GLIMPSEII Subarray mode - v1.0 Data Release

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Contents

1 GLIMPSEII Survey Overview

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. IRAC has four bands, centered at approximately 3.6, 4.5, 5.8 and 8.0 μm respectively. We refer to them as bands 1 - 4 in this document. The GLIMPSEI survey covered 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°, $\pm 1.5^\circ$ from $|l| = 5^\circ$ to 2°, and $\pm 2^\circ$ from $|l| = 2^\circ$ to 0°. GLIMPSEII coverage excludes the Galactic center region l=$\pm 1^\circ$, b=$\pm 0.75^\circ$ observed by the GALCEN GO program (PID=3677).

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 Benjamin et al. (2003), Churchwell et al. (2009) and the GLIMPSE web site (www.astro.wisc.edu/glimpse/glimpse2_dataprod_v2.1.pdf) for more description of the GLIMPSEII project.

Bulge/bar OH/IR stars, LPVs, carbon stars, and foreground AGB stars are likely to be saturated in the IRAC bands. In order to recover photometry of the most luminous of these sources, in May 2007 we obtained very short (0.02 sec frametime) exposures of these stars using the IRAC Subarray mode[2]. In the GLIMPSEII survey area, 58 positions of bright point sources and 9 positions of very bright diffuse flux were observed in Subarray mode. Table 1 gives information about these positions: the observer-specified target name, Galactic longitude (l) of the target position, Galactic latitude (b) of the target position, UTC Time at the start of the execution of the observation, AOR_key (unique observation identification number) and AOR_LABEL (observer-specified observation title). Each point source observation was one BCD frame per band. The diffuse flux observations were somewhat larger in area, a few frames per band per observation.

This document describes the data products from the GLIMPSEII Subarray mode data. The organization is as follows: §2 describes the data products; §3 gives an overview of the data processing; §4 discusses the quality checks; §5 provides a detailed description of the data products; and §6 describes the format. This document contains numerous acronyms, a glossary of which is given at the end.

2 Subarray mode Data Products

The GLIMPSEII Subarray mode enhanced data products consist of a Subarray mode Point Source List (GLMIIS) and mosaic images. These data products will be available at the Spitzer Science Center (SSC) and at the Infrared Science Archive (IRSA).

- SSC – http://ssc.spitzer.caltech.edu/legacy/glimpsehistory.html
- IRSA – http://irsa.ipac.caltech.edu/data/SPITZER/

[1] Although originally known as GLIMPSE, we will use the acronym GLIMPSEI to avoid confusion between it, GLIMPSEII and GLIMPSE3D

[2] http://ssc.spitzer.caltech.edu/irac/iracinstrumenthandbook/10/#_Toc257619100

The enhanced data products are:

1. The GLIMPSEII Subarray mode Point Source List (GLMIIS) consists of 61 sources extracted from the 58 point source positions observed in Subarray mode (Table 1). Figure 1 shows plots of the Spectral Energy Distributions (SEDs) of each source. For each IRAC band, the source list provides fluxes (with uncertainties), positions (with uncertainties), the local sky brightness, and a flag that provides information on source quality and any anomalies present in the data. See §5.1 for details. 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 source list is ASCII, using the IPAC Tables convention (http://irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html).

2. Several mosaics, each covering 3.1°×2.4°, 3.1°×3.45°, and 3.1°×4.5° areas (similar in size to the "regular" survey GLIMPSEII images), have been made which contain only the GLIMPSEII Subarray mode data. For example, the GLMSUB_00600+0000_mosaic_I1.fits image is 3.1°×3.45°and contains 12 of the GLIMPSEII Subarray mode areas. The images have a pixel size of 1.2″ These are 32-bit IEEE floating point single extension FITS formatted images projected in Galactic coordinates. The images are in units of surface brightness MJy/sr.

3 Data Processing

We used the irac_subcube_collapse.pro obtained from the SPITZER Science Center at the Contributed Software site for Data Analysis and Tools (http://ssc.spitzer.caltech.edu/dataanalysistools/tools/contributed/irac/subcubecollapse/) to collapse each subarray data cube file into a single coadded image, updating the header information appropriately for the exposure time and frametime to accommodate our pipeline software.

From this point on, the processing is as described in our online documents[3], and we briefly summarize here. Photometry is performed on individual IRAC frames using a modified version of DAOPHOT (Stetson 1987, Babler 2006[4]) and combined in the bandmerger stage to produce the source lists. We use the SSC-supplied bandmerger[5] (modified by the GLIMPSE team) in two stages, first to combine all 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). There was no lumping of sources and no array-location-dependent correction was applied. We provide 2MASS fluxes with the IRAC data, when available. Our processing used the data produced from SSC pipeline processing version S16.1.

