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Determining near-surface currents from measurements of the wave spectrum

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We present a newly developed, improved method for deducing the depth profile of a sub-surface current from measurement of the current-modified dispersion relation of surface waves, and test and validate the method with laboratory experiments.

Understanding and characterizing near-surface currents is important for a wide variety of applications including climate modeling, coastal engineering, and operational safety near coastlines, among others. Many conventional in situ methods struggle to measure the currents in a top few meters of the ocean, and measure the depth profile at only one point in the horizontal plane. An attractive alternative is to determine near-surface currents from measurements of the wave spectra, enabling remote sensing methods such as X-band radar.

The new method is iterative in nature, starting with the existing state-of-the art method as an initial guess, and estimating a correction factor that improves the accuracy of the reconstructed shear profile.

The method is tested using experimental data of waves traveling atop a controlled shear flow. Various shear depth-profiles are produced in the laboratory and measured using particle image velocimetry which serve as “truth” measurements. Waves are produced with a piston-type wavemaker and measured using a synthetic schlieren method. Using the new inversion method, we demonstrate a factor two improvement in accuracy in the reconstructed current profile relative to state-of-the-art methods.