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The Multi-Channel Maximum-Likelihood (MCML) method: a new approach for infrasound detection and wave parameter estimation

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We are presenting a new and novel approach to the detection and parameter estimation of infrasonic signals. Our approach is based on the likelihood function derived from a multi-sensor stochastic model expressed in different frequency channels. Using the likelihood function, we determine, for the detection problem, the Generalized Likelihood Ratio Test (GLRT) and, for the estimation of the slowness vector, the Maximum Likelihood Estimation (MLE). We establish new asymptotic results (i) for the GLRT under the null hypothesis leading to the computation of the corresponding p-value and (ii) for the MLE by focusing on the two wave parameters back-azimuth and horizontal trace velocity. The Multi-Channel Maximum-Likelihood (MCML) detection and estimation method is implemented in the time-frequency domain in order to avoid the presence of interfering signals. Extensive simulations with synthetic signals show that MCML outperforms the state-of-the-art multi-channel correlation detector algorithms like the Progressive Multi-Channel Correlation (PMCC) in terms of detection probability and false alarm rate in poor signal-to-noise ratio scenarios. We also illustrate the use of the MCML on real data from the International Monitoring System (IMS) and show how the improved performances of this new method lead to a refined analysis of events in accordance with expert knowledge.