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SOLAR SPECTRUM (SOLSPEC) MEASUREMENT FROM 180 TO 3000 NANOMETERS
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The purpose of the ~~investigation~~ investigation is the measurement of the absolute solar irradiances in the wavelength range from 180 to 3000 nm and the variabilities of the solar irradiances in this wavelength range. Measurements of the irradiances and variabilities thereto are used in: (1) solar-terrestrial/planetary relationships, in particular aeronomy of the stratosphere and mesosphere; (2) climatology; and (3) solar physics.

The solar variability has several time scales extending from the short-term variations to the 27-day rotation and continuing up to the 11-year cycle. The present investigation is part of a study of long-term variations which needs several flights separated by 12 and 18 months. Post-flight calibration to insure the accuracy of the measurements is essential for this investigation. The present instrument was flown for the first time onboard Spacelab 1. This instrument, in association with the absolute radiometers measuring the total irradiance, will determine which domain of the solar spectrum is responsible for any observed variations and which region of the atmosphere may respond to such variations. This instrument could also participate in the calibration of Sun spectrometers which may be flown on other missions.

Since the solar irradiance is the primary energy input to the Earth's atmosphere and climate system, a knowledge of its absolute magnitude and variability is fundamentally important. Calculations using simple models of the Earth radiation budget have shown the sensitivity of the global average surface temperature to the absolute value of the solar irradiance, namely the solar constant and of its variations. If the integrated solar irradiance is needed for determining the net radiation budget at the top of the atmosphere, the spectral distribution of solar irradiance is required in order to know the altitude within the atmosphere at which the solar energy is deposited. Indeed, the absorption and consequently the energy source at different altitude levels depends upon the magnitude of the available solar energy in wavelength intervals corresponding to absorption spectra of atmospheric species. Therefore, spectral intervals must be selected to study the photodissociation processes in the atmosphere and the related aeronomic chemistry. For instance, the ozone distribution, including the HO_x , NO_x , and ClO_x chemistry, is very important for the radiation budget, because it controls the incoming ultraviolet solar irradiance by absorption and the outgoing long wavelength radiation by emission. The temperature, dynamics, and chemistry of the atmosphere are thus directly related to the variability of the ultraviolet irradiance. Therefore, the absolute value of spectral irradiance and its variability are required for aeronomic and climatic modeling.

Many attempts in the past have been made to measure the solar constant and to derive its variability as a function of the solar cycle. All measurements from high altitude observatories, aircraft, or balloons are affected by atmospheric extinction. To compensate for the atmospheric extinction, corrections have to be applied which are valid to a certain accuracy. From those measurements it is difficult to derive

a long-term variability, since the variability is less than the measurement accuracies. From space no corrections are needed, but other problems may arise from the space environment. The data from Nimbus 6, Nimbus 7, and the Solar Maximum Mission (SMM) show a decrease in the solar constant of about 0.02 or 0.03 percent per year from minimum to maximum solar activity. The data obtained onboard SMM have revealed short-term variations of the solar constant with decreases of about 0.15 percent during several days. It should be noted that whereas the UV flux follows the solar activity, the solar constant has shown decreases during periods of high solar activity.

The relation between solar constant variability and spectral irradiances variability is a key problem, since it determines which region of the atmosphere is affected and how it will be affected by the solar output variations. Little is known in this area. Some observations from balloons have found variations at 368, 580, and 770 nm correlated with the variation of the solar constant measured at the same time by SMM. This instrument will extend the wavelength range of such investigations.

The instrument consists mainly of two parts: (1) three double spectrometers, and (2) an onboard calibration device.

The wavelength range extends from 180 to 3000 nm. Three double monochromators are necessary. They use concave holographic gratings of 10-cm focal length mounted on the same mechanical shaft which rotates with a precision of 2 arc sec. The accuracy of the spectral positioning is 10^{-2} nm. Filters placed on wheels at the exit slits remove the second-order signal. A ground glass diffuser is used at the entrance slit in order to reduce the effects of small angle, off axis pointing.