[3]http://www.astro.wisc.edu/glimpse/glimpse2_dataprod_v2.1.pdf
[4]http://www.astro.wisc.edu/glimpse/glimpse_photometry_v1.0.pdf
[5]http://ssc.spitzer.caltech.edu/postbcd/bandmerge.html

Table 1. Subarray Mode Target Position Information

TargetName	l (deg)	b (deg)	Start Of Execution (UTC)	AOR_key	AOR_LABEL
ptsrc 0	354.25644	-0.89222	2007-05-10 01:37:10.1	21509376	GLIMPSE II PT SRCS 0
ptsrc 1	358.29068	0.08092	2007-05-07 15:46:39.2	21508608	GLIMPSE II PT SRCS 1
ptsrc 2	358.16761	0.21303	2007-05-07 15:43:08.5	21507840	GLIMPSE II PT SRCS 2
ptsrc 3	358.13121	-0.02918	2007-05-07 15:48:28.6	21507072	GLIMPSE II PT SRCS 3
ptsrc 4	354.88376	-0.53888	2007-05-10 01:33:25.7	21506304	GLIMPSE II PT SRCS 4
ptsrc 5	352.90656	-0.36449	2007-05-10 01:42:51.7	21505280	GLIMPSE II PT SRCS 5
ptsrc 6	8.18335	0.74870	2007-05-09 08:09:27.2	21504512	GLIMPSE II PT SRCS 6
ptsrc 7	358.35836	0.08805	2007-05-07 15:44:54.8	21503744	GLIMPSE II PT SRCS 7
ptsrc 8	0.16919	-1.31450	2007-05-07 15:56:45.1	21503488	GLIMPSE II PT SRCS 8
ptsrc 9	354.79674	0.41650	2007-05-10 01:45:05.8	21502976	GLIMPSE II PT SRCS 9
ptsrc 10	5.15616	0.74002	2007-05-08 03:27:16.2	21496832	GLIMPSE II PT SRCS 10
ptsrc 11	352.12586	0.53885	2007-05-08 02:31:39.7	21496320	GLIMPSE II PT SRCS 11
ptsrc 12	7.15482	-0.46095	2007-05-08 05:24:26.6	21495808	GLIMPSE II PT SRCS 12
ptsrc 13	1.58436	0.28904	2007-05-08 03:03:36.7	21495296	GLIMPSE II PT SRCS 13
ptsrc 14	4.03862	0.05537	2007-05-08 03:07:59.4	21494784	GLIMPSE II PT SRCS 14
ptsrc 15	351.41739	0.64351	2007-05-08 02:27:48.7	21494272	GLIMPSE II PT SRCS 15
ptsrc 16	5.45214	0.28819	2007-05-08 03:25:22.5	21493760	GLIMPSE II PT SRCS 16
ptsrc 17	354.21330	-0.77103	2007-05-10 01:38:51.9	21493248	GLIMPSE II PT SRCS 17
ptsrc 18	353.60784	-0.23599	2007-05-10 01:40:52.7	21492736	GLIMPSE II PT SRCS 18
ptsrc 19	8.19281	0.13846	2007-05-08 05:36:15.8	21492480	GLIMPSE II PT SRCS 19
ptsrc 20	0.42528	-0.85876	2007-05-07 20:26:02.4	21508864	GLIMPSE II PT SRCS 20
ptsrc 21	356.41326	-0.32959	2007-05-08 02:47:02.9	21508096	GLIMPSE II PT SRCS 21
ptsrc 22	354.85142	-0.65468	2007-05-10 01:35:13.1	21507328	GLIMPSE II PT SRCS 22
ptsrc 23	7.30267	-0.05623	2007-05-08 05:34:13.7	21506560	GLIMPSE II PT SRCS 23
ptsrc 24	355.83060	-0.79684	2007-05-10 01:27:49.1	21505536	GLIMPSE II PT SRCS 24
ptsrc 25	352.91911	0.06335	2007-05-08 05:30:15.0	21504768	GLIMPSE II PT SRCS 25
ptsrc 26	5.71180	-0.50177	2007-05-08 03:16:11.9	21504000	GLIMPSE II PT SRCS 26
ptsrc 27	356.93325	-0.31292	2007-05-08 02:48:58.2	21503232	GLIMPSE II PT SRCS 27
ptsrc 28	3.50638	-1.40316	2007-05-08 03:13:51.2	21502720	GLIMPSE II PT SRCS 28
ptsrc 29	352.61566	-0.19449	2007-05-08 02:42:23.9	21502464	GLIMPSE II PT SRCS 29
ptsrc 30	10.16182	-0.36293	2007-05-09 08:07:03.6	21501440	GLIMPSE II PT SRCS 30
ptsrc 31	9.51697	-0.96399	2007-05-09 00:46:14.2	21501184	GLIMPSE II PT SRCS 31
ptsrc 32	3.08201	1.29754	2007-05-08 03:05:48.9	21500928	GLIMPSE II PT SRCS 32
ptsrc 33	357.65463	0.45044	2007-05-10 03:36:55.7	21500672	GLIMPSE II PT SRCS 33
