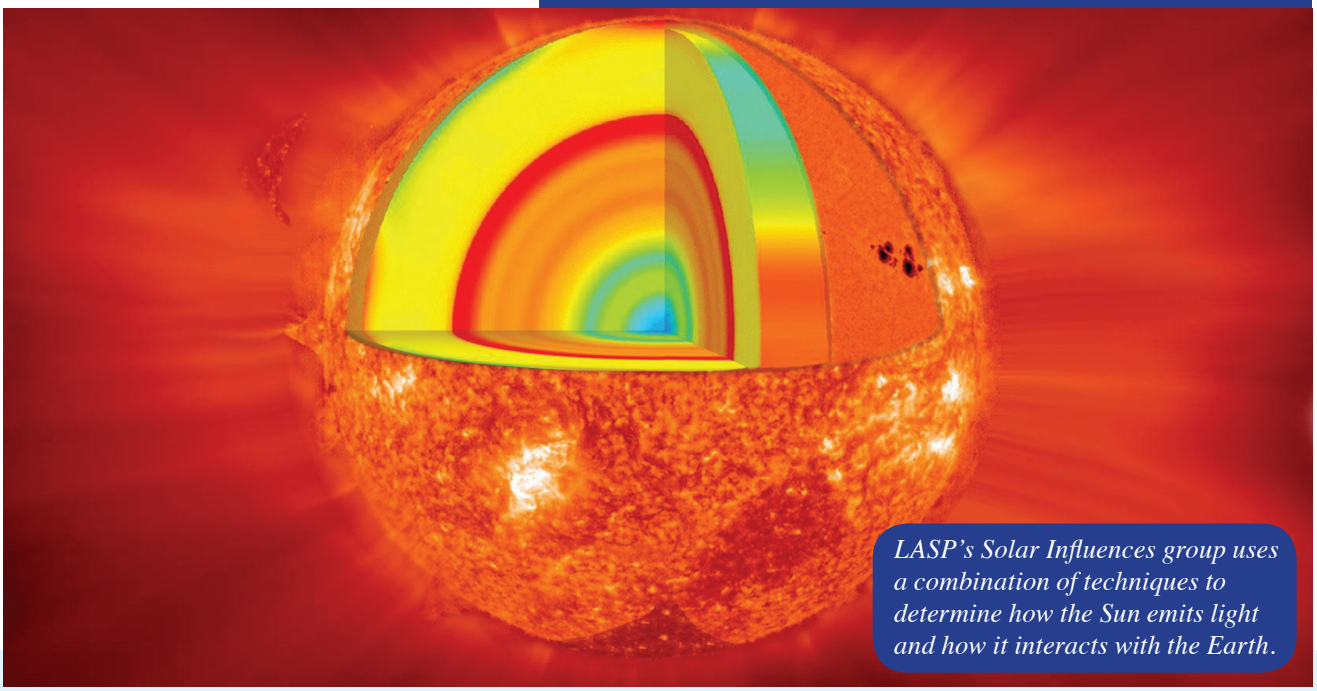
LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS
UNIVERSITY OF COLORADO **BOULDER**

Solar Influences



LASP's Solar Influences group uses a combination of techniques to determine how the Sun emits light and how it interacts with the Earth.

(Courtesy NASA)

Light from the Sun is the largest source of energy for Earth's atmosphere. The Solar Influences group at LASP studies the light from the Sun and how it interacts with the Earth and other planets.

In particular, we are interested in:

- Measuring the light that the Sun emits (total irradiance)
- Distribution of that light over the spectrum, from x-rays to the infrared (spectral irradiance)
- How and why light from the Sun varies in time from seconds to months to years to centuries
- How solar light affects Earth's climate and atmosphere
- The ways solar light affects space weather applications that impact space-based technology and human exploration in space

We answer these questions through a combination of measurements, analysis, and modeling. The LASP Solar Influences group builds accurate and precise instruments to measure the light from the Sun and we analyze the data from those instruments. We also model the Sun, how it emits light, and how that light interacts with Earth's atmosphere.

The LASP Solar Influences group focuses on Sun and climate, space weather, and solar modeling. We also maintain an archive for all the solar irradiance data sets measured by our instruments.

In addition to professional scientists, the Solar Influences group actively trains the next generation of scientists by involving graduate and undergraduate students in all of our research projects.

Solar Weather

Fluctuations in the Sun's radiation cause changes in the conditions of interplanetary space and in the conditions of near-Earth space. Scientists call this phenomenon "space weather."

Space weather affects a range of human endeavors—including telecommunications, GPS navigation, and satellite orbit tracking—because of its influence on Earth's upper atmosphere. LASP scientists are particularly interested in improving our understanding of solar output and its effects on space weather through accurate measurements and the creation of computer models.

