The South Adriatic Observatory: towards a multidisciplinary seafloor and water column research infrastructure

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INTRODUCTION

Continuous measurements are essential to assess the interannual variability of the thermohaline circulation,water masses properties and transports, and biochemical contents. The need for high-frequency sampling to resolve events and rapid processes (on different time scale) and the long-sustained measurements of multiple interrelated variables from the sea surface to the seafloor is provided by Southern Adriatic Node. It is formed by the observatory E2M3A located in the area of the Southern Adriatic Pit (Eastern Mediterranean) at 41°32'N, 18°04'E together with a system of moorings positioned along the Bari Canyon (mooring BB 41°20'N, 17°12'E) and the open-slope (FF 41°48'N, 17°02'E). The Canyon is generally assumed to play an important role in dense water sinking and sediment transfer to the deep Southern Adriatic basin.

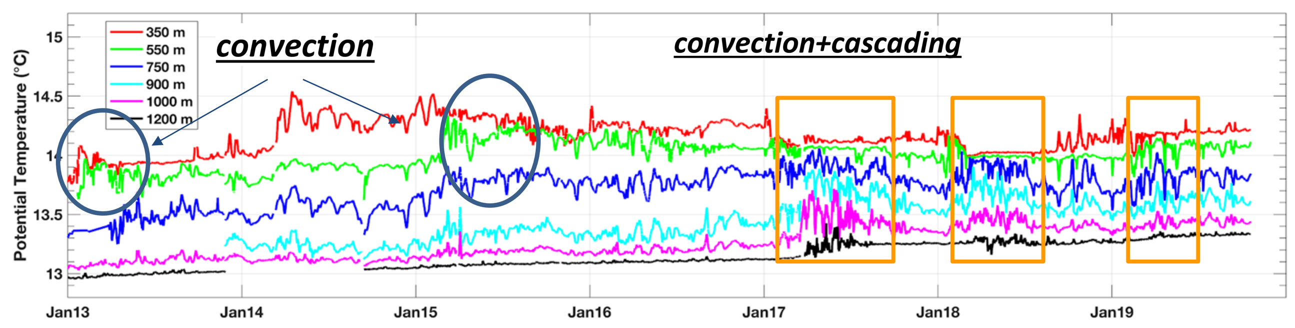
Recently the Southern Adriatic Node has been proposed as a candidate to join the European Multidisciplinary Seafloor and water column Observatory - EMSO ERIC consortium. It will contribute to gain a better understanding of phenomena happening and to explain the critical role that these phenomena play in the broader Earth systems.

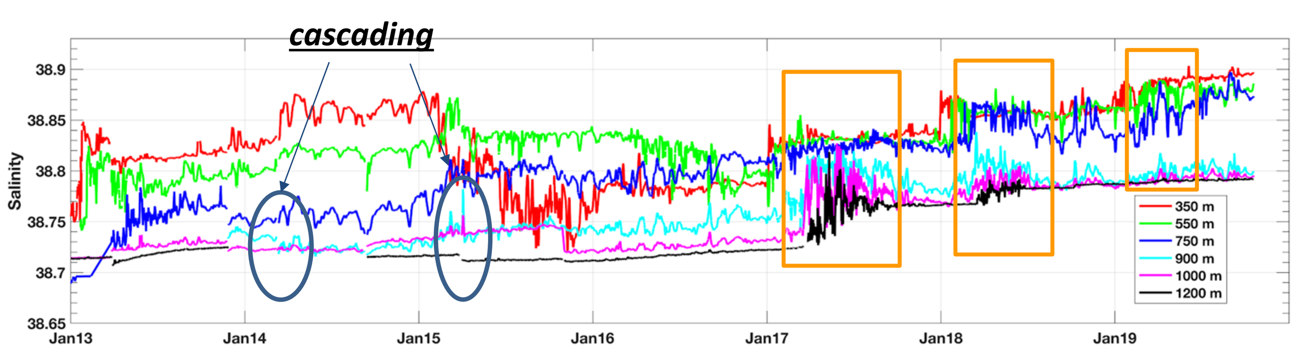
THERMOHALINE and CURRENT TIME SERIES - E2M3A

