Project: **1244**

Project title: **APOC - Anthropogenic impacts on particulate organic carbon cycling in the North Sea**

Principal investigator: **Wenyan Zhang**

Report period: **2024-11-01 to 2025-10-31**

The allocated resources have been used successfully to reach the project goals set for the allocation period. We will not use any more CPU node hours until the end of the allocation period. The results (partially achieved during the previous allocation period) were published in two publications (Chen et al., 2025; Tiwari et al., 2025) and one preprint (Porz et al., 2025 [preprint]).

Three model setups were used to meet the project goals for this year:

1. **A coupled hydro-/morphodynamics model (SCHISM-SED) with high resolution in the German Bight.** This setup has been used to investigate the impact of wind farms on sediment and carbon fluxes (Fig. 1).
2. **A coupled hydro-/sediment-dynamics-macrobenthos model (SCHISM-SED-TOCMAIM) for the North Sea**. This model was run for one year and 6 different scenarios each to estimate the impacts of dredging and dumping on carbon fluxes in the North Sea (Fig. 2).
3. **A coupled hydrodynamics-ecosystem model (SCHISM-ECOSMO) for the North Sea.** This model has been run from 1995-2005 with and without the effects of bottom trawling resuspension to gauge the effects of trawling-induced resuspension on air-sea CO2-exchange (Fig. 3).

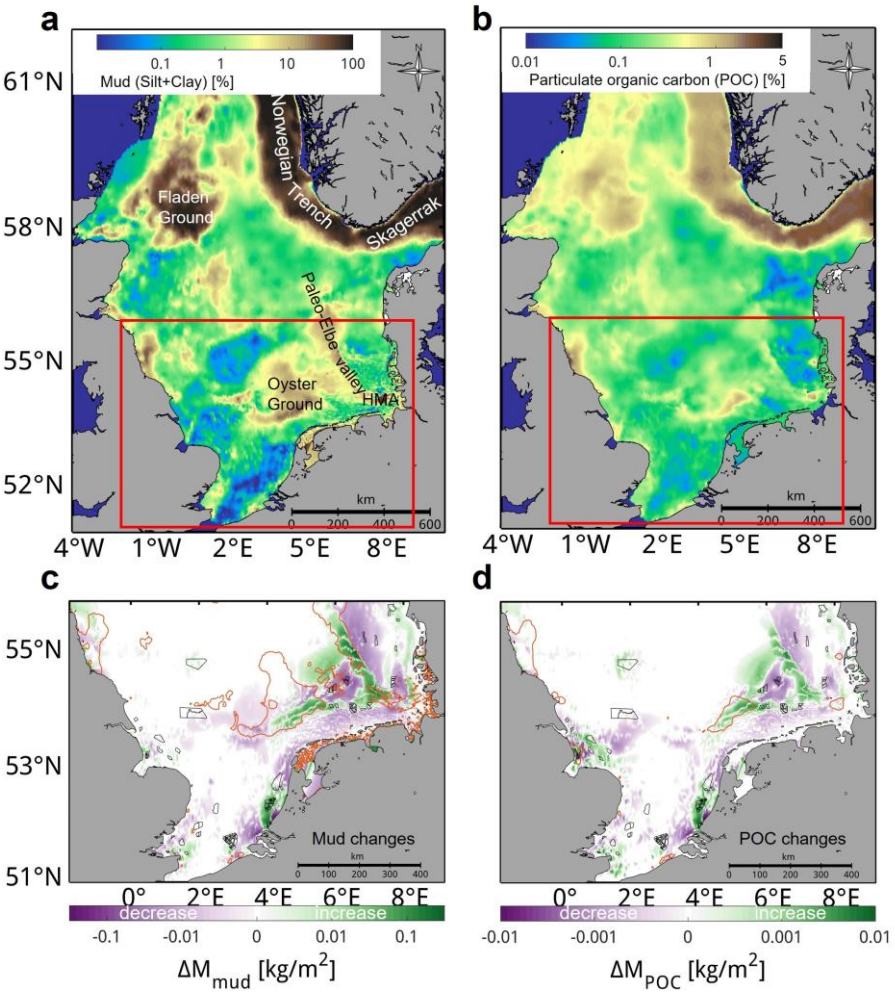


Figure 1. The initial distribution of (a) the mud content (p_{mud}) and (c) the total organic carbon content (p_{POC}) in the North Sea surface sediments and (b) (d) the spatial changes (OWF-REF) of the sediment mass (ΔM_{mud} and ΔM_{POC}) due to offshore wind farm. Positive and negative values in (b) and (d) refer to increase and reduction in mass, respectively. The black polygons in (b)(d) represent the locations of OWFs (OWF: the present-day scenarios with wind speed deficit inside of the OWFs; REF: the reference simulation).

