M-25

Canyon and Open Slope as Sources of Suspended Sediment Transport in the Margin and Basin of the Western Gulf of Lions

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Introduction

Dense shelf water cascading (DSWC) in the north-western Mediterranean has been identified as a major transport mechanism able to generate high sediment fluxes in submarine canyons and in the basin during the colder and drier years. However, observations of the spreading of dense shelf water cascading and its effects on sediment transport towards the continental rise and basin are scarce. A network of mooring lines equipped with current meters and turbidity sensors at 5 m above bottom were deployed between 300 m and 1900 m depth along the Lacaze-Duthier Canyon **(LDC)** and Cap de Creus Canyon **(CCC)**, as well as across its southern open slope **(SOS)** from October 2005 to October 2006 to study sediment transport in the deep margin of the Western Gulf of Lions **(Fig. 1)**

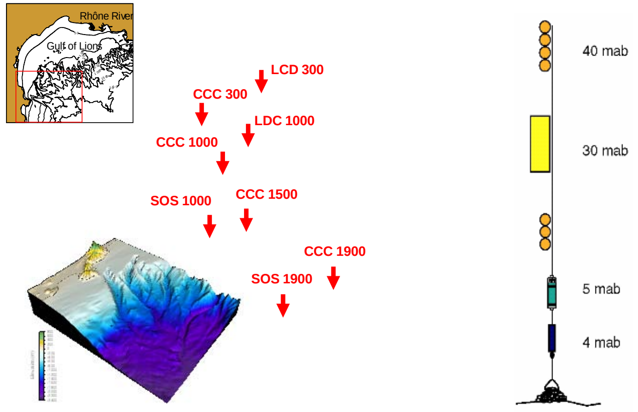

Fig. 1. Location of the moored instruments (labelling site and depth). Each mooring had an Aanderaa current meter with OBS 5 m above the bottom. CCC: Cap de Creus Canyon; LDC: Lacaze-Duthier Canyon; SOS: Southern Open slope.

Results

During 2006 there were DSWC pulses that reached deeper than the upper slope (300 m) in early January, late January and from March to mid April **(Figs. 2, 3, 4)**. These pulses produced temperature drops from 2.2ºC at 300 m depth to 0.13ºC at 1900 m depth **(Fig. 2)** and current speed peaks from 95 cm s^{-1} at CCC 300, to 54 cm s^{-1} at SOS 1000 m. Deeper, at the 1500 and 1900 m depth sites, increases of up to 20-30 cm s^{-1} occurred not only due to DSWC but also to open sea convection water **(Fig. 3)** .

The early January deep DSWC pulses resuspended the sediment accumulated during the warm season and induced the highest increase of deep sediment transport along the CCC down to 1900 m depth and also along the SOS at 1000 m depth **(Figs. 4, 5)**. The late January pulses occurred simultaneously with an extreme eastern storm and increased sediment transport, but only down to 1000 m depth **(Figs. 4, 6)**. The March-April pulses increased sediment transport at 1000 m depth both in the CCC and SOS but not at the canyon head (CCC 300), whereas at 1900 m depth increases of sediment transport were induced by open sea convection water **(Figs. 4,7)**.

During the deep cascading pulses, increases of suspended sediment transport began first at mid slope depths (1000 m depth), whereas at the canyon head it increased later in the January pulses and did not increase in the March-April pulses **(Figs. 5,6,7)**

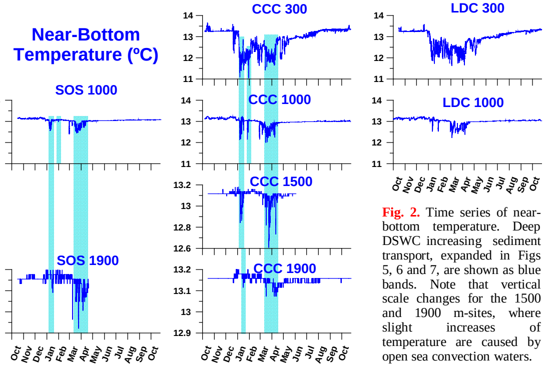

Fig. 2. Time series of near-bottom temperature. Deep DSWC increasing sediment transport, expanded in Figs 5, 6 and 7, are shown as blue bands. Note that vertical scale changes for the 1500 and 1900 m-sites, where slight increases of temperature are caused by open sea convection waters.

