

SR25: The making of

A secondary standard pyranometer with sapphire outer dome for the best data availability and measurement accuracy

Hukseflux invested more than 10 man-years in developing the infrastructure to manufacture, test and calibrate secondary standard pyranometers. Following the successful release of the SR20 secondary standard pyranometer, Hukseflux introduces SR25 with sapphire outer dome and internal heater. The results are excellent and patents on the SR25 working principle are pending.



Figure 1 SR25 with sapphire outer dome and internal heater is the new standard in high-accuracy solar radiation measurement



Figure 2 extensive testing of sensors, here outdoors on a frosty morning: clear difference between SR25 (left), versus an unheated pyranometer without sapphire dome (right)

Objective

The main objective for the SR25 design team was to bring solar radiation measurement to the next level by developing the highest accuracy pyranometer with the highest data availability. The results are excellent and patents on the SR25 working principle are pending.

Result: accuracy

To allow heating and further improve accuracy, Hukseflux focused on:

- reduction of “zero offset a” to close to zero

Zero offset a is caused by a temperature difference between domes and detector. The high thermal conductivity of SR25’s sapphire outer dome ensures excellent thermal coupling between body and domes. This results in a nighttime offset of $< 2 \text{ W/m}^2$, even when heated, unmatched by any pyranometer.

Result: data availability

To improve data availability Hukseflux focused on:

- suppression of dew deposition
- suppression of frost deposition

The combined use of sapphire and internal heating keeps the outer dome dew- and frost-free, highly increasing data availability, while maintaining high measurement accuracy, exceeding secondary standard requirements.

Result: infrastructure for efficiency

Hukseflux developed state-of-the-art facilities for calibration and for conformity assessment. The equipment and procedures were successfully implemented, allowing fast and accurate work.

Comparative testing

SR25 prototypes and product models were tested outdoor and indoor against competing secondary standard instruments.

Accuracy

As one of the comparative tests, during a 26 day period the nighttime offset of various pyranometer configurations was monitored. Looking at nighttime offsets, the performance of both the heated and the unheated SR25 is better than that of all other measured pyranometer configurations.

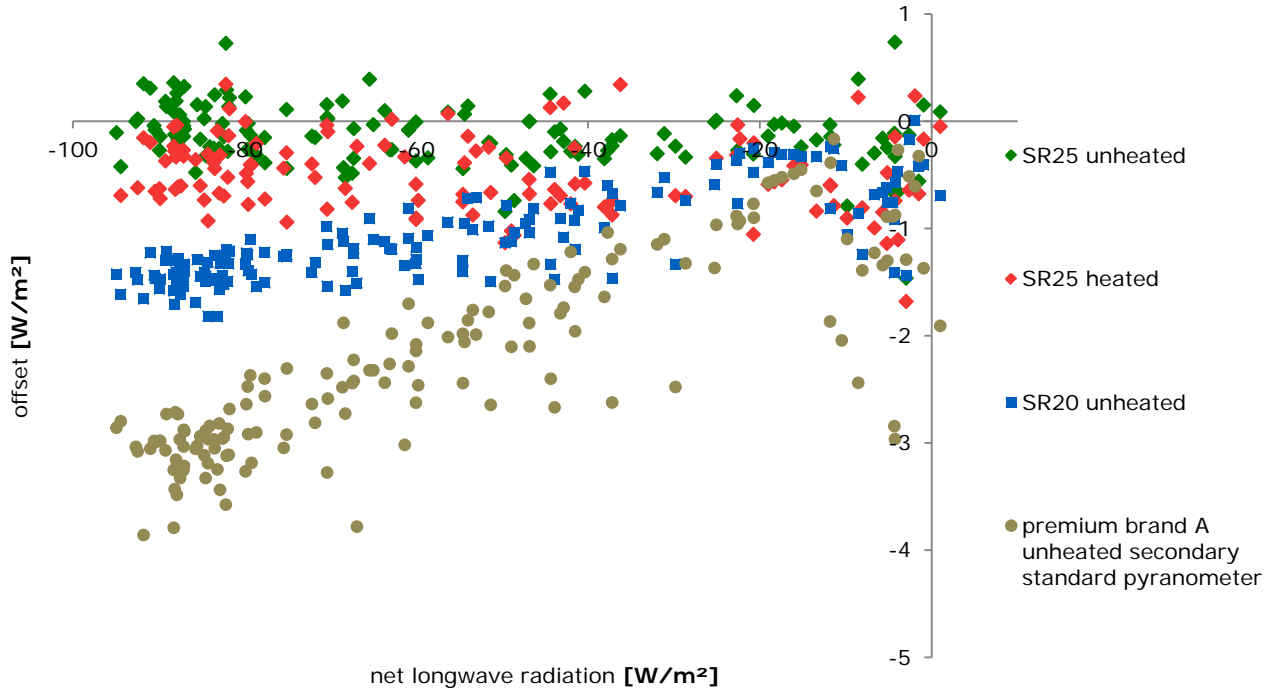


Figure 3 nighttime offsets of unventilated pyranometers versus net longwave radiation. SR25 has lower nighttime offset than the other secondary standard pyranometers both when unheated and when heated

