



ABSTRACT

The assessment of Cross Correlation bulletin (XSEL) was done in order to determine to what extent the XSEL can be used as a master bulletin against which the REB can be compared in a spot check manner for two data days in October 2018 (first check and on a very limited data set). 208 and 449 events were used for REB and XSEL bulletins, respectively. The objectives were: 1) investigate XSEL new events; 2) assess quality of XSEL. For the first objective, waveform data for the 244 XSEL new events were investigated. Of these 10 (4.1%) were found to build legitimate events. For the second objective, REB and XSEL bulletins were compared. Matched and unmatched events were identified based on the number of common defining phases (≥ 2) and the arrival time differences between common phases (≤ 6 sec). Events not meeting these conditions are considered as unmatched events. The number of matched, unmatched REB and unmatched XSEL were 125, 83 and 324 events, respectively. About 61% of the matched events have location difference < 1 deg. Arrival time differences between common phases showed that in most cases they were picked earlier in XSEL than in REB.

INTRODUCTION

PTS/IDC is tasked to produce Reviewed Event Bulletin (REB) in a timely manner (currently within 10 days). The REB is also expected to be a high quality product. To accomplish this task, IDC has implemented a procedure which makes detection, characterization, Global Association(GA) and then build events from Seismic, Hydroacoustic and Infrasound (SHI) waveform records. The automatic events built by such procedure are interactively analyzed by analysts using Analyst Review Station (ARS) software to produce the REB. As an alternative and/or supplement software, the PTS has been considering development and testing of NET-VISA and Cross-correlation software. The NET-VISA software is already incorporated into OPS and is being used after the completion of the analysis of automatic SEL3 bulletin. This software uses the same automatic detections as GA at the SEL3 stage to build events: in fact the software is in use to include events which might have not been seen by the GA approach. The Cross Correlation software is currently under testing and uses an entirely different approach. It does not use detection and associated parameters produced by GA to build events. It depends on the results of cross correlation of several thousands of master events (templates from known events) identified for different geographic regions on the globe with incoming waveform data. Event detection is decided based on the level of Cross Correlation technique SNR values which are adjusted on a daily bases. There is also a desire to use this technique as a Spot Check tool by slightly rearranging the approach of the process for event detection and building. This approach is different from "the usual Spot Check procedure" that involves human interaction. A bulletin produced using the Cross Correlation technique is named "XSEL". Testing of this technique is to provide initial understanding to what extent XSEL is ready to be used in a spot check tool and steer the development to consider this aspect in greater detail.

OBJECTIVES

- The objectives for the XSEL bulletin assessment are as follows.
- 1) To investigate the legitimacy of XSEL events marked as "New" in the XSEL bulletin.
- 2) To assess the overall quality of the XSEL bulletin by comparing it with the REB bulletin to identify matched and unmatched events in the respective bulletins considered thereby assessing the quality of the XSEL bulletin relative to the REB.

INPUT DATA

a) Input data for "New" XSEL events investigation
To accomplish the task of investigation of the "New" XSEL events, two data days, 23/10/2018 and 27/10/2108 were selected. Waveform data for these events were uploaded into ARS using the "lebvew" account. Table 1 summarizes the number of "New" XSEL events for the two data days. A total of 244 events were investigated. The geographic distribution of the "New" XSEL events is displayed in Figure 1.

Table 1: Table showing the number of "New" XSEL events.

Date	No. of "New" XSEL events
23/10/2018	140
27/10/2018	104
Total	244

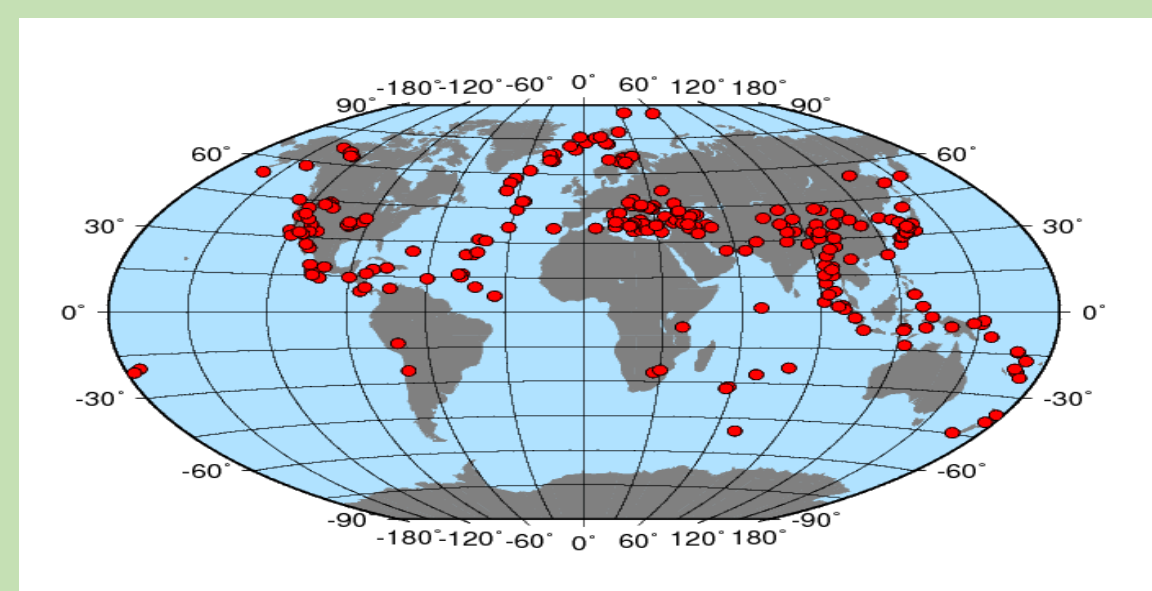


Fig. 1. Geographic distribution of the "New" XSEL events for the selected two data days.

b) Input data for comparing XSEL and REB bulletins.
For the comparison performed for this report, bulletins as obtained for two data days (23/09/2018 and 27/09/2018) were considered. For these data days a total of 208 (one infrasound event from REB excluded) and 449 events were available in REB and XSEL bulletins, respectively. A summary of number of events considered for comparison is presented in Table. 2 and Figure 2. Figure 3 shows the geographic distribution of the events.

