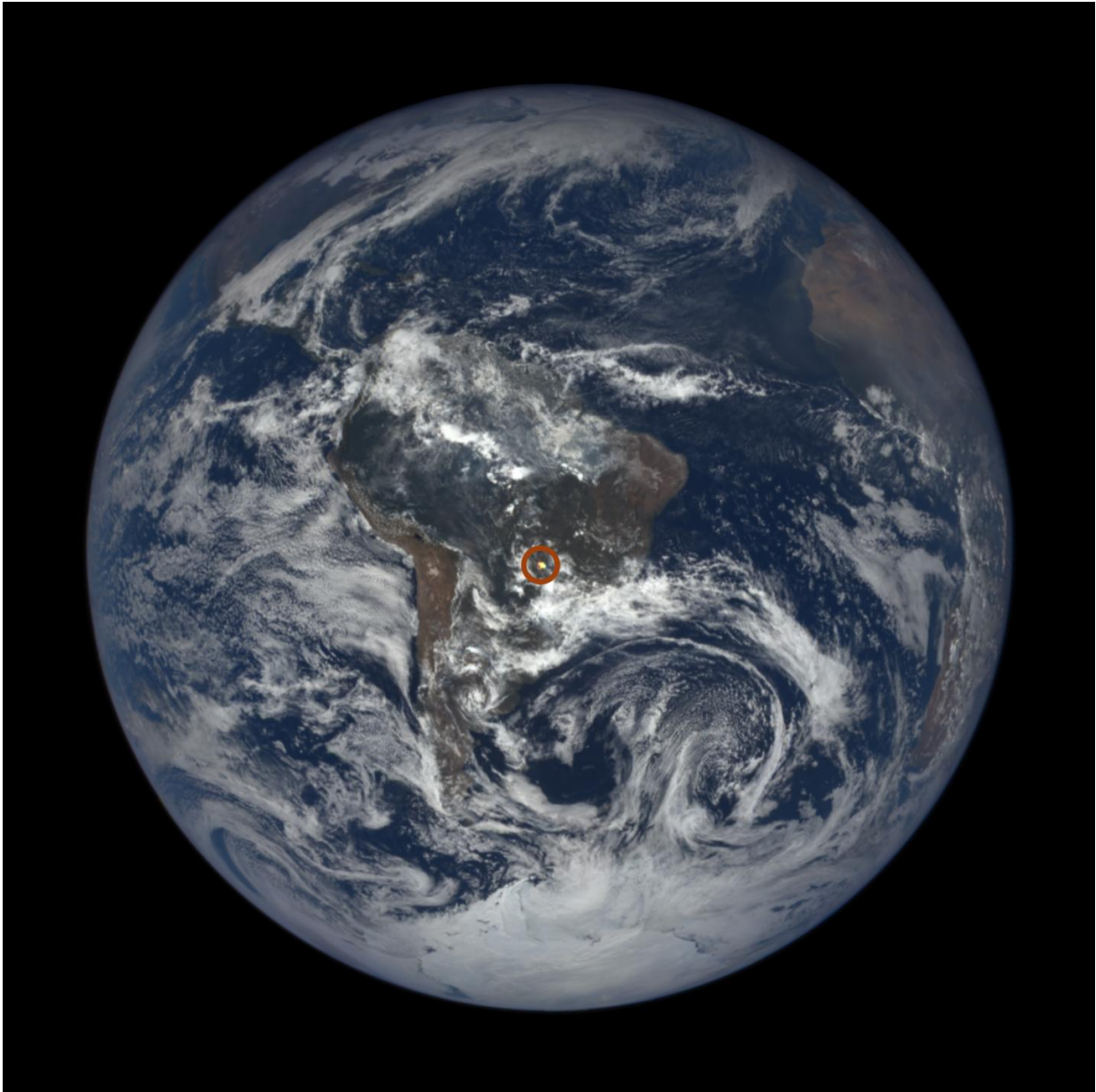


NASA's EPIC view spots flashes on Earth

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Sun glints off atmospheric ice crystals (circled in red) in this view captured by

NASA's EPIC instrument on NOAA's DISCOVER satellite. Credit: NASA's Goddard Space Flight Center

One million miles from Earth, a NASA camera is capturing unexpected flashes of light reflecting off our planet. The homeward-facing instrument on NOAA's Deep Space Climate Observatory, or DSCOVR, launched in 2015, caught hundreds of these flashes over the span of a year. As keen observers from outside NASA wrote in, questioning the source of these lights, scientists deciphered the tiny cause to the big reflections: high-altitude, horizontally oriented ice crystals.

