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Seismic and infrasound monitoring of military conflicts using machine learning

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The real-time seismo-acoustic monitoring of military conflicts can provide a unique alternative to conventional ground reports and sparse satellite coverage. The pressure waves generated by an explosion travel through the atmosphere and subsurface as sound and seismic waves, and their signature can be recorded by arrays of seismometers for ground motion or microbarometers for sound propagation. However, standard monitoring techniques can be both computationally expensive when localizing signals over large regions and/or prone to false detections when signals have low amplitudes. In this contribution we propose a Machine-Learning (ML) based solution to detect seismic and infrasound arrivals and locate sources close to real time. To validate our model we leverage the seismic data collected during the Russia-Ukraine conflict started in February 2022 using the Ukrainian primary station of the International Monitoring System (IMS), the Malin array (AKSAG). We test both the accuracy and computational efficiency of our approach against a threshold-based migration stacking model developed for near-real time monitoring in Ukraine. We hope that this first-ever ML detector of both seismic and acoustic phases could be employed for real-time monitoring of conflicts around the world across different network geometries and noise conditions.