

NR01

Analogue 4-component net radiometer with heating and spectrally flat Class C pyranometers

NR01 is a market leading 4-component net radiation sensor, mostly used in scientific-grade energy balance and surface flux networks. It offers 4 separate measurements of global and reflected solar pyranometers and downwelling and upwelling longwave radiation pyrgeometers, using 2 sensors facing up and 2 facing down. Advantages include its modular design with 2 pairs of identical sensors, spectrally flat pyranometers, low weight, ease of levelling, and low solar offsets in the longwave measurement. The unique capability to heat the pyrgeometers reduces measurement errors caused by dew deposition.



Figure 1 NR01 4-component net radiometer.



Figure 2 NR01 in use in a typical meteorological station.

Introduction

NR01 measures the 4 separate components of the surface radiation balance: downward and upward solar and longwave radiation. The solar radiation sensors are called pyranometers and the longwave sensors are called pyrgeometers. From these 4 separate components the net radiation is derived. For calculation of sky- and surface temperatures, it is necessary to compensate for irradiated heat by the pyrgeometers themselves (Stefan-Boltzmann law). A Pt100 temperature sensor is included in NR01's body for that purpose. Sunshine duration may be estimated according to 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 applied in networks. Reasons for its popularity:

- lowest price level at top level performance
- heated pyrgeometers, best night-time data availability
- “spectrally flat” pyranometers, essential for albedo measurement
- high-accuracy shortwave calibration
- low weight, low mounting costs
- modular design, 2 pairs of identical sensors
- practical levelling, servicing and recalibration

Operation

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

NR01 design

NR01 net radiometer has a modular design with 2 pairs of identical sensors: it is possible to take the instrument apart and easily replace individual sensors, and recalibrate them in using the same procedure. For this reason it is often selected for use in large monitoring networks.

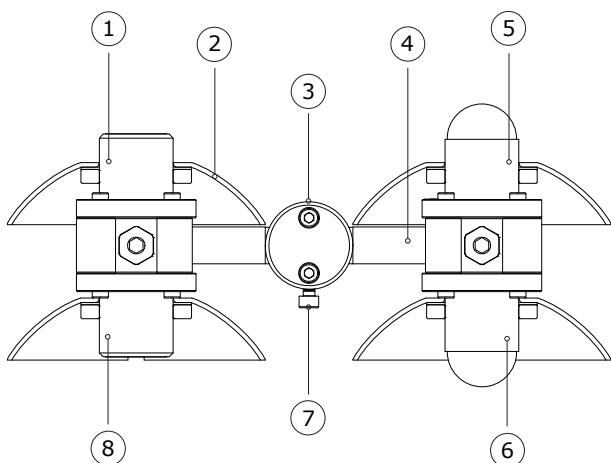


Figure 3 Overview of NR01:

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

NR01 specifications

Measurand (all 4 radiometer sensors)	net radiation
Measurand	global solar radiation
Measurand	reflected solar radiation
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 $\times 10^{-9}$ m
Spectral range longwave	4.5 to 42 $\times 10^{-6}$ m
Leveling	2-axis levelling assembly included
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 3/4 inch tube (tubes not included)
Calibration traceability solar	to WRR
Calibration uncertainty solar	< 1.8 %
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

Suggested use

- energy balance studies
- surface flux measurements
- climatological networks

Options

- longer cable, in multiples of 5 m, cable lengths above 20 m in multiples of 10 m
- 10 k Ω thermistor instead of Pt100 temp. sensor

See also

- **RA01** radiometer, a single side version of NR01. Combined with estimates of albedo and surface temperature, this instrument can also be used for estimation of net radiation
- **other sensors for the fluxnet community**
- **CMF01 mounting fixture** for mounting NR01 on a mast



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

NR01 benefits

In order to prevent condensation of water on the pyrgeometer windows, the NR01 has internal heating close to the pyrgeometers. This keeps the instrument above dew point. As water blocks longwave radiation, heating will improve the reliability of longwave radiation measurement, in particular at night, when the risk of condensation is highest. Solar offsets in the longwave radiation measurement are very low. Features like these have made NR01 net radiometers popular in energy balance and surface flux studies. In addition, NR01 is practical to mount; it is much lighter than competing models and a 2-axis levelling assembly is included. The levelling assembly fits a 1 inch NPS tube (the tube's recommended outer diameter equals 33.4×10^{-3} m). With the NR01 shim, included in NR01's delivery, a $\frac{3}{4}$ inch NPS tube may also be used.

Spectrally flat

Last but not least, for compliance with WMO and for the reflected solar radiation measurement, it is essential to employ spectrally flat pyranometers; the reflected solar radiation has a different spectrum compared to the global solar radiation. NR01 has spectrally flat sensors on board, they can measure global and reflected solar radiation using the same instrument with the same calibration.

Standards

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

Reference users

The National Ecological Observatory Network (NEON) of the USA is the world's largest network employing 4-component net radiometers. After extensive testing, in 2013 NEON released a **list of sensors**. We are proud that our model NR01 is on it. The Centre for Ecology and Hydrology (CEH) of the UK included NR01 in its new (2014) measurement network.

NOTE: the fact that a sensor is used in a network does not constitute a formal endorsement by the network owner.

About Hukseflux

Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation- and heat flux measurement. Hukseflux products and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

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