

SBC Dark and Cumulative Images

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ABSTRACT

SBC dark images have been collected to provide dark current subtraction for science images and to monitor the instrument health and performance. Cumulative images which add counts from the whole history of the detector's use are also generated to anticipate any long-term degradation in performance. Images collected to date show no loss of efficiency or indications of any problem.

1. Introduction

The Solar Blind Channel (SBC) of the ACS is a MAMA detector and, as is typical with these devices, exhibits a very low dark current. Nevertheless, to extract the best information from science images, dark images are measured and subtracted from observations. Additionally, the dark images can be used to locate problems with a multi-channel plate device especially if there are abrupt changes in rate.

Cumulative images have also been generated weekly. The first of these is a simple sum of all SBC images. A rate weighted image has also been computed to assess the possible reduction in sensitivity with detector exposure.

2. SBC dark images

Dark images were first collected in 2001 on the ground and a summation of these was used to make the dark calibration reference file. As of this writing, this is still the image being used for processing. A set of in-flight darks were taken in May 2002 and further monitoring pairs of darks have been taken approximately once per month. Initially, these were

scheduled separately from other SBC observations under proposals 9567 and 9652. Later the dark images were taken as part of the UV contamination monitoring program in proposals 9655 and 10047. The advantages of switching to this mode are that it reduces the number of times the SBC has to be turned on and, by taking the dark image at the end of the observing sequence when the temperature has increased to a typical operating value, possibly provides a more realistic measurement. The SBC is not thermally controlled. When it is first turned on the detector temperature is typically about 16°C and takes about eight hours to reach a fairly stable temperature of 26°C. The dark rate is temperature dependant, as illustrated in Figure 5.

3. Cumulative images

Multi-channel plates slowly lose sensitivity with use. The loss of sensitivity depends on the total extracted charge and the rate at which it is extracted (Danks, 1996). From data in this report we obtain an approximate relation between the count rate, r and the percentage efficiency loss rate, L of the form $\log_{10} L = 2.39 \log_{10} r - 10.48$ (Cox, 1999), or equivalently $L = 3.31 \times 10^{-11} r^{2.39}$. To estimate the degree to which the SBC is affected, we maintain two images. The first is a sum of all the exposures taken with the SBC; each week the new exposures are added to last week's cumulative image. At the same time we build an image which is the (count rate)^{2.39} integrated over all exposures. From this we estimate the probable efficiency loss in each pixel of the detector.

These images were accumulated until June 2003. At that time, an unrelated update to the OPUS pipeline created an error in the cumulative image software and no images have been maintained since. This has not yet been corrected and appears to be of such a low level of importance, that no effort has been put into resolving this.

4. Results

Dark Rate

Figure 1 shows the currently installed reference dark image. The total exposure time was 144000 seconds and was measured during thermal vacuum tests in 2001 with the SBC at temperatures between 20 and 30°C. (Martel, Hartig and Sirianni, 2001). The mean count rate over valid pixels in the image is 3.9×10^{-5} counts/sec. per pixel and an average over a 50 by 50 pixel region in the bright central area is 1.1×10^{-4} . The horizontal black bar corresponds to a broken anode. This bar and several hot pixels are excluded from the measurements of mean rate

An in-flight measurement under proposal 9022 was undertaken on May 31 2002. The temperature variation during this sequence is shown in Figure 4. There is a very slow climb, taking about eight hours to go from the temperature when the SBC is off, about 16°C, to a fairly stable temperature of 26°C.

A dark image derived from all the in-flight measurements and with a total exposure of 89760 seconds, appears to be slightly flatter than the reference image and has a mean count rate per pixel of 1.0×10^{-5} , about ten times less than the reference image. A dark created from just the higher temperature images taken near the end of the May 31 sequence with an exposure of 16800 seconds looks similar and is slightly more centrally weighted and has a roughly 20% higher count rate. Figure 2 shows the low and high temperature versions of the dark images. Normal observing with the SBC would involve turning it on for less than two hours. Therefore, the low temperature dark image may be the more appropriate one to use. The mean dark rate is in any case only about 10^{-5} counts per pixel per second and variations in this will scarcely impact observations.