Solar UV radiation is a primary energy input to Earth's atmosphere. High variability in the solar output in the UV directly causes variability in the temperature, density, and composition of the upper atmosphere.

The UV output of the Sun can vary on all timescales:

- Seconds to minutes during solar flares
- Days to months because of solar active region evolution and solar rotation
- Years to decades to centuries because of solar magnetic activity cycles

How does incoming UV affect the atmosphere? UV light is absorbed in the upper atmosphere, heating the thermosphere to temperatures between 500 and 1,500 Kelvin. Solar UV also ionizes atoms and molecules in the atmosphere, creating the ionosphere. Some UV light can dissociate the molecules, breaking them apart into atoms or smaller molecules, and thus initiating complex chemical reactions and changing the composition of the upper atmosphere.

The spectrum of the Sun in UV light consists of emission lines and continua that have their origins in the outer layers of the Sun: the chromosphere, transition-region, and corona. These layers of hot, ionized gases are strongly influenced by solar magnetic activity. Temperatures can range from 10,000 Kelvin in the chromosphere to a few million Kelvin in the corona.

With improved measurement and analysis of the Sun's variability in the UV light range, scientists hope to improve our understanding and even ability to predict the space weather that affects us here on Earth.

Sun and Climate

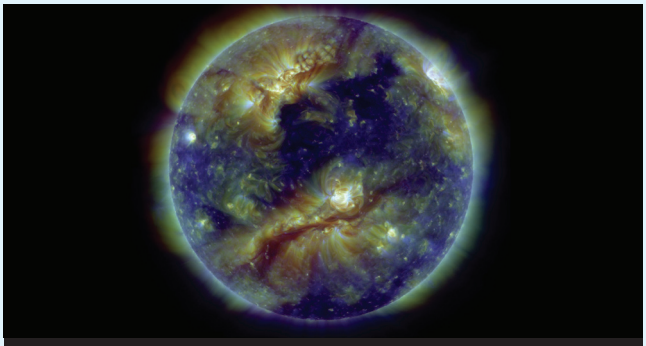
Solar radiation is the Earth's primary source of energy, exceeding by four orders of magnitude the next-largest source—radioactive decay from the Earth's interior. In addition to the direct interactions of the Sun's energy with the Earth and its atmosphere, many indirect effects are also important.

Other factors entering the climate puzzle, include:

- Greenhouse gases, both naturally present and introduced by human activities
- Clouds and aerosols
- Atmospheric and oceanic circulations

Solar radiation influences these factors and the complex interactions they have with each other. To establish the impact that humans have on climate, we must understand the natural factors that impact climate, the most important being the Sun.

Energy from the Sun establishes the basic structure of the Earth's surface and atmosphere and defines its external environment. Solar radiation powers the complex and tightly coupled circulation dynamics, chemistry, and interactions among the atmosphere, oceans, ice, and land that maintain the terrestrial environment as humanity's habitat.



This image was taken by NASA's Solar Dynamics Observatory, which carries the LASP-built Extreme Ultraviolet Variability Experiment (EVE).

(Courtesy NASA/GSFC/AIA)

Studies of the Earth system require precise and accurate knowledge of the intensity of solar radiation and the amount by which it varies. However, the careful measurement of the Sun is challenging because our atmosphere absorbs and scatters the light. For this reason, scientists were unable to make precise measurements until the advent of the satellite era, when instruments could be sent above the atmosphere to enable observations from space.

LASP researchers strive to better understand the Sun's influence on Earth through daily monitoring of space-based measurements:

- Total solar irradiance (TSI)—the total amount of solar radiative energy reaching the Earth's upper atmosphere in all spectra
- Spectral solar irradiance (SSI)—the amount of solar radiative energy reaching the Earth's upper atmosphere in a specific range of the spectrum

The Sun-Climate Research Center

In order to more fully understand the Earth's atmosphere, climate, and interaction with the sun, LASP researchers, in collaboration with the NASA Goddard Space Flight Center, have established the Sun-Climate Research Center (SCRC). Formed in fall 2010, the center focuses on research areas such as how solar variations shape Earth's atmosphere and climate. With a limited number of such agreements between U.S. universities and any of NASA's ten field centers, the SCRC underscores LASP's ability to develop high-caliber research and programmatic opportunities with Goddard.

To read more about Solar Influences at LASP, visit:
http://lasp.colorado.edu/home/science/solar-influences.

The Laboratory for Atmospheric and Space Physics (LASP) combines all aspects of space exploration through our expertise in science, engineering, mission operations, and data management. As an institute at the University of Colorado Boulder, LASP includes students throughout our activities. Learn more at http://lasp.colorado.edu.