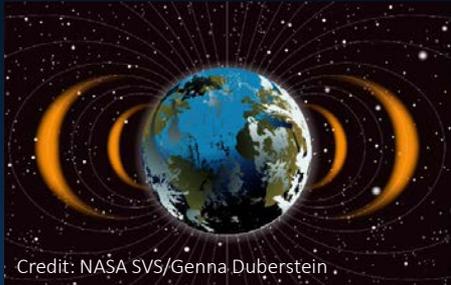


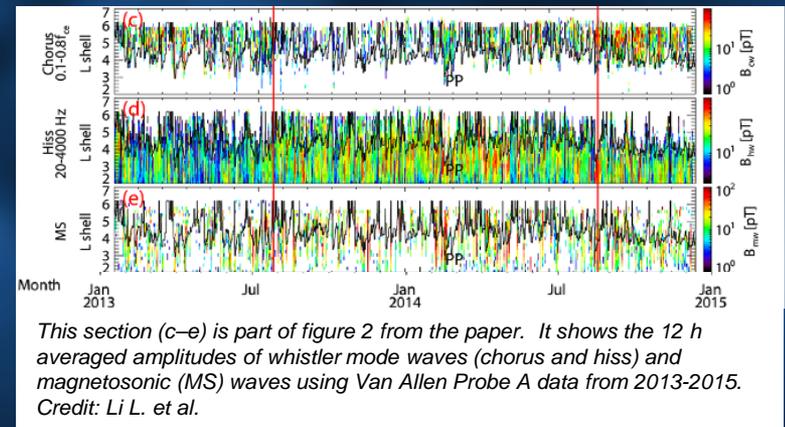
NASA Van Allen Probes find Plasma Waves Influence the Shape and Shifting of Radiation around Earth



NASA Heliophysics Van Allen Probes mission data provides clues to big mysteries in near-Earth space: how are Earth's radiation belts formed and what influences their shifting shapes? The defining scientific discovery of the early space age was the Van Allen Radiation Belts – typically two, but sometimes three, rings of radiation orbiting Earth that shrink and swell in response to geomagnetic storm activity. Since 2013, the Van Allen Probes have been flying through this dynamic, and often hazardous region, collecting data to help scientists better understand near-Earth space. The image to the left is from an animation showing the radiation belts around Earth.

An international team of researchers analyzed probes data on plasma waves in both the inner and outer belts and what's called the slot region – the space in between the two belts. The plasma in space that surrounds Earth and envelopes the belts is like an ocean, heaving and buzzing with waves, which is why it's no surprise that plasma waves play a key role in the belts' behavior. Unlike waves in the ocean, plasma waves in space respond to complex networks of magnetic and electric fields around them.

Some, like whistler waves, appear only in the outer belt and the slot region. Others, like magnetosonic waves, can appear almost anywhere in the belts. Analysis of the data and computer simulations show that although magnetosonic waves are more widespread, whistler waves have the most impact. This is because whistler waves, in particular the “chorus” and “hiss” whistler waves, can accelerate electrons to higher speeds when they pass through them – sometimes, close to the speed of light. An increase in the number of high-speed electrons there are in the belts translates to more dangerous levels of radiation.



This section (c–e) is part of figure 2 from the paper. It shows the 12 h averaged amplitudes of whistler mode waves (chorus and hiss) and magnetosonic (MS) waves using Van Allen Probe A data from 2013-2015. Credit: Li L. et al.

While “chorus” waves appear farther out – near the outer belt, “hiss” waves only appear close to Earth, where the plasma density is greater. The team found that intense “hiss” waves scatter the fastest electrons out of the belts, creating the slot region in between them. Compared to whistlers, magnetosonic waves don't play as large a role, despite the fact they can appear anywhere in the belts. However, the team did find that magnetosonic waves can accelerate some slower electrons to higher speeds, helping to repopulate some of the electrons ejected by hiss.

Together, all of these processes combine to generate the dynamic nature of Earth's radiation belts, helping to provide answers to fundamental space science questions we've had since the dawn of the space age.