

Synthesis 6 cm Images of 22 Strong Southern Radio Sources

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Abstract: We present 6 cm Australia Telescope images of 22 strong southern radio sources. At least one of these sources appears likely to be a gravitationally lensed mirage.

1. Introduction

Before the Australia Telescope was commissioned in April 1990, three facilities — the Molonglo Observatory Synthesis Telescope (MOST), the Fleurs Array, and ad hoc VLBI arrays — had been used to image radio sources in the southern sky with resolution better than a minute of arc. The MOST, operating at 36 cm, achieved a resolution of ~ 43 arcsec (Mills 1981). The Fleurs Array, operating at 21 cm, achieved a resolution of ~ 20 arcsec (Bunton *et al.* 1985). Southern hemisphere ad hoc VLBI arrays have recently achieved true imaging capability with resolutions as small as 0.002 arcsec, but compared with the number of sources in the sky, the number of sources imaged (~ 12) remains small (Preston *et al.* 1989, Jauncey *et al.* in press).

The Australia Telescope has a synthesized beam of 2 arcsec at a wavelength of 6 cm (Norris 1988), and as we have said, the southern sky remains almost unknown at such resolution. Hence an initial task for the new telescope is a survey of all strong sources listed in the Parkes catalogue.

The authors, in the course of a search for southern compact sources for use as calibrators, have observed the 221 sources in the Parkes Catalogue, which are south of declination -30° , and are listed as stronger than 1 Jy at either 2.7 or 5 GHz. Of these, 77 have proved to be compact and are now in routine use as calibrators. The remaining 144 sources are, of course, extended, and here we show images of 22 of these strong extended sources. This is not an unbiased sample; we deliberately present only sources whose simple structure allows them to be well imaged from relatively sparse observations.

2. Observations and Results

Most of these sources were observed with a 5-antenna 3 km array, and twelve 10-minute cuts separated by roughly 1 hour in hour angle. However, because this project was piggy-backed onto, and subsidiary to, the calibrator survey this level of observation was not always achieved. For some sources fewer than 12 cuts were obtained, for some only four antennas were available, and for many the array gave a very uneven UV coverage. For these reasons the synthesised beamwidth to half power ranged from 2 to 7 arcsec. All observations were made at a frequency of 4.790 GHz. The images obtained are shown in Figures 1, 2 and 3. Note that the source names correspond to B1950 but the map coordi-

nates are for equinox J2000. The lowest (outermost) contour shown is the lowest contour showing no obvious contribution from noise, and the ratio of the peak flux to this contour level has been taken as a measure of the dynamic range. Notwithstanding the imperfect observing parameters, a reasonable dynamic range was achieved for most sources. The very simple source 0420-625 yielded a dynamic range of 1600:1; the very diffuse source 0625-536 yielded a dynamic range of only 6:1. The median dynamic range was 100:1.

Table 1 lists the sources and shows optical and radio data. Columns 2 to 4 give optical data: identification, magnitude, and redshift, respectively. In column 2, E = elliptical Galaxy, G = unclassified galaxy, DB = double galaxy, Q = quasars, and * = stellar object of neutral colour. With the single exception of the redshift for 0743-673 which is based on observations by Bergeron and Kunth (1984), all optical data have been taken from the Parkes catalogue (Wright and Otrupcek, 1990) and the references cited therein.

Columns 5 to 9 show the radio data resulting from the current study. Column 5 gives the dynamic range achieved, column 7 the flux density, and columns 8 and 9 the position of peak emission.

3. Discussion

The majority of the radio images present no surprises. All but two show the double radio lobes which commonly straddle radio galaxies and quasars. In five cases (1136-321, 1355-416, 1547-795, 1916-300 and 2020-575) definitely, and three cases (0625-536, 1932-464 and 2150-520) possibly, a central radio source, almost certainly corresponding to the optical galaxy or quasar, is present. Of the other two images, that of the quasar 0743-673 shows a bright core and single lobe (again not unusual), and that of the galaxy 0420-625 shows a single almost unresolved component. We have of course many examples of such simple objects; as previously discussed, we have included this example to illustrate that the dynamic range achieved is a function of source complexity. Apart from 0743-673 and 0420-625, only four sources warrant individual mention.

In the Parkes Catalogue 0409-752 is optically identified as a possible galaxy. However its two components are unusually compact and it is possibly the result of gravitational lensing.

