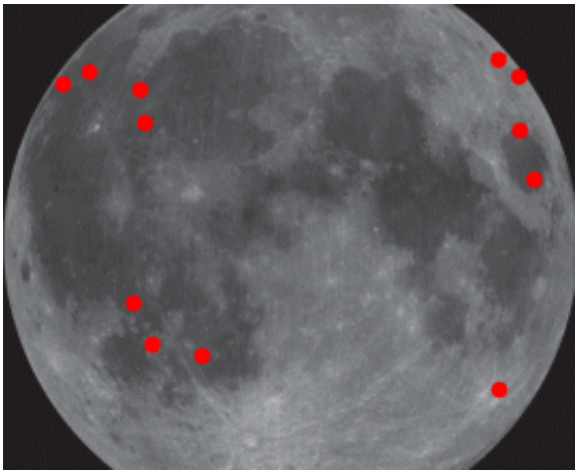
Lunar Leonid Strikes

December 4 2006



Each red dot denotes a meteoroid impact observed since Nov. 2005 by members of the NASA Meteoroid Environment Office. Credit: NASA

Meteoroids are smashing into the Moon a lot more often than anyone expected. That's the tentative conclusion of Bill Cooke, head of NASA's Meteoroid Environment Office, after his team observed two Leonids hitting the Moon on Nov. 17, 2006. "We've now seen 11 and possibly 12 lunar impacts since we started monitoring the Moon one year ago," says Cooke. "That's about four times more hits than our computer models predicted."

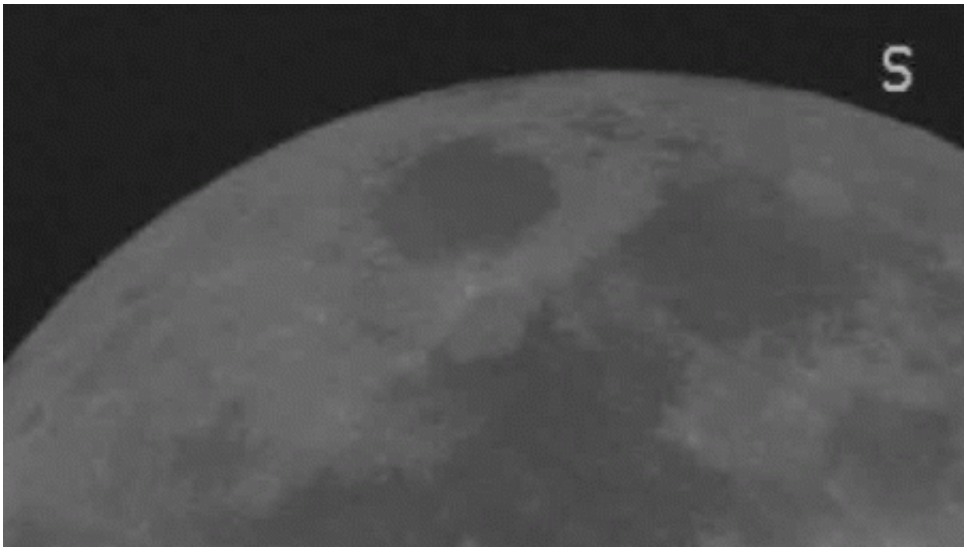
If correct, this conclusion could influence planning for future moon missions. But first, the Leonids:

Last month, Earth passed through a "minefield" of debris from Comet

55P/Tempel-Tuttle. This happens every year in mid-November and results in the annual Leonid meteor shower. From Nov. 17th to Nov. 19th both Earth and the Moon were peppered with meteoroids.

Meteoroids that hit Earth disintegrate harmlessly (and beautifully) in the atmosphere. But the Moon has no atmosphere to protect it, so meteoroids don't stop in the sky. They hit the ground. The vast majority of these meteoroids are dust-sized, and their impacts are hardly felt. But bigger debris can gouge a crater in the lunar surface and explode in a flash of heat and light. Some flashes can be seen from Earth.

During the passage through Tempel-Tuttle's debris field, Cooke's team trained their telescopes (two 14-inch reflectors located at the Marshall Space Flight Center) on the dark surface of the Moon. On Nov. 17th, after less than four hours of watching, they video-recorded two impacts: a 9th magnitude flash in Oceanus Procellarum (the Ocean of Storms) and a brighter 8th magnitude flash in the lunar highlands near crater Gauss.



An 8th-magnitude Leonid flash near crater Gauss. The movies play in 7x slow motion; otherwise the explosion would be nearly invisible to the human eye.

Credit: NASA

"The flashes we saw were caused by Leonid meteoroids 2 to 3 inches (5 to 8 cm) in diameter," says Cooke. "They hit with energies between 0.3 and 0.6 Giga-Joules." In plain language, that's 150 to 300 pounds of TNT.

How do you get so much energy out of a 3-inch meteoroid? "Leonids travel fast—about 144,000 mph," he explains. "At that speed, even a 3-inch rock packs tremendous energy."

For comparison, the ESA's SMART-1 probe crashed into the Moon on Sept. 2nd, delivering 0.6 Giga-Joules of energy to the lunar surface—the same as the brighter of the two Leonids.

"Leonid impacts are as energetic as the crash of a 700-lb spacecraft!" says Cooke.

With these latest detections, Cooke's group has tallied a dozen "lunar meteors" since Nov. 2005. Most were sporadic meteoroids--meaning they are part of no annual shower like the Leonids, but just random chips of asteroids and comets floating around in space. Cooke estimates that for every four hours they observe the Moon, they see one bright flash caused by the impact of a large meteoroid.

And that's surprising. "Our best models of the lunar meteoroid environment predict a much lower rate—only 25% of what we are actually seeing." The problem may be with the computer models: "They're based on observations of meteors in the skies of Earth," and those data may not translate well to the Moon.

The solution? "We need to spend more time watching the Moon," says Cooke. "With more data, we can draw stronger conclusions about the impact rate."

NASA needs that kind of information to decide, e.g., if it's safe for astronauts to go moonwalking during a meteor shower; and to calculate the necessary thickness of shielding for lunar spacecraft and habitats.

Next up: The Geminid meteor shower on December 13th-14th. Once again Earth and Moon will be peppered with meteoroids—this time from the asteroid 3200 Phaethon. Says Cooke, "we'll be watching."

Source: Science@NASA, by Dr. Tony Phillips