THE INTERPLANETARY NETWORK SUPPLEMENT TO THE HETE-2 GAMMA-RAY BURST CATALOG

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Received 2011 August 8; accepted 2011 October 20; published 2011 December 6

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 French Gamma-Ray Telescope experiment on board the \textit{High Energy Transient Experiment} 2 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.

\textit{Key words:} catalogs – gamma-ray burst: general – space vehicles: instruments

1. INTRODUCTION

The Wide Field X-Ray Monitor (WXM) and Soft X-Ray Camera (SXC) on board the \textit{High Energy Transient Experiment} (HETE-2) mission localized 79 gamma-ray bursts (GRBs) rapidly and precisely between 2001 and 2006 (Atteia et al. 2003; Kawai et al. 2003; Ricker et al. 2003; R. Vanderspek et al. 2011, in preparation; Villasenor et al. 2003). 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° from the detector axis and identified by on-board 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 four and nine spacecraft. They were, in addition to the IPN spacecraft comprising the interplanetary network (IPN), and in various orbits up to around 5lt-s from Earth (Hurley et al. 1992); \textit{Konus-Wind}, in various orbits up to around 4lt-s from Earth (Aptekar et al. 1995); \textit{BeppoSAX}, in low Earth orbit (Frontera et al. 1997; Hurley et al. 2000b); the \textit{Near-Earth Asteroid Rendezvous} (NEAR) mission, in orbit around the asteroid Eros at distances between 775 and 1060 lt-s from Earth (Trombka et al. 1999); \textit{Mars Odyssey}, launched in 2001 April and in orbit around Mars starting in 2001 October, up to 1250 lt-s from Earth (Hurley et al. 2006); \textit{RHESSI} in low Earth orbit (Smith et al. 2002); \textit{INTEGRAL}, in an eccentric Earth orbit at up to 0.5 lt-s from Earth (Rau et al. 2005); the \textit{MESSENGER} mission, launched in 2004 August, but commencing full operation only in 2007 (Gold et al. 2001); and \textit{Swift} (Gehrels et al. 2004) and \textit{SuZaku} (Takahashi et al. 2007; Yamaoka et al. 2009), both in low Earth orbit. Their timelines are presented in Figure 1.

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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* spacecraft detected, but did not localize bursts (Terrell et al. 1996, 1998; Terrell & 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 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 \( \delta T \), it may be localized to an annulus whose half-angle \( \theta \) with respect to the vector joining the two spacecraft is given by

\[
\cos \theta = \frac{c \delta T}{D},
\]

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 \( d\theta \) is

\[
d\theta = \sigma(\delta T)/D \sin \theta,
\]

where \( \sigma(\delta T) \) is the uncertainty in the time delay. \( \sigma(\delta T) \) 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
### Table 1

