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Evidence of a new branch in the surface circulation in the Sicily Channel

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The Sicily Channel (SC) plays a key role in the Mediterranean circulation. The SC circulation can be described as a two-layer exchange of inflowing Atlantic Water (AW) and outflowing of dense eastern Mediterranean waters discharging in the Tyrrhenian Sea. In this study, we focus on the interannual variability of the surface circulation. At the SC entrance due to topographic effect, the Algerian Current splits into three branches, one entering into the Tyrrhenian Sea, the Bifurcation Tyrrhenian Current (BTC), trapped by the topography while the two others pass through the SC and enter into the Eastern Mediterranean. These later branches are the Atlantic Tunisian Current (ATC), and the Atlantic Ionian Stream (AIS). We investigated the interannual variability of the SC surface circulation using a 50-year simulation of a high resolution model of the whole Mediterranean Sea. This eddy-resolving NEMO-MED12 model was forced by daily atmospheric fields from ARPERA forcing during the 1958-2012 period. The first five years of the simulation are considered as the model spinup. To separate large and mesoscale variability, we first investigate the different important regimes by clustering 30-m depth currents into groups having close statistical properties, applying a neuronal network classifier, the Self Organizing Algorithm (SOM), which is an unsupervised classification method made of a competitive neural network structured in two layers. Secondly, we applied a Hierarchical Ascendant Classification method (HAC) to reduce the number of classes. We then obtained 8 typical circulation regimes, which have a strong seasonal signature. For examples, Classes 1 and 2 mainly occur in winter and present an enhancement of the ATC while Classes 3 and 4 mainly occur in summer and characterize an enhancement of the AIS. While investigating the 8 typical regimes, we can see particular inter-annual variability, especially with the absence of the AIS (Classes 2 and 7) or a very strong coastal ATC (Class 1). However, five classes (Classes 3, 4, 6, 7, 8) evidence a new westward branch along the northern coast of Sicily, that we call the Tyrrhenian-Sicilian Current (TSC), which can feed the AIS at the western corner of Sicily. Due to the upwelling signature associated to the TSC and the fact that this upwelling is not wind-driven, we conclude that the Tyrrhenian-Sicilian Current is a density-driven current.