SERVS DATA RELEASE 1

Data description supplement

M. Lacy, JC Mauduit, M. Vaccari, A. DeGroot, L. Marchetti, A. Petric, A. Sajina, J. Surace & the SERVS Team

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1. The Images

Details of the image reduction are given in Mauduit et al. (2012, PASP, 124, 1135). Each SERVS field is a single mosaic with coverage and mask files also supplied. See Table 4 of this document for the meaning of the mask bits. **Note in particular that the [3.6] images have not been corrected to the SWIRE scale, these corrections were applied at the catalog level. Thus [3.6] fluxes derived from the images should be multiplied by the correction factors in Table 2.**

2. The Catalogs

Catalogs were obtained using Sextractor (see Table A1 of Mauduit et al. 2012 for details of the SExtractor parameters used). There are two classes of SERVS catalogs, which one you use should depend on your use case.

The **2-band high reliability** catalogs are matched [3.6] and [4.5] catalogs, with the low coverage areas near the edges of the survey omitted (POLY_12=1). These catalogs should be used if you are using SERVS to select your sample, as objects in this catalog should be highly reliable (>99.9%). To appear in the catalog objects must appear in both bands, and the detection in one band must be > 10-sigma in CSNR, where CSNR is the coverage-weighted signal-to-noise ratio, described in Section 2.3.

Objects in the **single band** catalogs are not required to have any counterparts in the other band. They are cut at CSNR > 5 and also have the low coverage areas at the edges of the survey omitted (POLY=1), resulting in a single-band reliability flag REL=1. They are thus deeper than the 2-band high reliability catalogs. These should be used if you are matching with a reliable catalog from another band (e.g. near-infrared), and simply want as many matches as possible, or are doing a statistical study. Catalogs with objects having REL=0 are excluded from the catalogs supplied to IRSA, they may be obtained by direct application to the SERVS PI.

2.1 Aperture corrections

The photometric apertures and aperture corrections are the same as those for SWIRE, but are reproduced in Table 1 below for completeness.

Band	Aper 1: 1.4"	Aper 2: 1.9"	Aper 3: 2.9"	Aper 4: 4.1"	Aper 5: 5.8"
[3.6]	0.585	0.736	0.87	0.92	0.96
[4.5]	0.569	0.716	0.87	0.905	0.95

Table 1: aperture corrections as a function of radius and band.

2.2 Flux uncertainties

The raw flux errors from SExtractor were multiplied by a factor of two to approximately account for the pixel value correlations produced by the resampling to half the native pixel size during mosaicking.

2.3 Flux corrections

Fluxes were checked against SWIRE, and, as noted in Mauduit et al., correction factors were applied to [3.6] fluxes (the [4.5] fluxes agree within 1% with SWIRE) as shown in Table 1 (note that these corrections are applied to the catalogs, not to the mosaics):

Field	Correction at [3.6]
ELAIS-N1	1.07
ELAIS-S1	1.07
Lockman	1.02
CDFS	1.02
XMM-LSS	1.02

Table 2: flux correction factors ([3.6] only)

2.4 Calculation of Signal-to-noise ratio CSNR

We estimated the signal-to-noise ratio of our objects by first measuring the noise (σ) in empty apertures in the sky. This noise is then scaled by the mean coverage within the photometric aperture (χ) compared to the median coverage of the mosaic ($<\chi>$) (aperture 2 was used as this is the one most commonly employed) and the coverage-weighted signal-to-noise estimated via:

$CSNR = FLUX\_APER\_2/(\sigma/\mathrm{sqrt}(\chi/<\chi>))$

2.5 Flag and Mask values

Bitwise flags are set by SExtractor on extraction, values are shown in Table 3.

Flag Value	Meaning
1 (BIT00)	The object has neighbors, bright and close enough to significantly bias the photometry, or bad pixels (more than 10% of the integrated area affected).
2 (BIT01)	The object was originally blended with another one.
4 (BIT02)	At least one pixel of the object is saturated (or very close to). Set using Table 3.
8 (BIT03)	The object is truncates (to close to an image boundary)
16 (BIT04)	Object's aperture data are incomplete or corrupted.
32 (BIT05)	Object's isophotal data are incomplete or corrupted.

Table 3: FLAG field values

The non-linearity flag (BIT02) was set retroactively based on plots of SERVS versus SWIRE flux. Where this became non-linear we set flag BIT04. The values used were:

Field	[3.6] threshold (microJy) (after flux correction)	[4.5] threshold (microJy) (after flux correction)
EN1	4000	4000
ES1	4000	4000
Lockman	3000	4000
CDFS	3000	4000
XMM	3000	4000

Table 4: Non-linearity thresholds (FLAG BIT04).

note that SExtractor can set other flag bits, but our catalogs did not contain them, so they are not listed here.

