The AXAF Guide/Aspect Star Catalog (AGASC) Version 1.6

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ABSTRACT

Version 1.6 is the third on orbit calibration of the AGASC. Using more than 30000 aspect camera star observations from over the course of the Chandra mission we are able to calculate the ACA (Aspect Camera Assembly) response to a much higher precision and over a broader band of star colors than previous calibrations. AGASC 1.5 was deemed to require improvement for Chandra flight operations after the discovery of a offset of up to 0.5 mags between the predicted AGASC magnitude and the observed ACA magnitude for red stars with a Tycho-2 color greater than 0.9. Here we present the calibration details of AGASC 1.6 and show the improvement over previous catalogs.

INTRODUCTION

This calibration is motivated by inaccurate values of MAG_ACA, the expected magnitude in the ACA bandpass, at B_{Tycho}-V_{Tycho} > 0.9 in the flight AGASC (version 1.5). This error results in predicted values exceeding half a magnitude brighter than the actual ACA observed magnitude. The below plot (Figure 1) shows this offset. To correct this problem, we have repopulated the MAG_ACA and MAG_ACA_ERR arrays in the AGASC for all stars originating from the Tycho-2 catalog (about 99% of the usable acquisition and guide stars). New predictions for these arrays are determined from a database of 31219 stars acquisition attempts from the past five years of operations. Only stars that were positively identified by the OBC and having valid Tycho-2 magnitude and color information were used.

Figure 1

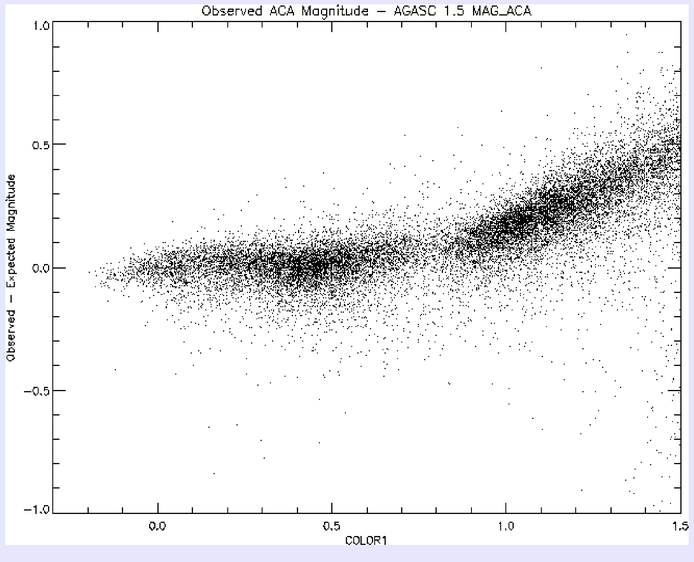


Figure 2

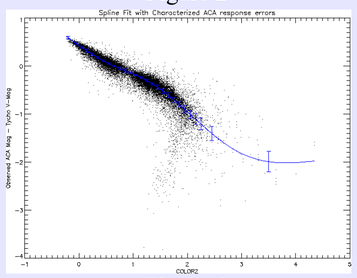


Figure 3

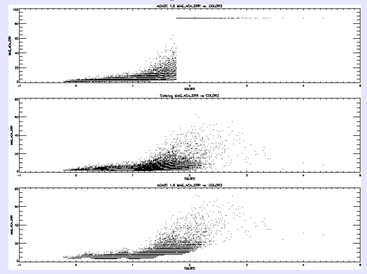


Figure 4

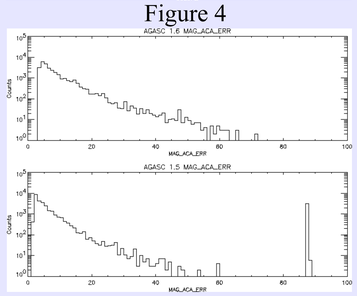
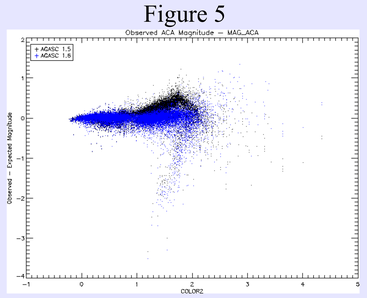


