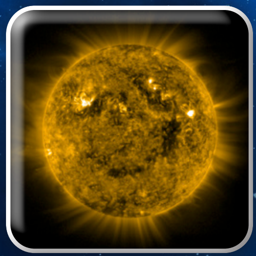
Space Weather Instruments

GOES-R Series



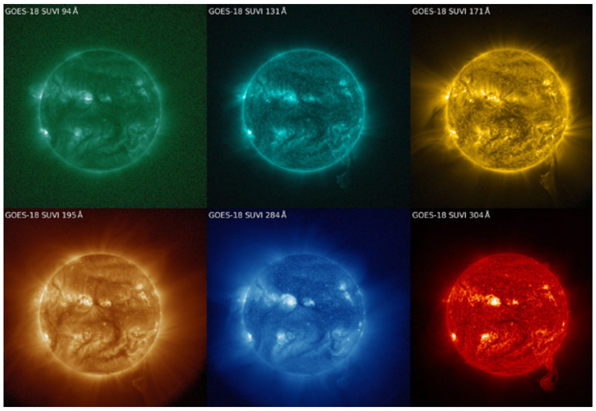

FACT SHEET

SPACE WEATHER

The changing environmental conditions from the sun's atmosphere are known as space weather. Space weather is caused by electromagnetic radiation and charged particles that are released from solar storms. Changes in the magnetic field and a continuous flow of solar particles during a powerful storm headed to Earth can disrupt communications, navigation, and power grids as well as result in spacecraft damage and exposure to dangerous radiation. GOES-R Series satellites host a suite of instruments that detect approaching space weather hazards.

MONITORING SOLAR ACTIVITY

GOES-R satellites include two instruments that measure solar ultraviolet light and X-rays. The **Solar Ultraviolet Imager (SUVI)** is a telescope that monitors the sun in the extreme ultraviolet wavelength range and compiles full-disk solar images. SUVI observes and characterizes complex active regions of the sun, solar flares, and eruptions of solar filaments that may give rise to coronal mass ejections (CMEs). SUVI observations can provide early warning of possible impacts to Earth's space environment and enable better forecasting of potentially disruptive events on the ground.

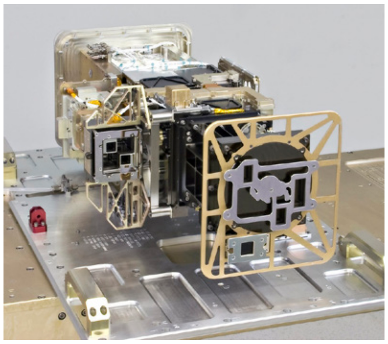


The GOES-18 SUVI captured a coronal mass ejection on July 10, 2022. The sun is seen SUVI's six extreme ultraviolet channels.

The **Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS)** detect solar flares and monitor solar irradiance that impacts the upper atmosphere. Solar irradiance is the power and effect of the sun's electromagnetic radiation per unit of area. EXIS is comprised of two main sensors that help scientists monitor activity on the sun.

The X-ray Sensor (XRS) monitors X-ray input into Earth's upper atmosphere and helps predict solar proton events that can penetrate Earth's magnetic field. XRS alerts scientists to X-ray flares that are strong enough to cause radio blackouts and aides in space weather predictions.

The Extreme Ultraviolet Sensor (EUVS) measures changes in solar extreme ultraviolet irradiance and its impact on the ionosphere. An excess can result in radio blackouts of high-frequency communications at low latitudes. Large solar flares increase the EUV energy deposited in Earth's upper atmosphere, which causes increased atmospheric drag on satellites in low-Earth orbit.



