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Vertical structure of tidal currents over Espartel and Camarinal sills, Strait of Gibraltar

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The Strait of Gibraltar is a strategic key connection between the Atlantic Ocean and the Mediterranean Sea as it is the last exit gate for the Mediterranean Water towards the North Atlantic. ADCP velocity data collected in the two main sills of this strait (Camarinal and Espartel sills) at its western approach has been used for analysing the vertical structure of main tidal components (M2, S2, O1 and K1) currents in this area. Two different periods were considered in correspondence to seasonal variations in density profiles from MEDATLAS database: “wintertime” in February-April and “summertime” in June-October. Amplitudes and phases of the various tidal constituents have been compared for both periods and locations. Stability of the tidal components has also been tested by computing the ratio std/mean.

In order to separate tidal velocities into barotropic and baroclinic components, dynamical mode decomposition (DMD) technique has been used, assuming that along axis diurnal and semidiurnal current in the Strait of Gibraltar oscillate in a senoidal form. A finite sum of the theoretical modes has been least-squares fitted to the observed currents to obtain estimates of the contributions of coeffcients for each mode. Relative importance of each mode can be established in terms on the energy associated.

For Espartel sill, barotropic mode is more energetic during wintertime than during summertime for M2 (above 85% of total energy in winter and almost 77% in summer), S2 (87.5% in winter and 73% in summer) and O1 (above 78% in summer and 70% in summer) components, K1 being more energetic during summertime (almost 80%) than during wintertime (around 70%). Baroclinic modes have smaller contribution to total energy. During wintertime, second baroclinic mode is clearly more energetic than the first one. This behaviour is not so evident for the summer period. It is

worth to mention the relatively high percentage of energy due to third baroclinic mode for M2 (8%) and O1 (9%) components during summertime, this percentage reducing considerably in the winter period. Over Camarinal sill, barotropic mode accounts for more than 90% of total energy in all the tidal components, the highest value (97%) observed for M2. For S2, O1 and K1 component, contribution of first baroclinic mode is 5%, the rest of modes with almost negligible contribution to total energy.