The measured fluxes of the two components of 0411-561 are equal to one part in 400. One might suspect that this extreme symmetry has been caused by self-calibration, but this seems unlikely; no such symmetry is seen in the other 21 sources, and the symmetry in 0411-561 was apparent even before self-calibration.

The lobes of 0625-536 are unusually contorted. The Parkes catalogue lists this as a double galaxy. Our image suggests that interaction between these optical components is disturbing the radio lobes.

In its very compact and symmetrical core components 2250-412 resembles our suspected gravitational mirage 0409-752, and in its parallel but offset tails it resembles the probable gravitational mirage 1830-210 (Jauncey *et al.* 1992). However its component separation, 17 arcsec, is a few times greater than that of most accepted gravitational mirages.

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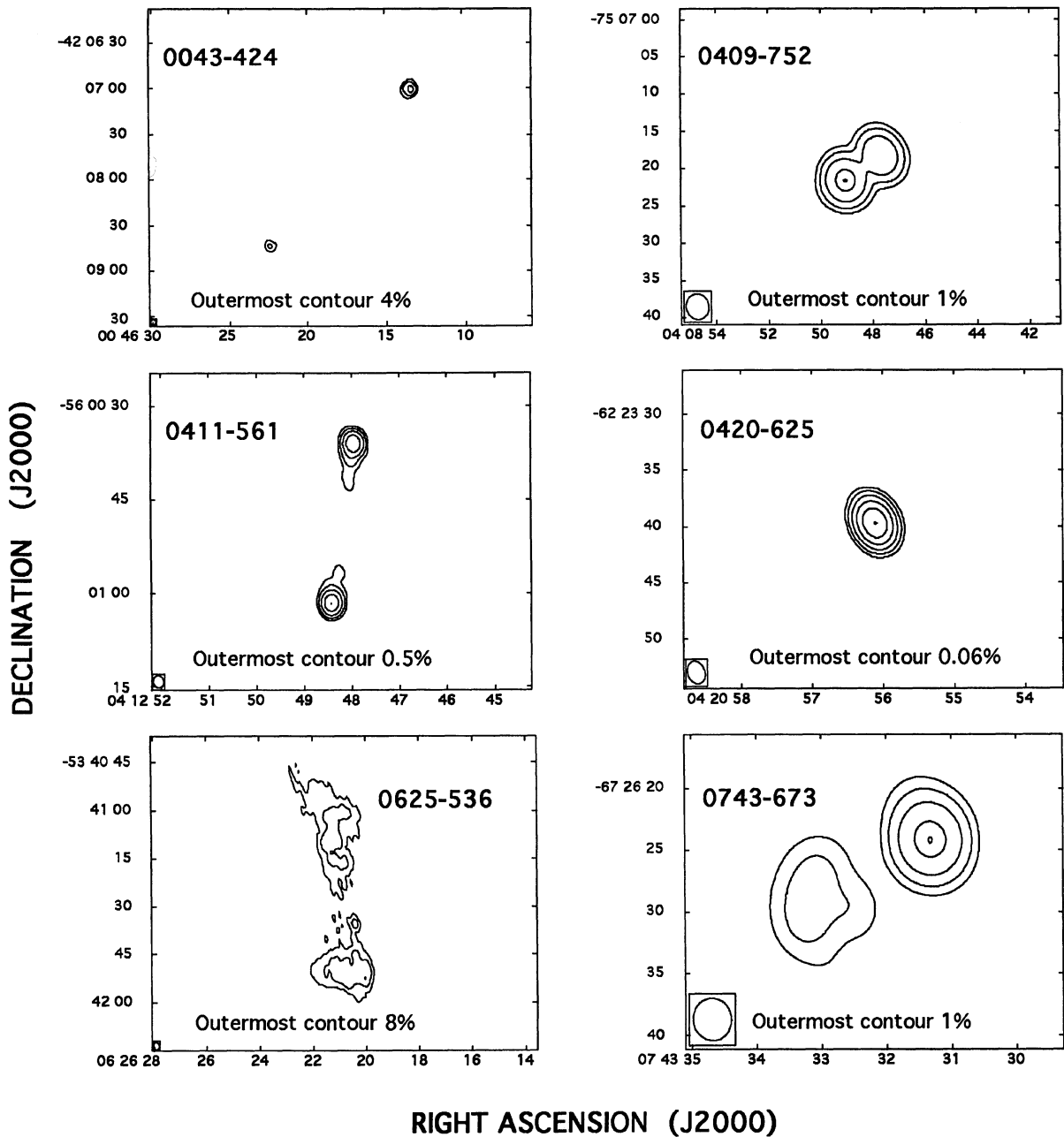


Figure 1 — Source images: B1950 names. The outermost contour level is annotated on each image. Subsequent levels increase by a factor of 4, except for the innermost (a dot) which marks the position of peak flux density. The beam is shown in the lower left-hand corner.

