OWNER'S MANUAL

SOLAR RADIATION METER

Model JMP-100 and JMP-200

TABLE OF CONTENTS

DECLARATION OF CONFORMITY

CE and ROHS Certificate of Compliance

Declare under our sole responsibility that the products:

Models:JMP-100, JMP-200
Type: Pyranometer Meter

are in conformity with the following standards and relevant EC directives:

Emissions: EN 61326-1:2013
Immunity: EN 61326-1:2013
Safety: EN 61010-1:2010

EU directive 2004/108/EC, EMC
EU directive 2002/95/EC, RoHS (Restriction of Hazardous Substances)
EU directive 2011/65/EU, RoHS2

Please be advised that based on the information available to us from our raw material suppliers, the products manufactured by us do not contain, as intentional additives, any of the restricted materials, including cadmium, hexavalent chromium, lead, mercury, polybrominated biphenyls (PBB), polybrominated diphenyls (PBDE).

INTRODUCTION

Solar radiation at Earth's surface is typically defined as total radiation across a wavelength range of 280 to 4000 nm (shortwave radiation). Total solar radiation, direct beam and diffuse, incident on a horizontal surface is defined as global shortwave radiation, or shortwave irradiance (incident radiant flux), and is expressed in Watts per square meter (W m^{-2}, equal to Joules per second per square meter).

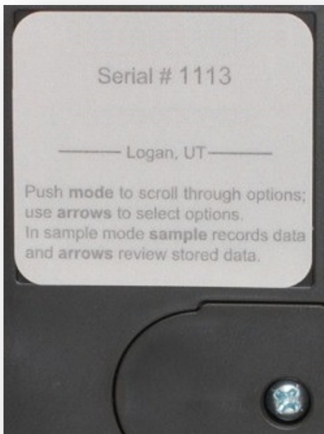
Pyranometers are sensors that measure global shortwave radiation. JMP series solar radiation me ters incorporate silicon-cell pyranometers, and are only sensitive to a portion of the solar spectrum, approximately 350-1100 nm (approximately 80 % of total shortwave radiation is within this range). However, silicon-cell pyranometers are calibrated to estimate total shortwave radiation across the entire solar spectrum. Silicon-cell pyranometer specifications compare favorably to specifications for World Meteorological Organization (WMO) moderate and good quality classifications and specifications for International Organization of Standardization(ISO) second class and first class classifications, but because of limited spectral sensitivity, they do not meet the spectral specification necessary for WMO or ISO certification.

Typical applications of silicon-cell pyranometers include incoming shortwave radiation measurement in agricultural, ecological, and hydrological weather networks, and solar panel arrays.

Instruments JMP series solar radiation meters consist of a handheld meter and a dedicated pyranometer that is integrated into the top of the meter housing (JMP-100) or connected by cable to an anodized aluminum housing (JMP-200). Integrated and separate sensors consist of a cast acrylic diffuser (filter), photodiode, and are potted solid with no internal air space. JMP series meters provide a real time irradiance reading on the LCD display that determines the radiation incident on a planar surface (does not have to be horizontal), where the radiation emanates from all angles of a hemisphere. JMP series meters include manual and automatic data logging features for making spot-check measurements or calculating daily solar insolation.

SENSOR MODELS

JMP series solar radiation meters covered in this manual are self-contained and come complete withhandheld meter and sensor.



Sensor model number and serial number are located on a label on the backside of the handheld meter.

