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Assessment of the impact of interactive analysis on Primary Array Seismic stations detections associated with building the automatically produced SEL3 events

Fekadu Kebede Alamneh[1], Ehsan Qorbani[2], Gerard Rambolamanana[3], Gerhard Graham[2]

[1] IGSSA, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia, (fkalamneh@gmail.com /+2251-940179856)
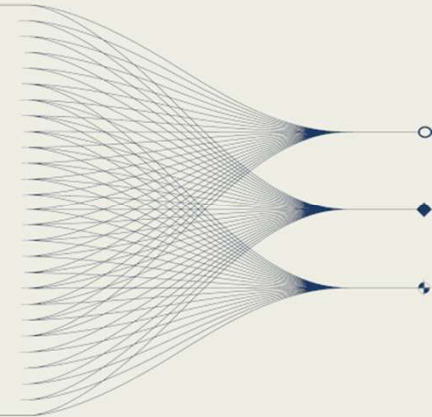[2] International Data Center, CTBTO, Vienna, 1400 Austria
[3] Previous staff with IDC

INTRODUCTION AND MAIN RESULTS

This presentation provides insights into the impact of interactive analysis as applied to the SEL3 automatic bulletin during the process leading to the REB production. The impact is assessed through evaluating actions performed on automatic detections by manually added, associated, dis-associated, renamed, retimed and performing FK analysis. The statistics obtained in relation to the actions under consideration are presented in graphical form.

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Introduction

The ability of automatic data processing at the CTBTO results in identifying and estimating parameters for phases detected by the International Monitoring System (IMS) stations. Use of these detections results in the production of three standard automatic bulletins with the final being the automatic Event List3 (SEL3). The SEL3 automatic bulletin is the more complete automatic bulletin and is an initial input of data for interactive analysis leading to the production of REB. During interactive analysis, the SEL3 event solutions are refined by modifying, or re-estimating automatically obtained phase attributes. These actions include: (1) manually adding phases, (2) manually associating valid automatic detections (3) disassociating inappropriately used phases, (4) renaming phases, (5) re-timing phases, and (6) re-estimating phase parameters for azimuth and slowness (FK analysis).

Objective

The main objective of this study is to assess the impact of interactive analysis in the process leading to the production of the REB. The data used for the purpose were obtained from the IMS stations that contributed waveform data during the study period.

Input data and assessment approach

The data used in this study is extracted from DC data base. For the purpose detection data for Primary Seismic arrays is utilized. The geographic distribution of the Primary Seismic array stations operating during the study period (2023-2024) is shown in Figure 1.
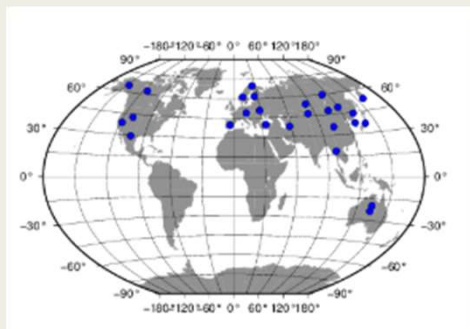

Fig. 1. Distribution of IMS Primary Seismic array stations that contributed to the assessment presented in this study.

To perform the assessment a Structured Query Language (SQL) was employed to extract the relevant parameters for the actions mentioned in the introduction. Extraction is performed using the Arrival Identification (Arid) number which is common (same) for the automatic detections used in both bulletins.

Results from all actions performed

The summary of the assessment of the impact of interactive analysis for all actions performed is shown in the following figure (see Fig. 2).
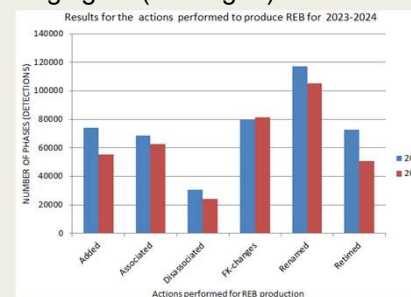

Fig. 2. Figure showing the summary of the results obtained for all actions performed.