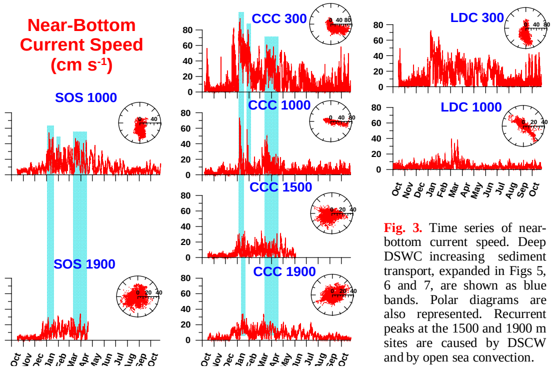

Fig. 3. Time series of near-bottom current speed. Deep DSWC increasing sediment transport, expanded in Figs 5, 6 and 7, are shown as blue bands. Polar diagrams are also represented. Recurrent peaks at the 1500 and 1900 m sites are caused by DSCW and by open sea convection.

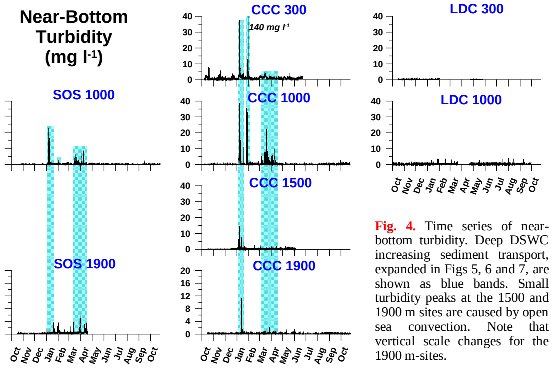

Fig. 4. Time series of near-bottom turbidity. Deep DSWC increasing sediment transport, expanded in Figs 5, 6 and 7, are shown as blue bands. Small turbidity peaks at the 1500 and 1900 m sites are caused by open sea convection. Note that vertical scale changes for the 1900 m-sites.

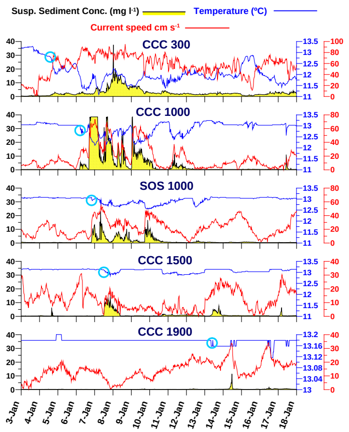

Fig. 5. Time series of near-bottom temperature, current and suspended sediment concentration during the first deep cascading pulse in early January 2006. Blue circles indicate the beginning of the deep cascading pulse. Note changes of scale in current speed of CCC 1500 and CCC 1990 and in temperature of CCC 1900.

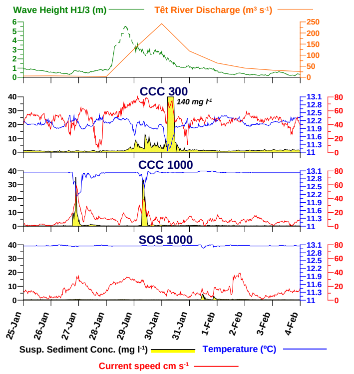

Fig. 6. Time series of significant wave height, Têt river discharge and near-bottom temperature, current and suspended sediment concentration measured at the mooring sites affected by the late January 2006 deep cascading pulse. Note the peak of the storm and the advection peak (140 mg l^{-1}) two days later affecting only the canyon head.

