Spatiotemporal modulation and analysis of high-resolution backscatter and Doppler X-band radar measurements of ocean surface waves in low sea states

Erin E. Hackett and *Andrew J. Kammerer*
School of Coastal and Marine Systems Science, Coastal Carolina University, Conway, SC

Craig F. Merrill and *Anne M. Fullerton*
Carderock Division, Naval Surface Warfare Center, Bethesda, MD

Thomas C. Fu
Office of Naval Research, Arlington, VA

High-resolution spatiotemporal distributions of Doppler and backscatter in low sea states are examined to better understand the phase relationship between Doppler and backscatter signals. The data were taken with a high-resolution (~30 cm range bin) dual-polarized X-band Doppler radar at low grazing angles from the Scripps Institution of Oceanography (SIO) pier in 2010. Time-series, correlation functions, and co-spectra between measured Doppler and backscatter are examined and findings are compared with published numerical simulation results. We also explore methodologies to analyze the data in the spatiotemporal domain using empirical orthogonal decompositions. The methods are introduced through their application to simple sinusoidal wave fields as well as more complex synthetic wave fields (Bretschnieder spectral model) for various geometries between the radar look direction and wave propagation direction to assist in the interpretation of empirical basis functions. Finally, the methodology is applied to the Doppler measurements made at SIO pier, and advantages and disadvantages of the methodology are highlighted including physical interpretation of the basis functions and potential connections to the more conventional Fourier transform based processing methodologies.