HYDROCHANGES NETWORK: LATEST OBSERVATIONS AND LINKS BETWEEN TIME SERIES

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Abstract

HYDROCHANGES is an international program supported by CIESM (www.ciesm.org/marine/programs/hydrochanges.htm) initiated in 2002, to monitor the long-term variability of hydrographic properties of Mediterranean water masses – a priority in the context of global warming. We present an overview of the most recent observations and attempt to link the different time series.

Keywords: Hydrology, Time Series, Monitoring

HYDROCHANGES (HC) is a network of continuous, long-term measurements of temperature (θ) and salinity (S) in the Mediterranean. The HC monitoring strategy is based on *permanency*, to address the long-term variability, *key sites* to address specific processes, *simplicity of logistics* with a local management and short shiptime requirement for maintenance, and *simple instrumentation* (short moorings generally a few meters above the seafloor, supporting self-contained quality CTDs). Moorings are located in key places (Fig. 1) to track the signals indicative of specific processes driving the Mediterranean functioning, especially in straits and channels and in regions where dense water formation (DWF) occurs, either open-sea convection or shelf cascading. Data sets (Fig. 2) have been already widely exploited, also linking them with repeated CTD sections [1, 2, 3, 4, 5, 6].

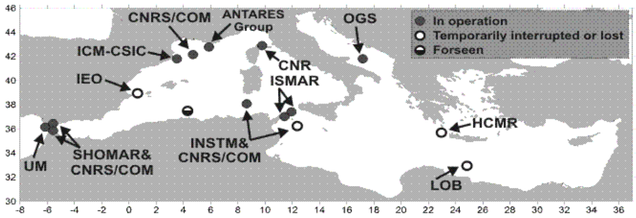

Fig. 1. Present status of the network and involved institutes.

There are some evidences of interannual θ (and S) increases (e.g., Fig. 2a, 2c and 2g), but the HC time series are too short yet to address issues on long-term variability. Nevertheless, they have demonstrated their relevance to accurately detect effects of DWF processes. This is particularly evident in the NW basin, showing the succession of offshore convection and shelf cascading in early 2005 and 2006 (Fig. 2). The mooring time series in the lower Catalan continental slope (Fig. 2g) recorded with unprecedented details the succession of episodes contributing to DWF in 2005: the arrival of open-sea convection water (positive jumps of θ and S in late January), the shelf cascading water (drop in θ and S in early March), and a warmer and saltier situation after April. Such a succession of events was recorded in 2006 too, while in early 2009 only signals pertaining to a less intense open-sea convection were recorded. The mooring at 42°N-5°E (Fig. 2f) also shows DWF in 2009, one week earlier, with an abrupt positive jump in θ and S in late February. The parallel marked increases of θ and S in the Sardinian Channel (SC) since summer 2005 (Fig. 2c) are likely to contain the remote signal of what happened in the northern part of the basin, with the new deep water slowly passing through the channel to reach the Tyrrhenian.

The various time series at Gibraltar (Fig. 2h) provide an insight in the interannual and seasonal variability of the outflow [3, 5] and inflow [4]. The latter has to be considered for DWF issues, as [4] reported a huge S increase (0.05/year) in the inflow between 2003 and 2007. In the outflow, the significant θ drop in March 2005 and 2006 might be directly related to a possible rapidly propagating barotropic response of DWF [6]. The monitoring of the Sicily Strait (SS) and the Corsica Channel (CC) is a fundamental task for the quantification of the highly variable heat and salt import from the Eastern Mediterranean, through the Tyrrhenian Sea, towards the western DWF sites (Fig.2b and 2d).

To improve HC we must add moorings in other key regions which are not currently monitored and add supplementary sensors to the CTDs (pressure systematically, oxygen and turbidity recommended). The complementary use of moored CTD vertical profilers would be a great asset, especially in the DWF areas. It requires also the dissemination of common practices (sampling frequency, processing, calibration frequency, archiving) and the set-up of a HC database and meta-database. The common access to all time-series would support efforts for linking the signals observed in both basins and at their connecting points, in order to get the comprehensive picture of the functioning of the Mediterranean. While it is likely to remain a long-lasting challenge, the precise monitoring of the θ and S is already providing reference data.

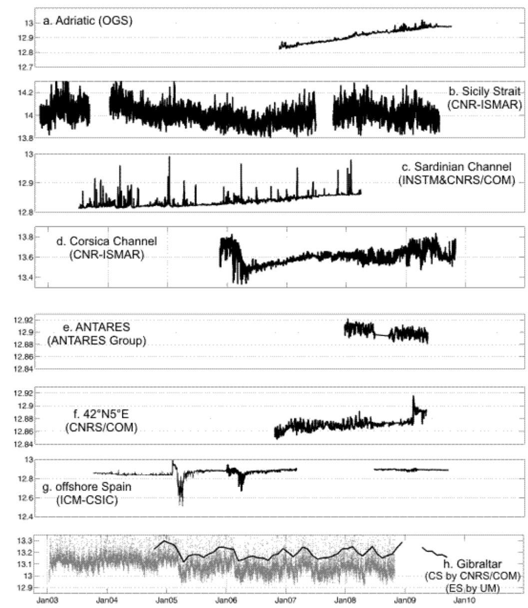

Fig. 2. θ times series in (a) Adriatic Sea, (b) SS, (c) SC, (d) CC, (e) ANTARES site, (f) 42°N5°E, (g) off Spain, (h) Gibraltar (Camarinal sill, CS, in grey, Espartel sill, ES in black).

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