The Astrophysical Journal Supplement Series, 196:1 (15pp), 2011 September doi:10.1088/0067-0049/196/1/1

THE INTERPLANETARY NETWORK SUPPLEMENT TO THE BURST AND TRANSIENT SOURCE EXPERIMENT 5B CATALOG OF COSMIC GAMMA-RAY BURSTS

K. Hurley[1], M. S. Briggs[2], R. M. Kippen[3], C. Kouveliotou[4], G. Fishman[4], C. Meegan[5], T. Cline[6,12], J. Trombka[7], T. McClanahan[7], W. Boynton[8], R. Starr[9], R. McNutt[10], and M. Boër[11]
[1] Space Sciences Laboratory, University of California, Berkeley, 7 Gauss Way, Berkeley, CA 94720-7450, USA; khurley@ssl.berkeley.edu
[2] NSSTC, University of Alabama in Huntsville, 320 Sparkman Drive, Huntsville, AL 35805, USA
[3] Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545, USA
[4] Space Science Office, VP62, NASA/Marshall Space Flight Center, Huntsville, AL 35812, USA
[5] NSSTC, Universities Space Research Association, 320 Sparkman Drive, Huntsville, AL 35805, USA
[6] NASA Goddard Space Flight Center, Code 661, Greenbelt, MD 20771, USA
[7] NASA Goddard Space Flight Center, Code 691, Greenbelt, MD 20771, USA
[8] Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA
[9] Department of Physics, The Catholic University of America, Washington, DC 20064, USA
[10] Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20723, USA
[11] Observatoire de Haute Provence (CNRS), 04870 Saint Michel l'Observatoire, France
Received 2011 March 25; accepted 2011 July 5; published 2011 August 17

ABSTRACT

We present Interplanetary Network localization information for 343 gamma-ray bursts observed by the Burst and Transient Source Experiment (BATSE) between the end of the 4th BATSE catalog and the end of the *Compton Gamma-Ray Observatory* (*CGRO*) mission, obtained by analyzing the arrival times of these bursts at the *Ulysses*, *Near Earth Asteroid Rendezvous* (*NEAR*), and *CGRO* spacecraft. For any given burst observed by *CGRO* and one other spacecraft, arrival time analysis (or "triangulation") results in an annulus of possible arrival directions whose half-width varies between 11 arcsec and 21°, depending on the intensity, time history, and arrival direction of the burst, as well as the distance between the spacecraft. This annulus generally intersects the BATSE error circle, resulting in an average reduction of the area of a factor of 20. When all three spacecraft observe a burst, the result is an error box whose area varies between 1 and 48,000 arcmin^2, resulting in an average reduction of the BATSE error circle area of a factor of 87.

Key words: catalogs – gamma-ray burst: general

1. INTRODUCTION

This paper presents the latest in a series of catalogs of gamma-ray burst (GRB) localizations obtained by arrival time analysis, or "triangulation" between the spacecraft in the 3rd Interplanetary Network (IPN; Table 1). Three of these catalogs (Hurley et al. 1999a, 1999b, 2005) were supplements to the Burst and Transient Source Experiment (BATSE) 3B and 4Br burst catalogs (Meegan et al. 1996; Paciesas et al. 1999) and to the catalogs of untriggered bursts published by Kommers et al. (2000) and Stern et al. (2000). In the present paper, we complete the BATSE triggered event catalog supplements with the data on 343 bursts which occurred between the end of the 4Br catalog (trigger 5586 on 1996 August 29) and the end of the *Compton Gamma-Ray Observatory* (*CGRO*) mission (corresponding to trigger 8121 on 2000 May 26). The BATSE data on these events will appear in M. S. Briggs et al. (2011, in preparation). As none of the information in the 3B or 4Br supplements has changed, we do not include any of the detailed data on those bursts in this catalog.

2. INSTRUMENTATION, SEARCH PROCEDURE, DERIVATION OF ANNULI, AND BURST SELECTION CRITERIA

With one exception, which we discuss below (the addition of the *Near Earth Asteroid Rendezvous* (*NEAR*) spacecraft to the IPN), these did not change from the 3B and 4Br catalogs. We review each briefly, but refer the reader to Hurley et al. (1999a, 1999b) for more detailed descriptions.

The *Ulysses* GRB detector (Hurley et al. 1992) consisted of two 3 mm thick hemispherical CsI scintillators with a projected area of about 20 cm^2 in any direction. The detector was mounted on a magnetometer boom far from the body of the spacecraft and had a practically unobstructed view of the full sky. During the period covered by this catalog, the *Ulysses*–Earth distance varied between about 1500 and 3100 lt-s. BATSE consisted of eight detector modules situated at the corners of the *CGRO* spacecraft. Each contained a Large Area Detector (LAD), consisting of a 50.8 cm diameter by 1.27 cm thick NaI scintillator (Meegan et al. 1996).

The *NEAR* mission was launched in 1996 February. Its orbit included an Earth flyby in 1998 January and an unsuccessful first attempt to enter into orbit around the asteroid Eros in 1998 December. The spacecraft finally went into Eros orbit in 2000 February. The mission carried a gamma-ray spectrometer for the study of the surface composition of Eros (Goldsten et al. 1997; McClanahan et al. 1999; Trombka et al. 1999). Its bismuth germanate anticoincidence shield was a right circular cylinder 8.9 cm in diameter by 14 cm long. Although it was not specifically designed as a GRB detector, an in-flight modification to the on-board software allowed the shield to record the time histories of bursts with 1 s time resolution in a single energy channel (∼0.15–10 MeV), and the first GRB was detected on 1997 September 2. During the period covered by this catalog, the *NEAR*-Earth distance varied between 0.03 and 1300 lt-s, approximately.

[12] Emeritus.

Table 1
IPN Catalogs of Gamma-Ray Bursts

Years Covered	Number of GRBs	Description
1990–1992	16	*Ulysses, Pioneer Venus Orbiter*, WATCH, SIGMA, PHEBUS GRBs[a]
1990–1994	56	*Granat*-WATCH supplement[b]
1991–1992	37	*Pioneer Venus Orbiter, Compton Gamma-Ray Observatory, Ulysses* GRBs[c]
1991–1994	218	BATSE 3B supplement[d]
1991–2000	211	BATSE untriggered burst supplement[e]
1992–1993	9	*Mars Observer* GRBs[f]
1994–1996	147	BATSE 4Br supplement[g]
1996–2000	343	BATSE 5B supplement[h]
1996–2002	475	*BeppoSAX* supplement[i]
2000–2006	226	HETE-2 supplement[j]

Notes.
[a] Hurley et al. (2000a).
[b] Hurley et al. (2000b).
[c] Laros et al. (1998).
[d] Hurley et al. (1999a).
[e] Hurley et al. (2005).
[f] Laros et al. (1997).
[g] Hurley et al. (1999b).
[h] Present catalog.
[i] Hurley et al. (2010).
[j] Hurley et al. (2011).

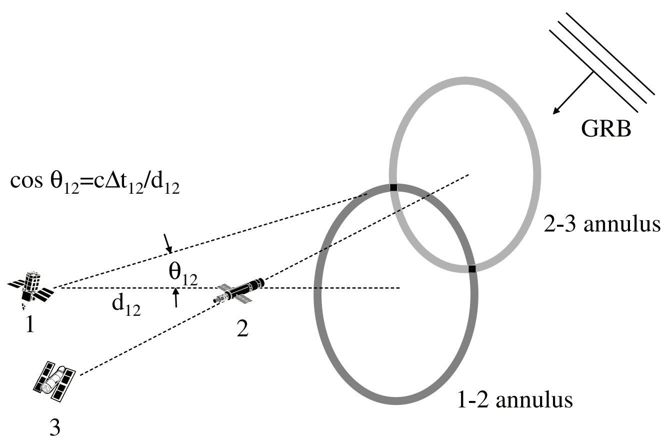

Figure 1. Triangulation technique. Each independent spacecraft pair is used to derive an annulus of location for the burst. Three spacecraft produce two possible error boxes. The ambiguity can be eliminated by the addition of a fourth, non-coplanar spacecraft, or by the anisotropic response of one of the detectors.

Every cosmic burst detected by BATSE in triggered mode was systematically searched for in the *Ulysses* and *NEAR* data by using the approximate arrival direction from BATSE and the positions of the *Ulysses* and *NEAR* spacecraft to calculate a window of possible arrival times at these spacecraft. Typical window lengths were 300–500 s, and the data were plotted and searched both by eye and software for a count rate increase corresponding to the BATSE event.

The triangulation technique is illustrated in Figure 1. When a GRB arrives at two spacecraft with a delay δT, it may be localized to an annulus whose half-angle θ with respect to the vector joining the two spacecraft is given by

$$\cos\theta = \frac{c\delta T}{D}, \quad (1)$$

where c is the speed of light and D is the distance between the two spacecraft. (This assumes that the burst is a plane wave, i.e., that its distance is much greater than D.) The annulus width $d\theta$, and thus one dimension of the resulting error box, is

$$d\theta = c\sigma(\delta T)/D \sin\theta, \quad (2)$$

where $\sigma(\delta T)$ is the uncertainty in the time delay. The radius of each annulus and its right ascension and declination are calculated in a heliocentric (i.e., aberration-corrected) frame. These annuli are given in Table 2, and an example is shown in Figure 2. In general, the annuli obtained by triangulations are small circles on the celestial sphere, so their curvature, even across a relatively small BATSE error circle, is not always negligible, and a simple, four-sided error box cannot be defined. An extreme example is shown in Figure 3. For this reason, we

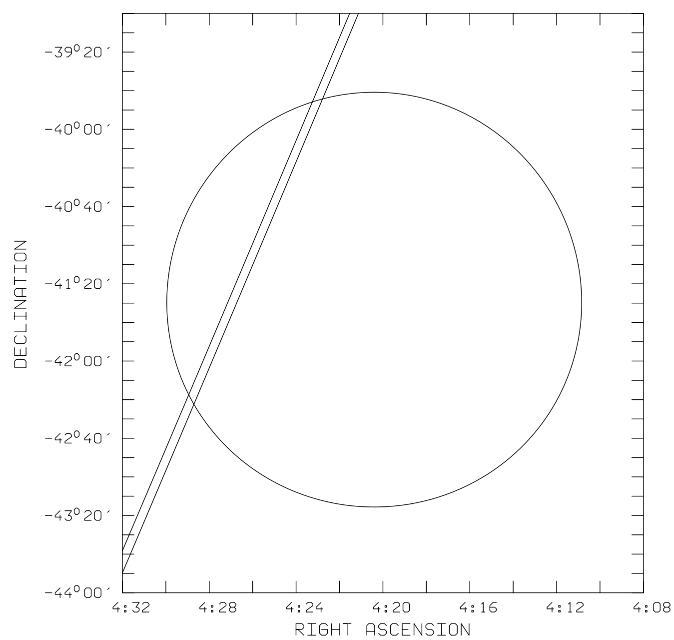

Figure 2. BATSE 1σ (statistical + systematic) error circle for trigger 5593 on 1996 September 6, and the 3σ IPN annulus.

Table 2
IPN Annuli

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
960831	10:28:30	5591	242.76	22.93	1.01	166.481	36.669	66.664	0.044	...	...	...	...
960906	22:39:48	5593	65.10	−41.47	0.80	347.768	−35.838	59.726	0.036	...	...	...	...
960907	06:50:11	5594	143.93	49.87	3.72	167.836	35.799	17.877	0.293	...	...	...	...
960912	13:57:27	5601	95.14	76.86	0.64	168.864	35.168	52.499	0.021	...	...	...	...
960913	23:05:18	5604	182.58	−23.45	0.92	169.129	35.010	57.377	0.066	...	...	...	...
960917	22:22:32	5606	313.87	−33.89	0.70	349.881	−34.568	28.471	0.094	...	...	...	...
960921	15:03:48	5609	345.27	−28.55	0.21	350.571	−34.178	5.417	0.030	...	...	...	...
960924	11:41:50	5614	37.28	2.70	1.53	351.097	−33.892	54.760	0.003	...	...	...	...
960927	03:47:18	5617	199.56	74.13	0.98	171.581	33.636	43.728	0.162	...	...	...	...
961001	20:53:05	5621	42.79	59.03	0.22	172.415	33.206	80.454	0.003	...	...	...	...
961006	08:56:04	5624	274.65	−28.88	1.66	353.186	−32.825	61.298	0.077	...	...	...	...
961009	09:19:13	5628	94.04	80.06	0.92	173.690	32.591	60.211	0.006	...	...	...	...
961009	13:37:45	5629	130.20	−80.23	0.37	353.719	−32.576	64.771	0.007	...	...	...	...
961017	11:16:43	5634	37.16	−10.68	2.89	354.974	−32.029	40.759	0.026	...	...	...	...
961019[b]	21:08:11	5637	321.87	−84.18	2.29	355.336	−31.883	48.530	0.092	...	...	...	...
961022	19:00:56	5642	159.63	−38.76	0.74	175.763	31.721	71.880	0.043	...	...	...	...
961026	06:11:50	5644	99.32	41.88	0.83	176.250	31.545	61.197	0.020	...	...	...	...
961029	06:45:50	5649	59.79	−48.89	0.31	356.654	−31.408	49.886	0.008	...	...	...	...
961102	11:38:23	5654	271.44	28.13	0.47	177.187	31.247	78.600	0.048	...	...	...	...
961126	06:43:19	5697	150.34	36.72	0.47	179.381	30.963	23.565	0.008	...	...	...	...
961130	05:13:52	5701	247.23	24.40	0.53	179.582	31.021	64.689	0.033	...	...	...	...
961202	18:31:01	5704	336.67	20.55	0.63	359.683	−31.074	55.677	0.004	...	...	...	...
961211	01:56:12	5709	281.71	54.82	1.01	179.848	31.341	73.909	0.053	...	...	...	...
961211	20:41:20	5710	296.11	41.26	2.64	179.849	31.372	87.329	0.128	...	...	...	...
961212	04:07:50	5711	182.86	34.48	0.50	179.851	31.386	3.959	0.047	...	...	...	...
961226	05:50:51	5726	21.04	78.25	0.70	179.405	32.147	68.153	0.012	...	...	...	...
961228	00:29:32	5729	160.28	−53.60	0.83	179.285	32.266	85.416	0.046	...	...	...	...
970111[d]	09:44:00	5773	231.25	18.73	0.15	177.731	33.366	49.981	0.024	...	...	...	...
970120	23:09:26	5890	196.09	60.83	3.26	176.114	34.175	35.676	0.097	...	...	...	...
970201	15:54:10	5989	55.13	−19.44	0.40	353.528	−35.134	56.194	0.004	...	...	...	...
970202	07:10:44	5995	49.58	−28.79	0.20	353.370	−35.183	46.326	0.030	...	...	...	...
970206	00:13:18	6029	170.01	16.57	1.20	172.416	35.461	18.016	0.061	...	...	...	...
970211	01:27:55	6082	242.93	38.54	1.44	171.036	35.800	55.210	0.141	...	...	...	...
970214	10:46:24	6090	339.81	15.75	0.71	350.068	−35.998	55.209	0.049	...	...	...	...
970223	08:26:17	6100	142.44	35.46	0.73	167.407	36.399	18.813	0.029	...	...	...	...
970304	08:04:05	6113	219.93	−9.33	1.19	164.652	36.584	70.684	0.012	...	...	...	...
970306	02:47:39	6115	18.34	21.36	0.66	344.110	−36.593	67.351	0.124	...	...	...	...
970315	15:40:54	6124	2.15	60.72	0.15	161.286	36.483	80.076	0.004	...	...	...	...
970330	08:58:52	6147	347.74	−19.12	1.60	337.446	−35.814	19.353	0.496	...	...	...	...
970403	15:53:17	6154	45.63	8.35	2.92	336.489	−35.523	77.246	0.274	...	...	...	...
970405	03:41:59	6159	98.84	22.84	0.46	156.176	35.414	50.871	0.051	...	...	...	...
970406	06:19:44	6161	50.81	−24.64	2.51	335.949	−35.327	60.305	0.183	...	...	...	...
970409	18:48:09	6167	15.07	36.30	0.81	335.270	−35.041	81.095	0.080	...	...	...	...
970411	09:52:25	6168	56.97	34.34	0.34	157.976	34.903	76.007	0.007	...	...	...	...
970419	06:12:14	6194	240.42	−63.04	0.77	333.737	−34.172	57.757	0.067	...	...	...	...
970420	20:14:02	6198	212.99	−15.91	0.33	153.524	34.015	76.007	0.003	...	...	...	...
970424	08:06:51	6206	266.61	−44.34	3.09	333.095	−33.658	47.144	0.009	...	...	...	...
970429	11:36:24	6214	34.72	26.98	0.98	332.568	−33.111	82.480	0.014	...	...	...	...
970508	21:41:46	6225	132.41	80.62	2.30	151.909	32.056	51.191	0.159	...	...	...	...
970509	13:23:26	6226	192.38	20.10	1.04	151.878	31.981	36.353	0.109	...	...	...	...
970511	15:00:07	6229	0.50	19.69	1.45	331.790	−31.740	59.560	0.176	...	...	...	...
970517	09:04:42	6235	112.11	−15.41	0.39	151.634	31.067	59.348	0.004	...	...	...	...
970603	09:49:05	6249	105.25	−13.85	1.10	151.858	29.027	62.667	0.085	...	...	...	...
970603	23:35:00	6251	177.05	62.31	1.12	151.881	28.958	37.101	0.036	...	...	...	...
970609	08:14:02	6262	61.78	−5.50	1.51	332.142	−28.310	87.005	0.085	...	...	...	...
970612	14:28:24	6266	290.23	43.52	0.68	332.339	−27.916	80.422	0.032	...	...	...	...
970614	23:07:42	6272	234.69	62.20	1.01	152.496	27.633	63.710	0.088	...	...	...	...
970616[f]	18:09:50	6274	20.44	−7.12	0.38	332.625	−27.416	49.820	0.004	...	...	...	...
970627	01:04:25	6279	227.74	39.98	1.61	153.491	26.188	67.845	0.065	...	...	...	...
970627	07:12:46	6280	120.84	42.28	0.9	153.515	26.159	33.510	0.183	...	...	...	...
970628	07:22:52	6283	24.06	6.22	2.82	333.611	−26.037	63.226	0.112	...	...	...	...
970629	14:16:39	6288	29.62	25.04	1.74	333.737	−25.884	70.556	0.106	...	...	...	...
970704	01:08:16	6293	74.82	−16.00	4.14	154.193	25.359	89.853	0.003	...	...	...	...
970713	06:16:27	6303	161.55	−14.35	0.74	155.229	24.283	41.047	0.065	...	...	...	...
970723	05:10:51	6315	114.46	−33.10	0.75	156.462	23.140	71.979	0.052	...	...	...	...
970801	06:21:45	6321	101.04	29.55	0.78	157.663	22.121	49.142	0.014	...	...	...	...

