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Overcoming Urban Noise and Model Uncertainty: Induced Seismicity Monitoring in Dutch Geothermal Fields

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Lack of data and urban noise pose significant challenges to monitoring anthropogenic seismicity in densely populated areas such as the Randstad region in the Netherlands. We deployed a temporary seismic array to monitor a geothermal doublet located at Kwintsheul, Netherlands. We implement innovative array processing, beamforming, and ML automatic-picking techniques to detect low-magnitude microseismic events that could be obscured by urban noise. Additionally, we propose a novel method to incorporate model uncertainties into hypocenter estimations based on the open-access subsurface information of the Netherlands. Contrary to previous studies, our analysis clearly shows that local low-magnitude seismicity does exist and highlights the value of denser seismic arrays and novel detection techniques for monitoring anthropogenic seismicity. The proposed hypocenter localization aids in avoiding under- or overestimation of location uncertainties, which is crucial for informed decision-making. This study advances seismic monitoring techniques in urban geothermal settings, providing critical data for informed decision-making and risk assessment of geothermal operations.