

# Study predicts best times for Curiosity to sample Mars' methane

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Conceptual diagram of NASA's Curiosity rover measuring methane on the surface of Mars. Credit: John P. Ortiz 2022.

Since methane was first detected in Mars' atmosphere 20 years ago, scientists have struggled to uncover its origins and how it is transported around the Red Planet. Measurements from atmospheric samples collected by NASA's Curiosity rover at Gale crater reveal fluctuations in methane levels over days and seasons, but pinpointing the timing and reasons for the variability has proved difficult. These emissions, possibly produced by subsurface microbes, could provide vital evidence of life on Mars. However, sampling strains Curiosity's limited resources, so determining both why fluctuations occur and when to best capture samples is paramount.

According to a recent study led by John Ortiz, an [environmental engineering](#) doctoral candidate at Johns Hopkins University, barometric pumping could be responsible for bringing gases from beneath the planet's surface into its atmosphere at irregular but predictable intervals. This [natural mechanism](#) could hold valuable information for the Curiosity mission, which is currently in its 11th year.

"Barometric pumping is a process in which variations in atmospheric [pressure](#) can push and pull gases from underground rock pores up to the surface," said Ortiz, of the Department of Environmental Health and Engineering. "Just like on Earth, daily [atmospheric pressure](#) changes on Mars are largely caused by heating from the sun—cooler air at night has higher pressure, warmer air during the day has lower pressure. The ground can essentially 'breathe' out gases like methane by pushing them up to the surface through fractures when atmospheric pressures are low and pulling them back underground when air pressure is high."

The team's results appear in the [Journal of Geophysical Research: Planets](#). Researchers included Ortiz's colleagues at Johns Hopkins, Los Alamos National Laboratory, Purdue University, and the Freshwater Trust.

For their investigation, the researchers used computer models to simulate

how methane moves beneath the Martian surface, as well as how it mixes within the atmosphere. They then compared their simulated methane concentrations with the Curiosity rover's measurements. Because Mars' weather and atmospheric pressures are much less chaotic than Earth's, the researchers were able to make predictions of atmospheric methane levels over time.

One significant finding of the researchers' [computer simulations](#) was a "puff" of methane just before the Martian sunrise—information that could guide Curiosity as it performs a series of atmospheric sampling experiments as part of a current campaign to characterize methane fluctuations at Gale crater.

"Our work suggests several key time windows for Curiosity to collect data, each of which has the potential to tell us something different about methane circulation and transport processes. We think these offer the best chance of constraining the timing of [methane](#) fluctuations and hopefully down the line bringing us closer to understanding where it comes from on Mars," said Harihar Rajaram, a professor of environmental health and engineering at Johns Hopkins and Ortiz's doctoral adviser.

Authors include: Kevin Lewis, an associate professor at Johns Hopkins University; Phillip Stauffer, a scientist at Los Alamos National Laboratory; Roger Wiens, a professor at Perdue University; and Dylan Harp, a computational hydrologist at Freshwater Trust.

**More information:** J. P. Ortiz et al, Sub-Diurnal Methane Variations on Mars Driven by Barometric Pumping and Planetary Boundary Layer Evolution, *Journal of Geophysical Research: Planets* (2024). [DOI: 10.1029/2023JE008043](#)

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