Geophysical Research Abstracts
Vol. 21, EGU2019-13632, 2019
EGU General Assembly 2019

Long-term modelling of the Corsica oil spill fate and transport incorporating biodegradation kinetics

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Oil spills remain a serious environmental problem, which can have significant environmental and economic consequences. Although significant attempts have been made worldwide to develop effective response strategies following the Deepwater Horizon (DWH) accident in the Gulf of Mexico in April 2010, significant knowledge gaps remain unsolved. During the 2010 DWH accident, huge amounts of oil were released into the Gulf of Mexico, adversely affecting marine wildlife. What prevented a worse outcome was the ability of nature to degrade oil: hydrocarbon-degrading microbes can feed on the crude oil. Although oil biodegradation by native bacteria is one of the most important natural processes that can attenuate the environmental impacts of marine oil spills, very few oil spill models include biodegradation kinetics of spilled oil, mostly represented as a first order decay process neglecting the effect of oil composition and oil droplets-water interface. To this end, the open source oil spill model MEDSLIK-II (http://medslikii.bo.ingv.it/), has been recently modified in the frame of the EU project Kill-Spill (http://www.killspill.eu/), to incorporate biodegradation kinetics of oil droplets dispersed in the water column. In this modified version (namely MEDSLIK-III), the “pseudo-component” approach has been adopted for simulating oil weathering process, under which chemicals in the oil mixture are grouped by physical-chemical properties and the resulting pseudo-component behaves as if it were a single substance with characteristics typical of the chemical group. The fate of each component is tracked separately. Biodegradation of oil droplets is modelled by Monod kinetics. The kinetics of oil particles size reduction due to the microbe-mediated degradation at water-oil particle interface is represented by the shrinking core model.

On the morning of October 7th 2018, the Tunisian vessel Ulysse collided with the Cypriot container ship CSL Virginia around 28 km north of Cap Corse, causing the leak of 530 m3 of fuel oil with API 16.2. That day the spill spread over 25 km and formed 7 distinct slicks. The fate and transport of the oil spill have been simulated using the modified MEDLSIK-II model for the period October-December 2018. The initial spill has been categorised into 4 PCs and the fate (spreading, evaporation, natural dispersion, dissolution and biodegradation) of each PC has been tracked separately. The model has been forced using hourly forecasts of ocean currents at a horizontal resolution of 1/24o provided by CMEMS and ECMWF 6hr analysis atmospheric fields. Model simulations show oil drifted and adhesed to the coasts of Italy, France and Monaco. The total fate of the spill, i.e. biodegraded, remaining in the water column and sedimented has also been estimated. Model results have been corrected by reinitializing oil spill simulations from the observed locations. Model predictions reveal a good agreement with observations.

Acknowledgement: Part of this research has received funding from the European Union’s Horizon 2020 research and innovation programme ODYSSEA: OPERATING A NETWORK OF INTEGRATED OBSERVATORY SYSTEMS IN THE MEDITERRANEAN SEA, GA No 72727.