GLIMPSEII - v1.0 Data Products and Data Delivery

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1 Quick Start

GLIMPSEI and GLIMPSEII data products are available at the Spitzer Science Center (SSC) (see http://ssc.spitzer.caltech.edu/legacy/glimpsehistory.html) and the Infrared Science Archive (IRSA) (e.g. http://irsa.ipac.caltech.edu/data/SPITZER/). For scientists who want to immediately use the GLIMPSEII data, §2.1 briefly describes the survey and data products; and §6 describes the source list entries and the images.

2 Overview

2.1 GLIMPSEII Survey and Data Products

The Galactic Legacy Infrared Midplane Survey Extraordinaire (GLIMPSEI)[1], using the *Spitzer* Space Telescope (SST) (Werner et al. 2004) Infrared Array Camera (IRAC) (Fazio et al. 2004) surveyed approximately 220 square degrees of the Galactic plane, covering a latitude range of $\pm 1^\circ$, and a longitude range of $|l| = 10^\circ - 65^\circ$ (Benjamin et al. 2003). GLIMPSEII imaged longitudes $\pm 10^\circ$ of the central region of the Galaxy. The latitude coverage is $\pm 1^\circ$ from $|l| = 10^\circ to\ 5^\circ$, $\pm 1.5^\circ$ from $|l| = 5^\circ to\ 2^\circ$, and $\pm 2^\circ$ from $|l| = 2^\circ to\ 0^\circ$ (excluding the Galactic center region l=$\pm 1^\circ$, b=$\pm 0.75^\circ$ observed by Susan Stolovy's General Observer (GO) program (PID=3677)). Figure 1 shows the GLIMPSEII coverage. IRAC has four bands, centered at approximately 3.6, 4.5, 5.8 and 8.0 μm respectively. We will refer to them as bands 1 - 4 in this document. GLIMPSEII had two-epoch coverage for a total of three visits on the sky. The observations consisted of two 1.2 second integrations at each position in the first epoch of data taking (September 2005) and a single 1.2 second integration at each position six months later (April 2006). See the GLIMPSE web site (http://www.astro.wisc.edu/glimpse/) for more descriptions of the GLIMPSEI and GLIMPSEII projects.

This document describes the data products from the GLIMPSEII Survey and specifically the v1.0 data products delivered in January 2007 and May 2007. The organization of this document is as follows: §2 gives an overview of the GLIMPSEII survey and data products; §3 describes the data processing; §4 discusses the validation of the source lists; §5 provides a detailed description of the

[1]Although originally known as GLIMPSE, we will use the acronym GLIMPSEI to avoid confusion between it, GLIMPSEII and GLIMPSE-3D

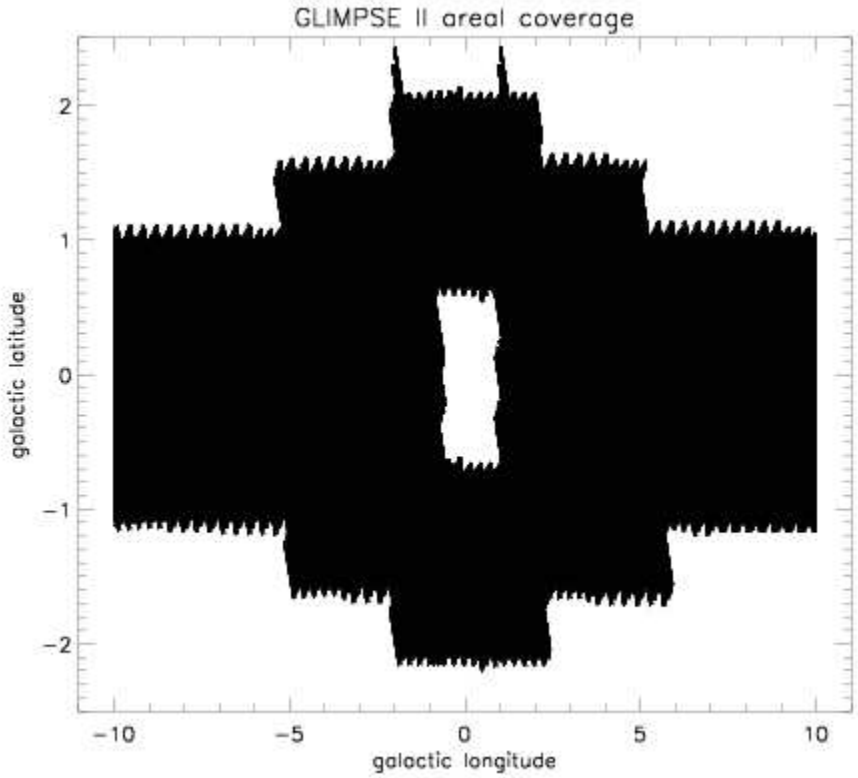

Figure 1: GLIMPSEII areal coverage of the inner Galactic plane.

data products; §6 describes the format; §7 presents the delivery schedule for the data products and Appendix A gives details about the Source Quality Flag. This document contains numerous acronyms, a glossary of which is given at the end.

The GLIMPSEII enhanced data products consist of a highly reliable Point Source Catalog (GLMIIC), a more complete Point Source Archive (GLMIIA), and mosaic images covering the survey area. The enhanced data products are:

1. The GLIMPSEII Catalog (GLMIIC, or the "Catalog"), consisting of point sources whose selection criteria (§3.2) are determined by the requirement that the reliability be ≥99.5%. Figure 2 shows the number of GLIMPSEII Catalog sources as a function of magnitude for each IRAC band. The estimated magnitude limit is given in Table 1. The photometric uncertainty is typically < 0.2 mag. 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 any anomalies present in the data. Sources were bandmerged with the Two Micron All Sky Survey Point Source Catalog (2MASS; Skrutskie et al. 2006), providing images at similar resolution to IRAC, in the J (1.25 μm), H (1.65 μm), and K_s (2.17 μm) bands. The 2MASS information we include from the 2MASS PSC is designation, counter (a unique identification number), fluxes, signal-to-noise, and a limited source quality flag. Users should refer back to the 2MASS Point Source Catalog for the complete 2MASS information about the source. The format of the Catalog is ASCII, using the IPAC Tables convention (http://irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html). The GLIMPSEII v1.0 Catalog contains about 16 million sources.

2. The GLIMPSEII Archive (GLMIIA or the "Archive"), consisting of point sources with a signal to noise > 5 in at least one band and less stringent selection critera than the Catalog (§3.2). The photometric uncertainty is typically < 0.3 mag. The information provided is in the same format as the Catalog. The number of GLIMPSEII Archive sources as a function of magnitude for each IRAC band is shown in Figure 2. The estimated magnitude limit is given in Table 1. The GLIMPSEII v1.0 Archive contains about 21 million sources. The GLIMPSEII Catalog is a subset of the Archive, but note that 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 (§3.2).

3. The GLIMPSEII Image Atlas: Mosaicked Images for each band, each covering $1.1^\circ \times 0.8^\circ$, $1.1^\circ \times 1.2^\circ$, or $1.1^\circ \times 1.6^\circ$, depending on the latitude coverage. These are 32-bit IEEE floating point single extension FITS formatted images covering the entire survey area. These images, in units of surface brightness MJy/sr, have a pixel size of $0.6''$. Mosaics of each band are made for larger ($3.1^\circ \times 2.4^\circ$, $3.1^\circ \times 3.45^\circ$, or $3.1^\circ \times 4.5^\circ$) areas, with a pixel size of $1.2''$. Also included are quicklook 3-color jpeg images of the same size as the FITS images.

Table 1. Estimated Magnitude Limits for GLIMPSEII sources

Band (μm)	[3.6]	[4.5]	[5.8]	[8.0]
Catalog/Archive	13.0	13.0	11.5	11.0

2.2 v1.0 Data Release

v1.0 data products consist of a point source Catalog and Archive and mosaics for the entire GLIMPSEII survey region using the epoch 1 data taken in September 2005, processed with SSC pipeline version S12.4. This dataset is the two-visit survey of the entire GLIMPSEII area, similar to the two-visit GLIMPSEI survey. (The third pass data (epoch 2) were taken in April 2006). There were a few frames that were missing or bad. These areas have been re-observed and the data will be included in future data releases. The older SSC S12.4 processing does not include the new flux calibration (Reach et al. 2005) and position refinement improvements. Photometry is performed on individual IRAC frames using a modified version of DAOPHOT (Stetson 1987) and combined in the bandmerger stage to produce the source lists. v1.0 data products incorporate some of the Wisconsin IRAC pipeline improvements, such as muxbleed correction and implementing a close source flag. We are providing 2MASS fluxes with the IRAC data, when available. We did not attempt to match instrumental background variations between the images in the mosaics but hope to for the v2.0 mosaics.

