

## VOLUME FLUX VARIABILITY IN THE BOSPHORUS STRAIT

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### Abstract

Recently collected time series of currents, salinity, and temperature were used to estimate volume transports along sections located across the northern and southern ends of the Bosphorus Strait. The volume fluxes in upper and lower layers display high variability that is especially distinct in the upper layer and is coherent with the water level difference between the ends of the strait and along-strait wind stress.

*Keywords: Bosphorus, Water Transport, Currents*

The Bosphorus (Istanbul) Strait is a part of the Turkish Straits System (TSS) that also includes the Sea of Marmara and further towards the south the Dardanelles (Çanakkale) Strait. The TSS is the only connection between the Black and Aegean/Mediterranean Seas, and plays a paramount role in water mass exchange between these basins. It has been established for centuries that due to the density contrast in the adjacent basins, the basic exchange flow in the Bosphorus Strait is characterized by Black Sea brackish waters flowing southward in a surface layer, and salty waters from the Sea of Marmara moving northward below (Marsigli, 1681; Ünlüata et al., 1990; Latif et al., 1991; Gregg and Özsoy, 2002). Furthermore, this two-layer exchange is modified by the atmospheric forcing and variability of the water levels in the Black and Marmara Seas.

The United States Naval Research Laboratory (NRL) and the NATO Undersea Research Center (NURC) in collaboration with the Turkish Navy Office of Navigation, Hydrography and Oceanography deployed two mooring sections (Black Sea and Marmara Sea entrances) in the Bosphorus Strait as a part of the TSS08 (NURC project) and EPOS (NRL project) programs in September 2008. Each section was configured with: two BARNY moorings (ADCP, wave/tide gauge, temperature, and conductivity sensors) and one line mooring with seven pressure, temperature, and conductivity sensors (T/C sensors). All moorings were recovered at the beginning of February 2009. Full high quality time series were returned from the BARNY moorings. Unfortunately, both line moorings were partially damaged; hence, the data return was limited.

layer transport is primarily highly coherent with the water level difference between the Black and Marmara Seas, secondarily with the local along-strait wind stress, and thirdly with the atmospheric pressure. The atmospheric forcing and water level difference can easily account for at least 70% of the variance of the upper layer volume transport in the Bosphorus Strait.

### References

- 1 - Gregg M.C. and Özsoy E., 2002. Flow, water mass changes, and hydraulics in the Bosphorus. *J. Geophys. Res.*, 107, doi:10.1029/2000JC000485.
- 2 - Latif M.A., Özsoy E., Oguz T. and Ünlüata Ü., 1991. Observations of the Mediterranean inflow into the Black Sea. *Deep-Sea Res.*, 38 (Suppl. 2): S711–S723.
- 3 - Marsigli L.F., 1681. Osservazioni intorno al Bosforo Tracio ovvero Canale di Constantinopoli rappresentate in lettera all sacra real maesta di Cristina Regina di Svezia, Roma, 108 pp.
- 4 - Ünlüata Ü., Oguz T., Latif M.A. and Özsoy E., 1990. On the physical oceanography of the Turkish Straits. In: Pratt, L.J. (Ed.), *The Physical Oceanography of Sea Straits*. NATO ASI Ser. Kluwer Academic Publishing, Dordrecht, pp. 25–60.

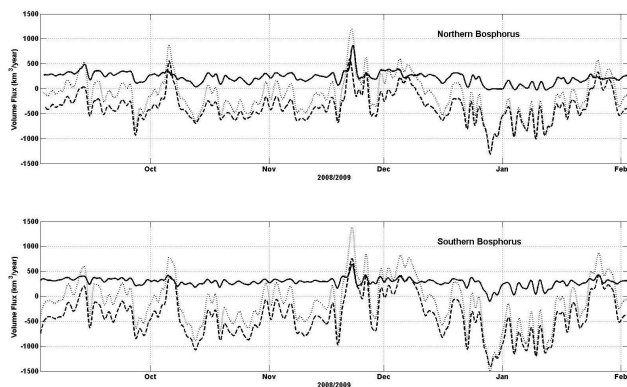


Fig. 1. Volume transports (km<sup>3</sup>/year) in the Bosphorus Strait: upper layers – dashed line; lower layers – continuous line, and net volume flux – dotted line.

The available data were then used to estimate volume transports in the upper and lower layers in the Bosphorus Strait. Time series of transport (upper, lower, and net) for both ends of the strait are shown in Figure 1. Time series means (September 2, 2008 – February 3, 2009) are 401 km<sup>3</sup>/year, 286 km<sup>3</sup>/year, and 115 km<sup>3</sup>/year for the upper layer, lower layer, and net transports, respectively, along the southern entrance section, and 361 km<sup>3</sup>/year, 222 km<sup>3</sup>/year, and 139 km<sup>3</sup>/year for the upper layer, lower layer, and net transport, respectively, along the northern entrance section. Additionally, at both locations, the volume transport shows high variability. This variability is generally more distinct for the volume flux of the upper layer. The fluctuations there could be twice as large as their respective mean values. Results from multiple and partial coherence analyses indicate that the variability of the upper