Table 2
(Continued)

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
970807	18:25:09	6329	289.44	−38.70	0.31	338.559	−21.400	46.918	0.008	...	...	...	...
970815[b]	12:07:04	6335	234.49	81.70	0.77	159.651	20.562	68.519	0.023	...	...	...	...
970816	02:17:44	6336	91.57	44.97	0.40	159.735	20.499	60.834	0.012	...	...	...	...
970825	22:02:59	6346	89.26	−10.18	2.70	161.146	19.463	77.923	0.113	...	...	...	...
970828[b,c]	17:44:36	6350	269.22	59.42	0.61	161.552	19.172	83.514	0.009	...	...	...	...
970831	17:39:30	6353	85.75	−47.33	0.68	341.984	−18.865	84.820	0.092	...	...	...	...
970912	21:52:24	6380	181.28	−23.46	0.91	163.720	17.661	43.153	0.062	243.059	−20.337	58.764	0.894
970919	18:14:29	6389	140.39	−4.74	0.72	164.672	17.013	34.800	0.024	65.902	20.742	76.440	0.131
970919	22:10:16	6390	298.55	59.56	2.69	245.970	−20.753	89.608	0.036	...	...	...	...
970925	07:04:05	6396	346.97	54.60	2.31	345.423	−16.503	71.881	0.049	...	...	...	...
970925	22:43:15	6397	326.84	−8.42	0.47	345.510	−16.444	17.689	0.053	248.407	−21.051	77.464	0.071
970926	22:56:19	6400	313.70	40.40	1.82	248.808	−21.099	80.916	0.090	...	...	...	...
970930	00:00:59	6404	281.45	−84.51	0.88	346.045	−16.086	69.476	0.003	250.000	−21.228	62.155	0.120
971005	01:15:55	6413	331.17	−56.25	1.88	346.692	−15.650	42.650	0.078	...	...	...	...
971006	05:16:57	6414	249.77	53.23	0.65	166.838	15.553	74.159	0.055	252.370	−21.447	75.317	0.372
971007	15:56:02	6416	221.72	−17.07	1.12	252.907	−21.491	31.928	0.932	...	...	...	...
971009	18:56:55	6422	273.51	−66.24	0.43	347.276	−15.258	69.557	0.006	...	...	...	...
971015	08:27:39	6436	279.99	18.62	1.36	255.630	−21.675	47.158	0.115	...	...	...	...
971024	22:22:55	6450	104.54	25.63	4.43	168.961	14.104	63.553	0.113	...	...	...	...
971029[a]	01:28:38	6453	101.12	24.67	0.34	169.364	13.819	65.090	0.022	79.882	21.821	19.439	0.260
971029	06:13:48	6454	66.87	−44.97	1.32	349.382	−13.805	71.076	0.190	79.940	21.822	68.174	1.223
971029	16:48:03	6455	243.03	70.63	3.95	260.070	−21.823	89.728	0.216	...	...	...	...
971110	18:53:26	6472	241.67	50.37	0.62	170.412	13.033	68.437	0.011	262.919	−21.777	74.010	0.357
971113	16:08:50	6476	216.57	−76.63	0.90	263.453	−21.749	59.759	0.170	...	...	...	...
971115	18:22:39	6479	84.63	41.69	11.81	83.793	21.729	26.553	3.647	...	...	...	...
971115	19:25:22	6480	60.89	−4.75	1.90	350.736	−12.762	69.085	0.087	...	...	...	...
971118	22:08:10	6487	319.19	−57.65	5.82	264.268	−21.686	58.731	0.578	...	...	...	...
971121	12:06:08	6489	187.63	−9.32	0.59	171.033	12.488	26.278	0.047	...	...	...	...
971122	14:40:42	6491	118.87	−30.72	2.70	84.707	21.625	63.148	0.503	...	...	...	...
971122	21:29:11	6492	300.49	78.47	1.38	84.752	21.621	79.679	0.148	...	...	...	...
971127	00:04:42	6504	225.61	31.93	1.44	171.244	12.254	60.829	0.096	265.086	−21.556	62.127	0.566
971207[e]	20:03:52	6525	133.74	−4.59	0.61	171.413	11.889	45.269	0.018	85.301	21.344	49.928	0.211
971208	07:48:12	6526	356.46	77.94	1.19	351.411	−11.874	88.032	0.326	85.270	21.320	58.716	10.050
971209	23:10:36	6527	241.35	62.21	0.77	171.404	11.832	70.341	0.004	265.214	−21.285	83.818	0.172
971210	07:43:33	6528	176.91	−51.95	1.11	171.401	11.823	64.581	0.051	...	...	...	...
971214[b,g]	23:20:41	6533	180.83	66.21	0.97	171.329	11.721	53.741	0.044	84.923	21.181	72.633	1.525
971218	14:34:59	6535	41.62	61.47	0.95	351.223	−11.657	83.434	0.016	84.632	21.108	49.930	0.293
971220	04:06:33	6539	33.23	−38.55	1.71	84.453	21.075	74.823	0.569	...	...	...	...
971225	18:00:34	6545	265.12	64.65	1.83	170.883	11.579	76.589	0.050	...	...	...	...
971227[h]	08:23:06	6546	190.04	54.28	1.66	170.783	11.569	50.842	0.060	...	...	...	...
980103	10:38:42	6557	236.69	−75.04	1.93	350.224	−11.561	83.117	0.112	262.621	−20.793	55.870	5.324
980105	00:44:41	6560	37.20	51.66	1.43	350.074	−11.566	73.941	0.003	82.434	20.761	46.466	0.647
980106	13:16:11	6561	106.99	12.79	3.01	169.923	11.576	63.318	0.080	...	...	...	...
980109[i]	01:12:25	6564	12.23	−60.82	1.97	349.654	−11.593	52.771	0.080	...	...	...	...
980113	04:07:25	6570	261.03	−23.83	0.61	349.162	−11.638	82.320	0.014	261.552	−20.685	4.845	9.969
980124[a]	06:34:33	6576	272.22	80.30	1.10	167.542	11.832	82.292	0.006	6.799	72.491	21.435	12.385
980125	10:21:06	6580	97.16	1.48	3.33	185.207	−71.691	83.622	20.996	...	...	...	...
980125	20:39:28	6581	350.68	35.81	0.99	347.276	−11.867	45.307	0.004	3.723	72.100	53.847	2.096
980129	15:19:43	6583	287.43	−64.92	2.37	346.615	−11.958	62.480	0.285	...	...	...	...
980203	22:47:08	6587	3.46	−17.65	0.27	345.613	−12.096	19.385	0.010	3.060	71.952	88.453	3.250
980208	12:50:59	6593	60.97	−75.49	0.29	344.694	−12.225	74.529	0.010	...	...	...	...
980214	06:27:20	6600	354.79	−32.35	2.43	343.483	−12.388	27.079	0.040	...	...	...	...
980218	03:45:23	6605	183.29	56.64	0.93	162.634	12.501	47.217	0.071	...	...	...	...
980219	13:52:43	6609	250.99	−54.72	0.49	342.318	−12.541	80.764	0.010	...	...	...	...
980222	02:25:34	6610	31.21	28.51	1.23	341.754	−12.610	63.862	0.032	...	...	...	...
980225	08:29:24	6615	126.17	14.44	0.47	161.021	12.699	34.247	0.151	...	...	...	...
980228	06:44:07	6617	24.51	13.43	4.67	340.357	−12.770	55.236	0.013	...	...	...	...
980228	16:54:01	6618	90.49	44.10	2.32	160.262	12.783	64.586	0.023	...	...	...	...
980301	08:58:54	6621	98.55	−31.04	0.76	160.110	12.800	73.321	0.010	...	...	...	...
980302	04:59:32	6625	31.30	−7.29	0.67	339.922	−12.818	50.106	0.136	...	...	...	...
980306	09:33:02	6629	7.05	−45.51	0.27	338.978	−12.911	41.548	0.027	...	...	...	...
980306	17:34:11	6630	341.63	−56.74	0.55	338.904	−12.918	45.667	0.018	...	...	...	...
980310	00:36:29	6634	75.19	−60.72	8.84	338.174	−12.983	85.921	0.026	...	...	...	...
980310	13:57:41	6635	242.41	−60.47	1.24	338.051	−12.993	81.321	0.003	...	...	...	...
980315	07:24:00	6642	74.65	31.57	1.53	157.031	13.069	73.938	0.134	...	...	...	...
980321	06:06:11	6651	42.25	7.59	4.00	335.803	−13.134	69.216	0.082	...	...	...	...

Table 2
(Continued)