2.3 v2.0 Data Release

This document describes the v1.0 products that are currently available. Here we give a brief description of the v2.0 data products that will be available starting in the Fall of 2007. v2.0 data products will use data processed with SSC pipeline version S13.2 and later and will include both epochs of the GLIMPSEII survey data. Source lists for each epoch will be provided along with source lists for the combined epochs. v2.0 products will also include GO time data for the one degree around the Galactic Center (PI: Stolovy), as processed by the Wisconsin IRAC pipeline,

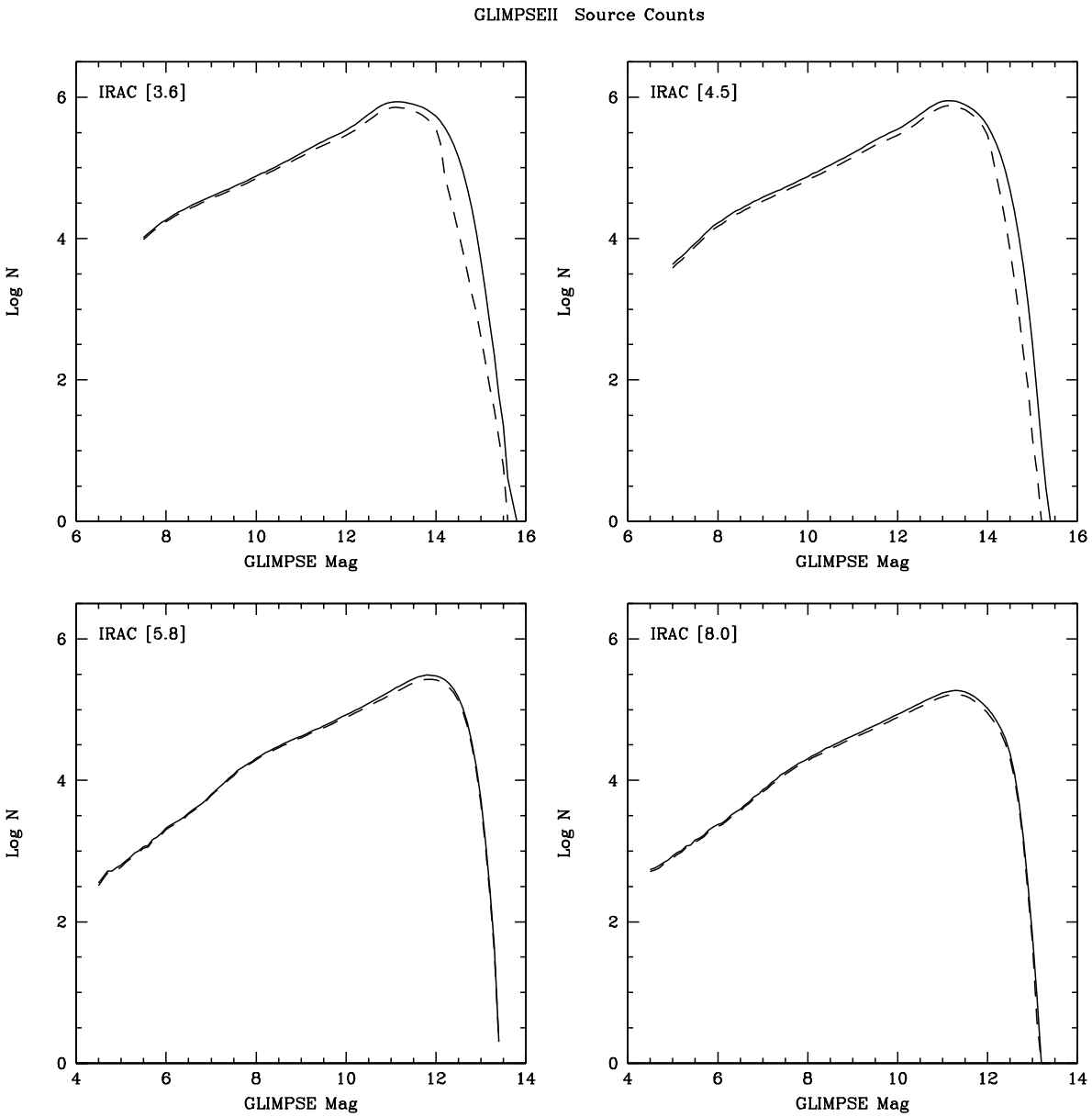

Figure 2: GLIMPSEII source counts versus magnitude. Plotted is the logarithm of the source counts in the GLIMPSEII Catalog (dashed lines) and Archive (solid lines) binned every 0.1 magnitudes. Each of the 4 bands is plotted, showing the effective limiting magnitude for each band. The band 1 & 2 distributions are very similar since most sources that make it into the Archive or Catalog have data in those bands. Sources from the entire GLIMPSEII region were used in these plots.

and will include any overlaps with the GLIMPSEI data. We plan to take some short exposure data to recover photometry from saturated sources and diffuse regions and these data will be delivered as well.

3 Pipeline Processing

3.1 Image Processing, Photometry, and Bandmerging

The GLIMPSE Pipeline Description document (GPD)[2] will describe in detail the GLIMPSE (GLIMPSEI, GLIMPSEII, GLIMPSE-3D) pipeline processing, including photometry and bandmerging to produce source lists. We note here some steps that are relevant to the final data products. 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[3]) are corrected for in the GLIMPSE pipeline. We correct for column pulldown[4] in bands 1 & 2, using an algorithm written by Lexi Moustakas (GOODS team) and modified by GLIMPSE to handle variable backgrounds. We correct for muxbleed[5] in bands 1 & 2 using a modified version of the IRAC Bright Source Artifact Corrector[6]. We correct for banding[7] in bands 3 & 4 using an exponential function. (For the v2.0 data release we will implement an improved banding correction for band 3 which uses an algorithm fitting each incidence of banding individually.)

We use a modified version of DAOPHOT 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 improve the flux estimates in these regions substantially. Cosmic rays are removed from the source list based on an algorithm that operates on the residual images. More details about the photometry steps can be found at http://www.astro.wisc.edu/glimpse/glimpse_photometry_v1.0.pdf. The array-location-dependent photometric corrections[8] were not applied to these source lists but will in the v2.0 source lists.

Prior to the bandmerge stage, we cull all sources with signal-to-noise less than 3. As a result, no sources in the Catalog or Archive will have signal-to-noise less than 3 in any band. We use the SSC-supplied bandmerger[9] (modified by the GLIMPSE team) in two stages, first to combine detections of the same source in the same band (in-band merge), and then to cross-correlate detections in different bands (cross-band merge). Signal-to-noise and flux information is used as well as position during the in-band merge, but only position is used for the cross-band merge (to avoid any systematic effects dependent on source color). Sources from the 2MASS All-Sky Point Source Catalog are merged with the IRAC fluxes in the cross-band merge stage only if it has a K_s detection.

Image processing for the mosaic image products include the column pulldown, muxbleed, and banding corrections mentioned above. Hot, dead, and missing pixels are masked. The SSC mo-

[2] will be found at http://www.astro.wisc.edu/glimpse/docs.html

[3] http://ssc.spitzer.caltech.edu/irac/dh/.

[4] Column pulldown is a reduction in intensity of the columns in which bright sources are found in Bands 1 and 2. See *Spitzer* Observer's Manual (SOM) at http://ssc.spitzer.caltech.edu/documents/som/.

[5] The multiplexer bleed effect is a series of bright pixels along the horizontal direction on both sides of a bright source in Bands 1 and 2

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

[7] Banding refers to streaks that appear in the rows and columns radiating away from bright sources in Bands 3 and 4. See the SOM.

[8] http://ssc.spitzer.caltech.edu/irac/locationcolor/

[9] http//ssc.spitzer.caltech.edu/postbcd/bandmerge.html

saicer MOPEX[10] is run to obtain the outlier mask (rmask; generally due to cosmic rays). Both the dual outlier bit and the temporal bit of the rmask are masked during the mosaicing. Stray light from bright sources outside the field of view scatters onto the detector and can appear in the images. To remove them, we use the SSC IRAC Stray Light Masker[11] modified to use the IRAC magnitudes from the GLIMPSEII source lists to predict the positions of the stray light. It creates a mask (smask) for each input IRAC frame. Not all of the stray light areas are found by the SSC Stray Light Masker. Most of the remaining stray light areas are removed by visual inspection. Artifacts that have only single-frame coverage (outside the nominal latitude range) are left in the mosaic. If there are areas of overlapping image artifacts that cause a gap in coverage, we do not mask that area. In bands 3 and 4 stray light areas can repeat (particularly along rows) and remain in the images because masking them would cause gaps in coverage. See SSC's IRAC image features web site[12] and the IRAC Data Handbook for more information about the detector artifacts. See also the GLIMPSE IRAC Instrument Artifact Gallery (http://www.astro.wisc.edu/glimpse/glimpse_artifact_gallery_v1.0.pdf) which gives examples of artifacts in the GLIMPSEI and GLIMPSEII images that are corrected for and examples of artifacts that remain in the GLIMPSEI and GLIMPSEII images. We use the Montage[13] package v2.2 to mosaic and project to Galactic coordinates.

