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The importance of the ecosystem in marine mercury modelling

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Mercury is a pollutant of global concern due to its ability for long-range atmospheric transport, combined with its capability to be methylated into the neurotoxin methylmercury in the marine environment. The consumption of methylmercury in seafood is the primary hazard of mercury to humans, but most mercury emissions are in the form of atmospheric inorganic mercury. The link between inorganic atmospheric mercury and organic mercury in biota is poorly understood. Here we present our newly developed mercury bioaccumulation model for the North and Baltic Sea based on a fully resolved biogeochemical hydrodynamic model. The modelled bioaccumulation falls well in the range of observations and works by combining a new bioaccumulation model combined with the MERCY Hg speciation model and the ECOSMO ecosystem model. In phytoplankton, bioaccumulated mercury is mostly inorganic. In zooplankton inorganic and organic mercury is roughly equal and it originates in similar amounts from direct uptake from the water column and dietary interactions. In planktivorous fish organic mercury originating from trophic interactions is by far the dominant contaminant, interestingly omnivorous have a higher fraction (~20%) of methylmercury from passive uptake than planktivorous fish, this likely due to the longevity (10~15 years) of these high trophic predatorial fish. Notable interactions between bioaccumulation and Hg speciation in the model are that the cyanobacterial uptake of Hg2+ and MMHg on the shallow sea surface layer decreased mercury release into the atmosphere and lead to a higher buildup of both organic and inorganic mercury throughout the water column, additionally, POC is a major factor transporting Hg to deep anoxic bottom water increasing the amount of methylmercury. Our results indicate that the ecosystem plays an essential role in marine Hg cycling and should not be carelessly ignored in models.