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A Feasibility Study of Earthquake Early Warning at the NITRO Near-Fault Observatory

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The performance of earthquake early warning systems (EEWS) is strongly controlled by near-fault source processes, network geometry, and real-time data transmission, making feasibility assessments critical for the system implementation. The effectiveness of a network-based EEWS at the recently established Northeastern Italy Thrust Faults Observatory (NITRO), a near-fault infrastructure designed to monitor the active thrust fault systems responsible for the 1976 M_w 6.4 Friuli earthquake.

The analysis is built on numerical simulations using the PRESTo early-warning framework (Satriano et al., 2012) with realistic, station-specific telemetry latencies measured over six months, and offline replays of the 2024 M_w 4.1 Preone earthquake. Alert timeliness, available lead time, and blind zone extent have been considered as proxies for the system performance, considering multiple configuration scenarios.

Results show that, under the current network layout, the blind zone radius for local earthquakes typically exceeds 18–25 km, covering a substantial portion of sites expected to experience strong ground shaking. Scenario-based simulations constrained by historical macroseismic intensity (Locati et al., 2022) indicate that roughly half of the damaged locations would lie within the blind zone, while only a limited fraction would receive alerts with actionable lead times (on the order of a few seconds to several seconds, depending on source-site distance and telemetry delays). Offline replays confirm the simulated alert latencies while showing the progressive stabilisation of real-time source parameter estimates.

Although the results of the analysis indicate that a network-based EEWS at NITRO is technically feasible, its capability to deliver effective near-fault early warning is currently limited by both network geometry and real-time latencies. Nonetheless, consistent with recent interdisciplinary studies, such systems can still provide valuable, rapid post-event information to civil protection authorities and the public. When integrated within existing seismic monitoring and automated processing workflows, EEWS outputs can enhance situational awareness and support emergency response in tectonically active regions.