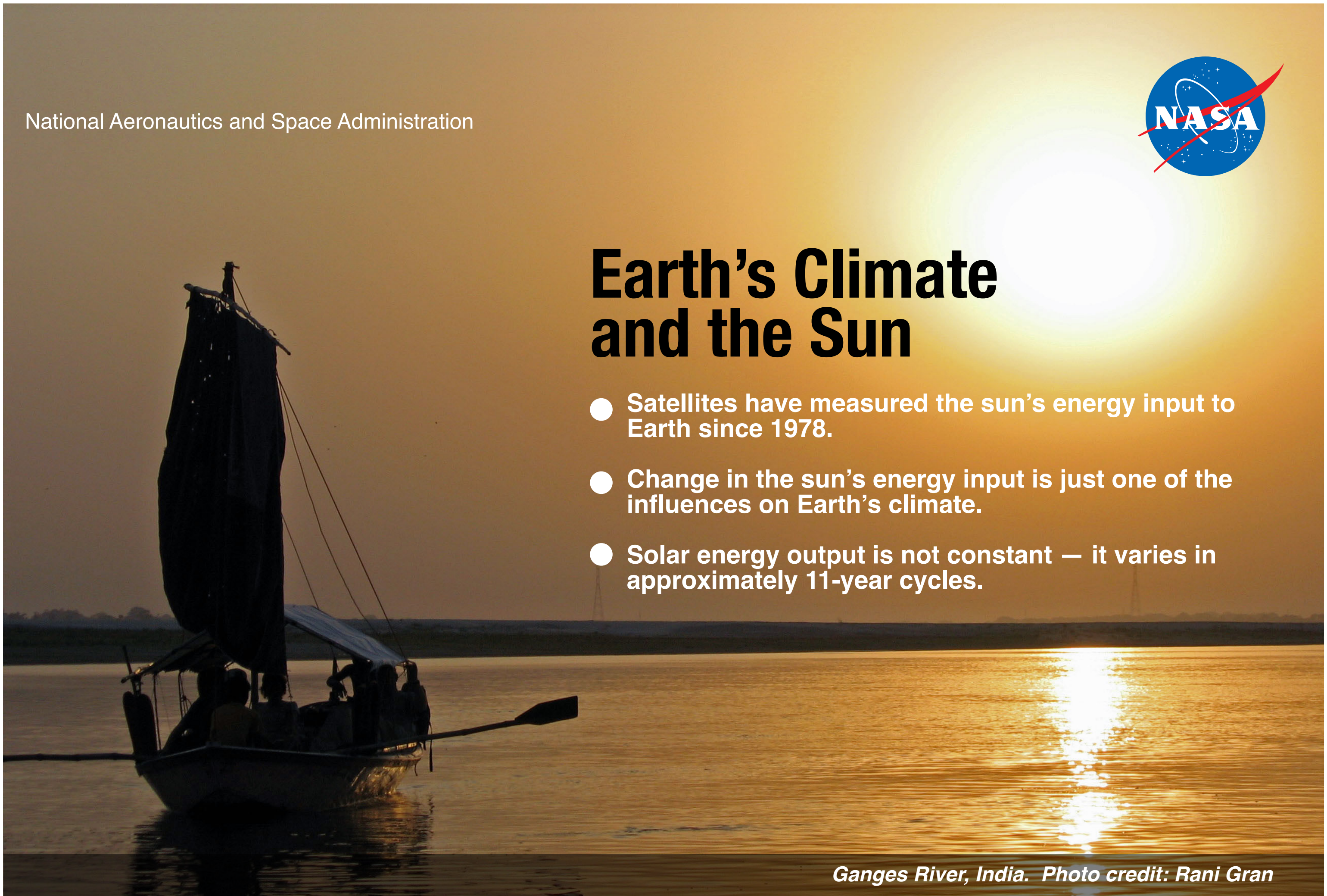
National Aeronautics and Space Administration



Earth’s Climate and the Sun

- **Satellites have measured the sun’s energy input to Earth since 1978.**
- **Change in the sun’s energy input is just one of the influences on Earth’s climate.**
- **Solar energy output is not constant — it varies in approximately 11-year cycles.**

Ganges River, India. Photo credit: Rani Gran

TSIS-1 Total and Spectral Solar Irradiance Sensor -1 Measures Sun’s Energy input to Earth

NASA's Total and Spectral solar Irradiance Sensor, or TSIS-1, is a mission to measure the sun's energy input to Earth. Various satellites have captured a continuous record of this solar energy input since 1978. TSIS-1 sensors advance previous measurements, enabling scientists to study the sun’s natural influence on Earth’s ozone layer, atmospheric circulation, clouds, and ecosystems. These observations are essential for a scientific understanding of the effects of solar variability on the Earth system.

TSIS-1 makes two key measurements: total solar irradiance, or TSI, the sun's total energy input into Earth, and solar spectral irradiance (SSI), the distribution of the sun’s energy input across ultraviolet, visible, and infrared wavelengths of light. TSI measurements are needed to quantify the solar variations in the total amount of energy input to the Earth. SSI measurements are also vital because different wavelengths of light are absorbed by different parts of the atmosphere.

