Sun-gazing satellite, designed to last 5 years, turns 10

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(Phys.org)—When a sun-gazing NASA satellite designed and built by the University of Colorado Boulder launched into space on Jan. 25, 2003, solar storms were raging.

A decade later, the four instruments onboard the Solar Radiation and Climate Experiment, or SORCE, have given scientists an unprecedented look at some of the most intense solar eruptions ever witnessed—including the notorious Halloween storms in October and November 2003—as well as the anomalously quiet solar minimum that hushed the sun's surface beginning in 2008 and, now, a new solar maximum that appears to be the least active in a century.

"We were there to see it transform from a fairly normal solar cycle to a very low-activity solar cycle," said Tom Woods, associate director of CU-Boulder's Laboratory for Atmospheric and Space Physics, known as LASP, and principal investigator for SORCE. "Of course we couldn't predict or know that, but it's very exciting."

The data generated by SORCE's instruments, which were originally designed to operate for just five years, are downloaded twice a day with the help of CU-Boulder undergraduates working at LASP mission control. Scientists are now using that data to better understand how energy from the sun affects Earth's climate. While human-produced greenhouse gases have been the dominant driver of climate change over the last several decades, the activity of the sun can either enhance or offset the resulting global warming.

"About 10 to 15 percent of the climate warming since 1970 is due to the sun," Woods said. "That's going to change now. Now that solar activity is low, the global warming trend could slow down some, but not nearly enough to offset the anthropogenic effects on global warming."

The current, lackluster solar maximum is being compared to periods when astronomers observed very few sunspots in the early 19th century known as the Dalton Minimum and in the last half of the 17th century known as the Maunder Minimum. During the Maunder Minimum, which coincided with an era known as the Little Ice Age, temperatures in Europe were especially cool, with rivers and canals freezing during the winter across the continent and rapidly advancing glaciers destroying villages in the Swiss Alps.

The SORCE mission is also a critical contributor to the long-term record of total solar irradiance—the magnitude of the sun's energy when it reaches the top of the Earth's atmosphere—which stretches back to 1978, when the Nimbus-7 satellite was launched. The Total Irradiance Monitor, or TIM, instrument onboard SORCE is taking the most accurate and most precise measurements of total solar irradiance ever collected.

"The total solar irradiance provides nearly all the energy powering the Earth's climate system, exceeding all other energy sources combined by 2,500 times," said Greg Kopp, LASP senior research scientist and co-investigator responsible for the TIM instrument. "Any change in total irradiance can thus have large effects on our climate."

Data from the SORCE mission have also begun a new record for measurements of visible and near-infrared light emitted from the sun. The solar spectral irradiance measurements are being made for the first time by the Spectral Irradiance Monitor, or SIM. Combined with other instruments onboard SORCE, scientists can now see all the wavelengths, including those in the ultraviolet range, emitted by the sun at once. This new way of seeing the sun has led to interesting discoveries, including that the energy emitted in some wavelengths of light vary out of phase with the sun's overall activity, actually increasing as the number of sunspots decreases.

Now that SORCE has doubled its original life expectancy, LASP scientists are building new instruments to take over when SORCE gives out. A new TIM built at LASP launched on NASA's Glory mission in 2011, but the satellite failed to make orbit. After the loss of Glory, CU-Boulder scientists, determined to avoid a gap in the record of total solar irradiance measurements, came up with a creative solution, repurposing a ground-based TIM to quickly make it space-worthy and then integrating it onto a U.S. Air Force satellite built by Ball Aerospace that is set to launch in August of this year.

"It's important to have continuous measurements of solar irradiance since we're looking for small changes in the sun's output over decades and even centuries," said Kopp. "Detecting such small changes using measurements disconnected in time would make this even more difficult."

A new SIM instrument, also built at LASP, is scheduled to launch in 2016 on a National Oceanic and Atmospheric Administration satellite. But while SORCE is expected to continue functioning for at least another year, allowing for overlapping measurements with the TIM instrument launching in August, it's uncertain if SORCE's SIM instrument will still be running when its successor makes it to space in 2016.

"We're definitely hoping and planning that SORCE lasts through this year," Woods said. "But 2016—I don't think SORCE's battery is going to last that long."

During SORCE's 10-year foray in space, the satellite also witnessed two rare transits of the planet Venus in front of the sun and another two less-infrequent transits by Mercury. When Venus, the larger of the two planets and the closer to Earth, blocked out part of the sun's light, SORCE's TIM instrument measured a corresponding drop in the amount of total solar irradiance. The measurements are now useful reference tools for astronomers hoping to discover planets around other stars by measuring a dip in a star's light from a planetary transit.

In all, CU-Boulder has received about $120 million from NASA for the construction and operation of SORCE. But in 2008, LASP took the unusual step of returning $3 million in cost savings from the SORCE mission to NASA that resulted from the program's efficient operations.

Researchers at LASP are planning to celebrate SORCE's 10th birthday with cake, a science seminar and a write-up of the satellite's top-10 accomplishments in NASA's The Earth Observer magazine.

But while the decade mark is typically an important milestone for celebration here on Earth, the more appropriate milestone for SORCE may come in 2014 at the 11-year mark, the average length of a complete solar cycle.

"Eleven years is special to us," Woods said. "Instead of having a big science conference this year, we're planning it for next January."

SORCE fact sheet:

- The 640-pound SORCE satellite was launched into space on Jan. 25, 2003, on a Pegasus XL launch vehicle from Florida's Kennedy Space Center.
- SORCE has four instruments onboard, all of which were designed and built at the University of Colorado Boulder's Laboratory for Atmospheric and Space Physics: the Total Irradiance Monitor (TIM), the Spectral Irradiance Monitor (SIM), the X-ray ultraviolet Photometer System (XPS) and the Solar and Stellar Irradiance Comparison Experiment (SOLSTICE).
- CU-Boulder has received about $120 million from NASA to design, build and operate SORCE. In 2008, LASP returned about $3 million in cost savings to NASA.
- SORCE is controlled by CU-Boulder staff and students at LASP's mission operations center in the CU Research Park.
- Measurements taken by SORCE extend the record of Total Solar Irradiance, or the amount of the sun's energy that reaches the top of Earth's atmosphere and drives the Earth's climate system. During its 10 years

in space, SORCE's TIM instrument established a new baseline for TSI that is 4.6 watts per square meter lower than previously measured.
- SORCE's SIM and SOLSTICE instruments have allowed scientists for the first time to look at most of the wavelengths of light emitted from the sun.
- SORCE's instruments observed two transits of Venus (June 2004 and June 2012) and two transits of Mercury (May 2003 and November 2006)
- The original principal investigator on the SORCE mission was LASP's Gary Rottman, who retired in 2005. The current principal investigator is LASP's Tom Woods.
- The SORCE website is at lasp.colorado.edu/sorce/.

More information: For more information, visit LASP's SORCE website at lasp.colorado.edu/sorce/index.htm.

Provided by University of Colorado at Boulder