Geophysical Research Abstracts
Vol. 13, EGU2011-8402, 2011
EGU General Assembly 2011

Seasonal and spatial variability of tidal currents at the mid-west Strait of Gibraltar

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The Strait of Gibraltar is the only connection between the eastern North Atlantic, where tidal ranges are in excess of 2 m, and the western Mediterranean Sea, where they are very small. Tides in the Strait move huge volumes of water back and forth to couple both regimes, originating intense tidal currents. That interact with the topography of the Strait and have marked influence on the mean flow. In this work, five year-long time series of Acoustic Doppler Current Profiler (ADCP) observations at a monitoring station in Espartel Sill, western Strait of Gibraltar, have been used to investigate the seasonality, in terms of harmonic constants, of tidal currents through the main channel of the Espartel Section. ADCP data collected by two auxiliary stations deployed in the channel allowed us to analyse their cross-strait spatial variability.

The percentage of total energy associated to tides is not evenly distributed in the water column due to frictional effects and other kinematic processes related to the vertical excursions of the mean interface. A seasonal signal of this percentage is observed with minimum values in autumn-wintertime for all the investigated years. It is related to the enhancement of subinertial currents, due to the sensitivity of the exchanged flows to the pass of atmospheric systems over the Mediterranean basin, more frequent and intense during this season, rather than to changes in the strength of the tidal currents.

The cross-strait tidal dynamics presents baroclinic features with a north-to south gradient in the Atlantic layer and greater amplitudes in the north. Below the interface (Mediterranean layer) the gradient changes sign and sharpens and the amplitude minimum is found close to the northern boundary, more or less in the same place where phase is maximum. Both features generate relative vorticity at tidal frequencies. M2 tidal flow in the lower layer appears as a horizontally sheared flow, with greater amplitudes in the southern half of the channel due to topography, which forces the tidal current to be displaced towards the Moroccan coast.