

Parker solar probe captures its first images of Venus' surface in visible light

February 9 2022, by Mara Johnson-Groh



Credit: NASA's Goddard Space Flight Center

NASA's Parker Solar Probe has taken its first visible light images of the surface of Venus from space.

Smothered in thick clouds, Venus' [surface](#) is usually shrouded from sight. But in two recent flybys of the planet, Parker used its Wide-Field Imager, or WISPR, to image the entire nightside in wavelengths of the visible spectrum—the type of light that the human eye can see—and extending into the near-infrared.

The images, combined into a video, reveal a faint glow from the surface that shows distinctive features like continental regions, plains, and plateaus. A luminescent halo of oxygen in the atmosphere can also be seen surrounding the planet.

"We're thrilled with the science insights Parker Solar Probe has provided thus far," said Nicola Fox, division director for the Heliophysics Division at NASA Headquarters. "Parker continues to outperform our expectations, and we are excited that these novel observations taken during our gravity assist maneuver can help advance Venus research in unexpected ways."

Such images of the planet, often called Earth's twin, can help scientists learn more about Venus' surface geology, what minerals might be present there, and the planet's evolution. Given the similarities between the planets, this information can help scientists on the quest to understand why Venus became inhospitable and Earth became an oasis.

"Venus is the third brightest thing in the sky, but until recently we have not had much information on what the surface looked like because our view of it is blocked by a thick atmosphere," said Brian Wood, lead author on the new study and physicist at the Naval Research Laboratory in Washington, DC. "Now, we finally are seeing the surface in visible wavelengths for the first time from space."

Unexpected capabilities

The first WISPR images of Venus were taken in July 2020 as Parker embarked on its third flyby, which the spacecraft uses to bend its orbit closer to the Sun. WISPR was designed to see faint features in the solar atmosphere and wind, and some scientists thought they might be able to use WISPR to image the cloud tops veiling Venus as Parker passed the planet.

"The objective was to measure the speed of the clouds," said WISPR project scientist Angelos Vourlidas, co-author on the new paper and researcher at Johns Hopkins University Applied Physics Laboratory.

But instead of just seeing clouds, WISPR also saw through to the surface of the planet. The images were so striking that the scientists turned on the cameras again during the fourth pass in February 2021. During the 2021 flyby, the spacecraft's orbit lined up perfectly for WISPR to image Venus' nightside in entirety.

"The images and video just blew me away," Wood said.

Glowing like an iron from the forge

Clouds obstruct most of the visible light coming from Venus' surface, but the very longest visible wavelengths, which border the near-infrared wavelengths, make it through. On the dayside, this red light gets lost amid the bright sunshine reflected off Venus' cloud tops, but in the darkness of night, the WISPR cameras were able to pick up this faint glow caused by the incredible heat emanating from the surface.

"The surface of Venus, even on the nightside, is about 860 degrees," Wood said. "It's so hot that the rocky surface of Venus is visibly glowing, like a piece of iron pulled from a forge."

As it passed by Venus, WISPR picked up a range of wavelengths from

470 nanometers to 800 nanometers. Some of that light is the near-infrared—wavelengths that we cannot see, but sense as heat—and some is in the visible range, between 380 nanometers and about 750 nanometers.

Venus in a new light

In 1975, the Venera 9 lander sent the first tantalizing glimpses of the surface after landing on Venus. Since then, Venus' surface has been revealed further with radar and infrared instruments, which can peer through the thick clouds by using wavelengths of light invisible to the human eye. NASA's Magellan mission created the first maps in the 1990s using radar and JAXA's Akatsuki spacecraft gathered infrared images after reaching orbit around Venus in 2016. The new images from Parker add to these findings by extending the observations to red wavelengths at the edge of what we can see.

The WISPR images show features on the Venusian surface, such as the continental region Aphrodite Terra, the Tellus Regio plateau, and the Aino Planitia plains. Since higher altitude regions are about 85 degrees Fahrenheit cooler than lower areas, they show up as dark patches amidst the brighter lowlands. These features can also be seen in previous radar images, such as those taken by Magellan.

Beyond looking at surface features, the new WISPR images will help scientists better understand the geology and mineral make-up of Venus. When heated, materials glow at unique wavelengths. By combining the new images with previous ones, scientists now have a wider range of wavelengths to study, which can help identify what minerals are on the surface of the planet. Such techniques have previously been used to study the surface of the Moon. Future missions will continue to expand this range of wavelengths, which will contribute to our understanding of habitable planets.

This information could also help scientists understand the planet's evolution. While Venus, Earth, and Mars all formed around the same time, they are very different today. The atmosphere on Mars is a fraction of Earth's while Venus has a much thicker atmosphere. Scientists suspect volcanism played a role in creating the dense Venusian atmosphere, but more data are needed to know how. The new WISPR images might provide clues about how volcanos may have affected the planet's atmosphere.

In addition to the surface glow, the new images show a bright ring around the edge of the planet caused by oxygen atoms emitting light in the atmosphere. Called airglow, this type of light is also present in Earth's atmosphere, where it's visible from space and sometimes from the ground at night.

Flyby science

While Parker Solar Probe's primary goal is solar science, the Venusian flybys are providing exciting opportunities for bonus data that wasn't expected at the mission's launch.

WISPR has also imaged Venus' orbital dust ring—a doughnut-shaped track of microscopic particles strewn in the wake of Venus' orbit around the Sun—and the FIELDS instrument made direct measurements of radio waves in the Venusian atmosphere, helping scientists understand how the upper atmosphere changes during the Sun's 11-year cycle of activity.

In December 2021, researchers published new findings about the rediscovery of the comet-like tail of plasma streaming out behind Venus, called a "tail ray". The new results showed this tail of particles extending nearly 5,000 miles out from the Venusian atmosphere. This tail could be how Venus' water escaped from the planet, contributing to its current dry

and inhospitable environment.

While the geometry of the next two flybys likely won't allow Parker to image the nightside, scientists will continue to use Parker's other instruments to study Venus' space environment. In November 2024, the spacecraft will have a final chance to image the surface on its seventh and final flyby.

The future of Venus research

Parker Solar Probe, which is built and operated by the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, isn't the first mission to gather bonus data on flybys, but its recent successes have inspired other missions to turn on their instruments as they pass Venus. In addition to Parker, the ESA (European Space Agency) BepiColombo mission and the ESA and NASA Solar Orbiter mission have decided to gather data during their flybys in the coming years.

More spacecraft are headed to Venus around the end of this decade with NASA's DAVINCI and VERITAS missions and ESA's EnVision mission. These missions will help image and sample Venus' atmosphere, as well as remap the surface at higher resolution with infrared wavelengths. This information will help scientists determine the surface mineral make-up and better understand the planet's geologic history.

"By studying the surface and atmosphere of Venus, we hope the upcoming missions will help scientists understand the evolution of Venus and what was responsible for making Venus inhospitable today," said Lori Glaze, director of the Planetary Science Division at NASA Headquarters. "While both DAVINCI and VERITAS will use primarily near-infrared imaging, Parker's results have shown the value of imaging a wide range of wavelengths."

Provided by NASA's Goddard Space Flight Center

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