SXT Dark Current Orbital Correction Report

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HISTORY

Not too long after entrance filter failures began in November 1992 it was discovered that CCD dark current varied over each daylight pass with a sharp decrease beginning at the end of UV flood. The cause of this variation was charge bleeding out of traps in radiation damaged pixels. The traps filled during the UV flood. This is a dark current effect only. The pedestal+spurious charge part of the CCD dark signal shows no variation with orbital phase nor exposure duration.

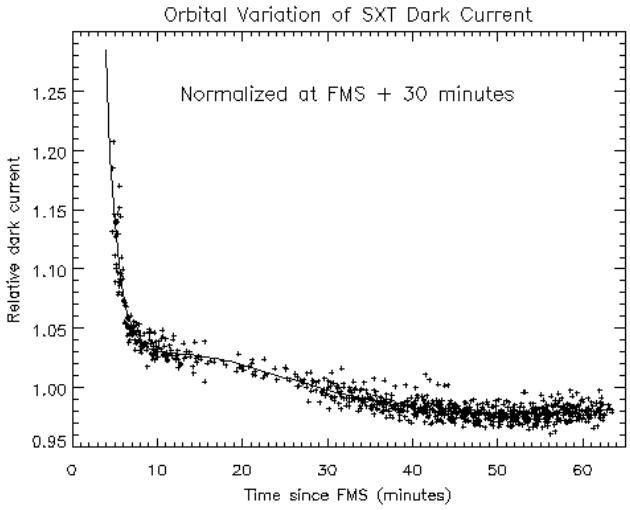

Figure 1: SDC dark current versus TFMS.

In December 1994 SXT experiments were run to better define the orbital variation of dark current and a 5th order polynomial fit was derived to describe it, as illustrated in Figure 1. In 1998 the program DC_ORBIT_CORRECT.PRO was writtent to adjust CCD dark signal to the time (since end of UV flood) of the x-ray images. As the polynomial fit used tim2fms from TIM2ORBIT.PRO as the independent variable, and this didn't properly take account of differences in the the morning interval (UV flood duration) the progrm SXT_UVF_INFO.PRO was written to generate the variable TFMS for use in properly computing the factor for dark current adjustment. The programs GET_DC_IMAGE.PRO and DARK_SUB.PRO were also modified in January 1998 to incorporate dc orbital adjustment.

Unfortunately, errors in SXT_UVF_INFO.PRO returned incorrect values of TFMS. Also, DC_ORBIT_CORRECT.PRO applied the dark frame adjustment

to the entire CCD dark signal rather than just to the dark current part. All ensuing SXT data products, including those in the YLA as of the end of 2015, incorporate these errors – which impact the intensity levels in SXT images.

ANALYSIS

I have corrected SXT_UVF_INFO.PRO and DC_ORBIT_CORRECT.PRO and revised GET_DC_IMAGE.PRO to utilize the corrected programs. To evaluate the significance of the dc orbital adjustment I have selected one HR AlMg SSC per week for the entire mission and created a data set of the 1072 SFRs used in creating these SSCs. DPE for these 1072 FFIs ranged from 9 to 30 (17.2 ms to 30.2 s). Using GET_DC_IMAGE.PRO I produced the dark frame with and without dc orbit correction (DOC).

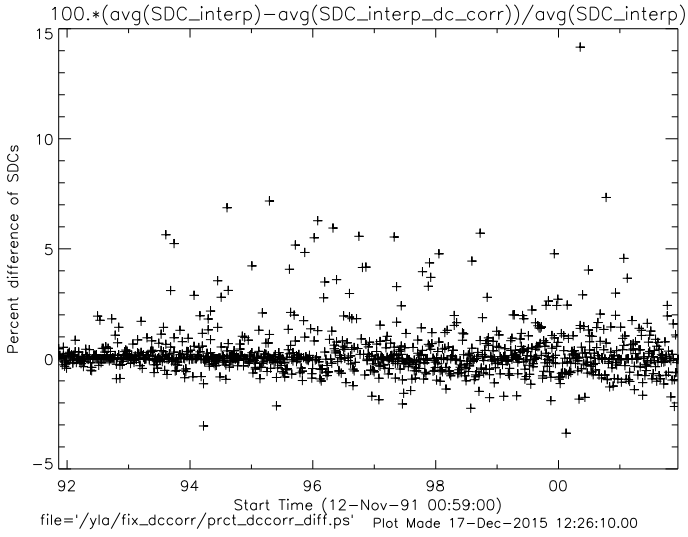

Figure 2: Percent difference in total SDC signal between simple dc_interp and dc_orbit_correct, which also sets dc_interp.

Except for a single DPE=30 case when a very early SFR and a late SDC produce a 14% adjustment most of the SDC changes are less than a few percent and with most of the adjustments causing an increase the dark signal. Figure 2 illustrates the percentage difference of the averaged dark frame with and withoud DOC. The same data are sorted and compared to DPE in Figure 3.

