DEMONSTRATION OF DIRECT MEASUREMENTS OF OCEAN SURFACE CURRENTS

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The objective of this study is to apply state-of-the-art radar techniques in oceanography to make fundamental measurements that may ultimately enable the synergistic measurements of ocean vector surface currents and winds from space. Our innovative concept to measure ocean surface currents combines a dual-beam along-track radar interferometer (ATI), which provides the total surface current vector, with a scatterometer capable of simultaneously detecting ocean vector winds. This pairing of observations is designed to separate the surface currents from the ocean clutter, which primarily arises from Bragg surface scatter contributions, but also other wave modulation factors and surface wind drift.

Two experiments were conducted in August 2007 and March 2008 off the Cal Poly San Luis Obispo pier at Avila Beach in San Luis Bay. Data were obtained under varying conditions of winds and waves. The Ka-band radar, the MSL landing radar breadboard was setup to measure phase from ocean surface backscatter over short intervals of time, shorter than the time it takes the ocean surface to decorrelate. Pairs of multiple pulsed radar bursts are combined so that the Doppler shift or phase difference between each pair is related to Doppler velocity. Phase is modulated by Bragg resonant waves, wave orbital velocity, and surface currents. The radar was operated over a variety of time lags, azimuth, and elevation angles. We added a methodology to measure the top-most surface currents through the use of dye tracing. The movement of a small patch of environmentally safe orange dye was observed within a buoy-defined grid with a time lapse camera mounted on the pier. The dye was deployed routinely from a kayak and then surface current velocity and direction were estimated from pairs of imagery.

Radar processing includes the following steps: Data are sorted by time stamps and azimuth angle; radar velocity is converted to a horizontal component using incidence angle and then averaged to 3-4 minute collections to reduce wave orbital velocity effects; the Bragg scattering correction is calculated before averaging based on radar anemometer wind direction; and the radar radial velocities are combined in pairs of two to produce radar surface vector which are then compared with in situ observations.

Successful derivations of radar surface currents were obtained under varying ocean wind, wave, and current conditions. Most accurate radar vectors were obtained when winds exceeded 5 m/s. The most accurate pairs of radial velocity components to derive vectors had angular separations greater than 60 degrees, which implies modified antenna configuration and data collection. Derived radar velocities ranged from about 4-20 cm/s. Derived radar vectors did not line-up with wind direction in several cases, indicating presence of non-wind derived surface currents. Improvements to wind measurements, radar placement on pier (higher from ocean surface), and radar sampling scenarios, as well as higher velocity current field are needed to develop a more robust measurement basis. More complete understanding of radar scattering at Ka-band is likely needed to improve corrections.