Madras Station Report

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In November of 2023, a new solar monitoring station was installed in Madras, Oregon. The installation was completed on November 16, 2023. Since its completion the new Madras station has been working properly with the data being published to the University of Oregon - Solar Radiation Monitoring Lab's website. This report outlines key features associated with the Madras station.

Figure 1. shows a photograph of the station. Key aspects of the station visible in the photograph include the CMP11 and RSP sensors, the data electronics logger box, the battery, and the solar panel used as a power source. These features will be discussed in the upcoming sections.

Figure 1. View of station from the East (looking West) showing instruments and power supply.

Table 1 below, gives the location and sensors at the site. Tables 2 and 3 at the end of this report outline key features of the station in greater detail.

Table 1. Madras station at a glance

Location Madras, OR	CMP11: GHI
Latitude: 44.6235	RSP: GHI, DNI, DHI
Longitude: -121.1427	Air Temperature
Altitude: 705 m	Frequency: 1 - Minute

The station was set up at the Deschutes Valley Water District office on the East side of Madras, OR. Permission was granted to set up the new station on the fence along the western edge of one of the equipment lots. Figure 2 is an ariel view of the site, with the specific location of the site highlighted by the arrow. The parking lot area where the station is located is behind a locked gate. There is security fence around the property boundary for the site. The barb wire visible in Figures 1 and 3 is part of the Deschutes water valley authority fence line.

Figure 2. Location of the Deschutes Valley Water District lot with arrow showing data station location.

The site is ideally situated with an excellent view of the sky in all directions. Horizon obstructions are less than 5° with some trees and telephone poles extending up slightly higher. Figures 6, 7, 8, 9 give views of the horizon looking North, East, South, and West.

At the site, a Rotating Shadowband Pyranometer (RSP) was installed which produces three component solar radiation measurements- global horizontal irradiance(GHI), direct normal irradiance (DNI), and diffuse horizontal irradiance (DHI). In addition to this, a Kipp and Zonen CMP11 was installed with a ventilator as a redundant GHI measurement. This pyranometer is a secondary standard Class-A instrument which produces high quality GHI measurements. The ventilator is installed to minimize the amount of soiling, dew, and frost on the sensor. The heater for the ventilator is not turned on. Having two GHI sensors allows for better quality control checks of the data. There is also an air temperature sensor at the site. The air temperature sensor is not forcibly ventilated.

A photograph of the sensors is shown in Figure 3 - left. The RSP is to the left in this picture, the CMP11 is to the right. The air temperature sensor is inside of the finned radiation shield below the CMP11. The fence surrounding the area is very sturdy. It was decided to connect the sensors directly to the fence.

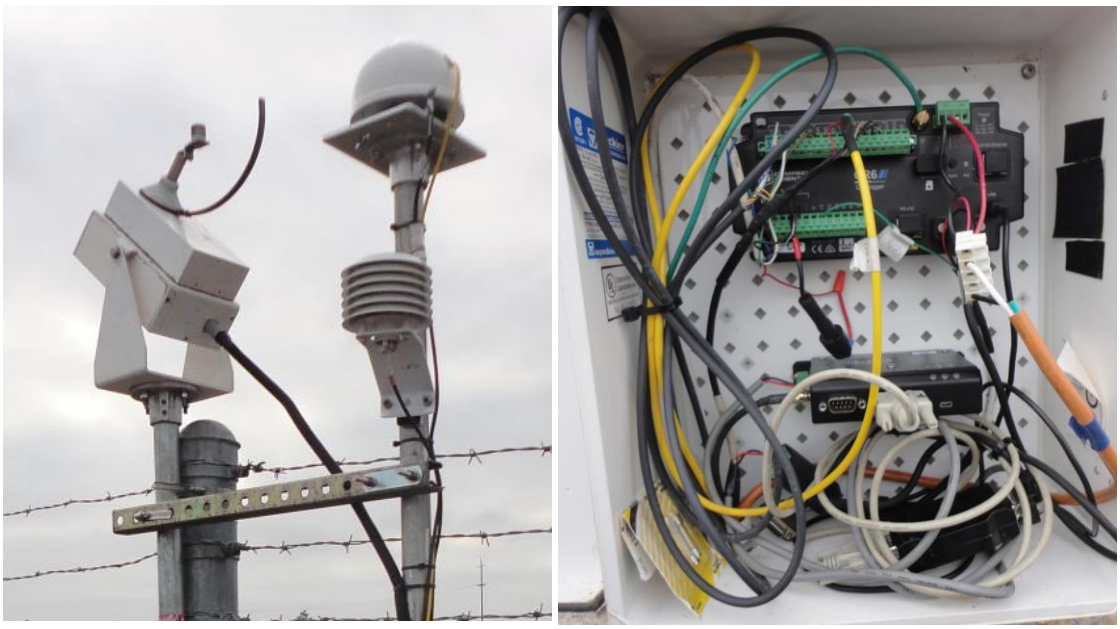

Figure 3. Left – Photo of the CMP11 and RSP sensors. Right – View inside the data collection box. The data logger and cell phone communications are visible.

