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Observations of flat-spectrum radio sources at λ 850 μm from the James Clerk Maxwell Telescope II. April 2000 to June 2005

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ABSTRACT

Calibrated data for 143 flat-spectrum extragalactic radio sources are presented at a wavelength of 850 μm covering a five-year period from April 2000. The data, obtained at the James Clerk Maxwell Telescope using the SCUBA camera in pointing mode, were analysed using an automated pipeline process based on the Observatory Reduction and Acquisition Control - Data Reduction (ORAC-DR) system. This paper describes the techniques used to analyse and calibrate the data, and presents the database of results along with a representative sample of the better-sampled lightcurves. A re-analysis of previously published data from 1997 to 2000 is also presented. The combined catalogue, comprising 10493 flux density measurements, provides a unique and valuable resource for studies of extragalactic radio sources.

Key words:
methods: data analysis - techniques: photometric - galaxies: BL Lacertae objects : general - galaxies: photometry - sources as function of wavelength: submillimetre

1 INTRODUCTION

In Paper 1 (Robson, Stevens & Jenness 2001) we described a series of monitoring observations of flat-spectrum radio-sources at a wavelength of 850 μm using the Submillimetre Common-User Bolometer Array, SCUBA (Holland et al. 1999), on the 15-m diameter James Clerk Maxwell Telescope on Mauna Kea, Hawaii. The data reported in this paper extend this work and comprise 10493 flux density measurements from pointing observations of 143 flat-spectrum extragalactic radio sources taken over the lifetime of SCUBA between 1997 April 5 and 2005 June 4. The observations have been reduced using the automatic SCUBA data reduction pipeline Jenness et al. (2002) encompassing on-line atmospheric extinction correction using quasi-continuous monitoring data from the Caltech Submillimetre Observatory (CSO) (Archibald et al. 2002).

The radio through submillimetre emission from this class of source is synchrotron emission from a relativistic jet emanating from the region of the supermassive black hole. These objects represent some of the most variable sources of emission we know, and understanding the emission processes requires multifrequency, multi-epoch observing. Indeed, one of the biggest limiting factors to progress is the lack of such data; therefore, this dataset will be a valuable database for such studies. For example, data presented in Paper 1 have been incorporated into multifrequency variability studies of individual objects such as 3C 273 (Soldi et al. 2008), 3C 279 (Lindfors et al. 2006) and NRAO 530 (Feng et al. 2006) but have also been used for calibration purposes (e.g. Stirling et al. 2004) and in statistical studies of large samples of objects (e.g. Siebenmorgen et al. 2004).

As discussed in Paper I, the observations presented in this paper were not part of a systematic blazar monitoring programme but were present in the JCMT pointing catalogue either because they were very bright, close to interesting parts of the sky or they are located where there are very few submillimetre point-sources suitable for pointing calibration. This means that the light curves are sometimes well-sampled and sometimes very sparsely sampled. In some cases only a few observations were taken, usually because the target was found to be too weak. Those are presented for completeness. A comprehensive discussion of the observation technique using jiggle mapping is detailed in Paper I and in Holland et al. (1999). As an archive resource, all data presented in paper 1 have been reanalyzed and are presented alongside the new data for completeness and uniformity of approach.

2 OBSERVATION SELECTION CRITERIA

Paper I discusses the specific issues associated with processing blazar pointing data while the paper by Jenness et al. (2002) discusses the general case of the pipeline process of data extraction and reduction in much greater detail. Only the new techniques are discussed in this paper.

The main selection criterion is that all data are from pointing observations of blazars present in the JCMT pointing catalogue but

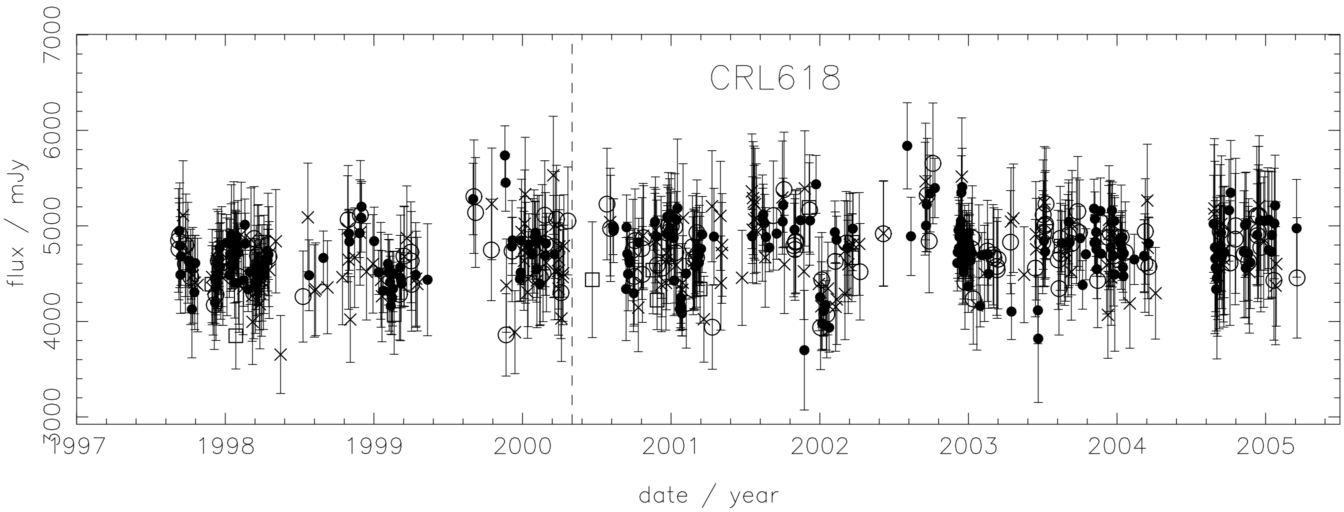

Figure 1. Light-curve of CRL 618 obtained using the same techniques as applied to the blazar data. The calibration is stable to better than 7 per cent.

other criteria must be included in order to generate an observation list suitable for automated processing.

The presence of the polarimeter in the beam (Greaves et al. 2003) during a pointing observation affects the calibration factor by approximately a factor of 2 due to attenuation by the waveplate, and additionally some blazars are themselves highly polarized at sub-millimetre wavelengths (Stevens et al. 1996; Nartallo et al. 1998; Jorstad et al. 2007) to the extent that it becomes difficult to accurately correct the data for this effect. All observations with the polarimeter in the beam have thus been discarded. In data taken since 2002 August 8 the data headers indicate whether the polarimeter is connected and these data are easily discarded. Between 1999 July 6 and 2002 August 8, the presence of the polarimeter must be inferred by using other metadata. In cases where it is inferred that the polarimeter has been used all pointing data from the night are discarded. This does leave open the rare possibility that the polarimeter is in the beam for a setup pointing and then removed prior to doing any polarimeter observations and this case can only be tested by examining the resulting flux density data. For observations taken during the polarimeter commissioning period (1998 May 13 to 1999 July 6) the presence of the polarimeter is harder to infer and can depend on observation log entries made by the observer. This approach is fairly inaccurate and results in manual removal of observations for this period.

For nights on which the Moon was observed (see e.g., Jessop et al. 2000), pointing observations are ignored because the SCUBA sensitivity must be adjusted in order to observe this bright source. That adjustment is not present in the data headers and it is easiest for the archive search to remove them. This only accounts for 18 nights of data during the period covered by this paper.

Although the data reduction attempts to be insensitive to small focus changes, large focus shifts can still be problematic especially given that a pointing observation is always done prior to a focus (and also prior to the first focus of the evening). The archive extraction routine disgards all pointings that are taken before the first focus of the night, all pointings that are taken more than 1.5 hours after the last focus of the night, and all pointings that are followed by a focus that changes by more than 0.2 mm unless they are closer to the previous focus than they are to the next.