SPECIFICATIONS

Calibration Uncertainty: ± 5 % (see Calibration Traceability below)

Measurement Repeatability: < 1 %

Non-stability (Long-term Drift): < 2 % per year

Non-linearity: < 1 % (up to 1750 W m^{-2})

Response Time: < 1 ms

Field of View: 180°

Spectral Range: 360 to 1120 nm (wavelengths where response is 10 % of maximum; see Spectral Response below)

Directional (Cosine) Response: ± 5 % at 75° zenith angle (see Cosine Response below)

Temperature Response: 0.04 ± 0.04 % per C (see Temperature Response below)

Operating Environment: 0 to 50 C
< 90 % non-condensing relative humidity up to 30 C
< 70 % non-condensing relative humidity from 30 to 50 C
Separate sensors can be submerged in water up to depths of 30 m

Meter Dimensions: 12.6 cm length, 7.0 cm width, 2.4 cm height

Sensor Dimensions: JMP-200: 2.4 cm diameter and 2.8 cm height

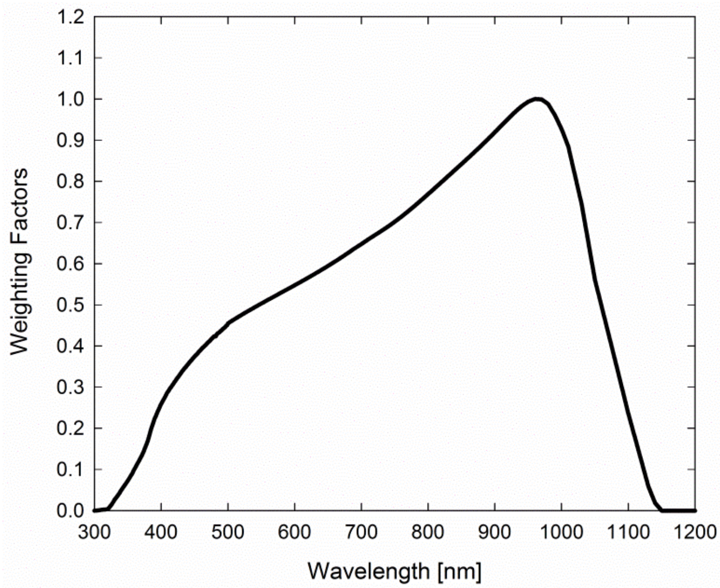
Mass: JMP-100: 150 g
JMP-200: 180 g

Cable: 2 m of shielded, twisted-pair wire.
Additional cable available
Santoprene rubber jacket (high water resistance, high UV stability, flexibility in cold conditions)

Calibration Traceability:

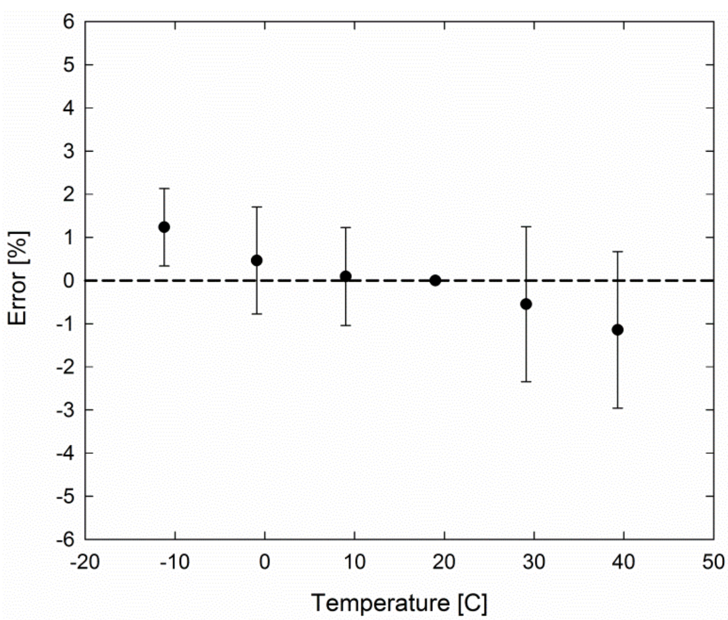
Instruments JMP series solar radiation meters are calibrated through side-by-side comparison to the mean of four model JSP-110 transfer standard pyranometers (shortwave radiation reference) under high intensity discharge metal halide lamps. The transfer standard pyranometers are calibrated through side-by-side comparison to the mean of at least two ISO classfiied reference pyranometers under sunlight (clear sky conditions) in Logan, Utah.Each of four ISO-classified reference pyranometers are recalibrated on an alternating year schedule (two instruments each year) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.