ptsrc 34	9.20667	0.47299	2007-05-08 05:38:20.0	21500416	GLIMPSE II PT SRCS 34
ptsrc 35	3.81208	-1.07240	2007-05-08 03:11:54.7	21499904	GLIMPSE II PT SRCS 35
ptsrc 36	353.61386	0.27482	2007-05-08 02:37:45.0	21499648	GLIMPSE II PT SRCS 36
ptsrc 37	5.88592	-0.39272	2007-05-08 03:17:53.7	21499392	GLIMPSE II PT SRCS 37
ptsrc 38	355.15584	-0.59775	2007-05-10 01:31:35.9	21499136	GLIMPSE II PT SRCS 38
ptsrc 39	5.90298	0.37816	2007-05-08 03:23:28.2	21498880	GLIMPSE II PT SRCS 39
ptsrc 40	7.43518	-0.11639	2007-05-08 05:26:15.6	21497344	GLIMPSE II PT SRCS 40
ptsrc 41	7.20602	-1.03834	2007-05-08 05:22:33.3	21497088	GLIMPSE II PT SRCS 41
ptsrc 42	6.29192	0.00731	2007-05-08 03:19:46.2	21496576	GLIMPSE II PT SRCS 42
ptsrc 43	351.55533	0.20396	2007-05-08 02:29:44.7	21496064	GLIMPSE II PT SRCS 43
ptsrc 44	355.99954	-0.04411	2007-05-10 01:49:54.2	21495552	GLIMPSE II PT SRCS 44
ptsrc 45	355.04789	0.04332	2007-05-08 02:44:49.7	21495040	GLIMPSE II PT SRCS 45
ptsrc 46	3.88938	-1.03100	2007-05-08 03:10:09.3	21494528	GLIMPSE II PT SRCS 46
ptsrc 47	359.06916	-1.32686	2007-05-08 02:55:06.2	21494016	GLIMPSE II PT SRCS 47
ptsrc 48	358.06714	-1.73787	2007-05-08 02:51:12.5	21493504	GLIMPSE II PT SRCS 48
ptsrc 49	1.46180	-0.99672	2007-05-08 03:01:27.9	21492992	GLIMPSE II PT SRCS 49
ptsrc 50	350.04916	-0.25267	2007-05-08 05:42:45.9	21509632	GLIMPSE II PT SRCS 50
ptsrc 51	358.77587	-2.05052	2007-05-08 02:57:10.7	21509120	GLIMPSE II PT SRCS 51
ptsrc 52	6.11549	0.53130	2007-05-08 03:21:37.4	21508352	GLIMPSE II PT SRCS 52
ptsrc 53	354.00569	0.28881	2007-05-08 05:45:27.5	21507584	GLIMPSE II PT SRCS 53
ptsrc 54	358.99128	-0.07553	2007-05-07 15:50:31.9	21506816	GLIMPSE II PT SRCS 54
ptsrc 55	355.39489	-0.45967	2007-05-10 01:29:45.0	21506048	GLIMPSE II PT SRCS 55
ptsrc 56	358.39836	-1.27079	2007-05-08 02:53:06.7	21505024	GLIMPSE II PT SRCS 56
ptsrc 57	0.64191	-1.14806	2007-05-08 02:59:26.7	21504256	GLIMPSE II PT SRCS 57
2007 sat2	351.61196	0.16473	2007-05-08 02:35:24.3	21498624	IRAC-0001 sat 2
2007 sat3	351.55622	0.20387	2007-05-08 02:33:40.1	21497600	IRAC-0002 sat3
2007 sat4	351.41800	0.64279	2007-05-08 02:40:10.5	21501696	IRAC-0003 sat4
2007 sat5	5.88883	-0.39004	2007-05-09 00:20:05.4	21498368	IRAC-0004 sat 5
2007 sat6	10.16225	-0.36346	2007-05-09 00:33:31.6	21501952	IRAC-0005 sat6
2007 sat7	351.31963	0.66121	2007-05-08 06:44:00.8	21497856	IRAC-0006 sat7
2007 sat8	350.50353	0.95962	2007-05-08 05:48:07.9	21502208	IRAC-0007 sat8
2007 sat9	351.24633	0.66348	2007-05-08 07:32:06.8	21498112	IRAC-0008 sat9
2007 sat10	353.18803	0.90376	2007-05-08 06:57:16.3	21492224	IRAC-0009 sat10

4 Quality Checks

4.1 Color-Color Plots

Figure 2 shows the Color-color plots of the Subarray mode Point Source List fluxes, compared to the fluxes of 10000 GLIMPSEII Archive sources from the l=6 deg area that have fluxes in all 4 IRAC bands. The GLIMPSEII Archive sources are shown in black triangles; the GLIMPSEII Subarray mode sources are shown in red diamonds.

