Analysis Of The Current Cituation Of Solar Radiation Measurement

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Abstract: This paper mainly discusses the development status of solar radiation measurement technology, it expounds the relevant content of the current world radiation measurement datum and its standardization. Article the direct radiation from the sun, the main measuring principle of total radiation and scattering radiation, this paper discusses the different types of radiation survey measuring elements, measuring range, emphasis and the current widespread use of measurement instruments. The development trend of future solar radiation measurement is put forward, and it is emphasized that nanotechnology and spectrum technology will become the focus of solar radiation instrument research and development.

Key words: Solar Radiation; Direct Radiation; Scattered Radiation; Measuring Instrument

1 Introduction

The meteorological radiation instrument is an important device to obtain meteorological radiation data, it uses a sensor to convert solar radiation elements analog to electric signal measurement, such as voltage, current and voltage signal by measuring solar radiation signals, provide important data for the energy conversion of time and space of the earth atmosphere system and change, is analysis of the distribution of atmospheric composition, biological, agricultural services and an important means of research and service of climate change, the economic and social development plays an important role.

The first instrument to measure solar radiation was designed and made in 1837 by the Frenchman Pouillet, who works based on a water car meter. Because of its simple design, only a few rough measurements can be made. In 1884, Frolich first used a thermoelectric reactor to make detectors, it was simple but required another absolute instrument to calibrate. After the Innsbruck meeting in 1905, the Angstrom compensated direct heliometer was widely used in Europe as a measuring instrument. [1,2]

Since 1970, solar radiation measuring instrument has entered an era of rapid development, all kinds of large-scale international comparison activities around the world in general, so far, scientists around the world have been able to measure the total solar radiation, direct radiation and other elements through a variety of measuring instruments, and it is widely used in production and life. [3]

2 Measurement methods

Meteorological radiation instruments are classified using various criteria, namely the type of variable to be measured, the field of view, the spectral response, the main use and so on.

Absolute radiometers are self-calibrating, meaning that the irradiance falling on the sensor is replaced by electrical power, which can be accurately measured. The substitution, however, cannot be perfect; the deviation from the ideal case determines the uncertainty of the radiation measurement. Most radiation sensors, however, need to be calibrated periodically. The uncertainty of the measured value, therefore, depends on the following factors, all of which should be known for a well-characterized instrument:

a) Resolution, namely, the smallest change in the radiation quantity which can be detected by the instrument;

b) Long-term drifts of sensitivity (the ratio of electrical output signal to the irradiance applied), namely, the maximum possible changeover, for example, one year;

c) Changes in sensitivity owing to changes of environmental variables, such as temperature, humidity, pressure and wind;

d) Non-linearity of response, namely, changes in sensitivity associated with variations in irradiance;

e) Deviation of the spectral response from that postulated, namely the blackness of the receiving surface, the effect of the aperture window and so on;

f) Deviation of the directional response from that postulated, namely cosine response and azimuth response;

g) Time-constant of the instrument or the measuring system;

h) Uncertainties in the auxiliary equipment. Instruments should be selected according to their end-use and the required uncertainty of the derived quantity. Certain instruments perform better for particular climate, irradiance and solar positions. [4,5]

3 Introduction to solar radiation measurement instruments

3.1 Photoelectric type radiation meter

The thermoelectric general radiation meter is a black coating thermocouple sensor with spherical glass cover inside and outside. The chassis is equipped with adjusting feet, desiccant and horizontal bubbles. Thermoelectric pyranometer using induction surface is coated with black paint to receive the total solar radiation and radiation energy into heat, the temperature difference generated at both ends of the thermocouple, which generates a voltage signal proportional to the solar radiation measurements, and the corrected coefficient can measure the total solar radiation. Total radiation table glass usually has two layer, mostly using quartz glass or soda lime glass, transmittance keeps smooth in 0.90 above, which can go through the wavelength at 300 nm to 3000 nm range shortwave radiation, the ultraviolet radiation and infrared radiation have the function of isolation. [6,7] Currently, the meteorological department business is shown in figure 1a) using the TBQ - 2 - B type thermoelectric total radiation table, shown in Figure 1b) for domestic FS - S6 thermoelectric total radiation table, according to the WMO grading standard, FS - S6 direct radiation watch belongs to the level of total radiation. [8]

TBQ - 2 - B thermoelectric total radiation meter technical parameters:

1.Sensitivity: 7 ~ 14 mu V/w. m - 2

2. Response time: no more than 30 seconds (99%)

3.The internal resistance: about 350 Ω

4.Stability: plus or minus 2%

5.Cosine response: no more than or minus 7% (sun height Angle 10)

6.Temperature characteristic: plus or minus 2% (- 20℃ ~ + 40 ℃)

7.Non-linear: plus or minus 2%

8.Weight: 2.5kg

9.Test range: 0 ~ 2000W/m2

10.Signal output: 0 ~ 20mv

11.Test accuracy: less than 2%

Fig. 1 a) TBQ - 2 - B thermoelectric total radiation meter, b) FS - S6thermoelectric total radiation meter

3.2 Diffuse radiometer

The Diffuse radiometer is used to measure the radiation of the sun on the horizontal surface. Scattered radiation table made up of thermoelectric type total radiation table and shading devices, using shading device to block off the sun's direct radiation, the output signal of total radiation table only scattered radiation component, using the calibration coefficients, calculate the irradiance is scattering irradiance. The scattered radiation meter is mainly used in meteorological industry. According to the different light shielding devices, the scattered radiation table is divided into the optical disc/ball type and the halo type scattered radiation meter. [9,10]

Solar tracker of shading ball model for diffuse radiation measurement is divided into two types of manual and automatic, Manual ball type automatic solar tracker in the measurement process, can process the rotating supporting rod should be synchronized with the apparent motion of the sun, you need to regularly check and adjust its running state, as shown in figure 2. Automatic solar tracker of shading ball model for diffuse radiation measurement r is a kind of automatic tracking device, which can be driven by mechanical devices to automatically track the path of the sun to achieve automatic scattered radiation measurements.

