EDDY PROCESSES OF THE WESTERN ADRIATIC CURRENT NEAR CAPE GARGANO

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Abstract

Eddy processes of the Western Adriatic Current near Cape Gargano are highly modulated by the wind, growing during calm periods following strong wind events. Both single anticyclones and trains of multiple eddies with a regular spacing are observed. Suppression of a single anticyclone in the lee of the Cape was observed by profiling SEPTR moorings to occur when the horizontal gradient of the thermocline depth was increased by the wind. Eddies also form cyclonic filaments extending offshore. Such a filament was observed through the new technique of seismic oceanography to have downslope tilting isotherms and a long, thin, offshore extension in the bottom boundary layer.

Keywords: Fronts, Mesoscale Phenomena, Adriatic Sea, Instruments And Techniques, Turbulence

Recent measurements from two international collaborative research programs reveal new details of eddy activity and instability of the Western Adriatic Current (WAC) as it rounds Cape Gargano in the central Adriatic Sea. The "Dynamics of the Adriatic in Real-Time" (DART) program was focused on understanding the predictability of this system with observation and modelling from October 2005 through September 2006. These included, among other things, measurements from long-term current moorings, profiling SEPTR moorings, tow-yo CTD profiles, remote sensing, and high-resolution modelling using the U.S. Navy Coastal Ocean Model. Remote sensing and modelling, supported by in situ observations, revealed two distinct cases of WAC eddy activity [1]. In the first case, a single anti-cyclonic circulation cell (typically 20-30 km horizontal and 25 m vertical scale) forms on the downstream side of the cape in the Gulf of Manfredonia (Figure 1a). In the second case, a multiple eddy train (30-40 km crest-to-crest wavelength) forms along the coast upstream of the cape and proceeds around it (Figure 1b). Both cases are linked to wind patterns; eddies grow and propagate as southeastward winds relax, and are suppressed when these winds are strong. Profiling SEPTR mooring measurements observed anticyclonic eddies in the lee of the Cape when the thermocline slope was weak and the absence of eddies when strong southeastward winds strengthened this thermocline slope.

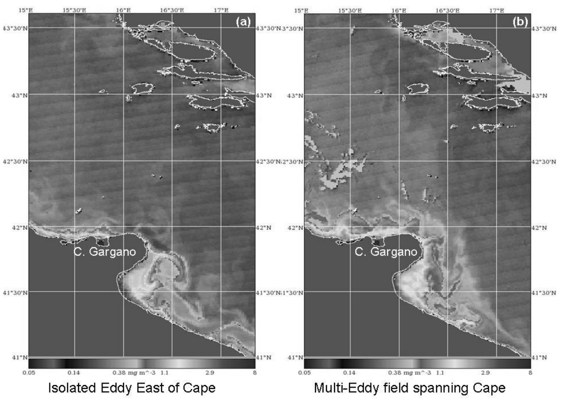

Fig. 1. Remote sensing Chlorophyll-a images from MODIS Aqua showing representative cases of (a) single anticyclonic WAC eddy downstream of Cape Gargano and (b) multiple eddy train around the Cape. This is a reproduction of Figure 2 from [1].

The AdriaSeismic09 research campaign used the new technique of seismic oceanography [2] to image the temperature gradient structure of the WAC frontal system during March 2009 at very fine horizontal scales (order 10 m). Sampling captured the details of a third WAC eddy case, a cyclonic filament extending offshore following a strong wind event (also observed during DART [3]). Both microstructure profiler and seismic sections crossed the filament multiple times. The filament frontal structure was baroclinic with down-sloping isotherms. Near the bottom, the tilt extended into a long, thin, offshore extension of coastal waters in the bottom boundary layer, followed by a subtle up-tilting structure offshore. These structures were all successfully imaged (Figure 2) by seismic measurements, revealing new fine-scale details of the filament structure that couldn't have been measured otherwise.

Although Adriatic wind regimes and Cape topography provide the background setting for eddy formation, frontal instabilities and mixing processes determine many details of eddy structure and evolution.

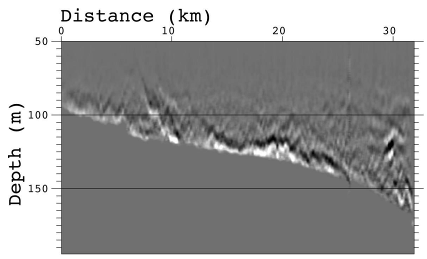

Fig. 2. Seismic reflectivity image showing the structure of the vertically tilting WAC filament edge (left), thin offshore extension of cold bottom water (center), and offshore up-tilting structure (right). Reflectivity is measured at 5-10 m horizontal resolution and is associated with band-limited vertical temperature gradient. E.g., the colder water at the bottom causes a decrease in sound speed and a negative reflection (black over white). The largest reflections correspond to temperature changes of about one degree C over ten meters of depth.

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