3.2 Source Selection for Catalog and Archive

Now we describe the selection criteria for the Catalog and Archive once photometry and bandmerging have been completed.

Catalog

The Catalog selection criteria are identical to those used for the GLIMPSEI Catalog which was determined to be $\geq$99.5% reliable from simulated data and study of the GLIMPSEI Observation Strategy Validation (OSV) data of the RCW49 region. A source must be detected at least twice in one band and at least once in an adjacent band for the general GLIMPSEI observing strategy of two visits on the sky, described in detail in the GLIMPSE Quality Assurance (GQA) document (http://www.astro.wisc.edu/glimpse/GQA-master.pdf). We call this the "2+1" criterion. The 2MASS K_s magnitude, when present, is used for the "2+1" criterion for IRAC band 1. To allow for the more general case of M detections out of N possible observations, we require that $M/N \geq 0.6$ in one band and $M/N \geq 0.4$ in an adjacent band.

In the two bands that satisfy the 2+1 criterion, only sources with flux greater than 0.6 mJy (<14.2 mag), 0.4 mJy (<14.1 mag), 2 mJy (<11.9 mag), and 10 mJy (<9.5 mag) in bands 1 through 4, respectively, are allowed in the Catalog. Similarly, the bright limit fluxes are 439 mJy (7 mag), 450 mJy (6.5 mag), 2930 mJy (4 mag) and 1590 mJy (4 mag) for bands 1 through 4, respectively, to remove sources at nonlinear response levels. The signal-to-noise in the band with the two detections satisfying the 2+1 criterion is required to be greater than 5. Sources with hot or dead pixels within 3 pixels of source center, those in wings of saturated stars, and those within 3 pixels of the frame

[10] http://ssc.spitzer.caltech.edu/postbcd/

[11] http://ssc.spitzer.caltech.edu/irac/straylight/

[12] http://ssc.spitzer.caltech.edu/irac/features.html

[13] http://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.

edge are culled from the Catalog.

Once a source satisfies the 2+1 criterion, the requirements for the other 2 bands of the same source are less stringent. Flux values above the bright limit flux are nulled, but values below the low-limit flux are allowed. Signal-to-noise <5 (down to a lower limit of 3) is allowed. Bands with hot or dead pixels and in wings of saturated stars are nulled, but those within 3 pixels of the frame edge are allowed.

Finally, sources are removed from the Catalog if there are Archive sources within $2''$ of the source because we found that the neighboring source could influence the flux for that source.

Archive
Requirements for source selection in the Archive are less stringent than for the Catalog. Therefore the Archive is less reliable than the Catalog but more complete. We require $M/N \geq 0.6$ in one band ($N \geq 2$) or $M/N \geq 0.4$ in any two bands. For a typical source observed two times, this translates to a detection twice in one band or once in two bands. The 2MASS K_s magnitude is allowed in the "1+1" criterion. We require that the signal-to-noise be greater than 5 in the band or bands used for source selection. The lower limit of the signal-to-noise for all bands is 3. Sources are removed from the Archive if there are Archive sources within $0.5''$ of the source. There are no further culls, leaving it to the user to cull or null based on values of the fluxes and flags (described in §5.1).

4 Source List Validation

We summarize here analysis we use to validate the Catalog and Archive point source lists. The GLIMPSE Quality Assurance document describes the GLIMPSEI v1.0 data validation in more detail. Much of it also applies to the GLIMPSEII data.

4.1 False sources/Asteroids

Verification of our source selection criteria (§3.2) was done with a Reliability study of the GLIMPSEI OSV data. See http://www.astro.wisc.edu/glimpse/cr_manuscript.pdf (Reliability and Completeness for the GLIMPSE Survey), http://www.astro.wisc.edu/glimpse/val.20040130.pdf (Observation Strategy Validation Report), and http://www.astro.wisc.edu/glimpse/addendum4.pdf (Addendum to the Validation Report). One cause of false sources in the source lists is imperfect muxbleed correction leaving faint point-like sources every four pixels along a row from a bright source in bands 1 and 2. We estimate about 90% of the muxbleed has been corrected by the Bright Source Artifact Corrector but the muxbleed remaining in the images can cause false sources. Most of the muxbleed sources have signal-to-noise less than 5 and do not make it into the source lists. Very few false sources due to muxbleed are found in high background areas (e.g. in the inner Galaxy). We estimate that $< 0.04\%$ of the Catalog sources may be due to muxbleed. We estimate that $< 0.2\%$ of the Archive sources may be due to muxbleed because of our less stringent selection criteria. The false detections due to muxbleed will be in only bands 1 and 2. An additional cause of false detections in the Archive occurs in regions surrounding saturated stars where the GLIMPSE source extractor may find false sources in the wings of the PSF. These sources are culled from the Catalog but only flagged in the Archive. Our source selection criteria remove the vast majority of other potential false detections, such as cosmic rays and stray light. In addition, our photometry

iteration on residual images reduces false source detections in variable backgrounds caused by both real sky variations as well as instrumental artifacts such as banding, stray light, muxbleed, and column pulldown.

Asteroid detection in the GLIMPSEII source lists will generally be limited to the Archive. Due to the observation strategy, source list criteria and IRAC positional offsets between bands 1 & 3 and 2 & 4 on the sky, nearly all asteroids should be culled from the Catalog. In the case that an asteroid is observed in a frame for bands 1 and 3, it will not be imaged in bands 2 and 4 until the AOR has progressed long enough to have positioned the IRAC band 2 and 4 detectors at the same area of sky. This is usually a sufficiently long period of time that the asteroid has moved far enough from its earlier position that the asteroid's band 2 and 4 detections are at a unique position compared to its bands 1 and 3 position. Thus, Catalog criteria of 2+1 detections in adjacent bands fails. However, the less stringent 1+1 Archive criteria can still be met and asteroids are usually 2 unique entries in the Archive: one entry having band 1 and 3 data and the second entry (at a slightly different position) with band 2 and 4 data.

4.2 Astrometric Accuracy

Sources bright enough to have 2MASS associations are typically within $0.3''$ of the corresponding 2MASS position, as discussed in §5.1. Figure 3 shows a comparison of GLIMPSEII source positions to the 2MASS PSC positions, in $0.05''$ bins, for a one degree longitude, 4 degrees of latitude area in the GLIMPSEII survey. The peak of the plot is at $0.15''$ and the majority of the sources have positional differences less than $0.3''$, similar to the GLIMPSEI v1.0 source lists. Fainter GLIMPSEII sources are likely to have larger errors due to poorer centroiding. See Section VII of the GQA for a more detailed discussion of positional accuracy.

4.3 Photometric Accuracy

Photometric accuracy was originally verified with simulated images consisting of known point source fluxes placed on residual images (IRAC images with point sources removed giving realistic backgrounds). The point source accuracy depends on background level. A table of photometric accuracy as a function of background level is given in the Addendum to the GLIMPSE Validation Report (http://www.astro.wisc.edu/glimpse/addendum4.pdf). For average background levels, the photometric accuracy is $\leq 0.2^m$ at magnitudes brighter than $\sim 14, \sim 12, \sim 10.5, \sim 9.0$ for bands 1 - 4 respectively.

Our goal was to achieve point source photometry accuracy of $\leq$0.2 mag. Table 2 shows a summary of the fraction of sources in both the Catalog and Archive that achieve this level. Band 3 shows a higher percentage of sources with photometric accuracy >0.2 mag, most likely due to its lower sensitivity.