Some nights have known problems with the secondary mirror (such as a failure of one axis) or problems with the dish shape resulting in very large variations in beam quality and calibration factors. These nights can not be detected automatically but are removed using a look-up table. Less than 10 nights were affected by these problems. Finally, all observations with a zenith sky opacity at 225 GHz greater than 0.30 are discarded (see e.g., Archibald et al. 2002).

3 CALIBRATION

Calibration is based on long-term observations of Uranus and, to a lesser extent Mars, thereby producing a time-dependent flux calibration factor (FCF) for SCUBA. These have been very stable over the period, changes due to upgrades of the instrument are clearly seen and reflected in the changing FCF. The values determined for Paper I were checked before re-processing the data and it was determined that the accuracy for the old narrow-band filter could be improved by calculating the FCF over shorter periods of a few months at a time rather than taking yearly averages. These calibration changes mean that for some periods the newly calculated flux densities can differ by up to 10 per cent from the results previously published in Paper I. In most cases the calibration difference is no more than 5 per cent. The calibration accuracy is shown in Fig. 1, where data for the best secondary calibrator, CRL 618, have been processed using the same recipes used to process the pointing data. The light-curve is flat with a Gaussian of 4730 ± 330 mJy fitting the distribution, corresponding to a calibration accuracy of ± 7 per cent over the 8 year period, agreeing with the accuracy demonstrated in Jenness et al. (2002). Data uncertainties were calculated as described in Paper I.

4 POST PIPELINE PROCESSING

The output data from the pipeline for any source are first averaged over an individual night; there has been no attempt to determine variability within a single night. The nightly averaged data are first viewed to determine whether there are any obviously erroneous points. While this is easy to accomplish for a calibration source, or a source that is not variable, for these variable extragalactic radio-sources, this can introduce a level of subjectivity. As described in section 2 early polarimeter observations are problematic and must

Table 2. These are the flux density measurements for a single source, 1908−202, provided as an example. Modified Julian Date (MJD) is defined as Julian Date − 2 400 000.5. The number of measurements taken on each night is given in the last column. The data for all sources are available in the online version of the article (see Supporting Information)

Date MJD	Date UT	Flux / mJy	Error / mJy	#
50630	19970701	1883.3	211	1
50917	19980414	1646.2	184	1
50918	19980415	1521.9	170	1
50919	19980416	1614.9	181	1
50920	19980417	1617.5	181	2
50925	19980422	1560.1	174	2
50927	19980424	1627.8	154	3
51311	19990513	1094.7	122	1
51360	19990701	942.9	105	1
51362	19990703	966.9	108	1
51780	20000824	1122.3	125	1
52027	20010428	800.4	89	1
52056	20010527	921.1	103	1
52109	20010719	780.1	87	1
52111	20010721	812.2	91	1
52133	20010812	804.0	63	3
52184	20011002	717.5	80	1
52428	20020603	899.7	101	1
52534	20020917	2116.6	237	1

be removed by inspection of the light curves. In general the light curves were inspected and in cases where a point was obviously discrepant or isolated, the processed map and observing log were inspected to decide whether the point was valid.

Manual removal of points mainly occurred for the following reasons:

- SCUBA occassionally suffered from what was thought to be a film of helium migrating across the array. In some cases this film obscured the central source.
- Some observations placed the target near to an extremely noisy bolometer that would affect the aperture photometry.
- Some images are extremely non-Gaussian 'pancakes'.
- Sometimes a fault in the system would result in the source being split into 2.
- There are occurrences of very out of focus images (probably tests of the focus system).

In total, approximately 50 observations (0.5 per cent) were removed manually from the data set.

5 THE DATA

The observed sources are presented in Table 1 which, for each source, lists the date of the first and last observation, the total number of observations and the number of nights on which the source was observed. The full set of results are available electronically, with a subset presented in Table 2 and the lightcurves for the sources with data from more than one night (filtering out 19 sources) are presented in Fig. 2.

6 CONCLUSIONS

This paper presents the second data release of SCUBA pointing data for flat-spectrum radio sources. In total we have now catalogued 10493 flux density measurements for 143 sources at 850 μm. Some of these sources have very sparsely sampled data but our observations provide perhaps the only measurements of these objects at submillimetre wavelengths. Other sources have well-sampled light curves that can be used as part of multifrequency studies. We have shown that with care, the data can be calibrated in an automated manner to an accuracy of < 10 per cent. Furthermore, the development and refinement of the pipeline process means that it is a relatively simple task to extract and calibrate all these data and make them available to the scientific community.

Table 1. The sources observed for this paper along with the J2000 RA/dec, the date of the first and last observation, the minimum and maximum flux densities measured for the period (in mJy), the total number of observations for that target and the number of nights during that period on which the source was observed

