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LP NET

1 About LP NET

LP NET net radiometer is designed to measure the Net radiation passing through a surface, across the spectral range between the near ultraviolet and the far infrared.. The Net radiation is defined as the difference between the radiation that strikes the top surface, and the radiation that strikes the bottom surface of the net radiometer. The upward facing surface measures direct and diffuse solar radiation plus long-wave irradiance from the sky (clouds), while the downward facing surface measures the reflected solar radiation (Albedo) plus the terrestrial long-wave irradiance.
LP NET is designed for continuous outdoor use, and is suitable for all weather conditions.
Although net radiometers are generally used in meteorology to measure radiation balance, the LP NET can also be used to measure indoor radiant temperature (ISO 7726).

2 Working Principle

LP NET is based on a thermopile sensor with one set of hot junctions in contact with the upper surface and a set of cold junctions attached to the lower surface. The difference in temperature between the two receivers is proportional to the net radiation. Through the Seebeck effect, the difference in temperature between hot and cold junctions is translated into a Difference of electric Potential. A hemispheric Teflon-coated dome protects the two receivers, and their particular shape allows an optimal cosine corrected response. The Teflon coating allows both a continuous outdoor use and a constant spectral response, ranging from the near ultraviolet (200nm) to the far infrared (100µm) spectral regions.

3 Installing and mounting the net radiometer for total irradiance measurements

- To allow cleaning the two receiving surfaces regularly, LP NET should be mounted in easily reachable places. The surfaces can be washed with plain water or pure ETHIL alcohol.
- Mount the instrument so that no shadow will be cast on it at any time of day, from obstructions such as buildings, trees, or any other obstacle.
- In the NORTHERN hemisphere, the net radiometer is normally oriented towards the SOUTH, while it should be oriented NORTHWARD, in the SOUTHERN hemisphere.
- The instrument should be mounted at least 1.5 meters above the ground surface. The flux on the downward facing sensor is representative for a circular area having a radius of 10 times the height.
- While mounting the net radiometer, avoid touching both receiving surfaces.

4 Electrical Connections and requirements for electronic readout devices

- LP NET does not require any power supply.
- LP NET is available with a 5 m. output cable
- LP NET is supplied with a PTFE, UV resistant, braided shield and 2-wire cable. The color code is as follows:
  shield → connected to the housing
  red → (+) positive pole of the signal generated by the detector
  blue → (-) negative pole of the signal generated by the detector

Fig.1 shows the wiring diagram:

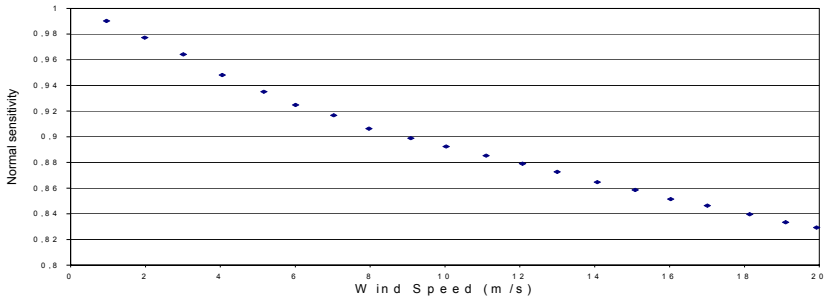

fig. 1

- LP NET has to be connected to a millivoltmeter or to a data acquisition system with input impedance higher than 4000kΩ. Normally, the output signal from the net radiometer does not exceed ±20 mV. In order to grant the best performances in measurements, the instrument resolution should be of 1μV.

5 Maintenance

In order to grant the instrument's best performance, the two receiving surfaces must be always kept clean; the cleaner you keep the instrument, the better the accuracy in measurements will be. Washing can be made with water and standard lens paper; in case this wouldn't work, use pure ETHIL alcohol. After using alcohol, the domes must be washed with water only.
We strongly recommend checking LP NET calibration every year. Calibration can be checked directly in the field, by mounting another net radiometer (sample) alongside, and comparing results. Calibration in the field is less precise than the one carried out in a laboratory, but has the advantage of not having to remove the instrument from its holder.

6 Calibration and measurements

Net radiometer sensitivity, indicated as **S** (or calibration factor), allows determining the net radiant flux passing through a surface. **S** factor is measured in $\mu V/(Wm^{-2})$.

- Once the difference of potential (DDP) has been measured at sensor ends, E_e flux is obtained through the following formula:

$$E_e = DDP/S$$

where;

E_e: indicates the radiant flux expressed in W/m^2,

DDP: indicates the difference of potential expressed in μV and measured by the multimeter,

S: indicates the calibration factor expressed in $\mu V/(W/m^2)$ and shown on the net radiometer label (calibration factor is also mentioned in the calibration report).

N.B. If the difference of potential (DDP) is positive, the radiation on the upper surface is higher than the radiation on the lower surface (it happens normally in daily hours); if DDP is negative, the radiation on the lower surface is higher that the one on the upper surface (it happens in nightly hours).

Each net radiometer comes factory calibrated and has its own calibration factor.
Calibration is performed inside Delta Ohm Metrological Laboratory, and is carried out by comparison with a reference net radiometer, using a solar simulator as a light source. Calibration is performed using a parallel light beam.