Spectral Response:



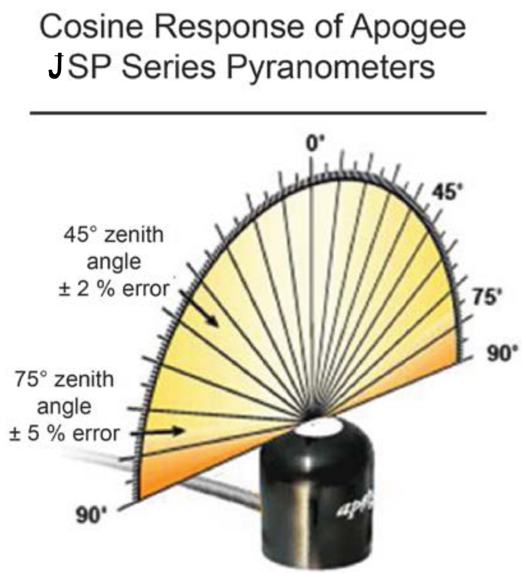
Spectral response estimate of silicon-cell pyranometers. Spectral response was estimated by multiplying the spectral response of the photodiode, diffuser, and adhesive. Spectral response measurements of diffuser and adhesive were made with a spectrometer, and spectral response data for the photodiode were obtained from the manufacturer.

Temperature response:

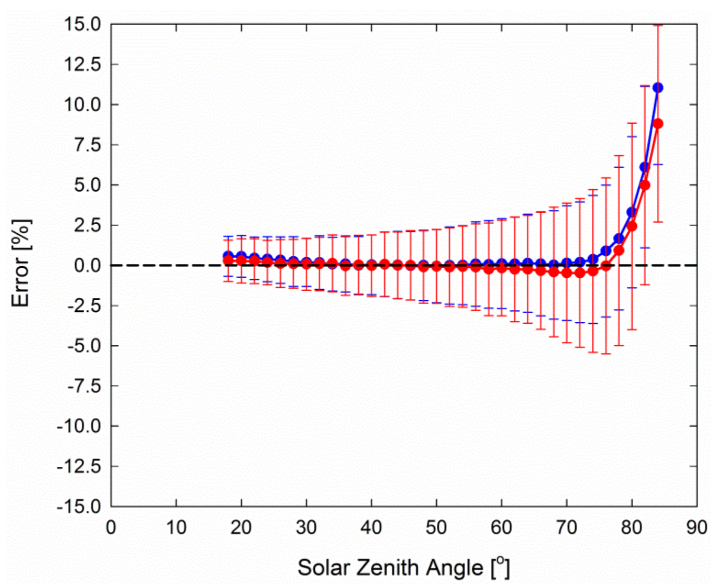


Mean temperature response of ten silicon-cell pyranometers (*errors bars represent two standard deviations above and below mean*). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, broad spectrum, electric lamp. At each temperature set point, a spectroradiometer was used to measure light intensity from the lamp and all pyranometers were compared to the spectroradiometer. The spectroradiometer was mounted external to the temperature control chamber and remained at room temperature during the experiment.

Cosine Response:



Directional, or cosine, response is defined as the measurement error at a specific angle of radiation incidence. Error for silicon-cell pyranometers is approximately ± 2 % and ± 5 % at solar zenith angles of 45° and 75°, respectively.



Mean cosine response of eleven silicon-cell pyranometers (*error bars represent two standard deviations above and below mean*). Cosine response measurements were made by Broadband Outdoor Radiometer Calibrations (BORCAL) performed during two different years at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. Cosine response was calculated as the relative difference of pyranometer sensitivity at each solar zenith angle to sensitivity at 45° solar zenith angle. The blue symbols are AM measurements, the red symbols are PM measurements.

