Norwegian Meteorological Institute

Backtracking of marine litter and microplastic from Norwegian OSPAR beaches

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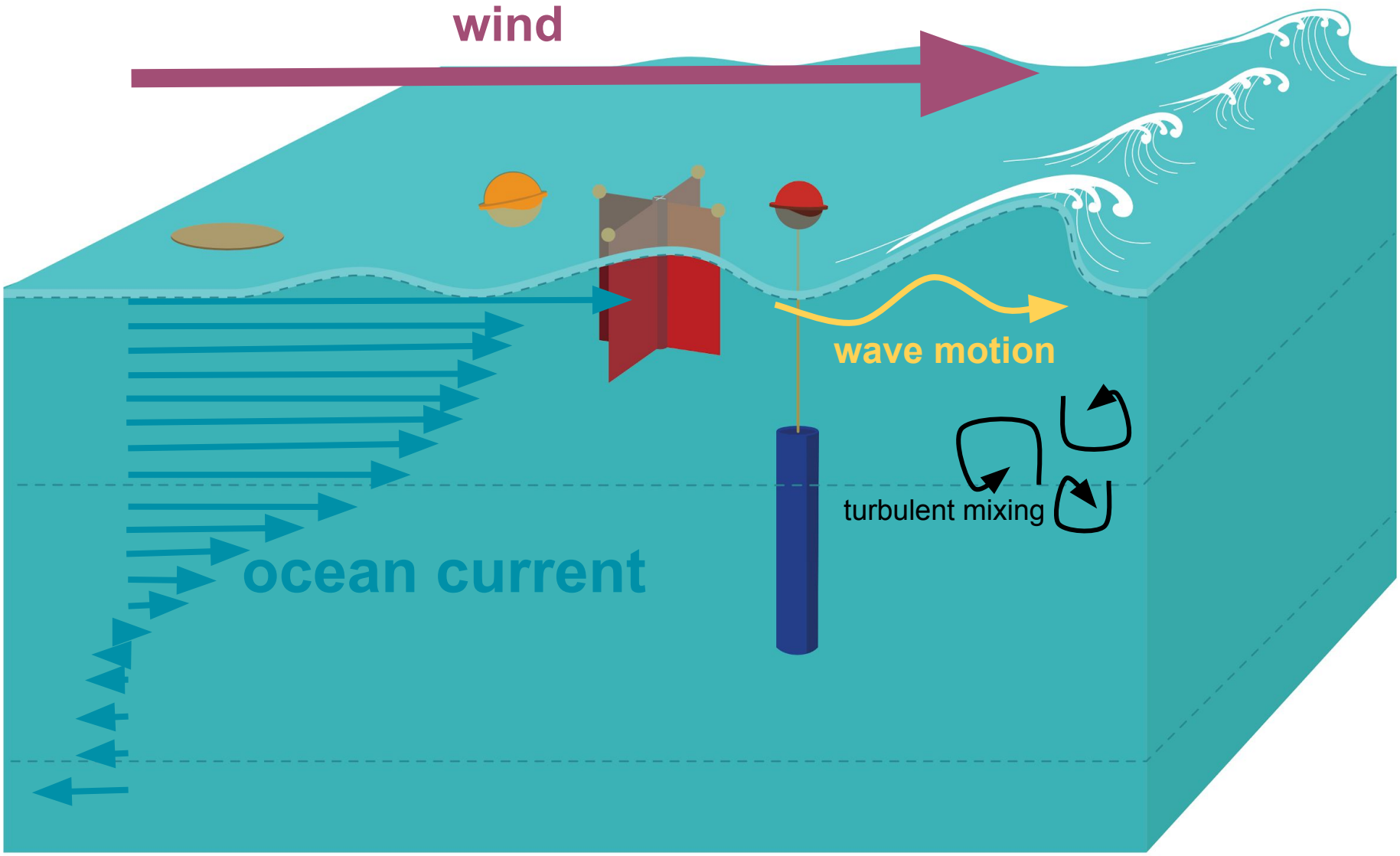
Abstract

Marine litter has been systematically registered at selected beaching sites within a framework of the OSPAR commission. We select a number of sites in the North Sea, Norwegian Sea and the Barents Sea to investigate where marine litter at these site could come from. Using results from hydrodynamic ocean models, wave models and atmospheric forecasts we backtrace litter from the beaching sites to possible origins within a limited time frame at the order of years. While the identified sources are hypothetical at first, we compare the types of registered plastic litter with reasonable sources in the regions identified as possible origins from the model. Thereby we distinguish between fishery related litter, industrial litter and litter from personal consumption, as the composition between these types differ between the OSPAR sites. Our modeling experiments are designed in co-production with stakeholders for planning strategies to address and reduce marine litter.