Figure 3 - right shows a detailed view inside the data collection box. Data from the site is collected by a Campbell Scientific CR6 data logger. Data is exported to SRML data collection computers using a Campbell Scientific CELL210 cellular modem over the Verizon network. The data interval is one-minute averages and these data are collected by the SRML every five minutes. In addition, every five minutes the data is processed and posted on the SRML website. This gives a “near real-time" data stream from the site. The five-minute time interval is long enough to allow for successful data processing of the various SRML monitoring sites. The data logger and electronics are located inside the white box in the center of Figure 1.

The station is powered by an 80 Amp-hour deep cycle battery which is subsequently charged by a 100-Watt solar module. The station is independent from any grid power. Both the PV module and the battery storage are visible in Figure 1. The battery is large enough to operate the station for an estimated 4 days without any recharge by the PV module. This would correspond to extreme extended overcast conditions for multiple days. These conditions are not typically seen, even in the cloudy winter months. To preserve the battery further, the CMP11 ventilator is turned off if the battery voltage goes below 12.2 V. Typically a fully charged battery is around 12.5 V. The 4-day value given above is a challenging to compute exactly and is a conservative estimate.

Efforts are underway to find a local technician that will perform routine cleaning of the site. Typically the dusty summer months require more frequent cleaning events. Currently the site is unmaintained.

The instruments were calibrated before installation and will be replaced by calibrated instruments during each summer visit to the site. The instruments were calibrated using the modern SRML

calibration technique where sensors are calibrated at the Eugene home office. Using this new method, each summer newly calibrated sensors will be installed at the site and the previous sensors will be brought back to Eugene for recalibration. Figures 4 and 5 show the calibration record for the CMP11 and RSP sensors. For more details regarding the SRML calibration process contact SRML staff.

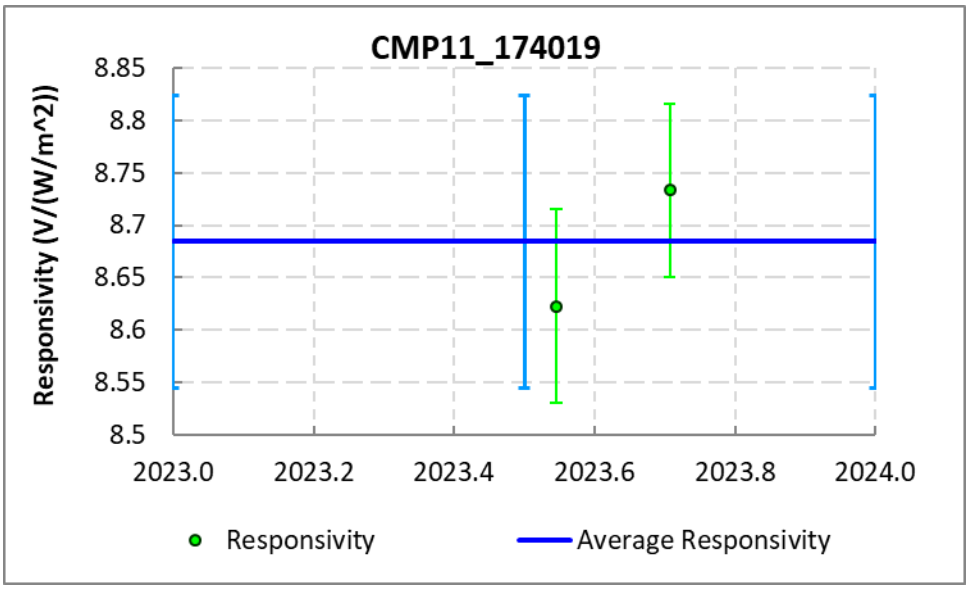

Figure 4. Calibration record for CMP11(174019). This sensor is new to the SRML, so there are not a significant number of calibration data points. The responsivity is reported at SZA = 45°.

