Mercury in the Labrador Sea during the GEOVIDE-GEOTRACES cruise in spring 2014


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Abstract

The oceanic mercury (Hg) cycle is heavily impacted by human emissions to the atmosphere. The Labrador Sea is one of the main entrances of atmospheric substances into the ocean interior. We report here the first high resolution Hg distribution pattern along a transect from Greenland to Labrador coasts performed after the 2013-14 winter convection. Total Hg concentrations in unfiltered (HgT UNF) samples ranged from 0.25 pM to 0.67 pM L\(^{-1}\) averaging 0.44 ± 0.1 pM L\(^{-1}\) (n = 112). Generally, Hg concentrations increased downward from surface to deep waters, and southward from Greenland to Labrador. Concentrations in filtered samples (HgT\(_{unf}\)) represented from 62 to 92 % of the HgT\(_{UNF}\) and exhibited a similar distribution. The most striking features of HgT\(_{UNF}\) distribution are: (i) the very low concentrations in the Labrador Sea Water formed during the 2013-14 winter convection, and (ii) the high concentrations in the waters of the Labrador Current, which receive waters from the Canadian Archipelago and the Baffin Bay.

Introduction

In the Labrador Sea (LS) intermediate and deep waters are produced during wintertime ocean convection. This convection mixes Arctic outflow and Atlantic waters with underlying layers and produces the Labrador Sea Water (LSW). With Denmark Strait Straits Overflow Water (DSOW) and Iceland-Scotland Overflow Water (ISOW), the LSW supplies the lower limb of the Atlantic Meridional Overturning Circulation, which redistributes heat and substances between polar and equatorial regions in the North Atlantic (e.g. Talley & McCartney, 1982). Deep convection in the LS varies from 200 to 2000 m from one year to the next. Under LSW, cold and fresh West Greenland Current flows northwardly along the Greenland coasts, whereas Labrador Current from North flows southeastwardly along the Labrador shelf (Fig. below). During the formation of LSW, gases and atmospheric deposition are sequestered and incorporated into the deepening water. In the upper part, the newly ventilated LSW (LSW\(_{vent}\)) underlies LSW produced in the previous winters (LSW\(_{prev}\)) (Azetsu-Scott et al., 2003; Yashayaev, 2007). Mercury is transferred to the surface ocean mainly by atmospheric deposition and continental runoff. In sea surface waters, Hg is taken up by biopumping, vertically transferred with settling material and potentially released at depth (e.g., Mason et al., 2012).

Results

The HgT\(_{UNF}\) concentrations ranged from 0.25 to 0.67 pM, averaging 0.44 ± 0.10 pM (n = 112). High HgT\(_{UNF}\) concentrations (> 0.55 pM) were found all along the water column of the Labrador coast, whereas lowest HgT\(_{UNF}\) concentrations (< 0.30 pM) were found in upper waters along the Greenland coast. Within the surface layers (0–350 m), Labrador Current (LC) waters exhibited higher mean HgT\(_{UNF}\) concentration than the Greenland Current (r-test p < 0.01). Our results suggest that LC waters (a mixture of the cyclonic Greenland Current and waters outflowing the Canadian Arctic Archipelago) are characterized by high HgT\(_{UNF}\) concentrations. This hypothesis is supported by the measurements performed in 2005 by Kirk et al. (2008), according to which HgT\(_{UNF}\) concentrations ranged from 0.8 to 1.1 pM L\(^{-1}\) in surface waters of the Hudson Strait and from 0.7 to 1.0 pM L\(^{-1}\) in surface waters of the Northern Baffin Bay reaching the LS through Davis Strait. Hg enrichment, in both filtered and unfiltered samples, is also noticeable below 2000 m along the southward Labrador slope current, originating during the cyclonic recirculation of ISOW (0.59 ± 0.02 pM L\(^{-1}\)) in the Irminger Sea and the LS. This observation can be related to the elevated concentrations of dissolved organic matter and HgT from Arctic rivers entrained during ISOW and DSOW formation (Hermes and Benner, 2006; Fisher et al., 2012).

In the convection zone of the central LS, down to 1400 m, which constitutes the LSW\(_{2013-14}\) (Yashayaev and Loder, 2016), vertical HgT\(_{UNF}\) profiles show low values (0.38 ± 0.05 pM). Below this LSW\(_{2013-14}\) layer, HgT\(_{UNF}\) concentrations increase gradually in the LSW\(_{prev}\), up to 0.50 pM, where ISOW is present.

Biological uptake and regenerative processes appear to control the oceanic Hg distribution in the LS. This nutrient-like behavior is confirmed by the present results (Fig. opposite). The correlation coefficient between HgT\(_{UNF}\) and the AOU, which is a proxy of the organic matter mineralization (mainly the microbial respiration) that the sample has experienced since it was last in equilibrium with the atmosphere, reached highly statistically significant values.

Bibliography