7 Sensitivity to wind speed

At the same radiant flux density, by increasing the wind speed, the net radiometer output signal will decrease (by increasing the wind speed, sensitivity will decreases). Measurements taken inside the wind tunnel, have shown that S_v sensitivity, related to the wind speed for LP NET, can be corrected by using the following functions:

$S_v=S_0(1-0.01\cdot V)$ $\quad V\leq 10m/s$

$S_v=S_0(0.95-0.005\cdot V)$ $\quad 10m/s<V<20m/s$

Where: S_0 = sensitivity at zero wind speed

V = wind speed in m/s

Fig. 2 shows the calibration factor related with wind speed.

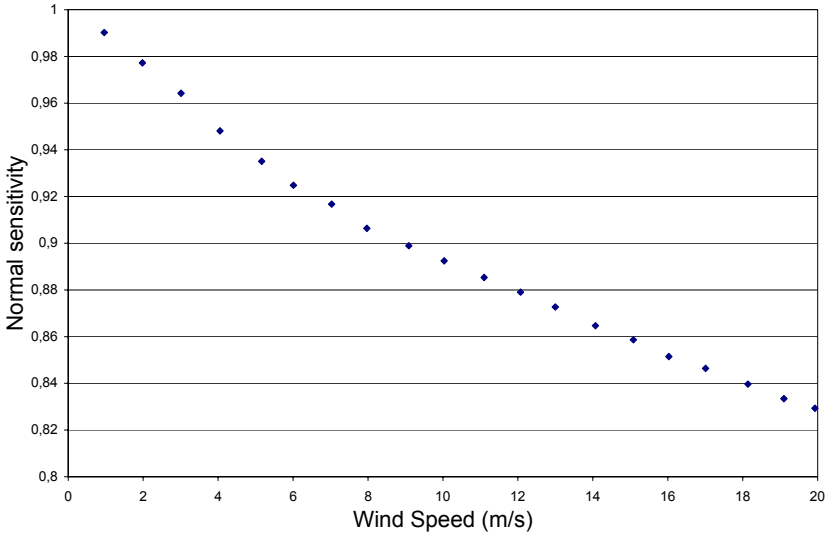

Fig. 2

Once we know both the net radiation - calculated through the sensitivity at zero wind speed (F_{net_0}) - and the wind speed in (V) in m/s, the correct data is obtained by using the following formula:

$F_{net}=F_{net\_0}/(1-0.011V)$ $\quad V\leq 10m/s$

$F_{net}=F_{net\_0}/(0.94-0.006V)$ $\quad 10m/s<V<20m/s$

8 Cosine response/Directional error

The radiation falling on a surface should be measured with a sensor, whose response related to the light incidence angle, has to be a Lambertian Response. A receiver is known as Lambertian when its sensibility (S_ϑ), related to the incidence angle between the light and the detector surface, has the following behavior:

$$S_\vartheta=S_0\cos(\vartheta)$$

Where: S_0 is the sensitivity when light strikes perpendicular to the surface,

ϑ is the angle between the incident light beam and the line which is normal to the surface.

Fig. 3 shows the typical behavior of the error related to the angle of incidence.

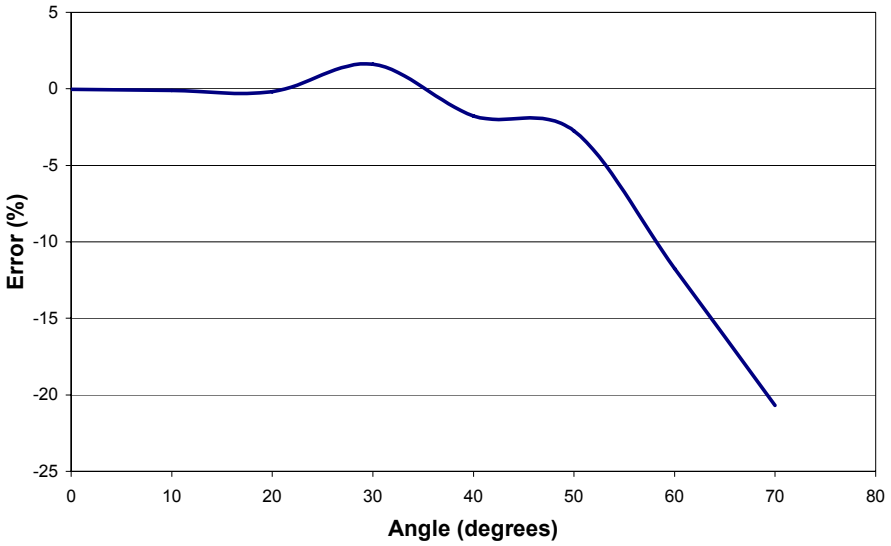

Fig. 3

9 Technical specifications

Typical sensitivity:	10 μV/(W/m^2)
Impedance:	2Ω ÷ 4 Ω
Measuring range:	±2000 W/m^2
Spectral range:	0.2 μm ÷ 100 μm
Operating temperature:	-40 °C ÷ 80 °C
Dimensions:	see fig 2
Weight:	0.35 Kg
Response time: (95%)	<75 sec

8 Ordering codes

ORDERING CODE	
LP NET	Net radiometer complete with Calibration Certificate. Connecting cable: 5 m standard length. Different cable lengths upon request.