

VVV Survey - ESO Phase 3 - Data Release 4

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|------------------------|---------------|
| Data Collection | VVV |
| Release Number | 4 |
| Data Provider | Dante Minniti |
| Date | 20.02.2015 |

Abstract

The VVV Survey data delivered to ESO in this 4th batch of the “VVV” collection includes the VISTA tile images that were processed by the Cambridge Astronomical Survey Unit (CASU). These data files were successfully uploaded via the Phase 3 to the ESO Archive before December 11, 2014. The data are from ESO programme 179.B-2002, with the VIRCAM instrument, using ZYJHKs filters, including multiple epochs in the Ks band, with total sky coverage of 540 sq deg.

Overview of Observations

This Phase 3 release contains observations up to 30 September 2013 with all the approved data from CASU v1.3 pipeline reduction, including images and associated single-band source catalogs. We refer to this 4th batch as DR4, though we note that DR3 was only a minor update to the data released previously in DR1.

DR4 replaces the previous releases of source catalogues that had been processed with the CASU v1.1 or v1.2 pipelines, and adds a large amount of new data. DR4 benefits from 2 significant improvements to the data quality: (1) the more accurate photometric calibration procedures implemented in the v1.3 pipeline; (2) more extensive Quality Control (QC) to identify bad data. Consequently a small number of observations that were included in previous data releases have now been removed. Similarly, a small number of images have been added to DR4 that had been excluded from previous data releases. These changes are detailed below under Data Quality.

The list for this Phase 3 DR4 has 18011^{*} tile images. If we count these plus associated confidence maps and catalogues they are approximately 10 TB of data (with the image and confidence maps in tile-compressed FITS format). The photometric calibration procedures for the J, H and Ks images are now believed to be highly reliable but we caution that the calibration of the Z and Y images is known to be less accurate in fields within 2 degrees of the Galactic equator, owing to high extinction. This issue is currently being addressed via dedicated VISTA photometric calibration observations in the Z and Y filters. Quality control of such a large dataset is never perfect, so visual inspection of the images is always recommended when studying individual sources.

The VVV photometric dataset is divided into different disk and bulge tiles. The tile nomenclature goes from d001 to d152 in the disk, and from b201 to b396 in the bulge. The coordinates of the tile centers are listed in Tables 1 and 2 below, for the bulge and disk,

*** The tile images are now 18004 after the removal of 7 due to their scientific quality.**

VVV_DR4_description

Release Content

TABLE 1: Bulge tiles coordinates and number of epochs

| ID | RA | Dec | Longitude | Latitude | Z | Y | J | H | Ks |
|------|--------------|--------------|-----------|----------|---|---|---|---|----|
| b201 | 18:04:24.384 | -41:44:53.52 | 350.74816 | -9.68974 | 1 | 1 | 1 | 1 | 41 |
| b202 | 18:08:00.144 | -40:27:29.88 | 352.22619 | -9.68971 | 1 | 1 | 1 | 1 | 41 |
| b203 | 18:11:29.496 | -39:09:52.92 | 353.70409 | -9.68973 | 1 | 1 | 1 | 1 | 46 |
| b204 | 18:14:52.992 | -37:52:03.36 | 355.18207 | -9.68974 | 1 | 1 | 1 | 1 | 37 |
| b205 | 18:18:11.136 | -36:34:02.64 | 356.66012 | -9.68976 | 1 | 2 | 1 | 1 | 37 |
| b206 | 18:21:24.360 | -35:15:52.20 | 358.13813 | -9.68975 | 1 | 1 | 1 | 1 | 42 |
| b207 | 18:24:33.096 | -33:57:33.48 | 359.61607 | -9.68977 | 1 | 1 | 1 | 1 | 44 |
| b208 | 18:27:37.728 | -32:39:07.20 | 1.09399 | -9.68974 | 1 | 1 | 1 | 1 | 43 |
| b209 | 18:30:38.640 | -31:20:34.08 | 2.5720 | -9.68971 | 1 | 1 | 1 | 1 | 45 |
| b210 | 18:33:36.168 | -30:01:55.56 | 4.04998 | -9.68973 | 1 | 1 | 1 | 1 | 46 |
| b211 | 18:36:30.624 | -28:43:12.36 | 5.52796 | -9.68978 | 1 | 1 | 1 | 1 | 41 |
| b212 | 18:39:22.272 | -27:24:25.20 | 7.00593 | -9.68975 | 4 | 4 | 1 | 1 | 35 |
| b213 | 18:42:11.424 | -26:05:34.80 | 8.48396 | -9.68974 | 3 | 4 | 1 | 1 | 42 |
| b214 | 18:44:58.320 | -24:46:42.24 | 9.96193 | -9.68974 | 1 | 1 | 2 | 3 | 44 |
| b215 | 17:59:15.960 | -41:13:55.92 | 350.74595 | -8.59756 | 1 | 1 | 1 | 1 | 40 |
| b216 | 18:02:55.992 | -39:57:07.92 | 352.21956 | -8.59753 | 1 | 1 | 1 | 1 | 44 |
| b217 | 18:06:29.472 | -38:40:04.08 | 353.69327 | -8.59756 | 1 | 1 | 1 | 1 | 45 |
| b218 | 18:09:56.880 | -37:22:46.56 | 355.16684 | -8.59757 | 2 | 1 | 1 | 1 | 39 |
| b219 | 18:13:18.768 | -36:05:16.08 | 356.64051 | -8.59760 | 2 | 2 | 1 | 1 | 37 |
| b220 | 18:16:35.568 | -34:47:34.08 | 358.11423 | -8.59759 | 1 | 1 | 1 | 1 | 40 |
| b221 | 18:19:47.688 | -33:29:42.36 | 359.58781 | -8.59757 | 1 | 1 | 1 | 1 | 46 |
| b222 | 18:22:55.560 | -32:11:41.28 | 1.06151 | -8.59755 | 1 | 1 | 1 | 1 | 45 |
| b223 | 18:25:59.544 | -30:53:32.28 | 2.53522 | -8.59757 | 1 | 1 | 1 | 1 | 45 |
| b224 | 18:28:59.952 | -29:35:16.80 | 4.0088 | -8.59759 | 1 | 1 | 1 | 1 | 46 |
| b225 | 18:31:57.120 | -28:16:54.84 | 5.4825 | -8.59755 | 2 | 2 | 1 | 1 | 38 |
| b226 | 18:34:51.360 | -26:58:27.84 | 6.9562 | -8.59757 | 1 | 1 | 1 | 1 | 39 |
| b227 | 18:37:42.912 | -25:39:56.88 | 8.42977 | -8.59756 | 4 | 3 | 1 | 1 | 43 |
| b228 | 18:40:32.088 | -24:21:21.96 | 9.9035 | -8.59757 | 1 | 1 | 2 | 2 | 44 |
| b229 | 17:54:12.456 | -40:42:07.56 | 350.74383 | -7.50542 | 1 | 1 | 1 | 1 | 44 |
| b230 | 17:57:56.496 | -39:25:54.48 | 352.2138 | -7.50537 | 1 | 1 | 1 | 1 | 38 |
| b231 | 18:01:33.792 | -38:09:24.48 | 353.68363 | -7.50537 | 3 | 3 | 1 | 1 | 40 |
| b232 | 18:05:04.920 | -36:52:38.28 | 355.15359 | -7.50541 | 2 | 2 | 1 | 1 | 36 |
| b233 | 18:08:30.312 | -35:35:38.04 | 356.62342 | -7.50539 | 1 | 1 | 1 | 1 | 40 |
| b234 | 18:11:50.472 | -34:18:24.48 | 358.09337 | -7.50535 | 1 | 1 | 2 | 3 | 37 |
| b235 | 18:15:05.832 | -33:00:59.76 | 359.56322 | -7.50542 | 1 | 1 | 2 | 2 | 45 |
| b236 | 18:18:16.752 | -31:43:24.24 | 1.03312 | -7.50538 | 1 | 1 | 1 | 1 | 37 |
| b237 | 18:21:23.640 | -30:25:39.36 | 2.50307 | -7.50541 | 1 | 1 | 1 | 1 | 38 |
| b238 | 18:24:26.808 | -29:07:46.20 | 3.9730 | -7.50540 | 1 | 1 | 2 | 2 | 41 |
| b239 | 18:27:26.568 | -27:49:45.84 | 5.44287 | -7.50536 | 1 | 1 | 1 | 1 | 36 |
| b240 | 18:30:23.256 | -26:31:39.36 | 6.91271 | -7.50540 | 1 | 2 | 1 | 1 | 42 |
| b241 | 18:33:17.136 | -25:13:27.12 | 8.38261 | -7.50541 | 1 | 1 | 1 | 1 | 36 |
| b242 | 18:36:08.472 | -23:55:10.20 | 9.85251 | -7.50542 | 1 | 1 | 1 | 1 | 35 |

