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The distribution and speciation of mercury in the California Current: Implications for mercury transport via fog to land

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Abstract

Unfiltered seawater samples from vertical profiles collected at 60 stations within the California Current during four summer cruises spanning a two-year period from 2014 to 2015, were analyzed for elemental mercury (Hg^0), monomethyl mercury (MMHg), dimethyl mercury (DMHg) and total mercury (THg). Fog water samples, taken at sea and throughout a network of land based stations were also analyzed for MMHg and THg. Vertical profiles indicate that midwater regions around 300 m are associated with concentration maxima in methylated species. Cyclonic mesoscale eddies were shown to be strong sources of the gaseous mercury species to the lower atmosphere and a likely source of these species to fog. Calculated evasive flux of Hg^0 and DMHg were greatest in these regions (34 and 11 pmol m^{-2} d^{-1}, respectively), whereas anticyclonic eddies support little or no sea-air evasion. Incubation experiments showed that DMHg is stable over short time scales at natural seawater pH (7.8 to 8.2) but degrades rapidly to MMHg at low pH. Demethylation of only a small percent of the evading DMHg, on acidic marine aerosols associated with fog condensation nuclei, can account for over 100% of the MMHg observed in fog. The surface microlayer, enriched in MMHg (by 30x), may also contribute to sea-air flux through aerosol production. Neither shelf sediments nor oxygen minimum zones appear to be a major source of methylated mercury in the California Current.

Keywords: Dimethyl Mercury, Monomethyl Mercury, Mesoscale Eddies, Fog, Microlayer, California Current

1. Introduction

A disproportionately large concentration of monomethyl mercury (MMHg) in marine advective fog, relative to corresponding concentrations in rainwater from the same California Coastal region, has recently been reported (Weiss-Penzias et al., 2012, 2016). The factors contributing to this finding, as well as the biotic impacts to adjacent watersheds and trophic interactions, has become the subject of a collaborative