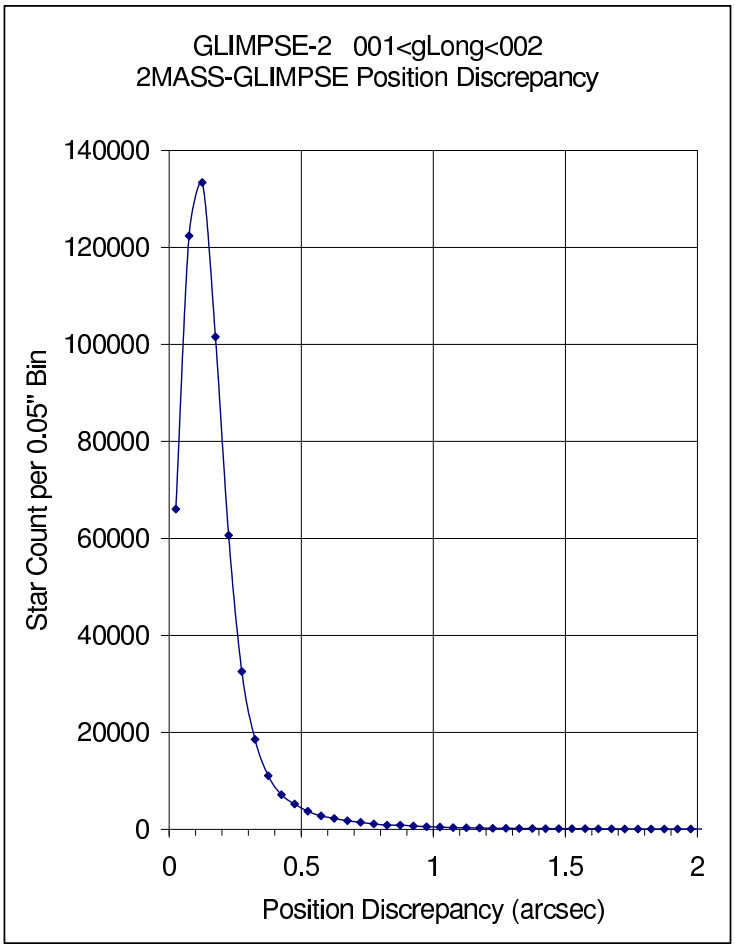

Figure 3: Comparison of GLIMPSEII source positions to their corresponding 2MASS PSC positions from sources of longitudes between 1 and 2 degrees and latitudes ± 2 degrees. The astrometric discrepancy plotted is the angular separation in arcseconds between the GLIMPSEII position and the 2MASS position. Note that sources with 2MASS associates have GLIMPSEII 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.

Table 2. Photometric Accuracy of the GLIMPSEII Sources

Band (μm)	[3.6]	[4.5]	[5.8]	[8.0]
Catalog				
No. with error >0.2 mag	804450	1559834	1613578	477445
Total number of entries	15480886	15306668	5819338	3873031
% with errors >0.2 mag	5.20	10.19	27.73	12.33
Archive				
No. with error >0.2 mag	1434478	2575421	1929150	567149
Total number of entries	19904844	18851933	6503918	4354946
% with errors >0.2 mag	7.21	13.66	29.66	13.02

Photometric accuracy was further verified by comparison with 100 flux calibrators distributed throughout the GLIMPSEII survey region. The flux predictions were supplied by Martin Cohen.

These calibrators span a wide range of fluxes in each IRAC band. The techniques used to produce the flux predictions are described in Cohen et al. (2003). Figure 4 shows the agreement between the GLIMPSEII magnitudes and the predicted magnitudes. Uncertainties in both the extracted and predicted magnitudes were added in quadrature to produce the plotted error bars. Figure 4 shows that there do not appear to be any large systematic errors related to, e.g. flux levels or spectral type. Table 3 gives details about the number of flux calibrators used for each band (varies due to saturation), average differences (GLIMPSEII magnitude minus the predicted magnitude), and RMS errors. The IRAC data in this release are from SSC IRAC pipeline processing version S12.4. The data plotted in Figure 4 were corrected to the SSC S13.2 pipeline calibration by compensating for the updated values of FLUXCONV and the magnitude zero points of Reach et al. (2005).

Table 3. Comparison of Flux Calibrators to Predicted Magnitudes

Band (μm)	[3.6]	[4.5]	[5.8]	[8.0]
No. Flux calibrators	44	47	86	84
Ave. [Observed-Predicted] mag	-0.037276	-0.022575	-0.000380	-0.014532
RMS error	0.082152	0.106877	0.095248	0.080239

Although Figure 3 shows a degree of scatter (typically 0.09 mags, see "RMS error" in Table 3), this seems reasonable when compared to the plotted errors in Figure 3. The exception may be IRAC band 4 where the plotted errors appear to be a bit small. Error assessment is being studied by comparing the quoted error (dF_i) with the RMS of the error (F_i_rms). From initial studies bands 2 and 4 appear to be the most systematically off. Band 2 errors appear to be systematically too large by about 10%. Band 4 errors are too small. Empirically the band 4 error *correction* appears to be related to the background level as well as the quoted error. The average band 4 error correction is around +20%, (i.e. df_b4'=df_b4*1.2) but ranges from about 0.8 to 2.0. Likewise there may be small corrections for bands 1 and 3. No corrections have been applied to the data, but we will make recommendations for corrections when our study is completed.

4.4 Color-Color and Color-Magnitude Plots

Color-color and color-magnitude plots were made of each Catalog and Archive Table (in approximately $1^\circ \times 2 - 4^\circ$ regions). An example set of color-color and color-magnitude plots is shown in Figures 5 and 6, respectively. The color-color plots generally show a peak near 0 color due to main sequence and giant stars, and a red tail corresponding to the large variety of stars with circumstellar dust and possibly galaxies. The color-magnitude plots can be used to show the limiting magnitudes where the flux errors become large and the colors begin to show large deviations. This is not apparent 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 each degree of longitude in the GLIMPSEII survey are available from the GLIMPSE web site (http://www.astro.wisc.edu/glimpse/glimpse2/v1.0/ColorColor/ and
http://www.astro.wisc.edu/glimpse/glimpse2/v1.0/ColorMag/).

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

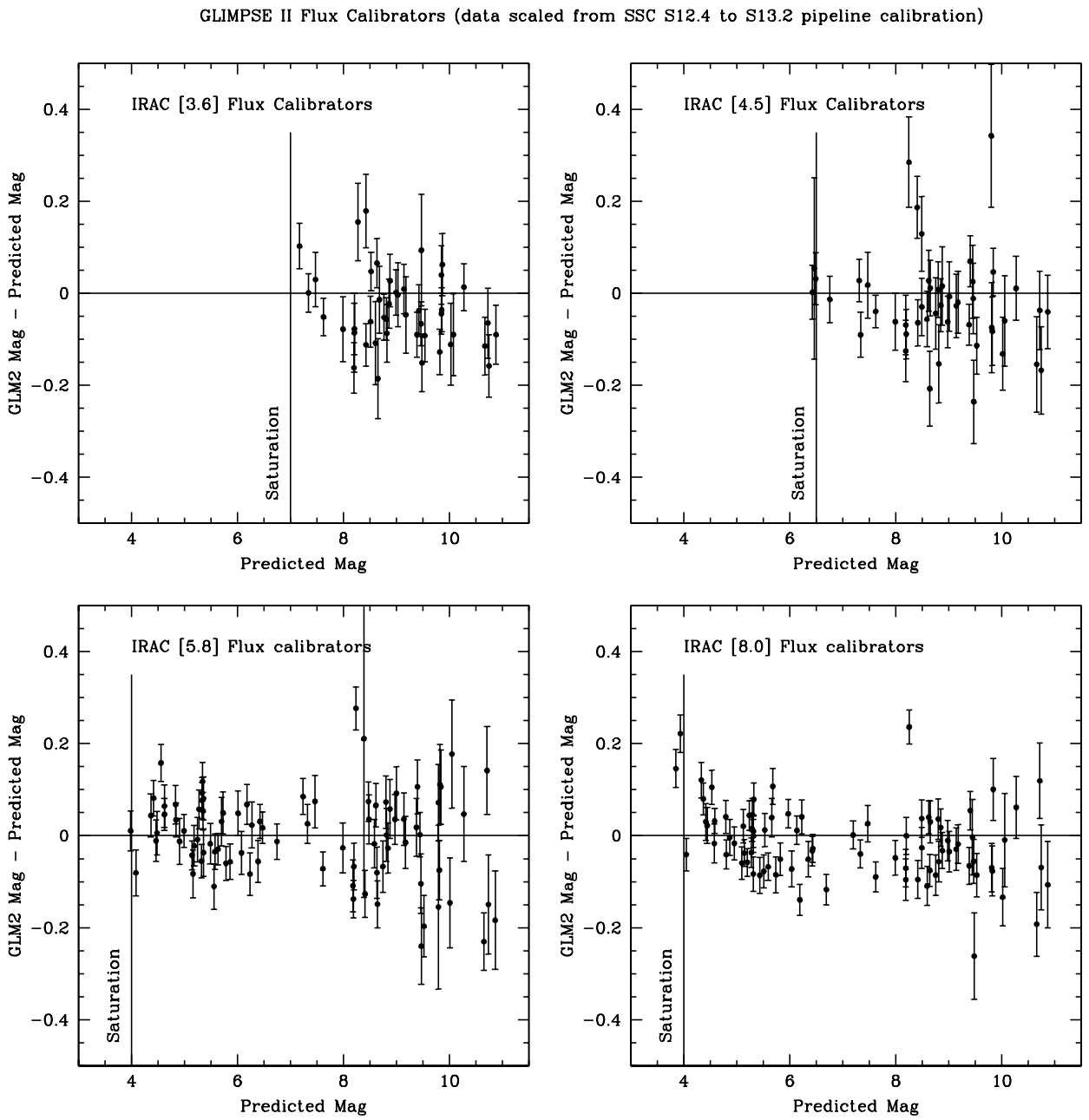

Figure 4: Comparison of GLIMPSEII flux calibrators to predictions provided by Martin Cohen for each IRAC band. Error bars are the root-sum-of-squares of the errors of both the extracted and predicted magnitudes for each source. The vertical lines are the best estimates of the saturation limits.

