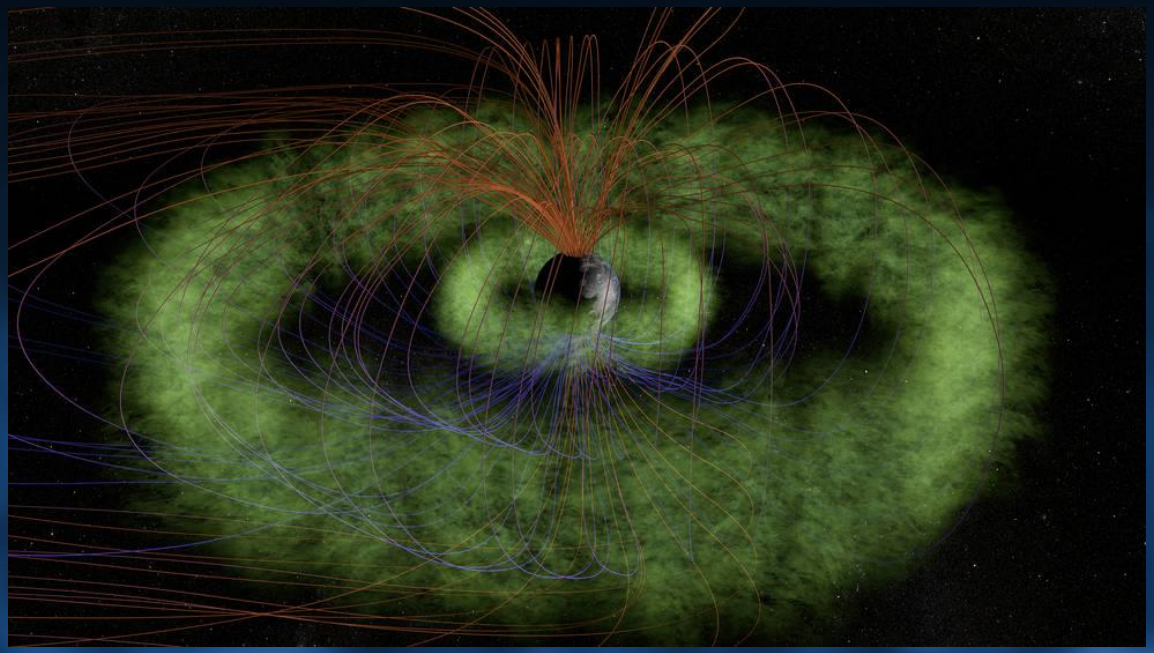
Locating the Origins of Whistling Electrons

The Van Allen belts are a region in which astronauts and satellites are vulnerable to harmful space weather effects. The energized particles within those belts are sometimes scattered into the upper atmosphere, but the mechanism responsible for hurling the energetic electrons out of the belts is still not precisely understood. Recently, two spacecraft were at just the right places at the right time to witness first hand both the impulsive electron loss and its cause – providing information about the fundamental physics in the belts which can ultimately help improve space weather predictions.

Data from one of the two satellites of NASA's Van Allen Probes mission and the FIREBIRD II CubeSat show that a common plasma wave in space is likely responsible for the impulsive loss of high-energy electrons into Earth's atmosphere. Known as whistler mode chorus, these waves are created by fluctuating electric and magnetic fields. The waves have characteristic rising tones — reminiscent of the sounds of chirping birds — and are able to efficiently accelerate electrons.



An artist's rendition of the Van Allen radiation belts, which circle Earth. Combined data from FIREBIRD II, which cruises at an average height of 500 km above Earth, and from one of the two Van Allen Probes, which travel in a highly elliptical orbit around the planet, observed how electrons can be ejected from the belts at tremendous speeds. From different vantage points, the missions helped track the chain of cause and effect of the loss of these high-energy electrons.

Late on Jan. 20, 2016, the Van Allen Probes observed chorus waves from its lofty vantage point in the belts (about 35,000 km above the Earth) and – immediately after – FIREBIRD II saw microbursts in low Earth orbit. Microbursts are localized, sub-second impulsive scatterings of energetic electrons out of the belts and into Earth's atmosphere. The observed scattering is prompt and occurs off-equator pointing to electron loss from the outer Van Allen belt. The observations provide the strongest evidence yet that chorus waves cause microbursts, from sub-relativistic (200 keV) to relativistic (1 MeV) energies.