

# Solar Radiation Standard and its Values Transfer System in China

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**Abstract:** This paper introduces the values transfer system of solar radiation in China. It mainly focuses on composition, traceability, conservation and long-term stability of the national and regional solar radiation standard. The China national standard group consists of two H-F and one PMO-6. They are compared with each other every year to ensure the consistency with WRR. The calibration of China regional radiation standards is taken place every two years in LiJiang, YunNan. Meanwhile, the operators are trained in theory and practice. In order to accomplish the accurate transfer of the WRR in China, the relevant criterion and calibration methods were established. It also gives the requirements of the comparison field and environment conditions in the radiation calibration.

## Introduction

The solar radiation observation network has been built in China since 1957. From then the solar radiation standard group and the values transfer system has also been set up, including national measurement standards and working standards. Two H-F type cavity pyr heliometer were imported as the topmost solar radiation standards in China at 1981, another PMO-6 type absolute radiometer was imported in 1991. These three instruments have consisted of China solar radiation standard group. From 1980s to 1990s, the radiation values transfer system in China was separated into four grades, including the first standard, the second standard, working standard and working radiometers. In order to lower the error of the values transfer after the 1990s, the second standard was canceled and working standard was calibrated directly by the first standard.

Solar radiation standard group of China were sent to World Radiation Center or Asia Regional Radiation Center to compare with the references standard every five years to ensure the consistency of China national radiation standard with international standard. The national radiation standard should be compared with each other once every year and China regional radiation standards were compared every two years and the quantity values were transferred. The values transfer system block diagram of solar radiation sees Figure1:

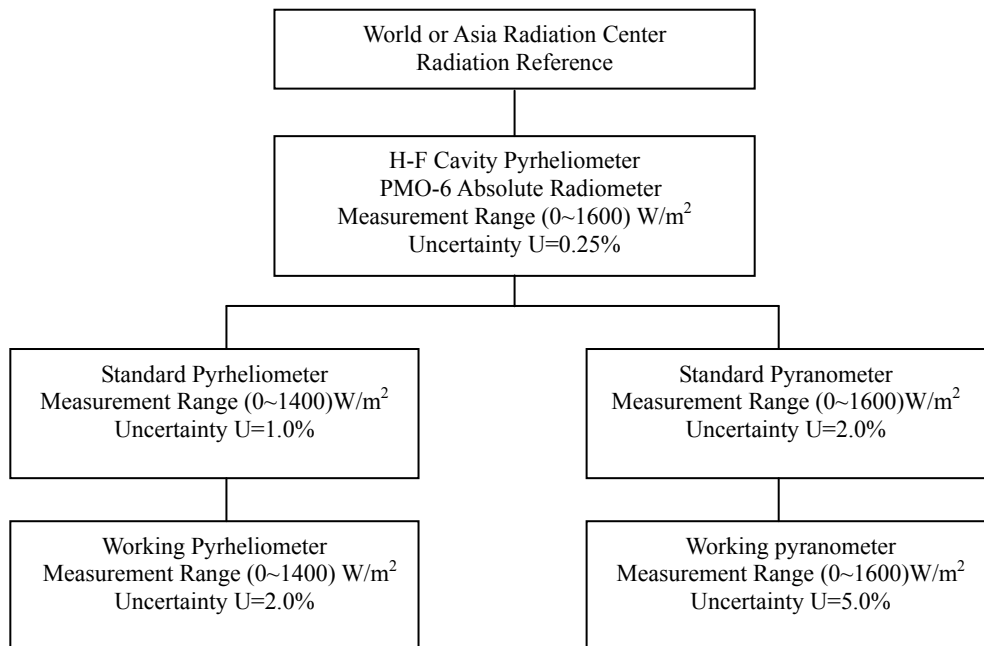


Figure 1 Values transfer system of solar radiation in China

## 1 Traceability of Solar Radiation Standard

H-F No.19743 and No.20294 joined the first comparison of pyrhemometers of region II , V holding by Japan in January, 1989. PSP type pyranometer No.20463 also joined it. H-F No.19743 and PMO-6 No.850406 were calibrated at Regional Radiation Center (Japan) in 1995.

