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The significance of Dense Shelf Water Cascading in the Mediterranean Sea and future projections at the light of climate change scenarios

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Increasing evidence has accumulated during the last few years showing the significance of Dense Shelf Water Cascading (DSWC) as a key driver of the deep Mediterranean Sea in many aspects. DSWC modifies the properties of intermediate and deep waters, carries massive amounts of organic matter to the basin thus fuelling the deep ecosystem, transports huge quantities of coarse and fine sedimentary particles that abrade canyon floors and rise the load of suspended particles, and also exports pollutants from the coastal area to deeper compartment. DSWC occurs every year in late winter and spring at the northernmost extensions of the Mediterranean Sea, which are the Gulf of Lion and the north Catalan margin, the Adriatic Sea and the Aegean Sea. This is because these areas are the most directly influenced by strong, persistent, dry northern winds blowing during winter months that cause the surface waters to loss heat and become denser. Low precipitation winters also favour the formation of dense shelf waters, as otherwise significant river discharge would add floatability to the upper layers and make the densification process more difficult. Yearly dense waters overflow the continental shelf edge and sink over the bottom till they reach their equilibrium depth, usually a few hundred meters depth. Deep penetrating, intense DSWC (i.e. that driving dense shelf waters deeper than 1,000 m) is more unusual, as illustrated by the fact that it has occurred only three times in the last twenty years in the Gulf of Lion. These events usually last some weeks and consist of various pulses of variable intensity.

Intense DSWC can be viewed as a regenerating mechanism for the deep ecosystem as following the initial impact, when damaging effects occur because of high turbulence and abrasion, it likely stimulates the recruitment and growth of numerous species, including those with the highest market value, as illustrated by the rose shrimp Aristeus antennatus.

In addition to DSWC, short-lived (hours to few days) large costal storms driven by eastern wet winds can also efficiently trigger the transport of matter and energy from shallow to deep. Recent observations along the north Catalan shoreline and continental shelf have shown the power these storms have to erode the coastline, remobilise coarse sediment and extensively damage coastal benthic communities either by abrasion, pulling up or burial.

Future projections of DSWC occurrence, in particular in its most intense expression, and also of large coastal storms have to be viewed at the light of on-going modelling efforts under various climate change scenarios. While the tendency for the decades to come points to a decreasing frequency of intense DSWC, especially in the Gulf of Lion, which would add to a parallel reduction of offshore convection, trends for large coastal storms appear less consistent.