SeaSonde(r) HF Current-Mapping Radars Change the Nature of Coastal Ocean Observing Systems

Coastal High Frequency (HF) radars map ocean surface currents in real-time over large areas, revealing evolving current structures unobservable by any other instrument. These systems were proven to be effective over 30 years ago by the principals of CODAR Ocean Sensors (COS) while they were with the government.

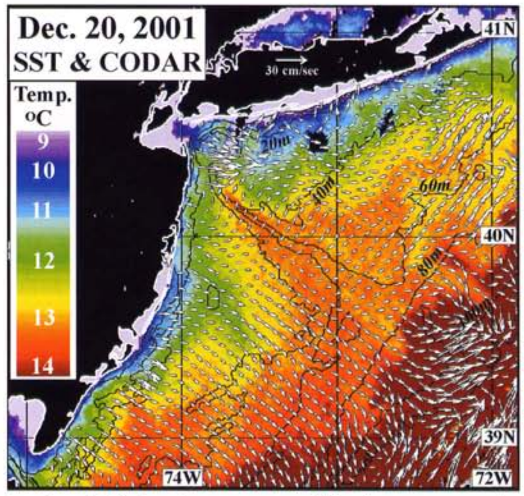
Only in the last 10 years has the SeaSonde finally emerged as a viable commercial, product. With COS' 100th SeaSonde shipped in March, 2002, this number accounts for the vast majority of the 130 total HF radars of any kind ever built and tested. And most of these100 have gone out our doors in the past three years, an indication of a rapidly expanding field. Nearly all reside in North America and Asia. What suddenly spurred this rarely used scientific curiosity from the late '60s to achieve acceptance as an indispensible ocean monitoring tool? This question is answered by reviewing a bit of the physics behind this measurement.

All HF radars operate by the same basic principle: the Doppler shift of Bragg-scattering surface waves transported by underlying currents. Only at HF (with a radar wavelength between 6 and 60 meters) can the sea echo be neatly decomposed. Microwave radars see an echo that is so complex as to be indecipherable in terms of the important underlying current information. Also, HF radars with their long wavelengths see well beyond the visible horizon that limits all microwave radars: the lower the frequency, the further the signal goes. If conventional radar wisdom is followed in forming and scanning a beam to derive bearing angle, the long wavelengths demand a huge coastal antenna facility. This has been the single major impediment blocking acceptance of this tool by the ocean community, as it imposes large initial and operating costs, besides restricting the most obviously desirable site locations.

The SeaSonde, generically termed CODAR in the mid 70s, overcomes this obstacle with compact antennas that rely on direction finding rather than beam forming. The receive antenna system is mounted on a post up out of reach or on the roof of a building, rather than sprawling over hundreds of meters of valuable seafront property at the shoreline. This, combined with a novel, highly efficient patented waveform that works well at HF, allows the SeaSonde to be very compact. Controlled by unattended desktop PCs, real-time files are sent to the desired user office. There they are combined with similar data from other SeaSondes viewing the same area from tens of kilometers away to produce total vector fields. Typically they generate current maps hourly, and often data are automatically uploaded to web sites for immediate access by the public.

The SeaSonde's flexibility, robustness, and user-friendly software have made operation so convenient that it has changed the face of the user community. Over the past decade the likely user has evolved from electrical engineers (radar specialists), to physical oceanographers focusing on validation and devising applications, to operational groups like the Japan Coast Guard and Taiwan Navy Weather.

Responding to various user needs, CODAR Ocean Sensors has introduced a variety of SeaSonde radar products. The standard SeaSonde operates between 12-27 MHz to ranges of 30-60 km with typical resolution of 1 to 3 km. The Hi-Res SeaSonde provides 200-500 meter range resolution over bays having smaller areas like 10-15 km. The latest addition to this growing family is our Long Range SeaSonde, achieving average daytime ranges of 170-200 km. The Long Range SeaSonde makes it possible for a country to map currents along large sections of its coastline, continuously, with low initial and operating costs.



Long Range SeaSonde surface current vectors off New Jersey coast, averaged 20-22 December 2001, overlain on AVHRR sea surface temperatures. Courtesy of Rutgers University, Institute of Marine and Coastal Sciences.

The figure is an example of a Long Range SeaSonde map. These data were produced by four radars operated by Rutgers University. They monitor the entire continental shelf off New Jersey. The current vectors were averaged from 20 to 22 December 2001 and overlain on satellite-derived AVHRR sea-surface temperatures (shown in color). Notice the offshore flow of cool water south of the Hudson Canyon, the weak flows within the canyon and along-isotherm flows north of the canyon especially evident in the mesoscale meanders south of Long Island. The power of SeaSonde current maps combined with satellite-derived data sets is clear; with an added benefit that the SeaSondes can provide near real-time data updates even when satellite data are unavailable.

Rutgers has a nested grid of SeaSondes operating in New Jersey. Besides the Long Range SeaSondes, standard SeaSondes provide higher resolution current maps in their LEO-15 observation area where the data aids in planning biosampling and other vessel operations. Currently, Rutgers oceanographers are working with CODAR engineers in testing a buoy mounted SeaSonde transmitter whose sea echoes are sensed by a coastal receiver. This novel approach extends the coverage of a Long Range SeaSonde from 200 km out to 300 km and allows for improved observations near shore.

For more information on HF radars and the SeaSonde family of products, please visit CODAR Ocean Sensors web site at www.codaros.com.