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Hydrological fine-structure evolution as a proxy of water mass property changes in the Tyrrhenian Sea

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The variability of the Tyrrhenian basin water masses properties, as inferred by the evolution of the typical step-like profile of the water column, is analyzed from 2003 to 2016. The dataset contains hydrological time series obtained in two deep control stations at a depth of about 3500 m. The study follows the evolution of double diffusion processes (a coherent basin feature) that leads to well-defined and permanent staircases. In each profile, four main steps can be recognized between 400 m and 2500 m both in conservative temperature (CT) and absolute salinity (SA), the main one having a thickness of about 400 m.

The Tyrrhenian Sea is a not particularly dynamic basin if compared with other areas of the Mediterranean Sea, yet the staircases show large hydrological and depth changes. In particular, an increase of CT and SA and an uplifting are observed in the second part of the time series. Such changes can be due to both internal and external forcing. To discern the nature of the forcing, a suitable method [1] has been applied to our case study. Changes in SA are found to be similar along both isobars and neutral surfaces, so they can be ascribed to an external forcing. On the other hand, the CT shows different trends along isobars and neutral surfaces: this suggests that internal forcing can play an important role.

The new Western Mediterranean Deep Water formed in severe winters after 2004-2005 and later in the Gulf of Lion (during the so-called Western Mediterranean Transition [2]) is suggested to be an external forcing producing the observed variability. Oscillatory movements of the neutral surfaces can also be observed after 2010. Computation of heat and salt fluxes (both for the whole water column and for each single step) sheds light on the conservative character of hydrological parameters of the step-system.

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[2] Schroeder, K., G. P.Gasparini, M. Tangherlini, and M. Astraldi, 2006. Geophys. Res. Lett., 33, L21607, doi:10.1029/2006GL027121.