NASA's Earth Polychromatic Imaging Camera (EPIC) instrument aboard DSCOVR is taking almost-hourly images of the sunlit planet from its spot between Earth and the sun. Alexander Marshak, DSCOVR deputy project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, first noticed light flashes occasionally appearing over oceans as he looked through that day's EPIC images.

Investigating the flashes, Marshak and his colleagues found that similar reflections from our pale blue dot caught the attention of astronomer Carl Sagan in 1993. Sagan was looking at images taken by the Galileo spacecraft, which launched in 1989 to study Jupiter and its moons. During one of its gravitational-assist swings around Earth, Galileo turned its instruments on this planet and collected data. Sagan and his colleagues used that to test a key question: Whether spacecraft could detect signatures of life from afar.

"Large expanses of blue ocean and apparent coastlines are present, and close examination of the images shows a region of [mirror-like] reflection in ocean but not on land," they wrote of the glints.

Flashes of light reflected off oceans - like those referenced by Sagan - could have a simple explanation, Marshak said: Sunlight hits a smooth part of an ocean or lake, and reflects directly back to the sensor, like taking a [flash](#)-picture in a mirror.

But when the scientists took another look at the Galileo images, they saw something Sagan and his colleagues apparently missed—bright flashes of light over land as well. And those flashes appeared in the EPIC images as well. As the contact listed on the website that posts all EPIC images, Marshak started getting emails from people curious about what the flashes were.

"We found quite a few very bright flashes over land as well," he said. "When I first saw it I thought maybe there was some water there, or a lake the sun reflects off of. But the glint is pretty big, so it wasn't that."

Instead, he and his colleagues Tamas Varnai of the University of Maryland, Baltimore County, and Alexander Kostinski of Michigan Technological University, thought of water elsewhere in the Earth system: ice particles high in the atmosphere. The scientists conducted a series of experiments, detailed in a new paper published in *Geophysical Research Letters*, to confirm the cause of the distant flashes.

First, the researchers cataloged all of the prospective sunlight glints over land in images from the EPIC camera. The flashes show up in three distinct colors because the camera takes the red, green and blue images several minutes apart. In all, the scientists found 866 bursts between DSCOVR's launch in June 2015 and August 2016.

The scientists reasoned that if these 866 flashes were caused by reflected sunlight, they would be limited to certain spots on the globe - spots where the angle between the sun and Earth is the same as the angle between the spacecraft and Earth, allowing for the spacecraft to pick up

the reflected light. When they plotted the locations of the glints with where those angles would match, given Earth's tilt and the spacecraft's location, the two matched.

This helped confirm that it wasn't something like lightning causing the flashes, Marshak said: "Lightning doesn't care about the sun and EPIC's location." The researchers also plotted angles to determine that the light was reflecting off of ice particles floating in the air nearly horizontally.

Another feature of the EPIC data helped confirm that the flashes were from a high altitude, not simply water on the ground. Two channels on the instrument are designed to measure the height of clouds, and when the scientists went to the data they found high cirrus clouds, 3 to 5 miles (5 to 8 kilometers) where the glints were located.

"The source of the flashes is definitely not on the ground. It's definitely ice, and most likely solar reflection off of horizontally oriented particles," Marshak said.

Detecting glints like this from much farther away than in this case could be used by other spacecraft to study exoplanets, he said. As an Earth scientist, however, Marshak is now investigating how common these horizontal ice particles are, and whether they're common enough to have a measureable impact on how much sunlight passes through the atmosphere. If so, it's a feature that could be incorporated into computer models of how much heat is reaching and leaving Earth.

The DSCOVR mission is a partnership between NASA, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Air Force, with the primary objective to maintain the nation's real-time solar wind monitoring capabilities, which are critical to the accuracy and lead time of space weather alerts and forecasts from NOAA.

More information: Carl Sagan et al. A search for life on Earth from the Galileo spacecraft, *Nature* (1993). [DOI: 10.1038/365715a0](https://doi.org/10.1038/365715a0)

Alexander Marshak et al. Terrestrial glint seen from deep space: oriented ice crystals detected from the Lagrangian point, *Geophysical Research Letters* (2017). DOI: 10.1002/2017GL073248 , onlinelibrary.wiley.com/doi/10.1002/2017GL073248/abstract

Provided by NASA's Goddard Space Flight Center

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