The sensors of TSIS-1, the Total Irradiance Monitor (TIM) and the Spectral Irradiance Monitor (SIM), are significantly improved versions of sensors included on NASA’s Solar Radiation and Climate Experiment (SORCE) mission launched in 2003. Both sensors are more accurate and more precise than their predecessors.

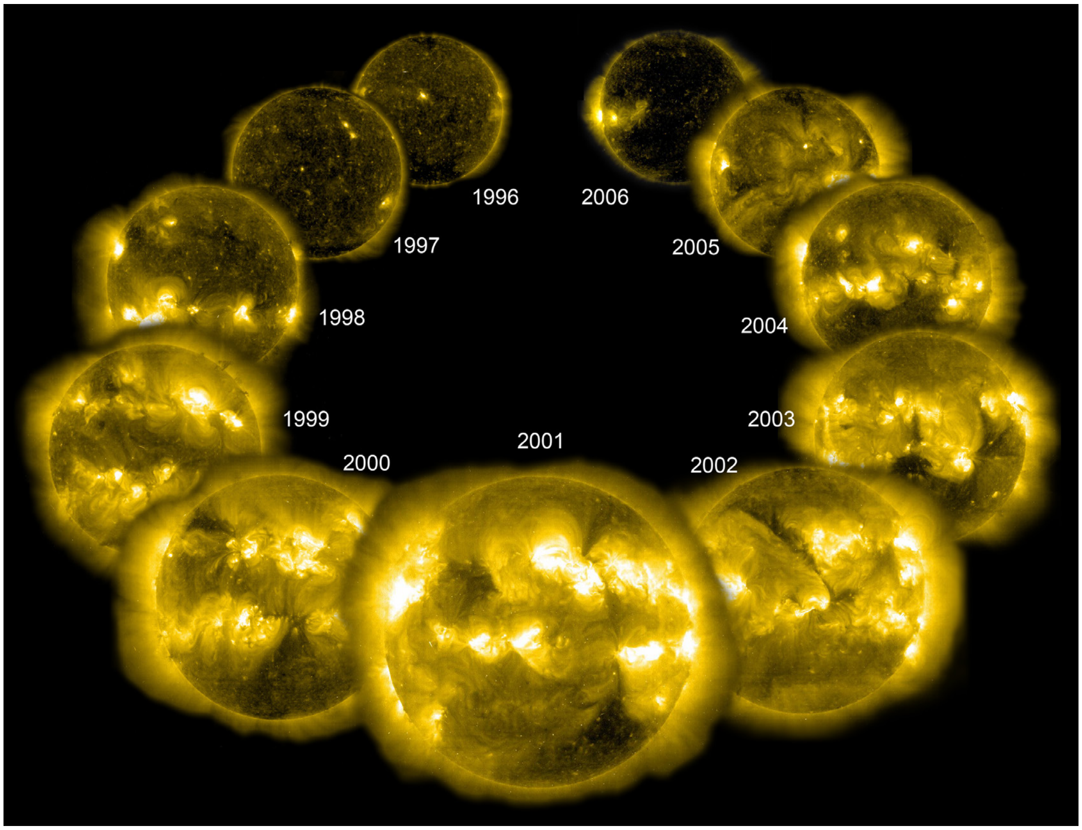
NASA Goddard Space Flight Center manages the project. The University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) built both instruments and provides mission operations. The International Space Station carries TSIS-1.

Why measure solar irradiance?

Solar irradiance is the fundamental energy source that drives Earth's climate and weather systems. TSI measurements provide a quantitative record of changes in solar irradiance, an essential step toward a definitive understanding of Earth's climate history. Establishing the input solar energy baseline provides the foundation for evaluating Earth's climate variations, including those caused by human activities. However, we have only measured the TSI accurately from space for fewer than 40 years, and we do not know how it varies over longer timescales. Thus, it is essential to continue TSI and SSI measurements in an unbroken chain.

How does solar activity influence solar irradiance?

The sun naturally varies in approximately 11-year cycles between more and less activity. In times of greater activity more sunspots can be seen on the sun's surface. These darker areas represent cooler regions on the sun, but they are surrounded by bright areas called faculae. The brightness of the faculae overwhelms the sunspots, so the sun is brighter and produces more energy during times when there are more sunspots. TSIS-1's sensors detect these changes in energy caused by sunspots and faculae as well as by other causes.



During periods of peak activity (front three images) sunspots, solar flares and coronal mass ejections are more common, and the sun emits slightly more energy than during periods of low activity (back images).

Can changes in the Sun affect our climate?

If it weren't for the sun, the Earth would be no more than a frozen rock without life. The sun provides the energy to drive our climate, and even small changes in the sun's output can have a direct impact on Earth. Irradiance changes can alter the climate in at least two ways. First, solar radiation has a direct effect when it is absorbed by and therefore heats the various regions of the Earth system. Second, solar radiation can cause indirect effects in various ways, such as when sunlight interacts with molecules in the upper atmosphere to produce ozone.

Has the sun caused global warming during the last century?

Studies of the link between solar activity and climate show that variations in the TSI have been too small to explain the Earth's warming during the last century.