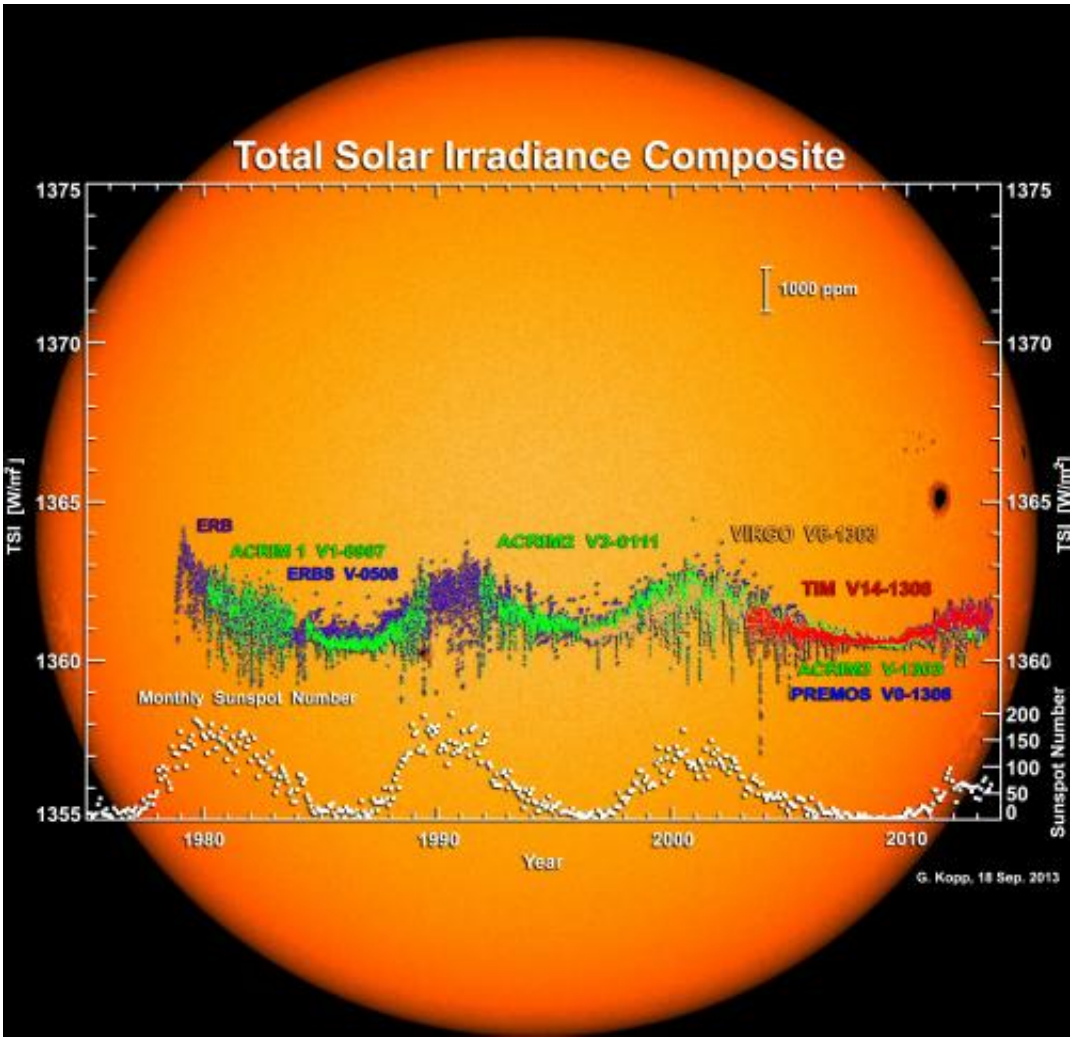
New instrument continues gathering Sun's effects on the Earth

December 5 2013



This image shows total solar irradiance (shown in color) over the past three solar cycles since 1978 adjusted to a ground-based cryogenic instrument funded by NASA in collaboration with the National Institute of Standards and Technology (NIST). Credit: Greg Kopp, LASP, University of Colorado / NASA

Maintaining a record of solar measurements is important in understanding the sun's effect on Earth and the National Oceanic and Atmospheric Administration's (NOAA), Total solar irradiance Calibration Transfer Experiment, or TCTE, is now providing that information.

