The Interplanetary Network Supplement to the HETE-2 Gamma-Ray Burst Catalog

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ABSTRACT

Between 2000 November and 2006 May, one or more spacecraft of the interplanetary network (IPN) detected 226 cosmic gamma-ray bursts that were also detected by the FREGATE experiment aboard the HETE-II spacecraft. During this period, the IPN consisted of up to nine spacecraft, and using triangulation, the localizations of 157 bursts were obtained. We present the IPN localization data on these events.

Subject headings: gamma-rays: bursts — techniques: general — catalogs

[5]

1. Introduction

The Wide Field X-Ray Monitor (WXM) and Soft X-Ray Camera (SXC) aboard the High Energy Transient Experiment (HETE-2) mission localized 79 gamma-ray bursts (GRBs) rapidly and precisely between 2001 and 2006 (Vanderspek et al. 2011). About 1400 more GRBs, however, occurred outside their fields of view and were not detected or localized by them. In some cases these events were detected by the HETE-2 French Gamma-Ray Telescope (FREGATE) at angles up to 180 degrees from the detector axis and identified by onboard and/or ground-based software. These detections were used to initiate searches through the data of the spacecraft comprising the interplanetary network (IPN), and in many cases precise, delayed localizations could be obtained by triangulation, and multiwavelength counterpart searches were initiated. Between 2000 November and 2006 May, when these detections occurred, the IPN contained between 4 and 9 spacecraft. They were, in addition to HETE: *Ulysses,* in heliocentric orbit at distances between 670 and 3000 light-seconds from Earth (Hurley et al. 1992); *Konus-Wind* , in various orbits up to around 4 light-seconds from Earth (Aptekar et al. 1995); *BeppoSAX* , in low Earth orbit (Frontera et al. 1997, Hurley et al. 2000b); the *Near-Earth Asteroid Rendezvous* mission (NEAR), in orbit around the asteroid Eros at distances between 775 and 1060 light-seconds from Earth (Trombka et al. 1999); *Mars Odyssey*, launched in 2001 April and in orbit around Mars starting in 2001 October, up to 1250 light-seconds from Earth (Hurley et al. 2006); the *Ramaty High Energy Solar Spectroscopic Imager* (RHESSI) in low Earth orbit (Smith

[5]NOTE TO EDITOR: Please instruct the typesetter to allow ”anchor” tags to compile. They are used in table 5, and the referee may want to follow some of these links

et al. 2002); the *International Gamma-Ray Laboratory* (INTEGRAL), in an eccentric Earth orbit at up to 0.5 light-seconds from Earth (Rau et al. 2005); the *Mercury Surface, Space Environment, Geochemistry, and Ranging* mission (MESSENGER), launched in 2004 August, but commencing full operation only in 2007 (Gold et al. 2001); and *Swift* (Gehrels et al. 2004) and *Suzaku* (Takahashi et al. 2007; Yamaoka et al. 2009), both in low Earth orbit. Their timelines are presented in figure 1. In this paper, we present the localization data obtained by the IPN for these bursts.

At least two other spacecraft recorded GRB detections during this period, although they were not used for triangulation and therefore were not part of the IPN. The *Rossi X-Ray Timing Explorer* (RXTE) All Sky Monitor detected and localized some HETE bursts (Smith et al. 1999). It operated in the low energy X-ray range, where the light curves of gamma-ray bursts differ significantly from the high energy range where the other IPN instruments operate, and it was not utilized for triangulation. The *Defense Meteorological Satellite Program* (DMSP) spacecraft detected, but did not localize bursts (Terrell et al. 1996, 1998; Terrell and Klebesadel 2004).

2. Observations

Whenever a gamma-ray burst or a rapid transient event was detected by the HETE onboard or ground-based software, a search was initiated in the data of the IPN spacecraft. For the spacecraft within a few light-seconds of Earth, the search window was centered on the HETE trigger time, and its duration was somewhat greater than the HETE event duration. For the spacecraft at interplanetary distances, the search window was twice the light-travel time to the spacecraft if the event arrival direction was unknown, which was the case for most events. If the arrival direction was known, even coarsely, the search window was defined by calculating the expected arrival time at the spacecraft, and searching in a

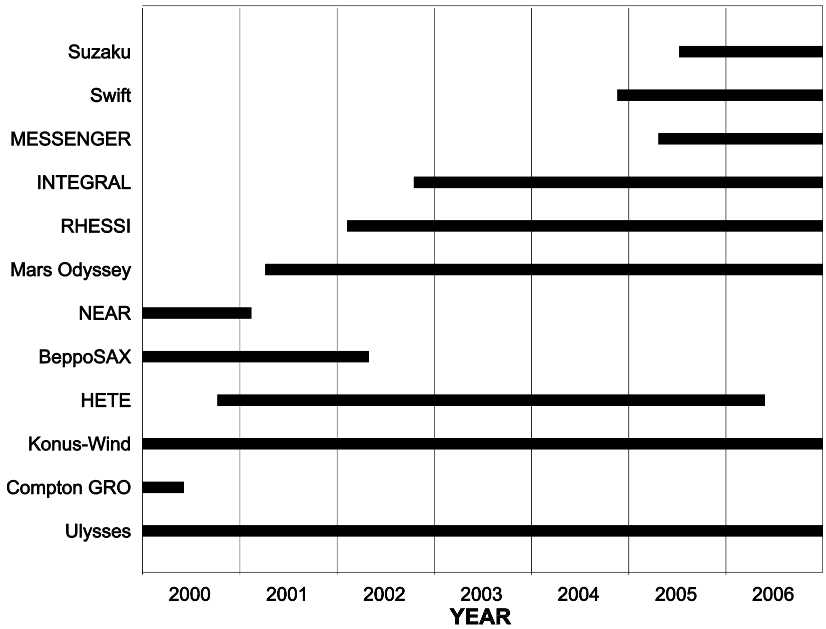

Fig. 1.— The timelines of the missions comprising the interplanetary network between 2000 and 2006. During the period when HETE was operational, there were a minimum 3 and a maximum of 8 other missions in the network. Note that the *Compton Gamma-Ray Observatory* mission ended before HETE was launched.

window around it. In addition to these searches, which were initiated by HETE events, the HETE data were searched whenever an IPN spacecraft detected an event. Of the more than 1400 events detected by up to 7 IPN spacecraft, 226 were detected by HETE; these are listed in table 1. Table 2 shows the number of events observed by each spacecraft in the IPN, and table 3 gives the number of bursts that were detected by a total of N spacecraft, where N is between 2 and 9.

3. Localizations

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

$$cos\theta = \frac{c\delta T}{D} \tag{1}$$

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 dθ, is

$$d\theta = \mathrm{c}\sigma(\delta\mathrm{T})/\mathrm{Dsin}\theta \tag{2}$$

where $\sigma(\delta\mathrm{T})$ is the uncertainty in the time delay. $\sigma(\delta\mathrm{T})$ is generally of the order of 100 ms or more, when both statistical and systematic uncertainties are considered; thus triangulation between two near-Earth spacecraft, for which D is at most $\sim$40 light-ms, does not constrain the burst arrival direction. When D is of the order of several light-seconds (e.g., the distance between *Konus-Wind* and a near-Earth spacecraft), annuli with widths of several degrees can be obtained; when D is several hundred light-seconds (i.e. an interplanetary spacecraft and a near-Earth spacecraft), annulus widths of the order of arcminutes or less are possible. When two interplanetary spacecraft and a near-Earth spacecraft observe a GRB, a small error box can be obtained. Table 4 gives the number of events observed by 0, 1, and 2 interplanetary spacecraft.

In some cases, no localizations can be obtained which constrain the burst arrival direction significantly, even though the spacecraft separations are several light-seconds. This is due to the fact that one or more of the spacecraft recorded the event with low time resolution.

Note that the Swift BAT observes numerous bursts outside its coded field of view (as indicated by the footnote in table 1). The Swift data on these events is nevertheless useful for triangulations.

