New ISO 9060 Pyranometer Classifications

With the release of the new ISO 9060:2018 pyranometer classifications, ISO did away with the old, confusing standards and has now grouped all pyranometers into three new categories: A, B, and C. With this, Apogee's pyranometers are all ranked in the C Classification, but not all C Class pyranometers are created equal. For example, the Apogee SP-510 thermopile sensor is only negligibly different than a Class B. The ISO standards are listed below, along with the Apogee pyranometer specifications.

ISO 9060:2018(E) Pyranometer classification list					Apogee models	
	Parameter	A (Secondary standard)	B (First class)	C (Second class)	Apogee SP-510 Thermopile	Apogee SP-110 Silicon-cell
A	Response time	< 10 s	< 20 s	< 30 s	0.5 s*	< 0.001 s*
B	Zero offset A	±7 W/m^2	±15 W/m^2	±30 W/m^2	±8 W/m^2 ±30 W/m^2 (heated)	N/A
B	Zero offset B	±2 W/m^2	±4 W/m^2	±8 W/m^2	±5 W/m^2	N/A
B	Zero offset C	±10 W/m^2	±21 W/m^2	41 W/m^2	±13 W/m^2 ±35 W/m^2 (heated)	N/A
C1	Non-stability	±0.8 %	±1.5 %	±3 %	±2 %	±2 %
C2	Nonlinearity	±0.5 %	±1 %	±3 %	±1 %	±1 %
C3	Directional response	±10 W/m^2	±20 W/m^2	±30 W/m^2	±25 W/m^2	±30 W/m^2
C4	Spectral error	±0,5 %	±1 %	±5 %	±2 %	±4 %
C5	Temperature response	±1 %	±2 %	±4 %	±4 %	±3 %
C6	Tilt response	±0.5 %	±2 %	±5 %	±1 %	N/A
C7	Additional signal processing errors	±2 W/m^2	±5 W/m^2	±10 W/m^2	N/A	N/A

* Pyranometers with response times < 0.5 seconds are classified as "fast response" pyranometers.

Response time: time for 95 % response

Zero offset A: response to −200 W/m^2 net thermal radiation

Zero offset B: response to 5 K/h change in ambient temperature

Zero offset C: total zero off-set including zero offset A, zero offset B, and other sources

Non-stability: percentage change in responsivity per year

Nonlinearity: percentage deviation from the responsivity at 500 W/m^2 due to the change in irradiance within 100 W/m^2 to 1000 W/m^2

Directional response (for beam radiation): the range of errors caused by assuming that the normal incidence responsivity is valid for all directions when measuring from any direction (with an incidence angle of up to 90° or even from below the sensor) a beam radiation whose normal incidence irradiance is 1000 W/m^2

Spectral error: maximum spectral error observed for a set of global horizontal irradiance clear sky spectra defined in the *ISO 9060:2018(E)* document

Temperature response: percentage deviation due to change in ambient temperature within the interval from −10 °C to 40 °C relative to the signal at 20 °C

Tilt response: percentage deviation from the responsivity at 0° tilt (horizontal) due to change in tilt from 0° to 180° at 1000 W/m^2 irradiance