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| b243 | 17:49:13.848 | -40:09:29.16 | 350.74206 | -6.41324 | 1 | 1 | 1 | 1 | 42 |
| b244 | 17:53:01.608 | -38:53:51.72 | 352.20875 | -6.41323 | 1 | 1 | 1 | 1 | 41 |
| b245 | 17:56:42.504 | -37:37:54.84 | 353.67546 | -6.41323 | 2 | 2 | 1 | 1 | 37 |
| b246 | 18:00:17.064 | -36:21:40.32 | 355.14219 | -6.41321 | 1 | 2 | 1 | 1 | 37 |
| b247 | 18:03:45.792 | -35:05:09.96 | 356.60888 | -6.41323 | 1 | 1 | 1 | 1 | 41 |
| b248 | 18:07:09.120 | -33:48:25.20 | 358.0755 | -6.41322 | 1 | 1 | 1 | 1 | 37 |
| b249 | 18:10:27.504 | -32:31:27.12 | 359.54218 | -6.41323 | 1 | 1 | 2 | 1 | 45 |
| b250 | 18:13:41.328 | -31:14:17.16 | 1.00886 | -6.41325 | 1 | 1 | 1 | 1 | 39 |
| b251 | 18:16:50.952 | -29:56:56.04 | 2.47562 | -6.41319 | 1 | 1 | 2 | 2 | 39 |
| b252 | 18:19:56.736 | -28:39:25.92 | 3.94224 | -6.41326 | 1 | 1 | 2 | 2 | 40 |
| b253 | 18:22:58.968 | -27:21:46.80 | 5.40892 | -6.41319 | 2 | 2 | 1 | 1 | 37 |
| b254 | 18:25:58.008 | -26:04:00.12 | 6.87563 | -6.41325 | 1 | 1 | 1 | 1 | 42 |
| b255 | 18:28:54.072 | -24:46:06.60 | 8.34231 | -6.41319 | 1 | 1 | 1 | 1 | 37 |
| b256 | 18:31:47.496 | -23:28:07.32 | 9.80903 | -6.41325 | 1 | 1 | 1 | 1 | 34 |
| b257 | 17:44:20.112 | -39:36:02.16 | 350.74076 | -5.32104 | 1 | 1 | 1 | 1 | 52 |
| b258 | 17:48:11.328 | -38:20:59.64 | 352.20485 | -5.32102 | 1 | 1 | 3 | 3 | 54 |
| b259 | 17:51:55.560 | -37:05:36.24 | 353.66885 | -5.32101 | 1 | 1 | 1 | 2 | 48 |
| b260 | 17:55:33.360 | -35:49:53.40 | 355.13291 | -5.32104 | 2 | 2 | 3 | 2 | 51 |
| b261 | 17:59:05.184 | -34:33:52.92 | 356.59692 | -5.32103 | 1 | 1 | 2 | 2 | 62 |
| b262 | 18:02:31.512 | -33:17:36.24 | 358.06096 | -5.32105 | 1 | 1 | 1 | 1 | 61 |
| b263 | 18:05:52.752 | -32:01:04.80 | 359.525 | -5.32104 | 1 | 1 | 1 | 1 | 76 |
| b264 | 18:09:09.288 | -30:44:20.04 | 0.98899 | -5.32099 | 1 | 1 | 1 | 1 | 75 |
| b265 | 18:12:21.528 | -29:27:23.40 | 2.45295 | -5.32106 | 1 | 1 | 1 | 1 | 49 |
| b266 | 18:15:29.784 | -28:10:15.24 | 3.91703 | -5.32105 | 1 | 1 | 1 | 1 | 49 |
| b267 | 18:18:34.368 | -26:52:57.36 | 5.38103 | -5.32101 | 1 | 1 | 2 | 2 | 47 |
| b268 | 18:21:35.616 | -25:35:30.48 | 6.84507 | -5.32101 | 1 | 1 | 3 | 2 | 46 |
| b269 | 18:24:33.792 | -24:17:55.68 | 8.30909 | -5.3210 | 1 | 1 | 2 | 2 | 46 |
| b270 | 18:27:29.184 | -23:00:14.04 | 9.77309 | -5.32107 | 1 | 1 | 1 | 1 | 46 |
| b271 | 17:39:31.128 | -39:01:49.44 | 350.73953 | -4.22883 | 1 | 1 | 1 | 1 | 46 |
| b272 | 17:43:25.536 | -37:47:22.20 | 352.20141 | -4.22884 | 1 | 1 | 1 | 1 | 46 |
| b273 | 17:47:12.888 | -36:32:31.92 | 353.66332 | -4.22886 | 1 | 1 | 1 | 1 | 51 |
| b274 | 17:50:53.688 | -35:17:20.76 | 355.12516 | -4.2289 | 1 | 1 | 1 | 1 | 51 |
| b275 | 17:54:28.416 | -34:01:49.80 | 356.58709 | -4.22886 | 1 | 1 | 1 | 1 | 47 |
| b276 | 17:57:57.528 | -32:46:01.20 | 358.04898 | -4.22882 | 1 | 1 | 5 | 5 | 53 |
| b277 | 18:01:21.456 | -31:29:56.40 | 359.51088 | -4.22881 | 1 | 1 | 6 | 6 | 53 |
| b278 | 18:04:40.584 | -30:13:36.84 | 0.97275 | -4.22884 | 1 | 1 | 1 | 1 | 50 |
| b279 | 18:07:55.272 | -28:57:03.60 | 2.43463 | -4.22884 | 1 | 1 | 1 | 1 | 51 |
| b280 | 18:11:05.880 | -27:40:17.76 | 3.89659 | -4.22886 | 2 | 2 | 1 | 1 | 50 |
| b281 | 18:14:12.696 | -26:23:20.76 | 5.35849 | -4.22883 | 1 | 1 | 1 | 1 | 45 |

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| b282 | 18:17:16.056 | -25:06:13.68 | 6.82039 | -4.22886 | 1 | 2 | 1 | 1 | 45 |
| b283 | 18:20:16.224 | -23:48:57.60 | 8.28222 | -4.22888 | 1 | 1 | 1 | 1 | 46 |
| b284 | 18:23:13.488 | -22:31:32.88 | 9.74416 | -4.22889 | 1 | 1 | 1 | 1 | 47 |
| b285 | 17:34:46.896 | -38:26:51.72 | 350.73871 | -3.13666 | 1 | 1 | 2 | 2 | 55 |
| b286 | 17:38:44.256 | -37:12:59.40 | 352.19896 | -3.13667 | 1 | 1 | 1 | 1 | 54 |
| b287 | 17:42:34.488 | -35:58:41.88 | 353.65931 | -3.13667 | 1 | 2 | 1 | 1 | 47 |
| b288 | 17:46:18.096 | -34:44:01.68 | 355.11962 | -3.13673 | 1 | 1 | 2 | 2 | 50 |
| b289 | 17:49:55.536 | -33:29:00.24 | 356.57994 | -3.13668 | 1 | 1 | 1 | 1 | 51 |
| b290 | 17:53:27.288 | -32:13:39.72 | 358.04023 | -3.13673 | 1 | 2 | 2 | 1 | 50 |
| b291 | 17:56:53.736 | -30:58:01.20 | 359.50054 | -3.13672 | 1 | 1 | 1 | 2 | 50 |
| b292 | 18:00:15.264 | -29:42:06.12 | 0.96088 | -3.13663 | 1 | 1 | 1 | 2 | 48 |
| b293 | 18:03:32.280 | -28:25:56.28 | 2.4212 | -3.13666 | 1 | 1 | 1 | 1 | 91 |
| b294 | 18:06:45.096 | -27:09:32.76 | 3.8815 | -3.13671 | 1 | 1 | 1 | 1 | 90 |
| b295 | 18:09:54.024 | -25:52:56.64 | 5.34179 | -3.13672 | 1 | 1 | 1 | 1 | 92 |
| b296 | 18:12:59.352 | -24:36:09.00 | 6.80204 | -3.13666 | 1 | 2 | 2 | 2 | 94 |
| b297 | 18:16:01.416 | -23:19:10.92 | 8.26235 | -3.13668 | 1 | 1 | 1 | 1 | 41 |
| b298 | 18:19:00.456 | -22:02:03.12 | 9.72271 | -3.13666 | 3 | 1 | 1 | 1 | 42 |
| b299 | 17:30:07.272 | -37:51:11.88 | 350.73789 | -2.04453 | 1 | 1 | 2 | 2 | 55 |
| b300 | 17:34:07.344 | -36:37:53.76 | 352.19711 | -2.04451 | 1 | 2 | 1 | 1 | 55 |
| b301 | 17:38:00.240 | -35:24:09.00 | 353.65635 | -2.04453 | 1 | 1 | 2 | 2 | 51 |
| b302 | 17:41:46.440 | -34:09:59.40 | 355.11565 | -2.04449 | 1 | 1 | 1 | 2 | 50 |
| b303 | 17:45:26.424 | -32:55:27.48 | 356.57487 | -2.04453 | 1 | 1 | 1 | 1 | 51 |
| b304 | 17:49:00.600 | -31:40:34.32 | 358.03411 | -2.04446 | 1 | 1 | 1 | 1 | 51 |
| b305 | 17:52:29.424 | -30:25:22.08 | 359.49334 | -2.04452 | 2 | 2 | 2 | 1 | 51 |
| b306 | 17:55:53.256 | -29:09:51.84 | 0.95261 | -2.04456 | 1 | 1 | 1 | 1 | 48 |
| b307 | 17:59:12.432 | -27:54:05.04 | 2.41186 | -2.04451 | 1 | 1 | 1 | 1 | 91 |
| b308 | 18:02:27.312 | -26:38:03.12 | 3.87111 | -2.04447 | 1 | 1 | 1 | 1 | 92 |
| b309 | 18:05:38.232 | -25:21:47.52 | 5.33034 | -2.04451 | 1 | 1 | 1 | 1 | 94 |
| b310 | 18:08:45.480 | -24:05:18.96 | 6.78962 | -2.04454 | 1 | 1 | 1 | 1 | 96 |
| b311 | 18:11:49.320 | -22:48:38.52 | 8.24891 | -2.04449 | 1 | 1 | 2 | 1 | 40 |
| b312 | 18:14:50.040 | -21:31:47.64 | 9.70816 | -2.04447 | 1 | 4 | 1 | 1 | 40 |
| b313 | 17:25:32.232 | -37:14:49.92 | 350.73753 | -0.95236 | 1 | 1 | 1 | 1 | 47 |
| b314 | 17:29:34.800 | -36:02:05.64 | 352.19625 | -0.9523 | 1 | 1 | 1 | 1 | 47 |
| b315 | 17:33:30.168 | -34:48:52.92 | 353.65504 | -0.95232 | 1 | 1 | 1 | 1 | 53 |
| b316 | 17:37:18.768 | -33:35:14.28 | 355.11368 | -0.95231 | 1 | 1 | 1 | 1 | 53 |
| b317 | 17:41:01.104 | -32:21:10.80 | 356.57248 | -0.95229 | 1 | 1 | 1 | 1 | 47 |
| b318 | 17:44:37.584 | -31:06:45.00 | 358.03121 | -0.9523 | 1 | 1 | 1 | 1 | 46 |
| b319 | 17:48:08.616 | -29:51:58.32 | 359.48996 | -0.95233 | 1 | 1 | 5 | 4 | 53 |
| b320 | 17:51:34.560 | -28:36:52.56 | 0.94861 | -0.95235 | 1 | 1 | 1 | 1 | 49 |
| b321 | 17:54:55.800 | -27:21:28.44 | 2.40742 | -0.95234 | 1 | 2 | 1 | 1 | 50 |

