Space Operations Digest

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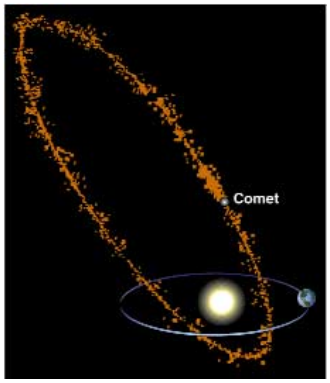
Space Operations Digest was created to share information of interest to satellite operators and others in the space community. This issue examines micrometeoroid storms and their effects on satellites.

Celestial Showers and Storms

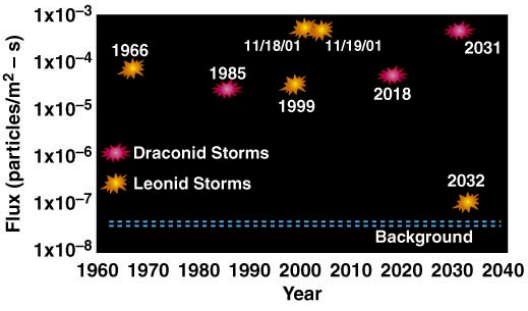
Background. Micrometeoroid showers take place when Earth intersects a comet's orbit and encounters clouds of tiny debris particles trailing the comet. Showers occur several times a year. They normally are harmless spectacles, which result when dozens, sometimes hundreds, of particles burn up per hour in Earth's atmosphere. Micrometeoroid storms (when more than 1,000 particles per hour can be seen at peak periods) occur when Earth comes across dense rings trailing comets.



Micrometeoroid outbursts result from the Earth's crossing a comet's trail. Because the trail consists of multiple substreams, each encounter may entail several bursts over a few hours.

The Leonids. Comet Temple-Tuttle orbits the sun in 33-year cycles. It creates the intense Leonid storms, which registered a peak debris rate in 1966 approaching 100,000 displays per hour. Leonid particles impact Earth's atmosphere at a speed of about 70 km/sec and can pose a significant threat to satellites.

The intensity of each Leonid storm varies widely, depending on the density of the debris stream and the distance between Earth and the center of the stream. Long-term projections remain imprecise. Other micrometeoroid-producing systems, such as the Draconids, occur as well. We are learning more about these systems.



Micrometeoroid Burst History and Projection (Adjusted to account for risks to satellites)

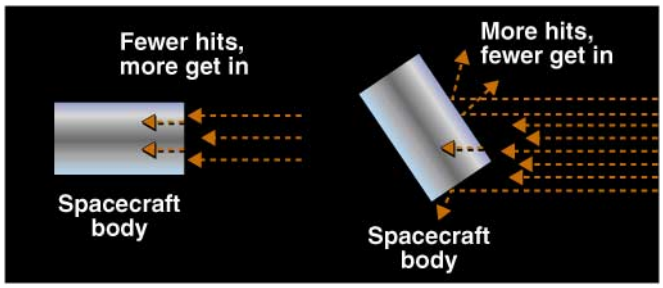
Satellite Damage. Should a particle strike a satellite, multiple problems can ensue. In 1991 the Solar A satellite was believed to have experienced a hit from a Perseid particle. The telescope filter was damaged and substantial capability was lost. In 1993 the Olympus communication satellite lost its Earth-acquisition capability and had to be abandoned. This incident took place during a Perseid shower. The damage was attributed to a power surge caused by a micrometeoroid impact.

In response to these threats, satellite owners have adopted various means to protect their assets. In the widely publicized 1998–2000 Leonid season, only a few minor anomalies were attributed to meteor strikes.

Next Wave. Two more storms, in November 2001 and 2002, are expected in the current phase of Leonid activities. Each may unleash multiple bursts over periods of 16 hours, with well over 1,000 micrometeoroids observable at peak periods.

Risk Mitigation. Subject to operational constraints, satellite owners can employ several simple techniques to greatly reduce risks:

Before a storm arrives, turn telescopes away from the debris stream, adjust solar panels, and orient the satellite to minimize damage potential. Review procedures for rebooting the subsystems and have experienced personnel on duty.



Minimize damage by attitude control.

During the storm, turn off equipment sensitive to electrostatic discharge (ESD). Avoid commanding the satellite or firing thrusters.

Lessons Learned. As events from the recent Leonid storms demonstrated, situational awareness and advanced preparation are vital. Because two more storms are anticipated, we urge satellite operators to maintain vigilance.

The Aerospace Corporation's publication, "Dynamics of Meteor Outbursts and Satellite Mitigation Strategies," provides background information and analyzes tradeoffs among mitigation options. It is a valuable resource to consult when planning for the next storm.

The mission of the Center for Orbital and Reentry Debris Studies is to provide state-of-the-art, objective technical analyses and assessments on space debris, collision avoidance, reentry breakup, and related space hazards. For more information, contact Bill Ailor at 310-336-1135, or via email at William.H.Ailor@aero.org, or visit CORDS online at **http://www.aero.org/cords/**.