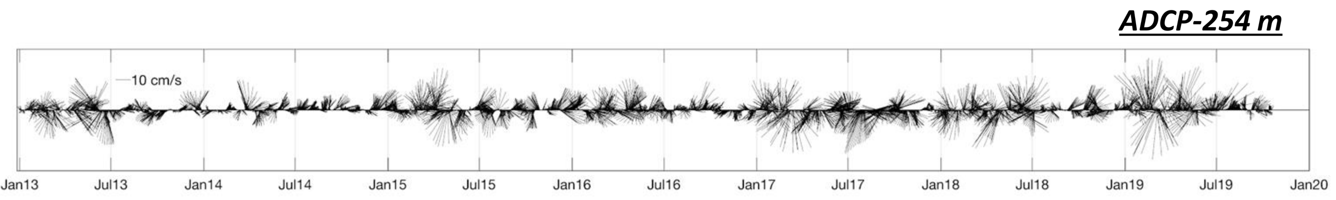
The dense waters of North Adriatic origin flow southwards, mostly intermittently, along the Adriatic shelf and sink into the basin, both along the open slope and, more markedly, through the canyon of Bari. Thus, the basin due to its morphology, is considered as a reservoir that collects these waters together with those formed in-situ by open deep water formation (DWF) processes, exiting the Adriatic as the ADW that feeds the thermohaline circulation of the Eastern Mediterranean.

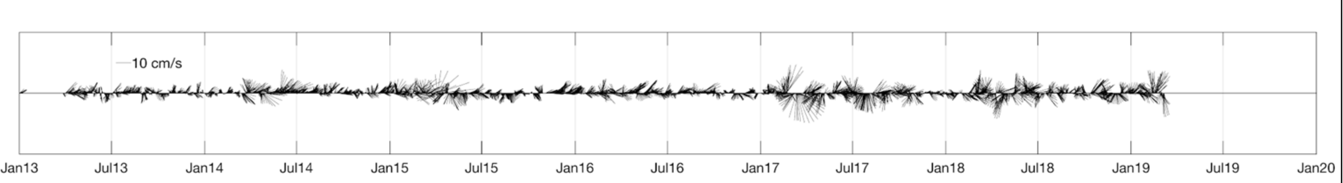
The intrusion of very dense waters of North Adriatic origin **(cascading)** evidenced at the E2M3A, occurred in **late march 2014, January 2015** and less intense in **winter 2016,** remarked from salinity homogenization at the 900 -1000 m depth. This has most likely contributed to enhance the lithogenic material fluxes at the bottom trap. During **winter 2017** there is evidence of both a convective event involving the intermediate layer and the entrance of large high-frequency oscillations influencing the deep layer, specially the layer between 900m and 1100m. The latter appears also in **2018 and 2019** reducing in intensity in time and its origin is still under studying.