Forces affecting marine plastic tansport



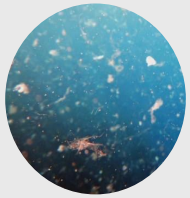
Method

We use a Lagrangian particle tracking model (OpenDrift) to backtrace marine plastic. The environmental forcing is provided from ocean circulation models, atmospheric models and wave models.

marine litter / macroplastic

- floating at the surface
- subject to surface currents, winds, and waves

microplastic



- at surface or submerged
- subject to surface currents, winds, and waves and turbulent vertical mixing

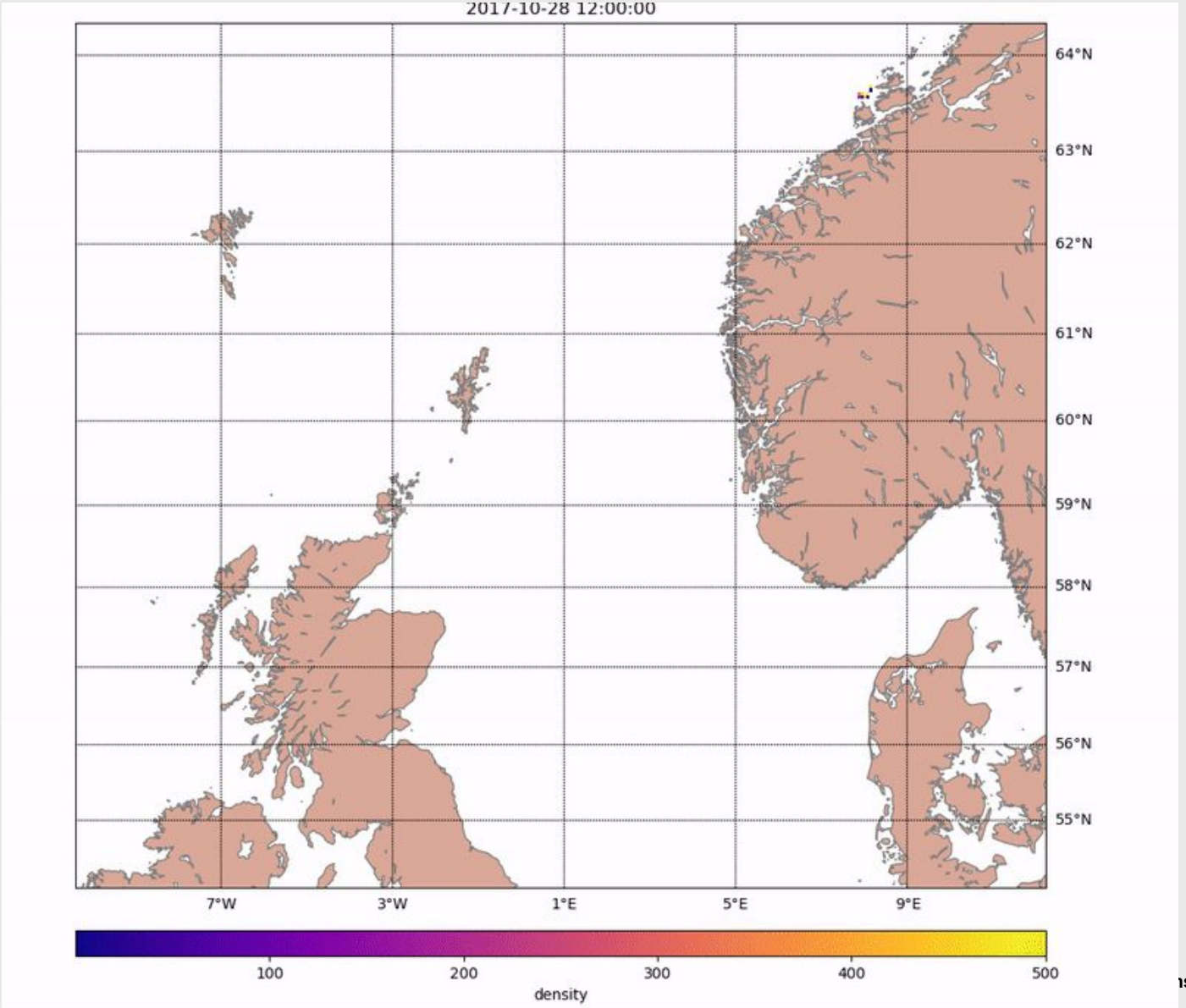
Drift Simulations

Numerical litter and plastic particles are released every 10 days
Release locations: The OSPAR beaches in Norway
Particles are back-tracked for 360 days
Simulations extend over 2 years
Drift is simulated using the python-based
OpenDrift trajectory model (Dagestad et al. 2018)
Vertical mixing sheme based on eddy diffusivities from ocean model (Nordam et al. 2019)

