

Correction of Solar Radiation Bias in Air Temperature from Compact Weather Sensors for PV Monitoring

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1. Introduction

Multi-parameter compact weather sensors are widely used in the PV industry to measure wind speed, wind direction, relative humidity, air temperature, and barometric pressure. Most commercially available models rely on a passive radiation shield to protect the air-temperature sensor. International standards often specified use of a radiation shield for air temperature measurements. These shields typically use one to three louvers that block direct solar radiation while still allowing airflow around the sensor. We present experimental investigation to show that unless there is a forced air circulation, there is still a solar radiation loading effect on the air temperature measurements that can be removed using an energy balance correction. In the paper, we present a comparison between three different air temperature measurements using different radiation shields and the above-mentioned correction.



Air temperature probe under an open-path radiation shield



Air temperature probe under a louvered passive radiation shield



Aspirated radiation shield with forced air

2. The Problem of Air Temperature

- PV performance models require air temperature measurement.
- Air temperature is seemingly the simplest parameter to measure, but the most difficult in practice.
- A solar radiation shield avoids the solar loading effect.
- Aspirated shields consume power and are most accurate.
- Passive shields consume no additional power and are widely used.
- Solar loading is still an issue.
- We propose a solar loading correction using energy balance.

3. Theory

The energy balance of a thermometer can be rearranged to correct the errors due to solar radiation.

$$T_{air} = T_{measured} - \left(\frac{a_s S_t}{C_p k \sqrt{u/d}} \right)$$

Where:

a_s = absorptivity of temperature sensor to solar radiation

S_t = total incoming shortwave radiation (W/m²)

C_p = specific heat of air (Jmol⁻¹C⁻¹)

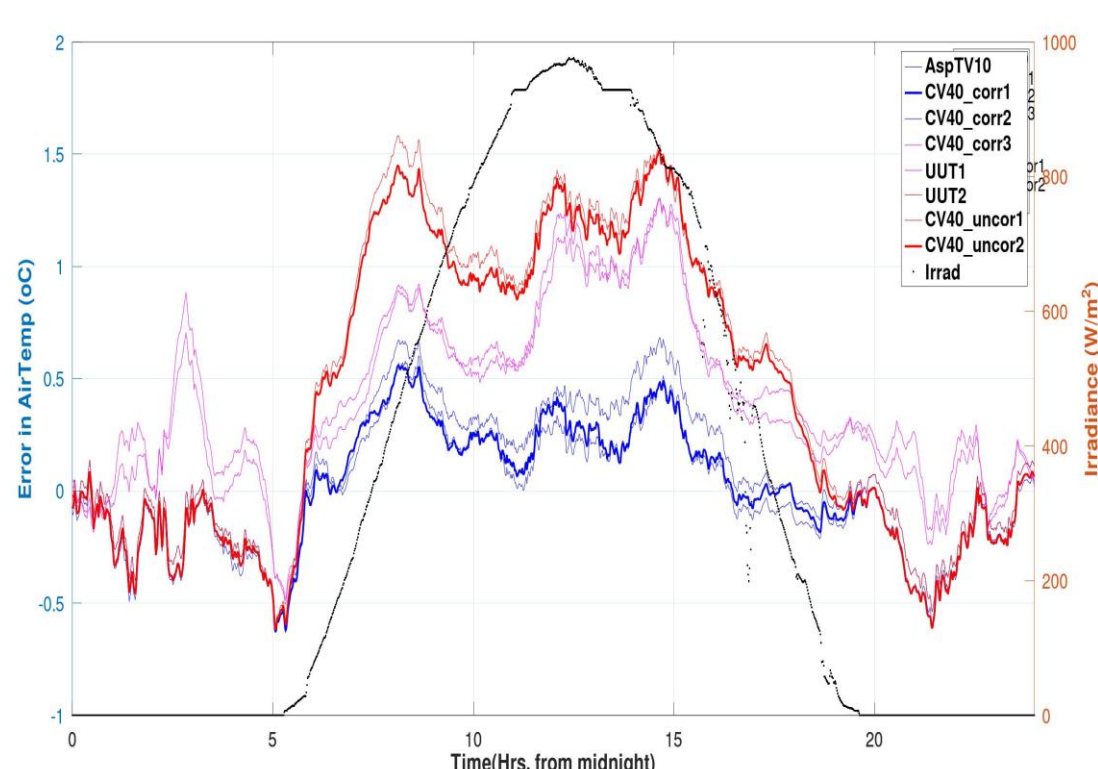
u = wind speed (m/s)