| Date       | Universal Time | HETE Identifier | Observed by   |
|------------|----------------|-----------------|---------------|
| 2000 Nov 2 | 15:53:48       | U0171144      | Uly, Kon, NEA |
| 2000 Nov 5 | 16:25:28       | U0171145      | Uly, Kon, NEA |
| 2000 Nov 6 | 15:15:15       | U0171146      | Uly, Kon, NEA |
| 2000 Nov 15| 12:49:08       | U0171148      | Kon           |
| 2000 Nov 15| 14:06:41       | U01711420     | Kon, SAX      |
| 2000 Dec 25| 07:09:20       | U01710803     | Uly, Kon, NEA |
| 2001 Jan 10 | 19:59:07   | U01710809     | Uly           |
| 2001 Jan 26| 09:10:40       | H1487          | Uly, Kon, NEA, XTE |
| 2001 Feb 4 | 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       | U01711424     | Uly           |
| 2001 Jun 7 | 14:55:23       | U01710814     | Uly, MO, Kon  |
| 2001 Jun 9 | 05:39:28       | U01710815     | Uly           |
| 2001 Jun 12| 02:33:14       | H1546          | Uly, Kon, SAX |
| 2001 Jun 13| 07:33:55       | H1547          | Uly           |
| 2001 Jun 19| 15:17:01       | U01710816     | Kon, SAX      |
| 2001 Jun 28| 01:10:03       | H1569          | Uly, MO, Kon  |
| 2001 Jun 29| 12:21:07       | H1573          | Kon, SAX      |
| 2001 Jul 22| 04:01:53       | U01710820     | Kon           |
| 2001 Jul 26| 01:31:22       | H1611          | Uly, MO, Kon  |
| 2001 Aug 1 | 18:30:33       | H1669          | Uly, Kon, SAX |
| 2001 Aug 27| 10:48:28       | H1723          | Kon           |
| 2001 Aug 28| 04:18:25       | H1729          | Uly           |
| 2001 Sep 3 | 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           |
| 2001 Oct 8 | 19:55:52       | H1782          | Uly           |
| 2001 Nov 15| 20:16:17       | H1846          | Uly, Kon, SAX |
| 2001 Dec 8 | 12:33:52       | U01710826     | Uly           |
| 2001 Dec 12| 04:00:02       | U01710827     | 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 9 | 07:49:57       | U01710829     | 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 5 | 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           |
| 2002 Apr 18| 17:43:09       | U01710806     | Uly, Kon, RHE |
| 2002 May 8 | 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 6 | 03:30:27       | H2094          | Uly, MO, Kon  |
| 2002 Jul 14| 15:49:22       | U01710831     | Uly, MO, Kon  |
| 2002 Jul 15| 20:03:32       | H2123          | Uly           |
| 2002 Jul 25| 16:25:40       | U01711017     | MO, Kon, RHE |
| 2002 Aug 1 | 12:58:42       | H2177          | Uly           |
| 2002 Aug 1 | 13:03:27       | H2178          | Uly           |
| 2002 Aug 13| 02:44:40       | H2262          | Uly, MO, Kon  |
| 2002 Aug 13| 12:21:01       | U01710205     | Uly           |
| 2002 Aug 19| 14:57:36       | H2275          | Uly, Kon, RHE |
| 2002 Sep 4 | 06:53:47       | H2315          | Uly, MO, Kon  |
| 2002 Oct 4 | 12:06:13       | H2380          | Kon           |
| 2002 Oct 7 | 20:15:09       | U01710834     | Kon           |
| 2002 Oct 14| 06:31:46       | H2389          | Uly, Kon      |
| 2002 Oct 16| 10:29:03       | H2397          | Uly, MO, Kon  |
| 2002 Oct 20| 20:12:54       | H2413          | Uly, MO, Kon, RHE |
| 2002 Oct 23| 02:53:46       | U01710835     | Uly, MO, Kon, RHE |
| 2002 Oct 25| 20:18:30       | H2418          | Uly, Kon, RHE |
| Date         | Universal Time a | HETE Identifier b | Observed by c |
|--------------|------------------|-------------------|---------------|
| 2002 Nov 4  | 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 1  | 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 1  | 20:43:38         | H2523             | Uly, Kon, INT |
| 2003 Jan 15 | 03:22:34         | H2533             | Kon, INT      |
| 2003 Jan 15 | 06:25:12         | UBD1 10801        | Uly, MO, Kon, RHE, INT |
| 2003 Jan 17 | 17:36:14         | UBD1 11683        | Kon, INT      |
| 2003 Jan 27 | 12:32:32         | UBD1 10839        | Uly, Kon, RHE, INT |
| 2003 Feb 4  | 12:45:34         | H2568             | Uly, MO, Kon, RHE, INT |
| 2003 Feb 13 | 00:52:10         | H2589             | Kon           |
| 2003 Feb 15 | 11:13:31         | UBD 10890         | INT           |
| 2003 Feb 15 | 11:16:22         | UBD 10891         | Uly, INT      |
| 2003 Feb 15 | 17:11:52         | H2595             | Uly           |
| 2003 Feb 17 | 02:45:42         | UBD 10892         | Uly, MO, RHE, INT |
| 2003 Feb 20 | 16:12:44         | H2601             | Uly, INT      |
| 2003 Feb 26 | 03:46:31         | UBD 10893         | Kon, INT      |
| 2003 Mar 1  | 20:27:20         | H2610             | Uly, MO, Kon, RHE |
| 2003 Mar 4  | 13:47:10         | UBD 11646         | Kon           |
| 2003 Mar 7  | 14:31:58         | H2617             | Uly, Kon, RHE, INT |
| 2003 Mar 17 | 06:58:55         | UBD 10894         | Uly, Kon      |
| 2003 Mar 20 | 18:49:18         | UBD 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 3  | 03:37:46         | UBD 10896         | Uly, Kon, INT |
| 2003 Apr 4  | 23:26:52         | H2661             | Kon           |
| 2003 Apr 5  | 02:17:29         | H2662             | Uly, MO, Kon, INT |
| 2003 Apr 13 | 07:34:44         | H2678             | Uly, MO, Kon, RHE, INT |
| 2003 May 1  | 20:44:48         | H2699             | Kon           |
| 2003 May 18 | 01:23:45         | H2714             | Uly, Kon, RHE, INT |
| 2003 May 19 | 09:32:22         | UBD 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         | UBD 11684         | INT           |
| 2003 Jul 3  | 19:13:54         | H2754             | Uly, Kon, RHE |
| 2003 Jul 21 | 23:41:12         | UBD 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 3  | 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         | UBD 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         | UBD 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 9  | 11:10:19         | H2917             | Uly, MO, INT  |
| 2003 Nov 11 | 16:45:13         | H2924             | Uly, Kon, RHE, INT |
| 2003 Nov 20 | 05:51:58         | UBD 11464         | Kon, RHE      |
| 2003 Nov 30 | 02:04:51         | UBD 11547         | MO, Kon, RHE |
| 2003 Dec 3  | 05:58:56         | H2949             | Kon           |
| 2003 Dec 18 | 06:28:08         | UBD 11468         | Kon           |
| 2003 Dec 20 | 03:29:56         | H2976             | INT           |
| 2004 Feb 9  | 03:36:50         | UBD 11473         | MO, Kon, INT  |
| 2004 Feb 20 | 00:55:11         | UBD 11084         | MO, Kon, RHE, INT |
| 2004 Feb 25 | 09:52:21         | H3059             | MO            |
| 2004 Feb 28 | 00:08:56         | H3066             | MO, Kon, RHE |
| 2004 Feb 28 | 00:12:44         | H3067             | MO, Kon, RHE |
| 2004 Mar 19 | 07:46:01         | H3128             | Kon           |
| 2004 Apr 3  | 16:55:03         | H3143             | Kon           |
| 2004 Apr 3  | 23:23:56         | H3144             | MO, Kon       |
Table 1
(Continued)