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
980326[j]	21:18:53	6660	133.33	−18.64	2.13	154.713	13.166	40.795	0.046	...	...	...	...
980329	03:44:38	6665	105.58	39.44	0.81	154.299	13.170	49.905	0.011	...	...	...	...
980401	04:31:53	6672	125.70	18.27	0.77	153.767	13.166	28.628	0.026	...	...	...	...
980409	02:08:32	6683	206.37	9.83	1.16	152.518	13.110	55.219	0.006	...	...	...	...
980420	10:06:52	6694	292.81	26.56	0.61	331.093	−12.917	54.005	0.117	...	...	...	...
980425[k]	21:49:08	6707	291.91	−53.11	1.66	330.567	−12.778	49.723	0.428	...	...	...	...
980508	04:07:28	6744	334.08	20.46	1.78	329.773	−12.366	36.216	0.007	...	...	...	...
980518	09:47:11	6763	330.70	58.42	2.76	329.496	−11.926	73.027	0.158	...	...	...	...
980519[l]	12:20:12	6764	356.10	76.30	1.07	329.486	−11.873	89.974	0.037	...	...	...	...
980520	19:12:15	6767	353.71	−11.32	2.05	329.478	−11.810	24.911	0.205	...	...	...	...
980609	20:32:15	6814	320.52	−18.65	0.93	329.955	−10.685	13.060	0.108	...	...	...	...
980611	00:48:59	6816	275.27	55.02	0.70	330.015	−10.612	79.525	0.006	...	...	...	...
980616	13:28:55	6828	213.32	36.37	1.05	150.334	10.253	63.133	0.031	...	...	...	...
980617	02:51:51	6829	55.95	−3.82	3.19	330.369	−10.216	82.000	0.026	...	...	...	...
980626	22:39:46	6877	17.65	−72.98	0.92	331.097	−9.529	70.259	0.084	...	...	...	...
980627	04:20:29	6880	159.71	−0.23	3.18	151.118	9.514	16.198	0.140	...	...	...	...
980627	12:36:35	6882	180.20	22.83	2.01	151.146	9.488	28.702	0.162	...	...	...	...
980703[b,m]	04:22:45	6891	359.07	12.01	0.48	331.647	−9.065	33.149	0.112	...	...	...	...
980703	13:48:28	6892	228.00	3.27	2.37	151.684	9.037	75.772	0.131	...	...	...	...
980706	15:59:47	6904	159.70	57.84	2.27	151.981	8.801	49.644	0.003	...	...	...	...
980708	14:38:04	6912	14.38	−19.58	0.59	332.175	−8.647	39.773	0.074	...	...	...	...
980718	02:58:26	6930	318.96	−46.43	0.74	333.190	−7.880	41.549	0.011	...	...	...	...
980724	20:34:40	6944	193.92	−0.77	2.01	153.969	7.314	57.853	0.153	...	...	...	...
980802	08:01:14	6961	252.64	−32.16	1.38	335.007	−6.571	77.726	0.066	...	...	...	...
980803	13:36:20	6963	141.19	57.98	0.42	155.163	6.461	52.891	0.003	...	...	...	...
980810	18:35:29	6985	349.93	24.64	0.35	336.088	−5.803	26.197	0.005	...	...	...	...
980811	06:45:08	6986	266.80	3.51	1.22	336.154	−5.758	67.189	0.079	...	...	...	...
980815	21:21:57	6992	210.94	−32.22	2.37	156.760	5.329	63.841	0.101	...	...	...	...
980821	17:16:05	7012	123.50	−12.00	0.23	157.537	4.776	39.518	0.007	...	...	...	...
980828	19:38:05	7028	146.41	20.73	0.58	158.492	4.088	22.939	0.008	...	...	...	...
980829	05:20:49	7030	240.00	−54.20	1.45	158.546	4.047	89.502	0.036	239.713	−25.432	30.837	0.652
981005	18:00:26	7142	275.24	44.05	1.22	260.540	−24.703	71.356	0.041	...	...	...	...
981009	01:08:30	7147	188.42	36.62	1.61	163.796	−0.127	42.675	0.171	...	...	...	...
981011	19:35:56	7150	37.91	−60.07	1.70	344.111	0.419	81.168	0.057	263.983	−24.471	87.743	0.426
981015	04:52:21	7156	287.82	−80.32	0.99	344.486	0.776	83.671	0.114	265.913	−24.320	57.275	0.143
981015	12:59:26	7157	121.54	20.19	2.35	164.523	−0.810	47.263	0.021	...	...	...	...
981021	09:36:28	7167	133.70	57.74	4.65	165.135	−1.427	60.671	0.110	...	...	...	...
981021	23:08:12	7170	357.16	1.67	1.73	345.192	1.488	13.059	0.043	269.781	−23.971	88.404	0.016
981022	18:02:02	7172	14.89	48.92	1.01	345.270	1.570	52.890	0.010	90.234	23.926	63.901	0.027
981030	03:07:32	7183	200.20	48.64	6.11	165.957	−2.342	51.176	0.150	...	...	...	...
981031	09:41:44	7185	278.25	−24.57	1.13	346.067	2.476	73.940	0.004	275.199	−23.371	3.232	2.237
981104	02:16:00	7188	104.34	12.41	2.79	97.330	23.095	13.231	0.485	...	...	...	...
981111	06:43:40	7207	110.88	65.59	1.49	166.884	−3.600	76.310	0.145	...	...	...	...
981121	01:26:17	7219	15.51	42.33	1.09	347.408	4.590	44.186	0.209	107.104	21.530	78.692	0.720
981125	08:26:25	7228	254.63	29.87	0.94	347.565	5.013	86.140	0.063	289.575	−21.055	60.057	0.116
981125	21:06:21	7230	202.31	61.86	0.88	167.581	−5.064	73.880	0.088	...	...	...	...
981128	19:16:06	7236	131.69	39.35	2.97	167.657	−5.347	59.359	0.247	...	...	...	...
981130	00:53:04	7240	348.93	−12.83	0.87	347.681	5.468	18.143	0.021	292.269	−20.496	54.505	0.014
981203	00:59:12	7247	161.46	32.91	0.54	167.723	−5.751	40.026	0.067	...	...	...	...
981203	07:17:40	7248	293.34	−27.24	0.63	347.726	5.778	65.532	0.031	294.147	−20.082	7.862	0.117
981205	05:41:24	7250	90.99	43.73	0.86	167.738	−5.958	84.912	0.035	...	...	...	...
981211	20:29:38	7255	332.52	−9.73	0.55	347.692	6.562	19.888	0.052	299.050	−18.904	35.873	0.035
981223	12:11:15	7277	191.94	12.51	0.24	167.262	−7.546	30.971	0.024	...	...	...	...
981226	10:47:04	7281	267.15	−24.40	1.84	347.077	7.778	81.380	0.003	...	...	...	...
990102	05:06:36	7293	277.38	39.33	0.61	346.532	8.275	69.597	0.256	...	...	...	...
990102	13:51:58	7295	203.48	2.74	0.58	166.498	−8.299	40.542	0.185	...	...	...	...
990104	16:02:33	7301	129.96	1.19	0.89	166.293	−8.441	37.073	0.005	...	...	...	...
990108	08:21:06	7310	62.13	−12.11	0.62	345.891	8.681	76.311	0.121	...	...	...	...
990111	11:57:21	7318	43.85	38.27	0.87	345.506	8.872	61.424	0.057	...	...	...	...
990111	17:58:20	7319	173.65	27.82	1.72	165.474	−8.885	38.466	0.040	...	...	...	...
990117	07:30:21	7328	19.66	−1.29	0.95	344.697	9.188	37.532	0.250	...	...	...	...
990123[n]	09:46:56	7343	229.08	42.31	0.44	163.719	−9.464	81.344	0.011	...	...	...	...
990128	09:27:37	7357	269.66	−37.10	4.25	342.825	9.648	77.192	0.148	...	...	...	...
990129	05:15:50	7360	94.92	−12.28	0.35	162.670	−9.672	64.162	0.021	...	...	...	...
990203	15:41:20	7368	324.93	23.50	1.02	341.593	9.819	20.126	0.047	...	...	...	...
990204	00:24:30	7369	31.56	1.42	1.20	329.984	−8.182	63.293	0.050	...	...	...	...

Table 2
(Continued)

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
990204	05:10:26	7374	247.41	8.75	0.76	161.058	−9.868	86.079	0.054	331.241	−7.638	86.476	0.067
990208	04:12:44	7378	296.10	−39.40	2.29	332.365	−7.147	46.571	0.026	...	...	...	...
990210[a]	04:28:14	7379	108.11	50.11	1.46	160.198	−9.924	75.939	0.167	153.511	6.639	57.736	0.364
990216	06:29:45	7390	274.94	−40.34	0.55	338.818	9.955	78.916	0.103	336.993	−5.070	67.265	0.096
990220[a]	12:03:17	7403	163.05	55.60	1.61	157.825	−9.939	63.651	0.123	159.427	3.950	49.577	0.151
990226	08:34:46	7429	244.47	10.66	0.76	336.427	9.869	88.595	0.194	...	...	...	...
990228	04:20:47	7433	172.54	−40.73	4.14	155.990	−9.835	36.535	0.186	...	...	...	...
990304	10:15:36	7446	8.32	−58.25	0.91	334.974	9.742	73.654	0.004	...	...	...	...
990308[o]	05:15:07	7457	189.18	3.55	1.90	154.076	−9.636	35.514	0.239	...	...	...	...
990311	22:11:45	7464	43.95	19.25	0.37	333.213	9.519	69.514	0.067	...	...	...	...
990314	20:05:12	7469	184.01	−12.86	1.83	152.549	−9.413	31.146	0.054	...	...	...	...
990316	09:40:39	7475	152.08	−4.44	0.26	152.198	−9.354	6.868	0.316	...	...	...	...
990316	12:28:59	7477	102.45	−6.20	1.53	152.172	−9.350	47.816	0.056	...	...	...	...
990319	21:40:46	7484	286.45	31.61	0.78	331.431	9.219	46.418	0.038	355.444	3.731	69.275	0.037
990320	23:01:59	7486	5.70	6.70	3	356.075	4.037	12.090	0.888	...	...	...	...
990321[a]	19:49:07	7487	42.26	0.23	2.84	331.023	9.138	70.658	0.263	356.602	4.294	45.269	0.253
990322	04:03:56	7488	12.49	−68.32	1.74	356.803	4.393	75.151	0.066	...	...	...	...
990323	17:29:37	7491	332.58	−76.54	0.71	330.628	9.057	86.292	0.003	357.744	4.849	82.881	0.007
990329	22:56:18	7494	72.44	68.34	1.43	1.535	6.682	76.208	0.071	...	...	...	...
990330	19:26:07	7497	160.65	34.31	0.86	182.064	−6.936	45.284	0.072	...	...	...	...
990331	05:13:21	7498	2.78	19.44	2.28	329.174	8.726	27.504	0.296	2.308	7.054	17.135	0.787
990403	09:48:02	7503	298.87	−5.05	0.37	328.608	8.581	30.582	0.037	4.285	7.999	64.650	0.092
990411	04:25:31	7515	329.84	−83.44	0.51	147.380	−8.231	87.393	0.160	...	...	...	...
990413	07:54:08	7518	180.00	−18.44	0.96	147.079	−8.136	33.874	0.178	...	...	...	...
990414	18:32:01	7519	238.46	−45.81	1.26	146.886	−8.076	81.169	0.093	...	...	...	...
990415	03:01:10	7520	71.83	−3.45	0.95	146.842	−8.060	71.924	0.166	...	...	...	...
990424	03:12:31	7527	88.87	−60.33	0.49	145.835	−7.705	71.931	0.014	197.684	−14.115	87.328	0.025
990424	22:09:22	7529	84.00	36.64	0.68	145.762	−7.676	72.599	0.024	18.215	14.343	62.860	0.028
990425	02:19:26	7530	332.67	−7.41	0.47	325.745	7.672	14.678	0.018	18.334	14.393	49.643	0.033
990427	15:43:57	7534	354.14	−19.27	0.59	325.526	7.583	37.518	0.034	20.076	15.132	43.176	0.023
990505	07:51:07	7548	227.69	−47.68	1.03	145.018	−7.352	78.266	0.020	...	...	...	...
990506[p]	11:23:30	7549	178.94	−26.23	0.16	144.962	−7.322	37.432	0.012	206.256	−17.631	27.010	0.045
990506	23:53:55	7550	140.25	2.78	1.24	144.937	−7.309	11.266	0.257	...	...	...	...
990510[q]	08:49:06	7560	207.51	−80.22	0.60	144.802	−7.234	78.069	0.005	209.072	−18.699	61.828	0.029
990516	23:54:23	7569	253.55	−3.64	0.77	324.654	7.122	76.968	0.004	214.006	−20.457	40.158	0.040
990518	17:18:45	7575	343.33	−38.68	0.31	324.641	7.102	48.881	0.032	35.316	20.898	73.423	0.053
990522	04:13:45	7578	39.38	27.07	0.67	324.644	7.071	72.668	0.013	37.981	21.764	3.078	0.316
990527	13:56:55	7586	344.56	−20.00	0.79	324.721	7.053	30.339	0.047	42.269	23.055	72.875	0.022
990528	09:42:15	7588	65.86	−15.92	1.31	144.742	−7.052	76.339	0.036	...	...	...	...
990531	15:56:24	7592	52.35	36.54	0.34	324.839	7.062	81.666	0.004	45.591	23.972	12.606	0.041
990604	19:59:40	7598	91.09	38.05	1.22	145.007	−7.094	69.939	0.073	...	...	...	...
990611	11:57:01	7605	343.20	−47.09	0.69	325.370	7.194	55.415	0.041	...	...	...	...
990615	15:47:54	7607	173.92	−56.08	1.50	145.654	−7.283	52.790	0.034	...	...	...	...
990703	10:57:19	7630	175.28	79.23	1.85	75.078	28.722	62.519	0.053	...	...	...	...
990707	19:39:17	7638	72.41	21.84	1.55	147.758	−8.142	77.589	0.088	79.321	28.900	7.885	2.350
990712[a]	07:45:19	7647	126.52	8.65	3.63	148.289	−8.391	28.976	0.006	83.755	28.947	43.539	0.042
990712	18:55:16	7648	281.34	11.79	1.17	328.344	8.421	45.158	0.150	264.225	−28.943	43.883	0.162
990713	21:38:18	7651	310.46	−27.28	0.77	328.481	8.488	38.529	0.010	...	...	...	...
990714	18:13:48	7652	231.19	19.66	0.63	148.587	−8.538	88.209	0.032	266.180	−28.914	59.250	0.034
990715	23:59:35	7655	154.42	44.51	2.33	148.743	−8.615	56.966	0.253	...	...	...	...
990716	06:28:34	7657	337.26	−44.61	1.08	328.776	8.633	52.838	0.069	...	...	...	...
990718	12:06:51	7660	286.92	1.33	0.86	329.062	8.778	43.828	0.275	...	...	...	...
990722	07:23:18	7665	213.38	35.53	0.43	149.562	−9.036	75.657	0.054	...	...	...	...
990722	21:20:45	7667	149.69	−54.44	2.08	149.640	−9.076	41.352	0.095	...	...	...	...
990728	11:03:44	7678	209.62	−56.84	0.36	150.403	−9.493	67.026	0.004	279.882	−27.931	54.978	0.071
990802[a]	01:04:43	7688	34.75	40.50	0.72	331.053	9.863	61.703	0.043	104.460	27.298	59.843	0.035
990803	06:29:35	7695	258.63	−2.03	0.63	331.230	9.966	71.671	0.003	...	...	...	...
990806[r]	14:28:06	7701	33.99	−74.03	2.51	151.716	−10.254	85.648	0.125	...	...	...	...
990807	21:55:46	7703	338.61	20.52	1.72	331.909	10.373	11.542	0.262	...	...	...	...
990816	02:44:43	7711	187.97	6.70	0.91	153.146	−11.148	29.188	0.087	...	...	...	...
990822	12:03:35	7727	111.57	−38.07	0.70	154.131	−11.807	45.287	0.146	...	...	...	...
990825	15:43:22	7737	71.08	58.56	1.78	127.430	21.738	54.560	0.147	...	...	...	...
990829	05:43:40	7744	338.60	−2.18	1.44	335.181	12.555	15.668	0.948	...	...	...	...
990907[s]	17:35:11	7755	113.42	−69.79	1.45	156.674	−13.687	62.108	0.071	...	...	...	...
990909	07:51:14	7760	28.53	−29.46	6.51	336.924	13.889	60.696	0.007	320.846	−16.657	56.387	0.045
990915	23:15:22	7766	97.10	71.87	0.60	337.964	14.753	86.375	0.008	146.672	14.063	63.089	0.012

Table 2
(Continued)

