CYGNUS-X IRAC Data Description: Data Processed by the Wisconsin IRAC pipeline

CYGNUS-X: A Spitzer Legacy Survey of the Cygnus-X Complex

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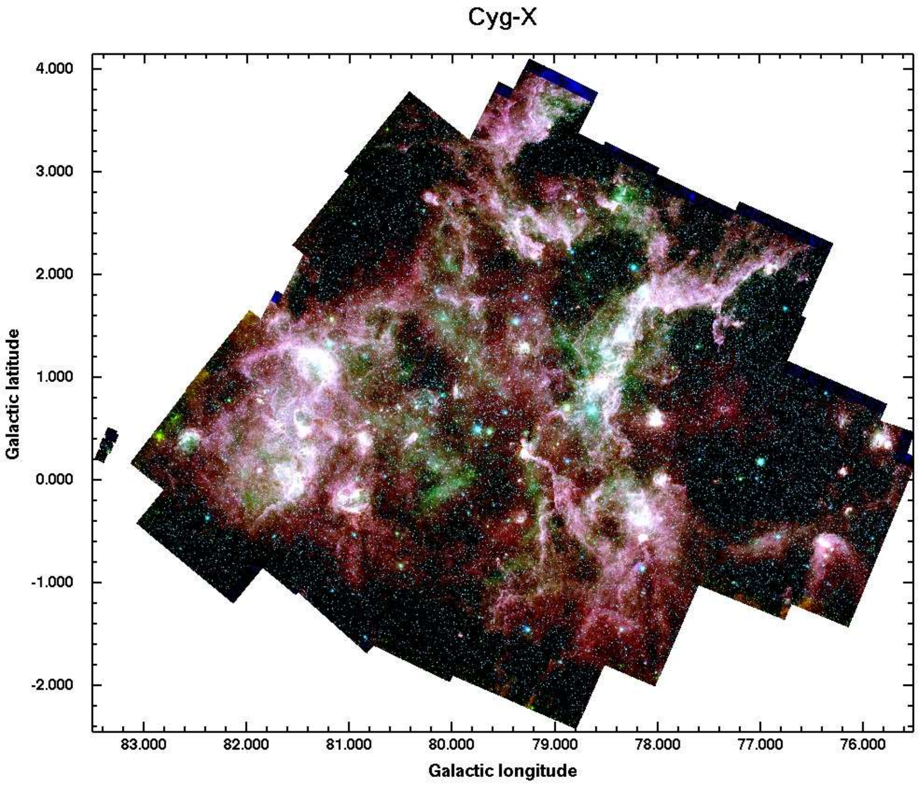

Contents

1 Quick Start

The Spitzer Legacy Survey of the Cygnus-X Complex (Cygnus-X; Hora et al. 2007, Kraemer et al. 2010, Beerer et al. 2010) mapped a 6°x6° area with IRAC & MIPS (l=76° to 82°, b=-2.3° to 4.1°) of the Cygnus-X region (see Figure 1). This region contains the richest known concentration of massive protostars and the largest OB associations in the nearest 2 kpc. More information on this project can be found at the Cygnus-X team web site (https://www.cfa.harvard.edu/cygnusX/). The Cygnus-X team delivered source lists and images to the Infrared Science Archive (IRSA) in 2011. Their data description document can be found at http://irsa.ipac.caltech.edu/data/SPITZER/Cygnus-X/docs/CygnusDataDelivery1.pdf. The Cygnus-X IRAC data have also been processed by the Wisconsin GLIMPSE IRAC pipeline. These Cygnus-X IRAC data products are available at IRSA. For those who are familiar with GLIMPSE pipeline-processed data, Cygnus-X data products are very similar. There are two types of source lists: a high reliability point source Catalog and a more complete point source Archive. The other main product is the set of mosaicked images. Cygnus-X is a Spitzer "Cryogenic (Cold) Mission" program, with data taken with IRAC's 3.6, 4.5, 5.8 & 8.0 μm channels. This Cygnus-X data release contains source lists (3,913,559 Catalog sources and 4,455,066 Archive sources) and mosaic images (with and without background matching and gradient correction) for the entire survey region. With this data delivery, all Cygnus-X Wisconsin GLIMPSE pipeline-processed enhanced IRAC data products have been delivered to IRSA.

Our source lists are a result of doing photometry on each IRAC frame, averaging all detections of a single band (in band-merge), then doing the merging of all wavelengths, including 2MASS J,H, and K_s, at a given position on the sky (cross-band merge).

We processed the Cygnus-X and SMOG data to provide consistency with our other GLIMPSE products. The Spitzer Galactic Plane surveys Cygnus-X, GLIMPSE, GLIMPSEII, GALCEN, GLIMPSE3D, Vela-Carina, SMOG, GLIMPSE360 and Deep GLIMPSE data products are available at the Infrared Science Archive (IRSA).

- irsa.ipac.caltech.edu/data/SPITZER/GLIMPSE/

2 Cygnus-X Survey and Data Products Overview

2.1 Project Overview

Cygnus-X is a Cryogenic Mission Spitzer Cycle 4 Program (PID 40184; PI= Joe Hora) that mapped 6 degrees of longitude of the Galactic plane that had not been mapped by other Spitzer Galactic Plane surveys (GLIMPSE, GLIMPSEII, GALCEN, GLIMPSE3D, Vela-Carina, GLIMPSE360, Deep GLIMPSE and SMOG; GLIMPSE360 and Deep GLIMPSE are Warm Spitzer surveys). The specific area covered by Cygnus-X is l=76° to 82°, b=-2.3° to 4.1° (see Figure 1).

Cygnus-X used the Spitzer Space Telescope (SST; Werner et al. 2004) Infrared Array Camera (IRAC) (Fazio et al. 2004) and the Multiband Imaging Photometer (MIPS) (Rieke et al. 2004). Cryogenic (Cold) Mission Spitzer has four IRAC bands, centered at approximately 3.6, 4.5, 5.8 & 8.0 μm. The MIPS instrument took data at 24, 70 & 160 μm. The IRAC observations consist of three visits on each sky position with 0.6 and 12 second frametime High Dynamic Range exposures providing a large dynamic range of sensitivity (see Table 1).

This differs from some of the previous GLIMPSE surveys which are 2-3 visit 2-sec frametime exposures, though is similar to GLIMPSE360, Deep GLIMPSE, and SMOG (see Table 2). The IRAC data were taken in three campaigns from November 2007 to November 2008. The MIPS data were taken in November-December 2007. The Wisconsin GLIMPSE IRAC pipeline produced enhanced IRAC data products in the form of a point source Catalog, a point source Archive, and mosaicked images for the Cygnus-X survey IRAC data. IRAC data processed by SSC pipeline S16.1, S18.1 and S18.5 were used to make the data products. See Benjamin et al. (2003), Churchwell et al. (2009) and the GLIMPSE web site (www.astro.wisc.edu/glimpse/) for more description of the GLIMPSE projects. See the Cygnus-X website[1] and http://irsa.ipac.caltech.edu/data/SPITZER/Cygnus-X/docs/CygnusDataDelivery1.pdf for more information on their data delivery.

This document describes the Wisconsin pipeline-processed IRAC data products from the Cygnus-X survey. The organization of this document is as follows: §2 gives an overview of the Cygnus-X survey, and data products, §3 describes the data processing; §4 discusses the quality checks and validation of the source lists; §5 provides a detailed description of the data products; and §6 describes the format. Appendix A gives details about the Source Quality Flag. This document contains numerous acronyms, a glossary of which is given at the end.

[1] www.cfa.harvard.edu/cygnusX/data.html

Table 1. Cygnus-X Sensitivity Limits in magnitudes[a],[b]

Source List	3.6 μm Lower	3.6 μm Upper	4.5 μm Lower	4.5 μm Upper	5.8 μm Lower	5.8 μm Upper	8.0 μm Lower	8.0 μm Upper
Archive	17.13	6.0	16.76	5.5	14.38	3.0	13.57	3.0
Catalog	17.08	6.0	16.63	5.5	14.25	3.0	13.12	3.0

[a] Based on 3 visits of 0.6 & 12 second HDR frames, photometry done on individual frames

[b]The IRAC faint limit is defined as the point where 99% of the IRAC sources (with a non-NULL entry for that IRAC band) are brighter than that quoted faint limit.

Table 2. Cygnus-X and Similar Spitzer Galactic Plane Surveys

Survey	Coverage	Approx. Area	Instrument/Bands	Exp. Time	Reference
Cygnus-X	l= 76°– 82°; b = -2.3°– +4.1°[a]	24 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	3 × 10.4 s	Hora et al. (2007)
GLIMPSE I	10°< $\|l\|$ <65°; $\|b\|$ < 1°	220 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	2 × 1.2 s	Churchwell et al. (2009)
GLIMPSE II	$\|l\|$ < 10°; $\|b\|$ <1.5° [a]	54 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	3 × 1.2 s[b]	Churchwell et al. (2009)
GLIMPSE 3D	< $\|l\|$ < 31°;$\|b\|$ > 1°[a]	120 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	3(2) × 1.2 s[c]	Churchwell et al. (2009)
Vela-Carina	l=255°– 295°; b ≈ -1.5°– +1.5°[a]	86 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	2 × 1.2 s	Zasowski et al. (2009)
GLIMPSE 360	l=65°– 76°,82°– 102°,109°–265° $\|b\|$ < 3°[a]	511 sq. deg.	IRAC [3.6],[4.5]	3 × 10.4 s	Whitney et al. (2008)
Deep GLIMPSE	l = 265°–350°, b°=-2°– +0.1° l = 25°–65°, b= 0°– +2.7°	208 sq. deg.	IRAC [3.6],[4.5]	3 × 10.4 s	Whitney et al. (2011)
SMOG	l=102°– 109°; b= 0°– 3°	21 sq. deg.	IRAC [3.6],[4.5],[5.8],[8.0]	4 × 10.4 s	Carey et al. (2008)

[a]Irregular region; see survey documentation for details. [b]GLIMPSE II data products include the *Spitzer* Galactic Center survey (S. Stolovy; PID=3677) which has five visits. [c]Some portions of GLIMPSE 3D use two visits and others have three.

2.2 IRAC Data Products Overview

The Wisconsin pipeline-processed Cygnus-X IRAC enhanced data products consist of a highly reliable Point Source Catalog (CYGXC), a more complete Point Source Archive (CYGXA), and mosaic images covering the survey area. The enhanced data products are:

1. The Cygnus-X Catalog (CYGXC, or the "Catalog") consists of the highest reliability point sources. See §3.4 for a discussion of the Catalog criteria. Figure 2 shows the number of Cygnus-X Catalog sources as a function of magnitude for the four IRAC bands. For each IRAC band the Catalog provides fluxes (with uncertainties), positions (with uncertainties), the areal density of local point sources, the local sky brightness, and a flag that provides information on source quality and known anomalies present in the data. Sources were bandmerged with the Two Micron All Sky Survey Point Source Catalog (2MASS; Skrutskie et al. 2006). 2MASS provides images at similar resolution to IRAC, in the J (1.25 μm), H (1.65 μm), and K_s (2.17 μm) bands. For each source with a 2MASS counterpart, the CYGXC also includes the 2MASS designation, counter (a unique identification number), fluxes, signal-to-noise, and a modified source quality flag. For some applications, users will want to refer back to the 2MASS Point Source Catalog for a more complete listing of source information. The Cygnus-X Catalog format is ASCII, using the IPAC Tables convention (irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html).