Table 2: Summary of number of events on each day.

Date	REB	XSEL
2018/10/23	69	212
	(Infrasound Exc.)	
2018/10/27	139	237
Total	208	449

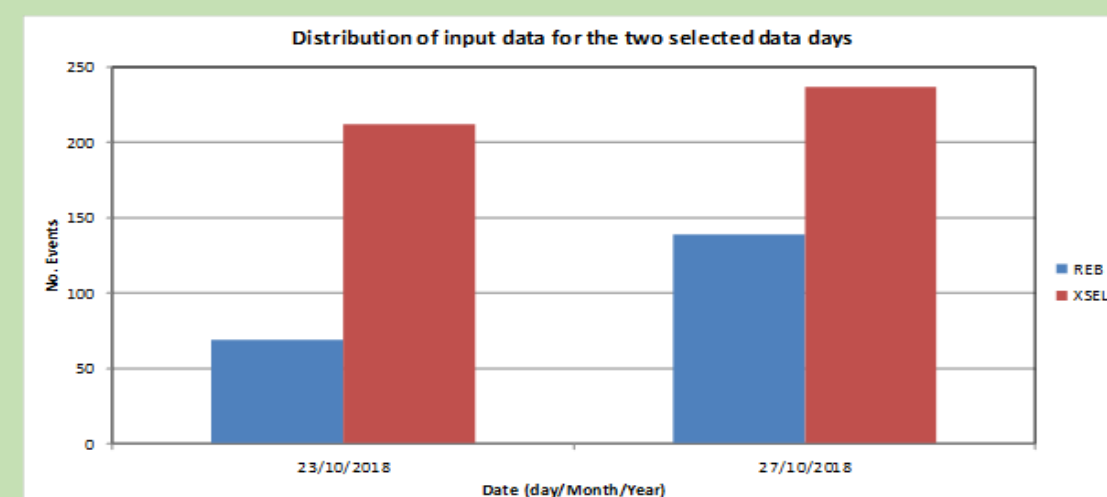


Fig. 2. Graphical display of number of events used.

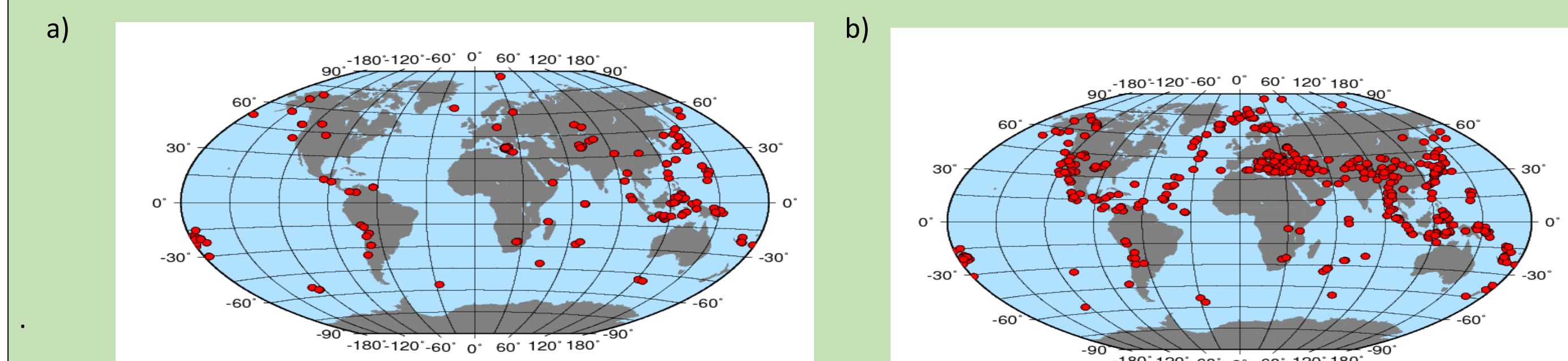


Fig.3. Geographical distribution of: a) REB and b) XSEL events

COMPARISON APPROACH AND CRITERIA

For the first objective, waveform data for "New" XSEL events are uploaded into ARS using a "lebvew" account and investigated (analyzed) for legitimacy by employing the Analysis Rules and Guidelines given in the "Analyst Instructions for Seismic, Hydroacoustic and Infrasound data" document. With regard to the second objective, REB bulletins are to be compared with the corresponding XSEL bulletins for the selected data days. Matched and unmatched events are identified based on the number of common defining phases and arrival time differences between these common phases. For this assessment, two events, one from each bulletin are considered as matched events if they share at least 2 station/phase pairs defining with arrival time difference between phase picks not exceeding 6 seconds. Otherwise, events not meeting these conditions are considered as unmatched events for the respective bulletins.

COMPARISON RESULTS

Comparison results for objective 1.

