EGU24-12927, updated on 05 May 2024
https://doi.org/10.5194/egusphere-egu24-12927
EGU General Assembly 2024

Surface circulation and marine debris: exploring the impact of northwestern African upwelling on offshore transport

Luuk Rader[1], Borja Aguiar-González[2], Timothy Price[3], Eugenio Fraile-Nuez[4], Daura Vega-Moreno[5], and Francisco Machín[2]

[1]Department of Earth Sciences, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands
[2]Oceanografía Física y Geofisica Aplicada (OFYGA), IU-ECOAQUA, University of Las Palmas de Gran Canaria, Canary Islands 35017, Spain
[3]Department of Physical Geography, Faculty of Geosciences, Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, The Netherlands
[4]Centro Oceanográfico de Canarias, Instituto Español de Oceanografía (IEO), Consejo Superior de Investigaciones Científicas (CSIC), Calle Farola del Mar 22, 38180 Santa Cruz de Tenerife, Spain
[5]Chemistry Department, University of Las Palmas de Gran Canaria, Canary Islands 35017, Spain

Amidst the global challenge of plastic pollution, the marine environment surrounding the Canary Islands is not immune to this pressing issue. Besides, the northwestern African upwelling system is an ideal environment for fisheries, which eventually become potential contributors to marine floating debris. Entanglement in large marine floating debris of fisheries origin represents a prevalent cause of stranding incidents for sea turtles. However, connecting the fisheries activity with the offshore flow of this debris towards the open ocean and the Canary Islands proves challenging due to the high mesoscale variability in the region, which hampers a straightforward visualization of clear patterns of distribution.

This study aims to investigate the offshore transport of marine floating debris originating from the upwelling zone and elucidate the underlying driving mechanisms. Additionally, the study also aims to uncover the upwelling-related origins of marine debris observed in proximity to the Canary Islands.

To analyse the oceanward transport of marine debris, OceanParcels is used, a Lagrangian tool to estimate the trajectories of virtual particles released into the ocean. These particles are released along the African coast, and their trajectories are computed following two different approaches. Firstly, seasonally averaged surface velocities are used to account for the mean seasonal fields leading to the marine debris distribution. Secondly, daily-varying surface velocities are used to simulate real ocean conditions as closely as possible. Jointly, these views provide insights into the key features responsible for transporting particles offshore. Lastly, Stokes drift is incorporated to account for its impact on particle trajectories.

The results using seasonally-averaged surface velocities reveal the formation of offshore-orientated corridors through which particles, representing marine debris, are advected

oceanward. This is confirmed following the daily-varying simulations. These corridors are hypothesized to be formed by the recurrent detachment of the coastal jet stream at certain key locations of the African coastline, then leading the transport of marine debris offshore. Furthermore, virtual particles are observed that are advected offshore via upwelling filaments, i.e. cold-water tongues that extend oceanward from the inner continental shelf. Importantly, Stokes drift appears to counterwork the offshore transport of marine debris likely due to a prevailing strong southward and coastward surface advection. However, it is noted that accounting for the Stokes drift is an ongoing field of research and its effect may be overestimated as currently implemented.

On the one hand, the upwelling zone north of Cape Ghir seems to be responsible for the largest amount of upwelling-related marine debris of a northern origin, reaching the Canary Islands through a northeast-to-southwest orientated corridor. On the other hand, the upwelling zone between Cape Ghir and Cape Bojador appears to be mostly responsible for the marine debris reaching the Canary Islands with a southern origin.