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MOHID-Lagrangian: A lagrangian transport model from local to global scales. Applications to the marine litter problem.

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The CleanAtlantic project (<http://www.cleanatlantic.eu/>) aims to protect biodiversity and ecosystem services in the Atlantic Area by improving knowledge and capabilities to monitor, prevent and remove (macro) marine litter. The project will also contribute to raise awareness and change attitudes among stakeholders. Marine litter originates from diverse sources (land and sea-based origins) and has no frontiers as the coastal and ocean circulation turns it into a transnational issue that demands collaborative work and coordination. The need for transnational consistent approaches is at the heart of the Marine Strategy Framework Directive (MSFD) implementation, which requires consistency in terms of marine litter assessment, monitoring and development of programme of measures. This modeling objective, within the CleanAtlantic project, is fully aligned with the collective action n°55 of the OSPAR Regional Plan, which aims to develop sub-regional or regional maps of hotspots of floating litter. These maps will be based on mapping of circulation of floating masses of marine litter, identification of hotspots of accumulation on coastal areas and the role of prevailing currents and winds. The biggest challenge to marine litter modeling is the heterogeneity of the actual litter particles spanning a wide range of different physical properties such as size, density or shape, among others. This, together with a strong interaction with the medium, through processes such as degradation, sinking, beaching, etc and an inherent sensitiveness to initial conditions due to chaotic advection by ocean currents, the effect of wind and waves and the necessary time and space scales to resolve ocean transport, shows how intricate marine litter modeling can be. The number of free parameters, absence of well-known initial conditions and precise equations set to describe all the processes involved require the use large ensembles of simulations to explore a range of possible scenarios, in order to derive useful information about the motion of marine litter. As part of the project, the MARETEC modeling group at the Instituto Superior Técnico – Universidade de Lisboa in collaboration with the University of Santiago de Compostela, developed a Lagrangian transport model, MOHID Lagrangian. This tool can be applied to forecast the formation of retention areas (hotspots) with the highest probability for litter accumulation in any particular region. The abilities of this open-source lagrangian tool include its easy implementation, robustness, computing efficiency being able to simulate millions of particles in short times, the capacity to use any Eulerian circulation

fields from other models, as well as the ability to simulate different types of lagrangian particles. The capabilities of the models to predict the origin of marine litter accumulated on the seafloor and coastal areas were assessed and the connection of major rivers with sinks of marine litter during heavy raining conditions was studied. When appropriate, models were calibrated by matching real and predicted marine litter accumulations locations on the shoreline. The area of influence of land and sea-based marine litter sources was assessed and different scenarios of mitigation measures will be evaluated.