Geophysical Research Abstracts
Vol. 21, EGU2019-10249-1, 2019
EGU General Assembly 2019

Inversions of the North Ionian basin-wide circulation. The rotating tank experiment BiOS-CRoPEx.

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The residual circulation in the Ionian Sea (central Mediterranean) is characterized by an important peculiarity: on decadal scale it alternates its polarity from cyclonic to the anticyclonic patterns. Due to this peculiarity and its importance for the Mediterranean basin-wide circulation, rather intense research was devoted in recent years at understanding the mechanism forcing the inversions of the Ionian Sea circulation. At least three hypotheses have been proposed so far: (i) wind-driven effect; (ii) so-called pumping mechanism, essentially based on the continuity of the water volumes between the Adriatic, Ionian and Aegean; (iii) an internal mechanism called BiOS (Adriatic-Ionian Bimodal Oscillating System) based on a feedback between the Adriatic and Ionian. According to this theory, the Adriatic produces water of varying density, which then generates inversions of the bottom density gradient in the Ionian, forcing the circulation inversions. In order to demonstrate the validity of the BiOS mechanism, we performed a series of experiments in the 13-m diameter "CORIOLIS" rotating platform at LEGI (Laboratoire des Écoulements Géophysiques et Industriels) in Grenoble (France).
In particular, the influence of deep and intermediate, geostrophically adjusted dense water outflow on the near-surface vorticity field of a stratified basin was investigated in detail. Different scenarios, aimed at reproducing the fate of convectively generated Adriatic bottom water overflow in the Ionian Sea, its variability in intensity and density contrast, as well as the dynamics emerging from the presence of both Adriatic and Aegean waters in the abyssal layer in the Ionian were considered. Measurements were based on Particle Image Velocimetry realized for the first time within a very large field of view covering the entire tank and at several different levels, using a motorized high-speed rotating mirror laser scanner technique. The processed velocity vectors represent thus a volume of (10mx10mx1m) with a spatial resolution of less than one cm, that is a unique achievement to date for such large-scale systems. Based on the obtained results, aspects of the phenomena affecting the local bottom-arrested layers (e.g. roll waves, Ekman drainage), as well as the emerging near-surface mesoscale and basin-scale residual circulation (circulation reversals) are discussed and put in the context of the BiOS theory and, more generally, of the decadal and inter-annual variability observed in the central Mediterranean basin.