		RA(J2000)	Dec(J2000)	UT(min)	UT(max)	Flux(min)	Flux(max)	Nobs	Nnights
0003−066		00 06 13.9	−06 23 35.33	19970808	20050601	765.9	1578.1	120	60
0016+731		00 19 45.8	73 27 30.02	20000922	20020426	176.4	358.4	7	6
0048−097		00 50 41.3	−09 29 05.21	19970909	20030828	374.2	1032.7	24	12
0106+013		01 08 38.8	01 35 00.32	19970705	20050604	187.1	1333.1	154	66
0119+041		01 21 56.9	04 22 24.73	20000804	20000804	158.4	158.4	1	1
0133+476		01 36 58.6	47 51 29.10	19970405	20050531	960.7	2805.0	227	90
0135−247		01 37 38.3	−24 30 53.89	20000809	20050603	220.0	735.9	35	23
0138−097		01 41 25.8	−09 28 43.67	20040111	20040111	208.2	208.2	2	1
0149+218		01 52 18.1	22 07 07.70	19980228	20020917	372.8	531.6	9	5
0202+319		02 05 04.9	32 12 30.10	20020805	20040904	213.7	395.0	4	4
0215+015		02 17 49.0	01 44 49.70	19971208	20011212	352.2	567.5	8	6
0212+735		02 17 30.8	73 49 32.62	20010108	20041007	168.4	512.3	5	4
0219+428	(3C 66A)	02 22 39.6	43 02 07.80	19970910	19970910	719.0	719.0	2	1
0221+067		02 24 28.4	06 59 23.34	19971002	20020304	166.9	461.3	39	23
0224+671		02 28 50.1	67 21 03.03	19980215	20041019	259.6	685.1	23	13
0234+285		02 37 52.4	28 48 08.99	19971006	20041216	761.8	1810.8	68	29
0235+164		02 38 38.9	16 36 59.27	19970808	20050601	457.9	2697.2	78	41
0300+471		03 03 35.2	47 16 16.28	19981028	20031216	333.2	586.6	4	4
0306+102		03 09 03.6	10 29 16.34	20010114	20010114	274.5	274.5	1	1
0316+413	(3C 84)	03 19 48.2	41 30 42.10	19970816	20041216	1095.5	2427.5	243	87
0333+321		03 36 30.1	32 18 29.34	20010909	20010909	451.9	451.9	3	1
0336−019		03 39 30.9	−01 46 35.80	19970705	20050601	419.1	1724.1	197	90
0338−214		03 40 35.6	−21 19 31.17	20010207	20050106	409.4	599.6	67	21
0355+508		03 59 29.7	50 57 50.16	19980105	20041216	1364.0	3519.1	28	18
0415+379	(3C 111)	04 18 21.3	38 01 36.07	19970706	20040831	414.7	2410.4	71	39
0420−014		04 23 15.8	−01 20 33.07	19970810	20050601	956.0	8168.3	244	104
0422+004		04 24 46.8	00 36 06.33	20031216	20031216	1026.8	1026.8	1	1
0430+052	(3C 120)	04 33 11.1	05 21 15.62	19980310	20031216	821.5	1821.3	7	4
0454−234		04 57 03.2	−23 24 52.02	20020211	20041216	506.3	2238.3	30	14
0458−020		05 01 12.8	−01 59 14.26	20000129	20050126	215.2	476.1	17	9
0521−365		05 22 58.0	−36 27 30.85	19971013	20030130	960.3	2973.9	38	22
0528+134		05 30 56.4	13 31 55.15	19970406	20041216	564.1	1560.6	129	62
0529+075		05 32 39.0	07 32 43.35	19971217	20040201	277.6	683.8	25	14
0537−441	(PKS 0537)	05 38 50.4	−44 05 08.94	19971013	20031220	993.6	7161.3	45	22
0552+398		05 55 30.8	39 48 49.17	19970909	20041108	188.6	668.3	82	43
0605−085		06 07 59.7	−08 34 49.98	19970908	20031113	281.5	767.2	28	19
0607−157		06 09 41.0	−15 42 40.67	19970410	20031216	772.4	3378.2	82	39
0642+449		06 46 32.0	44 51 16.59	19970410	20041007	326.8	653.2	97	37
0716+714		07 21 53.4	71 20 36.36	19970910	20041220	454.9	2930.8	76	33
0723−008		07 25 50.6	−00 54 56.54	20010207	20031223	462.6	609.8	4	4
0727−115		07 30 19.1	−11 41 12.60	19970912	20040311	434.5	1239.3	20	17
0735+178		07 38 07.4	17 42 19.00	19971208	20040311	243.9	852.7	33	19
0736+017		07 39 18.0	01 37 04.62	19970410	20041108	499.5	3732.6	76	40
0745+241		07 48 36.1	24 00 24.11	19970410	20040311	203.1	527.0	69	30
0748+126		07 50 52.0	12 31 04.83	19980316	20010207	235.1	682.0	6	4
0754+100		07 57 06.6	09 56 34.85	19970410	20030203	630.7	1141.8	6	6
0814+425		08 18 16.0	42 22 45.41	20000325	20041007	214.5	559.5	39	17
0818−128		08 20 57.4	−12 58 59.17	20011005	20011005	225.6	225.6	5	1
0823+033		08 25 50.3	03 09 24.52	20001119	20040110	262.2	671.0	22	11
0829+046		08 31 48.9	04 29 39.09	19970410	20040915	345.0	936.3	35	21
0836+710		08 41 24.4	70 53 42.17	19970410	20041124	343.1	1337.2	95	54
0851+202	(OJ 287)	08 54 48.9	20 06 30.64	19970410	20040311	747.0	4540.0	82	46
0859+470		09 03 04.0	46 51 04.14	20010416	20010416	164.1	164.1	1	1
0917+449		09 20 58.5	44 41 53.99	19970410	20020121	168.7	324.7	17	12
0917+624		09 21 36.2	62 15 52.18	20010207	20010207	200.4	200.4	1	1
0923+392		09 27 03.0	39 02 20.85	19970405	20050323	835.0	2338.1	1179	354
0925−203		09 27 51.8	−20 34 51.23	20030428	20030428	301.6	301.6	1	1
0954+556		09 57 38.2	55 22 57.61	19970410	20050115	188.4	288.8	21	9
0954+658		09 58 47.2	65 33 54.82	19970410	20050604	210.6	1105.4	163	69
1012+232		10 14 47.1	23 01 16.57	20001209	20040118	124.8	453.9	15	11
1034−293		10 37 16.1	−29 34 02.81	19970410	20041019	325.4	1094.0	115	35

Table 1 – *continued*

		RA(J2000)	Dec(J2000)	UT(min)	UT(max)	Flux(min)	Flux(max)	Nobs	Nnights
1044+719		10 48 27.6	71 43 35.94	19970410	20050513	218.6	1162.1	193	85
1053+815		10 58 11.5	81 14 32.68	20010428	20030304	415.1	450.4	3	3
1055+018		10 58 29.6	01 33 58.82	19970410	20050319	388.0	3000.4	278	118
1116+128		11 18 57.3	12 34 41.72	20000812	20050128	226.5	345.5	15	10
1124−186		11 27 04.4	−18 57 17.44	20000418	20030529	219.7	710.8	47	16
1128+385		11 30 53.3	38 15 18.55	19991230	20040122	253.3	373.3	3	3
1144+402		11 46 58.3	39 58 34.30	20001209	20050116	97.2	670.6	37	20
1147+245		11 50 19.2	24 17 53.84	19980130	20040113	307.8	555.3	34	22
1156+295		11 59 31.8	29 14 43.83	19970410	20041230	245.9	1999.8	176	77
1213−172		12 15 46.8	−17 31 45.40	19980319	20030316	233.3	728.5	27	10
1216+487		12 19 06.4	48 29 56.16	20001226	20050604	117.0	228.2	24	15
1219+285		12 21 31.7	28 13 58.30	19970410	20011031	277.2	759.6	99	50
1226+023	(3C 273)	12 29 06.7	02 03 08.60	19970405	20050319	2268.2	16209.7	508	210
1243−072		12 46 04.2	−07 30 46.57	20020218	20020218	177.1	177.1	2	1
1244−255		12 46 46.8	−25 47 49.29	20000213	20030213	702.0	2293.0	29	11
1253−055	(3C 279)	12 56 11.2	−05 47 21.52	19970407	20050319	3658.4	17011.2	599	234
1308+326		13 10 28.7	32 20 43.78	19970410	20050125	170.3	1507.3	696	216
1313−333		13 16 08.0	−33 38 59.17	19970410	20050529	327.7	1640.9	38	24
1328+307		13 31 08.3	30 30 32.96	20000213	20050125	217.4	271.7	7	5
1334−127		13 37 39.8	−12 57 24.69	19970410	20041220	936.7	5019.7	124	56
1354+195		13 57 04.4	19 19 07.37	20000323	20030127	205.1	384.2	9	6
1413+135		14 15 58.8	13 20 23.71	19970410	20040308	213.8	1830.8	102	56
1418+546		14 19 46.6	54 23 14.78	19970604	20050602	157.9	995.5	302	122
1502+106		15 04 25.0	10 29 39.20	20010105	20041215	134.1	866.4	30	14
1510−089		15 12 50.5	−09 05 59.83	19970606	20041220	269.4	1135.5	84	43
1514−241		15 17 41.8	−24 22 19.48	19970410	20030507	838.8	1875.8	39	25
1519−273		15 22 37.7	−27 30 10.79	20010206	20010206	185.1	185.1	1	1
1538+149		15 40 49.5	14 47 45.88	19970706	20000317	201.5	324.4	6	5
1548+056		15 50 35.3	05 27 10.45	19980219	20041214	533.7	984.3	13	6
1600+335		16 02 07.3	33 26 53.07	20020322	20020322	173.4	173.4	1	1
1606+106		16 08 46.2	10 29 07.78	19971006	20040317	210.2	2056.1	22	12
1611+343		16 13 41.1	34 12 47.91	19970405	20041227	528.3	1043.8	272	119
1622−253		16 25 46.9	−25 27 38.33	20020425	20020425	473.2	473.2	1	1
1622−297		16 26 06.0	−29 51 26.97	20020425	20020425	277.9	277.9	1	1
1633+382		16 35 15.5	38 08 04.50	19970405	20050318	497.0	5565.0	84	42
1637+574		16 38 13.5	57 20 23.98	20000205	20050601	311.1	809.3	123	44
1638+398		16 40 29.6	39 46 46.03	20000603	20000603	236.5	236.5	1	1
1642+690		16 42 07.8	68 56 39.76	20000809	20040118	427.8	597.4	63	24
1641+399	(3C 345)	16 42 58.8	39 48 36.99	19970602	20050509	1203.6	4078.4	451	150
1656+477		16 58 02.8	47 37 49.23	20010303	20020303	160.5	221.7	7	4
1655+077		16 58 09.0	07 41 27.54	20000604	20020606	309.9	502.0	9	8
1657−261		17 00 53.2	−26 10 51.72	19970701	20030324	228.7	791.2	22	15
1716+686		17 16 13.9	68 36 38.68	19980317	19980322	277.8	341.2	43	5
1717+178		17 19 13.0	17 45 06.44	20020422	20030529	364.3	1954.3	3	2
1730−130		17 33 02.7	−13 04 49.55	19970405	20050531	731.7	4084.5	121	59
1739+522		17 40 37.0	52 11 43.41	19970405	20030320	101.4	799.6	63	25
1741−038		17 43 58.9	−03 50 04.62	19970701	20050601	713.0	2028.0	17	13
1749+701		17 48 32.8	70 05 50.77	20010522	20010522	346.1	346.1	1	1
1749+096		17 51 32.8	09 39 00.73	19970410	20020604	896.1	2705.0	46	25
1803+784		18 00 45.7	78 28 04.02	19970405	20030529	604.9	1269.8	20	15
1758+388		18 00 24.8	38 48 30.70	20000605	20020323	116.9	170.7	11	6
1800+440		18 01 32.3	44 04 21.90	20000321	20030705	427.4	1396.6	32	17
1807+698		18 06 50.7	69 49 28.11	20010423	20050528	764.8	1020.1	6	6
1823+568		18 24 07.1	56 51 01.49	19970405	20050529	386.3	1209.6	143	66
1908−202		19 11 09.7	−20 06 55.11	19970701	20020917	717.5	2116.6	25	19
1921−293		19 24 51.1	−29 14 30.12	19970703	20050531	2282.2	6020.9	88	44
1923+210		19 25 59.6	21 06 26.16	19981027	20030625	467.8	2030.0	17	13
1928+738		19 27 48.5	73 58 01.57	19971005	20010721	329.1	1025.3	22	9
1954+513		19 55 42.7	51 31 48.55	20000824	20050124	235.3	405.0	3	3
1958−179		20 00 57.1	−17 48 57.67	19970701	20021230	410.7	2164.8	45	18
2007+776		20 05 31.0	77 52 43.25	19970701	20011002	302.5	592.3	26	16

