Geophysical Research Abstracts
Vol. 15, EGU2013-13898-1, 2013
EGU General Assembly 2013

Modelling the Adriatic Sea Bottom Trapped Gravity "River"

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Cold and dry intense winds blowing over shallow sea shelfs produce favorable conditions for water column evaporation and cooling. The new formed water is denser than the out-shelf environmental water and moves away from the production basin, barotropically adjusted. This flow propagates as a wide and slow “river” whose destiny is twofold: on one hand local sea bottom changes force the denser waters to cascade into deeper depressions, while it mixes with the warmer ambient waters, decreasing velocity and so terminate their well defined propagation when it reaches the local neutral buoyancy, and spreading become mainly isopycnic.
In this context, the semi-enclosed Adriatic Sea (the North-easternmost sub-basin of Mediterranean Sea) is a representative domain to investigate the dynamics of this bottom trapped gravity “river” (namely North Adriatic Dense Water, NadDW). NAdDW originates in the northern shallow Adriatic (average depth is approximately 20 m) part, and then it moves southward parallel to the eastern Italian coast and branches to partially fill the mid-Adriatic (Jabuca) and the South Adriatic pits. NAdDW reaches the southern Adriatic in 2-3 months covering a route of approximately 800 km, moving with an average speed in the order of 10 cm/s.
To investigate different aspects that contribute to produce and spread the dense water an eddy resolving high-resolution (1 km) numerical model has been setup in the Adriatic Sea. The numerical runs have relied on the Coupled Ocean-Atmosphere- Wave-Sediment Transport (COAWST) modeling system, which is based on the ocean model ROMS (Regional Ocean Modeling System), the wave model SWAN (Simulating WAves Nearshore), and the CSTMS (Community Sediment Transport Modeling System) routines (Benetazzo et al., 2013). To drive the modeling system, the atmosphere forcings provided by the operational meteorological model COSMO-I7 (an atmospheric mesoscale model developed in the framework of the COSMO Consortium) have been used. The COAWST capability to couple different numerical models have allowed to emphasize the relative importance of different aspects on dense water generation and flow. In particular, this study has investigated the role of continental runoffs (the largest freshwater source of the Adriatic, i.e. Po river, is located in the generation area), movable bottom sediments (and their effect on the water density), and wave forcing terms (on ocean circulation, mixing, and bulk flux formulation). The selected period for the analysis brackets the winter 2012, an extraordinary season during which the northern Adriatic Sea water temperature dropped to about 6°C.

References

Benetazzo A., Carniel S., Sclavo M., Bergamasco A., 2013. Wave-current interaction: effect on the wave field in a semi-enclosed basin. Ocean Modeling. http://dx.doi.org/10.1016/j.ocemod.2012.12.009