Spectral Energy Distributions (SEDs) of several sources. The l=0°-1° and l=4°-5° Catalogs and Archives were run through our SED grid and fitter (Robitaille et al. 2006, 2007), using a large grid of stellar atmosphere models. Four data points were required for the fit. About >98% (Archive) and >99% (Catalog) of the sources were well-fit within the χ^2 per datapoint < 3 and are therefore likely valid data. The remaining <1% (Catalog) and <2% (Archive) sources were examined individually and we found that about 1/2 to 2/3 of the sources have a datapoint that is questionable

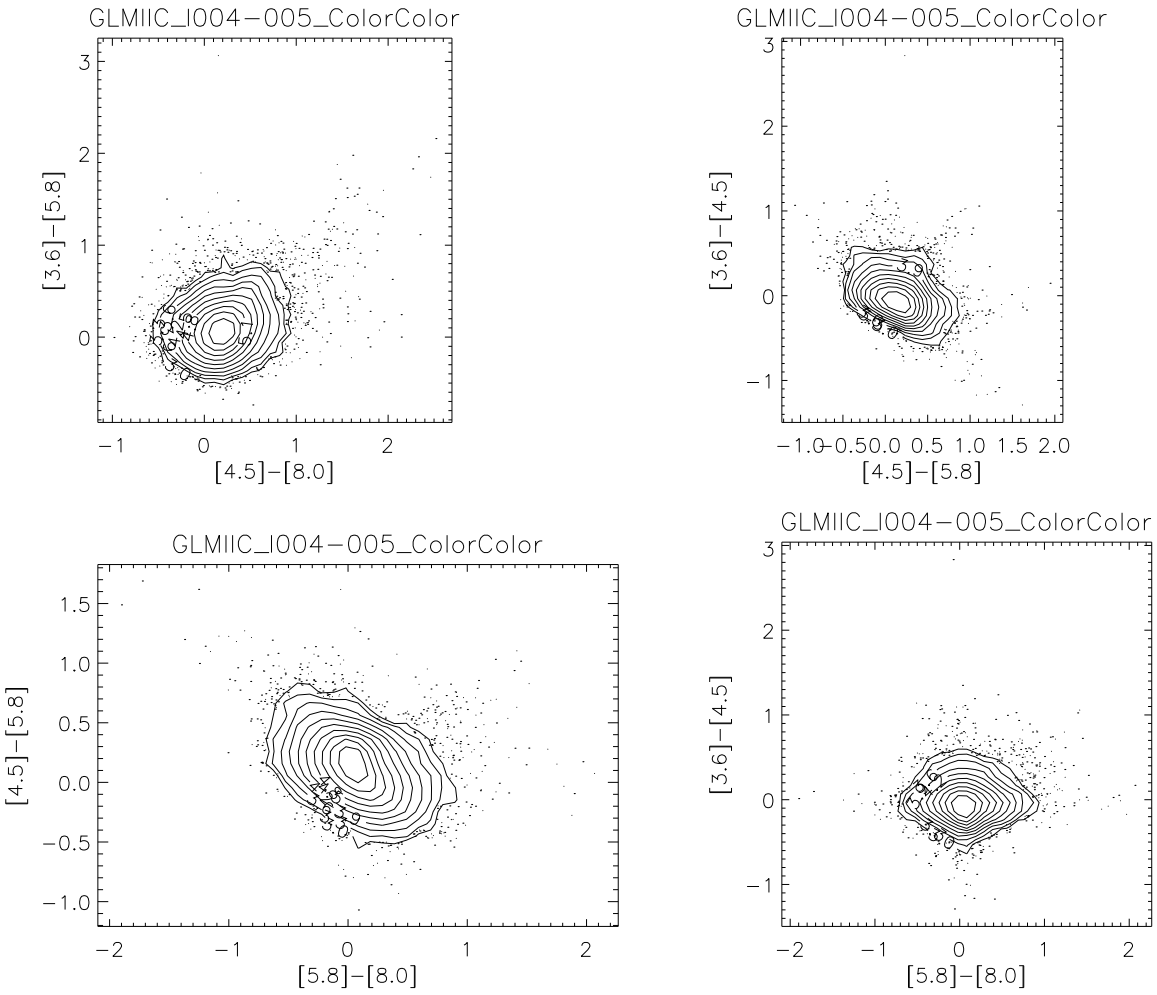

Figure 5: Color-color plots of the region $l = 4 - 5^\circ$ and $|b| < 1.55^\circ$ for sources in the Catalog. 10 contours are evenly spaced between log(# sources/mag^2)=2.0 and the log of maximum number of sources per square magnitude. The contours are labelled with the log of the number of sources per square magnitude. Outside of the lowest contour, the positions of individual sources are plotted.

(due to bad or matched IRAC or 2MASS fluxes, or variability between IRAC and 2MASS). The rest are real sources not well fit by stellar atmospheres, e.g. dusty Young Stellar Objects and evolved stars. As another sanity check, the values of the Source Quality Flag were plotted as a function of source position. No obvious problems were apparent.

5 Data Products Description

5.1 Catalog and Archive Fields and Flags

Each entry in the GLIMPSEII Catalog and Archive has the following information:

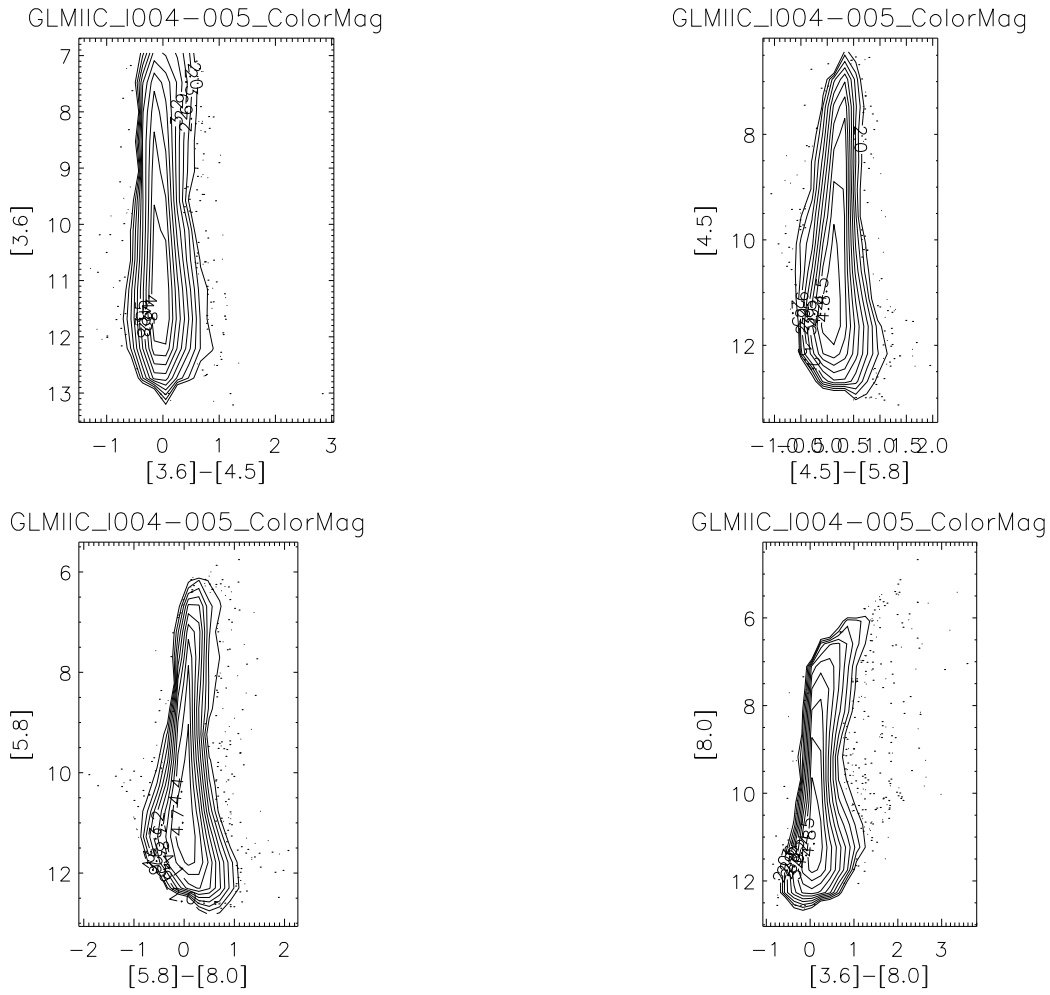

Figure 6: Color-magnitude plots of the region $l = 4 - 5°$ and $|b| < 1.55°$ for sources in the Catalog. 10 contours are evenly spaced between log(# sources/mag^2)=2.0 and the log of the maximum number of sources per square magnitude. The contours are labelled with the log of the number of sources per square magnitude. Outside of the lowest contour, the positions of individual sources are plotted.