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
990918	05:33:14	7770	262.08	1.97	1.47	338.315	15.059	74.579	0.022	...	...	...	...
991001	01:22:30	7781	6.16	36.76	1.23	340.262	16.894	29.573	0.007	...	...	...	...
991004	01:53:05	7785	329.94	−15.62	0.84	340.707	17.351	37.766	0.176	...	...	...	...
991004	13:14:20	7788	210.75	−19.04	0.74	160.776	−17.421	46.532	0.025	162.265	6.174	52.721	0.032
991006	18:56:41	7792	102.38	10.21	1.98	161.099	−17.768	65.945	0.119	...	...	...	...
991007	01:49:27	7793	234.18	−3.39	1.50	164.315	5.059	68.655	0.041	...	...	...	...
991009	16:49:55	7794	257.27	−46.92	0.59	161.512	−18.227	77.853	0.111	...	...	...	...
991014[t]	21:52:34	7803	101.61	12.55	1.74	162.232	−19.069	66.132	0.011	...	...	...	...
991018	19:02:41	7810	224.03	−3.68	1.50	173.680	−0.150	51.459	0.080	...	...	...	...
991025	16:56:30	7822	257.25	44.02	0.73	343.613	20.906	69.603	0.024	179.104	−3.200	87.294	0.062
991030	01:46:04	7831	123.00	−47.52	0.98	164.123	−21.680	42.338	0.341	...	...	...	...
991104	17:07:07	7840	53.13	55.08	0.77	344.730	22.714	59.060	0.068	6.893	7.520	58.963	0.073
991105[u]	16:40:44	7841	167.80	−64.18	2.37	187.654	−7.933	59.028	0.030	...	...	...	...
991106	19:03:32	7842	39.24	60.63	0.95	344.939	23.101	53.740	0.073	8.506	8.396	56.932	0.220
991108	06:46:05	7845	3.64	−54.89	1.05	345.081	23.380	80.688	0.036	...	...	...	...
991113	22:41:00	7854	3.42	32.85	0.53	345.580	24.468	18.646	0.053	14.040	11.337	24.817	0.040
991115	18:48:07	7858	294.22	40.44	0.56	345.725	24.826	45.196	0.041	15.459	12.071	75.420	0.096
991120	05:46:49	7864	51.19	−56.61	0.50	166.038	−25.706	78.626	0.018	...	...	...	...
991121	11:21:44	7868	301.59	−61.57	0.83	166.114	−25.952	80.829	0.119	...	...	...	...
991127	14:54:59	7884	16.48	−10.44	0.33	346.426	27.203	48.091	0.007	24.627	16.571	28.297	0.048
991201	11:39:51	7888	327.61	27.20	3.84	346.558	28.003	13.727	0.328	...	...	...	...
991210	00:14:10	7898	297.16	−45.45	0.70	346.649	29.799	87.774	0.009	...	...	...	...
991210	15:00:09	7900	293.01	−75.69	4.01	166.645	−29.928	63.048	0.157	...	...	...	...
991211	04:34:41	7901	215.26	11.72	6.10	215.198	−21.141	28.297	0.132	...	...	...	...
991216[v]	16:07:01	7906	77.94	10.88	1.03	346.505	31.225	84.910	0.007	39.504	22.787	37.867	0.015
991228	11:39:50	7923	167.64	34.27	5.66	165.701	−33.764	59.851	0.023	...	...	...	...
991229	15:11:23	7925	332.99	33.64	2.42	345.584	34.012	9.251	0.090	49.703	26.172	63.907	0.019
000101	01:19:59	7929	300.77	28.49	0.38	345.306	34.527	36.431	0.020	231.612	−26.724	87.970	0.014
000103	23:35:08	7932	167.90	−57.99	0.54	164.922	−35.141	22.852	0.191	...	...	...	...
000108	16:48:07	7939	236.35	−78.82	0.71	164.295	−35.974	49.485	0.015	...	...	...	...
000109	10:27:14	7941	248.88	−28.53	1.09	164.063	−36.270	68.034	0.049	238.208	−28.431	8.715	0.518
000111	02:41:58	7943	134.73	−16.56	5.28	59.533	28.736	83.076	0.021	...	...	...	...
000115[a]	14:49:32	7954	116.55	−15.79	1.66	162.849	−37.500	41.932	0.007	63.063	29.491	72.728	0.021
000123	13:49:41	7965	318.07	14.10	1.43	340.896	38.972	31.501	0.092	249.248	−30.606	81.281	0.098
000126	08:15:51	7969	327.61	−42.67	0.45	340.115	39.443	83.813	0.039	...	...	...	...
000126	23:26:29	7971	118.00	5.04	0.65	159.928	−39.547	62.171	0.037	71.871	30.998	47.444	0.041
000130	01:17:37	7973	228.05	21.96	5.70	254.219	−31.312	54.268	0.050	...	...	...	...
000131	14:57:57	7975	93.96	−52.03	0.29	158.479	−40.275	45.001	0.028	75.417	31.456	84.898	0.053
000201	03:02:09	7976	140.07	15.91	0.73	158.315	−40.348	61.232	0.076	75.796	31.499	58.109	0.078
000205	08:39:52	7984	8.41	30.18	1.11	336.858	40.937	29.095	0.146	...	...	...	...
000207	23:56:22	7986	289.70	59.25	0.66	335.899	41.262	36.343	0.032	...	...	...	...
000212	22:31:05	7987	16.09	35.62	0.62	334.001	41.787	32.622	0.032	...	...	...	...
000221	23:39:10	7994	125.76	77.70	0.45	330.269	42.423	60.950	0.020	...	...	...	...
000225	01:35:29	7997	110.56	0.53	2.35	93.185	32.496	35.172	0.193	...	...	...	...
000226	03:51:49	7998	143.68	29.82	1.64	148.479	−42.565	71.677	0.066	...	...	...	...
000229	02:45:02	8004	296.73	47.87	1.44	275.936	−32.473	80.737	0.093	...	...	...	...
000301	02:33:54	8005	3.69	72.68	1.00	326.770	42.614	35.343	0.016	96.604	32.460	61.436	0.033
000302[a]	02:50:25	8008	58.20	54.28	0.53	326.334	42.610	61.365	0.045	97.277	32.444	31.157	0.035
000306	18:00:31	8019	226.07	40.92	1.46	324.346	42.529	68.987	0.033	...	...	...	...
000307	21:50:47	8022	88.49	6.80	0.53	143.857	−42.490	70.863	0.031	101.056	32.300	26.778	0.050
000310	08:16:41	8026	127.51	−10.86	1.27	102.600	32.215	47.686	0.099	...	...	...	...
000312[a]	05:23:54	8030	320.29	37.92	0.72	322.063	42.288	4.894	0.130	283.768	−32.141	77.432	0.027
000314	08:51:42	8036	137.71	50.66	1.72	141.197	−42.150	89.988	0.073	...	...	...	...
000320	08:15:27	8045	82.48	4.44	2.39	108.642	31.731	37.682	0.866	...	...	...	...
000323	09:02:07	8049	190.73	48.08	0.98	317.802	41.365	77.623	0.112	110.381	31.548	62.193	0.259
000324	05:10:13	8050	207.02	−24.04	0.82	137.511	−41.275	60.926	0.017	290.848	−31.495	75.535	0.103
000326	05:18:56	8053	333.36	−26.36	2.36	316.827	41.054	68.837	0.005	291.959	−31.367	36.005	0.081
000330	08:37:10	8056	312.40	32.00	0.93	294.188	−31.076	65.453	0.053	...	...	...	...
000331	03:47:58	8058	169.40	−15.02	5.35	114.611	31.017	68.235	0.850	...	...	...	...
000331	07:00:10	8059	19.11	−46.29	4.18	294.679	−31.008	61.529	0.360	...	...	...	...
C000331	23:43:41	8061	32.00	59.77	3.72	115.042	30.957	59.472	0.709	...	...	...	...
000402	14:30:58	8063	343.53	6.65	0.79	314.550	40.141	41.782	0.109	295.871	−30.839	57.853	0.096
000408	02:35:48	8069	138.51	67.22	1.43	313.110	39.385	73.978	0.006	118.582	30.408	37.903	0.029
000415	08:40:40	8075	134.85	69.42	0.81	311.559	38.342	71.589	0.113	121.864	29.814	40.896	0.394
000420	01:22:56	8080	139.06	−44.66	1.88	130.766	−37.656	11.080	1.174	...	...	...	...
000420[a,b]	14:22:10	8081	129.26	−14.59	0.41	130.682	−37.577	22.393	0.042	124.020	29.375	44.927	0.102

Table 2
(Continued)

Date	UT	N_B	$\alpha_{2000,B}$	$\delta_{2000,B}$	$\sigma_{\mathrm{stat},B}$	$\alpha_{2000,\mathrm{IPN1}}$	$\delta_{2000,\mathrm{IPN1}}$	R_{IPN1}	δR_{IPN1}	$\alpha_{2000,\mathrm{IPN2}}$	$\delta_{2000,\mathrm{IPN2}}$	R_{IPN2}	δR_{IPN2}
000421	12:23:34	8084	174.91	16.98	3.09	130.548	−37.446	67.930	0.346	...	...	...	...
000424	09:04:26	8085	233.06	71.80	1.38	125.454	29.060	67.301	0.197	...	...	...	...
000424	18:18:07	8086	105.03	53.98	0.95	130.124	−36.981	89.693	0.028	...	...	...	...
000429	10:07:22	8087	100.23	−4.81	0.51	129.641	−36.327	42.960	0.036	127.210	28.643	43.169	0.056
000508A[w]	19:10:50	8098	253.54	−20.38	0.42	309.093	35.106	76.490	0.071	309.926	−27.912	51.499	0.084
000508B	21:30:19	8099	89.89	2.39	0.55	129.094	−35.093	51.227	0.011	...	...	...	...
000509	22:36:50	8100	344.19	−39.27	2.99	310.199	−27.829	28.602	0.530	...	...	...	...
000511	01:11:59	8101	331.24	−36.11	0.88	309.043	34.837	76.354	0.191	310.458	−27.749	22.991	0.526
000513	11:21:35	8104	338.91	−45.11	2.08	310.984	−27.576	32.370	0.099	...	...	...	...
000518	05:41:51	8110	71.33	53.91	1.84	131.860	27.255	49.611	0.100	...	...	...	...
000519	08:18:07	8111	346.03	3.33	1.03	309.092	33.938	47.691	0.046	312.026	−27.187	43.331	0.080
000524	00:09:05	8116	109.19	−41.36	1.32	129.278	−33.499	14.464	0.136	132.594	26.906	69.699	0.120
000525	10:24:13	8120	280.22	−39.44	2.75	312.719	−26.830	30.209	0.115	...	...	...	...
000526	10:01:33	8121	231.29	−10.32	0.95	309.410	33.298	88.067	0.134	...	...	...	...

Notes.
[a] Degenerate localization.
[b] Localized by the *Rossi X-Ray Timing Explorer* (*RXTE*) All-Sky Monitor (Smith et al. 1999a).
[c] Localized by the *Advanced Satellite for Cosmology and Astrophysics* (*ASCA*) (Murakami et al. 1997b).
[d] Localized by *BeppoSAX* (Galama et al. 1997).
[e] Localized by *BeppoSAX* (Piro et al. 1997a).
[f] Localized by the *RXTE* Proportional Counter Array (Marshall et al. 1997) and by *ASCA* (Murakami et al. 1997a).
[g] Localized by *BeppoSAX* (Antonelli et al. 1997).
[h] Localized by *BeppoSAX* (Piro et al. 1997b).
[i] Localized by *BeppoSAX* (in't Zand et al. 1998a).
[j] Localized by *BeppoSAX* (Celidonio et al. 1998).
[k] Localized by *BeppoSAX* (in't Zand et al. 1998b).
[l] Localized by *BeppoSAX* (Nicastro et al. 1998).
[m] Localized by *BeppoSAX* (Galama et al. 1998).
[n] Localized by *BeppoSAX* (Heise et al. 1999).
[o] Localized by the *RXTE* All-Sky Monitor (Smith et al. 1999b).
[p] Localized by the *RXTE* Proportional Counter Array (Takeshima & Marshall 1999).
[q] Localized by *BeppoSAX* (Dadina et al. 1999).
[r] Localized by *BeppoSAX* (Piro et al. 1999a).
[s] Localized by *BeppoSAX* (Piro et al. 1999b).
[t] Localized by *BeppoSAX* (in't Zand et al. 2000).
[u] Localized by BeppoSAX (Smith et al. 1999c).
[v] Localized by the *RXTE* Proportional Counter Array (Takeshima et al. 1999) and by the *Chandra X-Ray Observatory* (Piro et al. 1999c).
[w] Localized by the *RXTE* All-Sky Monitor (Smith et al. 2000).

do not cite the intersection points of the annuli with the error circles. A prescription for deriving these points, however, may be found in Hurley et al. (1999a).

When three experiments (*Ulysses*, *NEAR*, and BATSE) observe a burst, the result is two annuli which generally intersect to define two widely separated error boxes. The BATSE error circle is used to distinguish the correct one. An example is shown in Figure 4.

A number of degenerate cases can occur when there is a three-experiment detection. First, the annuli can intersect at grazing incidence. Geometrically, this corresponds to the case $\theta_1 + \theta_2 \approx \angle$NBU, where θ_1 is the radius of the first IPN annulus in Equation (1), θ_2 is the radius of the second IPN annulus in Equation (1), and $\angle$NBU is the *NEAR*–BATSE–*Ulysses* angle. When this occurs, the annuli may cross at one, two, three, or four points, often defining a long, narrow error box. An example is shown in Figure 5. Second, if the three spacecraft are approximately aligned, i.e., $\angle$NBU $\approx 0^\circ$, one annulus can be completely contained within the other, i.e., $\theta_1 \approx \theta_2$. Because *NEAR* and *CGRO* are in the ecliptic plane, and *Ulysses* is outside it, this case did not occur for any of the bursts discussed here. Third, if the burst arrives along the line joining two spacecraft, then $\theta \approx 0^\circ$ and $\sin\theta \approx 0$, and the annulus has a small radius but a very large width $d\theta$. In these cases, the width of the annulus can exceed its radius, and the annulus becomes a circle; the second annulus intersects it to define a single error box. Finally, if the annuli intersect almost at grazing incidence, the two intersections are close to one another and may both be located within the BATSE 1σ error circle, making it impossible to determine the correct location. An example is shown in Figure 6. A total of 11 events in this catalog produced degenerate localizations.

The main selection criterion for a burst in this catalog is that it must have been detected by BATSE and/or *Ulysses* and/or *NEAR*. As in previous catalogs, we sometimes utilized various criteria to determine whether a burst was actually detected, such as the goodness of fit between the light curves, as judged by the correlation coefficient and a chi-squared statistic, as well as the ratio of the observed *Ulysses* counts to the BATSE counts. There is, however, a difference in the triangulation technique between the events presented here and those presented in previous catalogs. GRB time histories are energy-dependent.

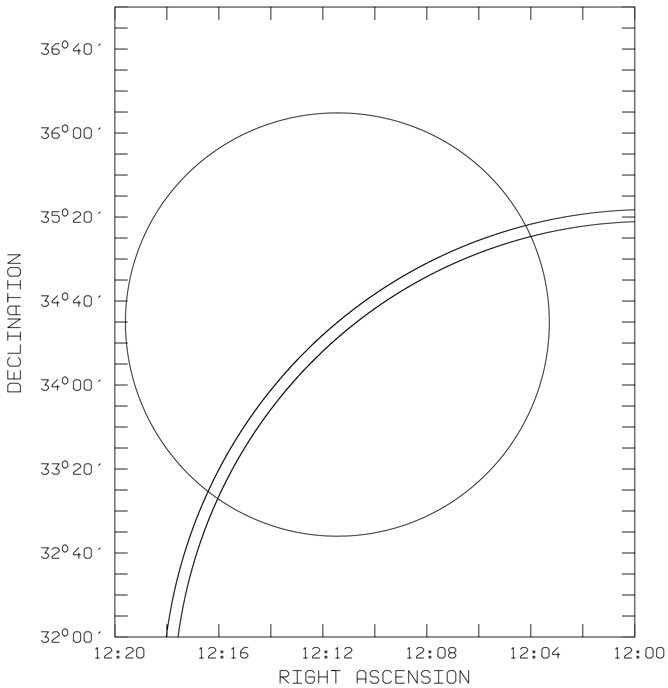

Figure 3. BATSE 1σ (statistical + systematic) error circle for trigger 5711 on 1996 December 12, and the 3σ IPN annulus. The curvature of the annulus makes it impossible to describe the resulting error box with the four annulus/error circle intersection points.

