Abstract View

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Mixing and Spreading of the Mediterranean Outflow

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ABSTRACT

Hydrographic and current profiler data taken during the 1988 Gulf of Cadiz Expedition have been analyzed to diagnose the mixing, spreading, and descent of the Mediterranean outflow. The θ–S properties and the thickness and width of the outflow were similar to that seen in earlier surveys. The transport of pure Mediterranean Water (i.e., water with $S \geq 38.4$ psu) was estimated to be about 0.4×10^6 m^3 s^{-1}, which is lower than historical estimates—most of which were indirect—but comparable to other recent estimates made from direct velocity observations.

The outflow transport estimated at the west end of the Strait of Gibraltar was about 0.7×10^6 m^3 s^{-1} of mixed water, and the transport increased to about 1.9×10^6 m^3 s^{-1} within the eastern Gulf of Cadiz. This increase in transport occurred by entrainment of fresher North Atlantic Central Water, and the salinity anomaly of the outflow was consequently reduced. The velocity-weighted salinity decreased to 36.7 psu within 60 km of the strait and decreased by about another 0.1 before the deeper portion of the outflow began to separate from of the bottom near Cape St. Vincent. Entrainment appears to have been correlated spatially with the initial descent of the continental slope and with the occurrence of bulk Froude numbers slightly greater than 1. In the western Gulf of Cadiz, where entrainment was much weaker, Froude numbers were consistently well below 1.

The outflow began in the eastern Strait of Gibraltar as a narrow (10 km wide) current having a very narrow range of θ–S properties. The outflow broadened as it descended the continental slope of the northern Gulf of Cadiz and reached a maximum width of 80 km in the western Gulf of Cadiz. The descent of the outflow was very asymmetric: The southern (offshore) edge of the outflow descended about 1000 m from Gibraltar to Cape St. Vincent, while the northern (onshore) edge of the outflow descended only a few hundred meters. The northern, onshore side thus remained considerably higher in the water column and thus entrained relatively warm North Atlantic Central Water.

This caused the outflow to develop horizontal θ–S variability and, by about 140 km downstream, the across-stream variation in temperature on an isopycnal was more than 2°C.

Much of the volume transport in the western Gulf of Cadiz was contained within two preferred modes or cores. The deeper, offshore core had a central σ_θ = 27.8 kg m^{-3}, and the shallower onshore core, which was still in contact with the bottom in the Gulf of Cadiz, had a central σ_θ = 27.5 kg m^{-3}. These two cores develop as a result of the spreading and horizontally varying entrainment noted above, combined with topographic steering.

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