designation	SSTGLMC GLLL.llll±BB.bbbb, SSTGLMA 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$_i$, 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 1 - 4) (3.6 μm, 4.5 μm, 5.6 μm and 8.0 μm) and t is the 2MASS wavelength band (J, H, K$_s$). Details of the fields are as follows:

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 SSTGLMC (GLIMPSEII Catalog) or SSTGLMA (GLIMPSEII Archive).

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 http://pegasus.phast.umass.edu/ipac_wget/releases/allsky/doc/sec2_2a.html for more information about these fields.

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[14] 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 GLIMPSEII point source accuracy 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.

Flux
For each IRAC band i = 3.6, 4.5, 5.6, 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 errors 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 for the S12.4 SSC processing version are from Martin Cohen 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	277.5	179.5	116.5	63.13

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). Magnitude uncertainties are estimated to be <0.2 mag for the Catalog and < 0.3 mag for the Archive. The uncertainties are smaller in bands 1 and 2 than bands 3 and 4 due to lower

[14] http://ssc.spitzer.caltech.edu/postbcd/pointingrefine.html

backgrounds in bands 1 & 2 and the lower sensitivity of the band 3 detector. Table 2 shows the percentages of sources meeting the 0.2 mag accuracy criterion.

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.

Diagnostics

The associated flux diagnostics are a local background level (sky_i) (i = 3.6, 4.5, 5.6, 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 local background, an output of DAOPHOT, is provided because high backgrounds were shown to affect the reliability of IRAS sources, and for IRAC as well (especially bands 3 and 4) (see the GQA document). However, the effects may not be easily characterizable in the quoted error. The Signal/Noise is the flux (F_i) divided by the flux error (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 section. 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 than twice per band.

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 (see §VIII of the GQA) 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, after point source extraction on individual IRAC frames. 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, and has likely increased the error assigned to the source flux. If just one of the IRAC detections 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. We are continuing to study the effects of various SQF bits on data quality.

Table 5 shows the SQF sequence for the January 2007 GLIMPSEII v1.0 data release. The stray light flag has not been implemented, but will be in future data releases. We have determined that false sources from such regions do not make it into the Catalog due to our 2+1 source selection criterion (§3.2). In addition, our photometry algorithm has been modified substantially to find sources in high background regions that gives it the ability to find sources in stray light and banded regions as well, increasing the photometric uncertainties accordingly.

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[a]	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
17	stray light[b]	GLIMPSE
19	linearization not applied	SSC dmask
20	saturated star wing region	GLIMPSE
20	diffraction spike (d)	2MASS
30	within three pixels of edge of frame	GLIMPSE

[a]Due to the short exposure time and high sky backgrounds in the GLIMPSEII fields, we have not seen evidence for latent sources in the images, even though they are flagged via an automatic algorithm in SSC's processing.

[b]We plan to have this implemented in a future data release.

• Flux calculation Method Flag (MF_i). This is a flag for each band indicating how the final averaged

flux was determined by weighting individual flux measurements. An MF=2 could indicate a variable source. Table 6 defines the values for this flag.

Table 6. Method Flag (MF)

MF	Description
0	all fluxes in agreement within errors
1	some discrepant fluxes discarded
2	all fluxes were discrepant; use this source with caution

5.2 GLIMPSEII Image Atlas

The IRAC images are mosaicked using the Montage[15] package 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. The angular size of each tile is 1.1°×0.8°, 1.1°×1.2°, and 1.1°×1.6°, depending on the latitude range covered for the particular longitude. Three tiles span the latitude range of the survey and ∼20 span the longitude range, giving a total of ∼60 mosaic images in each band to cover the survey region. The pixel size is 0.6″ , smaller than the native IRAC pixel size of 1.2″ . 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. We also provide larger (3.1°×2.4°, 3.1°×3.45°, and 3.1°×4.5°) FITS files with a pixel size of 1.2″ for an overview look that covers the full latitude range of GLIMPSEII. There are 28 of these mosaics. For a quick-look of the mosaics, we provide 3-color jpeg files (bands 1, 2 and 4) for each area covered by the FITS files. These are rebinned to much lower resolution to make the files small. Note that outside the nominal survey coverage we do not necessarily have full coverage in all four IRAC bands. This can be seen in the jpeg files.

6 Product Formats

6.1 Catalog and Archive

• The Catalog and Archive are broken into 1° (longitude) x 2.3-4° (latitude) areas for the GLIMPSEII Survey. 20 Catalog files and 20 Archive files were delivered for the entire survey region. Each Catalog, 1° in longitude (all latitudes), has from about 450,000 to 1.4 million sources and each Archive Area has from 600,000 to 1.8 million sources. The Catalog and Archive files are in IPAC Table Format (http://irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html). Filenames are GLMIIC_llmin.tbl and GLMIIA_llmin.tbl, for the Catalog and Archive respectively (e.g. GLMIIC_l006.tbl, GLMIIC_l007.tbl, GLMIIA_l006.tbl, GLMIIA_l007.tbl, etc.) The entries are sorted by increasing Galactic longitude within each file. Due to the nature of the survey mapping, there are areas that were observed with latitudes outside of the nominal GLIMPSEII survey region. Source lists are provided for those areas. There is a small amount of IRAC coverage from l=9.8° to 10° and l=350° to 350.2° where there was overlap between the GLIMPSEII and GLIMPSEI surveys. Source lists in these areas use data from both the GLIMPSEII and GLIMPSEI

[15] http://montage.ipac.caltech.edu

surveys. The GLIMPSEI data (SSC pipeline processing S10.5 and earlier) bandmerged with the GLIMPSEII data used the same flux calibration as the GLIMPSEII data (SSC processing S12.4).

• 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 (SSTGLMC GLLL.llll±BB.bbbb) Archive (SSTGLMA 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 error in t=J,H,K_s bands	mag	R*4	6F7.3	99.999,99.999
19–26	mag_i,$dmag_i$	Magnitudes & 1σ error in IRAC band i	mag	R*4	8F7.3	99.999,99.999
27–32	F_t,dF_t	Fluxes & 1σ error in t=J,H,K_s bands	mJy	R*4	6E11.3	-999.9,-999.9
33–40	F_i,dF_i	Fluxes & 1σ error 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

• Example of GLMIIC entry:

SSTGLMC G004.0000-00.9893 17583907-2559569 173833910 4.000028 -0.989365 0.3 0.3
269.662811 -25.999187 0.3 0.3 0 14.126 0.062 12.361 0.054 11.665 0.035
11.045 0.067 11.046 0.060 10.920 0.111 11.073 0.069
3.565E+00 2.036E-01 1.164E+01 5.788E-01 1.439E+01 4.637E-01
1.060E+01 6.528E-01 6.850E+00 3.816E-01 4.994E+00 5.122E-01 2.350E+00 1.496E-01
4.571E-01 1.867E-01 4.710E-01 2.889E-01 3.297E+00 2.016E+00 8.302E+00 3.342E+01
17.51 20.11 31.02 16.23 17.95 9.75 15.71 112.0 106.0 31.9 20.4
2 3 2 3 2 3 2 3 8192 8192 8192 0 8192 8192 9216 0 0 0 0

The columns in this example are described in Table 8.