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| b322 | 17:58:12.648 | -26:05:48.12 | 3.86612 | -0.95234 | 2 | 2 | 1 | 1 | 51 |
| b323 | 18:01:25.416 | -24:49:52.68 | 5.32477 | -0.95232 | 1 | 1 | 1 | 1 | 46 |
| b324 | 18:04:34.440 | -23:33:42.84 | 6.78355 | -0.95232 | 1 | 1 | 1 | 1 | 46 |
| b325 | 18:07:39.984 | -22:17:20.40 | 8.24226 | -0.95238 | 3 | 2 | 1 | 1 | 46 |
| b326 | 18:10:42.288 | -21:00:45.72 | 9.70101 | -0.95231 | 1 | 2 | 1 | 1 | 47 |
| b327 | 17:21:01.656 | -36:37:48.00 | 350.73744 | 0.13984 | 1 | 1 | 1 | 1 | 52 |
| b328 | 17:25:06.528 | -35:25:37.20 | 352.19621 | 0.13989 | 1 | 1 | 1 | 3 | 54 |
| b329 | 17:29:04.152 | -34:12:56.52 | 353.65492 | 0.13987 | 2 | 2 | 1 | 3 | 49 |
| b330 | 17:32:55.008 | -32:59:47.76 | 355.11368 | 0.13984 | 1 | 2 | 1 | 2 | 50 |
| b331 | 17:36:39.504 | -31:46:13.08 | 356.57236 | 0.13988 | 1 | 1 | 2 | 2 | 62 |
| b332 | 17:40:18.120 | -30:32:14.28 | 358.0311 | 0.13982 | 1 | 1 | 1 | 2 | 62 |
| b333 | 17:43:51.192 | -29:17:52.80 | 359.48985 | 0.13988 | 1 | 1 | 1 | 1 | 70 |
| b334 | 17:47:19.128 | -28:03:10.80 | 0.94855 | 0.13988 | 1 | 1 | 1 | 1 | 66 |
| b335 | 17:50:42.288 | -26:48:09.36 | 2.40731 | 0.13985 | 1 | 1 | 1 | 1 | 49 |
| b336 | 17:54:00.984 | -25:32:49.92 | 3.8661 | 0.13985 | 1 | 1 | 1 | 1 | 49 |
| b337 | 17:57:15.528 | -24:17:14.28 | 5.32478 | 0.13981 | 1 | 1 | 2 | 3 | 48 |
| b338 | 18:00:26.208 | -23:01:23.16 | 6.78348 | 0.13983 | 1 | 1 | 1 | 3 | 48 |
| b339 | 18:03:33.336 | -21:45:17.64 | 8.24226 | 0.13983 | 1 | 1 | 2 | 2 | 46 |
| b340 | 18:06:37.152 | -20:28:59.16 | 9.70099 | 0.13985 | 1 | 1 | 1 | 1 | 46 |
| b341 | 17:16:35.472 | -36:00:07.56 | 350.73765 | 1.23203 | 1 | 1 | 1 | 1 | 79 |
| b342 | 17:20:42.432 | -34:48:30.24 | 352.19686 | 1.23205 | 1 | 1 | 1 | 1 | 79 |
| b343 | 17:24:42.144 | -33:36:20.88 | 353.65613 | 1.23203 | 1 | 1 | 1 | 1 | 68 |
| b344 | 17:28:35.040 | -32:23:41.64 | 355.11542 | 1.23207 | 1 | 1 | 1 | 1 | 72 |
| b345 | 17:32:21.576 | -31:10:35.04 | 356.57468 | 1.23205 | 1 | 1 | 1 | 1 | 58 |
| b346 | 17:36:02.160 | -29:57:02.52 | 358.03399 | 1.23203 | 1 | 1 | 1 | 1 | 57 |
| b347 | 17:39:37.152 | -28:43:06.24 | 359.49322 | 1.23206 | 1 | 1 | 1 | 1 | 49 |
| b348 | 17:43:06.960 | -27:28:47.64 | 0.95251 | 1.23203 | 1 | 1 | 1 | 1 | 50 |
| b349 | 17:46:31.896 | -26:14:08.52 | 2.41172 | 1.23201 | 1 | 1 | 3 | 3 | 58 |
| b350 | 17:49:52.296 | -24:59:09.96 | 3.87096 | 1.23204 | 1 | 1 | 2 | 2 | 57 |
| b351 | 17:53:08.496 | -23:43:53.40 | 5.33027 | 1.23202 | 1 | 1 | 1 | 1 | 52 |
| b352 | 17:56:20.760 | -22:28:20.28 | 6.78955 | 1.23201 | 1 | 1 | 1 | 1 | 54 |
| b353 | 17:59:29.376 | -21:12:31.68 | 8.24885 | 1.23202 | 1 | 1 | 1 | 1 | 56 |
| b354 | 18:02:34.608 | -19:56:29.04 | 9.70808 | 1.23199 | 2 | 2 | 1 | 1 | 58 |
| b355 | 17:12:13.584 | -35:21:49.68 | 350.73827 | 2.32427 | 1 | 1 | 4 | 6 | 61 |
| b356 | 17:16:22.488 | -34:10:45.12 | 352.19857 | 2.32417 | 1 | 1 | 2 | 2 | 64 |
| b357 | 17:20:24.096 | -32:59:06.36 | 353.65894 | 2.32423 | 1 | 1 | 1 | 1 | 55 |
| b358 | 17:24:18.888 | -31:46:56.64 | 355.11924 | 2.32422 | 1 | 1 | 1 | 1 | 54 |
| b359 | 17:28:07.296 | -30:34:17.40 | 356.57962 | 2.3242 | 1 | 1 | 2 | 1 | 53 |
| b360 | 17:31:49.680 | -29:21:11.16 | 358.03989 | 2.32423 | 1 | 1 | 1 | 1 | 50 |
| b361 | 17:35:26.472 | -28:07:39.36 | 359.50024 | 2.32421 | 1 | 1 | 1 | 1 | 47 |

