A SECOND CATALOG OF GAMMA RAY BURSTS: 1978-1980 LOCALIZATIONS FROM THE INTERPLANETARY NETWORK

J.-L. Atteia, C. Barat, K. Hurley, M. Niel, G. Vedrenne
C.E.S.R., B.P. 4346, 31029 Toulouse Cedex, France

W.D. Evans, E.E. Fenimore, R.W. Klebesadel, J.G. Laros
Los Alamos National Laboratory, Los Alamos, NM

T. Cline, U. Desai, B. Teegarden
Goddard Space Flight Center, Greenbelt, MD

I. Estulin*, V. Zenchenko, A. Kuznetsov, and V. Kurt
Institute for Space Research, Moscow, U.S.S.R.

*Deceased

ABSTRACT

82 gamma ray bursts were detected between 1978 September 14 and 1980 February 13 by the experiments of the interplanetary network (Prognoz 7, Venera 11 and 12 SIGNE experments, Pioneer Venus Orbiter, International Sun-Earth Explorer 3, Helios 2, and Vela). 65 of these events have been localized to annuli or error boxes by the the method of arrival time analysis. The distribution of sources is consistent with isotropy, and there is no statistically convincing evidence for the detection of more than one burst from any source position. The localizations are compared with those of two previous catalogs.

1. Introduction. In a previous catalog (Klebesadel et al., 1982), localization and earth crossing time data were presented for 111 gamma ray bursts which occurred between 1967 July and 1979 June. In it, information on events occurring between 1978 September 14 and 1979 June 13 was obtained from the data base of the interplanetary network. A final analysis of the localization, time history, and earth crossing time data from this network has now been completed (Atteia et al., 1985), and a brief summary of the localizations will be given here. Since the data of the KONUS experiments (Mazets et al., 1981) cover the same time period, comparisons will be made with both the KONUS catalog and that of Klebesadel et al. (1982).

2. Characteristics of the Network. The network comprises over 30 separate detectors, with different sensitivities and geometries. As a whole, however, the response of the network was isotropic, and the weakest burst detected had a fluence of 3×10^{-7} erg/cm^2. One of the criteria for acceptance in this catalog was that an event be detected by instruments on at least two different spacecraft. Confirmation of candidate events was therefore sought not only in the data base of the interplanetary network, but also in those of the HEAO A-1 and C-1 experiments, and in the published data from the KONUS experiments. Wherever practical and feasible, these data were used to complete or refine the localizations, as explained in detail in Atteia et al. (1985).

3. Comparison of Three Catalogs. Table 1 compares the numbers of events and localizations in the catalogs of Klebesadel et al. (1982) and Mazets et al. (1981) with those of this catalog. If the 3σ error box sizes are considered, it is evident that the present catalog represents an improvement of a factor of 5-10. A more qualitative impression may be obtained by considering Figures 1, 2, and 3, which display the localizations of the three catalogs in galactic coordinates.

4. Spatial Distribution. A subset of 47 bursts localized in this catalog has been used to study the spatial distribution of bursters in galactic coordinates. The selection criteria for these events is discussed in Atteia et al. (1985). This study is limited, for statistical reasons, to a consideration of possible north-south asymmetries. Such an asymmetry is present in the data of the KONUS catalog, which detected 40 events in the south galactic hemisphere, and 20 in the north. The possible causes have been discussed in Laros et al. (1982 and 1983) and in Mazets and Golenetskii (1982). In the present catalog, 24 events have been found to lie in the north galactic

hemisphere, and 23 in the south. Thus the data are consistent with the hypothesis that bursters are distributed isotropically and that the network had an isotropic response. On the other hand, the KONUS data are inconsistent with the hypothesis that bursters are distributed isotropically and that the KONUS experiment has an isotropic response (probability <0.01). It is, however, possible to choose a slightly anisotropic distribution (42% of the bursters in the north hemisphere, 58% in the south) which agrees with both data sets with probability >0.1.

Although a large number of overlapping error regions may be found in this catalog, the number is roughly in agreement with that which would be predicted on the basis of purely random coincidences. Thus it seems quite likely that no cases were detected in which more than one burst was emitted from a single source. This is discussed further in paper OG1.2-5, and in Atteia et al. (1985).

Figure 4 displays the distribution of 86 gamma ray bursts. 84 of them have been taken from the 3 catalogs cited above, and two from Katoh et al. (1984) and Hueter (1984). Figure 5 shows the latitude distribution of these localizations, as well as that expected if the distribution is isotropic. Caution should be exercised in interpreting these two figures, as no attempt has been made to correct them for possible selection effects (e.g. Laros et al., 1982 and 1983; Mazets and Golenetskii, 1982).