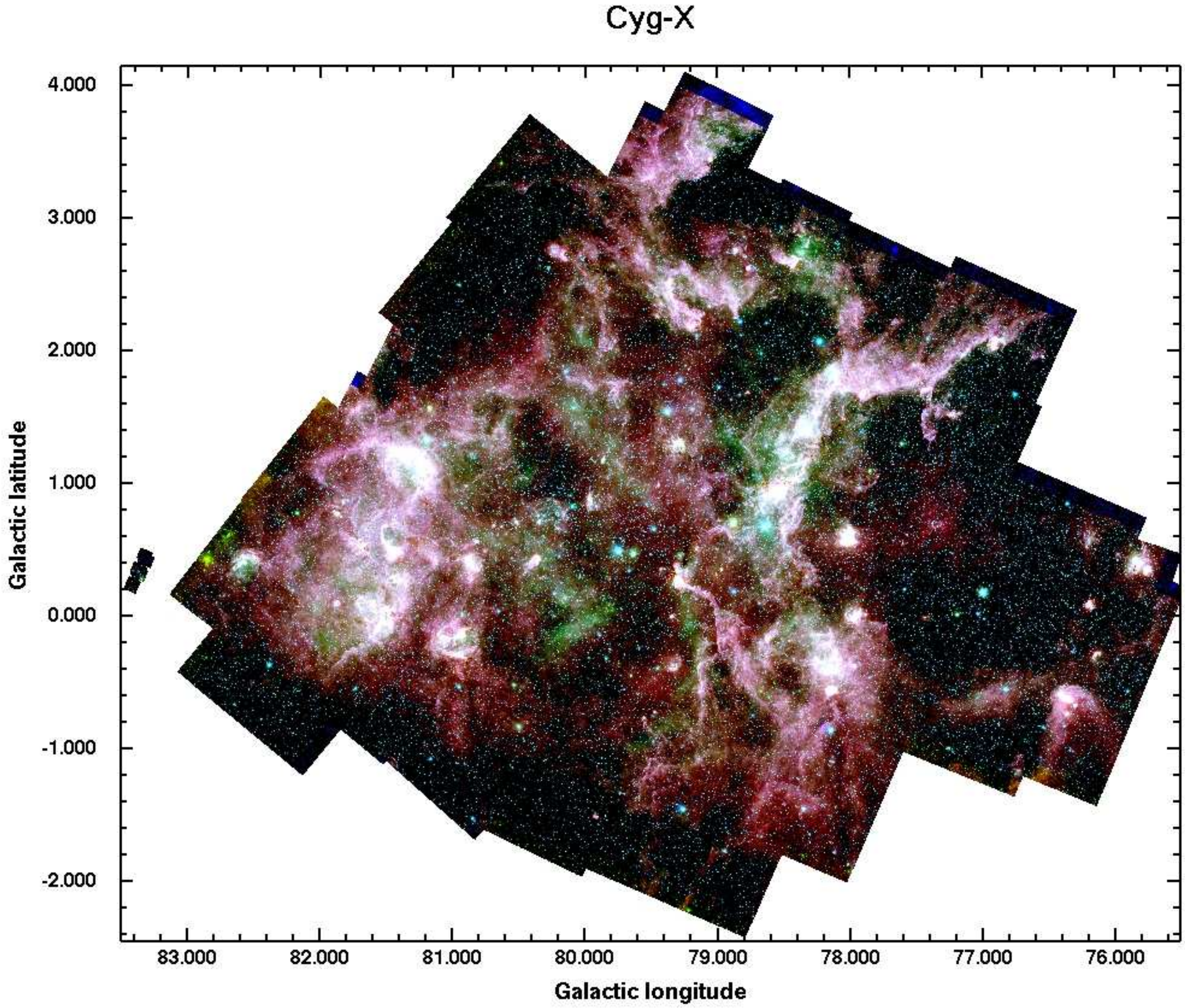

Figure 1: The area observed by the Cygnus-X survey with the IRAC instrument. This is a 3-color image ([3.6], [4.5] and [8.0] in blue, green, and red respectively) of the survey region. Wisconsin GLIMPSE pipeline processed IRAC source lists and enhanced images for the entire survey area have been delivered to IRSA.

2. The Cygnus-X Archive (CYGXA or the "Archive") consists of point sources with less stringent selection critera than the Catalog (§3.4). The information provided is in the same format as the Catalog. The number of Archive sources as a function of magnitude for each IRAC band is shown in Figure 2. The Catalog is a subset of the Archive, but the entries for a particular source might not be the same due to additional nulling of magnitudes in the Catalog because of the more stringent requirements (§3.4).

3. The Cygnus-X Image Atlas comprises mosaicked images for each band, each covering e.g. $3.1^\circ\times3.9^\circ$ with $1.2''$ pixels. These are 32-bit IEEE floating point single extension FITS formatted images covering the survey area. These images are in units of surface brightness MJy/sr. Mosaics of each band are also made for smaller e.g. $1.1^\circ\times2.2^\circ$ areas, with a pixel

size of 0.6″ . The 1.2″ pixel mosaics are provided with and without background matching and gradient correction. The background matching and gradient correction process (§3.1) may be removing real sky variations so we provide these images *in addition* to the images that do not have the background matching. Also included are quicklook 3-color jpeg images (IRAC [3.6], IRAC [4.5] and IRAC [8.0]) of the same size as the FITS images.

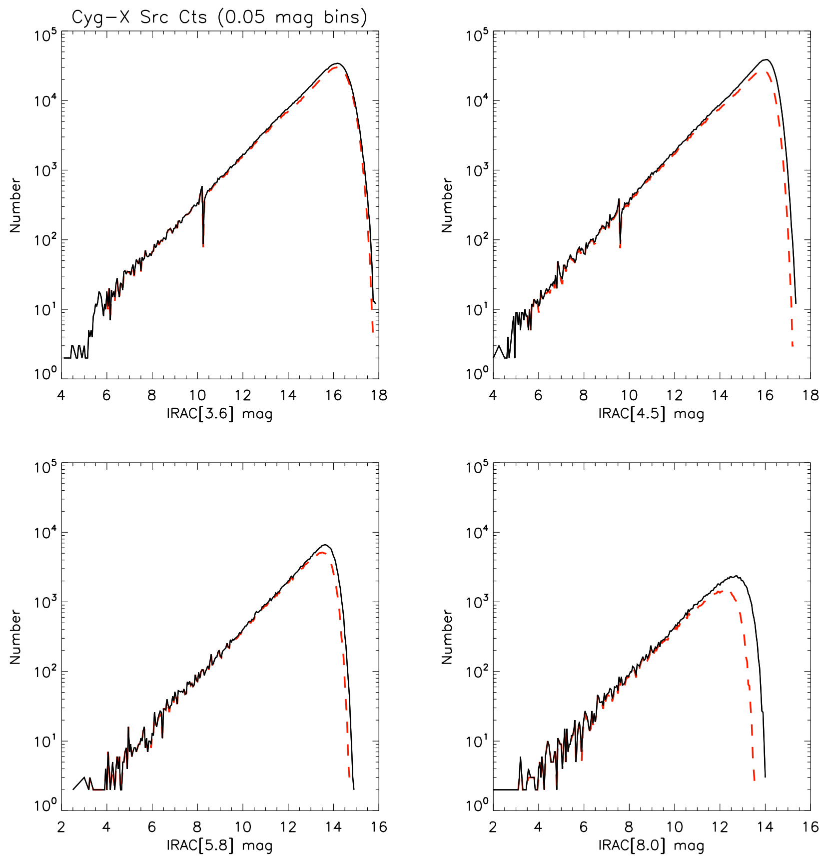

Figure 2: Cygnus-X Catalog and Archive source counts versus magnitude for IRAC [3.6], [4.5], [5.8] & [8.0]. The dashed red lines are the Catalog; the black solid lines are the Archive. All the Cygnus-X data are included. The glitch in the [3.6] plot at 10.25 and the [4.5] plot at 9.6 are at the boundary where either the 0.6 sec FT data or the 12 sec FT data are used for photometry (see §3.3).

3 Pipeline Processing

3.1 Image Processing

Image processing steps for photometry include masking hot, dead, and missing data pixels (using SSC supplied flags). Pixels associated with saturated stars are masked using an algorithm generated by GLIMPSE; this algorithm finds most of the saturated stars. Pixels within a PSF-shaped region (with a 24-pixel radius) of a saturated source are flagged. Several image artifacts (described in Hora et al (2004) and the IRAC Data Handbook[2]) are corrected for in the Wisconsin GLIMPSE pipeline. A description of the Spitzer Cold Mission IRAC image features is found at irsa.ipac.caltech.edu/data/SPITZER/docs/irac/features/. We correct for column pulldown[3] in bands [3.6] & [4.5], using an algorithm written by Lexi Moustakas (GOODS team) and modified by GLIMPSE to handle variable backgrounds. We correct for muxbleed[4] in bands [3.6] & [4.5] using a modified version of the IRAC Bright Source Artifact Corrector[5]. We correct for banding[6] in band [5.8] by using an algorithm fitting each incidence of banding individually and band [8.0] using an exponential function.

Image processing for the mosaic image products include the column pulldown, muxbleed and banding corrections mentioned above. Hot, dead, and missing pixels are masked. Outlier masking (e.g. cosmic rays, stray light from bright sources outside the field of view; rmask) was done using IRACproc (Schuster et al 2006). The instrument artifacts found by visual inspection of the higher resolution $0.6''$ mosaics were removed. Latent images from bright sources are removed when possible. If there are areas of overlapping image artifacts that cause a gap in coverage, we do not mask that area. Latent images can repeat (particularly along rows and columns) and remain in the images because masking them would cause gaps in coverage. See SSC's IRAC image features web sites[7], and the IRAC Data Handbook for more information about the detector artifacts. We used the Montage[8] package v3.0 to mosaic and project to Galactic coordinates.

We match instrumental background variations between the IRAC frames using Montage's level background correction algorithm[9]. Instrument artifacts such as full array pull-up, frame pull-down and offsets between AORs are mostly removed from the images. Offsets between AORs and full array pull-ups have been mitigated. In the background matching process, Montage introduces unwanted large-scale gradients. Our gradient correction algorithm finds the large-scale gradients by taking the corrections table produced by Montage and creating a smoothed version to eliminate small-scale corrections. This is done by using a Radial Basis Function interpolation with a smoothing factor of 1000. We then find the difference between the corrections and the smoothed corrections, find the standard deviation of this difference, then reject all points which deviate by more than 5 sigma. A new smoothed correction map is computed and the process is repeated until no points are rejected (typically 10 iterations). Once this is complete, a final correction map is computed and removed from the image, thus undoing the large-scale gradients introduced by Montage. The background matching and gradient correction may be removing real sky variations so we provide these images *in addition* to the images that do not have the background matching.

[2]irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook

[3]Column pulldown is a reduction in intensity of the columns in which bright sources are found in bands [3.6] and [4.5]. See the *Spitzer* Observers Manual (SOM) at ssc.spitzer.caltech.edu/documents/som/.

[4]The multiplexer bleed effect is a series of bright pixels along the horizontal direction on both sides of a bright source in Bands [3.6] and [4.5]

[5]http://spider.ipac.caltech.edu/staff/carey/irac_artifacts

[6]Banding refers to streaks that appear in the rows and columns radiating away from bright sources in Bands [5.8] and [8.0]. See the SOM.

[7]irsa.ipac.caltech.edu/data/SPITZER/docs/irac/features/

[8]montage.ipac.caltech.edu/;Montage is funded by the National Aeronautics and Space Administration's Earth Science Technology Office, Computation Technologies Project, under Cooperative Agreement Number NCC5-626 between NASA and the California Institute of Technology. Montage is maintained by the NASA/IPAC Infrared Science Archive.

[9]montage.ipac.caltech.edu/docs/algorithms.html#background

3.2 Photometry

We use a modified version of DAOPHOT (Stetson 1987) as our point source extractor, performing Point Spread Function (PSF) fitting on individual IRAC frames. We repeat the photometry calculations on the residual (point-source removed) images (referred to as "tweaking" in Table 5), which has been shown to substantially improve the flux estimates in complex background regions. More details about the photometry steps can be found at
www.astro.wisc.edu/glimpse/glimpse_photometry_v1.0.pdf. The cold mission array-location-dependent photometric corrections[10] were applied to the source lists.

3.3 Bandmerging to Produce Source Lists

The point source lists are merged at two stages using a modified version of the SSC bandmerger[11]. Before the first stage, source detections with signal-to-noise (S/N) less than 3 are culled. During the first stage, or in-band merge, all detections at a single wavelength are combined using position, S/N and flux to match the sources. The 0.6 second flux is included if the signal-to-noise is greater than (5,5,5,7) and the magnitudes are brighter than (10.25, 9.6, 9.0, 9.0), for the four IRAC bands [3.6], [4.5], [5.8], and [8.0], respectively. This prevents Malmquist bias for the 0.6 second data from affecting the results. The 12 second flux is included if the magnitude is fainter than (10.25, 9.6, 6.5, 6.5) for the IRAC bands [3.6], [4.5] [5.8], and [8.0] respectively. For [5.8] and [8.0] if both criteria are met, the 0.6 and 12 second fluxes are combined, weighted by the propagated errors. Fluxes of sources within $1.''6$ in the IRAC frame are combined together or "lumped" into one flux.