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| b362 | 17:38:58.008 | -26:53:43.80 | 0.96059 | 2.32418 | 1 | 1 | 1 | 1 | 49 |
| b363 | 17:42:24.624 | -25:39:25.92 | 2.42098 | 2.3242 | 2 | 2 | 1 | 1 | 48 |
| b364 | 17:45:46.632 | -24:24:47.88 | 3.88124 | 2.32419 | 2 | 2 | 1 | 1 | 48 |
| b365 | 17:49:04.368 | -23:09:50.40 | 5.34158 | 2.32416 | 1 | 2 | 1 | 1 | 54 |
| b366 | 17:52:18.096 | -21:54:34.92 | 6.80192 | 2.32418 | 2 | 2 | 2 | 1 | 55 |
| b367 | 17:55:28.104 | -20:39:02.88 | 8.26224 | 2.32419 | 2 | 2 | 2 | 2 | 43 |
| b368 | 17:58:34.656 | -19:23:15.00 | 9.72265 | 2.32423 | 2 | 2 | 1 | 2 | 43 |
| b369 | 17:07:55.872 | -34:42:57.24 | 350.73892 | 3.41637 | 1 | 1 | 3 | 5 | 66 |
| b370 | 17:12:06.480 | -33:32:24.36 | 352.20083 | 3.41644 | 1 | 1 | 2 | 2 | 65 |
| b371 | 17:16:09.864 | -32:21:16.20 | 353.6628 | 3.41638 | 1 | 1 | 1 | 2 | 57 |
| b372 | 17:20:06.384 | -31:09:35.28 | 355.12466 | 3.41637 | 1 | 1 | 1 | 1 | 58 |
| b373 | 17:23:56.496 | -29:57:23.04 | 356.58663 | 3.41642 | 1 | 1 | 1 | 1 | 51 |
| b374 | 17:27:40.584 | -28:44:42.36 | 358.04853 | 3.4164 | 1 | 1 | 1 | 2 | 52 |
| b375 | 17:31:19.032 | -27:31:34.68 | 359.51046 | 3.41635 | 1 | 1 | 1 | 1 | 52 |
| b376 | 17:34:52.152 | -26:18:01.44 | 0.97243 | 3.41644 | 1 | 1 | 1 | 1 | 52 |
| b377 | 17:38:20.328 | -25:04:05.16 | 2.43434 | 3.41638 | 1 | 1 | 1 | 1 | 48 |
| b378 | 17:41:43.848 | -23:49:46.56 | 3.89631 | 3.41638 | 1 | 2 | 1 | 1 | 49 |
| b379 | 17:45:03.024 | -22:35:07.44 | 5.35828 | 3.41637 | 1 | 1 | 1 | 1 | 53 |
| b380 | 17:48:18.120 | -21:20:09.24 | 6.8202 | 3.4164 | 1 | 1 | 1 | 1 | 54 |
| b381 | 17:51:29.424 | -20:04:53.40 | 8.28204 | 3.4164 | 2 | 2 | 2 | 2 | 45 |
| b382 | 17:54:37.224 | -18:49:20.64 | 9.74399 | 3.41636 | 2 | 2 | 2 | 2 | 45 |
| b383 | 17:03:42.216 | -34:03:30.60 | 350.73979 | 4.50856 | 1 | 1 | 1 | 2 | 79 |
| b384 | 17:07:54.408 | -32:53:29.40 | 352.2038 | 4.50857 | 1 | 1 | 1 | 1 | 78 |
| b385 | 17:11:59.352 | -31:42:51.12 | 353.66783 | 4.50858 | 1 | 1 | 1 | 1 | 74 |
| b386 | 17:15:57.480 | -30:31:37.92 | 355.13195 | 4.5086 | 1 | 1 | 1 | 1 | 73 |
| b387 | 17:19:49.176 | -29:19:52.68 | 356.59597 | 4.50856 | 1 | 1 | 1 | 1 | 58 |
| b388 | 17:23:34.824 | -28:07:36.84 | 358.06004 | 4.50857 | 1 | 1 | 1 | 1 | 60 |
| b389 | 17:27:14.784 | -26:54:52.56 | 359.52411 | 4.50859 | 1 | 1 | 1 | 1 | 50 |
| b390 | 17:30:45.384 | -25:43:05.52 | 0.96034 | 4.50854 | 1 | 1 | 1 | 1 | 51 |
| b391 | 17:34:15.096 | -24:29:30.12 | 2.42444 | 4.50852 | 1 | 1 | 1 | 1 | 56 |
| b392 | 17:37:40.080 | -23:15:31.32 | 3.8885 | 4.50858 | 1 | 1 | 3 | 3 | 58 |
| b393 | 17:41:00.672 | -22:01:10.92 | 5.35253 | 4.50853 | 1 | 1 | 1 | 1 | 52 |
| b394 | 17:44:17.136 | -20:46:29.64 | 6.81666 | 4.50854 | 1 | 1 | 1 | 1 | 51 |
| b395 | 17:47:29.736 | -19:31:29.28 | 8.28074 | 4.50857 | 1 | 1 | 1 | 1 | 57 |
| b396 | 17:50:38.736 | -18:16:11.28 | 9.74476 | 4.50855 | 1 | 1 | 1 | 1 | 57 |

TABLE 2: Disk tile coordinates and number of epochs

| ID | RA | Dec | Longitude | Latitude | Z | Y | J | H | Ks |
|------|--------------|--------------|-----------|----------|---|---|---|---|----|
| d001 | 11:43:24.936 | -63:31:38.64 | 295.4377 | -1.64975 | 1 | 1 | 1 | 1 | 47 |
| d002 | 11:56:12.576 | -63:52:21.00 | 296.89672 | -1.64979 | 1 | 1 | 1 | 1 | 47 |
| d003 | 12:09:17.184 | -64:08:46.68 | 298.35572 | -1.64971 | 1 | 1 | 1 | 1 | 43 |
| d004 | 12:22:35.184 | -64:20:48.12 | 299.8147 | -1.64971 | 1 | 1 | 1 | 1 | 43 |
| d005 | 12:36:02.640 | -64:28:18.84 | 301.27373 | -1.64973 | 2 | 1 | 1 | 1 | 43 |
| d006 | 12:49:35.184 | -64:31:14.88 | 302.73271 | -1.64977 | 1 | 1 | 1 | 1 | 43 |
| d007 | 13:03:08.352 | -64:29:34.44 | 304.1917 | -1.64978 | 1 | 1 | 1 | 1 | 45 |
| d008 | 13:16:37.632 | -64:23:18.24 | 305.65072 | -1.64970 | 1 | 1 | 1 | 1 | 44 |
| d009 | 13:29:58.632 | -64:12:30.24 | 307.10972 | -1.64971 | 5 | 5 | 1 | 1 | 43 |
| d010 | 13:43:07.272 | -63:57:15.84 | 308.56873 | -1.64973 | 1 | 1 | 1 | 1 | 43 |
| d011 | 13:55:59.856 | -63:37:42.60 | 310.02772 | -1.64971 | 1 | 1 | 1 | 1 | 40 |
| d012 | 14:08:33.240 | -63:14:00.24 | 311.48673 | -1.6497 | 1 | 1 | 1 | 1 | 39 |
| d013 | 14:20:44.808 | -62:46:19.92 | 312.94573 | -1.64979 | 1 | 1 | 3 | 3 | 39 |
| d014 | 14:32:32.496 | -62:14:52.80 | 314.40472 | -1.64974 | 1 | 1 | 1 | 3 | 38 |
| d015 | 14:43:42.144 | -61:40:33.96 | 315.83598 | -1.64972 | 1 | 1 | 3 | 3 | 42 |
| d016 | 14:54:38.784 | -61:02:16.44 | 317.29497 | -1.64975 | 1 | 1 | 2 | 4 | 40 |
| d017 | 15:05:08.712 | -60:20:51.00 | 318.75395 | -1.64975 | 1 | 1 | 1 | 2 | 40 |
| d018 | 15:15:11.880 | -59:36:30.60 | 320.21293 | -1.64975 | 1 | 3 | 1 | 1 | 37 |
| d019 | 15:24:48.600 | -58:49:27.84 | 321.67194 | -1.64978 | 1 | 1 | 7 | 7 | 45 |
| d020 | 15:33:59.400 | -57:59:54.60 | 323.13095 | -1.64976 | 1 | 1 | 7 | 7 | 44 |
| d021 | 15:42:45.072 | -57:08:02.40 | 324.58996 | -1.64971 | 1 | 1 | 1 | 1 | 41 |
| d022 | 15:51:06.576 | -56:14:02.40 | 326.04898 | -1.64975 | 1 | 1 | 1 | 2 | 41 |
| d023 | 15:59:04.920 | -55:18:04.32 | 327.50799 | -1.64974 | 1 | 1 | 1 | 1 | 45 |
| d024 | 16:06:41.208 | -54:20:17.88 | 328.96694 | -1.64974 | 1 | 1 | 2 | 2 | 44 |
| d025 | 16:13:56.640 | -53:20:51.36 | 330.42599 | -1.64974 | 1 | 1 | 1 | 1 | 37 |
| d026 | 16:20:52.320 | -52:19:53.40 | 331.88495 | -1.64978 | 1 | 1 | 1 | 1 | 38 |
| d027 | 16:27:29.400 | -51:17:30.84 | 333.34393 | -1.64976 | 2 | 2 | 3 | 2 | 41 |
| d028 | 16:33:49.032 | -50:13:50.52 | 334.80299 | -1.64976 | 1 | 1 | 1 | 1 | 39 |
| d029 | 16:39:52.248 | -49:08:58.92 | 336.26199 | -1.64971 | 1 | 1 | 1 | 1 | 44 |
| d030 | 16:45:40.128 | -48:03:01.80 | 337.72099 | -1.64973 | 1 | 1 | 2 | 2 | 44 |
| d031 | 16:51:13.632 | -46:56:04.20 | 339.17999 | -1.64971 | 1 | 1 | 1 | 1 | 43 |
| d032 | 16:56:33.720 | -45:48:11.16 | 340.63896 | -1.64975 | 1 | 1 | 1 | 1 | 43 |
| d033 | 17:01:41.256 | -44:39:26.64 | 342.09795 | -1.64972 | 1 | 1 | 1 | 1 | 40 |
| d034 | 17:06:37.104 | -43:29:54.96 | 343.55695 | -1.64975 | 2 | 2 | 1 | 1 | 39 |
| d035 | 17:11:22.032 | -42:19:39.72 | 345.01595 | -1.64979 | 3 | 3 | 1 | 1 | 45 |
| d036 | 17:15:56.760 | -41:08:44.16 | 346.47495 | -1.64979 | 1 | 1 | 1 | 1 | 45 |
| d037 | 17:20:21.984 | -39:57:11.16 | 347.9340 | -1.64973 | 1 | 1 | 1 | 1 | 38 |
| d038 | 17:24:38.352 | -38:45:04.32 | 349.39294 | -1.64975 | 1 | 1 | 1 | 1 | 36 |
| d039 | 11:45:52.488 | -62:28:17.40 | 295.43747 | -0.55759 | 1 | 1 | 3 | 3 | 48 |
| d040 | 11:58:14.160 | -62:48:15.12 | 296.89617 | -0.55758 | 1 | 1 | 1 | 1 | 47 |
| d041 | 12:10:50.928 | -63:04:04.80 | 298.35479 | -0.55753 | 1 | 1 | 1 | 1 | 44 |
| d042 | 12:23:39.672 | -63:15:39.60 | 299.8135 | -0.55756 | 1 | 1 | 1 | 1 | 43 |
| d043 | 12:36:36.744 | -63:22:53.40 | 301.27213 | -0.55754 | 1 | 1 | 1 | 1 | 43 |