TABLE 1. COMPARISONS OF 3 GAMMA RAY BURST CATALOGS

	Klebesadel et al. 1982	Mazets et al. 1981	This Catalog
Total No. of Events	111	143	81
Total No. of Localizations	62	80	65
% Sky Covered by Localizations	78(3σ)	46(1σ)	9(3σ)
Average No. of Arcmin^2/Localization	1.2×10^6	8.5×10^5	2.1×10^5
No. of Events in Common with Klebesadel et al.	----	33	38
No. of Events in Common with This Catalog	----	68	----

No. of Events Which All 3 Catalogs Have in Common: 33

5. Acknowledgements. This work was supported on the French side by CNES Contracts 78-212, 79-212, and 80-212; at LANL, the effort was carried out under NASA Contracts A-47981B (PVO), NAS 5-22307 (ISEE-3), and under the auspices of the United States Department of Energy.

6. References.

Atteia, J.-L. et al. (1985), Ap. J. Supp. (submitted)
Hueter, G. (1984), in AIP Conference Proceedings No. 115, High Energy Transients in Astrophysics, S. Woosley, Editor, AIP Press, New York, p. 373
Katoh, M. et al. (1984), in AIP Conference Proceedings No. 115, High Energy Transients in Astrophysics, S. Woosley, Editor, AIP Press, New York, p. 390
Klebesadel, R. et al. (1982), Ap. J. Lett., 259, L51
Laros, J. et al. (1982), Astrophys. Space Sci., 88, 243
Laros, J. et al. (1983), Astrophys. Space Sci., 96, 213
Mazets, E. et al. (1981), Astrophys. Space Sci., 80, 3
Mazets, E. and Golenetskii, S. (1982), Astrophys. Space Sci., 88, 247

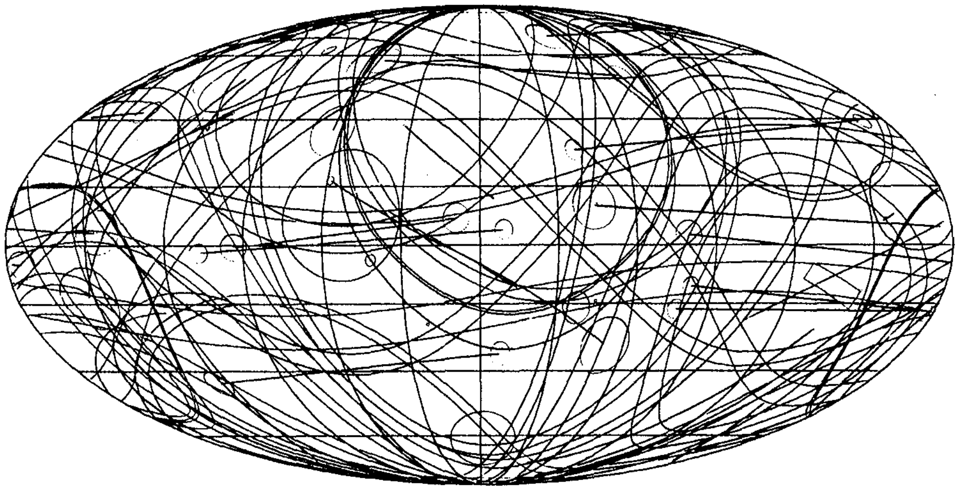

Fig. 1. The 62 localizations of Klebesadel et al. (1982) in galactic coordinates. 78% of the sky is covered by these 3σ regions.

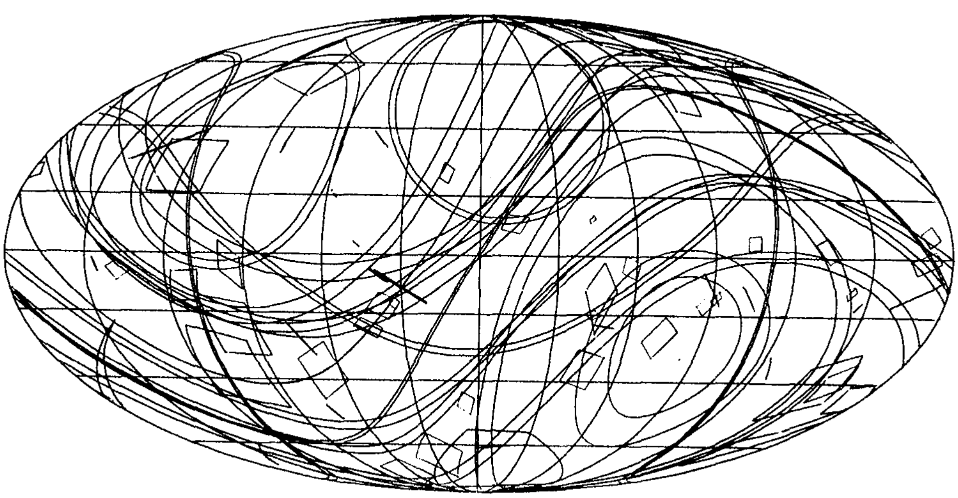

Fig. 2. The 80 localizations of Mazets et al. (1981) in galactic coordinates. 46% of the sky is covered by these 1σ regions.