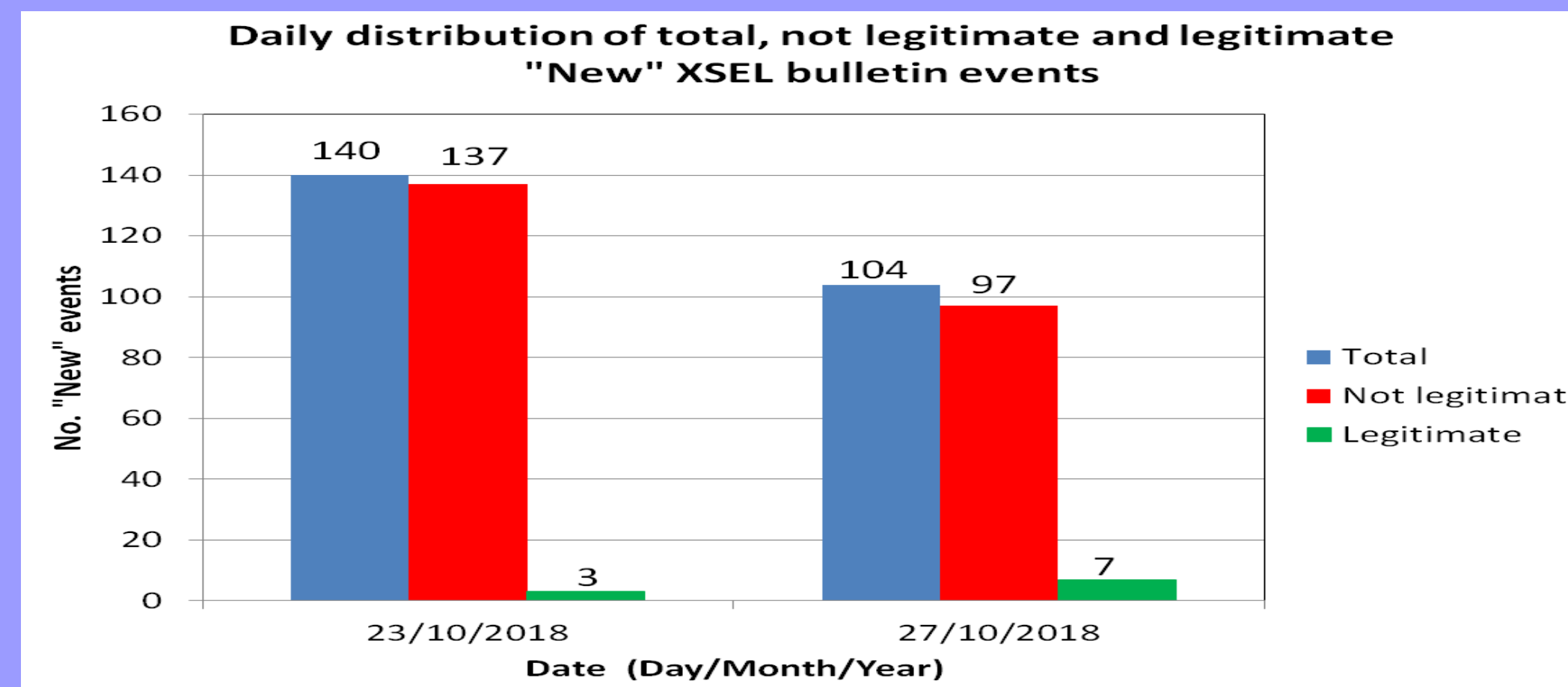


Fig. 4. Graphical display of number of events obtained as legitimate or not legitimate during investigation

As can be seen from Figure 4 only 10 events out of a total of 244 events were found legitimate. Sample waveform data and alpha list displays for the legitimate "New" XSEL event are given below in Figure 5.

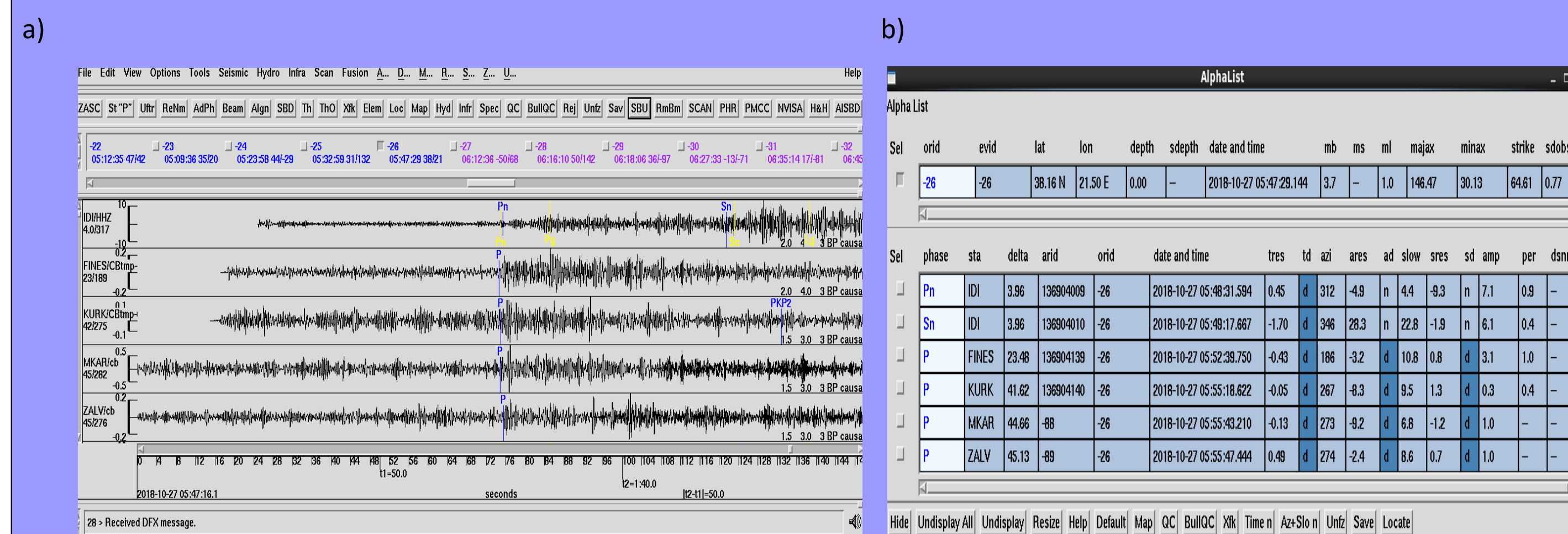


Fig. 5. Sample waveform data for the legitimate "New" XSEL event: a) waveform data and b) Alpha list display.

