Eppley Precision Spectral Pyranometer (PSP)

This radiometer measures sun and sky irradiance in the range of wavelengths 0.285 to 2.8 microns, including most of the solar spectrum. The PSP is intended to weight the energy flux in all wavelengths equally. It is a "hemispheric receiver" intended to approximate the cosine response for oblique rays. Specifications:

1. Sensitivity approximately 9 microvolts per W/m2. Thus an irradiance of 1000W/m2 will produce a DC potential of 9 millivolts.
2. Impedance is approximately 650 Ohms. Thus, if current is drawn from the PSP, the output voltage will drop.
3. Temperature dependence is 1% over -20 to +40C
4. Linearity is plus or minus 0.5% from 0 to 2800 W/m2
5. Response time is 1 second (for a 1/e relaxation)
6. Cosine response: 1% for 0 to70 degrees from zenith; 3% from 70 to 80 degrees
7. Size 5.75 inches diameter; 3.75 inched high
8. Weight 7 pounds

The YCEO PSP instrument is an old model; at least 30 years old. New instruments can be purchased from the Eppley Laboratory Company in Philadelphia for about $2300. When handling the PSP take care to avoid hitting or dropping it.

The output potential from the PSP can be measured with a good digital voltmeter. For most applications a precision of at least 0.1 millivolt is required. A voltmeter precision of 0.01millivolt would give improved results (e.g. Extech 530, Fluke 87, Agilent U12521a).

For normal irradiance measurements, the PSP should be mounted horizontally with an unobstructed view of the full sky in all directions. On clear days, the irradiance will rise and fall smoothly with the sun, largely controlled by the cosine of the solar zenith angle. On cloudy days, the irradiance will be much lower and will change quickly with time.

The PSP can be used to separate the direct and indirect solar irradiance by blocking either the direct beam or the indirect skylight. To block the direct beam, shadow the sensor dome with a small opaque object held about a meter away. To block the skylight, hold a cylinder over the sensor dome aimed at the sun. The sum of these two components should equal the total irradiance found when the dome is unobstructed.

The strength of the direct solar beam, without the cosine factor, can be found by tilting the PSP so that it directly faces the sun. If this irradiance falls below the solar constant, the cause is probably absorption by the earth's atmosphere. The solar constant varies from 1412W/m2 in early January to 1321W/m2 due to the ellipticity of the earth's orbit. On rare occasions, the measured irradiance will exceed the solar constant. This can only occur when additional light sources are present. The most likely is a tall thunderstorm cloud down-sun from the instrument, reflecting sunlight onto the sensor.

The PSP can be used to determine broad band albedo by turning the instrument to compare zenith and nadir views. The zenith (i.e. uplooking) view gives the solar irradiance while the nadir view gives the reflected irradiance from the test surface. The ratio of nadir to zenith irradiance values is the albedo. A special wooden long-handled mounting pole is available for albedo measurement. For both zenith and nadir views, be sure the PSP is held level (or parallel to the ground in some applications). The operator should stand on the down-sun side to avoid shadows falling on the PSP or the test surface. For nadir view, the PSP height is important. A height too low will block the illumination of the test surface. Held too high, it will sample reflected light from adjacent areas. The zenith and nadir measurements should be repeated several times to check against temporal changes in insolation, especially on cloudy days with rapid insolation fluctuations.

Note that the ASD portable spectrometer, with hemispherical receiver (RCR1), can measure the same quantities as the Eppley PSP, but with spectral resolution. Total irradiance from the PSP can be compared against the spectral irradiance from ASD by integrating the ASD data over wavelength.