The second stage, or cross-band merge, combines all wavelengths for a given source position using only position as a criterion in order to avoid source color effects. Cross-band lumping is done with a $1.''6$ radius. Position migration can still occur in the bandmerging process which results in a small number of sources that are within $1.''6$ of another source. In the cross-band merge stage we also merge with the All-Sky 2MASS (Skrutskie et al 2006) point source list. Note that we only propagate a subset of the 2MASS quality flags and information, and users should refer to the original 2MASS catalog available through IRSA for full information. We include the unique numeric identifier assigned by the 2MASS project "cntr" (tmasscntr in the Cygnus-X source lists) to allow this cross-referencing.

3.4 Source Selection for Catalog and Archive

Now we describe the selection criteria for the Catalog and Archive once photometry and bandmerging have been completed. These criteria were established to produce high reliability single frame photometry where the abundance of cosmic rays can contribute to false sources.

The Catalog is a more reliable list of sources, and the Archive is a more complete list both in number of sources and flux measurements at each wavelength (less nulling of fluxes). The main differences between the Catalog and Archive are 1) fluxes brighter than a threshold that marks a nonlinear regime are nulled (removed) in the Catalog; 2) sources within $2.0''$ of another are culled (removed) from the Catalog, whereas the Archive allows sources as close as $0.''5$ from another; 3) sources within the PSF profile of a saturated source are culled from the Catalog but not the Archive; and 4) the Catalog has higher signal-to-noise thresholds and slightly more stringent acceptance criteria (e.g.,

[10]http://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/calibrationfiles/locationcolor/
[11]ssc.spitzer.caltech.edu/dataanalysistools/tools/bandmerge/

number of detections in various bands) . Users who want a more "bullet-proof" list and don't want to have to get as familiar with the source quality flags, or who will be doing the kind of analysis that does not allow for manual inspection of very many source Spectral Energy Distributions (SEDs), should use the Catalog. Users who want more complete SEDs and source lists, and are willing to invest time to understand the source quality flags, can make use of the Archive. This allows the use of lower limits for fluxes that are nearly saturated, more data points at lower signal-to-noise, more sources in crowded regions, and more sources in the wings of saturated sources. Using the source quality flag, these sources can be identified and should be more carefully inspected to verify their quality. Both Archive and Catalog users can improve the quality of their data by paying attention to the source quality flag (§5.1.6 and Appendix A), as well as other diagnostic information such as the close source flag (see §5.1.6).

Our source list criteria have been developed to ensure that each source is a legitimate astronomical source (*culling* criteria) and that the fluxes reported for the IRAC bands are of high quality (*nulling* fluxes if they do not meet quality standards).

3.4.1 Culling Criteria - is it a real source?

The IRAC source lists were produced from photometry on individual BCD frames. The 12 second exposures suffer from cosmic rays. For this reason, stringent selection criteria were developed to limit false sources. To ensure high reliability of the final point-source Catalog (CYGXC) by minimizing the number of false sources, we adopt the following selection criteria: Given M detections out of N possible observations (see §5.1.5), we require that $M/N \geq 0.6$ in one band (the selection band), and $M/N \geq 0.32$ in an adjacent band (the confirming band), with a $S/N > 5, 5, 5, 7$ for IRAC bands [3.6], [4.5], [5.8] and [8.0], respectively. The 2MASS K_s band is counted as a detection. As an example, a source is typically observed three times at 0.6 second frametime and three times at 12 second frametime for a total of six possible observations in each band. Such a source detected four times in band [3.6] with $S/N > 5$, and three times in band [4.5] with $S/N > 5$ would be included in both the Catalog and Archive. For a typical source, extracted from 3×12 sec frametime images, the minimum detection criterion ($M/N \geq 0.32$) amounts to being detected twice in one band and once in an adjacent band. Thus, we sometimes refer to this as the 2+1 criterion. In our source selection process, we don't allow fluxes in bands with hot or dead pixels within 3 pixels of source center, those in wings of saturated stars, and/or those within 3 pixels of the frame edge. Sources are also culled when they are too close to another source because this neighboring source could influence the flux for the source: We use the Archive list to search for near neighbors, and cull from the Catalog sources within $2''$

For the Archive (CYGXA), the culling criteria are less stringent. The M/N and S/N criteria are the same as for the Catalog to limit false sources caused by cosmic rays. The close source criteria is relaxed: Sources are removed from the Archive if there are neighboring Archive sources within $0''.5$ of the source.

3.4.2 Nulling Criteria - ensuring high quality fluxes

To ensure high quality fluxes for each source, a flux/magnitude entry for a band in the *Catalog* will be nulled, i.e. removed, for any of the four following reasons: 1) the source is brighter than the 0.6 sec. saturation magnitude limits, 6.0, 5.5, 3.0, 3.0 for IRAC bands [3.6], [4.5], [5.8] and [8.0], respectively; 2) the source location is flagged as coincident with a bad pixel; 3) the S/N is less than 6, 6, 6, 10 for IRAC bands [3.6], [4.5], [5.8] and [8.0], respectively in order to mitigate Malmquist bias; 4) for 12-second only data, if $M < 2$ or M/N is less than 0.6 in order to mitigate faint cosmic ray detections. If all fluxes for a source are nulled, the source is removed from the Catalog.

For the *Archive*, the nulling criteria are less stringent. The magnitude is nulled if the S/N is less than 5 in that band. For photometry with 12 second only data, if $M/N < 0.3$ the magnitude is nulled.

The actual null values for the fields in the entry for a source are given in Table 7.

Since the selection (or culling) criteria are fairly similar between the Catalog and Archive, the total number of sources is not that different. However, the Catalog sources have more fluxes nulled.

4 Quality Checks and Source List Validation

We summarize here analysis used to validate the Catalog and Archive point source lists. Additional information can be found in documents at www.astro.wisc.edu/glimpse/docs.html. A study of completeness in all the GLIMPSEs point source lists can be found in Kobulnicky et al. 2013.

4.1 Astrometric Accuracy

Sources bright enough to have 2MASS associations are typically within 0.3″ of the corresponding 2MASS position, as discussed in §5.1.3. Figure 3 shows a comparison of Cygnus-X source positions to the 2MASS PSC positions, in 0.02″ bins. The peak of the plot is at 0.1″ and the majority of the sources have positional differences less than 0.3″ , similar to previous GLIMPSE source lists. Fainter Cygnus-X sources are likely to have larger uncertainties due to poorer centroiding.

4.2 Precision and Accuracy of the Photometry

Figure 4 shows the photometric uncertainty for the entire Cygnus-X survey region. For all bands, there is a jump in uncertainties at the brighter magnitudes which shows the boundary between the 0.6 and 12 sec frametime photometry (with shorter exposures having larger uncertainties).

The reliability of the flux uncertainities was studied by comparing the quoted error (dFi) with the root mean square (RMS) of the measurements (Fi_rms) for thousands of sources in a given flux range; if a large fraction of the sources have intrinsic variability, this method will produce an upper limit to the uncertainties. The DAOPHOT output uncertainties include a PSF fitting component, photon noise, read noise, and goodness of flat fielding; the strength of each component is not perfectly determined. Based on our comparison to the RMS of the measurements, we have decreased our photometry uncertainties produced by DAOPHOT by 5% in the [3.6] band, 35% in the [4.5] band and increased the uncertainties 5% in the [5.8] band and 35% in the [8.0] band.

Flux calibrators were supplied by Martin Cohen (Cohen et al. 2003) for many of the GLIMPSE projects. However, there were no flux calibrators in the Cygnus-X region. We do provide comparison of fluxes from the overlap region between Cygnus-X and GLIMPSE360 (see Figure 7). The mean difference between Cygnus-X [3.6] and GLIMPSE360 around l=76°and l=82° is typically about 0.02 mag or smaller. The IRAC [4.5] agreement is better than 0.01 mag.

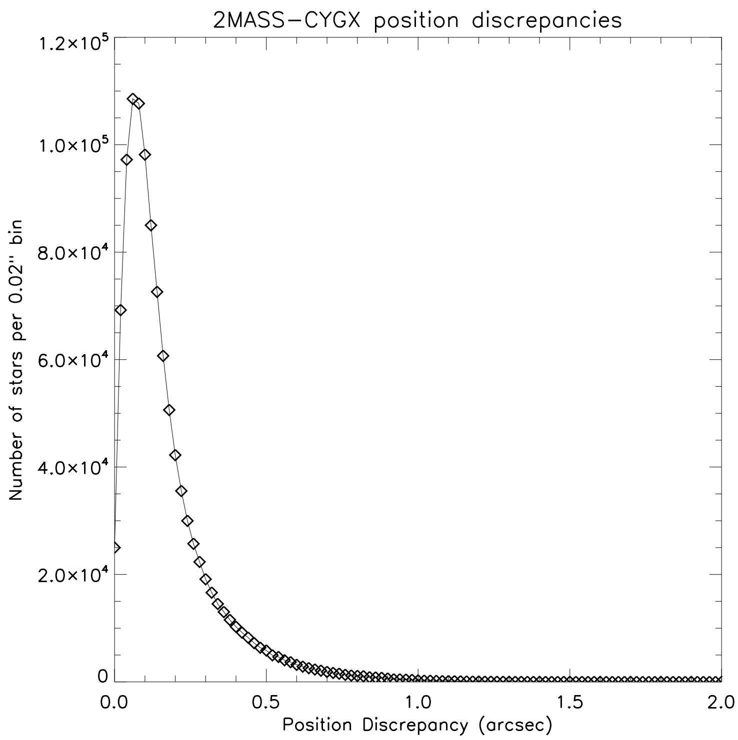

Figure 3: Comparison of Cygnus-X source positions to their corresponding 2MASS PSC positions. The astrometric discrepancy plotted is the angular separation in arcseconds between the Cygnus-X position and the 2MASS position. Note that sources with 2MASS associates have Cygnus-X positions that are in part derived from the 2MASS position. Thus this is not a comparison of a pure IRAC-only position with the 2MASS position.

For a comparison of photometry between the different GLIMPSE projects (Cold & Warm Missions; 2 sec FT & HDR mode), see the Deep GLIMPSE Document §5 (http://www.astro.wisc.edu/glimpse/deepglimpse_dataprod_v1.3.pdf). The stability of the Cygnus-X photometry is based on the l=76°and l=82° area of GLIMPSE360 overlap.

4.3 Color-Color and Color-Magnitude Plots

Color-color and color-magnitude plots were made of the Catalog and Archive files (in approximately 2°× 6° regions). An example set of color-color and color-magnitude plots is shown in Figures 5 & 6, respectively. The color-color plots generally show a peak near 0 color due to main sequence and giant stars. The outliers in Figure 5 (the points) comprise 0.4% of the sources. Sources with these unusual colors usually either have intrinsic color variations due to e.g., dust scattering or emission; or have poor flux extractions. The color-magnitude plots can be used to show the limiting magnitudes where the flux uncertainties become large and the colors begin to show large deviations. This is not significant in Figure 6 which demonstrates that our fluxes are accurate at the faint end. Postscript files of the color-color and color-magnitude plots for source lists for each set of 2 degrees of longitude in the Cygnus-X survey are available from the GLIMPSE Cygnus-X web site (www.astro.wisc.edu/glimpse/cygx/ColorColor/ and www.astro.wisc.edu/glimpse/cygx/ColorMag/).