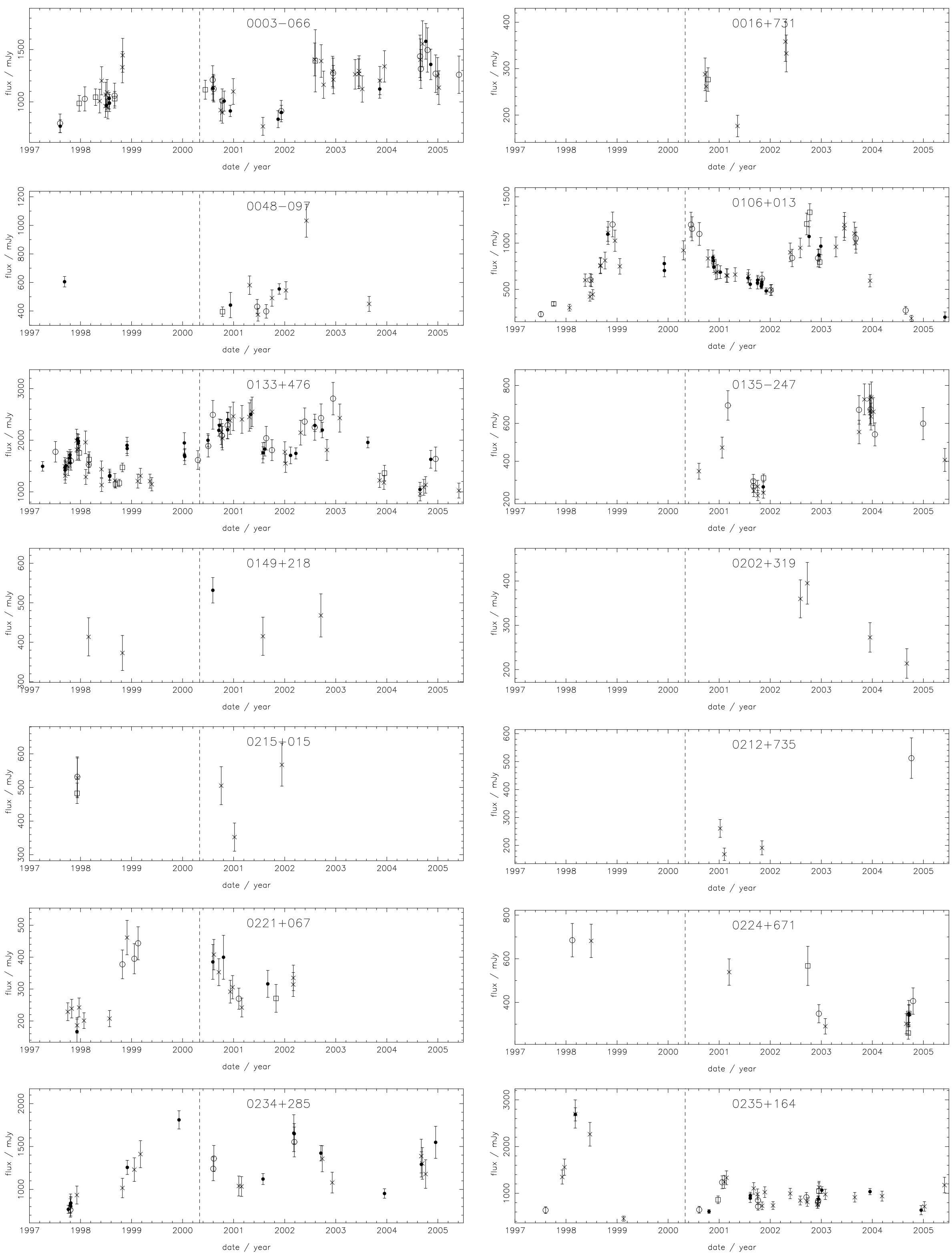

Figure 2. Light curves for well-sampled data sets. The vertical dashed line indicates the break between this paper and Paper I (although all data have been reanalyzed). Solid circles indicate 3 or more measurements, open circle indicates 2 measurements, open box indicates 2 measurements but the error was derived by the separation of the two points and cross indicates a single mesurement.

Table 1 – *continued*

		RA(J2000)	Dec(J2000)	UT(min)	UT(max)	Flux(min)	Flux(max)	Nobs	Nnights
2005+403		20 07 44.9	40 29 48.60	20010721	20010721	347.2	347.2	2	1
2008−159		20 11 15.7	−15 46 40.25	20010721	20030905	267.4	561.4	7	4
2021+317		20 23 19.0	31 53 02.31	19970405	20010612	307.3	463.0	8	6
2037+511		20 38 37.0	51 19 12.66	19970405	20040829	383.0	516.8	18	12
2059+034		21 01 38.8	03 41 31.32	19980422	20010721	206.1	536.0	3	3
2121+053		21 23 44.5	05 35 22.09	20000812	20011003	420.1	722.4	11	7
2134+004		21 36 38.6	00 41 54.21	20010721	20030614	340.6	624.2	5	4
2145+067		21 48 05.5	06 57 38.60	19970810	20041216	1289.4	3831.5	122	59
2155−152		21 58 06.3	−15 01 09.33	20010721	20041120	481.1	1025.2	9	5
2200+420	(BL Lac)	22 02 43.3	42 16 39.98	19970405	20041216	1024.2	5159.4	201	93
2201+315		22 03 15.0	31 45 38.27	19970405	20041003	452.5	1330.0	19	11
2223−052	(3C 446)	22 25 47.3	−04 57 01.39	19970703	20050531	794.6	4032.8	144	66
2227−088		22 29 40.1	−08 32 54.44	19970920	20040826	311.6	2332.3	12	9
2230+114		22 32 36.4	11 43 50.90	19970528	20011002	1182.5	5541.5	13	9
2234+282		22 36 22.5	28 28 57.41	20000530	20040827	263.6	834.3	21	13
2243−123		22 46 18.2	−12 06 51.28	19981028	20011002	416.2	505.4	4	3
2251+158	(3C 454.3)	22 53 57.7	16 08 53.56	19970606	20041216	1316.4	26346.7	125	66
2255−282		22 58 06.0	−27 58 21.26	19970808	20041114	617.1	6556.6	51	27
2318+049		23 20 44.9	05 13 49.95	19971203	20050108	149.3	589.5	67	37
2345−167		23 48 02.6	−16 31 12.02	19971005	20011002	769.3	1041.4	9	4
2351+456		23 54 21.7	45 53 04.24	20050531	20050531	297.7	297.7	2	1