| | | | | | | | | | |
|------|--------------|--------------|-----------|----------|---|---|---|---|----|
| d044 | 12:49:38.376 | -63:25:42.96 | 302.73081 | -0.55755 | 1 | 1 | 1 | 1 | 41 |
| d045 | 13:02:40.560 | -63:24:06.84 | 304.18948 | -0.5576 | 1 | 1 | 1 | 1 | 45 |
| d046 | 13:15:39.288 | -63:18:05.40 | 305.64814 | -0.55754 | 1 | 1 | 1 | 1 | 44 |
| d047 | 13:28:30.696 | -63:07:42.24 | 307.10682 | -0.55756 | 4 | 4 | 1 | 1 | 44 |
| d048 | 13:41:11.112 | -62:53:02.04 | 308.56549 | -0.55756 | 2 | 4 | 1 | 1 | 42 |
| d049 | 13:53:37.224 | -62:34:12.00 | 310.02413 | -0.5576 | 1 | 1 | 1 | 1 | 40 |
| d050 | 14:05:46.176 | -62:11:20.04 | 311.48283 | -0.55756 | 1 | 1 | 1 | 1 | 41 |
| d051 | 14:17:35.520 | -61:44:36.60 | 312.94152 | -0.55757 | 1 | 1 | 1 | 1 | 38 |
| d052 | 14:29:03.312 | -61:14:12.48 | 314.40014 | -0.55761 | 1 | 1 | 1 | 1 | 38 |
| d053 | 14:40:08.135 | -60:40:18.48 | 315.85883 | -0.55752 | 1 | 1 | 2 | 2 | 45 |
| d054 | 14:50:49.032 | -60:03:07.56 | 317.3175 | -0.55758 | 1 | 1 | 2 | 2 | 42 |
| d055 | 15:01:05.424 | -59:22:51.24 | 318.77616 | -0.55761 | 1 | 1 | 1 | 2 | 39 |
| d056 | 15:10:57.120 | -58:39:41.40 | 320.23482 | -0.55759 | 2 | 2 | 1 | 1 | 37 |
| d057 | 15:20:24.264 | -57:53:49.92 | 321.69349 | -0.55755 | 1 | 1 | 1 | 1 | 39 |
| d058 | 15:29:27.264 | -57:05:28.32 | 323.15217 | -0.55754 | 1 | 1 | 6 | 6 | 42 |
| d059 | 15:38:06.720 | -56:14:47.40 | 324.61087 | -0.55755 | 1 | 1 | 1 | 1 | 40 |
| d060 | 15:46:23.352 | -55:21:57.60 | 326.0695 | -0.55754 | 1 | 1 | 1 | 1 | 40 |
| d061 | 15:54:18.096 | -54:27:08.64 | 327.52817 | -0.55761 | 1 | 1 | 1 | 1 | 44 |
| d062 | 16:01:51.840 | -53:30:29.16 | 328.98684 | -0.55756 | 1 | 1 | 2 | 2 | 43 |
| d063 | 16:09:05.616 | -52:32:08.16 | 330.44549 | -0.55755 | 1 | 1 | 2 | 2 | 39 |
| d064 | 16:16:00.456 | -51:32:13.20 | 331.90419 | -0.55754 | 1 | 1 | 1 | 1 | 38 |
| d065 | 16:22:37.368 | -50:30:51.84 | 333.36286 | -0.55756 | 1 | 2 | 2 | 2 | 40 |
| d066 | 16:28:57.360 | -49:28:10.56 | 334.82153 | -0.55755 | 1 | 1 | 2 | 2 | 40 |
| d067 | 16:35:01.416 | -48:24:15.84 | 336.28015 | -0.55756 | 1 | 1 | 1 | 1 | 42 |
| d068 | 16:40:50.520 | -47:19:13.08 | 337.73882 | -0.55761 | 1 | 1 | 2 | 2 | 41 |
| d069 | 16:46:25.560 | -46:13:07.32 | 339.19753 | -0.55758 | 1 | 1 | 2 | 2 | 44 |
| d070 | 16:51:47.400 | -45:06:03.96 | 340.65613 | -0.55757 | 1 | 1 | 1 | 1 | 42 |
| d071 | 16:56:56.928 | -43:58:06.96 | 342.11483 | -0.55761 | 1 | 1 | 1 | 1 | 39 |
| d072 | 17:01:54.864 | -42:49:20.28 | 343.57351 | -0.55754 | 1 | 1 | 1 | 1 | 38 |
| d073 | 17:06:42.000 | -41:39:48.24 | 345.03215 | -0.55756 | 1 | 3 | 1 | 1 | 46 |
| d074 | 17:11:19.032 | -40:29:33.72 | 346.49083 | -0.55759 | 1 | 1 | 1 | 1 | 45 |
| d075 | 17:15:46.608 | -39:18:39.96 | 347.94953 | -0.55759 | 1 | 1 | 1 | 1 | 34 |
| d076 | 17:20:05.328 | -38:07:09.84 | 349.40822 | -0.55752 | 1 | 1 | 1 | 1 | 34 |
| d077 | 11:48:10.080 | -61:24:47.16 | 295.43749 | 0.53461 | 1 | 1 | 1 | 1 | 48 |
| d078 | 12:00:07.584 | -61:44:03.84 | 296.89636 | 0.53458 | 1 | 1 | 1 | 1 | 47 |
| d079 | 12:12:18.648 | -61:59:20.40 | 298.35521 | 0.53456 | 1 | 1 | 1 | 1 | 47 |
| d080 | 12:24:40.392 | -62:10:30.00 | 299.81408 | 0.53461 | 1 | 1 | 1 | 1 | 47 |
| d081 | 12:37:09.600 | -62:17:27.96 | 301.27295 | 0.53465 | 1 | 1 | 2 | 2 | 42 |
| d082 | 12:49:42.840 | -62:20:11.40 | 302.73182 | 0.53458 | 1 | 1 | 1 | 1 | 41 |
| d083 | 13:02:16.560 | -62:18:38.16 | 304.19066 | 0.53466 | 1 | 1 | 2 | 2 | 42 |
| d084 | 13:14:47.232 | -62:12:50.04 | 305.64955 | 0.53458 | 1 | 1 | 1 | 1 | 39 |
| d085 | 13:27:11.328 | -62:02:48.84 | 307.10837 | 0.53460 | 1 | 1 | 1 | 1 | 51 |
| d086 | 13:39:25.632 | -61:48:39.24 | 308.56725 | 0.53465 | 1 | 1 | 1 | 1 | 50 |
| d087 | 13:51:27.144 | -61:30:28.08 | 310.02613 | 0.53456 | 1 | 1 | 1 | 1 | 44 |
| d088 | 14:03:13.176 | -61:08:22.20 | 311.48497 | 0.53458 | 3 | 4 | 1 | 2 | 42 |
| d089 | 14:14:41.544 | -60:42:30.60 | 312.94386 | 0.53465 | 1 | 1 | 1 | 1 | 39 |

