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# LARGE-SCALE LABORATORY EXPERIMENTS OF THE GIBRALTAR EXCHANGE FLOW, INCLUDING GULF OF CADIZ AND ALBORAN SEA

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## Abstract

Results from large scale laboratory experiments of a realistic physical model of the Gibraltar Strait and adjacent Gulf of Cadiz and Alboran Sea are presented. The physical model includes all forcings: the baroclinic exchange flow, the barotropic tide, the realistic bathymetry and the Earth’s rotation. Results show that experiments are able to model and correctly reproduce such a large area of 250km x 150km with different dynamics, including turbulent mixing at the hydraulic control areas, the Mediterranean outflow propagation in the Gulf of Cadiz and the formation of internal solitary waves propagating in the Alboran Sea, revealing intriguing insights in the reach dynamics of the area.

*Keywords: Gibraltar Strait, Straits and channels*

Results from large scale laboratory experiments of a realistic physical model of the Gibraltar Strait and adjacent Gulf of Cadiz and Alboran Sea are presented, including all forcings: the baroclinic exchange flow, the barotropic tide, the realistic bathymetry and the Earth’s rotation. The experiments were conducted at the Coriolis platform at LEGI, Grenoble (France), the largest rotating tank in the world. The baroclinic exchange flow was realized using a lock-exchange configuration with two different salinities at each side. Scaled semi-diurnal (M2) tides for both spring tide (ST) and neap tide (NT) regimes were generated, including the transient with the superposition of the M2+S2 tide. The experimental duration was of 13 rotational days. Similarity has been achieved for the Froude, Rossby, Burger numbers, and the Reynolds number is 5,000. Variation parameters in the experiments were the density difference and the different barotropic flows. The results show that experiments are able to model such a large area of 250km x 150km with different dynamics, including turbulent mixing at the hydraulic control areas, the Mediterranean outflow propagation in the Gulf of Cadiz and the formation of internal solitary waves propagating in the Alboran Sea.

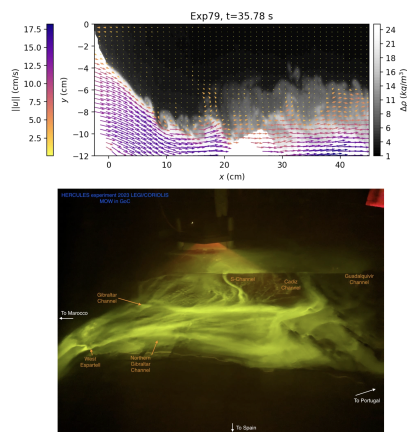


Fig. 1. Instantaneous PIV/PLIF image downstream CS (0,-3). Vertical scale 1/2,500, horizontal scale 1/25,000, velocity scale 1/20, density scale 6.25. Bottom - Fluorescent dye highlighting the propagation of the MOW in the different channels of the Gulf of Cadiz.

Measurements techniques were based on PIV in all regions at different horizontal and vertical sections, including combined PIV/PLIF in high mixing regions (Camarinal/Espartell Sills) which deliver the full turbulent fluxes crucial for parametrization of small-scale turbulent processes (see Figure 1). They appear to be very different during the different phase of the tide. Intrusive devices (ADV, ADV profilers, SSH, CTD) have been used as well, especially to track the Mediterranean outflow in the Gulf of Cadiz. The

dense water transport reveals to be crucially determined by the bathymetric features (see Figure 1).

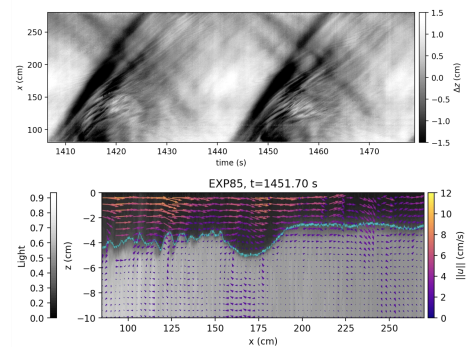


Fig. 2. Hovmöller diagram of the Mediterranean interface during two tidal cycles highlighting the internal tide, the soliton and small-scale instabilities propagating in the Alboran Sea. (Bottom) Dye image with the evident soliton with superposed characteristic velocity field. Speed: 8cm/s, amplitude: 2cm, wavelength 20cm. Scales as in Fig.1.

Solitons are produced during spring tide (ST) at CS and propagate toward the Alboran Sea (see figure 2), at each tidal inversion (West-East). Preliminary results suggest hence that they are not related to the relaxation of the internal hydraulic jump downstream of Camarinal Sill, but rather from an internal bore generated by the internal tide at CS at the tidal inversion (West-East).

## References

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