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EDITED AND REVIEWED BY
Peng Chen,
Ministry of Natural Resources, China

*CORRESPONDENCE
Peng Ren
pengren@upc.edu.cn

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Editorial: Prediction and (back) tracking of marine oil spill drift and diffusion

Peng Ren[1]*, Weimin Huang[2] and Chunbo Luo[3]

[1]College of Oceanography and Space informatics, China University of Petroleum (East China), Qingdao, China, [2]Department of Electrical and Computer Engineering, Memorial University of Newfoundland, St. John's, NL, Canada, [3]Department of Computer Science, University of Exeter, Exeter, United Kingdom

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Editorial on the Research Topic
Prediction and (back)tracking of marine oil spill drift and diffusion

This Research Topic aims to advance the current understanding of marine oil spill monitoring, with a specific focus on prediction and tracking methodologies that account for drift and diffusion dynamics. Five papers have been published, featuring contributions from a wide array of academic and industrial entities spanning 14 organizations, including the Chinese Academy of Sciences, University of Chinese Academy of Sciences, Key Laboratory of Earth Observation (Sanya), China University of Geosciences, Shenzhen University, Università degli Studi di Napoli Parthenope, UiT The Arctic University of Norway, Norwegian Meteorological Institute, King Abdullah University of Science and Technology, Ecole Polytechnique, Democritus University of Thrace, ORION Research, Cyprus University of Technology, and Centro Euro-Mediterraneo sui Cambiamenti Climatici, hailing from eight countries: China, Italy, Norway, Saudi Arabia, France, Greece, Cyprus, and Spain. The papers included in this Research Topic showcase a diverse range of geological backgrounds and demonstrate cutting-edge research in this scientific field.

Within the scope of this Research Topic, significant advancements have been presented by esteemed researchers. Meng et al. introduced a novel approach employing the two-scale boundary perturbation model and an advanced integral equation model, enhanced with the incorporation of the Marangoni and local balance models, to predict sea surface scattering phenomena, both with and without surfactants. de Aguiar et al. proposed the utilization of an ocean ensemble model, B-EPS, for modeling oil slick drift, offering a comparative analysis of its uncertainty against a higher resolution deterministic ocean model, N-HighRes. Hammoud et al. conducted a comprehensive variance-based sensitivity analysis, strategically constraining the set of uncertain parameters, subsequently conducting realistic simulations of oil spills in the Red Sea region over a two-week period post-release. Liu et al. endeavored to enhance the precision of oil spill modeling by developing a support vector regression-based parameterization model for the wind drift factor. This was achieved through the integration of extensive buoy data and ocean hydrodynamic reanalysis, thereby augmenting the model's accuracy. Keramea et al. conducted a meticulous post-operational

analysis, leveraging SAR validation, to scrutinize the outputs of the MEDSLIK and OpenDrift models comprehensively. Importantly, all methodologies proposed were rigorously analyzed in contexts closely aligned with real-world oil spill incidents or simulated scenarios reflective of actual conditions. These scholarly contributions collectively represent invaluable additions to existing literature, offering profound insights and paving the way for further advancements in the field.

While this Research Topic provides a comprehensive overview of current research in marine oil spill monitoring, there remain areas warranting further investigation. Two observations are offered here:

(a) Deep learning methodologies hold promise for predicting and tracking marine oil spill drift and diffusion dynamics. While machine learning techniques have been employed to varying extents in the papers within this Research Topic, the exploration of deep learning approaches for marine oil spill monitoring remains an open challenge. The Topic Editors have been at the forefront of this endeavor, pioneering the development of new generative adversarial networks for oil spill detection (Yu et al., 2018). Moreover, the Topic Editors have advanced the application of generative adversarial networks for refining forecasted wind fields, thereby enhancing the predictive accuracy of numerical models for marine oil spill drifts (Li et al., 2022). These efforts, combined with the contributions of the papers in this Research Topic, constitute a comprehensive literature encompassing both physical science and machine learning aspects of monitoring dynamic marine oil spills.

(b) The research pertaining to marine oil spill backtracking warrants further attention. While marine oil spill drift and diffusion prediction has received considerable attention within this Research Topic, its reverse process, i.e., oil spill backtracking remains a significant practical challenge, necessitating in-depth investigation. The Topic Editors have been among the first to explore marine oil spill backtracking using deep learning methodologies, notably through the development of self-attention temporal convolutional networks for refining wind fields to facilitate accurate and timely oil spill backtracking (Li et al., 2024). The research complements the work on marine oil spill prediction published in this Research Topic and potentially establishes a foundation for deep learning-based approaches to oil spill backtracking.

In summary, this Research Topic has represented a comprehensive synthesis of state-of-the-art research in marine oil spill monitoring. Furthermore, it has delved into comprehensive investigations of various ocean environmental elements, which can extend beyond oil spills to encompass the accurate and timely monitoring of various pollution sources. It thus offers broader potential solutions for effective ocean environmental protection. Rather than a culmination, this Research Topic is viewed as a new starting point for advancing research in the prediction and (back) tracking of marine oil spills and other pollution sources. Anticipated in the future within this field is the integration of deep learning methodologies with ocean environmental knowledge as a predominant theme, offering valuable insights for society.

Author contributions

PR: Conceptualization, Writing – original draft. WH: Conceptualization, Writing – original draft. CL: Conceptualization, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision

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