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Vorticity and potential vorticity analysis for viscous bottom flow along the Sicily Channel (central Mediterranean Sea)

Federico Falcini and Ettore Salusti
ISAC, CNR, Rome, Italy (f.falcini@artov.isac.cnr.it)

A dense water vein, i.e., the Eastern Mediterranean Deep Water (EMDW), which flows westward along the bottom of the Sicily Channel (Mediterranean Sea)shows an unexpected cross-channel tilting of the deep water interface around the main sill of the Channel. From cross-stream averages of the EMDW thickness and velocity, we here discuss a new diagnostic model for vertical vorticity (ζ) and potential vorticity (Π) of this deep flow, and its cross-stream profile properties. Our model takes into account friction and mixing, which are important features for current crossing marine straits. We find that, approaching the main sill of the Sicily Channel, the current vorticity decreases because of sea bottom topography and friction, reaching large negative values over the Channel main sill. Downstream of the sill, the vorticity of the vein increases again reaching usual values. We demonstrate that friction tends to decrease Π as long as ζ is positive but, once ζgecomes negative, the corresponding Π has a remarkable increase due to strong bottom friction in the sill region. These diagnoses on ζ and Π for deep flow allow one to gain general insights on the stability, path and cross-sectional structure of deep currents flowing along straits, as well as on some morphodynamic features that may result from the interaction between the bottom current and the seafloor.