DEPLOYMENT AND INSTALLATION

JMP series solar radiation meters are designed for spot-check measurements, and calculation of daily insolation (total solar radiation incident on a planar surface over the course of a day) through the built-in logging feature. To accurately measure global shortwave radiation incident on a horizontal surface, the sensor must be level. For this purpose, each JMP model comes with a different option for mounting the sensor to a horizontal plane.

The AL-210 leveling plate is recommended for use with the JMP-100.

The AL-100 leveling plate is recommended for use with the JMP-200. To facilitate mounting to a cross arm, the AM-110 mounting bracket is recommended for use with the AL-100.

In addition to leveling, all sensors should also be mounted such that obstructions (e.g., weather station tripod/tower or other instrumentation) do not shade the sensor.

OPERATION AND MEASUREMENT

JMP series solar radiation meters are designedwith auser-friendly interface allowing quick and easy measurements.

To power the meter, slide the included battery (CR2320) into the battery holder, after removing the battery door from the meter's back panel. The positive side (designated by a "+" sign) should be facing out from the meter circuit board.

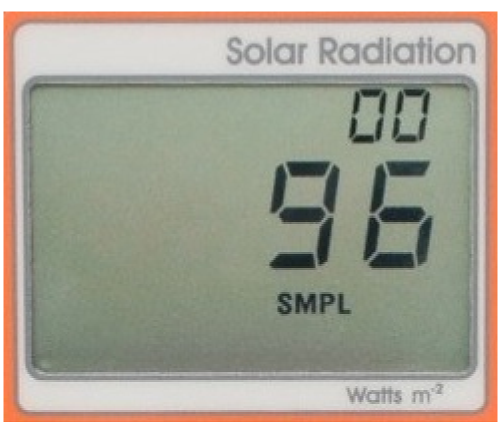

Press the power button to activate the LCD display. After two minutes of non-activity the meter will revert to sleep mode and the display will shut off to conserve battery life.

Press the mode button to access the main menu, where the appropriate logging (manual or automatic) is selected and where the meter can be reset.

Press the sample button to log a reading while taking manual measurements.


Press the up button to make selections in the main menu. This button is also used to view and scroll through the logged measurements on the LCD display.


Press the down button to make selections in the main menu. This button is also used to view and scroll through the logged measurements on the LCD display.



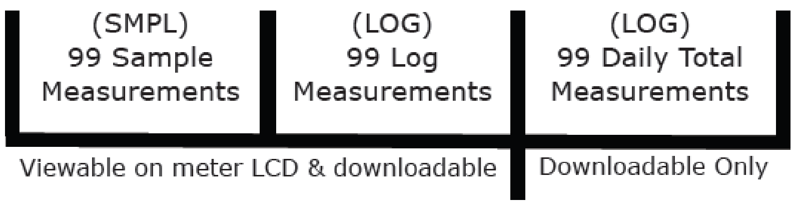
The LCD display consists of the total number of logged measurements in the upper right hand corner, the real-time irradiance value in the center, and the selected menu options along the bottom.

Logging: To choose between manual or automatic logging, push the mode button once and use the up/down buttons to make the appropriate selection (SMPL or LOG). Once the desired mode is blinking, press the mode button two more times to exit the menu. When in SMPL mode press the sample button to record up to 99 manual measurements (a counter in the upper right hand corner of the LCD display indicates the total number of saved measurements). When in LOG mode the meter will power on/off to make a measurement every 30 seconds. Every 30 minutes the meter will average the sixty 30 second measurements and record the averaged value to memory. The meter can store up to 99 averages and will start to overwrite the oldest measurement once there are 99 measurements. Every 48 averaged measurements (making a 24 hour period), the meter will also store an integrated daily total in megajoules per square meter per day (MJ m^{-2} d^{-1}).

