On the origin of the seasonal and interannual T-S variability of the inflow through the Strait of Gibraltar

Jesús García Lafuente[(1)], Cristina Naranjo[(1)], Ricardo Sánchez[(2)], José C.Sánchez Garrido[(1)], Simone Sammartino[(1)]

[(1)] University of Málaga, CEIMAR, Spain.
[(2)] Laboratorio oceanográfico de Cádiz, Instituto Español de Oceanografía

During several years of the last decade, the hydrological properties of the Atlantic inflow through the Strait of Gibraltar were monitored at a station located over the Moroccan continental shelf south of Camarinal sill. The station, deployed and maintained by the Centre Oceanologique de Marseille in collaboration with SHOMAR (Morocco) was part of the HydroChanges monitoring network sponsored by the CIESM1 and collected a good quality set hydrological observations at 80 m depth from 2003 to the end of 2008, when the scientific equipment was lost. In an interesting paper, Millot (2007) analyzed the time subseries spanning from 2003 to early 2007 and showed an indisputable seasonal signal in the Atlantic inflow and a trend of the salinity of the Atlantic water that was flowing toward the Mediterranean Sea at the depth of the station. Since the inflowing water comes from the Gulf of Cadiz, any signal detected in the inflow must be present in that area, a fact that has inspired the present work, which makes use of different experimental (ARGO Global Marine Atlas, Altimetry, QuickScat winds, and the whole time series at Camarinal), re-analysis (NCEP-NCAR) and numerical (ECCO model) data to address the topic. The seasonal local signals of temperature and salinity in the Gulf of Cadiz, both of them neatly depicted in the analyzed data, show up different origins. The temperature oscillation is accounted for by the surface heat flux to a very great extent (more than 80%), while the salinity signal is not sensitive to any surface flux at all, but to advective fluxes. ARGO Global MarineI Atlas and ECCO model data strongly suggests that the seasonal fluctuations of the position and extension of the North Atlantic Subtropical Gyre are driving the seasonal salinity signal observed in the Gulf of Cadiz, which is later advected into the Mediterranean Sea through the Strait of Gibraltar. The important conclusion to be drawn is that the interannual variations of the seasonal fluctuations of the Gyre will generate short-term trends of the seawater properties observed in the Gulf of Cadiz (intra–decadal variability) and, hence, in the Strait. Actually, the ECCO database indicates that such a short-term trend of the Gyre position to be displaced to the east took place during the same years as the salinity trend in the inflow reported by Millot (2007). Thus the salinification mentioned by this author would have its origin in the large scale dynamics of the North Atlantic Subtropical Gyre, since the more to the east the Gyre reaches, the easier will be to find saltier water in the Gulf of Cadiz. To this regard it is worth noting that the trend of the North Atlantic Subtropical Gyre to be displaced to the east stopped in year 2007, which coincides with the end of the short-term trend that was being detected by the monitoring station. Millot's analyses embraced the period from February 2003 to February 2007, which ended before the trend changed, and he could not envisage that change. As far as the salinity of the inflow is a fundamental ingredient of the thermohaline circulation of the Mediterranean Sea, the understanding of the mechanism that causes the interannual variability of the seasonal pattern of the North Atlantic Subtropical Gyre would be critical for studies of

the interannual variability of the Mediterranean Sea circulation. The issue is currently under study although large scale wind field in the North Atlantic is the most likely candidate.