H-F No.19743 and PMO-6 No.850406 joined the 9th comparison of the international pyrhemometer (IPC-IX) in 2000 and the tenth comparison (IPC-X) in 2005.

In January, 2007, H-F No.20294 joined the comparison of regional pyrhemometer holding by Regional Radiation Center (RA- II ) in Tsukuba, Japan. All previous results of international comparisons see Table 1.

Table 1 Results of international comparisons

Number	Type	1989	1995	2000	2005	2007
20294	H-F	1.0029				1.0008
19743	H-F	1.0009	0.9992	0.9985	1.0005	
850406	PMO-6		1.0011	0.9997	1.0006	
		RSG	RSG	WSG	WSG	RSG
standard		RA II .V (Japan)	RA II (Japan)	WRC (Switzerland)	WRC (Switzerland)	RA II (Japan)

## 2 Conservation, Transfer and Stability of Solar Radiation Standard

The solar radiation standard group consists of two H-F type cavity pyrhemometers and one PMO-6 type absolute radiometer. They're conserved and used by China National Center for Meteorological Metrology, Atmospheric Observation Technology Center, CMA. In order to ensure the long-term stability of national solar radiation standard, these three standard instruments are compared with each other every year .The ratios of H-F No. 20294 and PMO-6 No.850406 to H-F No. 19743 are given in Figure2 and the values transfer for the lower grade NIP type standard pyrhemometer (Figure3) and PSP type standard pyranometer (Figure4) are done at the same time every year to ensure the lower uncertainty of the transfer values of the WRR in China.

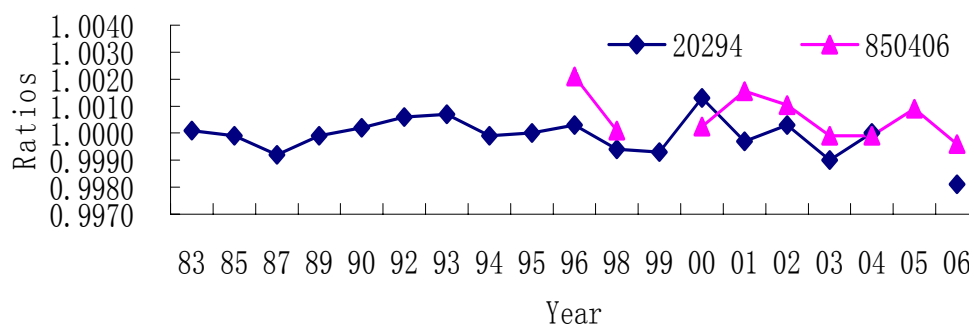


Figure 2 Stability of national radiation standard group

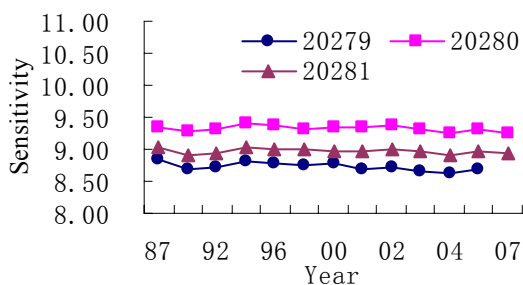


Figure 3 Stability of NIP pyrhemometer sensitivity

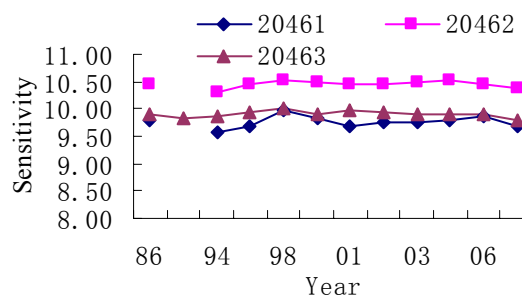


Figure 4 Stability of PSP pyranometer sensitivity

It can be concluded from Fig2, Fig3, Fig4 that the year changes of ratios of the national radiation standards were less than  $\pm 0.25\%$ , the change per year of sensitivity of NIP pyrheliometer was less than  $\pm 1\%$  and PSP pyranometer less than  $\pm 2\%$ .