157 bursts could be localized by the method above; table 5 gives the localization information, and the first column (the date of the GRB) contains a link to a map on the IPN website. Triangulation annuli are given in the 8 IPN columns: these are the right ascension and declination of the annulus center α, δ, the annulus radius R, and the uncertainty in the radius δR. One or two annuli are specified. In addition to triangulation annuli, several other types of localization information are included in this catalog. The 3 SAX columns give the right ascension, declination, and radius of the BeppoSAX gamma-ray burst monitor (GRBM) error circle (Frontera et al. 2009). The 3 HETE columns give the right ascension, declination, and radius of the WXM or SXC error circle, whichever is smaller (Vanderspek et al. 2011). Combining these error circles with the IPN annuli often results in smaller error regions. In one case, GRB040810, the HETE attitude could not be determined precisely, and consequently the IPN annulus does not intersect the error circle. We have omitted the HETE error circle coordinates for this burst. The two Ecliptic columns give the ecliptic latitudes of the bursts, measured northward (positive) from the ecliptic plane towards the north ecliptic pole. These are derived by comparing the count rates of the two *Konus-Wind* detectors (Aptekar et al. 1995), and can be considered to be at the 90–95% confidence level. In some cases, however, systematic uncertainties can result in incorrect estimates. Two cases are noted in table 5 where the estimated ecliptic latitude

and the IPN localization are inconsistent; this is thought to be due to these systematics. Planet-blocking is specified by the right ascension and declination of the planet's center and its radius, in the 3 Planet columns. When a spacecraft in low Earth or Mars orbit observes a burst, the planet blocks up to ≈ 3.7 sr of the sky. This is often useful for deciding which of two annulus intersections is the correct one, or for eliminating portions of a single annulus. Finally, the Other column gives the right ascension, declination, and radius of any other localization region, which is obtained in one of several ways. For example, error circles can be derived from the intersection of an IPN annulus and a HETE WXM one-dimensional localization. Or they may be from the *Swift* spacecraft [1]. Or they may be derived from planet-blocking by a second spacecraft in addition to the data in the Planet column. In this case the error circle given is the complement of the planet-blocking circle, that is, a circle whose RA is the RA of the planet plus 180 degrees, whose declination is the negative of the planet's declination, and whose radius is 180 degrees minus the planet's angular radius. The units of all entries in table 5 are degrees, and all coordinates are J2000. For some events, no triangulation was possible, but coarse constraints on the burst arrival direction can be derived from planet-blocking, ecliptic latitudes, or both. This information is not given here, but information on these events, as well as the ones in this catalog, may be found at the IPN website [2]. Figures 2 and 3 show examples of IPN localizations. Table 6 gives the localization areas in square degrees for the bursts in table 5.

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[1]http://swift.gsfc.nasa.gov/docs/swift/archive/grb_table/

[2]http://ssl.berkeley.edu/ipn3/index.html

4. Conclusions

This is the tenth in a continuing series of IPN catalogs (table 7); the localization data for all of them can be found in electronic form at the IPN website. The IPN is, in effect, a full-time, all-sky monitor, when the duty cycles and viewing constraints of all its instruments are considered. Its threshold for 50% detection efficiency is about $6 \times 10^{-7}\,\mathrm{erg\,cm^{-2}}$ or $1\,\mathrm{photon\,cm^{-2}\,s^{-1}}$. Over the HETE-2 mission, 226 bursts were detected by HETE-FREGATE and at least one other IPN instrument and 157 of them could be localized to some extent by triangulation. The more precise and/or rapid localizations were announced via 55 GCN Circulars, resulting in multiwavelength counterpart searches. Regardless of precision and speed of the localizations, however, burst data such as these are useful for numerous studies, such as searching for indications of activity from previously unknown soft gamma repeaters, associating supernovae with bursts, or searching for neutrino and gravitational radiation associated with bursts.

5. Acknowledgments

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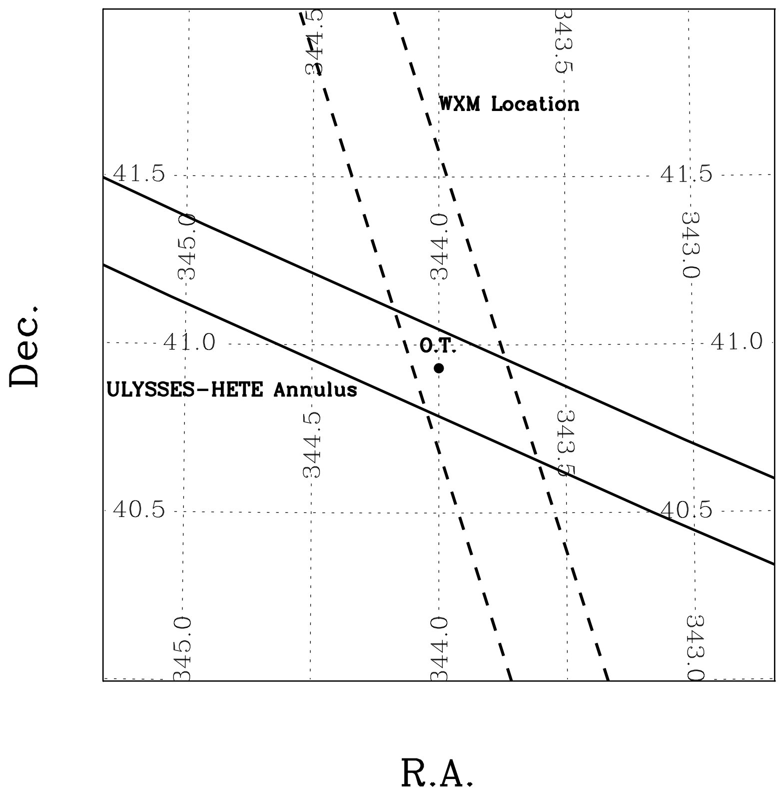

Fig. 2.— Localizations of GRB010921. The dashed lines show the one-dimensional WXM localization; the solid lines show the FREGATE/Ulysses annulus. An optical transient (OT) was identified by Price et al. (2001).

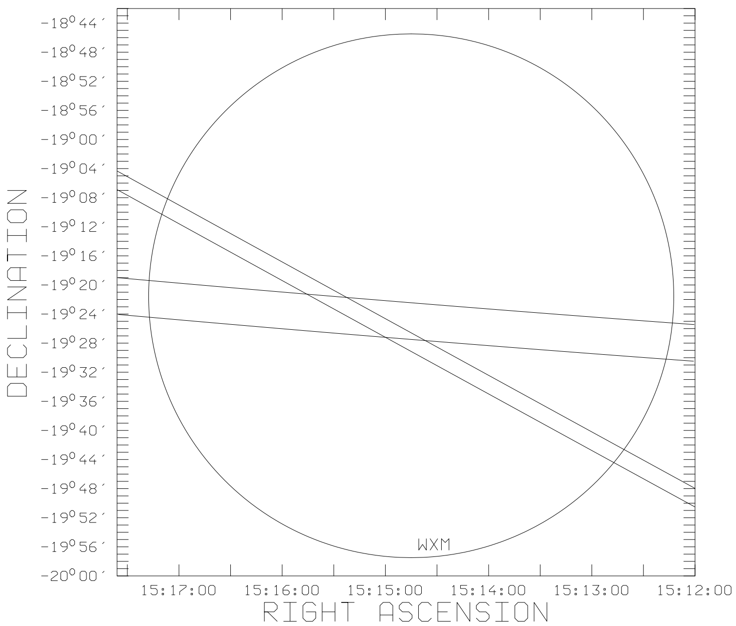

Fig. 3.— Localizations of the short/hard GRB020531. The wider annulus is the Ulysses/Odyssey triangulation; the narrower one is the Ulysses/FREGATE triangulation. The circle is the WXM localization. *Chandra* and optical observations were performed, but no counterpart was found for this burst.

Table 1. IPN/HETE gamma-ray bursts

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2000 Nov 02	15:53:48	UBID 11414	Uly,Kon,NEA
2000 Nov 05	16:25:28	UBID 11415	Uly,Kon,NEA
2000 Nov 06	15:15:15	UBID 11416	Uly,Kon,NEA
2000 Nov 15	12:49:08	UBID 11418	Kon
2000 Nov 15	14:06:41	UBID 11420	Kon,SAX
2000 Dec 25	07:09:20	UBID 10803	Uly,Kon,NEA
2001 Jan 10	19:59:07	UBID 10809	Uly,Kon
2001 Jan 26	09:10:40	H1487	Uly,Kon,NEA,XTE
2001 Feb 04	21:52:49		Kon
2001 Mar 26	03:14:58	H1495	Uly,Kon,SAX
2001 Mar 26	08:33:12	H1496	Kon
2001 Apr 28	10:04:51	UBID 11424	Uly
2001 Jun 07	14:55:23	UBID 10814	Uly,MO,Kon
2001 Jun 09	05:39:28	UBID 10815	Uly
2001 Jun 12	02:33:14	H1546	Uly,Kon,SAX
2001 Jun 13	07:33:55	H1547	Uly,Kon
2001 Jun 19	15:17:01	UBID 10816	Kon,SAX
2001 Jun 28	01:10:03	H1569	Uly,MO,Kon
2001 Jun 29	12:21:07	H1573	Uly,Kon,SAX
2001 Jul 22	04:01:53	UBID 10820	Kon
2001 Jul 26	01:31:22	H1611	Uly,MO,Kon
2001 Aug 01	18:30:33	H1669	Uly,Kon,SAX
2001 Aug 27	10:48:28	H1723	Kon
2001 Aug 28	04:18:25	H1729	Uly,Kon
2001 Sep 03	23:28:08	H1748	Uly,MO,Kon
2001 Sep 21	05:15:52	H1761	Uly,Kon,SAX
2001 Sep 23	09:24:30	H1764	Uly,Kon,SAX
2001 Sep 28	16:53:56	H1770	DMS
2001 Sep 29	00:22:37	H1771	Uly,Kon
2001 Oct 08	19:55:52	H1782	Uly,Kon
2001 Nov 15	20:16:17	H1846	Uly,Kon,SAX
2001 Dec 08	12:33:52	UBID 10826	Uly,Kon