Many natural conditions on Earth such as the surface temperature or air temperature depend on energy that comes from the sun in the form of electromagnetic radiation. A solar cycle lasts about 11 years and typically has modest changes in solar radiation. There are also dramatic solar events that eject solar material, but the energy variation caused by these particle emissions, when averaged over a year or longer, is small compared to variations in the sun's electromagnetic radiation.

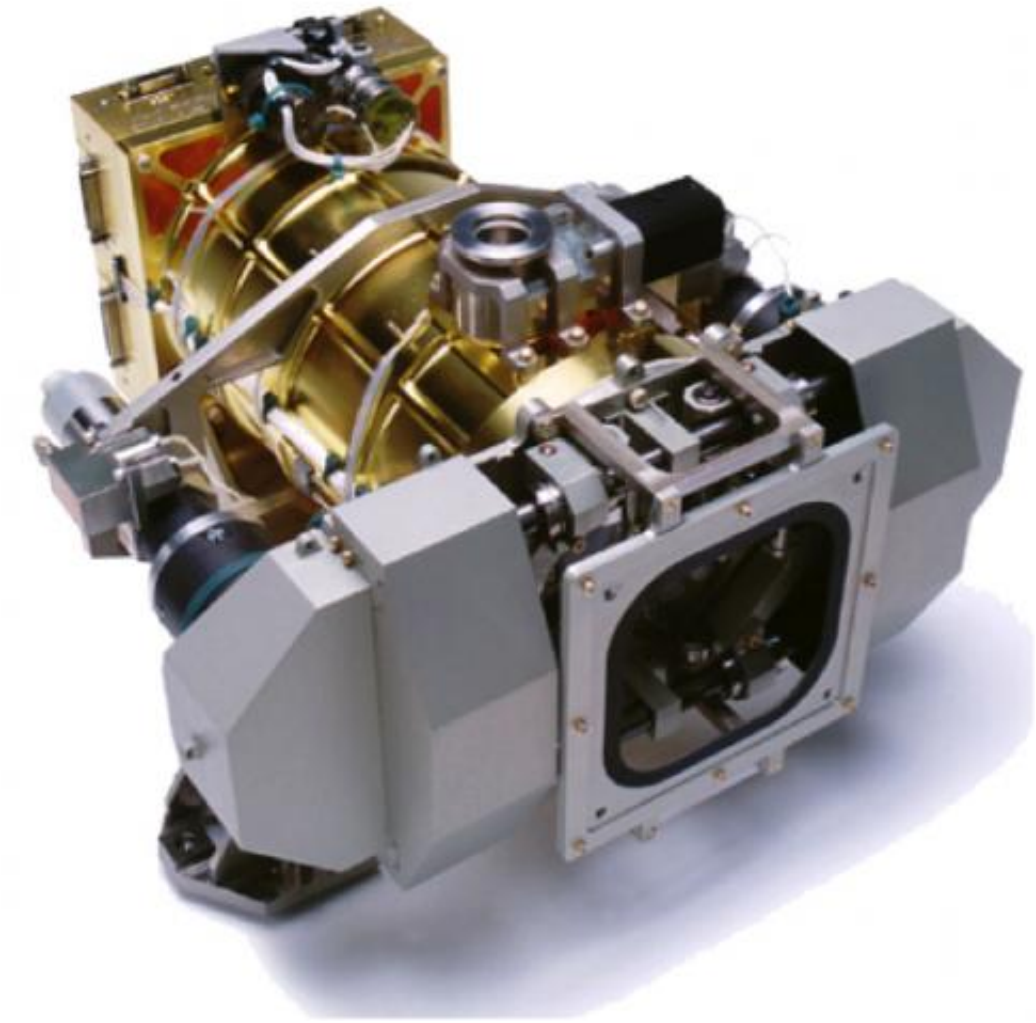
Scientists have noted these changes in the sun's energy by observing from Earth's surface for more than a hundred years, but were only able to begin to determine their magnitude and impact on Earth's climate with more accurate measurements from space, starting in 1978 with measurements of the "total solar irradiance," or TSI, made by NASA's Nimbus 7 satellite.

It is important to continue this TSI measurement record without a break in the data. The TCTE is designed to prevent such a break by continuing measurements from space to determine how solar changes are influencing Earth's climate.

A NOAA, Joint Polar Satellite System-sponsored mission, TCTE launched aboard U.S. Air Force Space Test Program Satellite-3, Tuesday, Nov. 19, 2013, from NASA's Wallops Flight Facility in Virginia. Since launch, TCTE successfully turned on and is transmitting information.