| Date         | Universal Timea | HETE Identifier b | Observed byc |
|--------------|-----------------|-------------------|--------------|
| 2004 Apr 8   | 15:41:27        | UBID 11482        | Kon, RHE     |
| 2004 Apr 9   | 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 3   | 15:40:58        | H3309             | Kon, RHE, INT |
| 2004 Jul 9   | 00:58:07        | UBID 11549        | Kon, RHE, INT |
| 2004 Jul 12  | 18:32:26        | H3423             | RHE, INT     |
| 2004 Aug 2   | 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 4   | 02:17:03        | H3568             | Kon          |
| 2004 Oct 6   | 12:18:09        | H3570             | Kon, RHE     |
| 2004 Oct 9   | 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 7   | 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     |
| 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^e |
| 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 11560        | Swi^e        |
| 2004 Dec 29  | 10:38:51        | H3639             | RHE          |
| 2005 Jan 2   | 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 9   | 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 6   | 03:33:12        | UBID 11575        | Kon, Swi^e   |
| 2005 Apr 1   | 14:20:15        | H3706             | MO, Kon, INT, Swi^e |
| 2005 Apr 3   | 16:16:11        | UBID 11577        | Kon, RHE     |
| 2005 Apr 8   | 16:22:50        | H3711             | Kon, RHE, INT |
| 2005 Apr 16  | 22:35:54        | UBID 11581        | Kon, RHE, Swi^e |
| 2005 May 9   | 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 2   | 22:01:43        | H3786             | RHE          |
| 2005 Jun 26  | 23:37:32        | H3849             | MO, Kon      |
| 2005 Jul 9   | 22:36:36        | H3862             | RHE          |
| 2005 Jul 29  | 01:09:39        | H3882             | RHE          |
| 2005 Jul 30  | 11:10:42        | UBID 11643        | Kon          |
| 2005 Aug 3   | 19:14:00        | UBID 11644        | Swi^e        |
| 2005 Aug 7   | 10:58:44        | H3889             | Suz          |
| 2005 Aug 8   | 11:02:12        | H3891             | MO, Kon, INT |
| 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     |
Table 1 (Continued)

