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Tracking cold bottom water in the Gargano Peninsula and Bari Canyon regions of the Adriatic using seismic oceanography

Warren Wood (1), Jeffrey Book (1), Sandro Carniel (2), Dennis Lindwall (1), Giovanni Bortoluzzi (3), and Richard Hobbs (4)

(1) Naval Research Laboratory, Stennis Space Center, MS, United States, (2) C.N.R. - Institute of Marine Sciences, Venice, Italy, (3) C.N.R. - Institute of Marine Sciences, Bologna, Italy, (4) University of Durham, United Kingdom

Tracking cold, dense bottom water from conventional ship sampling is difficult - equipment safety concerns result in incomplete sampling near the seafloor, and lateral variability can be significant. Mooring time series are poor at mapping dense water vein spatial extents and can even completely miss sampling narrow veins. The relatively new technique of seismic oceanography (SO) could potentially provide a new way of identifying and characterizing these bottom waters that is not as subject to the constraints and difficulties of present methods. Furthermore, combining SO with conventional sampling is particularly appealing for better characterization of the quick and small scales of dense water cascades and bottom trapped phenomenon..

There is a relationship between oceanic temperatures and the seismic data such that seismic images can be made to represent a quantitative measure of vertical temperature gradient through much of the water column and even very near the seafloor. The SO technique involves towing a low frequency, broadband (20-250 Hz) sound source (such as an air gun array) and a long, 600-1200 m, array of hydrophones. SO uses much lower frequencies than conventional Acoustical Oceanography (AO) techniques, and is affected by the acoustic impedance (product of sound speed and density) directly, not via proxy such as impurities or biota in the water. The sound pulses reflect off the (mostly temperature) contrasts in the water, and are recorded on the hydrophone array, creating an image of temperature gradient. Because the reflection coefficients are small, signal-enhancing techniques such as synthetic aperture (common midpoint binning) processing is required.

The images generated using SO allow for the tracking of very thin (less than 10 m thick) bottom currents provided that the temperature contrast between the bottom, and overlying water is strong enough (0.3 to 1.2 degrees C, depending on acoustic noise levels) and abrupt enough (10-15 meters). The lateral resolution of the SO technique is similar to the vertical resolution – therefore adequate to detect changes over as little as 5-10 meters. The images are not an instantaneous snap-shot, but occur over a finite time. Each column of image pixels is a combination of sound pulses that occur over 2-4 minutes, depending on source fire rate and ship speed.

In March of 2009 an international SO field effort (AdriaSeismic09) took place the Gargano Peninsula, and Bari Canyon areas of the southern Adriatic Sea. On several seismic profiles through these areas a layer of cold bottom water, between 7 and 10 m thick is clearly imaged. Temperatures in the overlying water typically ranged from 12.5 to 13.5 degrees C, and those of the bottom water typically ranged from 12.0 to 12.5 degrees C. Some of these thin bottom water masses were observed in shallow, coastal waters about 100 m deep and some were as deep as 350m. Undulations with later wavelength of 500m and shorter, and amplitudes of several meters are clearly visible in the upper surfaces of the cold water masses.