The image mask bits (BIT00-BIT07 set based on combinations of the cBCD masks; see the IRAC instrument handbook, http://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook , BIT08 and BIT09 set by the SERVS processing) are as follows:

Mask Value	Interpretation
1 (BIT00)	Overall data quality (set if poor)
2 (BIT01)	Set if pixel contains radhit
4 (BIT02)	Set if optical ghost present
8 (BIT03)	Set if stray light present
16 (BIT04)	Set if saturation donut
32 (BIT05)	Set if pixel contains latent image
64 (BIT06)	Set if pixel is saturated
128 (BIT07)	Set if column pulldown present
256 (BIT08)	Set if mosaic coverage <4 (added to the catalogs post-extraction)
512 (BIT09)	Set if bright star is present

Table 5: Mask bit values.

With the exception of BIT08, which is not actually present in the mask images, but rather is set at the catalog level) these mask bits were picked up by SExtractor when it was run (note also that BIT08 is an addition to Table 6 of Mauduit et al. 2012). In high coverage regions most of these bits have little effect on photometry, with the exception of the bright star mask (BIT09), though in lower coverage (<6) they may be important. In a few cases BIT08 is set in the centers of bright stars due to over-zealous radhit rejection. The latent image bit (BIT05) and donut saturation bit (BIT04) seems to be mostly set from radhits, or not at all, and do not seem to correctly trace the centers of bright stars, rather than use the mask bits, the saturation flag bit (BIT02) should be used for identifying saturated sources.

2.6 Polygonal regions for high reliability catalogs

The high reliability catalogs are confined to regions of known high coverage, these are defined as polygons with vertices given in Table 6. Sources within these polygons have the appropriate POLY value set to unity in the catalogs.

Field	Polygon corners (decimal degrees)
EN1	243.13 55.36, 240.95 54.78, 241.88 53.64, 244.02 54.21 (rectangle)
ES1	10.38 -43.04, 8.48 -43.04, 8.45 -44.96, 10.41 -44.96 (rectangle)

Field	Polygon corners (decimal degrees)
CDFS	54.38 -27.30, 54.38 -28.80, 53.42 -28.80, 53.42 -28.95, 51.80 -28.95, 51.80 -27.13 (irregular)
Lockman	159.88 58.90, 162.55 56.58, 164.61 57.20, 162.06 59.58 (rectangle)
XMM-LSS	37.13 -5.40, 37.13 -4.18, 33.97 -4.18, 33.97 -5.06, 34.15 -5.40(PA 0 rectangle missing corner)

Table 6: Polygon vertices for defining the high reliability catalogs.

2.7 Positional accuracy

The source positions are referenced to 2MASS in the Spitzer pipeline. Our investigation reveals possible small systematic errors in the positions relative to the 2MASS frame (<0.15”) which users may wish to apply for high accuracy work, these are given in Table 7.

Field	Mean RA Offset (SERVS-2MASS) (arcsec)	Mean Dec Offset (SERVS-2MASS) (arcsec)
EN1	-0.04	-0.05
ES1	0.14	-0.05
Lockman	0.11	0.00
CDFS	0.03	-0.02
XMM-LSS	-0.06	0.04

Table 7: systematic astrometric offsets with respect to 2MASS

2.7 Catalog Columns

The SPITZER-SERVS catalogs in this data release were constructed by Mattia Vaccari, Lucia Marchetti & Eduardo Gonzalez-Solares. Fluxes (and corresponding AB magnitudes) are aperture-corrected using the correction factors adopted by SWIRE DR2/3 by Surace et al. (2005) (http://irsa.ipac.caltech.edu/data/SPITZER/SWIRE/docs/delivery_doc_r2_v2.pdf)

Single-band catalogs

Column	Type	Description	Unit
NAME	String	Source name	
ID	Integer	ID number	-
RA	Double	Right Ascension	Decimal Degrees
DEC	Double	Declination	Decimal Degrees
FLUX_APER_1	Double	Flux in 1.4” radius aperture	microJy
FLUX_APER_2	Double	Flux in 1.9” radius aperture	microJy
FLUX_APER_3	Double	Flux in 2.9” radius aperture	microJy
FLUX_APER_4	Double	Flux in 4.9” radius aperture	microJy
FLUX_APER_5	Double	Flux in 5.8” radius aperture	microJy
FLUXERR_APER_1	Double	Flux error in 1.4” radius aperture	microJy
FLUXERR_APER_2	Double	Flux error in 1.9” radius aperture	microJy
FLUXERR_APER_3	Double	Flux error in 2.9” radius aperture	microJy
FLUXERR_APER_4	Double	Flux error in 4.9” radius aperture	microJy
FLUXERR_APER_5	Double	Flux error in 5.8” radius aperture	microJy
FLUX_ISO	Double	Isophotal flux	microJy
FLUX_AUTO	Double	Kron flux	microJy
FLUXERR_ISO	Double	Uncertainty in FLUX_ISO	microJy
FLUXERR_AUTO	Double	Uncertainty in FLUX_AUTO	microJy

Column	Type	Description	Unit
KRON_RADIUS	Float	Kron radius	pixels
CLASS_STAR	Float	Stellaricity (on a scale from 0, definitely a resolved object, to 1, definitely unresolved)	-
FLAGS	Short	Table 2	-
MASK	Short	Table 4	-
COV	Double	Coverage of 100s frames (exposure time in seconds /100)	-
CSNR	Double	Coverage-weighted SNR in aperture 2	-
RELIABILITY	Short	1 if both CNSR>1 and POLY=1, otherwise 0	
POLY	Short	1 if within high coverage polygon, 0 otherwise	