Fig. 2 Ball scattering radiometer

3.3 Photosynthetic active radiometer

The photosynthetic effective radiation meter is an instrument used to measure the solar radiation of the horizontal plane from 400nm to 700nm. Photosynthetic effective radiometer can be divided into two types: total radiation phenotype and special type. [11]

The design principle of pyranometer is based on solar radiation and colored glass at 2800 nm coverage in the light radiation meter outer respectively from 400 nm to 2800 nm and 700 nm to be different, the transmittance caused by the simultaneous observation data, to obtain the corresponding total solar radiation spectrum, and subtracting the latter you can get the photo synthetically active radiation. A special type of photo synthetically active radiation meter is a photoelectric detection instrument is a photosensitive device using silicon photodiode to develop into a cosine corrector using current signal, for use as a calibration system output signal, complete the photo synthetically active radiation measurement. [12,13] The key to the photo synthetically active radiometer is his transmittance to ensure that the spectral response of the sensor is accurate and reasonable.

3.4 Net pyrradiometer

From the sky (including the sun and air) and projected downward from the surface (including soil, plants, water) to the total radiation projected on the difference is called the net radiation, the net radiation is that surface heat, radiation is received on the surface is greater than the emission of radiation, net radiation is negative said the surface heat loss, net radiation by measuring net pyrradiometer According to the structure of the net radiation table, it can be divided into two types: total radiation phenotype and four-component type. Figure 3 shows a wide range of fnp-2 net radiometer used in Chinese terrestrial meteorological observation business, with a 20% error in actual application. [14]

3.5 Ultraviolet radiometer

Ultraviolet radiometer is used to measure theUV radiation on the horizontal surface. The ultraviolet radiation spectrum of solar ultraviolet radiation is be-

tween 100nm and 400nm, and the ultraviolet radiation between 315 nm and 400 nm is called UVA. It is not affected by atmospheric ozone and can cause sunburn to human skin. Ultraviolet radiation between 280 nm and 315 nm is called UVB, which is affected by atmospheric ozone, can also cause significant sunburn to human skin. Ultraviolet radiation between 100 nm and 280 nm is absorbed by ozone and cannot reach the ground.

Fig. 3 FNP-2 Net pyrradiometer

The sensor of ultraviolet radiation meter is a photoelectric sensing device, which can measure ultraviolet radiation of different bands and choose different photoelectric sensing devices and filter glass. According to the distribution characteristics of solar ultraviolet radiation, UV - A, UV -B, UV - AB and UV - E radiation meter are present. According to the principle of measurement, the common uv radiation meter is usually divided into three types: wide-band, narrow-band and spectral scanning. The wide-band UV radiation meter is measured in uv-a or uv-b spectral region or in the entire wide-band ultraviolet region that affects human health. The common models are UVS AB - T and UVB - 1.

3.6 Pyrgeometer

Earth´s radiation table (Pyrgeometer) for measuring the spectral range from 3 microns to 100 microns or by atmospheric downward projection surface long wave radiation, upward projection instrument, also known as long wave radiation table or atmospheric radiation table according to different long wave incident window, the earth radiation can be divided into two kinds. A type of incident window is a hemispherical glass cover that has interference filter layer in the inner wall, providing the whole spherical field. The typical instrument has CGR4 long wave radiation table, as shown in Figure 4.

Fig. 4 CGR4- Pyrgeometer

3.7 Solar tracker

Solar tracker devices that track the trajectory of the sun are also known as Solar tracking devices. [15] According to different tracking mode, the solar tracker can be divided into manual tracking, semi-automatic tracking and automatic tracking, with the progress of automation technology, manual tracker has gradually become obsolete, as semi-automatic tracking could not keep accurate tracking state, Automatic sun tracker is calculating the solar altitude angle and the azimuth angle according to the program, and use the photoelectric sensor to feedback the position, through the solar elevation angle and azimuth angle or rotation mechanism of different instructions and drives the motor to automatically adjust the position, to the purpose of tracking the sun. In theory, calculation of the position of the sun is accurate, but in actual operation, the tracking process may appear various uncertain factors, therefore, the researchers developed four quadrant positioning sensor, the sensor light intensity by setting the threshold to achieve automatic tracking under different conditions. If the threshold is exceeded by the photoelectric sensor sun tracking synchronization operation and maintenance, if less than the threshold value, calculated by the location of the program to keep the sun tracker for sun synchronous operation,

to achieve automatic sun tracking.

4 Conclusion

To sum up, meteorological radiometric instruments have been widely used in the meteorological industry, they are not only used in daily business observation, but also provided reliable data for medium and long-term climate prediction and research. Moreover, the meteorological radiation measuring instrument is widely used in agriculture, construction, medicine and energy industry, having energy conservation and environmental protection can increase crop production, biomedical research and solar energy resource development.

Meteorological radiation measuring instrument is thermoelectric and spectral type direction, measurement range, from micron to nano direction can be predicted, measuring instrument classification in the future will be more detailed, more accurate measurement data is more diverse, can provide strong technical support for the production and people's life.

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