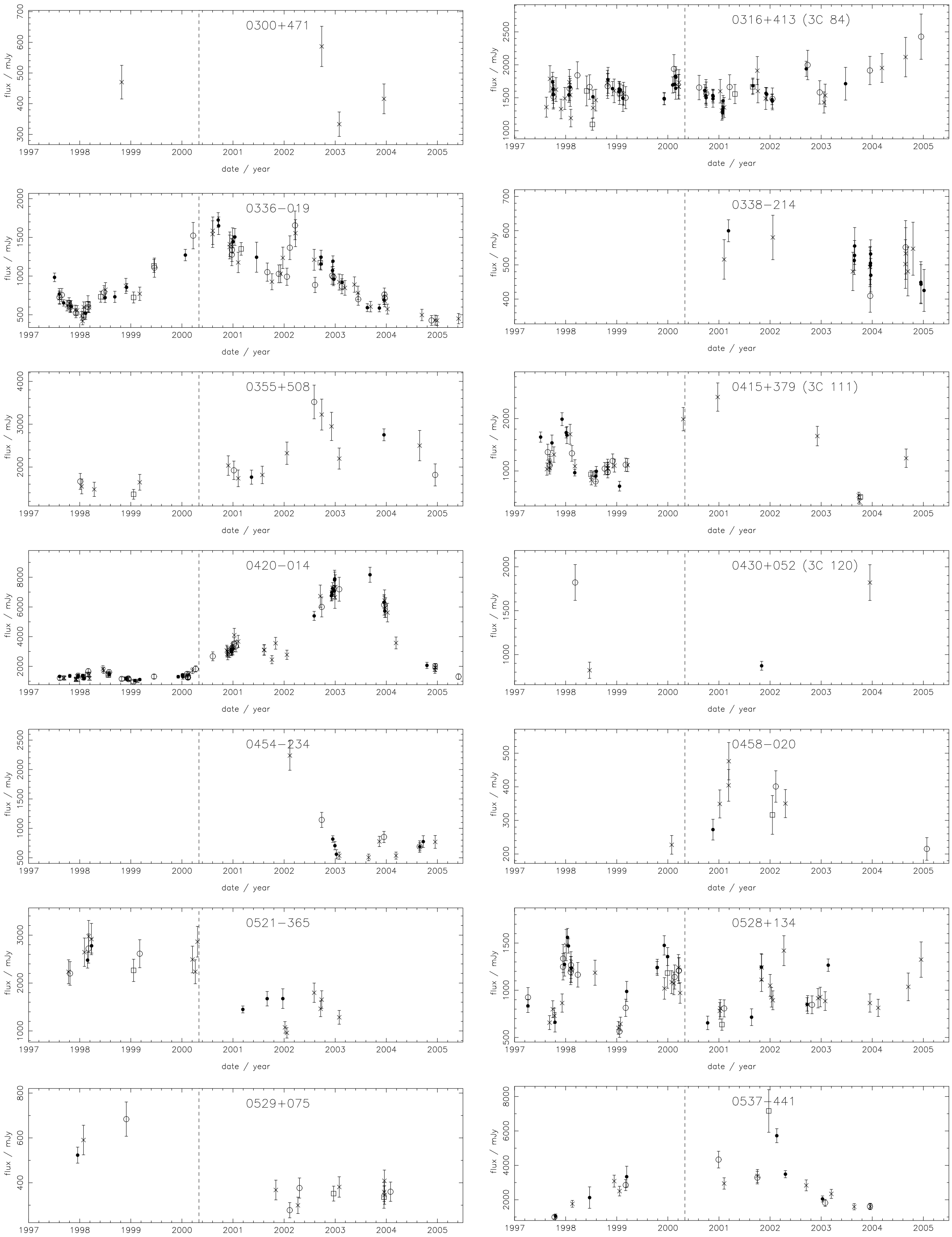

Figure 2 – *continued*

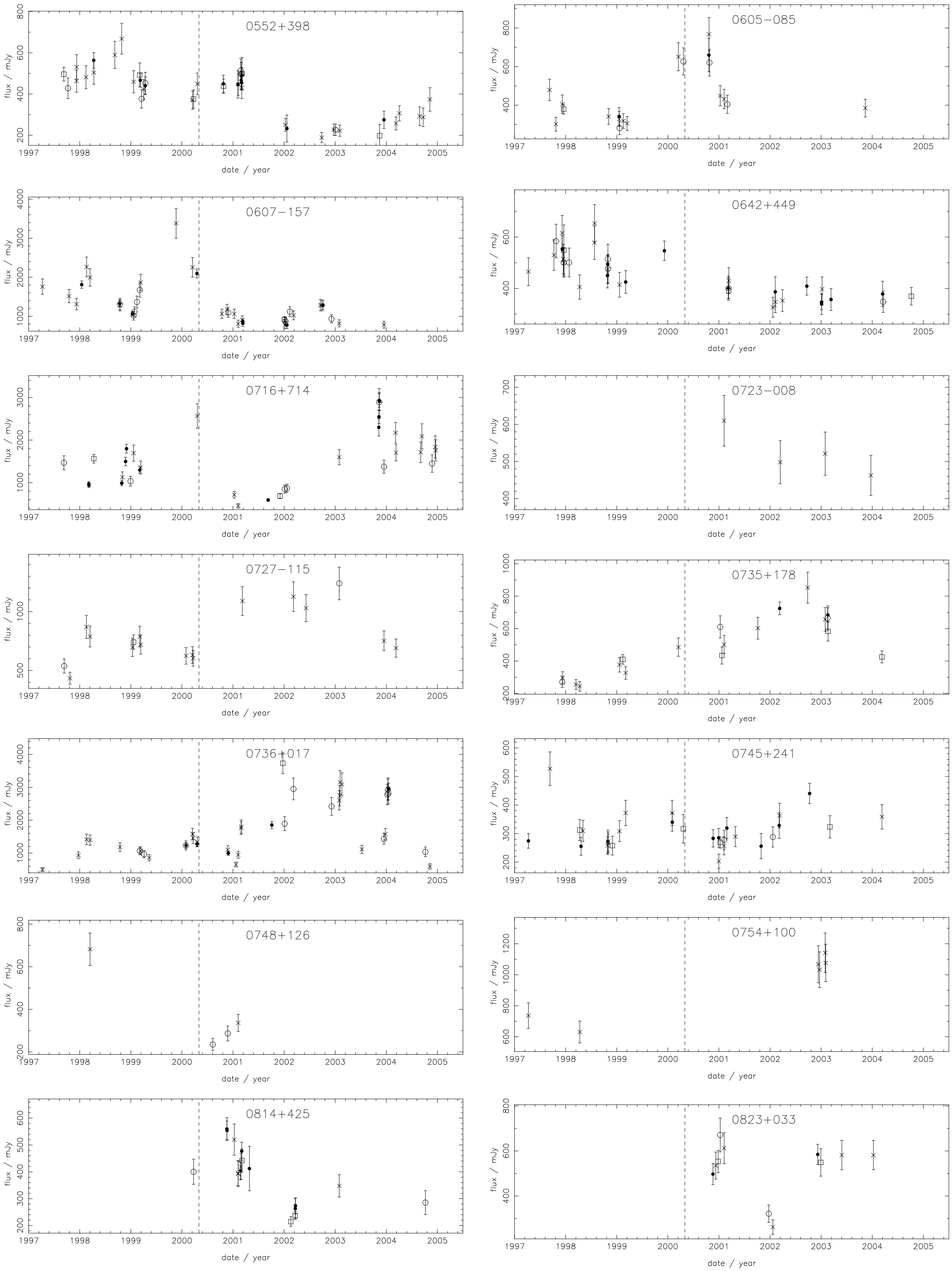

Figure 2 – *continued*

