SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
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The Effectiveness of Automatic Seismic Phase Picking and Detection Capabilities of Deep Learning Methods for Local On- and Offshore Seismic Data: The Case of the Terceira Rift, Azores, Portugal

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INTRODUCTION AND MAIN RESULTS

Using UPFLOW OBS and IPMA land data, this study evaluates the performance of PickBlue and EQTransformer when applied to local network, achieving picking precisions of ±0.5 seconds for P and ±1.0 second for S phases. Preliminary results suggest that deep learning methods can substantially improve the accuracy and precision of hypocentral locations.

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Introduction

The Terceira Rift represents the primary locus of active seismicity in the Azores region (Fig. 1a,b). In this study, we evaluate the effectiveness of deep learning methods for event detection, phase picking and classification for seismicity analysis in the Azores.

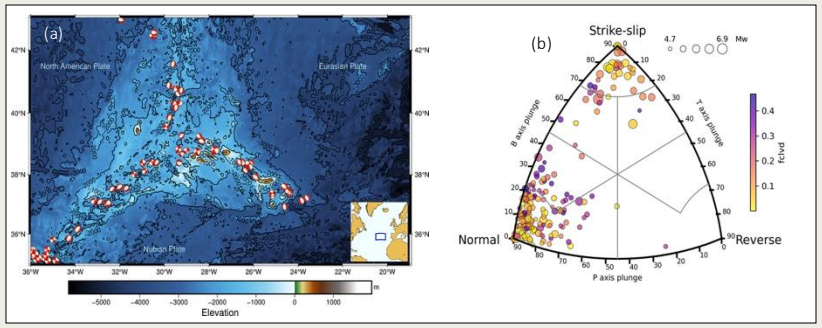

Fig.1: Focal mechanisms (a) represents the seismicity with Mw > 4, extracted from Global CMT (Ekström et al., 2012). Diagram (b) classifies faulting system in the region.

Data

Data from ocean-bottom seismometer (OBS) (UPFLOW, Tsekhmistrenko et al., 2025) (Fig. 2a) and land-based seismic records (Fig. 2b) is used in this study.

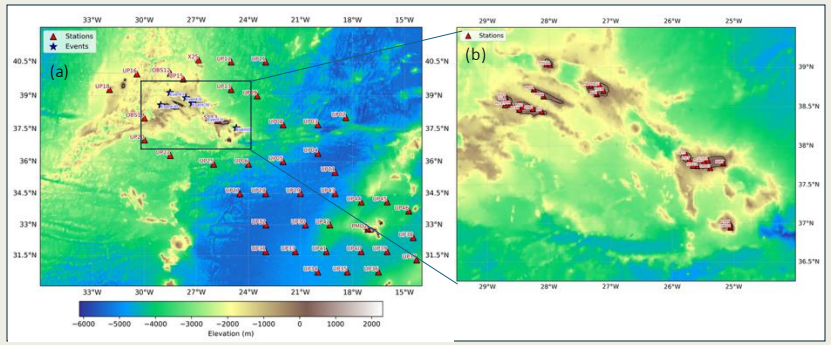

Fig.2: Map (a): OBS UPFLOW OBS stations, map (b): land-based stations from the Instituto Portugues de Mar e Atmosfera (IPMA). Black stars represent 5 selected events from ISC catalog (Storchak et al., 2020) used as benchmark.

Applied methods

PickBlue (PB) (Bornstein et al., 2024) for OBS and Earthquake Transformer (EQT) (Mousavi et al., 2020) for land-based seismic data integrate the models used for phase picking and classification. Fig. 3 presents an example of model output.

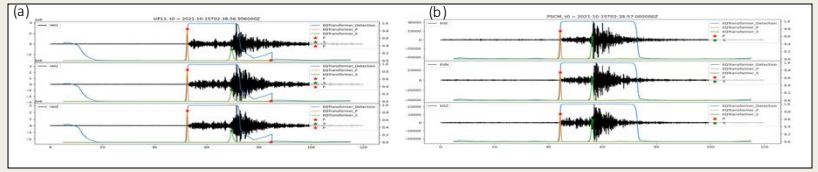

Fig.3: Model output for stations UP13 (OBS) (a) and PSCM (EQT) (b). Red and green lines, and stars represent probability curves and pick probability for P and S, respectively. Blue line represent event detection probability curve.

