

Research paper

Fate and transport of oil in sediment laden marine waters

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Received 5 October 2010;

revised 25 March 2011;

accepted 26 March 2011.

Available online 31 May 2011.

Abstract

Spilled oil when present in sediment-enriched waters, is known to interact with sediments. Oil droplets form aggregates with sediments due to collision and dissolved oil partitions (absorption and adsorption) into sediments due to capillarity and surfactant ions. This may change the fate and transport of both oil and sediments. Interaction with sediments acts as a natural oil removal process. This has been recognized as a crucial component in developing oil spill countermeasures. However, no comprehensive models are currently available to describe the process. This paper presents a novel numerical model developed to simulate oil-sediment interaction and transport in near-shore waters. The present model simulates, oil and sediment transport, oil-sediment aggregate (OSA) formation, oil partitioning into sediments, and sediment aggregation. The critical information provided by the model such as the fraction of oil removed due to sediment interaction would be useful in developing oil spill countermeasures.

The model results are compared with the limited data from laboratory experiments and show a good agreement.

Scenario simulations showed that up to 65% of released oil may be removed from the water column as OSAs.

They further showed that when oil droplets and sediment particles are smaller (less than 0.1 mm), the amount of OSAs formed is higher. According to the scenario simulations, the amount of oil partitioned into sediments is 4–5 orders of magnitude smaller than the amount of OSAs formed.

Highlights

► New numerical model to simulate oil-sediment interaction and transport in marine waters. ► Oil and sediment transport, oil-sediment aggregate formation (OSA), oil partitioning into sediments are modeled. ► Fraction of oil removed due to sediment interaction useful for oil spill countermeasures is calculated. ► Model results are compared well with experimental data. ► Scenario simulations show that up to 65% of released oil may be removed from the water column as OSAs.

Keywords: Coastal oil spills; Oil sediment interaction; Oil sediment aggregates; Oil partitioning; Sediment aggregation