Vertical Current Shear Retrieval from Shipboard Marine X-band Radar

Björn Lund, Hans C. Graber, Hitoshi Tamura,
Clarence O. Collins III, Sergey M. Varlamov

A new method to determine near-surface vertical current shear from shipboard marine X-band radar (MR) data is presented. A three-dimensional fast Fourier transform is employed to obtain the wavenumber-frequency spectrum of a MR image sequence. Near-surface currents are estimated from the Doppler-shifted surface gravity wave signal within the spectrum. They represent a weighted mean of the upper ocean flow. The longer the ocean waves on which the current estimates are based, the greater their effective depth. The novelty lies in the wavenumber-dependent retrieval method, yielding ~ 100 independent current estimates at effective depths from ~ 2–8 m per ~ 12 min measurement period. Results are based on MR data collected from R/V *Roger Revelle* during the 2010 Impact of Typhoons on the Ocean in the Pacific experiment in the Philippine Sea. Shipboard acoustic Doppler current profiler (ADCP) and anemometer measurements are used to demonstrate that results are in accord with physical expectations. The wind- and wave-driven flow is obtained by subtracting ADCP-based background currents from the radar measurements. The resulting Ekman flow at ~ 2 m is on average ~ 1.6% of the wind speed and ~ 38.9° to the right of the wind. With increasing effective depth, the speed factor decreases and the deflection angle increases. Based on WAVEWATCH III modeling results, the MR-sensed Stokes drift speed at ~ 2 m (~ 8 m) is ~ 50% (~ 25%) of the Ekman flow. These findings are consistent with previous observations and Ekman theory.