Abstract  In the fast time-varying shallow water environment, the phone-space adaptive processing using sample-matrix-inversion (SMI) approach outperforms the iterative least-mean-squared (LMS) approach due to its rapid convergence. The SMI approach uses singular-value-decomposition (SVD) to decompose a sample-matrix into a set of spatial eigenvectors and their associated eigenvalues. Adaptive beamforming is applied by matching the steering vectors with the spatial eigenvectors weighted by their eigenvalues. When a long towed-array undergoes significant maneuvering, the array shape and/or the target-to-array relative geometry changes rapidly within a processing interval. A signal in the phone-space sample-matrix is split into more than one eigenvector resulting in signal mismatch in the subsequent beamforming. Its power is split into many eigenvalues resulting in signal loss in the processing.

In subarray beam-space adaptive beamforming (SABS ABF), a beam-space sample-matrix is formed at each search cell by focusing subarrays to a cell using the dynamically updated array shape at each time step. The SMI adaptive beamforming then is done by decomposing the beam-space sample-matrix and matching the beam-eigenvectors with a unity steering vector. The beam-space sample-matrix has a lower rank than the phone-space sample-matrix so that a stable estimation can be reached with fewer time samples. The dynamic array shape compensation in SABS ABF makes a signal in the beam-space sample-matrix less likely to be split by the SVD. The subsequent processing, after the SVD, experiences less signal mismatch and signal loss. A dynamic cable model is used to simulate a long towed-array going through turns in a measured shallow water current field. Simulations show that significant signal loss in phone-space SMI processing is recovered in SABS ABF processing.