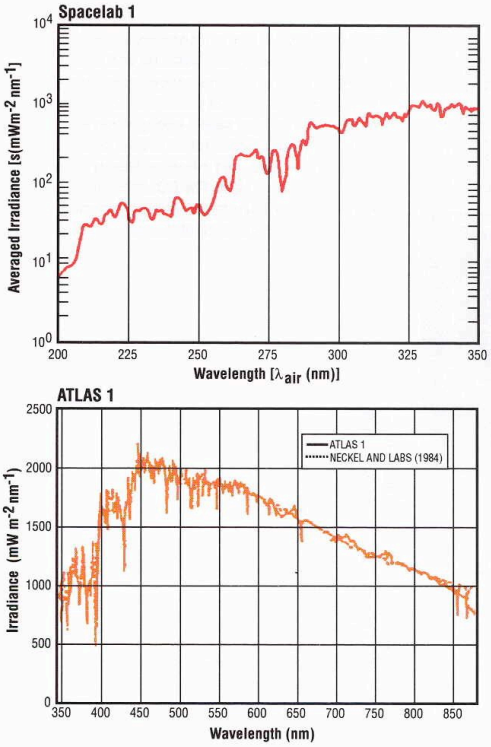
Solar Spectrum Measurement from 180 to 3,200 Nanometers

SOLSPEC

Purpose

Since the Earth System is driven by energy received from the Sun, it is important to measure the spectral details of the solar energy available to the system. Different wavelengths of the Sun's rays penetrate the atmosphere to particular depths where they trigger chemical reactions. Although most solar energy that reaches Earth's surface is visible light, the energy present in X-ray and ultraviolet wavelengths can vary significantly during solar cycles and can change the amount of energy available for chemical reactions in the middle and upper atmospheres, affecting the chemical composition and thermal structure at those heights.

The SOLSPEC instrument measures the energy in the ultraviolet, visible, and infrared wavelengths between 180 and 3,200 nm with a 1- to 5-percent accuracy. This part of the solar spectral irradiance is being studied to determine accurately the amounts of these energies and how they change with time. It is important that scientists know which wavelength ranges of the solar spectrum are involved in the variability of the solar constant. Variability below 300 nm influences the ozone layer and chemical balance in Earth's upper atmosphere, while variability above 700 nm affects water vapor and carbon dioxide absorption at lower altitudes. Data gathered will enable scientists to identify the regions of the atmosphere that are likely to respond to particular variations in solar infrared, visible, and ultraviolet ranges, allowing investigators to better understand and anticipate atmospheric changes.



After Spacelab 1 (1983), the SOLSPEC science team determined the mean of 19 undisturbed spectra to produce this solar ultraviolet irradiance spectrum. The preliminary analysis of ATLAS 1 ultraviolet spectra at this resolution reveals no significant differences between the two sets of measurements.

Although data analysis for ATLAS 1 is not complete, the science team has made a preliminary comparison of the ATLAS 1 solar visible radiation data with those measured in 1984 by Neckel and Labs, who used a similar, ground-based instrument located at a high-altitude observatory. While this comparison is not definitive, these data sets also appear to be in close agreement.

Results from Previous Missions

The SOLSPEC instrument flew on Spacelab 1 in 1983 and was part of the ATLAS 1 payload in 1992. The Shuttle is an excellent vehicle for the SOLSPEC investigations because of its operational flexibility and maneuverability, which allow the SOLSPEC instrument to perform special, perhaps unscheduled, observations at opportune times. For instance, during the added ninth day of the ATLAS 1 mission, the instrument was able to make observations of the light backscattered by the ozone layer. These measurements can be compared to those taken by SSBUV and SUSIM.

Instrument Operations

The SOLSPEC instrument is a double-monochromator that uses two holographic gratings as a dispersive element. The instrument has three spectrometers (one each for the ultraviolet, visible, and near-infrared portions of the spectrum), scanning at 650 different positions. Each position corresponds to a 1-nm bandpass in the ultraviolet and visible ranges and to a 20-nm bandpass in the infrared, producing a total of 1,950 bands. A hollow cathode lamp measures the wavelength scale of the spectrometers.

Four calibration lamps (two deuterium and two tungsten ribbon lamps) are included to assure accuracy in flight. Their light follows the same optical path as the Sun's light. During normal operations, observations of the Sun will alternate with observation of the calibration lamps at 15-minute intervals during orbital day. During orbital night, only the calibration lamps are observed. The instrument is calibrated once a day during the ATLAS 2 mission. Also, the entire system is calibrated on the ground against a blackbody at 3,300 K (3,027 °C/5,481 °F) and a set of deuterium and tungsten ribbon lamps.

In addition to the SOLSPEC scientists stationed at Marshall Space Flight Center during the ATLAS 2 mission, some members of the instrument team will be on duty in Europe at the Belgian Royal Institute of Meteorology. From this center, they will be able to communicate with the SOLSPEC instrument and monitor its data.

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ATLAS 2

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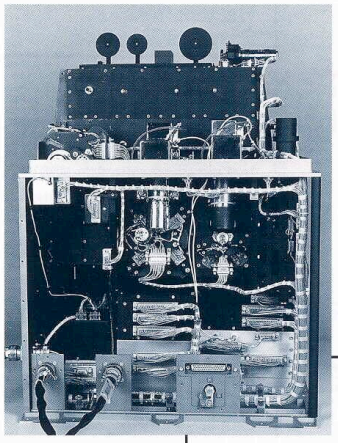
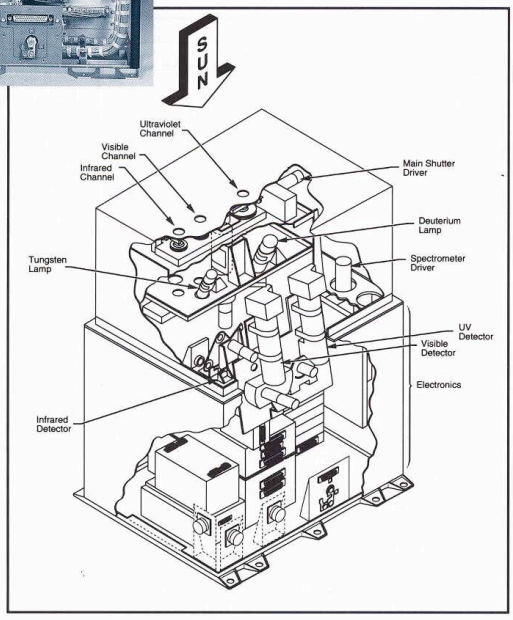
SOLSPEC



The SOLSPEC instrument consists of an onboard lamp calibration package and three double spectrometers that record solar ultraviolet, visible, and infrared radiation. Concave holographic gratings select sunlight wavelengths, photomultiplier tubes record ultraviolet and visible light, and a lead sulfide detector measures infrared light. The SOLSPEC is calibrated once a day and is activated during the Shuttle's Sun-pointing attitudes.



Spectral coverage: 180 to 3,200 nm

Bandpass in ultraviolet and visible: 1 nm

Bandpass in infrared: 20 nm

Total number of bandpasses: 1,950

Precision of individual bandpass: 0.01 nm

Photometric accuracy: 5% in ultraviolet, 1% in infrared and visible

Time to record solar spectrum: 13 min

Number of spectra per orbit: 3

Data rate: 500 b/sec

Mass: 32 kg

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