HUKX

Sensor
Technology

Brochure

Analog 4-component net radiometer

NR01

NR01
Analog 4-component net radiometer

with heating and spectrally flat Class C pyranometers

NR01 is a market-leading 4-component net radiation sensor, primarily used in scientific-grade energy balance and surface flux networks. It offers 4 separate measurements: global and reflected solar radiation (via pyranometers) and downwelling and upwelling longwave radiation (via pyrgeometers), using two upward-facing and two downward-facing sensors.

Key advantages include its modular design with two pairs of identical sensors, its use of (WMO compliant) spectrally flat pyranometers, low weight, ease of leveling, and low solar offsets in the longwave measurement. NR01's unique capability to heat the pyrgeometers helps reduce measurement errors caused by dew deposition.

Figure 1 NR01 analog 4-component net radiometer

Introduction

NR01 measures the 4 separate components of the surface radiation balance: global solar radiation (downward), reflected solar radiation (upward), and downwelling and upwelling longwave radiation. The solar radiation sensors are called pyranometers and the longwave sensors are referred to as pyrgeometers.

From these 4 separate components, the net radiation is derived. To calculate sky and surface temperatures, it is necessary to compensate for irradiated heat emitted by the pyrgeometers themselves (Stefan-Boltzmann law). A Pt100 temperature sensor is included in NR01's body for this purpose. Sunshine duration may also be estimated using the WMO-approved pyranometric method.

The best 4-component net radiometer

Since its introduction in 2007, the NR01 4-component net radiometer has become widely used in monitoring networks. Reasons for its popularity include:

– lowest price point for top-level performance
– heated pyrgeometers for superior nighttime data availability
– "spectrally flat" pyranometers, WMO compliant, which is essential for albedo measurement
– low weight and reduced mounting costs
– modular design with 2 pairs of identical sensors
– easy leveling, servicing, and recalibration

Figure 2 NR01 in use in a typical meteorological station.

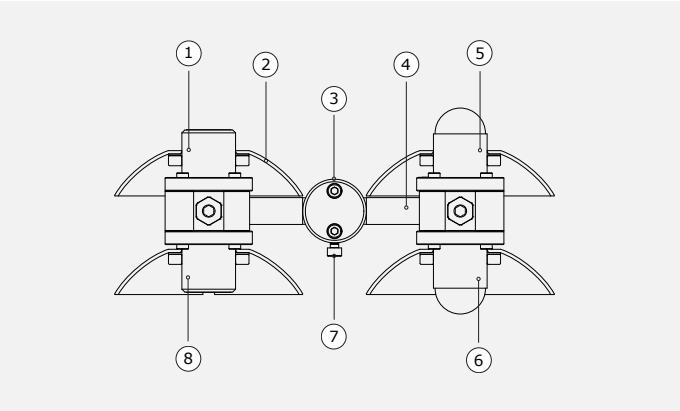

Figure 3 Overview of NR01:

1. upfacing pyrgeometer
2. sun screens
3. leveling assembly for x- and y-axis
4. leveling assembly for x- and y-axis
5. upfacing pyranometer
6. downfacing pyranometer
7. leveling assembly for x- and y-axis
8. downfacing pyrgeometer

Compliance to standards: Spectrally flat pyranometers

To comply with WMO standards and for accurate reflected solar radiation measurement, it is essential to use spectrally flat pyranometers. Reflected solar radiation has a different spectrum than global solar radiation. NR01 has spectrally flat sensors that can measure both global and reflected solar radiation using the same instrument with the same calibration. By contrast, competing models often apply pyranometers that are not spectrally flat, and typically employ different pyranometers and pyrgeometers for the upfacing and downfacing measurements.

Applicable instrument-classification standards are ISO 9060 and WMO-No. 8 *Guide to Meteorological Instruments and Methods of Observation.*

Operation

Using the NR01 net radiometer is easy. It directly connects to the most commonly used data logging systems. The irradiance levels (in W/m^2) are calculated by dividing the NR01 outputs, small voltages, by the sensitivities of the sensors. Longwave irradiance should be corrected using the instrument body temperature. The sensitivities of all sensors are provided on NR01's product certificate.

