Hypoxia in the Holocene Baltic Sea: comparing modern versus past intervals using sedimentary trace metals

NIELS A.G.M. VAN HELMOND[1], TOM JILBERT[1,2] AND CAROLINE P. SLOMP[1]

[1]Department of Earth Sciences, Utrecht University, The Netherlands; n.vanhelmond@uu.nl & c.p.slomp@uu.nl
[2]Department of Environmental Sciences, University of Helsinki, Finland; tom.jilbert@helsinki.fi

Anthropogenic nutrient inputs have led to a rapid expansion of bottom water hypoxia in the Baltic Sea over the past century. Two earlier intervals of hypoxia, coinciding with the Holocene Thermal Maximum (8-4 ka before present; BP) and the Medieval Climate Anomaly (1.7-0.7 ka BP), have also been identified in sediment records. Recent studies have suggested that modern hypoxia is more widespread than the earlier intervals, although the maximum intensity of hypoxia may have been similar in all three.

Here we reassess the variations in past and present day hypoxia in the Baltic Sea based on trace metal concentrations in sediments from the Farö Deep (F80) and the Northern Gotland Basin (LL19). During hypoxic intervals sediment records are enriched in numerous trace metals, but distinct differences are observed between the profiles for different elements, suggesting multiple modes of trace metal enrichment.

Molybdenum (Mo) enrichments correlate strongly with organic carbon in all intervals, indicative of sulfidic conditions in the bottom waters. However our new data suggest moderate drawdown of the water column MoO_4^{2-} inventory during the modern hypoxic interval, in accordance with more widespread sulfidic bottom water conditions. Elevated concentrations of uranium (U) for the modern interval support this conclusion, and suggest that U may be a more reliable indicator of bottom water hypoxia intensity than Mo. We also discuss the suitability of rhenium (Re) as a hypoxia proxy for the Baltic Sea.

Chalcophile elements show profiles more similar to those of sulfur (S), which are distinct from those of organic carbon and Mo, U and Re. Several chalcophile elements, for example zinc (Zn) and lead (Pb) are also so strongly affected by recent anthropogenic pollution that they cannot be used as a quantitative indicator of the intensity of modern hypoxia. Our data highlight that human activities have led to more widespread and more intense hypoxia in the modern Baltic Sea than at any other time in the Holocene.