EGU2020-13103
https://doi.org/10.5194/egusphere-egu2020-13103
EGU General Assembly 2020

Investigation of long-term fate of mercury in the ocean using a new global model

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Numerical modeling is useful for evaluating the international efforts, such as the Minamata Convention on Mercury, that are directed towards the reduction of anthropogenic emissions. We have developed a new global model for mercury, denoted FATE-Hg, which is based on a fully coupled atmosphere-ocean chemical transport model and low and high-order marine ecosystem models. The model considers methylated mercury production in the open ocean seawater, bioconcentration, and food-web biomagnification from particle organic matter to fish. In this study, we performed a long-term simulation over three centuries with changes in anthropogenic emission since the Industrial Revolution, and investigated the long-term evolution of total mercury (THg) in the ocean. The simulated oceanic THg showed a phase lag of 5–10 years from the anthropogenic emission in the surface-intermediate oceans. As of 2010, oceanic THg was 410 Gg, which is 1.6–16.9 times higher than that estimated by the previous model. The estimated overall turnover time of oceanic THg determined by our model was 320 years, which is significantly shorter than those estimated by previous model-based studies. Additionally, we estimated geographic THg sources in the upper ocean. The results showed that North America (NA), Europe (EU), and East Asia are the dominant source regions in most ocean sections in the Northern Hemisphere, though the emissions from NA and EU have fall considerably since the 1970s. This result indicated that a significant amount of mercury that had been emitted from NA and EU in the past persists in present-day seawater.