| | | | | | | | | | |
|------|--------------|--------------|-----------|---------|---|---|---|---|----|
| d090 | 14:25:50.400 | -60:13:03.72 | 314.40272 | 0.53463 | 1 | 1 | 1 | 1 | 40 |
| d091 | 14:36:38.352 | -59:40:11.64 | 315.86159 | 0.53462 | 1 | 1 | 1 | 1 | 39 |
| d092 | 14:47:04.392 | -59:04:05.52 | 317.32043 | 0.53461 | 1 | 1 | 1 | 1 | 39 |
| d093 | 14:57:07.920 | -58:24:56.16 | 318.77932 | 0.53465 | 1 | 1 | 1 | 1 | 44 |
| d094 | 15:06:48.648 | -57:42:55.44 | 320.23818 | 0.53459 | 1 | 1 | 1 | 1 | 42 |
| d095 | 15:16:06.552 | -56:58:13.80 | 321.6970 | 0.53459 | 1 | 1 | 1 | 1 | 41 |
| d096 | 15:25:01.920 | -56:11:02.04 | 323.15588 | 0.53461 | 1 | 1 | 1 | 1 | 42 |
| d097 | 15:33:35.208 | -55:21:30.60 | 324.61479 | 0.53459 | 1 | 1 | 1 | 1 | 41 |
| d098 | 15:41:46.968 | -54:29:49.20 | 326.07365 | 0.53465 | 1 | 1 | 1 | 1 | 42 |
| d099 | 15:49:37.968 | -53:36:07.56 | 327.5325 | 0.53463 | 1 | 1 | 1 | 1 | 38 |
| d100 | 15:57:09.024 | -52:40:34.32 | 328.99135 | 0.53458 | 2 | 2 | 2 | 1 | 39 |
| d101 | 16:04:20.976 | -51:43:17.40 | 330.45023 | 0.53459 | 1 | 1 | 1 | 1 | 52 |
| d102 | 16:11:14.736 | -50:44:24.72 | 331.90911 | 0.5346 | 1 | 1 | 1 | 1 | 51 |
| d103 | 16:17:51.216 | -49:44:03.48 | 333.36798 | 0.5346 | 4 | 4 | 1 | 1 | 40 |
| d104 | 16:24:11.328 | -48:42:20.16 | 334.82687 | 0.53461 | 1 | 1 | 1 | 1 | 39 |
| d105 | 16:30:15.960 | -47:39:21.24 | 336.28568 | 0.5346 | 1 | 1 | 1 | 1 | 40 |
| d106 | 16:36:06.000 | -46:35:12.12 | 337.7445 | 0.5346 | 1 | 1 | 1 | 1 | 40 |
| d107 | 16:41:42.312 | -45:29:57.84 | 339.20338 | 0.5346 | 2 | 2 | 2 | 2 | 43 |
| d108 | 16:47:05.712 | -44:23:43.44 | 340.66229 | 0.53457 | 2 | 2 | 2 | 2 | 44 |
| d109 | 16:52:16.944 | -43:16:33.24 | 342.12118 | 0.53461 | 1 | 1 | 2 | 2 | 41 |
| d110 | 16:57:16.776 | -42:08:31.56 | 343.58005 | 0.53462 | 1 | 1 | 1 | 1 | 38 |
| d111 | 17:02:05.904 | -40:59:42.36 | 345.03883 | 0.53459 | 1 | 1 | 1 | 1 | 37 |
| d112 | 17:06:45.024 | -39:50:08.52 | 346.49771 | 0.53457 | 1 | 1 | 3 | 4 | 39 |
| d113 | 17:11:14.736 | -38:39:53.28 | 347.95664 | 0.53461 | 1 | 1 | 1 | 1 | 35 |
| d114 | 17:15:35.640 | -37:29:00.24 | 349.41546 | 0.5346 | 1 | 1 | 1 | 1 | 35 |
| d115 | 11:50:18.720 | -60:21:09.00 | 295.43768 | 1.6268 | 1 | 1 | 1 | 1 | 48 |
| d116 | 12:01:53.760 | -60:39:47.52 | 296.89732 | 1.62677 | 1 | 1 | 1 | 1 | 48 |
| d117 | 12:13:40.992 | -60:54:32.76 | 298.35689 | 1.62684 | 1 | 1 | 1 | 1 | 44 |
| d118 | 12:25:37.800 | -61:05:19.68 | 299.81648 | 1.62674 | 1 | 1 | 1 | 1 | 44 |
| d119 | 12:37:41.304 | -61:12:02.52 | 301.27608 | 1.62684 | 1 | 1 | 3 | 3 | 43 |
| d120 | 12:49:48.408 | -61:14:39.48 | 302.73567 | 1.62683 | 1 | 1 | 1 | 1 | 41 |
| d121 | 13:01:55.944 | -61:13:09.12 | 304.19526 | 1.6268 | 1 | 1 | 1 | 1 | 41 |
| d122 | 13:14:00.720 | -61:07:32.16 | 305.65484 | 1.62675 | 1 | 1 | 1 | 1 | 37 |
| d123 | 13:25:59.640 | -60:57:50.40 | 307.11447 | 1.62681 | 1 | 1 | 1 | 1 | 50 |
| d124 | 13:37:49.704 | -60:44:08.88 | 308.57402 | 1.62675 | 1 | 1 | 1 | 1 | 49 |
| d125 | 13:49:28.248 | -60:26:32.28 | 310.03361 | 1.6268 | 1 | 1 | 1 | 1 | 40 |
| d126 | 14:00:52.872 | -60:05:08.16 | 311.49324 | 1.62678 | 3 | 4 | 1 | 2 | 38 |
| d127 | 14:12:01.440 | -59:40:04.44 | 312.9528 | 1.62677 | 2 | 3 | 1 | 1 | 41 |
| d128 | 14:22:52.272 | -59:11:29.76 | 314.4124 | 1.62684 | 1 | 1 | 1 | 1 | 41 |
| d129 | 14:33:24.024 | -58:39:34.56 | 315.87197 | 1.62678 | 1 | 1 | 1 | 1 | 41 |
| d130 | 14:43:35.688 | -58:04:28.20 | 317.33156 | 1.62679 | 1 | 1 | 1 | 1 | 36 |
| d131 | 14:53:26.616 | -57:26:21.48 | 318.79117 | 1.62676 | 1 | 1 | 1 | 1 | 44 |
| d132 | 15:02:56.424 | -56:45:24.48 | 320.25077 | 1.62679 | 1 | 1 | 1 | 1 | 43 |
| d133 | 15:12:05.040 | -56:01:48.00 | 321.71037 | 1.62674 | 1 | 1 | 1 | 1 | 41 |
| d134 | 15:20:52.560 | -55:15:41.76 | 323.16993 | 1.62676 | 1 | 1 | 1 | 1 | 41 |
| d135 | 15:29:19.344 | -54:27:15.48 | 324.62955 | 1.62682 | 1 | 1 | 1 | 1 | 45 |

