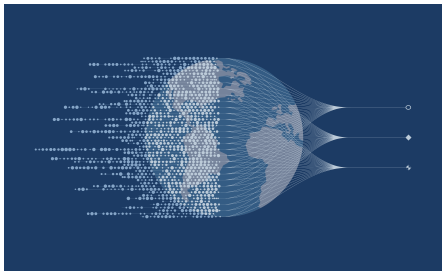

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Explosion Yields Using Fourier Neural Operators and Long-Range Infrasound Observations

Understanding the propagation of long-range acoustic waves is a cornerstone of infrasound research, yet solving the wave equation remains a computationally intensive challenge. This complexity is further exacerbated by the need for recalculations whenever the sound speed structure or source characteristics change. In this study, we present an innovative application of the Fourier Neural Operator (FNO), a cutting-edge machine learning technique, to address these challenges. Specifically, we leverage the FNO for yield estimation from infrasonic observations over distances of hundreds of kilometers. The FNO is trained to predict statistical transmission losses using atmospheric specifications provided by ECMWF and propagation simulation tools developed at CEA. The transmission losses are combined with an explosive source model to estimate the near-source spectral characteristics of explosive events within a Bayesian framework. A comprehensive sensitivity analysis was conducted to optimize the FNO's hyperparameters, providing insights into their influence on the results. Furthermore, we evaluate the impact of various gradient-based optimizers and their combination, on yield estimates and associated uncertainties. This approach is demonstrated with infrasound signals recorded at distances of several hundred kilometers from the Hukkakero military range, where extensive ammunition destruction activities over the past decade have generated a rich dataset of explosive events.

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