Reset: To reset the meter, in either SMPL or LOG mode, push the mode button twice (RUN should be blinking), then while pressing the down button, press the mode button once. This will erase all of the saved measurements in memory, but only for the selected mode. That is, performing a reset when in SMPL mode will only erase the manual measurements and performing a reset when in LOG mode will only erase the automatic measurements.

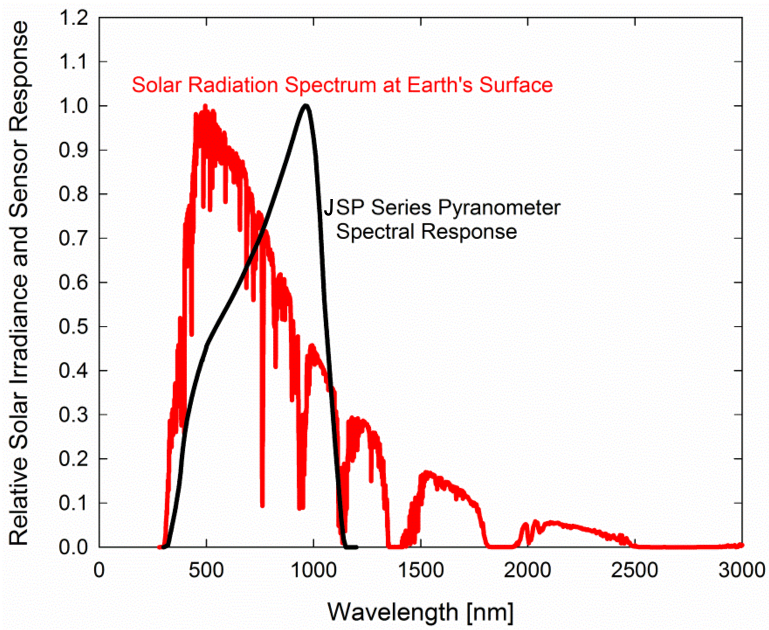
Review/Download Data: Each of the logged measurements in either SMPL or LOG mode can be reviewed on the LCD display by pressing the up/down buttons. To exit and return to the real-time readings, press the sample button. Note that the daily total values are not accessible through the LCD and can only be viewed by downloading to a computer.

Downloading the stored measurements will require the AC-100 communication cable and software (sold separately).The meter outputs data using the UART protocol and requires the AC-100 to convert from UART to USB, so standard USB cables will not work.



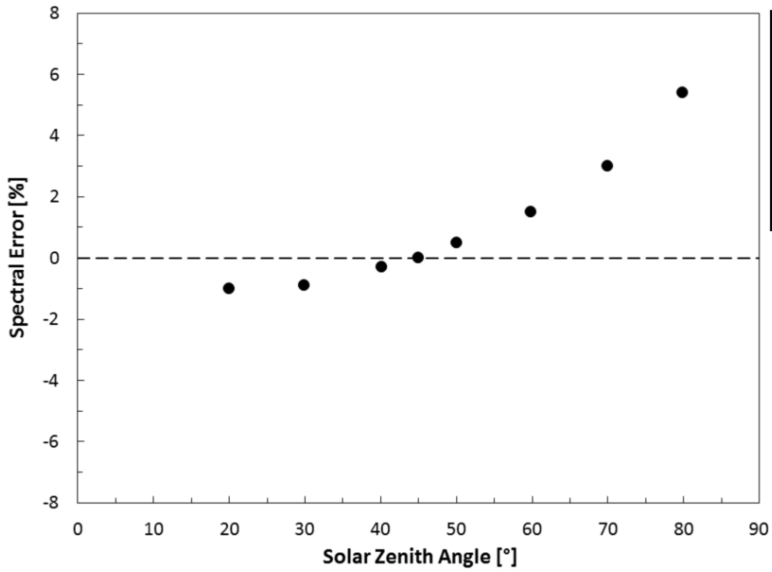
Spectral Errors for Measurements with Silicon-cell Pyranometers:

