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Steric and mass-induced Mediterranean sea level trends from 15 years of altimetry data

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Long-term series of almost 15 years of altimetry data (1992-2005) have been combined with other datasets (SST, temperature and salinity profiles and NAO records) to study sea level trends over the Mediterranean Sea. Although Sea Level Total (SLT) is mainly driven by SLV (the steric contribution), SLM (the mass-induced component) plays some role in modulating SLT oscillation. When SLT is rising (falling), the Mediterranean is losing (gaining) mass and both steric and mass-induced contributions counteract each other to produce the net sea level variations. For the period 1992-2005, increasing trends of 2 mm/yr, 1.3 mm/year and 0.7 mm/year have been found over the whole Mediterranean for SLT, SLV and SLM, respectively. SLV, mainly driven in the Mediterranean Sea by thermal expansion or contraction of the water column (thermosteric effect), trend only accounts for 65% of SLT trend, 35% remaining in SLM. A decreasing trend in SLT, more evident in the thermosteric component, from 2001 onwards is also detected. Mediterranean averaged SST exhibits an increasing trend of 0.067 C/year during 1992-2005, higher values locating in the eastern basin and lower in the western. This means an increase of approximately 1 C over 15 years, although this result is biased by year 2003, when Europe was affected by an exceptional heat wave.

Sea level rise is particularly important in the Levantine basin south of Crete with values up to 10 mm/year due to cooperation of both steric and mass-induced components. Some other rising spots are localised throughout the Levantine basin and in the Adriatic and Alboran Seas, with more moderate increasing trends. Decreasing trends mainly concentrate in the Balearic basin, between the Balearic Islands and the African coasts (some 5 mm/year decreasing rate) and in the Ionian basin southeast of Italy and

Sicily where the higher decreasing trends are reached (up to 10 mm/year), the mass-induced contribution being widely dominant here. It might be that the decreasing trend over the Ionian basin was one of the several consequences of the Eastern Mediterranean climate Transient (EMT), which has brought noticeable changes in circulation patterns over this basin in the last decades.

Spatial distribution of water column averaged salinity trends clearly shows differences between eastern and western basins. Positive trends detected in the Levantine area, where LIW is traditionally formed, may be suggesting long-term changes in the haline properties of this water mass. The higher state of NAO during recent decades may be cooperating to this increasing trend. Some other concomitant factors such as decrease in fresh water input as a result of human activities and decrease in precipitation since 1940 may also be involved. Thus, ultimately NAO might be responsible for the recent changes detected in the Mediterranean thermohaline circulation as well as for the sea level variations. Although correlation between NAO index and SLT is rather low in the whole basin, in the easternmost and westernmost areas (Levantine and Balearic basins) NAO influence on SLT might be more effective.