Table 8. Example of Catalog/Archive Entry

designation	SSTGLMC G004.0000-00.9893	Name
tmass_desig	17583907-2559569	2MASS designation
tmass_cntr	173833910	2MASS counter
l,b	4.000028 -0.989365	Galactic Coordinates (deg)
dl,db	0.3 0.3	Uncertainty in Gal. Coordinates (arcsec)
ra,dec	269.662811 -25.999187	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	14.126 12.361 11.665	Magnitudes (2MASS J,H,K_s) (mag)
	0.062 0.054 0.035	Uncertainties (2MASS) (mag)
mag,dmag	11.045 11.046 10.920 11.073	Magnitudes (IRAC bands 1-4) (mag)
	0.067 0.060 0.111 0.069	Uncertainties (IRAC) (mag)
F,dF	3.565E+00 1.164E+01 1.439E+01	2MASS Fluxes (mJy)
	2.036E-01 5.788E-01 4.637E-01	Uncertainties in 2MASS fluxes (mJy)
F,dF	1.060E+01 6.850E+00 4.994E+00 2.350E+00	IRAC Fluxes (mJy)
	6.528E-01 3.816E-01 5.122E-01 1.496E-01	Uncertainties in IRAC fluxes (mJy)
F_rms	4.571E-01 1.867E-01 4.710E-01 2.889E-01	RMS_flux (mJy) (IRAC)
sky	3.297E+00 2.016E+00 8.302E+00 3.342E+01	Sky Bkg (MJy/sr) (IRAC)
SN	17.51 20.11 31.02	Signal to Noise (2MASS)
SN	16.23 17.95 9.75 15.71	Signal to Noise (IRAC)
srcdens	112.0 106.0 31.9 20.4	Local Source Density (IRAC) (#/sq arcmin)
M	2 3 2 3	Number of detections (IRAC)
N	2 3 2 3	Number of possible detections (IRAC)
SQF	8192 8192 8192	Source Quality Flag (2MASS)
SQF	0 8192 8192 9216	Source Quality Flag (IRAC)
MF	0 0 0 0	Flux Calculation Method Flag (IRAC)

6.2 GLIMPSEII 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 GLIMPSEII processing such as IRAC frames included in the mosaicked image and coordinate information.

The mosaic images are each 1.1°x 0.8°, 1.1°x 1.2°, and 1.1°x 1.6°, depending on the latitude coverage, with 0.6″ pixels. The 1.1°x 0.8° mosaics are 128 Megabytes in size. The 1.1°x 1.2° mosaics are 192 Megabytes in size and the 1.1°x 1.6° mosaics are 255 MB. There are three mosaics per one degree galactic longitude interval with 0.05° overlap in longitude between mosaics. For example, for the Galactic longitude of 8°, the centers of the three mosaics will be (8.5°, +0.75°), (8.5°, 0.0°), and (8.5°, -0.75°). The longitude range is 7.95° to 9.05° for each of the three mosaics. The latitude ranges are 0.35° to 1.15°, -0.40° to +0.40°, and -1.15° to -0.35°, also overlapping by 0.05°. Filenames are GLM_*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 channel number. For example, GLM_00850+0075_mosaic_I1.fits is a 1.1°x 0.8° IRAC channel 1 mosaic centered on l=8.50°, b=0.75°. We provide low-resolution 3-color jpeg images for each area, combining bands 1, 2, and 4 to be used for quick-look purposes. The filename for this jpeg file is similar to the mosaic FITS file: e.g. GLM_00850+0000.jpg We also provide larger (3.1°x 2.4°, 3.1°x 3.45°and 3.1°x 4.5°) mosaic FITS files (1.2″ pixels) for each band, along with low resolution 3-color jpegs. Each 3.1°x 2.4° mosaic is about 269 Megabytes in size. The 3.1°x 3.45° mosaic is 388 Megabytes in size and the 3.1°x 4.5° mosaic is 504 Megabytes. The filenames are similar to the other FITS and jpeg images: e.g. GLM_00900+0000_mosaic_I1.fits, GLM_00900+0000_3x2.jpg.

Here is an example of the FITS header for a 1.1°x 0.8° file, GLM_00850+0000_mosaic_I1.fits:

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 6640 / length of data axis 1
NAXIS2  =                 4840 / 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= 'S12.4.0 '           / SSC pipeline that created the BCD
PIPEVERS= '1v04    '           / GLIMPSE pipeline version
MOSAICER= 'Montage V2.2'       / SW that originally created the Mosaic Image
FILENAME= 'GLM_00850+0000_mosaic_I1.fits' / Name of associated fits file
PROJECT = 'GLIMPSEIIA'         / Project ID
FILETYPE= 'mosaic  '           / Calibrated image(mosaic)/residual image(resid)
CHNLNUM =                    1 / 1 digit Instrument Channel Number
DATE    = '2006-11-06T18:33:32' / file creation date (YYYY-MM-DDThh:mm:ss UTC)
COMMENT --------------------
COMMENT Proposal Information
COMMENT --------------------
OBSRVR  = 'Ed Churchwell'      / Observer Name
OBSRVRID=                   90 / Observer ID of Principal Investigator
PROCYCLE=                    5 / Proposal Cycle
PROGID  =                20201 / Program ID
PROTITLE= 'GLIMPSE II: Imaging the Centra' / Program Title
PROGCAT =                   30 / Program Category
COMMENT -----------------------------
COMMENT Time and Exposure Information
COMMENT -----------------------------
SAMPTIME=                  0.2 / [sec] Sample integration time
FRAMTIME=                  2.0 / [sec] Time spent integrating each BCD frame
EXPTIME =                  1.2 / [sec] Effective integration time each BCD frame
COMMENT DN per pixel=flux(photons/sec/pixel)/gain*EXPTIME
NEXPOSUR=                    2 / 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=                    4 / Fowler number
COMMENT --------------------
COMMENT Pointing Information
COMMENT --------------------
CRPIX1  =            3320.5000 / Reference pixel for x-position
CRPIX2  =            2420.5000 / Reference pixel for y-position
CTYPE1  = 'GLON-CAR'           / Projection Type
CTYPE2  = 'GLAT-CAR'           / Projection Type
CRVAL1  =           8.50000000 / [Deg] Galactic Longtitude at reference pixel
```

```
CRVAL2  =           0.00000000 / [Deg] Galactic Latitude at reference pixel
EQUINOX =               2000.0 / Equinox for celestial coordinate system
DELTA-X =           1.10666668 / [Deg] size of image in axis 1
DELTA-Y =           0.80666667 / [Deg] size of image in axis 2
BORDER  =           0.00333333 / [Deg] mosaic grid border
CD1_1   =      -1.66666665E-04
CD1_2   =       0.00000000E+00
CD2_1   =       0.00000000E+00
CD2_2   =       1.66666665E-04
PIXSCAL1=                0.600 / [arcsec/pixel] pixel scale for axis 1
PIXSCAL2=                0.600 / [arcsec/pixel] pixel scale for axis 2
OLDPIXSC=                1.221 / [arcsec/pixel] pixel scale of single IRAC frame
RA      =         271.15618896 / [Deg] Right ascension at mosaic center
DEC     =         -21.59907150 / [Deg] Declination at mosaic center
COMMENT ----------------------
COMMENT Photometry Information
COMMENT ----------------------
BUNIT   = 'MJy/sr  '           / Units of image data
GAIN    =                  3.3 / e/DN conversion
JY2DN   =           310192.375 / Average Jy to DN Conversion
ETIMEAVE=               1.2000 / [sec] Average exposure time for the BCD frames
PA_AVE  =                89.89 / [deg] Average position angle
ZODY_AVE=              0.09187 / [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=          0.457191199 / Average MJy/sr to DN/s Conversion
COMMENT ----------------------------
COMMENT AORKEYS/ADS Ident Information
COMMENT ----------------------------
AOR001  = '0014347776'         / AORKEYS used in this mosaic
AOR002  = '0014348032'         / AORKEYS used in this mosaic
AOR003  = '0014347520'         / AORKEYS used in this mosaic
AOR004  = '0014347264'         / AORKEYS used in this mosaic
AOR005  = '0014347008'         / AORKEYS used in this mosaic
DSID001 = 'ads/sa.spitzer#0014347776' / Data Set Identification for ADS/journals
DSID002 = 'ads/sa.spitzer#0014348032' / Data Set Identification for ADS/journals
DSID003 = 'ads/sa.spitzer#0014347520' / Data Set Identification for ADS/journals
DSID004 = 'ads/sa.spitzer#0014347264' / Data Set Identification for ADS/journals
DSID005 = 'ads/sa.spitzer#0014347008' / Data Set Identification for ADS/journals
NIMAGES =                  334 / 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, GLM_00850+0000_mosaic_I1.hdr includes:

```
COMMENT ----------------------------------------
```

```
COMMENT Info on Individual Frames in Mosaic
COMMENT ---------------------------------------
IRFR0001= 'SPITZER_I1_0014347776_0207_0000_01_levbflx.fits' / IRAC frame
DOBS0001= '2005-09-22T02:52:07.006' / Date & time at frame start
MOBS0001=      53635.121093750 / MJD (days) at frame start
RACE0001=           270.921204 / [Deg] Right ascension at reference pixel
DECC0001=           -21.261402 / [Deg] Declination at reference pixel
PANG0001=                90.08 / [deg] Position angle for this image
FLXC0001=              0.11040 / Flux conversion for this image
ZODY0001=              0.09135 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
IRFR0002= 'SPITZER_I1_0014347776_0228_0000_01_levbflx.fits' / IRAC frame
COMMENT Image contribution to mosaic <5% of IRAC image
DOBS0002= '2005-09-22T02:57:07.805' / Date & time at frame start
MOBS0002=      53635.121093750 / MJD (days) at frame start
RACE0002=           271.837494 / [Deg] Right ascension at reference pixel
DECC0002=           -21.257566 / [Deg] Declination at reference pixel
PANG0002=                89.75 / [deg] Position angle for this image
FLXC0002=              0.11040 / Flux conversion for this image
ZODY0002=              0.09028 / [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 333
.
IRFR0334= 'SPITZER_I1_0014348032_0206_0000_01_levbflx.fits' / IRAC frame
DOBS0334= '2005-09-22T08:28:06.139' / Date & time at frame start
MOBS0334=      53635.351562500 / MJD (days) at frame start
RACE0334=           271.076141 / [Deg] Right ascension at reference pixel
DECC0334=           -20.933035 / [Deg] Declination at reference pixel
PANG0334=                90.10 / [deg] Position angle for this image
FLXC0334=              0.11040 / Flux conversion for this image
ZODY0334=              0.09059 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
```

