

Status of the *Chandra* Source Catalog Project

The first official release of the *Chandra* Source Catalog (CSC) is now fully available for use by the astronomical community. The release is accessible publicly through the catalog web site (<http://cxc.cfa.harvard.edu/csc/>), which also contains a wealth of supporting information for prospective catalog users. The catalog production database, which includes information about observations processed to-date during the production phase of the catalog, has been available since October 2008.

Release 1 of the CSC includes 94,676 sources detected in ACIS imaging observations released publicly prior to the start of 2009 (see Figure 1). Only point and compact sources, with observed spatial extents $< \sim 30$ arcsec, are included in this release; sources larger than this are not detected by the current catalog algorithms. In general, observations of fields containing highly extended sources are not included in this release. However, if the extended emission is isolated to a single ACIS CCD, then the remainder of the field covered by the other CCDs is included. Multiple observations of the same field are not co-added prior to performing source detection; instead, source detection is performed on each observation individually.

A subsequent release (1.1) is planned for later this year to extend the catalog to include public HRC-I imaging observations, and newly public ACIS observations, but will otherwise retain the same limitations as Release 1.

The CSC is capable of supporting many diverse scientific investigations. However, users should carefully review the “Caveats and Limitations” section of the catalog web site when assessing the efficacy of the catalog for their particular line of enquiry. Since the catalog is constructed from a subset of public pointed *Chandra* observations, users should be aware that there may be fundamental and significant selection effects that restrict the source content of the catalog and which therefore may limit scientific studies that require an unbiased source sample.

Catalog Contents

Release 1 of the CSC includes detected sources with fluxes that are at least 3 times greater than their estimated 1σ uncertainties (typically corresponding to about 10 net source counts on-axis and roughly 20–30 net source counts off-axis).

The catalog includes numerous raw measurements, as well as scientifically useful source properties derived from the data. These include estimates of the source position measured from each observation in which a source is detected, as well as raw source and PSF extents, and the deconvolved source extent, in several energy bands. Aperture photometry for sources detected in ACIS observations is provided for 5 energy bands — broad (0.5–7.0 keV), ultra-soft (0.2–0.5 keV), soft (0.5–1.2 keV), medium (1.2–2.0 keV), and hard (2.0–7.0 keV) — using several different methods. Band images and exposure maps in FITS format are provided for each source, together with a full-field limiting sensitivity map.

Cross-band (hard, medium, soft) spectral hardness ratios are reported for all detected sources, and absorbed power-law and black-body spectral fits are performed for sources with at least 150 net counts. Source pulse-invariant spectra and spectral response matrices are produced for sources detected in ACIS observations.

Several source variability measures are included, both within a single observation of a source and between multiple observations that include the same source. Intra-observation measures include Kolmogorov-Smirnov and Kuiper test probabilities, and a Gregory-Loredo odds ratio. An optimally binned light curve is produced for each source.

Catalog Statistical Properties

As part of the official catalog release, a characterization of the statistical properties of the catalog is provided. Preliminary analysis of both simulations and real datasets indicates that the statistical properties of the CSC may be characterized as follows:

- False source rates of $\ll \sim 1$ per observation for exposures ≤ 50 ks, and ~ 1 per observation for exposures ≥ 120 ks;
- 50% completeness (see Figure 2) at broad-band fluxes of $\sim 7 \times 10^{-15}$ ergs cm^{-2} s^{-1} for a ~ 10 ks observation, improving to $\sim 9 \times 10^{-16}$ ergs cm^{-2} s^{-1} for a ~ 125 ks observation;
- Positional uncertainties (see Figure 3) of $\leq 1''$ (95% confidence) for sources with more than 10 counts, located within $3'$ of the optical axis, $\leq 2''$ for sources with more than 30 counts, within $10'$, and $\leq 5''$ for sources with more than 50 counts, within $15'$;
- Flux accuracies of better than $\sim 35\%$ (1σ) for sources with more than 30 counts, within $3'$ of the optical axis, $\sim 30\%$ for sources with more than 50 counts, within $10'$, and $\sim 25\%$ for sources with more than 100 counts, within $15'$.

Data Access and User Documentation

The easiest way to query the CSC is via the CSCview web interface, on the catalog web site. CSCview enables the user to search for sources matching user-supplied constraints for any of the catalog properties, including searching by source position (cone search). The user can select which of the extensive set of catalog parameters they wish to display for matching sources, or can choose to see one of the pre-defined sets of parameters optimized for common queries. Besides displaying the results of a search on the screen, the user may choose to save the search results in a data table. CSCview also provides access for downloading any of the file-based data products that are included in the catalog.

