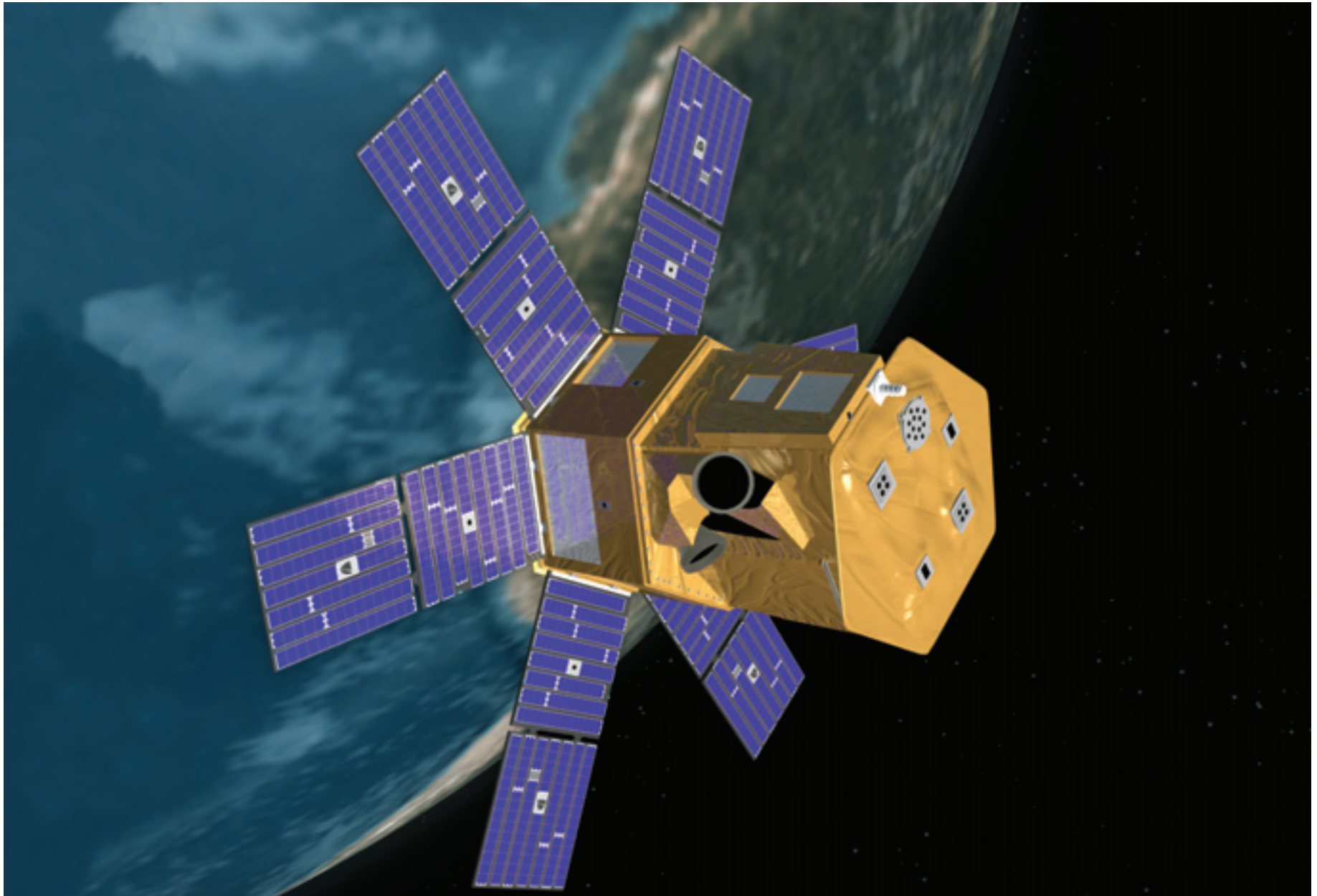


National Aeronautics and  
Space Administration

**Goddard Space Flight Center**

**SORCE**





### SORCE PROGRAM

The Solar Radiation and Climate Experiment (SORCE) is a small free-flying satellite carrying four scientific instruments to measure the solar radiation incident at the top of the Earth's atmosphere. SORCE is a joint partnership between NASA and the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado. SORCE is scheduled for launch on a Pegasus XL rocket in early 2003 from Kennedy Space Center, Cape Canaveral, Florida.

The SORCE satellite orbits the Earth accumulating solar data. Data obtained by SORCE will be used to model the Sun's output and to explain and predict the effect of the Sun's radiation on the Earth's atmosphere and climate. With solid knowledge of natural factors like the Sun impacting the climate, we can begin to explore the impact that humans have on climate.

### PROGRAM OBJECTIVES/HISTORY

The primary goal of SORCE is to enable solar-terrestrial studies by providing precise daily measurements of the total solar irradiance (TSI) and the solar spectral irradiance at wavelengths extending from the ultraviolet to the near infrared. Ultraviolet radiation from the Sun is completely absorbed by the Earth's atmosphere, and therefore its first detection came only after access to space was provided by sounding rockets in the 1950s. Instrumentation to make ultraviolet observations steadily improved, and today we have a fairly comprehensive understanding of the solar ultraviolet irradiance and its large variability.