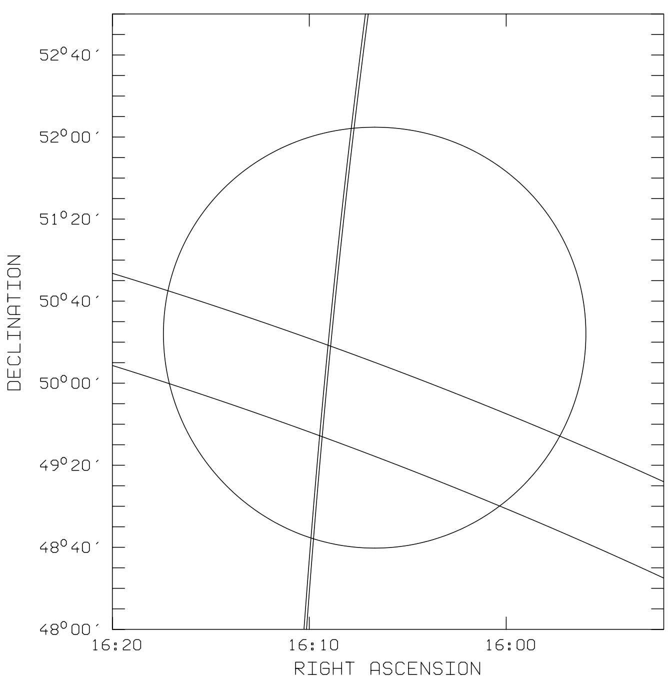

Figure 4. BATSE 1σ (statistical + systematic) error circle for trigger 6472 on 1997 November 10, and the 3σ *Ulysses*–BATSE and *NEAR*–BATSE annuli. Because *NEAR* was closer to Earth than *Ulysses* (smaller D in Equation (2)), and had only 1 s time resolution (resulting in a larger $\sigma(\delta T)$ in Equation (2)), the *NEAR*–BATSE annulus is wider.

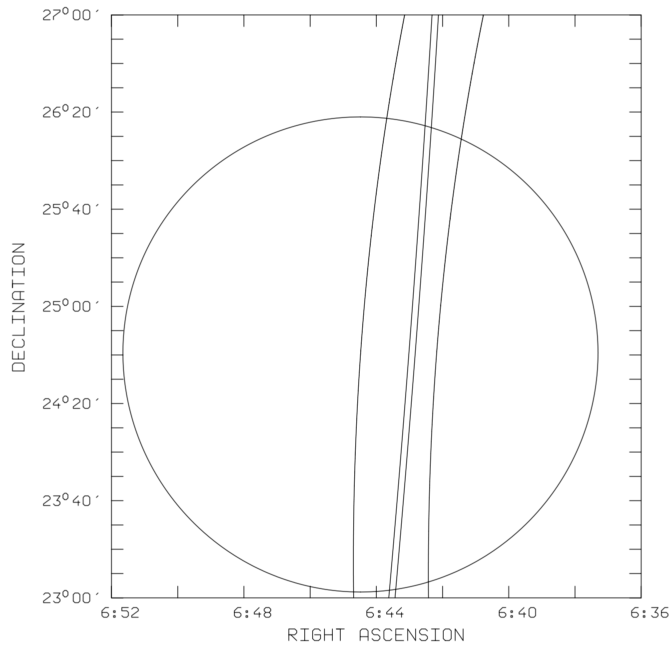

Figure 5. BATSE 1σ (statistical + systematic) error circle for trigger 6453 on 1997 October 29, and the 3σ *Ulysses*–BATSE and *NEAR*–BATSE annuli. Again, the *NEAR*–BATSE annulus is wider. Because the two annuli intersect at grazing incidence, they define a single error box whose length is much greater than the radius of the BATSE error circle.

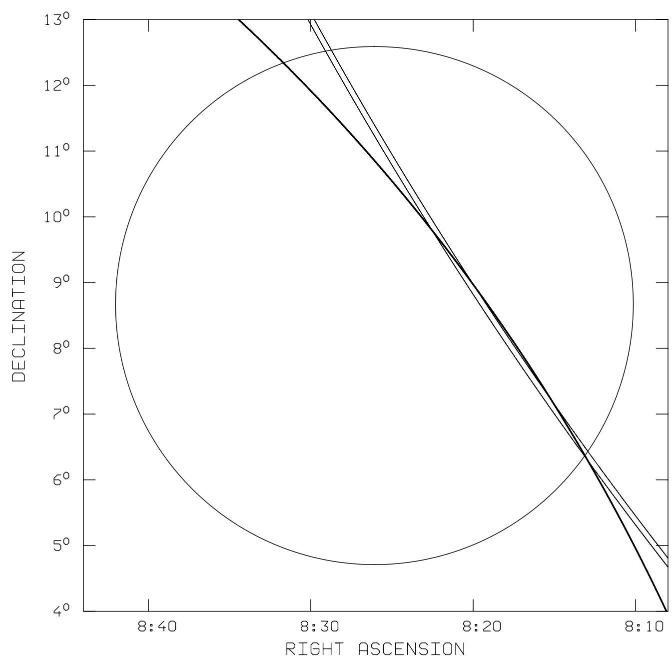

Figure 6. BATSE 1σ (statistical + systematic) error circle for trigger 7647 on 1999 July 12, and the 3σ *Ulysses*–BATSE and *NEAR*–BATSE annuli. The two annuli intersect nearly at grazing incidence, defining two error boxes within the BATSE error circle.

A time history taken in the 25–150 keV *Ulysses* energy range may differ from that taken in the *NEAR* $\sim$ 150–10,000 keV range. The magnitude of this difference varies considerably from event to event and can easily be judged in, say, the χ^2 technique (Hurley et al. 1999a), where the goodness of fit is reflected in the value of χ^2 per degree of freedom. When the match between two time histories is poor, the estimate of the statistical uncertainty in the time difference may become unreliable. This, in turn, renders the annulus width estimates, and hence the confidence value for the error box suspect. We have been able to avoid this problem here by comparing time histories in the same or very similar energy ranges. Thus the *Ulysses* 25–150 keV time histories were compared to 25–100 keV BATSE time histories, while the *NEAR* time histories were compared to the $>$100 keV BATSE time histories.

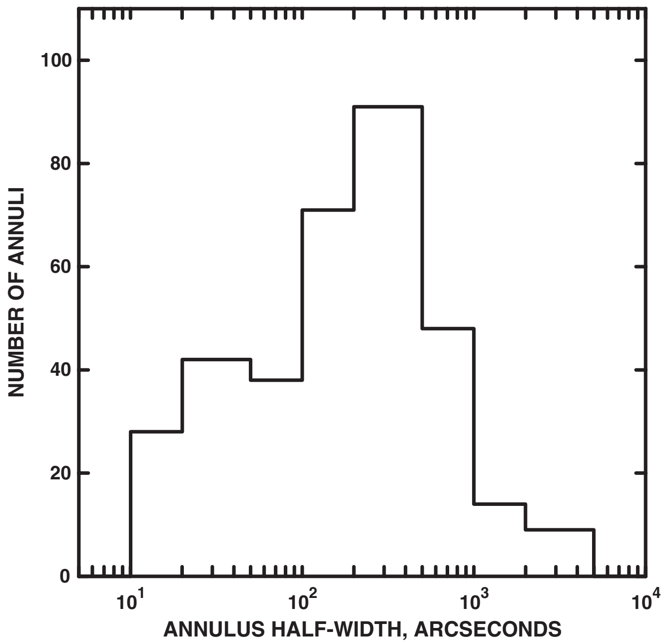

Figure 7. Distribution of 343 IPN annulus half-widths.

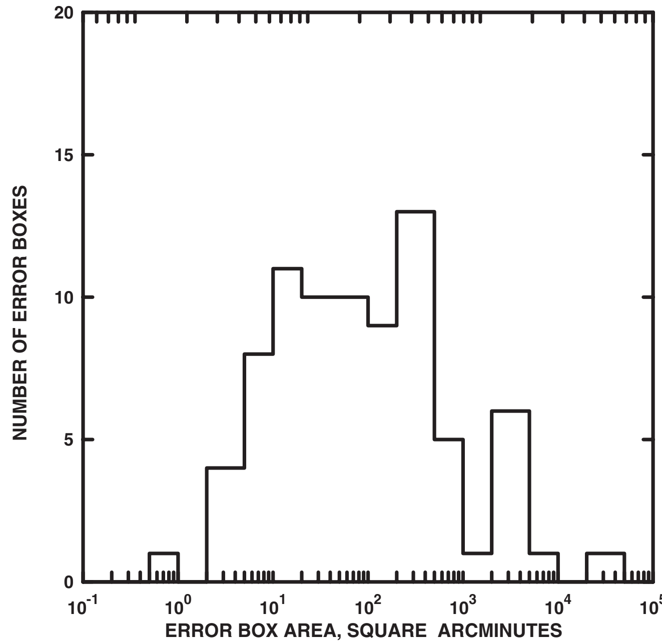

Figure 8. Distribution of 80 IPN error box areas.

3. A FEW STATISTICS

There are 1068 bursts in the 5B catalog (M. S. Briggs et al. 2011, in preparation). Of these, 343 were observed by *Ulysses* and/or *NEAR*, and in some cases, other spacecraft as well.[13] Ninety-one bursts were detected by all three spacecraft. Thus the IPN observed approximately one out of every 3.1 BATSE bursts over this period. The fraction of BATSE bursts observed by the IPN is slightly higher in this catalog than in previous ones due to the addition of the *NEAR* spacecraft. The combination of the 3B and 4Br supplements and the present catalog contains 708 bursts.

The histogram of Figure 7 shows the distribution of annulus half-widths (i.e., δR_{IPN} in Table 2) for the 343 bursts localized. The smallest is about 11″, the largest is 21°, and the average is 9′.6. (The largest annulus width occurred for BATSE 6580 on 1998 January 25, when the *NEAR* spacecraft passed the Earth at a distance of only 0.478 lt-s on its way to encounter with Eros.)

Of the 343 bursts, 253 were localized to single annuli by the IPN, and another 11, although detected by all three spacecraft, were degenerate localizations which prevented the derivation of a useful error box. These may be treated as single annuli. Considering these 264 annuli, 185, or 70%, intersect the BATSE 1σ error circles, whose radii are defined by $r_{1\sigma} = \sqrt{\sigma_{\mathrm{stat}}^2 + \sigma_{\mathrm{sys}}^2}$, where σ_{sys} is the systematic error, 1°.6, and σ_{stat} is the statistical error. The combined IPN/BATSE error regions are an average factor of ∼20 smaller than the BATSE error circles. 70% is somewhat less than the percentage which would be predicted purely on the basis of statistics (87%). A detailed comparison of the IPN and BATSE localizations results in several more complicated BATSE error models that render the BATSE and IPN localizations consistent (Briggs et al. 1999).

Although 91 bursts were observed by *Ulysses*, *NEAR*, and BATSE, 11 were degenerate, leaving 80 with well-defined IPN error boxes. The smallest has an area of approximately 0.7 arcmin^2, and the largest, 48,000 arcmin^2. The average area is 1100 arcmin^2, and the average ratio of the area of the BATSE error circle to the area of the IPN error box is ∼87. Forty-six, or 58%, of these error boxes are partially or completely contained within their corresponding BATSE error circles. A histogram of IPN error box sizes is shown in Figure 8. The centers and corners of the 80 error boxes are given in Table 3. However, in some cases, the curvature of the annuli may render a simple, four-corner error box description inaccurate.

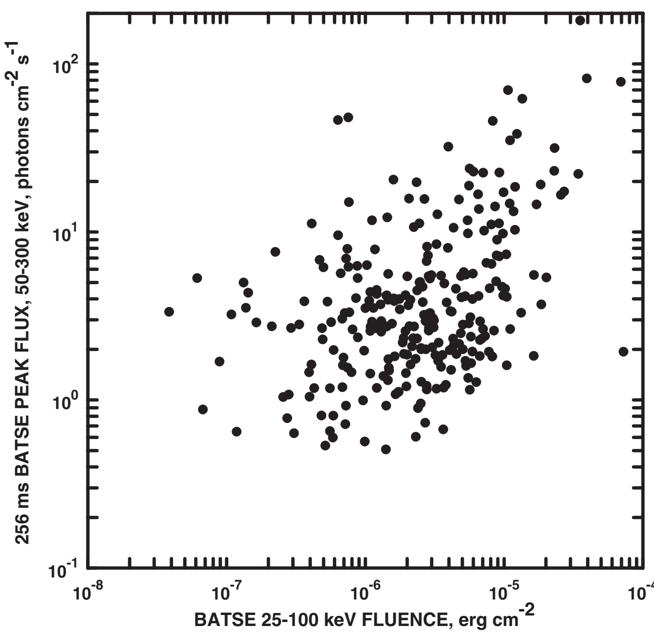

Figure 9. Peak fluxes (measured over 256 ms, 50–300 keV) and 25–100 keV fluences of 272 of the bursts in this catalog. No entries are given in the 5B catalog for 71 of the bursts.

Figure 9 shows the BATSE peak fluxes and fluences for 272 of the 343 bursts with flux and fluence entries in the 5B catalog. Although the *Ulysses* and *NEAR* GRB detectors are roughly 100 and 16 times smaller in area than a single BATSE LAD, Figure 9

[13] A list of all cosmic bursts and the spacecraft which detected them may be found at http://ssl.berkeley.edu/ipn3/masterli.html or http://heasarc.gsfc.nasa.gov/W3Browse/.

