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7.3 GSETT-2 Evaluation: Detection of aftershocks from the W. Caucasus earthquake of 29 April 1991

Introduction

On 29 April 1991 a large earthquake (M_S = 7.3) occurred in western Caucasus, with coordinates 42.453N, 43.673E, h = 17 km (NEIC).

The earthquake was followed by a large number of aftershocks. According to the catalogue of Starovoit et al (1992), 114 aftershocks were recorded on the day of the main shock (29 April) and 360 aftershocks had been recorded by the end of May.

The earthquake occurred early during GSETT-2 (main phase), and caused a considerable load at the NDCs as well as EIDCs. The day 29 April has been selected as one of the days for which reprocessing will be made at EIDCs. Consequently, this day is useful for studying the performance of the experimental global system during a day of particularly high seismic activity.

Method

In this paper we address the detection capability of the system in place during GSETT-2, and compare with NEIC bulletins. We use the method of Ringdal (1975), whereby the system to be evaluated is compared with an independent reference system. The reference is in this case provided by the catalogue of Starovoit et al (1992). The event sizes in that catalogue are quoted in terms of the K-value of each event. The K-value is related to M_S by the formula

$$K = M_s \cdot 1.8 + 4.0 \quad (1)$$

We have converted all K-values to M_S using (1) prior to applying the maximum-likelihood estimation technique.

Data

Table 7.3.1 summarizes the number of detected events by the various systems. We note that the two EIDCs for which we had data (reprocessed CELs from Stockholm and Washington) had a very similar performance, and reported about half of the events in the reference catalogue. NEIC reported only one third of the reference events in their monthly bulletin. The rapid QED service (Quick Epicenter Determination) reported very few of the events.

Note that the QED follows approximately the same time schedule as the CELs and FEB. Therefore, a comparison between the QED and the final CEL is of interest. We note, however, that the revised CELs were compiled with a delay of many months.

Detectability

The results of the detectability study are summarized in Figs. 7.3.1-6.3.4 and Table 7.3.2.

Figs. 7.3.1-7.3.2 show the detectability estimates for the GSETT-2 revised CEL (STOIDC) and NEIC. The data cover aftershocks during the day 29 April. The detectability of GSETT-2 is better than NEIC by at least one half magnitude unit. However, it is noteworthy that almost all of the "larger" events missed by either system were earthquakes within 3 hours of the main shock.

In light of this observation, we also computed detectability statistics for the time interval 12-24 GMT on 29 April, i.e., excluding the first 3 hours after the main shock. The results are shown in Figs. 7.3.3-7.3.4, and show improvements for both systems. In particular, the improvement is significant for NEIC.

Conclusion

The detectability of the GSETT-2 system for the W. Caucasus earthquake sequence is better than that of NEIC. The difference is particularly significant during the first 3 hours after the main shock.

It appears that a main reason for this good GSETT-2 performance is the reporting by sensitive regional arrays. It was also helpful to have a local station (KIV) at only 2 degrees distance, but it appears that almost all of the events would have been reported even without KIV data. However, the KIV data undoubtedly contributed to improving the location accuracy of the GSETT-2 reportings.

F. Ringdal

References

Ringdal, F. (1975): On the estimation of seismic detection thresholds, *Bull. Seism. Soc. Am.*, 65, 1631-1642.

Starovoit et al (1992): Catalog of aftershocks of the West Caucasus earthquake of 29 April 1991.

	Number of Events
Starovoit et al catalogue	115
Stockholm CEL (revised)	63
Washington CEL (revised)	57
NEIC monthly list	35
QED list	6

Table 7.3.1. Earthquakes reported for 29 April 1991, Caucasus sequence. For the two CELs in the table, only events confirmed by the Starovoit et al catalogue have been counted.