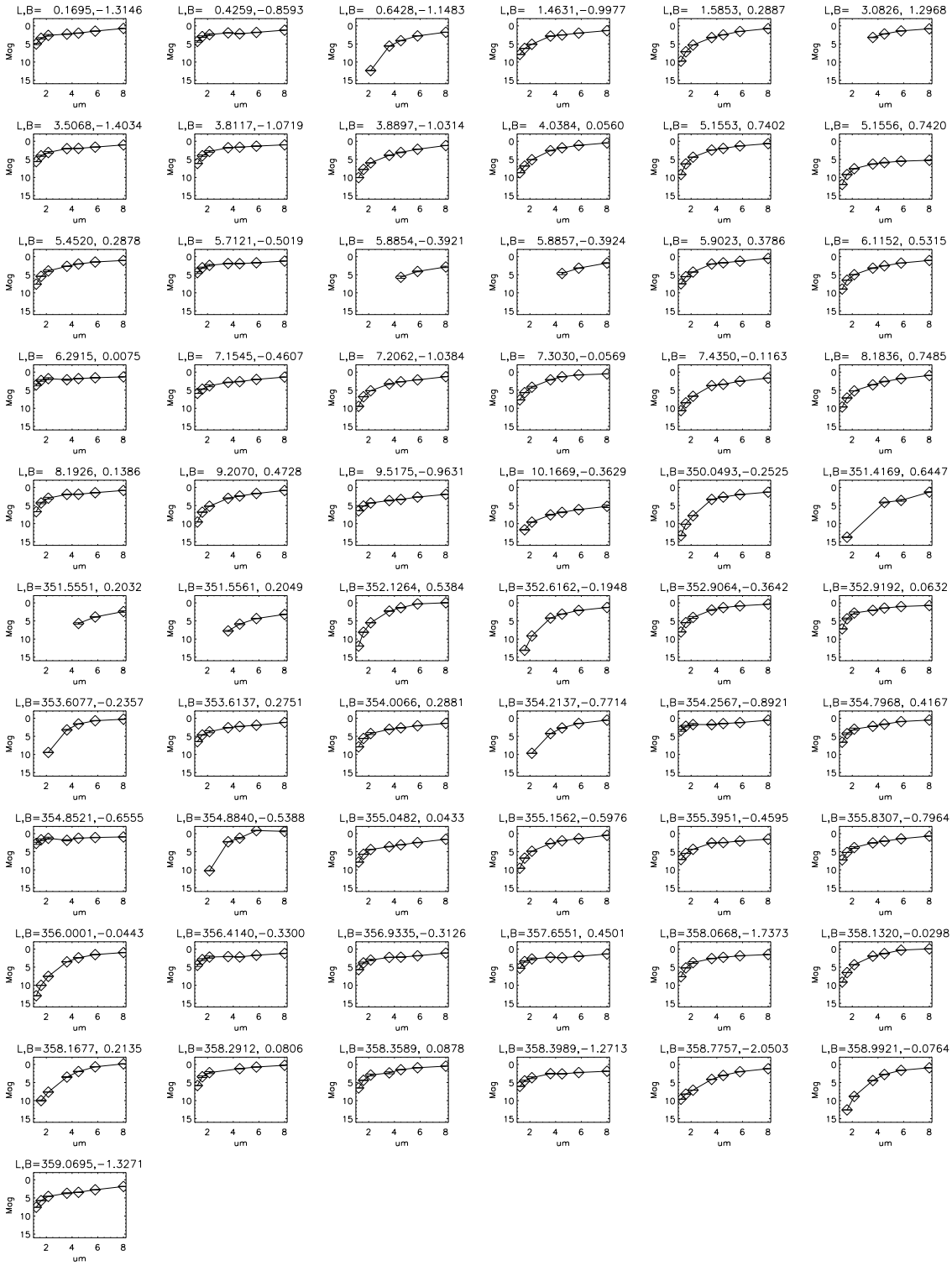

Figure 1: Spectral Energy Distributions (SEDs) of the 61 GLIMPSEII Subarray mode point sources.