The catalog website (<http://cxc.cfa.harvard.edu/csc/>) is also the place to look for a large bank of user documentation. Sections describe in detail the contents of the catalog, including important caveats and limitations; how to access the catalog; threads that include example catalog searches; and the statistical characterization of the catalog properties, and suggested language for acknowledging the use of the CSC in publications. The user documentation on the catalog website will continue to be improved and extended over the coming months.

— Ian Evans for the *Chandra* Source Catalog project team

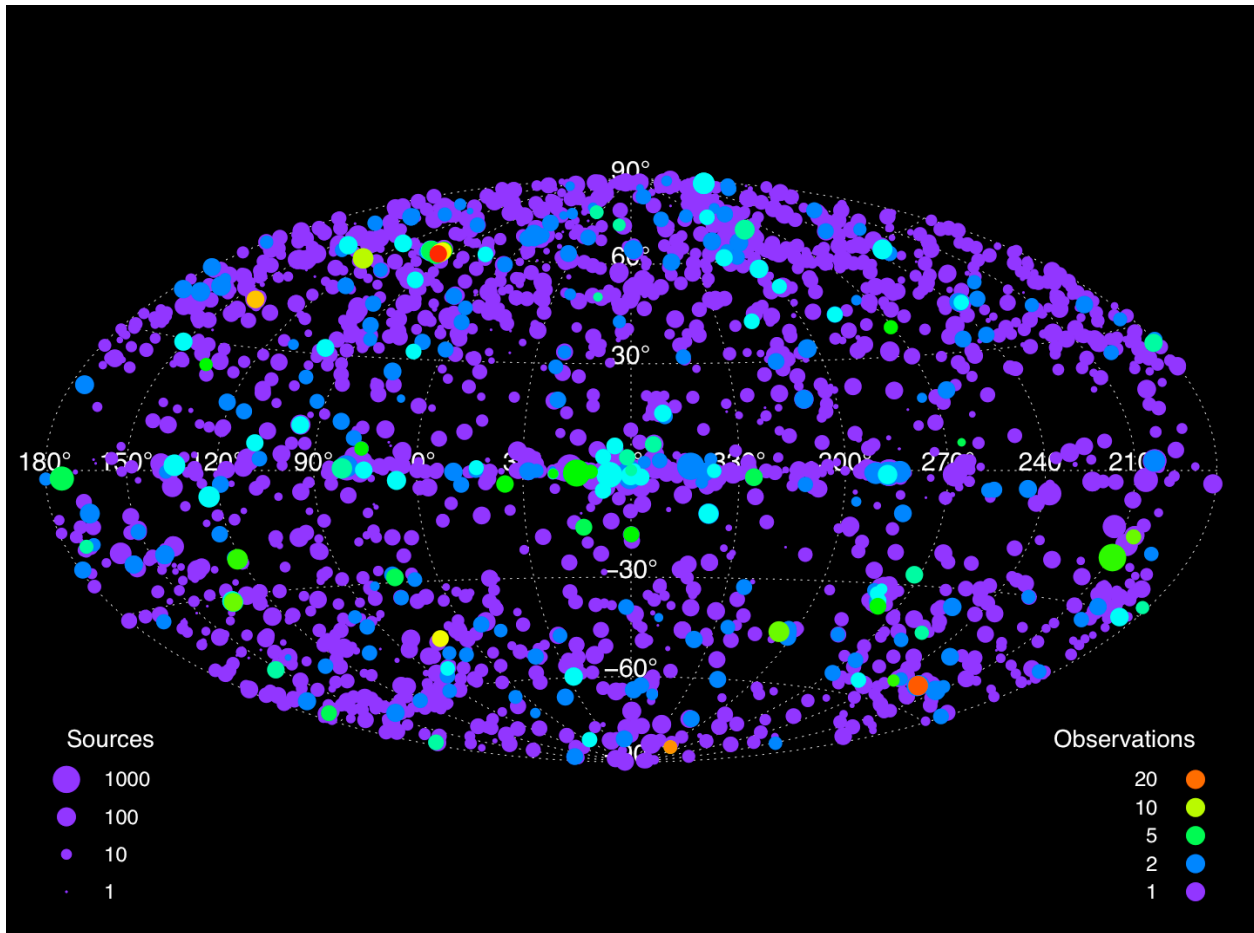


Fig. 1. This figure shows the locations of observations included in the CSC (in Galactic coordinates). The size of each symbol is proportional to the logarithm of the number of sources detected in the observation (1 to ~1000 sources per field), while the color encodes the number of approximately co-located observations.

