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UI instruments aboard twin NASA spacecraft set for launch Aug. 24

August 21 2012, BY GARY GALLUZZ

An artist's rendering shows the twin Radiation Belt Storm Probes (RBSP) satellites in tandem orbit above the Earth. Image credit: NASA.

On Aug. 24, NASA will launch two identical satellites from Cape Canaveral, Fla., to begin its Radiation Belt Storm Probes (RBSP) mission to study the extremes of space weather and help scientists improve space weather forecasts.

Why should you care?

Because, says a University of Iowa space physics researcher, if you've ever used a cell phone, traveled by plane, or stayed up late to catch a glimpse of the northern lights, then you have been affected by space weather without even knowing about it.

Scientists want to better understand how the Van Allen radiation belts—named after UI astrophysicist James A. Van Allen—react to solar changes, thereby contributing to Earth's space weather. Changes in space weather can disable satellites, overload power grids, and disrupt GPS service.

In addition, coronal mass ejections (CMEs) periodically release billions of tons of charged particles from the sun into space. And, with the 11-year solar cycle expected to peak in 2013, there is an increased potential for CME-caused power surges to knock out electric transformers that support lighting, heating, air conditioning, sewage treatment, and many other necessities of daily life.

Space weather storms are made up of gusts of electrically charged particles—atoms that have been stripped of electrons—that constantly flow outward from the sun. When these particles reach the Earth, some become trapped in the Earth's magnetosphere to form the Van Allen radiation belts, two donut-shaped regions that encircle Earth. The RBSP mission will collect data on particles, magnetic and electric fields, and waves to reveal how the belts change in space and over time.

Craig Kletzing [KLET-zing], F. Wendell Miller Professor of physics and astronomy in the University of Iowa College of Liberal Arts and Sciences, is the principal investigator for the UI team that designed the Electromagnetic Instrument Suite with Integrated Science (EMFISIS). One of five different RBSP instrument pairs, or suites, EMFISIS is a $30 million NASA project to study how various amounts of space radiation form and change during space storms.

The other four instrument suites are directed by teams from the University of New Hampshire, the University of Minnesota, the New Jersey Institute of Technology, and the National Reconnaissance Office. The two RBSP spacecraft—each weighing 1,455 pounds—were constructed for NASA at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md.

Says Kletzing: "The Radiation Belt Storm Probes is actually the first NASA mission to be launched in more than two decades that's going back to revisit the radiation belts since they were discovered by the late University of Iowa professor James A. Van Allen over 50 years ago. There are still lots of things we don't understand about how they work, about how the sun delivers energy to the local environment around the Earth, and particularly about how it creates these two bands of very energetic particles that we call the radiation belts."

Like many other NASA projects, the Radiation Belt Storm Probes mission has two main reasons for existing: it will gather practical information and it is a part of mankind's continuing exploration of space.

"The practical reason is: that's a part of space that we utilize. The outer radiation belts are where all our communication satellites exist, the various things that make sure that GPS works, as well as telephone communications," Kletzing says. "They can be affected by these particles, and, in fact, it has happened that those satellites have actually been knocked out by radiation.

"So, understanding these effects and how they happen and, hopefully, get beyond to where we can do some level of prediction is a very important practical reason.

"Additionally, the various manned missions that NASA has planned to go beyond the Space Station to places like the moon or Mars also require transiting through this region," he says. "So, understanding the right time to go—when the particles are fewest so that you don't impact human health—is a very important thing to understand."

The less practical reason for undertaking the RBSP project is familiar to mountain climbers and other explorers—because it's there.

"We want to know how the heck the darn thing works," he says. "We've learned from science over the years that you can't always predict that one thing you learn here will influence another field and allow whole breakthroughs to occur. So it's really both. The practical, direct reasons, but also if we understand the physics of the radiation belts, that helps us understand physics in other stellar systems and all sorts of other phenomena that are related."

Here's how the RBSP project will work:

- One rocket will launch two satellites.
- The two satellites will orbit the Earth from about 300 miles above the Earth out to as far as 25,000 miles at apogee.
- The satellites will be given slightly different orbits so that over time, one will run ahead of the other.
- They will fly nearly identical orbits that cover the entire radiation belt region, lapping each other during the course of the two-year mission.

"We talk about one spacecraft lapping the other," says Kletzing. "What makes that exciting is that both spacecraft are exactly the same—all the same sets of measurements are on the two different spacecraft. So, for the first time, we'll have completely identical sets of instruments on both sides that we can compare between the two satellites. And actually say, 'Oh, this is happening here, and that's happening there.' Maybe they work together or maybe they're different things. But we've never had a pair of identical spacecraft in this region before."

The RBSP project is a collaborative effort between research teams at several universities, with the Johns Hopkins Applied Physics Laboratory having constructed the spacecraft. The UI's EMFISIS instruments will measure the various kinds of waves the spacecraft will encounter.

At the UI, Kletzing, together with UI collaborator and co-investigator Bill Kurth, built the Waves and search coil magnetometer sections for the EMFISIS investigation. The UI also worked with the Goddard Space Flight Center, which built a magnetometer as a part of the UI instrument suite. Also, the University of New Hampshire provided the computer that controls all of the EMFASIS measurements. So, the hardware part of the UI project is actually a three-institution collaboration, Kletzing says, and the theory and modeling teams at UCLA and Los Alamos National Laboratory bring the total collaboration to five institutions.

It's not surprising that the UI is helping give scientists a clearer picture of space weather in the Van Allen radiation belts. The study of space weather really began at Iowa in 1958, when UI space physicist James A. Van Allen discovered the radiation belts using data from Explorer 1, the first successful U.S. spacecraft. Van Allen's discovery improved our understanding of the Earth and the solar system and created a new field of research called magnetospheric physics.

Provided by University of Iowa

Citation: UI instruments aboard twin NASA spacecraft set for launch Aug. 24 (2012, August 21) retrieved 20 April 2024 from
https://phys.org/news/2012-08-ui-instruments-aboard-twin-nasa.html

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