Figure 5



ANALYSIS

Figure 2 shows the observed offset of Tycho magnitude (VMAG) from MAG_ACA against COLOR2, as well as the fit to be used for calibration. The data were grouped into color bins with width of 1/10th mag. Color bins containing less than 100 observations were combined with stars from the adjacent bin. To eliminate outliers that do not represent the majority of observed stars, the data are then iteratively sigma-clipped about the bin mean. This reduces the number of data points to 29066. We then apply a cubic spline fit with seven equally spaced nodes to model the clipped data. The number of nodes was chosen to provide a best fit to the ridge line of points. The data was not truncated to a maximum color before fitting, the entire range was fit for completeness. Stars with colors greater than 2.5 should be naturally eliminated in the selection process due to their large error terms. The scatter plot in figure 5 shows the new MAG_ACA for the calibration stars highlighted in blue. MAG_ACA_ERR is also repopulated to correctly propagate the catalog errors and to account for the uncertainty in the ACA response. The ACA response error is determined by comparing the calculated magnitude error to the observed spread of the data using the following relations.

$$error_{aca}^2 = error_{magnitude}^2 + error_{col}^2 \left(\frac{dfit}{dcol}\right)^2$$

$$error_{response\ bin}^2 = \left| \sum error_{obs}^2 - \sum error_{aca}^2 \right| / N_{bin}$$

This error is then combined with the calculated error to determine the total catalog error. These errors are compared above in figure 3 and 4.

TESTING

AGASC 1.6 only effects stars from the Tycho-2 catalog. Figure 6 shows a scatter plot of MAG_ACA for all the Tycho-2 stars in the AGASC against Tycho-2 color. All plots in the lower right corner are generated from this data. The scatter plot of MAG_ACA_ERR against color is shown for the new and old AGASC in figure 7. The most noticeable change is the addition of calculated errors for COLOR2 > 1.76 (1.5/0.85), where AGASC 1.5 uses a truncated error. Also notable is that the bluest stars have reduced errors as a result of eliminating the extended tail of the polynomial fit. The below distribution in figure 8 shows very little overall change in MAG_ACA. We do not expect AGASC 1.6 to have a dramatic effect on star selection, only to give a better representation of reality. When we look at the distribution of MAG_ACA_ERR in both catalogs (figure 9), we see that the artificial errors for stars with COLOR2 > 1.76 has been eliminated, allowing these stars to be included in early stages of star selection. The minimum error for stars has increased slightly in AGASC 1.6. This is due to the addition of a component to account for uncertainty in the ACA response.

Figure 6

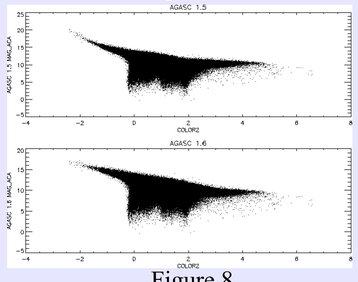


Figure 7

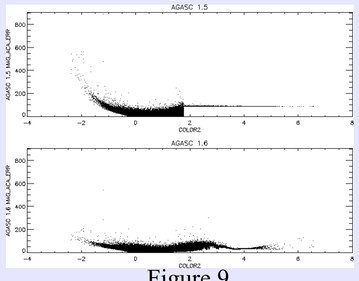


Figure 8

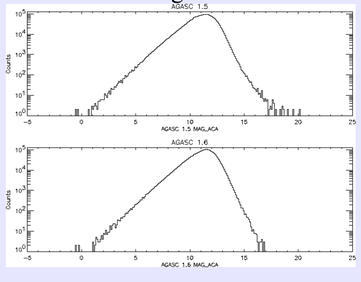


Figure 9