Forcing data (hourly)
Ocean currents: Nordic 4km operational archive
Waves: Mywave WAM 4km (Stokes drift, wave height)
Wind: ECMWF+AROME

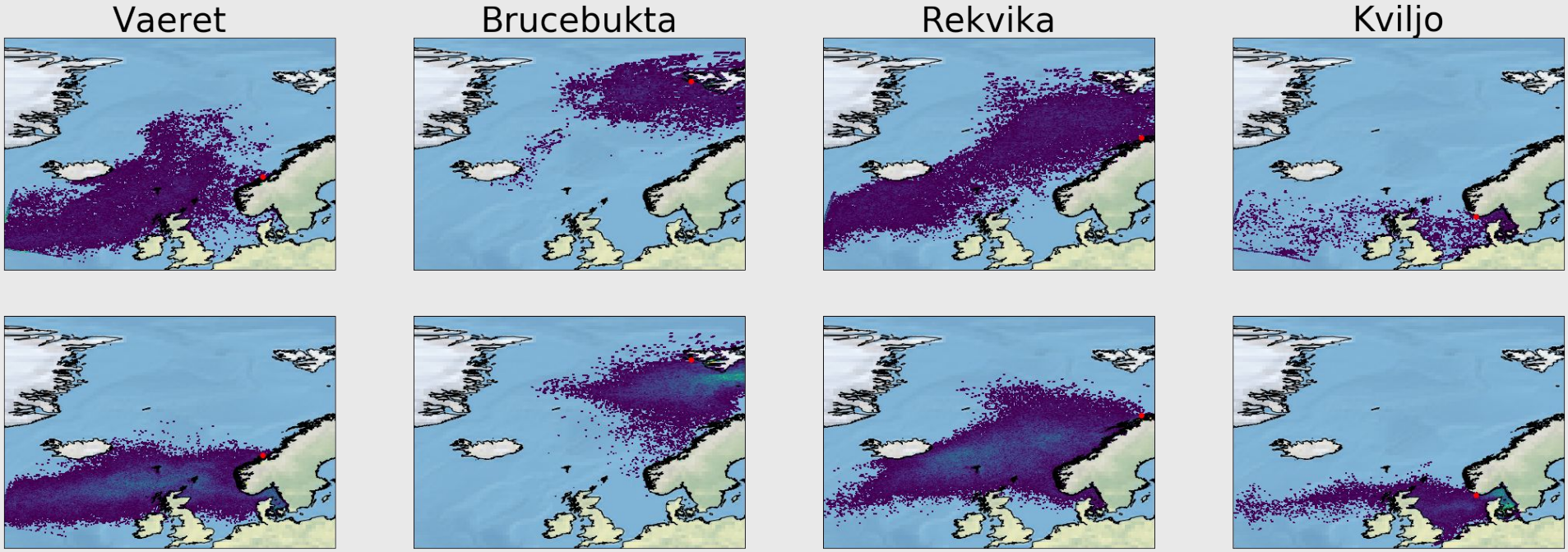
Two types of simulations done
Litter: Larger, floating particles. Always on surface
Microplastic: Smaller particles with buoyancy ranging from 0.001-0.02 m/s. Vertical mixing included. See depth distribution below.

Example: Frøya backwards simulation



Results for 4 OSPAR sites

particles concentrations of backtracing simulation - 360 days before stranding. These results should be understood as likelihood of origin of marine litter found at the selected site.



top row: marine litter / macroplastic
bottom row: microplastic

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Summary and conclusions

We have run backtracking simulations with plastic (both litter and microplastic) from Norwegian OSPAR* beaches. The trajectory model OpenDrift includes forcing from ocean currents, surface wind drag and waves (Stokes drift). Wind drag and Stokes drift is especially important for larger plastic litter. For microplastic, vertical mixing is parameterized using a random walk process, affecting microplastic transport as drift at depth differs from drift near the surface. This alters the potential origin of microplastic and litter pollution significantly.

Difference in origin between microplastic and litter(when considering equal potential sources of plastic). Inclusion of wind, waves, and vertical mixing, in addition to ocean currents, play an important role determining where the plastic pollution on Norwegian beaches come from.

References

Dagestad, K.-F., Röhrs, J., Breivik, Ø., and Ådlandsvik, B.: OpenDrift v1.0: a generic framework for trajectory modelling, Geosci. Model Dev., 11, 1405-1420, 2018.

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Nordam, T., Nepstad, R., Litzler, E. & Röhrs, J. On the use of random walk schemes in oil spill modelling. Marine Pollution Bulletin 146, 631–638 (2019).

Do it yourself? Download the trajectory model here: https://github.com/OpenDrift/opendrift

*OSPAR: Protecting and conserving the North-East Atlantic and its resources. Including monitoring and categorizing types of marine litter.

Read more here:https://www.ospar.org/

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