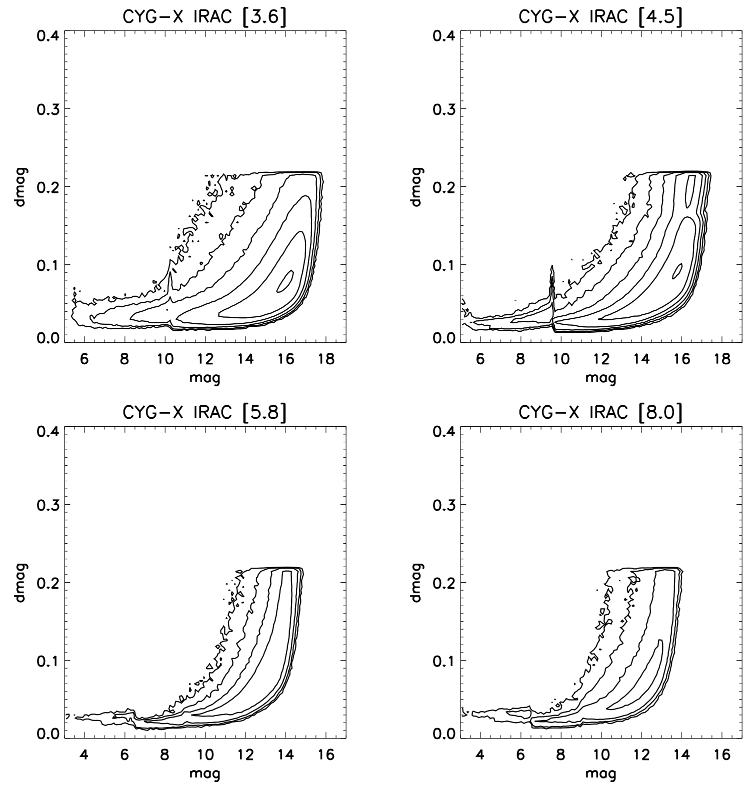

Figure 4: Magnitude uncertainty vs. magnitude for each IRAC band included in the Cygnus-X Archive for the entire survey area. Contours show the density of sources. The lack of data above dmag of 0.22 is caused by the criterion that Archive data have signal to noise ratios of 5 or better. The "bump" at [3.6]=10.25 and [4.5]=9.6 is the boundary where the 0.6 sec frametime data are used for brighter sources and the 12 sec frametime data are used for fainter sources. For bands [5.8] and [8.0], the bump is at 6.5 mag and a very small bump at 9.0 mag.

4.4 Comparison of source lists produced by the Wisconsin GLIMPSE IRAC pipeline with the Cygnus-X Legacy team source lists

The Cygnus-X Legacy team (Hora et al. 2007) delivered source lists and images to IRSA in 2011. Their data description document is http://irsa.ipac.caltech.edu/data/SPITZER/Cygnus-X/docs/CygnusDataDelivery1.pdf. The project website is https://www.cfa.harvard.edu/cygnusX/. Table 3 shows the number of sources found from the Legacy team processed and the GLIMPSE processed Cygnus-X data. Also shown is the number of GLIMPSE-processed Cygnus-X Archive sources matched to the Legacy team Archive. The results from these matched sources were used in Figure 7.

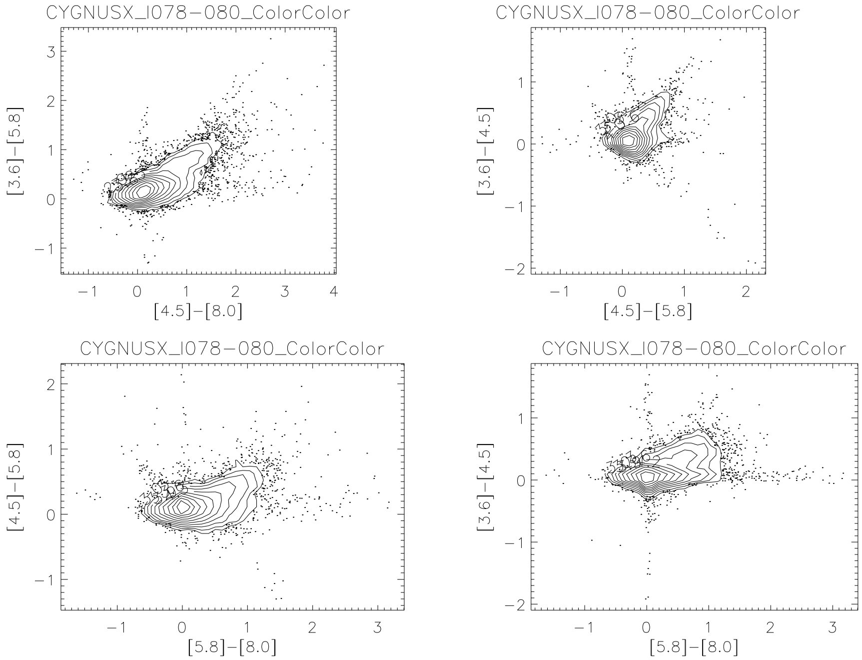

Figure 5: Color-color plot of the region $l = 78^{\circ}{-}80^{\circ}$ for sources in the Cygnus-X Archive. 10 contours are evenly spaced between log(# sources/mag^2)=2.0 and the log of maximum number of sources per square magnitude. The contours are labeled with the log of the number of sources per square magnitude. Outside of the lowest contour, the positions of individual sources are plotted.

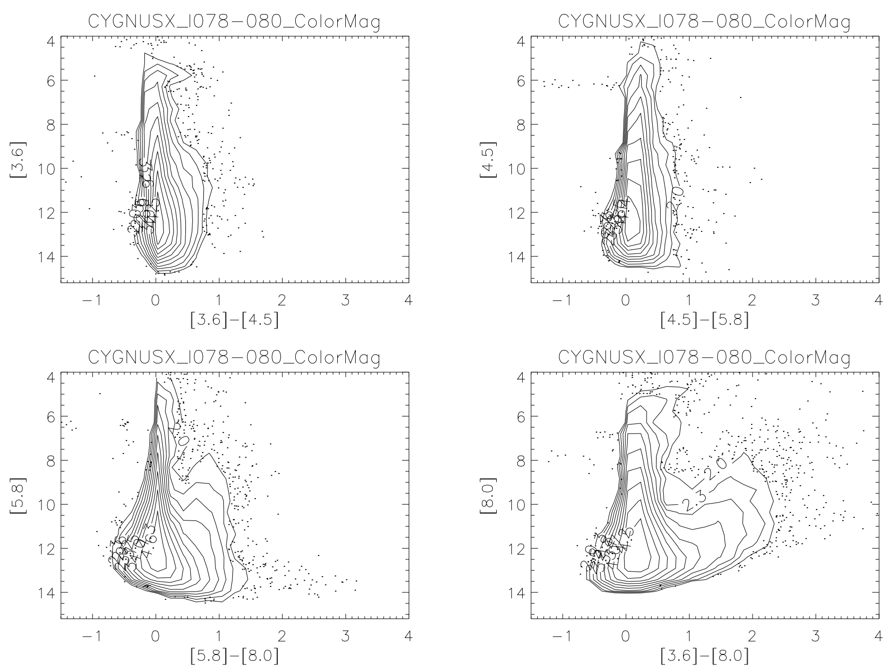

Figure 6: Same as Figure 5 except that these are Color-magnitude plots.

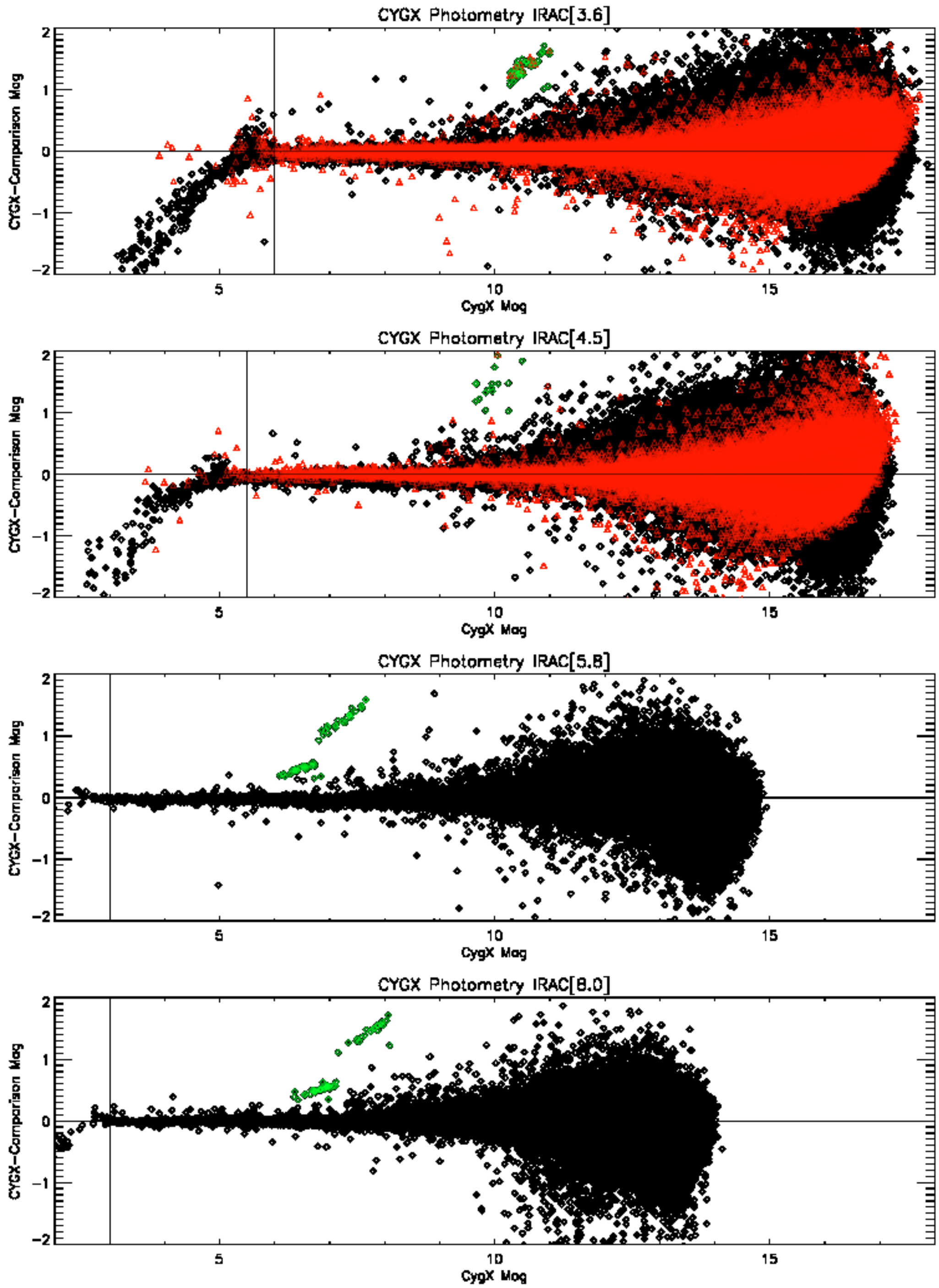

Figure 7: The comparison of Cygnus-X Archive fluxes produced by the Wisconsin GLIMPSE IRAC (GLM) pipeline with the Cygnus-X legacy team source lists as well as GLIMPSE360 fluxes. Data in black diamonds are the comparison with the Legacy Cygnus-X values for all 4 IRAC bands. Red triangles are the comparison with the GLIMPSE360 survey which contains only IRAC [3.6] and [4.5] data (warm mission data). The vertical lines at 6.0, 5.5, 3.0 and 3.0 are the saturation limits for the 0.6 sec HDR mode data for IRAC bands 3.6, 4.5, 5.8, and 8.0 μm respectively. The mean difference, GLM Cygnus-X - Legacy Cygnus-X, as a function of magnitude is about -0.05 mag for [3.6] and [4.5] and for [5.8] and [8.0] it is between about -0.02 and -0.04 mag. For GLM Cygnus-X - GLIMPSE360, the mean difference is about -0.02 mag for [3.6] and 0.0 mag for [4.5]). See the text for more details.