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2001 Dec 12	04:04:02	UBID 10827	XTE
2001 Dec 16	02:55:24	H1870	Uly,Kon,SAX
2002 Jan 13	02:04:11	H1891	Kon,SAX
2002 Jan 14	02:51:03	H1892	Uly
2002 Jan 16	20:47:37	H1893	Uly
2002 Jan 24	10:41:15	H1896	Uly,Kon
2002 Jan 27	20:57:25	H1902	Uly,MO,Kon
2002 Feb 09	07:49:57	UBID 10829	Uly,Kon,SAX
2002 Feb 14	18:49:38	H1923	Uly,MO,Kon,RHE
2002 Feb 21	08:07:36	H1929	Uly,MO,Kon,SAX
2002 Mar 05	11:55:25	H1939	Uly,MO
2002 Mar 13	01:17:51	H1955	Uly,MO,Kon,RHE
2002 Mar 31	16:32:29	H1963	Uly,Kon
2002 Apr 18	17:43:09	UBID 10806	Uly,Kon,RHE
2002 May 08	04:07:01	H2038	Kon
2002 May 31	00:26:18	H2042	Uly,MO
2002 Jun 25	11:25:49	H2081	Kon,RHE
2002 Jul 06	03:30:27	H2094	Uly,MO,Kon
2002 Jul 14	15:49:22	UBID 10831	Uly,MO,Kon
2002 Jul 15	20:03:32	H2123	Uly
2002 Jul 25	16:25:40	UBID 10117	MO,Kon,RHE
2002 Aug 01	12:58:42	H2177	Uly
2002 Aug 01	13:03:27	H2178	Uly
2002 Aug 13	02:44:40	H2262	Uly,MO,Kon
2002 Aug 13	12:21:01	UBID 10205	Uly
2002 Aug 19	14:57:36	H2275	Uly,Kon,RHE
2002 Sep 04	06:53:47	H2315	Uly,MO,Kon
2002 Oct 04	12:06:13	H2380	Kon
2002 Oct 07	20:15:09	UBID 10834	Kon
2002 Oct 14	06:31:46	H2389	Uly,Kon
2002 Oct 16	10:29:01	H2397	Uly,MO,Kon
2002 Oct 20	20:12:54	H2413	Uly,MO,Kon,RHE

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2002 Oct 23	02:53:46	UBID 10835	Uly,MO,Kon,RHE
2002 Oct 25	20:18:30	H2418	Uly,Kon,RHE
2002 Nov 04	09:06:32	H2436	Uly,Kon
2002 Nov 13	06:38:57	H2449	Uly,Kon,INT
2002 Nov 14	08:12:06	H2455	Kon
2002 Dec 01	05:30:04	H2483	Uly,MO,Kon,RHE
2002 Dec 11	11:18:34	H2493	Uly,Kon,RHE
2002 Dec 14	03:27:27	H2496	Uly,Kon
2003 Jan 01	20:43:38	H2523	Uly,Kon,INT
2003 Jan 15	03:22:34	H2533	Kon,INT
2003 Jan 15	06:25:12	UBID 10801	Uly,MO,Kon,RHE,INT
2003 Jan 17	17:36:14	UBID 11683	Kon,INT
2003 Jan 27	12:32:32	UBID 10839	Uly,Kon,RHE,INT
2003 Feb 04	12:45:34	H2568	Uly,MO,Kon,RHE,INT
2003 Feb 13	00:52:10	H2589	Kon
2003 Feb 15	11:13:31	UBID 10890	INT
2003 Feb 15	11:16:22	UBID 10891	Uly,INT
2003 Feb 15	17:11:52	H2595	Uly
2003 Feb 17	02:45:42	UBID 10892	Uly,MO,RHE,INT
2003 Feb 20	16:12:44	H2601	Uly,INT
2003 Feb 26	03:46:31	UBID 10893	Kon,INT
2003 Mar 01	20:27:20	H2610	Uly,MO,Kon,RHE
2003 Mar 04	13:47:10	UBID 11646	Kon
2003 Mar 07	14:31:58	H2617	Uly,Kon,RHE,INT
2003 Mar 17	06:58:55	UBID 10894	Uly,Kon
2003 Mar 20	18:49:18	UBID 10895	Uly,Kon,RHE
2003 Mar 24	03:12:43	H2641	Kon
2003 Mar 25	22:01:14	H2642	Kon
2003 Mar 28	11:20:58	H2650	Uly,Kon,INT
2003 Mar 29	11:37:15	H2652	Uly,MO,Kon,RHE,INT
2003 Apr 03	03:37:46	UBID 10896	Uly,Kon,INT
2003 Apr 04	23:26:52	H2661	Kon

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2003 Apr 05	02:17:29	H2662	Uly,MO,Kon,INT
2003 Apr 13	07:34:44	H2678	Uly,MO,Kon,RHE,INT
2003 May 01	20:44:48	H2699	Kon
2003 May 18	01:23:45	H2714	Uly,Kon,RHE,INT
2003 May 19	09:32:22	UBID 10001	Kon,RHE,INT
2003 May 19	14:04:53	H2716	Uly,MO,Kon,RHE
2003 May 28	13:03:03	H2724	Uly,MO,RHE
2003 Jun 18	05:25:54	UBID 11684	INT
2003 Jul 03	19:13:54	H2754	Uly,Kon,RHE
2003 Jul 21	23:41:12	UBID 11409	Uly,MO,Kon,RHE,INT
2003 Jul 25	11:46:27	H2779	Uly,MO,Kon,RHE,INT
2003 Jul 26	06:38:25	H2780	Uly,MO,Kon,RHE,INT
2003 Aug 03	15:44:55	H2788	Kon,INT
2003 Aug 14	03:06:13	H2804	Uly,MO,Kon,INT
2003 Aug 21	05:31:35	H2814	Uly,MO,Kon,INT
2003 Aug 22	18:40:28	UBID 11451	Uly,Kon,INT
2003 Aug 24	16:47:35	H2821	Kon
2003 Sep 13	17:06:57	H2849	Kon
2003 Sep 26	16:52:48	UBID 11454	MO,Kon,RHE,INT
2003 Oct 26	05:35:43	H2882	Uly,Kon
2003 Oct 27	17:07:09	H2884	Uly,MO,Kon,RHE
2003 Nov 09	11:10:19	H2917	Uly,MO,INT
2003 Nov 11	16:45:13	H2924	Uly,Kon,RHE,INT
2003 Nov 20	05:51:58	UBID 11464	Kon,RHE
2003 Nov 30	02:04:51	UBID 11547	MO,Kon,RHE
2003 Dec 03	05:58:56	H2949	Kon
2003 Dec 18	06:28:08	UBID 11468	Kon
2003 Dec 20	03:29:56	H2976	INT
2004 Feb 09	03:36:50	UBID 11473	MO,Kon,INT
2004 Feb 20	00:55:11	UBID 11084	MO,Kon,RHE,INT
2004 Feb 25	09:52:21	H3059	MO
2004 Feb 28	00:08:56	H3066	MO,Kon,RHE

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2004 Feb 28	00:12:44	H3067	MO,Kon,RHE
2004 Mar 19	07:46:01	H3128	Kon
2004 Apr 03	16:55:03	H3143	Kon
2004 Apr 03	23:23:56	H3144	MO,Kon
2004 Apr 08	15:41:27	UBID 11482	Kon,RHE
2004 Apr 09	13:39:08	H3153	Kon
2004 Apr 10	12:19:47	H3154	Kon
2004 Apr 14	11:08:20	H3166	Kon,RHE,INT
2004 Apr 23	09:54:35	H3175	RHE,INT
2004 Apr 24	06:54:59	H3180	INT
2004 Apr 25	16:23:33	H3183	MO,Kon,RHE,INT
2004 Apr 29	10:52:55		MO,Kon,RHE,INT
2004 May 11	13:01:46	H3218	Kon,RHE,INT
2004 May 12	19:23:31	H3225	MO,Kon
2004 Jun 03	15:40:58	H3309	Kon,RHE,INT
2004 Jul 09	00:58:07	UBID 11549	Kon,RHE,INT
2004 Jul 12	18:32:26	H3423	RHE,INT
2004 Aug 02	18:02:21	H3485	MO,Kon,INT
2004 Aug 10	14:15:36	H3489	MO,Kon,RHE
2004 Aug 29	21:20:48	H3517	Kon,INT
2004 Sep 12	04:24:44	H3556	Kon
2004 Sep 21	00:23:00	H3562	Kon
2004 Sep 24	11:52:11	H3564	MO,Kon
2004 Oct 04	02:17:03	H3568	Kon
2004 Oct 06	12:18:09	H3570	Kon,RHE
2004 Oct 09	06:38:18	H3571	MO,Kon,RHE
2004 Oct 16	04:39:38	H3578	Kon,RHE,INT
2004 Oct 25	22:47:56	UBID 11556	MO,Kon,INT
2004 Oct 27	18:18:38	H3584	Kon,INT
2004 Nov 07	15:49:31	UBID 11685	Kon,RHE,INT
2004 Nov 19	14:43:46	H3608	Kon,INT
2004 Nov 21	18:25:28	H3610	Kon,INT