Table 3
IPN Error Boxes

Date	N_B	α_{2000}	δ_{2000}
970912	6380	$11^{\rm h}57^{\rm m}49^{\rm s}.30$	$-22^\circ39'16''.50$
		$11^{\rm h}53^{\rm m}29^{\rm s}.31$	$-23^\circ6'46''.07$
		$12^{\rm h}2^{\rm m}2^{\rm s}.79$	$-22^\circ18'32''.45$
		$11^{\rm h}53^{\rm m}36^{\rm s}.51$	$-22^\circ58'8''.65$
		$12^{\rm h}2^{\rm m}10^{\rm s}.11$	$-22^\circ9'37''.02$
970919	6389	$9^{\rm h}14^{\rm m}51^{\rm s}.83$	$-6^\circ29'50''.75$
		$9^{\rm h}15^{\rm m}12^{\rm s}.79$	$-6^\circ37'34''.39$
		$9^{\rm h}14^{\rm m}25^{\rm s}.88$	$-6^\circ25'0''.55$
		$9^{\rm h}15^{\rm m}17^{\rm s}.84$	$-6^\circ34'39''.26$
		$9^{\rm h}14^{\rm m}30^{\rm s}.93$	$-6^\circ22'4''.82$
970925	6397	$21^{\rm h}54^{\rm m}36^{\rm s}.88$	$-9^\circ49'12''.61$
		$21^{\rm h}54^{\rm m}40^{\rm s}.82$	$-9^\circ39'14''.38$
		$21^{\rm h}54^{\rm m}20^{\rm s}.46$	$-9^\circ50'32''.75$
		$21^{\rm h}54^{\rm m}53^{\rm s}.31$	$-9^\circ47'53''.03$
		$21^{\rm h}54^{\rm m}33^{\rm s}.09$	$-9^\circ59'18''.15$
970930	6404	$19^{\rm h}13^{\rm m}25^{\rm s}.33$	$-81^\circ25'12''.15$
		$19^{\rm h}15^{\rm m}1^{\rm s}.31$	$-81^\circ31'38''.65$
		$19^{\rm h}11^{\rm m}45^{\rm s}.57$	$-81^\circ18'56''.02$
		$19^{\rm h}15^{\rm m}7^{\rm s}.63$	$-81^\circ31'26''.39$
		$19^{\rm h}11^{\rm m}51^{\rm s}.82$	$-81^\circ18'43''.94$
971006	6414	$16^{\rm h}44^{\rm m}33^{\rm s}.41$	$53^\circ51'41''.97$
		$16^{\rm h}45^{\rm m}8^{\rm s}.79$	$54^\circ14'8''.53$
		$16^{\rm h}44^{\rm m}42^{\rm s}.78$	$53^\circ29'23''.13$
		$16^{\rm h}44^{\rm m}23^{\rm s}.60$	$54^\circ14'0''.71$
		$16^{\rm h}43^{\rm m}58^{\rm s}.37$	$53^\circ29'14''.57$
971029	6454	$4^{\rm h}25^{\rm m}9^{\rm s}.62$	$-45^\circ12'26''.15$
		$4^{\rm h}26^{\rm m}20^{\rm s}.00$	$-46^\circ30'50''.65$
		$4^{\rm h}26^{\rm m}6^{\rm s}.49$	$-43^\circ59'21''.53$
		$4^{\rm h}24^{\rm m}7^{\rm s}.18$	$-46^\circ25'20''.73$
		$4^{\rm h}23^{\rm m}58^{\rm s}.95$	$-43^\circ53'43''.13$
101197	6472	$16^{\rm h}9^{\rm m}11^{\rm s}.98$	$49^\circ56'14''.30$
		$16^{\rm h}9^{\rm m}2^{\rm s}.84$	$50^\circ18'30''.94$
		$16^{\rm h}9^{\rm m}28^{\rm s}.45$	$49^\circ34'23''.68$
		$16^{\rm h}8^{\rm m}54^{\rm s}.92$	$50^\circ18'3''.47$
		$16^{\rm h}9^{\rm m}20^{\rm s}.64$	$49^\circ33'56''.21$
971127	6504	$15^{\rm h}36^{\rm m}59^{\rm s}.65$	$33^\circ9'48''.51$
		$15^{\rm h}37^{\rm m}11^{\rm s}.83$	$33^\circ51'42''.30$
		$15^{\rm h}37^{\rm m}39^{\rm s}.08$	$32^\circ34'46''.44$
		$15^{\rm h}36^{\rm m}18^{\rm s}.77$	$33^\circ44'40''.80$
		$15^{\rm h}36^{\rm m}46^{\rm s}.43$	$32^\circ27'37''.75$
971207	6525	$8^{\rm h}35^{\rm m}48^{\rm s}.12$	$-4^\circ26'27''.59$
		$8^{\rm h}36^{\rm m}8^{\rm s}.19$	$-4^\circ41'59''.90$
		$8^{\rm h}35^{\rm m}22^{\rm s}.31$	$-4^\circ13'6''.31$
		$8^{\rm h}36^{\rm m}14^{\rm s}.09$	$-4^\circ39'43''.93$
		$8^{\rm h}35^{\rm m}28^{\rm s}.23$	$-4^\circ10'48''.66$
971208	6526	$2^{\rm h}8^{\rm m}46^{\rm s}.29$	$71^\circ55'17''.81$
		$23^{\rm h}50^{\rm m}17^{\rm s}.51$	$76^\circ24'28''.59$
		$3^{\rm h}23^{\rm m}54^{\rm s}.43$	$64^\circ23'50''.74$
		$23^{\rm h}50^{\rm m}52^{\rm s}.85$	$75^\circ44'52''.81$
		$3^{\rm h}19^{\rm m}35^{\rm s}.08$	$63^\circ55'27''.58$
971209	6527	$16^{\rm h}9^{\rm m}11^{\rm s}.34$	$60^\circ26'13''.05$
		$16^{\rm h}8^{\rm m}57^{\rm s}.06$	$60^\circ36'37''.29$
		$16^{\rm h}9^{\rm m}29^{\rm s}.14$	$60^\circ15'59''.41$
		$16^{\rm h}8^{\rm m}53^{\rm s}.25$	$60^\circ36'26''.28$
		$16^{\rm h}9^{\rm m}25^{\rm s}.37$	$60^\circ15'48''.45$
971218	6535	$2^{\rm h}48^{\rm m}54^{\rm s}.76$	$61^\circ41'35''.98$
		$2^{\rm h}47^{\rm m}19^{\rm s}.97$	$61^\circ56'19''.76$
		$2^{\rm h}50^{\rm m}37^{\rm s}.52$	$61^\circ28'24''.24$
		$2^{\rm h}47^{\rm m}10^{\rm s}.50$	$61^\circ54'42''.12$
		$2^{\rm h}50^{\rm m}28^{\rm s}.04$	$61^\circ26'47''.20$
980103	6557	$16^{\rm h}9^{\rm m}30^{\rm s}.14$	$-75^\circ40'3''.44$
		$15^{\rm h}23^{\rm m}19^{\rm s}.42$	$-80^\circ27'18''.51$
		$16^{\rm h}30^{\rm m}33^{\rm s}.89$	$-70^\circ32'58''.72$
		$15^{\rm h}27^{\rm m}51^{\rm s}.11$	$-80^\circ34'44''.25$
		$16^{\rm h}33^{\rm m}7^{\rm s}.62$	$-70^\circ37'5''.46$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
980105	6560	$2^{\rm h}26^{\rm m}18^{\rm s}.69$	$50^\circ17'10''.93$
		$2^{\rm h}23^{\rm m}16^{\rm s}.00$	$50^\circ48'54''.29$
		$2^{\rm h}29^{\rm m}18^{\rm s}.37$	$49^\circ45'18''.94$
		$2^{\rm h}23^{\rm m}15^{\rm s}.02$	$50^\circ48'31''.22$
		$2^{\rm h}29^{\rm m}17^{\rm s}.38$	$49^\circ44'55''.77$
980113	6570	$17^{\rm h}28^{\rm m}47^{\rm s}.34$	$-25^\circ29'38''.45$
		$17^{\rm h}21^{\rm m}21^{\rm s}.14$	$-35^\circ27'39''.92$
		$17^{\rm h}28^{\rm m}31^{\rm s}.22$	$-25^\circ46'51''.85$
		$17^{\rm h}21^{\rm m}29^{\rm s}.11$	$-35^\circ27'47''.38$
		$17^{\rm h}28^{\rm m}38^{\rm s}.66$	$-25^\circ46'40''.89$
980125	6581	$21^{\rm h}16^{\rm m}48^{\rm s}.14$	$24^\circ11'54''.31$
		$21^{\rm h}8^{\rm m}44^{\rm s}.40$	$22^\circ32'15''.06$
		$21^{\rm h}25^{\rm m}42^{\rm s}.62$	$25^\circ49'2''.49$
		$21^{\rm h}8^{\rm m}47^{\rm s}.01$	$22^\circ32'4''.97$
		$21^{\rm h}25^{\rm m}45^{\rm s}.53$	$25^\circ48'51''.75$
980203	6587	$0^{\rm h}20^{\rm m}26^{\rm s}.01$	$-16^\circ29'26''.13$
		$0^{\rm h}16^{\rm m}40^{\rm s}.61$	$-19^\circ44'53''.25$
		$0^{\rm h}21^{\rm m}51^{\rm s}.06$	$-13^\circ14'11''.19$
		$0^{\rm h}16^{\rm m}35^{\rm s}.29$	$-19^\circ44'53''.70$
		$0^{\rm h}21^{\rm m}46^{\rm s}.25$	$-13^\circ14'12''.10$
980829	7030	$16^{\rm h}6^{\rm m}16^{\rm s}.08$	$-56^\circ14'23''.81$
		$16^{\rm h}5^{\rm m}51^{\rm s}.34$	$-56^\circ53'46''.28$
		$16^{\rm h}7^{\rm m}11^{\rm s}.25$	$-55^\circ34'43''.32$
		$16^{\rm h}5^{\rm m}18^{\rm s}.99$	$-56^\circ53'59''.76$
		$16^{\rm h}6^{\rm m}39^{\rm s}.97$	$-55^\circ35'0''.13$
981011	7150	$3^{\rm h}29^{\rm m}18^{\rm s}.30$	$-64^\circ26'11''.52$
		$3^{\rm h}31^{\rm m}6^{\rm s}.77$	$-64^\circ3'31''.19$
		$3^{\rm h}28^{\rm m}23^{\rm s}.58$	$-64^\circ52'6''.37$
		$3^{\rm h}30^{\rm m}11^{\rm s}.07$	$-64^\circ0'14''.56$
		$3^{\rm h}27^{\rm m}26^{\rm s}.56$	$-64^\circ48'45''.85$
981015	7156	$19^{\rm h}55^{\rm m}18^{\rm s}.17$	$-79^\circ48'57''.37$
		$19^{\rm h}55^{\rm m}28^{\rm s}.04$	$-79^\circ59'15''.22$
		$19^{\rm h}50^{\rm m}56^{\rm s}.57$	$-79^\circ46'40''.51$
		$19^{\rm h}59^{\rm m}41^{\rm s}.48$	$-79^\circ51'0''.50$
		$19^{\rm h}55^{\rm m}8^{\rm s}.57$	$-79^\circ38'39''.16$
981021	7170	$23^{\rm h}52^{\rm m}33^{\rm s}.10$	$0^\circ13'55''.00$
		$23^{\rm h}52^{\rm m}41^{\rm s}.98$	$0^\circ16'35''.34$
		$23^{\rm h}52^{\rm m}40^{\rm s}.02$	$0^\circ20'7''.35$
		$23^{\rm h}52^{\rm m}26^{\rm s}.05$	$0^\circ7'38''.02$
		$23^{\rm h}52^{\rm m}24^{\rm s}.20$	$0^\circ11'13''.93$
981022	7172	$0^{\rm h}52^{\rm m}44^{\rm s}.26$	$48^\circ43'14''.59$
		$0^{\rm h}52^{\rm m}32^{\rm s}.76$	$48^\circ45'19''.96$
		$0^{\rm h}52^{\rm m}54^{\rm s}.54$	$48^\circ42'43''.84$
		$0^{\rm h}52^{\rm m}33^{\rm s}.99$	$48^\circ43'45''.23$
		$0^{\rm h}52^{\rm m}55^{\rm s}.76$	$48^\circ41'8''.98$
981031	7185	$18^{\rm h}21^{\rm m}39^{\rm s}.75$	$-26^\circ35'48''.68$
		$18^{\rm h}23^{\rm m}41^{\rm s}.79$	$-28^\circ48'2''.57$
		$18^{\rm h}19^{\rm m}44^{\rm s}.28$	$-24^\circ20'10''.79$
		$18^{\rm h}23^{\rm m}44^{\rm s}.04$	$-28^\circ47'58''.92$
		$18^{\rm h}19^{\rm m}46^{\rm s}.59$	$-24^\circ20'18''.56$
981121	7219	$0^{\rm h}50^{\rm m}47^{\rm s}.19$	$42^\circ39'11''.37$
		$0^{\rm h}44^{\rm m}28^{\rm s}.43$	$43^\circ45'25''.68$
		$0^{\rm h}55^{\rm m}44^{\rm s}.82$	$42^\circ11'21''.73$
		$0^{\rm h}45^{\rm m}49^{\rm s}.58$	$43^\circ4'16''.49$
		$0^{\rm h}57^{\rm m}4^{\rm s}.58$	$41^\circ26'14''.81$
981125	7228	$17^{\rm h}16^{\rm m}8^{\rm s}.26$	$31^\circ22'47''.36$
		$17^{\rm h}15^{\rm m}48^{\rm s}.83$	$31^\circ28'23''.26$
		$17^{\rm h}15^{\rm m}53^{\rm s}.49$	$31^\circ12'24''.44$
		$17^{\rm h}16^{\rm m}23^{\rm s}.10$	$31^\circ33'9''.46$
		$17^{\rm h}16^{\rm m}27^{\rm s}.66$	$31^\circ17'11''.31$
981130	7240	$23^{\rm h}15^{\rm m}12^{\rm s}.91$	$-12^\circ38'25''.93$
		$23^{\rm h}15^{\rm m}17^{\rm s}.82$	$-12^\circ39'36''.09$
		$23^{\rm h}15^{\rm m}10^{\rm s}.94$	$-12^\circ39'42''.43$
		$23^{\rm h}15^{\rm m}14^{\rm s}.89$	$-12^\circ37'9''.41$
		$23^{\rm h}15^{\rm m}8^{\rm s}.01$	$-12^\circ37'15''.71$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
981203	7248	$19^{h}14^{m}18^{s}.69$	$-26^{\circ}02'55''.33$
		$19^{h}14^{m}28^{s}.33$	$-26^{\circ}14'7''.33$
		$19^{h}13^{m}41^{s}.84$	$-25^{\circ}45'40''.13$
		$19^{h}14^{m}54^{s}.01$	$-26^{\circ}18'59''.36$
		$19^{h}14^{m}8^{s}.63$	$-25^{\circ}51'23''.24$
981211	7255	$22^{h}17^{m}31^{s}.51$	$-8^{\circ}14'58''.44$
		$22^{h}17^{m}55^{s}.09$	$-8^{\circ}24'27''.59$
		$22^{h}17^{m}27^{s}.84$	$-8^{\circ}18'23''.96$
		$22^{h}17^{m}35^{s}.14$	$-8^{\circ}11'32''.35$
		$22^{h}17^{m}7^{s}.31$	$-8^{\circ}5'12''.99$
990206	7374	$16^{h}23^{m}10^{s}.08$	$7^{\circ}9'18''.42$
		$16^{h}23^{m}6^{s}.63$	$7^{\circ}31'38''.73$
		$16^{h}23^{m}25^{s}.07$	$7^{\circ}6'54''.93$
		$16^{h}22^{m}55^{s}.08$	$7^{\circ}11'41''.83$
		$16^{h}23^{m}13^{s}.53$	$6^{\circ}46'54''.68$
990216	7390	$18^{h}10^{m}40^{s}.00$	$-40^{\circ}15'2''.40$
		$18^{h}10^{m}13^{s}.97$	$-40^{\circ}19'7''.94$
		$18^{h}12^{m}34^{s}.85$	$-41^{\circ}20'7''.18$
		$18^{h}8^{m}53^{s}.48$	$-39^{\circ}11'19''.00$
		$18^{h}11^{m}6^{s}.00$	$-40^{\circ}10'56''.74$
990319	7484	$19^{h}10^{m}20^{s}.35$	$31^{\circ}48'53''.08$
		$19^{h}10^{m}10^{s}.35$	$31^{\circ}49'44''.86$
		$19^{h}10^{m}48^{s}.51$	$32^{\circ}12'35''.90$
		$19^{h}9^{m}52^{s}.33$	$31^{\circ}24'35''.96$
		$19^{h}10^{m}30^{s}.34$	$31^{\circ}48'1''.27$
990323	7491	$22^{h}26^{m}17^{s}.99$	$-77^{\circ}10'5''.25$
		$22^{h}26^{m}9^{s}.07$	$-77^{\circ}10'20''.91$
		$22^{h}26^{m}42^{s}.30$	$-77^{\circ}10'9''.44$
		$22^{h}25^{m}53^{s}.69$	$-77^{\circ}10'0''.91$
		$22^{h}26^{m}26^{s}.91$	$-77^{\circ}9'49''.56$
990331	7498	$23^{h}36^{m}26^{s}.09$	$22^{\circ}15'25''.94$
		$23^{h}36^{m}3^{s}.11$	$23^{\circ}6'8''.76$
		$23^{h}38^{m}58^{s}.79$	$21^{\circ}40'51''.55$
		$23^{h}33^{m}47^{s}.99$	$22^{\circ}49'4''.80$
		$23^{h}36^{m}44^{s}.61$	$21^{\circ}23'43''.95$
990403	7503	$20^{h}2^{m}12^{s}.39$	$-3^{\circ}46'15''.30$
		$20^{h}1^{m}40^{s}.50$	$-3^{\circ}33'41''.87$
		$20^{h}2^{m}58^{s}.43$	$-4^{\circ}16'59''.69$
		$20^{h}1^{m}25^{s}.69$	$-3^{\circ}13'43''.91$
		$20^{h}2^{m}44^{s}.14$	$-3^{\circ}58'27''.99$
990424	7527	$5^{h}30^{m}15^{s}.47$	$-64^{\circ}57'6''.11$