Table 3. Comparison of Source Counts in the Cygnus-X Catalog and Archive

Legacy Cygnus-X Source List	Total Sources	3.6 μm Sources	4.5 μm Sources	5.8 μm Sources	8.0 μm Sources
Catalog	2,894,385	2,756,953	2,762,950	822,744	462,065
Archive	3,521,905	3,263,725	3,036,121	823,344	463,305
GLIMPSE Cygnus-X Source List					
Catalog	3,913,559	3,782,516	3,200,334	619,305	208,999
Archive	4,455,066	4,335,931	4,254,423	751,313	325,446
Matched Sources					
Archive		2,947,817	2,774,164	677,493	309,494

Figure 7 shows the Wisconsin GLIMPSE pipeline-processed Cygnus-X Archive magnitudes versus both the Legacy project Cygnus-X values as well as a comparison of sources which overlap with the warm mission GLIMPSE360 project. Data in black diamonds are the comparison with the Legacy Cygnus-X values for all 4 IRAC bands. Red triangles are the comparison with the GLIMPSE360 survey (around l=76°and l=82°) which contains only IRAC [3.6] and [4.5] data. The vertical lines at 6.0, 5.5, 3.0 and 3.0 are the saturation limits for the 0.6 sec HDR mode data for IRAC bands 3.6, 4.5, 5.8, and 8.0 μm respectively. Data brighter than these values are subject to saturation effects and photometry for these sources are unreliable. These sources are included in the GLIMPSE Archive for source completeness but photometry should be treated as suspect. Additionally there is a small subset of GLIMPSE-processed source photometry (green data points) that are likely outside of their quoted uncertainties due to the transition between HDR mode data of 0.6 second and 12 second exposures (see §3.3). These sources (with 'method flag' values of 192 and 195; see §5.1.6) have the situation where the 12 second exposure data was extracted resulting in a magnitude faint enough not to be classified as affected by saturation. However from the comparison with Cygnus-X legacy values the source most likely suffered non-linearity effects. The number of sources suffering this effect is small, typically about 50 per IRAC band (out of over 3 million sources). For IRAC [3.6] these sources are roughly at mag=10.25 and for IRAC [4.5] at mag=9.6. For IRAC [5.8] and [8.0] the affected sources occur at two locations: mag=6.5 and roughly 7.0. For these two bands the dual locations are caused by either the source only being extracted in 12 sec data, or in both 12 and 0.6 second data and then being co-added.

The agreement between GLIMPSE pipeline-processed Cygnus-X fluxes and these two different projects is good, and typically to within combined uncertainties of the two comparison datasets. Small systematic offsets are seen, but the values are typically less than 0.05 mags in all 4 bands (GLM Cygnus-X - Legacy Cygnus-X: -0.05 mag for IRAC [3.6] and [4.5] and about -0.02 mag to -0.04 mag for [5.8] and [8.0]. For GLM Cygnus-X - GLIMPSE360, the results are -0.02 mag for [3.6] and 0.0 mag for [4.5]).

4.5 Other checks

Spot checks include inspection of residual images to verify proper point source extraction; overplotting the positions of the sources in the Catalogs and Archives on mosaic images; and plotting Spectral Energy Distributions (SEDs) of several sources. In addition to these and other tests described in previous documents, our source lists have been extensively tested by users analyzing the data on evolved stars, YSOs, and other sources throughout the Galaxy and the Magellanic Clouds (GLIMPSE, SAGE-LMC, SAGE-SMC).

5 Data Products Description

5.1 Catalog and Archive Fields and Flags

Each entry in the Cygnus-X Catalog and Archive has the following information:

designation	SSTCYGXC GLLL.llll±BB.bbbb, SSTCYGXA GLLL.llll±BB.bbbb
2MASS PSC names	2MASS designation, 2MASS counter
position	l, b, dl, db, ra, dec, dra, ddec
flux	mag_i, dmag_i, F_i, dF_i, F_i_rms (IRAC)
	mag_t, dmag_t, F_t, dF_t (2MASS)
diagnostic	sky_i, SN_i, $\mathrm{srcdens}_i$, # detections M_i out of N_i possible (IRAC)
	SN_t (2MASS)
flags	Close Source Flag, Source Quality Flag (SQF_i), Flux Method Flag (MF_i) (IRAC)
	Source Quality Flag (SQF_t) (2MASS)

where i is the IRAC wavelength number (IRAC bands 3.6, 4.5, 5.8 and 8.0 μm) and t is the 2MASS wavelength band (J, H, K_s).

Details of the fields are as follows:

5.1.1 Designation

This is the object designation or "name" as specified by the IAU recommendations on source nomenclature. It is derived from the coordinates of the source, where G denotes Galactic coordinates, LLL.llll is the Galactic longitude in degrees, and ±BB.bbbb is the Galactic latitude in degrees. The coordinates are preceded by the acronym SSTCYGXC (Cygnus-X Catalog) or SSTCYGXA (Cygnus-X Archive).

5.1.2 2MASS PSC information

The 2MASS designation is the source designation for objects in the 2MASS All-Sky Release Point Source Catalog. It is a sexagesimal, equatorial position-based source name of the form hhmmssss±ddmmsss, where hhmmssss is the right ascension (J2000) coordinate of the source in hours, minutes and seconds, and ±ddmmsss is the declination (degrees, minutes, seconds). The 2MASS counter is a unique identification number for the 2MASS PSC source. See www.ipac.caltech.edu/2mass/releases/allsky/doc/sec2_2a.html for more information about these fields.

5.1.3 Position

The position is given in both Galactic (l, b) and equatorial (α, δ) J2000 coordinates, along with estimated uncertainties. The pointing accuracy is $1''$ (Werner et al. 2004). The SSC pipeline does pointing refinement[12] of the images based on comparison with the 2MASS Point Source Catalog, whose absolute accuracy is typically $< 0.2''$ (Cutri et al. 2005). After applying the SSC geometric distortion corrections and updating to the 2MASS positions, the GLIMPSE point source accuracy

[12] irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/50/#_Toc296497447

is typically $\sim 0.3''$ absolute accuracy, limited by undersampling of the point-spread function. The position uncertainties are calculated by the bandmerger based on the uncertainties of individual detections, propagated through the calculation of the weighted mean position. Sources with 2MASS associates have positions in part derived from the 2MASS position.

5.1.4 Flux

For each IRAC band i = 3.6, 4.5, 5.8, and 8.0 μm and, when available 2MASS band t = J, H, and K_s, the fluxes are expressed in magnitudes (mag_i, mag_t) and in mJy (F_i, F_t). Each IRAC flux is the error-weighted average of all independent detections of a source. The 2MASS magnitudes and uncertainties are from the 2MASS All-Sky Release Point Source Catalog. They are the j_m, j_msigcom, h_m, h_msigcom, and k_m, k_msigcom columns from the 2MASS PSC. The zeropoints for converting from flux to magnitude are from Reach et al (2005) for the IRAC bands and Cohen et al. 2003 for 2MASS and given in Table 4.

Table 4. Zeropoints for Flux to Magnitude Conversion

Band	J	H	K_s	[3.6]	[4.5]	[5.8]	[8.0]
Zeropoints (Jy)	1594	1024	666.7	280.9	179.7	115.0	64.13

The IRAC flux/magnitude uncertainties (dF_i; $dmag_i$) are computed during the photometry stage and take into account photon noise, readnoise, goodness of flat fielding, and PSF fitting (Stetson 1987).

The rms deviation (F_i_rms) of the individual detections from the final flux of each source is provided. The F_rms is calculated as follows: F_rms=$\sqrt{\sum (F_j - <F>)^2/M}$ where j is an individual IRAC frame, $<F>$ is the average Flux, and M is the number of detections.

5.1.5 Diagnostics

The associated flux diagnostics are a local background level (sky_i) (i = 3.6, 4.5, 5.8, and 8.0 μm) in MJy/sr, a Signal/Noise (SN_i), a local source density ($srcdens_i$) (number of sources per square arcmin), and number of times (M_i) a source was detected out of a calculated possible number (N_i). The Signal/Noise is the flux (F_i) divided by the flux uncertainty (dF_i). The Signal/Noise for the 2MASS fluxes (SN_t) have been taken from the 2MASS PSC (the j_snr, h_snr and k_snr columns). The local source density is measured as follows: The individual IRAC frame is divided into a 3×3 grid, each of the nine cells being $1.71'$ x $1.71'$. A source density is calculated for each cell (number of sources per $arcmin^2$), and is assigned to each source in that cell. The local source density can be used to assess the confusion in a given region, along with the internal reliability. M_i and N_i can be used to estimate reliability. N_i is calculated based on the areal coverage of each observed frame; due to overlaps some areas are observed more often per band.

Detections (M) can be thrown out by exposure time (when combining 0.6 and 12 second frametime data, for example), or because they have bad SQF flags. Detections are also thrown out at the beginning of bandmerging for sensitivity or saturation reasons. If *any* detections without bad flags went into the final flux, then only those good detections are counted. If all detections had bad flags, then all are counted, and the final source will have some bad quality flags also. Bad in this context is 8=hot/dead pixel and 30=edge (see §5.1.6 and Appendix A for SQF details). N is all frames containing the position of the combined source in this band (*not* including the edge of the frame, within 3 pixels) for which the exposure time was used in the final flux. As for M, if *any* good detections are used, we only count the good detections, but if they're all bad we count all of them and set flags in the final source. For sources not detected in a band, the position of the final cross-band merged source is used for calculating N.

5.1.6 Flags

There are three types of flags: the Close Source Flag, the Source Quality Flag and the Flux Calculation Method Flag. The Close Source Flag is set if there are Archive sources that are within $3''$ of the source. The Source Quality Flag provides a measure of the quality of the point source extraction and bandmerging. The Flux Calculation Method Flag describes how the final Catalog/Archive flux was determined.

• The Close Source Flag is set when a source in the Archive is within $3.0''$ of the source. It was found that the magnitudes of a source with nearby sources closer than about $2''$ are not reliably extracted and bandmerged. A source that has Archive sources within $2.0''$ of the source are *culled* from the Catalog. A source that has Archive sources within $0.5''$ of the source are *culled* from the Archive. The flag is defined as follows:

0=no Archive source within $3.0''$ of source
1=Archive sources between $2.5''$ and $3.0''$ of source
2=Archive sources between $2.0''$ and $2.5''$ of source
3=Archive sources between $1.5''$ and $2.0''$ of source
4=Archive sources between $1.0''$ and $1.5''$ of source
5=Archive sources between $0.5''$ and $1.0''$ of source
6=Archive sources within $0.5''$ of source

• The Source Quality Flag (SQF) is generated from SSC-provided masks and the GLIMPSE pipeline, during point source extraction on individual IRAC frames and bandmerging. Each source quality flag is a binary number allowing combinations of flags (bits) in the same number. Flags are set if an artifact (e.g., a hot or dead pixel) occurs near the core of a source - i.e. within ∼3 pixels. A non-zero SQF will in most cases decrease the reliability of the source. Some of the bits, such as the DAOPHOT tweaks, will not compromise the source's reliability, but has likely increased the uncertainty assigned to the source flux. If just one IRAC detection has the condition requiring a bit to be set in the SQF, then the bit is set even if the other detections did not have this condition. Sources with hot or dead pixels within 3 pixels of source center (bit 8), those in wings of saturated stars (bit 20), and those within 3 pixels of the frame edge (bit 30) are culled from the Catalog.

Table 5 gives the Source Quality Flag bits and origin of the flag (SSC or GLIMPSE pipeline). Each of the 7 bands has its own Source Quality Flag. For the cross-band confusion flag and the cross-band merge lumping flag, when the condition is met for one of the bands, the bit is set for all the source's bands.

The value of the SQF is $\sum 2^{(bit-1)}$. For example, a source with bits 1 and 4 set will have SQF = $2^0 + 2^3 = 9$. If the SQF is 0, the source has no detected problems. More information about these flags and a bit value key can be found in Appendix A.