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2004 Nov 27	10:11:27	UBID 11559	Kon
2004 Nov 29	23:43:13	H3617	Kon
2004 Dec 11	07:49:50	H3621	MO,Kon,RHE
2004 Dec 11	11:31:47	H3622	Kon,RHE,INT
2004 Dec 11	23:57:44	UBID 11560	MO,Kon,RHE,INT,Swi[d]
2004 Dec 23	14:06:37	UBID 11562	MO,Kon,RHE,Swi[e]
2004 Dec 24	20:20:57	UBID 11563	Kon,RHE,Swi[e]
2004 Dec 26	20:34:19	UBID 11650	Swi[e]
2004 Dec 29	10:38:51	H3639	RHE
2005 Jan 02	04:43:56	UBID 11687	Kon
2005 Jan 11	06:52:31	UBID 11565	Kon,INT
2005 Jan 28	04:19:54	UBID 11574	MO,Kon,Swi
2005 Feb 09	01:31:41	UBID 11568	Kon
2005 Feb 13	19:34:42	UBID 11569	INT
2005 Feb 15	02:15:28		Kon,Swi[e]
2005 Feb 15	02:33:12	UBID 11570	Swi
2005 Mar 06	03:33:12	UBID 11575	Kon,Swi[e]
2005 Apr 01	14:20:15	H3706	MO,Kon,INT,Swi[e]
2005 Apr 03	16:16:11	UBID 11577	Kon,RHE
2005 Apr 08	16:22:50	H3711	Kon,RHE,INT
2005 Apr 16	22:35:54	UBID 11581	Kon,RHE,Swi[e]
2005 May 09	09:31:19	H3748	Kon,RHE,MES
2005 May 30	04:44:42	UBID 11686	MO,Kon,RHE
2005 May 31	04:27:25	UBID 11583	Kon,RHE
2005 Jun 02	22:01:43	H3786	RHE
2005 Jun 26	23:37:32	H3849	MO,Kon
2005 Jul 09	22:36:36	H3862	RHE
2005 Jul 29	01:09:39	H3882	RHE
2005 Jul 30	11:10:42	UBID 11643	Kon
2005 Aug 03	19:14:00	UBID 11644	Swi[e]
2005 Aug 07	10:58:44	H3889	Suz
2005 Aug 08	11:02:12	H3891	MO,Kon,INT

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2005 Aug 13	21:13:44	H3894	RHE,INT
2005 Aug 19	16:23:55	UBID 11652	Swi[e]
2005 Aug 24	11:57:42	H3898	Kon,RHE,Suz
2005 Aug 24	23:12:16	UBID 11648	Swi[e]
2005 Aug 27	19:53:30	H3901	Kon
2005 Aug 28	15:47:01	UBID 11649	Kon,Suz
2005 Sep 10	17:29:59	H3926	Suz
2005 Sep 11	15:59:34		Swi[e]
2005 Sep 15	21:23:04	UBID 11689	Swi[e] ,Suz
2005 Sep 22	19:55:50	UBID 11658	MO,Kon,INT,Swi[e]
2005 Oct 21	13:21:56	H3947	Kon
2005 Oct 22	13:07:58	H3950	MO,Kon,INT
2005 Oct 28	13:36:01	H3951	Kon,INT
2005 Oct 31	22:01:02	UBID 11660	Kon,RHE,INT,Suz
2005 Nov 03	09:25:41	UBID 11661	MO,Kon,RHE,INT,Swi[d] ,Suz
2005 Nov 11	07:47:48	UBID 11664	MO,Kon,RHE,Swi[d]
2005 Nov 17	12:33:30	UBID 11665	Kon,RHE,Swi[d] ,Suz
2005 Nov 24	08:16:52	H3970	Kon,RHE
2005 Nov 27	22:55:20	H3971	MO,Kon,Suz
2005 Dec 01	22:49:11	UBID 11666	Suz
2005 Dec 07	19:04:09	H3975	MO,Kon,RHE,Swi[d] ,Suz
2005 Dec 27	18:07:16	UBID 11668	Swi[e]
2006 Jan 05	06:49:28	H3995	MO,Kon,INT,Swi[e] ,Suz
2006 Jan 11	08:48:59	H3999	Kon,RHE,INT,Swi[d]
2006 Jan 15	04:03:04	H4000	Kon,INT,Swi[d]
2006 Jan 21	22:24:54	H4010	Kon,RHE,Swi[d] ,Suz
2006 Jan 24	15:54:41	H4012	Kon,RHE,Swi[e] ,Suz
2006 Jan 26	09:30:05	H4013	RHE,INT
2006 Feb 06	01:02:12	H4021	MO,Kon,Swi[d]
2006 Feb 13	00:44:14	UBID 11670	RHE
2006 Mar 25	12:02:17	H4041	Kon,RHE
2006 Apr 28	08:54:38	UBID 11674	Swi[e]

Table 1—Continued

Date	Universal Time [a]	HETE Identifier [b]	Observed by [c]
2006 May 10	07:43:27	H4064	MO,Kon,INT,Swi[e]
2006 May 26	16:28:29	H4073	Kon,Swi[e]

[a]Universal time is the Earth-crossing time of the start of the event

[b]H indicates a triggered burst; UBID stands for untriggered burst identifier

[c]Kon: *Konus-Wind*; DMS: *Defense Meteorological Satellite Program*; INT: *International Gamma-Ray Laboratory*; MO: *Mars Odyssey*; MES: *Mercury Surface, Space Environment, Geochemistry, and Ranging* mission; NEA: *Near Earth Asteroid Rendezvous* mission; RHE: *Ramaty High Energy Solar Spectroscopic Imager*; SAX: *BeppoSAX*; Suz: *Suzaku*; Swi: *Swift*; Uly: *Ulysses*; XTE: *Rossi X-Ray Timing Explorer*

[d]Burst was outside the coded field of view of the BAT

[e]Burst was localized by Swift

Table 2. Number of HETE bursts observed by each spacecraft

Ulysses	Odyssey	Konus	SAX	HETE	NEAR	XTE	RHESSI	INTEGRAL	Swift	MESSENGER	Suzaku
87	68	181	13	226	5	2	79	69	30	1	14