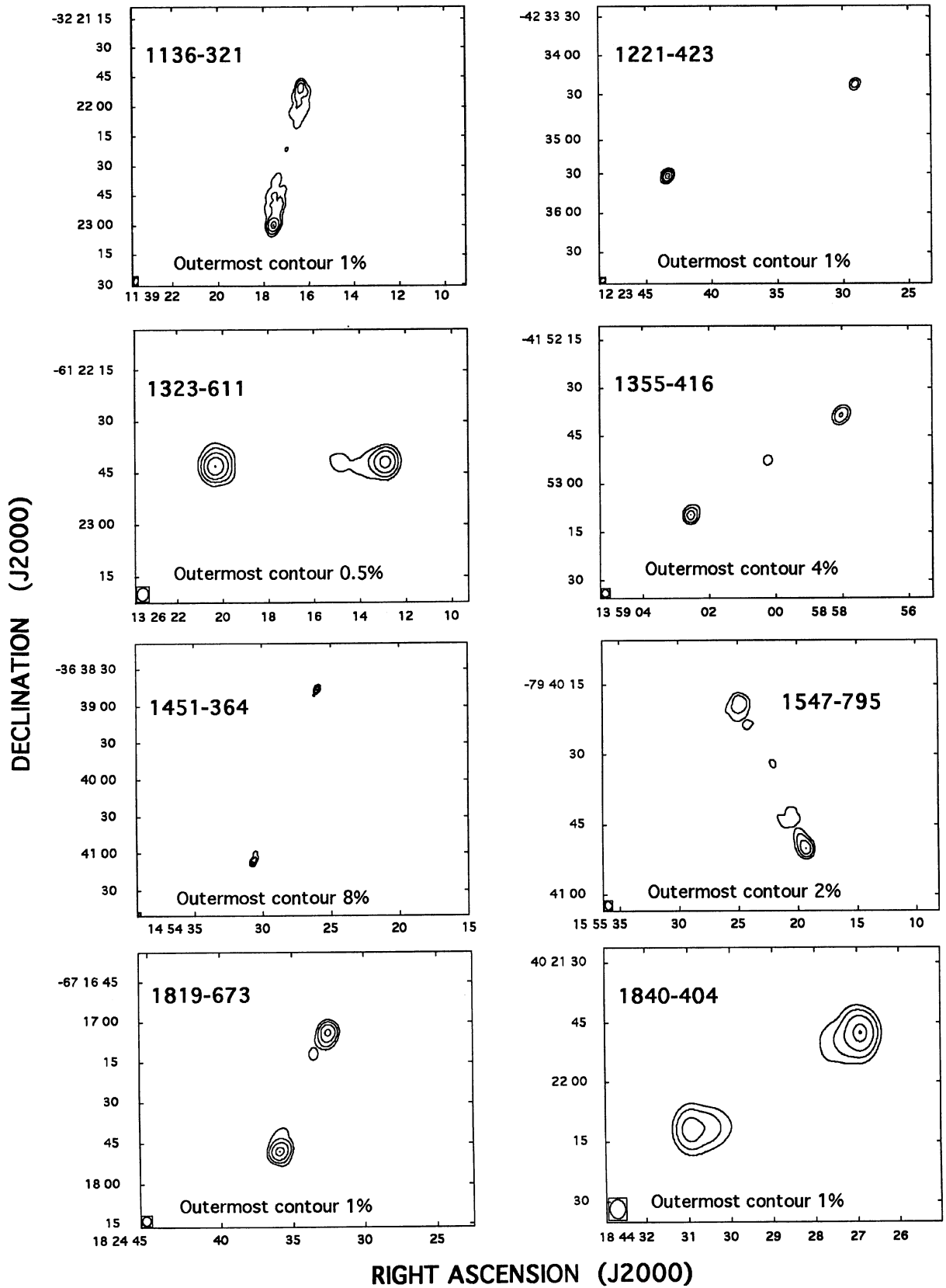


Figure 2 — Source images. As for Figure 1.

