# 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 NR/V 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.

## References

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