Comparison results for objective 2

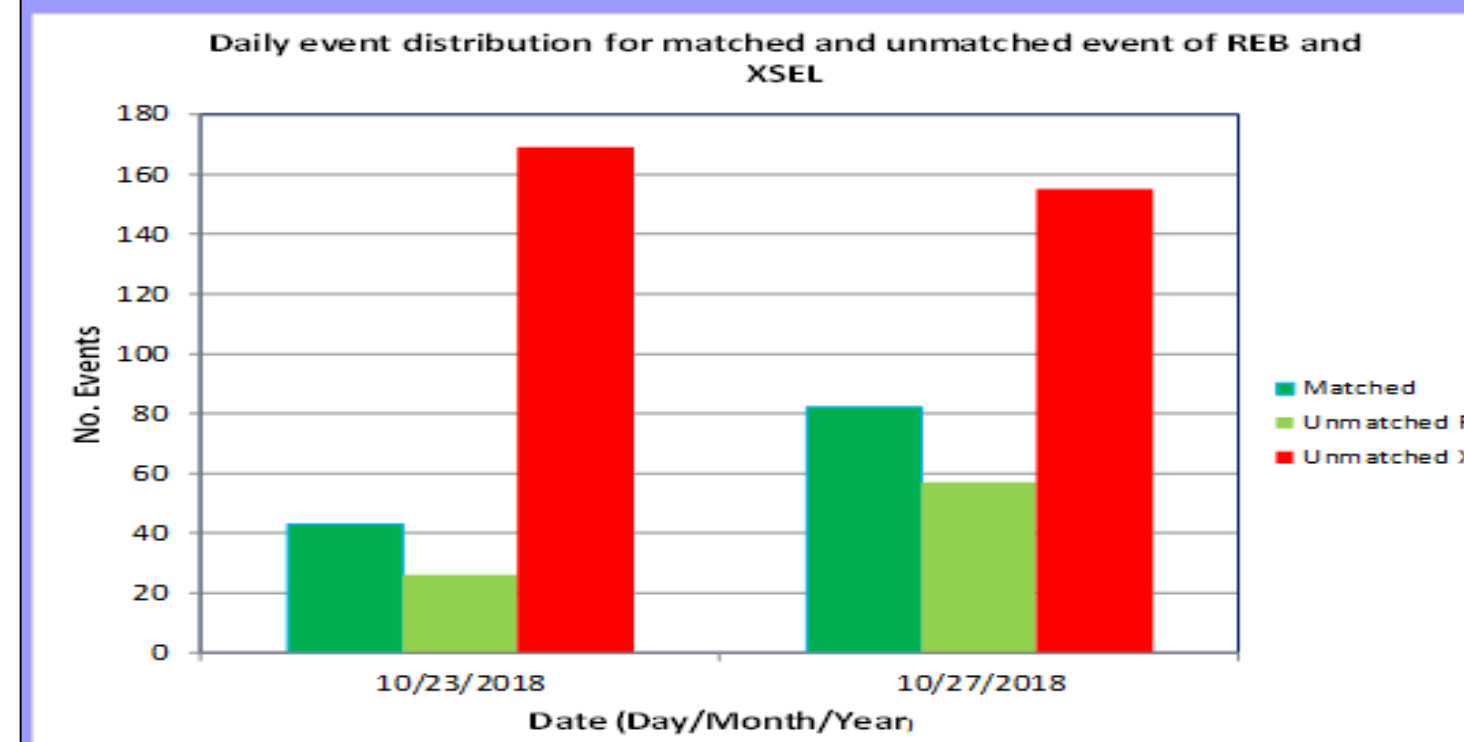


Fig. 6. Graphical display of the number of matched and unmatched events

As can be seen from Figure 6, the number of matched, unmatched REB and unmatched XSEL events is 125, 83 and 324, respectively.

