Heliophysics nugget: Mapping tons of meteoric dust in the sky

August 9 2013, by Karen C. Fox

Larger meteoroids cause bright flashes of light when they hit Earth's atmosphere, such as this fireball caught during the Perseid meteor shower Aug. 12, 2006. The bulk of meteoric activity is much less showy: Some 10 to 40 tons of meteor dust enter our atmosphere every day. Credit: Courtesy of Pierre Martin

(Phys.org) —Heliophysics nuggets are a collection of early science results, new research techniques, and instrument updates that further our attempt to understand the sun and the dynamic space weather system that surrounds Earth.

On Aug.11 and 12, 2013, the annual Perseid meteor shower will peak, filling the sky with streaks of light, commonly known as shooting stars. Such visually stunning showers are actually but the tip of the iceberg when it comes to meteoroids slamming into Earth's atmosphere: Some 10 to 40 tons of material of invisible meteoric dust enters the atmosphere from interplanetary space every day.

The big showers like the Perseids, and later the Leonids in November, are caused when Earth and its atmosphere travels through a region of the sky filled with left over debris lost by a particular comet. In the case of the Perseids, the small fragments were ripped of the tail of comet Swift-Tuttle, which orbits the sun once every 130 years. The fragments light up due to the immense friction created when they plough into the gas surrounding Earth. Each such fragment is approximately the size of a dime, but the more constant, sporadic meteoroids have been around much longer, breaking down over time into tiny fragments only about as wide as a piece of human hair.

"This is interplanetary dust," said Diego Janches, who studies micrometeoroids at NASA's Goddard Space Flight Center in Greenbelt, Md. "The fragments are either remnants from the solar system's formation, or they are produced by collisions between asteroids or comets from long ago."

Janches researches such tiny meteoroids using radar systems set up around the globe, in places such as Sweden, Puerto Rico and Alaska, or the radar system he deployed and operates in Tierra Del Fuego, Argentina. These fragments plough into Earth's atmosphere at speeds of between 7 to 44 miles per second. They also bring with them minerals and metals from their parent bodies, such as sodium, silicon, calcium and magnesium.

"The small meteoroids feed the atmosphere with all these extra materials," Janches said. "They come in, release metallic atoms that get deposited in the mesosphere and then get pushed around from pole to pole by the general global circulation. So by using the metals as tracers, you can answer some important questions about the general composition and movement of the atmosphere."

The radar systems set up around the world can track such motion. The meteors collide with atoms in the atmosphere and leave behind a path of electrons and charged particles. This electrically charged region acts as a perfect mirror for radar waves, so the radar bounces back carrying both position information and Doppler shift information. This can be used to measure speed and direction of the background atmospheric winds at the altitudes where the meteoric tails are produced, between 40 and 60 miles high in the sky. Because there are so many such trails, they can be used to measure the velocity and direction of the winds continuously, helping to map out very complex wind patterns on a minute-by-minute basis.

Similar techniques, but using lasers, can be used to map how something like sodium sweeps through the entire atmosphere, thus tracing the global circulation system. This system also sweeps the meteoric dust to the poles where, during the summertime, they can serve as nuclei for ice crystals in the sky forming what's called night-shining or noctilucent clouds.

Provided by NASA

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