JMP series solar radiation meters are calibrated under electric lamps in a calibration laboratory. The calibration procedure simulates calibration under clear sky conditions at a solar zenith angle of approximately 45°. However, due to the limited spectral sensitivity of silicon-cell pyranometers compared to the solar radiation spectrum (see graph below), spectral errors occur when measurements are made in conditions that differ from conditions the sensor was calibrated under (e.g., the solar spectrum differs in clear sky and cloudy conditions, thus measurements in cloudy conditions result in spectral error because sensors are calibrated in clear sky conditions).

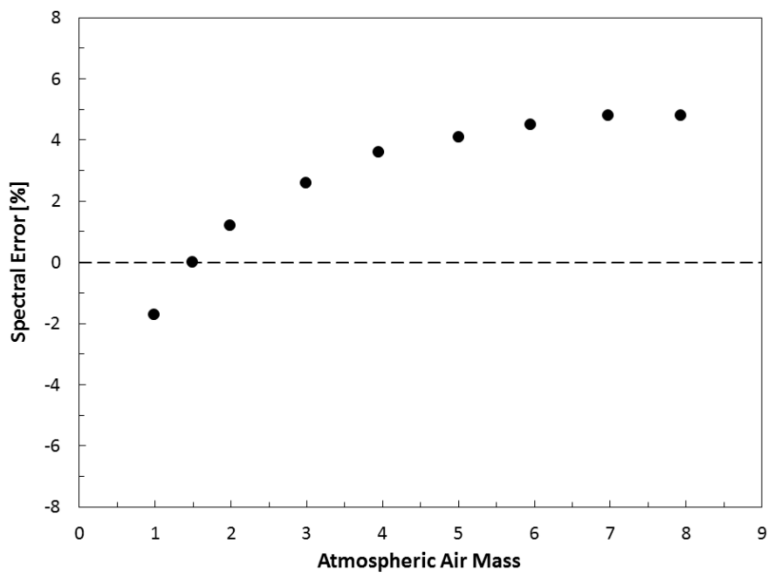


Spectral response of silicon-cell pyranometers compared to solar radiation spectrum at Earth's surface. Silicon-cell pyranometers, such as NSP series, are only sensitive to the wavelength range of approximately 350-1100 nm, and are not equally sensitive to all wavelengths within this range. As a result, when the spectral content of solar radiation is significantly different than the spectrum that silicon- cell pyranometers were calibrated to, spectral errors result.

Silicon-cell pyranometers can still be used to measure shortwave radiation in conditions other than clear sky or from radiation sources other than incoming sunlight, but spectral errors occur when measuring radiation with silicon-cell pyranometers in these conditions. The graphs below show spectral error estimates for silicon-cell pyranometers at varying solar zenith angles and varying atmospheric air mass. The diffuser is optimized to minimize directional errors, thus the cosine response graph in the Specifications section shows the actual directional errors in practice (which includes contributions from the spectral shift that occurs as solar zenith angle and atmospheric air mass change with time of day and time of year). The table below provides spectral error estimates for shortwave radiation measurements from shortwave radiation sources other than clear sky solar radiation.



Spectral error for pyranometers as a function of solar zenith angle, assuming calibration at a zenith angle of 45°.



Spectral error for pyranometers as a function of atmospheric air mass, assuming calibration at an air mass of 1.5.