		$5^{h}30^{m}3^{s}.96$	$-64^{\circ}56'13''.48$
		$5^{h}30^{m}17^{s}.39$	$-64^{\circ}59'51''.07$
		$5^{h}30^{m}13^{s}.56$	$-64^{\circ}54'21''.12$
		$5^{h}30^{m}26^{s}.99$	$-64^{\circ}57'58''.69$
990424	7529	$5^{h}39^{m}11^{s}.39$	$37^{\circ}40'32''.29$
		$5^{h}39^{m}18^{s}.41$	$37^{\circ}47'0''.92$
		$5^{h}39^{m}2^{s}.96$	$37^{\circ}40'23''.67$
		$5^{h}39^{m}19^{s}.83$	$37^{\circ}40'40''.86$
		$5^{h}39^{m}4^{s}.37$	$37^{\circ}34'2''.40$
990425	7530	$22^{h}9^{m}42^{s}.06$	$-5^{\circ}24'20''.37$
		$22^{h}9^{m}36^{s}.81$	$-5^{\circ}26'12''.66$
		$22^{h}9^{m}50^{s}.82$	$-5^{\circ}24'25''.74$
		$22^{h}9^{m}33^{s}.28$	$-5^{\circ}24'14''.77$
		$22^{h}9^{m}47^{s}.29$	$-5^{\circ}22'27''.82$
990427	7534	$23^{h}30^{m}58^{s}.70$	$-18^{\circ}37'38''.24$
		$23^{h}31^{m}1^{s}.34$	$-18^{\circ}39'57''.37$
		$23^{h}31^{m}9^{s}.02$	$-18^{\circ}37'55''.65$
		$23^{h}30^{m}48^{s}.38$	$-18^{\circ}37'20''.71$
		$23^{h}30^{m}56^{s}.06$	$-18^{\circ}35'19''.04$
990506	7549	$11^{h}54^{m}48^{s}.63$	$-26^{\circ}42'14''.17$
		$11^{h}54^{m}41^{s}.72$	$-26^{\circ}47'17''.23$
		$11^{h}54^{m}58^{s}.08$	$-26^{\circ}39'27''.22$
		$11^{h}54^{m}39^{s}.17$	$-26^{\circ}45'0''.44$
		$11^{h}54^{m}55^{s}.55$	$-26^{\circ}37'9''.10$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
990510	7560	$13^{h}38^{m}10^{s}.45$	$-80^{\circ}29'41''.54$
		$13^{h}37^{m}56^{s}.21$	$-80^{\circ}31'23''.17$
		$13^{h}38^{m}40^{s}.64$	$-80^{\circ}28'3''.20$
		$13^{h}37^{m}40^{s}.08$	$-80^{\circ}31'19''.71$
		$13^{h}38^{m}24^{s}.60$	$-80^{\circ}27'59''.88$
990516	7569	$16^{h}29^{m}49^{s}.30$	$2^{\circ}43'24''.46$
		$16^{h}29^{m}45^{s}.99$	$2^{\circ}48'31''.42$
		$16^{h}29^{m}50^{s}.46$	$2^{\circ}38'59''.88$
		$16^{h}29^{m}48^{s}.15$	$2^{\circ}47'48''.36$
		$16^{h}29^{m}52^{s}.62$	$2^{\circ}38'16''.46$
990518	7575	$23^{h}9^{m}14^{s}.99$	$-36^{\circ}55'58''.69$
		$23^{h}9^{m}7^{s}.78$	$-36^{\circ}59'3''.08$
		$23^{h}9^{m}35^{s}.77$	$-36^{\circ}55'45''.14$
		$23^{h}8^{m}54^{s}.20$	$-36^{\circ}56'11''.84$
		$23^{h}9^{m}22^{s}.19$	$-36^{\circ}52'54''.19$
990522	7578	$2^{h}35^{m}6^{s}.90$	$24^{\circ}45'10''.36$
		$2^{h}35^{m}9^{s}.98$	$25^{\circ}4'28''.95$
		$2^{h}35^{m}10^{s}.29$	$24^{\circ}25'21''.82$
		$2^{h}35^{m}3^{s}.34$	$25^{\circ}4'49''.12$
		$2^{h}35^{m}3^{s}.69$	$24^{\circ}25'46''.95$
990527	7586	$22^{h}44^{m}12^{s}.61$	$-18^{\circ}39'30''.68$
		$22^{h}44^{m}14^{s}.20$	$-18^{\circ}42'36''.58$
		$22^{h}44^{m}23^{s}.66$	$-18^{\circ}41'7''.47$
		$22^{h}44^{m}1^{s}.55$	$-18^{\circ}37'53''.78$
		$22^{h}44^{m}11^{s}.01$	$-18^{\circ}36'24''.71$
990531	7592	$3^{h}18^{m}36^{s}.10$	$36^{\circ}4'56''.41$
		$3^{h}18^{m}37^{s}.74$	$36^{\circ}7'24''.87$
		$3^{h}18^{m}36^{s}.56$	$36^{\circ}2'20''.04$
		$3^{h}18^{m}35^{s}.65$	$36^{\circ}7'32''.72$
		$3^{h}18^{m}34^{s}.47$	$36^{\circ}2'27''.94$
990707	7638	$4^{h}59^{m}6^{s}.70$	$22^{\circ}9'40''.56$
		$4^{h}56^{m}16^{s}.64$	$19^{\circ}50'48''.25$
		$5^{h}1^{m}31^{s}.38$	$24^{\circ}37'29''.49$
		$4^{h}56^{m}57^{s}.78$	$19^{\circ}46'0''.83$
		$5^{h}2^{m}11^{s}.09$	$24^{\circ}30'31''.77$
990712	7647	$8^{h}13^{m}51^{s}.06$	$6^{\circ}40'31''.83$
		$8^{h}12^{m}48^{s}.85$	$6^{\circ}14'57''.99$
		$8^{h}14^{m}55^{s}.24$	$7^{\circ}7'12''.60$
		$8^{h}13^{m}3^{s}.99$	$6^{\circ}20'6''.46$
		$8^{h}15^{m}25^{s}.07$	$7^{\circ}17'43''.44$
Or		$8^{h}21^{m}25^{s}.20$	$9^{\circ}26'26''.57$
		$8^{h}22^{m}38^{s}.32$	$9^{\circ}50'15''.96$
		$8^{h}20^{m}8^{s}.71$	$9^{\circ}1'45''.49$
		$8^{h}22^{m}24^{s}.58$	$9^{\circ}44'52''.10$
		$8^{h}19^{m}40^{s}.29$	$8^{\circ}50'59''.26$
990712	7648	$18^{h}50^{m}14^{s}.52$	$11^{\circ}12'29''.96$
		$18^{h}49^{m}37^{s}.10$	$11^{\circ}26'59''.82$
		$18^{h}49^{m}38^{s}.21$	$11^{\circ}5'46''.90$
		$18^{h}50^{m}50^{s}.91$	$11^{\circ}19'11''.80$
		$18^{h}50^{m}52^{s}.14$	$10^{\circ}57'54''.15$
990714	7652	$15^{h}33^{m}14^{s}.74$	$21^{\circ}8'47''.18$
		$15^{h}33^{m}20^{s}.57$	$21^{\circ}12'7''.36$
		$15^{h}33^{m}23^{s}.82$	$21^{\circ}7'45''.30$
		$15^{h}33^{m}5^{s}.65$	$21^{\circ}9'49''.01$
		$15^{h}33^{m}8^{s}.92$	$21^{\circ}5'26''.88$
990728	7678	$14^{h}8^{m}5^{s}.23$	$-57^{\circ}37'39''.76$
		$14^{h}7^{m}36^{s}.48$	$-57^{\circ}49'9''.05$
		$14^{h}8^{m}34^{s}.21$	$-57^{\circ}27'22''.10$
		$14^{h}7^{m}36^{s}.12$	$-57^{\circ}47'51''.42$
		$14^{h}8^{m}33^{s}.85$	$-57^{\circ}26'3''.05$
990909	7760	$1^{h}24^{m}46^{s}.81$	$-29^{\circ}13'26''.45$
		$1^{h}24^{m}58^{s}.87$	$-29^{\circ}10'52''.71$
		$1^{h}24^{m}34^{s}.87$	$-29^{\circ}17'20''.48$
		$1^{h}24^{m}58^{s}.73$	$-29^{\circ}9'32''.23$
		$1^{h}24^{m}34^{s}.74$	$-29^{\circ}16'0''.01$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
990915	7766	$7^h9^m34^s.67$	$72^\circ56'16''.15$
		$7^h11^m46^s.43$	$73^\circ6'15''.97$
		$7^h9^m19^s.24$	$72^\circ54'13''.39$
		$7^h9^m50^s.08$	$72^\circ58'18''.42$
		$7^h7^m21^s.98$	$72^\circ45'54''.01$
991004	7788	$13^h59^m3^s.37$	$-17^\circ58'40''.91$
		$13^h59^m10^s.31$	$-17^\circ59'45''.23$
		$13^h59^m6^s.19$	$-17^\circ52'6''.37$
		$13^h59^m0^s.50$	$-18^\circ5'15''.66$
		$13^h58^m56^s.44$	$-17^\circ57'36''.62$
991025	7822	$17^h28^m55^s.29$	$43^\circ59'7''.80$
		$17^h30^m19^s.93$	$42^\circ23'4''.75$
		$17^h27^m58^s.40$	$44^\circ49'50''.26$
		$17^h29^m46^s.37$	$43^\circ14'26''.99$
		$17^h26^m59^s.46$	$46^\circ9'16''.81$
991104	7840	$21^h22^m59^s.30$	$-31^\circ42'9''.20$
		$21^h22^m43^s.83$	$-31^\circ45'5''.20$
		$21^h23^m56^s.41$	$-31^\circ52'32''.60$
		$21^h22^m2^s.53$	$-31^\circ31'42''.25$
		$21^h23^m14^s.75$	$-31^\circ39'13''.03$
991106	7842	$2^h48^m40^s.24$	$59^\circ19'39''.50$
		$2^h48^m33^s.66$	$59^\circ37'47''.75$
		$2^h50^m20^s.07$	$58^\circ50'54''.40$
		$2^h46^m55^s.90$	$59^\circ48'18''.18$
		$2^h48^m46^s.10$	$59^\circ1'32''.90$
991113	7854	$0^h15^m13^s.02$	$34^\circ19'57''.03$
		$0^h15^m21^s.74$	$34^\circ23'22''.87$
		$0^h15^m32^s.23$	$34^\circ19'8''.42$
		$0^h14^m53^s.80$	$34^\circ20'44''.95$
		$0^h15^m4^s.31$	$34^\circ16'30''.73$
991115	7858	$19^h37^m48^s.37$	$40^\circ12'26''.24$
		$19^h37^m27^s.20$	$39^\circ46'3''.42$
		$19^h37^m59^s.21$	$41^\circ13'32''.61$
		$19^h37^m41^s.76$	$39^\circ4'19''.79$
		$19^h38^m10^s.45$	$40^\circ37'40''.01$
991127	7884	$1^h7^m50^s.57$	$-10^\circ41'27''.40$
		$1^h7^m40^s.92$	$-10^\circ43'46''.87$
		$1^h8^m4^s.23$	$-10^\circ39'24''.32$
		$1^h7^m36^s.90$	$-10^\circ43'30''.18$
		$1^h8^m0^s.20$	$-10^\circ39'7''.78$
991216	7906	$5^h9^m36^s.17$	$11^\circ19'45''.69$
		$5^h9^m44^s.57$	$11^\circ22'24''.12$
		$5^h9^m18^s.36$	$11^\circ11'39''.03$
		$5^h9^m53^s.56$	$11^\circ27'41''.96$
		$5^h9^m27^s.71$	$11^\circ17'5''.93$
991229	7925	$22^h17^m40^s.13$	$35^\circ01'35''.96$
		$22^h17^m17^s.67$	$35^\circ14'33''.15$
		$22^h17^m20^s.37$	$35^\circ21'16''.17$
		$22^h18^m2^s.82$	$34^\circ39'46''.52$
		$22^h18^m3^s.74$	$34^\circ47'46''.16$
000101	7929	$20^h10^m16^s.63$	$29^\circ09'18''.30$
		$20^h9^m57^s.74$	$29^\circ17'20''.98$
		$20^h10^m9^s.22$	$29^\circ10'19''.25$
		$20^h10^m24^s.06$	$29^\circ8'17''.11$
		$20^h10^m35^s.85$	$29^\circ1'7''.78$
000109	7941	$16^h31^m46^s.24$	$-30^\circ28'6''.14$
		$16^h33^m37^s.78$	$-31^\circ3'29''.75$
		$16^h29^m54^s.75$	$-29^\circ40'54''.86$
		$16^h33^m28^s.06$	$-31^\circ11'36''.68$
		$16^h29^m49^s.27$	$-29^\circ50'31''.22$
000123	7965	$21^h23^m0^s.08$	$12^\circ59'44''.08$
		$21^h24^m18^s.79$	$12^\circ42'0''.22$
		$21^h22^m41^s.30$	$12^\circ56'1''.29$
		$21^h23^m18^s.86$	$13^\circ3'27''.02$
		$21^h21^m39^s.16$	$13^\circ18'6''.30$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
000126	7971	$7^h45^m6^s.23$	$7^\circ45'39''.93$
		$7^h45^m49^s.27$	$7^\circ56'26''.30$
		$7^h44^m57^s.13$	$7^\circ46'43''.92$
		$7^h45^m15^s.31$	$7^\circ44'35''.89$
		$7^h44^m22^s.29$	$7^\circ34'40''.23$
000131	7975	$6^h13^m31^s.21$	$-51^\circ57'57''.88$
		$6^h13^m14^s.55$	$-52^\circ1'58''.21$
		$6^h13^m24^s.13$	$-51^\circ54'57''.50$
		$6^h13^m38^s.32$	$-52^\circ0'58''.20$
		$6^h13^m47^s.86$	$-51^\circ53'57''.29$
000201	7976	$9^h15^m58^s.68$	$18^\circ10'57''.24$
		$9^h16^m35^s.91$	$18^\circ18'20''.02$
		$9^h15^m44^s.57$	$18^\circ14'41''.14$
		$9^h16^m12^s.77$	$18^\circ7'13''.21$
		$9^h15^m21^s.34$	$18^\circ3'32''.21$
000301	8005	$23^h39^m26^s.70$	$75^\circ47'29''.61$
		$23^h38^m29^s.90$	$75^\circ51'14''.55$
		$23^h40^m4^s.53$	$75^\circ46'55''.06$
		$23^h38^m48^s.84$	$75^\circ48'3''.56$
		$23^h40^m23^s.19$	$75^\circ43'42''.53$
000307	8022	$5^h56^m17^s.91$	$7^\circ56'36''.06$
		$5^h55^m59^s.62$	$7^\circ55'14''.39$
		$5^h56^m20^s.79$	$7^\circ59'34''.83$
		$5^h56^m15^s.04$	$7^\circ53'37''.29$
		$5^h56^m36^s.24$	$7^\circ57'57''.97$
000323	8049	$12^h51^m40^s.81$	$48^\circ47'10''.24$
		$12^h52^m46^s.21$	$48^\circ29'42''.39$
		$12^h50^m8^s.88$	$48^\circ50'45''.44$
		$12^h53^m12^s.55$	$48^\circ43'31''.26$
		$12^h50^m34^s.56$	$49^\circ4'38''.37$
000324	8050	$13^h43^m39^s.53$	$-20^\circ2'30''.98$
		$13^h43^m24^s.36$	$-19^\circ56'6''.16$
		$13^h43^m59^s.22$	$-20^\circ7'0''.01$
		$13^h43^m19^s.84$	$-19^\circ58'2''.21$
		$13^h43^m54^s.70$	$-20^\circ8'56''.27$
000326	8053	$22^h11^m20^s.82$	$-26^\circ - 9' - 39''.91$
		$22^h11^m42^s.35$	$-26^\circ8'52''.35$
		$22^h11^m0^s.13$	$-26^\circ11'2''.39$
		$22^h11^m41^s.49$	$-26^\circ8'17''.09$
		$22^h10^m59^s.28$	$-26^\circ10'27''.12$
000402	8063	$22^h48^m34^s.68$	$6^\circ27'20''.16$
		$22^h49^m12^s.81$	$6^\circ25'32''.97$
		$22^h48^m33^s.04$	$6^\circ19'20''.79$
		$22^h48^m36^s.28$	$6^\circ35'19''.65$
		$22^h47^m56^s.46$	$6^\circ29'7''.54$
000408	8069	$9^h9^m9^s.45$	$66^\circ35'18''.82$
		$9^h10^m0^s.78$	$66^\circ34'39''.88$
		$9^h8^m33^s.36$	$66^\circ35'10''.70$
		$9^h9^m45^s.43$	$66^\circ35'26''.53$
		$9^h8^m17^s.80$	$66^\circ35'56''.94$
000415	8075	$8^h59^m25^s.63$	$70^\circ2'30''.58$
		$9^h20^m34^s.44$	$69^\circ46'18''.73$
		$8^h45^m25^s.93$	$69^\circ57'18''.09$
		$9^h12^m5^s.70$	$70^\circ4'45''.91$
		$8^h32^m56^s.27$	$70^\circ9'18''.00$
000429	8087	$6^h33^m19^s.34$	$-4^\circ24'38''.42$
		$6^h33^m1^s.28$	$-4^\circ25'23''.91$
		$6^h33^m23^s.34$	$-4^\circ21'6''.95$
		$6^h33^m15^s.34$	$-4^\circ28'9''.98$
		$6^h33^m37^s.42$	$-4^\circ23'52''.99$
000508	8098	$16^h54^m24^s.03$	$-20^\circ25'30''.94$
		$16^h54^m0^s.20$	$-20^\circ26'4''.00$
		$16^h54^m34^s.26$	$-20^\circ33'44''.43$
		$16^h54^m13^s.86$	$-20^\circ17'17''.67$
		$16^h54^m47^s.86$	$-20^\circ24'57''.68$