E2M3A OCEANOGRAPHIC DATA





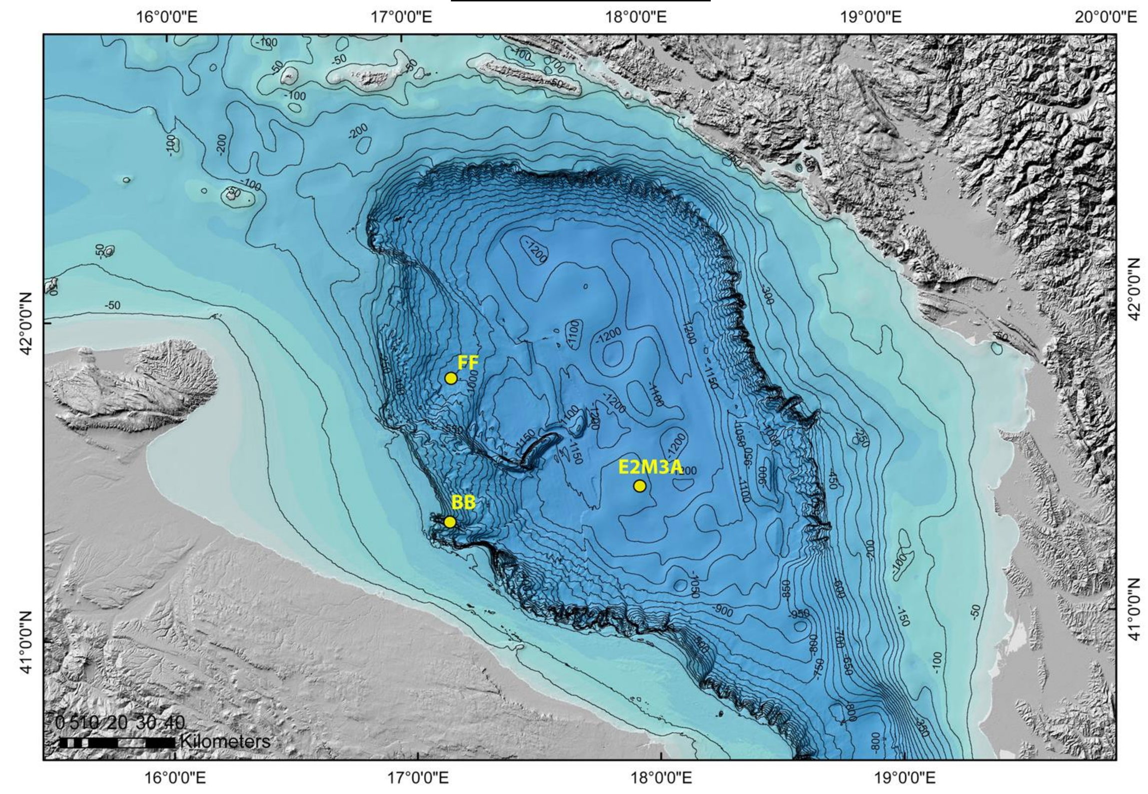




Currents at E2M3A site reveal an homogeneous layer from about 200 m to 300 m depth, with particularly high values (maximum speeds around 27-29 cm/s) during the first half of years 2013, 2015, 2017, 2018 and reaching the highest values in 2019 (maximum speed of about 35 cm/s). The direction, however, is quite variable.

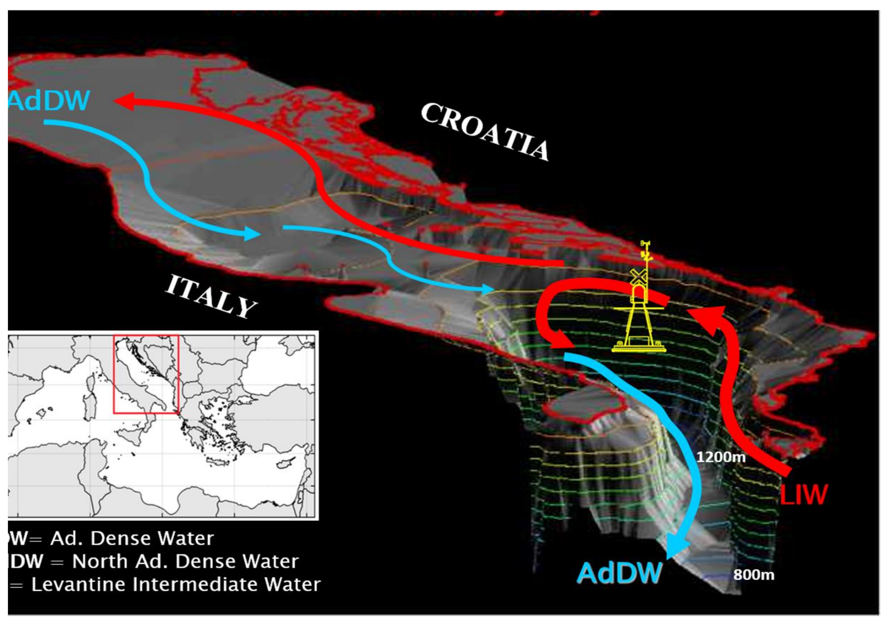
In the bottom layer weaker currents are in general registered, and they overall intensify from 2017 onwards. However, the maximum speed value is found in spring 2015 (about 25 cm/s).

STUDY AREA



The southern Adriatic is the deepest part of the Adriatic Sea with a maximum depth of 1200 m. In its western side, surface waters coming from the northern Adriatic spread southward along the Italian coast, whereas the surface Ionian water flow along the eastern margin of the basin. Below the surface layer, the MLIW (Modified Levantine Intermediate Water), from the Eastern Mediterranean basin, enters the Adriatic Sea on the eastern side of the Otranto Strait, at 200-600 m depth.