The onboard calibration device consists of two deuterium lamps, two tungsten ribbon lamps, and one hollow cathode lamp. The deuterium and tungsten ribbon lamps are used to monitor changes of the instrument response either on the ground or in space. The hollow cathode lamp permits a determination of the instrument wavelength scale and some bandpasses of the spectrometers. The instrument is calibrated against a black body at 3300 K and a set of tungsten ribbon lamps. An overview schematic is shown in Figure II-4.

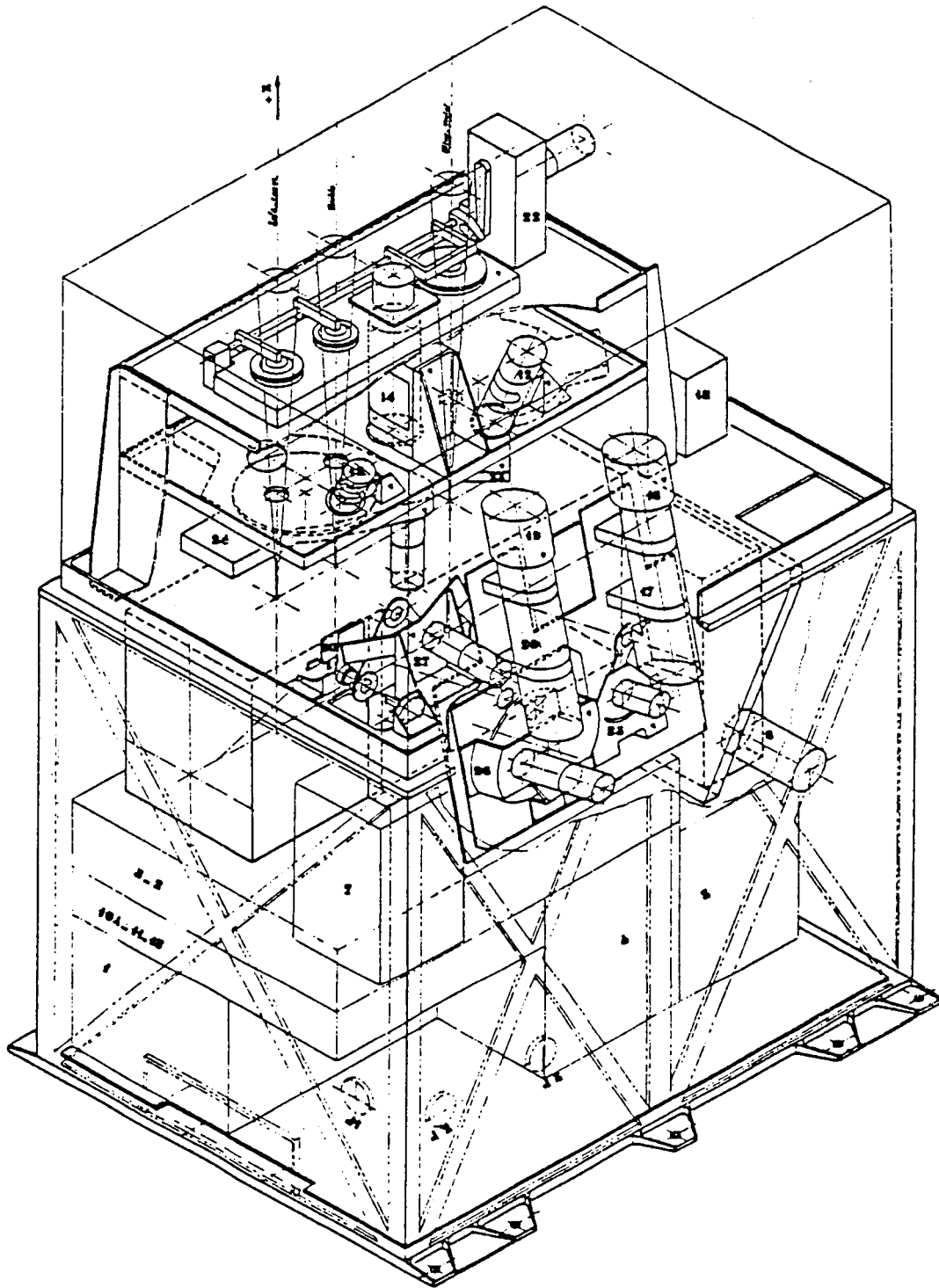


Figure II-4. SOLSPEC instrument overview schematic.