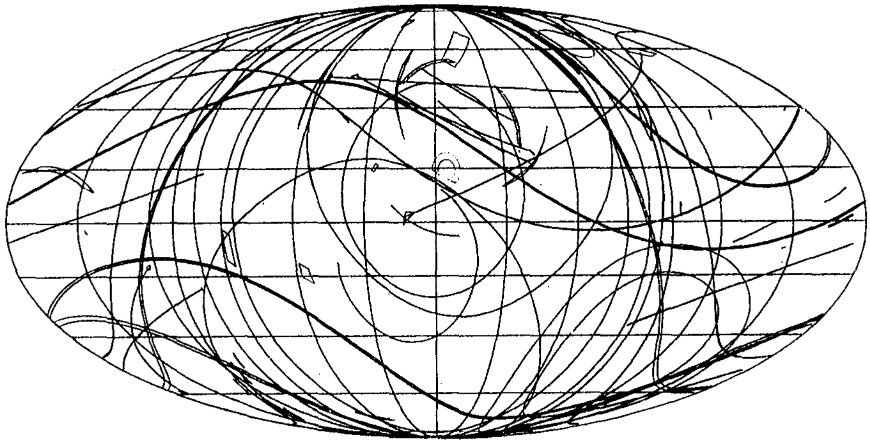

Fig. 3. The 65 localizations of Atteia et al. (1985) in galactic coordinates. 9% of the sky is covered by these 3σ regions.

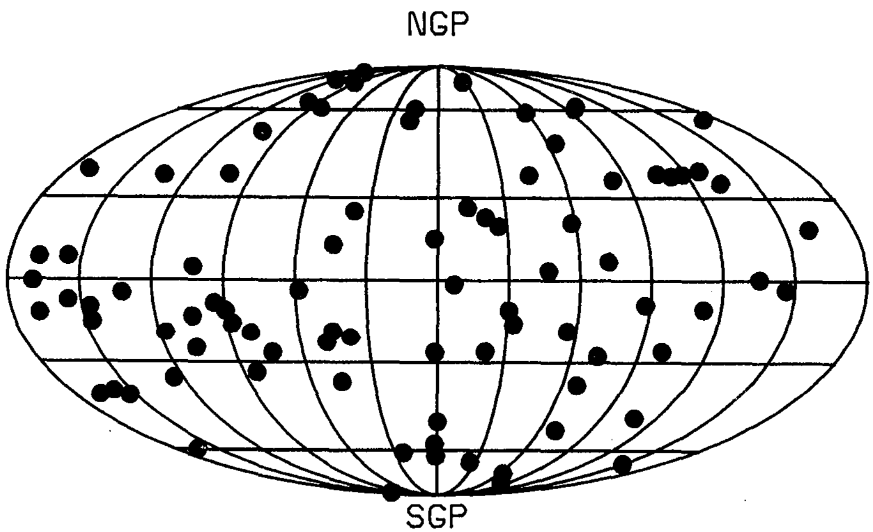

Fig. 4. The distribution of 86 bursters, taken from the references given in the text.

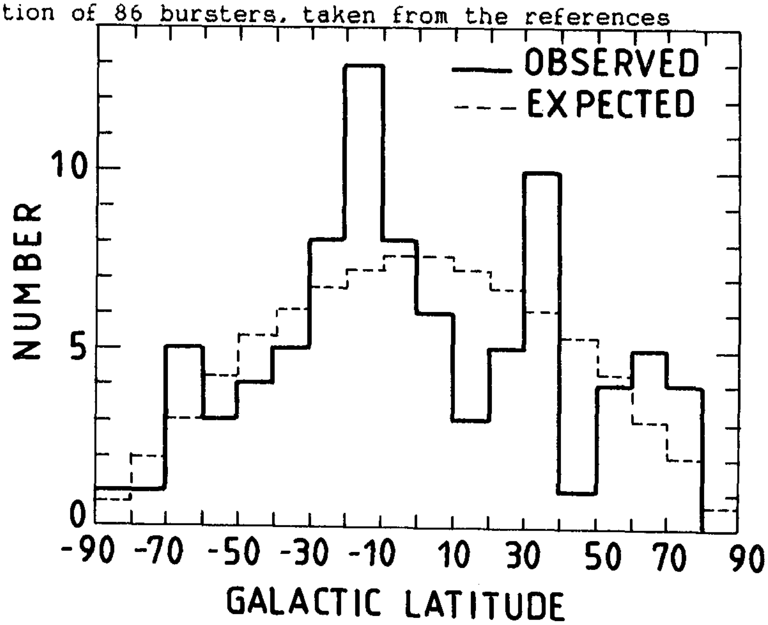

Fig. 5. The distribution of the number of bursters as a function of galactic latitude, in 10° bins, based on the 86 events in Fig. 4. The dashed line is the distribution expected on the basis of isotropy.