The long term dark rate trend is shown in Figure 3, and indicates no increase over two years of exposure to the space environment. The cluster of points at May 31st 2002 corresponds to the dedicated dark rate measurements of proposal 9022 during which the temperature increased. The temperature dependence of the mean dark rate as measured while in flight is shown in Figure 5. This indicates very little variation below about 24°C and so a new dark image has been generated derived from summing all measurements taken below this temperature.

Cumulative images

The rate-weighted cumulative image through July 2003 is shown in Figure 6. The maximum number of counts, apart from the known hot pixels, is about 80000. To calculate the percentage efficiency loss, we multiply the value in the rate-weighted image by 3.3×10^{-11} . This translates into an efficiency loss of at most 2.4×10^{-5} percent, a truly negligible amount. For this reason we do not consider the loss of the cumulative image generation as a problem requiring special attention.

5. Conclusions

The ACS SBC is functioning well, although it is not heavily used. The dark rate remains stable but is about ten times lower than the value represented by the calibration file. A new calibration file based on measurements taken with the temperature below 24°C will be installed. No special effort should be made to correct the cumulative image problem.

Figure 1: Reference SBC dark image.

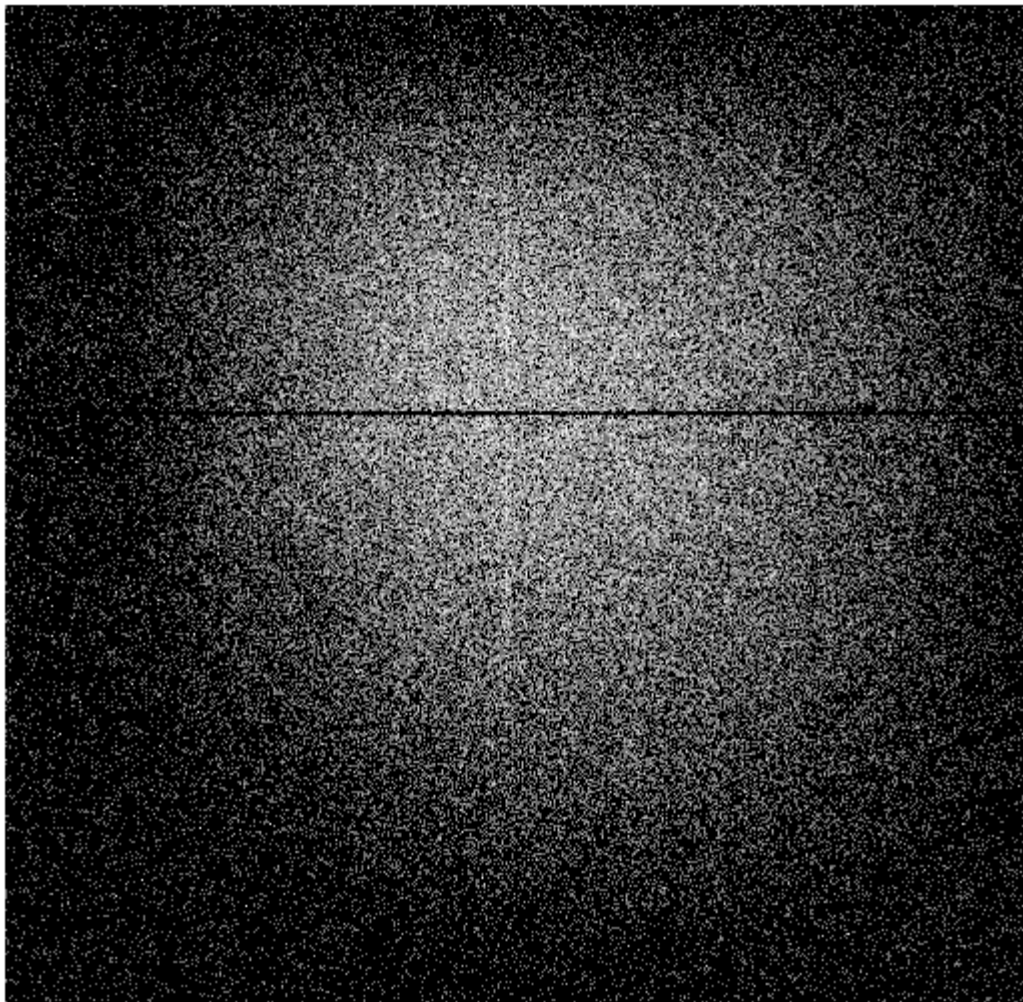
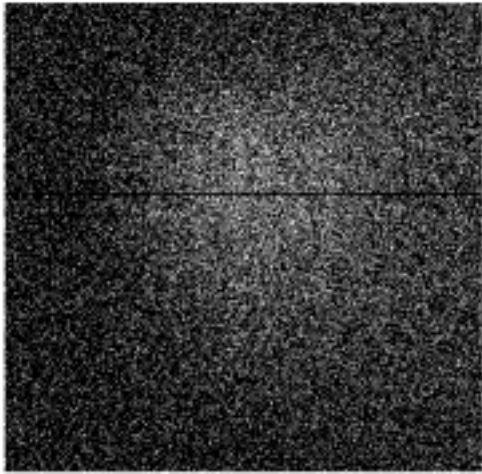
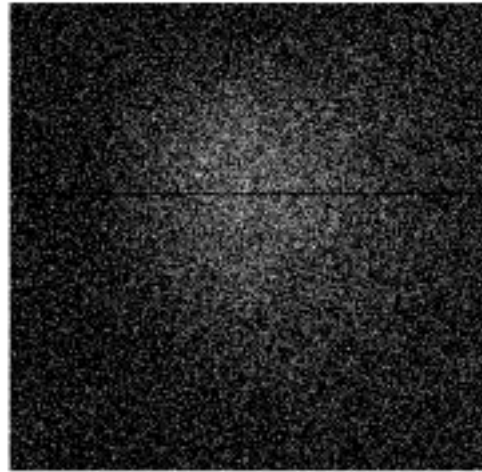