Table 5. Source Quality Flag (SQF) Bits

SQF bit	Description	Origin
1	poor pixels in dark current	SSC pmask
2	flat field questionable	SSC dmask
3	latent image	SSC dmask
3	persistence (p)	2MASS
4	photometric confusion (c)	2MASS
7	muxbleed correction applied	GLIMPSE
8	hot, dead or otherwise unacceptable pixel	SSC pmask,dmask,GLIMPSE
9	muxbleed correction applied is $> 3\sigma$ above bkg	GLIMPSE
9	electronic stripe (s)	2MASS
10	DAOPHOT tweak positive	GLIMPSE
11	DAOPHOT tweak negative	GLIMPSE
13	confusion in in-band merge	GLIMPSE
14	confusion in cross-band merge (IRAC)	GLIMPSE
14	confusion in cross-band merge (2MASS)	GLIMPSE
15	column pulldown corrected	GLIMPSE
16	banding corrected	GLIMPSE
19	data predicted to saturate	GLIMPSE
20	saturated star wing region	GLIMPSE
20	diffraction spike (d)	2MASS
21	pre-lumping in in-band merge	GLIMPSE
22	post-lumping in cross-band merge (IRAC)	GLIMPSE
22	post-lumping in cross-band merge (2MASS)	GLIMPSE
23	photometry quality flag	2MASS
24	photometry quality flag	2MASS
25	photometry quality flag	2MASS
30	within three pixels of edge of frame	GLIMPSE

• Flux calculation Method Flag (MF_i). The flux calculation method flag indicates by bit whether a given frametime was present, and whether that frametime was used in the final flux. Table 6 defines the values for this flag: value= $2^{(present\_bit-1)} + 2^{(used\_bit-1)}$

Table 6. Flux Calculation Method Flag (MF)

ft (sec)	present bit	(value)	used bit	(value)
0.6	1	(1)	2	(2)
1.2	3	(4)	4	(8)
2	5	(16)	6	(32)
12	7	(64)	8	(128)
30	9	(256)	10	(512)
100	11	(1024)	12	(2048)

For example, if 0.6 and 12 sec frametime data were present, but only the 12 sec data were used, then bits 1 and 7 will be set (fluxes present) and bit 8 will be set (12 sec used) and the MF will be 2^0

+ $2^6 + 2^7 = 1 + 64 + 128 = 193$ (see Table 6). Note that, in practice, MF of 193 is rarely assigned because some detections are thrown out at the beginning of bandmerging because of sensitivity or saturation issues (§3.3).

For Cygnus-X 12/0.6 sec frametime HDR mode, the relevant numbers work out to be
3 - short exp data used, long exp data absent
67 - short used, long present but unused
192 - long exp used, short absent
193 - long exp used, short present but unused
195 - long exp used, short exp used

5.2 Cygnus-X Image Atlas

Using the Montage package, the IRAC images are mosaicked into rectangular tiles that cover the surveyed region. The units are MJy/sr and the coordinates are Galactic. The mosaic images conserve surface brightness in the original images. We provide 1.2″ pixel mosaics as well as higher resolution 0.6″ pixel mosaics. We provide larger (e.g. 3.1°×3.9°, 3.1°×3.4°, 3.1°×3.1° and 3.1°×2.1°) FITS files with a pixel size of 1.2″ , with and without background matching and gradient correction, for an overview look of the Cygnus-X areas. The background matching and gradient removal may be removing real sky variations so we provide these images *in addition* to the 1.2″ pixel images that do not have the background matching. The angular sizes of the higher resolution tiles (pixel size of 0.6″) are 1.1°×2.2°. Three tiles span the latitude range of the areas. World Coordinate System (WCS) keywords are standard (CTYPE, CRPIX, CRVAL, CD matrix keywords) with a Galactic projection (GLON-CAR, GLAT-CAR; Calabretta and Greisen 2002). See (§6.2) for an example of a FITS header. The mosaicked images are 32-bit IEEE floating point single-extension FITS formatted images. For a quick-look of the mosaics, we provide 3-color jpeg files (IRAC [3.6], [4.5] and [8.0]) for each area covered by the FITS files. These are rebinned to much lower resolution to make the files small. Some artifacts remain in the images since removing them would cause gaps in coverage.

6 Product Formats

6.1 Catalog and Archive

• The Catalog and Archive are broken into approximately 2° (longitude) x 6° (latitude) areas for the Cygnus-X Survey. The Catalog and Archive files are in IPAC Table Format. Filenames are CYGXC_llmin-lmax.tbl and CYGXA_llmin-lmax.tbl, for the Catalog and Archive respectively (e.g. CYGXC_l078-080.tbl, CYGXC_l080-084.tbl, CYGXA_l078-080.tbl, CYGXA_l080-084.tbl, etc.) The entries are sorted by increasing Galactic longitude within each file.

An example of a Cygnus-X entry is

SSTCYGXC G078.9132+01.3123 20265535+4033451 305842202 78.913272 1.312306 0.3 0.3
306.730687 40.562543 0.3 0.3 0 13.120 0.025 12.681 0.021 12.474 0.022
12.289 0.033 12.250 0.023 12.231 0.057 12.376 0.066
9.005E+00 2.074E-01 8.668E+00 1.676E-01 6.829E+00 1.384E-01

3.411E+00 1.047E-01 2.263E+00 4.785E-02 1.474E+00 7.672E-02 7.186E-01 4.381E-02
9.318E-02 1.133E-01 1.411E-02 5.531E-02 1.053E+00 1.026E+00 5.862E+00 1.789E+01
43.43 51.70 49.35 32.59 47.30 19.21 16.40 74.5 62.5 12.0 9.6
3 6 3 6 3 6 3 6 29360136 29360136 29360128 542272 1600 512 34304 192 192 192 192

Table 7 gives all of the available fields per source. Table 8 shows how to decode the above entry into these fields.

- Each source in both the Catalog and Archive has the entries given below.

Table 7. Fields in the Catalog and Archive

Column	Name	Description	Units	Data Type	Format	Nulls OK? or Value
1	designation	Catalog (SSTCYGXC GLLL.llll±BB.bbbb) Archive (SSTCYGXA GLLL.llll±BB.bbbb)	-	ASCII	A26	No
2	tmass_desig	2MASS PSC designation	-	ASCII	A16	null
3	tmass_cntr	2MASS counter (unique identification number)	-	I*4	I10	0
4	l	Galactic longitude	deg	R*8	F11.6	No
5	b	Galactic latitude	deg	R*8	F11.6	No
6	dl	Uncertainty in Gal. longitude	arcsec	R*8	F7.1	No
7	db	Uncertainty in Gal. latitude	arcsec	R*8	F7.1	No
8	ra	Right ascension (J2000)	deg	R*8	F11.6	No
9	dec	Declination (J2000)	deg	R*8	F11.6	No
10	dra	Uncertainty in right ascension	arcsec	R*8	F7.1	No
11	ddec	Uncertainty in declination	arcsec	R*8	F7.1	No
12	csf	Close source flag	-	I*2	I4	No
13–18	mag_t,$dmag_t$	Magnitudes & 1σ uncertainty in t=J,H,K_s bands	mag	R*4	6F7.3	99.999,99.999
19–26	mag_i,$dmag_i$	Magnitudes & 1σ uncertainty in IRAC band i	mag	R*4	8F7.3	99.999,99.999
27–32	F_t,dF_t	Fluxes & 1σ uncertainty in t=J,H,K_s bands	mJy	R*4	6E11.3	-999.9,-999.9
33–40	F_i,dF_i	Fluxes & 1σ uncertainty in IRAC band i	mJy	R*4	8E11.3	-999.9,-999.9
41–44	F_i_rms	RMS dev. of individual detections from F_i	mJy	R*4	4E11.3	-999.9
45–48	sky_i	Local sky bkg. for IRAC band i flux	MJy/sr	R*4	4E11.3	-999.9
49–51	SN_t	Signal/Noise for bands t=J,H,K_s	-	R*4	3F7.2	-9.99
52–55	SN_i	Signal/Noise for IRAC band i flux	-	R*4	4F7.2	-9.99
56–59	$srcdens_i$	Local source density for IRAC band i object	no./sq $'$	R*4	4F9.1	-9.9
60–63	M_i	Number of detections for IRAC band i	-	I*2	4I6	No
64–67	N_i	Number of possible detections for IRAC band i	-	I*2	4I6	No
68–70	SQF_t	Source Quality Flag for t=J,H,K_s flux	-	I*4	3I11	-9
71–74	SQF_i	Source Quality Flag for IRAC band i flux	-	I*4	4I11	-9
75–78	MF_i	Flux calc method flag for IRAC band i flux	-	I*2	4I6	-9

Table 8. Example of Catalog/Archive Entry

designation	SSTCYGXC G078.9132+01.3123	Name
tmass_desig	20265535+4033451	2MASS designation
tmass_cntr	305842202	2MASS counter
l,b	78.913272 1.312306	Galactic Coordinates (deg)
dl,db	0.3 0.3	Uncertainty in Gal. Coordinates (arcsec)
ra,dec	306.730687 40.562543	RA and Dec (J2000.0) (deg)
dra,ddec	0.3 0.3	Uncertainty in RA and Dec (arcsec)
csf	0	Close source flag
mag,dmag	13.120 12.681 12.474	Magnitudes (2MASS J,H,K_s) (mag)
	0.025 0.021 0.022	Uncertainties (2MASS) (mag)
mag,dmag	12.289 12.250 12.231 12.376	Magnitudes (IRAC 3.6,4.5,5.8,8.0 μm) (mag)
	0.033 0.023 0.057 0.066	Uncertainties (IRAC) (mag)
F,dF	9.005E+00 8.668E+00 6.829E+00	2MASS Fluxes (mJy)
	2.074E-01 1.676E-01 1.384E-01	Uncertainties in 2MASS fluxes (mJy)
F,dF	3.411E+00 2.263E+00 1.474E+00 7.186E-01	IRAC Fluxes (mJy)
	1.047E-01 4.785E-02 7.672E-02 4.381E-02	Uncertainties in IRAC fluxes (mJy)
F_rms	9.318E-02 1.133E-01 1.411E-02 5.531E-02	RMS_flux (mJy) (IRAC)
sky	1.053E+00 1.026E+00 5.862E+00 1.789E+01	Sky Bkg (MJy/sr) (IRAC)
SN	43.43 51.70 49.35	Signal to Noise (2MASS)
SN	32.59 47.30 19.21 16.40	Signal to Noise (IRAC)
srcdens	74.5 62.5 12.0 9.6	Local Source Density (IRAC) (#/sq arcmin)
M	3 6 3 6	Number of detections (IRAC)
N	3 6 3 6	Number of possible detections (IRAC)
SQF	29360136 29360136 29360128	Source Quality Flag (2MASS)
SQF	542272 1600 512 34304	Source Quality Flag (IRAC)
MF	192 192 192 192	Flux Calculation Method Flag (IRAC)

6.2 Cygnus-X Image Atlas

The mosaicked images for each IRAC band are standard 32-bit IEEE floating point single-extension FITS files in Galactic coordinates. Pixels that have no flux estimate have the value NaN. The FITS headers contain relevant information from both the SSC pipeline processing and the GLIMPSE processing such as IRAC frames included in the mosaicked image and coordinate information.

We provide native resolution images (1.2″ pixels) (e.g. 3.1°x 3.9° mosaic FITS files) for each band, along with low resolution 3-color jpegs. Other mosaics are 3.1°×3.4°, 3.1°×3.1°and 3.1°×2.1°. Filenames are CYGX_*lcbc*_mosaic_I*ch*.fits, where *lc* and *bc* are the Galactic longitude and latitude of the center of the mosaic image, I denotes IRAC, and *ch* is the IRAC instrument channel number (1=[3.6], 2=[4.5], 3=[5.8], 4=[8.0]). For example, CYGX_07800+0250_mosaic_I1.fits is a 3.1°x 3.4° IRAC channel 1 [3.6] mosaic centered on l=78.00°, b=+2.50°. We provide low-resolution 3-color jpeg images for each area, combining IRAC [3.6] and [4.5] and [8.0] to be used for quick-look purposes. The filename for this jpeg file is similar to the mosaic FITS file: e.g. CYGX_07800+0250_3.1x3.4.jpg. We also provide the background matched and gradient corrected 1.2″ pixel mosaics and 3-color jpegs. The background matched and gradient corrected image filenames have "corr_" pre-pended to the filename (e.g. corr_CYGX_07800+0250_mosaic_I1.fits). This comment line is added to the FITS header for these images:

```
COMMENT Background Matched, Gradient Corrected
```

The angular sizes of the higher resolution (0.6″ pixels) tiles are 1.1°×2.2°. Three tiles span the latitude range of the areas. There are three mosaics per 1.1 degree Galactic longitude interval with 0.05° overlap between mosaics. The filenames are similar to the other FITS and jpeg images: e.g. CYGX_07950+0095_mosaic_I1.fits, CYGX_07950+0095.jpg.

