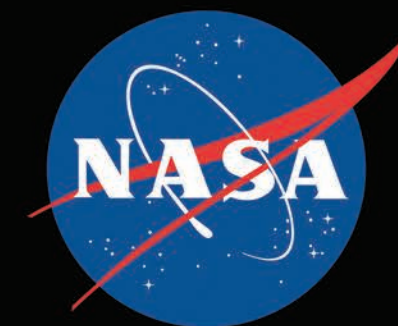


National Aeronautics and Space Administration



# Van Allen Probes

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*Exploring the Extremes of Space Weather*



# Van Allen Probes—Exploring the

## About the Van Allen Probes Mission

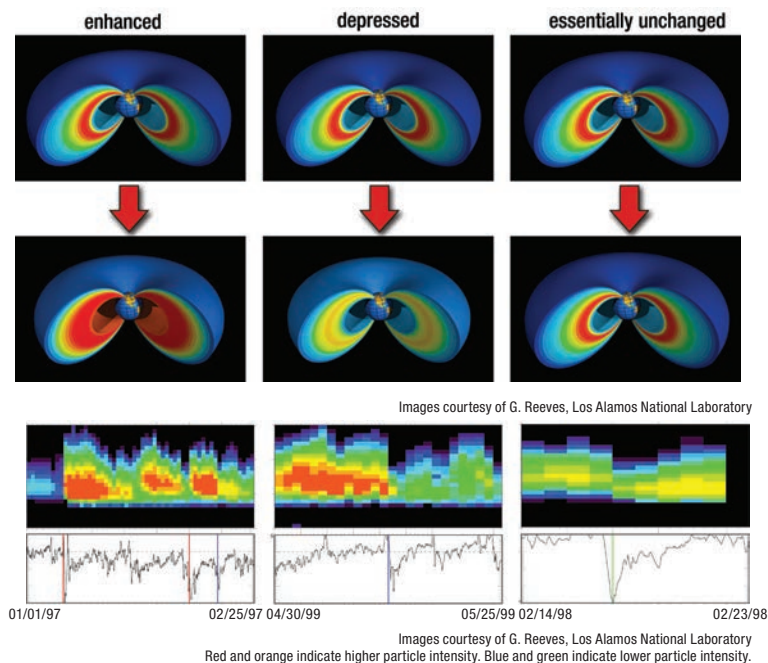
*To help us understand how Earth responds to changes in the sun's energy and how that response affects life and society, NASA launched the Van Allen Probes August 30, 2012. These twin spacecraft will investigate this extreme region of space for a minimum of two years, searching for answers to critical questions about the behavior of the Van Allen radiation belts. The spacecraft will chase each other in a common orbit, investigating the storms caused by our sun and gathering data to solve the mysteries that are critical to our modern way of life. The ability to predict the behaviors of the radiation belts will enable engineers and space weather forecasters to better protect our astronauts working in this region as well as our satellite investments that we depend on for communication, defense, shipping, air and ground navigation, and much more.*

### What is radiation?

You may have heard the term radiation used in different ways, sometimes in relation to medicine, or the sun, or even heat. Sometimes it refers to electromagnetic waves of energy such as X-rays or gamma rays, and other times it refers to fast-moving particles. When we talk about radiation in the Van Allen belts, we are referring to electrically charged particles such as protons and electrons that move close to the speed of light, about 186,000 miles a second or about 700 million miles an hour. The faster something moves, the more energy it has. Even tiny particles like electrons that are moving close to the speed of light have so much energy that they can do serious damage to any matter that they hit. Challenge question: Imagine if it were possible for you to ride your bike at a "relativistic" speed (moving close to the speed of light). How fast could you travel from Earth to the moon? (Hint: First you need to research the distance to the moon.)

### What are the Van Allen radiation belts and why do we want to study them?

The Van Allen radiation belts are two donut-shaped regions encircling Earth where high-energy particles are trapped by Earth's magnetic field. Sometimes after a solar storm, the number of particles can increase dramatically, and their speeds can become close to the speed of light. This can be extremely dangerous for our technology in this region as well as for astronauts working there. Other times after similar space weather events, the particles decrease in number and speed, and sometimes conditions seem to stay the same. The data on the left show three very similar solar storms that all produced energies of 1.2–2.4 MeV. After the first storm in 1997, the radiation became more intense; the second graph shows data taken in 1999, when the radiation belts decreased in intensity; and the third graph shows that after a storm in 1998, the radiation remained pretty much the same. The pictures on the right show an artist's interpretation of the radiation belts during such events.



Van Allen Probes will explore this mysterious space weather, which can impact our way of life as we become increasingly dependent on space-based infrastructure. Extreme space weather can disable satellites, cause power grid failures, and disrupt GPS services. What we find out will be used by engineers to design radiation-hardened spacecraft and satellites and will be used by forecasters to warn astronauts and spacecraft operators of hazardous conditions. Earth's radiation belts also provide a perfect laboratory in which to understand many other places in the universe that are known to have similar processes but are farther away and harder to study. We have a place in Earth's own backyard that can provide answers to some of the mysteries of our galaxy and beyond.

### What are the main questions we want to answer?

**The Van Allen Probes mission will answer three overarching science questions:**

- What causes the radiation belts to become enhanced (increasing in particle density and energy)?
- What causes the radiation belts to decrease in particles and energy, and how are the particles lost?
- There is an electric current of slower-moving charged particles that moves through the radiation belts called the ring current. How does this affect the radiation belts, and how do other geomagnetic processes (changes in Earth's magnetic field) affect radiation belt behavior?

### Why are they named Van Allen radiation belts?

Dr. James Van Allen and his students at The University of Iowa were the first to detect the inner and outer radiation belts surrounding Earth in 1958 using instruments onboard Explorer 1. This was one of the first space age