High reliability dual-band catalogs

Column	Type	Description	Unit
NAME	String		
ID_12	Long	ID number	
RA	Double	Right Ascension (mean of [3.6] and [4.5]	Decimal Degrees
DEC	Double	Declination (mean of [3.6] and [4.5]	Decimal Degrees
POLY_12	Integer	1 if POLY_1=1 or POLY_2=1, 0 otherwise	

Column	Type	Description	Unit
REL_12	Integer	1 if REL_1=1 or REL_2=1, 0 otherwise	
ID_1	Integer	ID number, [3.6]	
RA_1	Double	Right Ascension [3.6]	Decimal Degrees
DEC_1	Double	Declination [3.6]	Decimal Degrees
FLUX_APER_1_1	Double	Flux in 1.4” radius aperture [3.6]	microJy
FLUX_APER_2_1	Double	Flux in 1.9” radius aperture [3.6]	microJy
FLUX_APER_3_1	Double	Flux in 2.9” radius aperture [3.6]	microJy
FLUX_APER_4_1	Double	Flux in 4.9” radius aperture [3.6]	microJy
FLUX_APER_5_1	Double	Flux in 5.8” radius aperture [3.6]	microJy
FLUXERR_APER_1_1	Double	Flux error in 1.4” radius aperture [3.6]	microJy
FLUXERR_APER_2_1	Double	Flux error in 1.9” radius aperture [3.6]	microJy
FLUXERR_APER_3_1	Double	Flux error in 2.9” radius aperture [3.6]	microJy
FLUXERR_APER_4_1	Double	Flux error in 4.9” radius aperture [3.6]	microJy
FLUXERR_APER_5_1	Double	Flux error in 5.8” radius aperture [3.6]	microJy
FLUX_ISO_1	Double	Isophotal flux [3.6]	microJy
FLUX_AUTO_1	Double	Kron flux [3.6]	microJy
FLUXERR_ISO_1	Double	Uncertainty in FLUX_ISO [3.6]	microJy
FLUXERR_AUTO_1	Double	Uncertainty in FLUX_AUTO [3.6]	microJy
KRON_RADIUS_1	Float	Kron radius [3.6]	pixels

Column	Type	Description	Unit
CLASS_STAR_1	Float	Stellaricity (1=star) [3.6]	
FLAGS_1	Short	Table 2 [3.6]	
MASK_1	Short	Table 4 [3.6]	
COV_1	Double	Coverage of 100s frames (exposure time in seconds /100) [3.6]	
CSNR_1	Double	Coverage-weighted SNR in aperture 2 [3.6]	
POLY_1	Integer	Within high coverage polynomial at [3.6]	
REL_1	Integer	POLY_1=1 and CSNR_1>5	
ID_2	Integer	ID number, [4.5]	-
RA_2	Double	Right Ascension [4.5]	Decimal Degrees
DEC_2	Double	Declination [4.5]	Decimal Degrees
FLUX_APER_1_2	Double	Flux in 1.4" radius aperture [4.5]	microJy
FLUX_APER_2_2	Double	Flux in 1.9" radius aperture [4.5]	microJy
FLUX_APER_3_2	Double	Flux in 2.9" radius aperture [4.5]	microJy
FLUX_APER_4_2	Double	Flux in 4.9" radius aperture [4.5]	microJy
FLUX_APER_5_2	Double	Flux in 5.8" radius aperture [4.5]	microJy
FLUXERR_APER_1_2	Double	Flux error in 1.4" radius aperture [4.5]	microJy
FLUXERR_APER_2_2	Double	Flux error in 1.9" radius aperture [4.5]	microJy
FLUXERR_APER_3_2	Double	Flux error in 2.9" radius aperture [4.5]	microJy

Column	Type	Description	Unit
FLUXERR_APER_4_2	Double	Flux error in 4.9" radius aperture [4.5]	microJy
FLUXERR_APER_5_2	Double	Flux error in 5.8" radius aperture [4.5]	microJy
FLUX_ISO_2	Double	Isophotal flux [4.5]	microJy
FLUX_AUTO_2	Double	Kron flux [4.5]	microJy
FLUXERR_ISO_2	Double	Uncertainty in FLUX_ISO [4.5]	microJy
FLUXERR_AUTO_2	Double	Uncertainty in FLUX_AUTO [4.5]	microJy
KRON_RADIUS_2	Float	Kron radius[4.5]	pixels
CLASS_STAR_2	Float	Stellaricity (1=star) [4.5]	-
FLAGS_2	Short	Table 3 [4.5]	-
MASK_2	Short	Table 4 [4.5]	-
COV_2	Double	Coverage of 100s frames (exposure time in seconds /100) [4.5]	-
CSNR_2	Double	Coverage-weighted SNR in aperture 2 [4.5]	-
POLY_2	Integer	Within high coverage polynomial at [4.5]	
REL_2	Integer	POLY_2=1 and CSNR_2>5	
Separation	Double	[3.6], [4.5] position difference	arcsec