	μ	σ	μ_{90}
All events on 29 April:			
GSETT-2 revised CEL	3.62	0.28	3.98
NEIC	4.07	0.37	4.55
Events during 1200-2400 on 29 April:			
GSETT-2 revised CEL	3.58	0.22	3.86
NEIC	3.86	0.10	3.99

Table 7.3.2. Detectability estimates for Caucasus sequence, in terms of M_s computed from Starovoit et al (1992). Note that μ is the 50% incremental detection threshold, and μ_{90} is the 90% threshold

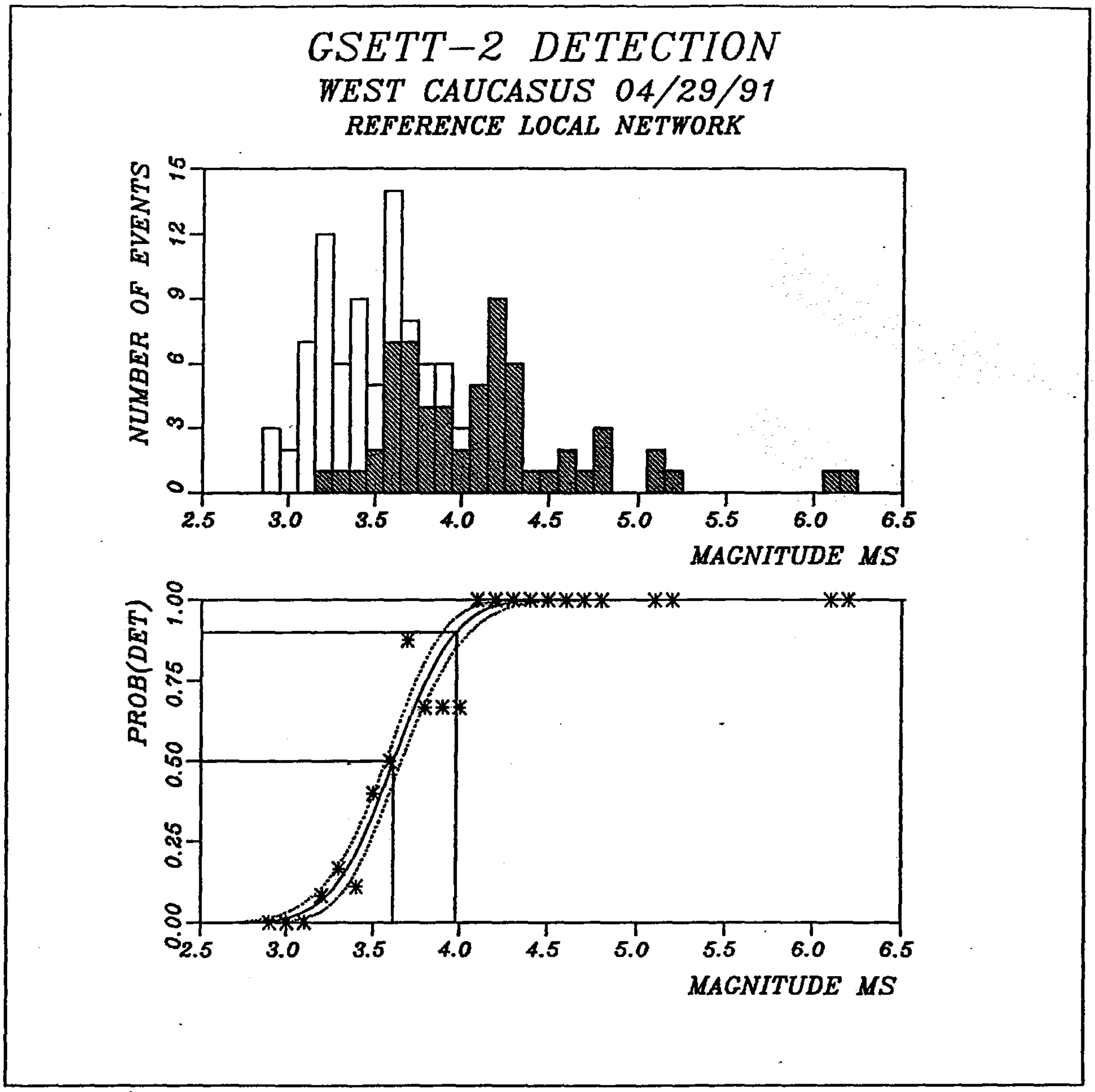

Fig. 7.3.1. *Detectability results for GSETT-2 revised CEL; 29 April*: Detectability estimate for W. Caucasus aftershocks using the catalogue of Starovoit et al (1992) as reference. The upper part shows the number of reference events at each magnitude, with the hatched columns indicating the number of detections. The lower part is a maximum likelihood detection curve.

