Scientists identify origin of hiss in upper atmosphere

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Scientists have solved a 40-year-old puzzle by identifying the origin of the intense radio waves in the Earth's upper atmosphere that control the dynamics of the Van Allen radiation belts — belts consisting of high-energy electrons that can damage satellites and spacecraft and pose a risk to astronauts performing activities outside their spacecraft.

The source of these low-frequency radio waves, which are known as plasmaspheric hiss, turns out to be not lightning or instabilities from a plasma, as previously proposed, but an intense electromagnetic wave type called "chorus," which energizes electrons and was initially thought to be unrelated to hiss, said Jacob Bortnik, a researcher with the UCLA Department of Atmospheric and Oceanic Sciences.

The findings appear March 6 in the journal *Nature*.

"That chorus waves are the dominant source of plasmaspheric hiss was a complete surprise," said Bortnik, whose research was federally funded by the National Science Foundation.

"Numerous theories to explain the origin of hiss have been proposed over the past four decades, but none have been able to account fully for its observed properties," Bortnik said. "Here, we show that a different wave type, called chorus, can propagate into the plasmasphere from tens of thousands of kilometers away and evolve into hiss. Our new model naturally accounts for the observed frequency band of hiss, its incoherent nature, its day-night asymmetry in intensity, its association

with solar activity and its spatial distribution.

"The connection between chorus and hiss is very interesting because chorus is instrumental in the formation of high-energy electrons outside the plasmasphere, while hiss depletes these electrons at lower equatorial altitudes," he said.

Beginning in the late 1960s, spacecraft observations of wideband electromagnetic noise at frequencies below a few kilohertz established the presence of a steady, incoherent noise band in the frequency range between 200 Hz and 1 kHz. This emission was dubbed plasmaspheric hiss because of its unstructured nature, its spectral resemblance to audible hiss and its confinement to the plasmasphere, a dense plasma region around the Earth.

Bortnik was initially studying chorus, not hiss, when he made the discovery — one of many examples of serendipity in science.

Hiss tends to be confined inside of the plasmasphere, and chorus outside of it. Bortnik was modeling chorus because he knew it was important in creating high-energy electrons in space. While chorus occurs outside the plasmasphere, it leaks inside of it.

A better understanding of plasmaspheric hiss will help scientists to more accurately model the behavior of the high-energy electrons in the Van Allen radiation belts and thus improve their forecasts of space conditions, Bortnik said.

Source: University of California - Los Angeles