4.2 Comparsion with GLIMPSEII Survey fluxes

We matched 27 of the 61 Subarray mode sources with sources from the GLIMPSEII Archive to provide a check on the Subarray flux measurements. The others were likely so saturated in the

GLIMPSEII survey mode (frametime = 2 sec) that they did not get detected by our starfinding algorithms. All of the matched sources are saturated in band 4 (this is why they were chosen for followup in Subarray mode).

For two of the 27 matched sources, in bands 1-3, the magnitudes agree to within errors (0.1 mags). These sources have magnitudes fainter than our GLIMPSEII nonlinear saturation limits.

The other 25 sources agree poorly because they are brighter than our nonlinear saturation limits (For the Archive we do not null sources brighter than the nonlinear saturation limits). These saturation limits are: 7, 6.5, 4, and 4 for bands 1-4 respectively. The user should use the Subarray mode fluxes for all 61 sources over anything found in the GLIMPSEII Archive.

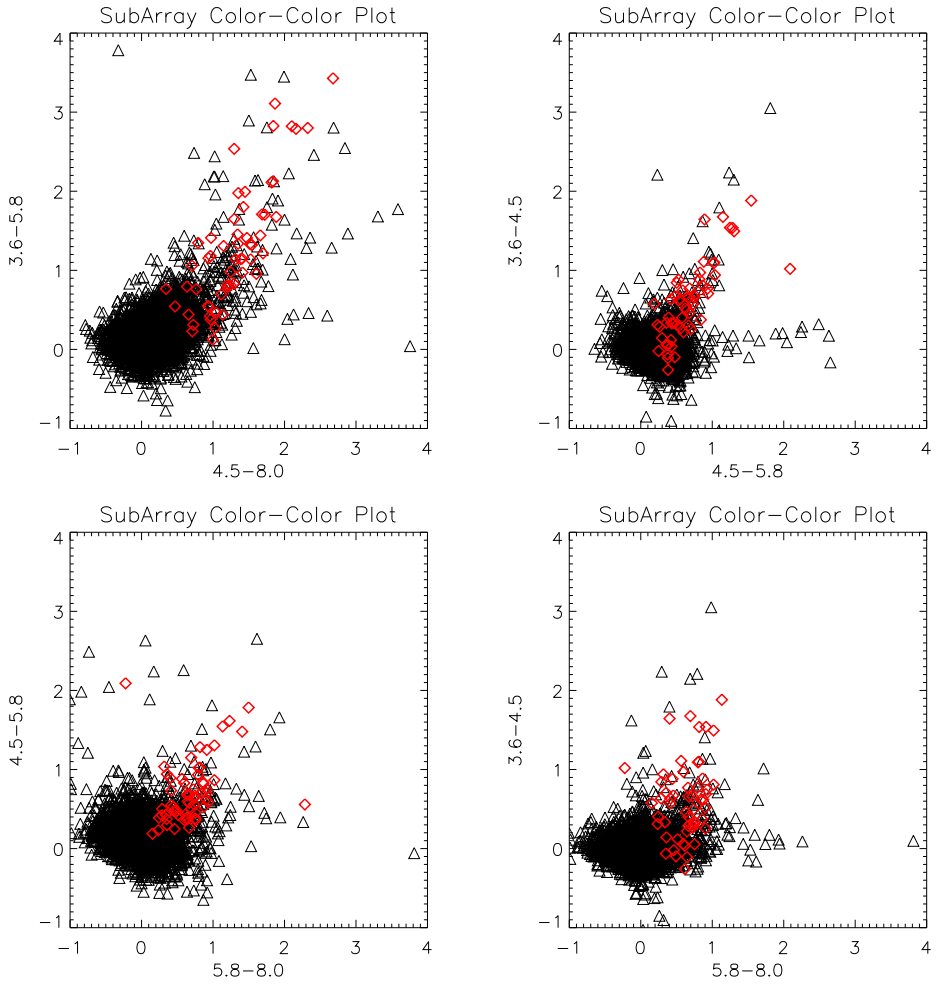

Figure 2: Color-Color plots of the GLIMPSEII Subarray mode sources compared to a subset of the GLIMPSEII survey data: 10000 sources from the GLIMPSEII l=6 deg Archive that had fluxes in all four bands were used as "field stars" and are plotted as black triangles. The GLIMPSEII Subarray mode fluxes are plotted as red diamonds.

5 Data Products Description

Here we provide information on the fields and flags recorded for each point source provided in the Subarray Mode Point Source List. More detailed information on the file formats for the Point Source List, as well as mosaics, can be found in the following section.