| Date       | Universal Time | HETE Identifier | Observed by |
|------------|----------------|-----------------|-------------|
| 2005 Sep 10| 17:29:59       | H3926           | Suz         |
| 2005 Sep 11| 15:59:34       |                 | Swi³        |
| 2005 Sep 15| 21:23:04       | UBID 11689      | Swi³, Suz   |
| 2005 Sep 22| 19:55:50       | UBID 11658      | MO, Kon, INT, Swi³, Suz |
| 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 3 | 09:25:41       | UBID 11661      | MO, Kon, RHE, INT, Swi³, Suz |
| 2005 Nov 11| 07:47:48       | UBID 11664      | MO, Kon, RHE, Swi³ |
| 2005 Nov 17| 12:33:30       | UBID 11665      | Kon, RHE, Swi³, Suz |
| 2005 Nov 24| 08:16:52       | H3970           | Kon, RHE    |
| 2005 Nov 27| 22:55:20       | H3971           | MO, Kon, Suz |
| 2005 Dec 1 | 22:49:11       | UBID 11666      | Suz         |
| 2005 Dec 7 | 19:04:09       | H3975           | MO, Kon, RHE, Swi³, Suz |
| 2005 Dec 27| 18:07:16       | UBID 11668      | Swi³        |
| 2006 Jan 5 | 06:49:28       | H3995           | MO, Kon, INT, Swi³, Suz |
| 2006 Jan 11| 08:48:59       | H3999           | Kon, RHE, INT, Swi³ |
| 2006 Jan 15| 04:03:04       | H4000           | Kon, INT, Swi³ |
| 2006 Jan 21| 22:24:54       | H4010           | Kon, RHE, Swi³, Suz |
| 2006 Jan 24| 15:54:41       | H4012           | Kon, RHE, Swi³, Suz |
| 2006 Jan 26| 09:30:05       | H4013           | RHE, INT    |
| 2006 Feb 6 | 01:02:12       | H4021           | MO, Kon, Swi³ |
| 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      | Swi³        |
| 2006 May 10| 07:43:27       | H4064           | MO, Kon, INT, Swi³ |
| 2006 May 26| 16:28:29       | H4073           | Kon, Swi³   |

Notes.

- Universal time is the Earth-crossing time of the start of the event.
- H indicates a triggered burst; UBID stands for untriggered burst identifier.
- 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.
- Burst was outside the coded field of view of the BAT.
- 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   |
| 0         | 104 | 83  | 39  |

~40 lt-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 that 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 Burst Alert Telescope (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.