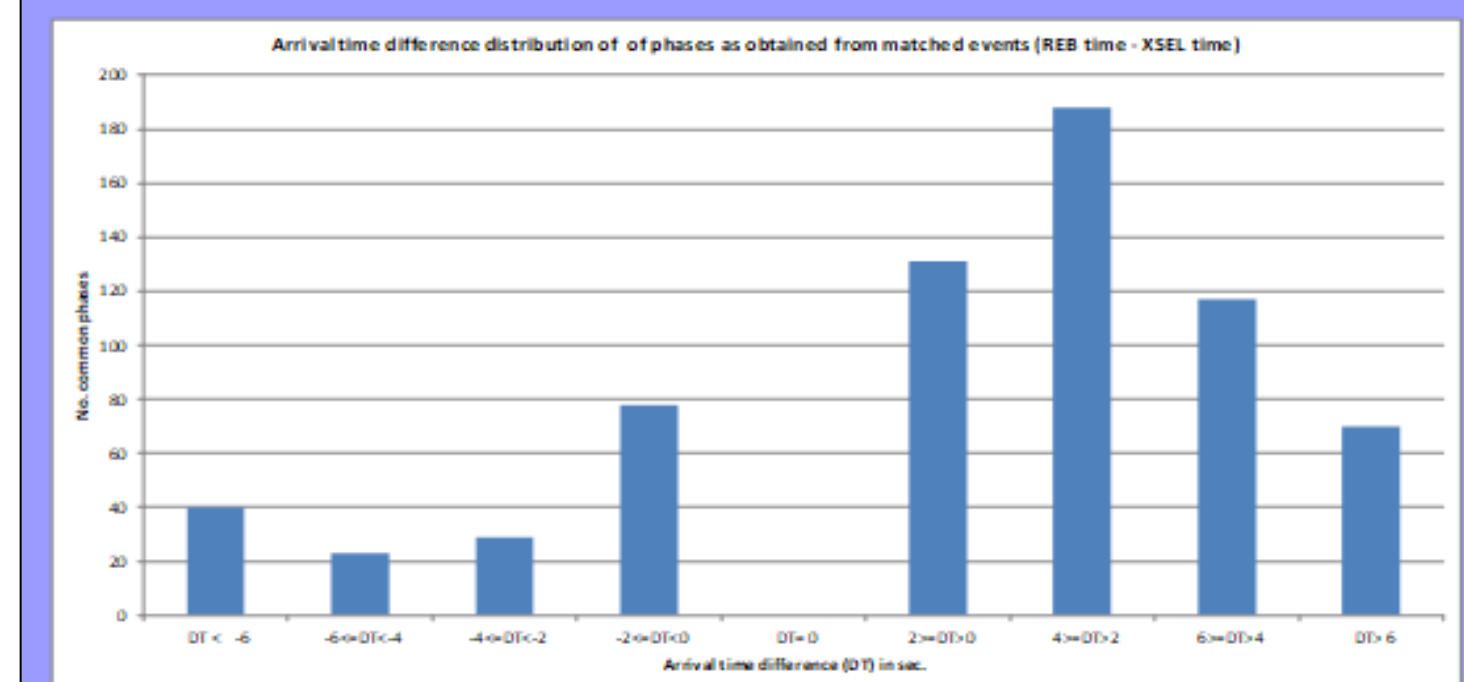


Fig. 8. Arrival time distribution for common station/phases pairs.

As can be seen from Figure 8, in most cases arrival times were picked earlier in XSEL than in REB.

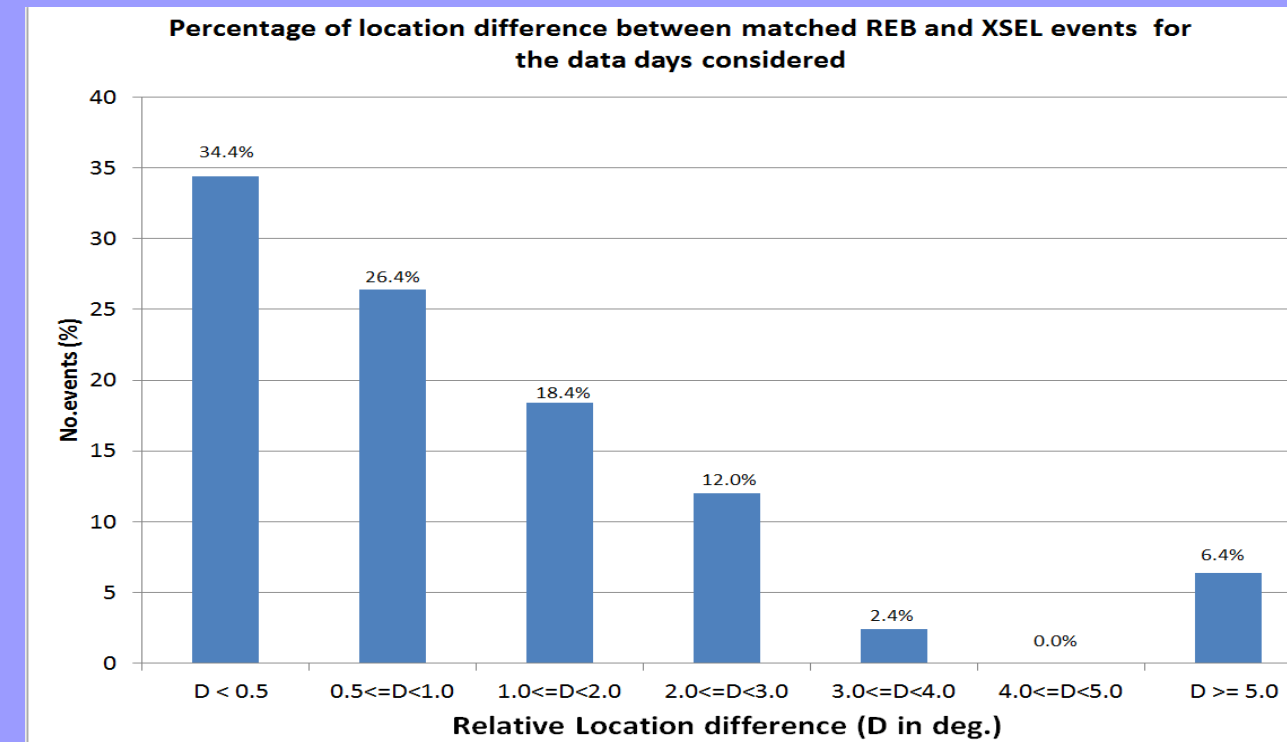


Fig. 7. Graphical display of location differences between matched events. The percentage of the number of events with location difference of < 1 deg. is 61%.