5.1 Source List Fields and Flags

Each entry in the Point Source List has the following information:

designation	SSTGLMS 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)
Target Name	Observer-specified target name

where i is the IRAC wavelength number (IRAC bands 1 - 4) (3.6 μm, 4.5 μm, 5.8 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 SSTGLMS (GLIMPSEII Subarray Mode Point Source List).

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[6] 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

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

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, 5.8, 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 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 S13.2 and later SSC processing version are from Reach et al 2005 for the IRAC bands and Cohen et al. 2003 for 2MASS and given in Table 2.

Table 2. 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.

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 local background is an output of DAOPHOT. 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 not a meaningful number for the Subarray mode data and is set to -9.9. M_i and N_i can be used to estimate reliability. N_i is calculated based on the areal coverage of each observed frame.

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 flux was determined.

• The Close Source Flag is set to -9 for the Subarray Mode Point Source List.

• 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 some 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. Each of the seven bands has its own SQF. Table 3 shows the SQF sequence for the GLIMPSEII Subarray mode Point Source List. 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 issues. More information about these flags and a bit value key can be found in Appendix A of the GLIMPSEII data delivery document (www.astro.wisc.edu/glimpse/glimpse2_dataprod_v2.1.pdf).

Table 3. 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
17	stray light	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	GLIMPSE
22	post-lumping in cross-band merge	2MASS
23	photometric quality flag	2MASS
24	photometric quality flag	2MASS
25	photometric 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. For the Subarray mode data we have set this flag to 3.

5.2 GLIMPSEII Subarray mode Images

The IRAC images are mosaicked into rectangular tiles that cover the surveyed region using the Montage[7] v3.0 package. 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. 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 provide 3.1°×2.4°, 3.1°×3.45°, and 3.1°×4.5° FITS files (matching the size of the "regular" GLIMPSEII survey mosaics). Several subarray mode positions are contained in a single mosaic. No background matching was done for these very small fields.

6 Product Formats

6.1 Subarray Mode Source List

• The GLIMPSEII Subarray Mode Point Source List file is in IPAC Table Format (http://irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html). The entries are sorted by increasing Galactic longitude within the file. The format is the same as for previous GLIMPSE point source lists except that we have added a Target Name to the end of the entry to identify which IRAC observation the source was extracted from. Table 1 can then be used to get more information about the observation.

An example of a Subarray Mode Point Source List entry is

SSTGLMS G358.1320-00.0297 17411303-3032305 163513794 358.132014 -0.029792 0.3 0.3
265.304592 -30.541619 0.3 0.3 -9 9.143 0.019 6.505 0.024 4.332 0.016
1.951 0.045 1.245 0.082 0.303 0.057 -0.052 0.036
3.510E+02 6.142E+00 2.560E+03 5.660E+01 1.234E+04 1.818E+02
4.659E+04 1.949E+03 5.709E+04 4.291E+03 8.702E+04 4.585E+03 6.727E+04 2.249E+03
4.659E+04 5.709E+04 8.702E+04 6.727E+04 2.118E+01 7.073E+01 1.394E+02 1.584E+02
57.14 45.24 67.86 23.91 13.30 18.98 29.91 -9.9 -9.9 -9.9 -9.9
1 1 1 1 1 1 1 1 29360128 29360128 29360128 0 1024 0 32768 3 3 3 3 ptsrc 3

Table 4 gives all of the available fields per source. Table 5 shows how to decode the above entry into these fields.

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

Table 4. Fields in the Subarray mode Source List

Column	Name	Description	Units	Data Type	Format	Nulls OK? or Value
1	designation	Subarray (SSTGLMS 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 dra is in units of arcseconds, so to convert to seconds of time, multiply by cos(dec)/15.	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	-9
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
79	targetname	Observer-specified target name	-	ASCII	A10	No