| | | | | | | | | | |
|------|--------------|--------------|-----------|---------|---|---|---|---|----|
| d136 | 15:37:25.872 | -53:36:39.24 | 326.08912 | 1.62676 | 1 | 1 | 1 | 1 | 41 |
| d137 | 15:45:12.720 | -52:44:01.32 | 327.54872 | 1.62676 | 1 | 1 | 1 | 1 | 36 |
| d138 | 15:52:40.584 | -51:49:30.36 | 329.00835 | 1.62678 | 2 | 2 | 2 | 1 | 38 |
| d139 | 15:59:50.184 | -50:53:14.64 | 330.4679 | 1.6268 | 2 | 2 | 2 | 2 | 51 |
| d140 | 16:06:42.360 | -49:55:21.36 | 331.92752 | 1.62681 | 1 | 1 | 1 | 1 | 48 |
| d141 | 16:13:17.904 | -48:55:57.72 | 333.38714 | 1.62678 | 4 | 4 | 1 | 1 | 41 |
| d142 | 16:19:37.608 | -47:55:10.20 | 334.8467 | 1.62678 | 3 | 2 | 1 | 1 | 39 |
| d143 | 16:25:42.312 | -46:53:04.92 | 336.30624 | 1.62678 | 1 | 1 | 1 | 1 | 40 |
| d144 | 16:31:32.832 | -45:49:46.92 | 337.7659 | 1.62684 | 1 | 1 | 1 | 1 | 40 |
| d145 | 16:37:09.936 | -44:45:22.32 | 339.22547 | 1.62682 | 1 | 1 | 1 | 1 | 42 |
| d146 | 16:42:34.392 | -43:39:55.44 | 340.68506 | 1.62681 | 1 | 1 | 2 | 2 | 42 |
| d147 | 16:47:46.920 | -42:33:30.96 | 342.14462 | 1.62677 | 1 | 1 | 2 | 3 | 37 |
| d148 | 16:52:48.216 | -41:26:12.48 | 343.60424 | 1.62683 | 1 | 1 | 1 | 1 | 37 |
| d149 | 16:57:38.976 | -40:18:04.32 | 345.06387 | 1.6268 | 1 | 1 | 1 | 1 | 38 |
| d150 | 17:02:19.800 | -39:09:10.08 | 346.52343 | 1.62677 | 1 | 1 | 4 | 4 | 41 |
| d151 | 17:06:51.312 | -37:59:32.64 | 347.98303 | 1.62675 | 1 | 1 | 3 | 4 | 38 |
| d152 | 17:11:14.064 | -36:49:15.24 | 349.4426 | 1.62674 | 1 | 1 | 1 | 1 | 35 |

The VVV Survey observations planned for Year 1 (March - September 2010) comprised ZYJHKs maps and 5 epochs in the Ks-band to test for variability, for all bulge and disk fields (348 tiles covering >540 sq deg). The VVV Survey Year 1 data is now complete in all filters, though some of the observations were taken later in 2010 or in 2011. The Year 2 (2011), Year 3 (2012) and Year 4 (2013) observations follow the same pattern on the sky, but were acquired only in the Ks-band. The number of epochs observed varies from tile to tile due to the different observational constraints. The number of epochs is larger in the bulge region, which was prioritized in order to achieve the primary science goal of mapping the bulge in 3 dimensions by detecting RR Lyrae variables.

All observations from Years 1 to Year 4 have been completed.

The files for this VVV Survey DR4 include images, confidence maps and their respective photometric catalogues that have passed Quality Control (QC). We make a distinction between single filter source lists, which are part of this release, and merged multi-band photometric catalogues, which are a distinct data product. The source lists are categorised in the ESO archive as PRODCATG=SCIENCE.SRCTBL.

Release Notes

Data Reduction and Calibration

This DR4 is based on the new CASU version v1.3 pipeline, which produces publication quality results provided that appropriate checks are made. The main changes to the pipeline since version 1.1 are as follows.

- (i) The magnitude zero point error estimate for tiles is now calculated from the zero-point variation in the component pawprint images;
- (ii) All tile catalogues have been re-grouted taking into account both detector level

magnitude zero points variations and atmospheric seeing variations. (“Grouting” refers to the process of constructing calibrated tile images and catalogues from the 6 overlapping VIRCAM pawprint images).

- (iii) A bug involving how the aperture 2 correction was calculated is now fixed and tile catalogues have now been re-grouted to include this. The change in the associated apermag2 results (source magnitudes in aperture 2) is typically at the level of ~ 0.05 mag.
- (iv) Prior to re-grouting all the stacked pawprint photometric zero-points were re-computed using the latest version of the photometry software.
- (v) Post re-grouting all the tile photometric zero-points have also been updated.

Full details of the pipeline procedure and the version changes can be found at:
<http://apm49.ast.cam.ac.uk/surveys-projects/vista/data-processing/>

The photometric and astrometric calibrations are both derived from the 2MASS Point Source Catalogue. The photometric calibration includes an additional colour term designed to correct for the effect of interstellar extinction on the 2MASS to VISTA photometric transformations. This works well in the J, H and Ks bandpasses and improvements in the pipeline between v1.1 and v1.3 have fixed the calibration of a small number of tiles that previously appeared to have problems at the 0.1 mag level (by comparison with 2MASS and by using the tile overlap regions). Remaining fields with slightly poorer than average photometric calibration in J, H or Ks are solely due to poor and changing weather conditions. Changeable conditions will be apparent from the FITS catalogue headers of the tile images and tile catalogues in this release: they list the zero points and the seeing for the 6 constituent pawprints (PAWMAGZP, PAWSEENG) as well as the tile (MAGZPT, SEEING). The seeing is given in arcseconds for the pawprints but in pixels for the tile.

The only changes to individual DR4 FITS images are in the headers. The zero points will in general be slightly different than in the previously releases owing to slight improvements in the calibration procedure as noted above. Also, the ESO Grades describing data quality for each OB have in some cases been updated. A very small change to the astrometric WCS coefficients was also implemented, affecting only data taken after 20101201. The effect on the astrometry is much less than 1 arcsecond. The PV2_3 and PV2_5 FITS header keywords for subsequent data changed from 42.0, -10000.0 to 44.0, -10300.0.

The tile catalogues have slightly changed photometry compared to previous releases, owing to the updated zero points and the new aperture corrections for aperture 2. Most users will wish to use aperture 1, aperture 2 or aperture 3 magnitudes, which correspond to aperture diameters of 1.0, $\sqrt{2}$ and 2.0 arcsec respectively. The trade off is between a smaller and more accurate aperture correction for larger apertures vs. increased effects of overlapping apertures on the photometry in crowded fields. The CASU aperture photometry does attempt to deblend the fluxes of adjacent sources with overlapping apertures but the results are not as good as profile fitting photometry (which is much more computationally intensive). Consequently, some users may wish to do their own profile fitting photometry on small portions of the images in this release, in the more crowded fields. See e.g. Mauro et al. (2013). Profile fitting photometry products are planned for a future VVV release.

The team has worked on the quality control using the v1.3 data, as detailed below.

The limiting magnitudes are similar to the ones for DR1 since we cover the same fields. Maps of limiting magnitudes are given in Saito et al. (2012). In the least crowded fields in the disk region the 5σ limiting magnitudes are approximately: 20.5, 20.0, 19.5, 18.8, 18.0, 17.1 for Z, Y, J, H, Ks, Ks (variability OBs) respectively. The calibration of the VVV Survey photometry was investigated as function of crowding in the bulge and disk fields, using the overlap regions between adjacent tiles and adjacent pawprint.

The VVV saturation limit ranges between Ks=10-12 mag, with Year 1 disk observations featuring a fainter saturation limit due to the slightly longer exposure time, e.g. $\text{DIT}_{\text{Ks}}=10\text{s}$ in multicolor observations, as compared for $\text{DIT}_{\text{Ks}}=4\text{s}$ in the variability study. $\text{DIT}=4\text{s}$ was used for all Ks observations in the bulge. The saturation limit also varies between the 16 VIRCAM detectors. For brighter magnitudes the 2MASS photometry should be preferred. The photometric limit is typically Ks=17.5mag, but in high density fields like the in the Galactic center region it can be Ks<16 mag (see photometric completeness in Saito et al.2012).

The photometric catalogues contain calibrated aperture photometry, and the limiting magnitudes correspond to the aperture photometry. For some specific scientific purposes it would be better to obtain profile fitting (PSF) photometry, or differential image analysis (DIA) photometry which can give better and deeper photometry in the most crowded regions. The stacked VIRCAM pawprint images can be better for PSF or DIA photometry than the contiguous tile images contained in this release, despite the longer exposure time of the tile images. Stacked pawprint images taken up to 2011 Sep 30 are publicly available at the VISTA Science Archive (surveys.roe.ac.uk/vsa).

Data Quality

The same words of caution as before apply as in previous releases: even though we checked the images for defects, we are still identifying images that need to be reprocessed or reacquired.

The Quality Control for the Phase 3 data from v1.3 was performed with involvement of ESO and of most of the scientists from the VVV Survey Science Team. We checked image defects, telescope problems, seeing, zero points, magnitude limits, ellipticities, airmass, etc. Algorithmic quality control cuts to remove images with low zero points (after correcting for the seasonal trend), seeing that was significantly outside specification, or high average ellipticity were also applied.