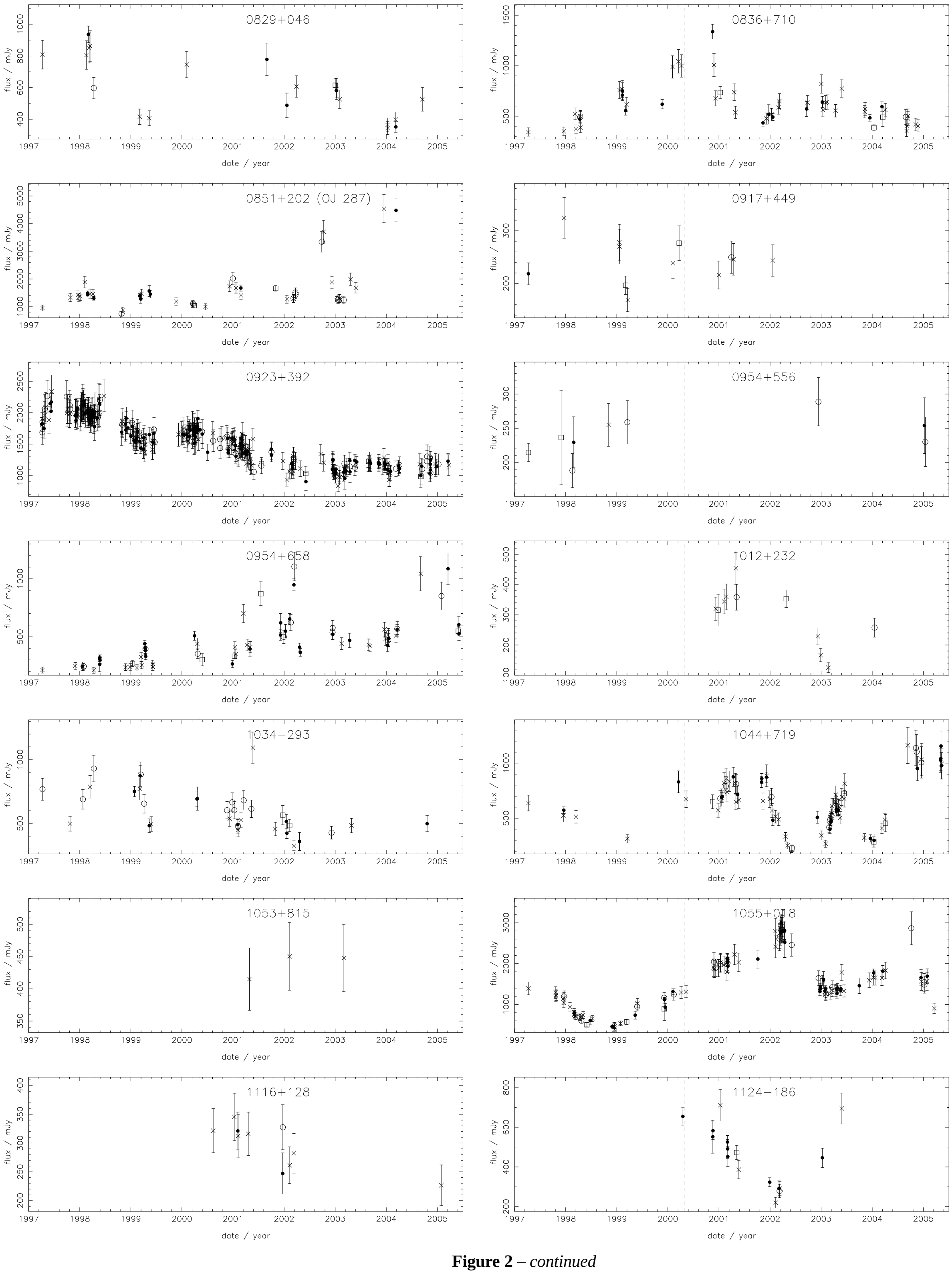

Figure 2 – *continued*

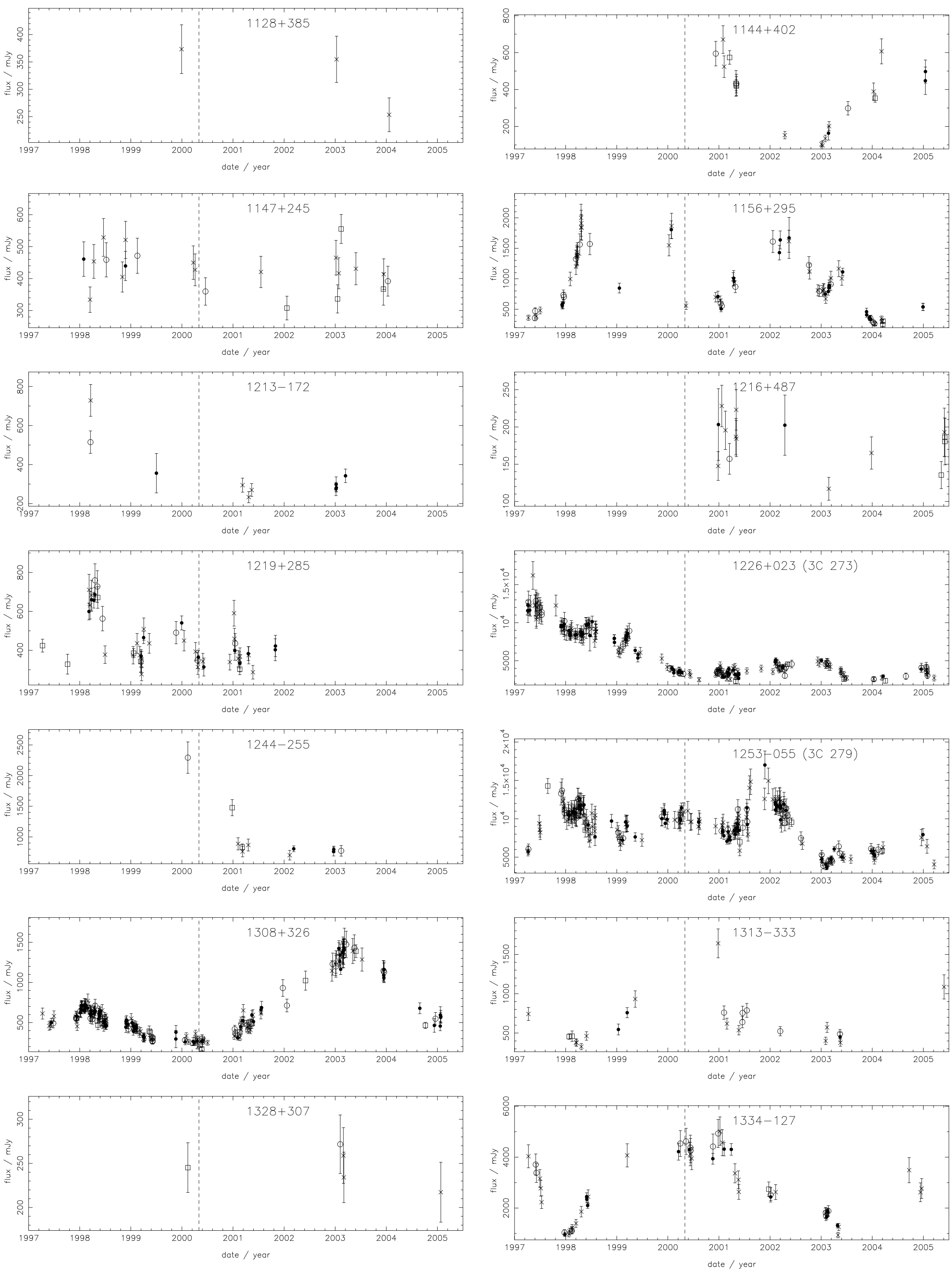

Figure 2 – *continued*

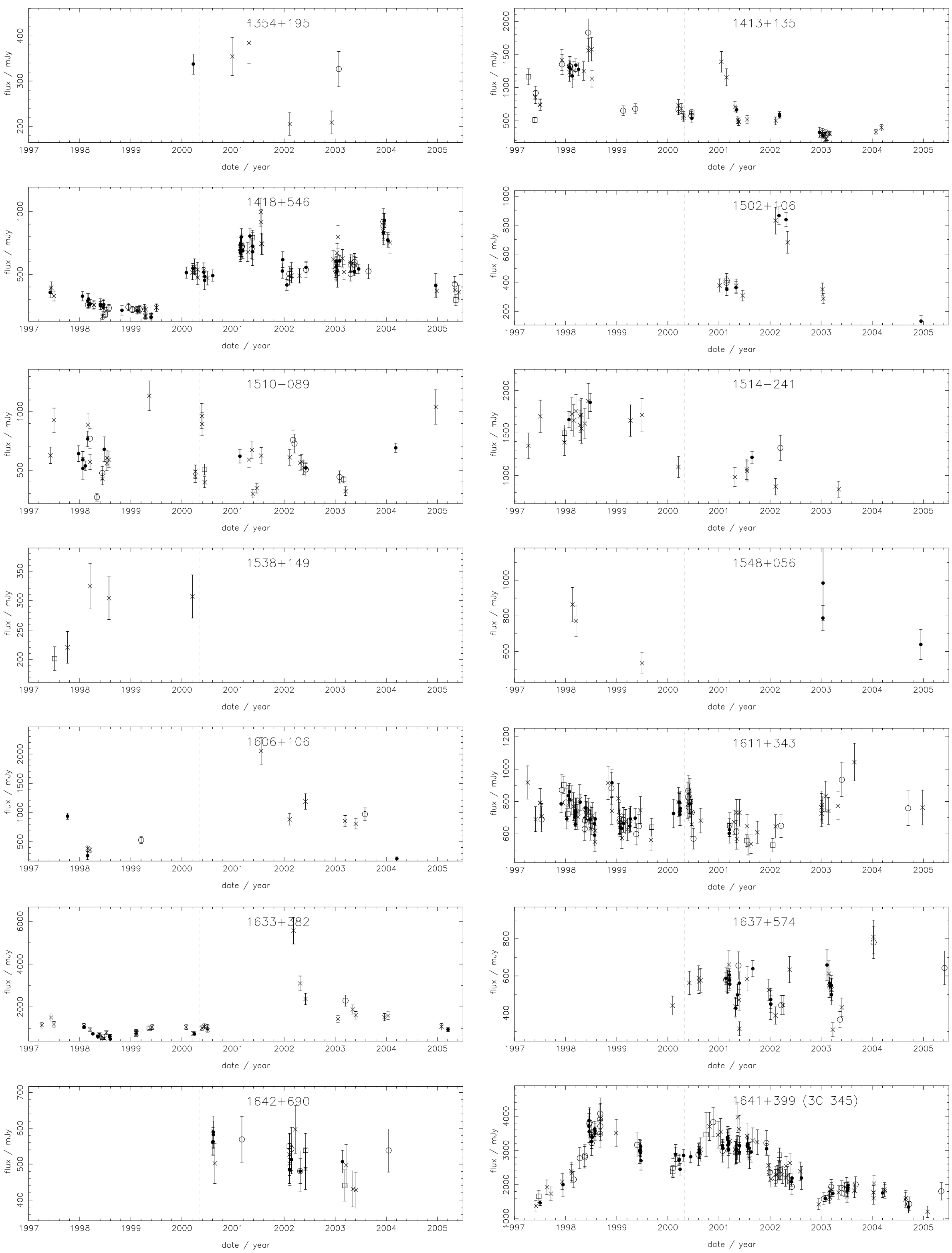

