Anthropogenic turbidity flows in La Fonera Submarine Canyon

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Bottom trawling is a non-selective fishing technique involving the towing of a heavy collecting device to harvest living resources. Recent studies have shown bottom trawling is a driver of seabed evolution[1] and sediment transfer in canyons[2]. Present knowledge on trawling-induced resuspension and transport is based on seldom and geographically localized observations and *a posteriori* interpretations. Our aim is to assess trawling impact on sediments dynamics in La Fonera submarine canyon (NW Mediterranean Sea) and improve the understanding of its sedimentary functioning. Our methodology combines inverse analysis and the implementation of a process-based numerical model (Nixes-TC). Model results are compared to data at the Montgrí valley mooring station deployed at 980m depth (41°52.49'N; 3°20.66'E). Nixes-TC follows the principles of the models developed by Parker[3] and Bradford and Katopodes[4,5], solving depth-averaged conservation equations for fluid momentum, fluid continuity and suspended sediment mass. Fishing grounds are defined on both flanks of the canyon on the basis of satellite-based navigation tracks from the Vessel Monitoring System. Model responses obtained at the mooring site for different initial conditions over the fishing grounds allow the decomposition of the modelled signal into two functions: a transfer function and an amplitude function. The former contains the processes between the remobilisation over the canyon flanks and the arrival of the event at the mooring point whilst the latter is related to the external forcing. We consider the signal obtained at the mooring station as linear superposition of n different instantaneous remobilisation events over the fishing grounds. The modelled instantaneous sediment transport at the mooring site is given by the convolution of the transfer function and the different amplitudes. We consider these amplitudes as a function of the part of the measured signal due to the external forcing that we isolate through application of the Autoregressive-Moving Average (ARMA) model. By linearizing and discretizing the problem, we are able to relate the discrete data measurements at the mooring site to the discrete inverse model parameters (i.e. unknown amplitude of the different events). This comparison (i.e. measurements vs inverse model results)(Fig.1B) allows us to infer the amplitude time series of the different events and to deduce the key variable in trawling impact, which is the remobilisation over the fishing grounds causing turbidity events comparable to those measured at the mooring station (Fig.1A). The inferred resuspension over the fishing grounds is integrated in Nixes-TC in terms of instantaneous sediment flux over the area affected by trawling, allowing us to take into account the non-linearity inherent to turbidity currents. Based on the good agreement found between modelled transport and measurements at the mooring site (Fig1B), we identify the propagation patterns of the resuspended sediment towards the canyon axis and beyond. Our results are in agreement with previous studies in La Fonera submarine canyon: trawling impacts extend substantially deeper than the fishing grounds and lead to the development of trawl-driven depocentres[6], and confirm the value of numerical models to complete and enlarge our understanding of the sediment transfer from shallower to deeper areas in the ocean.

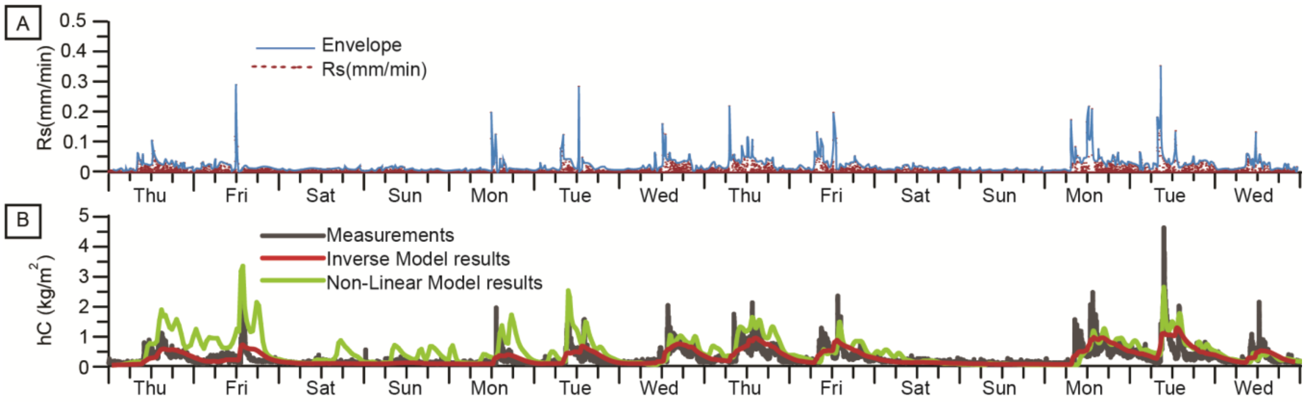

Figure 1. A) Time series of remobilisation events over the LFC fishing grounds obtained through inverse modelling (red dots) and its envelope (blue line). This remobilisation corresponds to the activity of 16-21 fishing vessels operating in the area in agreement with the actual fishing fleet in the investigated fishing grounds. B) Values of instantaneous sediment transport at the mooring site for the inverse model (red), the non-linear model (green) and the in situ measurements (grey).

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