INTERNAL TIDES STRUCTURE IN THE STRAIT OF SICILY AND MALTA PLATEAU

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Abstract
The structure of internal tides (ITs) in the Sicily strait and Malta plateau is investigated by using a very high model resolution (ROMS). Barotropic to barolinic energy conversion is highest over near and super-critical slopes of the Adventure shelf's break, the Malta plateau and in the surrounding of the Pantelleria isle. Our simulated currents compare favorably to those of ship board and radar measurements. The converted energy feeding the ITs is estimated to be 124 MW, 60 % of which is within the semidiurnal frequencies. The most energetic semi-diurnal tide, namely M_2, propagates with strong dissipation occurring close to its generation sites. In contrast, the energy of diurnal ITs is totally dissipated in the vicinity of the shelf break where they are topographically-trapped.

Keywords: Tides, Adventure Bank, Malta Channel, Continental slope, Coastal models

1. Introduction
The region covered by the present study includes the Sicily strait and the Malta plateau, a dynamically active area connecting the eastern and western Mediterrenean sub-basins. This area is characterized by important dynamical processes occurring over a large spectrum of temporal and spatial scales. Even this area has been extensively studied during the last years [1-2], very few is known about the generation and the internal tides energetics. In fact, except sparse observations [3-5], the vertical structure has not been sufficiently addressed and very few is known about the generation of the internal tides (ITs) in this region based on sparse observations. In this study we try to quantify the ITs enregetics and to clarify the vertical modes structure associated to the diurnal and semidiurnal frequencies.

2. Model setup
The model used in this study is based on the Regional Oceanic Modelling System (ROMS), a three dimensional primitive equations, finite difference, hydrodynamic model. The bahymetry used is deduced from gebco 1' resolution. Realistic summer stratification is used [6]. Tidal forcing is appended at the four open boundaries by setting M_2, S_2, K_1 and O_1 elevations deduced fom 2D gravity model (MOG2D).

3. Results
In order to well investigate the distribution of the ITs in the area of study and for a better representation of the mesoscale eddy activity, we carried out two numerical simulations in which the grid resolution is chosen to be 1/32° and 1/60°, respectively. The spatial resolution significantly affects the converted energy feeding the internal tides. The finer spatial resolution the higher the converted energy. Indeed, the converted energy is 10 % higher with the finest resolution (1/60°) but the ratio between flux divergence and the converted energy remains almost the same.
The Messina strait, the narrowest passage through the western sill of the Adventure Bank, the northwest of Sicily and the northwest of the Pantelleria Isle are the main generation sites for M_2. Three sites are identified for K_1, namely, the eastern edge of the Adventure Bank, the surrounding of Malta plateau and the Messina strait.
In the Sicilian Channel, the converted energy feeding the internal tides is estimated to be 124 MW, 60 % of which is within the semidiurnal band (M_2 and S_2). The K_1 converted energy is 80 % of that of M_2 but is entirely lost in the vicinity of the shelf break. The K_1 internal energy is topographically-trapped near its generation regions. The M2 internal tide propagates namely toward the north from the western sill of the Adventure Bank where the second baroclinic mode is exicted. Far from this generation site the first baroclinic mode dominates as suggest the wavelet orthogonal functions decompositions (WEOF) of the baroclinic velocity.
The modeled currents compare favorably to ship board [4] and radar data [5]. The finest resolution gives the best results namely in the C01 station located in the western sill of the Adventure Bank. Increasing the horizontal resolution improves the magnitude of the major semiaxis in the surface layers for the semi-diurnal constituents and the diurnal ellipses estimation in the bottom layers. The improvement of the simulated surface currents in the Malta channel is confirmed by their comparsion to those deduced from radar measurements.
Vertical thermocline displacement induced by the internal tides in the Adventure Bank over a neap cycle is estimated to be between 10 m and 15 m in the thermistor station [4] and it is in good agreement with previous estimations [4]. Besides, the power spectra of the vertical displacement amplitude in this location shows that K_1 prevails M_2 below the mixed layer (~20 m) which is also in agreement with measurement estimations [4]. Finally, the EOF decomposition of the temperature at this location shows that almost 90 % of the total temperature variance is contained in the first three modes.

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