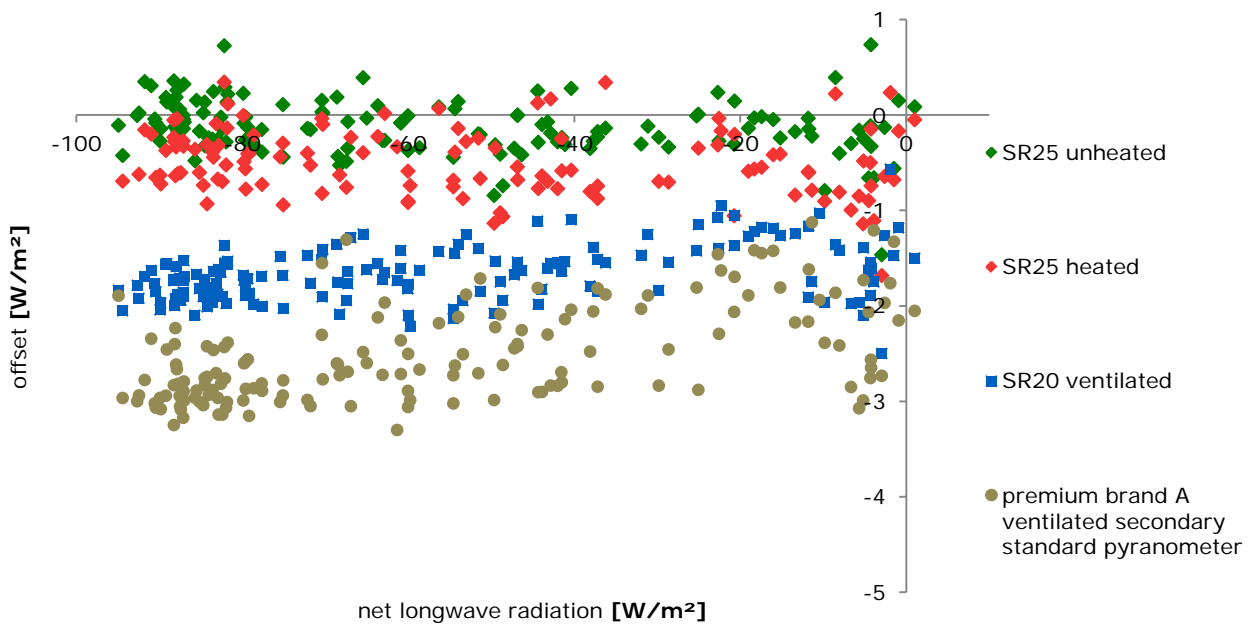


Figure 4 nighttime offsets of ventilated pyranometers and SR25 versus net longwave radiation. SR25 has lower nighttime offset than the ventilated secondary standard pyranometers both when unheated and when heated

Data availability

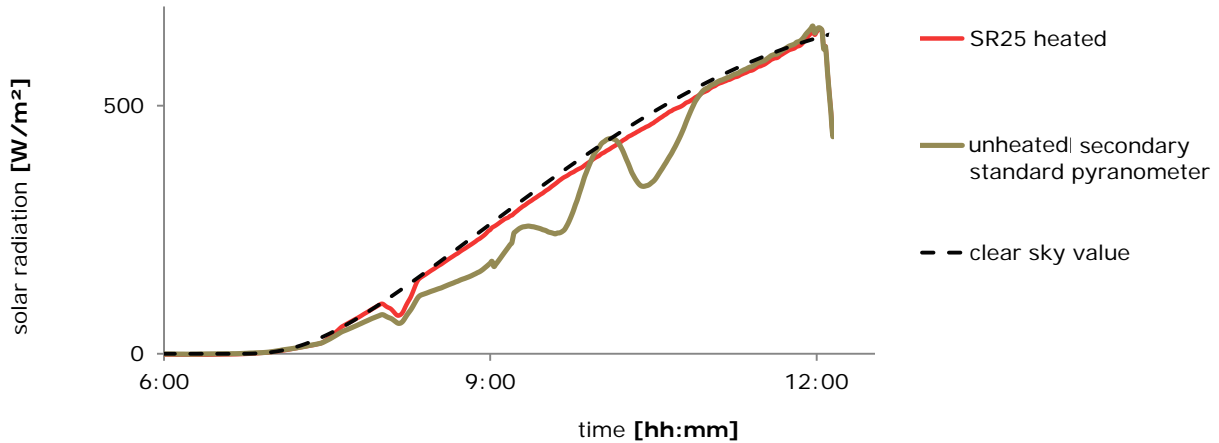


Figure 5 morning solar radiation measurement data, comparing clear sky value with SR25 heated, suppressing dew deposition successfully, and one unheated secondary standard pyranometer. SR25 heated follows the ideal clear sky solar radiation while the unheated secondary pyranometer is covered with dew, and deviates from ideal