Extreme Ultraviolet and X-ray Irradiance Sensors. Credit: Laboratory for Atmospheric and Space Physics (LASP)

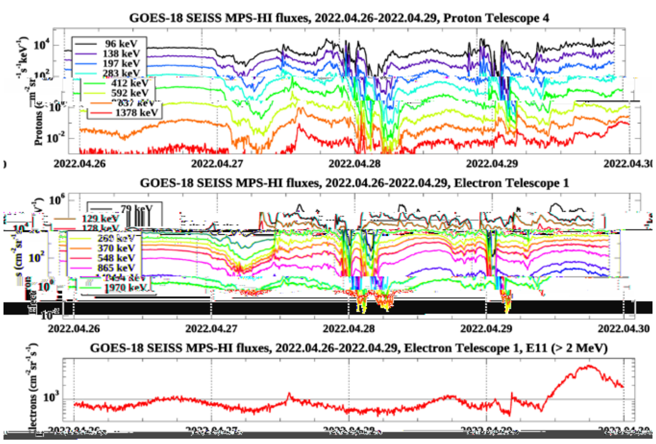
GOES-U will host an additional solar instrument, the **Compact Coronagraph-1 (CCOR-1).** CCOR-1 will image the solar corona (the outer layer of the sun's atmosphere) to help detect and characterize CMEs. CCOR will capture white light imagery of the upper solar corona. Sequences of CME images can be used to determine the size, velocity, density, and direction of CMEs. CME imagery is currently the only source of 1+ day watches for impending geomagnetic storm conditions and CCOR-1 will ensure continuity of measurements currently provided by the aging

Large Angle and Spectrometric Coronagraph (LASCO) instrument. CCOR-1 is part of NOAA's Space Weather Follow On Program.

IN-SITU MEASUREMENTS

GOES-R Series satellites carry two instruments that measure the near-Earth space environment. **The Space Environment In-Situ Suite (SEISS)** is comprised of four sensors that monitor proton, electron and heavy-ion fluxes in Earth's magnetosphere. The Energetic Heavy Ion Sensor (EHIS) measures heavy ion fluxes to provide a complete picture of the energetic particles surrounding Earth. This information is used to help scientists protect astronauts and high-altitude aircraft from high levels of harmful radiation. The Solar and Galactic Proton Sensor (SGPS) measures solar and galactic protons in the magnetosphere. These measurements are crucial to the health of astronauts on space missions and for warnings of radio communication blackouts near Earth's poles and disruptions of commercial air transportation flying polar routes.

Two Magnetic Particle Sensors (MPS) measure electrons and protons. MPS-LO measures low-energy electrons and protons to assess the electrostatic discharge risk satellites. Electrostatic discharge can cause serious and permanent damage to satellite hardware, affect navigation, and interfere its measurements. MPS-HI monitors medium and high-energy protons and electrons that can shorten the life of a satellite and damage its equipment.



These plots show a number of radiation belt disturbances over three days on April 27-29, 2022, detected by the GOES-18 MPS-HI sensor.

The **Magnetometer** measures the magnetic field in the outer portion of the magnetosphere to detect charged particles that can be dangerous to spacecraft and human spaceflight. These geomagnetic field measurements can provide warnings of sudden magnetic storms to satellite operators and power utilities. The GOES-T and GOES-U satellites carry an upgraded magnetometer instrument, called the Goddard Magnetometer (GMAG). GMAG provides improved magnetic field variation measurements.

Astronauts working outside the International Space Station are especially vulnerable to radiation from solar storms.

BENEFITS

Solar eruptions can cause geomagnetic and solar radiation storms, which can disrupt communications, navigation systems, and power utilities. These eruptions can also damage satellite electrical systems and cause radiation damage to orbiting satellites, high-altitude aircraft, and the International Space Station. SUVI, CCOR-1 and EXIS provide solar and coronal imaging and detection of solar eruptions, while SEISS and the Magnetometer monitor, respectively, energetic particles and the magnetic field variations associated with space weather. Together, observations from these instruments enable NOAA's Space Weather Prediction Center to issue space weather forecasts and provide early warning of possible impacts to Earth's space environment and potentially disruptive events on the ground.

- **Detection of coronal holes, solar flares, and coronal mass ejection source regions**
- **Characterization of size, velocity, density, and direction of coronal mass ejections**
- **Monitoring of energetic particles responsible for radiation hazards**
- **Data for power blackout forecasts**
- **Warning of communications and navigation system disruptions**