ADRIATIC VERSUS AEGEAN WATER IN THE ABYSSAL LAYERS OF THE IONIAN BASIN

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Abstract

In situ measurements and a numerical model for the description of bottom-arrested currents are used to elucidate aspects of the evolution of the Transient of the Eastern Mediterranean Basin.

Keywords : Adriatic Sea, Aegean Sea, Strait Of Otranto, Abyssal, Stratification.

CTD measurements carried out in the southern Adriatic sea and in the western Ionian basin (Eurafrican Mediterranean sea) during May 2003 by the German research vessel POSEIDON (POSEIDON cruise 298) and numerical simulations are used to elucidate aspects of the abyssal circulation of this oceanic region. The observations suggest that dense waters of Adriatic origin were strongly diluted along their way on the Italian continental slope, whilst their characteristics remained better preserved in a region located further east. The very steep topographic slope along the Italian shelf in the region of the Gulf of Taranto induces strong entrainment of intermediate waters in the bottom layers. Instead, the bottom waters of Adriatic origin which, along their path further east, encounter gentler topographic variations, are weakly diluted by turbulent mixing and, therefore, better preserve their original characteristics. The remarkable differences in the mixing along these two different paths are accentuated by the presence of a noticeable zonal gradient of potential density existing in the near-bottom layers of the northern Ionian basin. In order to verify our observational hypothesis suggesting that different paths for the southward spreading of ADW exist, which are characterized by different entrainment rates, we performed numerical simulations using a nonlinear, reduced-gravity plume model. In this model the only active layer is the bottom layer, which, due to a simple entrainment parameterization, can entrain prescribed ambient water over complex bathymetric features. Due to this simplified structure, a very high spatial resolution can be reached. In the simulations, a constant rate of ADW production (0.6 Sv (1Sv = $10^6 m^3 s^{-1}$)) at the constant potential density of 29.21 was prescribed in the northern part of the South Adriatic Pit. Near the bottom, the ambient density structure was determined by interpolating the near bottom density data of Levitus [1]. Moreover, from this dataset a vertical density gradient was defined, which was used to determine the density difference of the ambient water located between the top of the descending bottom-arrested current and the bottom. Fig. 1 shows the area where the simulated bottom plume is characterized by a potential density larger than 29.194 (i.e. the part of the plume having density values not smaller than those of the observed core of ADW), after 270 simulated days. The simulation evidences that the ADW bottom vein flows towards the abyssal plain of the Ionian basin following different paths. The flow along the Italian coast is characterized by very pronounced mixing, with the consequence that virtually no flow of ADW denser than 29.194 is able to escape the gulf of Taranto. The complex flow along the eastern part of the Ionian basin, instead, is affected by mixing in a less stronger extent, and, thus, it better preserves its original characteristics. Thus, in our numerical simulations, bottom water masses with characteristics closest to ADW are found in the eastern rather than in the western part of the Ionian basin. In the absence of entrainment, the situation would have been completely different. In Fig. 1 we present also the paths of different tracers, located initially within the bottom current at the strait of Otranto, after 150 simulated days of a run carried out without including entrainment. In this case, obviously, the whole bottom current preserves its original density, as no dilution processes are considered. It flows southward following exclusively the route along the Italian shelf. Such a different behavior in the two simulations can be clearly explained by the fact that entrainment acts as a further friction term and decreases the density contrast between bottom current and overlying fluid; this considerably enhances the ageostrophic flow behavior [see, e.g., 2, 3]. These differences in the simulated mixing are accentuated by the presence, in the bottom layers of the northern Ionian basin, of a zonal gradient of potential density: since the Transient, the values of near-bottom potential density increases toward east, which contributes to produce a stronger dilution of the waters of Adriatic origin in the western rather than in the eastern part of the northern Ionian basin [4].

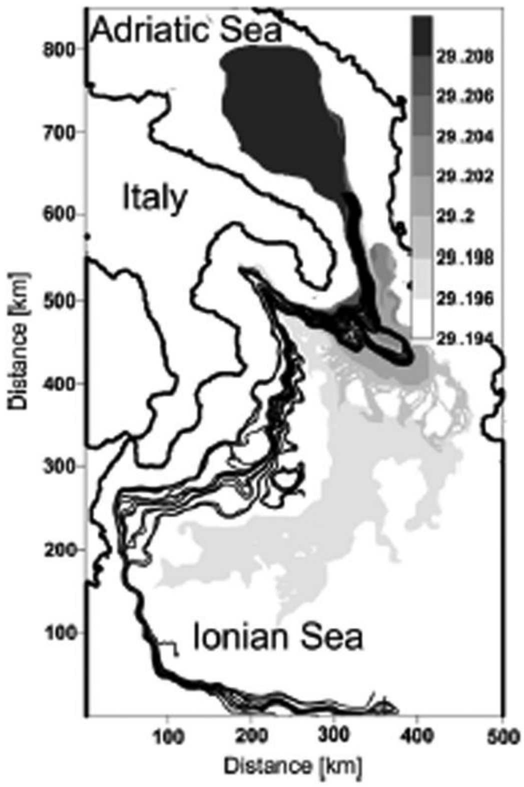

Fig. 1. Bottom density distribution at t = 270 days simulated using the nonlinear plume model (run with entrainment) and paths of the tracers at t = 150 days simulated in the model run without entrainment.

References

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