### SPACECRAFT AND INSTRUMENTS

The SORCE satellite consists of four scientific instruments and a spacecraft bus. The four instruments were designed and built by LASP, and LASP procured the spacecraft from Orbital Sciences Corporation in Dulles, Virginia. The stowed spacecraft is 39.4 inches (100 centimeters) wide x 63.1 inches (160.3 centimeters) high. Deployed, SORCE is 133.6 inches (339.3 centimeters) wide x 63.1 inches (160.3 centimeters) high. The spacecraft, at launch, weighs 627 pounds (282 kilograms). The spacecraft is powered by 348 watts of electric power from its solar array.

The four instruments include the Total Irradiance Monitor (TIM), the Spectral Irradiance Monitor (SIM), Solar Stellar Irradiance Comparison Experiment (SOLSTICE) and the Extreme Ultraviolet Photometer System (XPS). TIM, SIM and SOLSTICE will measure solar irradiance and the solar spectrum to help scientists understand the Sun's role in climate change. The XPS will measure high-energy radiation from the Sun.

### OPERATIONS

The satellite will fly at an altitude of 645 km in a 40 degree inclination orbit about the Earth. All four instruments will take readings of the Sun during each of the satellite's 15 daily orbits. The information will be transmitted to ground stations at NASA's Wallops Flight Facility in Virginia and a station in Santiago, Chile.

### MANAGEMENT

SORCE is a principal investigator led mission with NASA's Goddard Space Flight Center providing management and engineering oversight and review. Scientists and engineers at LASP designed, built, calibrated, and tested the four science instruments on SORCE. The Mission Operations Center and the Science Operations Center are both operated at LASP and LASP will operate the spacecraft over its five-year mission life. LASP is responsible for the acquisition, management, processing, and distribution of the science data.

SORCE is a key component of NASA's Earth Observing System (EOS) program. SORCE will address long-term climate change, natural variability and enhanced climate prediction, and atmospheric ozone and UV-B radiation, measurements that are critical to studies of the Sun; its effect on our Earth system; and its influence on humankind.

### FOR THE CLASSROOM

The solar activity is observable with the appearance and disappearance of active magnetic regions on the Sun. In the visible spectral range, these active regions appear as dark regions and are called sunspots. The sunspots are associated with large magnetic fields erupting from the Sun and often appear in pairs of opposite magnetic polarities. The bright regions surrounding a sunspot are called faculae. This simple experiment examines sunspot activity using a pinhole camera.

#### Materials needed

Mailing tube (~1 m long), cardboard box, aluminum foil, scissors, white tracing paper (thin), tape, pencil.

#### Procedure

1. With thick aluminum foil or with 2 layers of foil, make a tiny hole (about 0.5 mm) with a sharp pencil. Remove any end caps on the mailing tube. Attach this foil to one end of the mailing tube with the hole in the center of the tube. It is best to wrap this foil over the end of the mailing tube and secure tightly with tape so that light can only enter into the tube through the tiny hole.
2. Cut a hole in the middle of the cardboard box bottom so that the mailing tube can slide through this hole. Trace the mailing tube diameter onto the bottom of the box before cutting so that the mailing tube is a tight fit into the box. This box serves as a shield to keep stray light off the back end of the mailing tube.
3. Place a sheet of white tracing (thin) paper over the other end of the mailing tube and tape down. Your mailing tube is now a pinhole camera!
4. On a clear, sunny day, point the mailing tube's end with the tiny hole towards the Sun. Then pivot the back of the mailing tube until the image of the Sun falls onto the paper. Initial alignment is easier without the paper fully attached so one can peer into the tube to see where the solar image is going.

**WARNING:** Do not look directly at the Sun as its intense brightness can damage your eyes.

5. With an assistant or prop to steady the mailing tube, trace the image of the Sun (circle) and any dark spots (the sunspots) on the paper. If the solar image is difficult to see, one can use the pinhole camera inside from a sun-facing window that allows the mailing tube to peer past its curtains or shades. With a 1 m mailing tube, the solar diameter will be about 10 mm on the paper. Label the current date and time on the paper. You will need to trace lightly so as not to tear the paper.

6. Count the number of sunspots and note the location of each sunspot.

7. On the next day or a few days later, repeat steps 3-6 with a fresh copy of paper. Repeat as often as you want on other days. It is best to repeat the measurement at about the same time of day.

#### Questions

How many sunspots are there on each day?  
Did the number of sunspots change on different days?

Did the sunspots move from one day to another?

How dark are the sunspots compared to the quiet Sun background?

Can you see the bright faculae region surrounding the sunspots?

Is the limb (outer edge) of the Sun darker or brighter than the center?

How much is the total area of the sunspots compared to the area of the Sun?

#### Discuss with students

Discuss the questions. Discuss how sunspots evolve.

Discuss how their sunspot measurements appear similar to and different from solar images taken by ground-based and space-based telescopes. You can examine the daily solar images obtained at different wavelengths from:

- <http://umbra.nascom.nasa.gov/images/latest.html>
- <http://www.bbso.njit.edu/cgi-bin/LatestImages>
- <http://www.spaceweather.com/>

Discuss how to calculate the rotation speed of the Sun by measuring the movement of the sunspots. This calculation is simpler and more accurate if tracking a sunspot at the center of the solar disk with two measurements taken 1 day apart. For this approach, use:

- speed = distance / time where
- time (1 day) = 86400 seconds
- distance on Sun = 1.4 x 10<sup>6</sup> km x (distance moved on paper ÷ diameter of disk on paper)

For more information on SORCE, visit:

<http://lasp.colorado.edu/sorce/>

