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Doppler Correction of Wave Frequency-Spectra Measured by Underway Vessels

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“Sea State and Boundary Layer Physics in the Emerging Arctic Ocean" is an ongoing Departmental Research Initiative sponsored by the Office of Naval Research. The field component took place in the fall of 2015 within the Beaufort and Chukchi Seas and involved the deployment of a number of wave instruments including a downward looking Riegl laser rangefinder mounted on the foremast of the R/V Sikuliaq. Although time series measurements on a stationary vessel are thought to be accurate, an underway vessel introduces a Doppler shift to the observed wave spectrum. This Doppler shift is a function of the wavenumber vector and the velocity vector of the vessel. Of all the possible relative angles between wave direction and vessel heading there are two main scenarios: I) vessel steaming into waves and II) vessel steaming with waves. Previous studies have considered only a subset of cases, and all were in scenario I. This was likely to avoid ambiguities, which arise when the vessel is steaming with waves. This study addresses the ambiguities and analyzes arbitrary cases. In addition, a practical method is provided which is useful in situations when the vessel is changing speed or heading. These methods improved the laser rangefinder estimates of spectral shapes and peak parameters when compared to nearby buoys and a spectral wave model.