DK-Proposal 26

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Fate of Mercury in Arctic (FOMA)

Disciplines:
Ecology, toxicology, bioaccumulation

Research:
Mercury (Hg) is a heavy metal, which is typically found at low background concentrations in most natural environments. However, the Sub-Arctic and Arctic are documented to have among the highest environmental exposures to mercury. Concern about Hg in the Arctic environment has increased in light of data suggesting Hg levels have increased over time. Data from Arctic peat cores indicates that the ambient level of present time mercury is three times higher than pre-industrial times while it was 30 times higher in the 1950s than pre-industrial levels.

Organic forms of Hg are well known neurotoxicants that can result in toxicity even at very low exposure concentrations. Global elemental Hg is emitted from natural and industrial sources and may remain in the atmosphere for up to a year, resulting in long-range transport of Hg on global scale. As such, atmospheric transport represents a major pathway of Hg to the Arctic environment. However, effective deposition of elemental mercury requires a chemical (oxidation) change. Recent discoveries show that during Arctic spring the chemical oxidation of elemental mercury is much faster than at lower latitudes, referred to Atmospheric Mercury Depletion Event (AMDE).
This results in a larger proportion of bio-accumulation of mercury and larger effect on higher trophic levels than would be predicted from generalisation of studies at mid latitudes and if only distillation processes are included.
AMDEs are observed only during the Arctic spring, which are followed by a drastic increase in the phytoplankton production due to the increased irradiation.
The deposited mercury is then converted by naturally occurring bacteria in the ice/snow or in the marine environment to either methylmercury compounds or elemental mercury. Finally, phytoplankton and zooplankton are reaching their annual maximum concentration during the AMDEs. The bio-magnification is thus more efficient with the consequence that high levels are found in top predators and humans. The purpose of this proposal is to increase further the knowledge of the processes leading to mercury accumulation in the Arctic environment and high levels of mercury in sea mammals, and finally to determine the effects of those levels. The processes involve transport, transformations and inter-compartment transport: atmospheric transport of mercury, reactions responsible for atmospheric mercury depletion1 episodes, fluxes of mercury to snow and ice, transport of mercury into the marine system, conversion of abiotic mercury into biotic mercury followed by bioaccumulation. Following activities are planned:
1) Atmosphere: Determine the atmospheric processes converting gaseous elemental mercury to reactive gaseous mercury. Moreover the further fate of reactive gaseous mercury will be studied as well. The observed processes will be parameterised into atmospheric long-range transport models.
2) The lower trophic levels: Describe the processes transporting mercury from the snow to the marine environment, from the abiotic to the biotic compartment and in the first steps in the food chain.

3) Higher trophic levels and effects: Determine the mercury budget on the higher trophic levels from field studies and the proposed effects of methyl mercury.