Here is an example of the FITS header for the 3.1°x 3.4° CYGX_07800-0085_mosaic_I1.fits:

```
---------------------------------- extension 0 ---------------------------------
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 9300 / length of data axis 1
NAXIS2  =                10200 / length of data axis 2
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
TELESCOP= 'SPITZER '           / Telescope
INSTRUME= 'IRAC    '           / Instrument ID
ORIGIN  = 'UW Astronomy Dept'  / Installation where FITS file written
CREATOR = 'GLIMPSE Pipeline'   / SW that created this FITS file
CREATOR1= 'S18.5.0 '           / SSC pipeline that created the BCD
PIPEVERS= '1v04    '           / GLIMPSE pipeline version
MOSAICER= 'Montage V3.0'       / SW that originally created the Mosaic Image
FILENAME= 'CYGX_07800-0085_mosaic_I1.fits' / Name of associated fits file
PROJECT = 'CYGXL   '           / Project ID
FILETYPE= 'mosaic  '           / Calibrated image(mosaic)/residual image(resid)
CHNLNUM =                    1 / 1 digit Instrument Channel Number
DATE    = '2016-03-04T08:08:42' / file creation date (YYYY-MM-DDThh:mm:ss UTC)
COMMENT --------------------
COMMENT Proposal Information
COMMENT --------------------
OBSRVR  = 'Joseph Hora'        / Observer Name
OBSRVRID=                   53 / Observer ID of Principal Investigator
PROCYCLE=                    7 / Proposal Cycle
PROGID  =                40184 / Program ID
PROTITLE= 'A Spitzer Legacy Survey of the' / Program Title
PROGCAT =                   27 / Program Category
COMMENT ----------------------------
COMMENT Time and Exposure Information
COMMENT ----------------------------
SAMPTIME=                  0.2 / [sec] Sample integration time
FRAMTIME=                 12.0 / [sec] Time spent integrating each BCD frame
EXPTIME =                 10.4 / [sec] Effective integration time each BCD frame
COMMENT DN per pixel=flux(photons/sec/pixel)/gain*EXPTIME
NEXPOSUR=                    3 / Typical number of exposures
COMMENT Total integration time for the mosaic = EXPTIME * NEXPOSUR
COMMENT Total DN per pixel=flux(photons/sec/pixel)/gain*EXPTIME*NEXPOSUR
AFOWLNUM=                    8 / Fowler number
COMMENT --------------------
COMMENT Pointing Information
COMMENT --------------------
CRPIX1  =            4650.5000 / Reference pixel for x-position
CRPIX2  =            5100.5000 / Reference pixel for y-position
```

```
CTYPE1  = 'GLON-CAR'           / Projection Type
CTYPE2  = 'GLAT-CAR'           / Projection Type
CRVAL1  =          78.00000000 / [Deg] Galactic Longtitude at reference pixel
CRVAL2  =          -0.85000002 / [Deg] Galactic Latitude at reference pixel
EQUINOX =               2000.0 / Equinox for celestial coordinate system
DELTA-X =           3.09999990 / [Deg] size of image in axis 1
DELTA-Y =           3.40000010 / [Deg] size of image in axis 2
BORDER  =           0.00000000 / [Deg] mosaic grid border
CD1_1   =      -3.33333330E-04
CD1_2   =       0.00000000E+00
CD2_1   =       0.00000000E+00
CD2_2   =       3.33333330E-04
PIXSCAL1=                1.200 / [arcsec/pixel] pixel scale for axis 1
PIXSCAL2=                1.200 / [arcsec/pixel] pixel scale for axis 2
OLDPIXSC=                1.221 / [arcsec/pixel] pixel scale of single IRAC frame
RA      =         308.30291748 / [Deg] Right ascension at mosaic center
DEC     =          38.55240631 / [Deg] Declination at mosaic center
COMMENT ----------------------
COMMENT Photometry Information
COMMENT ----------------------
BUNIT   = 'MJy/sr  '           / Units of image data
GAIN    =                  3.3 / e/DN conversion
JY2DN   =          2727868.250 / Average Jy to DN Conversion
ETIMEAVE=              10.4000 / [sec] Average exposure time for the BCD frames
PA_AVE  =              -154.23 / [deg] Average position angle
ZODY_EST=              0.03796 / [Mjy/sr] Average ZODY_EST
ZODY_AVE=             -0.00084 / [Mjy/sr] Average ZODY_EST-SKYDRKZB
COMMENT Flux conversion (FLUXCONV) for this mosaic =
COMMENT Average of FLXC from each frame*(old pixel scale/new pixel scale)**2
FLUXCONV=          0.112641305 / Average MJy/sr to DN/s Conversion
COMMENT -----------------------------
COMMENT AORKEYS/ADS Ident Information
COMMENT -----------------------------
AOR001  = '0027110400'         / AORKEYS used in this mosaic
AOR002  = '0027108352'         / AORKEYS used in this mosaic
AOR003  = '0027110912'         / AORKEYS used in this mosaic
AOR004  = '0027107328'         / AORKEYS used in this mosaic
AOR005  = '0027107072'         / AORKEYS used in this mosaic
AOR006  = '0027112448'         / AORKEYS used in this mosaic
AOR007  = '0027107584'         / AORKEYS used in this mosaic
AOR008  = '0027108608'         / AORKEYS used in this mosaic
AOR009  = '0027108096'         / AORKEYS used in this mosaic
AOR010  = '0027111680'         / AORKEYS used in this mosaic
AOR011  = '0027107840'         / AORKEYS used in this mosaic
AOR012  = '0027111424'         / AORKEYS used in this mosaic
AOR013  = '0027111168'         / AORKEYS used in this mosaic
AOR014  = '0027106816'         / AORKEYS used in this mosaic
AOR015  = '0027106560'         / AORKEYS used in this mosaic
```

```
AOR016  = '0027990016'         / AORKEYS used in this mosaic
DSID001 = 'ads/sa.spitzer#0027110400' / Data Set Identification for ADS/journals
DSID002 = 'ads/sa.spitzer#0027108352' / Data Set Identification for ADS/journals
DSID003 = 'ads/sa.spitzer#0027110912' / Data Set Identification for ADS/journals
DSID004 = 'ads/sa.spitzer#0027107328' / Data Set Identification for ADS/journals
DSID005 = 'ads/sa.spitzer#0027107072' / Data Set Identification for ADS/journals
DSID006 = 'ads/sa.spitzer#0027112448' / Data Set Identification for ADS/journals
DSID007 = 'ads/sa.spitzer#0027107584' / Data Set Identification for ADS/journals
DSID008 = 'ads/sa.spitzer#0027108608' / Data Set Identification for ADS/journals
DSID009 = 'ads/sa.spitzer#0027108096' / Data Set Identification for ADS/journals
DSID010 = 'ads/sa.spitzer#0027111680' / Data Set Identification for ADS/journals
DSID011 = 'ads/sa.spitzer#0027107840' / Data Set Identification for ADS/journals
DSID012 = 'ads/sa.spitzer#0027111424' / Data Set Identification for ADS/journals
DSID013 = 'ads/sa.spitzer#0027111168' / Data Set Identification for ADS/journals
DSID014 = 'ads/sa.spitzer#0027106816' / Data Set Identification for ADS/journals
DSID015 = 'ads/sa.spitzer#0027106560' / Data Set Identification for ADS/journals
DSID016 = 'ads/sa.spitzer#0027990016' / Data Set Identification for ADS/journals
NIMAGES =                 4126 / Number of IRAC Frames in Mosaic
```

In addition to the FITS header information given above, the associated ASCII .hdr file includes information about each IRAC frame used in the mosaic image. For example, CYGX_07800-0085_mosaic_I1.hdr includes:

```
COMMENT ----------------------------------------
COMMENT Info on Individual Frames in Mosaic
COMMENT ----------------------------------------
IRFR0001= 'SPITZER_I1_0027110400_0131_0000_02_levbflx.fits' / IRAC frame
DOBS0001= '2008-08-19T04:46:46.800' / Date & time at frame start
MOBS0001=      54697.199218750 / MJD (days) at frame start
RACE0001=           305.788971 / [Deg] Right ascension at reference pixel
DECC0001=            38.751781 / [Deg] Declination at reference pixel
PANG0001=              -168.73 / [deg] Position angle for this image
FLXC0001=              0.10880 / Flux conversion for this image
ZODE0001=              0.03800 / [MJy/sr] ZODY_EST for this image
ZODY0001=             -0.00130 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
IRFR0002= 'SPITZER_I1_0027110400_0133_0000_02_levbflx.fits' / IRAC frame
DOBS0002= '2008-08-19T04:47:12.195' / Date & time at frame start
MOBS0002=      54697.199218750 / MJD (days) at frame start
RACE0002=           305.823914 / [Deg] Right ascension at reference pixel
DECC0002=            38.746441 / [Deg] Declination at reference pixel
PANG0002=              -168.71 / [deg] Position angle for this image
FLXC0002=              0.10880 / Flux conversion for this image
ZODE0002=              0.03800 / [MJy/sr] ZODY_EST for this image
ZODY0002=             -0.00129 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
```

```
.
.       Information on the IRAC frame: filename, date of observation, central
.       position, position angle, flux convert and zodiacal light for
.       frames 3 through 4124
.

IRFR4125= 'SPITZER_I1_0027990016_0353_0000_02_levbflx.fits' / IRAC frame
DOBS4125= '2008-11-03T21:55:58.173' / Date & time at frame start
MOBS4125=      54773.914062500 / MJD (days) at frame start
RACE4125=           306.013580 / [Deg] Right ascension at reference pixel
DECC4125=            38.545654 / [Deg] Declination at reference pixel
PANG4125=               108.32 / [deg] Position angle for this image
FLXC4125=              0.10880 / Flux conversion for this image
ZODE4125=              0.03438 / [MJy/sr] ZODY_EST for this image
ZODY4125=              0.00093 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
IRFR4126= 'SPITZER_I1_0027990016_0383_0000_02_levbflx.fits' / IRAC frame
DOBS4126= '2008-11-03T22:02:21.962' / Date & time at frame start
MOBS4126=      54773.917968750 / MJD (days) at frame start
RACE4126=           305.824066 / [Deg] Right ascension at reference pixel
DECC4126=            38.360176 / [Deg] Declination at reference pixel
PANG4126=               108.20 / [deg] Position angle for this image
FLXC4126=              0.10880 / Flux conversion for this image
ZODE4126=              0.03443 / [MJy/sr] ZODY_EST for this image
ZODY4126=              0.00098 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
END
```

7 APPENDIX A - Source Quality Flag Bit Descriptions

A.1 IRAC Source Quality Flag

Information is gathered from the SSC IRAC bad pixel mask (pmask), SSC bad data mask (dmask) and the GLIMPSE IRAC pipeline for the Source Quality Flag. Table 5 lists the bits and the origin of the flag (SSC or GLIMPSE pipeline). See ssc.spitzer.caltech.edu/irac/products/pmask.html and ssc.spitzer.caltech.edu/irac/products/bcd_dmask.html for more information about the IRAC pmask and dmask.

bit
1 poor pixels in dark current
This bit is set when a source is within 3 pixels of a pixel identified in the SSC IRAC pmask as having poor dark current response (bits 7 and 10 in the pmask).

2 flat field questionable
If a pixel is flagged in the SSC IRAC dmask as flat field applied using questionable value (bit 7) or flat field could not be applied (bit 8), a source within 3 pixels of these pixels will have this bit set.

3 latent image
This flag comes from the latent image flag (bit 5) from the dmask. The SSC pipeline predicts the positions of possible latent images due to previously observed bright sources.

7 muxbleed correction applied (the [3.6] and [4.5] bands)
This bit is set if the source was within 3 pixels of a pixel that had a muxbleed correction applied.

8 hot, dead or otherwise unacceptable pixel
Hot, dead or unacceptable pixels are identified in the IRAC pmask as having an unacceptable response to light (bits 8, 9 and 14 in the IRAC pmask). Also considered bad pixels are ones flagged as bad or missing in bit 11 and 14 in the IRAC dmask. SQF bit 8 is set if a source is within 3 pixels of any of these bad pixels. Sources with this bit set are culled from the Catalog.

9 muxbleed correction $> 3\sigma$ above the background (the [3.6] and [4.5] bands)
This bit is set if the source was within 3 pixels of a pixel where there was a muxbleed correction applied which is $> 3\sigma$ above the background.