CONCLUSION

The decision as to whether to reprocess all of the YLA level-1 and level-2 data products hinges not on the changes in the SDCs but on the evaluation of the x-ray images themselves. Figure 4 illustrates the need for regenerating the

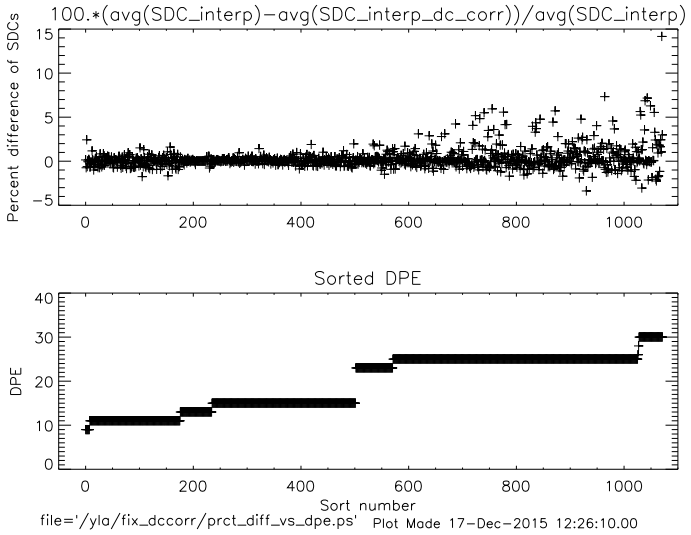

Figure 3: Illustration of the dependence of the effect of dc_orbit_correct on DPE.

YLA data products. Analysis of these data shows that 10% of YLA level-1 FFIs have a mean intensity error >5%. Figure 5 shows that, especially around solar minimum, DOC can make a substantial difference in SXT image intensity.

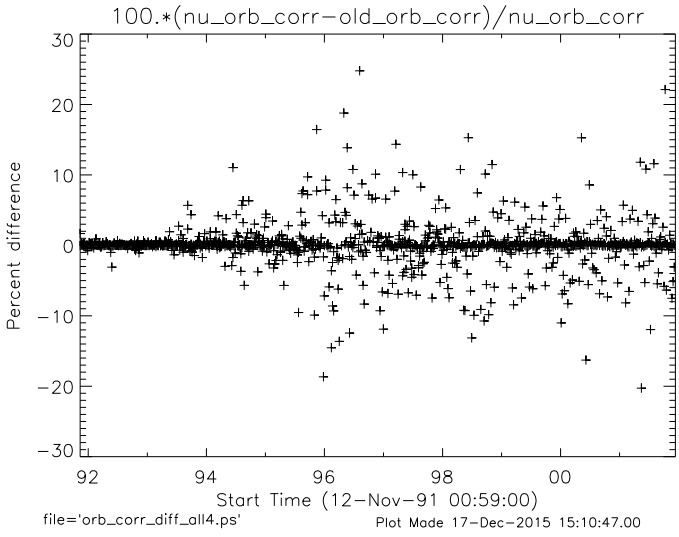

Figure 4: Differences in total signal in 1072 sxt_prep'd SFRs between new (corrected) orbit correction software and 1998 version used for YLA2015.

A pixel by pixel analysis would show a much broader variation, concentrated

towards the fainter pixels. In my opinion this analysis is not necessary – we must do the reprocessing.

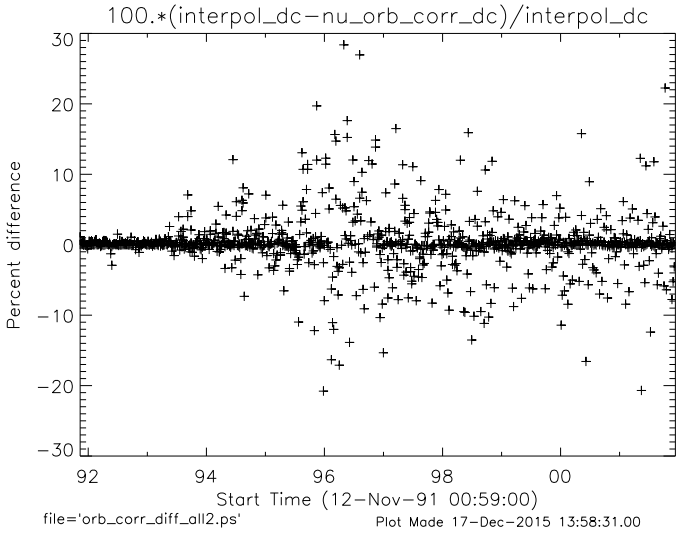

Figure 5: Effect on the total signal of the processed FFIs of using the new dc orbit correction on 1072 HR AlMg SFRs, spread uniformly over the *Yohkoh* mission.

I do not intend to regenerate the level-3 browse/movie images as the DOC changes would have little, if any, impact on the visual appearance of the images. Likewise, I do not advocate doing anything with the level-2 uncertainty images other than what automatically happens as a result of the fixes to the dark frame creation programs discussed above.