

LP02 sunshine duration sensor

Sunshine duration measurement according to the WMO "pyranometric method"

LP02 is a solar radiation sensor, a pyranometer, that is applied in most common solar radiation observations. It complies with the second class specifications of the ISO 9060 standard and the WMO Guide. LP02 pyranometer may be used with suitable software as sunshine duration sensor. This pyranometric method has been approved by WMO and is increasingly popular, because of its simplicity, easy instrument calibration and high instrument stability.



Figure 1 LP02 second class sunshine duration sensor / pyranometer



Figure 2 pyranometer in use with LI19 read-out unit

Introduction

LP02 is a solar radiation sensor that is applied in general observations. It measures the solar radiation received by a plane surface from a 180° field of view angle. This quantity, expressed in W/m², is called "hemispherical" solar radiation. Measuring in a horizontal position it is known as global horizontal irradiance or GHI. Using LP02 is easy. The pyranometer can be connected directly to commonly used data logging systems.

Sunshine duration

The World Meteorological Organisation, WMO, defines sunshine hours as "the sum of the time intervals (in hours) during which the direct normal solar irradiance exceeds a threshold of 120 W/m²". For the most accurate measurement of this quantity tracker-based systems with a pyrheliometer are employed.

The pyranometric method

WMO has approved the "pyranometric method" to calculate sunshine duration from pyranometer measurements in WMO-No. 8, Guide to Meteorological Instruments and Methods of Observation. This implies that LP02 may be used, in combination with appropriate software, to measure sunshine duration. The method involves an algorithm which estimates sunshine hours by comparing the 10-minute mean global horizontal irradiance (GHI) with the solar radiation outside the earth's atmosphere on a horizontal surface at that time and location (G_0).

Programming

The algorithm for sunshine duration involves:

- local time (typically from GPS)
- day of the year (typically from GPS)
- geographical coordinates (typically from GPS)
- GHI (from pyranometer)

Benefits of the pyranometric method

Many meteorological stations employ a pyranometer. Not only in that case, but even if a new pyranometer must be purchased, the pyranometric method is much more cost-effective than using a dedicated sunshine duration sensor. A further advantage is that the standardised calibration of pyranometers according to ISO 9847 is applicable. In addition, the instrument stability of pyranometers is much better than that of sunshine duration sensors based on photodiodes. Model LP02 offers a non-stability of < 1 %/yr. Higher class pyranometers such as model SR20 reach < 0.5 %/yr. Competing instruments employing photodiodes attain non-stabilities no better than < 2 %/yr. In summary:

- method is standardised by WMO
- normal pyranometer calibration may be used (no return to factory required)
- better instrument stability than photodiode based sunshine duration sensors
- cost effective (combined with GHI), low-maintenance, easy calibration
- any ISO / WMO compliant pyranometer may be employed

Measurement uncertainty

The measurement uncertainty strongly depends on the measurement site and season. An estimate of achievable accuracy at mid-latitude sites is ± 2 hr/day ($k = 2$). With optimisation to local conditions this can be improved to ± 0.6 hr/day^[1]. Although this does not meet uncertainty requirements for WMO stations (specifying the larger of 0.1 h or 2 %), WMO does state that "individual applications may have less stringent requirements"^[2]. Competing instruments, which typically specify an accuracy > 90 %, do not comply to WMO either.

Application note

The relevant algorithm is described in WMO manual WMO-No. 8, Guide to Meteorological Instruments and Methods of Observation, paragraph 8.1.4 b. Hukseflux has issued its own application note. Get a free copy.

See also

view our complete product range of sensors; other pyranometer models may be used for sunshine duration measurement as well.

LP02 specifications

Measurand 1	hemispherical solar radiation
Measurand 2	sunshine duration
Measurement method (for measurand 2)	WMO pyranometric method
Requirements (for measurand 2)	-local time -day of the year -geographical coordinates
ISO classification	second class pyranometer
Calibration uncertainty	< 1.8 % ($k = 2$)
Non-stability	< 1 %/yr *
Calibration traceability	to WRR
Rated operating temperature range	-40 to +80 °C
Standard cable length	5 m

* Other pyranometer models may be used as well, non-stability of < 0.5 %/yr is attainable.

Standards

Applicable instrument classification standards are ISO 9060 and WMO-No. 8. Pyranometer calibration is according to ISO 9847.

References

1. Emanuele Vuerich et al, (2012), *Updating and development of methods for worldwide accurate measurements of sunshine duration*, presented at TECO-2012, published on internet, accessed 8-Jan-2014
2. WMO-No. 8, (2008), *Guide to Meteorological Instruments and Methods of Observation*, seventh edition, Annex 1.B, subscript point 5, and 8.1.3, published on internet, accessed 8-Jan-2014

About Hukseflux

Hukseflux Thermal Sensors, founded in 1993, aims to advance thermal measurement. We offer a complete range of sensors and systems for measuring heat flux, solar radiation and thermal conductivity. We also provide consultancy and services such as performing measurements and designing instrumentation according to customer requirements. Customers are served through the main office in Delft in the Netherlands, and locally owned representations in the USA, China, India and Japan.

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