### 3 Conservation, Transfer and Stability of China Regional Radiation Standard

Eight regional calibration centers of radiation instruments were set up by China Meteorological Administration (CMA) in 1994. Every calibration center was equipped with three TBQ-2-B type working standard pyranometers (stability of year within  $\pm 2\%$ ) and three TBS-2-B type working standard pyrheliometers (stability of year within  $\pm 1\%$ ). All of these make up of China regional (province) grade radiation standard group. These eight regional calibration centers of CMA are in HeiLongJiang, XinJiang, GanSu, XiZang, ZheJiang, GuangDong, YunNan province. There is a national conference of standard radiation instruments every two years, mainly about calibration, comparison and training in operation. From the first national standard radiation instruments conference in 1994 until now, there has been holding seven conferences. Its aim is to transfer the values of WRR to China regional radiation standard and other domestic departments' standard pyrheliometers and pyranometers to ensure the lower uncertainty in radiation measurement. At the same time the relative personnel who are engaged in the calibration of radiation instruments can be trained and communicate with each other both in theory and practical operation. LiJiang city in YunNan Province (altitude 2397m, longitude  $100^{\circ}25'$ , latitude  $26^{\circ} 86'$ ) has been chosen formally as the radiation calibration field in China.

The required environmental conditions of the values transfer of direct radiation and total radiation are clear sky, stable solar radiation, the solar elevation larger than  $30^{\circ}$ , hollowness around, without any obstacle above the detector surface, air temperature between  $20\pm 10^{\circ}\text{C}$ , wind speed smaller than 5m/s, relative humidity no more than 80%. Pyrheliometers are calibrated by H-F cavity pyrheliometer No.19743 and PMO-6 absolute radiometers No.850406. Pyranometers are calibrated by standard values getting from direct radiation and scattered radiation (measured by PSP with shading).

The stabilities of most of working standard pyrheliometers of the eight regional calibration centers see Figure5. The change of pyrheliometer of Guangdong Province No.9412 was larger than the permitted error in 1998. In the Fig5, the sensitivity of the pyrheliometer No.9412 was the corrected value. The stabilities of most of standard pyranometers see Figure6.

