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Inversions of vertical transfers between the Atlantic and Mediterranean waters by meteorological forcing in the Strait of Gibraltar

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The Strait of Gibraltar is the scenario of a very energetic baroclinic exchange between Atlantic and Mediterranean waters: fresh and warm Atlantic waters enter into the Mediterranean while salty and cold Mediterranean waters outflow to the Atlantic. Those water fluxes fluctuate at different timescales, the most important of which is the semidiurnal one. Other less important but non-negligible source of variability is the meteorological forcing that induces fluctuations in the range of few days of period and the seasonal and interannual variations. Moreover, the two-way exchange is influenced by vertical transfers of heat, salt and mass between the Mediterranean and Atlantic waters during their passage through the Strait. This fact modifies their TS properties having impact on the net heat and salt exchanges of the Mediterranean Sea with the global ocean.

The aim of this work is to analyse the temporal variability of vertical transfers between the Atlantic and Mediterranean waters along their path through the Strait of Gibraltar, with emphasis on the reversal episodes of those vertical transports along the Strait. To do that we analyse the outputs of a numerical simulation covering the entire Mediterranean basin (1/6º of spatial resolution) with enhanced resolution in the area of the Strait (1/200º). Another special feature of this model is that it was only forced through the specification of both the atmospheric pressure and heat & water fluxes at the sea surface so, it does not include the forcing exerted by tides. Tides were excluded from the experiment to further investigate the effects of a realistic atmospheric forcing over the mean flow.

The vertical fluxes between layers present enhanced fluctuations between late autumn and wintertime for all years investigated. On the contrary, minimum values are obtained in summer. This result is ascribed to the sensitivity of the horizontal exchange flows to the passage of atmospheric systems over the Mediterranean basin, which are more frequent and intense during winter. Those atmospheric fronts attach wind stress over the upper layer that results to be, to a large extent, the main source for this variability in detriment of the atmospheric pressure, which plays here a secondary role. Moreover, those enhanced fluctuations can be strong enough to occasionally reverse the vertical fluxes, thus promoting water conveying from the fast-flowing layers (lower layer west of the main sill of Camarinal [CS] / upper layer east of CS) to the slow-flowing ones (upper layer west of CS / lower layer east of CS). Those episodes are associated to intense wind regimes, which are able to modify the long-term transfers between layers.