

Microwave observations of the Chinese Solar Broadband Radio Spectrometer at Huairou

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Abstract. This work presents an overview of the microwave observations of the Chinese Solar Broadband Radio Spectrometer at Huairou (SBRS/Huairou) during 1997-2011. The relationships between the microwave bursts and solar flares and the calibration of spectrometers are also studied.

Keywords. radio bursts, solar flare, calibration

1. Observations and Calibration

The Chinese Solar Broadband Radio Spectrometer at Huairou (SBRS/Huairou) contains three frequency bands: 1.0-2.0 GHz, 2.6-3.8 GHz, 5.2-7.6 GHz (Fu *et al.* (2004)). Since 1997, it has observed thousands of microwave bursts and accumulated a great number of observation data. Table 1 presents a list of the radio bursts and the related X-class flares. There are 54 X-class flares observed by SBRS/Huairou during 1997-2011. As for all class flares, 2661 soft X-ray flares (including 17 X-class, 215 M-class, 2429 C-class, and 166 B-class flares) were recorded from National Geophysical Data Center (NGDC) in 2000. Among them, 1224 flares (7 X-class, 98 M-class, 79 C-class, and 71 B-class flares) were observed by SBRS/Huairou. Besides these events, 77 microwave bursts without obviously related soft X-ray flares were also observed by SBRS/Huairou in the same year. They took place tens of minutes to several hours before or after some flares. Table 2 presents the relationship between microwave bursts and solar flares observed in 2000.

Following the fundamental method of Tanaka *et al.* (1973) and Yan *et al.* (2002), we make the analysis of the calibration constants and the standard deviation of calibration at three frequency bands of SBRS during 1997-2009. At 2.6-3.8 GHz band, Tan *et al.* (2009) indicated that the calibration result has correlation with the local air temperature. A correction factor that varied with local air temperature was considered. This correction can reduce the error of calibration about 30%. We choose the daily noon solar flux without sunspots before or after three days as the radio flux of quiet sun, and obtain the spectrum of quiet solar radio emission. Fig. 1 shows the comparison between the observation and numerical simulation (Smerd (1950)) of quiet solar radio emission. It indicated the electron temperature of chromospheres about $\sim 10^4 K$.

2. Summary

From our analysis on the observations of SBRS/Huairou, we may obtain the following conclusions: all the powerful flares with class $\geq M4.0$ were observed to have relationships with microwave bursts, part of the other flares are also associated with the microwave bursts. The calibration analysis indicates that the calibration constants are correlated

Table 1. Microwave bursts and the recorded X-Class soft X-ray flares observed by SBRS

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Tot.
Radio burst	31	181	113	324	631	531	369	240	171	31	15	0	0	15	147	2790
associated X-Class flares	1	8	1	7	5	5	7	5	11	1	0	0	0	0	3	54
X-Class flares	3	14	4	17	21	11	20	12	18	4	0	0	0	0	8	132

Table 2. The relationship between microwave bursts and soft X-ray flares in 2000

All SXR flares (2661)	17 X-class	215 M-Class	2429 C-Class	166 B-Class	no flare
SXR flares with observation of SBRS	7	98	1048	71	-
Associated radio burst	7	79 (~ 80%)	160	1	77

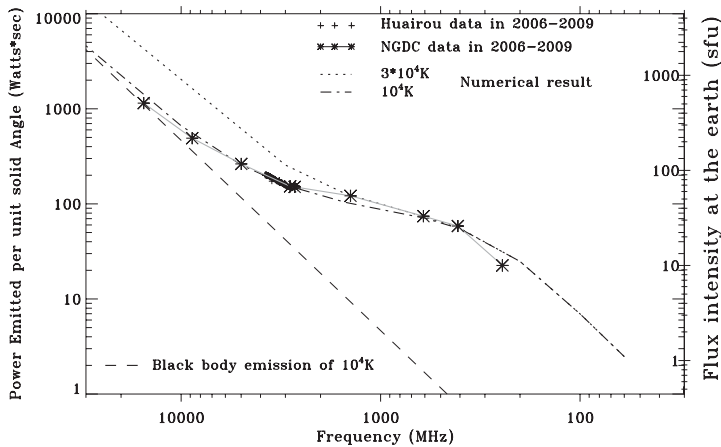


Figure 1. Comparison between observations and numerical result of the spectrum of quiet solar radio emission

with the local air temperature. One possible reason is that the electronic apparatus are affected by the air temperature.

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