Table 3. Number of HETE bursts observed by N spacecraft

N=1	2	3	4	5	6	7	8	9
0	66	51	66	32	10	1	0	0

Table 4. Number of bursts observed by N interplanetary spacecraft

N=0	1	2
104	83	39

Table 5. IPN localization data

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
02 Nov 2000	15:53:48	...	...	...	...	...	...	354.406	60.286	35.980	.051	326.877	38.620	8.366	.241	44.2	64.2	...	...	...	...	...	...
05 Nov 2000	16:25:28	...	...	...	...	...	...	356.196	61.623	81.624	.007	147.416	-39.240	86.898	.014	29.0	51.0	75.6	1.9	65.3	...	...	...
06 Nov 2000	15:15:15	...	...	...	...	...	...	176.784	-62.049	80.598	.005	147.588	-39.438	86.300	.024	-34.5	-54.5	...	...	...	...	...	...
15 Nov 2000	12:49:08	...	...	...	...	...	...	35.705	10.260	59.205	59.205	...	...	...	...	20.3	40.3	228.6	-1.1	65.4	...	...	...
15 Nov 2000	14:06:41	34.0	-7.0	21.0	...	...	...	35.476	10.449	57.783	9.966	...	...	...	...	-49.2	-29.2	...	...	...	...	...	...
25 Dec 2000	07:09:20	...	...	...	...	...	...	87.871	79.410	87.891	.070	160.019	-51.921	57.619	.073	-37.6	-17.6	...	...	...	...	...	...
10 Jan 2001	19:59:07	...	...	...	...	...	...	132.592	73.611	60.761	.247	...	...	...	...	-16.0	0.0	...	...	...	...	...	...
26 Jan 2001	09:10:40	...	...	...	...	...	...	151.507	64.894	20.901	.221	358.044	62.712	67.295	.077	35.0	90.0	...	...	...	...	...	...
26 Mar 2001	03:14:56	...	...	...	...	...	...	179.284	30.842	81.704	.010	179.013	30.912	81.620	.007	-64.6	-44.6	...	...	...	...	...	...
28 Apr 2001	10:04:51	...	...	...	...	...	...	187.246	12.083	43.251	1.276	...	...	...	...	...	...	...	...	...	...	...	...
07 Jun 2001	14:55:23	...	...	...	...	...	...	194.822	-16.204	60.413	.149	197.174	-18.391	59.767	.141	57.3	77.3	...	...	...	...	...	...
09 Jun 2001	05:39:28	...	...	...	...	...	...	15.236	17.634	73.526	1.019	...	...	...	...	...	...	156.0	-2.0	66.0	...	...	...
12 Jun 2001	02:33:13	...	...	...	270.823	-32.134	1.200	195.706	-20.176	67.085	.037	...	...	...	...	-20.9	-.9	...	...	...	...	...	...
13 Jun 2001	07:33:55	...	...	...	255.167	14.268	1.200	195.719	-21.183	68.368	.141	...	...	...	...	37.0	57.0	...	...	...	...	...	...
19 Jun 2001	15:17:01	...	...	...	...	...	...	333.322	-13.980	54.064	1.092	...	...	...	...	2.3	22.3	84.7	-1.3	66.2	267.600	-25.100	60.000
28 Jun 2001	01:10:03	...	...	...	...	...	...	17.860	35.509	22.480	.027	22.804	36.511	23.871	.023	-3.2	16.8	...	...	...	...	...	...
29 Jun 2001	12:21:06	...	...	...	248.158	-18.723	.250	198.213	-37.276	47.033	.094	...	...	...	...	-9.8	10.2	...	...	...	...	...	...
26 Jul 2001	01:31:22	...	...	...	...	...	...	18.498	66.329	61.224	.058	35.816	61.893	56.371	.051	-14.7	5.3	...	...	...	...	...	...
01 Aug 2001	18:30:33	...	...	...	...	...	...	195.532	-73.857	87.355	.013	195.901	-73.436	86.920	.010	17.8	37.8	318.0	-1.0	67.0	...	...	...
27 Aug 2001	10:48:28	...	...	...	...	...	...	230.635	-15.579	62.677	19.515	...	...	...	...	-56.1	-90.0	182.5	-.4	65.9	...	...	...
28 Aug 2001	04:18:25	...	...	...	...	...	...	62.334	-81.305	33.161	.100	...	...	...	...	-54.5	-34.5	...	...	...	...	...	...
03 Sep 2001	23:28:08	...	...	...	...	...	...	54.776	-76.877	27.359	.535	311.404	-80.550	38.241	.289	-75.0	-45.0	...	...	...	...	...	...
21 Sep 2001	05:15:50	...	...	...	343.923	40.951	2.150	232.347	67.603	59.998	.151	...	...	...	...	...	...	...	...	...	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
23 Sep 2001	09:24:29	320.0	24.0	25.0	...	...	...	232.819	66.685	65.321	.024	232.521	66.660	65.430	.012	30.0	90.0	...	...	...	...	...	...
29 Sep 2001	00:22:37	231.3	-1.4	85.0	...	...	...	233.198	64.420	69.826	.008	...	...	...	...	25.0	35.0	...	...	...	...	...	...
08 Oct 2001	19:55:52	...	...	...	...	...	...	235.090	61.141	45.635	.016	...	...	...	...	53.1	73.1	...	...	...	304.600	38.800	4.500
15 Nov 2001	20:16:17	...	...	...	...	...	...	244.359	55.057	59.481	.007	244.316	55.082	59.445	.007	45.0	72.0	...	...	...	...	...	...
08 Dec 2001	12:33:52	...	...	...	...	...	...	70.813	-55.727	70.171	.181	...	...	...	...	-12.3	7.7	...	...	...	...	...	...
16 Dec 2001	02:55:23	...	...	...	...	...	...	253.050	56.662	66.185	.121	4.524	-2.966	65.798	3.633	13.0	53.0	284.9	.7	66.0	...	...	...
13 Jan 2002	02:04:11	84.0	52.0	41.0	...	...	...	29.920	8.403	87.953	1.104	...	...	...	...	20.3	40.3	...	...	...	...	...	...
14 Jan 2002	02:51:03	...	...	...	...	...	...	80.133	-62.867	42.170	.019	...	...	...	...	...	...	351.6	-1.7	65.6	...	...	...
16 Jan 2002	20:47:37	...	...	...	...	...	...	260.723	63.680	58.944	.187	...	...	...	...	...	...	337.0	-1.6	65.8	...	...	...
24 Jan 2002	10:41:15	...	...	...	143.204	-11.460	.200	82.121	-66.103	67.978	.126	...	...	...	...	-30.4	-10.4	...	...	...	...	...	...
27 Jan 2002	20:57:25	...	...	...	123.774	36.742	.133	263.182	67.504	71.315	.033	212.437	46.648	63.394	.042	...	...	...	...	...	...	...	...
09 Feb 2002	07:49:57	205.0	-51.0	42.0	...	...	...	84.040	-72.126	29.284	.091	228.401	-15.435	74.240	1.400	-80.0	-50.0	...	...	...	...	...	...
14 Feb 2002	18:49:38	...	...	...	...	...	...	263.637	74.269	48.487	.007	214.994	45.635	13.855	.022	...	...	...	...	...	203.000	35.000	1.000
21 Feb 2002	08:07:43	...	...	...	...	...	...	261.985	76.891	64.953	.024	35.840	-45.406	82.517	.022	4.6	24.6	...	...	...	48.700	36.300	1.000
05 Mar 2002	11:55:25	...	...	...	190.762	-14.552	.417	71.959	-81.411	79.798	.172	...	...	...	...	...	...	...	...	...	...	...	...
13 Mar 2002	01:17:51	...	...	...	...	...	...	38.126	-45.154	50.867	.106	54.712	-83.968	51.854	.039	-37.0	-77.0	320.3	-.9	66.4	...	...	...
31 Mar 2002	16:32:29	...	...	...	199.095	-17.923	.130	342.727	-83.005	77.904	.277	...	...	...	...	-22.7	-2.7	...	...	...	...	...	...
18 Apr 2002	17:43:09	...	...	...	...	...	...	144.775	76.594	59.737	.010	144.492	76.481	59.649	.012	-2.4	17.6	66.5	-.4	66.0	...	...	...
08 May 2002	04:07:01	...	...	...	...	...	...	140.911	19.030	50.632	33.026	...	...	...	...	-40.0	-90.0	67.2	1.5	65.9	...	...	...
31 May 2002	00:26:18	...	...	...	228.688	-19.358	.600	326.337	-61.748	76.468	.019	221.813	50.447	70.124	.042	...	...	...	...	...	...	...	...
25 Jun 2002	11:25:49	...	...	...	311.058	7.170	.310	353.989	-7.348	43.530	43.530	...	...	...	...	10.0	35.0	39.2	22.4	67.0	...	...	...
06 Jul 2002	03:30:27	...	...	...	...	...	...	334.339	-52.007	61.058	.083	38.350	-55.778	68.454	.151	-36.0	-20.0	344.4	30.6	64.3	...	...	...
14 Jul 2002	15:49:22	...	...	...	...	...	...	156.402	50.016	33.895	.047	216.714	57.187	27.376	.198	60.0	90.0	...	...	...	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
15 Jul 2002	20:03:32	...	...	...	...	...	...	336.751	-49.716	49.483	.171	...	...	...	...	...	...	36.1	-1.7	66.0	...	...	...
25 Jul 2002	16:25:40	...	...	...	...	...	...	310.413	-19.442	34.991	.036	...	...	...	...	30.0	60.0	...	...	...	...	...	...
01 Aug 2002	12:58:42	...	...	...	315.560	-53.770	.460	340.771	-46.253	18.647	1.001	...	...	...	...	...	...	...	...	...	...	...	...
13 Aug 2002	02:44:40	...	...	...	296.658	-19.588	.017	343.511	-44.137	45.890	.013	27.514	-61.948	73.158	.014	-3.6	16.4	...	...	...	...	...	...
13 Aug 2002	12:21:01	...	...	...	...	...	...	163.618	44.051	25.618	.114	...	...	...	...	...	...	87.0	1.1	65.8	...	...	...
19 Aug 2002	14:57:36	...	...	...	351.855	6.279	.018	345.048	-43.011	49.664	.022	...	...	...	...	-1.0	19.0	...	...	...	...	...	...
04 Sep 2002	06:53:47	...	...	...	...	...	...	348.596	-40.644	30.722	.023	16.387	-64.641	4.088	.777	-45.8	-65.8	...	...	...	...	...	...
14 Oct 2002	06:31:46	...	...	...	...	...	...	176.706	36.392	79.270	.074	...	...	...	...	3.4	23.4	198.2	-7.5	60.0	...	...	...
16 Oct 2002	10:29:01	...	...	...	...	...	...	357.102	-36.221	83.633	.050	...	...	...	...	...	...	...	...	...	8.433	46.789	.350
20 Oct 2002	20:12:54	...	...	...	...	...	...	177.814	35.981	86.775	.006	167.275	64.505	61.969	.014	42.6	62.6	...	...	...	322.000	51.900	1.000
23 Oct 2002	02:53:46	...	...	...	...	...	...	346.018	-64.280	89.298	.075	178.184	35.855	81.932	.025	-41.4	-21.4	250.2	5.1	63.6	...	...	...
25 Oct 2002[a]	20:18:30	...	...	...	...	...	...	178.617	35.716	73.532	.038	178.651	35.687	73.528	.047	-40.0	-90.0	114.1	-.3	66.6	...	...	...
04 Nov 2002	09:06:32	...	...	...	...	...	...	.031	-35.348	84.340	.075	...	...	...	...	20.3	90.0	260.8	-.9	66.5	...	...	...
13 Nov 2002	06:38:57	...	...	...	23.473	40.462	.455	1.143	-35.171	78.389	.031	...	...	...	...	20.0	80.0	...	...	...	...	...	...
01 Dec 2002	05:30:04	...	...	...	...	...	...	182.643	35.415	54.438	.008	150.318	58.576	42.548	.011	-9.8	10.2	...	...	...	...	...	...
11 Dec 2002	11:18:34	...	...	...	122.250	6.739	.067	182.993	35.844	62.483	.009	...	...	...	...	-20.9	-.9	...	...	...	...	...	...
14 Dec 2002	03:27:27	...	...	...	...	...	...	182.931	36.057	27.754	.117	...	...	...	...	39.7	90.0	...	...	...	...	...	...
01 Jan 2003	20:43:38	...	...	...	...	...	...	2.000	-37.525	58.137	.010	2.133	-37.462	58.022	.015	-15.0	0.	...	...	...	...	...	...
15 Jan 2003	06:25:12	...	...	...	...	...	...	323.570	-50.600	29.644	.032	.172	-38.846	43.468	.030	-67.5	-47.5	...	...	...	...	...	...
17 Jan 2003	17:36:14	...	...	...	...	...	...	97.614	30.602	36.412	2.850	94.151	26.344	36.539	5.476	10.3	30.3	...	...	...	...	...	...
27 Jan 2003	12:32:32	...	...	...	...	...	...	357.600	-40.079	66.202	.013	357.724	-40.063	66.295	.011	-1.0	19.0	...	...	...	...	...	...
04 Feb 2003	12:45:34	...	...	...	...	...	...	355.483	-40.811	73.705	.019	322.901	-47.182	86.882	.029	22.0	32.0	327.8	-35.6	66.0	...	...	...
