ChemicalDrift - A new open source ocean pollution model

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Abstract

A novel, open source numerical model, ChemicalDrift, has been designed to simulate the transport and fate of chemicals in the marine environment from coastal waters to the global ocean. ChemicalDrift is implemented as a module within the Lagrangian framework OpenDrift.

In the context of increasing marine resource exploitation and mounting environmental pressures, sustainable management and planning are imperative. Numerical models, especially when integrated with data from monitoring surveys, play a crucial role in assessing the state and trends of chemical pollution.

ChemicalDrift captures the complex interplay of oceanic physical processes and chemical transformations, including advection, diffusion, sedimentation, resuspension, particle adsorption, degradation, and volatilization. These processes are modelled to account for the distinct properties of metals and organic compounds, as well as changes in environmental parameters such as temperature and salinity.

ChemicalDrift has been used to assess the impacts of shipping activities in European seas. The study compared baseline conditions from 2018 with projections for future scenarios in 2050. The modelling results, supported by toxicological studies, highlighted the potential negative impacts of exhaust gas cleaning systems (EGCSs), commonly known as scrubbers. Additionally, copper and zinc from antifouling paints were projected to exceed recommended thresholds, particularly along the southern North Sea coast.

The proposed model is aimed at being a versatile tool for environmental assessment studies. Integrated into the open-source Python package OpenDrift, the model's modular architecture enables distinct physical and chemical sub-processes to be implemented as separate algorithms, facilitating enhancements and the implementation of new features. Future uses may include global studies of shipping-related pollution and high-resolution modelling of sensitive coastal regions affected by multiple sources, such as aquaculture and land-based discharges from water treatment plants, agriculture, industry, and rivers. ChemicalDrift also has the potential to be integrated into more comprehensive tools for spatial planning and the sustainable management of marine resources.