Figure 2: In-flight dark images.



Sum of all in-flight darks



Sum of darks at 26°C

Figure 3: SBC mean dark rate as a function of observation date.

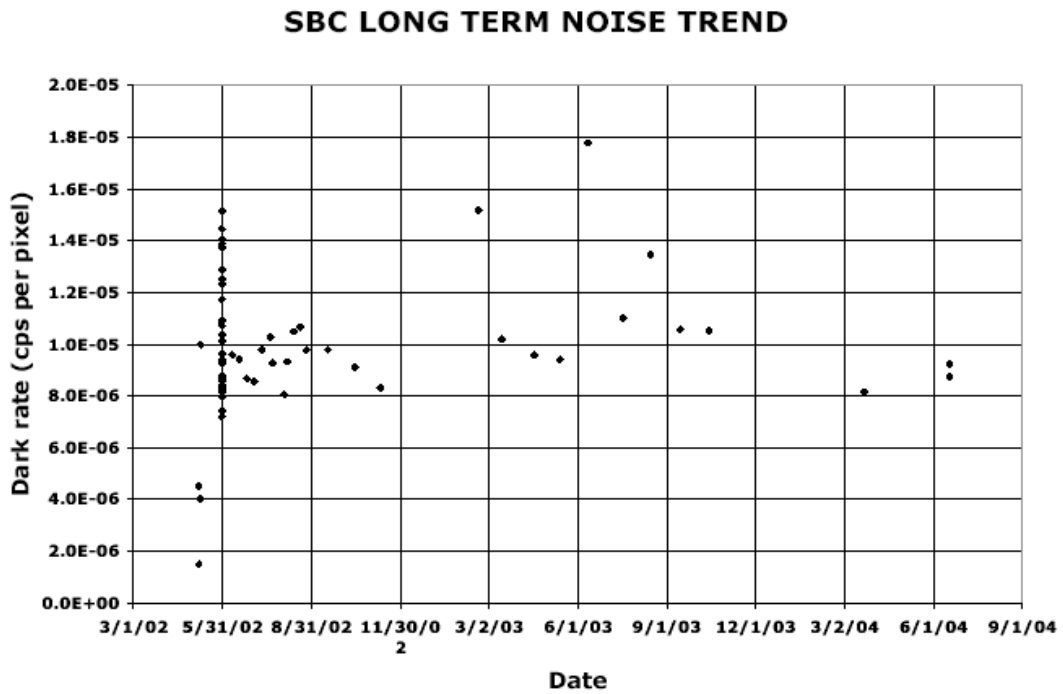


Figure 4: Temperature variation during dedicated SBC dark measurement