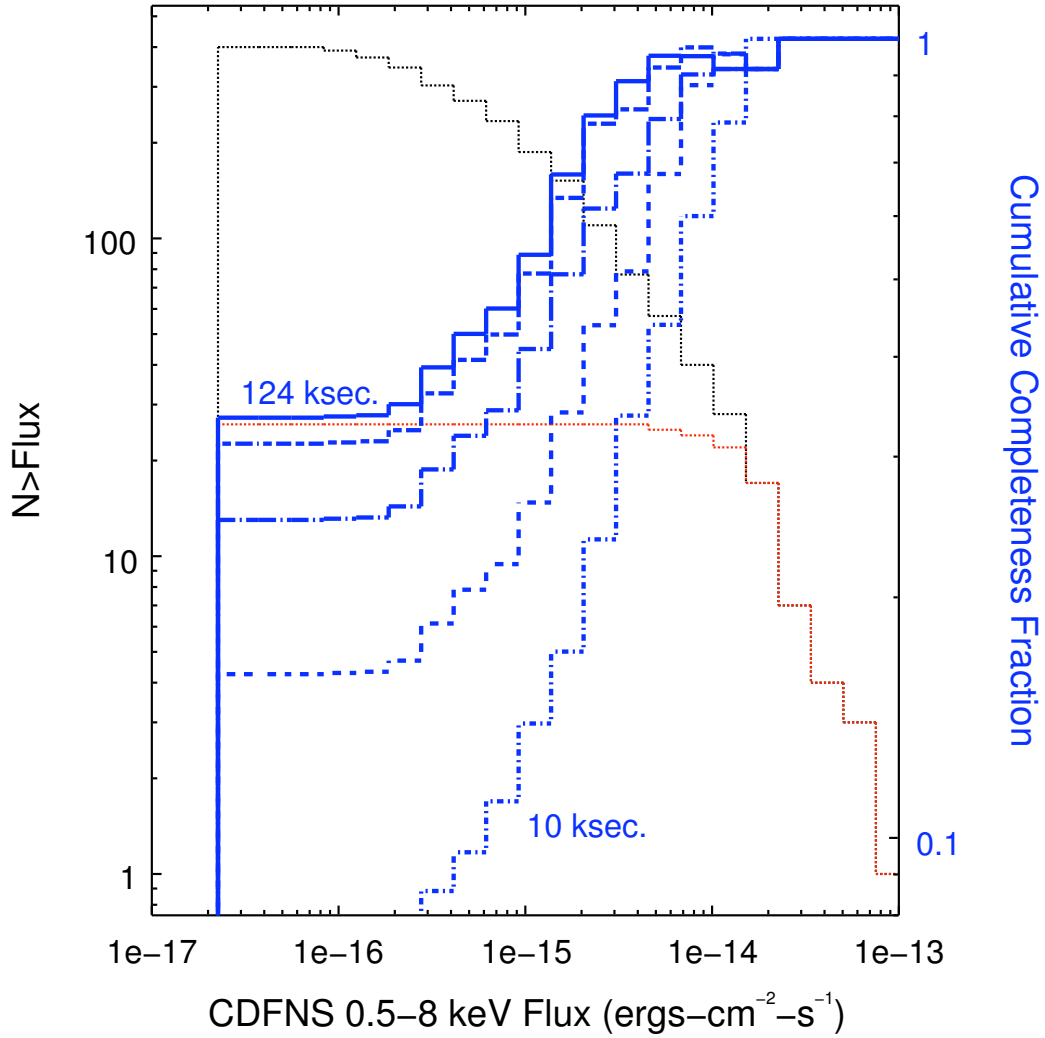


Fig. 2. The black curve shows the cumulative flux distribution for all *Chandra* Deep Field (CDF) North and South sources. The red curve shows the corresponding distribution for CDF sources associated with CSC sources for a 10 ks observation. The ratios of the two distributions (blue curves) provide an estimate of the completeness fraction for the CSC. Completeness fractions for 10 and 124 ks observations are labeled. Fractions for intermediate exposures of 30, 60, and 95 ks are also plotted.