Spectral Errors for Shortwave Radiation Measurements with Pyranometers

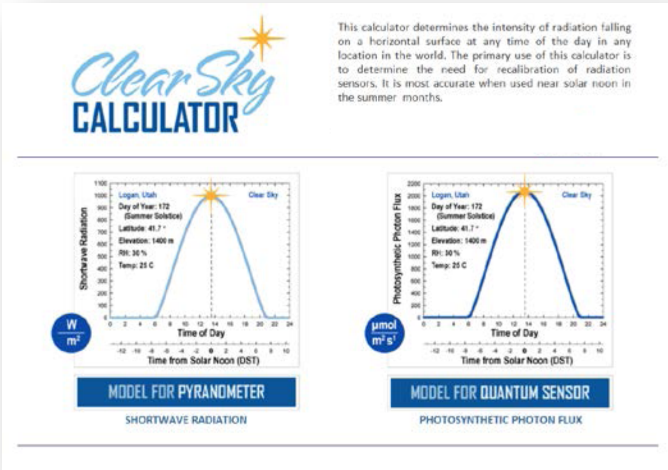
Radiation Source (Error Calculated Relative to Sun, Clear Sky)	Error [%]
Sun (Clear Sky)	0.0
Sun (Cloudy Sky)	9.6
Reflected from Grass Canopy	14.6
Reflected from Deciduous Canopy	16.0
Reflected from Conifer Canopy	19.2
Reflected from Agricultural Soil	-12.1
Reflected from Forest Soil	-4.1
Reflected from Desert Soil	3.0
Reflected from Water	6.6
Reflected from Ice	0.3
Reflected from Snow	13.7

MAINTENANCE AND RECALIBRATION

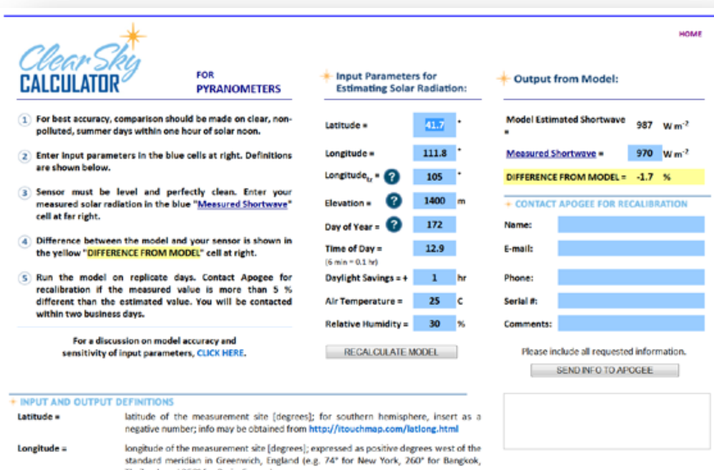
Moisture or debris on the diffuser is a common cause of low readings. The sensor has a domed diffuser and housing for improved self-cleaning from rainfall, but materials can accumulate on the diffuser (e.g., dust during periods of low rainfall, salt deposits from evaporation of sea spray or sprinkler irrigation water) and partially block the optical path. Dust or organic deposits are best removed using water or window cleaner and a soft cloth or cotton swab. Salt deposits should be dissolved with vinegar and removed with a soft cloth or cotton swab. **Never use an abrasive material or cleaner on the diffuser.**

The Clear Sky Calculator (www.clearskycalculator.com) can be used to determine the need for pyranometer recalibration. It determines total shortwave radiation incident on a horizontal surface at any time of day at any location in the world. It is most accurate when used near solar noon in spring and summer months, where accuracy over multiple clear and unpolluted days is estimated to be ± 4 % in all climates and locations around the world. For best accuracy, the sky must be completely clear, as reflected radiation from clouds causes incoming radiation to increase above the value predicted by the clear sky calculator. Measured values of total shortwave radiation can exceed values predicted by the Clear Sky Calculator due to reflection from thin, high clouds and edges of clouds, which enhances incoming shortwave radiation. The influence of high clouds typically shows up as spikes above clear sky values, not a constant offset greater than clear sky values.

To determine recalibration need, input site conditions into the calculator and compare total shortwave radiation measurements to calculated values for a clear sky. If sensor shortwave radiation measurements over multiple days near solar noon are consistently different than calculated values (by more than 6%) the sensor should be cleaned and re-leveled.