Table 3
(Continued)

Date	N_B	α_{2000}	δ_{2000}
000511	8101	22h21m11s.04	−37°31′16″.36
		22h23m59s.98	−37°29′58″.08
		22h17m30s.71	−38°0′47″.61
		22h24m41s.79	−37°1′41″.22
		22h18m21s.62	−37°32′16″.94
000519	8111	23h4m31s.12	1°7′45″.21
		23h4m52s.90	1°9′0″.38
		23h4m24s.48	1°2′29″.56
		23h4m37s.74	1°13′1″.04
		23h4m9s.31	1°6′30″.21
000524	8116	7h33m27s.09	−40°27′41″.11
		7h32m52s.91	−40°33′8″.02
		7h32m13s.15	−40°15′23″.78
		7h34m43s.58	−40°40′1″.25
		7h34m1s.21	−40°22′13″.58

demonstrates that they are capable of detecting bursts with very small fluences, provided that the peak flux is relatively high and vice versa.

4. TABLES OF ANNULI AND ERROR BOXES

The 14 columns in Table 2 give (1) the date of the burst, in yymmdd format; this contains a link to a figure on the IPN Web site showing the annulus or error box and the BATSE error circle, (2) the Universal Time of the burst at Earth, (3) the BATSE number for the burst, (4) the BATSE right ascension of the center of the error circle (J2000), in degrees, (5) the BATSE declination of the center of the error circle (J2000), in degrees, (6) the total 1σ statistical BATSE error circle radius, in degrees, (the approximate total 1σ radius is obtained by adding 1°.6 in quadrature, but see Briggs et al. 1999 for an improved error model), (7) the right ascension of the center of the first IPN annulus, epoch J2000, in the heliocentric frame, in degrees, (8) the declination of the center of the first IPN annulus, epoch J2000, in the heliocentric frame, in degrees, (9) the angular radius of the first IPN annulus, in the heliocentric frame, in degrees, (10) the half-width of the first IPN annulus, in degrees; the 3σ confidence annulus is given by $R_{\mathrm{IPN1}} \pm \delta\ R_{\mathrm{IPN1}}$, (11) the right ascension of the center of the second IPN annulus, epoch J2000, in the heliocentric frame, in degrees, (12) the declination of the center of the second IPN annulus, epoch J2000, in the heliocentric frame, in degrees, (13) the angular radius of the second IPN annulus, in the heliocentric frame, in degrees, and (14) the half-width of the second IPN annulus, in degrees; the 3σ confidence annulus is given by $R_{\mathrm{IPN2}} \pm \delta\ R_{\mathrm{IPN2}}$.

The BATSE data have been taken from the latest online catalog and are given here for convenience only; the catalog[14] should be considered to be the ultimate source of the most up-to-date BATSE data. The data in Table 2 are also available electronically.[15] A footnote indicates if the localization was degenerate, as defined in the previous section, and if the annulus or error box was confirmed by an independent observation (see the discussion section). The references in the latter footnotes are not meant to be exhaustive; in most cases, there are numerous reports of follow-up observations. Most of the published references may be found on the IPN Web site.[16]

14 Available at http://gammaray.msfc.nasa.gov/batse/.

15 At http://ssl.berkeley.edu/ipn3/index.html.

16 At http://ssl.berkeley.edu/ipn3/bibliogr.html.

Table 3 gives the centers and corners of the error boxes for the three-spacecraft localizations. The four columns contain the following: (1) the date of the burst, (2) the BATSE trigger number, (3) the right ascension of the center of the error box, on the first row, and the right ascensions of the four corners on the following four rows, and (4) the declination of the center of the error box, on the first row, and the declinations of the four corners on the following four rows.

All coordinates are J2000.

5. DISCUSSION AND CONCLUSION

The years covered in this supplement were witness to a number of dramatic events which changed the course of GRB studies. Two missions became operational which had the capability of independently determining small (several arcminute) error boxes rapidly, namely the *Rossi X-Ray Timing Explorer* (*RXTE*), launched on 1995 December 30, and *BeppoSAX*, launched on 1996 April 30. The first GRB counterpart identifications were made starting in 1997, based on *BeppoSAX* positions, and later identifications came not only from *BeppoSAX*, but also from *RXTE* and the IPN. Apart from the fact that these identifications were a breakthrough in understanding the origin of GRBs, they were also important because they provided the first localizations which were as accurate as or more accurate than the IPN ones. Thus they serve as a confirmation of the IPN accuracy. As noted in Table 2, a total of 22 bursts were either localized independently, confirming the IPN annulus or error box. Still another event, the giant flare of 1998 August 27 from SGR1900+14, and the discovery of its transient radio emission (Hurley et al. 1999c; Frail et al. 1999) provided a confirmation of the IPN accuracy during this period.

Although this represents the last installment of the IPN supplements to the BATSE burst catalogs, work is continuing on the localization of IPN bursts and on the preparation of catalogs of these events. Data on these events may be found at the IPN Web site.[17]

Support for the *Ulysses* GRB experiment was provided by JPL Contract 958056. Joint analysis of *Ulysses* and BATSE data was supported by NASA Grants NAG 5-1560 and NAG5-9701. *NEAR* data analysis was supported under NASA Grants NAG 5-3500 and NAG 5-9503. We are also grateful to the *NEAR* team for their modifications to the XGRS experiment which made gamma-ray burst detection possible.

REFERENCES

Antonelli, L., Butler, R., Piro, L., et al. 1997, IAU Circ., 6792
Briggs, M., Pendleton, G., Kippen, R. M., et al. 1999, ApJS, 122, 503
Celidonio, G., Coletta, A., Feroci, M., et al. 1998, IAU Circ., 6851
Dadina, M., di Ciolo, L., Coletta, A., et al. 1999, IAU Circ., 7160
Frail, D., Kulkarni, S., & Bloom, J. 1999, Nature, 398, 127
Galama, T., Groot, P. J., Strom, R. G., et al. 1997, ApJ, 486, L5
Galama, T., van Paradijs, J., Antonelli, L. A., et al. 1998, GCN Circ., 127
Goldsten, J., McNutt, R. L., Jr., Gold, R. E., et al. 1997, Space Sci. Rev., 82, 169
Heise, J., Delibero, C., Daniele, M. R., et al. 1999, IAU Circ., 7099
Hurley, K., Atteia, J.-L., Barraud, C., et al. 2011, ApJS, submitted (arXiv:0907.2709)
Hurley, K., Briggs, M. S., Kippen, R. M., et al. 1999a, ApJS, 120, 399
Hurley, K., Briggs, M. S., Kippen, R. M., et al. 1999b, ApJS, 122, 497
Hurley, K., Cline, T., Mazets, E., et al. 1999c, Nature, 397, 41
Hurley, K., Guidorzi, C., Frontera, F., et al. 2010, ApJS, 191, 179
Hurley, K., Laros, J., Brandt, S., et al. 2000a, ApJS, 533, 884

17 http://ssl.berkeley.edu/ipn3/interpla.html

Hurley, K., Lund, N., Brandt, S., et al. 2000b, ApJS, 128, 549
Hurley, K., Sommer, M., Atteia, J.-L., et al. 1992, A&AS, 92, 401
Hurley, K., Stern, B., Kommers, J., et al. 2005, ApJS, 156, 217
in't Zand, J., Heise, J., Piro, L., et al. 1998a, IAU Circ., 6854
in't Zand, J., Kuiper, L., Amati, L., et al. 2000, ApJ, 545, 266
in't Zand, J., Muller, J. M., Piro, L., et al. 1998b, IAU Circ., 6805
Kommers, J., Lewin, W., Kouveliotou, C., et al. 2000, ApJ, 533, 696
Laros, J., Boynton, W. V., Hurley, K. C., et al. 1997, ApJS, 110, 157
Laros, J., Hurley, K. C., Fenimore, E. E., et al. 1998, ApJS, 118, 391
Marshall, F., Takeshima, T., Barthelmy, S., Robinson, C., & Hurley, K. 1997, IAU Circ., 6683
McClanahan, T., Trombka, J. I., Floyd, S. R., et al. 1999, Nucl. Instrum. Methods Phys. Res. A, 422, 582
Meegan, C., Pendleton, G. N., Briggs, M. S., et al. 1996, ApJS, 106, 45
Murakami, T., Fujimoto, R., Ueda, Y., & Shibata, R. 1997a, IAU Circ., 6687
Murakami, T., Ueda, Y., Yoshida, A., et al. 1997b, IAU Circ., 6732
Nicastro, L., Antonelli, L. A., Celidonio, G., et al. 1998, IAU Circ., 6912
Paciesas, W., Meegan, C. A., Pendleton, G. N., et al. 1999, ApJS, 122, 465
Piro, L., Capalbi, M., Ricci, R., et al. 1999a, GCN Circ., 409
Piro, L., Costa, E., Feroci, M., et al. 1997a, IAU Circ., 6656
Piro, L., Garmire, G., Garcia, M., et al. 1999b, GCN Circ., 500
Piro, L., Soffitta, P., Butler, R. C., et al. 1997b, IAU Circ., 6797
Piro, L., et al. 1999c, GCN Circ., 393
Smith, D., Levine, A. M., Bradt, H. V., et al. 1999a, ApJ, 526, 683
Smith, D., Levine, A. M., Hurley, K., & Barthelmy, S. 2000, GCN Circ., 665
Smith, D., Tilanus, R. P. J., & Baas, F. 1999b, GCN Circ., 2275
Smith, M., in't Zand, J., Tarei, G., Dadina, M., & Piro, L. 1999c, IAU Circ., 7301 (Erratum 7303)
Stern, B., Tikhomirova, Ya., Stepanov, M., et al. 2000, ApJ, 540, L21
Takeshima, T., Markwardt, C., Marshall, F., Giblin, T., & Kippen, R. 1999, GCN Circ., 478
Takeshima, T., & Marshall, F. 1999, GCN/RXTE PCA Burst Position Notice, 07 May
Trombka, J., Boynton, W. V., Brückner, J., et al. 1999, Nucl. Instrum. Methods Phys. Res. A, 422, 572