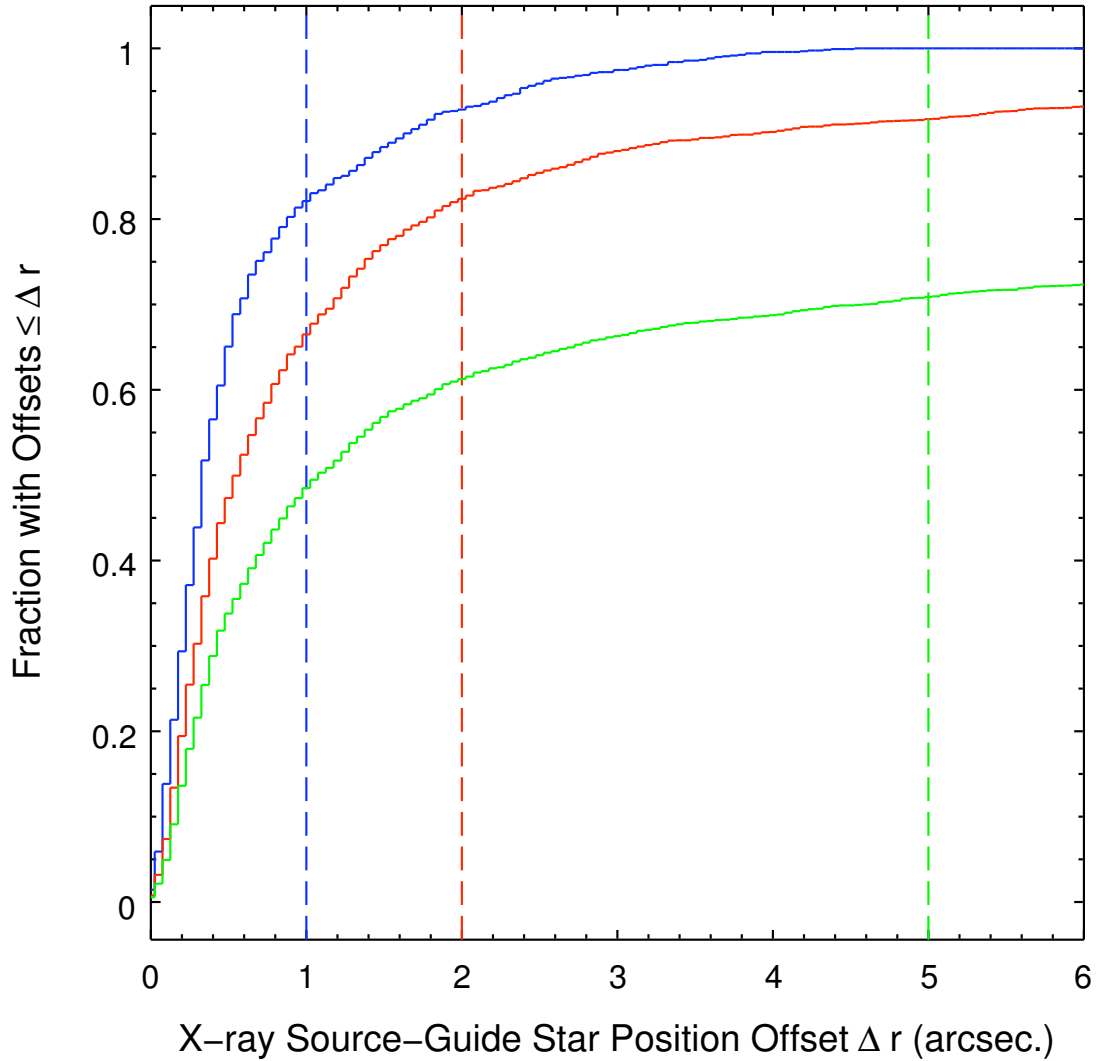


Fig. 3. Astrometric uncertainty derived from comparison of CSC and AXAF (*Chandra*) Guide and Acquisition Star Catalog (AGASC) source positions. CSC and AGASC sources are considered to match if their positional offsets are less than 5 times the CSC position error. The cumulative distributions of offsets are displayed for 3 different subsets of CSC sources: sources with > 10 net ACIS “b” band counts and off-axis angle $\theta < 3'$ (blue), sources with > 30 net counts and $\theta < 10'$ (red), and sources with > 50 net counts and $\theta < 15'$ (green). Vertical dashed lines indicate 1σ catalog requirements for those sets.