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A near-real time oil spill detection and forecasting system for Iliad Digital Twins of the Ocean

Katerina Spanoudaki[1], Sabrina Outmani[2], Maria Luisa Quarta[2], Laura Vettorello[2], Noemi Fazzini[2], Georgios V. Kozyrakis[1], Vassiliki Metheniti[1,3], Marco Folegani[2], and Nikos Kampanis[1]
[1]Coastal & Marine Research Laboratory, Foundation for Research and Technology Institute of Applied and Computational Mathematics, Heraklion, Crete, Greece
[2]Meteorological Environmental Earth Observation-MEEO S.r.l, Ferrara, Italy
[3]National and Kapodistrian University of Athens, Department of Environmental Physics and Meteorology, Greece

The EU funded Iliad project builds on the assets resulting from two decades of investments in policies and infrastructures for the blue economy aiming to establish an interoperable, data-intensive, and cost-effective Digital Twin of the Ocean (DTO). Iliad DTO combines ocean observations, state-of-the-art forecast models, citizen science, AI and advanced computing infrastructures (cloud computing, HPC, Internet of Things, Big Data, social networking, and more) to create high-resolution, multi-variable and multi-dimensional near real-time virtual representations of the ocean. Continuously integrating data from numerous in-situ sensors and satellites, Iliad DTO can provide a platform for researchers, policy makers, the industry, and citizens, to monitor the impact of climate change and human activities on ocean health and productivity and make data driven management decisions for a sustainable blue economy. Several Digital Twin (DT) pilots will be undertaken in key thematic areas such as offshore wind energy, wave and tidal energy, biodiversity assessments, fisheries and aquaculture, marine pollution and more.

The current work presents the Oil Spill Response Digital Twin pilot developed in the frame of Iliad. The DT focuses on Cretan Sea and aims to provide early detection of marine oil spills and operational forecasting of spill trajectories to support immediate response to pollution events, minimizing thus the impact on marine ecosystems, coastal communities and the economy and reducing the time for environmental recovery. A multi-model approach is followed for predicting the fate and transport of oil spills, employing MEDSLIK-II and OpenDrift particle tracking models, coupled to operational, high-resolution numerical weather (WRF), hydrodynamic (NEMO) and sea state (WAVEWATCH III) models for Cretan Sea. Real-time observations (current speed/direction, sea water temperature, wave height) from novel, low-cost on-line sensors are integrated in the DT and assimilated into the operational metocean forecasting chain for validation purposes and for improving models' forecasting skills. A near-real time automatic oil spill detection system, from Sentinel-1 SAR images, is developed, which allows early detection of marine oil spills and triggers the oil spill forecasting system, producing accurate short-term forecasting of spills' trajectories and fate. Automatic detection and classification of oil spill events employs a trained FCOS which

performs initial object detection, fine-tuned with a dataset of +1000 SAR images, including 4 different classes (oil spill, look-alike, ship, land). Image pre-processing and oil spill mask delineation is performed using SNAPpy-based (Sentinel Application Platform Python toolbox) adaptive thresholding algorithms. The oil spill detection and forecasting system is tested by reconstructing the Ulysse-Virginia oil spill, which occurred off the coast of Corsica on October 7th, 2018. Sentinel-1 images are used to detect and delineate the coverage of the spill, to initiate Medslik-II and OpenDrift models for simulating the oil spill fate and transport. Oil spill predictions are produced using different metocean forcings, highlighting the importance of high-resolution metocean data in accurate forecasting of oil spill trajectories. Quantitative metrics are used to evaluate the ability of the oil spill models to reproduce the satellite oil spill observations.

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