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The spatial distribution of trace metals in North Sea and Baltic Sea – defining a baseline to study effects of potential ocean alkalinity enhancement activities

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Carbon dioxide removal from the atmosphere is indispensable for limiting global warming to 2°C [1]. The ocean is already the biggest natural CO_2 sink and ocean alkalinity enhancement (OAE) aims at increasing its capacity. OAE can utilize natural materials like olivine, however, this likely raises concentrations of (toxic) trace metals in marine environments. Hence, prior to coastal deployment of additional alkalinity, a solid understanding of the ecosystems and current baselines in terms of trace metal background and alkalinity are required to assess ecological risks and co-benefits. Analysis of trace metal concentrations and patterns allows to monitor their transport and bioavailability, while this data can potentially also be used as a proxy to quantify the effectiveness of CO_2 storage or OAE dispersion.

Baltic and North Sea are potential deployment sites for OAE, but as coastal seas they are already highly anthropogenically impacted. For both seas there is a relative lack of studies conducted during winter time, which is a time of enhanced bentho-pelagic mixing and release of legacy pollution. In addition, they have rarely been studied synoptically, despite the Baltic Sea outflow playing a major role in the biogeochemistry of the North Sea and linking the data is crucial.

In this data-driven approach, we sampled the North Sea, Skagerrak, Kattegat, and the Baltic Sea with focus on deep basins during the winter 2022/23. Filtered (<0.45 µm) seawater samples were subjected to multi-element analysis via ICP-MS/MS, using a sea*FAST*™-SP2 system for the online-elimination of the salt matrix and pre-concentration of 37 analytes. Overall, low limits of detection in the ng/L or sub-ng/L range were yielded.

Multi-element fingerprints pointed to different pollutant sources and transport pathways. For North Sea surface water, concentrations ranged 3.40-36.90 and 180-4620 ng/L for Co and Mn with highest levels in the German Bight, while other elements like Pb appear to have a different source than fluvial.

From this dataset, a baseline of today's trace metals distribution during winter can be derived. It can help attribute future changes via OAE to their source and be used for subsequent *Measurement, Reporting und Verification* (MRV).

[1] IPCC (2022) AR6 WG-III, 84.

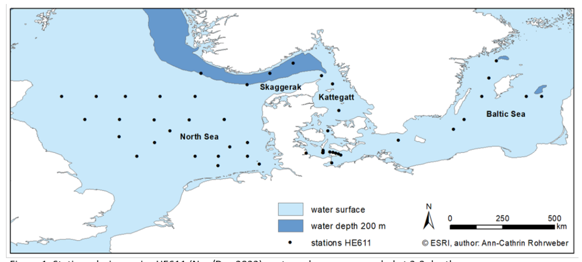

Figure 1: Stations during cruise HE611 (Nov/Dec 2022); water column was sampled at 2-9 depths.