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Sub-surface and near-bottom thermohaline circulation of a shallow sea during a dense water production event: a case study from the northern Adriatic Sea.

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Cold, dry, and intense winds blowing over shallow sea shelves produce favorable conditions for water column cooling and evaporation: the newly formed water is denser than the out-shelf environmental water and thus is forced to move away from the production basin. The semi-enclosed Adriatic Sea is a representative domain to investigate the dynamics of this gravity flow. Indeed, such a flow (the so-called Northern Adriatic Dense water, NADW) originates in the northern shallow Adriatic and moves southeastward leant to the Italian coast, in quasi-geostrophic conditions, strongly modulated by ocean circulation (tide and wind driven) and pressure gradients. Along its way southward, NADW partially slide into sea bottom depressions and promote renewal of deeper and older water masses.
Production and spreading of dense water in the northern Adriatic Sea were simulated by means of an eddy-resolving high-resolution (1.0 x 1.0 km2) numerical model, which relied on the Coupled-Ocean-Atmosphere-Wave-Sediment-Transport (COAWST) system, based on the 3-D ocean model ROMS (Regional Ocean Modeling System) and the wave model SWAN (Simulating Wave Nearshore). To drive COAWST, the atmosphere forcings provided by the meteorological model COSMO-I7 (an atmospheric mesoscale model developed in the framework of the COSMO Consortium) were used. Initial and boundary conditions were derived from numerical models operational in the Adriatic and Mediterranean Sea. An observational dataset has been also used with the dual-purpose of describing the NADW formation process and assess numerical model outputs.
The selected period for the analysis brackets early February 2012, an exceptionally cold period during which the northern Adriatic Sea experienced a Cold Air Outbreak (CAO) that forced water temperature to drop to about 6° C, with water density exceeding 1030 kg/m3. Results presented reveal some new insights on how NADW generates in the northern Adriatic Sea, triggered by tidal and wave forcing. Results also support a quantitative characterization of the NADW mass formation in the northern basin, by estimating volumes that leaves production area and contribute to its water renewal.