Gaseous Elemental Mercury Measurements at GMD Barrow and the 2015 Arctic GEOTRACES Cruise to the North Pole

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Gaseous elemental mercury (Hg^o) in the near-surface air was monitored at the Global Monitoring Divison (GMD) Barrow Observatory and on the U.S. Coast Guard icebreaker Healy (2015 Arctic GEOTRACES cruise Dutch Harbor – North Pole – Barrow - Dutch Harbor) from August to October 2015. In addition, dissolved Hg^o in the near-surface seawater was continuously monitored on the ship. Atmospheric Hg^o concentrations at Barrow averaged 1.21 ng m^{-3} with a standard deviation of 0.08 ng m^{-3}, while shipboard values were 1.25 and 0.11 ng m^{-3}, respectively. During the 48 hours centered on the ship's closest approach to Barrow (~100 km), the averages were 1.21 (Barrow) and 1.18 (Ship) ng m^{-3}, a mere ~2.5% difference. In comparison, this difference is smaller than the average inter-annual concentration variability at Barrow (1997-2002) and Alert, Nunavut, Canada (A. Steffen, per. comm.). This lack of difference at the two locations indicates that the Barrow Observatory, for this species and time period, was highly representative of the Arctic marine environment. However, 2015 was an anomalous year for Arctic sea ice. February 2015 marked the lowest "maximum" winter ice coverage on record, while ice coverage in September was the 4th lowest on record (National Snow and Ice Data Center).

On the ship the dissolved Hg^o concentrations in the open water were very low suggesting the potential for diffusive Hg^o deposition to the ocean from the atmosphere. The marginal ice zones showed a well-mixed balance of similar Hg^o concentrations between the near surface air and water. However, under contiguous ice during mid-cruise, the results showed that dissolved Hg^o built up such that the concentrations were much higher than found in open water. This difference demonstrated that the contiguous ice was effectively a "lid" that limited gas exchange. Regional comparisons of Hg^o concentrations, to place the measurements near the sea ice into perspective, would not have been possible without the measurements at the Barrow Observatory. The instrument at Barrow was a newer Tekran model 2537x that allowed remote control and data up/down-loading.

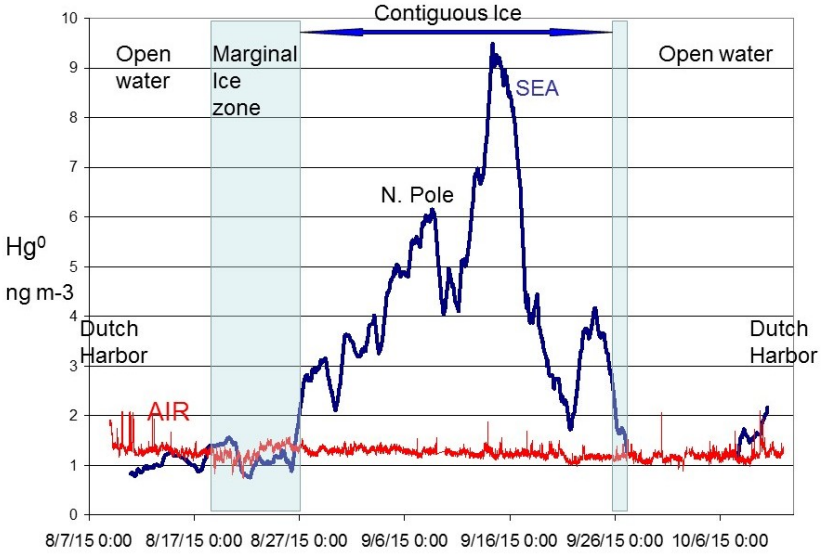

Figure 1. Ship concentrations of Hg^o in the atmosphere and surface water, indicating where the water concentrations are subsaturated or supersaturated. As can be seen, dissolved Hg^o was highest (supersaturated) under the contiguous ice surrounding the north pole.