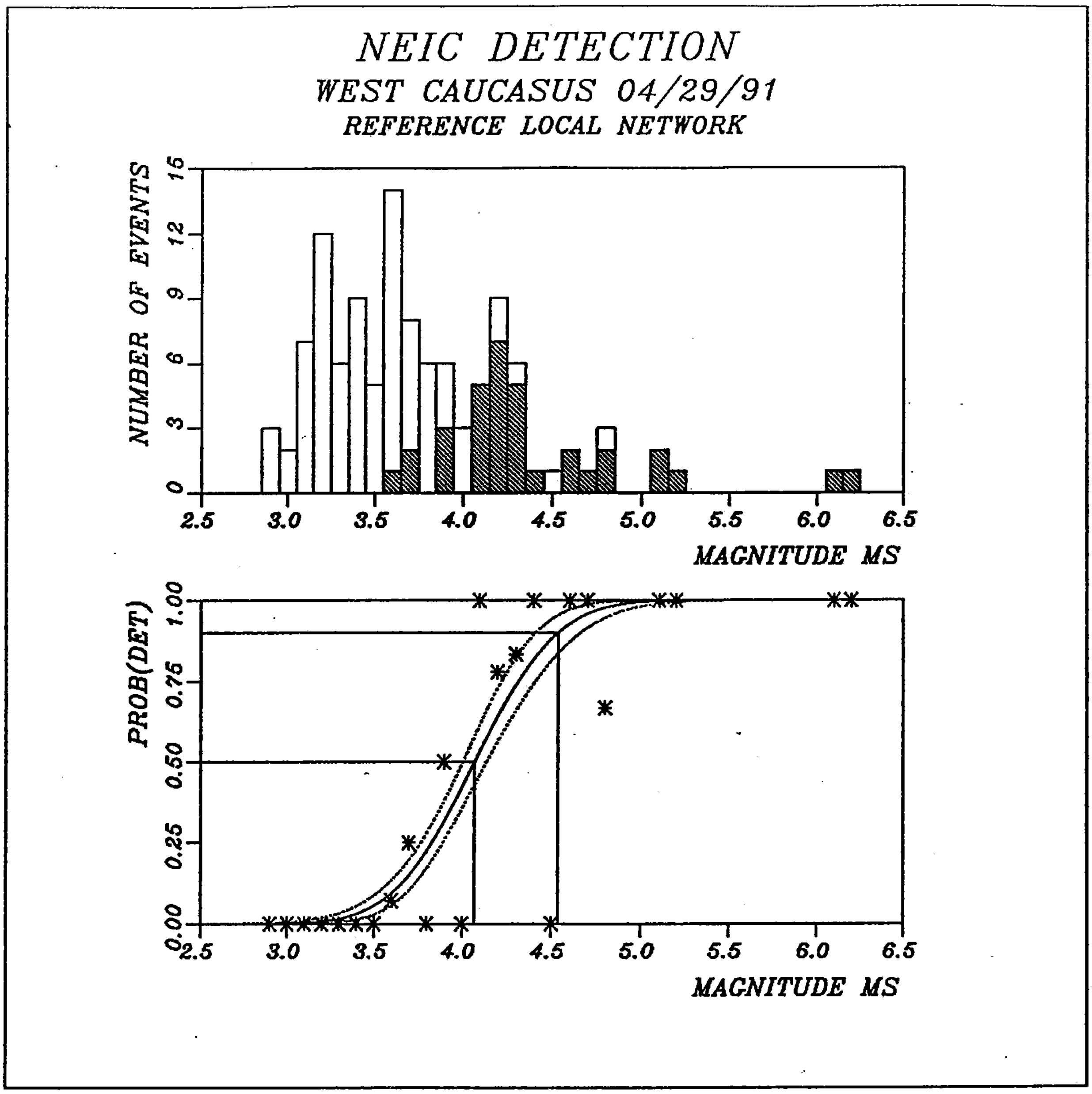

Fig. 7.3.2. *Detectabililty results for NEIC bulletin; 29 April:* Detectability estimate for W. Caucasus aftershocks using the catalogue of Starovoit et al (1992) as reference. The upper part shows the number of reference events at each magnitude, with the hatched columns indicating the number of detections. The lower part is a maximum likelihood detection curve.