The results obtained in this study indicate that about 73937(20.69%), 68569(19.19%), 30603(14.19%), 79835(28.83%), 117024(32.76%) and 72875(26.32%), were obtained for adding, associating, disassociating, FK changes, renaming and retiming actions, respectively for the year 2023. As can be seen from the above figure comparable results for the respective actions performed were also obtained for the year 2024. As can also be seen from the figure, the number of renamed detections stand the highest.

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Manually added and associated detections

During interactive analysis detections missed by automatic analysis and automatic detections un-associated to a SEL3 event are manually added and associated, respectively. The following figure (Fig. 3) displays the results obtained for each primary seismic array station that contributed data for the assessment of the impact of Interactive analysis on the SEL3 bulletin.
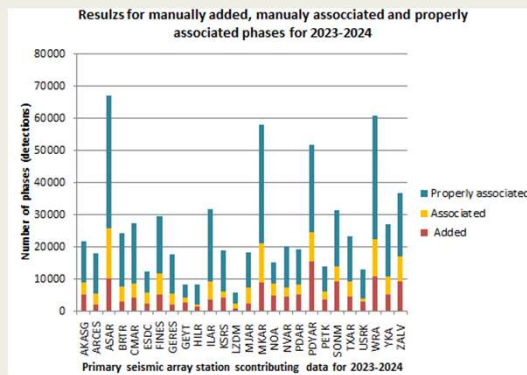

Fig. 3. Display of the number of manually added and associated detections for the Seismic Primary array stations.

As can be seen from the figure a significant number of changes were performed on detections to obtain a good quality REB.

FK changes and retimed detections

Among actions performed during interactive analysis the use of Frequency wave number (FK) analysis and proper naming of phases play an important role in identifying and characterizing phases to be associated to an event. The following figure (Fig. 4) shows such assessment results for Primary Seismic array stations.
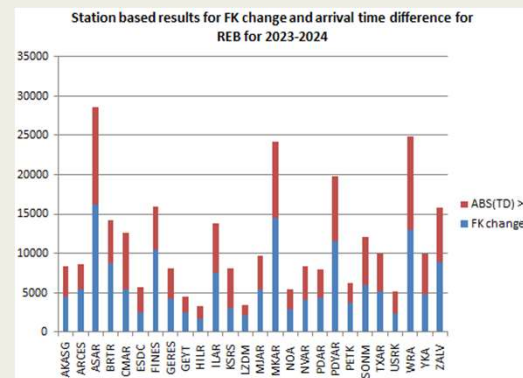

Fig. 4. Figure showing the number of detections for which FK and retiming of automatic detections were performed for the years 2023-2024.

As can be seen from Figure 3 a significant number of detections should undergo FK parameter changes (Azimuth and slowness changes) and retiming (in this case retiming by more than 2 seconds is considered).

Dis-associated and renamed detection

The results obtained for dis-associating and renaming of phases performed during interactive analysis are presented in Figure given below (Fig. 5).
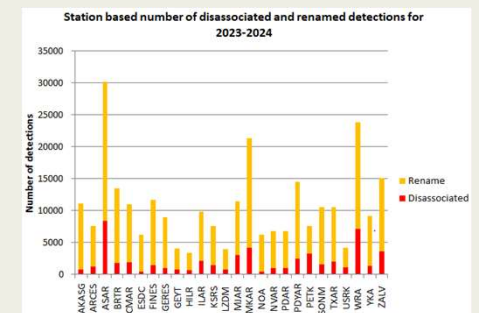

Fig. 5. Figure showing number of detections dis-associated and renamed during interactive analysis for the years 2023-2024.

Discussion and conclusion

The results presented in this study show the need for:
a) Significant improvement in the form of station tuning as well as automatic algorithm optimization to reduce analyst workload and expedite the issuance of REB in a timely manner.
b) Considering a plan for improving the quality of the IMS seismic array stations network data.