MODEL ESTIMATES OF M_2 INTERNAL TIDE ENERGETICS IN THE SICILIAN CHANNEL

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Abstract
The M_2 internal tide energetics in the Sicilian channel have been investigated by using a three-dimensional sigma coordinate model (ROMS). Realistic topography and stratification from existing observations were used. We have identified three potential sites of M_2 internal tide generation, namely the western sill of the Adventure Bank, northwest of Sicily and north of Pantelleria isle. The conversion rate from the M_2 surface to internal tide energy integrated over the whole model domain amounts to 47.5 MW, 75 % of which are found to be generated over the three prominent topographic features mentioned above
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Introduction
The Strait of Sicily has been extensively studied during the last years [1, 2]. However, very few is known about the generation of the internal tide in this strait. Indeed, except sparse observations [3, 4], the vertical structure has not been sufficiently addressed. Within the framework of what has previously been studied concerning the internal tides generation and propagation in some potential areas, we try to clarify the distribution of the M_2 internal tides in the Strait of Sicily as well as its energetics. We use a fully three-dimensional sigma coordinate model, the Regional Ocean Modeling System (ROMS). The horizontal resolution is 1/32° in both longitudinal and latitudinal directions.

Internal tidal energy budget
The governing equation for the baroclinic energy is given by

$$\frac{\partial}{\partial t}\left(\bar{\rho}_0\frac{\vec{u}_i^2}{2}+\frac{g\rho'^2}{2}\left(-\frac{d\rho_0}{dz}\right)^{-1}\right)=-\vec{\nabla}\cdot(p_i\vec{u}_i)+g\rho' w_{bt}+D+A(1)$$

where $\bar{\rho}_0$ is the reference water density, ρ_0 is the background basic density stratification, ρ' is the water density perturbation, $\vec{u}_i$ is the baroclinic velocity, w_{bt} is the vertical velocity induced by the barotropic tide flow, p_i is the internal pressure perturbation, D and A denote the dissipation and the advection of the baroclinic energy, respectively. The left side of (1) is the rate variation of the baroclinic energy density, $p_i\vec{u}_i$ is the energy flux that is associated with the propagation of the internal tide, and $g\rho' w_{bt}$ represents the conversion rate from surface to internal tide energy.

Assuming that the advection of baroclinic energy is neglected, integration of the equation (1) over a given domain and taking the average over one tidal period (denoted by an overbar) yields:

$$\iiint g\ \overline{\rho' w_{bt}}dV=\iint\overline{p_i\vec{u}_i}\overrightarrow{dS}+\iiint\bar{D}dV$$

The model-predicted distribution of the depth-integrated conversion rate from the M_2 barotropic to baroclinic tidal energy shows that there are three distinct sites of strong generation, one at the narrowest passage through the western sill of the Adventure Bank, and the two others are in the northwest of Sicily and the north of the Pantelleria isle. The M_2 mode conversion integrated over these prominent topographic features sums up to 35.6 MW, which is 75% of that integrated over the whole model domain. M_2 internal tide is mostly efficient over the narrowest passage through the western sill where the baroclinic energy conversion amounts to 17.1 MW. It is about 11.3 MW in the northwest of Sicily and 7.2 MW in the north of the Pantelleria isle. The net M_2 baroclinic energy flux away from the region including the western sill accounts for 8.5 MW, 5.5 MW of which is directed toward the north and 3 MW toward the south. For the region including the Pantelleria isle, the energy flux divergence has been estimated to be 60% of the integrated conversion energy, mainly directed toward the Tunisian coasts (2.6 MW).

The local dissipation within the western sill of the Strait of Sicily amounts to 8.9 MW corresponding to 52 % of the baroclinic energy conversion where it is about 40 % within the north of Pantelleria isle and about 71 % in the northwest of Sicily. It is important to note that 42.3% of the barolinic energy generated in the whole modelled region is dissipated in close proximity to the baroclinic M_2 generation sites already identified.

The baroclinic energy flux divergence (Figure) emphasizes the localised nature of generation and depicts the propagation of energy away from the narrowest passage through the western sill toward the north and southwest. The main direction of propagation from the Pantelleria isle is toward the Tunisian coasts.

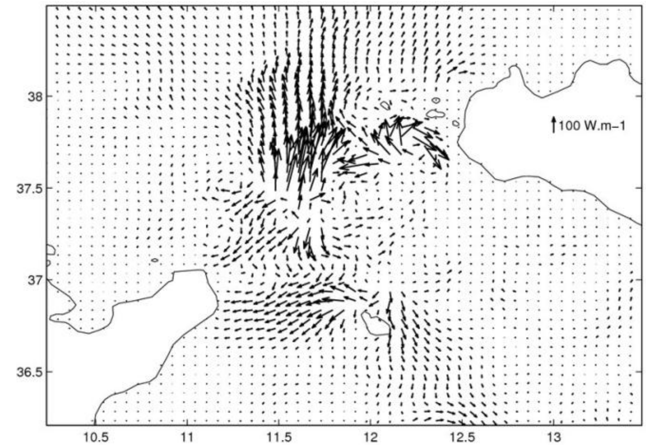

Fig. 1. The depth-integrated M_2 baroclinic energy flux

References
1 - Astraldi, M., Gasparini, G. P., Gervasio, L., and Salusti, E, 2001. Dense water dynamics along the Strait of Sicily (Mediterranean Sea), *J. Phys. Oceanogr.*, 31: 3457-3475.
2 - Beranger, K., Mortier, L., Gaparini, G.P., Gervasio, L., Astraldi, M., and Crépon, M, 2004. The dynamics of the Sicily Strait: a comprehensive study from observations and models, *Deep-Sea Res. I*, 51: 411-440.
3 - Artale V, Provenzale A, and Santoleri R, 1989. Analysis of internal temperature oscillations of tidal period on the Sicilian continental shelf. *Cont. Shelf Res.*, 9: 867-868.
4 - Gasparini, G.P., Smeed, D., Alderson, S., Sparnocchia, S., Vetrano, A., and Mazzola, S, 2004. Tidal and subtidal currents in the Strait of Sicily, *J. Geophys. Res.*, 109: 1-19.