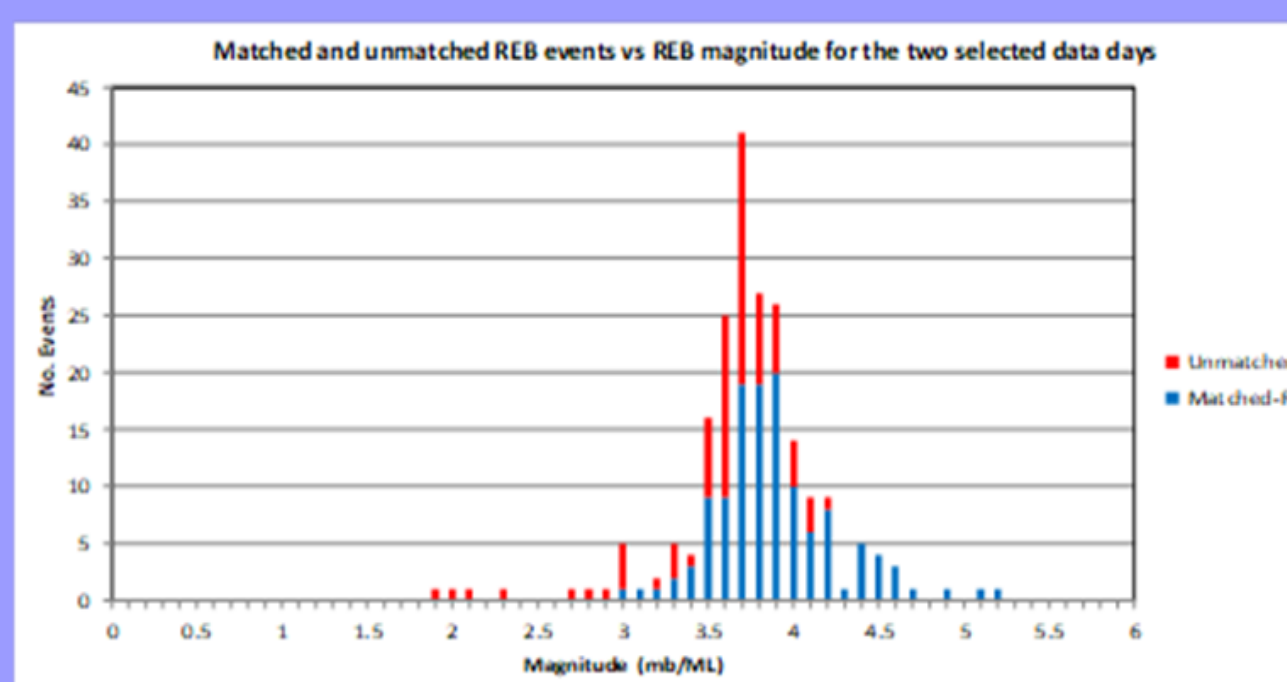


Fig. 9. Magnitude distribution of REB events
Figure 9 shows that some large REB events are not present in the XSEL bulletin.

