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Multi-model statistical system for monitoring the dispersion of pollutants: Mediterranean case study

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INTRODUCTION

The Mediterranean Sea is facing escalating environmental threats due to increasing maritime activities, resulting in increased marine pollution. Effectively addressing these challenges necessitates an expanded focus on reliable monitoring services to predict and mitigate the impacts of pollution spills. This study aims to comprehensively understand the dynamics of oil spills in the Mediterranean region, with the objective of establishing a robust and user-friendly framework for an application. This application not only assesses historical oil spill events but also elucidates the intricate interplay of environmental factors, serving as a predictive tool for effective monitoring and planning.

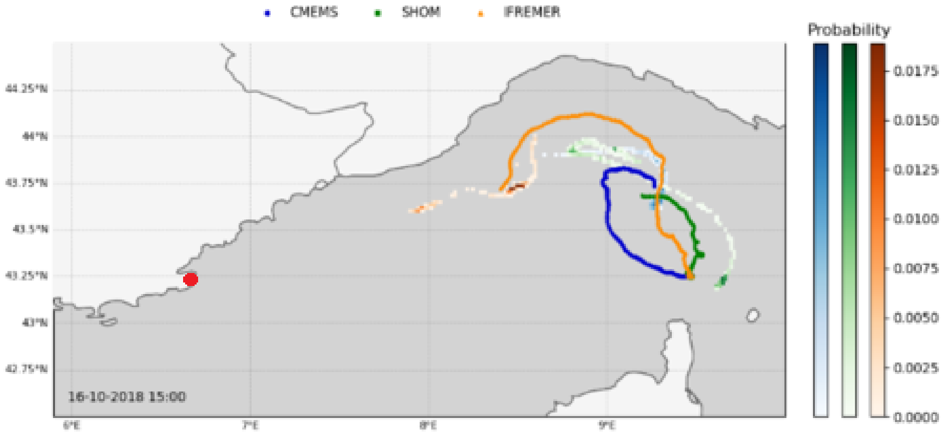
METHODOLOGY

The study centers on determining the dispersion velocity of pollutants, accounting for three significant contributions influencing spill movement: surface velocity of currents, Stokes drift induced by waves, and wind influence within the initial 10 meters above the sea surface. These contributions are fine-tuned using coefficients, building on established methodologies. Data integration from three oceanic models—Copernicus Marine Environmental Monitoring Service (CMEMS), Naval Hydrographic and Oceanographic Service (SHOM), and the French Research Institute for the Exploitation of the Sea (IFREMER)—provides a nuanced analysis of surface current velocities, addressing uncertainties within the ensemble.

The dispersion simulation utilizes the OceanParcels Lagrangian Particle Tracking Model (PTM), tailored to specific events. The analysis includes the temporal and spatial evolution of oil slicks, determining particle release parameters, and evaluating centroids at each moment. Comparison with Synthetic Aperture Radar (SAR) satellite imagery refines model precision, offering real-world validation and aiding in model selection for accurate environmental protection decision-making.

RESULTS

Validation with a real-case scenario, a shipping accident off the coast of Corsica in October 2018, reveals distinctive trajectories among models (Figure1). Integrating wind and Stokes drift refines outputs, with notable alignment to observed events, showcasing enhanced predictive capabilities, especially during the detection of hydrocarbons in France on October 16th (Figure2).



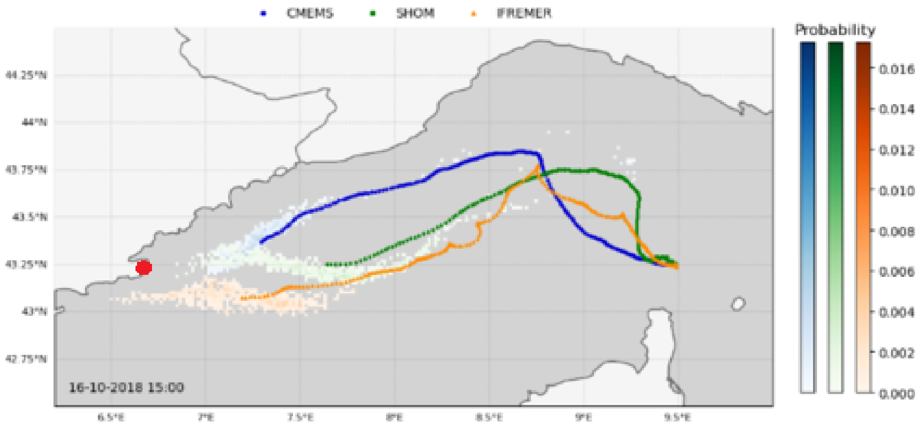


Figure 1(left) – Models trajectory simulated with sea surface currents, showing the evolution of the centroid trajectory and particle distribution in space and time. On the right the color bar showing the values of the particles' experimental distribution. Figure 2 (right) -Trajectories simulated with the contributions of sea surface currents, wind at 10m and stokes drift, showing the evolution of the centroid trajectory and particle distribution in space and time.

Graphical representations illustrate the spatio-temporal evolution of the particle cloud, providing comprehensive insights into oil spill movement.

CONCLUSIONS

Despite evident progress, persistent uncertainties in climate services pose challenges in predicting and mitigating oil spill impacts. Sustained investments in research and development for climate monitoring services are crucial for addressing uncertainties and ensuring the long-term sustainability of the Mediterranean ecosystem. The future lies in refining models, integrating high-resolution data, and advancing climate monitoring to enhance prediction accuracy and minimize environmental repercussions from pollutant spills in the Mediterranean basin.