Fitting Normal Modes to HF Radial and Total Surface Current Vector Data over Enclosed Bays and Estuaries

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ABSTRACT

A technique referred to as Normal Mode Analysis (NMA) has been demonstrated by Lipphardt et al. (*J. Geophys. Res.*, 105, 3425-3450, 2000) for representing total vector CODAR HF radar data in Monterey Bay. These modes satisfy the coastal boundary constraint of no flow normal to the shore, and inherently represent both divergent and rotational flow as two sets of ortho-normal basis functions. In prior investigations by others, the domain had a large open boundary at which additional information from a numerical model was needed to completely represent the surface flows in the Bay. The modes were fitted to data only in the two-site overlap region where total vectors were calculated. We apply NMA for completely enclosed bays, using two-dimensional finite element methods to derine these modes where the shoreline is the mathematical boundary for the problem. This is an improvement over prior studies with open boundaries where additional information was needed to represent the flow within.

We also extended this methodology by fitting to radial velocities from each radar by itself -- as well as simultaneous radial data from multiple coastal radars viewing the same bay. It was applied to Corpus Christi Bay where two SeaSondes have been operated by Texas A&M University for two years. First, we employed simulations, where we resolved arbitrary current flow patterns into two sets of radial data. Noise was added to the vectors, and the extraction accuracy was studied. Ability to derive meaningful total velocity patterns depends on the noise level; the percent coverage of the bay by the radial measurements; and the availability of simultaneous radial data from different sites / angles. Surprisingly good extraction is often obtained with only single radar coverage. Finally, this method is tested with actual, hourly SeaSonde HF radar data over this Bay, both at the single-site radial level and by employing both sites. Comparisons are made with the real-time total-vector maps produced by the radar software over the common coverage area. Our bay-conforming natural mode-pattern resonanccs are being used in studies that relate their strengths to wind stress across the bay surface.