NUMERICAL MODELING OF THE SURFACE CIRCULATION IN THE SEA OF MARMARA DURING THE
TSS EXPERIMENT (SEPTEMBER 2008 – MARCH 2009)
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Abstract
ROMS and SWAN models are used to simulate and to exploit the Marmara Sea general circulation and the response to windstorms
within the framework of the international scientific program “Turkish Straits System (TSS) 08-09”. Model results show a general
circulation in agreement with previous literature and the data collected as well as a remarkable impact of windstorms with complete
reversal of the surface flow and frequent upwelling events.

Keywords: Marmara Sea, Currents, Circulation Models

Between August 2008 and March 2009, the international scientific program “Turkish Straits System (TSS) 08-09” was carried out under the coordination
of the NATO Undersea Research Centre (NURC, La Spezia, Italy), jointly with the NRL project “Exchange Processes in Ocean Straits” (EPOS). During
September 2008 and February 2009 the NRV Alliance sampled extensively the Marmara Sea waters with the deployment of several different instruments
(e.g., CTDs, moorings, bottom-mounted ADCPs and profilers, surface lagrangian drifters, Wave Raider, meteorological buoy etc.), some of them
providing 1 to 6 months time-series of currents, tracers or meteorological conditions.

Several realistic numerical experiments of the Marmara Sea circulation have
been carried out in order to understand the ongoing dynamics, providing simulations of the autumn-winter general circulation and the windstorm-
induced circulation. The core ocean model used is the Regional Ocean
Modeling System (ROMS, [1]), run uncoupled or coupled 2-way with the
wave model SWAN [2]. The numerical grid (same for both models) covers the
entire Marmara Sea, with two open boundaries located a few kilometers up
strait in the Bosphorus and Dardanelles straits and a varying horizontal
resolution of 500 – 1500 m. CTD data collected during the field trial either in
late August 2008 or early February 2009 provide the initial field for the ocean
model. Lateral boundary conditions are provided by NRL bottom-mounted
ADCPs (momentum fluxes) while available moorings and CTDs provide
temperature and salinity profiles in the straits. The non-hydrostatic, high-
resolution (7 km in the horizontal) numerical weather prediction model
COSMO-ME, run at the Italian national meteorological centre of the Italian air
force provides surface boundary conditions for both ROMS and SWAN.

The general circulation derived using ROMS is in agreement with the general
picture provided by [3], and fairly agrees with the observations collected. A
major focus of this modeling exercise is to study the wind driven circulations in
the Marmara Sea and model results show complete reversal of the upper
layer flow depending on the sector of provenance of the wind storm. Westward (eastward) flow associated with north-easterlies (south-westerlies)
also trigger upwelling/downwelling dynamics along the coastline of the
Marmara Sea, with relevant storm-induced basin-wide oscillation of the mixed
layer depth.

In addition, the 2-way coupled ROMS/SWAN model is used to simulate
wave-current interactions in the area. Wave-current interactions are considered
using the Mellor’s equation for the inclusion of radiation stress and stokes
drift in the momentum balance equation [4] and the inclusion of wave breaking
as TKE injection as surface boundary condition of the Generic Length Scale
turbulence model following [5]. The impact of wave current interactions is
eventually assessed using skill scores based on surface lagrangian drifters.

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