Table 5. Example of Source List Entry on Previous page

designation	SSTGLMS G358.1320-00.0297	Name
tmass_desig	17411303-3032305	2MASS designation
tmass_cntr	163513794	2MASS counter
l,b	358.132014 -0.029792	Galactic Coordinates (deg)
dl,db	0.3 0.3	Uncertainty in Gal. Coordinates (arcsec)
ra,dec	265.304592 -30.541619	RA and Dec (J2000.0) (deg)
dra,ddec	0.3 0.3	Uncertainty in RA and Dec (arcsec)
csf	-9	Close source flag
mag,dmag	9.143 6.505 4.332	Magnitudes (2MASS J,H,K_s) (mag)
	0.019 0.024 0.016	Uncertainties (2MASS) (mag)
mag,dmag	1.951 1.245 0.303 -0.052	Magnitudes (IRAC bands 1-4) (mag)
	0.045 0.082 0.057 0.036	Uncertainties (IRAC) (mag)
F,dF	3.510E+02 2.560E+03 1.234E+04	2MASS Fluxes (mJy)
	6.142E+00 5.660E+01 1.818E+02	Uncertainties in 2MASS fluxes (mJy)
F,dF	4.659E+04 5.709E+04 8.702E+04 6.727E+04	IRAC Fluxes (mJy)
	1.949E+03 4.291E+03 4.585E+03 2.249E+03	Uncertainties in IRAC fluxes (mJy)
F_rms	4.659E+04 5.709E+04 8.702E+04 6.727E+04	RMS_flux (mJy) (IRAC)
sky	2.118E+01 7.073E+01 1.394E+02 1.584E+02	Sky Bkg (MJy/sr) (IRAC)
SN	57.14 45.24 67.86	Signal to Noise (2MASS)
SN	23.91 13.30 18.98 29.91	Signal to Noise (IRAC)
srcdens	-9.9 -9.9 -9.9 -9.9	Local Source Density (IRAC) (#/sq arcmin)
M	1 1 1 1	Number of detections (IRAC)
N	1 1 1 1	Number of possible detections (IRAC)
SQF	29360128 29360128 29360128	Source Quality Flag (2MASS)
SQF	0 1024 0 32768	Source Quality Flag (IRAC)
MF	3 3 3 3	Flux Calculation Method Flag (IRAC)
targetname	ptsrc 3	Target Name (IRAC)

6.2 GLIMPSEII Subarray mode Images

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 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. 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 GLIMPSE pipeline produced FITS images: e.g. GLMSUB_00600+0000_mosaic_I1.fits.

Here is an example of the FITS header for a 3.1°x 3.45° file, GLMSUB_00600+0000_mosaic_I1.fits (which contains data from 12 of the Subarray mode positions):

```
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  =                10350 / 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= 'S16.1.0 '           / SSC pipeline that created the BCD
PIPEVERS= '1v04    '           / GLIMPSE pipeline version
MOSAICER= 'Montage V3.0'       / SW that originally created the Mosaic Image
FILENAME= 'GLMSUB_00600+0000_mosaic_I1.fits' / Name of associated fits file
PROJECT = 'GLIMPSEIISUB'       / Project ID
FILETYPE= 'mosaic  '           / Calibrated image(mosaic)/residual image(resid)
CHNLNUM =                    1 / 1 digit Instrument Channel Number
DATE    = '2010-05-27T22:10:52' / 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 =                   27 / Program Category
COMMENT -----------------------------
COMMENT Time and Exposure Information
COMMENT -----------------------------
SAMPTIME=                 0.01 / [sec] Sample integration time
FRAMTIME=                 0.02 / [sec] Time spent integrating each BCD frame
EXPTIME =                 0.01 / [sec] Effective integration time each BCD frame
COMMENT DN per pixel=flux(photons/sec/pixel)/gain*EXPTIME
NEXPOSUR=                   64 / 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=                    1 / Fowler number
COMMENT --------------------
COMMENT Pointing Information
COMMENT --------------------
CRPIX1  =            4650.5000 / Reference pixel for x-position
CRPIX2  =            5175.5000 / Reference pixel for y-position
CTYPE1  = 'GLON-CAR'           / Projection Type
CTYPE2  = 'GLAT-CAR'           / Projection Type
CRVAL1  =           6.00000000 / [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 =           3.09999990 / [Deg] size of image in axis 1
DELTA-Y =           3.45000005 / [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      =          269.81677246 / [Deg] Right ascension at mosaic center
DEC     =          -23.77234459 / [Deg] Declination at mosaic center
COMMENT ----------------------
COMMENT Photometry Information
COMMENT ----------------------
BUNIT   = 'MJy/sr  '           / Units of image data
GAIN    =                  3.3 / e/DN conversion
JY2DN   =              2622.950 / Average Jy to DN Conversion
ETIMEAVE=               0.0100 / [sec] Average exposure time for the BCD frames
PA_AVE  =               -90.63 / [deg] Average position angle
ZODY_EST=              0.13001 / [Mjy/sr] Average ZODY_EST
ZODY_AVE=              0.08263 / [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=          0.112641312 / Average MJy/sr to DN/s Conversion
COMMENT ----------------------------
COMMENT AORKEYS/ADS Ident Information
COMMENT ----------------------------
AOR001  = '0021496832'         / AORKEYS used in this mosaic
AOR002  = '0021498368'         / AORKEYS used in this mosaic
AOR003  = '0021495808'         / AORKEYS used in this mosaic
AOR004  = '0021493760'         / AORKEYS used in this mosaic
AOR005  = '0021506560'         / AORKEYS used in this mosaic
AOR006  = '0021504000'         / AORKEYS used in this mosaic
AOR007  = '0021499392'         / AORKEYS used in this mosaic
AOR008  = '0021498880'         / AORKEYS used in this mosaic
AOR009  = '0021497344'         / AORKEYS used in this mosaic
AOR010  = '0021497088'         / AORKEYS used in this mosaic
AOR011  = '0021496576'         / AORKEYS used in this mosaic
AOR012  = '0021508352'         / AORKEYS used in this mosaic
DSID001 = 'ads/sa.spitzer#0021496832' / Data Set Identification for ADS/journals
DSID002 = 'ads/sa.spitzer#0021498368' / Data Set Identification for ADS/journals
DSID003 = 'ads/sa.spitzer#0021495808' / Data Set Identification for ADS/journals
DSID004 = 'ads/sa.spitzer#0021493760' / Data Set Identification for ADS/journals
DSID005 = 'ads/sa.spitzer#0021506560' / Data Set Identification for ADS/journals
DSID006 = 'ads/sa.spitzer#0021504000' / Data Set Identification for ADS/journals
DSID007 = 'ads/sa.spitzer#0021499392' / Data Set Identification for ADS/journals
DSID008 = 'ads/sa.spitzer#0021498880' / Data Set Identification for ADS/journals
DSID009 = 'ads/sa.spitzer#0021497344' / Data Set Identification for ADS/journals
DSID010 = 'ads/sa.spitzer#0021497088' / Data Set Identification for ADS/journals
DSID011 = 'ads/sa.spitzer#0021496576' / Data Set Identification for ADS/journals
DSID012 = 'ads/sa.spitzer#0021508352' / Data Set Identification for ADS/journals
NIMAGES =                   20 / 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, GLMSUB_00600+0000_mosaic_I1.hdr includes:

```
COMMENT ----------------------------------------
COMMENT Info on Individual Frames in Mosaic
COMMENT ----------------------------------------
IRFR0001= 'SPITZER_I1_0021496832_0000_0000_01_levbflx.fits' / IRAC frame
COMMENT Image contribution to mosaic <5% of IRAC image
DOBS0001= '2007-05-08T03:27:16.223' / Date & time at frame start
MOBS0001=      54228.144531250 / MJD (days) at frame start
RACE0001=           268.653015 / [Deg] Right ascension at reference pixel
DECC0001=           -24.130829 / [Deg] Declination at reference pixel
PANG0001=               -89.90 / [deg] Position angle for this image
FLXC0001=              0.10880 / Flux conversion for this image
ZODE0001=              0.12885 / [MJy/sr] ZODY_EST for this image
ZODY0001=              0.08147 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
IRFR0002= 'SPITZER_I1_0021498368_0016_0000_01_levbflx.fits' / IRAC frame
COMMENT Image contribution to mosaic <5% of IRAC image
DOBS0002= '2007-05-09T00:25:27.575' / Date & time at frame start
MOBS0002=      54229.019531250 / MJD (days) at frame start
RACE0002=           270.117279 / [Deg] Right ascension at reference pixel
DECC0002=           -24.062845 / [Deg] Declination at reference pixel
PANG0002=               -90.53 / [deg] Position angle for this image
FLXC0002=              0.10880 / Flux conversion for this image
ZODE0002=              0.12936 / [MJy/sr] ZODY_EST for this image
ZODY0002=              0.08199 / [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 19
.

IRFR0020= 'SPITZER_I1_0021508352_0000_0000_01_levbflx.fits' / IRAC frame
COMMENT Image contribution to mosaic <5% of IRAC image
DOBS0020= '2007-05-08T03:21:37.426' / Date & time at frame start
MOBS0020=      54228.140625000 / MJD (days) at frame start
RACE0020=           269.377533 / [Deg] Right ascension at reference pixel
DECC0020=           -23.406866 / [Deg] Declination at reference pixel
PANG0020=               -90.49 / [deg] Position angle for this image
FLXC0020=              0.10880 / Flux conversion for this image
ZODE0020=              0.13010 / [MJy/sr] ZODY_EST for this image
ZODY0020=              0.08273 / [MJy/sr] ZODY_EST-SKYDRKZB for this image
```

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GLOSSARY

2MASS	Two Micron All Sky Survey
BCD	Basic Calibrated Data, released by the SSC
GLIMPSE	Galactic Legacy Infrared Midplane Survey Extraordinaire
GLMIIS	GLIMPSEII Subarray Mode Point Source List
IPAC	Infrared Processing and Analysis Center
IRAC	*Spitzer* Infrared Array Camera
IRSA	InfraRed Science Archive
PSF	Point Spread Function
SSC	*Spitzer* Science Center
SED	Spectral energy distribution
SQF	Source Quality Flag
SST	*Spitzer* Space Telescope