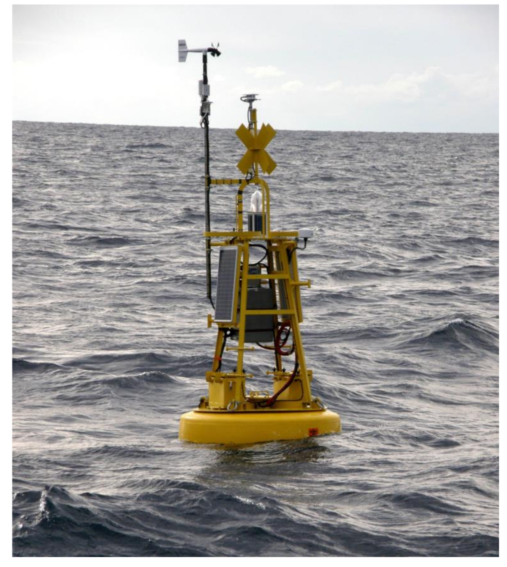
The southern Adriatic is a site of dense water formation. The Adriatic Deep Water (AdDW) is generated through deep vertical convection, caused by surface heat losses following cold continental wind events occurring in late winter. Occasionally, the North Adriatic Deep Water (NAdDW), produced by surface heat loss and evaporation driven by Bora storms during winter in the Northern Adriatic Sea, contribute to the AdDW. NAdDW constitutes the densest water of the whole easter Mediterranean, flows mostly along the western shelf of the central Adriatic Sea as a bottom-arrested density current and arrives to the Gargano Peninsula after 2–4 months since it has been produced. Recently shorter arrival times (3-4 weeks) have been observed.



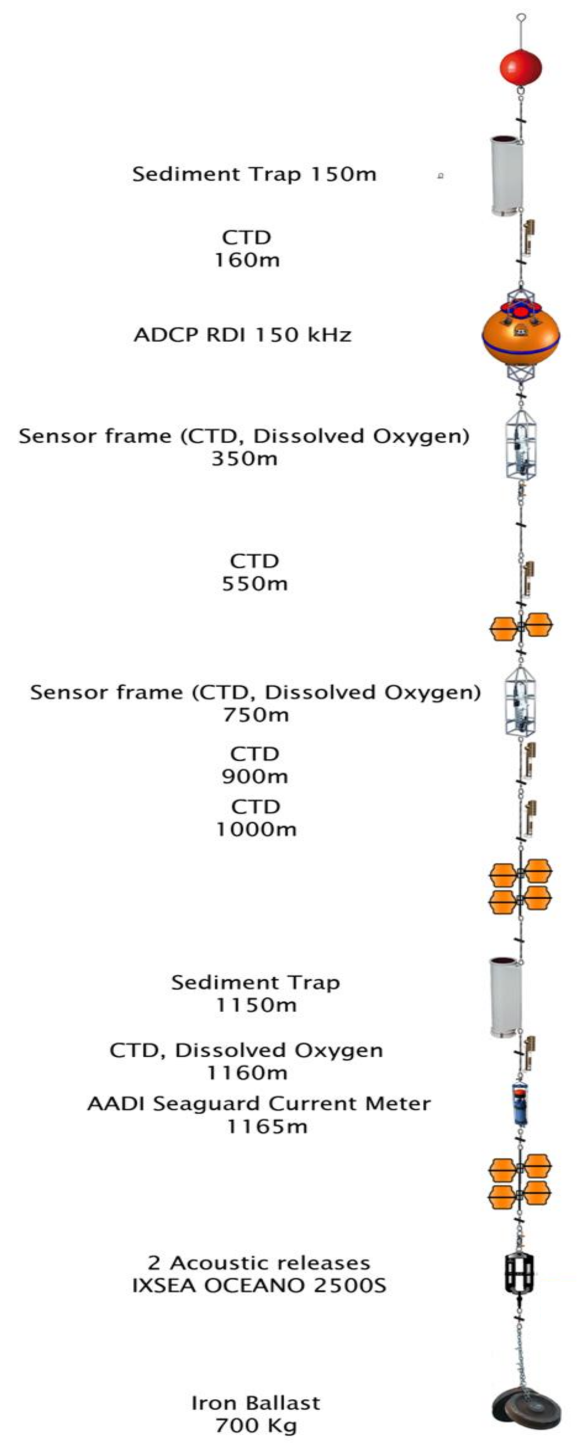
REMARKS

- Signals of transport through the canyon to the deep pit layer are evident, in particular environmental conditions, from the physical and biogeochemical data measured simultaneously at high frequency by the various system components (E2M3A and BB and FF moorings).
- However, episodes of cascading and deep convection are correlated but not always directly linked.
- The 2017 strong event signal depicted in E2M3A is weak in BB. On the contrary, during winter 2018 this signal is more clear on BB.
- After the 2012 convection events until 2018, BB moring data do not show very significant episodes but only of lower intensity that are not clearly identified in the E2M3A time series.
- Both sites clearly show a slow salinification of the deep layer.

