

HF Radar Measurements of Surface Wind Field

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Abstract: It is well known that HF radars are capable of measuring wind direction by using the relative strength of the echoes from the approaching and receding ocean waves at the Bragg resonant wavelengths. Here we investigate the ability of our Multifrequency Coastal Radar (MCR) to measure wind speed as well as direction. In this study we use data collected over Monterey Bay, California in December of 2000. At that time the M1 buoy (deployed by Dr. Francisco Chavez at the Monterey Bay Aquarium Research Institute, MBARI) was in the radar's observational area, near the Bay mouth, and measured wind speed and direction. Two MCR's near Santa Cruz and Moss Landing, California operated at 4.8, 6.8, 13.4 and 21.8 MHz, measuring currents at effective depths of about 2.5, 1.8, 0.9 and 0.6 m respectively. Using the method of partial least squares we developed an algorithm for estimating the surface wind vector from multifrequency HF radar data. This method uses as inputs the relative echo strengths of the approaching and receding Bragg lines as well as the near

surface currents estimated for the four effective depths mentioned above. Partial least squares is a predictive technique based on relationships estimated from a training data set within which both inputs and outputs are known. We use the M1 buoy winds as output 'truth' for our training set. Our work indicates that the method produces excellent results. The wind speed and direction are determined with biases of -0.7 m/s and -1° , standard errors of prediction of 1.3 m/s and 30.5° and R^2 values of 0.66 and 0.89 respectively for all wind speeds. For wind speeds above 5 m/s the performance is significantly better. An investigation of the weights in the partial least squares algorithm indicates that the relative echo strength in the Bragg lines, near surface currents and near surface current shear are important in determining the wind estimates. We show examples of wind field maps over Monterey Bay, California and comparisons with buoy measurements. We think that this method will find useful application in measuring the detailed structure of the wind field in coastal regions on a few kilometer size scale.