7 GLIMPSEII Data Delivery Schedule

Documentation will be provided with each data delivery.

```
January 2007 (delivered)
  derived from data taken in September 2005 (epoch 1) with S12.4 SSC processing
  v1.0 source lists - point source Archive and Catalog, IRAC+2MASS
       (about 16 million Catalog sources, 21 million Archive sources)
  v1.0 mosaics and 3-color jpgs
      1.1x0.8 deg 0.6" pixel mosaics - for 8 degrees of longitude
           (l=6 through 9 deg; l=350 through 353 deg)- 96 fits files
```

```
       3.1x2.4 deg 1.2" pixel mosaics  (centered at l=9 and 351 deg)- 8 fits files

  May 2007
    v1.0 mosaics and 3-color jpgs
     the remaining images for the rest of the GLIMPSEII survey from data taken
     in September 2005 and processed by SSC pipeline version S12.4.
      1.1x1.2 deg 0.6" pixel mosaics for l=5,4,3,354,355,356 deg (72 fits files)
      1.1x1.6 deg 0.6" pixel mosaics for l=2,1,0,359,358,357 deg (72 fits files)
      3.1x3.45 deg 1.2" pixel mosaics centered at l=6,354 deg  (8 fits files)
      3.1x4.5 deg 1.2" pixel mosaics of l=0,3,357        (12 fits files)

*NOTE* Re-delivery of mosaics delivered in January 2007, with a slightly updated
      fits header (see the README file accompanying the data files for the details):
      1.1x0.8 deg 0.6" pixel mosaics for l=6,7,8,9,350,351,352,353 deg (96 fits files)
      3.1x2.4 deg 1.2" pixel mosaics centered at l=9,351 deg    (8 fits files)

  Fall 2007
    v2.0 source lists - both epochs (all 3 passes) + Galactic center
    v2.0 mosaics - some of them

  Spring 2008
    v2.0 mosaics - the remaining mosaics for the rest of the GLIMPSEII survey,
      including the Galactic center
    v2.0 source lists of each epoch separately, to be used for variable stars and
      asteroid hunting.
    v2.0 source lists of the subarray mode data
```

8 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 http://ssc.spitzer.caltech.edu/irac/products/pmask.html and http://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. Due to the short exposure times (two seconds) and high sky backgrounds in the GLIMPSEII survey we have not seen latent images in the data, even though they are flagged.

7 muxbleed correction applied (bands 1 & 2)
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). After inspecting IRAC frames, we have added bit 12 to the pmask to flag additional pixels we found to be bad. 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.

9 muxbleed correction $> 3\sigma$ above the background (bands 1 & 2)
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 (bands 1 & 2)
This bit is set if the source is within 3 pixels of a column pulldown corrected pixel.

16 banding corrected (bands 3 & 4)

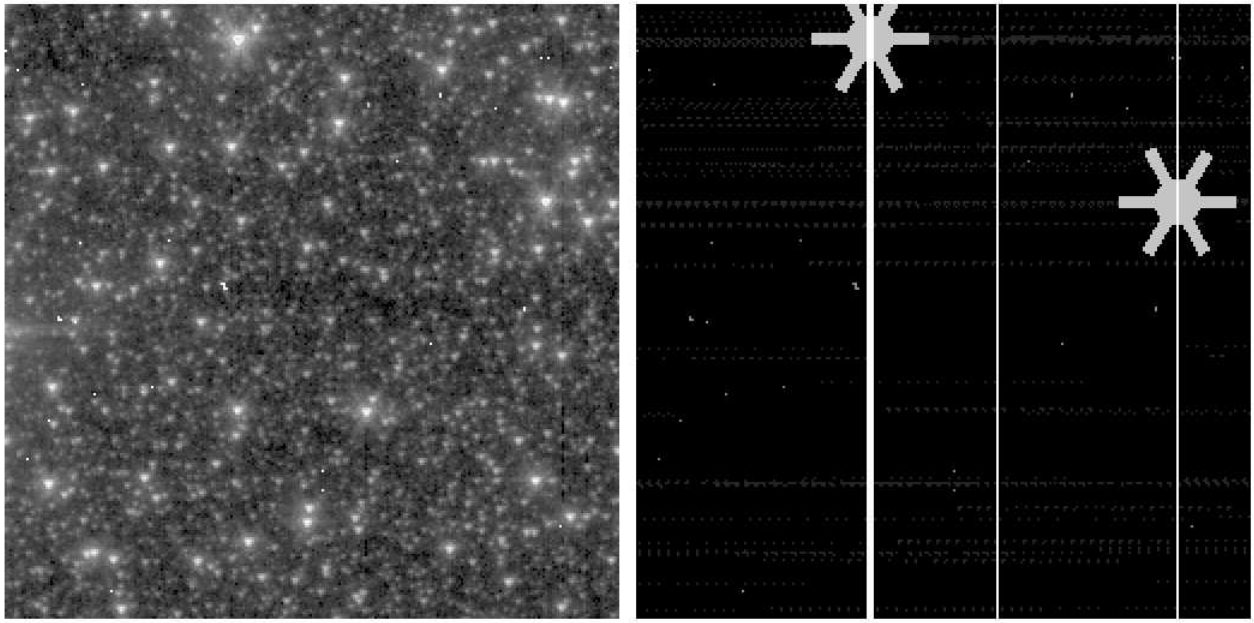

Figure 7: The band 1 IRAC frame (AOR 14347776, exposure 159) is on the left (corrections were applied for muxbleed and column pulldown); the flags for that frame are shown on the right. The PSF-shaped areas around the bright sources correspond to SQF bit 20. The vertical lines correspond to where the 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.

This bit is set if the source is within 3 pixels of a banding corrected pixel.

19 linearization correction not applied
This bit is set when a source is within 3 pixels of a pixel identified in the SSC IRAC dmask as not having a linearization correction applied (bit 12 in the dmask).

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. See Figure 7 for an example of the shapes of the saturated star wing areas flagged by this bit.

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.

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

http://www.ipac.caltech.edu/2mass/release/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 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.

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 = $2^{(bt-1)}$ 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 30 => 536870912

For example, the Source Quality Flags in the example in Table 8 are 8192 for all three 2MASS bands and IRAC bands 2 and 3. This translates to bit 14 being set, which means the bandmerger reported confusion in the cross-band merge step. IRAC band 4 has a SQF of 9216. This means bit 14 (cross-band merge confusion) has been set (value=8192). We subtract 8192 from 9216 and get 1024. This means bit 11 has been set (the DAOPHOT tweak negative bit).

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GLOSSARY

2MASS	Two Micron All Sky Survey
BCD	Basic Calibrated Data, released by the SSC
dmask	A data quality mask supplied by the SSC for the BCD
GLIMPSEI	Galactic Legacy Infrared Midplane Survey Extraordinaire
GLMIIC	GLIMPSEII Point Source Catalog
GLMIIA	GLIMPSEII Point Source Archive
GPD	GLIMPSE Pipeline Description
GQA	GLIMPSE Quality Assurance
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 method of weighting fluxes
MIPS	*Spitzer* Multiband Imaging Photometer
OSV	Observation Strategy Validation
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
SQF	Source Quality Flag
SST	*Spitzer* Space Telescope
smask	Stray light mask