Long range transport of mercury to the Arctic and across Canada

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This study is the most extensive study to date on the transport of mercury to the Arctic. Moreover, it is the first such study to use a fully-coupled, online chemical transport model, Environment Canada's Global/Regional Atmospheric Heavy Metals model (GRAHM), where the meteorology and mercury processes are fully integrated. It is also the only study to date on the transport of mercury across Canada. We estimated source attribution from Asia, North America, Russia and Europe at six arctic verification stations, as well as three subarctic and eight midlatitude Canadian stations.

We have found that Asia, despite having transport efficiencies that were almost always lower than those of North America and often lower than those of Russia, was the dominant source of gaseous atmospheric mercury at all verification stations: it contributed the most mercury (29–37% at all stations, seasons and levels considered), its concentrations frequently explained nearly 100% of the variability in the concentrations produced by the simulation performed with full global emissions, particularly in the absence of local sources, and it generated the most long range transport (LRT) events, causing 43%, 67% and 75% of the events at the arctic, subarctic and midlatitude stations, respectively. For the Arctic, Russian transport efficiencies tended to be the strongest, as expected, while European and Asian efficiencies were lower and higher, respectively, than those found in the literature. This disagreement is likely produced by mercury's long lifetime relative to that of other pollutants. The accepted springtime preference for the trans-Pacific transport of Asian pollution was evident only in the midlatitude group of stations, being masked in the arctic and subarctic groups by the occurrence of atmospheric mercury depletion events. Some neighbouring arctic stations recorded dissimilar numbers of LRT events; despite their proximity, the behaviour of mercury at these stations was governed by different dynamics and transport pathways. The column burden of GEM in the lowest 5 km of the Northern Hemisphere was largest in summer from Asia, North America and Russia, but in winter from Europe. In the vertical, transport of mercury from all source regions occurred principally in the mid-troposphere.

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