One hundred and fifty-seven 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 Web site. Triangulation annuli are given in...
| Date         | UT     | SAX  | HETE  | IPN  | IPN   | Ecliptic | Planet | Other |
|--------------|--------|------|-------|------|-------|----------|--------|-------|
|              | α      | δ    | R     | α    | δ     | R        | δR    | αδR  |
| 02 Nov 2000  | 15:53:48 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 05 Nov 2000  | 16:25:28 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 06 Nov 2000  | 15:15:15 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 08 Nov 2000  | 12:49:08 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 15 Nov 2000  | 14:06:41 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 25 Dec 2000  | 07:09:20 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 10 Jan 2001  | 19:59:07 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 26 Jan 2001  | 09:10:40 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 26 Mar 2001  | 03:14:56 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 28 Apr 2001  | 10:04:51 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 07 Jun 2001  | 14:55:23 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 09 Jun 2001  | 05:39:28 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 02 Jul 2001  | 15:17:01 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 02 Jun 2001  | 01:10:03 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 09 Jun 2001  | 12:21:06 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 01 Jul 2001  | 01:31:22 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 01 Aug 2001  | 18:30:33 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 27 Aug 2001  | 10:48:28 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 28 Aug 2001  | 04:18:25 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 03 Sep 2001  | 23:28:08 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 23 Sep 2001  | 05:15:50 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 08 Oct 1999  | 19:55:52 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 15 Nov 2001  | 20:16:17 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 08 Dec 2001  | 13:33:52 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 16 Dec 2001  | 02:55:23 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 13 Jan 2002  | 02:04:11 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 14 Jan 2002  | 02:51:03 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 24 Jan 2002  | 20:47:37 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 24 Jan 2002  | 10:41:15 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 27 Jan 2002  | 20:57:25 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 09 Feb 2002  | 07:49:57 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 18 Feb 2002  | 18:49:38 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 21 Feb 2002  | 08:07:43 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 05 Mar 2002  | 11:55:25 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 13 Mar 2002  | 01:17:51 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 15 Mar 2002  | 16:32:29 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 18 Apr 2002  | 17:43:09 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 08 May 2002  | 04:07:01 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 31 May 2002  | 00:26:18 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 25 Jun 2002  | 11:25:49 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| 06 Jul 2002  | 03:30:27 |      | 0     | 0.8  | 0.8   | 0.8    | 0.8    | 0.8  |
| Date          | UT          | SAX | HETE | IPN | Eccliptic | Planet | Other | Other |
|--------------|-------------|-----|------|-----|-----------|--------|-------|-------|
| 14 Jul 2002  | 15:49:22    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 15 Jul 2002  | 20:03:32    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 25 Jul 2002  | 16:25:40    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 01 Aug 2002  | 12:58:42    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 13 Aug 2002  | 02:44:40    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 13 Aug 2002  | 12:21:01    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 19 Aug 2002  | 14:57:36    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 04 Sep 2002  | 06:53:47    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 14 Oct 2002  | 06:31:46    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 16 Oct 2002  | 10:29:01    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 20 Oct 2002  | 20:12:54    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 23 Oct 2002  | 02:53:46    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 25 Oct 2002  | 20:18:30    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 04 Nov 2002  | 09:06:32    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 13 Nov 2002  | 06:38:57    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 01 Dec 2002  | 05:30:04    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 11 Dec 2002  | 11:18:34    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 14 Dec 2002  | 06:57:27    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 01 Jan 2003  | 20:43:38    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 15 Jan 2003  | 06:25:12    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 17 Jan 2003  | 17:36:14    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 27 Jan 2003  | 12:32:32    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 04 Feb 2003  | 12:45:34    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 15 Feb 2003  | 11:13:31    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 15 Feb 2003  | 11:16:22    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 15 Feb 2003  | 17:11:52    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 17 Feb 2003  | 02:45:42    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 20 Feb 2003  | 16:12:44    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 01 Mar 2003  | 20:27:20    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 07 Mar 2003  | 14:31:58    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 17 Mar 2003  | 06:58:55    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 21 Mar 2003  | 22:01:14    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 25 Mar 2003  | 22:10:58    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 28 Mar 2003  | 11:20:58    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 29 Mar 2003  | 11:37:15    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 03 Apr 2003  | 03:37:46    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 05 Apr 2003  | 02:17:29    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 13 Apr 2003  | 07:34:44    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 01 May 2003  | 20:44:48    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 18 May 2003  | 01:23:45    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 19 May 2003  | 09:32:22    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 19 May 2003  | 14:04:53    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 03 Jul 2003  | 19:13:54    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| 21 Jul 2003  | 23:41:12    | ... | ...  | ... | ...       | ...    | ...   | ...   |
| Date        | UT       | SAX | HETE | IPN | Ecliptic | Planet | Other |
|------------|----------|-----|------|-----|----------|--------|-------|
| 25 Jul 2003| 11:46:27 | ...  | ...  | ...  | ...      | ...    | ...   |
| 26 Jul 2003| 06:38:25 | ...  | ...  | ...  | ...      | ...    | ...   |
| 03 Aug 2003| 15:44:55 | ...  | ...  | ...  | ...      | ...    | ...   |
| 14 Aug 2003| 03:06:13 | ...  | ...  | ...  | ...      | ...    | ...   |
| 21 Aug 2003| 05:31:35 | ...  | ...  | ...  | ...      | ...    | ...   |
| 22 Aug 2003| 18:40:28 | ...  | ...  | ...  | ...      | ...    | ...   |
| 26 Sep 2003| 17:52:48 | ...  | ...  | ...  | ...      | ...    | ...   |
| 27 Oct 2003| 17:47:29 | ...  | ...  | ...  | ...      | ...    | ...   |
| 09 Nov 2003| 11:10:19 | 323.750 | 25.500 | 00.000 | 388.075 | 284.185 | 10.000 |
| 11 Nov 2003| 16:45:13 | ...  | ...  | ...  | ...      | ...    | ...   |
| 26 Nov 2003| 02:04:51 | ...  | ...  | ...  | ...      | ...    | ...   |
| 03 Dec 2003| 05:58:56 | ...  | ...  | ...  | ...      | ...    | ...   |
| 18 Dec 2003| 06:28:08 | ...  | ...  | ...  | ...      | ...    | ...   |
| 09 Feb 2004| 03:36:50 | ...  | ...  | ...  | ...      | ...    | ...   |
| 26 Feb 2004| 05:51:11 | ...  | ...  | ...  | ...      | ...    | ...   |
| 25 Feb 2004| 09:52:21 | ...  | ...  | ...  | ...      | ...    | ...   |
| 28 Feb 2004| 09:36:56 | ...  | ...  | ...  | ...      | ...    | ...   |
| 03 Apr 2004| 16:55:03 | ...  | ...  | ...  | ...      | ...    | ...   |
| 10 Apr 2004| 16:23:56 | ...  | ...  | ...  | ...      | ...    | ...   |
| 08 Apr 2004| 15:41:27 | ...  | ...  | ...  | ...      | ...    | ...   |
| 09 Apr 2004| 13:39:08 | ...  | ...  | ...  | ...      | ...    | ...   |
| 10 Apr 2004| 12:19:47 | ...  | ...  | ...  | ...      | ...    | ...   |
| 14 Apr 2004| 11:08:20 | ...  | ...  | ...  | ...      | ...    | ...   |
| 25 Apr 2004| 16:23:33 | ...  | ...  | ...  | ...      | ...    | ...   |
| 29 Apr 2004| 10:52:55 | ...  | ...  | ...  | ...      | ...    | ...   |
| 12 May 2004| 19:23:31 | ...  | ...  | ...  | ...      | ...    | ...   |
| 03 Jun 2004| 15:40:58 | ...  | ...  | ...  | ...      | ...    | ...   |
| 12 Jul 2004| 18:32:26 | ...  | ...  | ...  | ...      | ...    | ...   |
| 02 Aug 2004| 18:02:21 | ...  | ...  | ...  | ...      | ...    | ...   |
| 10 Aug 2004| 14:15:36 | ...  | ...  | ...  | ...      | ...    | ...   |
| 29 Aug 2004| 21:20:48 | ...  | ...  | ...  | ...      | ...    | ...   |
| 21 Sep 2004| 00:23:00 | ...  | ...  | ...  | ...      | ...    | ...   |
| 24 Sep 2004| 11:52:11 | ...  | ...  | ...  | ...      | ...    | ...   |
| 09 Oct 2004| 06:38:18 | ...  | ...  | ...  | ...      | ...    | ...   |
| 25 Oct 2004| 22:47:56 | ...  | ...  | ...  | ...      | ...    | ...   |
| 27 Oct 2004| 18:18:38 | ...  | ...  | ...  | ...      | ...    | ...   |
| 07 Nov 2004| 15:69:31 | ...  | ...  | ...  | ...      | ...    | ...   |
| 19 Nov 2004| 14:43:46 | ...  | ...  | ...  | ...      | ...    | ...   |
| 21 Nov 2004| 18:25:28 | ...  | ...  | ...  | ...      | ...    | ...   |
| 27 Nov 2004| 10:11:27 | ...  | ...  | ...  | ...      | ...    | ...   |
| 29 Nov 2004| 23:43:13 | ...  | ...  | ...  | ...      | ...    | ...   |
| 11 Dec 2004| 07:49:50 | ...  | ...  | ...  | ...      | ...    | ...   |
| 11 Dec 2004| 23:57:44 | ...  | ...  | ...  | ...      | ...    | ...   |
| Date         | UT   | SAX  | α   | δ   | R   | α1  | δ1  | R1  | δR1 | α2  | δ2  | R2  | δR2 | α   | δ   | R   | δR |
|--------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 23 Dec 2004  | 14:06:37 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11 Jan 2005  | 06:52:31 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 28 Jan 2005  | 04:19:54 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 03 Apr 2005  | 16:16:11 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 09 May 2005  | 09:31:19 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 30 May 2005  | 04:44:42 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 31 May 2005  | 04:27:25 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 26 Jun 2005  | 11:10:42 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 08 Aug 2005  | 11:02:12 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 24 Aug 2005  | 11:57:42 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 28 Aug 2005  | 15:47:01 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 22 Oct 2005  | 03:07:58 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 31 Oct 2005  | 22:01:02 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 03 Nov 2005  | 09:25:41 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11 Nov 2005  | 07:47:48 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 17 Nov 2005  | 12:33:30 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 24 Nov 2005  | 08:16:52 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 27 Nov 2005  | 12:35:20 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 07 Dec 2005  | 19:04:09 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11 Jan 2006  | 08:48:59 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 15 Jan 2006  | 04:03:04 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 06 Feb 2006  | 01:02:12 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 25 Mar 2006  | 12:02:17 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