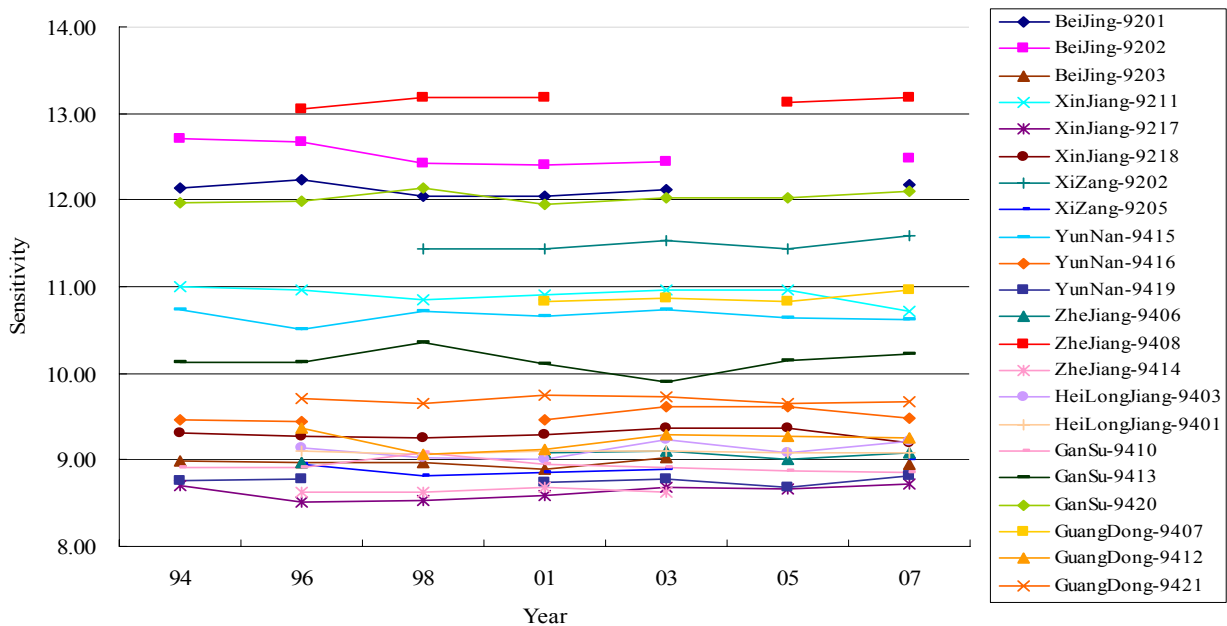


Figure 5 Stability of most standard pyrheliometers sensitivity

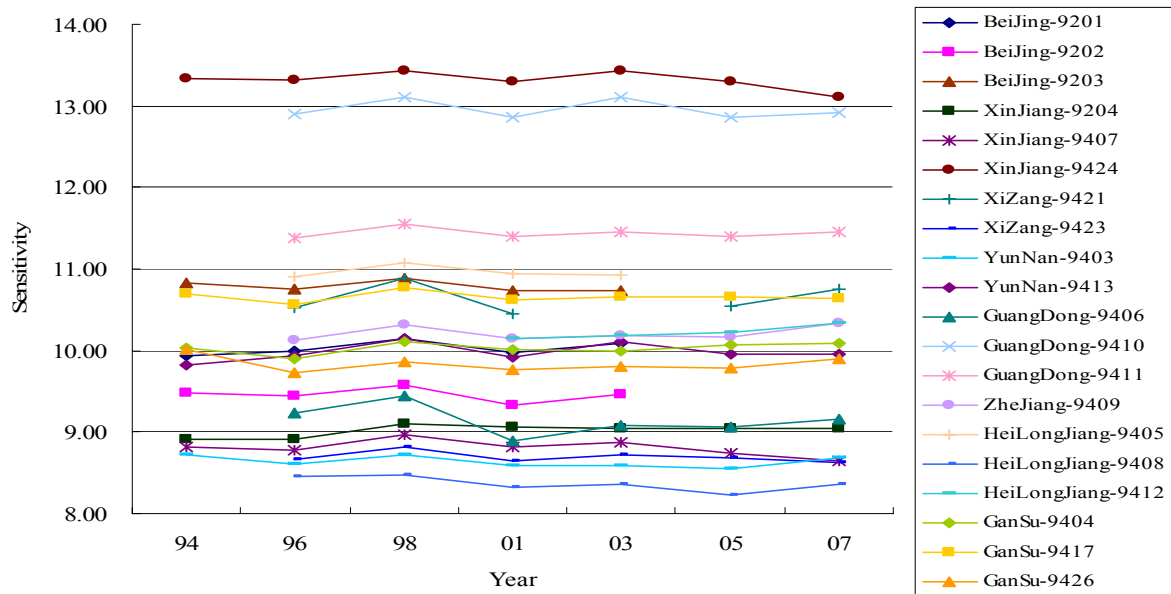


Figure 6 Stability of most standard pyranometers sensitivity

#### 4 Conclusions

By the figure of ratios of the solar radiation standard group and the sensitivity-change figures of working standard NIP pyrhemometers and PSP pyranometers, we could know that the results of comparisons are good, the characters of these instruments are stable, and can satisfy the requirements of WMO completely. The calibration results of the eight regional radiation standards indicate that the stabilities of these working standards are within the permitted error.

#### References

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