Randal Jackson**
Senior Science Editor: **Daniel Bailey**
Science Editor: **Susan Callery**

Site last updated: March 31, 2023