SYNTHETIC APERTURE RADAR IMAGE ANALYSIS AS A TOOL FOR VALIDATION OF BAROCLINIC INTERNAL WAVE 3D MODELING IN ALGECIRAS BAY (STRAIT OF GIBRALTAR)

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INTRODUCTION

Algeciras Bay (South coast of Spain) constitutes a physical environment of special characteristics, due to its bathymetric configuration and geographical location, close to the eastern boundary of the Strait of Gibraltar. The interaction between the mesotidal, predominantly semidiurnal tidal regime of the Strait of Gibraltar with the water stratification, due to the presence of Atlantic water at the upper layer and Mediterranean water (more salty and cold) at the lower one, has important hydrodynamical consequences, being the generation of the so-called baroclinic internal wave by hydraulic jump over Camarinal Sill one of the most remarkable effects (see, e.g., Bruno et al., 2002). Because of its wide connection to the Strait, the tidal hydrodynamics of Algeciras Bay is expected to be subject to these peculiar short-period phenomena, and some evidences of the penetration of internal waves into the Bay have been inferred from recent high-resolution experimental time series from ADCP and CTD moorings. In order to conduct a more holistic spatial analysis of this process, results from a 3D numerical simulation of the M_2 tidal dynamics in Algeciras Bay (and, in extension, the Strait of Gibraltar) were compared with Synthetic Aperture Radar image analysis from ENVISAT satellite at analogue tidal stages, focusing on the high-frequency disturbances on the free-surface elevation by the incoming internal wave.

THE MODEL

The three-dimensional, nonlinear, high-resolution, finite-difference, sigma-coordinated UCA 3D hydrodynamical model is based on the numerical solving of 3D equations of motion. The system is coupled to a two-dimensional, depth-averaged scheme (Álvarez et al., 1999) by the splitting technique (Madela and Piacsek, 1977). For the modeling of the M_2 tidal hydrodynamics in the Strait of Gibraltar and Algeciras Bay, it was chosen a calculation domain extended from the western Strait boundary to the Alboran Sea. The model Arakawa-C staggered grid had a horizontal resolution of

500 m and 50 vertical sigma-levels. The system was forced by a single M_2 tidal wave and the zero-frequency constituent Z_0.

RESULTS AND CONCLUSIONS

The ASAR images were processed and compared with those from the simulations of the M_2 tidal dynamics in the Strait of Gibraltar. From the comparison, a significant agreement between model and satellite results was found (Fig. 1). This agreement lies in the main internal wave parameters for the free-surface elevation, namely amplitude (order of 1 cm), period (about 20 – 25 minutes), wavelength (1.8 km) and delaying respect to the main M_2 tidal wave. ASAR images had revealed as a powerful complement to internal wave 3D modeling. It provides a wide, holistic spatial validation of model results not available from traditional analyses of experimental data records by single-point moorings or ship transects.

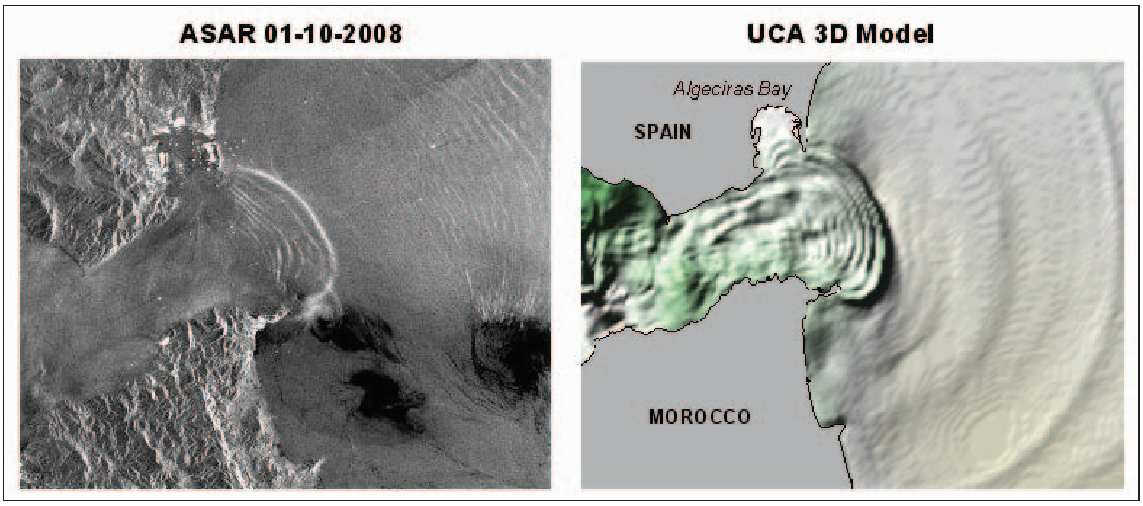

Figure 1. An example of comparison between ASAR image and UCA 3D results for free-surface elevation at analogue tidal stage, showing the internal wave coming to the Mediterranean Sea close to Algeciras Bay.

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