**Table 5**
(Continued)

**Note.** The *Konus* ecliptic latitude band and the IPN localization are inconsistent (see the text).
Table 6
Error Box Areas

| Date       | Universal Time | (Area deg²) |
|------------|----------------|-------------|
| 2000 Nov 2 | 15:53:48       | 1.57E-01    |
| 2000 Nov 5 | 16:25:28       | 9.63E-04    |
| 2000 Nov 6 | 15:15:51       | 1.09E-03    |
| 2000 Nov 15| 12:49:08       | 3.75E+03    |
| 2000 Nov 15| 14:06:41       | 1.00E+03    |
| 2000 Dec 25| 07:09:20       | 5.90E-02    |
| 2001 Jan 10| 19:59:07       | 4.19E+01    |
| 2001 Jan 26| 09:10:40       | 1.29E-01    |
| 2001 Mar 26| 03:14:56       | 7.53E-02    |
| 2001 Apr 28| 10:04:51       | 6.29E+02    |
| 2001 Jun 7 | 14:55:23       | 3.71E-01    |
| 2001 Jun 9 | 05:39:28       | 7.07E+02    |
| 2001 Jun 12| 02:33:13       | 1.91E-01    |
| 2001 Jun 13| 07:33:55       | 3.08E-01    |
| 2001 Jun 19| 15:17:01       | 4.55E+01    |
| 2001 Jun 28| 01:10:03       | 1.56E-02    |
| 2001 Jun 29| 12:21:06       | 6.35E-02    |
| 2001 Jul 26| 01:51:22       | 8.69E-02    |
| 2001 Aug 1 | 18:30:33       | 5.37E-01    |
| 2001 Aug 27| 10:48:28       | 9.41E+02    |
| 2001 Aug 28| 04:18:25       | 2.22E+01    |
| 2001 Sep 3 | 23:28:08       | 2.99E+00    |
| 2001 Sep 21| 05:15:50       | 1.40E+00    |
| 2001 Sep 23| 09:24:29       | 1.29E-01    |
| 2001 Sep 29| 00:22:37       | 7.40E-01    |
| 2001 Oct 8 | 19:55:52       | 2.90E-01    |
| 2001 Nov 15| 20:16:17       | 8.18E-01    |
| 2001 Dec 8 | 12:33:52       | 4.39E+01    |
| 2001 Dec 16| 02:55:23       | 2.18E+00    |
| 2002 Jan 3 | 02:04:11       | 4.79E+00    |
| 2002 Jan 14| 02:51:03       | 6.89E+00    |
| 2002 Jan 16| 20:47:37       | 8.06E-01    |
| 2002 Jan 24| 10:41:15       | 8.35E-02    |
| 2002 Jan 27| 20:57:25       | 9.86E-03    |
| 2002 Feb 9 | 07:49:57       | 6.26E-01    |
| 2002 Feb 14| 18:49:38       | 2.08E-03    |
| 2002 Feb 21| 08:07:43       | 7.79E-03    |
| 2002 Mar 5 | 11:55:25       | 2.92E-01    |
| 2002 Mar 13| 01:17:51       | 2.29E-01    |
| 2002 Mar 31| 16:32:29       | 5.24E-02    |
| 2002 Apr 18| 17:43:09       | 2.69E-01    |
| 2002 May 8 | 04:07:01       | 1.48E+03    |
| 2002 May 31| 00:26:18       | 8.43E-03    |
| 2002 Jun 25| 11:25:49       | 3.05E-01    |
| 2002 Jul 6 | 03:30:27       | 8.44E-02    |
| 2002 Jul 14| 15:49:22       | 4.23E-02    |
| 2002 Jul 15| 20:03:32       | 5.87E+01    |
| 2002 Jul 25| 16:25:40       | 2.30E+00    |
| 2002 Aug 1 | 12:58:42       | 4.54E-01    |
| 2002 Aug 13| 02:44:40       | 1.97E-05    |
| 2002 Aug 13| 12:21:01       | 2.68E+01    |
| 2002 Aug 19| 14:57:36       | 8.40E-04    |
| 2002 Sep 4 | 06:53:47       | 1.81E-01    |
| 2002 Oct 14| 06:31:46       | 3.71E+00    |
| 2002 Oct 16| 10:29:01       | 7.53E-02    |
| 2002 Oct 20| 20:12:54       | 1.30E-03    |
| 2002 Oct 23| 02:53:46       | 1.72E-02    |
| 2002 Oct 25| 20:18:30       | 1.30E+01    |
| 2002 Nov 4 | 09:06:32       | 1.04E+01    |
| 2002 Nov 13| 06:38:57       | 6.10E-02    |
| 2002 Dec 1 | 05:30:04       | 5.97E-04    |
| 2002 Dec 11| 11:18:34       | 2.57E-03    |
| 2002 Dec 14| 03:27:27       | 1.60E+01    |
| 2003 Jan 1 | 20:43:38       | 3.79E-01    |
| 2003 Jan 15| 06:25:12       | 6.14E-03    |
| 2003 Jan 17| 17:36:14       | 2.21E+02    |

