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Interferometry of background acoustic-gravity waves

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In addition to acoustic-gravity waves generated in the ocean and atmosphere by strong transient events such as earthquakes and tsunamis, there exists a certain background level of acoustic-gravity waves. Because of their large free path length and a wide spatial distribution of the wave sources, background acoustic-gravity waves form a diffuse (but not necessarily isotropic), random wave field. Wave fields generated by uncorrelated sources are known to retain finite correlation at ranges large compared to the wavelength and spatial dimensions of the random wave sources. A technique known as noise (or wave) interferometry has been shown in seismology, helioseismology, acoustics, and other fields to be an effective tool for retrieving information about the deterministic propagation environment and the random wave field from two-point cross-correlation functions of diffuse noise. Here, we apply wave interferometry to acoustic-gravity waves in the coupled ocean-atmosphere system. The primary dataset analyzed in this study was obtained by 30 differential pressure gauges deployed from January 2009 to February 2010 on the seafloor offshore the South Island of New Zealand in the course of the Marine Observations of Anisotropy Near Aotearoa (MOANA) Seismic Experiment [Yang, Z., A. Sheehan, J. A. Collins, and G. Laske (2012), The character of seafloor ambient noise recorded offshore New Zealand: Results from the MOANA ocean bottom seismic experiment, Geochem. Geophys. Geosyst., 13, Q10011]. By applying time-reversal ideas to processing of cross-correlations of random wave fields, we have developed a compressed cross-correlation function technique to compensate for wave dispersion in evaluating the cross-correlation function of a random wave field. When applied to the seafloor pressure data, the technique drastically reduces the signal averaging times necessary for emergence of deterministic features and allows for accurate passive measurements of wave travel times and directivity. The reduction in the averaging time makes it possible to study dynamics on the acoustic-gravity wave field and helps to identify specific wave types that contribute to observed pressure variations. We will discuss implications of the seafloor measurements for observations of acoustic-gravity waves in air above the ocean and feasibility of extending the wave interferometry to other modalities of observation of background acoustic-gravity waves, including ionospheric radio sounding performed with Dynasonde systems.