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An internal mechanism driving decadal oscillations of the thermohaline circulation and properties in the Eastern Mediterranean

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This work focuses on the interdependence among the Dense Water Formation (DWF) activity in the Adriatic and Aegean Seas (Dense Water source areas), the changes in the characteristic water mass circulation patterns and the salinity oscillations occurring in all basins of the Eastern Mediterranean. We use both numerical model results (1960-2000 hindcast experiment using a 1/10o x 1/10o POM model implemented within the Mediterranean basin) and field observations. Model results reveal that water mass exchanges through the straits of Dense Water (DW) source areas (the Otranto and Cretan Arc Straits respectively), give evidence of DW outflow anticorrelated decadal oscillations, during the simulated 40-year period. This leads to the finding that the Eastern Mediterranean Transient (EMT) event was not a unique phenomenon, although being the strongest, in the study period. The alteration of DWF sites activity is found strongly correlated with periods of increased salinity and temperature over each basin, which present the same decadal variability. Atmospheric forcing analysis has shown that it cannot account for such decadal oscillations although unambiguously plays a key role on DWF processes. On the other hand, the model results show that the change of the Atlantic Water pathway in the Ionian basin and the subsequent modification of the Levantine and/or Cretan Intermediate Water (LIW/CIW) pathways is the main factor for the salinity redistribution in the Eastern Mediterranean, as the observations also revealed for the EMT period. According to the mechanism proposed here, the dense water formation process taking place in an active source area (either the Adriatic or the Aegean) modifies the AW pathway due to lateral advection changes. The increased AW volume received by the active area progressively leads to a long term freshening and subsequent reduction of the DWF intensity. At the same time this process preconditions the inactive area through the corresponding changes in the pathways of LIW and/or CIW, which act as salt carriers. Therefore, the proposed mechanism affects both the preconditioning and the dense water formation decay phase of the two source areas. The existence of these decadal time scale interactions leads to the conclusion that the two EMT-like events, identified during the 1960-2000 integration period, are part of an oscillating pattern of the basin that is mainly internally driven.