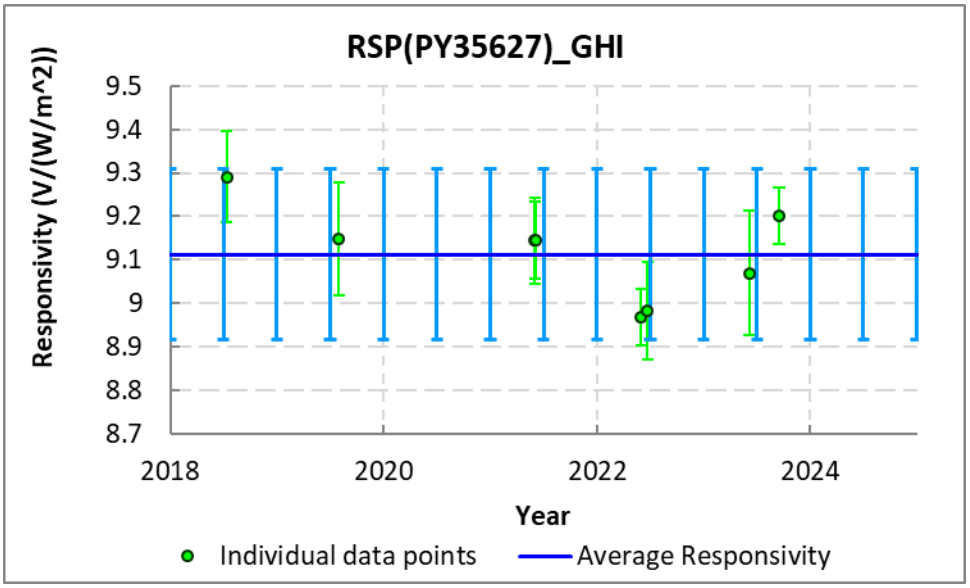

Figure 5. Calibration record for RSP(PY35627).

Data collection began at the site on 2023-11-16. Since that time data has been uploaded to the SRML website at 5-minute intervals. The data can be obtained from the SRML website at: http://is-solardata01.uoregon.edu/SelectArchival.html

Since installation of this station on November 16, 2023, the SRML has not had any issues with the data collection. Occasionally, the data may be affected by snow or ice but the ventilator on the CMP11 should help this situation and allow the two instruments to be compared when doing data analyses. We welcome any comments or questions on this new data station installation.

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Supplemental Material

Views of the site facing North, East, South, and West are shown in Figures 6 – 9. Note the minimal horizon obstructions in each photo. This results in quality irradiance measurements throughout the day.

Figure 6. View of the station facing North. The bricks in the foreground are part of the Deschutes Water Valley Authority equipment storage.

Figure 7. View of the station facing East.

Figure 8. View of the station facing South.

Figure 9. View of the station facing West

Table 2. Features of the Madras station

Station acronym	MDO	Acronym used in SRML data storage
Latitude	44.6235	
Longitude	-121.1427	
Altitude	705 m	
Address	Deschutes Valley Water District office	East edge of Madras, Oregon.
Senor height	2.5 m	Height above ground
Horizon obstructions	Less than 5°	Very minor tree and building obstructions
Description of site	Edge of a gravel parking lot	The parking lot stores equipment for the Deschutes Water District
Surrounding vegetation	Sage brush, juniper, grasses, bare dirt	See Figures for images
Climate zone	Cold semi-arid	Similar to much of Eastern Oregon
Start date	2023-11-16	Date station was completed
Data sample interval	3 second	Sensors sampled every 3 seconds
Data averaged to	1 minute	3 second data averaged to 1-minute values
Data collection interval	5 minutes	Data collected from logger every 5 minutes
Cleaning schedule	Yearly	The SRML is working on finding a local technician for the dusty summer months.
Website	http://is-solardata01.uoregon.edu /SelectArchival.html	Data updated every 5 minutes
SRML contact info	Jpeters4@uoregon.edu	

Table 3. Sensor / Component details of the Madras station

GHI (1)	CMP11 (SN: 174019)	Primary GHI sensor. Sensor may vary in time
GHI(1) ventilator	VU01	Sensor ventilated pre-dawn to dusk
GHI(1) Uncertainty	1.6%	U95% at SZA = 45°
GHI(1) Element number	1000	CMP11 column header in data file
GHI(2), DNI, DHI	RSP (SN: 35627)	Rotating Shadowband Pyranometer, Licor Pyranometer photodiode sensor. Sensor may vary in time
GHI(2) Uncertainty	2.2%	U95% at SZA = 45° of the GHI component. DNI and DHI components assumed to be the same.
GHI(2) Element number	1002	RSP GHI column header in data file
DNI Element number	2012	RSP DNI column header in data file
DHI Element number	3002	RSP DHI column header in data file
Air Temperature	Temperature probe	Campbell Scientific 107 Temperature probe, Not forcefully ventilated
Air temp Element number	9300	Air temperature column header in data file
Data logger	CR6 (9472)	Campbell Scientific data logger
Data logger program	MDO_2023-11-09.CR6	Data logger program will change in time.
Communications	Cell 210	Campbell Scientific cell modem
Cell phone provider	Verizon	
Power consumption of system	10 W	This number includes, operating the data logger, cell phone, RSP rotation motor, and CMP11 ventilator. These components do not all run continuously. The ventilator is the main power draw.
Energy need per day	10 Amp hour	Estimated energy needed per day.
Power source	100 W Solar modules	All power supplied by the PV module
Battery storage	80 Amp hour battery	Battery storage for low light conditions. 80 AH corresponds to complete discharge.
Battery only operation	4 days	Expected number of days of operation with minimal sun. The battery is recharged from the PV. This was computed by discharging ½ of the 80 AH of the battery. This is good for battery longevity.