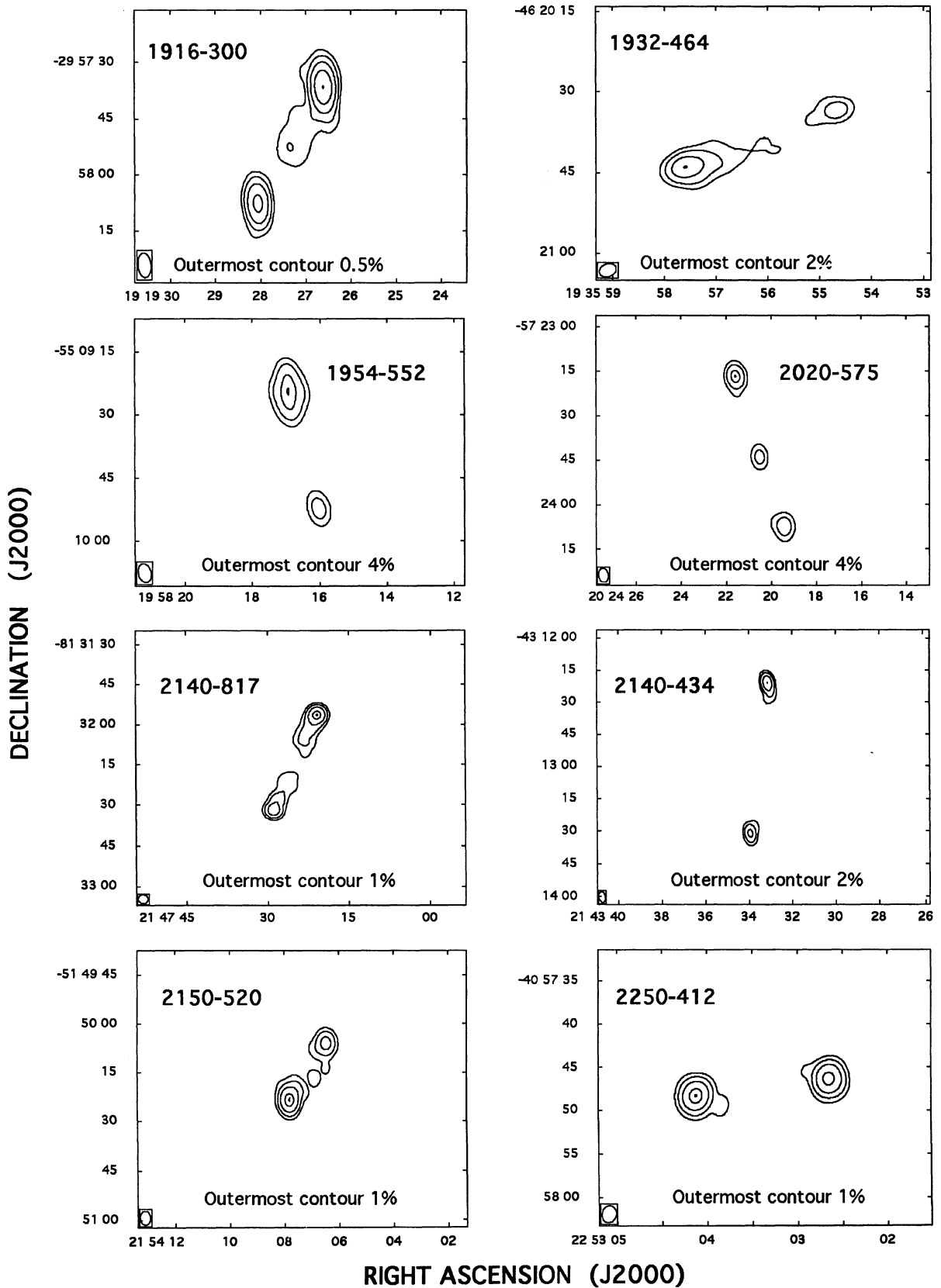


Figure 3 — Source images. As for Figure 1.

Table 1: Source list, optical identifications, and radio flux densities and positions.

