A new auroral phenomenon discovered by Finnish researchers a year ago is probably caused by areas of increased oxygen atom density occurring in an atmospheric wave channel. The speculative explanation offered by the researchers gained support from a new study. Credit: Graeme Whipps.

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Validity of the wave guide theory confirmed

Northern Lights are born when charged particles ejected by the Sun, such as electrons, collide with
oxygen atoms and nitrogen molecules in Earth’s atmosphere. The collision momentarily excites the atmospheric species, and this excitation is released in the form of light.

New types of aurora borealis are rarely discovered. The identification of this new auroral form last year was the result of an exceptional collaboration between hobbyists who provided observations and researchers who started looking into the matter.

The new auroral form named dunes is relatively rare, and its presumed origin is peculiar.

"The differences in brightness within the dune waves appear to be caused by the increased density of atmospheric oxygen atoms," says Professor Minna Palmroth.

A year ago, researchers at the Centre of Excellence in Research of Sustainable Space concluded that the dune-like shape of the new auroral emission type could be caused by concentrations of atmospheric oxygen. This increased density of oxygen atoms is assumed to be brought about by an atmospheric wave known as a mesospheric bore traveling horizontally within a wave guide established in the upper atmosphere.

This rare wave guide is created in between the boundary of the atmospheric layer known as the mesosphere, which is called the mesopause, and an inversion layer that is intermittently formed below the mesopause. This enables waves of a certain wavelength to travel long distances through the channel without subsiding.

The electron precipitation and temperature observations made in the recently published study supported the interpretations of the dunes' origins made a year earlier. An independent observation was made of the wave channel appearing in the area of the dunes, but there are no observation data for the mesospheric bore itself yet.

"Next, we will be looking for observations of the mesospheric bore in the wave guide," Maxime Grandin says.

According to the observation data, electron precipitation occurred in the area where the dunes appeared on 20 January 2016. Therefore, it is highly likely that electrons having the appropriate energy to bring about auroral emissions at an altitude of roughly 100 kilometers were involved. The observations were collected by the SSUSI instrument carried by a DMSP satellite, which measures, among other things, electron precipitation.

On the night in question, there was an exceptionally strong temperature inversion layer in the mesosphere, or a barrier generated by layers of air with different temperatures. The inversion layer associated with the origins of the wave channel was measured with the SABER instrument carried by the TIMED satellite. The observation supports the hypothesis according to which the auroral form originates in areas of increased oxygen density occurring in the upper atmosphere wave guide.


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