CU-Boulder instrument package to study space weather set for NASA launch Feb. 9

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A $32 million University of Colorado at Boulder instrument package set for launch Feb. 9 by NASA should help scientists better understand the violent effects of the sun on near-Earth space weather that can affect satellites, power grids, ground communications systems and even astronauts and aircraft crews.

The CU-Boulder Extreme Ultraviolet Variability Experiment, or EVE, will fly on NASA's Solar Dynamics Observatory known as SDO, the space agency's first mission as part of its "Living With a Star" program. EVE will measure rapid fluctuations in the sun's extreme ultraviolet, or EUV, output that can have profound effects on Earth's upper atmosphere, according to Senior Research Associate Tom Woods of CU-Boulder's Laboratory for Atmospheric and Space Physics, principal investigator on the EVE experiment.

"SDO will target how solar activity is created and the resulting space weather by measuring the sun's interior, its magnetic field, the hot plasma of the solar corona and the radiation streaming from the sun," said Woods. "The weather in space above 30 miles from Earth's surface affects our technology, our satellites and our communications and navigation systems like GPS. Our goal is to use this research to make better space weather predictions."

EVE includes three spectrographs -- two built at CU-Boulder's LASP -- to measure the solar EUV radiation. The instrument package will make measurements every 10 seconds at 10 times the resolution of previous instruments, providing scientists and space weather forecasters with the information to provide more accurate, real-time warnings of communications and navigation outages. "We can look at data every minute, 24 hours a day, to help us forecast what the sun is doing," said Woods.

Space weather on Earth is driven by violent transfer of matter and energy from the sun to Earth, said Woods. Violent events like solar flares -- explosions in the sun's atmosphere equal to a billion atomic bombs -- and coronal mass ejections, which are enormous bubbles of plasma that send billions of tons of material into interplanetary space, trigger large changes in Earth's upper atmosphere.

Solar EUV radiation from the sun deposited in Earth's upper atmosphere can double its temperature in minutes and increase the atmospheric density by four times in just hours. "Our satellites live in a place that is constantly changing," said Woods. "As density of the upper atmosphere increases, satellites start dragging and falling faster."

In addition to heating the atmosphere and increasing satellite drag, EUV radiation also can shatter the bonds of atmospheric molecules and atoms, creating a layer of charged particles that can disturb radio communications and GPS on Earth, said Woods. While UV radiation causes sunburns and skin cancer on Earth, all of the potentially deadly EUV racing toward the planet is absorbed by the upper atmosphere, he said.

CU-Boulder's EVE payload also will be carrying a spectrograph from the University of Southern California, said Woods. SDO will carry two other instrument packages: The Heliospheric and Magnetic Imager, or HMI, to map solar magnetic fields and use sound waves to peer beneath the sun's surface, and the Atmospheric Imaging Assembly, or AIA, that will photograph the sun's surface and atmosphere. The HMI was designed and built by Stanford University and Lockheed Martin Solar and Astrophysics Laboratory, both in Palo Alto, Calif. The AIA also was designed and built by the Lockheed Martin Solar and Astrophysics Laboratory.

SDO will launch aboard an Atlas V rocket from Cape Canaveral, Fla. The spacecraft, which will weigh 6,800 pounds at launch including fuel, will span more than 20 feet with the solar panels. SDO will be in a geosynchronous orbit about 22,000 miles from Earth, allowing constant contact with the primary ground station near Las Cruces, N.M.

"One of the most exciting things to me is that we will be better able to understand solar flares," said Woods. "With our previous instruments we have been able to see only about 3 percent of the solar flares that occur on the sun. With SDO, we will be able to see 100 percent of all the flares, which may number several a day during periods of strong activity."

EVE co-investigator and LASP Research Associate Frank Eparvier said such solar flares play a huge role in space weather. "Unlike the plasma from coronal mass ejections that can take days to reach Earth's atmosphere, the light from solar flares, primarily in the UV and X-ray portion of the light spectrum, reaches Earth in about eight and one-half minutes," he said. "By improving our models using data from the SDO mission, we can look for better precursors to such flares, giving us new predictability capabilities."

Solar cycles, which drive space weather, generally last about 11 years, said Woods. While the sun has been in a very quiet "minimum" phase in recent years, a series of violent solar events known as the "Halloween Storms" of 2003 included a large number of solar flares and coronal mass ejections that had dramatic effects on Earth's space weather.

"The Halloween Storms knocked out navigation and communication systems and even caused astronauts on the International Space Station to move to more shielded quarters," Woods said. "The storm knocked out GPS as far south as Florida, caused aircraft to be re-routed from over the Earth's poles because of radiation safety issues, and illuminated the Aurora Borealis as far south as Mexico through solar wind-magnetic field interactions in Earth's upper atmosphere."

"The sun is the driver of all space weather, so the Solar Dynamics Observatory will be a wonderful platform that will allow us to more clearly see what is headed our way," said LASP Director Daniel Baker, chair of the National Research Council Committee on Solar and Space Physics. "The data returned from this mission will have a huge impact on our ability to create better space weather models and to mitigate the potentially damaging effects of space weather on Earth and in near-Earth orbit."

LASP has a long history of making solar measurements dating back to the 1940s, even before NASA was formed, said Woods. LASP projects have ranged from designing, building and flying NASA's Solar Mesospheric Explorer Satellite, which measured the sun's effect on ozone production and destruction of ozone in the 1980s, to the Solar Radiation and Climate Experiment, a $100 million NASA satellite designed, built and now being controlled by LASP to measure the effects of solar radiation on Earth's climate.

"LASP has a great tradition of working with students in all phases of our programs, starting with helping to design the instruments, helping to calibrate and test them as well as helping to operate them," said Woods. "Our primary focus is getting science results, and our students also will be helping with the data analysis for the EVE experiment." Data from SDO will be used by a number of national and international groups, including NASA, the National Oceanic and Oceanic Administration and the U.S. Air Force, said Woods.

Data will be downloaded continuously from SDO to the ground station at White Sands, N.M., and transmitted to LASP's Space Technology Building at the CU Research Park for analysis. "I've been working on this project for eight years, so I'm very excited about the launch," said Woods. "This mission will give us a whole new view of the sun."

Provided by University of Colorado at Boulder

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