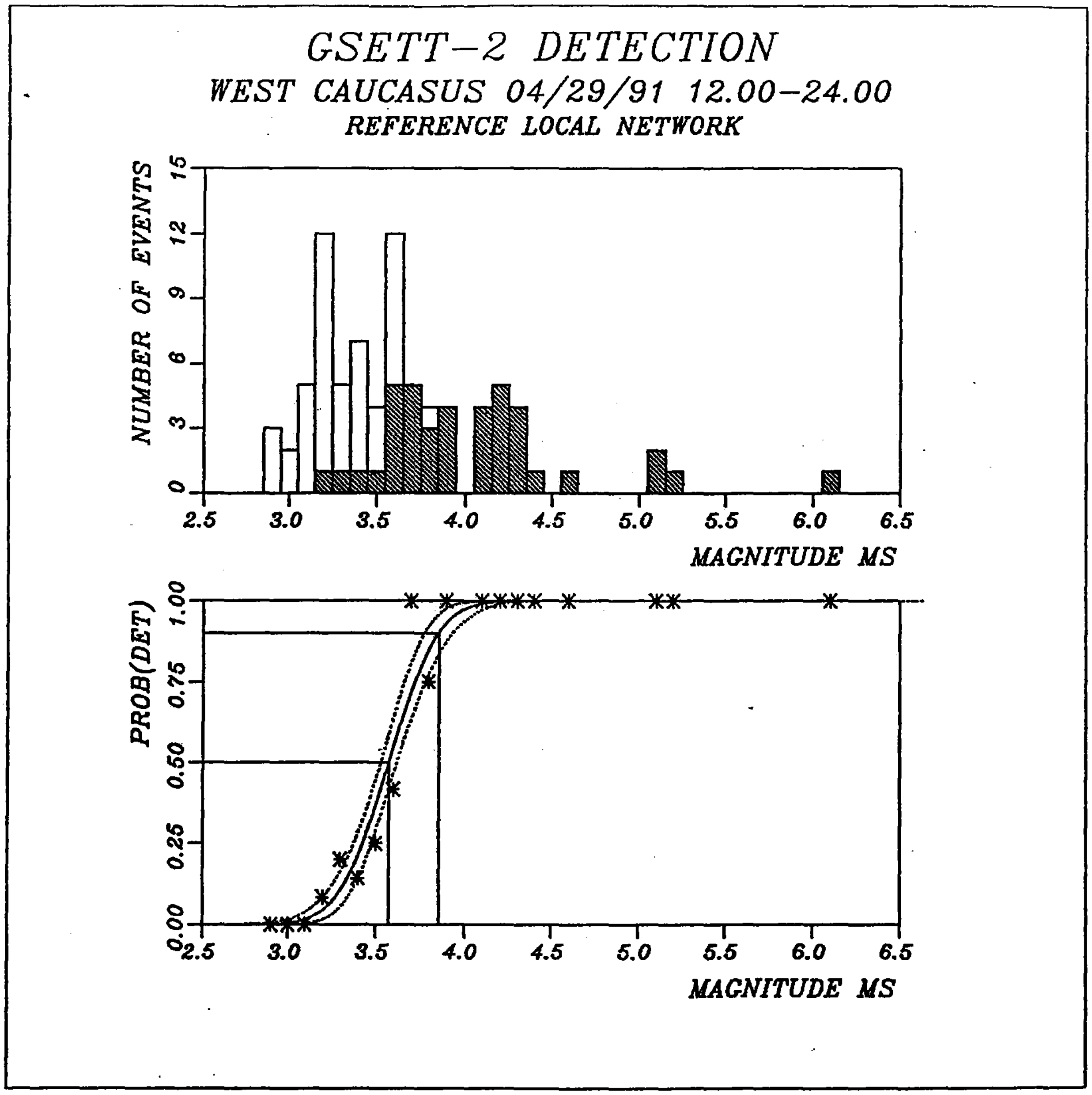

Fig. 7.3.3. *Detectability results for GSETT-2 revised CEL; 29 April 1200-2400*: Detectability estimate for W. Caucasus aftershocks using the catalogue of Starovoit et al (1992) as reference. The upper part shows the number of reference events at each magnitude, with the hatched columns indicating the number of detections. The lower part is a maximum likelihood detection curve.