d = characteristic dimension of temperature sensor

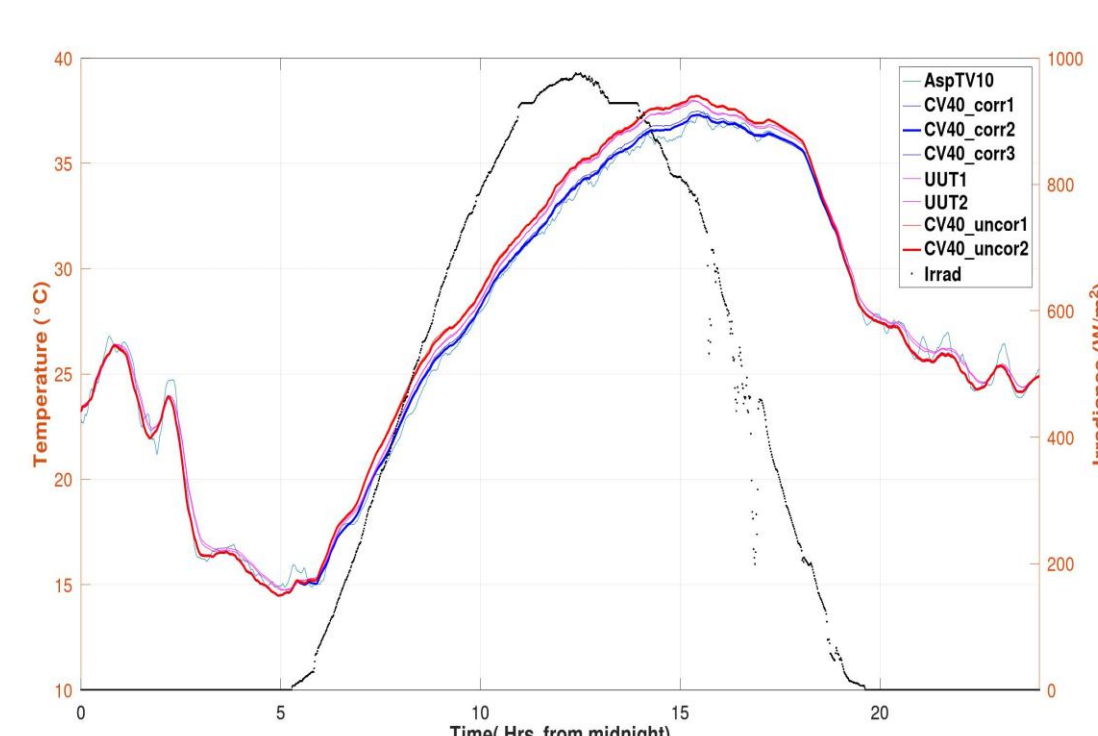
4. Experimental Arrangement

- We installed three units of each type of sensors shown above.
- A TempVue™10 installed in an aspirated shield was used as a reference.
- Data were collected over several days.
- The following parameters were measured:
 - Air temperature from all three types
 - RH/BP
 - GHI
 - Precipitation
 - Air temperature with and without the above correction compared and shown below

5. Results and Discussions



Maximum error before correction: 1.5°C
Maximum error after correction: 0.36°C



Conclusions

- All units tested show a bias due to solar loading in air temperature measurement.
- This bias can be removed provided we have:
 - GHI
 - Wind speed
 - Absorption characteristic(s) of the sensor body material
- Specifying a type of radiation shield does not solve the problem.