Homepage of the Clear Sky Calculator. Two calculators are available: One for pyranometers (total shortwave radiation) and one for quantum sensors (photosynthetic photon flux).



Clear Sky Calculator for pyranometers. Site data are input in blue cells in middle of page and an estimate of total shortwave radiation is returned on right-hand side of page.

TROUBLESHOOTING AND CUSTOMER SUPPORT

Verify Functionality:

Pressing the power button should activate the LCD and provide a real-time irradiance reading. Direct the sensor head toward a light source and verify the irradiance reading responds. Increase and decrease the distance from the sensor to the light source to verify that the reading changes proportionally (decreasing irradiance with increasing distance and increasing irradiance with decreasing distance). Blocking all radiation from the sensor should force the reading to zero.

Battery Life:

When the meter is maintained properly the coin cell battery (CR2320) should last for many months, even after continuous use. The low battery indicator will appear in the upper left hand corner of the LCD display when the battery voltage drops below 2.8 V DC. The meter will still function correctly for some time, but once the battery is drained the pushbuttons will no longer respond and any logged measurements will be lost.

Pressing the power button to turn off the meter will actually put it in sleep mode, where there is still a slight amount of current draw. This is necessary to maintain the logged measurements in memory. Therefore, it is recommended to remove the battery when storing the meter for many months at a time, in order to preserve battery life.

Master Reset:

If a meter ever becomes non-responsive or experiences anomalies, such as a low battery indicator even after replacing the old battery, a master reset can be performed that may correct the problem. Note that a master reset will erase all logged measurements from memory.

First press the power button so that the LCD display is activated. While still powered, slide the battery out of the holder, which will cause the LCD display to fade out. After a few seconds, slide the battery back into the holder. The LCD display will flash all segments and then show a revision number (e.g. "R1.0"). This indicates the master reset was performed and the display should return to normal.

Error Codes and Fixes:

Error codes will appear in place of the realtime readingon the LCD displayand will continue to flash until the problem is corrected.

Err 1: battery voltage out of range. **Fix:** replace CR2320 battery and perform master reset.
Err 2: sensor voltage out of range. **Fix:** perform master reset.
Err 3: not calibrated. **Fix:** perform master reset.
Err 4: CPU voltage below minimum. **Fix:** replace CR2320 battery and perform master reset.

Modifying Cable Length:

Although it is possible to splice additional cable to the separate sensor of the JMP-200, note that the cable wires are soldered directly into the circuit board of the meter. Care should be taken to remove the back panel of the meter in order to access the board and splice on the additional cable, otherwise two splices would need to be made betweenthe meter and sensor head.

WARRANTY POLICY

What is Covered

All products manufactured are warranted to be free from defects in materials and craftsmanship for a period of four (4) years from the date of shipment from our factory. To be considered for warranty coverage an item must be evaluated either at our factory or by an authorized distributor.

Products not manufactured by (spectroradiometers, chlorophyll content meters) are covered for a period of one (1) year.

What is Not Covered

The customer is responsible for all costs associated with the removal, reinstallation, and shipping of suspected warranty items to our factory.

The warranty does not cover equipment that has been damaged due to the following conditions:

1. Improper installation or abuse.

2. Operation of the instrument outside of its specified operating range.

3. Natural occurrences such as lightning, fire, etc.

4. Unauthorized modification.

5. Improper or unauthorized repair.

Please note that nominal accuracy drift is normal over time. Routine recalibration of sensors/meters is considered part of proper maintenance and is not covered under warranty.

Who is Covered

This warranty covers the original purchaser of the product or other party who may own it during the warranty period.

What We Will Do

At no charge we will:

1. Either repair or replace (at our discretion) the item under warranty.

2. Ship the item back to the customer by the carrier of our choice.

Different or expedited shipping methods will be at the customer’s expense.