During a period of 26 days in spring 2015, the reduction in data availability due to dew deposition on domes was monitored for various sensor configurations. The Hukseflux outdoor test facility was used for this experiment.

SR25 with heating had no reduction in data availability due to dew. SR20 ventilated with ventilation unit VU01 had one dew event. The unheated SR25 performs better than SR20 in this dew test. This can be explained by the better thermal coupling between body and dome in SR25. During clear nights the temperature of the outer dome of SR25 is higher than the temperature of the outer dome of SR20, making it less susceptible to dew.

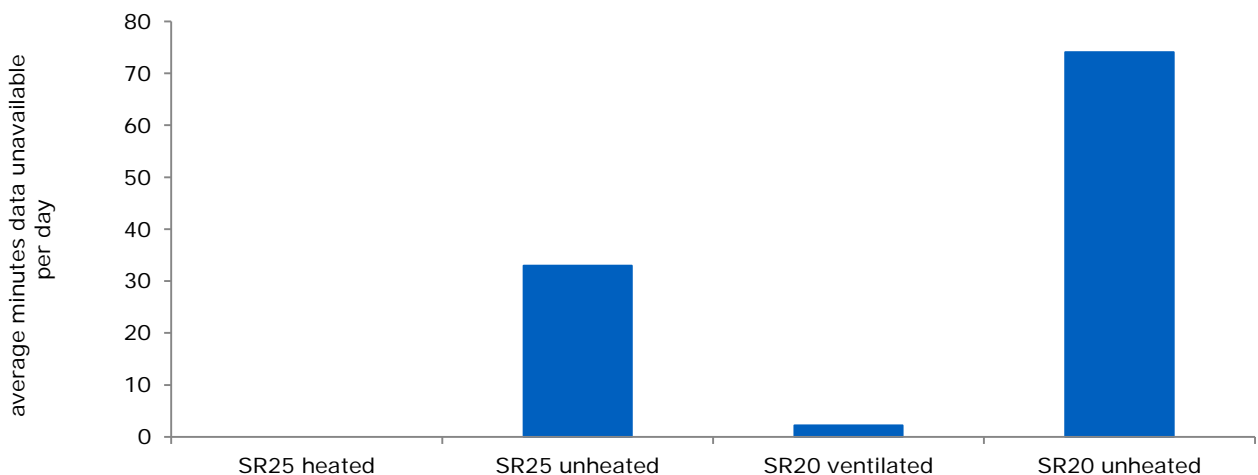


Figure 6 average reduction of data availability due to dew in minutes per day for various sensor configurations. SR25 with heating had no reduction in data availability due to dew

Individual testing of every instrument

In order to be classified as secondary standard, every pyranometer needs to be tested individually for all critical specifications. Each SR25 is supplied with a product certificate, reporting directional response, temperature response and response time (95 %).



Figure 7 extensive testing of sensors, here indoors at Hukseflux

Choosing the right instrument

Pyranometers are subject to classification in three classes according to ISO 9060. From second class to first class and from first class to secondary standard, the achievable accuracy improves by a factor 2. Measurement accuracy does not only depend on instrument properties, but also on measurement conditions. A very accurate instrument will quickly underperform without a regular schedule of maintenance. Our pyranometer [selection guide](#) assists you in choosing the right instrument. Whatever your application is, Hukseflux offers the highest accuracy in every class at the most attractive price level.

See also

- [SR25](#) and [SR25-D1](#) brochure
- view our complete [product range of solar sensors](#)

Worldwide support

Hukseflux has pyranometer calibration equipment and servicing facilities in the following regions:

- Europe
- United States of America
- China
- Japan



Figure 8 SR25 secondary standard pyranometer with sapphire outer dome is offered with analogue output and (as SR25-D1) with digital output – Modbus protocol

About Hukseflux

Hukseflux Thermal Sensors offers measurement solutions for the most challenging applications. We design and supply sensors as well as test & measuring systems, and offer related services such as engineering and consultancy. With our laboratory facilities, we provide testing services including material characterisation and calibration. Our main area of expertise is measurement of heat transfer and thermal quantities such as solar radiation, heat flux and thermal conductivity. Hukseflux is ISO 9001:2008 certified. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

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