15 Feb 2003	11:13:31	...	...	...	...	...	...	258.987	27.994	50.267	26.746	...	...	...	...	...	...	49.5	1.1	66.0	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
15 Feb 2003	11:16:22	...	...	...	...	...	...	172.187	41.653	63.190	.015	...	...	...	...	...	...	60.4	1.3	66.0	...	...	...
15 Feb 2003	17:11:52	...	...	...	...	...	...	172.120	41.673	35.066	.212	...	...	...	...	...	...	...	...	...	...	...	...
17 Feb 2003	02:45:42	...	...	...	...	...	...	142.957	45.167	69.286	.020	171.655	41.754	55.347	.037	...	...	273.3	-1.9	66.0	...	...	...
20 Feb 2003	16:12:44	...	...	...	...	...	...	170.433	41.932	52.457	.014	...	...	...	...	...	...	...	...	...	...	...	...
01 Mar 2003	20:27:20	...	...	...	...	...	...	167.255	42.211	76.320	.062	143.307	43.207	68.522	.187	-44.8	-24.8	49.5	1.3	66.0	...	...	...
07 Mar 2003	14:31:58	...	...	...	...	...	...	345.252	-42.228	70.351	.006	345.309	-42.140	70.421	.005	-9.8	10.2	...	...	...	...	...	...
17 Mar 2003	06:58:55	...	...	...	...	...	...	342.117	-41.894	42.675	.013	...	...	...	...	-90.0	-70.0	...	...	...	...	...	...
20 Mar 2003	18:49:18	...	...	...	...	...	...	161.033	41.729	85.855	.087	198.336	-8.918	67.438	1.929	35.	75.	146.0	7.0	66.0	...	...	...
25 Mar 2003	22:01:14	...	...	...	...	...	...	202.512	-11.410	41.600	41.600	...	...	...	...	4.6	24.6	308.9	-1.1	66.1	...	...	...
28 Mar 2003	11:20:58	...	...	...	182.712	-9.351	.013	158.685	41.319	55.342	.073	...	...	...	...	...	...	...	...	...	...	...	...
29 Mar 2003	11:37:15	...	...	...	161.208	21.515	.005	158.548	41.153	19.766	.011	144.844	39.234	22.574	.010	1.1	21.1	...	...	...	...	...	...
03 Apr 2003	03:37:46	...	...	...	...	...	...	157.362	40.758	21.166	.089	210.713	-10.123	48.723	7.742	-1.0	19.0	...	...	...	...	...	...
05 Apr 2003	02:17:29	...	...	...	...	...	...	325.339	-38.334	65.541	.005	336.901	-40.575	73.574	.009	-3.5	16.5	328.0	5.0	64.0	...	...	...
13 Apr 2003	07:34:44	...	...	...	...	...	...	155.176	39.729	34.374	.012	146.009	37.243	40.496	.034	30.0	65.0	...	...	...	...	...	...
01 May 2003	20:44:48	...	...	...	...	...	...	224.439	-21.108	81.248	1.325	...	...	...	...	-3.5	16.5	...	...	...	...	...	...
18 May 2003	01:23:45	...	...	...	...	...	...	331.814	-35.254	47.844	.007	331.671	-35.305	47.880	.008	11.9	31.9	...	...	...	...	...	...
19 May 2003	09:32:22	...	...	...	...	...	...	232.082	-20.521	14.462	14.462	258.097	17.544	59.957	31.336	-35.0	0.	...	...	...	...	...	...
19 May 2003	14:04:53	...	...	...	239.758	-33.488	2.277	329.561	-32.716	71.491	.004	331.653	-35.097	71.871	.003	...	...	...	...	...	...	...	...
03 Jul 2003	19:13:54	...	...	...	...	...	...	334.369	-28.960	57.488	.242	...	...	...	...	39.7	90.0	...	...	...	...	...	...
21 Jul 2003	23:41:12	...	...	...	...	...	...	337.148	-25.695	54.040	.009	336.658	-26.664	53.152	.010	-21.0	-15.0	...	...	...	...	...	...
25 Jul 2003	11:46:27	...	...	...	...	...	...	337.591	-25.334	33.733	.026	337.084	-26.223	32.755	.022	-42.3	-22.3	...	...	...	308.498	-50.682	.001
26 Jul 2003	06:38:25	...	...	...	...	...	...	337.690	-25.254	75.947	.013	337.228	-26.143	75.333	.006	-3.7	16.3	...	...	...	...	...	...
03 Aug 2003	15:44:55	...	...	...	...	...	...	334.282	9.785	33.750	33.750	...	...	...	...	-39.6	-19.6	...	...	...	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
14 Aug 2003	03:06:13	...	...	...	...	...	...	340.080	-23.356	34.094	.017	339.884	-23.916	33.542	.005	-52.8	-32.8	...	...	...	...	...	...
21 Aug 2003	05:31:35	...	...	...	...	...	...	340.962	-23.121	25.209	.147	...	...	...	...	-20.5	-40.5	...	...	...	325.540	-44.950	.750
22 Aug 2003	18:40:28	...	...	...	...	...	...	341.214	-22.933	76.569	.058	14.945	1.650	26.870	26.870	49.3	69.3	...	...	...	...	...	...
26 Sep 2003	16:52:28	...	...	...	...	...	...	93.495	18.059	70.092	2.497	88.564	9.267	73.269	1.006	10.0	90.0	...	...	...	...	...	...
27 Oct 2003	17:07:09	...	...	...	...	...	...	350.126	-17.040	78.936	.003	348.978	-16.607	79.442	.004	-69.0	-81.0	...	...	...	...	...	...
09 Nov 2003	11:10:19	...	...	...	323.750	25.500	10.000	342.902	-9.304	33.469	.048	351.221	-16.329	43.977	.104	...	...	...	...	...	...	...	...
11 Nov 2003	16:45:13	...	...	...	...	...	...	351.387	-16.222	86.227	.006	...	...	...	...	-12.3	7.7	...	...	...	71.769	18.081	.152
20 Nov 2003	05:51:58	...	...	...	...	...	...	66.832	18.252	30.177	5.439	...	...	...	...	0.	10.0	...	...	...	...	...	...
30 Nov 2003	02:04:51	...	...	...	...	...	...	171.258	4.715	58.586	.323	...	...	...	...	50.0	90.0	258.5	-6.1	65.8	...	...	...
03 Dec 2003	05:58:56	...	...	...	133.410	53.220	10.000	76.223	18.575	56.252	.710	...	...	...	...	25.0	55.0	...	...	...	...	...	...
18 Dec 2003	06:28:08	...	...	...	...	...	...	86.495	19.323	42.083	1.740	...	...	...	...	20.0	90.0	...	...	...	...	...	...
09 Feb 2004	03:36:50	...	...	...	...	...	...	211.112	-13.378	88.451	.198	...	...	...	...	-14.2	-34.2	292.3	1.1	66.4	...	...	...
20 Feb 2004	00:55:11	...	...	...	...	...	...	37.675	15.723	64.856	.044	334.951	-5.601	46.162	5.468	41.0	55.0	...	...	...	327.500	41.000	20.000
25 Feb 2004	09:52:21	...	...	...	...	...	...	41.236	16.899	74.499	.149	...	...	...	...	...	...	163.5	70.4	63.9	31.700	-1.900	293.900
28 Feb 2004	00:08:56	...	...	...	...	...	...	222.855	-17.387	31.387	.055	...	...	...	...	-10.0	-20.0	143.6	-50.0	62.6	...	...	...
03 Apr 2004	16:55:03	...	...	...	...	...	...	126.940	21.795	23.284	21.699	...	...	...	...	56.0	44.0	...	...	...	...	...	...
03 Apr 2004[a]	23:23:56	...	...	...	...	...	...	127.558	21.670	70.529	2.155	246.601	-22.856	58.610	.019	45.0	85.0	23.3	.3	66.4	...	...	...
08 Apr 2004	15:41:27	...	...	...	...	...	...	140.506	19.513	60.380	60.380	...	...	...	...	20.3	90.0	254.8	-11.6	55.0	...	...	...
09 Apr 2004	13:39:08	...	...	...	...	...	...	143.035	19.084	30.660	30.660	...	...	...	...	26.4	46.4	...	...	...	347.100	5.500	138.000
10 Apr 2004	12:19:47	...	...	...	...	...	...	145.462	18.470	43.991	49.460	...	...	...	...	20.3	90.0	324.3	.7	66.2	358.400	42.000	138.000
14 Apr 2004	11:08:20	...	...	...	...	...	...	158.473	14.708	31.926	9.122	...	...	...	...	-33.0	-23.0	...	...	...	...	...	...
25 Apr 2004	16:23:33	...	...	...	232.899	-39.721	3.468	261.760	-24.435	28.898	.020	...	...	...	...	...	...	...	...	...	...	...	...
29 Apr 2004	10:52:55	...	...	...	...	...	...	84.456	24.568	57.748	.009	304.075	-23.047	89.104	5.634	-30.0	-20.0	175.9	-6.4	62.9	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
12 May 2004	19:23:31	...	...	...	...	...	...	229.076	-13.686	24.155	5.923	273.836	-24.646	55.160	.011	16.0	36.0	...	...	...	...	...	...
03 Jun 2004	15:40:58	...	...	...	...	...	...	93.051	18.686	35.961	6.362	...	...	...	...	...	...	1.0	-1.6	66.0	9.500	-37.900	114.000
12 Jul 2004	18:32:26	...	...	...	...	...	...	32.992	-56.320	64.505	10.029	...	...	...	...	...	...	87.2	-27.5	66.4	...	...	...
02 Aug 2004	18:02:21	...	...	...	281.849	-44.489	5.000	327.836	-14.191	47.717	.032	...	...	...	...	...	...	...	...	...	...	...	...
10 Aug 2004	14:15:36	...	...	...	358.532	-35.074	1.000	332.624	-12.452	34.105	.014	...	...	...	...	...	...	...	...	...	...	...	...
29 Aug 2004	21:20:48	...	...	...	...	...	...	314.034	-13.036	70.203	4.883	...	...	...	...	2.3	22.3	...	...	...	...	...	...
21 Sep 2004	00:23:00	...	...	...	...	...	...	335.902	-7.816	45.473	4.276	...	...	...	...	-24.4	-4.4	...	...	...	...	...	...
24 Sep 2004	11:52:11	...	...	...	31.581	16.024	.213	359.188	-1.350	36.453	.022	...	...	...	...	-2.4	17.6	...	...	...	...	...	...
09 Oct 2004	06:38:18	...	...	...	...	...	...	.523	4.875	70.341	1.398	...	...	...	...	57.3	77.3	303.2	1.2	66.6	...	...	...
25 Oct 2004	22:47:56	...	...	...	...	...	...	17.944	6.803	35.664	.022	17.981	6.857	35.722	.021	-34.2	-14.2	...	...	...	...	...	...
27 Oct 2004	18:18:38	...	...	...	...	...	...	35.806	18.519	28.360	28.360	...	...	...	...	23.1	43.1	184.1	1.6	66.6	...	...	...
07 Nov 2004	15:49:31	...	...	...	...	...	...	58.107	22.819	65.110	3.606	...	...	...	...	...	...	...	...	...	...	...	...
19 Nov 2004	14:43:46	...	...	...	...	...	...	81.193	27.003	54.400	12.836	...	...	...	...	-9.0	-29.0	185.1	-1.4	66.3	...	...	...
21 Nov 2004	18:25:28	...	...	...	...	...	...	82.701	23.337	68.159	1.304	85.624	29.132	73.236	1.278	-50.0	-80.0	...	...	...	...	...	...
27 Nov 2004	10:11:27	...	...	...	11.200	32.500	5.000	89.737	22.731	80.695	28.764	...	...	...	...	39.7	59.7	152.2	-1.9	66.1	...	...	...
29 Nov 2004	23:43:13	...	...	...	...	...	...	92.947	22.146	45.975	5.904	...	...	...	...	-34.2	-14.2	...	...	...	...	...	...
11 Dec 2004	07:49:50	...	...	...	...	...	...	103.113	20.228	61.024	1.584	47.606	17.388	9.749	.044	2.0	12.0	179.3	6.7	65.4	...	...	...
11 Dec 2004	23:57:44	...	...	...	...	...	...	48.064	17.516	29.721	.018	103.981	20.185	76.929	1.404	3.4	23.4	...	...	...	...	...	...
23 Dec 2004	14:06:37	...	...	...	...	...	...	56.325	19.587	70.133	.009	...	...	...	...	-70.7	-50.7	...	...	...	100.197	-37.073	.004
11 Jan 2005	06:52:31	...	...	...	...	...	...	120.369	20.971	39.974	2.453	...	...	...	...	...	...	...	...	...	...	...	...
28 Jan 2005	04:19:54	...	...	...	...	...	...	262.356	-23.433	38.748	.015	...	...	...	...	-24.4	-4.4	...	...	...	219.587	-34.762	.050
03 Apr 2005	16:16:11	...	...	...	...	...	...	2.931	-3.508	37.896	22.599	...	...	...	...	-57.9	-37.9	283.1	13.3	66.3	...	...	...
09 May 2005	09:31:19	...	...	...	...	...	...	247.527	-20.514	61.499	1.761	283.399	8.465	84.706	.148	-65.8	-45.8	...	...	...	...	...	...