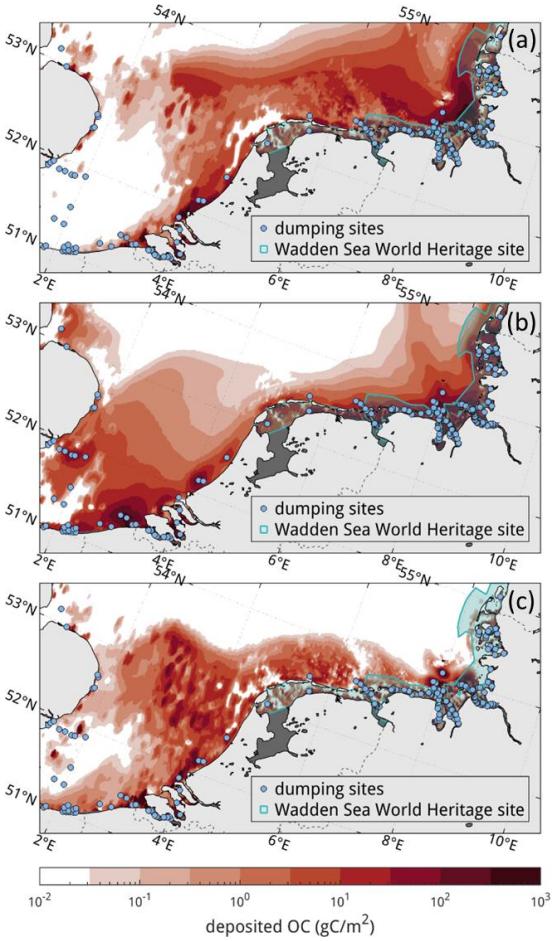
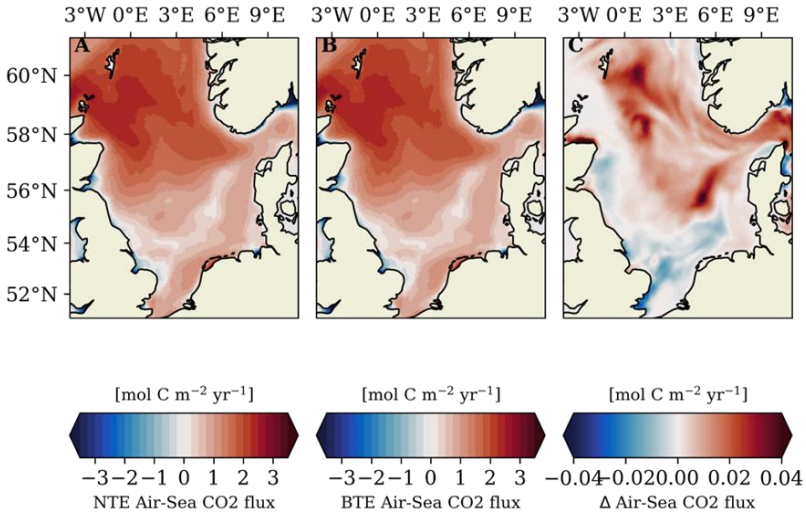


Figure 2. Dumping simulation results. Spatial distribution of dumped sediment organic carbon in the southeastern North Sea area after one year of continuous dumping with particle sinking velocities of (a,b) 0.05 mm/s and (c) 1 mm/s are shown. Dumped material is injected at the sea surface in (a,c) and at the seafloor in (b). Note the logarithmic colour mapping. Dumping locations are marked as blue circles and Wadden Sea World Heritage site in blue shading. Areas in dark grey are not included in the model domain.

Figure 3. Annual mean air-sea CO_2 flux (2000–2005) for (A) the No-Trawling Experiment (NTE) and (B) the Bottom-Trawling experiment (BTE). (C) shows the difference in air-sea CO_2 flux between the two experiments (BTE – NTE). Positive (red) values in panels (A) and and (B) indicate oceanic CO_2 uptake, while negative (blue) values indicate CO2 outgassing to the atmosphere.



References

Chen, J., Zhang, W., Porz, L., Arlinghaus, P., Hanz, U., Holtappels, M., Schrum, C., 2025. Physical Mechanisms of Sediment Trapping and Deposition on Spatially Confined Mud Depocenters in High-Energy Shelf Seas. J. Geophys. Res. Oceans 130, e2025JC022622. https://doi.org/10.1029/2025JC022622.

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Tiwari, P., Porz, L., Daewel, U., Kossack, J., Liu, F., Demir, K.T., Zhang, W., Schrum, C., 2025. Evaluating bottom trawling effects on North Sea productivity. ICES J Mar Sci 82, fsaf149. https://doi.org/10.1093/icesjms/fsaf149.