Some additional quality control procedures were implemented for this release that identified a small number of tiles or pawprints where telescope guiding had been lost and fields with blurred or distorted image profiles. In addition we also identified some bad tiles where there was a large variation in the seeing or in the zero points between the 6 constituent pawprints, even though the values for the tile had passed the quality threshold. Furthermore, since we now have full confidence in the photometric calibration of the J, H and Ks data we decided to release some tile images and catalogues that had been removed from previous releases. In some cases this was because the improved calibration meant that the image now pass the seasonally adjusted threshold for the zero points. In other cases, some Ks images have

variations in the background level that cause a poor cosmetic appearance without significantly affecting the time series photometry, which we consider to be the most important VVV science product. A good cosmetic appearance was required for all of the ZYJHKs master images from the Year 1 campaign to be part of this release.

There are a number of well known image defects intrinsic to VISTA, many of which are illustrated with pictures in the CASU web page located at:
casu.ast.cam.ac.uk/surveys-projects/vista/technical/known-issues

Known Issues

The Z and Y calibration is fairly good (errors believed to be <0.05 mag) for tiles centred $>2^\circ$ off the Galactic equator but at present it remains unreliable for tiles centred at latitudes $|b|<2^\circ$. It had been hoped that ESO observations of standard fields in all filters in the 1st year of observation would provide sufficient data to calibrate the VVV Z and Y data but in the event there was insufficient data at similar times and airmasses to VVV. A dedicated VVV Z and Y band calibration programme in photometric conditions has been approved for Period 95 to address the problem in the mid-plane, with the intention of using the overlap regions between tiles and between VIRCAM pawprints to propagate a reliable solution across the whole survey area.

Data Format

File Types

There are 3 types of file, all in FITS format. Tile images (file names ending in “_st_tl.-fits.fz”), associated weight maps (file names ending in “_st_tl_conf.fits.fz”) and tile catalogues (file names ending in “_st_tl_cat.fits”).

Calibrated magnitudes can be derived from the various aperture fluxes in the catalogues using the equation:

$$\text{CalMag} = \text{MAGZPT} - 2.5\log_{10}(\text{AperfluxN}/\text{EXPTIME}) - 0.05(\text{Airmass}-1) - \text{APCORN}$$

where the capitalised variables are quantities available in the FITS catalogue headers and the “N” in AperfluxN and APCORN (the aperture flux and aperture correction terms) should be replaced with the chosen photometric aperture (see list of columns below).

$$\text{Airmass} = 0.5(\text{AIRM START} + \text{AIRM END}).$$

Catalogue Columns

| | | |
|---|----------------|---|
| 1 | Seq No. | running number for ease of reference, in strict order of image detections |
| 2 | Isophotal flux | standard definition of summed flux within detection isophote, apart from detection filter is used to define pixel connectivity and hence which pixels to include. This helps to reduce edge effects for all isophotally derived parameters. |
| 3 | X coord | intensity-weighted isophotal centre-of-gravity in X |
| 4 | Error in X | estimate of centroid error |
| 5 | Y coord | intensity-weighted isophotal centre-of-gravity in Y |

| | | |
|----|------------------|--|
| 6 | Error in Y | estimate of centroid error |
| 7 | Gaussian sigma | these are derived from the three general intensity-weighted second moments |
| 8 | Ellipticity | the equivalence between them and a generalised elliptical Gaussian |
| 9 | Position angle | Orientation (east of north) of the elliptical Gaussian, in degrees |
| 10 | Areal profile 1 | number of pixels above a series of threshold levels relative to local sky. |
| 11 | Areal profile 2 | levels are set at T, 2T, 4T, 8T . . . 128T where T is the threshold. These |
| 12 | Areal profile 3 | can be thought of as a sort of poor man's radial profile. Note that for now deblended, i.e. overlapping images, only the first areal profile is |
| 13 | Areal profile 4 | computed and the rest are set to -1, flagging the difficulty of computing accurate profiles |
| 14 | Areal profile 5 | |
| 15 | Areal profile 6 | |
| 16 | Areal profile 7 | for blended images this parameter is used to flag the start of the sequence of the deblended components by setting the first in the |
| 17 | Areal profile 8 | sequence to 0 |
| 18 | Peak height | in counts relative to local value of sky - also zeroth order aperture flux |
| 19 | Error in pkht | |
| 20 | Aperture flux 1 | The aperture fluxes are sky-corrected integrals (summations) with a soft-edge (ie. pro-rata flux division for boundary pixels). However, for overlapping images they are more subtle than this since they are in practice simultaneously fitted top-hat functions, to minimise the effects of crowding. Images external to the blend are also flagged and not included in the large radius summations. Aperture 1 has a 1.0 arcsec diameter. Each successive aperture increases in size by a factor of sqrt(2) for apertures 1 to 7. |
| 21 | Error in flux | |
| 22 | Aperture flux 2 | Flux in a 1.414 arcsec diameter aperture. |
| 23 | Error in flux | |
| 24 | Aperture flux 3 | Flux in a 2 arcsec diameter aperture. |
| 25 | Error in flux | |
| 26 | Aperture flux 4 | Flux in a 2.282 arcsec diameter aperture. |
| 27 | Error in flux | |
| 28 | Aperture flux 5 | Flux in a 4 arcsec diameter aperture. |
| 29 | Error in flux | |
| 30 | Aperture flux 6 | Flux in a 4.564 arcsec diameter aperture. |
| 31 | Error in flux | |
| 32 | Aperture flux 7 | Flux in an 8 arcsec diameter aperture. |
| 33 | Error in flux | |
| 34 | Aperture flux 8 | Flux in a 10 arcsec diameter aperture. |
| 35 | Error in flux | |
| 36 | Aperture flux 9 | Flux in a 12 arcsec diameter aperture. |
| 37 | Error in flux | |
| 38 | Aperture flux 10 | Flux in a 14 arcsec diameter aperture. |
| 39 | Error in flux | |
| 40 | Aperture flux 11 | Flux in a 16 arcsec diameter aperture. |

| | | |
|----|------------------|--|
| 41 | Error in flux | |
| 42 | Aperture flux 12 | Flux in a 20 arcsec diameter aperture. |
| 43 | Error in flux | |
| 44 | Aperture flux 13 | Flux in a 24 arcsec diameter aperture. |
| 45 | Error in flux | |
| 46 | Petrosian radius | rp as defined in Yasuda et al. 2001 AJ 112, 1104 |
| 47 | Kron radius | rk as defined in Bertin and Arnouts 1996 A&A Supp 117, 393 |
| 48 | Hall radius | rh image scale radius eg. Hall & Mackay 1984 MNRAS 210, 979 |
| 49 | Petrosian flux | flux within circular aperture to $k \times rp$ with $k=2$ |
| 50 | Error in flux | |
| 51 | Kron flux | |
| 52 | Error in flux | |
| 53 | Hall flux | |
| 54 | Error in flux | |
| 55 | Error bit flag | bit pattern listing various processing error flags initially set to the no. of bad pixels within aperture 3 (the 2 arcsec diameter aperture) - note this can be fractional due to soft-edged apertures |
| 56 | Sky level | local interpolated sky level from background tracker |
| 57 | Sky rms | local estimate of variation in sky level around image |
| 58 | Av conf | average confidence level within default rcore aperture useful for spotting spurious outliers in various parameter selection spaces |
| 59 | RA | Sexagesimal RA and Dec explicitly put in columns for overlay programs that cannot, in general, understand astrometric solution coefficients. Note $r*4$ storage precision accurate only to 50 mas. |
| 60 | Dec | Astrometry can be derived more precisely from WCS in header and XY in columns 5 and 6 |
| 61 | Classification | Flag indicating most probable morphological classification: eg. -1 stellar, +1 non-stellar, 0 noise, -2 borderline stellar (Saturated images can be flagged by comparing the peak height + local sky with the SATURATE keyword in the header.) |
| 62 | Statistic | |
| 63 | MJDoff | Offset (in minutes) of the median epoch of observation of each object from the integer Modified Julian Date of the catalogue given by header keyword MJD_DAY. The epoch is MJD_DAY + MJDoff. |
| 64 | Blank64 | |
| 65 | Blank65 | |
| 66 | Blank66 | |
| 67 | Blank67 | |
| 68 | Blank68 | |
| 69 | Blank69 | |
| 70 | Blank70 | |
| 71 | Blank71 | |
| 72 | Blank72 | |
| 73 | Blank73 | |
| 74 | Blank74 | |

| | | |
|----|---------|--|
| 75 | Blank75 | |
| 76 | Blank76 | |
| 77 | Blank77 | |
| 78 | Blank78 | |
| 79 | Blank79 | |
| 80 | Blank80 | |

Acknowledgments

Please use the following statement in your articles when using these data: Based on data products from VVV Survey observations made with the VISTA telescope at the ESO Paranal Observatory under programme ID 179.B-2002.

Further Details

More detailed information can be found at: - the CASU webpages

<http://casu.ast.cam.ac.uk/surveys-projects/vista/>

- by contacting the VVV Science Team Members listed at the VVV Survey webpage

<http://vvvsurvey.org>

- the VVV Science Team papers:

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