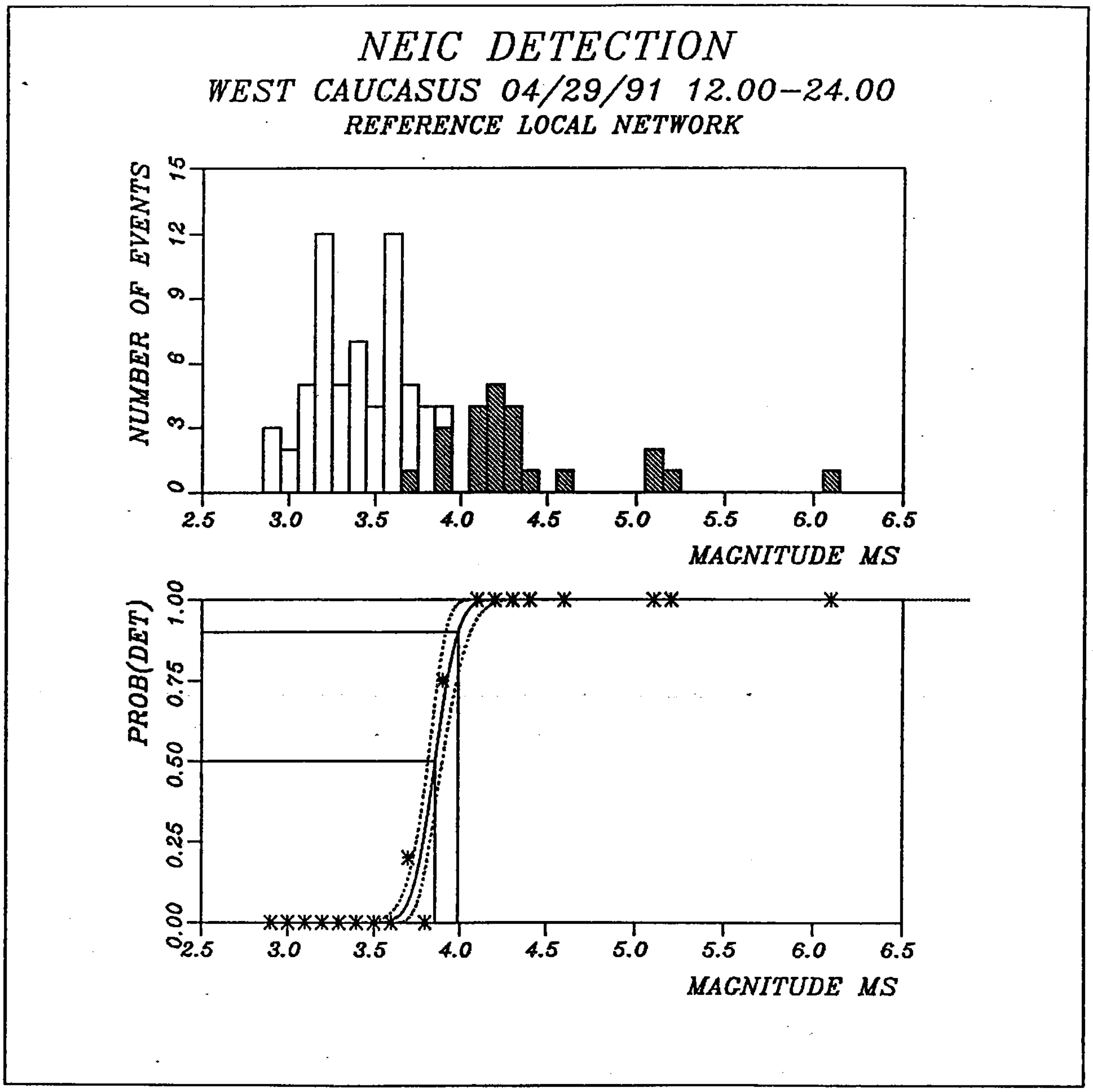

Fig. 7.3.4. *Detectability results for NEIC bulletin; 29 April 1200-2400*: Detectability estimate for W. Caucasus aftershocks using the catalogue of Starovoit et al (1992) as reference. The upper part shows the number of reference events at each magnitude, with the hatched columns indicating the number of detections. The lower part is a maximum likelihood detection curve.