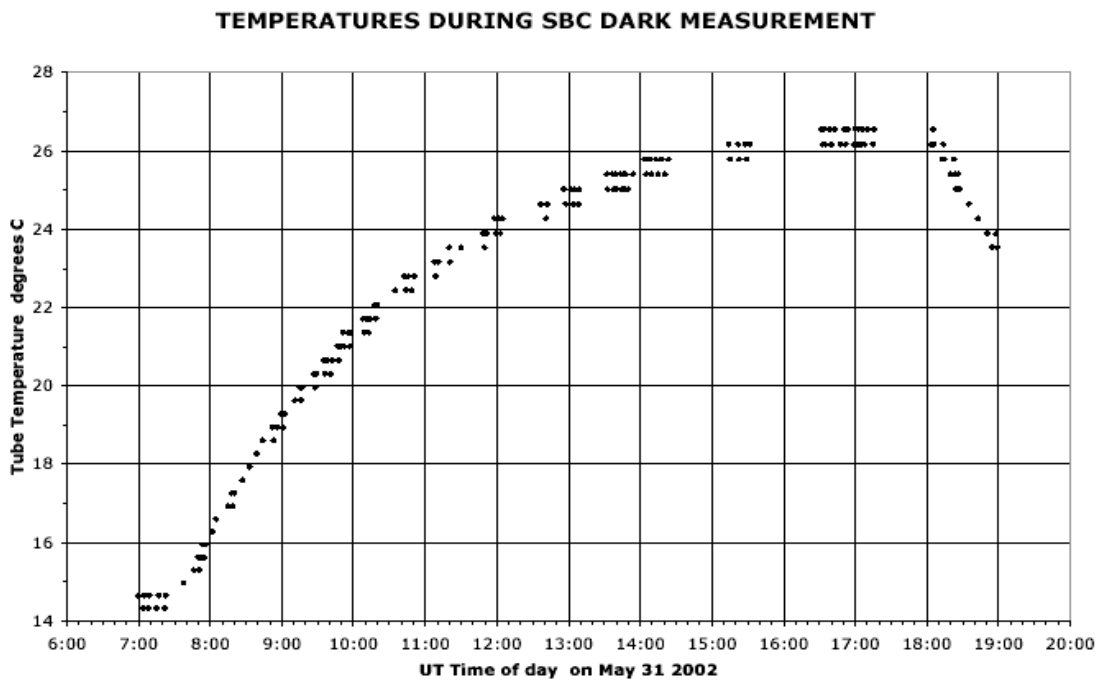


Figure 5: Temperature dependence of mean dark rate

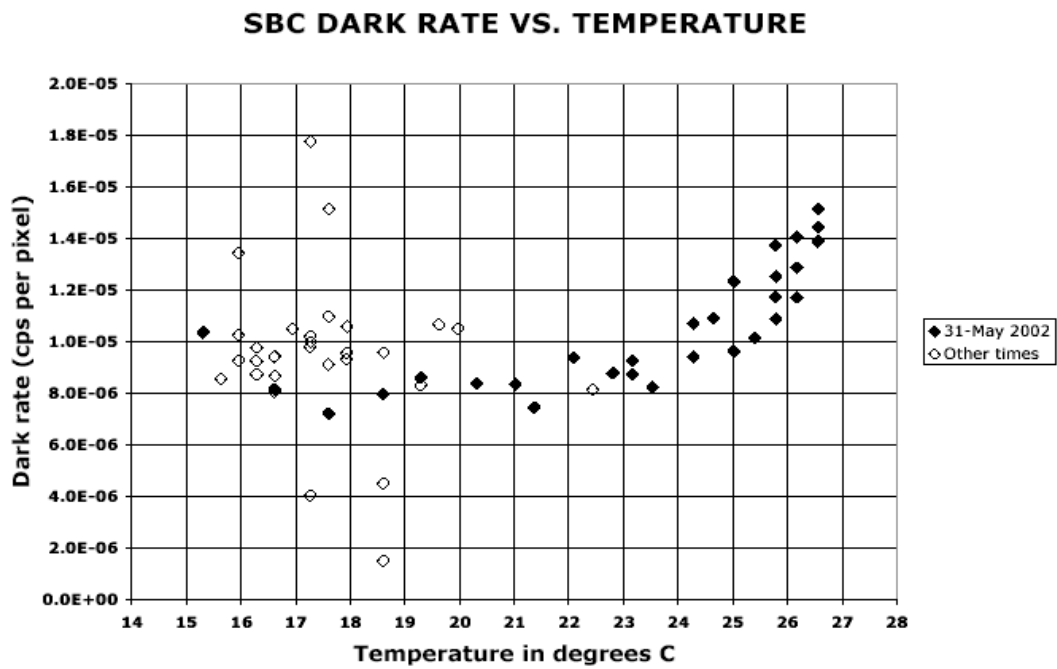
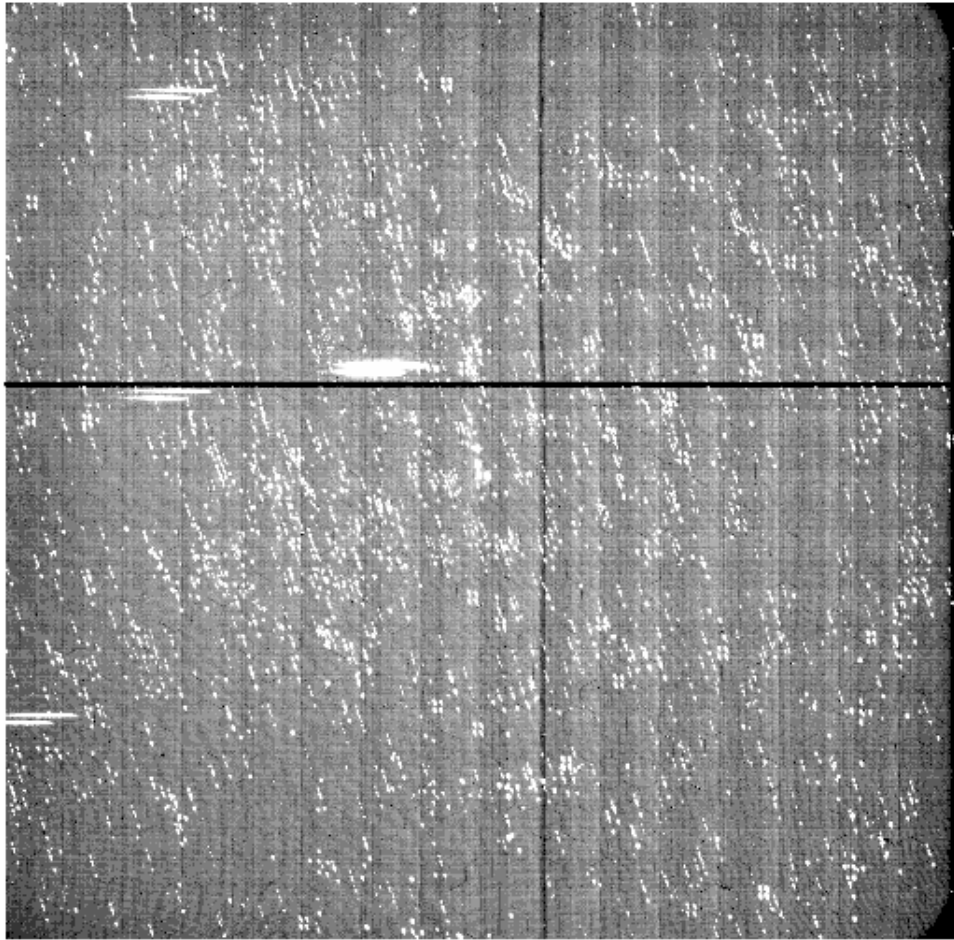


Figure 6: Rate-weighted cumulative image



6. References

- Danks, T., Bright Object Protection Review Response, Report GSFC-STIS-MAMA-03
- Cox, C., The cumulative ACS MAMA images. Technical Instrument Report ACS 99-04
- Martel, A.R., Hartig, G., and Sirianni, M., SBC MAMA Darks TB/TV 3 (Jul 2001)
http://adcam.pha.jhu.edu/instrument/calibration/results/by_item/detector/sbc/darks_jul01/