

Martian dust storm covers the entire planet

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A dust storm on Mars which began three weeks ago has grown to encompass the entire planet. It is comparable in scale to the storm observed by Viking I in 1977, while somewhat more patchy and diffuse than those observed by Mariner 9 in 1971-72 and by Mars Global Surveyor and the Hubble Space Telescope in 2001. What is unique, however, about this storm is that for the first time, researchers have a view of a Martian planet-encircling dust storm both from orbit and from the ground.

There is currently a constellation of six satellites orbiting Mars and analyzing the storm—ExoMars, MAVEN, Mangalyaan, Mars Reconnaissance Orbiter, Mars Express and Mars Odyssey. The Curiosity rover is viewing the storm from the ground while the Opportunity rover, which is solar powered, is currently offline since the dust is blocking the sunlight needed to recharge its batteries. Every one of these robotic explorers is engaged in studying this phenomenon and their combined data will provide the most comprehensive data on Martian weather and climate to date.

The storm was first detected by NASA's Mars Reconnaissance Orbiter as it was approaching Endeavour crater, the site being analyzed by the nearly 15-year-old Opportunity rover. The rover's team was immediately notified, in the case the storm grew enough to block out sunlight needed to power the rover. The contingency plans proved necessary, as by June 6, power levels on the rover dropped low enough to force it to hibernate.

This is not the first time Opportunity has been forced to suspend operations by Martian weather. In 2007, a previous Martian global dust storm also blocked out enough sunlight to force the rover to go into its emergency power mode. Afterwards, Opportunity and its then still active twin rover Spirit, recovered once the storm subsided. While the current storm is still less

powerful than its predecessor, there still a risk that the rover's small nuclear-powered heaters will not be enough to keep the main batteries warm enough to resume its explorations, a risk that grows every day the storm continues.

Curiosity, which arrived on Mars in 2012, is still fully operational. This rover is too large to be powered by even the most advanced solar panels, and so has a nuclear generator powered by five kilograms of plutonium to provide electrical power. This power source lets the rover continue normal operations, which now include beaming data back to Earth on conditions from the ground as the storm has intensified.

While it will take weeks and months to analyze the different aspects of the data sent by the satellites and rover, scientists on Earth are excited to have such a three-dimensional view of a Martian dust storm. Ever since they were first studied in the 1950s, the storms have been considered one of the primary ways of understanding the red planet's climate.

There have been many hypotheses about the mechanisms that create the dust storms, but none so far have been able to predict when a storm will happen or how long it will last. What is known is that these storms tend to occur during Mars' closest approach to the Sun, during the Martian spring and summer in its southern hemisphere, considered "dust storm season." During this time, local dust storm wind speeds can exceed the 65 kilometers per hour needed to pick dust up from the surface. However, unlike Earth where rain washes dust out of the sky, the arid climate on Mars allows the dust to stay in the atmosphere for weeks. That is how clouds of dust can cover the whole planet. Based on past statistics, it is estimated that the chance of this happening in any given Martian year is one in three.

While astronomers may not have been able to pin down the cause of these storms, they have been able to

look at some of the effects. The most prominent finding came from an analysis using the Mars Reconnaissance Orbiter, showing that up to ten percent of Mars' water loss is caused by these storms. Data from the 2007 dust storm revealed water vapor nearly 80 kilometers above the surface, an abnormally high altitude. Here, ultraviolet light from the Sun is able to break the chemical bonds of oxygen and hydrogen, allowing the hydrogen to escape into space.

This finding, which was published this past February, is another clue to the red planet's missing water. Recent studies using Curiosity data have shown that Mars once had an ocean at least 137 meters deep, something that had long been suspected but not proven. If the ocean existed, however, where is it now? The red planet's dust storms are a likely culprit for at least some of the missing water.

Before the storm erupted, Curiosity was engaged in its primary mission, analyzing the potential that Earth-like life could have existed on Mars in its earliest days. As the storm was developing, NASA presented new evidence that early Mars could have supported life. During its studies of three-billion-year-old sedimentary rock in Gale Crater, Curiosity uncovered organic molecules, an indication that at least some of the processes that led to life on early Earth also occurred on early Mars.

Curiosity has not, however, discovered the origin of these molecules. Most organic compounds on the Earth are produced by biological systems, but non-biological processes had to create the earliest biological molecules, precursors to biological systems, in the first place. Such processes have been observed on Saturn's moon Titan and Jupiter's moon Europa. The study of Earth's neighbor will provide even more knowledge about the potential for life on worlds beyond our own.

The rover also detected a regular pattern in the methane content in the atmosphere surrounding Gale Crater, which peaked in the summer months and dropped in the winter for the past three Martian years. Previous studies have found plumes of methane released from beneath the surface in a seemingly random fashion. This is the first time that changes in methane have had a pattern, one that scientists are using to make a prediction about methane concentrations for the coming year. And while geological causes for this methane release are much more likely, organic

processes have not been ruled out.



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