10 DAOPHOT tweak positive
11 DAOPHOT tweak negative
Bits 10 and 11 correspond to an iterative photometric step (tweaking). Photometry is initially performed by DAOPHOT/ALLSTAR using PSF fitting. This photometric step produces a list of sources, their positions and brightnesses, as well as a residual image of those sources removed from the input image. By flattening the residual image (smoothing it and then subtracting the smoothed image from the residual image) and then performing small aperture photometry at the location of each of the extracted sources, it is possible to determine if the extracted source was over or under subtracted due to any local complex variable background or the undersampled PSF. SQF bit 10 refers to sources that were initially under-subtracted. From the aperture photometry a positive flux correction was applied to the DAOPHOT/ALLSTAR extraction value (source was brightened via aperture photometry as compared to the initial PSF fitted DAOPHOT/ALLSTAR photometry). SQF bit 11 refers to sources that were initially over-subtracted. Using aperture photometry, a negative flux correction was applied to the DAOPHOT/ALLSTAR extraction value (source was dimmed via aperture photometry as compared to the initial PSF fitted DAOPHOT/ALLSTAR photometry). Sources with both SQF bits 10 and 11 set imply 1) the source was initially under-subtracted, but the aperture photometry over- corrected and thus a second aperture correction was applied or 2) multiple observations in a band consisting of at least one observation with a positive tweak and another observation with a negative tweak.

13 confusion in in-band merge
14 confusion in cross-band merge
These bits are set during the bandmerging process. The bandmerger reports, for each source and band, the number of merge candidates it considered in each of the other bands. If the number of candidates is greater than 2, then the bandmerger had to resolve the choice based on examination of the different band-pair combinations and position (and flux in-band) χ^2 differences between candidates. If the number of candidates is greater than 1, the confusion flag is set.

15 column pulldown corrected ([3.6] and [4.5] bands)
This bit is set if the source is within 3 pixels of a column pulldown corrected pixel.

16 banding corrected ([5.8] and [8.0] bands)
This bit is set if the source is within 3 pixels of a banding corrected pixel.

19 data predicted to saturate

This bit is set when a source is within 3 pixels of a pixel identified in the SSC IRAC dmask as being saturated (bit 10 in the dmask). GLIMPSE runs a saturated pixel predicter and sets bit 10 in the dmask. This program finds clusters of high-valued pixels. The cluster size and high pixel value are tuned so that sources above the IRAC saturation limits are flagged as saturated. Before photometry is done on an IRAC frame, these pixels are masked.

20 saturated star wing region
False sources can be extracted in the wings of saturated sources. This bit is set if the source is within a PSF-shaped region (with a 24-pixel radius) surrounding a saturated source determined from bit 10 in the dmask. See Figure 8 for an example from the GLIMPSE data of the shapes of the saturated star wing areas flagged by this bit. Sources with this bit set are culled from the Catalog.

21 pre-lumping in in-band merge
Sources in the same IRAC frame within a radius of 1.6″ are merged into one source (weighted mean position and flux) before bandmerging. This is potentially a case in which the source is incompletely extracted in one IRAC frame and a second source extracted on another IRAC frame. Or it could be a marginally resolvable double source. This bit is set for the band if sources have been lumped for that band.

22 post-lumping in cross-band merge
This bit is set if the source is a result of sources that were lumped in the cross-band merge step. Cross-band lumping is done with a 1.6″ radius. For example, say there are two sources within 1.6″ of each other. One source has data in bands K_s and [3.6] and [8.0] and the other has data in bands [4.5] and [5.8]. These two sources will be lumped into one source with data in all four IRAC bands.

30 within three pixels of edge of frame
Sources within three pixels of the edge of the IRAC frame are flagged since it is likely to be too close to the edge of the frame for accurate photometry to be done. Sources with this bit set are culled from the Catalog.

A.2 2MASS Source Quality Flag

For the 2MASS bands, the following contamination and confusion (cc) flags from the 2MASS All-Sky Point Source Catalog are mapped into bits 3, 4, 9 and 20 of the source quality flag. For more information about the cc flags, see
www.ipac.caltech.edu/2mass/releases/allsky/doc/sec2_2a.html#cc_flag. Users should consult the 2MASS PSC documentation for the complete information about the source, including all of their source quality flags.

bit
3 "p" persistence
Source may be contaminated by a latent image left by a nearby bright star.

4 "c" photometric confusion
Source photometry is biased by a nearby star that has contaminated the background estimation.

9 "s" electronic stripe
Source measurement may be contaminated by a stripe from a nearby bright star.

14 confusion in cross-band merge
This bit is set during the bandmerging process. The bandmerger reports, for each source and

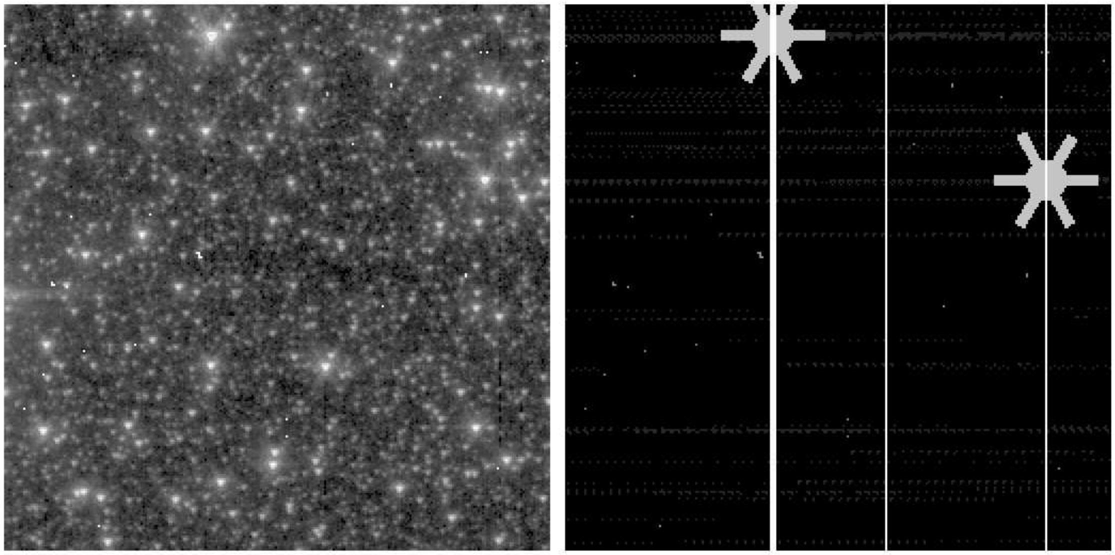

Figure 8: The IRAC [3.6] GLIMPSE frame (AOR 12110848, exposure 11) is on the left (corrections were applied for muxbleed and column pulldown); the flags for that frame are shown on the right. The PSF-shaped areas around the bright sources correspond to SQF bit 20. The vertical lines correspond to where the frame was corrected for column pulldown (SQF bit 15). The horizontal dots show which pixels were corrected for muxbleed (SQF bits 7 and/or 9). Various small dots are hot, dead or bad pixels (SQF bit 8). Bits in the SQF will have been set for sources within 3 pixels of any of these areas.

band, the number of merge candidates it considered in each of the other bands. If the number of candidates is greater than 2, then the bandmerger had to resolve the choice based on examination of the different band-pair combinations and position χ^2 differences between candidates. If the number of candidates is greater than 1, the confusion flag is set.

20 “d” diffraction spike confusion
Source may be contaminated by a diffraction spike from a nearby star.

22 post-lumping in cross-band merge
This bit is set for all bands (IRAC and 2MASS) if the source is a result of sources that were lumped in the cross-band merge step. Cross-band lumping is done with a 1.6″ radius.

23 Photometric quality flag
24 Photometric quality flag
25 Photometric quality flag

2MASS "ph" Flag =>	SQF bits 23, 24, 25			value
X	0	0	0	0
U	1	0	0	4194304
F	0	1	0	8388608

E	1	1	0	12582912
D	0	0	1	16777216
C	1	0	1	20971520
B	0	1	1	25165824
A	1	1	1	29360128

where

X - There is a detection at this location, but no valid brightness estimate can be extracted using any algorithm.

U - Upper limit on magnitude. Source is not detected in this band or it is detected, but not resolved in a consistent fashion with other bands.

F - This category includes sources where a reliable estimate of the photometric error could not be determined.

E - This category includes detections where the goodness-of-fit quality of the profile-fit photometry was very poor, or detections where psf fit photometry did not converge and an aperture magnitude is reported, or detections where the number of frames was too small in relation to the number of frames in which a detection was geometrically possible.

D - Detections in any brightness regime where valid measurements were made with no [jhk]_snr or [jhk]_cmsig requirement.

C - Detections in any brightness regime where valid measurements were made with [jhk]_snr>5 AND [jhk]_cmsig<0.21714.

B - Detections in any brightness regime where valid measurements were made with [jhk]_snr>7 AND [jhk]_cmsig<0.15510.

A - Detections in any brightness regime where valid measurements were made with [jhk]_snr>10 AND [jhk]_cmsig<0.10857.

A.3 Key to Bit Values

This section describes how to determine the bit values of a Source Quality Flag.

bt = bit in sqf
value = $2^{(bit-1)}$ i.e. bit 3 corresponds to 2^2=4

bit values: bt 1 => 1; 2 => 2; 3 => 4; 4 => 8; 5 => 16; 6 => 32; 7 => 64; 8 => 128 bt 9 => 256; 10 => 512; 11 => 1024; 12 => 2048; 13 => 4096; 14 => 8192; 15 => 16384; bt 16 => 32768; 17 => 65536; 18 => 131072; 19 => 262144; 20 => 524288; bt 21 => 1048576; 22 => 2097152; 23 => 4194304; 24 => 8388608; 25 => 16777216; 30 => 536870912

For example, the Source Quality Flags in the example in Table 8 are 29360136 for the 2MASS J and H bands and 29360128 for the K_s band. This translates to bits 23, 24, 25 and 4 being set for the J and H bands, which is the photometric quality A flag from the 2MASS PSC and the 2MASS confusion flag. For the K_s band flag, this translates to bits 23, 24 and 25 being set, which is the photometric quality A flag from the 2MASS PSC. IRAC [3.6] has a SQF of 542272. This means bits 7, 10, 11, 15 & 20 were set. This means tweaking was done in the source extraction and the source is within three pixels of a column pulldown and muxbleed corrected area, and in a saturated star wing region. IRAC [4.5] SQF is 1600. This means bits 7, 10 & 11 were set which means tweaking has been done in the source extraction and the source is within 3 pixels of a muxbleed corrected area. IRAC [5.8] SQF is 512, which means bit 10 was set which means positive DAOPHOT tweaking was done. IRAC [8.0] SQF is 34304. This means bits 10, 11 & 16 were set which means tweaking has been done in the source extraction and the source is within 3 pixels of a banding corrected area.

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GLOSSARY

2MASS	Two Micron All Sky Survey
BCD	Basic Calibrated Data, released by the SSC
Cygnus-X	Spitzer Legacy Survey of the Cygnus-X Complex
Deep GLIMPSE	Exploring the Far Side of the Galaxy
dmask	A data quality mask supplied by the SSC for the BCD
GALCEN	High Resolution Imaging of the Galactic Center with Spitzer/IRAC
GLIMPSE	Galactic Legacy Infrared Midplane Survey Extraordinaire
GLIMPSEII	Imaging the Central 10 Degrees of the Galactic Plane with IRAC
GLIMPSE3D	The Vertical Stellar and Interstellar Structure of the Inner Galaxy
GLIMPSE360	Completing the Spitzer Galactic Plane Survey
HDR	High Dynamic Range
IPAC	Infrared Processing and Analysis Center
IRAC	*Spitzer* Infrared Array Camera
IRS	*Spitzer* Infrared Spectrometer
IRSA	InfraRed Science Archive
MF	Method Flag used to indicate exposure times included in the flux
MIPS	*Spitzer* Multiband Imaging Photometer
MSX	Midcourse Space Experiment
pmask	A bad pixel mask supplied by the SSC for the BCD
PSF	Point Spread Function
rmask	Outlier (radiation hit) mask
SOM	*Spitzer* Observer's Manual
SSC	*Spitzer* Science Center
SED	Spectral energy distribution
SMOG	Spitzer Mapping of the Outer Galaxy
SQF	Source Quality Flag
SST	*Spitzer* Space Telescope
Vela-Carina	Galactic Structure and Star Formation in Vela-Carina
WISE	Wide-field Infrared Survey Explorer
YSO	Young Stellar Object