(Continued)
the 8 IPN columns: these are the right ascension (R.A.) and declination of the annulus center \( \alpha, \delta \), the annulus radius \( R \), and the uncertainty in the radius \( \delta R \). One or two annuli are specified. In addition to triangulation annuli, several other types of localization information are included in this catalog. The three SAX columns give the R.A., declination, and radius of the BeppoSAX gamma-ray burst monitor error circle (Frontera et al. 2009). The three HETE columns give the R.A., declination, and radius of the WXM or SXC error circle, whichever is smaller (R. Vanderspek et al. 2011, in preparation). 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 toward 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 R.A. and declination of the planet’s center and its radius, in the three planet columns. When a spacecraft in low Earth or Mars orbit observes a burst, the planet blocks up to \( \approx 3.7 \) 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 R.A., 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.28 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 R.A. is the R.A. of the planet plus 180°, whose declination is the negative of the planet’s declination, and whose radius is 180° 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 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 \( \times 10^{-7} \) erg cm\(^{-2}\) or 1 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.

28 http://swift.gsfc.nasa.gov/docs/swift/archive/grb_table/
29 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 \( \times 10^{-7} \) erg cm\(^{-2}\) or 1 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.

Notes.

a Hurley et al. (2000b).
 b Hurley et al. (2000c).
 c Laros et al. (1998).
 d Hurley et al. (1999a).
 e Laros et al. (2005).
 f Hurley et al. (1999b).
 g V. Pal’shin et al. (2011, in preparation).
 h Hurley et al. (2011).
 i Hurley et al. (2010).
 j Present catalog.
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.

Between 2000 and 2006, support for the interplanetary network came from the following sources: JPL Contracts 958056 and 1268385 (Ulysses), MIT Contract SC-R-293291 and NASA NAGS-11451 (HETE), NASA NNx07AH52G (Konus), NASA NAGS-13080 (RHESSI), NASA NAGS-12614 and NNG04GM50G (INTEGRAL), NASA NAGS-11451 and JPL Contract 1282043 (Odyssey), NASA NNG05GF72G (Swift), NASA NAGS-9126 (BeppoSAX), NASA NNx06AI36G (Suzaku), NASA NAGS-9503 (NEAR), and NASA NNX07AR71G (MESSENGER). In Russia, this work was supported by the Federal Space Agency of Russia and RFBR Grant 09-02-00166a. C.G., F.F., and E.M. acknowledge financial support by ASI-INAF contract I/088/06/0.

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