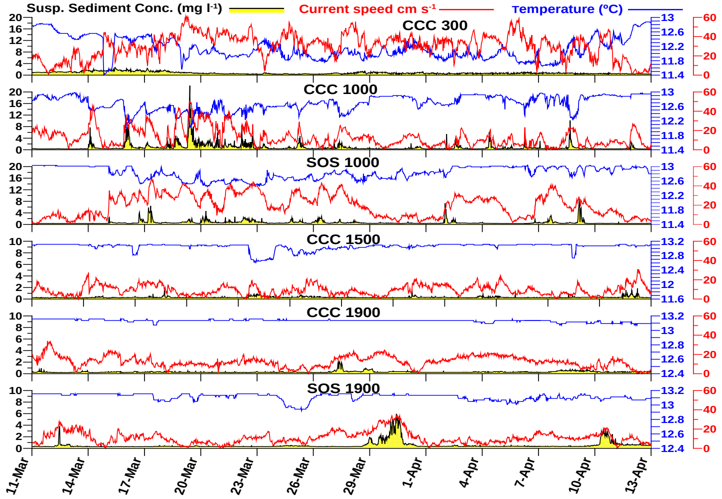

Fig. 7. Time series of the near-bottom temperature, current and suspended sediment concentration measured at the Cap de Creus submarine canyon and southern open slope mooring sites during the March-April deep cascading pulses. Note changes of scale in turbidity and temperature in CCC 1900 and SOS 1900. Note that turbidity peaks at SOS 1900 were not produced during the deep DSWC pulses (identified by the drops of temperature) but during the increases of current velocity and consequent sediment resuspension/ transport generated by the open sea convection waters

Discussion and Conclusions

Increases of sediment transfer from the shelf only reached the upper canyon and occurred in early January, due to a higher sediment availability after the warm season (main peak at CCC 300 in **Fig. 5**), and in late February due to the interaction of DSWC with a sporadic extreme storm that induced the downcanyon advection of shelf resuspended sediment two days after the peak of the storm. (main turbidity peak at CCC 300 in **Fig. 6**).

Most of the increases of deep sediment transport were generated from the mid canyon rather than from shallower areas (See most of the peaks at CCC 1000 in **Figs. 5, 6, 7**). This indicates a redistribution of sediments previously deposited at upper-mid canyon depths or even the erosion of ancient sediments.

At the canyon head, more frequent winnowing by DSWC often depletes the erodible sediment, transporting it to the upper-mid canyon zone. As a consequence, the sediment available to be transported by the sporadic deep cascading pulses is often at upper-mid canyon depths rather than on the shelf or the canyon head.

From CCC 1000, net fluxes show that most of the suspended sediment left the canyon and flowed along the southern open slope towards the Catalan margin, whereas a small part flowed downcanyon and was exported basinward through the canyon mouth **(Fig. 8)**, which fits with modeling approaches.

There is a multi step sediment transport from the shelf to the upper slope by storms and DSWC, from the upper slope to the deep slope by deep cascading pulses and from there, sediment is dispersed by strong currents induced by open sea convection waters.

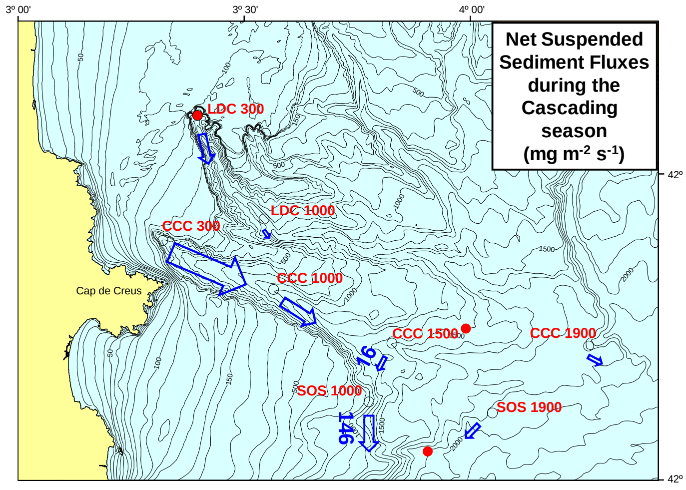

Fig. 8. Net suspended sediment fluxes with resultant directions during the DSWC season. From 1000 m depth, sediment tend to leave the canyon and be transported southward along the slope.