UNMATCHED EVENTS

I) Unmatched REB events

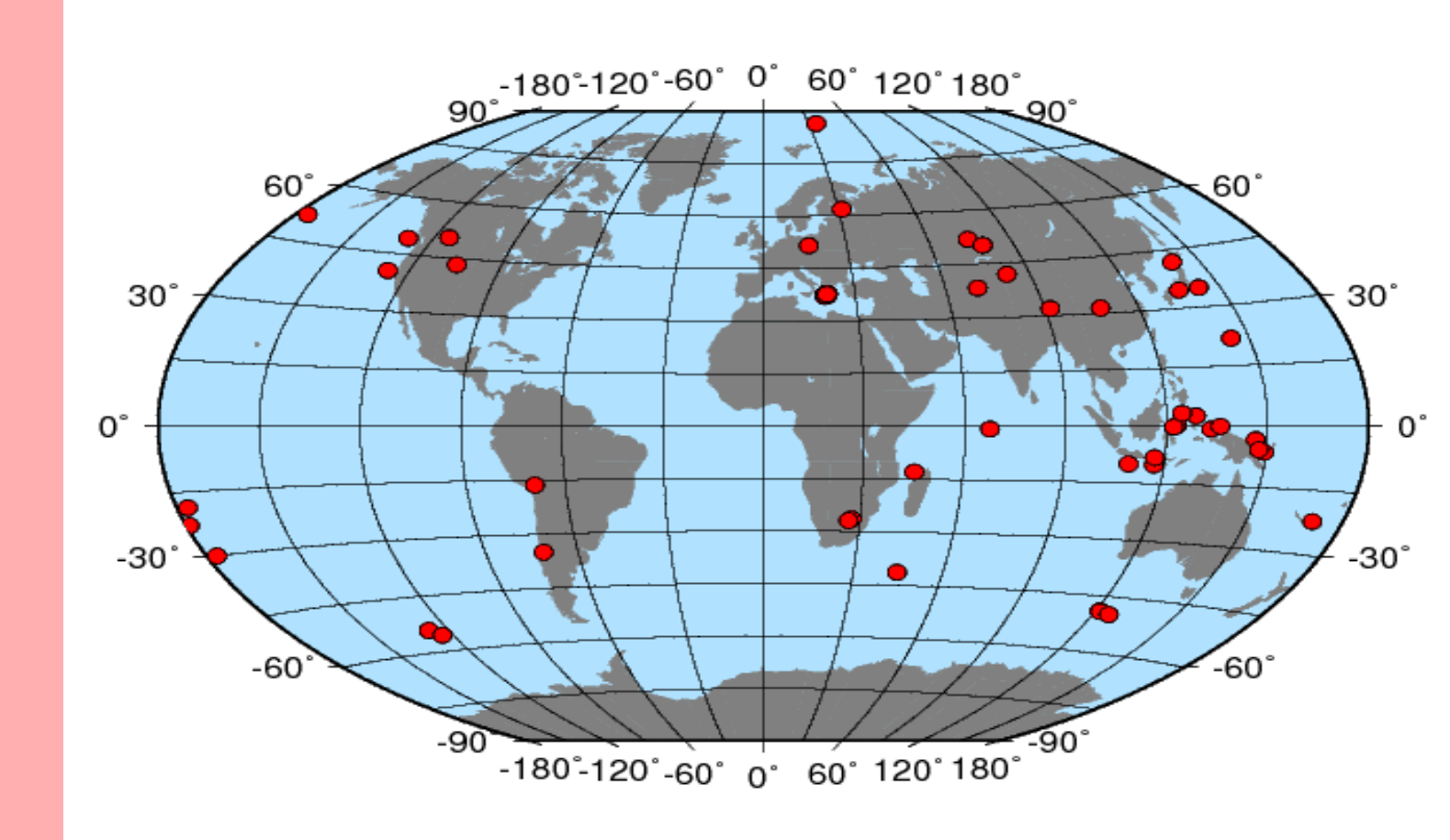


Fig. 10. Geographic distribution of unmatched REB events.

Sample waveform data and alpha list display for the unmatched REB event is shown in Figure 11.

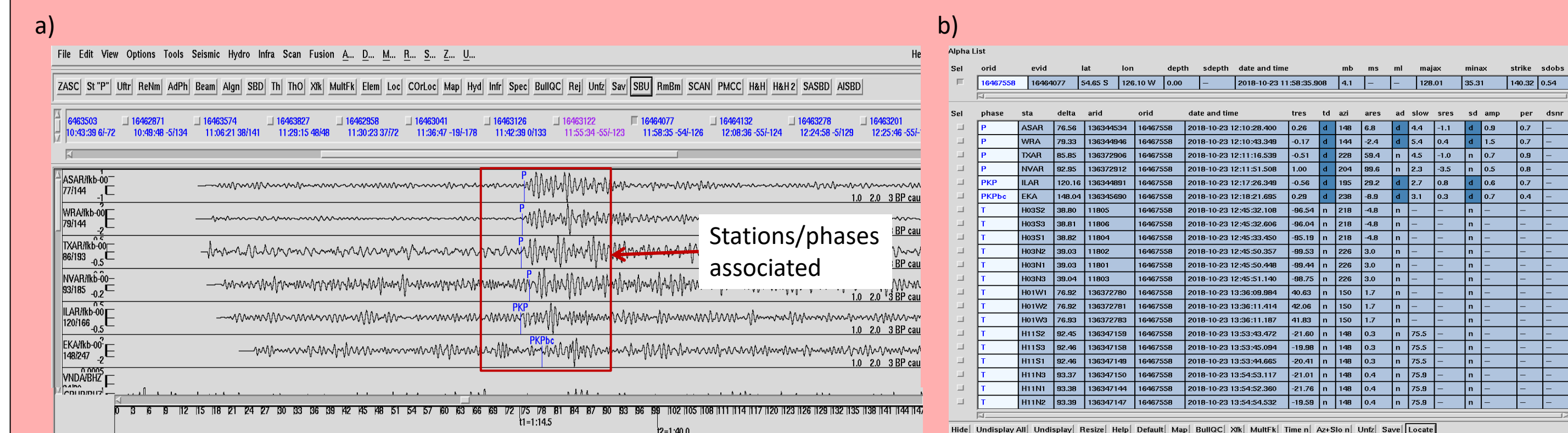


Fig. 11. Sample: a) waveform and b) Alpha list display for the unmatched REB event.