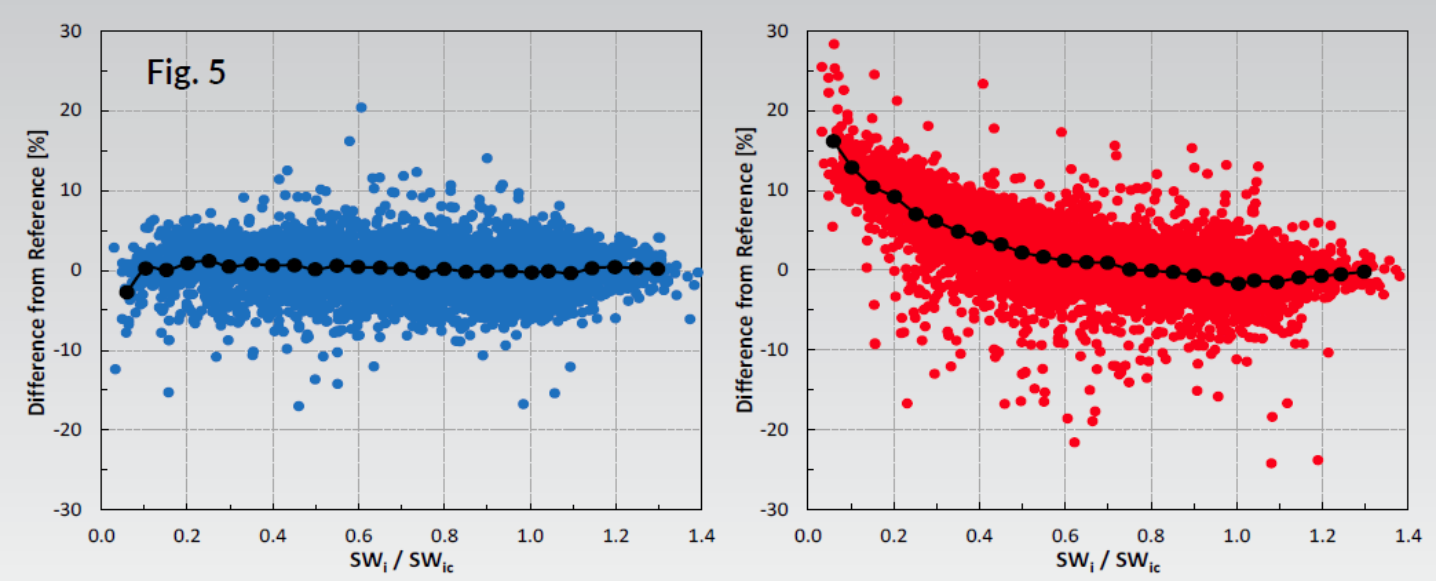

Fig. 5 Differences [%] of an SP-510 thermopile pyranometer and an SP-110 silicon-cell from the mean of the four secondary standard (reference) pyranometers as a function of cloudiness. Black lines are bin averages. The variable SWi / SWic is the ratio of measured global shortwave irradiance [W m^{-2}] to clear sky global shortwave irradiance [W m^{-2}] calculated from a model, and serves as a cloudiness index. Values of SWi / SWic near one indicate clear sky and values near zero indicate overcast sky. The predicted error values listed on each graph were calculated from the spectral response for each sensor and a solar spectrum for overcast conditions, assuming the pyranometers were calibrated under clear sky conditions.

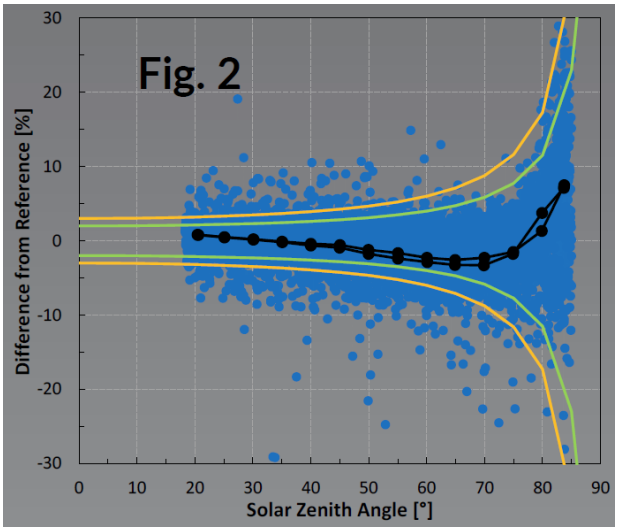

Fig. 2 Differences [%] of an SP-510 thermopile from the mean of four secondary standard (reference) pyranometers as a function of solar zenith angle. Black lines are bin averages for AM and PM. The green and orange lines are estimates of the specifications for first class (± 20 W m-2) and second class (± 30 W m-2) pyranometers, respectively, as a function of solar zenith angle.