Suggested use

– energy balance studies
– surface flux measurements
– climatological networks

NR01 benefits

The NR01 net radiometer has a modular design with two pairs of identical sensors. This makes it possible to take the instrument apart, easily replace individual sensors, and recalibrate them by using the same procedure. For this reason, it is often selected for use in large monitoring networks.

In order to prevent condensation on the pyrgeometer windows, the NR01 features internal heating close to the pyrgeometers, keeping the instrument above dew point. Since water blocks longwave radiation, heating will improve the reliability of longwave radiation measurement, especially at night, when the risk of condensation is highest. Solar offsets in longwave radiation measurement are very low. Features like these have made NR01 net radiometers a popular choice for energy balance and surface flux studies.

NR01 is also practical to mount. It is much lighter than competing models and includes a 2-axis leveling assembly. The assembly fits a 1-inch NPS tube (recommended outer diameter: 33.4 x 10^{-3} m). With the included NR01 shim, it can also be mounted on a ¾ inch NPS tube.

Figure 4 NR01 analog 4-component net radiometer, including two pyranometers, two pyrgeometers, a heater, and a 2-axis leveling assembly (mounting tube not included).

Reference users

Until 2022, the U.S. National Ecological Observatory Network (NEON) was the world's largest network employing 4-component net radiometers. After extensive testing, NEON published a list of sensors. We are proud that model NR01 made it onto this list.

In 2022, the Indian Defence Geo-Informatics Research Establishment (DGRE) selected NR01 for its 248-station climate monitoring network in the Himalayas.

The UK Centre for Ecology and Hydrology (CEH) also included NR01 in its measurement network.

NOTE: A sensor being included in a network does not constitute a formal endorsement by the network owner.

Options

– longer cable, in multiples of 5 m;
  cable lengths above 20 m in multiples of 10 m
– 10 kΩ thermistor instead of Pt100 temperature sensor

See also

– RA01 radiometer: a single-sided version of NR01. Combined with estimates of albedo and surface temperature, this instrument can also be used to estimate net radiation.
– other sensors for the FLUXNET community
– CMF01 mounting fixture for installing NR01 on a mast

NR01 specifications

measurand	net radiation (using all 4 sensors)
measurand	global solar radiation
measurand	reflected solar radiation
ISO 9060:2018 classification	both pyranometers: spectrally flat Class C
WMO compliance	both pyranometers: WMO Class C
measurand	downward longwave radiation*
measurand	upward longwave radiation*
optional measurand	surface temperature*
optional measurand	sky temperature*
optional measurand	albedo or solar reflectance
optional measurand	sunshine duration
included sensors	2 x identical ISO 9060 spectrally flat Class C pyranometer 2 x identical pyrgeometer with 150 ° field of view angle
spectral range solar	285 to 3000 x 10^{-9} m
leveling	2-axis leveling assembly included
spectral range longwave	4.5 to 42 x 10^{-6} m
heater on pyrgeometer	1.5 W at 12 VDC
temperature sensor	Pt100
measurand Pt100	instrument body temperature
required readout	4 x DC voltage, 1 x Pt100
mounting	on a 1-inch NPS tube; NR01 delivery includes a shim for easy alternative mounting on a ¾ inch tube (tubes not included).
calibration traceability solar	to WRR
calibration uncertainty solar	< 2.4 %
calibration traceability longwave	to WISG
calibration uncertainty longwave	< 7 %
rated operating temperature range	-40 to +80 °C
standard cable length	2 x 5 m (see options)

* required measurand instrument body temperature

About Hukx

Hukx is the leading innovator in solar radiation and heat flux sensor technology. We are proud to set the standard in high-accuracy measurement, and to be working at the heart of the energy transition.

Customers worldwide rely on our bestselling pyranometers and heat flux sensors. From sensor design and selection to supply and recalibration, we support you across the entire lifecycle.

Hukx is headquartered in the Netherlands, with locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia, and Japan.

Let us help you select the best sensor for your application.
Get in touch with our experts today via: info@hukx.com

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