Figure 2 – *continued*

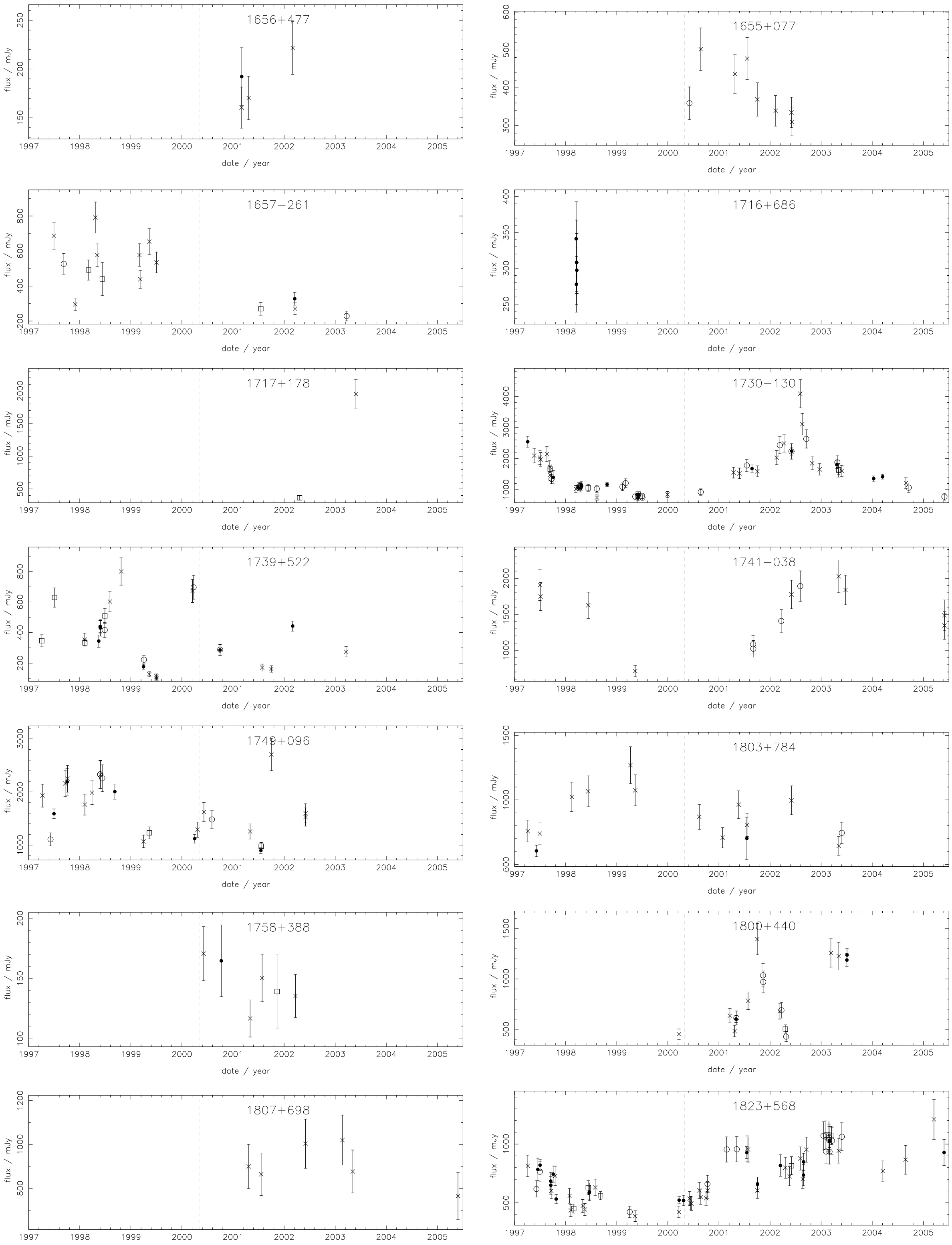

Figure 2 – *continued*

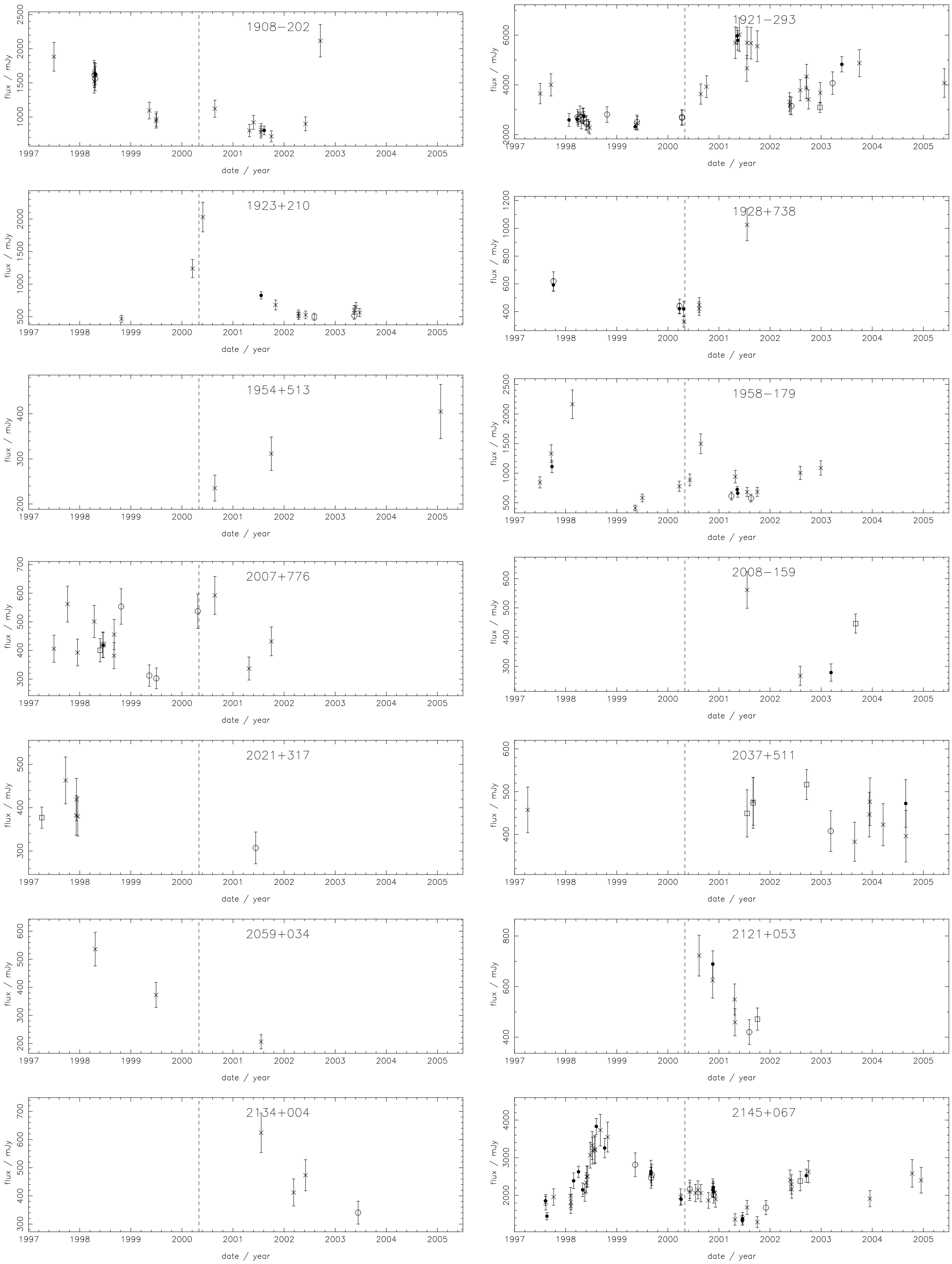

