A Climate Conundrum

During the COVID-19 pandemic, carbon dioxide increased at the same rate in the atmosphere despite lower emissions, say researchers from campus and JPL; plus, what is good for ozone reduction is bad for methane removal.
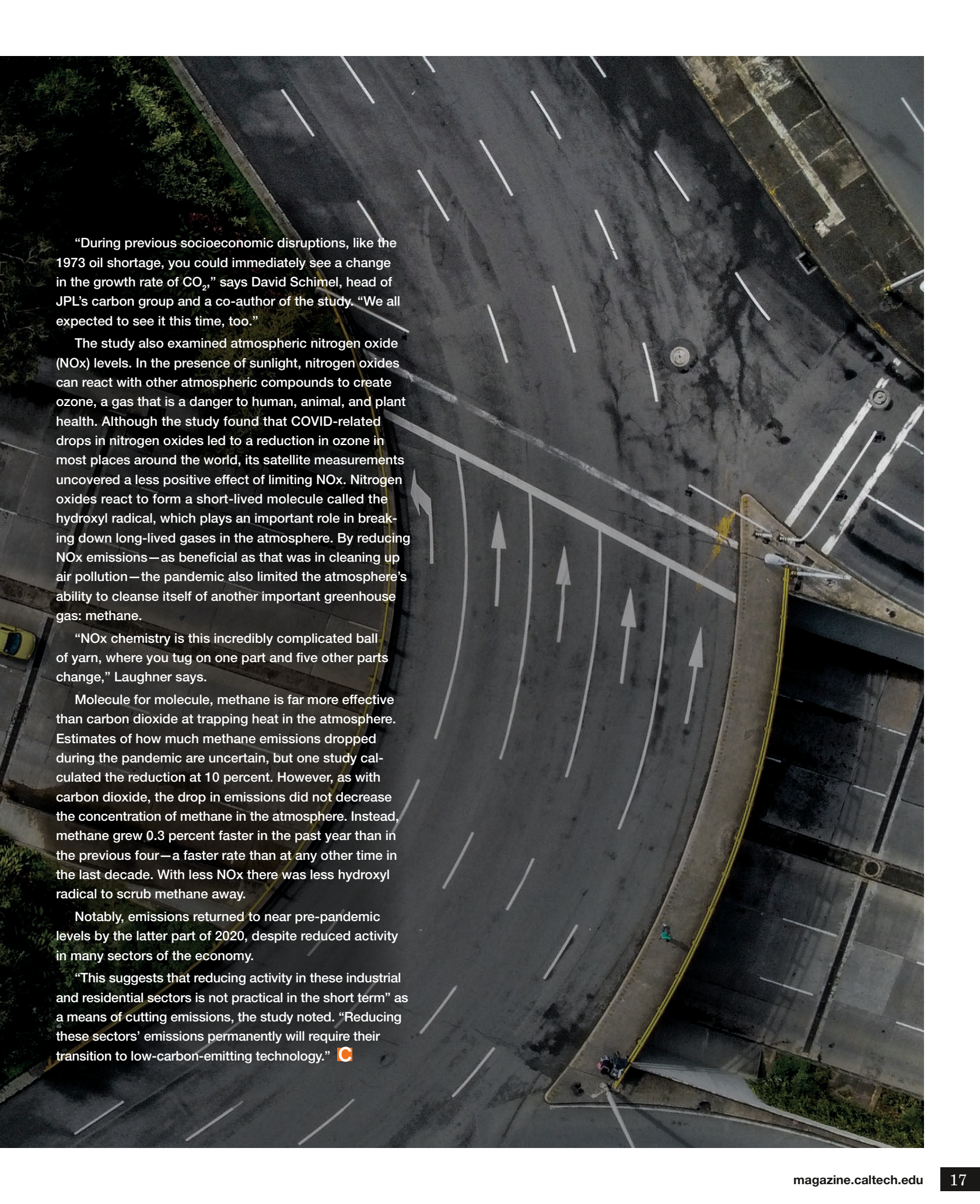
By Carol Rasmussen

A comprehensive new survey of the COVID-19 pandemic's effects on the atmosphere that uses satellite data from NASA and other international space agencies offers insights into addressing the dual threats of climate warming and air pollution.

"We're past the point where we can think of these as two separate problems," says Joshua Laughner, lead author of the study and a former postdoctoral fellow in the Division of Geological and Planetary Sciences who now works at JPL, which Caltech manages for NASA. "To understand what is driving changes to the atmosphere, we must consider how air quality and climate influence each other."

Published in November 2021 in the *Proceedings of the National Academy of Sciences*, the paper developed out of a workshop sponsored by the W. M. Keck Institute for Space Studies and led by scientists on campus and at JPL.

The COVID-19 pandemic and resulting limitations put on travel and other economic sectors by countries around the globe drastically decreased air pollution and greenhouse gas emissions within just a few weeks. However, while carbon dioxide (CO_2) emissions fell by 5.4 percent in 2020 compared to the previous year, the amount of carbon dioxide in the atmosphere continued to grow at about the same rate as in preceding years. While the drop in emissions was significant, the growth in atmospheric concentrations of CO_2 was within the normal range of year-to-year variation caused by natural processes. Also, the ocean did not absorb as much carbon dioxide from the atmosphere as it has in recent years, probably due to the reduced pressure of carbon dioxide in the air at the ocean's surface.

"During previous socioeconomic disruptions, like the 1973 oil shortage, you could immediately see a change in the growth rate of CO_2," says David Schimel, head of JPL's carbon group and a co-author of the study. "We all expected to see it this time, too."

The study also examined atmospheric nitrogen oxide (NOx) levels. In the presence of sunlight, nitrogen oxides can react with other atmospheric compounds to create ozone, a gas that is a danger to human, animal, and plant health. Although the study found that COVID-related drops in nitrogen oxides led to a reduction in ozone in most places around the world, its satellite measurements uncovered a less positive effect of limiting NOx. Nitrogen oxides react to form a short-lived molecule called the hydroxyl radical, which plays an important role in breaking down long-lived gases in the atmosphere. By reducing NOx emissions—as beneficial as that was in cleaning up air pollution—the pandemic also limited the atmosphere's ability to cleanse itself of another important greenhouse gas: methane.

"NOx chemistry is this incredibly complicated ball of yarn, where you tug on one part and five other parts change," Laughner says.

Molecule for molecule, methane is far more effective than carbon dioxide at trapping heat in the atmosphere. Estimates of how much methane emissions dropped during the pandemic are uncertain, but one study calculated the reduction at 10 percent. However, as with carbon dioxide, the drop in emissions did not decrease the concentration of methane in the atmosphere. Instead, methane grew 0.3 percent faster in the past year than in the previous four—a faster rate than at any other time in the last decade. With less NOx there was less hydroxyl radical to scrub methane away.

Notably, emissions returned to near pre-pandemic levels by the latter part of 2020, despite reduced activity in many sectors of the economy.

"This suggests that reducing activity in these industrial and residential sectors is not practical in the short term" as a means of cutting emissions, the study noted. "Reducing these sectors' emissions permanently will require their transition to low-carbon-emitting technology." **C**