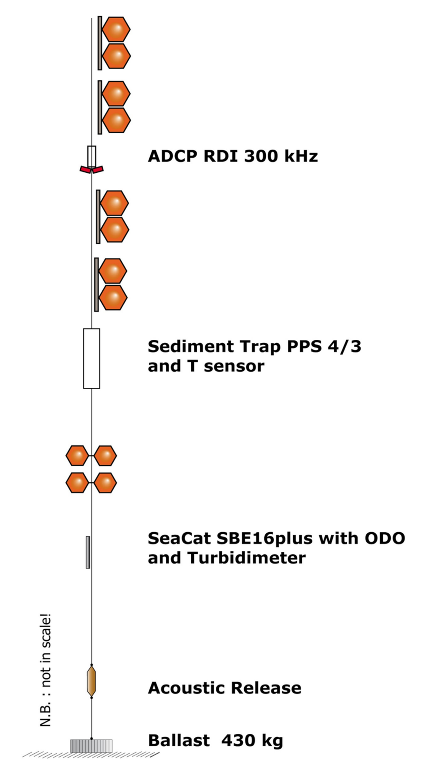
E2M3A - Surface Buoy



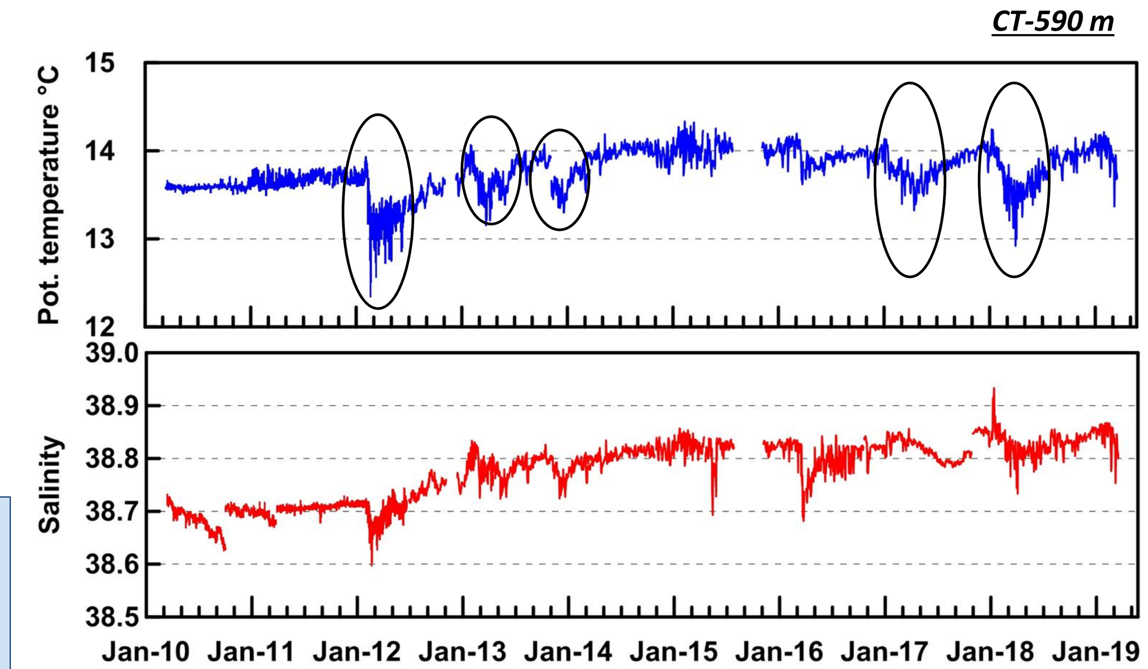
E2M3A - Mooring



BB e FF Mooring

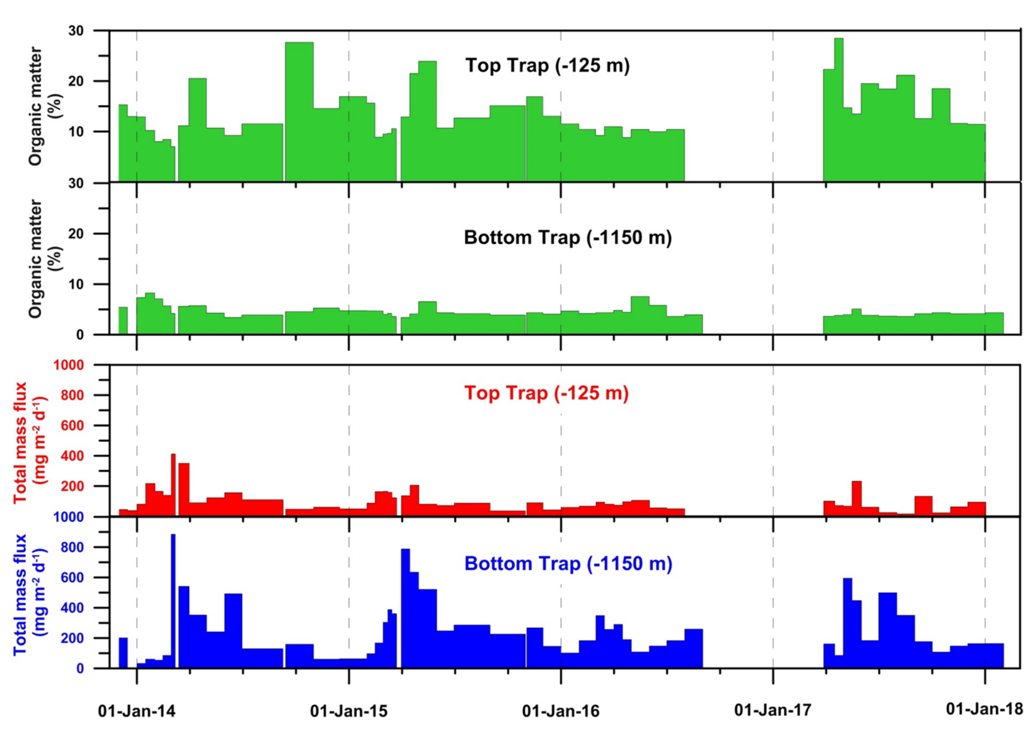


BB TEMPERATURE AND SALINITY TIME SERIES



Arrival of colder and denser water (NAdDW) produced in the shallow Northern Adriatic Sea is evidenced from temperature and salinity dropping at site **BB**. Measurement are collected 15 m above the bottom at **605 m** depth. Major event had place in winter 2012 and less intense episodes occurred during winter 2013, 2014, 2017 and 2018.

E2M3A SEDIMENT TRAP DATA



TEMPORAL FLUX VARIABILITY AND COMPOSITION

Total mass fluxes (TMF) measured at the top trap of E2M3A site were generally lower than those measured at the bottom trap, ranging from 16 to 412 mg m^{-2} d^{-1}, with a time-weighted average of 89 mg m^{-2} d^{-1}, whereas at the bottom trap TMF varied from 33 to 885 mg m^{-2} d^{-1}, with an average of 232 mg m^{-2} d^{-1}. The TMF showed a high temporal variability, with maximum values observed in late winter-spring in 2014, 2015 and 2017 at both depths, showing that particles dynamic is usually more intense in late winter-spring periods.

TMF fluxes increased considerably in the bottom trap reflecting the importance of the lateral advection of resuspended materials that appeared particularly active in this area.

OC content was generally higher in the top trap, on average 6.7% of TMF, with a maximum of 14.3%. In the bottom trap OC content was much lower (2.2 % of TMF on average), varying in a narrow range (from 1.7% to 4.1%).

The organic carbon (OC) fluxes (not showed) ranged from 1.7 to 22.2 mg m^{-2} d^{-1}, with a time-weighted average of 6.0 mg m^{-2} d^{-1} at the top trap, whilst in the bottom one ranged from 1.2 to 18.6 mg m^{-2} d^{-1}, with a time-weighted average 5.1 mg m^{-2} d^{-1}. The organic carbon fluxes at both depths are strongly influenced from TMF trends and intensities.

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