Source (B1950)	Ident.	Mag.	Redshift z	D.R. (%)	Component	Flux (Jy)	J2000	
							RA	DEC
0043-424	E	17.0	0.053	4	North	1.194	00:46:13.262	-42:07:00.56
"					South	0.203	00:46:22.417	-42:08:43.25
"					Total	1.453		
0409-752	G?	-	-	0.125	North	2.159	04:08:47.726	-75:07:18.25
"					South	2.829	04:08:49.034	-75:07:21.56
"					Total	4.988		
0411-561	-	-	-	0.5	North	0.395	04:12:47.956	-56:00:36.03
"					South	0.395	04:12:48.427	-56:01:01.57
"					Total	0.827		
0420-625	G	19.5	-	0.06	Single	1.013	04:20:56.112	-62:23:39.69
0625-536	DB	15.4	-	8	North	0.853	06:26:21.303	-53:41:10.08
"					South	0.763	06:26:20.351	-53:41:49.33
"					Total	1.658		
0743-673	Q	17.0	1.512	0.5	East	0.286	07:43:33.136	-67:26:29.53
"					West	1.448	07:43:31.332	-67:26:24.11
"					Total	1.745		
1136-321	-	-	-	0.5	North	0.103	11:39:16.326	-32:21:50.29
"					South	0.339	11:39:17.538	-32:22:59.94
"					Total	0.685		
1221-423	DB	17.0	-	1	East	1.095	12:23:43.370	-42:35:31.47
"					West	0.129	12:23:29.074	-42:34:22.26
"					Total	1.235		
1323-611	-	-	-	0.5	East	2.227	13:26:20.323	-61:22:42.84
"					West	1.155	13:26:12.880	-61:22:41.83
"					Total	3.514		
1355-416	Q	16.5	0.313	2	East	0.494	13:59:02.542	-41:53:09.56
"					Centre	0.037	13:59:00.171	-41:52:52.61
"					West	0.382	13:58:57.994	-41:52:38.46
"					Total	1.200		
1451-364	E	19.5	-	4	North	0.113	14:54:25.954	-36:38:45.47
"					South	0.121	14:54:30.752	-36:41:07.40
"					Total	0.211		
1547-795	G?	19.0	-	2	North	0.370	15:55:24.811	-79:40:18.82
"					South	0.706	15:55:19.362	-79:40:50.14
"					Total	1.477		
1819-673	*	-	-	1	North	0.431	18:24:32.502	-67:17:03.94
"					South	0.551	18:24:35.909	-67:17:48.00
"					Total	1.009		
1840-404	-	-	-	1	East	0.256	18:44:30.912	-40:22:12.19
"					West	0.566	18:44:26.927	-40:21:47.71
"					Total	0.822		
1916-300	-	-	-	2	North	0.211	19:19:26.618	-29:57:36.53
"					Centre	0.006	19:19:27.430	-29:57:52.18
"					South	0.086	19:19:28.067	-29:58:07.64
"					Total	0.303		
1932-464	-	-	-	2	East	2.966	19:35:57.621	-46:20:44.03
"					West	0.417	19:35:54.694	-46:20:33.30
"					Total	3.628		
1954-552	E	16.5	0.060	4	North	0.579	19:58:16.915	-55:09:25.26
"					South	0.068	19:58:16.015	-55:09:52.66
"					Total	0.655		
2020-575	-	-	-	4	North	0.427	20:24:21.574	-57:23:16.86
"					Centre	0.110	20:24:20.531	-57:23:44.54
"					South	0.208	20:24:19.413	-57:24:07.61
"					Total	0.753		
2140-434	-	-	-	1	North	0.419	21:43:33.130	-43:12:21.12
"					South	0.187	21:43:33.947	-43:13:31.15
"					Total	0.656		
2140-817	-	-	-	1	North	0.674	21:47:20.902	-81:31:56.37
"					South	0.312	21:47:28.892	-81:32:31.81
"					Total	1.003		
2150-520	*	-	-	0.5	East	0.911	21:54:07.816	-51:50:23.40
"					West	0.251	21:54:06.492	-51:50:05.88
"					Total	1.188		
2250-412	-	-	-	1	East	0.635	22:53:04.122	-40:57:48.37
"					West	0.576	22:53:02.652	-40:57:46.39
"					Total	1.226		