# Breathing cycles in Earth's upper atmosphere tied to solar wind disturbances

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A new University of Colorado at Boulder study shows the periodic "breathing" of Earth's upper atmosphere that has long puzzled scientists is due in part to cyclic solar wind disturbances, a finding that should help engineers track satellites more accurately and improve forecasts for electronic communication disruptions.

Aerospace engineering sciences department Associate Professor Jeff Thayer said the outer, gaseous shell of the atmosphere, known as the thermosphere, is known to expand and contract as it exchanges energy with the space environment, causing changes in thermosphere density. Changes in thermosphere density can alter the atmospheric drag of satellites, causing them to deviate from their predicted paths and complicating tracking and orbital adjustment maneuvers, he said.

While extreme ultraviolet radiation from the sun is the dominant mechanism that causes the thermosphere to "breathe," the new CU-Boulder study indicates high-speed wind from the sun triggers independent breathing episodes by creating geomagnetic disturbances, heating the thermosphere and altering its density. The wind streams are generated by relatively cool pockets on the sun's surface known as solar coronal holes that periodically rotate around the sun's surface, said Thayer.

"We were surprised to find the density changes were so consistent in our observations," said Thayer, lead study author. "Because of the huge increase in satellite activity in recent years, finding this new

thermosphere breathing mechanism should help improve our models and increase the accuracy satellite tracking and collision avoidance."

A paper on the subject was presented at the Fall Meeting of the American Geophysical Union held Dec. 15 to Dec. 19 in San Francisco. Co-authors included Research Associate Jiuhou Lei, Professor Jeffrey Forbes, Research Associate Eric Sutton and Professor Steve Nerem of CU-Boulder's aerospace engineering sciences department.

The thermosphere begins at about 60 miles above Earth and extends to about 300 miles in altitude. The thermosphere gas is known to expand and contract on a 27-day solar rotation period due to changes in extreme UV radiation, said Thayer. The new findings indicate the thermosphere also has periodic oscillations occur at four-to-five days, six-to-seven days and nine-to-11 days caused by the violent effect of the high-speed soar winds interacting with Earth and transferring energy through auroras and enhanced electric currents.

The team used data from the German Challenging Minisatellite Payload, or CHAMP, and the NASA Advanced composition Explorer satellite to measure the solar wind properties, The research was funded by a five-year, $7 million grant from the U.S. Air Force Office of Scientific Research to a CU-Boulder aerospace engineering science group led by Forbes.

In addition to helping monitor density changes in the thermosphere, the new findings should help researchers track the growing amount of space debris in the upper atmosphere that can damage satellites and threaten astronauts, said Thayer. Last year a ground-based Chinese missile was used to intentionally destroy an aging Chinese meteorological satellite, creating thousands of chunks of debris in low-Earth orbit, a region heavily used by spacecraft, including the International Space Station.

A better understanding of the characteristics of the thermosphere should also help scientists and engineers adjust radio communications and GPS signals during periods of significant solar wind activity, he said.

Source: University of Colorado at Boulder

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