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Numerical modelling for real-time forecasting of marine oil pollution and hazard assessment

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Many factors affect the motion and transformation of oil at sea. The most relevant of these are the meteorological and marine conditions at the air–sea interface; the chemical characteristics of the oil; its initial volume and release rates; and, finally, the marine currents at different space scales and timescales. All these factors are interrelated and must be considered together to arrive at an accurate numerical representation of oil evolution and movement in seawater.

The oil spill model code MEDSLIK-II is a freely available community model. By using a Lagrangian approach, MEDSLIK-II predicts the transport and diffusion of a surface oil slick governed by water currents, winds and waves, which are provided by operational oceanographic and meteorological models. In addition, the model simulates the oil transformations at sea: evaporation, spreading, dispersion, adhesion to coast and emulsification.

The model results have been validated using surface drifters and oil slicks observed by satellite in different regions of the Mediterranean Sea. It is found that the forecast skill largely depends on the accuracy of the Eulerian ocean currents: the operational models give useful estimates of currents, but high-frequency (hourly) and high spatial resolution is required, and the Stokes drift velocity has to be often added, especially in coastal areas.

MEDSLIK-II is today available at the Mediterranean scale allowing a possible support to oil spill emergencies. The model has been used during the Costa Concordia disaster, the partial sinking of the Italian cruise ship Costa Concordia when it ran aground at Isola del Giglio, Italy. MEDSLIK-II system was run to produce forecast scenarios of the possible oil spill from the Costa Concordia, to be delivered to the competent authorities, by using the currents provided every day by the operational ocean models available in the area. Moreover, MEDSLIK-II is part of the Mediterranean Decision Support System for Marine Safety (MEDESS4MS) system, which is an integrated operational multi-model oil spill prediction service, that can be used by different users to run simulations of oil spills at sea, even in real time, through a web portal. The MEDESS4MS system gathers different oil spill modelling systems and data from meteorological and ocean forecasting systems, as well as operational information on response equipment, together with environmental and socio-economic sensitivity maps.

MEDSLIK-II has been also used to provide an assessment of hazard stemming from operational oil ship discharges in the Southern Adriatic and Northern Ionian (SANI) Seas. Operational pollution resulting from ships consists of a movable hazard with a magnitude that changes dynamically as a result of a number of external parameters varying in space and time (temperature, wind, sea currents). Simulations of oil releases have been performed with realistic oceanographic currents and the results show that the oil pollution hazard distribution has an inherent spatial and temporal variability related to the specific flow field variability.