Solar irradiance is currently measured by the Total Irradiance Monitor or

TIM deployed in 2003 on NASA's Solar Radiation and Climate Experiment or SORCE mission. The TIM on TCTE is one of three nearly identical instruments built as part of NASA's investment in the Total Irradiance Monitor deployed in 2003 on the SORCE mission.



This is the Total Irradiance Monitor used to measure solar irradiance on the TCTE and SORCE missions. Credit: LASP, University of Colorado

While SORCE was designed to last for five years, it is still recording

data more than 10 years later, but the aging satellite is nearing the end of its battery life. It is critical for the continuity of the data stream to have both instruments overlap to allow for syncing the measurements, allowing the new more accurate TCTE calibration to be transferred to SORCE TIM, and then to earlier overlapping measurements, so greatly increasing the accuracy and value of the overall TSI record.

Mission scientists hope for an overlap period of about ten days for the two instruments in space. After that period, because there are other instruments on the Air Force satellite, TCTE will be turned on once a week for a few orbits of the Earth, typically lasting about an hour-and-a-half, with a view of the sun for about 45 minutes during each orbit.

"The basic input to the climate system is the sun. We need that basic measurement before we can do other science," said Jeffrey Privette, chief of Climate Services and Monitoring Division for NOAA's National Climatic Data Center in Asheville, N.C. "The important thing is to not lose this record. I'm very optimistic about the quality of the data and the ability to use it," he said.

The solar irradiance measurements achieved by the TIM deployed in 2003, and its near clone as part of TCTE, are significantly more accurate than their previous space-based predecessors, said Robert Cahalan, project scientist for SORCE and TCTE at NASA's Goddard Space Flight Center in Greenbelt, Md.

Prior to SORCE, the space-based solar irradiance measurements located their precision apertures, that control exposure to the sun's light, inside the instrument, requiring the light to travel past baffles and other instrument surfaces before reaching that aperture, allowing some unknown amount of sunlight to be reflected from those surfaces, and then to enter the aperture, resulting in lost precision. "The big innovation with the SORCE TIM is that the precision aperture is right out in front,

so the exposure is known very precisely," said Cahalan.

Even though the TIM on TCTE was built at the same time as the TIM currently flying on SORCE, scientists now have had the advantage with the current TIM of calibrating it with a ground-based cryogenic system operating at very cold temperatures to establish a more accurate measurement. This cryogenic system did not exist when the instrument on SORCE was launched.

This innovation will benefit the previous space-based solar data recorded since 1978. "Because we have a calibrated instrument, we will transfer that information to the data from SORCE, allowing us to correct the last 11 years of TIM data. And all the earlier instruments can potentially be corrected by their instrument teams and principal investigators," Cahalan said.

Scientists acknowledge that there is evidence that Earth's relationship to the sun, including changes in Earth's orbit, is a cause of some changes to the climate.. Yet over the last few decades, there has been no significant trend in the sun's energy output, its TSI, and over a 1,000 year timescale, Earth's orbit is remains essentially fixed and unchanged. Known orbital changes require more than 10,000 years to occur.

"In recent decades Earth has experienced a dramatic rise in temperature over the planet as a whole, and as the temperature has risen, ice has melted and the ocean has acidified (become less basic). These changes are traceable to the same cause, namely the increasing concentration of carbon dioxide and other greenhouse gases being emitted from fossil fuel use, trapping heat near Earth's surface, and being absorbed in the oceans," Cahalan said.

"During these decades, the sun's brightness (energy) has undergone several up-and-down cycles, in sync with the sunspot cycle, but with no

overall trend that could explain Earth's temperature trend," Cahalan said. "That doesn't mean we should stop measuring the sun. Just because the sun hasn't significantly brightened or dimmed since 1978, doesn't mean it won't brighten or dim between now and 2050. Even a very small trend in the sun would either enhance the warming, if the sun were brightening, or partially offset it, if the sun were dimming."

More information: For more information about JPSS and its precursor, Suomi NPP, please visit: www.jpss.noaa.gov/ and www.nasa.gov/npp

Provided by NASA's Goddard Space Flight Center

Citation: New instrument continues gathering Sun's effects on the Earth (2013, December 5) retrieved 1 May 2024 from https://phys.org/news/2013-12-instrument-sun-effects-earth.html