Table 5—Continued

		SAX			HETE			IPN								Ecliptic		Planet			Other		
Date	UT	α	δ	R	α	δ	R	α_1	δ_1	R_1	δR_1	α_2	δ_2	R_2	δR_2	β_1	β_2	α	δ	R	α	δ	R
30 May 2005	04:44:42	...	...	...	...	...	...	92.860	25.113	62.270	1.562	351.963	-5.764	63.674	.029	32.0	62.0	...	...	...	...	...	...
31 May 2005	04:27:25	...	...	...	...	...	...	273.795	-25.444	85.006	1.377	...	...	...	...	-72.0	-58.0	...	...	...	...	...	...
26 Jun 2005	23:37:32	...	...	...	...	...	...	189.729	-1.439	72.333	.060	...	...	...	...	42.6	62.6	132.8	-.3	66.7	...	...	...
30 Jul 2005	11:10:42	...	...	...	...	...	...	299.420	-24.459	65.300	1.418	...	...	...	...	15.0	90.0	227.5	-.9	66.2	...	...	...
08 Aug 2005	11:02:12	...	...	...	...	...	...	214.079	-10.640	50.072	.107	300.518	-18.523	72.621	1.693	47.0	57.0	...	...	...	...	...	...
24 Aug 2005	11:57:42	...	...	...	...	...	...	310.894	-18.861	86.415	1.345	...	...	...	...	...	...	171.2	12.0	66.4	...	...	...
28 Aug 2005	15:47:01	...	...	...	...	...	...	313.946	-17.495	67.526	4.817	...	...	...	...	30.2	50.2	271.9	-.1	66.2	...	...	...
22 Oct 2005	13:07:58	...	...	...	359.015	19.619	.082	47.914	16.542	46.453	.035	...	...	...	...	4.6	24.6	...	...	...	...	...	...
31 Oct 2005	22:01:02	...	...	...	...	...	...	54.351	28.079	49.791	6.449	...	...	...	...	-53.9	-33.9	...	...	...	...	...	...
03 Nov 2005	09:25:41	...	...	...	...	...	...	57.764	22.282	69.356	.197	44.315	16.190	79.803	.007	10.0	30.0	...	...	...	...	...	...
11 Nov 2005	07:47:48	...	...	...	...	...	...	221.693	-15.858	84.399	.031	250.315	-22.799	56.609	1.827	6.0	9.0	...	...	...	...	...	...
17 Nov 2005	12:33:30	...	...	...	...	...	...	258.886	-22.339	35.208	5.451	...	...	...	...	-21.4	-41.4	165.8	.2	66.6	...	...	...
24 Nov 2005	08:16:52	...	...	...	...	...	...	85.906	21.986	37.160	37.160	...	...	...	...	26.4	46.4	214.1	1.9	66.6	...	...	...
27 Nov 2005	22:55:20	...	...	...	...	...	...	217.421	-15.355	76.300	.029	216.586	-15.133	77.086	.029	-19.0	1.0	...	...	...	...	...	...
07 Dec 2005	19:04:09	...	...	...	...	...	...	216.367	-15.394	71.650	.082	97.119	20.055	65.557	1.797	32.3	52.3	...	...	...	...	...	...
11 Jan 2006	08:48:59	...	...	...	...	...	...	289.675	-17.642	69.609	1.700	292.210	-22.155	65.964	1.699	-61.5	-41.5	235.2	1.7	66.5	...	...	...
15 Jan 2006	04:03:04	...	...	...	...	...	...	113.722	20.658	41.389	2.035	...	...	...	...	-48.5	-28.5	...	...	...	...	...	...
06 Feb 2006	01:02:12	...	...	...	...	...	...	51.907	20.657	81.481	.055	119.173	18.429	50.519	1.967	0.0	-60.0	...	...	...	...	...	...
25 Mar 2006	12:02:17	...	...	...	...	...	...	175.446	7.539	71.997	2.107	...	...	...	...	49.3	69.3	274.5	-.7	66.7	...	...	...