Picking and detection performance

Probability threshold (for P/S), of 0.1/0.01 and 0.1/0.1 for PB and EQT, respectively, were used. Results were compared with 6 events (Fig. 2a) selected from ISC catalog (Storchak et al., 2020). Recordsections in Fig.4 show some examples of the results of the picking in Event-II, from EQT (left) and PB (right).

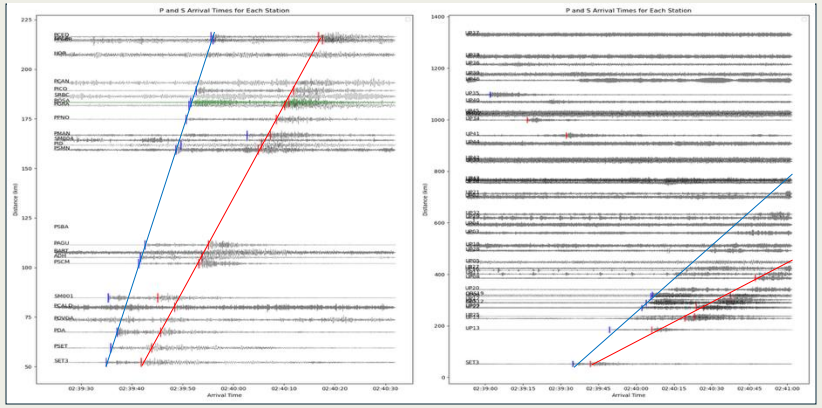

Fig 4: Recordsection illustrating picks from Event-II, EQT (left) and PB (right). Blue line represent P-phase and Red line represent S-phase

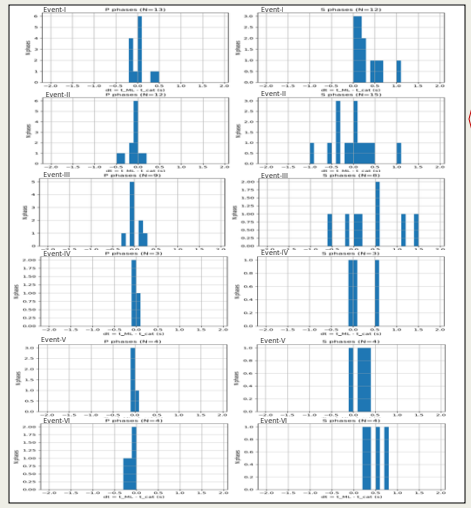

Fig. 5: Shows preliminary pick precision dt (dt = t_{cat} -t_{ML}) consistently below ±0.5 seconds for P and ±1 seconds for S-picks in almost all events, with exception on S-phase in Event-III.

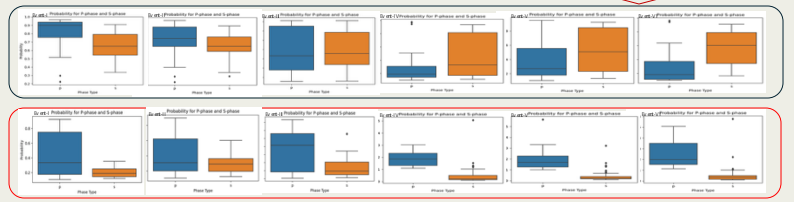

Fig. 6: Presents pick probabilities preference for P- and S-phases. Black rectangle indicates picks classified by EQT, while red rectangle highlights those identified by PB.

Conclusions

- Preliminary results suggest that P/S threshold pairs of 0.1/0.01 for OBS data and 0.1/0.1 for land data offer the most effective cut-off values.
- The strong detection performance and high pick precision of both EQT and PB highlight their potential as reliable auto-pickers for seismicity analysis along the Terceira Rift.

References

[1] Bornstein et al. 2024, **[2]** Ekström et al., 2012; **[3]**Mousavi et al., 2020; **[4]** Storchak et al., 2020; **[5]** Tsekhmistrenko et al., 2025