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Acoustic modeshape inversion using deep water ambient noise measurements

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Assuming that ambient noise can be represented by a sum of uncorrelated acoustic modes, the eigenvectors of the noise covariance matrix for a vertical line array should correspond to the sampled modeshapes. In previous work several authors have investigated using an eigendecomposition of the noise covariance to estimate the mode functions in shallow water, e.g., Wolf et al. [Proc. of the 1993 IEEE Oceans Conf.,vol. I, pp. 99-104]], Hursky et al. [J. Acoust. Soc. Am., 109(4), pp. 1355-1366], and Nielsen and Westwood [J. Acoust. Soc. Am., 111(2), pp. 748-756]. While the same approach should work for deep water scenarios, only few deep water experiments have deployed arrays with sufficient aperture to resolve the modes, e.g., the work D'Spain et al.[Pure appl.∼geophys., Vol.∼158, pp.∼475-512]. This paper explores the problem of inverting for the acoustic modes of a deep water waveguide using ambient noise measurements. In particular the paper focuses on important signal processing issues, including data snapshot requirements, and the effects of array tilt. Data from a deep water propagation experiment will be used to quantify how well the empirical modes match the true modes derived from measured environmental data. [Work supported by an ONR Young Investigator Award.]