Figure 2 – *continued*

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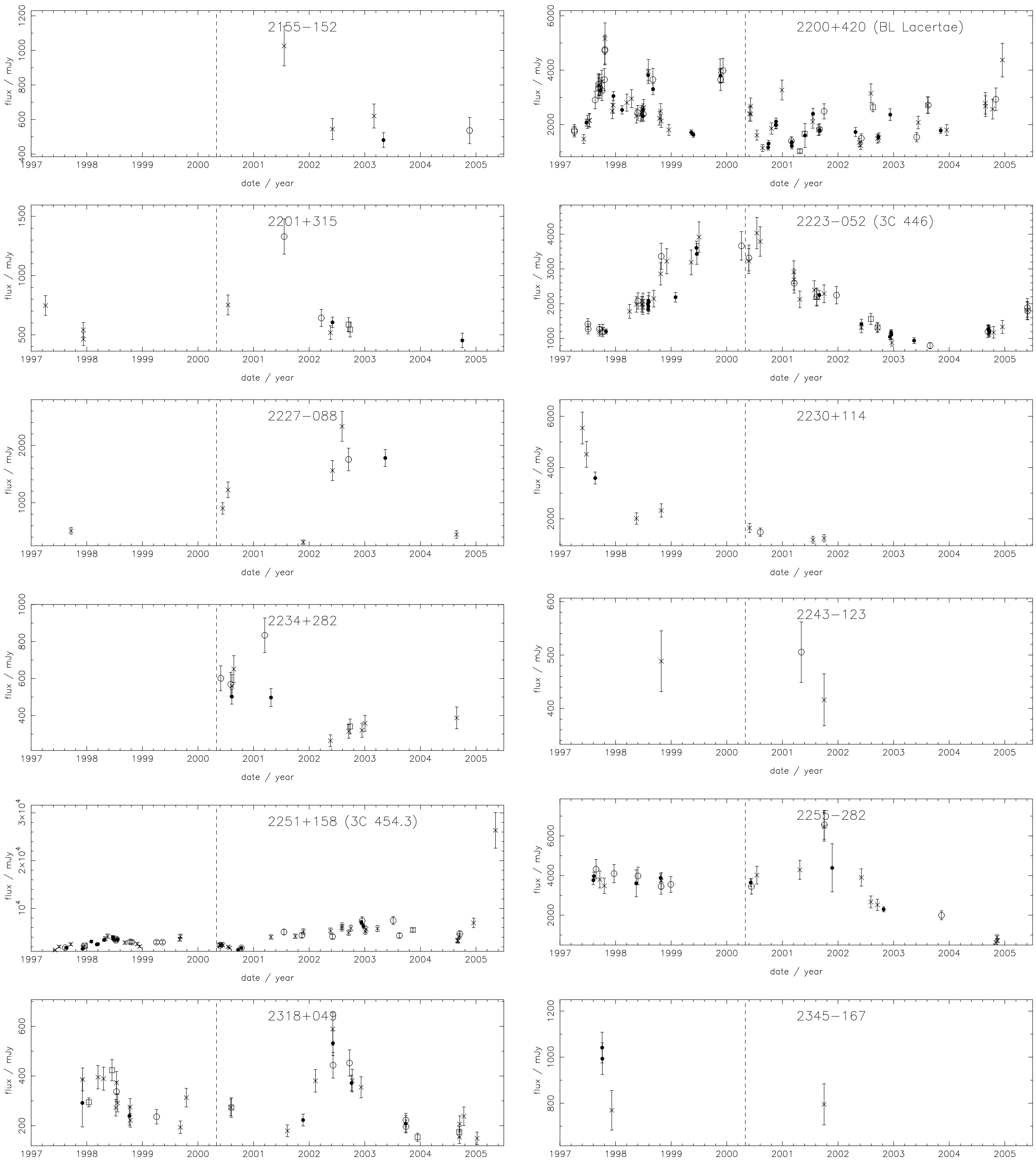

Figure 2 – *continued*