[a]The Konus ecliptic latitude band and the IPN localization are inconsistent (see text)

Table 6. Error box areas

Date	Universal Time	Area, square degrees
02 Nov 2000	15:53:48	1.57E-01
05 Nov 2000	16:25:28	9.63E-04
06 Nov 2000	15:15:15	1.09E-03
15 Nov 2000	12:49:08	3.75E+03
15 Nov 2000	14:06:41	1.00E+03
25 Dec 2000	07:09:20	5.09E-02
10 Jan 2001	19:59:07	4.19E+01
26 Jan 2001	09:10:40	1.29E-01
26 Mar 2001	03:14:56	7.53E-02
28 Apr 2001	10:04:51	6.29E+02
07 Jun 2001	14:55:23	3.71E-01
09 Jun 2001	05:39:28	7.07E+02
12 Jun 2001	02:33:13	1.91E-01
13 Jun 2001	07:33:55	3.08E-01
19 Jun 2001	15:17:01	4.85E+01
28 Jun 2001	01:10:03	1.56E-02
29 Jun 2001	12:21:06	6.35E-02
26 Jul 2001	01:31:22	8.69E-02
01 Aug 2001	18:30:33	5.37E-01
27 Aug 2001	10:48:28	9.41E+02
28 Aug 2001	04:18:25	2.22E+01
03 Sep 2001	23:28:08	2.99E+00
21 Sep 2001	05:15:50	1.40E+00
23 Sep 2001	09:24:29	1.29E+00
29 Sep 2001	00:22:37	7.40E-01
08 Oct 2001	19:55:52	2.90E-01
15 Nov 2001	20:16:17	8.18E-01
08 Dec 2001	12:33:52	4.39E+01
16 Dec 2001	02:55:23	2.18E+00
13 Jan 2002	02:04:11	4.79E+01
14 Jan 2002	02:51:03	6.89E+00
16 Jan 2002	20:47:37	8.00E+01

Table 6—Continued

Date	Universal Time	Area, square degrees
24 Jan 2002	10:41:15	8.35E-02
27 Jan 2002	20:57:25	9.86E-03
09 Feb 2002	07:49:57	6.26E-01
14 Feb 2002	18:49:38	2.08E-03
21 Feb 2002	08:07:43	7.79E-03
05 Mar 2002	11:55:25	2.92E-01
13 Mar 2002	01:17:51	2.29E-02
31 Mar 2002	16:32:29	5.24E-02
18 Apr 2002	17:43:09	2.69E-01
08 May 2002	04:07:01	1.48E+03
31 May 2002	00:26:18	8.43E-03
25 Jun 2002	11:25:49	3.05E-01
06 Jul 2002	03:30:27	8.44E-02
14 Jul 2002	15:49:22	4.23E-02
15 Jul 2002	20:03:32	5.87E+01
25 Jul 2002	16:25:40	2.30E+00
01 Aug 2002	12:58:42	4.54E-01
13 Aug 2002	02:44:40	1.97E-05
13 Aug 2002	12:21:01	2.68E+01
19 Aug 2002	14:57:36	8.40E-04
04 Sep 2002	06:53:47	1.81E-01
14 Oct 2002	06:31:46	3.71E+00
16 Oct 2002	10:29:01	7.53E-02
20 Oct 2002	20:12:54	1.30E-03
23 Oct 2002	02:53:46	1.72E-02
25 Oct 2002	20:18:30	1.30E+01
04 Nov 2002	09:06:32	1.04E+01
13 Nov 2002	06:38:57	6.10E-02
01 Dec 2002	05:30:04	5.97E-04
11 Dec 2002	11:18:34	2.57E-03
14 Dec 2002	03:27:27	1.60E+01
01 Jan 2003	20:43:38	3.79E-01

Table 6—Continued

Date	Universal Time	Area, square degrees
15 Jan 2003	06:25:12	6.14E-03
17 Jan 2003	17:36:14	2.21E+02
27 Jan 2003	12:32:32	6.31E-01
04 Feb 2003	12:45:34	6.80E-03
15 Feb 2003	11:13:31	1.50E+04
15 Feb 2003	11:16:22	7.38E+00
15 Feb 2003	17:11:52	8.77E+01
17 Feb 2003	02:45:42	1.04E-02
20 Feb 2003	16:12:44	7.99E+00
01 Mar 2003	20:27:20	1.76E-01
07 Mar 2003	14:31:58	9.48E-02
17 Mar 2003	06:58:55	6.77E-01
20 Mar 2003	18:49:18	8.34E-01
25 Mar 2003	22:01:14	2.37E+03
28 Mar 2003	11:20:58	5.46E-04
29 Mar 2003	11:37:15	7.84E-05
03 Apr 2003	03:37:46	2.04E+00
05 Apr 2003	02:17:29	2.33E-03
13 Apr 2003	07:34:44	1.37E-02
01 May 2003	20:44:48	1.15E+02
18 May 2003	01:23:45	8.43E-02
19 May 2003	09:32:22	1.47E+03
19 May 2003	14:04:53	9.65E-04
03 Jul 2003	19:13:54	7.73E+00
21 Jul 2003	23:41:12	3.06E-02
25 Jul 2003	11:46:27	8.48E-06
26 Jul 2003	06:38:25	2.44E-02
03 Aug 2003	15:44:55	1.70E+03
14 Aug 2003	03:06:13	5.98E-02
21 Aug 2003	05:31:35	4.73E-01
22 Aug 2003	18:40:28	1.20E+01
26 Sep 2003	16:52:28	6.37E+01

Table 6—Continued

Date	Universal Time	Area, square degrees
27 Oct 2003	17:07:09	2.73E-03
09 Nov 2003	11:10:19	3.72E-01
11 Nov 2003	16:45:13	3.94E-03
20 Nov 2003	05:51:58	2.45E+02
30 Nov 2003	02:04:51	2.24E+01
03 Dec 2003	05:58:56	3.07E+01
18 Dec 2003	06:28:08	2.70E+02
09 Feb 2004	03:36:50	8.55E+00
20 Feb 2004	00:55:11	1.06E+00
25 Feb 2004	09:52:21	7.16E+01
28 Feb 2004	00:08:56	1.31E+00
03 Apr 2004	16:55:03	9.50E+01
03 Apr 2004	23:23:56	8.74E-01
08 Apr 2004	15:41:27	8.78E+03
09 Apr 2004	13:39:08	1.75E+03
10 Apr 2004	12:19:47	8.21E+03
14 Apr 2004	11:08:20	4.49E+02
25 Apr 2004	16:23:33	3.00E-01
29 Apr 2004	10:52:55	2.06E-01
12 May 2004	19:23:31	3.60E-01
03 Jun 2004	15:40:58	1.33E+03
12 Jul 2004	18:32:26	3.86E+03
02 Aug 2004	18:02:21	6.39E-01
10 Aug 2004	14:15:36	6.10E+00
29 Aug 2004	21:20:48	4.21E+02
21 Sep 2004	00:23:00	3.92E+02
24 Sep 2004	11:52:11	1.97E-02
09 Oct 2004	06:38:18	6.71E+01
25 Oct 2004	22:47:56	1.10E+00
27 Oct 2004	18:18:38	1.74E+03
07 Nov 2004	15:49:31	2.35E+03
19 Nov 2004	14:43:46	7.12E+02

Table 6—Continued

Date	Universal Time	Area, square degrees
21 Nov 2004	18:25:28	1.12E+02
27 Nov 2004	10:11:27	7.93E+01
29 Nov 2004	23:43:13	5.70E+02
11 Dec 2004	07:49:50	5.64E-01
11 Dec 2004	23:57:44	2.07E-01
23 Dec 2004	14:06:37	4.92E-05
11 Jan 2005	06:52:31	1.13E+03
28 Jan 2005	04:19:54	3.00E-03
03 Apr 2005	16:16:11	1.27E+03
09 May 2005	09:31:19	1.70E+00
30 May 2005	04:44:42	2.31E-01
31 May 2005	04:27:25	8.38E+01
26 Jun 2005	23:37:32	4.76E+00
30 Jul 2005	11:10:42	2.02E+02
08 Aug 2005	11:02:12	7.85E-01
24 Aug 2005	11:57:42	7.83E+02
28 Aug 2005	15:47:01	2.24E+02
22 Oct 2005	13:07:58	1.16E-02
31 Oct 2005	22:01:02	6.24E+02
03 Nov 2005	09:25:41	7.00E-02
11 Nov 2005	07:47:48	2.01E-01
17 Nov 2005	12:33:30	6.14E+02
24 Nov 2005	08:16:52	1.97E+03
27 Nov 2005	22:55:20	6.48E-01
07 Dec 2005	19:04:09	9.96E-01
11 Jan 2006	08:48:59	1.24E+02
15 Jan 2006	04:03:04	2.63E+02
06 Feb 2006	01:02:12	2.13E-03
25 Mar 2006	12:02:17	9.89E+01

Table 7. 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]

[a]Hurley et al. (2000a)

[b]Hurley et al. (2000c)

[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]Hurley et al. (2011)

[i]Hurley et al. (2010)

[j]present catalog