Modeling mercury cycling in the marine environment

Johannes Bieser, Ute Daewel, and Corinna Schrum
Helmholtz Zentrum Geesthacht

Five decades of Hg science have shown the tremendous complexity of the global Hg cycle. Yet, the pathways that lead from anthropogenic Hg emissions to MeHg exposure through seafood are not fully comprehended. Moreover, the observed amount of MeHg in fish exhibits a large temporal and spatial variability that we cannot predict yet. A key issue is that fully speciated Hg measurements in the ocean are difficult to perform and thus we will never be able to achieve a comprehensive spatial and temporal coverage.

Therefore, we need complex modeling tools that allow us to fill the gaps in the observations and to predict future changes in the system under changing external drivers (emissions, climate change, ecosystem changes). Numerical models have a long history in Hg research, but so far have virtually only addressed inorganic Hg cycling in atmosphere and oceans.

Here we present a novel 3d-hydrodynamic mercury modeling framework based on fully coupled compartmental models including atmosphere, ocean, and ecosystem. The generalized high resolution model has been set up for European shelf seas and was used to model the transition zone from estuaries to the open ocean. Based on this model we present our findings on intra- and inter-annual dynamics and variability of mercury speciation and distribution in a coastal ocean. Moreover, we present the first results on the dynamics of mercury bio-accumulation from a fully coupled marine ecosystem model. Most importantly, the model is able to reproduce the large variability in methylmercury accumulation in higher trophic levels.