II) Unmatched XSEL events

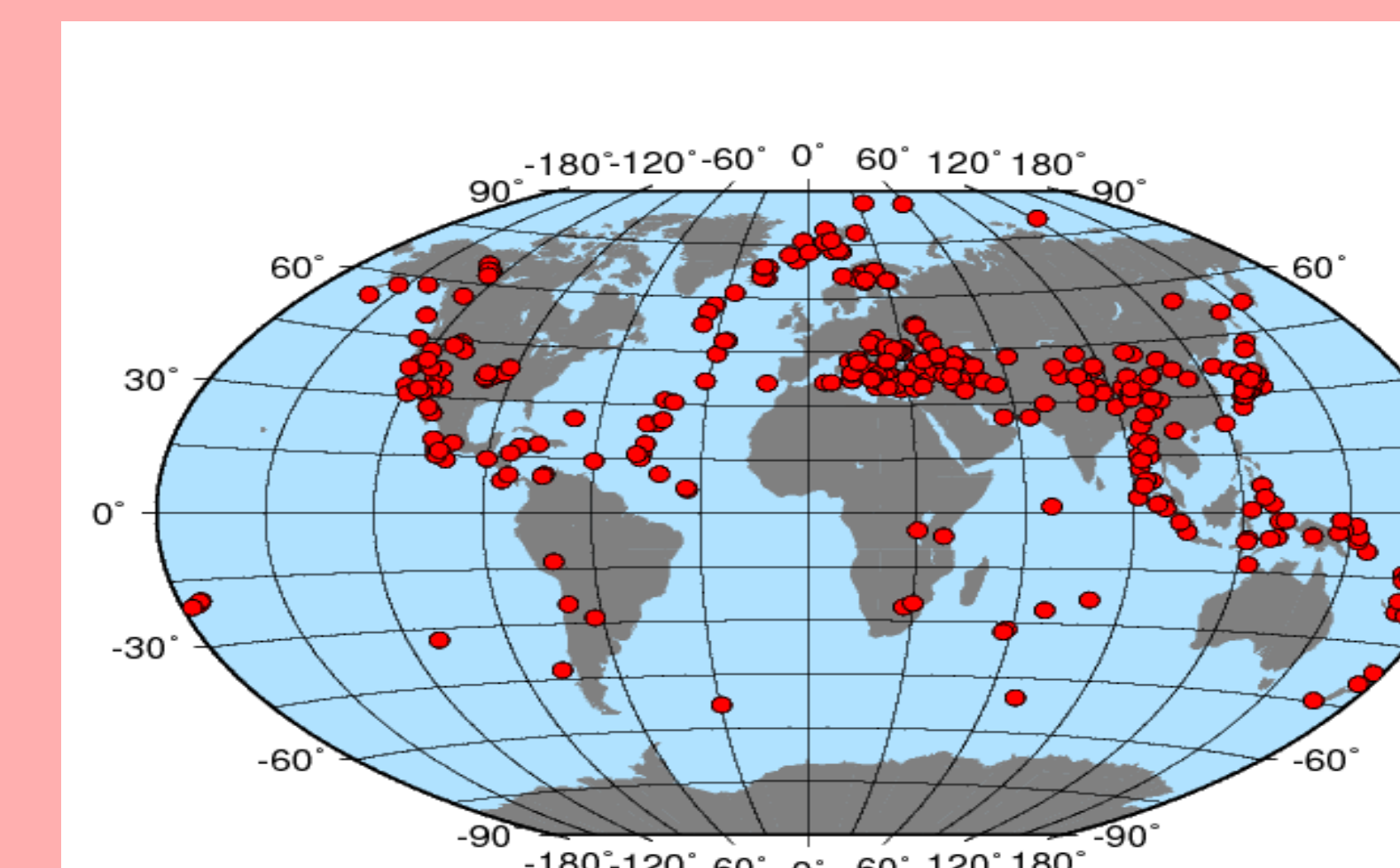


Fig. 12. Geographic distribution of unmatched XSEL events.

Sample waveform data display for the unmatched XSEL bulletin is shown in Figure 13.

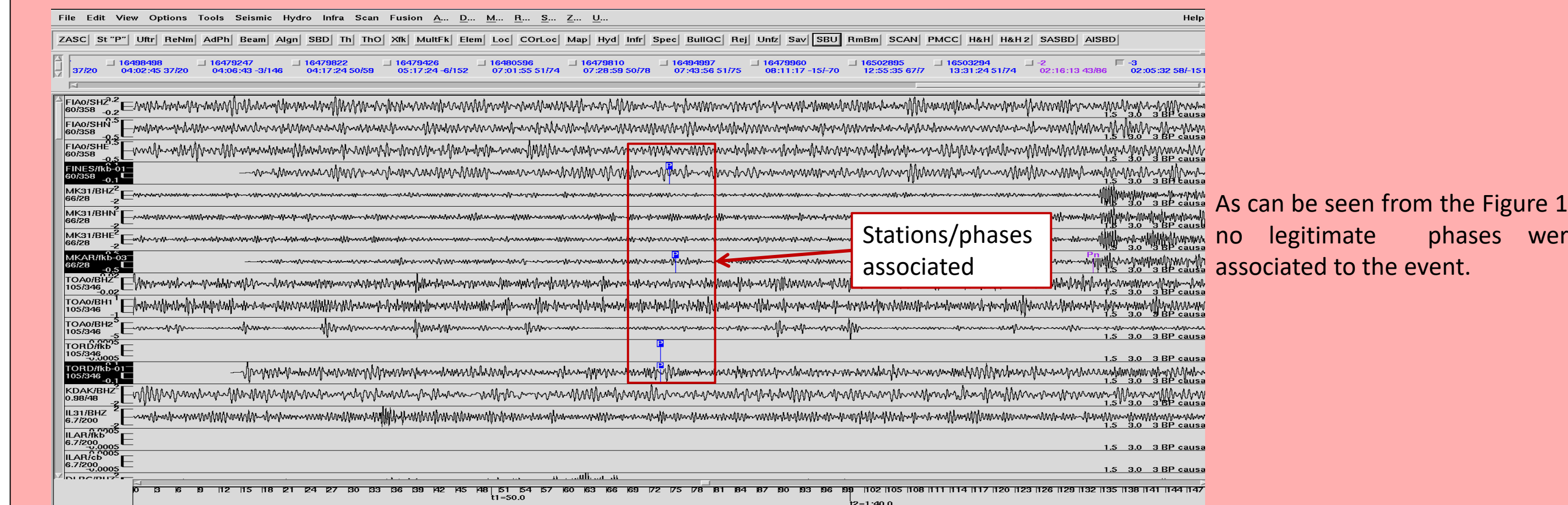


Fig. 13. Sample waveform display for the unmatched XSEL event.

Figure 12 shows that most of the unmatched XSEL events were located in Asia, South east Asia, North America and North Atlantic Ridge.

As can be seen from the Figure 13 no legitimate phases were associated to the event.

CONCLUSION

- Most of the unmatched XSEL events are located on land.
- Large arrival time differences between common station/phases pairs are observed.
- In most cases the cross correlation technique picks earlier than the standard STA/LTA IDC method.
- The majority of the NEW XSEL events were not legitimate when compared to the REB (only 10 out of 244 were legitimate)
- The technique needs to implement additional constraints to reduce the number of false events and reduce the parameter estimate differences for those matched events.